

APRIL 1960

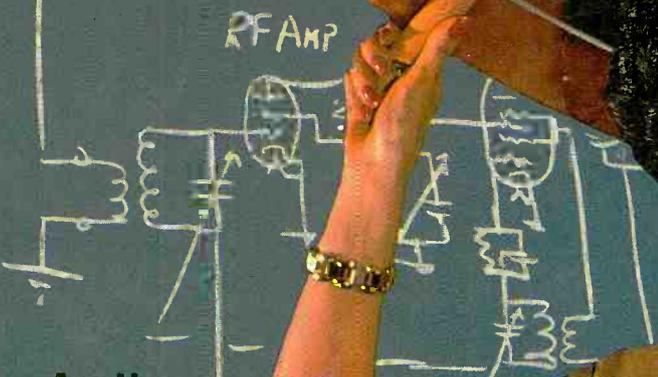
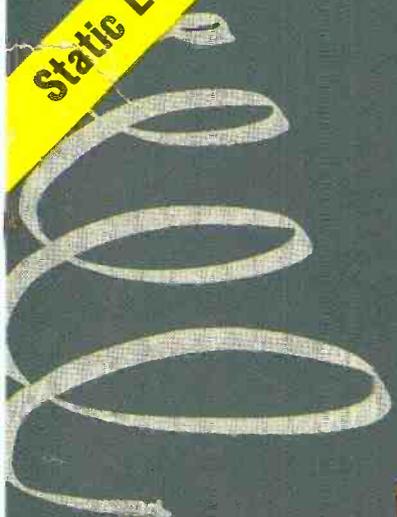
Radio-Electronics

Static Electronic Controls in Industry

HUGO GERNSBACK, Editor

Archimedes' Screw Antenna

See page 49



Using Audio Transformers

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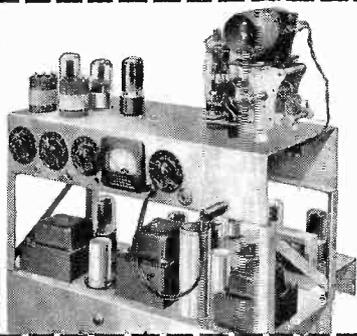
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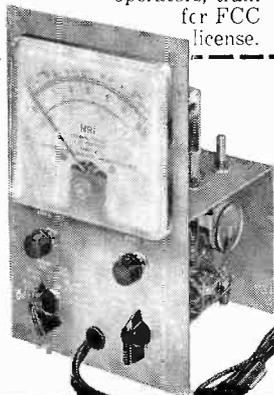
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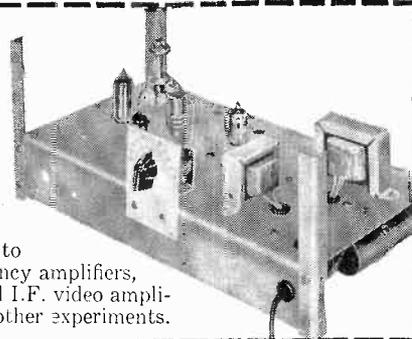


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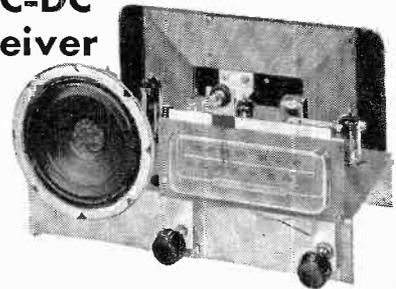
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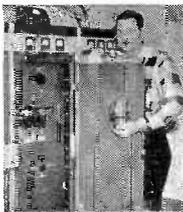
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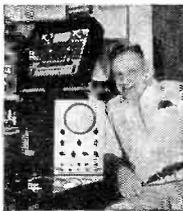
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"I am Chief Engineer of Station KGCU in Mandan, N. D. I also have my own spare time business servicing high frequency two-way communications systems." R. BARNETT, Bismarek, North Dakota.



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"I am doing very well in spare time TV and Radio. Sometimes have three TV jobs waiting and also fix car Radios for garages. I paid for instruments out of earnings." G. F. SEAMAN, New York, N. Y.



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EDITORIAL

- 31 Superception—Hugo Gernsback

ELECTRONICS

- 32 A Challenge to Americans—Rear Adm. John S. Thach, U.S.N.
- 36 Shoot With an All-Transistor Photoflash—Richard W. Alrons
- 33 Magnetometer at Work in Outer Space—Dolan Mansir
- 41 Headlight Tattle Tale—R. E. Young
- 42 New Semiconductor Radiation Detector—Fred Shunaman

RADIO

- 43 Transistor AM-FM Portables Are Here—R. F. Scott
- 45 Luna Part of Signal System
- 46 Paperthin Radio—Mohammed Ulysses Fips
- 48 Inventors of Radio, Thomas A. Edison—Eric Leslie
- 49 Spiral Conical Antenna (Cover Feature)—W. W. MacAlpine

TELEVISION

- 50 Teleducated Technicians—Jim Melton
- 52 Benchwork Can Be Tricky—Robert G. Middleton
- 55 We Troubleshoot the Horizontal Oscillator—R. D. Jacques
- 57 TV Service Clinic—Conducted by Jack Darr
- 60 How to Retouch, Repair, Refinish Cabinets, Part II—Jeff Markell

WHAT'S NEW

- 62 Pictorial Reports of New Developments

INDUSTRIAL ELECTRONICS

- 63 Static Controls in Industry—Tom Jaski
- 71 Preventive Maintenance Keeps Relays Working—H. B. Conant

TEST INSTRUMENTS

- 73 Get Double Value from Your Vtvm—W. S. Guertin, Jr.
- 79 Single-Pulse Generator—J. H. Thomas
- 82 Dry-Cell Tester
- 83 Dynamic Transistor Checker

AUDIO-HIGH FIDELITY

- 87 Design Your Own Preamp, Part IV—Norman H. Crowhurst
- 94 New Speaker Has No Cone
- 98 Bulk Eraser for Tape—Herbert C. McKay
- 100 Using Audio Transformers—Herbert Ravenswood

- | | |
|-------------------------|----------------------------------|
| 129 Business and People | 113 New Tubes and Semiconductors |
| 22 Correspondence | 6 News Briefs |
| 134 New Books | 127 Noteworthy Circuits |
| 132 New Literature | 124 Technicians' News |
| 110 New Patents | 116 Technotes |
| 119 New Products | 107 Try This One |
| | 128 50 Years Ago |

ON THE COVER

(story on page 49)
 What looks like the work of Alice in Wonderland's mad haberdasher is really a modified helical antenna, designed at ITT Laboratories, Nutley, N. J., and modeled as an example of what the smart Martian might be wearing. It was adapted for use in a classified radio communication program underway at the research center. The comely young lady is Marie Grey, draftsman at the Laboratories.
 Color original courtesy ITT Laboratories

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News Briefs

Medical FM Net

Radio Corp. of America has applied to the FCC for FM frequency assignments for a medical network. Two types of programs have been planned. One will be heard in the doctor's outer office and will consist solely of background music. The second program will be heard only in the inner office and will have 36 minutes a day of medical news and about 10 minutes of advertising. The program, it was said, will give physicians easier access to medical news and information.

New Prefixes

The National Bureau of Standards and the International Committee on Weights and Measures have adopted four new prefixes. These prefixes, in common use in Europe, are: *tera*, meaning trillion; *giga*, meaning billion; *nano*, billionth, and *pico*, trillionth. Sample uses of the prefixes are: 1 terawatt or 1,000,000,000,000 watts; 5 gigavolts or 5,000,000,000; 3 nanoamperes or .000,000,003 ampere; 7 picofarads or 7 micro-microfarads or .000,000,000,007 farads. These prefixes now become part of the list of prefixes in more common use which include micro, mega, kilo and milli.

Cleveland Ham Wins Edison Award

Walter Ermer, Sr., has been awarded the eighth annual Edison Radio Amateur Award for public service. General Electric Co., who sponsors the award, selected Ermer, W8AEU, as the ham with the most outstanding public service record for last year. He organized and directed a 300-man voluntary emer-

gency radio communications corps which served his home city, Cleveland, Ohio, on 23 occasions last year—including flood and storm alerts and searches for lost children. He will receive a trophy and \$500. The photograph shows Ermer and Police Lieut. Michael Roth, K8KNJ.

Long Telephone Cable

A new pair of telephone cables now connects West Palm Beach, Fla., and San Juan, Puerto Rico. The system, 1,250 land miles long, was built by American Telephone & Telegraph Corp. and Radio Corp. of Puerto Rico, a subsidiary of International Telephone & Telegraph Corp. (ITT). The system has 59 amplifiers. Each amplifier contains 3 tubes and 60 other components. The units, spaced about 44 miles apart, amplify voice currents about 1,000,000 times. About 1,500 volts are required at each end to operate the system. The cables can carry 48 two-way phone calls at one time.

New products for portable TV?

Two components, which rumor says are soon to appear, may make portable TV better and should revolutionize the picture-tube and battery business.

The first is a picture tube with a solid-state emitter. The cathode and heater of standard types are eliminated, and a little block of a semiconductor material fills the gap. When 25 ma at 6.3 volts is fed through it, enough electrons are supplied to put a picture on the screen. High voltage for the 8-inch version runs 7,000 volts. The peak-to-peak video driving signal is 20 volts. A 118° deflection angle makes for a very short tube indeed. G-E

and Sonotone are said to be dicker-ing for this Japanese-built prize.

Another item portable TV manufacturers want is a battery being developed by a leader in this field. The silver-mercury cell, said to be in late stages of production and expected on the market in about 6 months, combines the best features of mercury and nickel-cadmium types. It has the capacity of a mercury cell and the rechargeability of nickel-cadmium.

A simple comparison shows its ability. A rechargeable nickel-cadmium battery rated at 1,000 ma hours is the same size as a mercury battery that has a 2,400-ma-hour rating. The same size in a silver-mercury battery is rated at 2,000 ma hours and can be recharged as often as a nickel-cadmium cell. In Philco's portable TV (they are a prime bidder for the new battery), it would last twice as long as the one now used—8 hours without recharging instead of the present 4-hour limit.

Stereo Committee Out

The FCC rejected a request by the National Stereophonic Radio Committee to sponsor its reorganization. The Committee, set up by the electronics industry to test and evaluate stereo radio systems, has been forced to disband.

South Africa Wants TV

The TV Society of South Africa has been formed to fight the Government's anti-TV policy. The Government feels that TV would be detrimental to children and "the less developed races." The society intends to get one-half million signatures on a petition for TV and submit it to the government. The *London Observer* reports that "tests have been made by the South African Broadcasting Corp. that would enable TV to be speedily introduced if the (South African) Cabinet were to sanction it."

Radio-Wave Duct

Experiments on a frequency of 220 mc confirmed the existence of a radio-wave duct between the West African coast and Brazil. From ground level to 5,000 feet, the air temperature gradually drops. At about 5,000 feet there is a sharp rise in temperature. About 500 feet above this level, the temperature drops sharply again. This creates two re-



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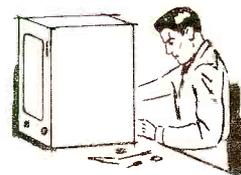
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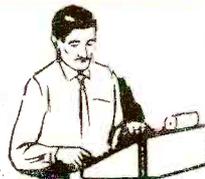
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Adjusting PA System



Computer Fingers



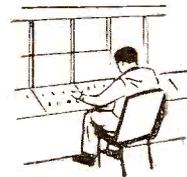
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You'll get answers to these and many other important questions. Ten big illustrations help give real depth to your understanding of AC amplifier applications. Like every other issue in Tung-Sol's exciting, much-talked-about series, this latest is expressly geared to the serviceman or the technically minded person planning a servicing career in the rapidly growing industrial electronics field. You'll be glad to add this issue to your permanent library of Tung-Sol Tips. It's crammed full of information that's aimed to help you in your job. Write today for your copy.

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To get a full understanding of the material in this issue, you should have some awareness of the operation of ac amplifiers, thyratrons or photoelectric tubes, for example. These were all the subjects of careful analysis in preceding issues of Tips. And they'll also serve as the springboard for discussions in issues of Tips that'll be coming up very soon. You can still get copies of these back issues. But supply is limited. So get your request in now. Back issues available: (1) Semiconductor Rectifiers; (2) Gas-filled Rectifiers; (3) Theory of Thyatron Operation; (4) Practical Applications of Thyratrons; (5) Photoelectric Theory and Operations; (6) AC Amplifiers. Specify which you would need to complete your Tung-Sol Tips library.

 **TUNG-SOL**[®]

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NEWS BRIEFS (Continued)

flecting surfaces for radio transmission. This duct carried a 100-watt signal from a Navy airplane over Brazil to another plane 1,430 miles away. It is believed that there might be three other ducts, one each in the North Atlantic, North Pacific and South Pacific areas.

TV Production Up

Manufacturers produced 6,349,380 TV sets in 1959 as compared with 5,748,676 sets in 1958, according to figures released by the Electronics Industries Association. Also up were radio production and TV sales. There were 15,622,357 radios produced in 1959, as against 11,817,243 in 1958. Stereo phonographs outsold monaural phonographs; stereo, 2,744,720; monaural, 1,653,137.

Channel Allocation

The FCC is considering five plans for TV channel allocation, according to a statement by Commission Chairman John C. Doerfer, before The Senate Interstate Commerce Committee. They are: a 50-channel vhf system keeping the present 12 vhf channels; a continuous 50-channel vhf system keeping channels 7 through 13 and removing channels 2 through 6 from use; a continuous 25-channel vhf system keeping channels 7 through 13; a 70-channel all-uhf system; the present 82-channel vhf-uhf system. The commission has presented Congress with the draft of a bill that will enable it to set minimum standards for TV set reception. They claim the bill is important to the success of any plan they adopt for channel allocation.

Police-Car Bugs

Some New York City police cars have "bugs" in them. The "bugs" are small tape recorders that go on when the car's transmitter is turned on. The department is using them in an attempt to find out which of the patrolmen in the cars sing or yodel or use improper language on the air.

Japanese Make Transistor TV

Transistor TV set from Japan may provide competition for Philco, Emerson and others with an 8-inch screen. Weighing 23 pounds, and 6¼ x 8 x 8¾ inches overall it operates from a 12-volt rechargeable battery or house ac power supply. Price has been tentatively set at near \$200, but is expected by the producers, Sony Corp., to drop at least 10% after about a year. It has 23 transistors, 14 diodes and a whip type antenna.

Rapid Air Photos

CBS Laboratories have announced the development of a system that can take an aerial photo and relay it to a ground station in about 2 seconds. The system, called Photo-scan, produces a picture made up of

It is an axiom in high fidelity that no single speaker is capable of ideally reproducing the entire musical range of a symphony orchestra. At least two speakers, each specifically designed to reproduce a part of the sound spectrum, are needed to do a really adequate job.

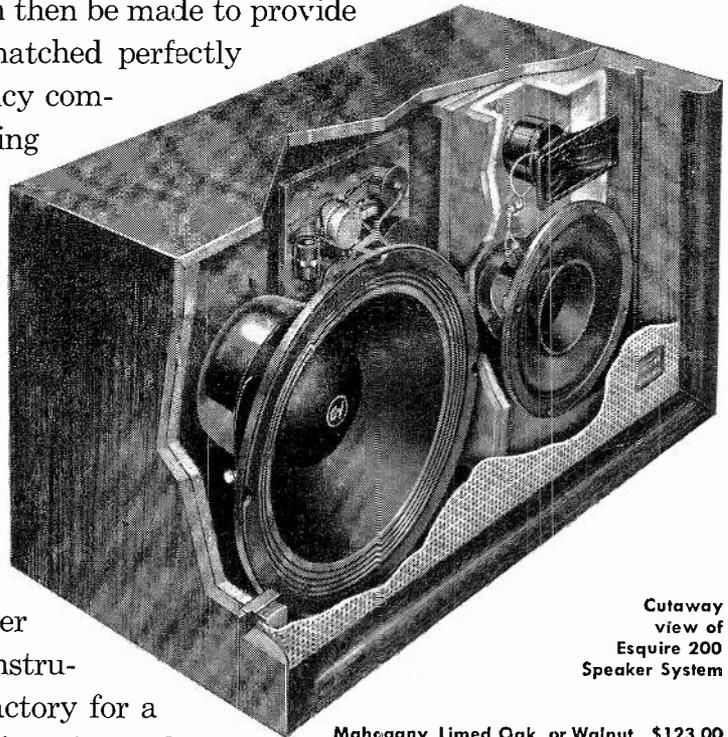
ELECTRO-VOICE ULTRA-COMPACT SYSTEMS OFFER MORE THAN JUST BASS RESPONSE

Ultra-compact systems are no exception to this rule. This is why two year's research went into the development of Electro-Voice's new ultra-compact line. In its tradition of providing the finest, Electro-Voice would not introduce a system in which only the bass speaker and enclosure had been engineered to the special requirements of the compact system. Each component within that enclosure had to be designed to make certain it was a perfect match to the other elements in the system. Laboratory measurements and exhaustive listening tests had to be coordinated and differences resolved. The result of these efforts can now be heard from the new Leyton, Esquire 200, Regal 300, or Royal 400. These speaker systems produce bass of astounding definition and solidity, clear undistorted treble, and remarkable brilliance in their upper ranges.

One of the key factors in producing this purity of sound was the judicious choice of crossover points, restricting each of the specially designed speakers to cover only the range over which its performance is most perfect. In all models, for example, the crossover from woofer to mid-range occurs at 200 cycles per second. With this degree of specialization, all forms of distortion are held to the lowest levels possible. Operating below 200 cycles, the bass speaker is not required to reproduce any of the mid-range spectrum and can act as a true piston.

The specially designed mid-range speaker can then be made to provide exceptionally flat response, with its level matched perfectly to that of the woofer. The very-high-frequency compression driver faces only the necessity of adding "sparkle", and dispersing high-frequency sound throughout the room. The result is a clarity and definition of sound that can best be described as transparent — enabling you to feel the deepest bass, marvel at the effortless clarity in the mid-range, and delight in the brilliant definition of the upper harmonics.

Whether you intend to purchase a new high-fidelity speaker system now or later, we urge you to visit your Electro-Voice dealer for a demonstration of these remarkable instruments. You may also write directly to the factory for a complete description of these new units. Ask for High-Fidelity Catalog No. 137.



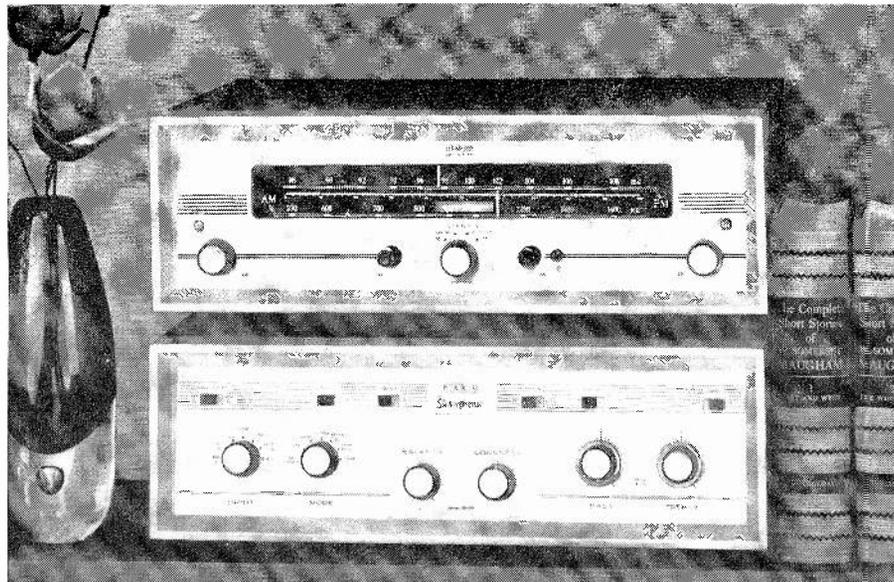
Cutaway
view of
Esquire 200
Speaker System

Mahogany, Lined Oak, or Walnut...\$123.00
Unfinished Birch.....\$111.00

CONSUMER PRODUCTS DIVISION

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2 Great New Stereo Kits

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A true 40-watt Stereo Preamp-Amplifier—so flexible it's the last amplifier you'll ever have to buy... and a super-sensitive AM/FM Stereo Tuner... both masterpieces of design, performance and appearance... both available in kit form (with simplified giant-size wiring diagrams and easy-to-follow step-by-step assembly instructions)... or factory-wired... and both crafted by PACO, the Kit Division of **PRECISION** Apparatus Co., Inc., world-famous manufacturers of electronic test equipment for over a quarter of a century.

THE SA-40 STEREO PREAMP-AMPLIFIER

STEADY-STATE POWER OUTPUT — 20 watts per channel (40 watts total)
MUSIC WAVEFORM POWER OUTPUT — 25 watts per channel (50 watts total)
PEAK POWER OUTPUT — 40 watts per channel (80 watts total)
RESPONSE — 30 cps to 90 Kc, ± 1.0 db
HARMONIC DISTORTION — less than 0.5% at 20 watts per channel output
14 PANEL CONTROLS — including dual bass and treble controls and switches for additional speakers
14 INPUTS — incl. 3 dual high level & 4 dual low level
OUTPUTS — incl. dual tape and separate preamp output
HUM AND NOISE LEVEL — 80 db below rated output (high level input)
SPEAKER CONNECTIONS — (Dual) 4, 8, 16 and 32 ohms
DAMPING FACTOR — 22
RUMBLE FILTER — 6 db per octave below 50 cps
GOLD AND SATIN HOODED CASE — with panel illumination and satin gold panel

MODEL SA-40—Kit, complete with case... \$79⁹⁵
 Net Price:
MODEL SA-40W—Factory wired, complete with case.
 Net Price: \$129.95

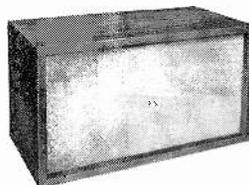
THE ST-45 AM/FM STEREO TUNER

FM:
SENSITIVITY — 2 microvolts for 30 db quieting
HARMONIC DISTORTION — less than 1%
DUAL LIMITERS, FOSTER-SEELEY DISCRIMINATOR
SEPARATE PILOT-INDICATED AFC — (push-button)
AM:
TUNED RF STAGE — low-distortion diode detector
10 Kc WHISTLE FILTER
ROTATABLY BUILT-IN FERRITE ANTENNA

GENERAL:
PROVISION FOR AM-FM SIMULCAST STEREO — or separate AM and FM Broadcast reception
INDEPENDENT AM AND FM TUNERS
CATHODE FOLLOWER OUTPUTS — on both AM and FM
EM-84 TUNING INDICATOR — for both AM and FM
PROVISION FOR MULTIPLEX ADAPTER

AVAILABLE 3 WAYS

MODEL ST-45—Kit, with factory-prealigned transformers, complete with case... Net Price: \$84⁹⁵
MODEL ST-45PA—Semi-Kit, with both FM and AM tuner sections factory-wired and completely pre-aligned and calibrated for hairline sensitivity, complete with case. Net Price: \$99.95
MODEL ST-45W—Factory-wired, aligned, calibrated and assembled, complete with case... Net Price: \$134.95



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PACO

COUNTERPART SPEAKER SYSTEM

A compact, wide-range, 2-way speaker system having unusually smooth response... with cross-over network and acoustic balance control... in semi-kit form... at a surprisingly moderate price. Assembles in less than 1 hour... complements any high fidelity system.

MODEL L2-U, Kit, unfinished
MODEL L2-F, Kit, walnut finish



Available at leading electronic parts distributors and wherever good sound is sold

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 Kit Division of **PRECISION** Apparatus Company, Inc.

about 120,000,000 elements as compared with the 250,000 elements of a TV picture. A camera takes a picture, the film is automatically and rapidly developed, and then moves before a special tube. This Line Scan Tube shines a small spot of light on the photo. A photomultiplier tube behind the film converts the varying amounts of light that pass through the film into a varying electrical current. This current modulates a radio signal to the ground station.

Calendar of Events

Nuclear Congress, April 3-8, New York Coliseum, New York, N. Y.

Spring Technical Conference on Electronic Data Processing, Apr. 12-13, Hotel Alms, Cincinnati, Ohio.

Conference on Automatic Techniques, April 18-19, Sheraton Cleveland Hotel, Cleveland, Ohio.

Symposium on Active Networks and Feedback Systems, April 19-21, Auditorium of Engineering Societies Bldg., New York, N. Y.

Southwest IRE Regional Conference and Electronics Show, April 20-22, Shamrock-Hilton Hotel, Houston, Tex.
PACE Annual Meeting, April 29-May 1, Nevele Hotel & Country Club, Ellenville, N. Y.

Semiannual Convention of Society of Motion Picture and TV Engineers, May 1-7, Ambassador Hotel, Los Angeles, Calif.

National Aeronautical Electronics Conference, May 2-4, Biltmore & Miami Hotels, Dayton, Ohio.

URSI-IRE Spring Meeting, May 2-5, Sheraton Hotel, Washington, D. C.

Western Joint Computer Conference, May 3-5, Jack Tar Hotel, San Francisco, Calif.

National Symposium on Microwave Theory and Techniques, May 9-11, Hotel Del Coronado, San Diego, Calif.

Electronic Components Symposium, May 10-12, Hotel Washington, Washington, D. C.

Electronic Parts Distributors Show, May 16-18, Conrad Hilton Hotel, Chicago, Ill. Closed show for manufacturers, representatives, distributors. RADIO-ELECTRONICS and GERNSBACK LIBRARY will exhibit in Room 504 and Booth 588.

EIA Annual Convention, May 18-20, Pick Congress Hotel, Chicago, Ill.

IRE Regional Technical Conference & Trade Show, May 23-25, Olympic Hotel, Seattle, Washington.

Armed Forces Communications & Electronics Association Convention, May 25-27, Sheraton Park Hotel, Washington, D. C.

Details on all events supplied by sponsoring organizations.

No Station Changes

There were no changes of any kind in the TV station picture since our March report. This is the second such lull since RADIO-ELECTRONICS started recording the activity. Both occurred, incidentally, this winter.

Signal Reflected from Sun

Solar contact has been made by the Radioscience Laboratory of Stanford University. The 40,000-watt transmitter used by the group of experimenters was turned on and

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The Master Course in Electronics will provide you with the mental tools of the electronics technician and prepare you for a First Class FCC License (Commercial) with a radar endorsement. When you successfully complete the Master Course, if you fail to pass the FCC examination, you will receive a full refund of all tuition payments.

“License and Good Job . . . Thanks”

“After finishing your Master Course, I passed the FCC exam for the 1st class license. I had my ticket for only one week and I got a job at WOC-TV, AM-FM. Incidentally, WOC is the oldest radio station west of the Mississippi. I sincerely feel that if it weren't for taking your Master Course, I would not have received my 1st class ticket. So I want to take this occasion to again thank you for such a fine preparation for electronics work.”

FRANCIS J. McMANUS
Davenport, Iowa

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ELECTRONICS TECHNICIANS:

RCA has positions for technicians, field engineers & instructor technicians to install, maintain, and teach military radar, communications, and fire control equipment. Company benefits.

RADIO OPERATORS & TECHNICIANS

American Airlines — Chicago, Detroit, St. Louis, Cincinnati and Cleveland — has openings for radio operators and radio mechanics. Operators must have a 2nd class FCC license and ability to type 40 wpm. Many company benefits.

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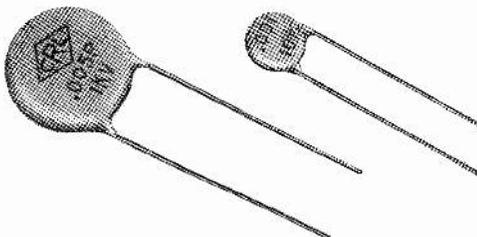
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Check Centralab for everything in Ceramic Capacitors



CENTRALAB, the pioneer in ceramic capacitors, gives you the finest product and the widest choice. Look over this partial list and see for yourself the wide range of CENTRALAB ceramic capacitors for industrial and radio-tv servicing. Check CENTRALAB, the world's largest manufacturer of ceramic capacitors—available through your electronic parts distributor.



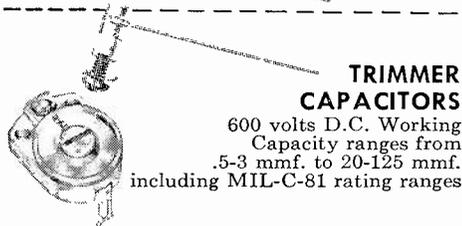
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500 volts and 1000 volts D.C. Working
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3000-6000 volts D.C. Working
4.7 mmf. through .005 mfd.

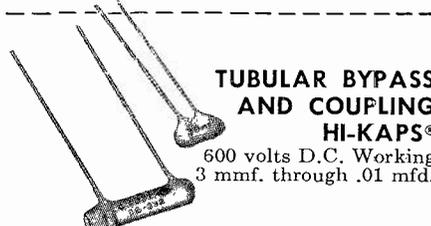
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1600 volts D.C. Working
.003 mfd. through .015 mfd.



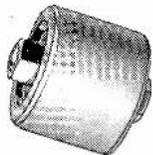
TRIMMER CAPACITORS

600 volts D.C. Working
Capacity ranges from
.5-3 mmf. to 20-125 mmf.
including MIL-C-81 rating ranges



TUBULAR BYPASS AND COUPLING HI-KAPS®

600 volts D.C. Working
3 mmf. through .01 mfd.

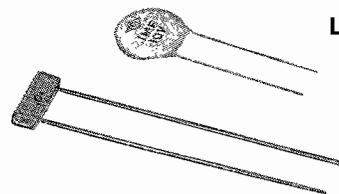


HIGH VOLTAGE-TRANSMITTING CAPACITORS
5 KV and 7.5 KV.
25 mmf. to 1000 mmf.



FEED-THRU CAPACITORS

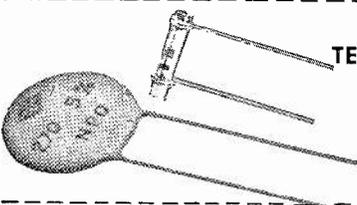
500 volts D.C. Working
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LOW VOLTAGE TRANSISTOR ULTRA-KAPS*

3 volts D.C. Working .1 mfd. —.2.2 mfd.	30 volts D.C. Working .02 mfd. —.1 mfd.
10 volts D.C. Working .05 mfd. —.47 mfd.	75 volts D.C. Working .05 mfd. —.1 mfd.
150 volts D.C. Working 100 mmf. —.02 mfd.	

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TEMPERATURE COMPENSATING CAPACITORS

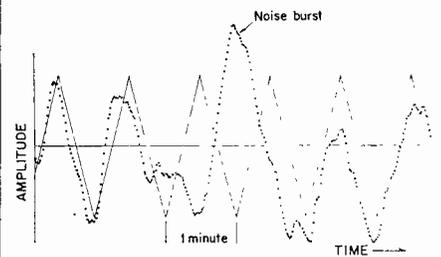
Disc and Tubular
NPO, N750, N330, N1500
various ranges from .5 mmf. to 750 mmf.



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NEWS BRIEFS (Continued)



off in 30-second pulses for 15 minutes, then kept silent while waiting for the echo, due to arrive in 17 minutes from the time the first pulse was sent. The frequency used, 25.6 mc, was chosen to minimize absorption by the sun's corona.

The contacts were recorded on tape at daybreak on the mornings of April 7, 10 and 12, 1959. Months were required to separate the echoes from solar background noise, which was 50,000 times stronger.

The graph shows the solar echo by dotted line, the way the perfect echo should look by the solid line.

Ultra-Fast Computers

Dr. Peter J. Isaacs of Sperry Gyroscope Co. at the Long Island, (N. Y.) Electronic Manufacturers Council predicted that computers will be built that can handle 10,000,000 calculations a second as compared with today's 250,000 rate. He also said that if these high-speed units were put to work on weather prediction problems, computer forecasts would be available before the expected weather instead of after it.

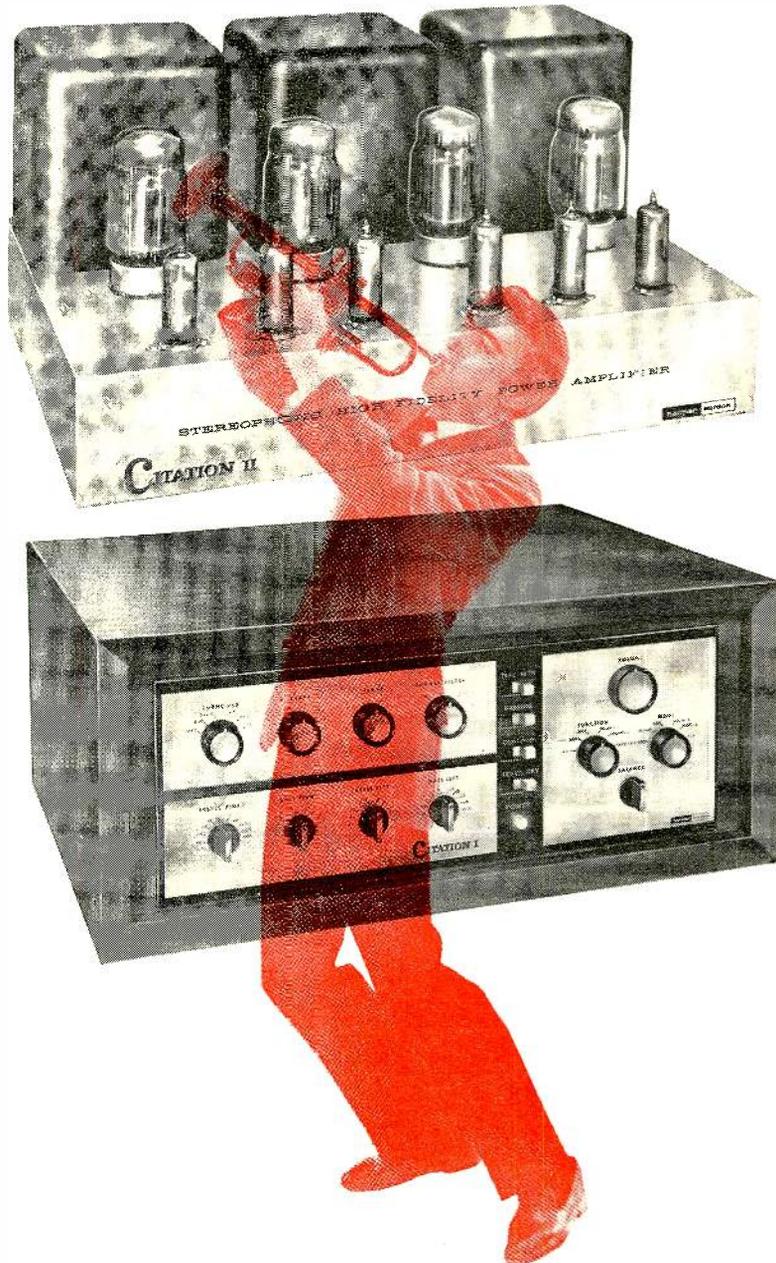
High-Frequency Diodes

General Electric Co. has announced that its research scientists have made tunnel diodes work at frequencies above 4,000 megacycles. The diodes are made of gallium arsenide instead of silicon or germanium. Tunnel diodes, the newest solid-state device in the transistor family, have already been put on the market to original equipment manufacturers, and G-E has announced an 83% price reduction, dropping the cost to manufacturers to between \$10 and \$15 a diode.

Sunspot Peak Definitely Past

The sunspot maximum period, which stretched out long after its theoretical peak early in 1958, showed a clear decline in the last 3 months of 1959, sunspot activity in December being lower than at any time since early 1956. Activity remained high so long after the expected peak that for many months observers believed that the peak might be still to come. Looking back over the period since March, 1958, however, a decline can be seen. The decline was so slow that the average sunspot number for 1959 is above

(Continued on page 18)



“When we heard the Citations our immediate reaction was that one listened through the amplifier system clear back to the original performance, and that the finer nuances of tone shading stood out clearly and distinctly for the first time.”

C. G. McProud, Editor, AUDIO Magazine

We know you will be interested in these additional comments from Mr. McProud's report:

Performance: “The quality of reproduction reminds us of the solidity of Western Electric theatre amplifiers of some years ago . . . The bass is clean and firm and for the first time we noted that the low-frequency end appeared to be present even at low volumes without the need for the usual bass boost.”

Specifications: “Our own measurements gave IM figures of 0.35 per cent at 60 watts; .08 per cent at 20 watts, and less than .05% (which is essentially unmeasurable) from 10 watts down.”

Construction: “It is obvious that considerable thought has gone into the preparation of the Citation as a kit (and) when the amplifier is completed, the user may be assured of having a unit he can be proud of . . . The kit is a joy to construct.”

For a copy of Mr. McProud's complete report and a Citation catalog, write Dept. RE-4, Citation Kit Division, Harman-Kardon, Westbury, N. Y. The Citation I is a complete Stereophonic Preamplifier Control Center. Price, \$159.95; Factory Wired, \$249.95. The Citation II is a 120 Watt Stereophonic Power Amplifier. Price, \$159.95; Factory Wired, \$229.95. Prices slightly higher in the West.

Build the Very Best **CITATION KITS** by **harman kardon**

HK-30

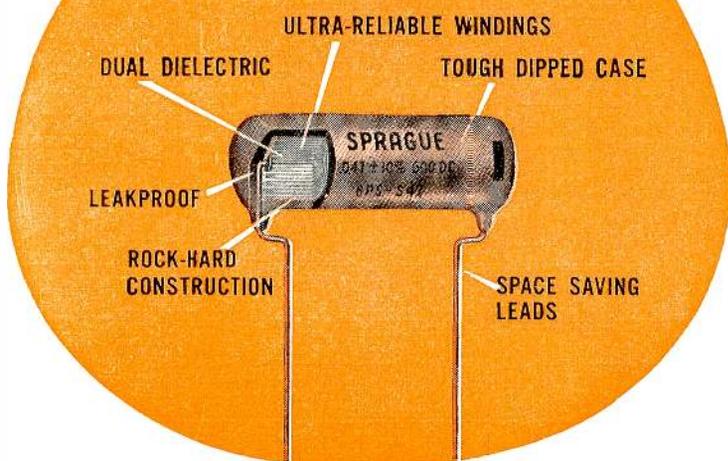
APRIL, 1960

13

NEW

ORANGE-DROP[®]

DIPPED DIFILM[®] CAPACITORS FOR EXACT ORIGINAL REPLACEMENT



THIS NEW . . . MINIATURE . . . DIFILM
CAPACITOR OUTPERFORMS ALL
OTHER DIPPED TUBULAR CAPACITORS!

SPRAGUE DIFILM *does it again!* First to give you at regular prices the finest molded tubular capacitor made—the DIFILM BLACK BEAUTY . . . and now the newest DIFILM capacitor—the ORANGE-DROP dipped capacitor.

SPRAGUE ORANGE-DROP CAPACITORS are especially made for easy installation in tight spots . . . where only an exact replacement will fit. They are the exact same dipped capacitors used by leading manufacturers in many TV sets.

WHY ORANGE-DROPS BEAT HEAT AND HUMIDITY

Sprague Orange-Drop Mylar* Paper Dipped Capacitors combine the proven long life of paper capacitors with the effective moisture resistance of film capacitors. Their duplex dielectric of kraft paper and polyester film is impregnated with HCX[®], Sprague's exclusive hydrocarbon material which saturates the paper and fills voids and pinholes in the film before the HCX polymerizes. The result is a solid, rock-hard capacitor section which is then double-dipped in bright orange epoxy resin for moisture protection. Leads are neatly crimped for easy installation on printed wiring boards.

SPRAGUE ORANGE-DROP CAPACITORS are a natural teammate for the molded DIFILM Black Beauty[®]. Black Beauties, born out of engineering to tough missile standards, are still far and away the best replacement capacitors—better than any other molded or dipped . . . paper, film, or film-paper combination . . . capacitor made for entertainment electronics.

Where a dipped capacitor is called for, no other dipped unit can match the ORANGE-DROP. Your distributor is stocked with all popular ratings in 200, 400, 600, and 1000 volts in handy Sprague Klear-Paks. Order some today.

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don't be vague—insist on

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An F.C.C. *commercial* (not amateur) license is your ticket to higher pay and more interesting employment. This license is Federal Government evidence of your qualifications in electronics. Employers are eager to hire *licensed* technicians.

WHICH LICENSE FOR WHICH JOB?

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

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

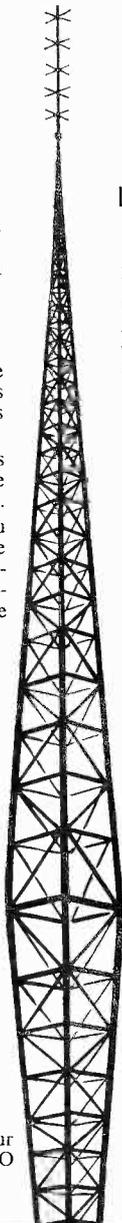
The **FIRST CLASS** radio telephone license qualifies you to install, maintain and operate every type of radiotelephone equipment (except amateur) including all radio and television stations in the United States, its territories and possessions. This is the highest class of radiotelephone license available.

GRANTHAM TRAINING PREPARES YOU

The Grantham course covers the required subject matter completely. Even though it is planned primarily to lead directly to a first class FCC license, it does this by **TEACHING** you electronics. Some of the subjects covered in detail are: Basic Electricity for Beginners, Basic Mathematics, Ohm's and Kirchhoff's Laws, Alternating Current, Frequency and Wavelength, Inductance, Capacitance, Impedance, Resonance, Vacuum Tubes, Transistors, Basic Principles of Amplification, Classes of Amplifiers, Oscillators, Power Supplies, AM Transmitters and Receivers, FM Transmitters and Receivers, Antennas and Transmission Lines, Measuring Instruments, FCC Rules and Regulations, and extensive theory and mathematical calculations associated with all the above subjects explained simply and in detail.

OUR GUARANTEE

If you should fail the F. C. C. exam after finishing our course, we guarantee to give additional training at **NO ADDITIONAL COST**. Read details in our free booklet.



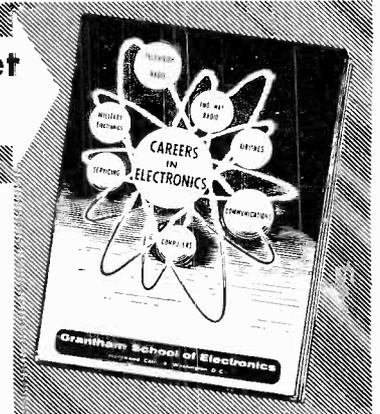
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HERE'S PROOF...

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

	License	Weeks
Mario Bidese, 342 Alexander Avenue, Greensburg, Pa.	1st	12
Richard M. Wilhoit, 2104 Santa Paula, Las Vegas, Nev.	1st	12
Larry R. Perrine, 7 Normandy Place, Champaign, Ill.	1st	15
Emerson F. Lawson, 111 Excelsior Ave., Union, S.C.	1st	12
Marion Woolsey, 3246 Warwick, Kansas City, Mo.	1st	12
Harold W. Johnson, 5070 Hermosa Ave., Los Angeles, Calif.	1st	15
Arthur W. Hardy, 66 Dresser Ave., Great Barrington, Mass.	1st	12
Ralph Frederick Beisner, 2126 Grand, Joplin, Mo.	1st	12
N. B. Mills, II, 110 So. Race St., Statesville, N.C.	1st	12
Dean A. Darling, 403 S. Chase Ave., Columbus 4, Ohio	1st	12
Paul D. Bernard, 408 First Ave., N.E., Watertown, S.D.	1st	18
Gerald L. Chopp, 518 Aubudon Road, Kohler, Wis.	1st	12

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

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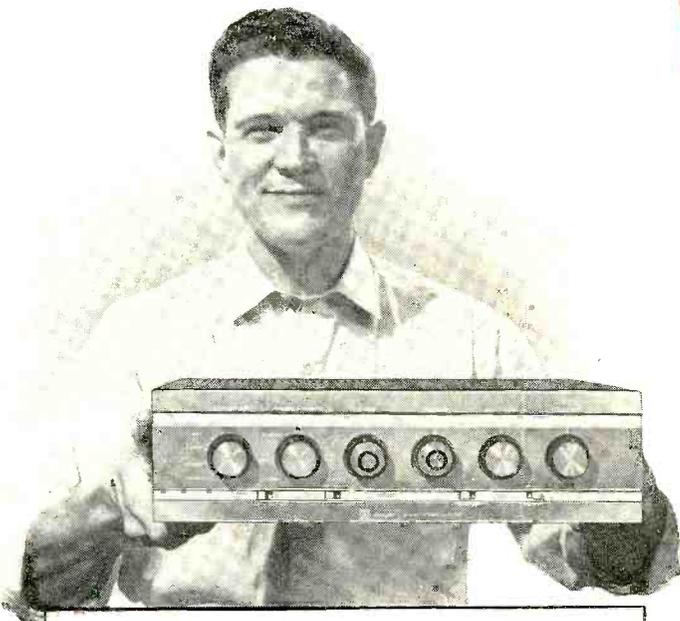
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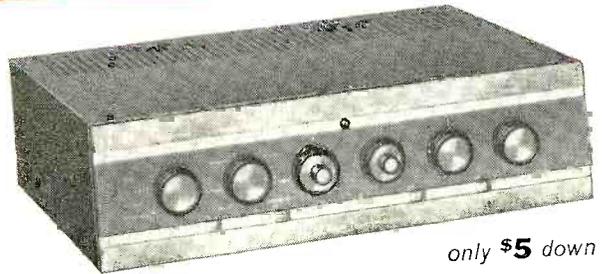
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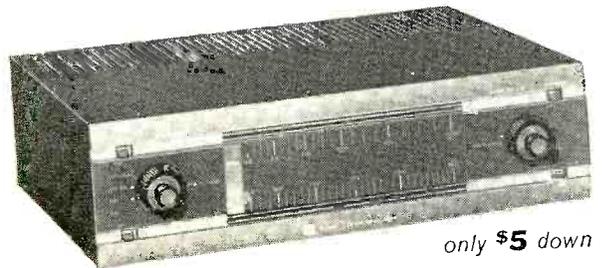
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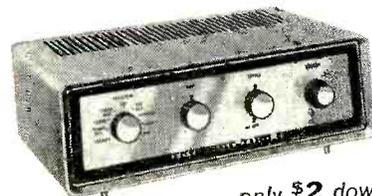


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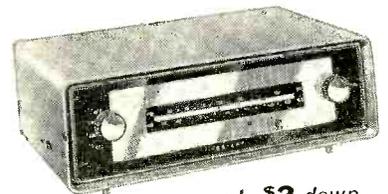
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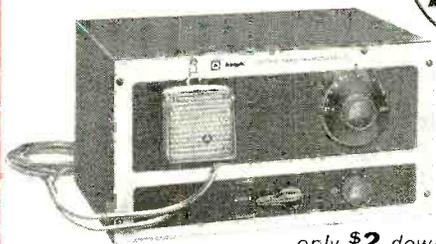


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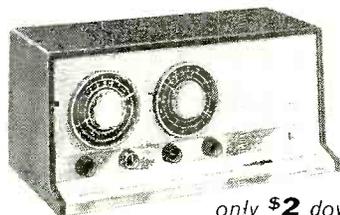
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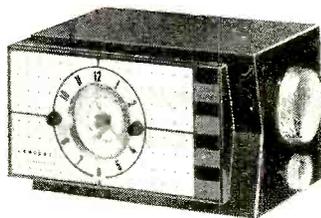
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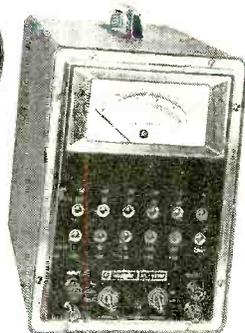


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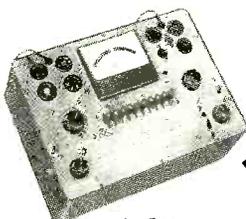


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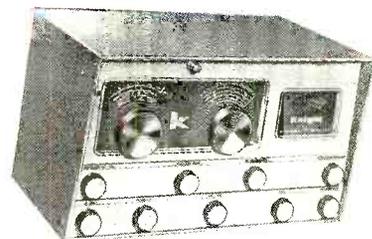
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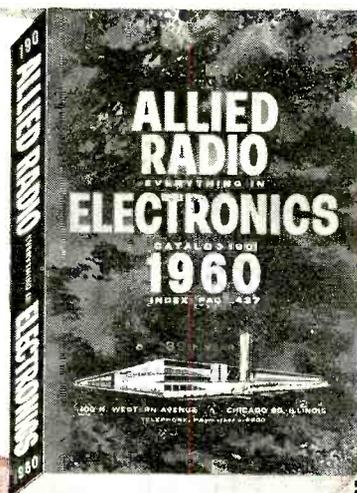
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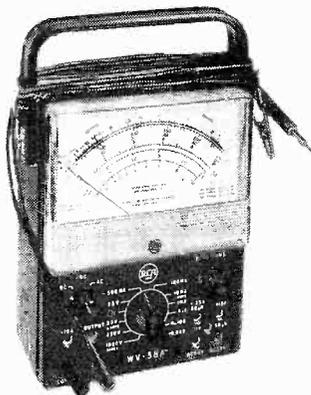
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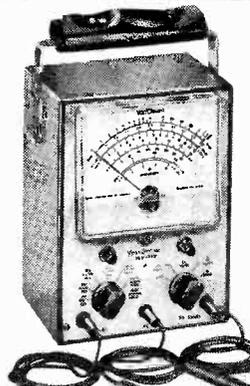
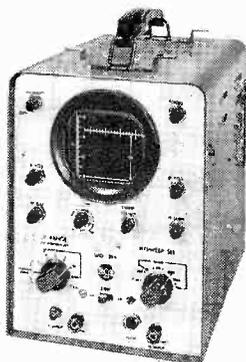
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SPECIFICATIONS: Measures: DC Volts—0.02 volt to 1500 volts in 7 overlapping ranges; AC Volts (RMS)—0.1 volt to 1500 volts in 7 overlapping ranges; AC Volts (peak-to-peak)—0.2 volt to 4000 volts in 7 overlapping ranges; Resistance—from 0.2 ohm to 1000 megohms in 7 overlapping ranges. Zero-center indication for discriminator alignment • Accuracy—± 3% of full scale on dc ranges; ± 5% of full scale on ac ranges • Frequency Response—flat within ± 5%, from 40 cycles to 5 Mc on the 1.5, 5, and 15-volt rms ranges and the 4, 14, and 40-volt peak-to-peak ranges • DC Input Resistance—standard 11 megohms (1 megohm resistor in probe).

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160, higher than at the maximum of any earlier sunspot cycle.

If the present rate of decline continues, the sunspot number for 1960 is expected to be around 115, with a corresponding lowering of the maximum frequencies usable for long-distance radio communications.

Mars Technical Net

The First Army schedule for April is: April 6, "Filter Design and Applications," James L. Prather; April 13, "New Semiconductors for High Frequency Circuits," W. A. McCarthy; April 20, "Modern Trends in Electronic Instrumentation," Walter A. Knoop; April 27, "TACAN and Similar Aircraft Navigation Systems," William Loebel.

The net is on the air Wednesday at 9 pm EST on 4030 kc, upper sideband.

Arrangements are being made to set up a Second Army Technical Net in the Washington, D. C., area.

Toll TV Trial

Zenith Radio Corp. has announced it will file application for a trial run on pay-TV soon. The FCC has already set up standards for such a test, including 3-year duration, testing in only one city (which must already have four good TV signals available to viewers) and no sales of decoding equipment to the general public during the test period.

Zenith has indicated that it's prepared to meet these stiff tryout requirements, and says it'll pick one of five cities presently under consideration.

Language Experts Lacking

According to Dr. Kenneth E. Harper of U. C. L. A., there is a shortage of electronic translating-machine personnel in this country. Dr. Harper says the Soviet Union has 450 machine-translating experts compared to our 120. He also says that the Russians are working with machines that can translate 20 pairs of languages. American experts use computers to translate Russian and German to English.

Telemetered Teeth

Transmitters in teeth may enable Dr. Allen Brewer of the School of Aviation Medicine, Brooks Air Force Base, San Antonio, Tex., to learn why some people grind their teeth for several hours each night. Dr. Brewer installed tiny radio transmitters in the dentures of two people to signal whenever the person brings his teeth together or grinds them. The signals are amplified and recorded so they can be studied.

The Air Force dentist expects to install smaller transmitters in natural living teeth. He believes they may eventually reveal the cause of periodontal disease. END

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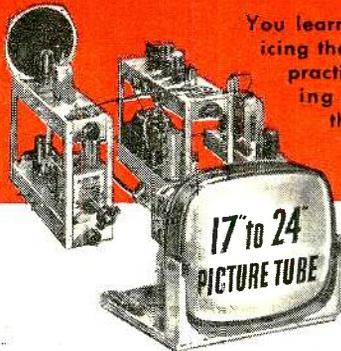
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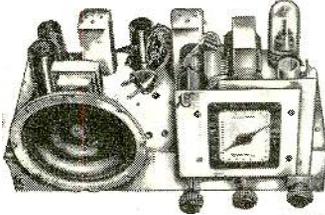
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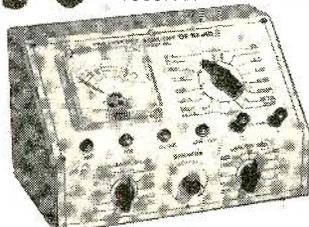
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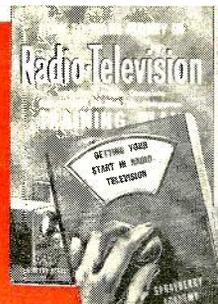
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Correspondence



VOLTAGE REGULATOR

Dear Editor:

The article "All-Transistor Voltage Regulator for Your Car" on page 107 of the February issue of RADIO-ELECTRONICS is very interesting, but a couple of points need clarification. First, on page 114, it says "the old regulator is not removed . . . because the reverse-current relay and the current regulator coil are also in the same box." This implies that the current regulator still functions, which is not the case. Since the field circuit of the generator is completely disconnected from the old regulator, the current regulator loses control. This leaves the generator without current limitation. This might cause generator overloading in some instances and should be carefully watched. It might be necessary to put a resistance in series with the field to assure that the output current does not get out of hand when the battery charge is low. Second, the reverse-current relay can be eliminated by connecting a suitable low-voltage silicon diode between the battery and the generator armature so that current flows from generator to battery in the forward direction. This diode must have a current rating sufficient for the generator output.

To guide the experimenter, it might be mentioned that, among American cars, Ford generators have the field grounded, while Auto-Lite and Delco-Remy generators have it connected to the armature terminal.

Another point that should be emphasized is that the new regulator box should be located in the coolest possible place for maximum reliability. Since large currents do not flow in the leads, it would be permissible to make them rather long to accomplish this. Mounting inside the passenger compartment might be desirable in some cases, of course avoiding locations near the heater.

I think that this project should give good results with the proper precautions.

CHARLES ERWIN COHN

Chicago, Ill.

HALL-EFFECT ERRATA

Dear Editor:

The article on the Hall Effect, "Something New in Semiconductors," by R. W. Crawford and N. P. Milligan, p. 105, January, contains so many serious errors that it must be rebutted.

1. Hall was not a physicist at Harvard—he was a graduate student at Johns Hopkins.

2. In paragraph 2 the authors state that the magnitude of the Hall voltage depends on carrier mobility for a given current and magnetic field. This is *not* so. The higher the mobility the greater the power available from the Hall generator.

3. In paragraph 3 the authors state that no practical devices using the Hall effect had been available until recently. Actually, one company produced and marketed a magnetic field Hall-effect probe over 5 years ago.

4. The authors failed to restrict their discussion sufficiently. By using the generic term "Hall-effect device," their statements become too inclusive to be correct. An example appears in paragraph 5. Here figures are given which are roughly correct for *low-impedance* Hall generators, but not correct for the high-impedance Hall-effect multiplier.

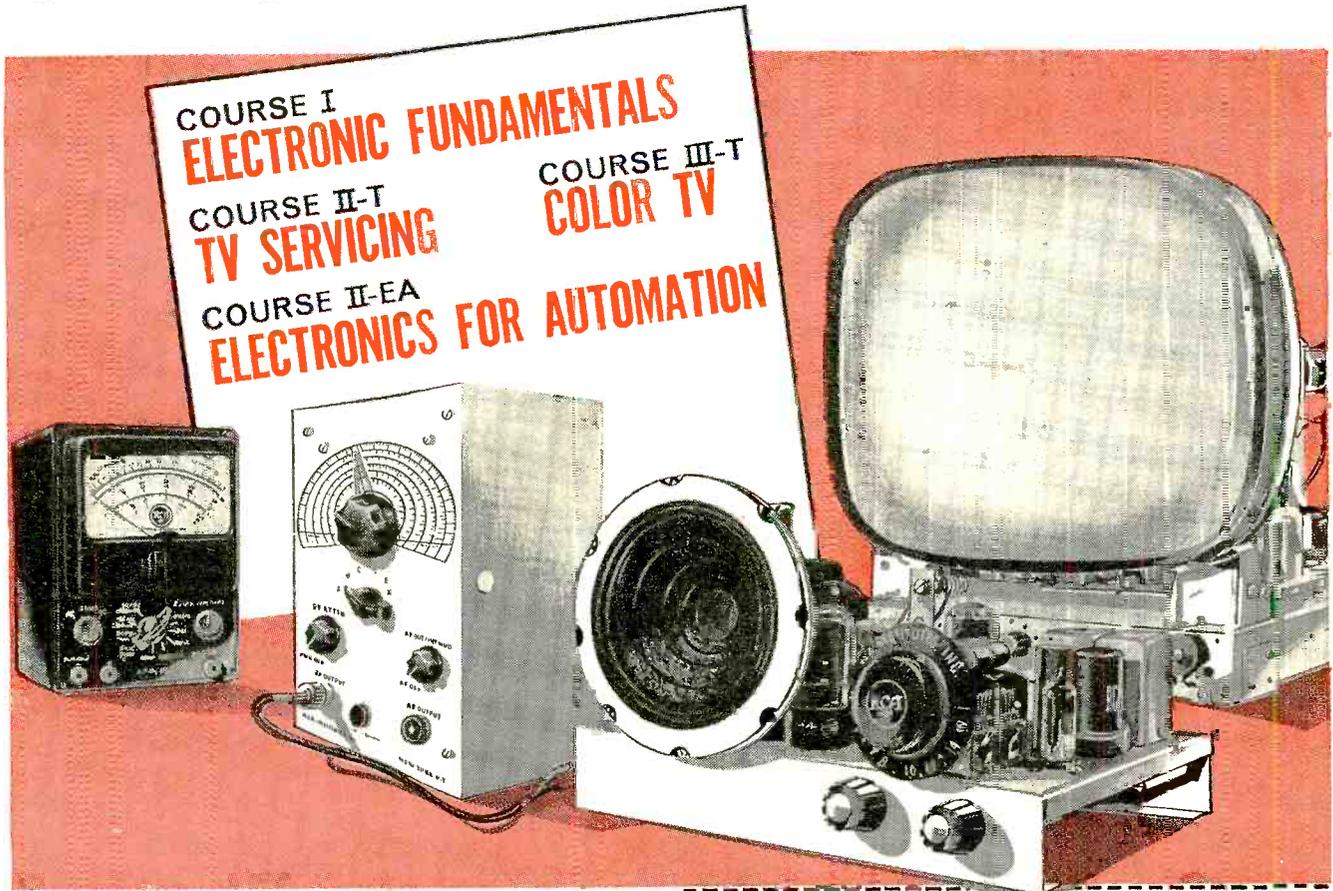
Too, there are other applications of the Hall-effect, for example, the magnetohydrodynamic generator mentioned on



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- "The performance of each portion of the Model 600 is of top calibre."
- "With this receiver we were able to appreciate FM-AM stereo broadcasts fully, which is more than we can say for most stereo tuners we have used."
- "(Loudness control) contours are well-chosen. The result is a well-balanced sound, free of boominess at any volume."
- "The rumble and scratch filters, which are most effective in their intended functions, hardly disturb musical content."
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CORRESPONDENCE (Continued)

page 8 of the same issue of RADIO-ELECTRONICS. This device is said to produce 900 watts of power—hardly a low-level device.

T. R. LAWSON, JR.
Westinghouse Electric Corp.
Pittsburgh, Pa.

Dear Editor:

In reply to Mr. Lawson's letter—

1. When Edwin Hall discovered his effect, he was working for his PhD at Johns Hopkins. He received his degree there in 1880, and thereupon joined the faculty at Harvard where he stayed until 1921.

2. The magnitude of the Hall voltage for a given geometry is a function of the Hall coefficient, which in turn is a function of carrier mobility and the resistivity of the material.

3. Our reference to the commercial availability of Hall-effect generators referred only to those utilizing indium arsenide or indium antimonide. To the best of our knowledge these units have been produced commercially only by Westinghouse and Ohio Semi-conductors in the United States and by Siemens in Germany. It is our understanding that only the Siemens and Ohio Semiconductors are on the market.

4. Mr. Lawson's criticism of our use of the generic term Hall-effect device is valid. It was our intention that our usage of the term be limited to the low-impedance devices described in the article. The appearance of a new device on the market often creates confusion until terms are standardized. We have seen the terms "Hall-effect device," "Hall-effect generator," "Hall generator" and "Hall plate" used synonymously. We frankly do not know which term will be adopted by the industry.

We did not mean to imply that the Hall-effect devices described in the article constituted the sole use of the Hall effect. Devices of the type described are, however, low-level devices.

We are aware of Mr. Lawson's work on the junction Hall generator but did not include it in our article since we were restricting ourselves to the commercially available types.

R. WAYNE CRAWFORD
NEAL P. MILLIGAN

Ohio Semiconductors
Columbus 14, Ohio

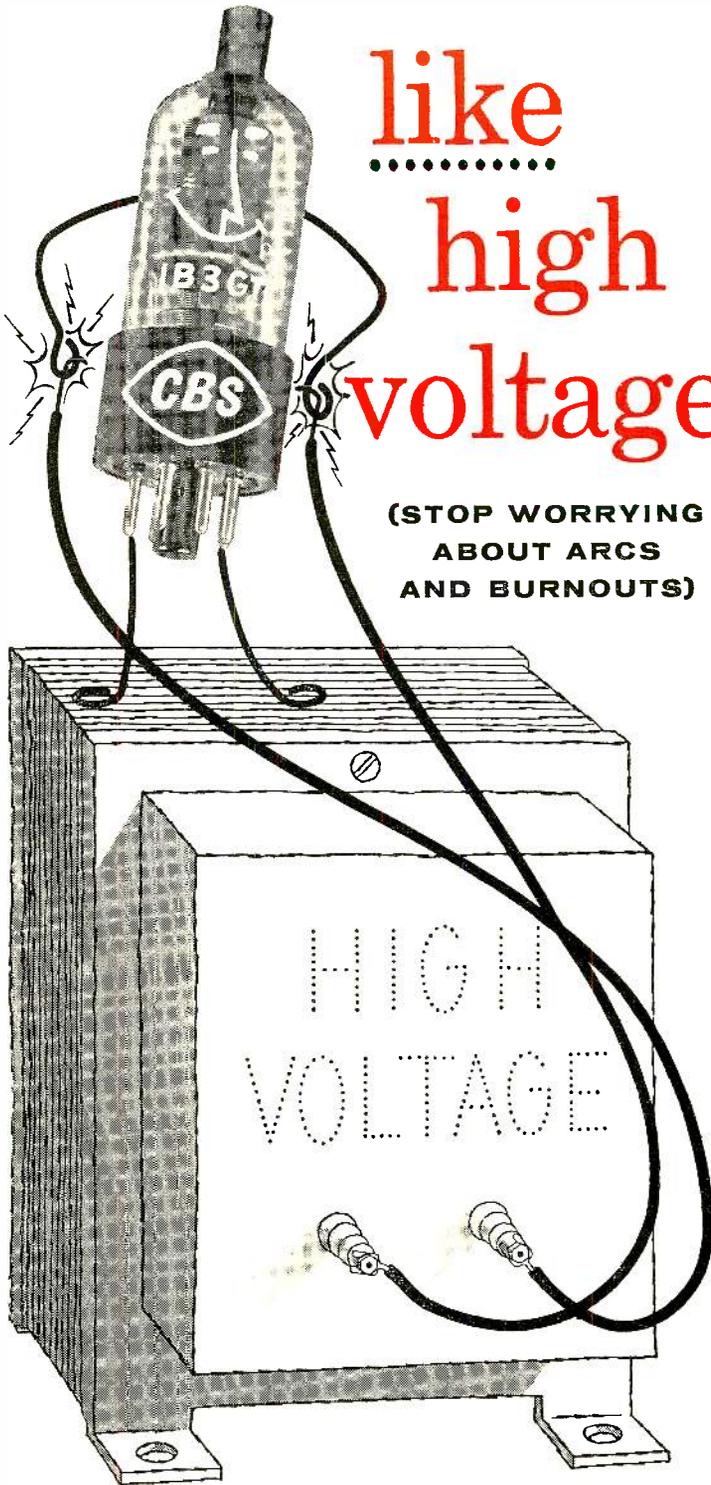
LICENSING AND STANDARDS

Dear Editor:

James A. Fred's letter in the September issue expressed fear that legislation will prevent individuals from servicing part-time. The legislation wanted by the service industry would require that this man pass an examination in order to practice. The other aim of the legislation is to control the ethics of the "sharp" full-time operator who bait-advertises low service rates, yet effectively receives pay far above that of the shop that advertises realistic service charges. This legislation would

I like high voltage

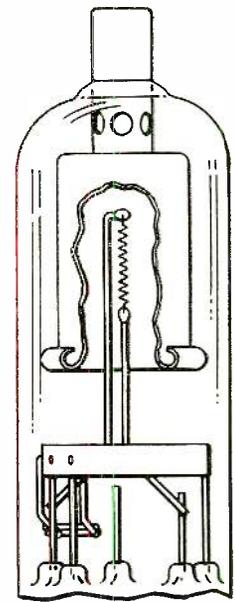
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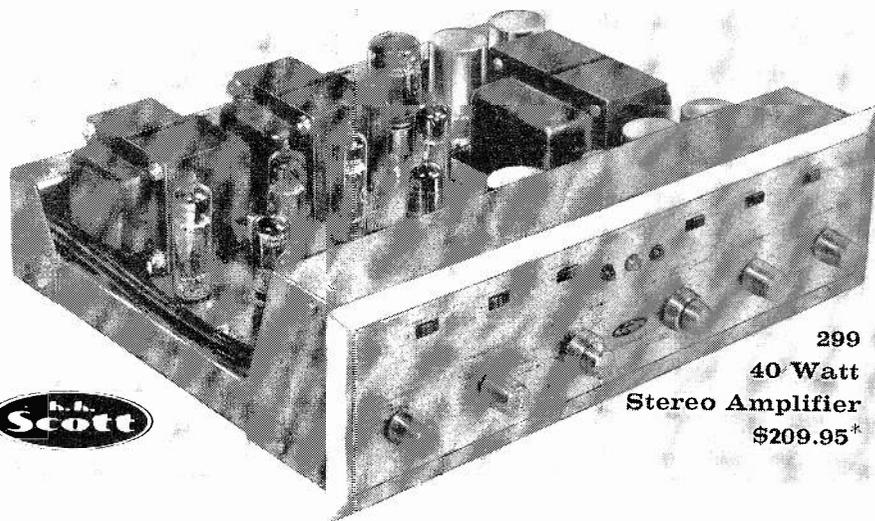
Receiving, industrial and picture tubes • transistors and diodes • audio components • and phonographs

3 NEW STEREO AMPLIFIERS

FROM



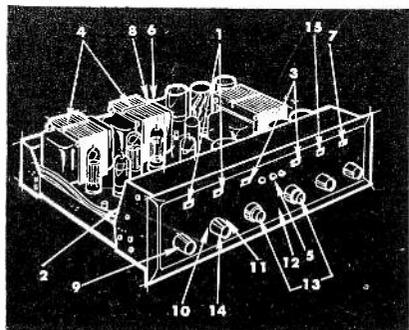
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 14. Special balancing circuit.
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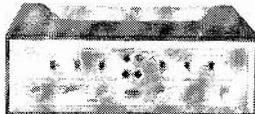
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This budget priced stereo amplifier has such features as Third Channel Output and separate tone controls usually found only in much more expensive equipment. It is backed by H. H. Scott's reputation for quality and engineering leadership. \$144.95*



130 Stereo Preamplifier

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*Slightly higher West of Rockies. Accessory case extra.



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CORRESPONDENCE (Continued)

protect the public from the unqualified beginner since it would set up a training and apprenticeship period, and from the gouger since his license could be revoked.

He speaks of a highly qualified and experienced individual who practices part-time. Why should a qualified person like that not be in the business full-time? He has probably learned that servicing gives such a poor return for the work involved that he must work at a better paying job. Now that he has security, he can work at his first love, electronics servicing. Might not licensing bring up the standards of the service industry so that he can find better remuneration as a shop owner and operator?

He mentions a friend of his who repaired a "toughie" that two regular repair shops turned down. This friend likes servicing so much that he is willing to give his time away to practice the art. His regular job assured him his mortgage was paid and his kids were fed. Might not the rise in standards that licensing might bring allow the men in the full-time service field to have security for the family by working 8 hours a day? Then they too could afford to tackle a "toughie" just for the joy and satisfaction of completing the job. We find great satisfaction in completing a tough repair job, and we often take a loss on the time spent on it.

We could hire out to the missile factories and find security in a standard wage and extra benefits. But we believe so greatly in the electronics service industry that we hope to raise its standards and bring it professional recognition that will give us all the benefits you get from the manufacturing industry. On top of that, we will be our own bosses.

FRANK T. KUROWSKI

Self-Employed
New Hartford, N. Y.

THANK-YOU NOTE

Dear Editor:

We, the officers of the Pennsylvania Federation, in behalf of the member chapters and delegates, wish to extend thanks to you and your publication RADIO-ELECTRONICS for the publicity afforded them during the past year.

Your column Technicians News is a generous contribution to organized service. Its value is great, as it enlightens association members in various locations on the thinking and activities of groups in other geographic sections, particularly with associations that are not yet aligned with a state or national organization.

Praiseworthy, too, are your recent efforts in compiling and printing the names and addresses of the known service organizations in the United States.

LEON J. HELK, SEC'Y.

Pennsylvania Federation
Television-Radio Service Associations

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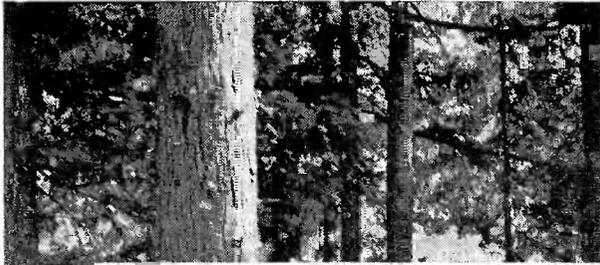
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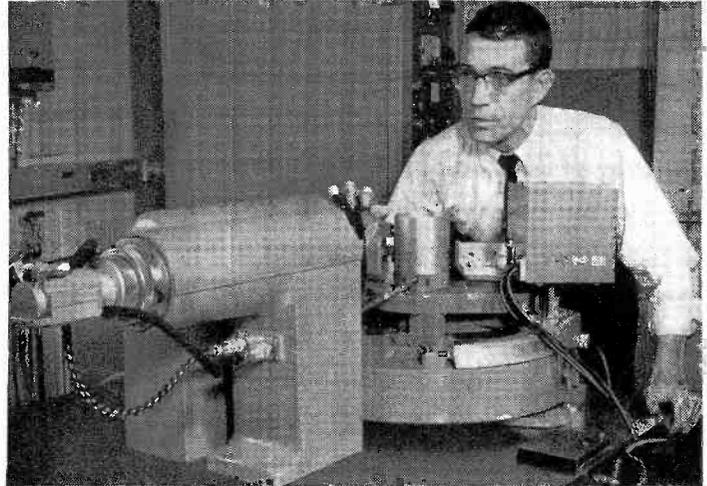
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to help make
telephone poles
last longer



Chemist Jack Wright developed the use of this X-ray fluorescence machine for testing the concentration of preservatives in wood. Here he bombards a boring from a test telephone pole with X-rays.

This Bell Labs chemist is using a fast, new technique for measuring the concentration of fungus-killing preservative in telephone poles.

A boring from a test pole is bombarded with X-rays. The preservative—pentachlorophenol—converts some of the incoming X-rays to new ones of different and characteristic wave length. These new rays are isolated and sent into a radiation counter which registers their intensity. The intensity in turn reveals the concentration of preservative.

Bell Laboratories chemists must test thousands of wood specimens annually in their research to make telephone poles last longer. Seeking a faster test, they explored the possibility of X-ray fluorescence—a technique developed originally for metallurgy. For the first time, this technique was applied to wood. Result: A wood specimen check in just two minutes—at least 15 times faster than before possible with the conventional microchemical analysis.

Bell Labs scientists must remain alert to *all* ways of improving telephone service. They must create radically new technology or improve what already exists. Here, they devised a way to speed research in one of telephony's oldest and most important arts—that of wood preservation.

Nature still grows the best telephone poles. There are over 21 million wooden poles in the Bell System. They require no painting, scraping or cleaning; can be nailed, drilled, cut, sawed and climbed like no other material. Scientific wood preservation cuts telephone costs, conserves valuable timber acres.



BELL TELEPHONE LABORATORIES

World Center of Communications Research and Development



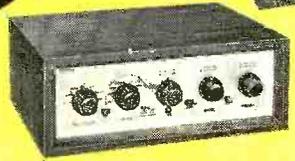
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Stereo Preamplifier HF85††



FM Tuner HFT90††
AM Tuner HFT94††
FM/AM Tuner HFT92††



100W Stereo Power Amplifier HF89
70W Stereo Power Amplifier HF87
28W Stereo Power Amplifier HF86



Stereo Integrated Amplifier AF4††



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New HF89 100-Watt Stereo Power Amplifier: Dual 50W highest quality power amplifiers. 200W peak power output. Uses superlative ultra-linear connected output transformers for undistorted response across the entire audio range at full power, assuring utmost clarity on full orchestra & organ. 60 db channel separation. IM distortion 0.5% at 100W; harmonic distortion less than 1% from 20-20,000 cps within 1 db of 100W. Kit \$99.50. Wired \$139.50.

HF87 70-Watt Stereo Power Amplifier. Dual 35W power amplifiers identical circuit-wise to the superb HF89, differing only in rating of the output transformers. IM distortion 1% at 70W; harmonic distortion less than 1% from 20-20,000 cps within 1 db of 70W. Kit \$74.95. Wired \$114.95.

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New HFS5 2-Way Speaker System Semi-Kit complete with factory-built 3/4" veneered plywood (4 sides) cabinet. Bellows-suspension, 5/8" excursion. 8" woofer (45 cps. res.), & 3 1/2" cone tweeter. 1 1/4 cu. ft. ducted-port enclosure. System Q of 1/2 for smoothest freq. & best transient resp. 45-14,000 cps clean, useful resp. 16 ohms.

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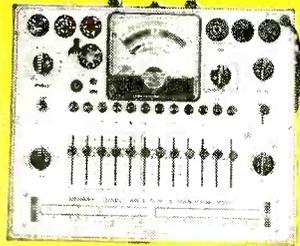
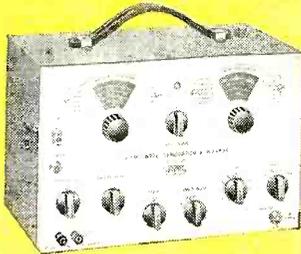
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SUPERCEPTION

... *The Next Development in Radio and Television* ...

FUTURE radio and television receivers will bear no resemblance to those now familiar to us. None of the original inventors and protagonists of broadcasting and television foresaw the tension, the strife and the dissension these noble and useful inventions could cause in the average household.

Unfortunately, today both radios and TV receivers have often become monstrous nuisances which all too often create unhappiness for unwilling eyes and ears. Usurping hearing and sight of others is barbaric, creating widespread and all too much lasting dissatisfaction among its victims.

Children and youths regularly trespass upon the time and nerves of their elders by forcing them to listen and thus participate in *their* program selections—unless the elders leave the room.

Husbands and wives continuously clash over the choice of programs—the former want sports events or other male entertainment, while the latter insist on drama or other female fare.

Yes, a family may conceivably have two separate radios and three TV sets, each in a different room—everyone has seen such split households—but we must all agree that this is an asinine and not very progressive solution to the problem, even if sufficient rooms are available. It won't prevail in the future.

In the present hectic and stressful civilization, when our nerves are under continuous assault from a wide variety of noises, the extra-high-decibel onslaught of radios and TV's injures our nervous systems far more than anyone cares to admit. And, unfortunately, the noise situation is steadily worsening, hence the increasing nervous collapse of a large percentage of our population.

The recent addition of hi-fi and stereo has done nothing to ameliorate the sonic impact on our audio centers. Our authorities, who get an increasing number of complaints, wonder where it will all end.

If this sounds as if we were roundly condemning and denouncing all electronic entertainment instruments and devices, let us assure you at once that nothing is further from our thoughts. Indeed, we who were in at the birth of all of them have spent our entire life and efforts in publicizing and propagandizing electronic sound and sight.

What we *do* object to is *the crude form* of our present-day electronic entertainment gear. Future historians will wonder how we possibly could have tolerated it so long!

Let us now visit our family of five of the not-too-distant future. It is 7 in the evening. The entire family is together once more, all assembled in the living room after dinner. All are listening to either their TV's, their radio or their hi-fi Stereo. *But the casual stranger entering the room hears not a sound, sees no picture on a screen!*

All is serene and quiet. The lights are low and the room has a pleasant cozy atmosphere. Father and mother are sitting on the couch, relaxed. *Their eyes are closed*, but by the alert expressions on their faces, you know that they are wide awake.

The two girls, 8 and 12, are sitting in comfortable overstuffed chairs, one listening to her radio, eyes wide open, and the other entertained by her TV, her eyes closed but fluttering while she follows the latest courtroom drama. Junior, age 16, sits at the table doing his homework, by the room's sole dimmed table lamp. He listens to the latest hi-fi stereo explorer's account recorded on board a huge space-liner in transit from the moon to the earth. The only

audible noise in the room is Junior's rustling homework papers.

The entire family wears individual, modern-styled headgear that runs over the forehead and back around the head. It is made of light aluminummagnesium with a soft plastic inside pad where it touches the forehead and hair in back. It can be adjusted for any size head. Its total weight is less than 5 ounces. Over the ears are tiny adjusting knobs for off, on, change of channel, intensity and volume control. The headband nowhere measures more than ¼ inch thick. *All the electronic components are contained within this thickness, along which they are distributed.* There is neither a visible antenna nor a connecting cord. Entirely transistorized, the long-life batteries are in the headband, too. Hence one can walk about the house without ever missing any part of a program.

The headgear is called a *superceptor*. It is at once a combination radio set, television receiver and hi-fi stereo. You can go to sleep with your superceptor, too. Special models are built for learn-while-you-sleep purposes; others will awaken you to music at the preset time.

Fantastic? Not any more than radio or television was in 1900.

The superceptor is just a few stages more sophisticated than today's receivers. At the present state of electronics, it becomes discernible that we will soon break through into the *inner consciousness* of man. We do not need ears or eyes to hear or see—anyone who dreams while asleep knows that. By going *directly* to our brain's hearing and sight centers, we can bypass the optic and audio nerves that lead to them. But how do we accomplish that? Here is one approach—there may be several others.

Last January, a trio of scientists at the University of California at Los Angeles reported in the *Proceedings of the Society for Experimental Biology and Medicine* that electromagnetic fields created by electromagnets could stimulate the brain without contacting the skull. Drs. Alexander Kolin and Norman Q. Brill and graduate student Paul Broberg reasoned that brain tissue is conductive; thus they thought that electric currents could be induced in the brain just as electric currents are induced in transformer coils. Such brain conductivity had been noted by Norwegian technicians working in a hydroelectric station. They "saw" bluish-white flickerings whenever they were near the large choke coils of the plant. The phenomenon is called *phosphores*. The UCLA researchers were able to duplicate the phosphenes by creating a low-frequency current in a magnet and placing their heads in its field.

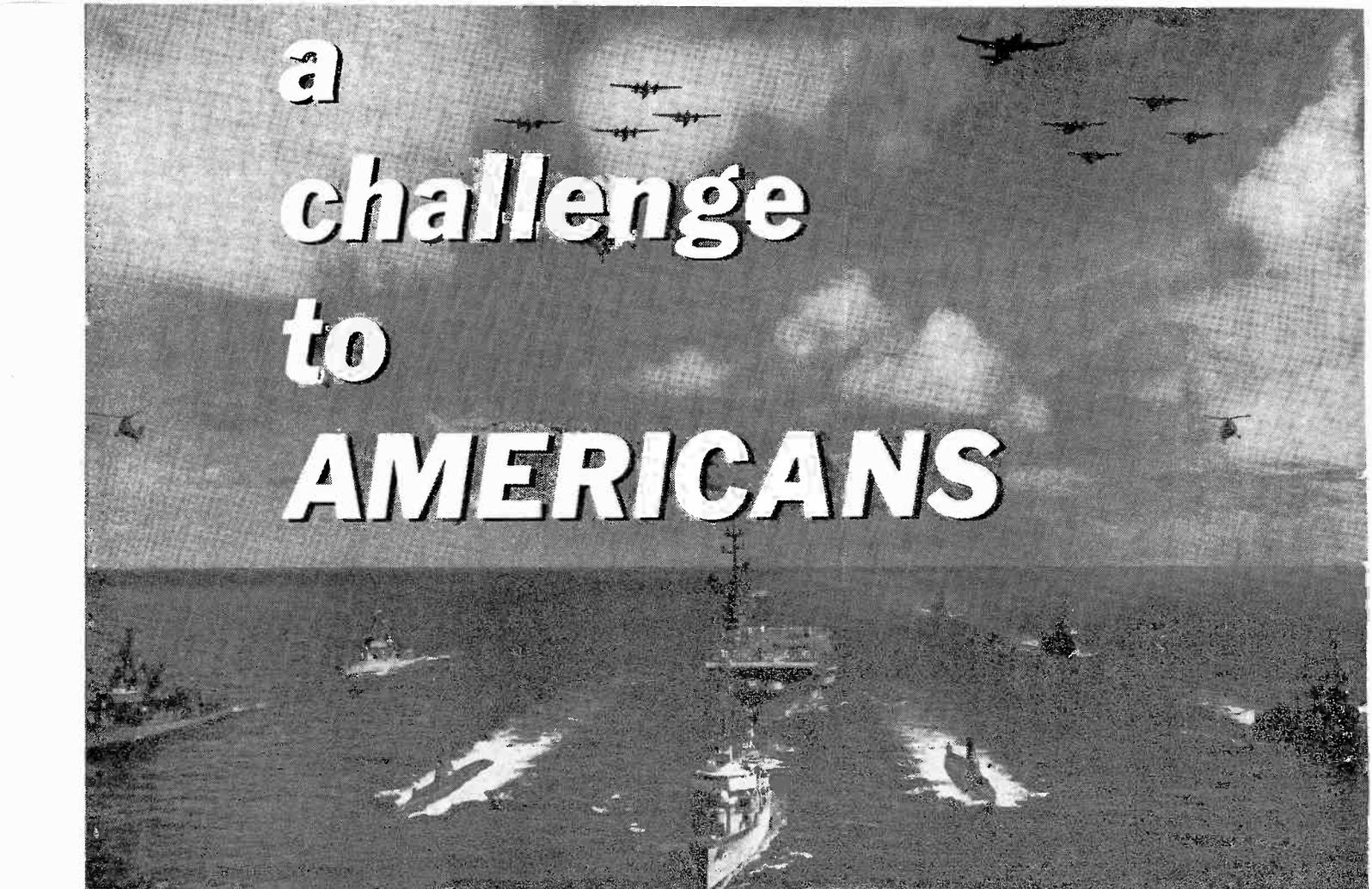
Such super-perception—we term it *superception*—has a long distance to go before we can perceive television images in our sight or optic brain centers, but we feel certain that it will be accomplished in the future. Tiny, solid-state electronic scanners, replacing the present cathode ray tube, may do the trick.

As for the much simpler audio superception, we have commented on this at length.* *It is already here.*

Will superception TV supplant screen television? Probably not. Large wall-screen projection will always remain for simultaneous viewing of specialized programs for the entire family and for their invited company's electronic fare.

—H.G.

*See "Future Audio Goals," October, 1959, RADIO-ELECTRONICS, page 33. See also "Microelectronics," page 33, February, 1960, RADIO-ELECTRONICS.



a challenge to AMERICANS

By Rear Admiral JOHN S. THACH, USN*

Official USN Photo

THE United States urgently needs an electronic device with specifications that may sound impossible. It must be a weapons system, almost entirely electronic, that covers the frequency spectrum from infrared on up beyond the X-band. It must function effectively for indefinite periods, around the clock, seven days a week, and be maintained by operators on stations with a minimum of technical assistance. It will be hurled, dropped, rolled, pitched, buffeted, chilled and heated. It must function equally well in air and partially or completely submerged in salt water. It must be mobile at rates ranging from 100 to 1,000 miles per hour. It must discriminate against random, natural and man-made interference. It must be able to detect, control, connect, coordinate, inform, position and activate up to 50 dissimilar vehicles, over at least 10,000 square miles. And, most important, it must find, localize, positively identify and destroy one or more elusive, highly maneuverable, invisible targets simultaneously.

Difficult as these specifications are, I almost have such a device. It is called Task Group ALFA. ALFA is a weapons system that will do all of these things to a greater or lesser degree, but not nearly well enough. That is why I am writing this article.

Task Group ALFA is the antisub-

*At the time this article was written Commander of Task Force ALFA; recently transferred to be Commander Anti-Submarine Defense Force, US Pacific Fleet.

marine hunter killer group I command: an aircraft carrier, four aircraft squadrons, seven destroyers and two anti-submarine submarines. Our mission is to accelerate the development of anti-submarine tactics, doctrine and equipment to improve the antisubmarine readiness of the Atlantic Fleet.

In ASW (antisubmarine warfare) electronics is not an aid; it is a necessity. We depend on it to extend our range of vision, navigate precisely, find and track our enemy, gather, display and disseminate command intelligence, guide weapons, provide communications—even to cook our food. Our list of electronic necessities could fill several books: radar, sonar, electronic countermeasures (ECM), magnetic-anomaly detection, target designation systems, fire control, vlf through uhf communications, loran, torpedoes, depth bombs, and on and on. But every one of them could be improved. Many may have to be replaced with devices employing entirely new concepts, circuitry and phenomena.

The antisubmarine problem is immense and extremely complicated. For simplicity we try to break it down into four progressive steps: detection, classification, localization and attack.

Detection

Initially locating submerged intruders is the most serious problem in antisubmarine defense. The primary system for underwater search is acoustic. Sound

can be used actively, by transmitting a sound pulse and then trapping and processing the echo returning from the target. Or passively, by simply detecting and processing the noise the target makes. Active sound search has the advantage of not requiring the target's cooperation. A sound pulse will bounce off a quiet submarine as effectively as it will from a noisy one. Unfortunately, it will also bounce off a whale, a school of fish, a pinnacle rising from the ocean floor or even a water disturbance or temperature gradient. Another disadvantage is the reduced range resulting from the two-way transmission path necessary in active pinging. Passive listening is longer-ranged on a given noise level. But both are limited by noise in the parent vehicle or equipment, as well as background noise of the ocean, ships and marine life.

Acoustic detection ranges can be extended by boosting power and lowering frequencies, but brute force is not enough. Even ships have practical limitations on equipment weight and size. Sensitivity must be improved. There are a number of approaches to improving sensitivity that look profitable:

▶ Cut down on competition our signal must overcome by reducing the noise of our own equipment and the vehicle toting it.

▶ Explore different transmission paths.

▶ Investigate various correlation

techniques, audio or visual, to bring the signal out of the noise.

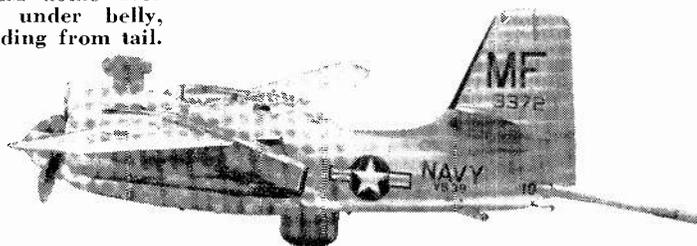
► Put our noise source and receiver at the optimum water depth for best sound transmission and interception.

A lot remains to be learned of the behavior of sound in water. Oceanographic research is a fertile field for electronic instrumentation and investigation. *The man who can produce a predictable, detectable response—acoustic, electromagnetic, electronic or just plain black magic—from a distant submarine fully submerged has his fortune and a healthy portion of his nation's security assured.*

Difficult as our problems are in finding the submerged submarine, we cannot put all our eggs in an underwater basket and allow him immunity on the surface. We need radar. As good as the submarine is getting, it cannot stay down forever. He must navigate. He must classify the targets he hears. He needs air. Above all, he is curious and has to be if he is to accomplish many of his missions. He knows that one peek is worth a dozen guesses. Every time he sticks something up above the surface for a peek or a breath of fresh air, he is giving us a detection opportunity. We need a radar that will assure it is a detection. The odds are on his side. All he has to reveal is a beanpole. In many situations, he need reveal it only for an instant. A rough sea is on his side. All we have to detect is a tiny object for an instant at long ranges in a clutter of sea return. But it is an opportunity; few as such opportunities are, we must make every one a detection. It can be done, electronically.

By the same token, the submarine may have to open up occasionally for an electronic peek. The submariner may have to run up an antenna and report to his boss or coordinate with another submarine; he may need a radar range to a target; he may have to radiate to control a weapon or to navigate. He may just be curious. Again he has the advantage. He can pick any one of the wide range of frequencies. His transmissions need be only a spurt. His antennas are small and close to the water. Again, every opportunity must

S2F Tracker: ECM dome over cockpit, radome under belly, MAD boom extending from tail.



Official USN Photos

be a detection. That means equipment far superior to what was designed for detecting yesterday's submarines. We are looking for rapid scan of the full spectrum; instant response on a microsecond transmission. Ideally, bearing and range instantly and automatically, on not one but several frequencies simultaneously.

Another phenomenon used now as a classifier may be exploited for detection: magnetic anomaly (irregularity in the earth's magnetic field). The short range of magnetic detection is an advantage in classification. For detection, this range might be increased by placing the detector in a buoy or vehicle (or series of them) away from any other magnetic interference. Entirely new techniques are certainly feasible, to capitalize on the submarine's slight but inherent magnetic field.

Our great basic need is for a system that can be carried by aircraft to detect fully submerged submarines anywhere. Using an aircraft's speed is the only way we can get wide area coverage. However, the surface of the water presents an impenetrable wall to our airborne detection gear. On either side of the wall we can search, but not through it. Underwater we can use sound; in air we use radar. We need a new system that can punch through the surface barrier to make the oceans as transparent as radar makes the air. We have tried to do it physically with sonobuoy, a handy little device that can be dropped from an aircraft. It lowers a hydrophone, raises an antenna and broadcasts to the aircraft whatever it hears, but not nearly well enough. Its range is short, with little indication of what or

where detectable underwater sounds are coming from.

Is it a real contact?

Classification is the two-dollar word given to the process of sorting out our contacts and determining which are submarines. For every solid submarine contact, we are led astray on spurious contacts that may number from 10 to 100. Whales, schools of fish, underwater mountain peaks that rise to within fathoms of the surface, uncharted natural magnetic anomalies, wrecks, ice, friendly submarines, underwater disturbances such as wakes and knuckles, even small fishing boats look and sound like submarines until we get close.

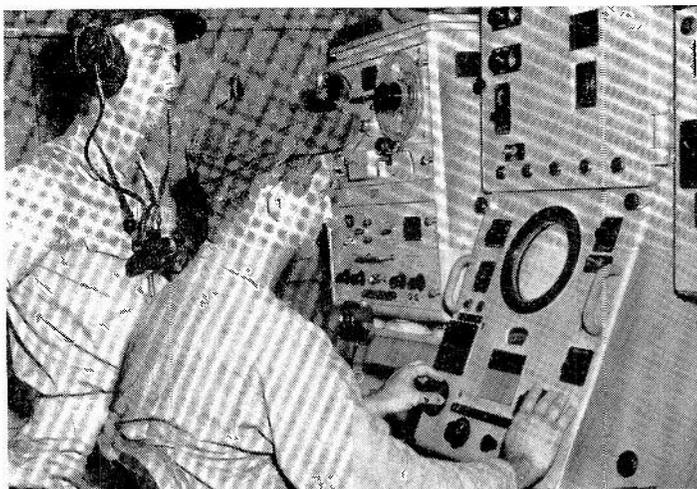
Even in wartime we cannot attack every contact we detect. Our stockpile of weapons would be depleted in no time, with no appreciable decrease in submarine population. Nor can we afford the time and effort lost in tracking down the host of spurious contacts our detection equipment reacts to.

As detection ranges increase, more contacts are made and classification problems are compounded. In addition, the increasing speed capabilities of modern submarines allow less and less time for classification. The answer must come from being able to recognize instantly all the unique characteristics of the submarine. Correlation techniques and memory methods to permit second and third looks at fleeting indications, are some of the tacks we can take. A television look underwater is not unreasonable under some circumstances.

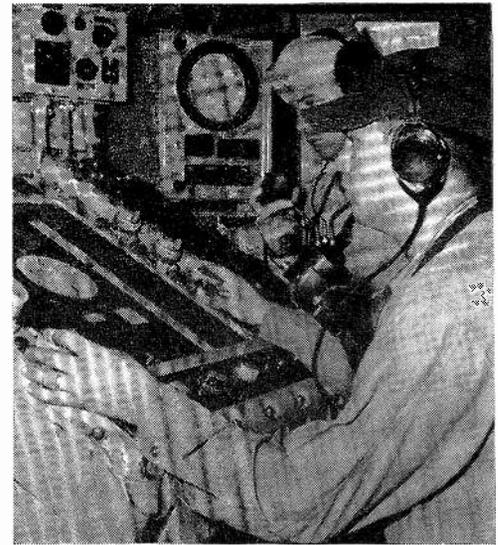
Classification is a problem on the same par with our detection difficulties. If detection equipment cannot classify, we must devise equipment that can.

Where is the sub?

This is the problem when detection is made by some tenuous means—a single radar look or a fleeting ECM contact, followed by immediate submergence of the target. Localization, hand-in-hand with classification, must bridge the period from initial detection until a vehicle that can do something about it can be brought into firm contact. We often know something is there; we have to know what it is and exactly *where* it is. Aircraft can call for help, put sonobuoys in the water, and try to hold with their magnetic anomaly detectors (MAD). Helicopters have their small and unsophisticated sonars to try to hold the contact until destroyers or submarines can be brought in. We cannot



Sonar operators track submarine.



Official USN Photos

A push of a button, and anti-submarine weapon ALPHA will be fired.

HSS-2 helicopter drops its sonar detection gear to search for hidden submarines.

afford to lose the few fleeting detections we get. We need positive holding devices to stay with anything we get long enough to identify it completely, and, if necessary, destroy it.

Attack

Our kill capability is presently the least of our worries. In general, if we can find and classify a submarine, we can destroy it if we have to. Of course, the enemy can also kill us so, while it is the least, it is still a considerable worry. Since it is much easier for a submarine to destroy Chicago, Detroit, New York plus a dozen other cities and strategic military bases, the submariner would prefer to do that than approach a hunter killer group.

We have several methods of trying to outshoot the submarine. The best is to keep our surface and subsurface vessels out of lethal range and send out an aircraft to attack. Next best is the destroyer with its hedgehogs (multiple ahead-thrown bombs), weapon ALFA (a rocket-propelled depth charge, and no relation to the task group of the same name) or antisubmarine torpedoes. All these require the surface attacker to drive right into the hostile submarine's sights. Most urgently we need range so we can kill a hostile craft well beyond its lethal range. We also need speed and depth with our torpedoes, lest tomorrow's submarine simply run away from our weapon. We need homing weapons with better acquisition ranges to improve the probability of a hit and reduce the time required of the fire-control solution, time we probably won't have. Since atomic depth charges are limited in number and extremely expensive, we must do most of our dirty work with conventional torpedoes. Political considerations may deny the use of atomic weapons. Furthermore, a hole smaller than a fist in the pressure hull of a submarine is adequate for a kill.

What we have and need

Ideally, I would want a single super vehicle that could locate, pinpoint and

(if necessary) destroy instantly every hostile submarine any potential enemy could deploy against the United States. There is no such vehicle. The operations of Task Group ALFA have proved again and again that, to do the job, I must employ the best capabilities of many types of vehicles in coordination. For speed, accuracy, range and staying power, I must call upon specialists in three mediums: air, surface and subsurface.

The basic antisubmarine aircraft is the carrier-based Gruman S2F Tracker. It is an electronic package equipped with engines, wheels and just enough space among its electronic equipment for four crew members to squeeze in. Into its fuselage are packed a complete radar, electronic countermeasures (ECM) equipment, a magnetic anomaly detector (MAD), sonobuoy receivers, uhf and mhf communications transceivers with associated homing equipment, navigational radio receivers and a tape recorder. Stowed behind the engines in the nacelles are expendable sonobuoys. There are rails on the wings for rockets, bombs, smoke markers or explosive sound signals. In its bomb bay it can carry either conventional or atomic depth bombs or homing torpedoes. A MAD boom extends from its tail, a radome from its belly and an ECM dome from over its cockpit. It fairly bristles with antennas.

Complete as this compact electronic package may seem, it is inadequate to combat modern submarines. Designated an all-weather aircraft, it requires too much of its crew's attention just to stay safely airborne at low altitude in foul weather. It needs an automatic navigation and control system to free its crew from the mundane task of saving their own skins, and allow them to concentrate on antisubmarine warfare. It needs a radar long-ranged and discriminating enough to pick out a periscope the size of a baseball bat from the clutter of sea return miles away.

Today the S2F is perhaps too fully equipped. Its pilot has trouble using all

the information available to him. It needs a presentation system that will give the plane commander data from all his equipment in the best form to allow him to analyze and act. It needs an automatic data link with the command post in the aircraft carrier and with other units with whom he must coordinate. It needs an active as well as a passive ECM capability, both of which must be more discriminating and quicker, and cover a wider band. It needs lightweight terminal equipment for monitoring directional sonobuoys, with simple, accurate display. It also needs miniature directional sonobuoys to monitor. All this must be packed into a small airframe, light enough to fly, rugged enough to be hurled off a catapult and snatched back aboard the carrier in a jolting stop that the Navy calls an arrested landing. It must be simple enough for rapid maintenance by semi-skilled technicians, cheap enough for you and me, the taxpayers, to afford. The crew would also like room for a coffee pot.

The Tracker's big brother in the airborne end of the ASW business is the land-based Lockheed P2V Neptune. It carries essentially the same equipment as the S2F, but more of it. Its radar is larger, more powerful and more discriminating, and the P2V has more communications equipment. Nearly twice the size of the S2F, with accommodations for duplicate crews, the P2V has the people and space for plotting information and controlling other forces, given the electronic eyes, ears and memory to do it.

Like the S2F, the P2V needs automatic navigation and control systems to make it truly all-weather and to keep track of the forces deployed over the wide area it can control. Its sonobuoys and associated receivers are no better than the Tracker's—there are just more of them. Its ECM is just as restricted and clumsy. Its APS 20 radar is far superior to the S2F's, but is still so frustrated in its search for the elusive periscope that any appreciable wave

height gives the peeking submarine an easy immunity.

Facing the same limitations is my third airborne vehicle, the Douglas AD-5W, the Guppy. It is a carrier-based single-engine skyhook. Its function is to provide wide-area surveillance around the task group with its APS 20 radar, and to provide an automatic relay for radar and communications over the wide area ALFA must investigate for submarines. It is essentially an elevated antenna for control stations in surface ships, showing its radar picture on the ship's scopes through automatic relay equipment, and receiving and automatically retransmitting uhf communications between surface forces, greatly extending the uhf line-of-sight. These two automatic features approach the solution to our needs. If we could add automatic navigation and control features, the crew could concentrate on working for me, and quit having to worry about staying alive.

A unique craft in ALFA's stable of airborne sub hunters is the Sikorsky HSS-1 helicopter. It carries a minimum of navigational equipment, a uhf transceiver and a sonar transducer that can be lowered into the water from a hover. The newest modification of the HSS gives it virtually an automatic all-weather capability. What it needs now is an equivalent advance in sonar performance. That is a major project. The helicopter is a critical vehicle for acoustic equipment. The sonar operator must listen for faint submarine indications against a high background level of helicopter self-noise, from both engine and rotor blades. It is also critical in its weight-carrying capacity. If the copter is to lift enough gasoline to carry out any respectable mission, a better sonar will demand transistor, printed-circuit type simplification.

Antisubmarine warfare's biggest surface vehicle is Task Group ALFA's flagship, the aircraft carrier. It is a high-speed mobile air base, logistics center and command post from which all the operations of the group are coordinated and controlled. Its radars, communications equipment, electronic navigational gear and electronic countermeasures devices are legion. Although improved versions of all of these would be welcome, the great need is to improve the carrier's capability as a control center. This means automatic collection, screening and presentation of information, varying from the turn count on a fleet-*ing* "sinker" to the prevalence of fish in the Gulf Stream. Added to the need for enough valid information is the ability to do something about it—directing, controlling and coordinating the forces available for contact investigation. While this is primarily a communication problem, accurate navigation is a vital corollary. I must know where my forces are—air, surface and subsurface—what they are doing, what they see, hear and feel, to decide where they should go and what they should do.

The mainstays of the antisubmarine

carrier group are the destroyers, the oldest, most overworked and most reliable vessels in the fleet. Like the carrier, they have numerous radars, communications and ECM equipment, all of which could profit from improvement. The area for priority effort, however, is underwater search: sonar. This is the most significant contribution to the task group's ability to find submarines. We need a detectable sound response from every piece of the ocean where a submarine could lurk. Areas which we cannot enter electronically, we must enter physically with the hydrophone. We need a variable depth sonar to overcome the difficulties caused by temperature discontinuities at all possible target depths.

Like the carrier, the destroyer needs automatic plotting and control facilities. The destroyer skipper often finds himself pursuing a contact in company with another destroyer or two, a P2V, three helicopters, two S2F's and an antisubmarine submarine. Just keeping track of his teammates is a major task. Directing all of them in effective coordination demands electronic help. During the 1960's, analog computers will give way to digital computers. Digital language will be used within the destroyer and between ships for data transmission. Information from ECM, radar, sonar and other detection systems will also be digitalized. It is quite conceivable that detection information from one vehicle may be sent in digital language to another's fire control system so the second may attack a target detected by the first.

Modern submarine improvements have drastically reduced the reaction time available to an opposing surface ship. To get the jump on today's submarine and stand him off long enough to get in the first lethal shot, the destroyer needs more effective electromagnetic and acoustic jamming and deception systems. ECM and radio direction-finding equipment must be developed to insure coverage of all submarine frequencies quickly enough to produce a lethal fire-control solution on a single submarine slip of the tongue. High-definition sonar is needed for shallow-water investigation and to help sort out a submarine from fish, wrecks, pinnacles or underwater disturbances in a manner just as positive, but a little more comfortable, than intercepting a torpedo or missile amidsthips.

For the future

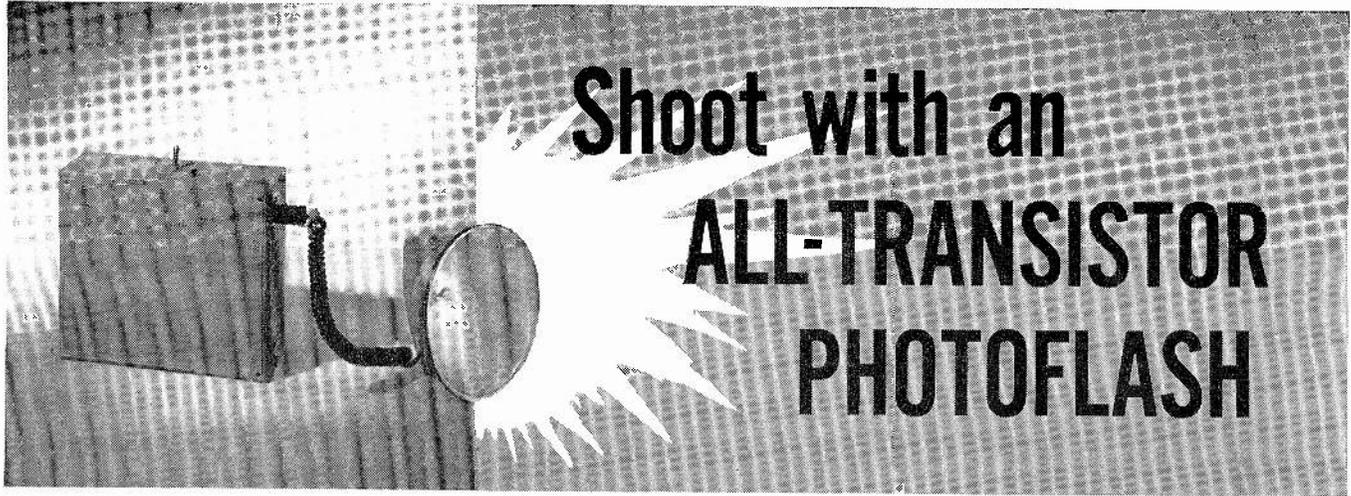
Detection systems will grow larger and more complex as their power requirements are increased and their frequencies lowered. As the destroyer electronics systems increase in size, in numbers of individual units and in complexity, maximum attention must be given to developing equipment both highly reliable and easy to maintain. That means a move toward such simplifiers as solid-state components, printed circuitry, modular construction and automatic warning of circuit malfunction.

Finally, to make the whole system effective, a precise navigation system must be developed for the destroyers. Many obstacles must be overcome before a small, precise shipboard navigation system can be developed. In the meantime, it may be necessary to develop a highly accurate relative position-fixing system, using a beacon or similar device, on a ship within the formation as a common reference point.

The antisubmarine submarines working underwater are up against the same sort of problems as destroyers. They, too, depend on active and passive sonar, radar, radio and ECM intercept, and a fire-control system unique but pointed toward the same solution. Unlike other vehicles, however, they have an additional and very uncomfortable problem. They look, sound and act just like the guys we all are after, a built-in invitation for a disastrous mistake we cannot afford to make. Neither can we afford to forfeit their services. Submarines are my most effective underwater ears.

First of all, we need a foolproof method of underwater identification, a submarine IFF that allows absolutely no mistakes. As soon as we are sure of who's on first, we must then give him a secure hot line to his surface and airborne teammates, so that he can stay silent at his best listening depth while they go after the target he is zeroed in on. And to make sure that my submarine finds the target before the target hears him. I need a submarine sonar that can give me both bearing *and* range passively. The minute a submarine has to put energy into the water actively, he has lost the initiative (and maybe his retirement benefits if it comes down to a shooting match).

Calling off the capabilities and limitations of each of my vehicles individually may be misleading. Task Group ALFA is not just a collection of individuals. A year's operations have proved the validity of the integrated antisubmarine weapons system concept—each unit and each type contributing its capabilities to compensate for the inherent limitations of others, and using the strengths of its teammates to plug the gaps in its own capabilities. Today this coordination within the task group is done with people and doctrine. All our needs have a common denominator—*automatic* navigation, *automatic* communication, *automatic* data exchange, *automatic* functions to free people for decision making, command and coordination. Unless the technical details can be taken care of by automation, computers and electronic analysis, people and doctrine alone will not be able to cope with the ever-increasing antisubmarine problem. Tomorrow's submarines will tax the capabilities of people to the utmost in just making decisions and pushing the right buttons. Every time people have to stop to figure out a problem that pressing the right button could solve automatically, the submarine has another jump on us that we cannot afford to give it. END



By RICHARD W. AHRONS

THE three-transistor electronic photoflash described here eliminates two major difficulties common to the many commercial units that use size-D flashlight cells for power. These problems are excessive battery drain during standby operation, and variation of light output with output voltage, decreasing as battery voltage drops with battery life. Both are overcome by the unique automatic control feature of this transistor unit.

Electronic photoflash operation is based on charging a large capacitor to about 450 volts over a period of 5-20 seconds and then discharging it through a photoflash lamp, creating the flash. The discharge usually has a 1/500-1/2,000-second duration. The output control built into the transistor unit maintains a constant output voltage, while output of commercial units may vary considerably with battery life.

Size-D flashlight cells are used in many portable photoflash units because of their low cost. Then, too, you can

get them almost everywhere. Their life in a 53-watt-second photoflash unit is about 80 flashes, a convenient number for the amateur photographer.

The dc-to-dc conversion is handled by rectifying the boosted transformer output of a transistor oscillator—commercial units use mechanical vibrators. If the dc-to-dc converter continues to operate after the capacitor is fully charged, a large amount of battery power is wasted. This is prevented by the automatic control feature of my unit, which turns off the oscillator when the photoflash capacitor reaches the proper voltage.

Here is an abbreviated list of performance characteristics of the photoflash unit:

- Charging time*—15 seconds
- Battery current drain* during charging—30 ampere-seconds

*Charging time and battery drain during charging was measured for charging the capacitor from 100 to 410 volts with fresh cells.

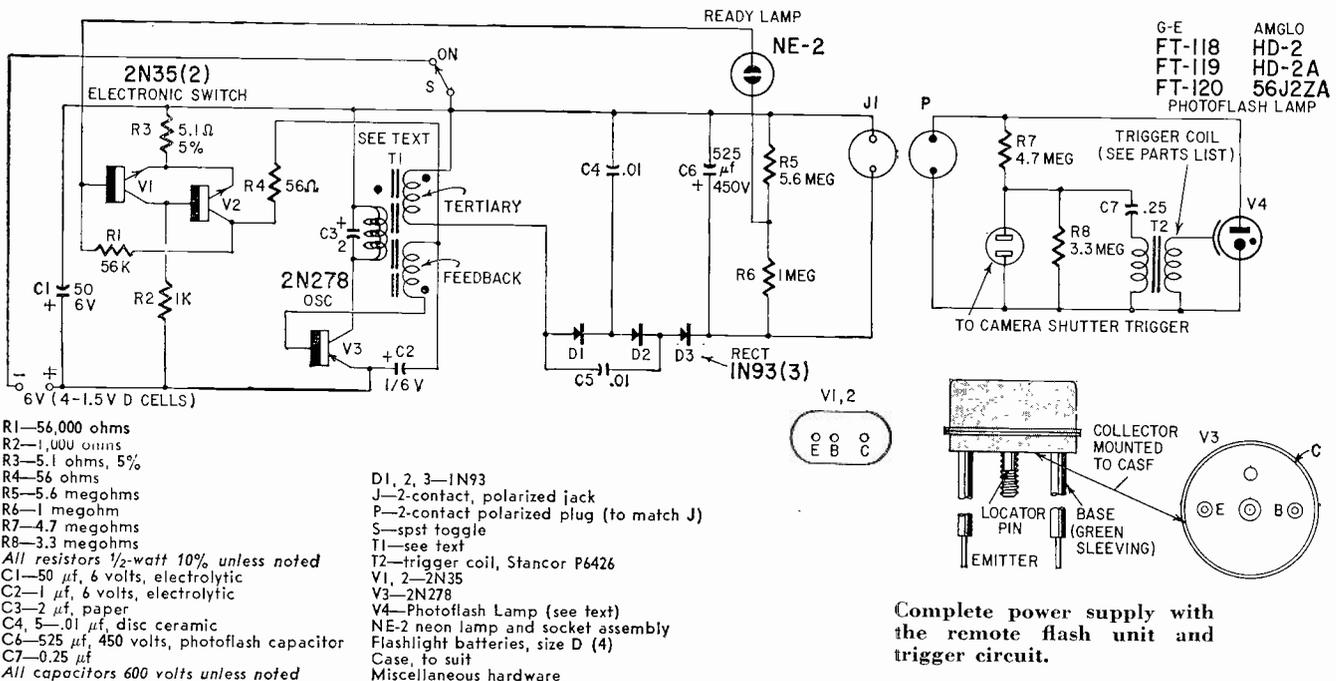
- Battery current drain during standby operation—15-25 ma
- Automatic control at output
- Constant light output
- Ready light

Transistor life is much longer than that of an electromechanical vibrator. Size and weight advantages are also obtained.

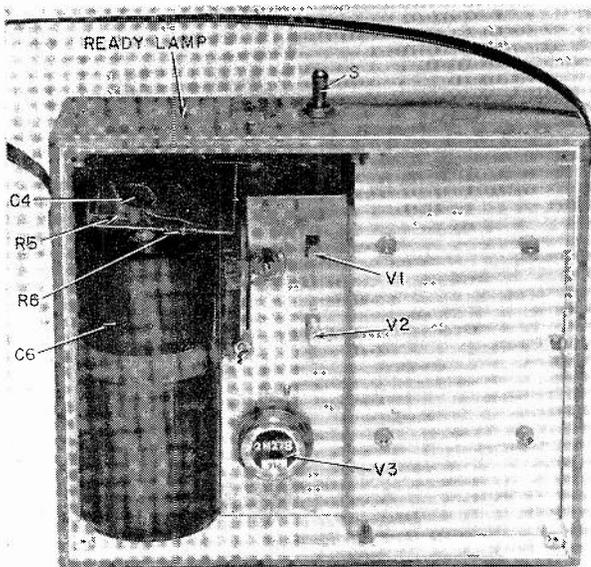
How it works

When the unit is turned on, capacitor C6 (see diagram) charges to about 450 volts and the neon ready lamp goes on. This triggers a switching circuit which turns off the transistor oscillator. If the photoflash lamp is not flashed before the capacitor voltage decays to about 95% of its top value (when the neon lamp went on), the transistor oscillator goes back into operation and brings the charge back up to a useful level.

The circuit of the transistor photoflash is shown in the diagram. Oscillator transistor V3 is kept oscillating



Complete power supply with the remote flash unit and trigger circuit.



Transistors are readily accessible should replacement become necessary.

by feedback through the transformer to its base. Base bias is provided through resistor R4, transistor V2 and resistor R3. Capacitor C3 and the inductance of transformer T1's primary set the oscillator frequency at about 10 kc. Diodes D1, D2 and D3 and capacitors C4 and C5 form a voltage tripler.

Automatic voltage control

When the voltage across capacitor C6 reaches 450, the neon lamp, which also acts as a ready light, goes on and the unit is ready to fire. Current through this lamp appears as base bias at transistor V1, normally cut off. This permits V1 to conduct, increasing the voltage drop across R2 and lowering V2's base bias.

The lowered base bias cuts off V2, which removes base bias from V3. This cuts off V3, stopping the oscillation. As the voltage across capacitor C6 drops because of leakage, current through the neon lamp also drops. As this current decreases, the voltage drop across R5 decreases and V2's base bias rises. When this bias has increased sufficiently, V2 conducts once again and applies base bias to V1, starting the oscillator. This cycle will repeat itself as long as the batteries last.

Points to remember

The values of R1 and R2 are critical but depend upon the particular transistors used. Try adjusting R2 over a range of values, using several values for R1. These resistors should be selected so that the oscillator resumes operation when the charge on capacitor C1 drops to about 95% of peak.

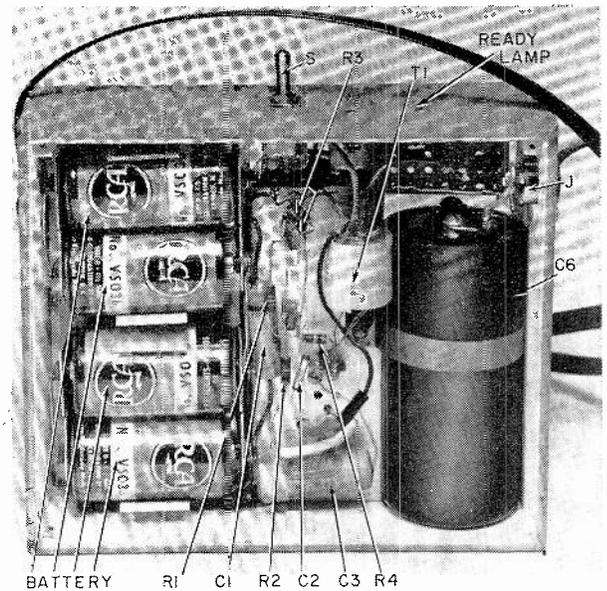
Transformer T1 is homemade. The ferrite core comes from a flyback transformer. The core cross-section is about $\frac{3}{8}$ inch square. The primary winding consists of 12 turns of No. 33 enameled

magnet wire, bifilar layer-wound, connected in parallel. The secondary (feedback) is 18 turns of No. 24 enameled magnet wire, layer-wound on top of the primary. The tertiary is made up of 660 turns of No. 30 enameled Formvar magnet wire, layer-wound in 10 layers with 3-mil Kraft paper separating each layer.

Using the photoflash

When the unit is completed and after all connections have been checked, insert the transistors and batteries. Turn the unit on. In about 15 seconds, the neon lamp will light. As soon as it does, you are ready to go. After each flash the light will go out and you will have to wait about 15 seconds before using the unit to take another photo.

Several photoflash lamps can be used



Batteries are on the reverse side, with most of the smaller components.

with this circuit. General Electric makes three, the FT-118, FT-119 and FT-120. All are electrically identical and differ only in basing. The FT-118 is the simplest mounting of the group. Using a Weber Brass Co. (3344 Payne Ave., Cleveland, Ohio) reflector, the lamp is inserted in the rear of the reflector and a slight crimp on the rear edge of the collar holds it in place. The FT-120 has a four-pin radio tube base and the FT-119 is baseless. It has two leads and must be specially mounted to avoid breaking them.

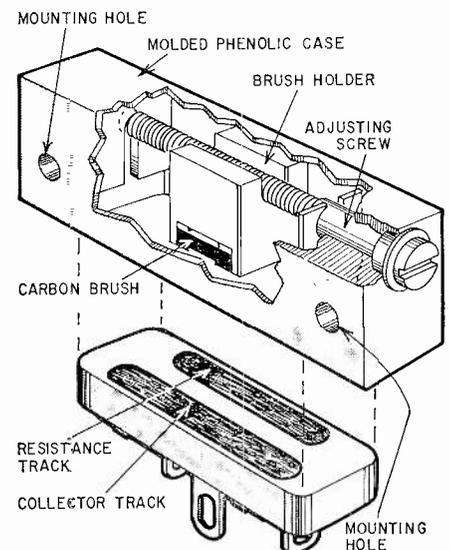
Anglo also has a group of photoflash lamps you can use. They are the HD-2, HD-2A and 56J2ZA. They come separately or with a reflector. The trigger circuit for both groups of photoflash tubes (see diagram) is built into the flash holder. END

ADJUSTABLE FIXED RESISTOR

Compact adjustable resistors for continuous stepless control are now being made for equipment manufacturers in values from 100 ohms to 2.4 megohms— $\frac{1}{4}$ -watt rating. These sealed precisely adjustable units are noninductive, watertight rheostats or potentiometers with a small slotted screw for screw-driver setting. They may be ordered with lugs (as shown) or wire pins for mounting.

The screw turns up to 25 full revolutions, moving a carbon contact brush across the molded resistance track, changing the amount of track in the circuit. Tolerance is either 10% or 20%. These units can be used at temperatures from -55° through 120°C and are manufactured by Allen-Bradley Co.

Resistors of similar construction and operation are made by other firms.



MAGNETOMETER AT WORK IN OUTER SPACE

Putting a magnetometer in a satellite, firing it into space, and getting data back is not a simple process, but electronics makes it work

By **DOLAN MANSIR***

* Varian Associates, Palo Alto, Calif.

The complete Vanguard III satellite. It is now in orbit around the earth.

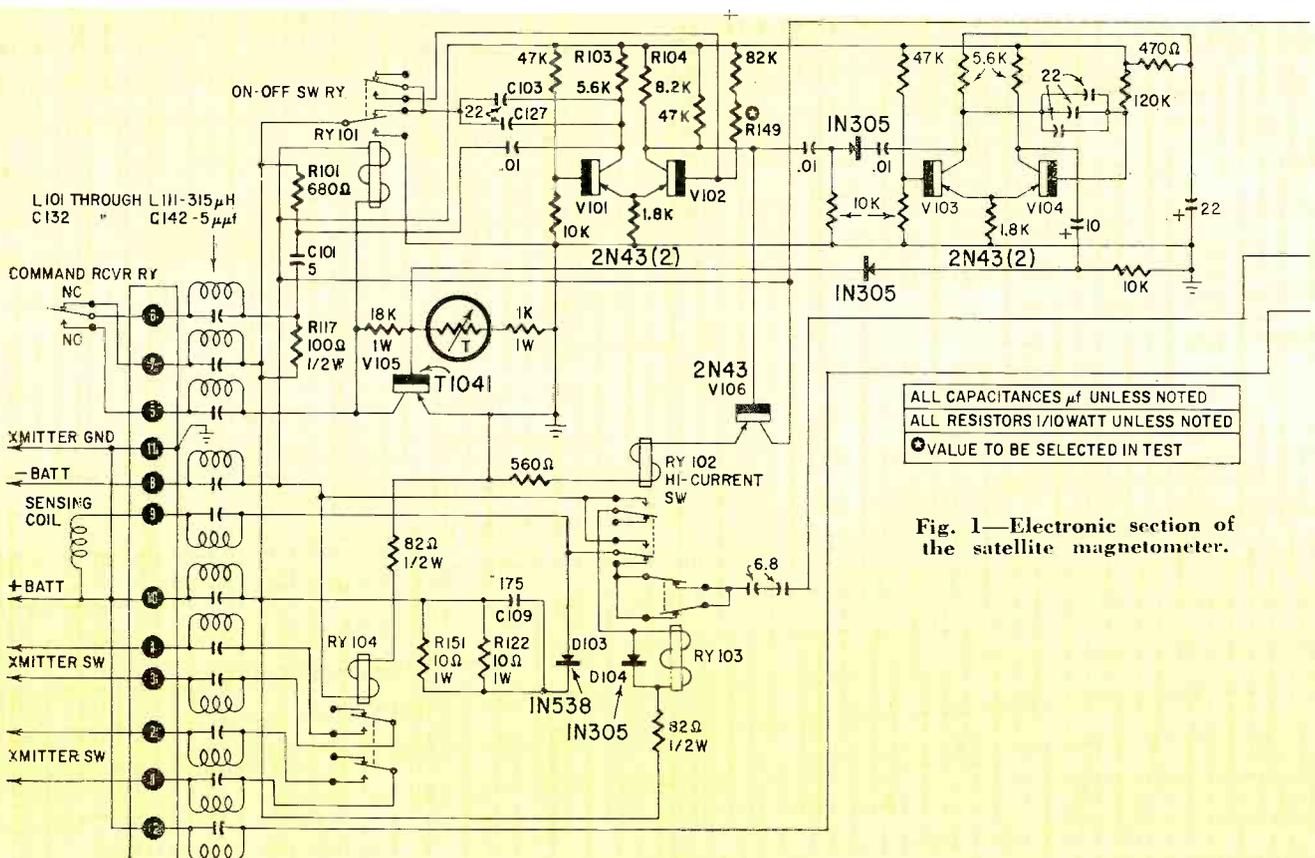


Fig. 1—Electronic section of the satellite magnetometer.

MAGNETOMETER is the name of an instrument for measuring magnetic forces or fields, especially weak fields such as the earth's.

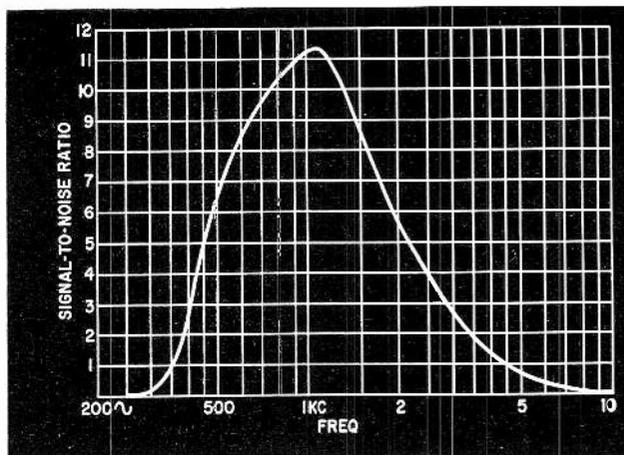
A simple magnetometer is a magnetic compass which measures direction. A slightly more complicated mechanism is a compass needle mounted on two jeweled bearings and carefully balanced for gravity effects. It can be used to measure the angle of the flux lines.

Magnitude can be measured with a variety of instruments ranging in complexity from a bar magnet suspended on a quartz thread to the instrument described below.

Intensity type magnetometers have been used for a number of years in geophysical exploration and submarine detection. In some geophysical applications the magnetometer is flown over a given area in a carefully plotted grid. Deviations from the ambient magnetic field for the area may indicate mineral deposits. Iron ore is most successfully located in this way. Of scientific interest is the fact that some magnetic materials imbedded in the earth are magnetized in a direction different from the direction of the earth's field in that area, indicating that at some time in the earth's history the magnetic fields were somewhat different than they now are.

The need to have a very accurate absolute measurement of the earth's magnetic field led to the development of the proton magnetometer, and advanced space technology spurred the

Fig. 2—Typical response curve of the satellite's amplifier.



The measurements were telemetered on the US space frequency of 108 mc (the tracking transmitter on 108.03 mc) to ground stations along the "picket fence" stretching from Blossom Point, Md., to the tip of Chile. The batteries on Vanguard III died Dec. 11, 1959.

The Vanguard magnetometer was developed by Varian Associates, Palo Alto, Calif., for an NASA (National Aeronautics & Space Administration) group headed by Dr. James Heppner. Dr. Heppner was associated with the Vanguard program at the US Naval Research Laboratory until Oct. 1, 1958, when the project was transferred to the NASA.

How a magnetometer works

Protons are simply the nuclei of hydrogen atoms, and there are two

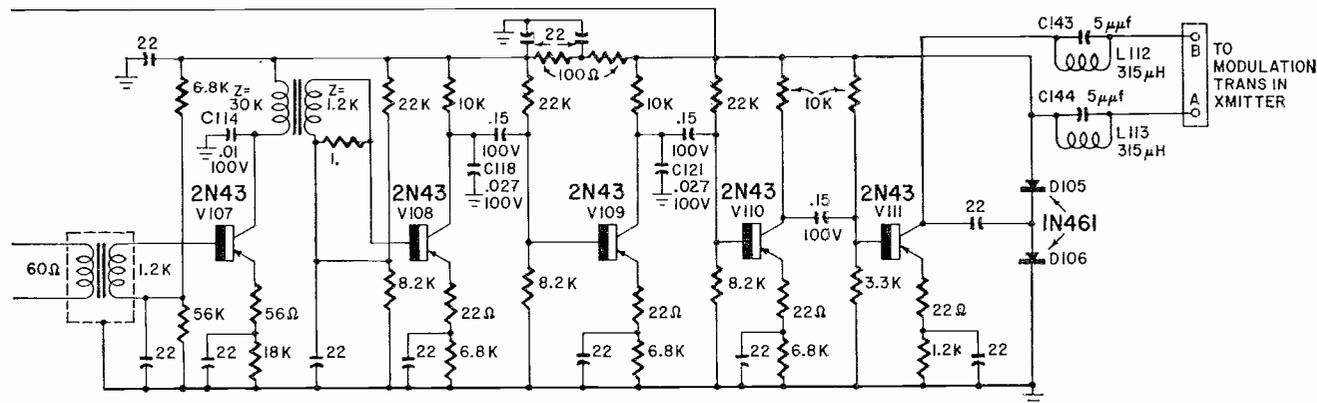
The equation for the precession frequency, *f*, is:

$$f \text{ (in kc)} = \frac{H \text{ (in gauss)}}{0.234868}$$

The constant 0.234868 is derived from the gyromagnetic ratio and *f* is an audio frequency relatively easy to telemeter. A nominal value of the earth's magnetic field is 0.5 gauss.

Causing and detecting precession

What does it take to cause a free precession and how do you detect it? If a bottle of water or other substance containing many hydrogen atoms is placed in a strong nonoscillating magnetic field, the nuclei of a majority of the atoms will align themselves with the applied magnetic field. Now, if the magnetic field is suddenly removed, the spinning atomic gyroscopes are given



development of magnetometers for space measurements.

Magnetometer in space

If you start a gyroscope spinning and then try to tip it over by giving it a push at the top or side, it won't fall over, but will start to wobble or precess. This simple principle can be used to explain the operation of the magnetometer now circling the earth in a Vanguard III satellite. The device, called a proton free-precession magnetometer, measures the earth's magnetic field above and in the highly ionized regions of the upper atmosphere.

reasons why they can be used to measure magnetic fields: Protons have magnetic moments, like very small bar magnets.

They spin on an axis through their magnetic poles, or at least their behavior indicates they do.

The magnetic moment and spin determine a property known as a gyromagnetic ratio. This merely means that the tiny bar magnets, spinning on their axes, will precess at a given frequency (like the gyroscope previously mentioned) if they are placed in a given magnetic field—if you follow the right sequence of steps to cause the precession to occur.

a "push" by the earth's magnetic field, and they start to precess in phase at a frequency given by the equation above. After about 3 seconds, the phase relationship is lost as the nuclei align with the earth's field and it is necessary to start over with the aligning process.

If the aligning field is exactly in the same direction as the earth's field, the protons do not get a push and no precession occurs. For best signal amplitude, the aligning field should be at right angles to the earth's field. Alignment affects only the signal amplitude, not the signal frequency.

In practice, the protons are actually placed in a bottle which is put in the

ELECTRONICS

center of a simple solenoid coil of wire. The coil does double duty—it furnishes the strong magnetic field to align (polarize) the protons, and the precessing magnetic moments of the protons induce the signal voltage in it. This is exactly analogous to an ac generator.

In the satellite magnetometer, 7 amperes dc is passed through the coil for 2.2 seconds. A relay then switches the current off and connects the coil to a high-gain band-pass amplifier which modulates the telemetry transmitter.

The Vanguard satellite magnetometer has four essential parts:

- ▶ A liquid abundant in hydrogen
- ▶ A coil of wire

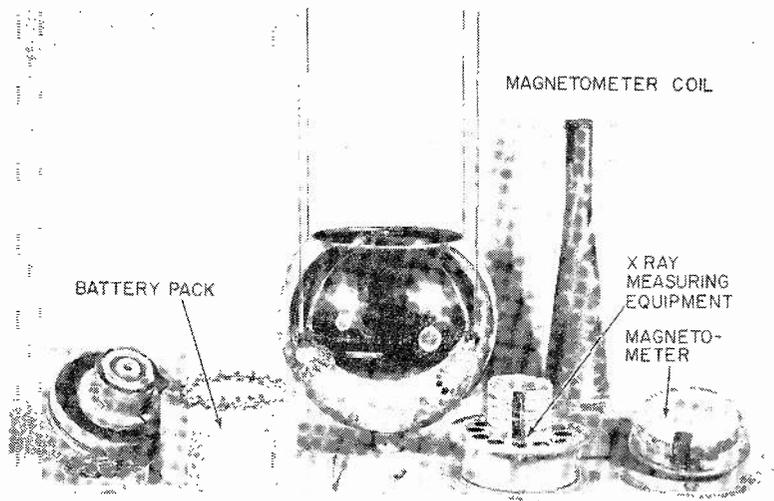


Fig. 5—Major components in the satellite.

- ▶ A switching circuit, called the programmer
- ▶ A band-pass amplifier

The liquid chosen for the satellite ride was normal hexane, commonly known as naphtha. It was picked chiefly because of its low freezing temperature.

The coil was made of 600 turns of No. 15 HF (heavy Formvar) aluminum wire on a 1-inch diameter phenolic cylinder 4 inches long. The coil form serves as a bottle to contain the hexane, with phenolic end plates cemented to the ends of the coil with Armstrong A-2 adhesive. An O ring sealed brass screw plug in one end allows filling with hexane. This coil is exposed to the outside atmosphere, or the lack of it, when in flight. The entire outside of the coil is covered with an etched Faraday shield for rf shielding.

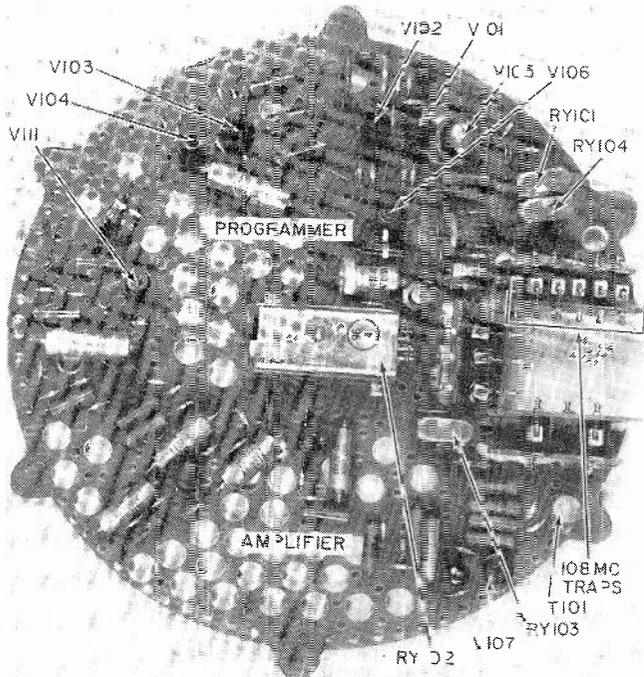


Fig. 3—Magnetometer module used in the Vanguard III.

Measurements on command

To conserve battery power, the magnetometer makes a measurement only on command from the ground. The programmer must respond to a momentary contact closure in a command receiver within the satellite, go through one polarize-measure cycle and turn off to await another command.

When the command relay's contacts close, terminals 5 and 6 on the magnetometer are shorted (Fig. 1). RY101, the on-off switching relay is energized through R117. The contacts of RY101 do two things: they turn on the magnetometer circuits on command, and they keep C103 and C127 charged, via R103, while the magnetometer is off. When the command receiver relay drops out, after 0.1-second closure, RY101 is held energized by V105's collector current, and the magnetometer is held on.

Immediately upon turn-on, the multi-vibrator (V101, V102) is triggered on because of the charge on C103 and C127. In a steady state, the multi-vibrator would be stable with V101 cut off and V102 operating near saturation. In the triggered state, V102 is cut off, resulting in a negative pulse of 2.2 seconds' duration at V102's collector. The negative pulse is directly coupled

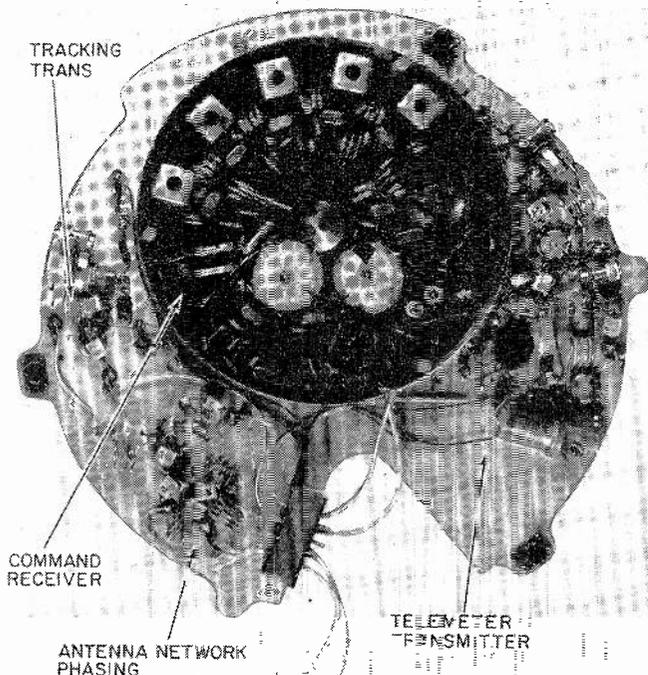


Fig. 4—The command receiver, tracking transmitter and telemetry transmitter that went into the Vanguard III.

to V106's base, operating as an emitter follower with relay RY102's coil in the emitter circuit.

RY102 is the high-current switching relay, so current is applied to the magnetometer coil and the protons are "polarized." The negative pulse at V102's collector is also differentiated and the trailing edge is used to trigger a second one-shot multivibrator (V103, V104), resulting in another negative pulse 2.2 seconds long. This pulse delays the turning off of the circuits while the precessing protons induce a signal into the magnetometer coil. This is the measuring time.

The trailing edge of the second pulse (differentiated also) is coupled to V105's base, driving this transistor toward cutoff, and allowing RY101 to drop out and turn the magnetometer off.

Relay RY103 is energized via RY102's contacts. RY103 disconnects the amplifier from the magnetometer coil during polarize time. Diode D104 slows RY103's contact reclosing time so the amplifier is reconnected to the coil only after transients caused by turning off the polarizing current have damped out.

A circuit consisting of R151, R122, C109 and D103 is connected across the coil to help damp out transients and limit the inductive current surge in the coil when RY102 opens.

Another relay, RY104, is energized all the time the magnetometer is on. It turns on the telemetry transmitter. This saves battery power during orbit. If the command receiver should fail to open after a command, the magnetometer would stay turned on because RY101 is held energized. If this condition should last beyond the time when the magnetometer would normally turn off, the space experiment would be permanently finished, since the turn-off pulse would be ineffective, even if the command relay did eventually drop out.

To safeguard the equipment, C101 is allowed to discharge through R101 to generate another trigger pulse to the first multivibrator, resulting in another polarize-measure cycle, when the command relay opens.

Transmission of data

The amplifier boosts the signal level sufficiently to modulate the telemetry transmitter. The signal level induced in the magnetometer coil by the precessing magnetic moments of the hydrogen nuclei is in the order of $2 \mu\text{v}$, so it is very important that the amplifier have a good noise figure. A combination of careful matching of the coil to the input base, choosing a low-noise transistor and operation of the first stage at high gain improves the amplifier's signal-to-noise ratio.

The amplifier's frequency response is determined largely by coupling capacitors in the last three stages, and by bypass capacitors C114, C118 and C121. Unbypassed resistors in the emitter circuits help stabilize the amplifier gain for temperature changes. The amplifier output voltage is clipped by D105 and

D106, to prevent overmodulation of the telemetry transmitter. The modulation transformer, V111's collector load, is located in the transmitter module.

With a battery supply of 14.6 volts, the output voltage into a 600-ohm load will be 4.4 peak to peak. A typical amplifier response curve is shown in Fig. 2. The upper frequency limits are determined by the earth's magnetic field at Washington, D. C., and Cape Canaveral, Fla., where ground tests were made. The lowest precession frequency encountered in space by Vanguard III to date is 300 cycles, and the highest 1,600 cycles.

Fig. 3 shows a completed magnetometer module. Terminals for external connections are in the rectangular area, and each terminal has a tuned trap (108 mc) to keep rf out of the magnetometer circuits. The relay in the center of the circuit card is the high-current-carrying relay (RY102) and is placed in the center because it is the heaviest component. The printed-circuit board is perforated so the Eccofoam potting compound can cover both sides.

Fig. 4 is a picture of a command receiver, tracking transmitter and

telemetry transmitter. The transmitters were developed at Naval Research Laboratory for use with the Varian magnetometer. The command receiver, also developed at NRL, is used for a number of satellite experiments.

Fig. 5 shows the major components in the satellite. The batteries fit in the bottom of the magnesium can in the lower hemisphere. The X-ray equipment sits on top of the battery pack. The potted magnetometer sits on top of the X-ray equipment with the transmitters and command receiver on top of the magnetometer.

The satellite battery pack is made of Yardney Silvercels, partly because they are nonmagnetic. Battery capacities are designed so that batteries for all circuits should go dead about the same time. Probably the command receiver batteries will fail first. With a maximum of 50 commands per day, the magnetometer batteries were expected to last about 90 days (actual life was 84 days).

The contributions of John Drake and Kelsey Robinson to the magnetometer development are gratefully acknowledged. END

HEADLIGHT TATTLETALE

By R. E. YOUNG

HOW many times have you walked away from your car and left the headlights on? Once is enough. The device described and illustrated here gives a warning whenever you turn the ignition off while the lights are still on. The warning comes in the form of a buzzer or a red light.

Wire A goes to the headlight terminal on the light switch. Lead B goes to the switched side of the ignition switch. Lead C is attached to the chassis—the dash or other convenient ground. And lead D is connected to the unswitched wire on the ignition switch or headlight switch.

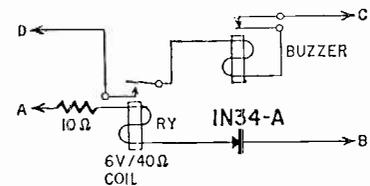
Circuit operation is easy to follow. With the headlights on, point A is at battery potential (6 or 12 volts). If the ignition is on, point B is at the same potential and no current flows through the relay. If the ignition is turned off, point B is no longer connected to the battery, but now forms a low-resistance (compared to the relay and diode) ground path through the ignition system. Therefore, current flows from A through the diode and relay, closing the relay's contacts and ringing the buzzer or lighting the warning lamp.

The diode keeps the relay from operating when the ignition is on and the lights are off. If the diode were not included, point B would be at battery potential, with a low-resistance path to ground through A and the headlamps when the ignition was on with the lights off. If it were not for the diode's high back resistance, current would flow, closing the relay and activating the alarm.

The diode connection shown is for cars with the negative battery terminal grounded. If your car has the positive terminal grounded, reverse the diode. In other words, if the alarm goes off with the ignition and the lights off, but not the other way around, the diode is connected backward.

The buzzer is not operated directly through the diode because of the high currents needed. A small lamp could probably be run directly off the diode.

The relay is a miniature low-drain 6-volt unit (Gyro Electronics, 325



Canal St., New York, N. Y.) that draws very little current. It can easily be adjusted to operate on less than 6 volts if necessary. If relay action is sluggish or nonexistent in this circuit, a quarter- or half-turn clockwise on the relay adjustment screw should be all that is needed. If the relay is mounted to the car's chassis or dash by a screw through its core, lead C is not needed, as the core is the normally open contact on the relay.

With minor modifications, this circuit can be used with a 12-volt system. The buzzer or bulb in this case should be a 12-volt unit and a resistor of about 50 ohms or so should be in series with the relay coil. END

NEW SEMICONDUCTOR RADIATION DETECTOR

Solid-state device approaches molecular size;
is 1,000 times as fast as earlier detectors

By **FRED SHUNAMAN**
MANAGING EDITOR

SCIENTISTS of the Hughes Aircraft Co. have just unveiled a radiation detector expected to have important applications in space exploration, military work, medical research and treatment, nuclear research and industrial processes. The device is 1,000 times as fast as the ionization chamber and operates at much lower voltages (3 to 30 volts is typical, though higher voltages can be used and in certain applications the contact potential of the diode is all that is required). It can be hooked up as a radiation-level detector to check a suspected contaminated area or as a laboratory instrument to measure the energy of the rays striking it. At present used as a detector of charged particles, it may be modified to act as a neutron detector as well.

Transistors (as well as semiconductor diodes) are radiation-sensitive. This is unimportant in most applications, but might render transistor equipment worthless in outer space, or even on earth under nuclear attack. But this weakness turned out to be a very valuable advantage when scientists started looking for a quicker, cheaper and better radiation detector. Their work culminated in the detector shown here (in enlarged model form) with the man who was chiefly responsible for its development, Dr. Stephen S. Friedland.

The Hughes radiation detector differs from an ordinary silicon diode in only two respects—the shallowness of the n-region and the purity of the silicon. Fig. 1 shows a typical p-n junction and a solid-state radiation detector for comparison. The n-layer may be as little as 1 micron thick—the rest of the diode is p-layer.

The diode is hooked up with a battery of a few volts in reverse bias (the direction of minimum current flow). The positive voltage applied to the n-portion

Dr. Friedland examines a vastly enlarged model of his new device.



of the diode tends to draw all the electron charge-carriers in that portion toward the end of the diode; the negative voltage at the other end attracts the holes, thus leaving a depletion region, in which there are few charge carriers, over the larger part of the semiconductor. This depletion region is made larger than in ordinary diodes or transistors by using purer silicon.

A charged particle penetrating the surface produces electron-hole pairs in the depletion area. Because of the voltage across the diode, the electrons thus formed are drawn toward the positive end and the holes toward the negative. Thus each particle produces a pulse in the small current through the diode, a pulse that is normally applied to the input of an amplifier.

The device has been used chiefly as an alpha-ray detector, but beta-ray detection is also possible, and neutrons can be detected by coating the n-surface with a material that emits a charged particle when struck by a neutron.

The new detector's small size, ruggedness and great speed will permit applications impossible to older devices. For example, it can be used in a hypodermic needle to penetrate malignant tissue in which boron has been concentrated and irradiated to kill cancerous cells. Inability to judge the amount of boron in the tissue or the exact effects of the irradiation made it difficult to obtain optimum results with this type of treatment. With a radiation-measuring device the guesswork can be eliminated, and the amount of malignant tissue destruction by the tiny atomic bombs produced by irradiating the boron can be closely ascertained.

When designed as a radiation detector, the new instrument can be a boon to soldiers in suspected "hot" areas or civilian decontamination squads. Instead of a relatively bulky and fragile ionization chamber, a detector on the end of a long rod can be used to explore the area ahead for dangerous radiation levels.

A three-dimensional device consisting of thousands of individual detectors in a sort of cubical lattice may well open a new door to nuclear research in space. Tracks of nuclear particles are plotted today with a similar cubical device built up of stacked photographic plates or films. Placed in the nose cone of a missile, it is useful only if the nose cone is recovered and then only after painful analysis of the particle tracks by comparing each film with those between which it was sandwiched. The three-dimensional solid-state detector assembly, fitted with coincidence circuits to follow the track of particles through the unit, could radio to earth the track, speed and energy of particles striking it. A similar device could be used for nuclear research in earth-bound laboratories, superseding the costly and time-consuming equipment and methods now in use.

As more is known about the possibilities of the detector, new applications will no doubt become evident. Already it is suggested that it may have important uses in the control circuits of nuclear reactors, and its small size opens many applications in industry, such as flow measurement, thickness gauging, level checking, and other processes where radioisotopes can be used with the detector. **END**

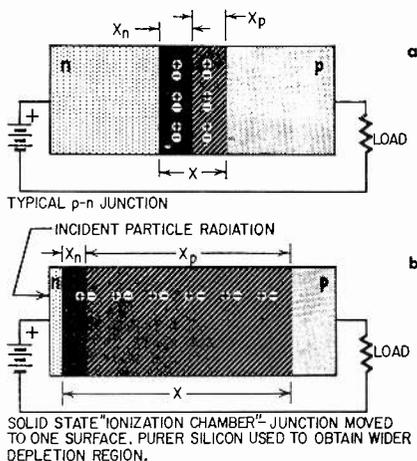


Fig. 1—Comparison of detector with ordinary n-p diode. X areas are depletion regions; X_p in p-type and X_n in n-type material.

TRANSISTOR AM-FM PORTABLES

ARE HERE...

Sony FM-AM all-transistor portable compares favorably with vacuum-tube versions

By R. F. SCOTT

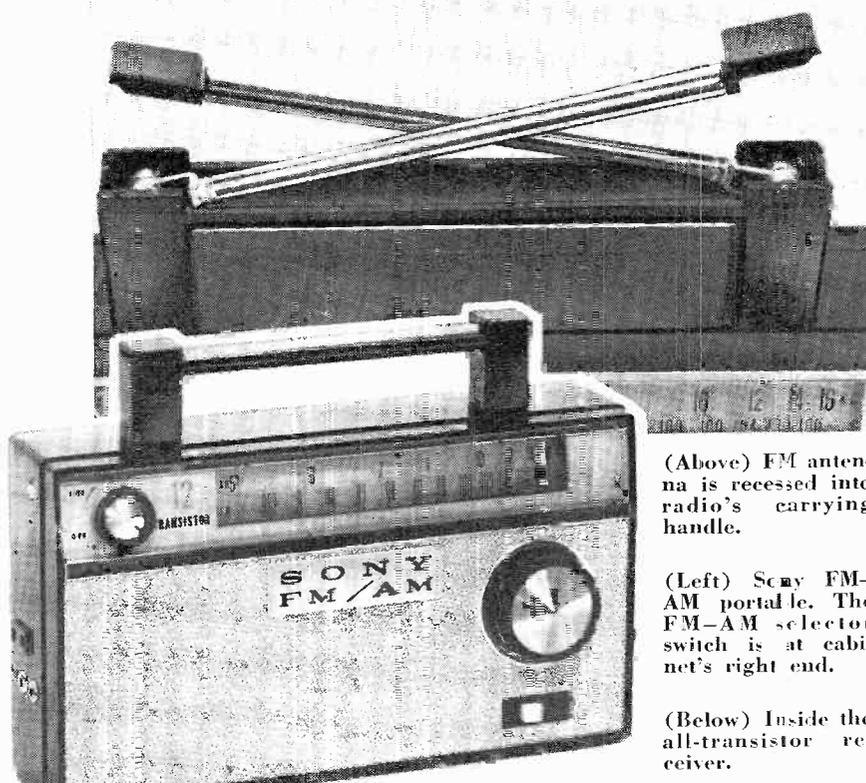
TECHNICAL EDITOR

MOST of the transistor FM-AM receivers that have been announced in the past were generally pre-production prototypes that never got as far as the production line, or regenerative or superregenerative types that were sadly lacking in performance and ease of operation. The Sony TFM-151 15-transistor portable has been on the market for about a year and has just been joined by the newer 12-transistor TFM-121. These sets, Japanese imports distributed in this country by Delmonico International (42-24 Orchard St., Long Island City, N. Y.), are superhets that compare favorably with many tube type FM-AM portables.

The TFM-121, described in this article, is in an unbreakable plastic case $9\frac{1}{4}$ inches wide, 5 inches high and $2\frac{1}{4}$ inches deep and weighs about 3 pounds with batteries. A close look at its circuitry and features will give you an insight into the types of sets you'll be servicing in the not too distant future.

The set uses 12 transistors and 4 diodes and is powered by 4 type C cells in series to deliver 6 volts. It has separate FM and AM front ends, a common 10.7-mc and 455-ke if amplifier, separate discriminator and AM diode detector, FM afc, a three-stage audio amplifier for FM and AM output, and detector and multiplex output jacks. Specifications of the TFM-121 are:

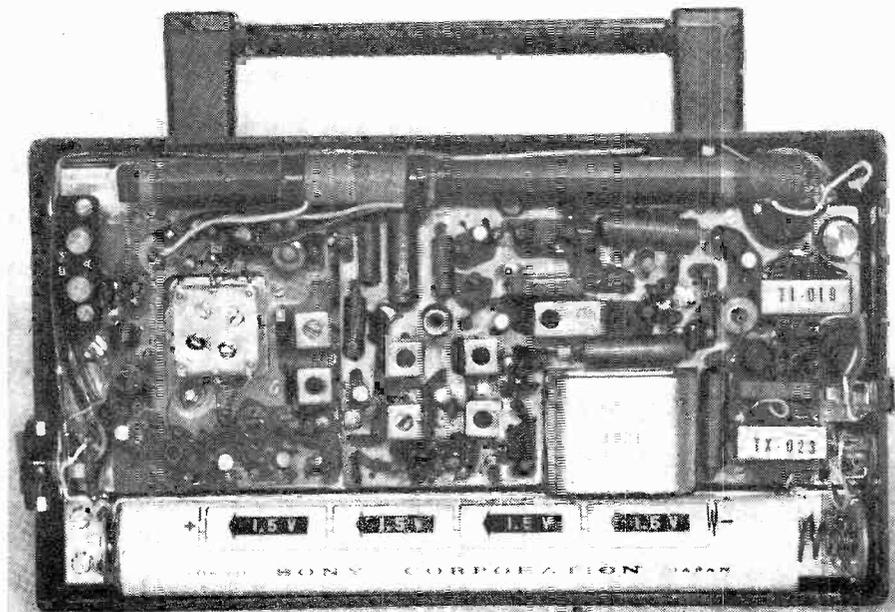
Frequency range	FM 87 to 109 mc AM 435 to 1605 ke
Intermediate frequencies	FM 10.7 mc AM 455 ke
Sensitivity	FM (max) $10\ \mu\text{v}$. This is approximately the value for 20-db quieting. $20\ \mu\text{v}$ for 30-db signal-to-noise ratio. AM (with built-in antenna) $78\ \mu\text{v}$
Selectivity	FM -3 db at 150 ke off resonance AM -20 db at 10 ke off resonance

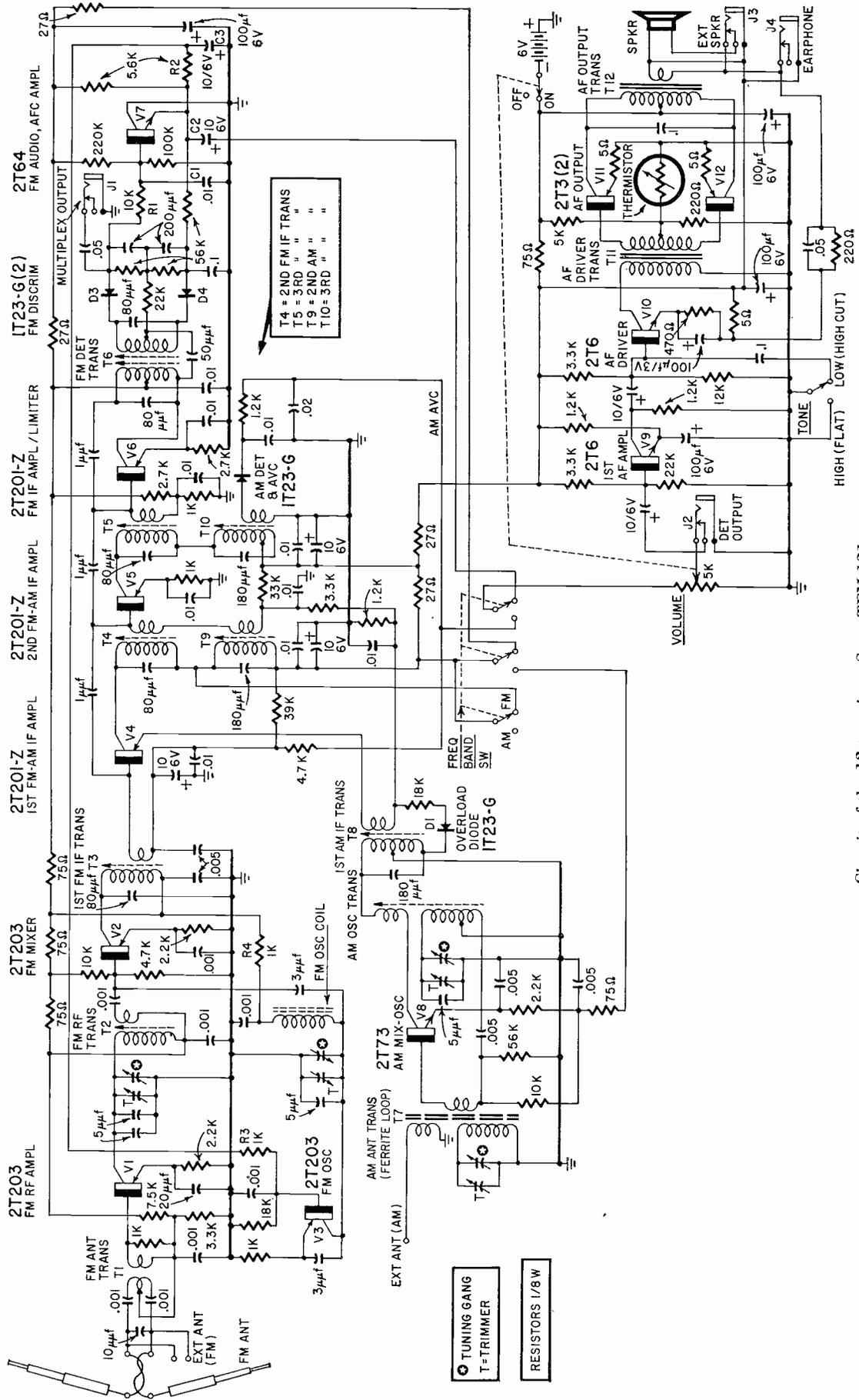


(Above) FM antenna is recessed into radio's carrying handle.

(Left) Sony FM-AM portable. The FM-AM selector switch is at cabinet's right end.

(Below) Inside the all-transistor receiver.





Circuit of the 12-transistor Sony TFM-121.

FM de-emphasis	50 μ sec
Power output	300 mw max, 150 mw before clipping
Distortion	2% at 50 mw output
Multiplex and detector output	0.1 v rms
Zero sig current drain	FM 18 ma AM 13 ma
Speaker	3 x 5-inch oval PM

Circuit analysis

The circuit of the Sony TFM-121 is shown in Fig. 1. On FM the set uses either the telescopic FM dipole built into the carrying handle or a 75-ohm external antenna. The antenna is transformer-coupled to the base of V1, which operates as a common-emitter amplifier. Primary and secondary of the coupling transformer are untuned. Although the 2T203 transistor in the rf amplifier circuit has an alpha cutoff just above 100 mc, approximately 10 db of gain is obtained through a small amount of controlled positive feedback developed by using an unusually small bypass capacitor across the emitter bias resistor.

The rf transformer's primary is tuned, and the signal is applied to the mixer's base through a low-impedance secondary. The mixer is a common-emitter type, biased for optimum conversion gain at the operating frequencies. The 2T203 FM oscillator is a Colpitts type operating 10.7 mc below the signal frequency. When operating below the carrier, the oscillator covers a lower range of frequencies and is more stable and efficient.

The FM if amplifier consists of three 2T201-Z high-gain p-n-p transistors as common-emitter amplifiers. These transistors have a fairly high base-to-collector capacitance so there is a considerable amount of positive feedback from collector to base. Since this causes instability and oscillation, it is neutralized by applying an equal or greater amount of negative feedback around the individual stages. The negative feedback voltage is taken from the secondaries of the second and third FM if transformers and the primary of the discriminator transformer, and fed to the bases through 1- μ f capacitors.

The detector stage (V6) is biased to operate as an amplifier-limiter to drive the Seeley type discriminator, which uses a pair of germanium diodes. Jack J1 is connected directly to the discriminator output for use with a multiplex adapter. The audio signal and the dc component are passed through the de-emphasis network (R1-C1) and applied to V7's base. This stage is operated as an emitter-follower dc amplifier. The audio signal is routed to the AM-FM switch and a three-stage amplifier through blocking capacitor C2 and the volume control. DETECTOR OUTPUT jack J2 delivers a signal of approximately 0.1 volt to an external recorder or amplifier. The audio amplifier is conventional with a class-B push-pull output stage. A thermistor stabilizes the base bias of the output transistors.

Jacks J3 and J4 are for external speaker and phones, respectively.

The afc circuit

One of the characteristics of the FM oscillator is that its output capacitance varies linearly with collector voltage. Since this output capacitance is across a part of the tuning capacitance, tuning would tend to shift with battery voltage. In this set, tuning is simplified and the oscillator stabilized against variations in battery voltage by a very simple afc circuit.

The dc component of the discriminator output is filtered by R2-C3 and applied to the base of oscillator V3 through decoupling resistor R3. Varying V3's base bias varies collector voltage by varying the current flow through R4. The circuit is adjusted so the discriminator's output pulls the oscillator on frequency when it is within 100 kc of the correct setting.

The AM circuit

The AM rf section is conventional. Mixer and oscillator functions are combined in the n-p-n converter, V8. There are two if stages, using V4 and V5 and a germanium diode half-wave AM and avc detector. In vacuum-tube FM-AM circuits using separate front ends, the secondaries of the first FM and AM if transformers are either switched into the if input circuit or connected in series as is done in the input to V5. In the TFM-121, the first if amplifier (V4) operates as a common-emitter amplifier with the 10.7-mc if carrier applied between the base and ground on FM, and as a common-base amplifier with the 455-kc if carrier applied in series with the emitter on AM.

Transistor if amplifiers are easily overloaded by strong signals and it is

difficult to design a circuit that will handle the wide range of avc voltages developed by the conventional diode or class-B transistor detector. If the avc voltage is too high, it biases the transistor for nonlinear operation and the stage distorts. On the other hand, too little avc voltage causes overloading on strong signals. Most transistor radios have some form of auxiliary avc that goes into operation on very strong signals and prevents overloading. The overload diode in the TFM-121 is somewhat different from those that we usually run across.

Overload diode D1 and its 18,000-ohm series resistor are shunted across the lower half of the primary of the first AM if transformer, T8. The diode's cathode returns to ground through the tap on the transformer and its anode is connected to the high end of V4's emitter bias resistor. The effective resistance of this shunt network is determined by D1's forward resistance. When the resistance is very high, the converter's overall gain is very high. When it is low, it reduces the Q of the tuned circuit and the stage gain drops.

Under normal signal levels, D1 is back-biased to cutoff by the voltage developed across V4's emitter resistor. The resistance shunting T8's primary and the converter stage gain are high. When a strong signal is tuned in, a large avc voltage is developed across the detector load and applied to V4's base. This reduces emitter current and lowers the back bias applied to D1. The reduction in bias lowers D1's effective resistance so it looks more and more like a small resistance across T8's primary. The Q of the transformer drops and the converter's output falls below the level that overloads the if amplifier. END

LUNA PART OF SIGNAL SYSTEM

THE moon is a component in the new communications system demonstrated by the Navy late in January. Signals originating at Annapolis, Md., were sent to the moon, reflected to a receiving site near Pearl Harbor, Hawaii, and automatically retransmitted via the moon to a station at Cheltenham, Md., for a round trip in 5 seconds.

Four teletype channels were operated in a multiplex setup to which, it was stated, more channels could be added. A facsimile circuit was also in use, and voice communication is also being experimented with. This system is usable whenever the moon is visible at both terminals, a period ranging from 5 to 12 hours per day. Since moon relaying effectively places the terminals within line of sight of each other, ultra high frequencies can be used and the circuit is immune from disruption by ionospheric disturbances. It is also practically unjammable.

Power on each side is 100,000 watts, concentrated into a tight beam and raised to an ERP (effective radiated

power) of 440 megawatts by high-gain, fully steerable 84-foot dish antennas at each transmitter and receiver site. The bandwidth is 16 kc and the present frequency in the order of 440 mc.

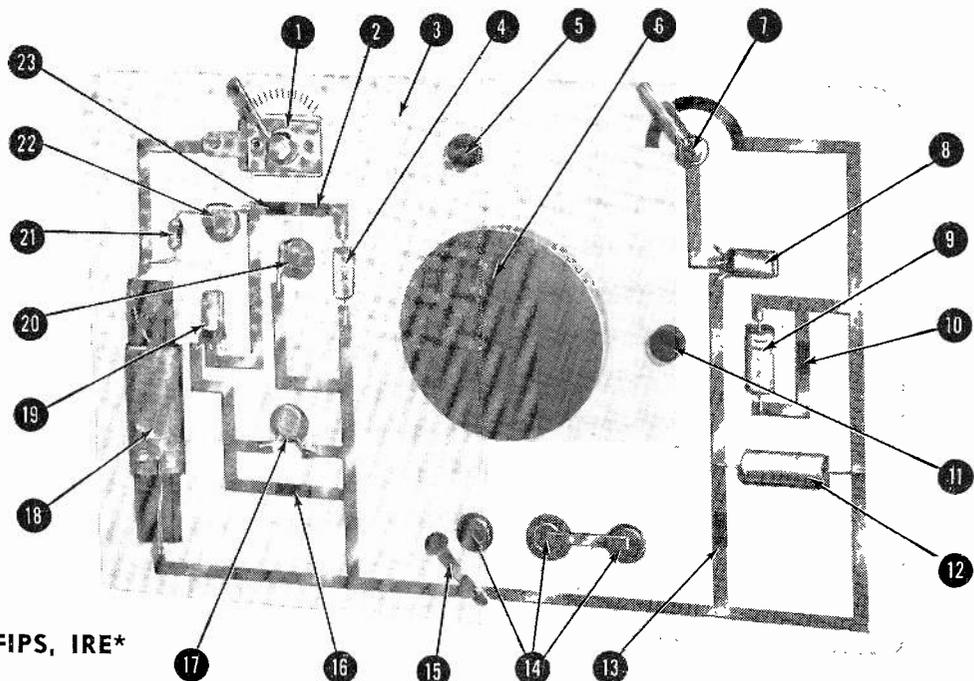
The idea of a moon relay was first proposed by Hugo Gernsback in his magazine *Radio News* in 1927, and among the messages transmitted during the demonstration was one of congratulations to him for the success of his 1927 concept. In the 1927 article, Gernsback foreshadowed the use of very short waves and beam antennas, both at the time rather unfamiliar ideas to the average communication engineer.

HUGO GERNSBACK,
YOUR 1927 MOON RELAY
WORKING WELL.
SHUNAMAI

Facsimile message received at U.S. Naval Communications Station, Washington, D.C. from Pearl Harbor, Hawaii, via moon relay system, Jan. 28, 1960.

PAPER THIN RADIO

Two-transistor receiver on a stiff sheet of paper



By MOHAMMED ULYSSES FIPS, IRE*

- | | |
|--|--|
| 1 Variable capacitor, 540-1600 kc (see text) | 12 100 µf, 6 volts, electrolytic capacitor |
| 2 10,000 ohms, 1/10 watt, resistor | 13 220 ohms, 1/10 watt, resistor |
| 3 Chassis, stiff paper, half size of letterhead | 14 4.5-volt battery (3 Mallory RM400R cells in series) |
| 4 10 µf, 6 volts, electrolytic capacitor | 15 On-Off switch (3 Mallory RM400R cells in series) |
| 5 Interstage transformer: primary 30,000 ohms; secondary 1,000 ohms (UTC DI-T23) | 16 50 ohms, 1/10 watt, resistor |
| 6 Speaker (see text) | 17 .05 µf, ceramic capacitor |
| 7 Volume control, 5,000 ohms, 1/10 watt | 18 Ferrite-loop antenna, 540-1600 kc (see text) |
| 8 2N109 transistor | 19 2N109 transistor |
| 9 0.1 µf, 6 volts, electrolytic capacitor | 20 .001 µf, ceramic capacitor |
| 10 5,600 ohms, 1/10 watt, resistor | 21 1N34-A diode |
| 11 Output transformer: primary 600 ohms; secondary 500 ohms (UTC DI-T20) | 22 .01 µf, ceramic capacitor |
| | 23 100,000 ohms, 1/10 watt, resistor |

Parts layout of the Paperthin radio. For best results, constructors should follow it closely.

WHEN the big boss called me into his august presence that blizzardy morning, the air was surcharged not only outside but in his office, too. There was a distinct high-tension charge in the air as the scowling big man waved me into a chair without a word.

He was puffing on a big, six-inch Havana *Morona* that jutted out into space at an ugly angle of 45°—always a sure sign that all was not well.

For a while he contemplated me silently, as if I were some loathsome transgalactic bug. Finally, he yanked the well-chewed cigar from underneath his big proboscis, rasped his throat and croaked:

"Fips, what in tarnation am I paying you a salary for here? You are supposed to be the new-idea boy on this magazine; instead you are the *no-idea* man. When, in a weak moment, I took you back after I fired you last year, I hoped that you had reformed and buckled down to work. Instead, your head is the same old vacuum—not an idea in your cranium!

"Have you any conception of what goes on in today's electronic world?"

* Institute Radio Electronology.

Here, the Japanese are drowning us in transistors and transistor radios. If you read the papers, you will have learned that in 1959 *Japan made 50% of all the transistors used in the US.* Soon they will make all our radios—indeed, this year their first transistor TV's will begin inundating us. What next? And what are *we* doing to stem that tide? Where is our superior American know-how? What have *YOU* to offer in our hour of need?"

"Boss," I said in my most ingratiating tones, "I have just the thing you want. I have been working on it for a year—a radio that can be *completely* mass-produced by automation, hence can be made cheaper than Japanese sets. It is also the lightest, slimmest radio in the world. Yes, *we can even export it to Japan!*"

For a moment the boss was speechless, but incredulous.

"When can you show me a sample?" he demanded gruffly.

"I will have it in exactly one week from today," I promised. "And you

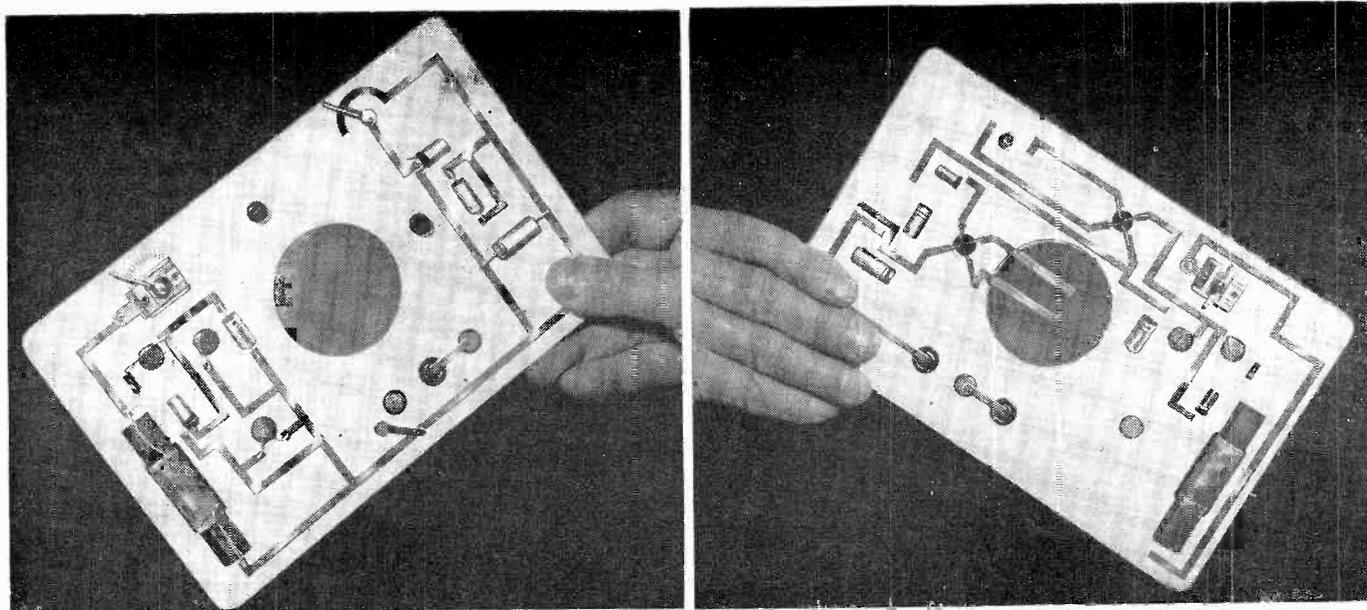
will be delighted with it. *You'll scoop the world.*"

For quite a while I had been working on my new and revolutionary radio, but it took me many months to iron out the bugs.

My latest model is a stiff, white paperboard, the usual artist's drawing board. It measures 5 inches by 6 inches, but can easily be made the size of a postal card, 5½ inches by 3¼ inches, when mass-produced. Its thickness is about 1/16 inch for the board part. *None of the components project more than 1/8 inch above the holding surface, hence the Paperthin Radio is the thinnest in the world. It is also the lightest.*

The model I describe here is made of a stiff paperboard. In mass production, the chassis can be made of plastic, fiber or other insulator.

All components are set in the paper chassis and cemented in place permanently—half the component juts out on one side, half on the other. All the wiring is traced in the usual conducting



Front and back views of the Paperthin radio. Note that almost all components are standard and readily available.

ink. For large-scale production, standard-method printed-circuit techniques will be used.

The antenna is a flat, thin strip of ferrite wound with about 100 turns of No. 30 enamel wire. It is cemented in a *tight-fitting* rectangular hole in the paper chassis. All fixed capacitors and resistors, transformer, batteries, etc., are standard makes and are cemented in holes in like manner.

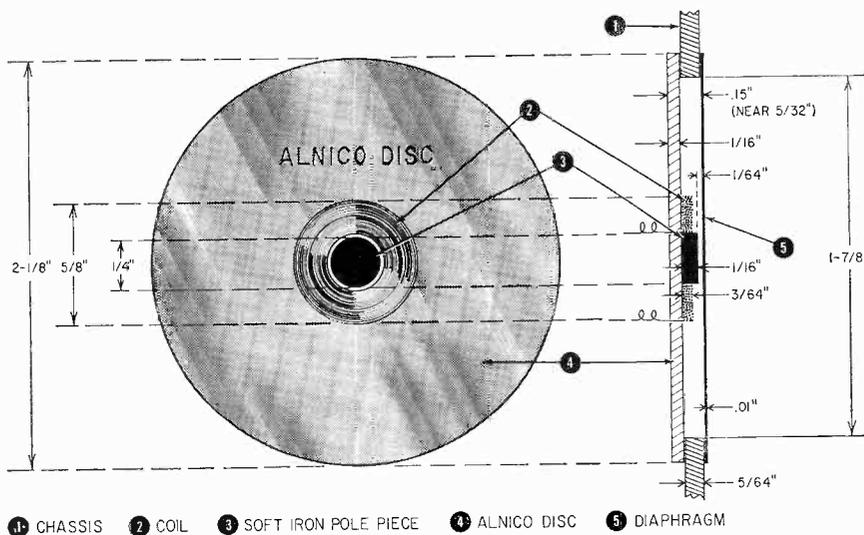
The tuning capacitor is a standard $\frac{3}{4}$ x $\frac{5}{8}$ -inch trimmer. Normally this has a capacitance of 3 to 40 μf . This is not sufficient for broadcast tuning range, as a minimum of 360 μf is needed. To increase the capacitance, I removed the .06-cm-thick mica insulator and substituted a .005-cm piece of special high-dielectric *polykap* plastic film.† This combination gives a little over 360 μf .

A short length of brass rod is soldered to the adjusting screw to replace the usual tuning knob, which would take up too much room. To insulate the handle, a short piece of soft-plastic tubing is slipped over it.

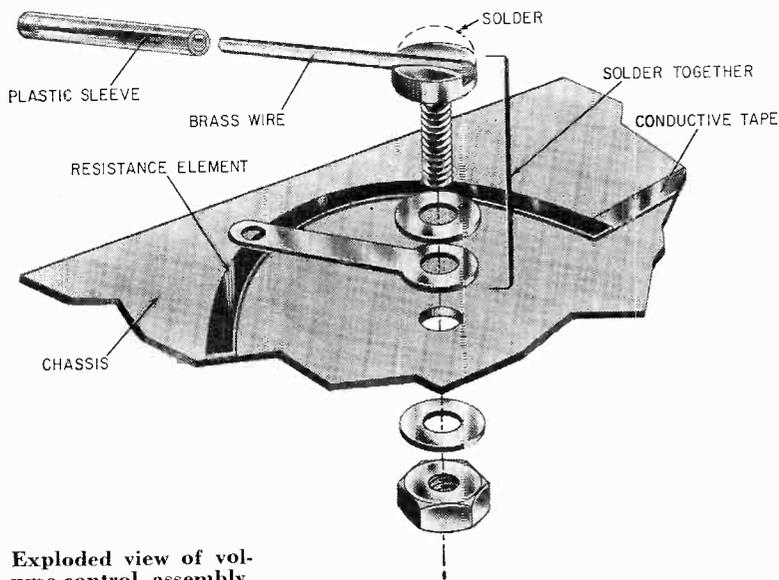
Now for the loudspeaker. This was the most troublesome component, because no *thin* electromagnetic loudspeaker is commercially available; none has ever been made. The detailed illustration explains its construction as conceived by me.

Because of its slimness, I named it the Leptospeaker (*Lepto*, from the Greek, thin.) Its main part is an Alnico disc $2\frac{1}{8}$ inches in diameter $\frac{1}{16}$ inch thick. It is magnetized in such a way that one pole forms the center part of the disc; the other pole is located around the rim. In the center is a soft-iron pole piece $\frac{1}{16}$ inch high by $\frac{1}{4}$ inch in diameter. On this is wound a magnet coil of No. 38 or 39 enameled copper wire to

† Not available commercially as yet.



Details of speaker construction.



Exploded view of volume-control assembly.

RADIO

the approximate impedance of 500 ohms.

This assembly is fastened with a special epoxy cement over a 1/8-inch hole in the paperboard chassis. On the other side of the hole there is fastened with epoxy cement a standard 2 1/2-inch iron telephone diaphragm.

The arrangement makes an excellent loudspeaker that requires no baffle, because the stiff paperboard acts as its own baffle. As the chassis is only about 1/16 inch thick, the vibrating speaker diaphragm is sufficiently distant from the pole piece so that it cannot touch it. (NOTE: The chassis cannot be too thin or the diaphragm will touch the pole piece and rattle.)

The two transistors are cemented flat into two holes cut into the chassis, one half protruding on one side, the other on the back side.

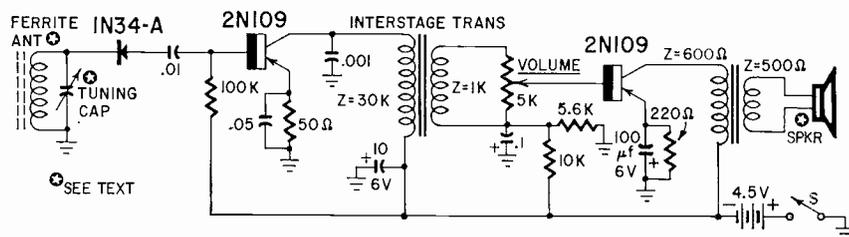
The same procedure is used with the batteries; flat spring clips for contacts are provided on both sides of the chassis—this assures positive connections.

For simplicity, one of the battery spring clips is mounted on a washer and riveted to the chassis. Moving the clip sideways breaks contact. This becomes the off and on switch.

The two-transistor circuit, as well as a parts list, used for the paperthin radio are given here. This receiver is excellent for city and suburban purposes. Extra transistors can, of course, be used with different circuits to increase range and output—but then the cost, too, goes up.

To increase the volume, the paperthin radio can be placed on a resonant wooden box. Ordinarily it can be placed at an angle on a simple wire frame, on a table or shelf. It needs no enclosure.

After the receiver has been tested, it should be sprayed on both sides with a plastic film to keep out moisture and



Circuit of the 2-transistor set.

dirt. When mass-produced, both sides will be covered with a tight-fitting, stiff plastic contour film (called "blister packaging"). NOTE: Tuning handle, off-and-on switch, loudspeaker diaphragm are not covered with blister packaging.

True to my promise, a week after our meeting, I marched into the boss' office and placed my brainchild on his desk. I switched it on and, if I must say so in all modesty, it performed beautifully, bringing in at least six stations at full loudspeaker volume.

The big boss, scowling ferociously, picked it up, turned it around and put it through its paces himself.

"And what do you call this contraption?" he bellowed.

Somewhat taken aback, I said: "This is the world's thinnest, lightest and perhaps the lowest priced paperthin radio ever invented."

"So," said he in his bossy voice, "and how much do you figure its cost if made by the million?"

"About \$2 or \$3. It could easily be sold for \$4 or \$5 at a good profit."

"And who would buy such a gadget?" growled the boss editor.

"Why, everybody, of course, and particularly children!"

"Great," spat out the Big Man. "And now tell me how do you repair such a toy?"

"Repair it?" I answered with some surprise. "The paperthin radio is so well constructed, it rarely needs repair. If it does, throw it away and get a new one—it's that cheap!"

"Hah, hah, hah," exploded the chief, his neck swelling a purplish red. "That's all I wanted to know! Here we publish a respectable magazine that's supposed to uplift our industry and lead it. Then you . . . you infernal idiot, come along with a toylike thingumajig that will be sold for next to nothing so at the end of the year our set manufacturers will have built 20,000,000 of your phantom radios and will have made less profit than they make building 1,000,000 decent radios. On top of that, they must invest tens of millions of dollars in automation machinery, which they may not get back in 10 years!"

"Worse, yet," he shrieked in an apoplectic rage, "a high percentage of our readers are service technicians, who make their living repairing sets in this country. Has it occurred to your evacuated brain how the servicing industry will receive the news of your radiotic

invention? They'll boycott us for life and the radio-electronic industry will bury us, you . . . you disgustingly stupid copy of a destructive and undermining termite—get out, OUT, and stay out!"

With that, the infuriated boss hurled my radio at me with such force that it would have smashed any receiver ever made.

Not mine. Luckily, I caught it and ducked out of the office at top speed. Somehow, in catching it, the on switch closed. As it was exactly 11 am, Station WROT came on. Before I turned it off, the announcer had said: "Here is the news on

APRIL 1ST"

INVENTORS of RADIO— Thomas A. Edison

Radio in 1885—eleven
years ahead of Marconi

By ERIC LESLIE

EDISON'S exact role in the history of wireless is clouded in confusion—of facts, of interpretations and even of language. One thing is clear. A dozen years before Hertz demonstrated the existence of radio waves, Edison had recognized a strange new phenomenon, which he named "etheric force" and predicted that it might be useful for communication.

Edison's discovery was due to his remarkable powers of observation. While working with a "vibrator magnet" one night in November, 1875, he noted a peculiar spark when a piece of metal was touched to the core of the magnet:

It seemed so strong that it struck us forcibly there might be something more than induction. We now found that if we touched any metallic part of the vibrator or magnet we got this spark. The larger the body of iron touched to the vibrator the larger the spark. We now connected a wire to X. [Fig. 1] the end of the vibrating rod & we found we could get a spark by touching a piece of iron to it & one of the most curious phenomena is that if you turn the wire round on itself & let the wire touch any part of itself you get a spark. . . . This is simply wonderful & a good proof that the cause of the spark is a new unknown force."

Not everybody agreed, and when he demonstrated his new force at the Polyclinic Club of the American Institute, he created a small storm. His opponents seemed upset by the name "etheric force," which now seems either an extremely lucky accident or a marvelous burst of intuition. Others were more sympathetic, and *The Operator*, a telegraphers' journal, printed a long article, based on an interview with the young inventor, in which it was suggested that the force might be applicable to telegraphy:

"The cumbersome appliances of transmitting ordinary electricity, insulating knobs, cable sheathings, and so on, may be left out of the prob-

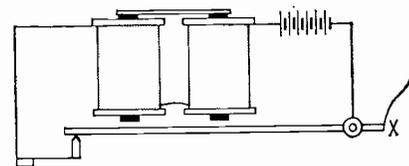
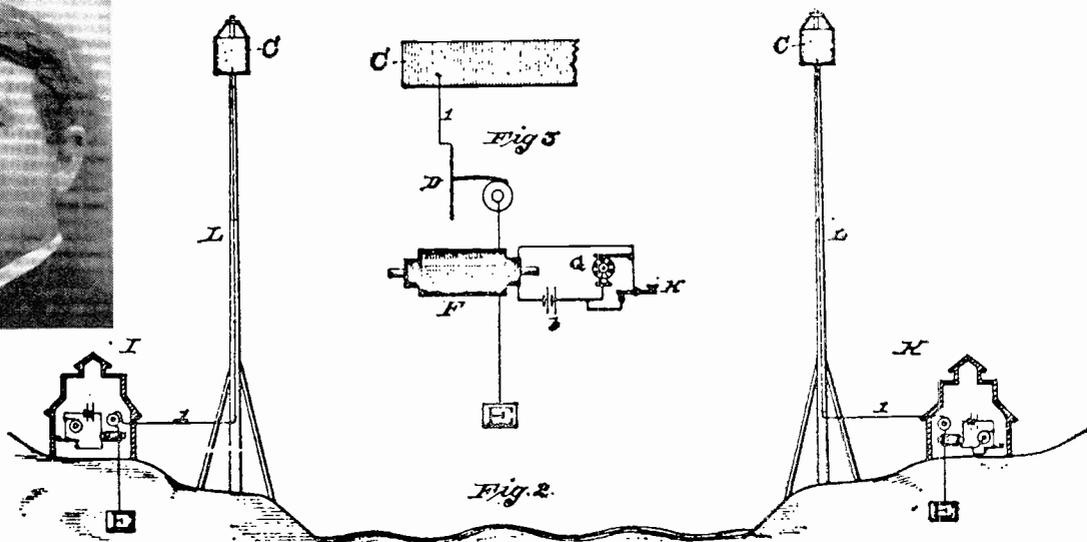


Fig. 1—Edison's vibrator.



National Park Service
Thomas A. Edison
as he looked
in 1883.

Fig. 2—Edison's patent drawing shows the works of his "Means for Transmitting Signals Electrically."



lem of quick and cheap telegraphic transmission; and a great saving of time and labor accomplished." An author in the *Scientific American*, Dec. 18, 1875, reports "... by this simple means signals have been sent for long distances, as from Mr. Edison's laboratory to his dwelling house in another part of the city, the only connection being the common system of gas pipes. Mr. Edison states that signals have also been sent the distance of 75 miles on an open circuit, by attaching a conducting wire to the Western Union telegraph line."

Ten years later—May 23, 1885, still two years before Hertz—Edison applied for a patent on a "Means for Transmitting Signals Electrically." The equipment (Fig. 2) consisted of an induction coil with a rotating or vibrating circuit breaker in the primary, and a high-voltage secondary with one end attached to a "condensing plate" on a high tower and the other to earth. The diagram looks like an operative radio hookup, though the type of inductance probably used and the breaking of

the primary rather than the secondary circuit makes it probable that any radio frequency radiated came from the primary by capacitance, or was due to accidental sparking and arcing in the secondary. At any rate, the patent was considered good enough to be purchased for \$30,000 by Marconi shortly before it expired.

Because of a confusion of language, Edison's wireless had been considered an induction device. Today "induction" is almost invariably an abbreviation of "electromagnetic induction." In 1885, with alternating current unheard of, it meant "electrostatic induction" unless qualified. The term is used in full by Edison in his patent.

The confusion is increased because the only practical application of the invention, the Lehigh Valley moving-

train "grasshopper telegraph" probably depended mainly on electromagnetic induction. Yet in describing that installation to a reporter, Edison said, "This invention uses what is called static electricity."

Edison's work on the vacuum tube, and his patented "Edison effect" on which all hot-cathode electron tubes are based, are too well known to mention here. With his etheric force, his wireless transmission patent, and the Edison effect, he had in his grasp a complete radio system. But he missed the opportunity to establish the first wireless communications network because he did not realize what these three things might do in combination. He himself was heard to remark much later in life that it was a pity he had not seen any connection between them.

END

SPIRAL CONICAL ANTENNA

COVER FEATURE

By W. W. MACALPINE*

THE antenna on this month's cover, although conceived early in 1959, is not yet a finished development. It was built to see how such a design might perform. There haven't been enough tests to give any conclusive results.

The cone is made of thin sheet brass cut into a conical version of the Archimedes spiral. It is cut from a flat semi-circular sheet and formed around a pyramidal frame consisting of six insulating rods. (The brass would be silver- or copper-plated in a finished model.) The slant cone has a 30-inch base diameter, 30-inch slant height, 26-inch axial height and a 60° apex angle. There are 10 turns on the spiral. An earlier model had the same cone dimensions, but only a five-turn spiral of 6-inch-wide brass.

The later model has undergone a few tests. It was mounted with its cone axis vertical to give an omnidirectional pat-

tern in the horizontal plane. A horizontal conducting plane was set up close to the cone's apex. The plane was a brass disc, sometimes cut into a left- or right-hand spiral and at other times an uncut sheet. Feed was by coaxial cable connected between the plane and the spiral's apex; ground to the spiral and center conductor to the disc, or vice versa. This drive resembled that of the "discone" antenna (see *Reference Data for Radio Engineers*, fourth edition, page 681). However, the spiral cone was not likely to have the broad-band characteristic of the discone, since the aperture of the spiral antenna is small compared to the free-space wavelength at the lowest frequency of resonance.

The five-turn spiral cone had a resonance at 14 mc with a voltage standing-wave ratio (VSWR) of 1.25 to 1 on a 50-ohm line. A test with a transformer of 4-1 impedance ratio (stepup to spiral) gave SWR a little under 6 to 1 on a 50-ohm line over the entire range of 7 to 17 mc. The impedance plot was



roughly a circle about one and one-half times around, on the Smith chart.

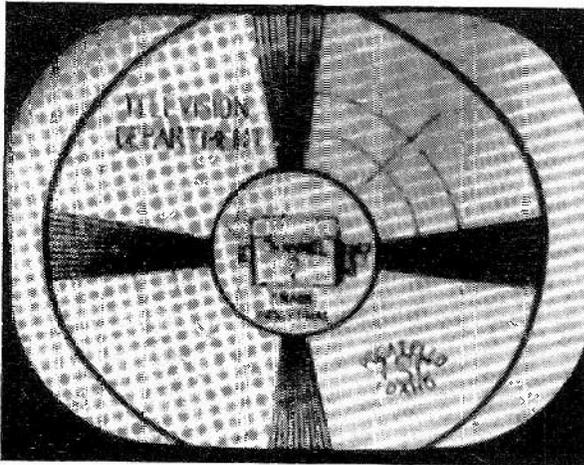
Other drive systems are possible, such as shorting the apex of the cone to the plane and driving between the apex and a tap on the cone. Another system would use two cones on the same axis with adjacent apexes as in the biconical antenna. Drive would be balanced feed to the apexes, or to taps on the cones if the apexes are shorted.

END

*Development Engineer, ITT Labs.

TELEDUCATED TECHNICIANS

By JIM MELTON



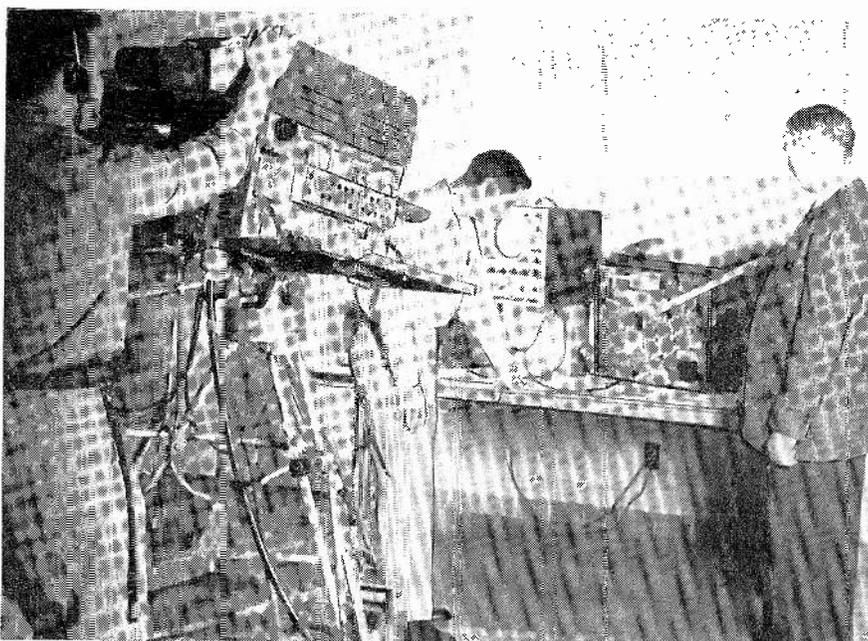
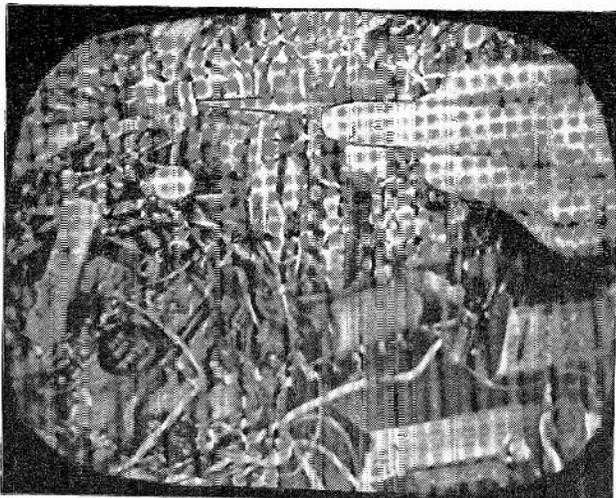
IF TV can be used to educate students in non-technical subjects, why not use it to teach TV servicing?

Idaho State College's school of trade and industrial education at Pocatello, a pioneer in education by closed-circuit TV, was confronted with a problem: How to give 48 students individualized instruction in TV in the face of a shortage of time and instructors.

Since 1941, the college had been experimenting with closed-circuit television, and its student-operated TV system now pipes classroom lectures and demonstrations to the Pocatello public schools. So it was only natural that the trade and industrial education school—which operates the closed-circuit teaching system—should turn to TV to teach its own student technicians.

The school found that one instructor could teach TV alignment to all 48 in one-third the time it formerly took 4 teachers instructing students in groups of 4. What's more, the teleducated technicians made higher average grades in lab tests than former classes trained by conventional techniques.

"Individualized instruction" can be given an entire class at once via 27-inch screens as the camera closes in on a chassis to let the instructor point out a component magnified to many times its actual size. In conventional classes the necessity to crowd close to the receiver limited demonstration sessions to 4 students. Patterns from a 5-inch oscilloscope are also enlarged to TV-screen size.

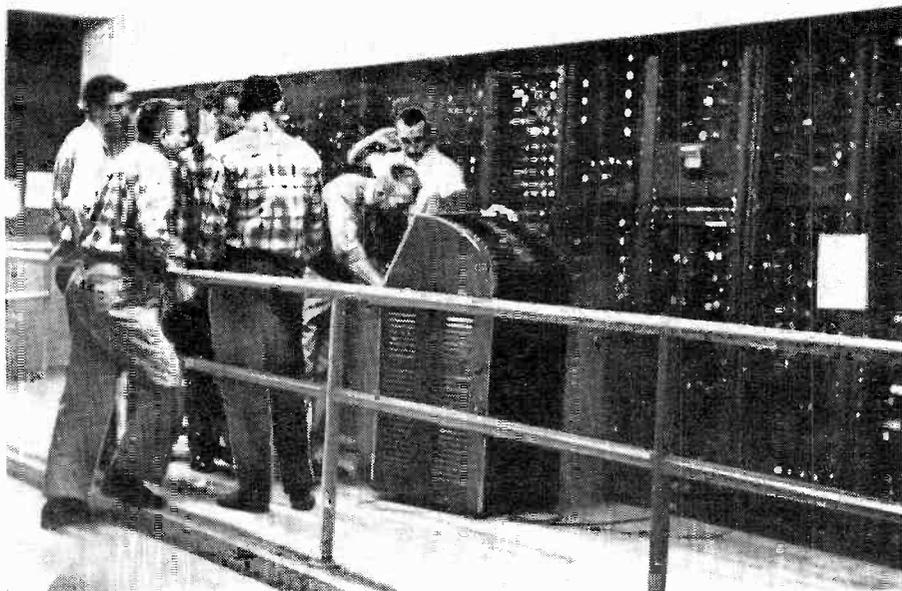


The camera focuses on a TV chassis during a lesson. Holding the pointer is William H. Shiflett, head of the school's electronics division which operates ISU's closed-circuit project. Three cameras are used in the TV servicing course—one fixed on an oscilloscope, one on the receiver and test equipment and the third following the instructor as he works on the set and uses the blackboard. A two-way sound system lets students viewing the televised courses ask questions.

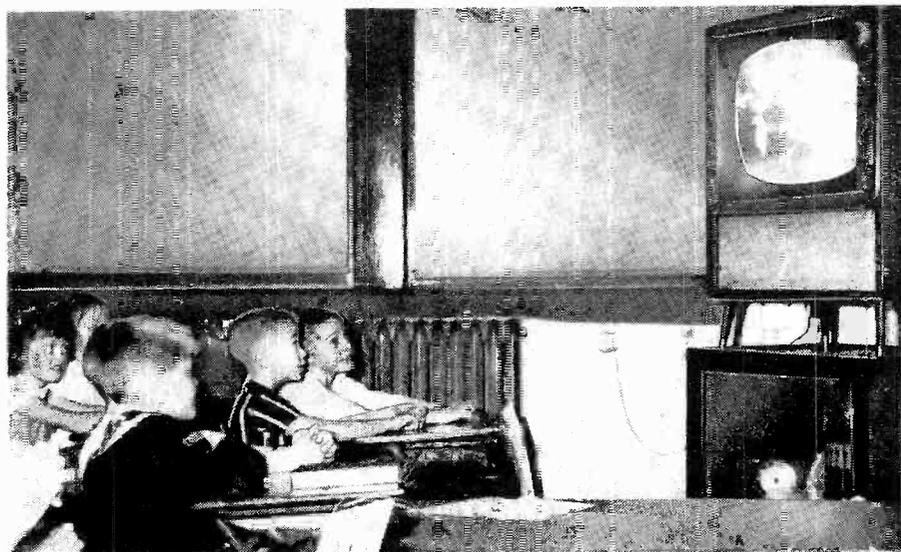
Students return to the laboratory to put their lessons to practical use. In lab tests, the slower students appear to have received the greatest benefit from the changeover to tele-education. Much of the equipment used in the college's educational TV program is constructed by students in this laboratory.



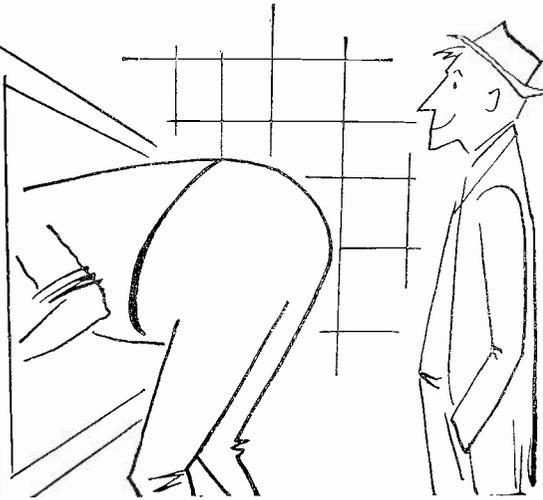
Idaho State's closed-circuit TV control room, completely manned by students, has equipment which would cost \$300,000 if purchased commercially. Included are six camera chains—two image Orthicon studio units, two field units, a Vidicon and an Iconoscope. The televised signal is of commercial standard and quality.



Elementary students at Pocatello's Jefferson School watch a televised lecture demonstration on music originating from the student-operated Idaho State College TV facility. The telecourses are distributed to schools through the courtesy of a local community antenna system which has donated a cable channel for morning use. The antenna system's private subscribers can watch the school instruction in their homes.



BENCHWORK CAN BE TRICKY



Red and Fuzzball run into a couple of color TV problems during a day at the bench

By ROBERT G. MIDDLETON

LOOKING for the built-in engineer?" asked Red facetiously. Fuzzball pulled his head out of the cabinet, bumping his slightly bald spot on the sharp edge (see Fig. 1).

"*****," he replied cordially. "It shouldn't happen to a dog but it does."

"You know," offered Red, "if you remove them screws, you can lift off the sides and top of the cabinet. Save you some lumps."

"Now he tells me. Why in Sam Hill can't these color TV manufacturers standardize! Every factory uses their own ideas and gets the technician fouled up like Hogan's goat."

Red held his hands up to his head and waved his forefingers like an ant's antlers. "Stop that old stuff," he said, "and get back with us. What are you looking for in there?"

"The purity went out and won't come back," Fuzz complained. "I was looking to see if the rim magnets had broken loose."

"You must be ill," Red consoled, lifting off the sides and top from the cabinet. "Look at them rim magnets—how could they break loose (see Fig. 2)?"

"I'll buy that," replied Fuzz, "but what's happened to the purity? Besides, if you're so smart, why ain't you rich?"

"Let me clue you in, buddy," retorted Red, "I am not interested in being the richest man in the graveyard. Now, do you want me to show you how to set up the purity?"

"I'm with you."

Red watched the screen, while Fuzz fiddled with the purity magnets and the rim magnets. "The left-hand side just won't come in on a red field," he finally announced. "Did you adjust the yoke position on the picture tube?"

"I'm way ahead of you," Fuzz replied. "I also measured the high voltage, and it's right on the button."

Red's eyes narrowed slyly. "Where's the degaussing coil then?" he asked. "Trouble with you is you don't demagnetize your tools, and first thing you know you got the shield of the picture tube magnetized."

Fuzz shrugged his shoulders. "Down there under the bench," he said.

Red yanked the rim magnets back in their shunts and plugged in the degaussing coil while Fuzz lit a wilted cigarette from behind his ear. He held

the coil squarely in front of the picture-tube screen for half a minute, and then backed up slowly till he reached the end of the cord. "You can unplug the coil now," he announced. "If you had degaussed the tube shield, you wouldn't have this headache."

Fuzz gave Red a double take and handed him a box of aspirin. "Take two," he advised, "they're small. For your information, I have already degaussed the tube shield."

"So you magnetized the shield again, after you degaussed it," Red countered. "I'm listening."

"Stop listening and start adjusting them purity magnets."

Red stood confidently in front of the screen while he gave the orders. "No," he directed, "try a little stronger field—no, go back now. Turn the assembly clear around. Put the tabs clear together—no, push that rim magnet closer to the tube—where you got that purity magnet anyhow, on the base of the tube?"

Let's blast

Fuzzball managed a twisted grin. "OK, Einstein, shall we dynamite?"

"I'd like to shove that dynamite down your throat, wise guy. It only takes one like you to fox up a chassis, and ten techs to fix it."

"Maybe it's the picture tube," Red suggested.

"Maybe it ain't, too," Fuzz retorted. "That purity was OK until 10 minutes ago, and then it suddenly it went out and won't come back. A picture tube isn't going to warp and flip that quick."

"It figures," agreed Red. "Suppose we reconstruct the crime. Let's go over this case from the beginning, and see if we pick up a clue."

"Well," Fuzz said thoughtfully, "I measured the high voltage—it's OK. I centered the yoke and slid it back and forth for the best purity. Adjusted the neck purity magnets. Then I trimmed up the rim magnets. The red field looked fine, except for the lower left-hand corner—it was out just a little bit."

"But did you get the tube in rough



Fig. 1 — X marks the spot where Fuzzball got his lump.

convergence first?" demanded Red.

"Right," Fuzz replied, "I had the purity almost but not quite perfect. Am I getting through to you?"

"So how did you lose purity?"

"Here's when it happened—the red field looked fine, except for the lower left-hand corner."

"You said that already."

"You didn't remember."

"Nothing of the sort—let's get on with the sordid details."

"OK. I plugged in the degaussing coil because it looked like the lower left side of the tube shield was magnetized. I gave it the treatment."

"Yeah, but how about the chassis?"

"You're really reaching for it. I set the corner of the chassis over the coil and let her rip for a full minute."

"Sounds good," admitted Red. "We're still missing something here—maybe we're doing too much talking. Suppose I watch while you re-enact this crime—maybe there's something you forgot to tell."

Fuzzball plugged in the degaussing coil and held it against the screen of the picture tube. Red put his fingers in his ears. The rim magnets were chattering like false teeth at an old-maid's sewing circle.

"Lordy have mercy!" Red blurted. "You didn't retract the rim magnets into the shunts!"

"Are you supposed to?" asked Fuzz innocently.

"My friend, that degaussing coil is strictly murder. Do I have to draw a diagram? If it takes the magnetism out of a tube shield, it's going to take the magnetism out of the rim magnets, too. Next thing, you'll lay the coil down over that voltmeter and we'll have to send it in for repair too."

Fuzzball grinned sheepishly. "OK, Red, give yourself a cigar. I'll bounce. In fact, I'll buy the suds this evening."

"And that," Red remarked, "reminds of the story about Oley Olson. It seems like he got so expert running the circular saw that he could do the job single-handed. Hit a spike one day, though, and sawed off a couple fingers. So the boss asked Oley to show him how the accident happened, and . . ."

Fuzz made a threatening back-hand at Red.

After replacing the weakened rim

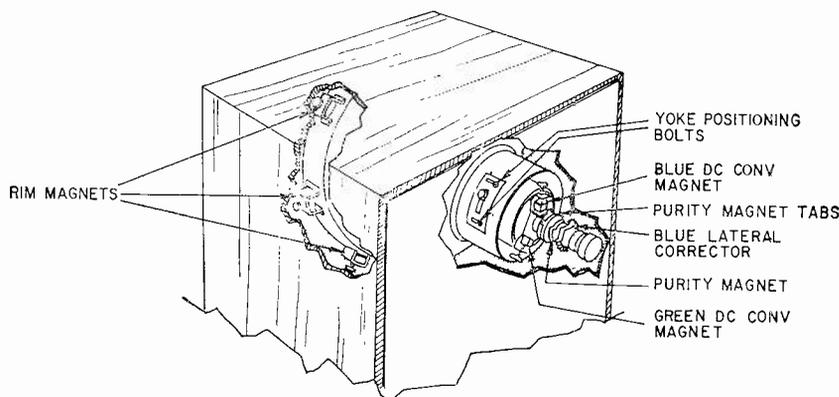


Fig. 2—The rim (field-equalizing) magnets are mounted pretty solidly, as Red pointed out.

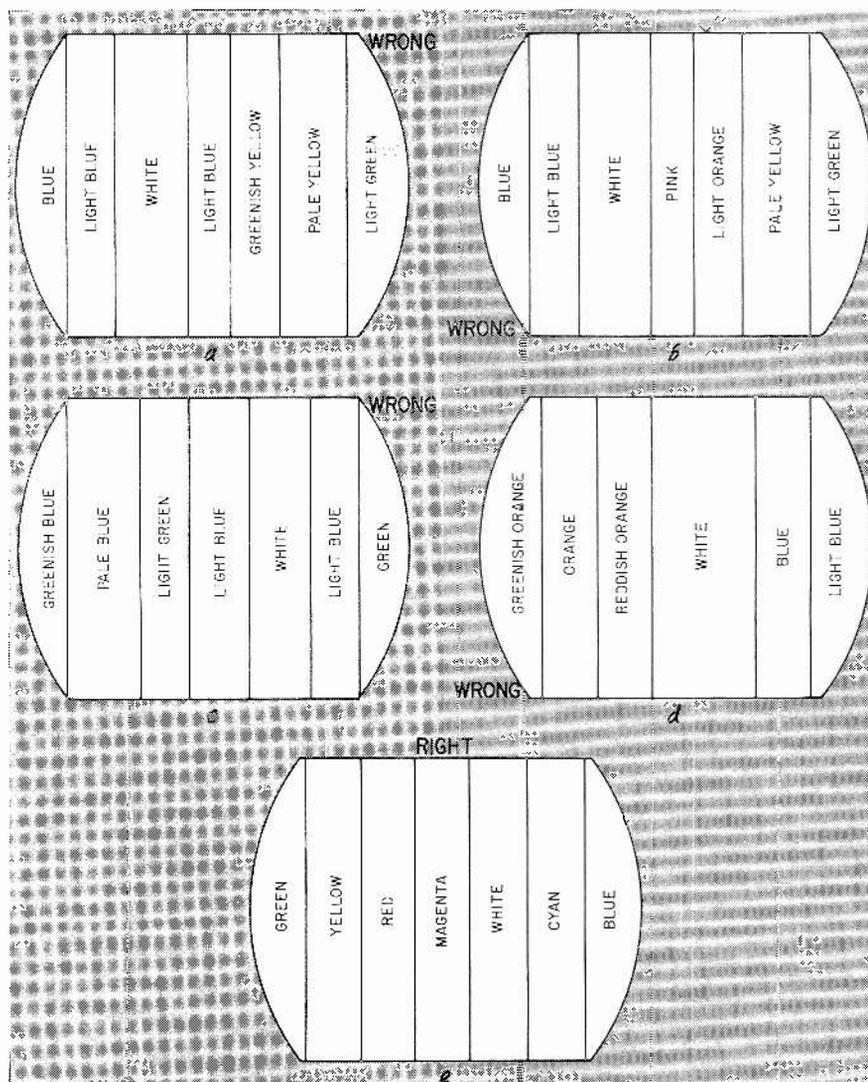


Fig. 3—Some of the patterns Fuzz was getting on the screen: a, b, c, d—all wrong; e—success at last.

magnets and restoring proper purity, Fuzz lapsed into silence till after lunch.

In the afternoon

"This color set is for the birds." Fuzz broke the silence barrier.

Misery loves company, and Red drifted over to Fuzzball's bench to share his trouble—cautiously of course. He had the receiver fired up with a color bar pattern, and it looked like the set was working OK. The bars were locked in good, the colors bright and clean.

"So what's the bind?" Red asked.

"It's these crazy mixed-up colors," said Fuzz impatiently. "Look!"

Fuzz turned the color phasing control through its range, and Red saw that he was only saying it because it was true. This generator puts out a green-yellow-red-magenta-white-cyan-blue sequence—Fuzz was getting one or two bars to show correct colors, but all the other bars were way off. The proper bar sequence wouldn't show (see Fig. 3).

"How's about that?" demanded Fuzz, stamping on his fresh-lit butt.

"This is a jolly bit," agreed Red. "Maybe the quadrature transformer is out of adjustment."

Fuzz looked at Red with a sheepish grin. "Sure, I must have lost my head."

Fuzz reached for a diddle-stick and turned one of the slugs in the quadrature transformer. The colors changed—a couple of bars began to look better and the others got worse. "Hand me that other diddle-stick, Red."

Now, Fuzz had a stick in each end of the transformer and was turning both slugs at the same time. Red scratched his head. "Still off home base," he said. "Let me turn the color

TELEVISION

phase control while you turn them slugs."

Red twisted the phase control back and forth while Fuzz kept working on the quadrature slugs. All the bars except the white one were changing color, and they got about any color they wanted, but not the right sequence. "No dice," announced Red finally.

"So what do we do now?" asked Fuzz, "send it back to the factory?"

"No!" exploded Red. "Let's sit down and analyze this thing carefully."

"I'm with you," agreed Fuzzball, "but we really got this dog loused up now. We're out in left field on quadrature."

"Speak for yourself," advised Red. "I'll get the quadrature in like Flynn, and we can take it from there."

Red switched the color bar generator to R - Y output, and connected a scope to the output of the R - Y detector in the chassis. A square wave appeared on the scope screen. Next, Red turned the slug for R - Y in the quad transformer, and the square wave increased in height. Finally, the square wave went through peak height and started falling. Red backed off a turn and left the slug at peak.

Then he switched the color bar generator to B - Y output. Just a little bit of deflection showed on the scope screen. Red touched up the R - Y quad slug to get a straight horizontal trace on the scope—the only sign of output from the R - Y detector was a couple of sharp pips on the trace.

"You can get a test of the R - Y detector output on an R - Y signal," Red explained, "but then you want to make the final quad adjustment on a B - Y signal, because a null is sharper and more accurate than a peak adjustment."

"That's right," agreed Fuzz. "They told us at the factory color school that an R - Y detector will null on a B - Y signal, but how about them little pips?"

"Color detectors are usually less than 100% perfect," explained Red. "An R - Y detector nulls on a B - Y signal, but there is a little spurious output from the detector when the edge of the B - Y bar is hitting the circuit."

How about the B - Y?

"Can we adjust the B - Y quad the same way?" asked Fuzzball.

"Sure thing," Red said, "let's get with it."

Red connected the scope input lead to the output of the B - Y detector, and once again a square wave turned up on the scope screen. By turning the B - Y slug in the quad transformer, Red peaked the output. The peak response was practically the same as when he was adjusting the R - Y detector.

"That shows," Red explained, "that both color detectors are putting out OK. Now, let's check the null of the B - Y detector."

He switched the color bar generator to R - Y output, and a slight touchup of the B - Y quad slug nulled the output. As before, there were a couple of small sharp pips on the horizontal trace.

"Let's see what the simultaneous display looks like now," suggested Fuzz.

Red switched the color bar generator to the seven-bar color display.

"No good," advised Fuzz. "Wait till I adjust the color phasing control."

"Save your time," advised Red. "The color phase is right when the detectors are nulled. We got some other kind of trouble here."

"How about the matrix?" Fuzz suggested. "Maybe there's circuit trouble in the G - Y matrix?"

"Could be," agreed Red. "Let's make a quick test."

He connected the scope input lead to the output of the G - Y matrix and switched the color bar generator to G - Y /90° output. A straight horizontal line appeared on the scope screen. Then he switched the generator to G - Y output, and a square wave showed on the screen.

"The matrix is working OK," Red announced with finality. "We'll find the trouble somewhere else."

"Could it be the picture tube?" asked Fuzz.

"No," Red replied, "the gray scale is OK, and all three guns have output. We saw that right along."

"So what now?"

"Let's sit down and analyze this thing calmly," advised Red.

"You said that before—you're getting in a rut," Fuzz replied.

"Do you have a better suggestion?"

"We can call the factory," came from Fuzz. "Pass the phone."

Listening to one end of a phone call can be maddening, and this one gave Red plenty of time to stew while Fuzz carefully recapped the symptoms. Red watched Fuzz's face fall—"One will get you ten that we're a bunch of high-grade idiots," he predicted.

Fuzz finally hung up the phone with a wry grin. "Carl figures we plugged the red and green chroma leads into the wrong grids of the picture tube during convergence. He says to check the service notes on this."

Silence ruled while Fuzz thumbed through the pages and checked the plug-in chroma leads. Finally he announced, "*****!" He quickly reversed the red and green leads. Now, with the generator switched to the simultaneous bar display, the picture tube lit up with the proper pattern.

Fuzz checked off the color bars in a subdued voice. "Green, yellow, red, magenta, white, cyan, blue," he chanted. "For 20 years," Fuzz remarked, "my dreams have been in black-and-white—but tonight, I will have a nightmare in NTSC colors."

"Maybe you better see a head-shrinker before you go home," suggested Red.

"Very interesting—in fact, it's fascinating," was Fuzzball's considered conclusion.

END



NEXT MONTH



Poor Man's Direction Finder

An ordinary portable radio may be directional enough to make it usable as a homing instrument. A few additions can make it a really sophisticated direction finder for woodsmen or sailors.



Microminiature Transistor Amplifier

Possibly the smallest amplifier that can be built from standard components, this unit can be used in many spots where ultracompactness is essential.



Electronics Can Save Your Heart

First of series on the important subject of electronics in medicine, this article explains the electrical factors in heart action and describes two important instruments: the electronic Pacemaker and the heart defibrillator.



TV Technician Repairs a Weld Timer

How a TV man used the experience gained in his work and the instruments from his own service bench to spot trouble, and cure it, in what at first sight was an entirely unfamiliar piece of equipment.

we troubleshoot the

HORIZONTAL OSCILLATOR

By R. D. JACQUES

HORIZONTAL oscillators have become pretty well standardized, at least down to three or four basic types. Specialized sweep-circuit testers can make testing and repairing these circuits much easier. But, even with a minimum of test gear, many tests can be made.

Horizontal sweep circuits have a dual purpose. They sweep the electron beam across the picture-tube screen and provide high voltage to the picture tube's ultor. The circuit also provides pulses for keyed agc, phase-comparison afc, etc. It is this interlocking nature of these functions that makes circuit analysis so complicated so often.

In practice, if we remember the basic principles of each circuit and apply our tests in the proper order, little trouble should be found. Just take that full 10-count on the service procedures.

First, let's assume we get a set with the typical complaint—good sound, no raster. The first step is to check all tubes, preferably by substitution. If this doesn't work, leave the good tubes in the set until other tests have been completed. This avoids double troubles—defects caused or aided by tubes with marginal characteristics. Find the major trouble first, then see how many of the original tubes can be replaced without interfering with performance.

Next check point is the B-plus supply. Check the voltage at the filter input. The B-plus supply should be within 10% of normal before going further.

The next step is to check the schematic and find out what type oscillator circuit is used, what flyback circuit is used, etc. Check voltages against the schematic.

If these tests do not reveal the trouble, we start with the horizontal oscillator. Unless it is working properly, all other tests are useless. Dc voltage measurements around the stage check it out pretty well. However, a scope is much faster. Just connect a strong signal to the set and hook your scope to the video detector output.

Set the scope's sweep to hold two horizontal sync pulses on the screen. This locks it on 7,875 cycles, half the horizontal oscillator frequency. Now, transfer the scope probe, without changing the horizontal sweep frequency, to the horizontal oscillator circuit. The pattern of Fig. 1-a shows two lines of video with sync and blanking pulses. Fig. 1-b shows the oscillator running at normal speed. Fig. 1-c is too

fast. Four pulses are seen. Fig. 1-d shows too-slow operation, with only a single pulse visible. Each wrong pattern points to a certain defect, as we shall see in a minute.

A scope finds horizontal oscillator troubles much faster than any other test instrument. As you can see, simply connecting it to the oscillator shows whether or not it's running. The simple test outlined above shows if it is running at the right frequency. Actually, this test should always be made first; voltage and other measurements should come later. If the scope shows the oscillator is running on frequency, we can eliminate quite a few tests in that circuit and proceed to others in the horizontal output circuit.

Assume we have found the oscillator not running or running at the wrong frequency. Obviously, we've got to repair this trouble before we can go any further, because the oscillator signal is absolutely essential to the performance of the rest of the circuit.

Cathode-coupled multivibrator

Look at Fig. 2, a typical oscillator circuit. It is the popular cathode-coupled multivibrator, using a ringing coil for stabilization. Like others, this circuit always uses a twin-triode tube—6SN7, 12AU7, 12BH7, 6CG7, etc. Common coupling between the two cathodes makes the circuit work as a multivibrator. The L-C network in the plate circuit of the input half of the tube stabilizes the oscillator. Its natural resonant frequency must be exactly 15,750 cycles per second. At this frequency, it is shock-excited into oscillation by the sawtooth pulses from the multivibrator.

If the oscillator is not running, shown by a lack of signals on the scope, take dc voltage measurements around the circuit. Those in Fig. 2 are typical of the circuit, but the set's schematic should be consulted for exact values. The negative voltage at the grid of the output half of the tube is a fairly good indication of oscillation when a scope is not available. If the dc voltages are all within 10% of normal and the oscillator still isn't working, a detailed check of components is in order. Only a few could cause trouble under the circumstances—R5, R6, C3 and ringing coil L.

The next step is to ground the sync input grid. The control action of the horizontal afc used with this type of

oscillator puts a dc correction voltage on this grid to hold the oscillator on frequency. If there is a defect in the afc circuit, too much dc will be found on the input grid, and the oscillator may be blocked or trying to run far off frequency. Grounding this grid puts it somewhere near where it should run, around zero volts. Now, if the oscillator is OK, it will be free-wheeling somewhere near the right frequency and you should be able to hold a picture on the screen by adjusting the horizontal hold control. The picture will not lock in, of course, as you have removed the sync input. If it does this, the oscillator is all right and you can look for sync troubles—defective tubes, resistors, leaky coupling capacitors, etc.

If this step does not get the oscillator working, leave the short in place and short out the ringing coil. If the plate load resistor is around the value shown,

HORIZ SYNC & BLANKING PULSES

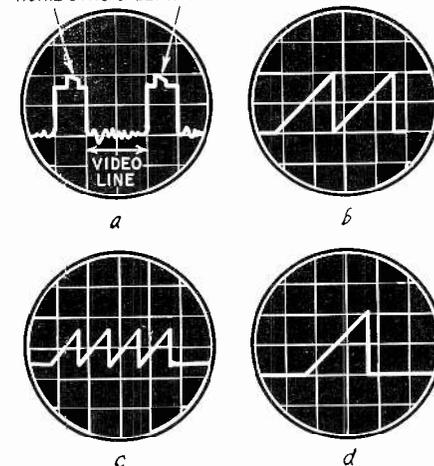


Fig. 1—Horizontal oscillator waveforms: a—two lines of video with sync and blanking pulses; b—oscillator running at normal speed; c—fast oscillator; d—slow oscillator

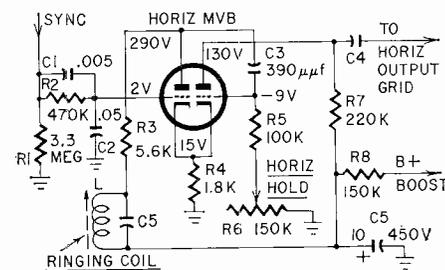


Fig. 2—Typical horizontal oscillator uses cathode-coupled multivibrator.

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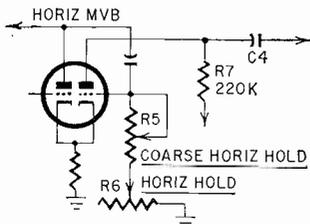


Fig. 3—Oscillator circuit has two pots in horizontal hold circuit.

5,600 ohms, add enough resistance in series with it to bring the total value up to about 15,000 ohms minimum. Otherwise, the plate circuit impedance will be too low and the circuit won't work. Now, the only frequency-determining parts left in the circuit are two resistors and one capacitor—R5, R6 and C3. If the oscillator still refuses to work, check them, preferably by replacement. Even a very small leakage in C3, for example, throws the oscillator so far off frequency that it cannot possibly work. Change in the value of R5, the grid resistor, also upsets things here. Once again you should be able to hold a picture on the screen momentarily by adjusting the hold control.

A popular variation of this circuit omits potentiometer R6, leaving only the fixed resistor R5 in the grid circuit. The ringing coil's slug is brought out through either the front or back panel of the set and marked "Horizontal Hold." In these circuits, the oscillator should work without the ringing coil in the circuit. The constants of the RC network must be such that the oscillator's natural frequency is very close to 15,750 cycles. If the circuit won't work without the ringing coil, remove R5 temporarily, substitute a potentiometer of approximately the same value, and rotate it until the oscillator is on frequency. (With the ringing coil still shorted out!) Remove the pot, measure the portion of the resistance used and install a fixed resistor of the same value for R5.

Now, take the short off the ringing coil, and adjust the slug for a locked-in picture. With this setting, the oscillator will be much more stable. We have used this method for some time on many sets with a reputation for horizontal instability and it has always given a decided improvement. At this point, we still have the input grid grounded. If this is removed and the picture promptly falls badly out of sync, there is definitely trouble in the phase-comparer circuit. Check all re-

sistors and capacitors there, also the tube for unbalance, etc.

A variation of this circuit, used in some Philco and Zenith sets, has two potentiometers in the horizontal hold circuit (Fig. 3). This allows a very good adjustment of the horizontal hold circuit, just as we mentioned before. To adjust these, set the front-panel horizontal hold control to center, short out the ringing coil and adjust auxiliary pot R5 for a stationary picture. Then take the short off the ringing coil and adjust it until the picture is locked in. This centers the operating point of the user's horizontal hold control and makes for maximum stability.

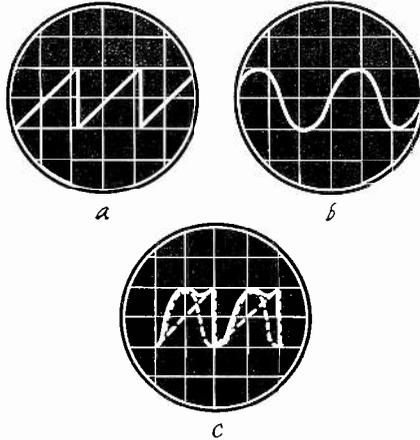


Fig. 5—Synchroguide waveforms: a—basic sawtooth developed by oscillator; b—ringing coil adds sine wave; c—results of sine wave plus sawtooth.

Philco puts this adjustment on the top or rear apron of the chassis. Zenith puts it on the rear apron and marks it "coarse horizontal." Either way, its purpose is the same and it is adjusted in the same way. In fact, if a given set is horizontally unstable, you can add this control, mounting it in an empty hole on the back of the chassis.

The Synchroguide circuit

About the next most common horizontal oscillator circuit is the pulse-width afc or Synchroguide circuit. It is similar to the circuit just described, in that it uses the same type of sine-wave stabilization as the horizontal oscillator. The major difference lies in the circuit's frequency-determining elements, which are in the coil-capacitor combination of the Synchroguide transformer, L1 and L2 in Fig. 4. Here again a twin-triode is always used, although some early versions used two separate triodes.

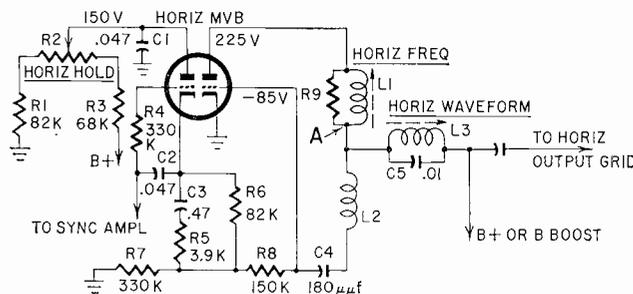


Fig. 4—The Synchroguide, another horizontal oscillator circuit.

If we apply the same tests to this oscillator and find it isn't running properly, we can go on just as before to dig out the trouble. Remove the sync input by shorting the input grid to ground. If this doesn't clear up the trouble, leave it grounded and short out L3-C5, the waveform adjustment in the plate circuit. This leaves only L1-L2 and C4 as the frequency-determining elements in the circuit. If the oscillator cannot be brought to the correct frequency by adjusting L1's slug, and C4 is good, (not open or slightly leaky), then the Synchroguide transformer is defective and must be replaced. (We're assuming here that all dc operating voltages have been checked and the tube replaced.)

This oscillator develops a rather high negative voltage on its control grid, as you can see from the voltages given. If it is not high enough, check the B-plus supply. Many sets feed this oscillator from the boost voltage, through a 150,000-ohm resistor. Check this quite carefully, as they have a habit of increasing slowly to about 500,000 ohms, which lowers the oscillator output more than slightly!

Also, check the little 180-µmf coupling capacitor very carefully. If even the slightest leakage develops across it, the oscillator can't build up enough peak-to-peak amplitude to drive the output tube. Frequency will also drift badly. Resistor R8 can also cause this drift, so check both of them, preferably by replacement, if the complaint is horizontal drift.

With the waveform coil shorted out, a fairly stable picture should be seen on the screen after the hold control is adjusted. This is exactly the procedure we followed a while ago. We made the oscillator run at a frequency which would make a picture, without the influence of the stabilizing coil. Unless the waveform (stabilizing) coil is completely open, it should have no effect on the oscillator frequency. That is, when you remove the short, you must be able to find a setting of the waveform coil slug which will lock a picture tightly in place. If you can't, the coil is definitely defective.

This oscillator generates the basic sawtooth waveform, shown in Fig. 5-a. This is what you see in the scope with the waveform coil shorted out. When we add the shock-excited ringing coil to the circuit, it generates a sine-wave signal (Fig. 5-b). The two are added together to produce the pattern familiar to us all (see Fig. 5-c). For correct adjustment, a scope should be used. Connect it to point A in Fig. 4, through a low-capacitance probe or a small capacitor, and adjust the waveform slug for a picture like Fig. 5-c. The sharp points should be just a wee bit above the peaks of the sine waves for the best sync. If the waveform comes up steeply at this point, the circuit's noise immunity will be much better. Noise pulses will not be able to trigger the oscillator too soon.

FOR some reason color demodulator stages seem to be about the most misunderstood parts of all color receivers. There's no reason for this because they are all basically pretty simple. I believe most of us get confused because of the complicated nature of the color signal. It's like pouring milk and water into a glass, stirring it and then trying to pour milk out one side and water out the other! Well that's exactly what we're doing! Like the farmer with his cream separator, though, we have to have some help in doing it!

Let's run over this circuit briefly. Forget all the complications and look at it one piece at a time. (All complicated circuits are made of a bunch of simple circuits, tied together!) A typical demodulator is a triode tube, like Fig. 1. Our color signal is fed to its grid, with all the color information in it—red, green, blue, etc. This information is in the form of phase differences—the modulation on any signal is in the form of differences: amplitude, phase, etc., from a given reference point.

If this were a simple amplitude detector, our input and output signal would look like the one in Fig. 1. The reference point here would be the bias voltage on the cathode. This is a simple dc voltage. Now you're all familiar with keyed stages—a pulse voltage is fed to the plate of a tube which can conduct only when the pulse is there, because there's no plate voltage at other times. These are keyed stages too. The keying voltage is the amplified 3.58-mc color-burst signal from the chroma reference oscillator. It is applied to the cathode of the demodulators.

In any color demodulation system, one set of values will be in phase with the reference signal and one out of phase by a given amount, usually 90°.

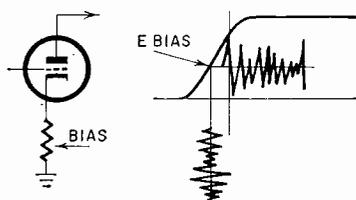


Fig. 1—Typical demodulator is a triode. Waveform shown would appear at its input and output if it were used as simple amplitude detector.

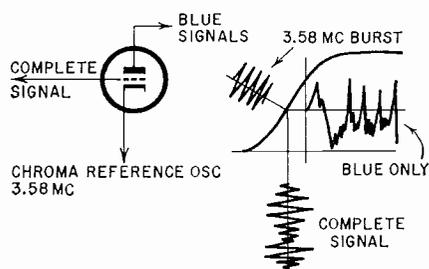


Fig. 2—We key the blue demodulator with a 3.58-mc signal applied to its cathode.



phase differences, from the combination of these, are used to give us any desired combination of colors. In the well-known R - Y B - Y system, blue is in phase, or 0 degrees, while red is 90°. Other colors are at different angles with respect to the burst.

Now let's forget the rest of the circuit and concentrate on the blue signals. The complete signal is fed to the grid of the blue demodulator. In it are certain components which denote the amplitude of the blue signals. These are in phase with the 3.58-mc oscillator signals. To extract them from the whole signal, we key the demodulator with a 3.58-mc signal by applying it to the cathode of the blue tube as in Fig. 2.

Now, the tube conducts, allowing signals to pass only when the voltage relationship between cathode and grid allows normal conduction. (Never mind any other voltages present, and concentrate on only the cathode-grid voltage relationship!) Out-of-phase signals find the tube cut off so they cannot pass (see Fig. 3). Here, the phase relationship between the reference signal, the bias voltage and the incoming signal or grid voltage is the most important thing.

This is admittedly quite an oversimplification, but the basic action of

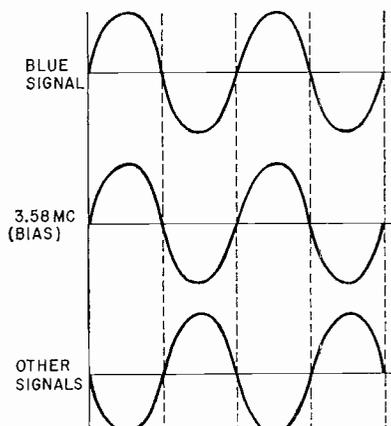


Fig. 3—Out-of-phase signals (those other than the blue signal) find the demodulator cut off.

this circuit, like all circuits, is simple! If you can keep the simple part in mind, it usually isn't too hard to grasp the principle behind the operation of any circuit. All of the other functions are merely duplications of this one. For example, the red demodulator works exactly like the blue, if we consider only the red demodulator circuit by itself. The bias voltage fed to its cathode is 90° out of phase with that fed to the blue cathode. However, we have nothing to do with the blue circuit while analyzing the red one! Therefore, circuit action is exactly the same!

If you want to analyze any circuit, no matter how complicated, try breaking it down into its most fundamental parts and working on them one at a time. Like the ancient fable about the bundle of sticks, you'll find they're a lot easier to break down singly than when you try to deal with them together!

Poor reception

Channel 6 is the nearest station, about 100 miles away. Other stations are up to 200 miles. I installed an all-band Yagi which gives satisfactory reception of channel 6 only. Could a 10-element Yagi cut to channel 6 be used to receive 5 and 7 also, with a separate Yagi cut for 11? Will an all-channel antenna bring in both 6 and 11?—E. B. J., Stambaugh, Mich.

A 10-element cut-channel Yagi is the best approach, but you should not expect satisfactory adjacent-channel reception.

Faint pix

Several of our technicians have worked on a Capehart 324 with a Standard Coil tuner, but have not been able to get more than a faint picture. Sound is OK.—R. A. R., Philadelphia, Pa.

The first step is to find where the loss of gain occurs. Start from the video amplifier and work back. Apply the outputs from an rf or if sweep and marker generator to pin 1 (input) of the 6AL5 picture-detector. This provides a video-frequency sweep voltage.

END

TELEVISION

A demodulator probe and scope at pin 11 (signal input) of the picture tube will show the video amplifier response curve. With an average scope and generator, nearly full-screen deflection should be obtained. Measure the video amplifier gain by noting the amount of vertical deflection at pin 11 of the picture tube, and then moving the probe back to pin 7 of the 6AL5 detector (detector output). The 6AH6 (video amplifier) has a g_m of about 6,000 μ hos and works into a 5,000-ohm load. A video amplifier gain of 40 or better will be found, unless there is a circuit defect. If the video amplifier is OK, check the if amplifier. Apply an if sweep signal at pin 1 (grid) of the first 6AG5 if tube. Connect a scope through a 50,000-ohm isolating resistor to pin 7 (output) of the 6AL5 picture detector. A response curve with a bandwidth of about 3.5 mc between the 50%-of-maximum points should be found. Stabilize the agc line with -1.5 volts of dc override bias.

If curve shape is poor, align the if amplifier, following the service notes for the set. The next step is to check the if stage gains. To measure gain, connect the if sweep generator to pin 1 of the 6AL5 picture detector tube. Note the deflection obtained on the scope screen. Then, move the sweep cable back to pin 1 of the third if (6AG5) tube. Observe the increase in vertical deflection.

A 6AG5 has a g_m of about 5,000 μ hos and works into a load impedance on the order of 3,000 ohms. A gain of about 15 is expected. Check the circuit components if gain is low.

The second if stage can be tested in a similar manner. Move the generator cable back to pin 1 of the second if 6AG5. Again, this should result in an increase of about 15 times in vertical deflection. If the pattern shows evidence of overload (artificial flat-topping), the generator output must be reduced.

The overall if gain is the product of the stage gains. So, if each stage has a gain of about 15, the total gain will be about 3,000.

To check the tuner response curve, apply an rf sweep signal at the antenna input terminals and connect the scope at the looker point. The bandwidth should be about 5 mc. A gain check is difficult to make. If you get a curve about 2 inches high, using average equipment, gain can be considered OK.

These tests will definitely localize the point of signal loss.

Vertical sync trouble

I am having vertical troubles with a Philco TV-300 chassis. The sync is not very good and I get retrace lines at times. This is intermittent and so is the sync, for that matter. The trouble seems to show up on different channels each time.—E. D., New York, N.Y.

There is a factory modification on

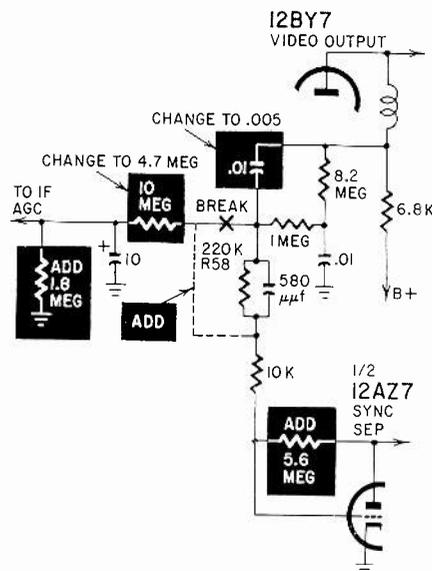


Fig. 4—Factory modification improves vertical sync on Philco TV-300 chassis.

this chassis for improving vertical sync (Fig. 4). Check the set to see if this modification has been made, and if not, make it. It will increase vertical sync amplitude and make both vertical and horizontal sync much more reliable.

The intermittent vertical retrace lines

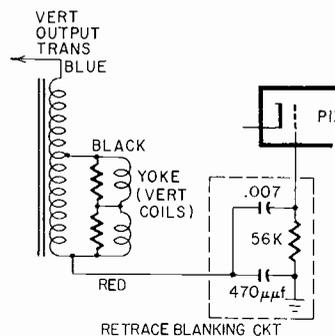


Fig. 5—Open capacitor in network causes retrace lines on the screen.

are probably caused by an intermittently opening capacitor in the network. Fig. 5 shows the original values. You can make this up out of separate units and replace the original. Be sure to get the polarity correct when connecting the network to the yoke or vertical output transformer. If retrace lines become much worse, your polarity is wrong—connect the network to the other side of the yoke.

Inadvisable conversion

Is it possible to convert a DuMont RA-103 from a 12JP4 to a 16- or 17-inch picture tube?—S. B., Cleveland, Ohio

This is not an easy conversion and requires extensive mechanical and electrical changes which would not justify the time and cost. We advise against this particular conversion.

Antenna improvement

I have antennas located on the top of a hill overlooking a valley, with open

line from the antennas. I believe that reflectors are needed at the antennas. Should I use a solid sheet of aluminum or is tubing suitable? If tubing is used, should it be cut to channel? The TV stations are located 80 miles away, and the lines are ½ mile long.—C. R., Williamson, W. Va.

Metal sheets or tubular-construction planar reflectors are less effective than Yagis cut to channel.

Tuner trouble

An RCA 7T103B in the shop has me going sideways. Channels 3 and 6 are OK, but 7 shows only a raster. It is the strongest local station. The tuner has been repaired and air-checked.—E. A. P., Council Bluffs, Iowa

There are three possibilities here. The supply leads to the tuner and first if stage may be "hot," causing oscillation on channel 7. If so, there will be a high dc voltage at the picture detector output on channel 7. Better high-frequency bypassing of the supply leads to tuner and if strip should cool the circuits. The second possibility is a marginal plate-supply voltage to the tuner's local oscillator. This should be checked. Finally, the first if stage can oscillate if the tuner's output circuit is misaligned.

Faster agc

I am operating an RCA KCS-47 receiver in a fringe area about 60 miles from Indianapolis, adjacent to an airfield. There is a problem of flutter, and also of resetting the agc control on different channels. Can you advise on the feasibility of changing the agc system to a faster-acting type?—P. L. J., West Lafayette, Ind.

This is a problem which can be tackled in more than one way. Keyed agc with a short time constant helps minimize flutter, but cannot eliminate it. When signal levels vary greatly, amplified agc gives a wider dynamic range. However, before reworking the chassis, I would suggest trying stacked Yagis to get a very narrow aperture, beamed at the desired station. High-gain antennas also lessen the demands on the receiver's dynamic range. Of course, flutter will still occur if a plane flies through the antenna aperture. If stacked Yagis do not give the desired flutter reduction, reworking the chassis to optimize agc action would be the next logical step.

Horizontal foldover

I'm having trouble with a Capehart TV, model 3C312M. I have replaced the flyback, using an exact replacement made by another manufacturer. I was unable to get any high voltage until I changed the cathode resistor in the horizontal output stage from 180 ohms to 360 and the cathode capacitor from 0.1 to .05 μ f. With the horizontal drive closed, there is severe foldover in the center of the screen, although there are no curved vertical lines. As I turn

the horizontal drive, I get a picture with shifting vertical lines, all curved to some extent. About halfway down from the top of the screen there is a deep bend; also right at the top of the picture, if the vertical size is cut down so you can see it. Opening the drive control all the way gives a Christmas-tree effect with possibly a loss of the raster and high voltage. Vary the width control and the same thing happens.—I B. A., Swansea, Mass.

You do have a large assortment of symptoms! However, two of them are significant: foldover in the center of the screen, and the fact that you were forced to change the residual bias on the 6BQ6 horizontal output tube to get a picture at all. This points to leakage through the coupling capacitor between the 12AU7 oscillator plate and the 6BQ6 grid, upsetting the bias. The horizontal instability, bending and tearing of the picture and the other symptoms are all indications of the same trouble. The leakage through this capacitor lowers the output of the horizontal oscillator by lowering the load impedance in its plate circuit. When you closed the drive trimmer, you added enough capacitance to allow more of the weak oscillator output to get through to the 6BQ6 grid, allowing the output tube to drive the flyback a little better.

The leaky capacitor is probably the .001- μ f unit between pin 6 of the 12AU7 and pin 5 of the 6BQ6. It would also be a very good idea to check the .047- μ f unit in the 12AU7 plate return circuit, the .01- μ f between pins 6 and 2 on the 12AU7 (the interstage coupling capacitor), and the 820- μ f capacitor in the shaper network between the horizontal discharge tube plate and the 6BQ6 cathode. Leakage in any of these can cause trouble. If any of them are bad, replace the resistors associated with them, such as the 6,800-ohm unit in the shaping network. Heavy currents through them may have caused a shift in their value.

Note: When you changed the cathode resistor, you increased the dc bias on the output tube to the point where the tube could conduct almost on the right portion of the curve and get a little output. The positive voltage leaking through the capacitor was bucking out enough of the normal bias to make the tube inoperative.

Poor sync and vertical roll

A G-E 17T14 chassis has an intermittent vertical roll. The set uses a 6CS6 clipper, and video can be seen feeding into the vertical oscillator grid at high contrast levels. Apparently the video gain (contrast) control has a lot to do with this. When the picture is too pale to be visible, the vertical hold is OK. When the contrast control and the local-distance switch are advanced to give good contrast, the picture is stable until a scene with much black in it appears. Then the vertical hold loses

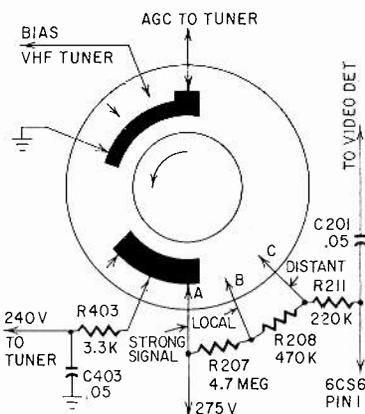


Fig. 6—Original connections of LOCAL-DISTANT switch on G-E 17T14 chassis.

control and the picture runs free until the scene goes lighter. We figured that the relative amplitudes of the signals fed to the 6CS6 had changed, causing imperfect clipping. Shunting capacitors from pin 7 of the 6CS6 to ground causes all hold (vertical and horizontal) to be lost. Shunting pin 1 gives an improvement. Video data are not seen at the vertical oscillator grid and the picture is much more stable. We are reluctant to add an unspecified part to

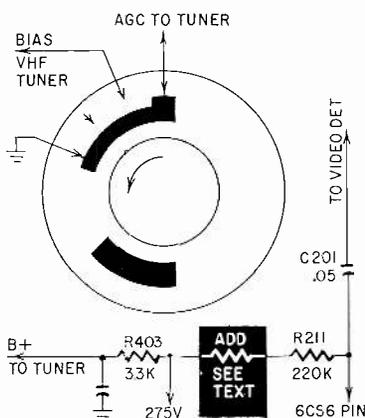


Fig. 7—Revised switch connections give best noise-cancellation action.

the set, but we can't give it back to the customer in this shape.—M. M., Baltimore, Md.

This is a common trouble with this series. It occurs because the agc is switched by the same wafer switch which controls the sync and noise inverter 6CS6—the local-distance switch (Fig. 6). When the switch is set to the point where agc is right for the signal level, the sync is being clipped by the noise inverter! When the noise inverter is right, agc is too weak, and so on.

The repair we have found best for this is to rewire the switch as shown in Fig. 7. Take the noise-canceller components completely off the switch and substitute a 5-megohm pot for the resistance. Set the switch to the point where agc voltage is best, giving the best picture. Adjust the contrast control for a satisfactory picture. Now adjust the 5-megohm pot for the best noise-cancellation action—this is usually just be-

fore the picture shows signs of sync clipping. Turn the control until the picture becomes unstable, then back it up until the picture is steady. Measure the amount of resistance in the circuit, and substitute a fixed resistor of the same value. Leave all noise-cancellation functions completely off the local-distant switch; the variation in picture quality caused by the change in agc will still make the customer happy.

If the vertical hold is not good enough, try rebuilding the vertical integrator. Use a smaller resistor in place of the present 82,000-ohm unit and increase the .0047- μ f capacitor to about .02 μ f. This allows a slightly higher level of 60-cycle sync to get through to the vertical oscillator, improving vertical hold action on this set immensely. This same trouble occurs in the M and MM series of portables.

TV check tube

I have a 5BP4 which I would like to use as a substitute tube for testing TV's. I understand some of the boys have wired up a 5-inch tube (any type) for this.—L. O. T., Los Angeles, Calif.

You have a good idea, but the wrong type of tube! The 5BP4 is an electrostatic-deflection tube, used for oscilloscope work. Unfortunately, this type of tube cannot be used for a substitute TV tube. You can use any tube of this kind which has magnetic deflection, like the larger CRT's used in the sets.

Probably the tube you have heard of is the type 5FP7/1812P7. This is available in surplus and has been used as an inexpensive substitute picture tube. For details on its use, see "Economy Test Tube" on page 57 of the March, 1958 issue.

Pix-tube change

Is it possible to replace a 16ZP4 with a 16GP4 in a Philco 51-T-1604 without any major reworking of the chassis?—J. A. L., Tipp City, Ohio

The 16GP4 is a 70° tube, while the 16ZP4 has a 52° deflection angle. Accordingly, the chassis would need reworking. END



"Remind me to take this customer off the books, Ingwanna."

How to RETOUCH REPAIR REFINISH



By JEFF MARKELL *

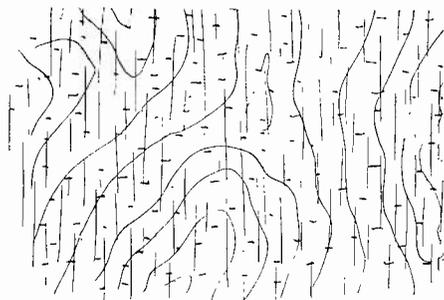
THE first half of this series (March, page 109) showed how to handle burns, scratches, gouges and other imperfections in TV and hi-fi cabinet finishes. This half goes on to tell what can be done to correct crazed finishes, loose legs and moldings, open joints and loose or blistered veneer. Refinishing is also discussed.

Cracked, crazed or alligatored finish are terms that denote various types of deterioration of aging finishes, although occasionally they may appear on a relatively young piece of furniture. For example, a cabinet subjected to considerable vibration—such as a speaker enclosure—may craze before it is very old. Cracks in the finish can be depended upon to occur over any cracks or checks in the underlying wood. Alligatoring is so called because the finish crazes in a pattern like alligator skin. It is usually a disease of old age. You have probably seen it on old pianos. It can occasionally occur on a relatively new piece of furniture if the finishing was done in a cold room.

With any of these conditions you may want to pause before deciding whether to try to repair the finish, strip the old finish off and refinish, or throw the whole piece away. A moderately crazed finish can sometimes be restored with a 50-50 mixture of linseed oil and turpentine plus a good deal of elbow grease. Commercially available scratch-fixing and crack-eradicating

* Markell Associates, Cabinet Design and Construction.

Much of the material in this article appears in the author's Gernsback Library book *Designing and Building Hi-Fi Furniture*. Artwork is also by courtesy of Gernsback Library.



Crazed finish caused by age or vibration.

Part II—Troubles that appear in old or misused cabinets can be corrected



mixtures will often work wonders on crazed or cracked surfaces. Also an overall French polishing (see page 110, March issue) will often do the trick. It's a lot of work, but it can give you a lovely-looking surface on a piece that had become a dismal mess.

It is claimed that a combination of treatments first with crack eradicator and then French polishing will clear up an alligatored finish. But I am afraid that, if the alligatoring is very bad, your best bet is to strip the whole thing down and refinish it, or discard the cabinet.

Grille cloth

A common cause of shabbiness in a basically sound and good cabinet is a baggy or torn grille cloth. The cloth need not necessarily be ripped, frayed or even pulled loose to make the cabinet look miserable. It may merely be dirty and discolored. Grille cloth is not expensive, particularly if you consider how much replacing a tired one can do toward sprucing up the entire appearance of an open-front TV console.

Loose, peeling, blistered veneer

Veneer that starts to loosen or peel will most often let go along an exposed edge, where atmospheric dampness can get under it. The most common places will be along the back of the top or sides, along the bottom of the sides, or along the hinge sides of doors. A good preventive for this kind of trouble is to seal such edges thoroughly with lacquer or varnish. Once they have started to go, of course, you are a wee mite late for prevention. If they haven't gone too far, they can be repaired, after which it would be a good idea to seal the edges thoroughly to prevent any recurrence.

If you have a few spots where the veneer is loose for lengths of 2 or 3 inches (and the veneer is still all there), you can repair it. But if you see a major area of a side or top that perhaps got thoroughly soaked, with the veneer checked, blistered and loosened up over a large area—don't even try.

A small area of loose veneer can be easily corrected by forcing some glue

under it with either a brush or a squeeze bottle. Then apply pressure to hold the veneer tight against the core while the glue sets. This can be done with clamps or by resting the entire weight of the cabinet on the affected side. By the way, if you use a squeeze bottle, be careful not to get too much glue in. It will only come squirting back out when you apply pressure.

In the occasional case of a panel where the veneer has stayed tight around the edges but has blistered somewhere toward the middle of the panel, you've got quite a tricky situation. This kind of patient does not usually respond well to treatment. But if you insist on trying, here is what I would suggest. Take an extremely sharp thin-bladed knife of the Exacto type and make a slit through the veneer, running lengthwise with the grain right down the center of the blister. Now, holding down one side of the blister with your fingers, squirt glue in under the other side, then repeat the process for the other half of the blister. Next take a little roller and roll the glue from the center line where your cut is—and where you squirted in the glue—out toward the edges of the blister. When you feel you've got it pretty well worked out, apply pressure, allow it to dry, and see what sort of results you've got. If you were able to get the glue thoroughly distributed under the blister, it will take well. If not, you may find a half a dozen little blisters where you had one big one before, but that is the chance you took in trying to meddle with the thing. The cabinet was probably useless as it was so you can't have done any real damage.

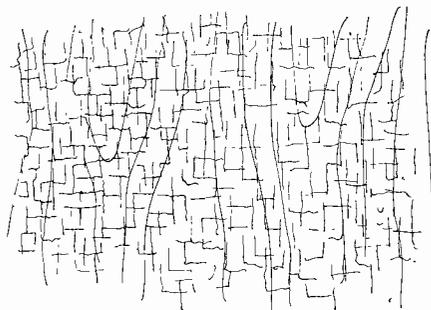
Open joints

If a cabinet is cracked open along a joint (and hasn't been dropped or abused), it is usually because the glue has dried out and let go, or excess humidity (or dryness) has warped the panels.

If the glue has given way, you haven't too much of a problem on your hands, but if warpage has set in you have a bit of trouble.

The basic cure for an open joint is glue and pressure. Whether you'll be able to use internal glue blocks (triangular wood strips placed inside the joints) or cleats and screws depends on the type of cabinet and the location of the open joint. For example, the inside of a speaker cabinet is never seen, nor is the inside of the tuner or amplifier compartment of an equipment cabinet. In such cases you have a good chance of effecting a successful repair even if the panels are warped because you can get inside to install glue blocks or cleats and screws to re-enforce and pull the halves of the joint back together. If the open joint is in a part of a cabinet that is readily visible, you'll have to rely entirely on glue and pressure.

In any event try to clean out the old glue before forcing additional glue into the open joint. Lumps of old glue re-



Alligatoring is crazing in a pattern like an alligator skin.

maining in the joint will make it difficult if not impossible for you to clamp the joint closed and keep it that way.

The ideal clamping tools for adequate and continuous pressure are cabinet-maker's pipe or bar clamps. If these are not available, another way of developing the required pressure on the joint is to run a heavy rope completely around the cabinet. Where the rope touches the corners of the cabinet they must be protected first with a thick wad of tissue, toilet tissue, or soft rags, and then, on top of that, L-shaped blocks of wood. When all the corners are adequately protected, take up on the rope by putting a rod or pipe through it and twisting it in the manner of a tourniquet. This method is a bit cumbersome, but it will develop considerable pressure.

Loose legs

Actually, I think more loose legs result from misuse than old age, so this defect may be listed in the wrong place. After all, if you load a cabinet full of heavy equipment (TV chassis, stereo amplifier, etc.) plus a lot of records and then start dragging it across the floor, you cannot blame old age or faulty construction for legs loosening. They are being subjected to lateral strains they were never intended to stand. Of course, legs can also loosen as a result of merely holding up a heavy load for a long time.

In tightening up a loose leg the first step is to find out what is loose. This in turn will depend on how the leg was attached in the first place. A common method of attaching four separate legs independently is with hangar bolts. A hangar bolt has a thread like a lag bolt at one end, and a machine-screw thread where the head ought to be. They are mounted by driving the lag bolt thread into the leg, then the machine screw thread fits into the bottom of the cabinet.

The possible sources of trouble here are:

1. The plate is loose from the bottom of the cabinet.
2. The leg is partly unscrewed from the plate.
3. The hangar bolt is loose in the leg.

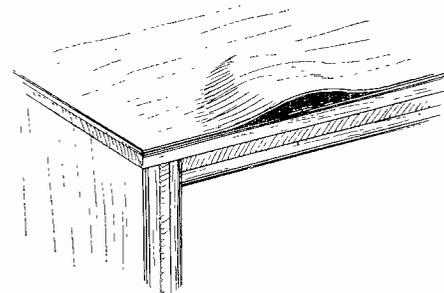
In the first two cases the solutions are obvious. If the plate is loose from the cabinet, tighten the screws. If the hangar bolt is loose in the plate, turn the leg to tighten it. If the bolt is loose in the leg, you've got one of two problems. The bolt has come loose by strip-

ping the threads in the leg or the leg is split.

In both cases the best thing to do is to replace the leg. If this is not possible (perhaps you cannot get a leg that matches) then you have to try to repair it.

Take the hangar bolt out of the leg and determine whether the trouble is a stripped thread or a split leg. If the thread is stripped squirt glue or one of the all-purpose adhesives into the hole, run the hangar bolt back in, then let the whole thing set. When the adhesive is thoroughly dry and hard, remount the leg. If the leg has been split, squirt glue in the hole and run the bolt back in. This will force glue out into the split. Now clamp the split closed, let it dry, and remount.

If the legs on your cabinet were not individual but attached to each other by a frame forming a base or bench under the cabinet, you'll find either broken



Moisture under the edge will cause veneer to lift or loosen.

dowels running from the frame into the legs, or glue failure again.

Lay the cabinet on its back to repair this and take the whole base off. Now examine the base for loose joints. Any that are loose should be knocked completely apart. Now look for broken dowels or splits in the rails near the dowel holes. If all the parts are OK, clean the old glue out of the dowel holes, reglue, reassemble and clamp until dry. If any of the dowels are broken, they should be replaced. By the way, use a hardwood such as birch for the replacement dowels if possible. The common pine doweling is not very strong, and the loads that go in audio cabinets are pretty heavy. What do you think broke that dowel in the first place?

If any of the rails have been split, force glue into the split and put a separate clamp on that part when you reassemble the whole base.

Loose molding

This is another case for cleaning out old glue and regluing. With moldings it is often desirable to hold them in place with very small wire brads rather than by clamps. It's often difficult to get a clamp onto a small molding, and you may crush it. The brads used should be extremely small. Their purpose is not to hold the molding permanently, that is the job of the glue. The brads are merely to hold the molding while the glue sets.

You will notice that in discussing

repairs to the wood structure of cabinets I have made very little mention of screws and nails. This is because furniture is basically held together not with fasteners but with glue. Granted that speaker enclosures are re-enforced with screws, the basic fastening is still glue. This is what held the cabinet together originally, and this is what you can rely on to repair it.

Refinishing

Doing this properly is a big job and I would recommend it only for a piece you love very dearly. The worst part of the job is stripping off the old finish and preparing the cabinet for refinishing. The first requirements are liberal quantities of paint remover, a scraper and a good deal of persistence. Different paint removers are used in different ways, so follow the directions on the can and be sure to get all the old finish off. You won't miss on the large areas like the top or sides, but watch it around moldings, doors and legs. You'll never get a decent new finish unless you remove all of the old finish.

Finishing new work was discussed in a previous article (August 1959, page 35) and, once you've gotten the old finish completely removed, the refinishing procedures will be the same as if you were finishing a new piece.

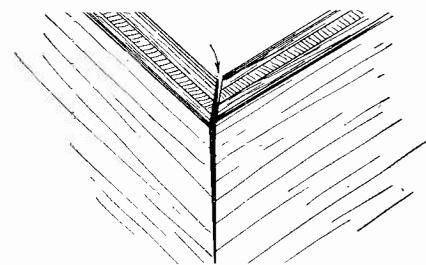
After you are through with the paint remover and have all the old finish off, wash the cabinet down well with turpentine or benzine to take off any paint-removing chemicals that may still be on the wood. Then sandpaper as for a new piece and, as with a new piece the better your sanding, the better your final results will be.

If you wish to stain the cabinet, you will have no trouble if you did a good job of getting the old finish off. But any spots where the old finish has not been fully removed will not take the stain.

If you were thinking of bleaching—don't. In bleaching an old piece you are almost certain to get spotty results.

The filling, sealing, finishing and rubbing operations in refinishing an old piece will be exactly the same as if you were applying the initial finish on a new unit, and you can expect just as good results.

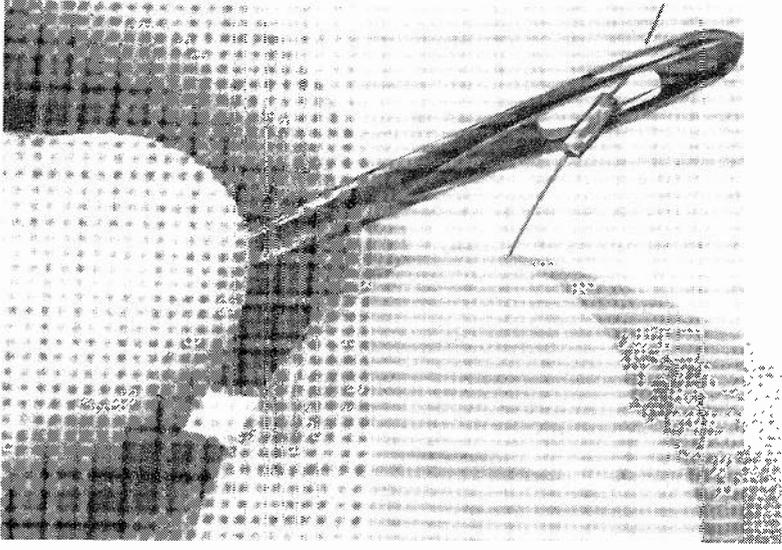
As a final word of caution I'd like to remind you when refinishing an old cabinet—after you have completed the removal of the old finish, examine the entire unit very carefully for any structural defects. Remedy any you find before you start the refinishing procedure. END



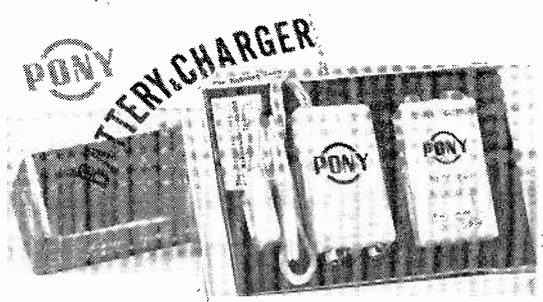
A typical open joint.

what's

new ?

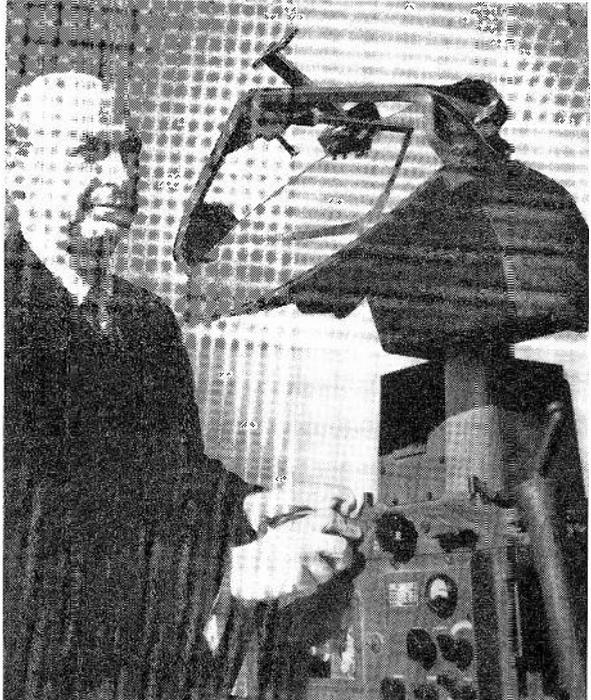
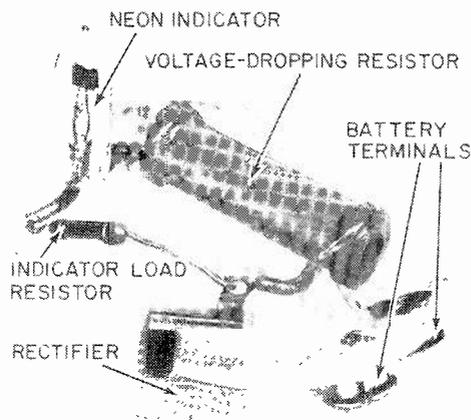


TINY LAMP by Sylvania Electric Products is the smallest incandescent lamp ever produced on an assembly line. This lamp is expected to be useful in many phases of microminiature circuitry. Operating voltage 1.5, current 40 ma.

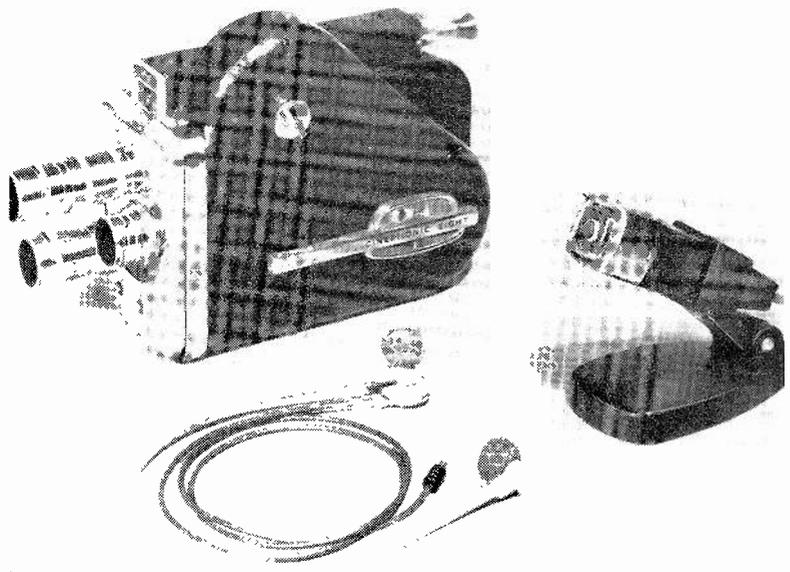


RECHARGEABLE BATTERY can be used in many small transistor radios. This 9-volt battery will operate for about 15 hours before it needs recharging. It can be recharged over 100 times, giving about 1,500 hours of use. The battery and the 117-volt charger (left in photo, in exploded form below) are imported from Japan by B & K Mfg. Co. of Chicago.

MOVIE CAMERA and projector can record sound on 8-mm film. Projector can add sound to existing movies while camera can record sound in exact synchronization with action. The Fairchild Cinephonic Eight series will shortly be placed on the market by Fairchild Camera & Instrument Corp. The company has color film available and can sound-stripe existing movies.



TELEMETRY SYSTEM can break through the layer of ionized air that surrounds a re-entering satellite or vehicle. The re-entering object has a "sheet" of highly conductive air at 2,000 to 3,000°F. around it. This system developed by International Telephone & Telegraph Corp. uses extremely high frequencies that get through this barrier where low and medium frequencies cannot. Installed in test capsules of various sizes and construction, the telemetry equipment will transmit such information as exterior and interior temperatures, the number of "g's" (multiples of the force of gravity proportionate to acceleration and deceleration factors) a pilot would have to withstand on re-entering, and the effects of vibration as the capsule plows into the earth's atmosphere.



STATIC CONTROLS

in INDUSTRY

Magnetic amplifiers are the key to control devices that have no moving parts

By **TOM JASKI**

WHEN you turn a motor on or off with a switch, you use digital control. Any on-off, all-or-nothing kind of control is digital. When you regulate a motor's speed with a rheostat, you use analog control—a gradual kind of change.

Obviously, most industrial controls are digital in nature. Just consider the gillions of motors turned on or off by switches or relays and contactors. And even many complex machine operations can be controlled with digital signals.

In analyzing machine controls we find that certain patterns or combinations of signals keep recurring. We can produce such signals with *LOGIC* units. These units are combinations of circuit elements which combine several input signals to produce a given output.

Logic is not used here in the usual sense. Instead it is derived from a logical kind of algebra (Boolean algebra) which was explained in *RADIO-ELECTRONICS* by Edmund Berkeley (late 1950 and early 1951 issues).

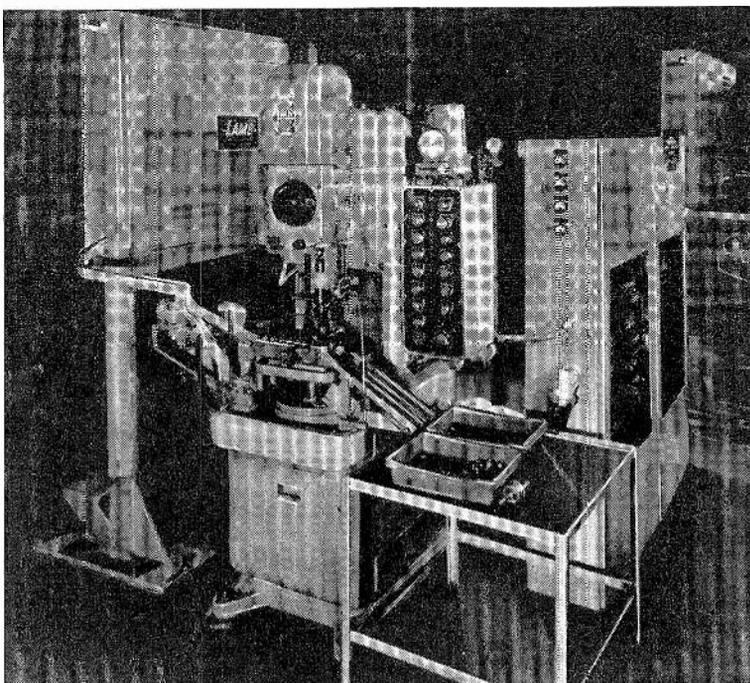
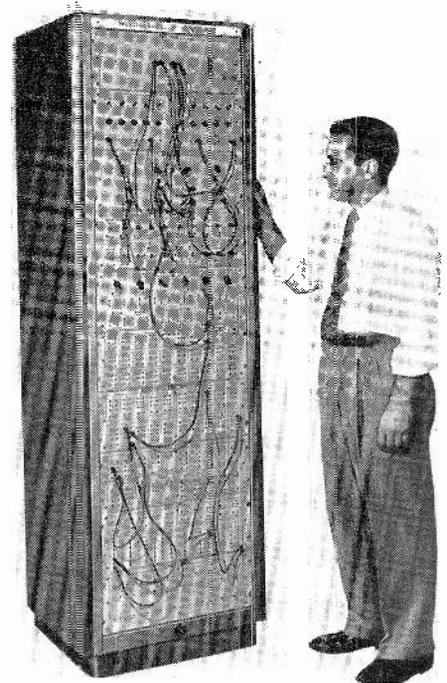
Here we need not concern ourselves with it. Instead we will look at the kind of control elements which form logic units and how these units are used to control machinery.

Magnetic-amplifier principles

Most of the important units are derived from magnetic amplifiers so, to be sure of our ground, let's review their operation briefly.

The magnetic amplifier is based on the principle that an alternating current sent through a coil wound on a ferromagnetic core meets considerable

Westinghouse computer for network calculations made from Ramey magnetic amplifier units.



CYPAK control (right) for automatic machine tool.

impedance resulting from the magnetic field being built up and broken down each half-cycle. But the iron core tends to keep its magnetization, so the building up and breaking down of the field does not proceed exactly the same way as the ac magnetizing force.

This is shown in Fig. 1, a magnetization or, more commonly, a B-H curve. (H is the magnetizing force caused by the current in the coil and B is the magnetic flux density resulting from it.)

Notice, when we increase H, B increases along a certain path or curve (from a zero value to *a*). As current is reduced and reversed, demagnetization and reverse magnetization do not follow as quickly. When the magnetizing field has dropped to zero, the level of magnetism in the core is still high (*b*) and considerable magnetizing force in the reverse direction must be applied to demagnetize the core completely (*c*). Now the core magnetizes in the opposite direction to point *d*, equivalent to *a*, and back through *e* and *f*, which are the opposite numbers to *b* and *c*. The process graphically produces what we call a *hysteresis loop*.

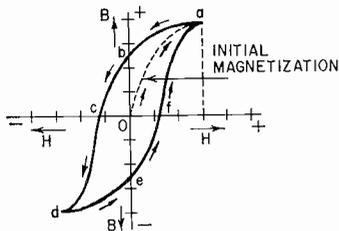


Fig. 1—Magnetization curve of iron core.

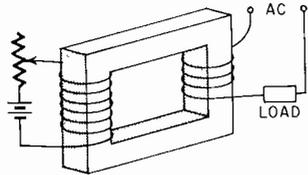


Fig. 2—Basic saturable reactor

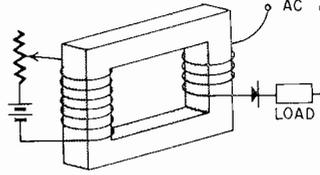


Fig. 3—Adding rectifier assures control at all times, but field induces voltage in control winding.

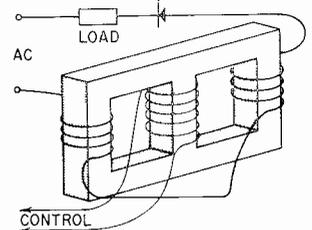


Fig. 4—Basic magnetic amplifier. Opposed fields from split load winding cancel in center (control) leg.

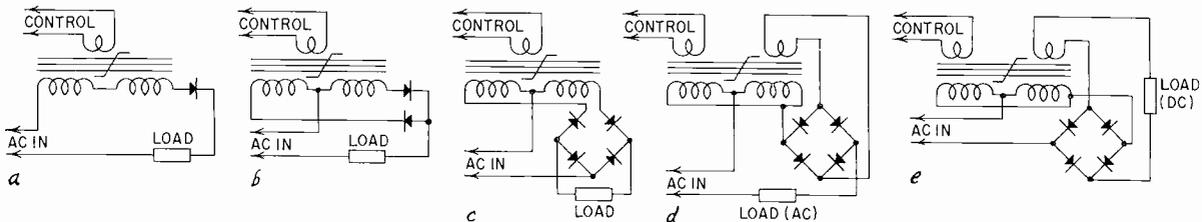


Fig. 5—Magnetic amplifiers in various circuits: a—Schematic representation of magnetic amplifier; b—magnetic amplifier with full-wave rectifier; c—full-wave bridge isolates ac and dc circuits; d—adding feedback winding can increase gain; e—shown with shunt feedback; c—series feedback uses heavy feedback winding capable of carrying load current.

It represents the losses in building up and breaking down the field. And the necessity of building up the field each time reduces the current we can send through the coil since we average the current to measure the total.

But consider what would happen if we had already magnetized the core, say to point *a*, and then sent the current through. Obviously, the current would be much greater, and at (*a*) it would be maximum. Thus we have a way to control such a current and do so by winding a second coil on the core and supplying it with dc from a convenient source. We regulate the magnetization with the dc.

This is called a saturable reactor (Fig. 2). If we magnetize in one direction, current in that direction would be heavy and much less in the other since we are building an opposing field. If we insert a rectifier in the load winding to make sure that we always have a load current in the same direction (magnetically) as the control current, we have control at all times (Fig. 3).

There is only one thing wrong here—the core with two windings acts as a transformer, and the load current may induce a high voltage in the control winding.

To avoid this, the load winding is divided into two parts—each on one leg of the core—wound so their fields oppose each other. A third leg is used for the control winding (Fig. 4), which is no longer affected by the load current. Basically, this is the magnetic amplifier as we use it. We can vary it by adding more windings or by using more rectifiers (Fig. 5), but in essence this is the basic component.

There are many ways to use magnetic amplifiers directly for control, and we can make digital and logic devices from them in several ways. One method was developed by Dr. Ramey, and his units

are used as examples because they have some advantages and are widely used in industry. They are marketed by Westinghouse in a *CYPACK* system.

Basic Ramey unit

With a core material which has the B-H curve shown in Fig. 6, the possibility of designing a digital device is much better if we can use the two extremes—the two saturated states of the core—as our two distinct states, our on and off. If we take such a core, add a winding, hook it up as in Fig. 7-a and supply enough current, the unit saturates itself one way or the other. If we add a second winding and apply a current 180° out of phase with the first one, the unit does not saturate when it is on. This was Ramey's idea—he called it a reset winding. Fig. 7-b shows the basic Ramey unit.

To understand its action, you must realize that, once the core is saturated, there is no reason for it to lose its magnetism unless a current which opposes the magnetism is applied to one of the coils. So, if we let the core saturate by blocking the reset current, in a half-cycle the unit saturates and produces a load current. But notice that the load current starts a half-cycle after the signal has been applied. This half-cycle is used to magnetize the core in the direction opposite to that which we could get from the reset winding.

When we want to use a number of these units together, we run into two contradictory demands: we need a low impedance in the reset winding to insure proper resetting, yet we need a high impedance to avoid loading the signal source. To satisfy both, we use rectifiers and a dc bias source (Fig. 8).

The bias current in the reset winding flows continuously, and to balance this effect we also have the same bias current in the load winding. If bias

current is always a little greater than the current supplied by the reset voltage source (E_r), D1 would appear to have a low impedance—the alternating reset current adds and subtracts from the bias so current I_r looks to the reset winding as if E_r were right across the coil. But if we supply an input signal current, it can cancel the bias current so that E_r —with no dc to add to and subtract from, and faced by the high impedance of the blocking diode D1—cannot send current through the reset winding. Resetting cannot take place and a half-cycle later there will be an output from the unit.

Looking at Fig. 8, here's what happens. We have already stated that to get an output the core must be saturated. But the reset current is 180° out of phase with the saturating current and prevents saturation. The reset current flows only because there is a bias current. If there were no bias current (I_r), point A is at a lower voltage than point B and I_r , the reset current, sees a high impedance for it simply reverse-biases diode D1.

But when we pass a bias current through D1 (ignoring D1's resistance), point A is brought to the same potential as point B. Now the impedance from A to B appears to be low (same potential, you see) and I_r can pass in the direction shown. Now if we supply a signal through diode D3, point A is brought to a higher potential than point B and the reset current (I_r) is blocked. (The signal we applied to block the reset current cannot go through diode D2 or D1.) With the reset current blocked, the core can saturate and we get an output signal on the next half-cycle.

Logic units

By simply adding inputs, we can
(Continued on page 68)

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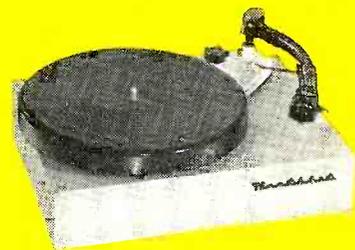
HEATHKIT EK-1 \$19.95



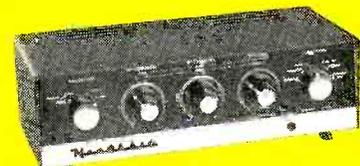
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(Six Meter)

A wonderful addition to the "ham shack" two new 6 and 10 meter transceiver kits

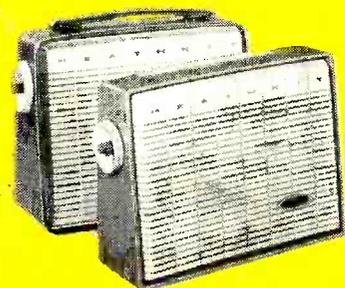
They're combination transmitters, designed for crystal control, and variable tuned receivers operating on the 6 and 10 meter amateur bands (50 to 54 mc for HW-29 and 28 to 29.7 mc for HW-19) in either fixed or mobile installations. Highly sensitive superregenerative receivers pull in signals as low as 1 microvolt; low power output is more than adequate for "local" net operation. Other features include: built-in RF trap on 10 meter version to minimize TVI; adjustable link coupling on 6 meter version; built-in amplifier metering jack and "press-to-talk" switch with "transmit" and "hold" positions. Can be used in ham shack or as compact mobile rigs. Not for Citizens Band use. 10 lbs.



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XR-2L (simulated leather and plastic) 7 lbs.
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It's easy and economical to go stereo with these two Heathkit "compatibles"—stereo preamp kit (AA-20)

Made for each other, either of these components can be incorporated with your present stereo system. The preamplifier (AA-20) features 4 inputs in each stereo channel and gives you a choice of 6 functions. It will accommodate a magnetic phonograph (RIAA equalized), a crystal or ceramic phonograph, and 2 auxiliary sources (AM-FM tuners, TV, tape recorders, etc.), and is completely self-powered. 8 lbs.

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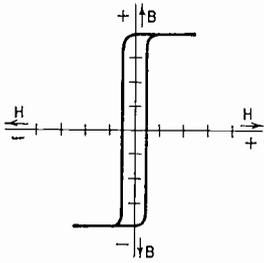


Fig. 6—B-H curve for special core material in Ramey units.

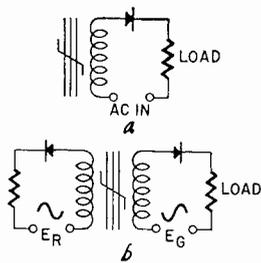


Fig. 7-a—Unit with rectifier can be self-saturating; b—basic Ramey unit with reset winding. Reset, supply voltages 180° out of phase.

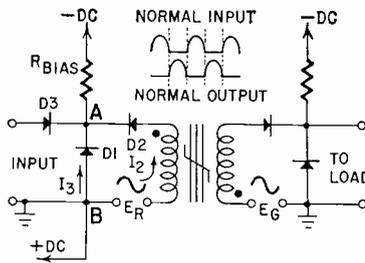


Fig. 8—Adding bias and rectifiers gives the Ramey units desired impedance characteristics.

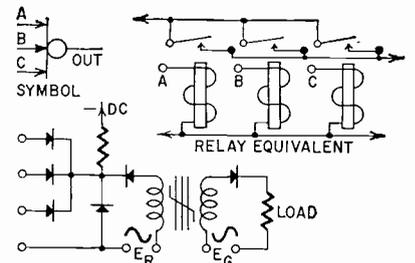


Fig. 9—Ramey OR unit and its symbol.

(Continued from page 64)
create a unit which can be made to give an output for any one of the input signals, one OR the other. We call this an OR unit. Such a unit is shown in Fig. 9 with three possible inputs and the symbol we use for it in control diagrams.

If we add more bias rectifiers and give each of them an input rectifier to cancel, there will be room for the reset current so long as there is one bias rectifier without a signal on it. This means that we must make sure there are as many input signals as bias rectifiers, and we call this an AND unit, shown for three input signals in Fig. 10.

If we design a unit in which we make the reset current the input signal, then we have a unit which will not produce an output when we have an input signal. This we call, simply enough, a NOT unit (Fig. 11).

For logical control we need at least one more basic unit—a memory unit. This we can make from two OR units and two NOT units as shown in Fig. 12. If NOT 1 produces a signal which is fed to NOT 2 through OR 2, NOT 2 will fail to produce an output in the next half-cycle, and NOT 1 will thus provide the reset for NOT 2 each half-cycle. But an input at 1 will reset NOT 1, so it will fail to produce an output for the resetting of NOT 2, which then will produce an output a half-cycle later. This output through OR 1 will reset NOT 1, and thus each cycle NOT 1 will repeat its failure to produce a signal, whether or not there is an input at 1. The state of the unit has changed, and it can be changed back only by applying an input to 2. Fig. 13 shows the actual circuits. Notice that we need not use four separate cores, but only two. By making the reset an input, we can use the OR

units simultaneously as NOT units and save components.

This memory unit retains its setting as long as the power remains on. If power fails, the unit may show the wrong saturation when the power comes back on. It is a little like turning on the gas without making sure the pilot light is lit. To avoid this, where necessary, Westinghouse can provide what is called a retentive memory circuit. It is shown in Fig. 14. Actually Fig. 14 shows the elements which make the memory retentive. Core SL is kept unsaturated by alternating voltages applied to the windings. When power fails, the core is left saturated in one direction or the other. If power is re-applied in the same phase as before, operation continues as before. But if there has been a phase shift, an output is obtained at either of the output terminals. This output is used to block the feedback current which resets the

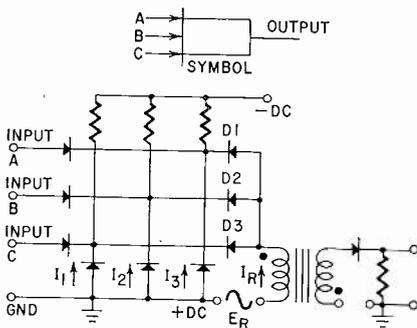


Fig. 10—Ramey AND unit requires three inputs to produce an output.

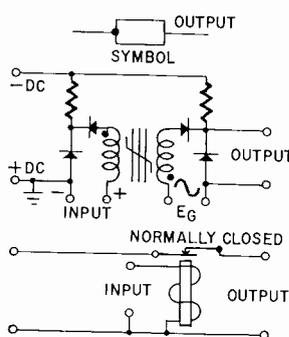


Fig. 11—NOT unit uses input for reset.

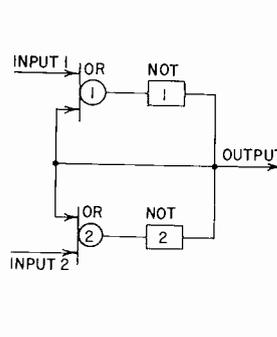


Fig. 12—Basic action of memory unit.

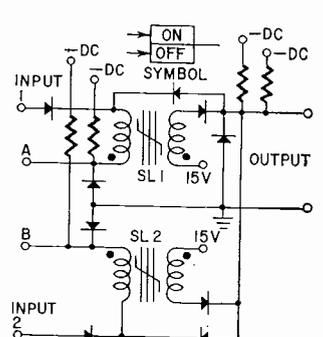


Fig. 13—Memory unit and its symbol.

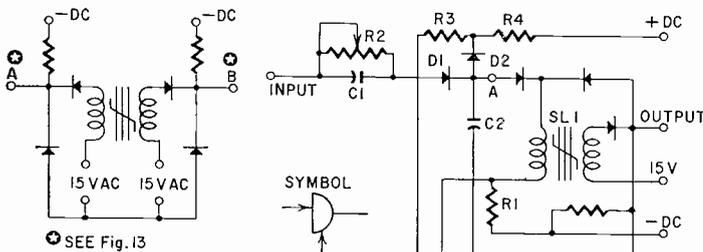


Fig. 14—Additional core can make memory retentive. Points A and B tie to A and B in Fig. 13.

Fig. 15—Delay circuit derived from memory unit. C2 is timing capacitor. R2 adjusts timing.

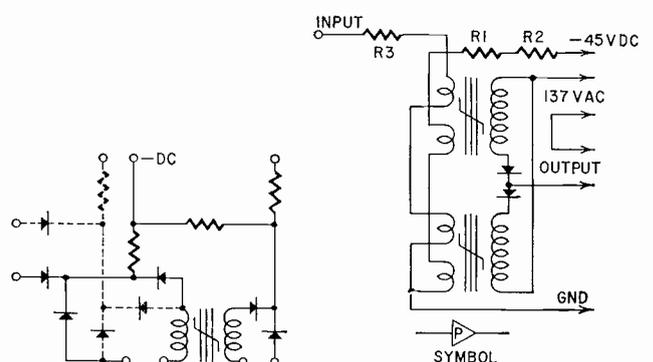


Fig. 16—Preamplifier is similar to basic unit, or with more than one input to AND circuit.

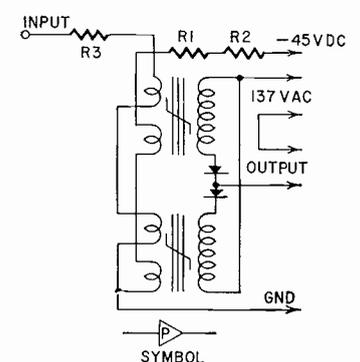
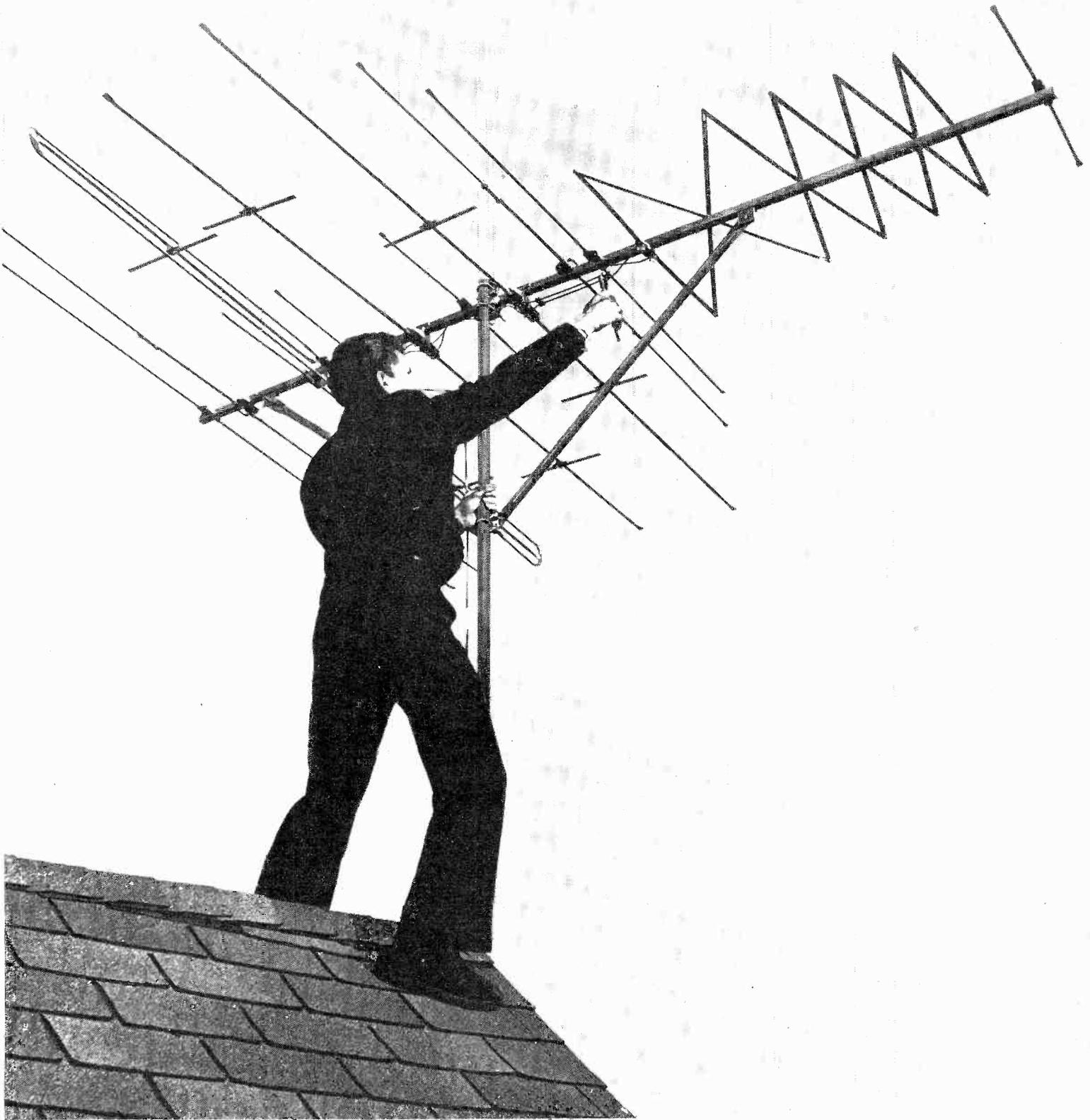


Fig. 17—Typical Ramey output amplifier (full-wave output). Extra windings are needed to connect core inputs in series.

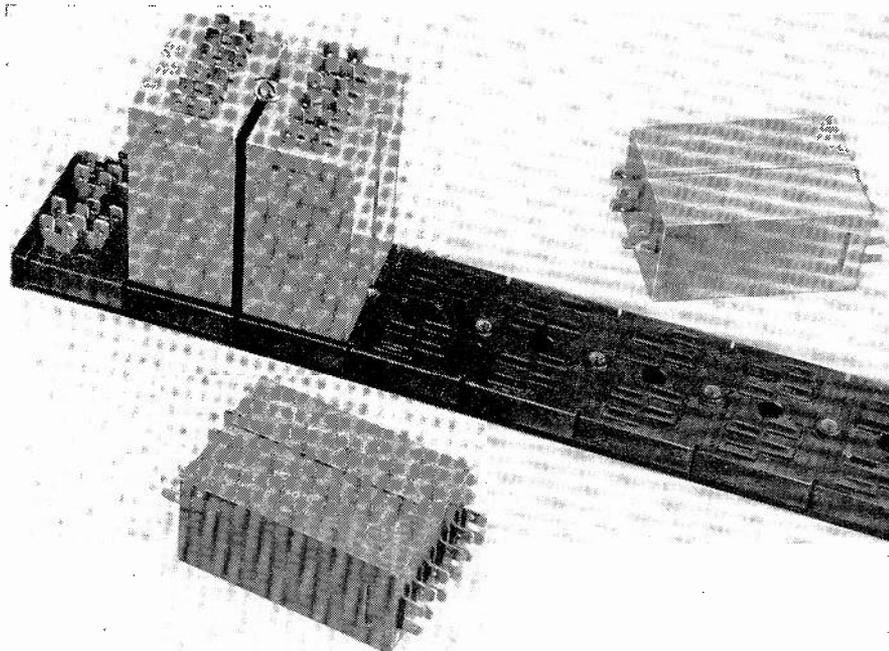


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CYPAK Ramey units and their bus system.

memory, preventing the change of state of the memory. The retentive unit is tied into the memory unit at points A and B as in Fig. 13.

An important control element for sequential operations is a time-delay circuit. It too can be built from Ramey switching units. The diagram is shown in Fig. 15. It looks like a memory unit, but has in addition R1, R2, R3 and R4 and C1 and C2 as well as D1 and D2. C1 is small compared to C2. From an input signal a little charge is put into C1 each cycle. C1 tends to discharge through R2 at a rate determined by R2's setting. Each increment of voltage at the input will be too small to reset unit SL1 until after C2 builds up enough charge (up to the clamping voltage set by R3, R4 and D2). C2 discharges when a RESET signal is applied to the reset input. With a signal at both inputs, the time delay will start as soon as we block the reset input, and this could be done by a NOT unit somewhere. Until reset, the unit will continue to produce an output.

Other units important to control are preamps and output amplifiers. Preamps are similar to AND units, but with only one input (sometimes two-input preamps are used) and Fig. 16 is self-explanatory by now. Typical power amplifiers (Fig. 17) consist of magnetic amplifiers with their input circuits in series and their outputs paralleled, providing full-wave output. They are needed to operate the final device—a relay or contactor, if we are dealing with motors—which does the actual switching.

Using logic units

Logic units can be used to make any two propositions interdependent or mutually exclusive. A typical simplified example would be as in Fig. 18. To smoke a cigarette, a man must have the cigarette AND the match AND the

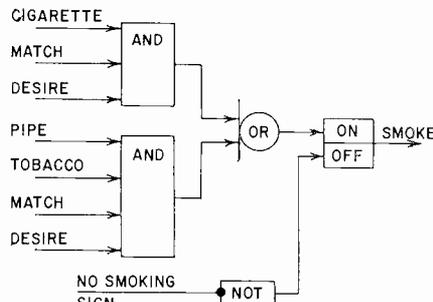


Fig. 18—Simplified illustration of the use of logic units for control.

desire to smoke. A three-input AND element is used. But perhaps a pipe would do instead. Then we would need a pipe, and tobacco, and a match and the desire to smoke, and this would require a four-input AND element. He must then make up his mind which he wants to do, and we need an OR element for the choice. However, if he finds himself in a no-smoking area, he will hold off until he is out of there, requiring a NOT unit, which will receive no signal as soon as he is out of the area, and thus will allow him to proceed with the smoke. The memory unit then allows the operation to proceed. Note that a number of conditions have been satisfied.

Applying this kind of logic thinking to, say, an elevator, we could operate the car if there is no open door on the car or corridor, and if the emergency brake has not operated and if there is no power failure. We can then operate the car by pushbutton OR by manual control. This kind of logic control can be applied to most kinds of machinery which can be controlled with digital signals. For an example, look at Fig. 19, which shows two diagrams with partial relay controls and their CYPAK equivalent. The letters labeling the components explain the operation, if

you think of the signals at the input of the CYPAK elements as substituting for the relay coils of the contacts shown.

CYPAK applications

The photo shows a CYPAK control for an automatic honing machine. (The control system is shown at the right.) But this is a modest application. Actually CYPAK has been used to control automatically huge industrial installations such as blast furnaces, steel rolling mills, mine hoists, etc. It is feasible to build a digital computer from CYPAK units, and Westinghouse has built one of these.

Why would we use such a system? The answer is almost too obvious. The control functions we have discussed would normally have to be carried out by relays of many kinds. And relay contacts, although reliable to a degree, require a great deal of maintenance, particularly in unfavorable environments—vapors, dust, danger of explosion and excessive vibration. CYPAK or similar controls without moving parts except for the final element, with no arcing relay contacts, with no mechanical wear reduce maintenance to almost nothing, will not wear out and are extremely durable and reliable. And this is why the system is called a static control system—it uses no moving parts!

As we said at the beginning, we can take magnetic amplifiers and build switching units. Or to be strictly impartial, we can use transistors or vacuum tubes and several other kinds of devices and build static control systems, and this is being done. Here we selected the CYPAK system because it has found many important applications in industry and is a prime example of a coordinated system of units which can perform all necessary control functions for quite complicated machinery.

This is the first of a series on static controls. The next article will appear in an early issue. ENL

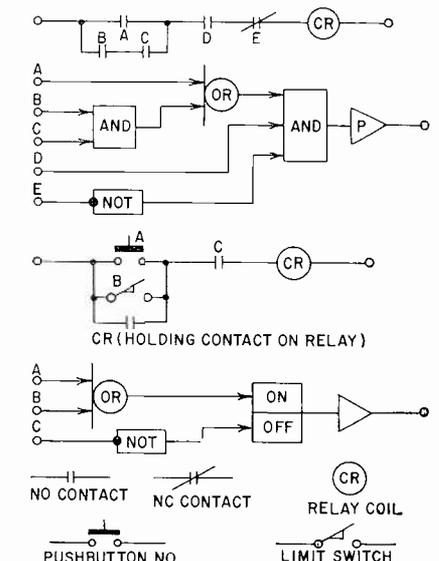


Fig. 19—Translating relay diagrams into CYPAK static control and vice versa.

PREVENTIVE MAINTENANCE KEEPS RELAYS WORKING

By H. B. CONANT

EVEN today that old saying about the ounce of prevention holds true. Preventive maintenance keeps equipment working at top efficiency and greatly extends the periods between major repairs.

Contacts are commonly neglected parts of many kinds of electrical equipment, and the only attention they receive is when they need filing or replacement. Of course, some are enclosed in sealed housings and are not accessible for servicing. Others use a wiping action (rotary tap switches) and are self-cleaning to a degree and seldom

give trouble. However, contacts which simply touch as in relays, leaf switches, automobile ignition systems and the like can be kept in top condition by a simple service operation performed at regular intervals before real trouble shows up.

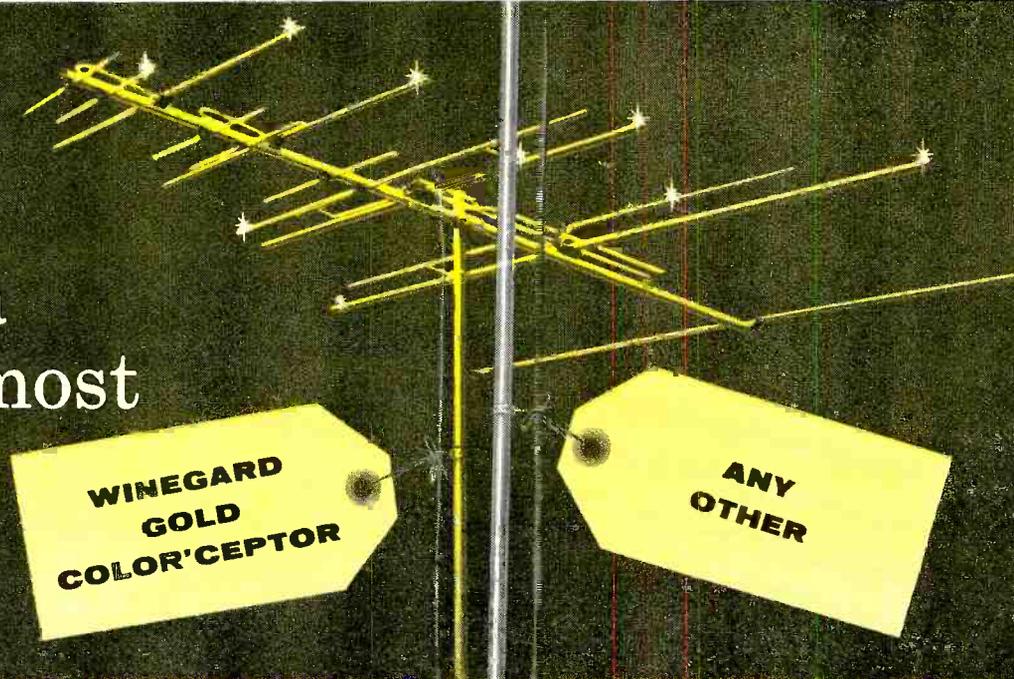
Contact efficiency is directly related to their ability to form an intimate metal-to-metal contact without any intervening film of metal oxide or sulfide or plain dirt. Any film adds unwanted resistance to the circuit which can cause heating, further oxidation, and burning or pitting of the

contacting surfaces. A common trouble in very sensitive relays whose contacts close with very light pressure is occasional failure to make contact.

Contact resistance is easily detected with a *low-range* ohmmeter and usually measures between a substantial fraction of an ohm to several ohms. Operating the contacts manually with the ohmmeter connected may disclose that contact resistance changes from one operation of the contacts to the next. Such a condition needs attention, and the following operations will insure freedom from contact trouble for long periods.

If the contacts have rough surfaces, but are not burned badly enough to require replacement, give them a light dressing with a contact file. Then cut a strip of crocus cloth so it is narrow enough to fit between the contacts and as long as can be manipulated conveniently. With the strip between the

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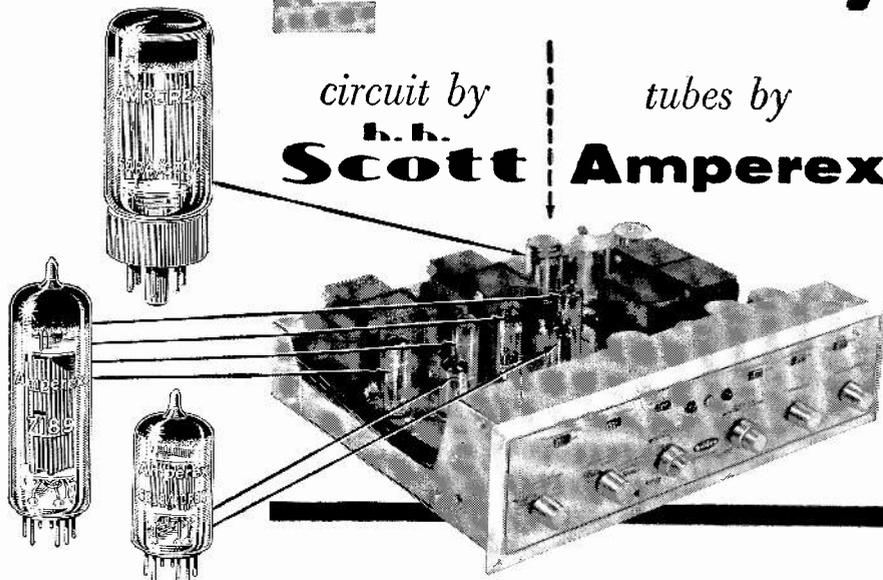
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12AT7/ECC81: Twin triodes, low
12AU7/ECC82: hum, noise and
12AX7/ECC83: microphonics
6BL8/ECF80: High gain, triode-pentode, low hum, noise and microphonics

RF AMPLIFIERS

6ES8: Frame grid twin triode
6ER5: Frame grid shielded triode
6EH7/EF183: Frame grid pentode for IF, remote cut-off
6EJ7/EF184: Frame grid pentode for IF, sharp cut-off
6AQ8/ECC85: Dual triode for FM tuners
6DCC8/EBF89: Duo-diode pentode

RECTIFIERS

6V4/EZ80: Indirectly heated, 90 mA
6CA4/EZ81: Indirectly heated, 150 mA
5AR4/GZ34: Indirectly heated, 250 mA

INDICATORS

6FG6/EM84: Bar pattern
1M3/DM70: Subminiature "exclamation" pattern

SEMICONDUCTORS

2N1517: RF transistor, 70 mc
2N1516: RF transistor, 70 mc
2N1515: RF transistor, 70 mc

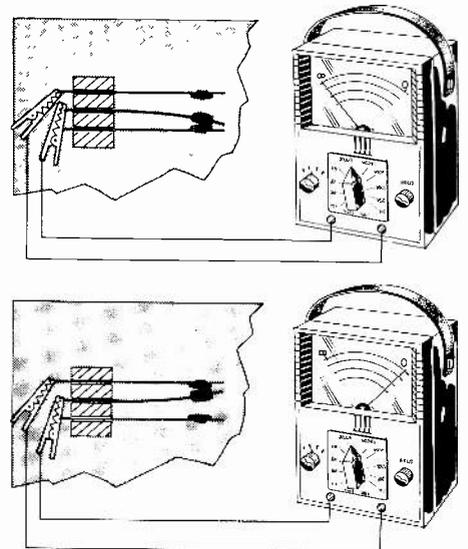
IN542:

Matched pair discriminator diodes

IN87A:

AM detector diode, subminiature

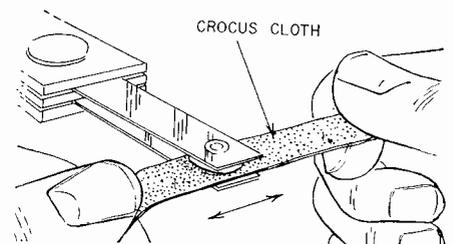
INDUSTRIAL ELECTRONICS



Checking contact resistance with a vom.

contacts, press them together manually and draw the strip back and forth several times. Turn the crocus cloth over and repeat the operation. Finally, repeat the process with a strip of clean wrapping or letter paper to pick up any residual particles. Now the ohmmeter should read practically zero resistance but, if some resistance remains, more work with the crocus cloth is needed.

Crocus cloth is available at most hardware stores and is made in only one grade. It is used for polishing metals, and the more it is used, the higher the polish. For a good job, use



Rough surfaces on relay contacts can be cleaned with strip of crocus cloth.

a new strip to start and finish with an old worn strip. Polishing the contacting surfaces in this manner removes the many microscopic high points and leaves a much greater area of metal surface for contact without removing as much of the contact metal as would a file. Also, the thin crocus cloth strip does not alter the relative angle between contacting surfaces. A file does.

Contacts polished this way will operate more reliably and for longer periods than new contacts, because new contacts are not usually polished.

Another form of contacts is the electrode tip of a resistance or spot welder intended to generate the welding heat within the metals being welded. Continued solid welds are insured and electrode life greatly extended if the electrode tips are kept polished. Some instability and drift in dc amplifiers can be traced to less-than-perfect contacts of tube pins and sockets. Polishing tube pins sometimes works miracles. END

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GET DOUBLE VALUE FROM YOUR VTVM

Simple modification makes a vtvm into a portable 2,000-ohm-per-volt voltmeter



By W. S. GUERTIN, JR.

Modified instrument is checked against a vom—readings are identical.

EVER out on a job, want to make a voltage reading and have no place to plug in your vtvm? I have, and it has made me modify my vtvm so I can use its voltage scales with or without 117 volts to power the meter.

Fig. 1 is the circuit of a typical vtvm when switched to DC VOLTS. Such circuits vary only in the value and location of the zero-adjust pot, the meter and the bias resistors. The voltage divider, which is what we're concerned with here, is usually the same.

Fig. 2 shows the voltmeter circuit after R1 and R2 have been added. See the table for the exact values. Pots slightly higher in resistance value than those shown in the table should be used to allow for exact calibration.

Total current through the circuit is 500 μ a for full-scale deflection. R1 limits the current through the meter to the appropriate value (either 200 or 400 μ a, depending on the manufacturer), while R2 bypasses the rest of the current around the meter. The circuit could be made more sensitive by designing it to operate on less current, but a new meter face would be needed. By using the values shown, the original markings on the meter can be retained.

Use decals or masking tape to mark the RANGE switch. Notice that the new

(Continued on page 78)

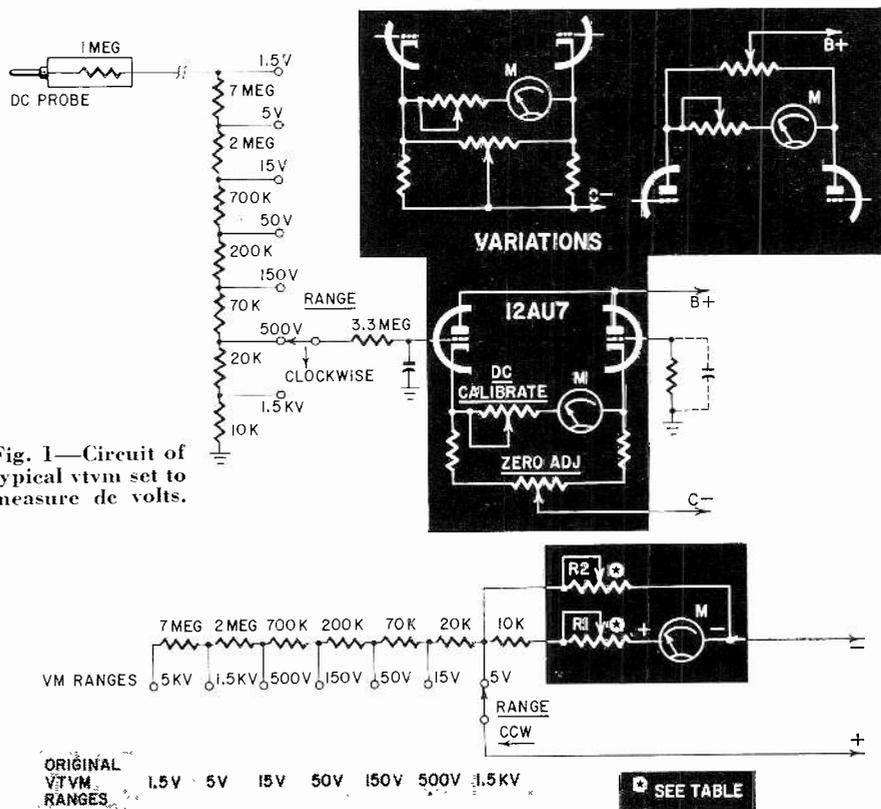
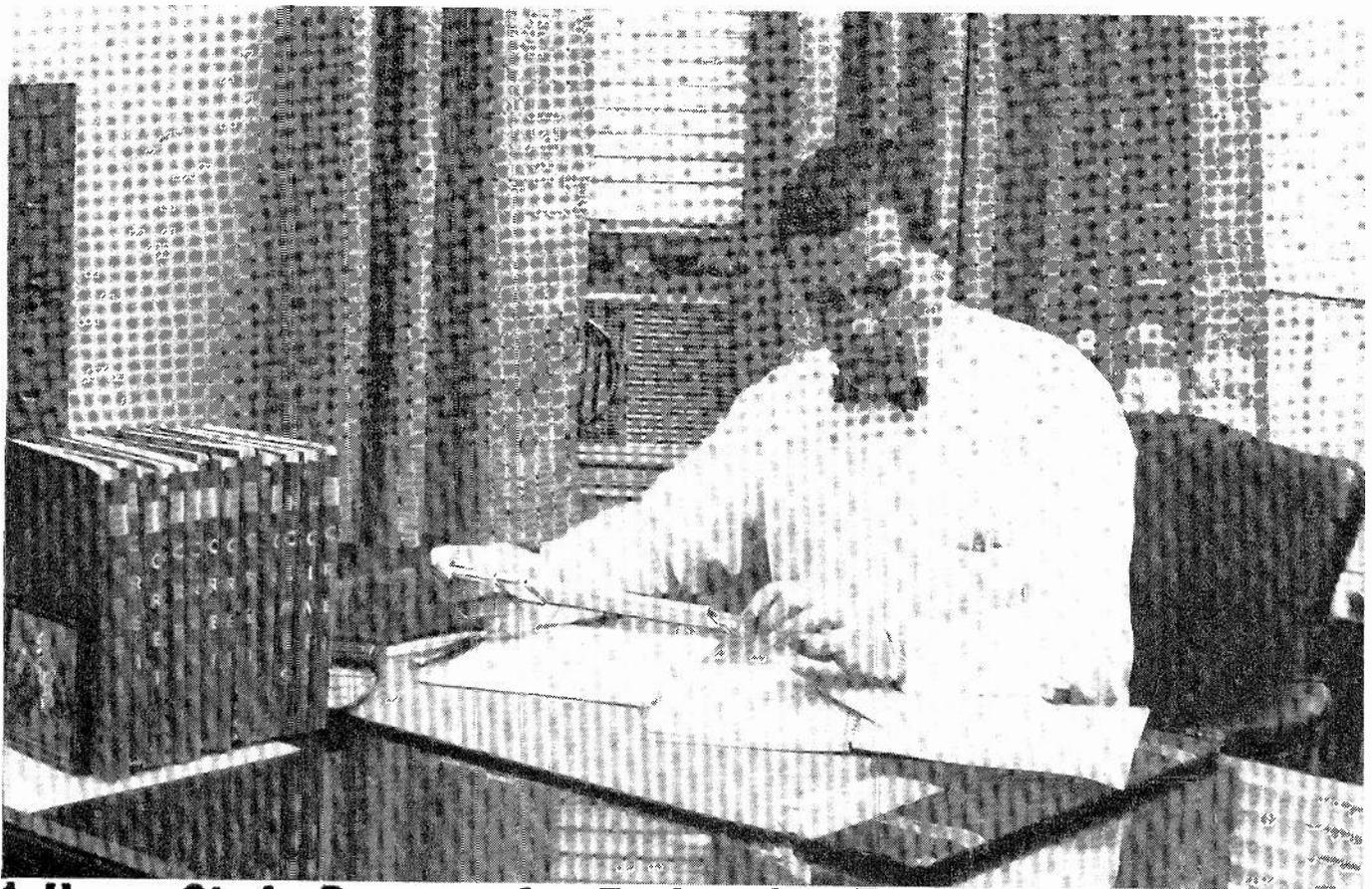


Fig. 1—Circuit of typical vtvm set to measure dc volts.

Fig. 2—Modified circuit reverses the range values.



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Now fifth in volume among American industries, the elec-

tronics industry offers almost unlimited employment and advancement opportunities. Applications of new electronic developments in automation, instrumentation, industrial electronics, aeronautical electronics, guided missiles, servomechanisms, computers, astronautics and telemetering create new jobs every day. Yet, paradoxically, industry growth does not always mean individual growth. Companies actively seeking men with modern, advanced technological knowledge are simultaneously firing mediocre men who lack this knowledge.

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20,400 are currently enrolled) keep pace with the needs of the ever-advancing electronics industry and are eagerly sought by employers who offer solid opportunities for rapid promotion.

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RADIO-ELECTRONICS

the National Council of Technical Schools, which first established scholastic and business standards for the technical school field. We were among the first three technical institutes whose curricula were accredited by the Engineers' Council for Professional Development. In 1946 we instituted the group training programs used by companies representing the cream of the electronics and aviation industries. CREI courses are widely employed today in company-sponsored educational plans by companies throughout the U. S. and Canada.

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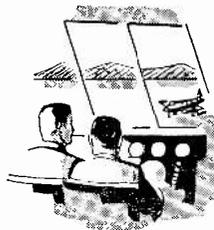


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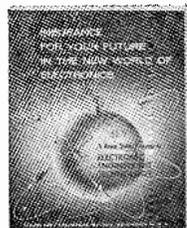
ables us to anticipate questions in our lesson material.

CREI STUDENTS are professional electronics engineers and technicians, all over the world and in every phase of electronics, about one-third military, the rest civilian. Their median age is 28. In 1958 they devoted approximately 1,572,400 hours to 104,831



lesson texts, answered and were individually graded upon 1,048,310 searching questions and engineering problems. They studied advanced electronics engineering technology associated with transistors, microwaves, forward scatter, computers, servomechanisms, radar, electronic navigational devices and the entire field of modern electronics. New students enrolled during the year are on the missile ranges of

Vandenburg AF Base and Cape Canaveral. They are at Alamogordo and China Lake, at SAC bases around the world. They are in the research laboratories and manufacturing plants where the latest electronic equipment is designed and produced. They maintain electronic equipment for United Air Lines, and Trans-Canada Air Lines. They share in electronics at All America Cables and Radio, Inc., and The Martin Co. They work for USIA (Voice of America) and Columbia Broadcasting System, for Gates Radio and Federal Electric, to name but a few. All of the firms mentioned offer their personnel CREI education under company sponsorship. CREI men are found by the hundreds among field engineers of major electronic manufacturers. They're across the world and across the street. They're men you'll compete with—to gain or hold your place in the electronics profession.



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want to convert interest and energy into dollars of income—if you want to convert your spare evening hours into material benefit and the personal satisfaction that comes with advancement and respect of your associates—then CREI's home study education assures you of:

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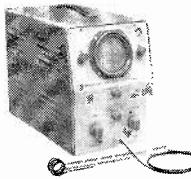
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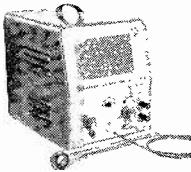
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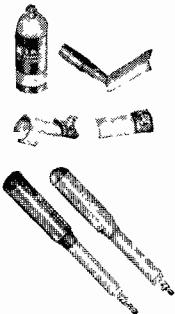
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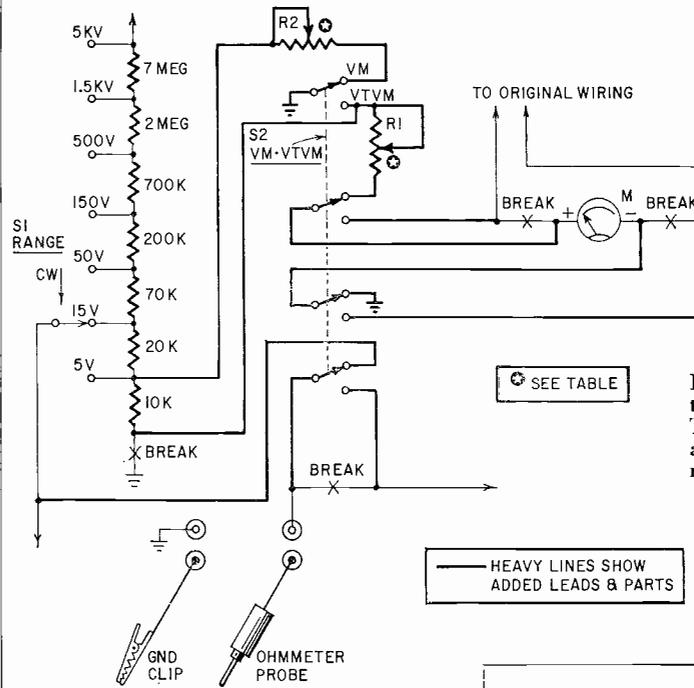


Fig. 3—Circuit of the modified unit. Two pots and a switch are the only parts required.

METER TYPE	R1	R2
400 μ a-600 Ω (EICO, PACO, etc.)	1.9K	50K
200 μ a-1200 Ω (Heath, Knight, RCA, etc.)	13.8K	16.6K

(Continued from page 73)
scales are reversed. Although the vtvm normally measures 1.5, 5, 15, 50, 150, 500 and 1,500 volts full scale as the RANGE switch is moved clockwise, it measures 5,000, 1,500, 500, 150, 50, 15 and 5 volts, respectively, when operating as a voltmeter.

The complete circuit is shown in Fig. 3. The original FUNCTION switch is set to the OHMS position. This isolates the voltage divider from the rest of the circuit, simplifying the switching circuit.

Calibration

To calibrate, turn the VTVM-VM switch to VM, the FUNCTION switch to OHMS, and the RANGE switch to 5V (the extreme clockwise position). Connect the leads to a known dc voltage of 5 or less, and adjust R1 until the meter reads this voltage. A fresh 4.5-volt battery is ideal. The voltage is measured between the ground and ohmmeter leads to insure a direct connection to the multiplier resistors. If a Uniprobe type of lead is used (two leads in one), the probe must be switched to ac-ohms—this shorts out the built-in 1-megohm resistor. The meter's 5-volt range is now calibrated. In this position, R2 does not affect the reading since it is simply connected across the battery.

Now switch to the 15-volt range and adjust R2 until the vtvm reads the same voltage it did on the 5-volt range. This completes the calibration. (You could use a higher-voltage battery and adjust R2 for its value but, in any case, only two calibrations are necessary: one on the 5-volt range, and one on any other range.)

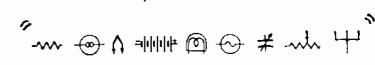
Using the meter

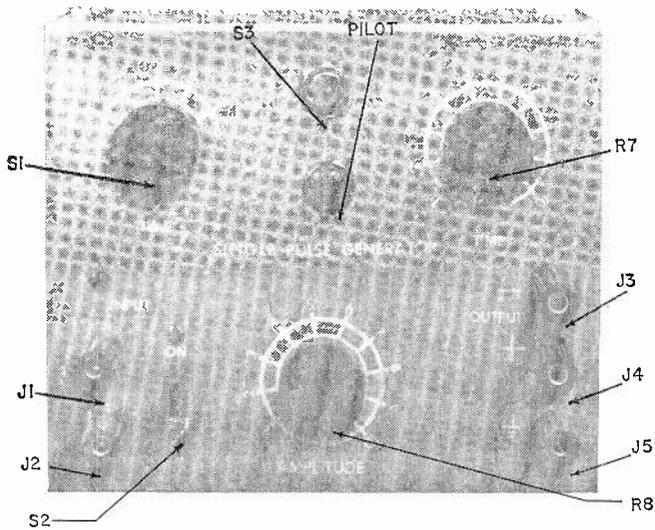
When operated as a vtvm, the original switch markings are used. To use

as a portable voltmeter, set the added switch to VM, and the RANGE switch to the desired range as indicated by the new markings. The FUNCTION switch may be left in any position. Measure the voltage with the ground and ohmmeter leads and read the voltage on the 5- or 15-volt scale.

These changes can be made to any vtvm very easily. Any four-pole two-position switch that fits may be used. I used an anti-capacitance lever switch.

Aside from drilling the hole for the switch (the pots can be mounted inside on a bracket), total wiring time should be no more than an hour and will be well worth the effort. For the price of two pots and a switch, you will own another piece of test equipment—a voltmeter with a sensitivity of 2,000 ohms per volt. END





It delivers the one shot so often needed when working with industrial and experimental circuits

SINGLE PULSE GENERATOR

By J. H. THOMAS

FOR experimental work and servicing counter, multivibrator, flip-flop and control circuits, as well as many other purposes, a single clean pulse controllable in duration and height, is very desirable. In fact, it is just about essential. To get such a clean square-topped pulse without switching transients may appear simple, but is more difficult than it might seem. The simple generator described here does deliver just such a pulse. Length can be anything from 1/5 second to about 1 μ sec. Pulse height is variable from 0 to nearly 100 volts, positive or negative.

A single pulse is normally delivered, but an input is provided for repetitive trigger. It uses any sharp spike pulse of about 30 volts to cause the same square-topped output, as fast as the duration of the pulse plus about 10% up to about 50 kc. Above 50 kc, recovery time becomes longer in proportion to the pulse.

The circuit

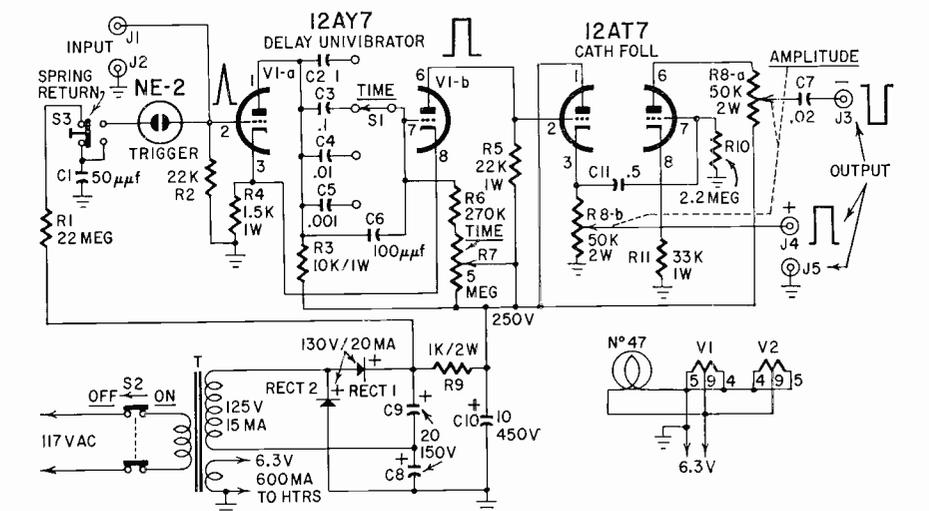
How we get such a single pulse is shown in Fig. 1. We start with a capacitor (C1) which is continuously charged through the normally closed contact of switch S3. Depressing the switch connects C1 to the NE-2 in series with the 22,000-ohm grid resistor. The NE-2 fires once, but only once, because the 50- μ mf capacitor has just enough stored energy for that. When the neon fires, it places a positive pulse (about 70 volts) on V1's grid. This trips the multivibrator, which normally has the second half (V1-b) conducting. The return of the 12AY7 to the normal state is delayed by selecting time constants with switch S1 and control R7 to control the length of the output pulse.

The multivibrator pulse is applied to

the cathode follower's grid. This prevents multivibrator loading and keeps the timing from changing. From the cathode follower we get a positive output pulse. From here we also feed the pulse through a reversing amplifier, which puts out the negative equivalent of the positive pulse. The high cathode

resistor for this triode (V2-b) assures that the negative pulse has about the same level as the positive pulse at the same setting of the level control.

The power supply is a voltage doubler, providing the 250 volts dc necessary for the multivibrator and allowing the use of a small instrument-type power

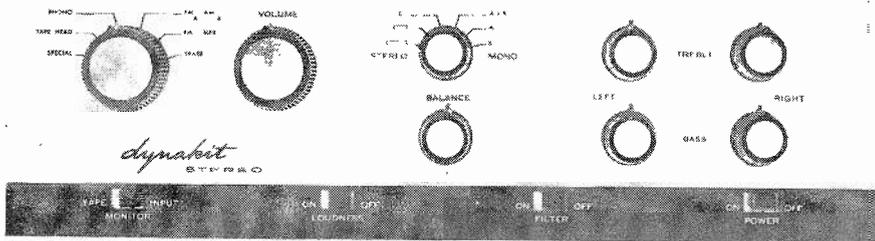


R1—22 megohms
R2—22,000 ohms
R3—10,000 ohms, 1 watt
R4—1,500 ohms, 1 watt
R5—22,000 ohms, 1 watt
R6—270,000 ohms
R7—pot, 5 megohms
R8—dual pot, 50,000 ohms, 2 watts, each section
R9—1,000 ohms, 2 watts
R10—2.2 megohms
R11—33,000 ohms, 1 watt
All resistors 1/2-watt 10% unless noted
C1—50 μ mf, disc ceramic
C2—1 μ f, paper
C3—0.1 μ f, ceramic
C4—0.01 μ f, disc ceramic
C5—0.01 μ f, disc ceramic
C6—100 μ mf, tubular ceramic
C7—0.02 μ f, disc ceramic
C8—20 μ f, 150 volts, electrolytic

C9—20 μ f, 150 volts, electrolytic
C10—10 μ f, 450 volts, electrolytic
C11—0.5 μ f, paper
All capacitors rated at 250 volts minimum unless noted
J1, 2, 3, 4, 5—binding posts
RECT1, 2—selenium, 130 volts, 20 ma, miniature
S1—1-pole 5-position rotary
S2—spdt slide
S3—spot pushbutton, spring return
T—power transformer; primary, 117 volts; secondary, 125 volts, 20 ma; 6.3 volts, 700 ma (Thordarson 26R32, Stancor PS-8415 or equivalent)
V1—12AY7
V2—12AT7
Neon lamp NE-2
Pilot light assembly with No. 47 bulb
Sockets, 9-pin miniature (2)
Case, 4 x 5 x 6 inches
Chassis to fit (see text)
Miscellaneous hardware

Fig. 1—Two-tube circuit is easy to build.

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Frequency response within 1 db 10 cps to 40 kc. Distortion (either IM or harmonic) less than .05%. Response and distortion unaffected by settings of volume control. Undistorted square wave performance demonstrates outstandingly fine transient performance. Noise and hum inaudible at normal listening levels. High gain permits operation with lowest level cartridges. (1 millivolt input gives 1 volt output on RIAA input.)

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1% tolerance components used in critical equalization-determining circuits. Tone control components matched to provide **absolutely flat** response at center settings. Highest quality plastic molded capacitors, low noise resistors, conservatively operated electrolytics, plated chassis and hardware, all lead to long life with unchanging specifications. One year guarantee on all parts.

★ Greater Flexibility

7 stereo inputs (or 14 monophonic ones) provide for all present and future sources. "Special" input provides option for special equalization characteristics. Provision for tape head, tape playback amplifier, and monitoring tape recordings. **Independent** tone controls for each channel. Exclusive Dyna "Blend" switch to control stereo separation. Unique feedback scratch filter takes out the hash and leaves in the music. Rear panel ac outlets enable switching other components with preamp on-off switch. Self-powered (with dc heater supply) permits use with any amplifiers.

★ Outstanding Appearance

Choice of bone white or charcoal brown textured finish cover. Solid brass, etched front panel. Designed by Raoul Ibarquen, prominent industrial stylist. Requires only 13" by 3 3/4" panel space and can be readily mounted on any thickness of panel with convenient PM-3 auxiliary mounting kit.

★ Easiest Assembly

About 8 hour average assembly time—from one-third to one-fourth that of other kits. Assembly speeded by use of pre-assembled printed circuit boards plus ultra-simple and accessible layout of parts. Complete pictorial diagrams included plus step-by-step instructions so that no technical skill is required. Also available fully wired and individually tested.

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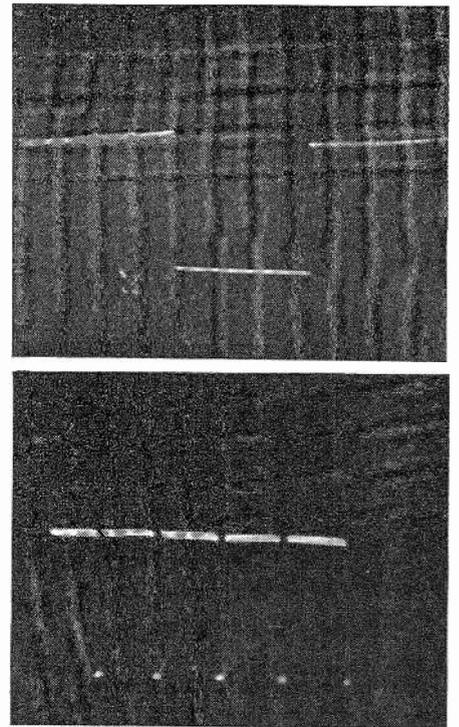


Fig. 2—Generator patterns: a—1/20 second pulse; b—100- μ sec pulse.

transformer. Pulses produced by this generator are shown in Fig. 2.

Building the unit

Construction is conventional. The unit is built into a 4 x 5 x 6-inch utility box, with a piece of 24-gauge galvanized sheet metal for a chassis. I like to use galvanized sheet metal because it is cheaper than copper and I can solder ground connections direct to the chassis. Nothing in the circuit is critical, *but do not ground one end of the high-voltage winding on the transformer*, as you may be accustomed to doing. The photos show top and bottom views of the chassis. This layout works fine, but it can be changed if desired.

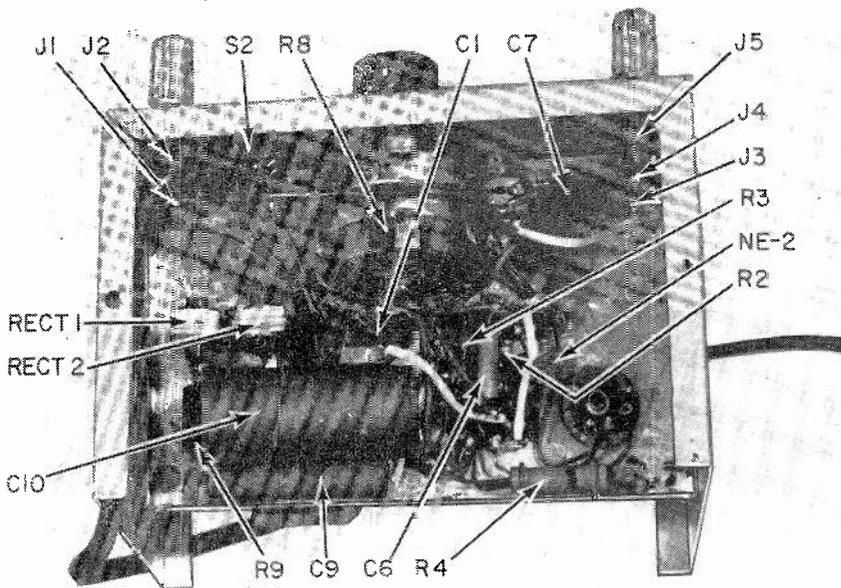
Using the generator

Nothing could be simpler than using this pulse generator. Just plug it in, connect it to the device to which you want to feed a single pulse, select the length and pulse height desired, and push the button. The generator will deliver one pulse each time you push the button. For repetitive operation, connect a sharp spike source to the input. If you prefer, move jack J1 to the other side of the neon tube (away from V1-a's grid). Then any pulse of sufficient height (about 70 volts) will trigger the device.

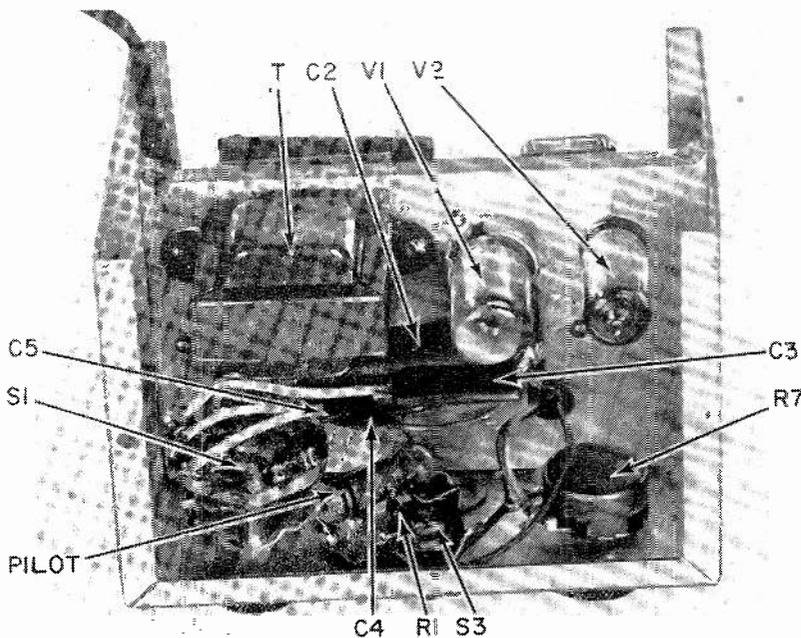
To calibrate the pulse height, use a scope and scope voltage calibrator as with any other waveform. Time calibration is a bit more difficult. The best procedure is to use a trigger with a known repetition rate and sync the scope sweep until only one or two (preferably) pips are shown. The sweep speed is then known (from the repetition rate) and you can measure the distance between pips and the length

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TEST INSTRUMENTS



Inside the case and under the chassis. Note the two miniature rectifiers on the left.



Top chassis view of the single-pulse generator. A shielded transformer is not required.

of one pip. Thus, if the repetition rate is say 50 kc and you have two pips, the time between pips is 1/50,000 second or 200 μ sec. If the pip length is 1/10 of this, you have a 20- μ sec pulse. At very short pulse lengths this is an accurate measurement only if you stretch the sweep out as long as possible.

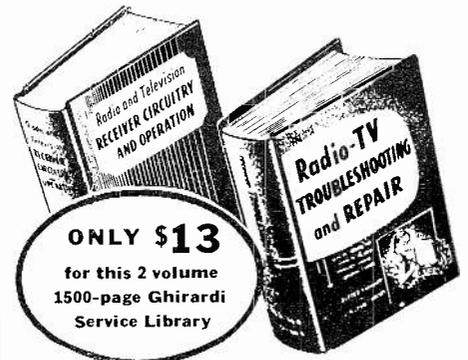
Using single pulses

Other than triggering counter circuits for servicing and experimental purposes, there are a host of other uses for this gadget. You can use it to produce, electrically or mechanically, a single sweep trace on a scope if you have a triggered scope sweep generator.

The single pulse of moderate amplitude is frequently used in biological experiments on nerve tissue. Also to trip a camera solenoid. Checking control circuits in another application. You could use it to step a stepping switch one step at a time. For this a relay is used between the generator and the stepping switch as not enough energy is available to step the switch directly. Anywhere a single pulse is needed, this generator will come in handy. It can also be used as a square or rectangular-wave generator, starting with pips or a sawtooth. I have found it well worth the small investment to add this generator to my bench equipment. END

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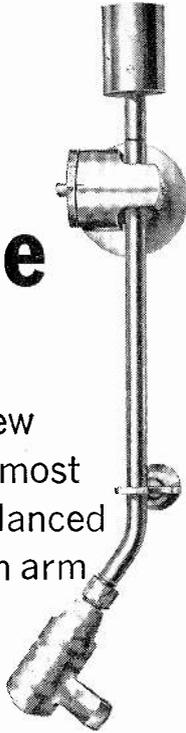
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try this simple test

...proves new
EMPIRE 98 most
perfectly balanced
transcription arm
...finest
for stereo
and
monophonic
records!



1. With an Empire 98 mounted on a turntable board and fitted with a cartridge, adjust counterweight until arm is balanced. 2. Dial stylus pressure desired (one gram for each marking on the built-in calibrated gram scale). 3. Place a record on turntable. Set stylus in groove. 4. Now, tilt the board. 5. Note: The arm remains in balance and the stylus remains in groove at every angle, even if held upside down. In the Empire 98 arm the lateral pivot is located on the "balance axis"—in a straight line with the counterweight and cartridge. Arms which place the pivot point outside the "balance axis"—will swing with every change in angle. The Empire 98 adjusts stylus pressure without disturbing the inherent balance. Once pressure is adjusted it does not vary even with warped records. Arms which move the position of the counterweight to obtain stylus pressure are inherently unbalanced because they shift the weight to the cartridge and create an inequality of mass on each side of the pivot.

WHAT ARM BALANCE MEANS TO YOU. The Empire 98 is so precisely balanced it will track a record without favoring one groove wall or the other, even on a non-level turntable. This assures equal output to both stereo channels, reduced distortion, minimum record and stylus wear. 12" arm, \$34.50

EMPIRE 88 STEREO/BALANCE CARTRIDGE. Superior moving magnet design is combined with a new 4-pole, hum-balanced construction for full channel separation, balanced high output from both channels. High vertical and lateral compliance, minimum dynamic mass and low tracking pressure reduce record and stylus wear to an absolute minimum. With diamond stylus, \$24.50



AUDIO EMPIRE

precision products of Dyna-Empire Inc.
1075 Stewart Ave., Garden City, N. Y.

TEST INSTRUMENTS

SIMPLE DRY CELL AND BATTERY TESTER

THE best type of dry-cell tester (loaded voltmeter) can be made for a few cents. All you do is use your vom or vtm plus specified resistors across its leads. Battery manufacturers agree that this is the best type of tester, but no commercial units are available because of the multitude of resistors ($\frac{1}{2}$ watt, 10%) needed for such a unit. However, the average shop encounters only a limited range of dry cells and the resistors needed to test them represent only a very small investment.

Needle-point prods are used with the tester to insure good contact with the battery. All leads are No. 24 stranded hookup wire. One end of each load resistor is bent into a loop so it can be mounted key-ring style on a paper clip.

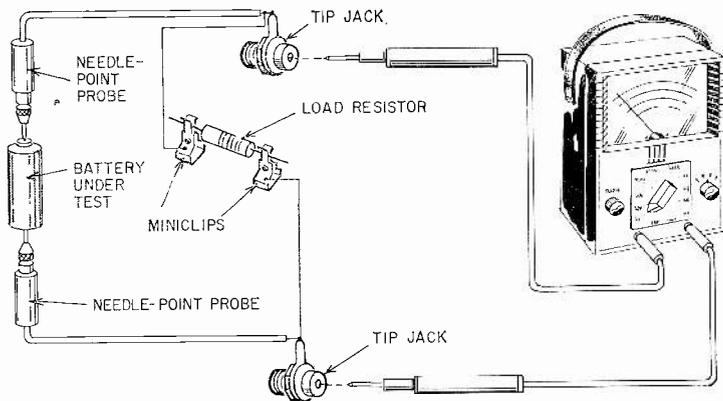
Values for the load resistors are based on "suggested current range" (from Eveready *Battery Engineering Bulletins* available from National Carbon Co., 30 E. 42 St., New York 17, N. Y.). The GOOD-FAIR-POOR quality ratings are based on discharge curves

supplied by the Burgess Battery Co. However, both loads and ratings are strictly my interpretation of the data supplied.

My rating theory is: GOOD if voltage is no more than 2% below nominal; FAIR if voltage is more than 2% but no more than 5% below nominal; POOR if voltage is more than 5% but no more than 10% below nominal. My load theory is: maximum of suggested current range if cell is normally subjected to a heavy drain (as in a flashlight or low-range ohmmeter); middle of the suggested current range if normally subjected to light loads (as in a high-range ohmmeter). For example, my table of loads and ratings reads:

BATTERY	VOLTAGE RATINGS			
	LOAD (ohms)	GOOD	FAIR	POOR
Z, 915 (penlight)	56	1.47	1.42	1.35
1, 935, small flashlight	18	1.47	1.42	1.35
2, 950, large flashlight	10	1.47	1.42	1.35
U15, 412	22K	22.0	21.5	20.0
U20, 413	27K	29.5	28.5	27

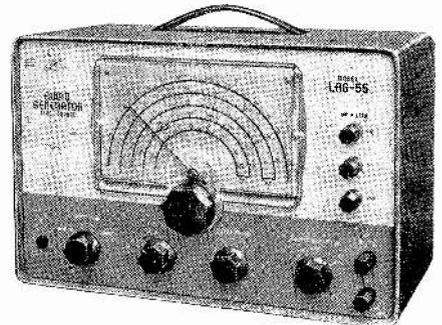
—Joseph H. Sutton



new "LEADER" test instrument

LAG-55 AUDIO GENERATOR SINE SQUARE

A multi-purpose generator for measurements on audio equipment—amplifiers, speakers, networks. Three waveforms: sine, square and complex for all types of measurements including response, distortion, transient and I-M distortion checks. Full range is from 20 to 200,000 cps, output 5 volts with minimum amplitude variation throughout whole range.



The LEADER test instruments are being used in the more than 36 countries, attesting their excellence in design, performance and usefulness.

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Cable Address "OHMATSUELEC" TOKYO

TEST INSTRUMENTS

Dynamic TRANSISTOR CHECKER

How one manufacturer solves the problem of checking transistors with a meterless circuit

MANY transistors can be unplugged from their sockets for testing. However, in a number of circuits the transistors are soldered into place. Because the service technician has to deal with both arrangements, a transistor checker that handles in-circuit as well as out-of-circuit testing is especially convenient. One unit that does just this is the Seco model 100.

This checker is designed for the service technician and has several innovations that help him in his work. It determines whether a transistor is an n-p-n or a p-n-p unit without damaging it. It also gives a comparative rating of transistor gain on a 0-100 scale. In addition, it checks power transistors.

How it works

When a transistor is plugged into the checker or connected to its clip leads, an oscillator circuit is formed with emitter-to-base feedback to sustain oscillation (see Fig. 1). Control R3 regulates the amount of feedback.

As long as the circuit oscillates transformer T steps up the collector output to light the neon lamp. As control R3 is turned up, feedback is reduced until at some point oscillation ceases and the neon lamp goes out. R3's dial reading (on a 0-100 scale) gives a measure of comparative gain. For finer voltage measurements, a vtvm or oscilloscope can be connected across the output jacks on the face of the tester. Naturally, the lamp brightness is in direct proportion to transistor output amplitude. When a vtvm or scope is used as an output indicator, the lamp is switched off to prevent limiting or clipping.

When more voltage than the tester (Continued on page 86)

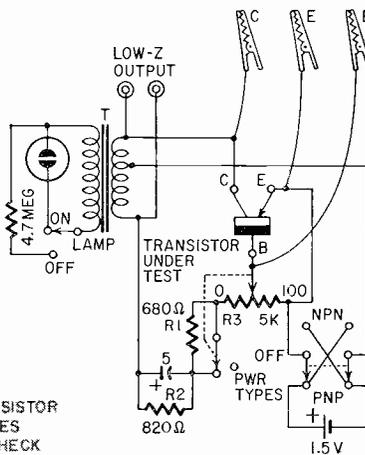


Fig. 1—Circuit of the Seco model 100.

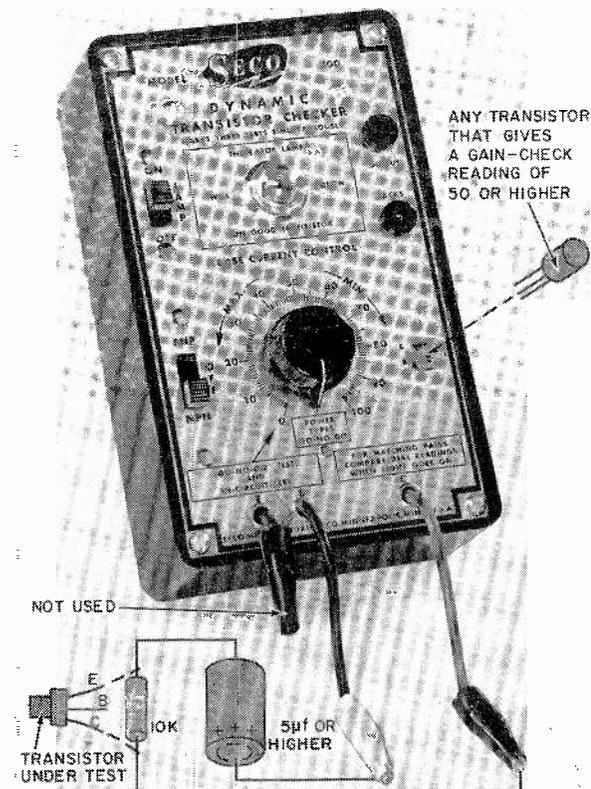


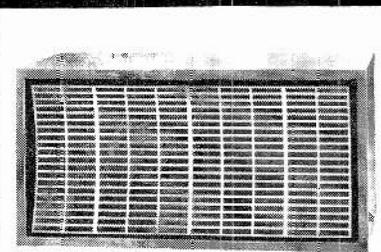
Fig. 2—This simple test detects transistors that dissipate too much current internally.

biggest sound

you ever heard from a bookshelf speaker

AUDAX CA-60

\$59.95 only 9"x10½"x18"



Among many individuals, there is a need to minimize on the space to be devoted to a component stereo system. A rash of "bookshelf" types have appeared in an attempt to meet this need. In practice, however, they seem neither fish nor fowl....either too large for compactly spaced bookshelves or too small for use as free-standing units.

The AUDAX CA-60 is a true bookshelf speaker system, measuring only 9" high by 10½" deep by 18" wide. It houses a 6" woofer and separate tweeter in a ducted-slot enclosure constructed of ¾" thick wood, finished in oiled, hand-rubbed walnut on four sides. The grille is shaped in an attractive parabolic contour, giving the unit a character which blends with a variety of surroundings.

A real powerhouse... handles 20 watts in integrated program material! Hear it at your dealer's.

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- Enclosed is 25¢ for book of 6 plans "How to Build Your Own Audax Enclosure"

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Atlas Radio Corp., 50 Wingold Ave., Toronto.

NOW YOU CAN HAVE YOUR CHOICE OF CENTURY'S UNIQUE Peak-to-Peak VACUUM TUBE VOLT METERS

Model VT-10
LINE OPERATED



Model VT-10
\$58.50
Net

TERMS: \$14.50 within 10 days. Balance \$11 monthly for 4 months.

FEATURES OF VT-1 and VT-10

- New advanced pentode amplifier circuit
- Large 6" 100-microampere meter, many times more sensitive than meters used in most V.T.V.M.s
- Simplified multi-color easy-to-read 4-scale meter
- No heat operation assures stability and accuracy
- Amplifier rectifier circuit with frequency compensated attenuator — a feature found only in costly laboratory instruments
- Meter completely isolated
- Hand-crafted circuitry eliminates the headaches of printed circuitry
- 1% resistors used for permanent accuracy
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- Deep brushed long lasting etched aluminum panel
- Matching cover protects instrument face — snaps on and off instantly.

WITH LARGE EASY-TO-READ 6" METER

featuring the sensational new
MULTI-PROBE (Patent Pending)

No extra probes to buy! The versatile
MULTI-PROBE does the work of 4 probes

- ① DC Probe ② AC-Ohms Probe
③ Lo-Cap Probe ④ RF Probe

No longer do you have to cart around a maze of entangled cables, lose time alternating cables or hunting for a misplaced probe. With just a twist of the MULTI-PROBE tip you can set it to function as either a DC Probe, AC-Ohms Probe, Lo-Cap Probe or RF Probe.

LINE OPERATED

Ideal for use on the test bench. Designed to run cool even under continuous operation . . . Line isolated.

BATTERY OPERATED

Completely portable . . . Invaluable wherever line connection is undesirable or unavailable . . . Unique circuitry assures low battery drain.

FUNCTIONS OF VT-1 and VT-10

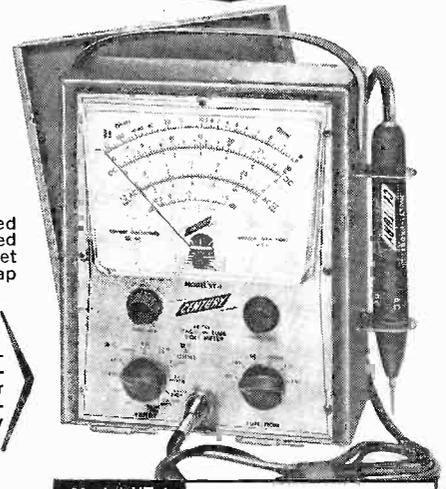
DC VOLTMETER . . . Will measure D.C. down to 1.5 volts full scale with minimum circuit loading, and give accurate readings of scale divisions as low as .025 volts . . . Will measure low AGC and oscillator bias voltages from .1 volts or less up to 1500 volts with consistent laboratory accuracy on all ranges . . . Zero center provided for all balancing measurements such as discriminator, ratio detector alignment and hi-fi amplifier balancing.

AC VOLTMETER . . . True Peak-to-Peak measurements as low as 3 volts of any wave form including TV sync, deflection voltages, video pulses, distortion in hi-fi amplifiers, AGC and color TV gating pulses . . . Scale divisions are easily read down to .1 volts . . . Measures RMS at 1/20th the circuit loading of a V.O.M. . . . Unlike most other V.T.V.M.'s there is no loss in accuracy on the lowest AC range.

ELECTRONIC OHMMETER . . . Measures from 0 to 1000 megohms . . . Scale divisions are easily read down to .2 ohms . . . Will measure resistance values from .2 ohms to one billion ohms . . . Will detect high resistance leakage in electrolytic and by-pass condensers.

RF and LO-CAP MEASUREMENTS . . . With these extra VT-1 functions you can measure voltages in extremely high-impedance circuits such as sync and AGC pulses, driving saw tooth voltages, color TV gating pulses, mixer output levels, I.F. stage-by-stage gain and detector inputs.

Model VT-1
BATTERY OPERATED



Model VT-1
\$58.50
Net

TERMS: \$14.50 within 10 days. Balance \$11 monthly for 4 months.

SPECIFICATIONS OF VT-1 and VT-10

- DC Volts — 0 to 1.5/6/30/150/300/600/1500 volts
- AC Volts (RMS and Peak-to-Peak) — 0 to 3/12/60/300/1200 volts
- Ohms — to a billion ohms, 10 ohms center scale — RX1/10/100/1K/10K/100K/1M
- RF — Peak reading demodulator supplied for use on all DC ranges
- Zero Center — available on all DC volt ranges with zero at mid-scale
- Decibels — from -10 Db to +10/22/36/50/62 based on the Dbm unit: ODb-1MW in 600 ohms
- Impedance — 11 megohms DC, 1 megohm AC, 10 megohms Lo-Cap
- Input Capacity — 130 mmfd. RMS, 250 mmfd. Peak-to-Peak, 25 mmfd. Lo-Cap

Model CT-1

IN-CIRCUIT CONDENSER TESTER

Here is an IN-CIRCUIT CONDENSER that DOES THE WHOLE JOB! The CT-1 actually steps in and takes over where all other in-circuit condensers fail. The ingenious application of a dual bridge principle gives the CT-1 a tremendous range of operation . . . and makes it an absolute 'must' for every serviceman.

in-circuit checks:

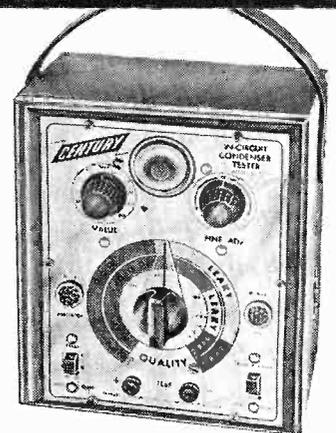
- ✓ Quality of condensers even with circuit shunt resistance . . . (This includes leakage, shorts, opens, intermittents)
- ✓ Value of all condensers from 200 mmfd. to .5 mfd.
- ✓ Quality of all electrolytic condensers (the ability to hold a charge)
- ✓ Transformer, socket and wiring leakage capacity

out-of-circuit checks:

- ✓ Quality of condensers . . . (This includes leakage, shorts, opens and intermittents)
- ✓ Value of all condensers from 50 mmfd. to .5 mfd.
- ✓ Quality of all electrolytic condensers (the ability to hold a charge)
- ✓ High resistance leakage up to 300 megohms
- ✓ New or unknown condensers . . . transformer, socket, component and wiring leakage capacity

OUTSTANDING FEATURES

- Ultra-sensitive 2 tube drift-free circuitry
- Multi-color direct scale readings for both quality and value . . . in-circuit or out-of-circuit
- Simultaneous readings of circuit capacity and circuit resistance
- Built-in hi-leakage indicator sensitive to over 300 megohms
- Cannot damage circuit components
- Electronic eye balance indicator for even greater accuracy
- Isolated power line
- Deep brushed long lasting etched aluminum panel
- Housed in sturdy gray hammertone finish steel case . . . comes complete with test leads

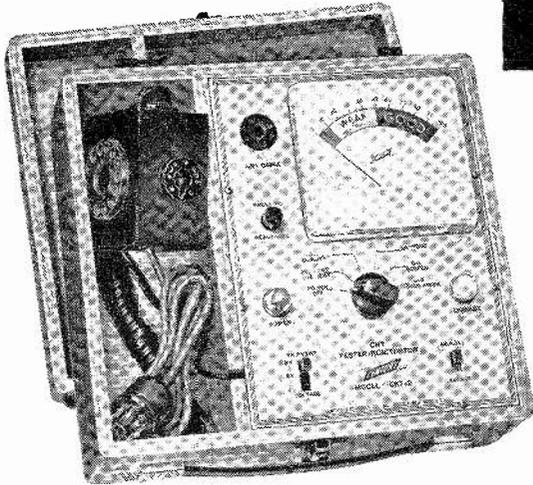


Model CT-1
\$34.50
Net

TERMS: \$9.50 within 10 days. Balance \$5 monthly for 5 months.

10 DAY FREE TRIAL ON CENTURY INSTRUMENTS OF YOUR CHOICE

See for yourself at no risk why thousands of servicemen all over the country selected CENTURY test equipment above all others. Send for instruments of your choice without obligation . . . try them for 10 days before you buy . . . only then, if satisfied, pay in easy-to-buy monthly installments — without any financing or carrying charges added.



Housed in hand-rubbed oak carrying case — complete with MULTI-HEAD

Model CRT-2
\$57.50
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TERMS: \$13.50 within 10 days. Balance \$11 monthly for 4 months.

Model CRT-2

CRT TESTER-REACTIVATOR

TESTS, REPAIRS and REACTIVATES

- ALL BLACK AND WHITE PICTURE TUBES (including 110° tubes) . . . from 8" to 30", whether 12 pin base, 8 pin base, 14 pin base . . . and the very latest 7 pin base.
- ALL COLOR PICTURE TUBES . . . Each of the red, green and blue color guns is handled separately.

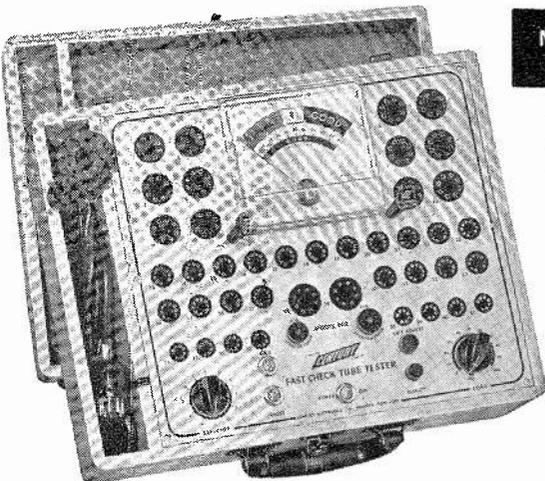
CHECK THESE EXCLUSIVE FEATURES

- ✓ THE MULTI-HEAD (Patent Pending) . . . A SINGLE PLUG IN CABLE AND UNIQUE TEST HEAD — A tremendous advance over the maze of cables and adapters generally found with other testers.
- ✓ WATCH IT REACTIVATE THE PICTURE TUBE — You actually see and control the reactivation directly on the meter as it takes place. This allows you for the first time to properly control the reactivation voltage and eliminates the danger of stripping the cathode of the oxide coating. It also enables you to see whether the build-up is lasting.
- ✓ CONTROLLED "SHOT" WITH HIGHER VOLTAGE FOR BETTER REACTIVATION — Stronger than any found in other testers — high enough to really do the job — yet controlled to avoid damage to the picture tube.
- ✓ UNIQUE HIGH VOLTAGE PULSE CIRCUIT — Will burn out inter-element shorts and weld open circuits with complete safety to the picture tube.

THE CRT-2 DOES ALL THIS RIGHT IN THE CARTON, OUT OF THE CARTON OR IN THE SET

- TEST**
 - For quality of every black and white and color picture tube, employing the time proven dynamic cathode emission test principle.
 - For inter-element shorts and leakage up to one megohm. Separate short test provided for each element in the picture tube.
 - For life expectancy.
- REPAIR**
 - Will clear inter-element shorts and leakage.
 - Will weld open elements.
 - The "SHOT" (high voltage controlled pulse) method of reactivation provided by the CRT-2 will restore picture tube to new life in instances where it was not possible before. The high voltage is applied without danger of stripping the cathode as you always have perfect control of the high voltage pulse.
- REACTIVATE**
 - The "BOOST" method of reactivation also provided by the CRT-2 is used effectively on tubes with a superficially good picture but with poor emission and short life expectancy. It will also improve definition, contrast and focus greatly and add longer life to the picture tube.

- ✓ VISUAL LIFE TEST — Enables both you and your customer to see the life-expectancy of any picture tube right on the meter . . . helps eliminate resistance to picture tube replacement when necessary.
- ✓ SPECIAL LOW SCREEN VOLTAGE TUBES — Will handle new type picture tubes with special low voltage of approximately 50 volts.
- ✓ SEPARATE FILAMENT VOLTAGES — including the very latest 2.35 volt and 8.4 volt types as well as the older 6.3 volt types.
- ✓ NEW "SF" PICTURE TUBES — Accommodates the different base pin connections of this new type picture tube.



Housed in hand-rubbed oak carrying case complete with CRT ADAPTER

Model FC-2
\$69.50
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TERMS: \$14.50 within 10 days. Balance \$11 monthly for 5 months.

Model FC-2

FAST-CHECK TUBE TESTER

Simply set two controls . . . insert tube . . . and press quality button to test any of over 900 tube types completely, accurately . . . IN JUST SECONDS!

The FAST-CHECK enables you to cut servicing time way down, eliminate unprofitable call-backs and increase your dollar earnings by selling more tubes with very little effort on your part. You make every call pay extra dividends by merely showing your customer the actual condition and life expectancy of the tube. The extra tubes you will sell each day will pay for the FAST-CHECK in a very short time.

PICTURE TUBE TEST ADAPTER INCLUDED WITH FAST-CHECK

Enables you to check all picture tubes (including the new short-neck 110 degree type) for cathode emission, shorts and life expectancy . . . also to rejuvenate weak picture tubes.

RANGE OF OPERATION

- ✓ Checks quality of over 900 tube types, employing the time proven dynamic cathode emission test. This covers more than 99% of all tubes in use today, including the newest series-string TV tubes, auto 12 plate-volt tubes, OZ4s, magic eye tubes, gas regulators, special purpose hi-fi tubes and even foreign tubes.
- ✓ Checks for inter-element shorts and leakage.
- ✓ Checks for gas content.
- ✓ Checks for life-expectancy.

SPECIFICATIONS

- No time consuming multiple switching . . . only two settings are required instead of banks of switches on conventional testers
- No annoying roll chart checking . . . tube chart listing over 900 tube types is located inside cover. New listings are added without costly roll chart replacement
- Checks each section of multi-section tubes and if only one section is defective the tube will read "Bad" on the meter scale
- 41 phosphor bronze beryllium tube sockets never need replacement
- 7-pin and 9-pin straighteners mounted on panel
- Large 4 1/2" D'Arsonval type meter is the most sensitive available, yet rugged — fully protected against accidental burn-out
- Special scale on meter for low current tubes
- Compensation for line voltage variation
- 12 filament positions
- Separate gas and short jewel indicators
- Line isolated — no shock hazards
- Deep brushed long lasting etched aluminum panel.

NOTE: The Fast-Check positively cannot become obsolete . . . circuitry is engineered to accommodate all future tube types as they come out. New tube listings are furnished periodically at no cost.

MAIL FREE TRIAL COUPON TODAY!

CENTURY ELECTRONICS CO., INC.

111 Roosevelt Ave., Dept. 104, Mineola, N. Y.

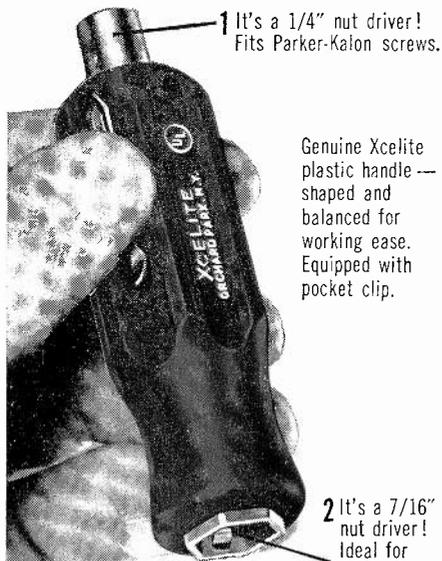
- Model VT-10 Vacuum Tube Volt Meter . . . \$58.50 \$14.50 within 10 days. Balance \$11 monthly for 4 months.
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- Prices Net F.O.B. Mineola, N. Y.

Yes, I want to take advantage of your 10 day FREE try-before-you-buy offer. Ship on approval the instruments I have checked. After I have tried the equipment for 10 full days I will either send you the down payment and agree to pay the balance in the monthly payments shown, or I will return the units and owe nothing.

Name Please print clearly
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NEW 4-WAY POCKET TOOL

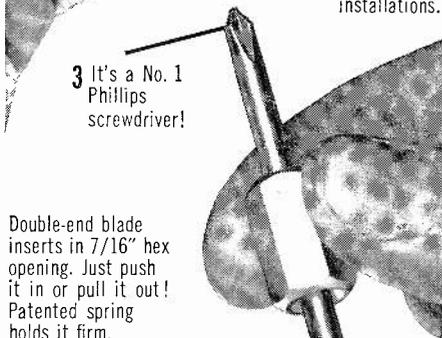
a real "working partner" for removing backs of TV sets and installing antennas



1 It's a 1/4" nut driver! Fits Parker-Kalon screws.

Genuine Xcelite plastic handle — shaped and balanced for working ease. Equipped with pocket clip.

2 It's a 7/16" nut driver! Ideal for antenna installations.



3 It's a No. 1 Phillips screwdriver!

Double-end blade inserts in 7/16" hex opening. Just push it in or pull it out! Patented spring holds it firm.

4 It's a 3/16" slotted screwdriver!



Ask to see "No. 600" next time you pick up parts...



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TEST INSTRUMENTS

(Continued from page 83)

provides (1.5 volts) is needed to test a particular transistor, insert an external battery in series with the collector of the transistor being checked. When testing power transistors, connect a 500-ohm potentiometer across the output terminals for additional loading.

Out-of-circuit tests

To test a transistor simply plug it into the socket on the face of the tester or connect it to the colored clip leads. Then, with the base current control at zero, turn the lamp switch on. Next push the type selector switch to n-p-n or p-n-p. If you don't know what type transistor you are checking, flip this switch first in one direction (p-n-p) and then in the other (n-p-n). The transistor will oscillate and light the lamp only when the type selector is in the proper position. The transistor cannot be damaged by this test as long as the base current control is set at zero. Now turn the base current control up slowly. When the light goes out, the dial reading shows the unit's gain.

If a transistor gives a reading of less than 40, it may be dissipating too much current inside itself. To check this, connect a resistor and capacitor as shown in Fig. 2 (solid lines) and plug a known-good transistor into the checker. Now turn the base-current control up until the light goes out. Note this reading. Next substitute the transistor for the 10,000-ohm resistor

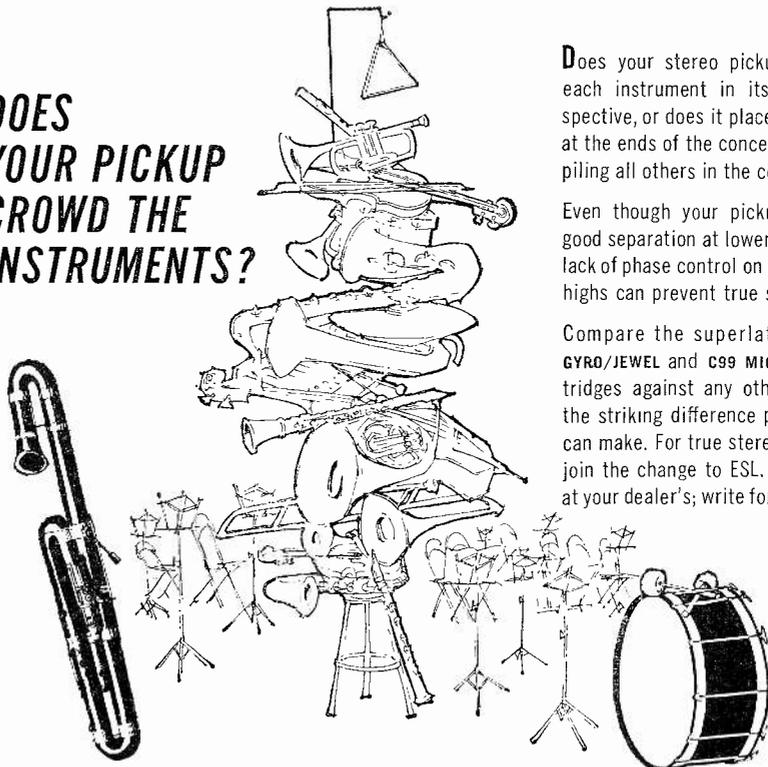
(dashed lines in Fig. 2). If the transistor is good, the indicator lamp will light and the transistor can be expected to work in all transformer-coupled and resistance-capacitance-coupled circuits. If the indicator lamp goes out during this test, the transistor may work in a very-low-impedance circuit, but is likely to create loss of sensitivity and distortion in most radio receiver applications.

In-circuit tests

For in-circuit tests, turn the checker on as before, but leave the transistor in the circuit. If you are working on a radio or audio amplifier, advance all gain and volume controls. Most of the time the checker, by placing the transistor under test in an oscillator circuit, will introduce an audio tone in the amplifier or audio section of the radio that can be heard from the set's speaker. This is ideal for circuit tracing. Start with the output stage and work back. Of course, when testing if and converter stages, the oscillations will not be passed on the speaker. For these stages connect a vtvm or scope across the instrument's output jacks to check for transistor oscillation.

When power transistors are to be checked, more base current is desired to give a better test of their ability. To do this a switch is included in the tester to add R1, a 680-ohm resistor. This increases base current 50 ma or more. R1 is normally shorted out on small-signal transistors. END

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DESIGN

Part IV—Volume and loudness controls,
direct and feedback types

YOUR OWN PREAMP

By NORMAN H. CROWHURST*

In the early days the volume control was just a potentiometer connected at a suitable place in the circuit. No one paid particular attention to just where it was connected, so long as a suitable point could be found. Nowadays we should call such a control a gain control. But because the name volume was used then it still remains, although volume is practically synonymous with loudness.

When engineers began to think about making a control that would alter the loudness of the reproduced program, rather than merely adjust the amplifier's gain, a new name had to be thought up to distinguish between the two. As a result we have volume controls and loudness controls. The volume control merely adjusts the amplifier's gain while the loudness control puts in some frequency compensation to produce a subjective effect equivalent to changing the loudness with which the program is played.

Before going further, perhaps we should explain briefly why a loudness control has to provide for loudness difference. If program material is recorded and replayed at the same sound

intensity, through a system that has an overall flat response, reproduction will be nearly perfect. The relative intensity of all the component frequencies will be reproduced in exactly the same proportion as the original. So for this one reproduced level, no loudness compensation is needed.

Loudness adjustment becomes necessary when the reproduction is played at a level different from the studio level. Frequently one will not want to play the program material as loud in one's living room as it was played in the recording studio, because the room is smaller and possibly slightly more reverberant in relation to its size than the studio. A loudness rather than a volume control is needed to cut the level because reducing the intensity of a 1,000-cycle tone by 15 decibels makes about the same change in loudness sensation as about a 6-db reduction in the region of 50 to 100 cycles. If a volume control were used to change level by 15 db all the way, the reduction in apparent level at 50 cycles would be equivalent to a 40-db change at 1,000 cycles. The bass would be all but inaudible. This can be seen from the Fletcher-Munson loudness contours of Fig. 1.

The loudness control should accen-

tuate the lower frequencies so a 15-db drop in level at about 1,000 cycles will be accompanied by a drop of only about 6 db at 50 cycles to produce a similar apparent loudness. Some adjustment is also desirable at the high end but not to such a great extent. About 2- to 3-db progressive boost between 3,000 and 10,000 cycles should accompany a 15-db reduction in level.

Turning down to a low level, by reducing the intensity at 1,000 cycles about 30 db, would require only a 10- or 12-db reduction at the low-frequency end. This means an 18- to 20-db boost will be necessary at the low end. Fig. 2 shows the response variation a good loudness control should give, based on the data of Fig. 1 and a studio loudness of 70 db.

Position in amplifier

The loudness control should be as close as possible to the preamp output so turning the loudness down will give the quietest possible background. This minimizes any noise developed in earlier stages.

A gain or volume control, on the other hand, should be close to the preamp input. It has to adjust for differences in the recorded level that may

* Author: *High-Fidelity Circuit Design* (Gernsback Library).

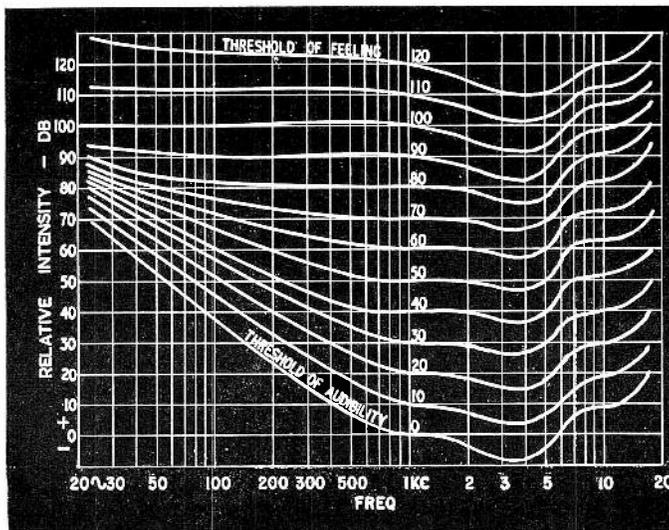


Fig. 1—Fletcher-Munson average loudness contours.

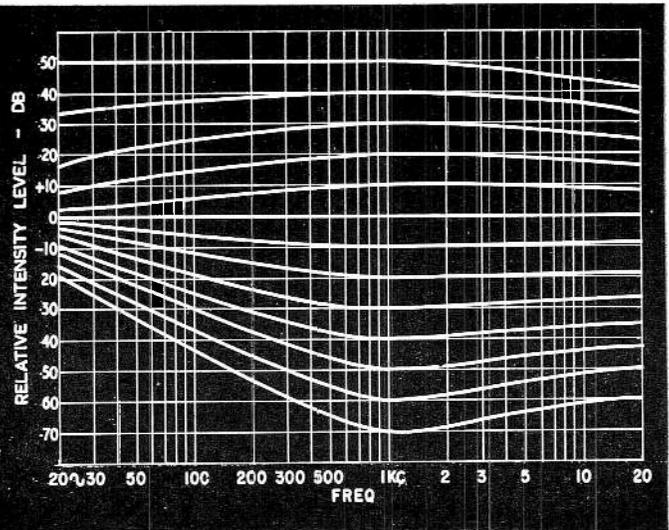


Fig. 2—Loudness compensation required, using the 70 db reference level of Fig. 1 as a standard.

AUDIO—HIGH FIDELITY

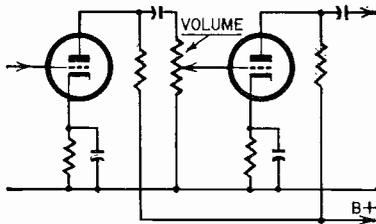


Fig. 3—The simple, conventional volume control circuit.

Fig. 4—If the potentiometer in Fig. 3 has too high a value, frequency response will vary as shown here. Curves are for a 1-megohm control with a 120- μ f input capacitance.

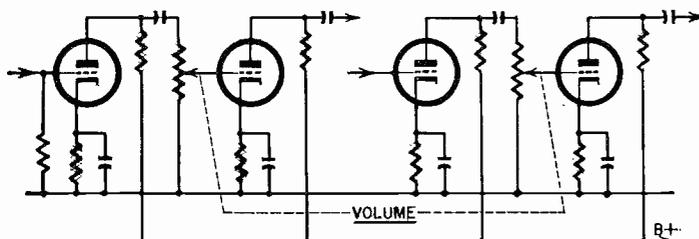
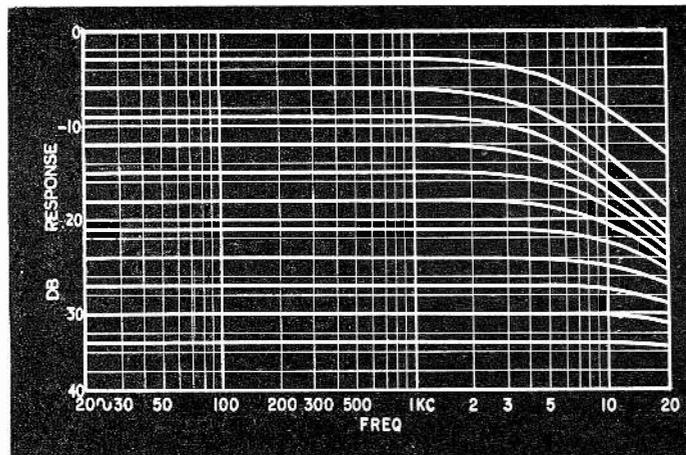


Fig. 5—Where a preamp has to handle a wide range of input signal levels, a divided control is helpful.

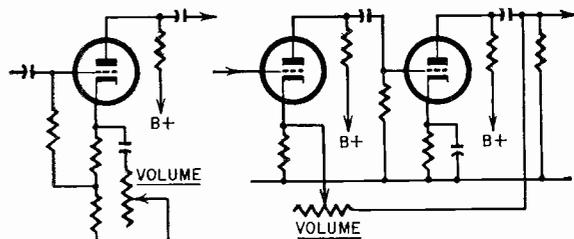


Fig. 6—Two feedback volume control circuits.

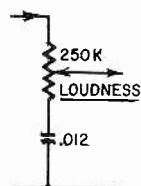


Fig. 7—Simplest form of loudness control. Capacitor adds variable bass boost.

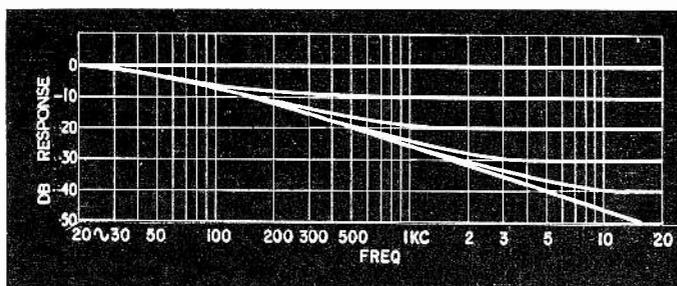


Fig. 8—Response range produced by circuit of Fig. 7.

not be caused by corresponding differences in original loudness. So it should be as close to the input as possible without hurting the noise level.

If the volume control is inserted immediately after the first stage and is kept turned well down, the level at the grid of the second stage is sometimes lower than that at the first, and the preamp's noise level suffers. So it may be best to get in two stages of amplification ahead of the volume control.

An alternative is to use a ganged volume control so only part of it immediately follows the first stage. This is particularly useful where a preamp is likely to have widely divergent input levels.

Direct type volume control

Both loudness and volume controls can be either direct or feedback types. The direct volume control uses a potentiometer connected between stages as in Fig. 3.

A volume control should adjust level

without varying frequency response. To do so, the pot's value should not be too high. A value of 100,000, or at the most 250,000, ohms is satisfactory. If a 1-megohm volume control is used, response deteriorates as the control is turned down a little way from the top (full-volume) position. Adjusting the control varies the response as shown in Fig. 4. This can be compensated for to some extent by using a capacitor from the top end to the slider, but even then response does not remain uniform. The best solution is to use a lower-resistance potentiometer.

The taper should be logarithmic to get good control with only one potentiometer. The regular log taper provides one-tenth the total resistance at the halfway rotation point, which means that the top half of the rotation causes a 20-db change in level. The overall effectiveness of the volume control is a little more than a 40-db range and includes an off position by turning to the extreme bottom end. It is satisfactory for most volume control purposes.

If a linear taper is used, the 20-db range requires nine-tenths the full rotation of the control and levels lower than this are compressed into one-tenth the rotation.

If two controls are used in cascade, one following the input stage and one later in the preamp (Fig. 5), a semi-log taper for each is better, although the log taper can also be used if a very wide range of input level is expected.

Feedback volume control

A feedback control can follow either of the circuits in Fig. 6. The difficulty in designing such a circuit is that response is almost certain to change with level. Also, even applying maximum feedback does not give an off position. The maximum range of the control is the same as the gain of the amplifier over which the control is placed.

A difficulty arises in many circuits, except single-stage types, because adjusting the feedback over a wide range causes considerable variation in the circuit's stability criteria. Thus the frequency response changes drastically with level. This can be minimized by using feedback over only one stage, but then there wouldn't be enough gain to provide an effective range of control. Of course, the change in stability criteria can be used to produce loudness-control compensation.

For these reasons, the regular gain or volume control is usually a straight-forward potentiometer. The idea of using a feedback volume control has been practically abandoned.

Direct loudness control

For a loudness control, we will first

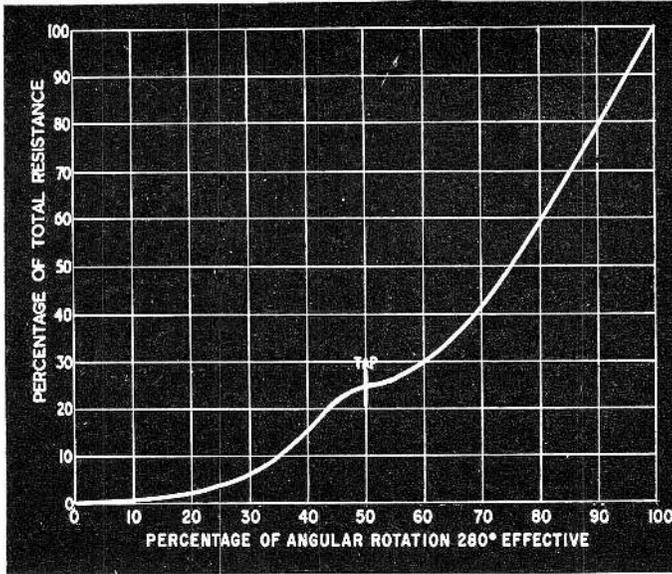
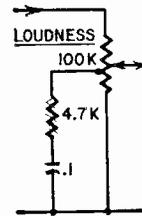


Fig. 10 (right)—Loudness control circuit using resistance taper of Fig. 9. Indicated values give 14 db maximum boost between 70 and 350 cycles.

Fig. 9—Standard resistance curve used for making loudness controls in single step.



consider the straightforward type that uses a simple potentiometer arrangement with various modifications. The simplest arrangement is to insert a capacitor at the bottom end of the potentiometer as in Fig. 7. It produces the variations shown in Fig. 8. This is somewhat unsatisfactory because the bottom end position produces a continued 6-db-per-octave downward slope throughout the entire frequency band and gives very muffled reproduction. It can be restricted by inserting a fixed resistor as well as a capacitor at the bottom end, but this also restricts the range of the control.

If we want the loudness control to act like the original volume control—to start from an off position—the simplest approach is to use a tapped potentiometer with the taper shown in Fig. 9, connected in the circuit shown in Fig. 10. However, it will have a much more restricted amount of boost than the circuit of Fig. 7.

A better control is formed by using two potentiometers, one with a linear and one with a logarithmic taper, connected as in Fig. 11. The first pot provides a satisfactory off position for the control. When the control is operated

in the range from mid-position to the top, the change in volume adjustment provided by the linear part is only a matter of 6 db. The second part of the control, using a logarithmic taper, produces a 20-db change in level over this same range of movement, resulting in a 26-db total level change for the top half of the control. The second part of the control can be designed on the same basis as the simple circuit of Fig. 7.

At about 50 cycles, the reactance of the capacitor inserted in the bottom end should equal the whole resistance of that section of the control. If a 100,000-ohm control is used, the capacitor should be about .03 μ f. This control should give a pretty good approximation of the correct loudness adjustment for the first few db change in level at the low end (Fig. 12).

It does not provide any compensation for the high end, and compensation at the low end is hardly adequate for the lower loudness levels. The only way to get adequate compensation for the lower loudness positions is to add another stage. This can be done by using a tapped control for the first half.

If a 100,000-ohm control with a linear taper and a center tap is used,

a 10,000-ohm resistor, in conjunction with a capacitance with a reactance of about 50,000 ohms at 50 cycles (this works out to .05 μ f), would be near enough for this purpose. It provides double the rate of boost from the center point on down. With this revised arrangement, at 1,000 cycles, the first stage attenuation is 17 db. It is calculated as follows: The 10,000-ohm resistor is in parallel with the bottom half of the 50,000-ohm potentiometer, because the capacitor's reactance is negligible at the middle and upper frequencies. This produces a combined bottom-end resistance of 8,300 ohms. The top half of the resistance is 50,000 ohms so the attenuation is the ratio 58.3/8.3, or 7 to 1, which corresponds to 17 db.

The second half of the loudness control gives about a 20-db attenuation, because of the log taper, as before. So the overall level reduction at the midpoint is approximately 37 db. This means the revised arrangement gives all the desired loudness adjustment in the top half of the control's rotation. The bottom half provides a control that goes right down to an off position.

The simplest way to add high-frequency compensation is to use a resistance and capacitance between the top end of one of the potentiometers and its slider. To give about 6-db maximum boost, which is about satisfactory, the resistance should be equal to the pot's overall resistance. In this case, the second potentiometer is probably the best one to apply it to, because it is the control principally responsible for the change in gain over the upper 25% of rotation. So the resistor should be a little less than 100,000 ohms to produce a maximum of about 6-db boost, say 82,000 ohms, and the appropriate capacitance can be calculated.

With a 6-db ultimate boost, the first critical frequency gives a lift of about 2 db. This should be at about 4,000 cycles. Then there is 4-db boost at 8,000 cycles, rising to an ultimate of 6 db. So the reactance should be about 160,000 ohms at 4,000 cycles. A 250- μ f capacitor should give about the right amount of boost. The complete circuit is shown in Fig. 13.

An alternate loudness control arrangement that we will not go through in (Continued on page 92)

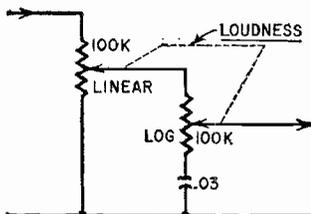
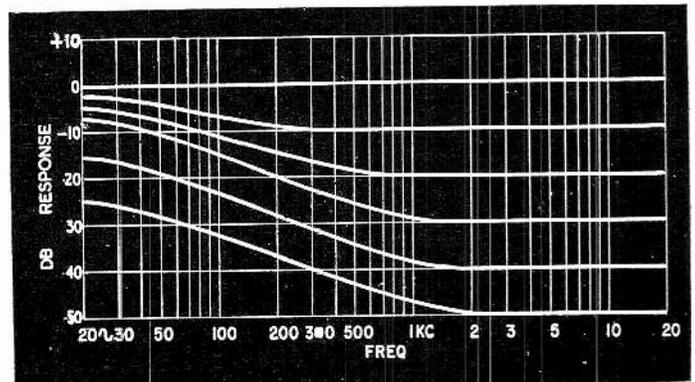


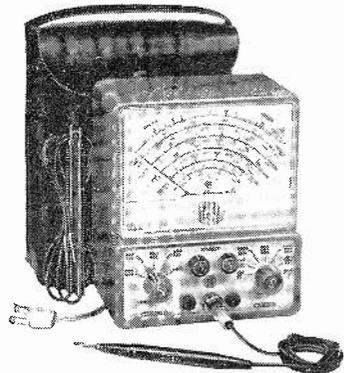
Fig. 11—This ganged control gives good response variation, especially at higher levels.

Fig. 12—Range of responses given by the circuit of Fig. 11.



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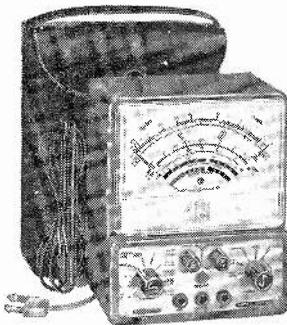
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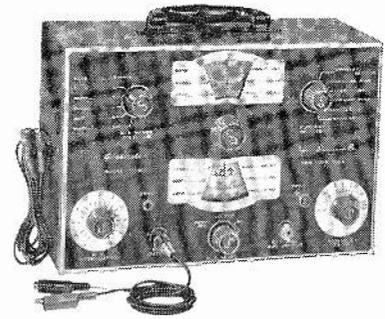
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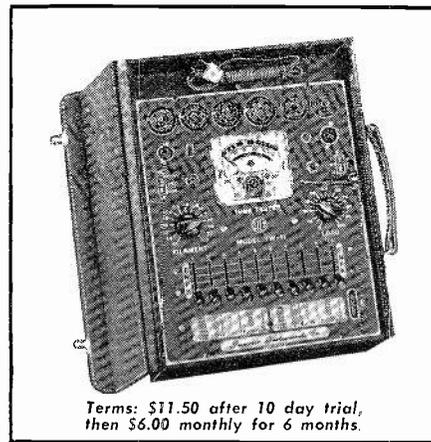
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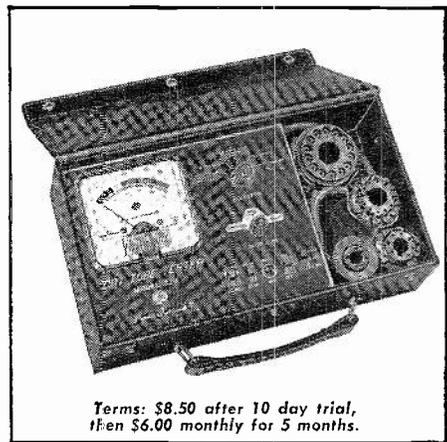
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Test ALL picture tubes—in the carton—out of the carton—in the set!

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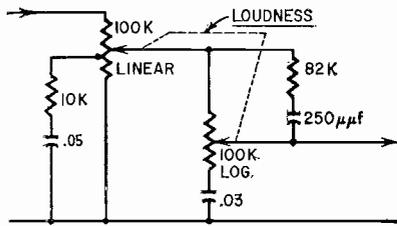


Fig. 13—Complete 2-section control, including high-frequency compensation.

(Continued from page 89)

detail here and which gives better possibilities of accurate compensation, uses switched positions. It is based on the philosophy that people usually listen at only certain ranges of level, rather than requiring a continual adjustment of loudness. According to this idea, we usually listen to our music either loud, medium or quietly played. For a moderate degree of adjustment at any of these general levels, the ordinary volume control can be used without producing too serious a deterioration in the loudness contour. This lets us use a switched high-medium-low arrangement like the one in Fig. 14. We will not go through this one in detail, because we also want to cover the feedback type in this article.

Feedback loudness controls

There must be a tremendous number of feedback loudness-control designs, but a relatively simple one that shows the general method is in Fig. 15. It is built around the two halves of a 12AX7. The first half uses a 100,000-ohm coupling resistor with 470,000 ohms in the following grid, and a 2,200-ohm bias resistor which also serves as the feedback bottom-end resistor. According to the tube manual, this gives a gain of 52. The second stage uses a 100,000-ohm coupling resistor with a 2,200-ohm bias resistor, as before, but the resistance into which the stage works varies according to the feedback.

If maximum feedback uses a minimum resistance of 100,000 ohms, the second stage's gain under this condition is about 40, yielding an overall gain for the two stages of about 2,000. Attenua-

tion caused by the feedback is about 45 to 1, which leaves us with a loop gain in the region of 2,000/45, or 45.

Now to see what we require. We will assume a range of 40 db. At the lowest level, we need a 3-db boost at about 500 cycles, with about 30 db of boost at 25 cycles. If the time constant in the feedback gives the 3-db point at 500 cycles, the 6-db-per-octave slope will produce 26 db at 25 cycles. So we need an extra 4 db because of the feedback. If we make the unity slope point (e) for loop gain at 25 cycles, it will be the leveling-off point, before the response

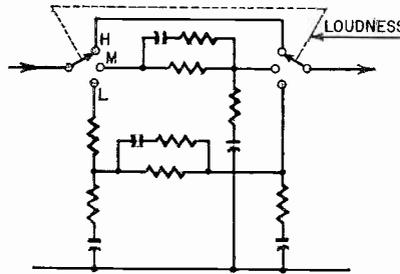


Fig. 14—Alternate approach uses fixed compensation equalizers.

falls off. The unity slope point (e) will be 500 divided by the square root of the rolloff ratio (\sqrt{n}) to get the no-feedback reference, and by the feedback extension factor to get the actual point. So the product of $e\sqrt{n}$ must be 20 with 4 db at the unity slope point. Using the chart we showed last month (RADIO-ELECTRONICS, March 1960, page 55, Fig. 3), we select a rolloff ratio of 12 and a feedback extension factor of 5.8, and feedback comes out to about 30.5 db. This makes the forward rolloff at 41.6 cycles.

For the top level, we need to know how the time constants change with feedback. Thus, 30.5 db of feedback corresponds to a voltage ratio of 33.5 (this is the ratio by which feedback reduces gain). The loop gain is 1 less, or 32.5. If we drop to 8-db of feedback, a voltage ratio of 2.5, we need a loop gain of 1.5. The time-constant ratio changes in proportion to the loop gain because it is controlled by the resist-

ance associated with the capacitor. The change in loop gain is a ratio of 32.5/1.5, or 21.6. So from being a 12/1 rolloff ratio in one direction, it finishes up 1.8 in the opposite direction.

The 8-db feedback with a time-constant ratio of 1.8 gives a unity slope point of -2.5 db. This reference is $41.6/(\sqrt{1.8} \times 1.58) = 19.7$ cycles. (The 41.6 is the forward rolloff, 1.8 is the rolloff ratio and 1.58 is the feedback extension factor corresponding to 8-db feedback.) The feedback path has a 3-db point at $41.6/1.8$, or 23 cycles. So the two effects practically cancel, leaving a slight boost before the rolloff.

Now to try a mid-level, using a loop gain of 7, which gives 18 db of feedback corresponding to a voltage ratio of 8. The rolloff ratio is 2.6 in the original direction, so the 3-db point in the feedback is at $41.6 \times 2.6 = 108$ cycles. The combination of 18-db feedback with a time-constant ratio of 2.6 gives 2 db at the unity slope point. This comes at $(41.6 \times \sqrt{2.6})/2.8 = 24$ cycles. (The 2.8 corresponds to 18-db feedback.) The boost caused by the feedback path is 13 db, making a total boost of 15 db. (Rolloff at 108 cycles is

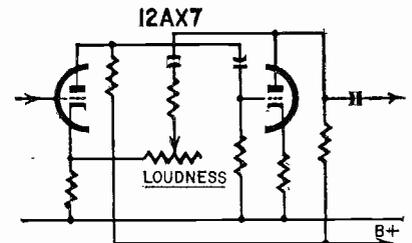


Fig. 15—Basic circuit for a feedback type loudness control.

13 db down at 24 cycles. So total boost is the 13 db here plus 2 db caused by feedback interaction.) This is just half the final value. Now we have to trim the gain so these responses come in the right places.

To get a 30.5-db feedback, with a forward gain of 2,000, the feedback fraction needs to be $2,000/32.5 = 62$. The cathode resistor is 2,200 ohms so the

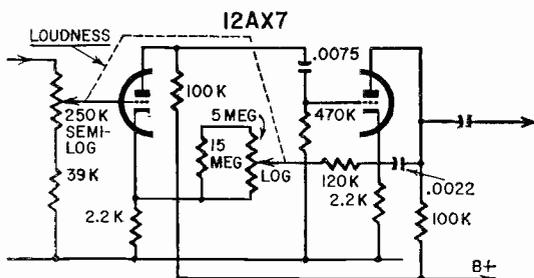
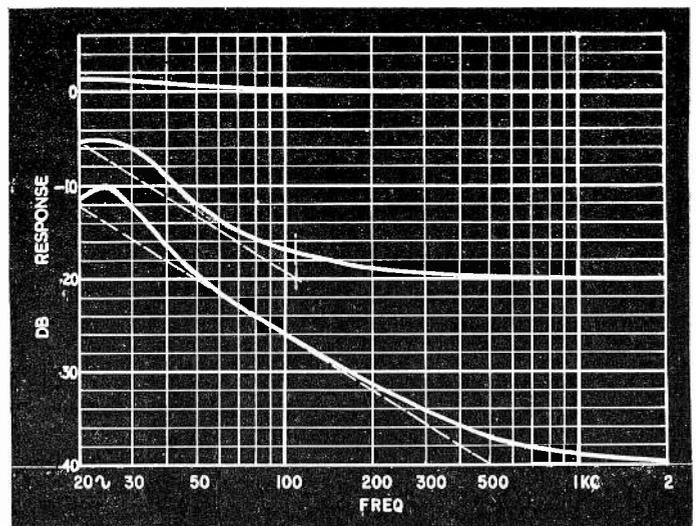


Fig. 16—The circuit of Fig. 15 designed for good low-frequency compensation over a 40-db loudness range. High frequencies are not treated, as this depends on stray capacitance which, in turn, depends on how the circuit is laid out.

Fig. 17—The three selected responses discussed in the text to show the behavior of the circuit of Fig. 16.



AUDIO—HIGH FIDELITY

feedback resistor should be 135,000 ohms. Using 120,000 ohms will allow a slight margin. At the other end, 8-db feedback, with a gain which will rise to about 2,500, requires a feedback fraction of $2,500/1.5 = 1,670$. The feedback resistor needs to be 3.7 megohms. A 5-megohm pot with 15 megohms in parallel will produce this. The mid-point should produce 18-db feedback. The forward gain we can estimate as about 2,400. So the fraction needs to be $2,400/7 = 340$, requiring about 750,000 ohms. With the 120,000 ohms fixed, the variable needs to provide 630,000 ohms. This means we need a 5-megohm pot with a log taper (since maximum feedback is zero on the pot and gives minimum level).

Now to square up the gain differences. We are using 8-, 18- and 30.5-db feedback for loudness levels separated by 20-db intervals. So a straightforward potentiometer adjustment must provide a stretch of $40 - 22.5 = 17.5$ db of extra range, a ratio of 7.5 to 1. A 250,000-ohm pot with a bottom-end resistor of $250/6.5 = 39,000$ ohms will serve. At the middle position, the feedback makes a difference of 10 db out of the total 20, so the pot should provide an additional 10 db. This means the tapping should be $289,000/3.162$ minus 39,000 ohms from the bottom end, or 53,000 ohms. On a 250,000-ohm pot this requires a semi-log taper.

This has all the resistance values fixed. Now we need only to select capacitors that give a forward rolloff point of 41.6 cycles, with a 520,000-ohm circuit resistance, and a feedback rolloff point of 500 cycles, with a 135,000-ohm circuit resistance. This yields values of .0075 μ f and .0022 μ f, respectively. The complete circuit is shown in Fig. 16 and the responses in Fig. 17.

So we have a feedback circuit that provides a reasonable approach to loudness control. This circuit can be changed in a number of ways. Other circuits could also be devised, which would produce variable boost and rolloff (and none of which may produce exactly what is required although there are endless possibilities to try). The simplest and best approach is to use the straightforward passive equalizer type and work out a circuit that does get pretty close to the responses required, such as the one in Fig. 14.

Of course, it would be possible to figure out a feedback circuit, using switched components for fixed level compensation that would come close to the required response because then the coupling capacitors and other elements can be changed to get the right value for each particular response. But it probably does not pay to be too critical. After all, the Fletcher-Munson curves are the response of an average ear. No individual has such a convenient set of parameters. Everyone deviates from average one way or another. So provided we can get a reasonable approximation, we have served the purpose of a loudness control. **TO BE CONTINUED**

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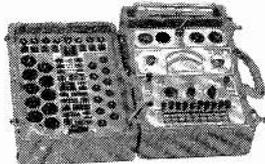
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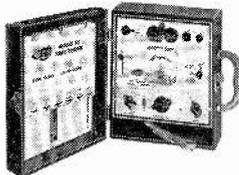


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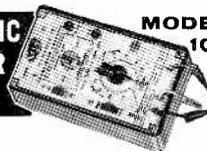


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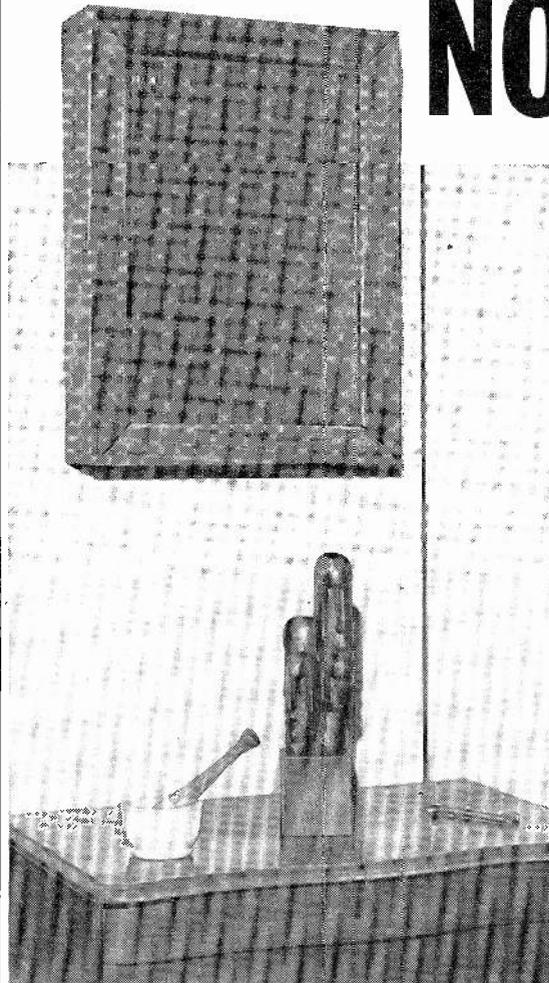
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NEW SPEAKER

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A SPEAKER with a conventional voice coil, but using a flat 15 x 22-inch wooden panel instead of a cone, was demonstrated recently by Abraham Cohen, veteran loudspeaker engineer who was formerly engineering manager for University Loudspeakers, and author of popular hi-fi books as well as technical engineering papers.

As the photo indicates, the reproducing area of the speaker is a perfectly flat sheet made, according to its designer, of strips carefully matched for strength and compliance. A framework to hold the perimeter of the panel rigid and support the mechanical assembly increases the dimensions to 24 x 18 inches, and the depth to 4½ inches.

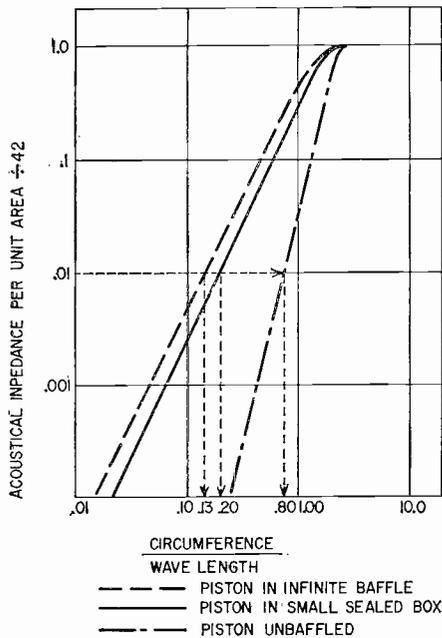
The extreme flatness of the speaker lends itself to a number of mounting methods. Normally standing on a low base on the floor, it can be built into the doors of a hi-fi cabinet, mounted in the wall between two rooms or installed in the picture-on-the-wall fashion shown here. The speaker is bi-

directional, projecting sound to the rear practically as well as to the front. This gives it the name Bi-Phonic Coupler. The rear of the speaker, in the floor-mounting models demonstrated, was finished with strip bamboo.

The Bi-Phonic coupler, its inventor pointed out at the demonstration, is a sound radiator using a completely un-baffled large rigid piston. Physically, a radiating piston does not care what kind of baffle confines it as long as it sees the necessary radiation resistance into which to develop the proper power. Although the Bi-Phonic radiator is un-baffled, as low a frequency as is desired may be obtained if piston size is chosen so its radiation resistance is equivalent to that of a baffled piston of a smaller size.

However, the type of baffle will determine the radiation resistance that the piston sees. Determined by the baffle conditions, the piston size will vary for a given radiation resistance into which acoustic power may be developed. An

AUDIO—HIGH FIDELITY



infinite wall baffle presents the maximum radiation resistance (per unit area of piston), while for a small sealed box, nominally under 7.6 cubic feet, the radiation resistance for the same-size piston is approximately half that in an infinite baffle. Similarly, a completely un baffled piston has presented to it an even lower radiation resistance. These relative characteristics of different types of baffles are shown in the accom-

panying curve, a modified composite representation of radiation resistance characteristics from "Acoustical Engineering" by H. F. Olson (1957 edition). For a given radiation resistance it is possible to select three sizes of pistons that will radiate the same acoustic power per unit area for a given frequency, depending on whether the piston chosen is mounted in a true infinite baffle, a small enclosed box or left un baffled. The 440 Bi-Phonic coupler piston size (15 x 22 inches) was chosen to produce the same power output per unit area when un baffled as that produced by a 12-inch diameter piston in a sealed bookshelf enclosure, Mr. Cohen stated.

The vibrating panel is driven with a 2-inch voice coil cemented to its center. The rest of the speaker assembly consists of a 7½-inch diameter ceramic magnet assembly weighing 20 pounds. Because of its rigidity, it moves very slightly, even for the loudest notes. It is this feature, plus its large area, states the designer, that permits it to reproduce notes down to 30 cycles without additional baffling. With the help of the small tweeter seen mounted in the corner of the panel, response is extended upward beyond the limits of audibility.

The new speaker is in production, being manufactured by the Advanced Acoustics Corp. founded by Mr. Cohen. He is now its president. **END**

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Dick Brani (right) discusses the new SAGE "memory" with a field engineer.

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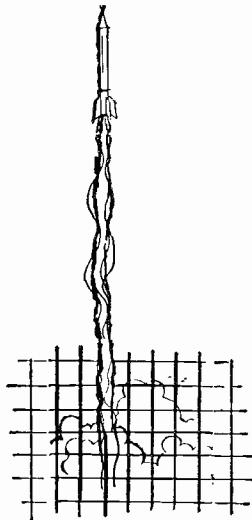
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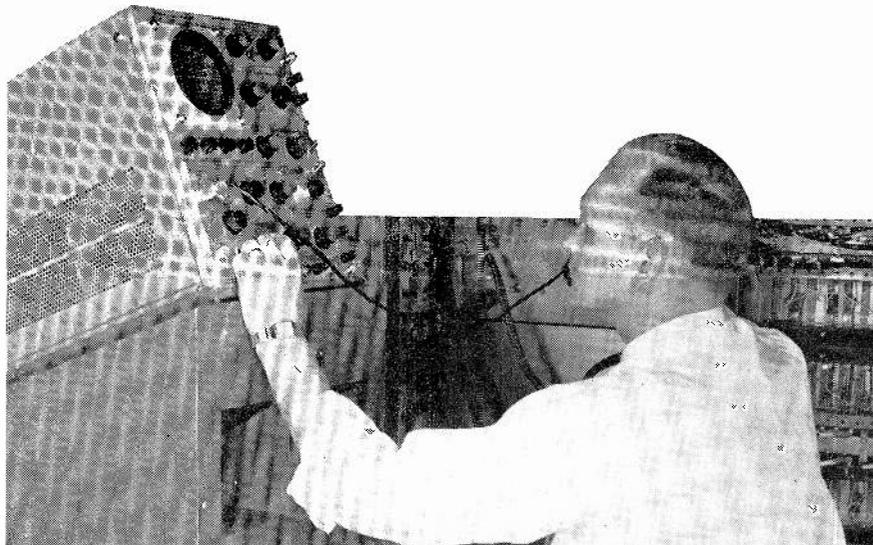
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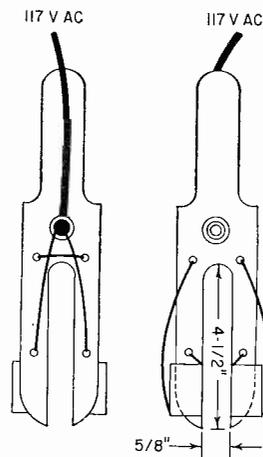


AUDIO—HIGH FIDELITY

BULK ERASER FOR TAPE

An excellent bulk eraser for recording tape can be made from the coils from a discarded magnetic sander or other vibrating type tool. Just reverse the connections to one coil so that when they face each other a strong magnetic field is produced.

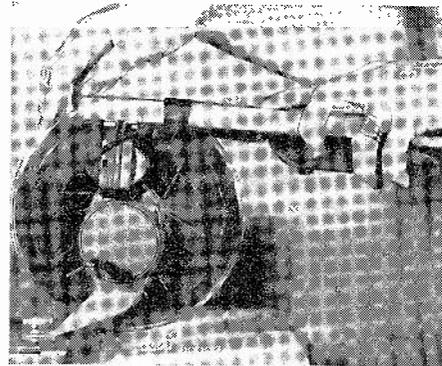
The coils are mounted on a fork made of any light wood (see diagram).



Above—Coils mounted on wooden fork.

Left—Parts layout, wiring arrangement.

Below—Eraser used to clear 7-inch reel of standard magnetic tape.



The fork's slot is $\frac{5}{8}$ inch wide and $4\frac{1}{2}$ inches deep to handle 7-inch reels. The leads from the coils are fed through holes bored in the fork, to keep them from obstructing the slot. A switch mounted at the base of the fork is convenient, but not necessary.

A simple stand to support a $\frac{5}{16}$ -inch pin horizontally 5 or 6 inches above the base or any home movie film rewind holds the reel while erasing.

This eraser does a remarkably clean job on a 7-inch reel in about 30 seconds, and is very convenient to handle and store—Herbert C. McKay

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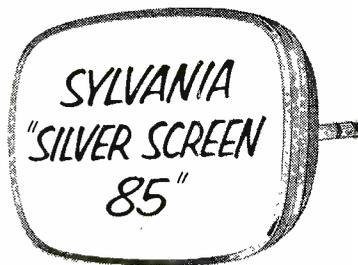
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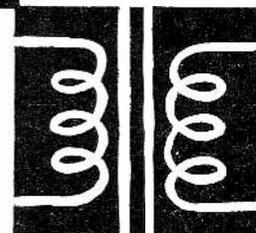
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We have all seen and used audio transformers, but how many of us know how to modify their frequency response to suit our needs?

By **HERBERT RAVENSWOOD**

IN a previous article ("Design Calculations for R-C-Coupled Amplifiers," RADIO-ELECTRONICS, October, 1957), a number of fallacies that often crop up were uncovered and the correct procedure was outlined. As an audio transformer is a much more complicated device than a simple R-C coupling network, it would seem that the possibilities of getting confused are much greater. Therefore, it is surprising to find that, although detailed prediction with audio transformers is not as simple a matter as in R-C-coupled circuits, it is not too difficult to understand them correctly.

The principal thing is to understand the significance of the equivalent circuits which the transformer introduces and how we can work around them to get the results we need. Let's take each of the common kinds of audio transformers in turn and consider the factors that control its performance.

Input transformers

The practical circuit of an input transformer is shown in Fig. 1, together with the necessary equivalent circuits for estimating behavior at both ends of its frequency response. To calculate its precise performance, the electrical properties of the transformer, such as primary inductance, leakage inductance and various capacitances, as well as winding resistance and core losses, should be known in detail.

But in practice, a knowledge of the way circuit constants react with these electrical properties of the transformer is enough to permit adjusting the performance as required, once an initial check has been taken on the performance in any particular circuit. Anyway, most transformer manufacturers do not oblige us with these electrical properties so we *could* make the accurate calculation, and we have to be content with this approach to getting the correct performance.

At the low-frequency end, the transformer's primary inductance acts as a shunt reactance to the source resistance combined with the load resistance. The source resistance may be some kind of microphone or pickup, or a line from another amplifier. In each of these

cases the source impedance does look like *some* value of resistance.

In the last case the input transformer is working from a line and the impedance that we are concerned with is what is connected to the other end of the line. This means that the source impedance may not necessarily be the nominal value quoted. Usually line impedances are quoted as 250, 500 or 600 ohms. But, when an amplifier has an output impedance quoted as 600 ohms, this does not necessarily mean that the impedance looking back from the output terminals is 600 ohms. What the rating means is that the amplifier will give its correct performance *when it is loaded externally by 600 ohms*.

This is also true of an input transformer. It will give its correct performance when a 600-ohm source is connected to it. With a 600-ohm output it may have a source impedance, looking back into the amplifier, of 60 ohms—assuming a damping factor of 10. If such an output is connected by a line to a 600-ohm input, the 600-ohm input will not be terminated by a 600-ohm source but by a 60-ohm source, and performance may not be as specified.

In addition to the source impedance

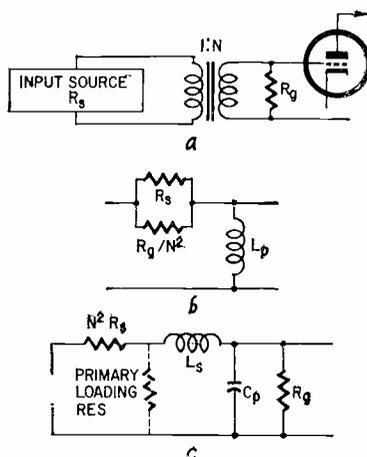


Fig. 1-a—Practical circuit of an input transformer; b—equivalent circuit for low-frequency response; c—equivalent circuit for high-frequency response. Dashed resistor shows equivalent position of a resistance connected across the primary winding.

or resistance, the transformer is also loaded on its secondary if a grid resistor is connected in parallel with it. The total loading effect can be calculated by dividing the grid resistor across the secondary by the square of the stepup turns ratio and then considering this equivalent resistor as being in parallel with the input resistance.

Suppose, for example, the stepup ratio of the transformer is 10 to 1 and the grid resistor is 220,000 ohms. The 220,000 ohms divided by 100 gives an effective parallel resistance on the primary of 2,200 ohms. If the source resistance is actually 600 ohms, the equivalent resistance that the primary inductance is shunting will be 600 ohms in parallel with 2,200 ohms, or about 470 ohms. The 3-db point, in this instance, appears where the reactance of the primary inductance is equal to 470 ohms.

In practice, the primary inductance changes with frequency and signal level, so the response is not constant nor does it follow a fixed roll-off shaping.

A convenient way to make adjustments is based on the 2-to-1 step sequence. This is a series of db-loss figures that can easily be memorized and used as a basis for estimating how much the circuit values should be changed to effect a given improvement in the low-frequency response.

When reactance is 4 times the circuit resistance, the loss is 0.25 db. When reactance falls to twice the value of the circuit resistance, the loss is 1 db. When reactance and resistance are equal, it is the well-known figure of 3 db. When reactance falls to half this value, the loss increases to 7 db, while at a quarter of the 3-db value it rises to 12 db. This sequence, covering a change in reactance over a ratio of 16 to 1 or alternatively a corresponding change in associated circuit resistances, covers a sufficient range for all practical response estimates.

To illustrate this method of estimating response, suppose an input transformer working with circuit resistances that calculate out to an effective parallel value of 600 ohms on the pri-

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mary shows a loss of 3 db at 20 cycles. If the circuit resistance can be reduced to a quarter of this value, or 150 ohms, the loss at 20 cycles will be only 0.25 db.

High-frequency calculation

The high-frequency response is a little more complicated than the low end. The leakage inductance of the transformer, together with the secondary capacitance combined with grid input capacitance and stray capacitances, contribute to the normal high-frequency response. Sometimes, besides these simple and essential components there is some interwinding capacitance—capacitance between points on the primary and points on the secondary winding. Audio transformers are usually designed so there is no such capacitance or it is connected in such a way that the primary-to-secondary capacitance cannot affect the transformer's frequency response. We will return to this point later as it is a complication and we want to deal with the simple circuit first.

The thing that seems to cause the most confusion in figuring out the high-frequency response of a transformer and determining how to improve its performance, is an understanding of just what leakage inductance is.

A transformer's primary inductance is set up by the magnetic field induced in the core by the current in its primary. From the viewpoint of this simple primary inductance, the magnetic field wraps itself completely around both windings. Because the magnetic material which forms the core has a very high permeability—up in the thousands, or tens of thousands—the magnetic field in the core exceeds that in the air space surrounding the windings by many thousand times, and the voltages generated in both windings are to all intents and purposes proportional to the turns in the windings. This means that, at any given operating condition for the transformer, the primary inductance will bear a relation to the inductance of the secondary proportional to the turns ratio squared. This is why it is immaterial whether we consider the low-frequency response from the primary or secondary side, because we can either consider the primary inductance and transform the secondary impedances back to the primary or vice versa. The conclusion will be exactly the same although different numbers are used.

Although the magnetic field in the core is so large that it completely swamps the magnetic field in the air surrounding the windings at low frequencies so they do not contribute any measurable component to the primary inductance, the wide range of frequencies over which an audio transformer operates means that the small field between the windings can have some effect at the high-frequency end of the range.

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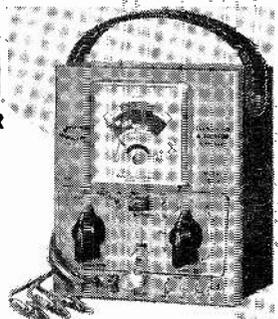
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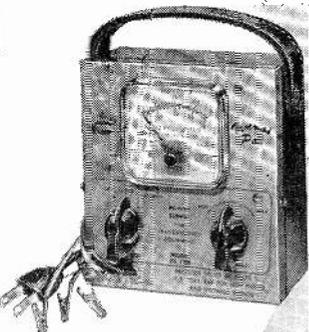


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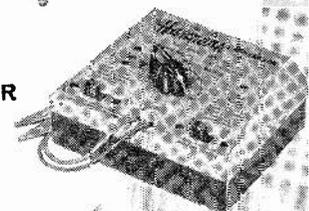


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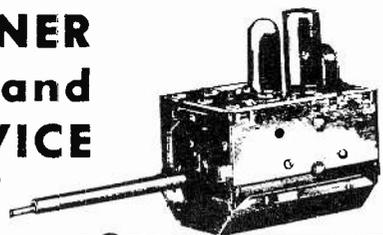
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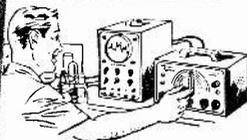
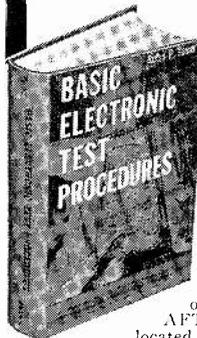
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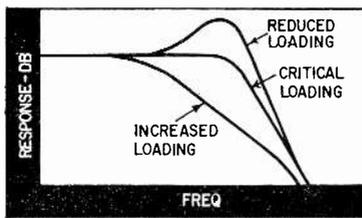


Fig. 2—Variations of an audio transformer's high-frequency response with the effective loading by circuit resistance values, not considering interwinding capacitance.

consider that, although the great bulk of the magnetic field is concentrated in the core, the air space surrounding each winding will still have exactly the same magnetic field that there would be if the same current circulated in the winding without the presence of a magnetic core. This is true for both primary and secondary windings. The current in each of these windings will set up a magnetic field around that winding only.

Some of this leakage field gets down between the two windings and some of it passes through the middle of each of them. But the net result is that *some of the magnetic field induces voltage in one winding but not in the other*, thus allowing a voltage difference from the ideal calculated by the turns ratio squared, between the two windings. As this voltage difference is generated by a changing magnetic field, induced in turn by the current in the windings, it has all the properties of an inductance.

But notice that it is a voltage difference. If the transformer had a 1-to-1 ratio so the same voltage would be on both windings, at low frequencies we could regard the transformer as a direct ac connection from one side to the other. But at the high-frequency end of the range, there can be an appreciable difference in voltage due to the leakage field. This means that the direct connection is no longer effective, but it is as if there is a series inductance between primary and secondary. This explains why leakage inductance can be regarded as a series inductance instead of a shunt inductance.

Now, when we take the equivalent circuit for the high-frequency end and rearrange it somewhat, we can see that it reduces to a resonant circuit in which the source resistance connected to the primary is a series loading resistance in the tuned circuit, while the shunt resistance connected across the secondary is a parallel loading resistance. This means that reducing the secondary shunt resistance will load down the circuit, reducing any tendency to peak, while increasing the primary source resistance will have the same effect. Alternatively, reducing the primary source resistance will increase the tendency to peak.

From this we can see that connecting a resistance across the primary will raise the high-frequency response,

while connecting it across the secondary will drop the high-frequency response. This fact can prove quite useful in juggling the response at both ends so we get the required combined overall response.

Fig. 2 shows a typical series of response curves for different degrees of loading. In this we have not distinguished between loading effected by increasing the primary source resistance or by adding additional shunt resistance across the secondary. Under some circumstances this choice will make a little difference in the shape of the response—shifting the peak frequency. But this is a complicated matter to calculate precisely and it is better to leave it out of the present discussion.

Line-to-grid once again

Let's go back to our line-to-grid transformer that had a 3-db loss at 20 cycles when the source resistance was 600 ohms. Reducing the primary resistance to 150 ohms—easily achieved by some suitable matching pad—might cause a peak at the high-frequency end

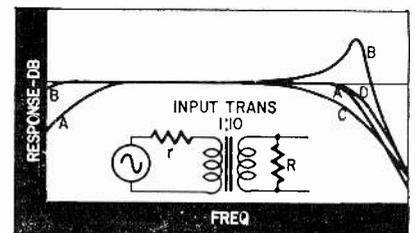


Fig. 3—Adjusting the response of an input transformer by changing circuit values. R and r represent basic circuit values and not actual resistances.

Curve	r	R
AA	600Ω	infinity
BB	150Ω	infinity
BC	300Ω	30,000Ω
BD	200Ω	60,000Ω

because the resonant circuit consisting of the leakage inductance and secondary capacitance would be insufficiently damped. Assuming we have a 10-to-1 stepup ratio and that originally no secondary grid resistance was connected, we might compromise by using a 300-ohm resistor on the primary, together with a 30,000-ohm resistor on the secondary. This will transfer back to the primary as another 300 ohms for the bass response effect, and the result at this end will be the same as a total circuit resistance of 150 ohms. It will also load down the high frequencies instead of causing too much peak. Maybe it will load the high frequencies down too much. If this happens, maybe 200 ohms as a primary source resistance, together with 60,000 ohms on the secondary, would give a satisfactory response.

A possible set of response curves for these conditions is shown in Fig. 3. These should not be taken to be indicative of a response for any particular audio input transformer. They just show the way adjustments may be made by using different combinations of circuit resistance.

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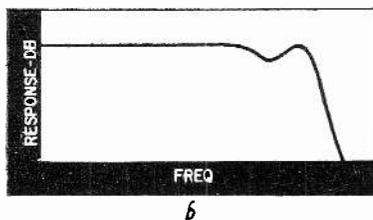
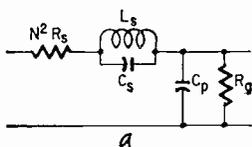


Fig. 4-a—Equivalent circuit of an input or interstage transformer for high-frequency response when interwinding capacitance interacts with leakage inductance as well as secondary winding capacitance; b—the kind of response caused by circuit a.

Now let's consider what interwinding capacitance can do. If the primary impedance is low, say less than 600 ohms, the whole primary may be regarded as effectively grounded in comparison to the high secondary impedance. This means that at any frequency within the audio range, the capacitance between primary and secondary may be regarded merely as contributing to the total effective secondary capacitance. On the other hand, if the primary impedance is relatively high, say 600 ohms or higher, interwinding capacitance cannot necessarily be ignored.

As mentioned earlier, the safest way is to arrange that the interwinding capacitance has no effect on the response. This is done by grounding (ac-wise) the parts of each layer adjacent to one another. Now, any capacitance between primary and secondary is virtually between two points both at ground potential and, as there is no audio voltage on either of them, there cannot be any transfer across this capacitance.

If this precaution is not followed, there will be some capacitive transfer between primary and secondary. At the high frequencies, the phase angle of the currents passing through this transfer capacitance may oppose the phase angle set up by the leakage inductance in the regular inductive transfer. This means that we have a virtual series wavetrap circuit without an equivalent network, as shown in Fig. 4. The result of this is a response with a dip in it. However, some ways of connecting the windings will result in a different phase relation so the current due to the normal transfer, with its leakage inductance, is additive to the capacitance transfer circuit. The effect is exactly similar to a change in the values of the effective leakage inductance and shunt capacitance. The shape of the resulting response will be similar to that already discussed, but as if the transformer electrical constants were changed slightly. But we do not know what the constants are supposed to be

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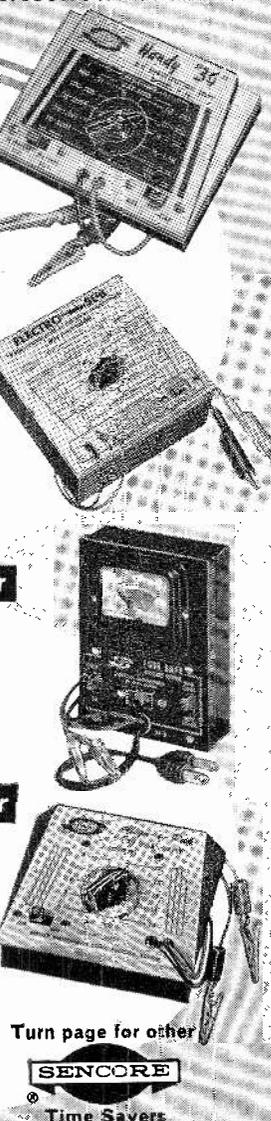
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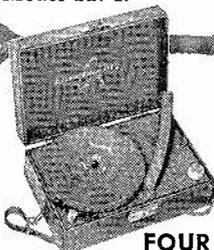
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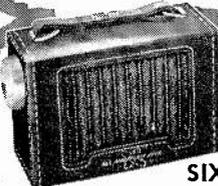
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(the manufacturer does not publish them).

Interstage transformers

These transformers are no longer used as much as they were in the earlier days of audio, but they sometimes form a useful phase splitter because under some circumstances they provide better balance and less distortion than tube type phase splitters. This may not be generally recognized, but it is true.

For output stages where power is required to drive the grid of the output tubes, an interstage transformer (more commonly called a driver transformer) is almost a necessity (although there are circuits that can dispense with it). However, performance of a driver transformer requires taking into account the effect of grid current through the windings. This will be discussed in a further article because there is not enough space here.

Some variations in the catalog way

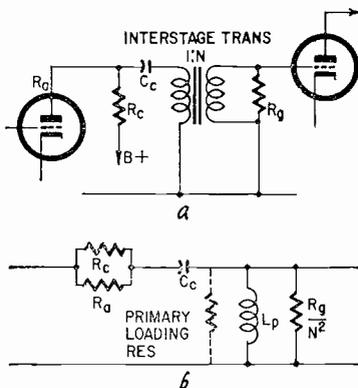


Fig. 5—A parallel-fed interstage or driver transformer will have different low-frequency parameters than the input transformer of Fig. 1. Note the different effect of the primary loading resistor, shown dotted in (b), compared with its effect on high-frequency response shown in Fig. 1-c.

of listing interstage transformers should be clarified before going further. In the early days, the turns ratio of a transformer was expressed to show the electrical "advantage" gained by putting it in circuit. Thus "3-to-1" signified that the transformer would deliver three times the voltage developed at the preceding stage's plate to the following stage grid. As long as interstage transformers were used only to give stepup, there was no confusion.

Then came power drive, with the use of stepdown drive (or interstage) transformers to provide the required low source impedance for the output stage grids. Logically the ratio is expressed with the number representing the primary before that for the secondary. Thus 1.5-to-1 logically means the primary has one and a half times as many turns as the secondary. But, according to the earlier school, this could also mean a 1.5-to-1 stepup. So, in the interests of consistency, the more modern way of listing an interstage

stepup transformer would be: 1:3.

So it happens that we may find some lists showing 3-to-1 and others 1-to-3, for the same basic product. This is not all. It was recognized that a mere statement of ratio was not enough. A microphone-to-line transformer and a plate-to-grid interstage might each have a 1-to-3 stepup ratio, but they are far from interchangeable because they use quite different numbers of actual turns to accommodate radically different impedances. So the next step, now quite widely used, is to list windings by impedance ratings.

For example, using this method, our original 3-to-1 interstage, which can also be listed as a 1-to-3 (more logically the latter), can now appear with the primary listed as impedance 10,000 ohms, secondary 90,000 ohms. This is intended to convey that the primary is intended to work in a 10,000-ohm plate circuit. It does not indicate that the secondary should be connected to a resistance of 90,000 ohms, but that the transformer will make the 10,000 ohms source, due to the primary-connected plate impedance, "look" like 90,000 ohms at its secondary terminals.

This is because the secondary voltage will be three times the primary voltage, while any secondary current will require a corresponding primary current of three times the magnitude. Thus the transfer changes effective impedance by $3 \times 3 = 9$ times.

The interstage transformer which does not have to handle power, but is merely a voltage transfer device, is essentially similar to an input transformer except that it may have to handle somewhat higher levels. Also, a good interstage transformer is parallel-fed, to avoid passing a polarizing current through its primary winding. The circuit of the transformer we are considering is illustrated in Fig. 5.

The equivalent circuit reduces to a resonant circuit consisting of the coupling capacitor and the primary inductance. The source resistance, made up of the ac resistance R_a of the preceding tube in conjunction with the plate coupling resistance R_c as a parallel combination, appears as series damping. The secondary load resistance R_g , which is reflected through the transformer turns ratio squared, acts as shunt damping. Notice in this case that, if a resistance were connected across the primary instead of the secondary, it will still have the same effect on the low-frequency resonant circuit because it still acts as shunt damping across the effective primary inductance.

Thus we have in this type of circuit another way to adjust the high-frequency and low-frequency response independently so we can get the best combined overall response. A resistance connected in parallel with the secondary will load down both ends of the frequency response. A resistance connected in parallel with the primary will lift the high-frequency response and load down the low-frequency response.

AUDIO—HIGH FIDELITY

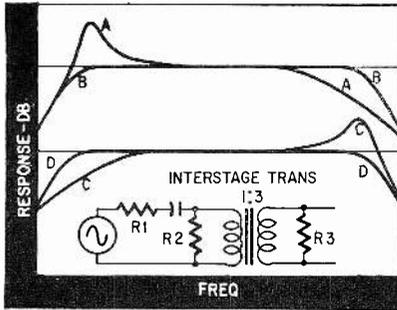


Fig. 6—The method adopted for flattening the overall response in two interstage-coupling transformer circuits.

Curve	Trans-former	R1	R2	R3
AA	1	6,500Ω	infinity	470,000Ω
BB	1	6,500Ω	15,000Ω	470,000Ω
CC	2	7,700Ω	infinity	1 megohm
DD	2	4,400Ω	infinity	220,000Ω

Note that in each case R1 is the equivalent of R_a and R_c, of Fig. 5-a, in parallel.

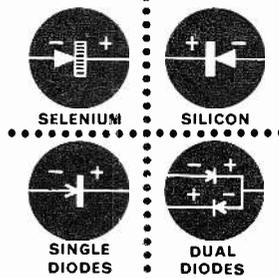
This takes care of quite a wide range of variations, but suppose we happen to want to lift the low-frequency response and load down the highs. At first sight it seems we do not have a combination that will produce this effect. But in practice this is not difficult to achieve. The approach is to reduce the source resistance on the input side to coupling capacitor C_c, by shunting down the plate coupling resistor or altering the operating conditions of the tube so its effective ac resistance is lower. In doing this be careful not to run into overload. This will lift *both* ends of the response somewhat. Now, by loading the secondary side of the transformer the loading effect on the high-frequency response will usually act more rapidly than it does on the low-frequency response. In this way it is usually possible to lift the low-frequency response and pull down the high-frequency response. If this method does not work, the only alternative is to try a different value for the coupling capacitor, or a different transformer. Fig. 6 shows response curves with different combinations of resistance connected in the circuit of Fig. 5.

Output transformers

This is different from the other transformers we have considered so far in that it uses a stepdown instead of stepup ratio. The primary is the high-impedance winding, while the secondary operates at low impedance. Normally, modern output transformers are direct-coupled because they use push-pull circuits, and the only components in the primary circuit contributing to low-frequency response are the plate resistance and the transformer's primary inductance.

The capacitance effective for the high-frequency rolloff is the primary capacitance, and the resistance providing series loading for the effective high-frequency resonant circuit is the load resistance. The resistance providing shunt loading is the ac resistance of

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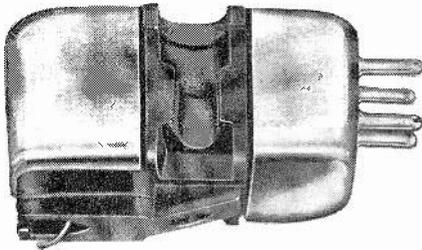
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AUDIO—HIGH FIDELITY

the tubes. This is just the reverse of the input and interstage transformer. But the response follows a similar arrangement and Fig. 7 shows the actual circuits together with the equivalent circuits for low-frequency and high-frequency rolloff, while Fig. 8 shows the response produced by various values of ac and load resistance.

Because of this functional transposition of the important circuit elements, according to whether a transformer is stepup or stepdown, it is customary to use symbols that can be considered as related to the high- and low-impedance windings, rather than to primary and secondary. This makes formulas and charts more universally applicable. Thus C_p is the winding capacitance of the high-impedance winding—secondary of a stepup, primary of a stepdown. The inductance labeled L_p may be primary or secondary, but it is the "primary" inductance of the transformer—that due to the magnetization of the core.

Leakage inductance, which is due to magnetic field leaking *between* windings, not through the core, is given the symbol L_s . This is a function of the physical spacing between the *two* coils (primary and secondary) and may be given a value in terms of either one, according to which circuit is used as a reference for all the impedances associated with the transformer.

Similarly C_s , occupying a similar circuit position to L_s , represents *equivalent* interwinding capacitance. This is not any capacitance you can measure on a capacitance bridge or

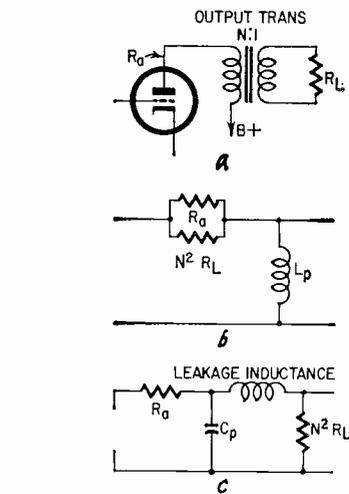


Fig. 7—Output transformer: a—practical circuit; b—low-frequency parameters; c—high-frequency parameters. For simplicity, only a single-ended transformer is shown, but a push-pull type has precisely similar equivalents.

very far without departing completely from the operating specification in other aspects. However, the effective ac resistance of the tubes is controlled by any feedback that is taken from the plate circuit to some earlier stage in the amplifier, and this effectively modifies the apparent frequency response of the transformer as well as probably having an effect on the amplifier's frequency response due to the feedback over the amplifier circuits.

Space has run out on this discussion of audio coupling arrangements and we are left with some points that still need

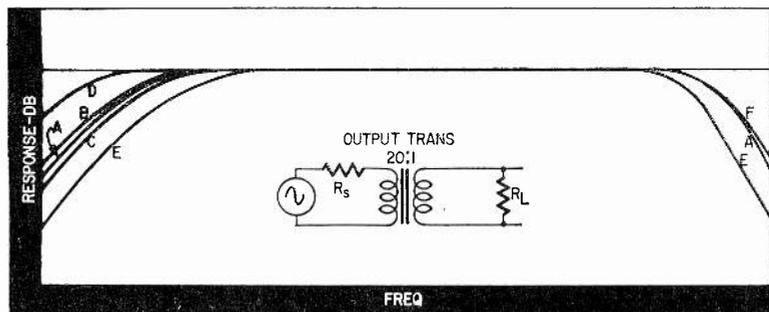


Fig. 8—Variations in response of an output transformer with different values of R_s and R_L . (R_s is the effective value of R_a in Fig. 7-a, which may be modified due to feedback.) These responses represent only the transformer-circuit response and do not take into account other possible feedback effects.

Curve	R_s	R_L
AA	1,000 Ω	10 Ω
BE	1,000 Ω	5 Ω
CF	1,000 Ω	20 Ω
DF	500 Ω	10 Ω
EE	2,000 Ω	10 Ω

meter, but is a measure of the effective capacitive transfer between windings due to the voltage distribution dependent on the external connections (what part of each winding is grounded). In a well-designed, correctly connected transformer, the quantity C_s is effectively eliminated.

In practice, of course, the load resistance that can be used and the ac resistance that appears are determined by the amplifier's specification, and it is not usually possible to adjust these

discussion: why frequency response changes with level, and how to control this effect; the overall effect of feedback on the frequency response of different kinds of circuit, and the question of high-frequency stability in different kinds of tube coupling circuits. A way of thinking this thing out, called the interaction concept, helps considerably in analyzing the situation and estimating a suitable arrangement. These things will be discussed in a future article.

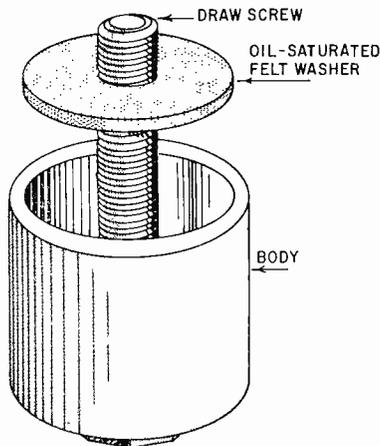
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CHASSIS-PUNCH CARE

To the electronics builder, a chassis punch is probably as useful as his soldering gun or his own two hands. And like most all other shop tools, a chassis punch requires a certain amount of care if it is to lead a long useful life.

To protect my punches I cut felt



washers from an old felt hat, saturate each with oil and slip one over each draw screw as shown. The rest of the punch is assembled as used just as before. The oil keeps the parts lubricated, makes the punch work easier, and deters rust. A chassis punch is relatively expensive, so I give mine the care they so rightly deserve.—John A. Comstock

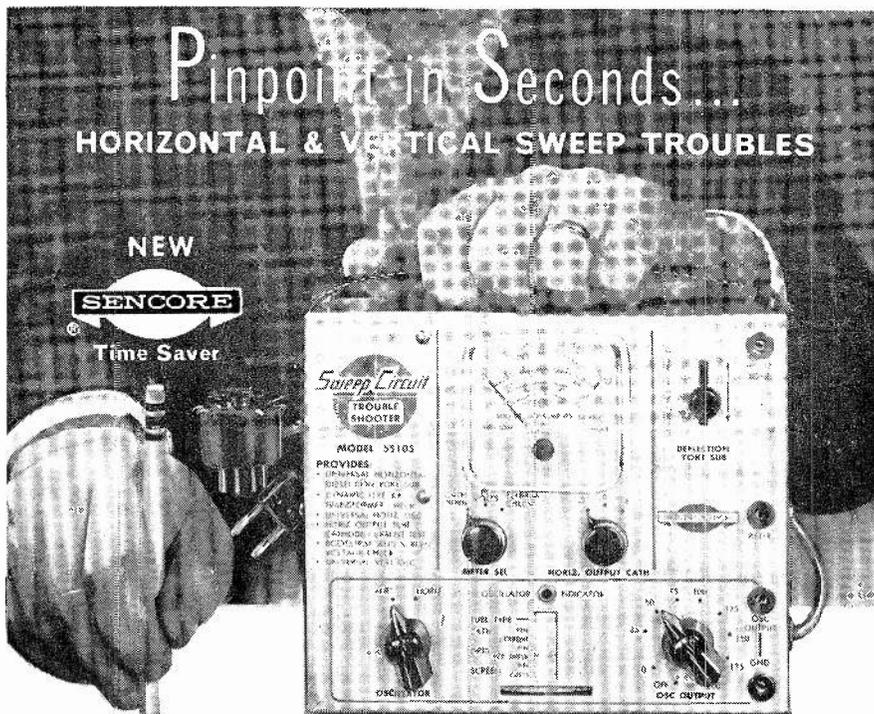
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When I have to solder live electric wires, I avoid the possibility of getting a shock when the solder touches the joint by insulating it with a length of spaghetti. By slipping the insulation over the solder, I avoid the unpleasant experience of receiving an unnecessary jolt.—John Abram

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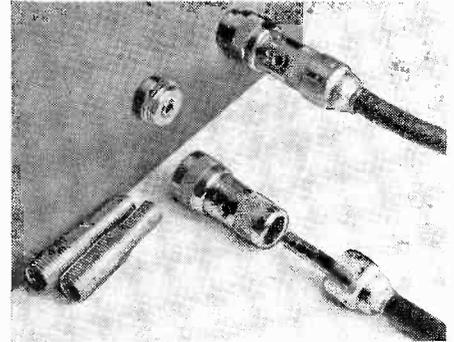
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The miniature mike chassis shown in the photo is a Switchcraft Mini-Con 5501MP. The miniature mike connector is a Switchcraft Mini-Con 5501F.—Art Trauffer

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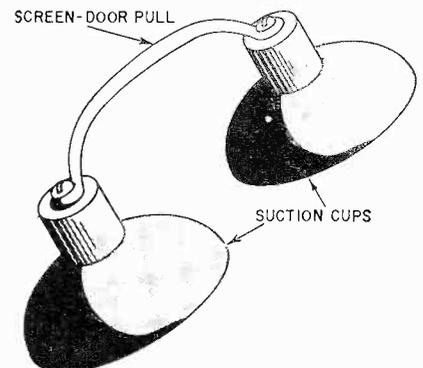
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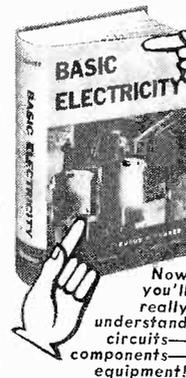
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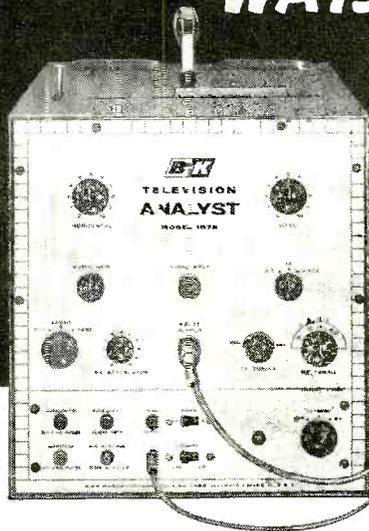
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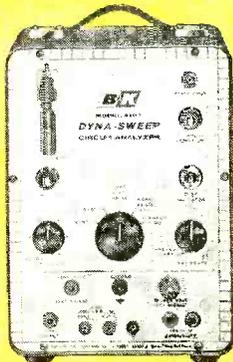
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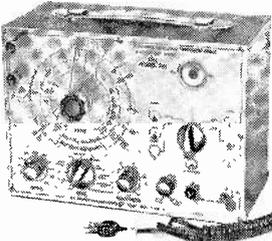
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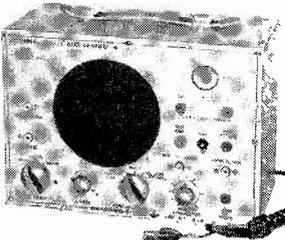
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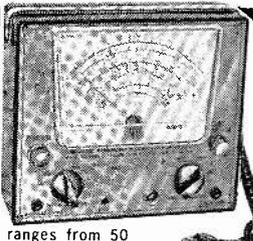
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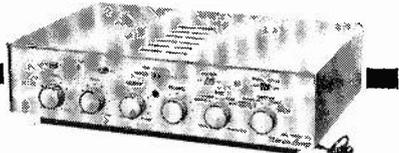
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In carrier-current signaling, messages are carried along power lines. This system includes a squelch. Receive-transmit switch S2 is shown in receive position. Of the two transmit positions, one is equipped with a spring return for momentary use.

Signals from the line pass through C1 and appear across transformer T1's primary. The lower secondary is grounded during receive and V1 acts as a diode detector. Potentiometer R1

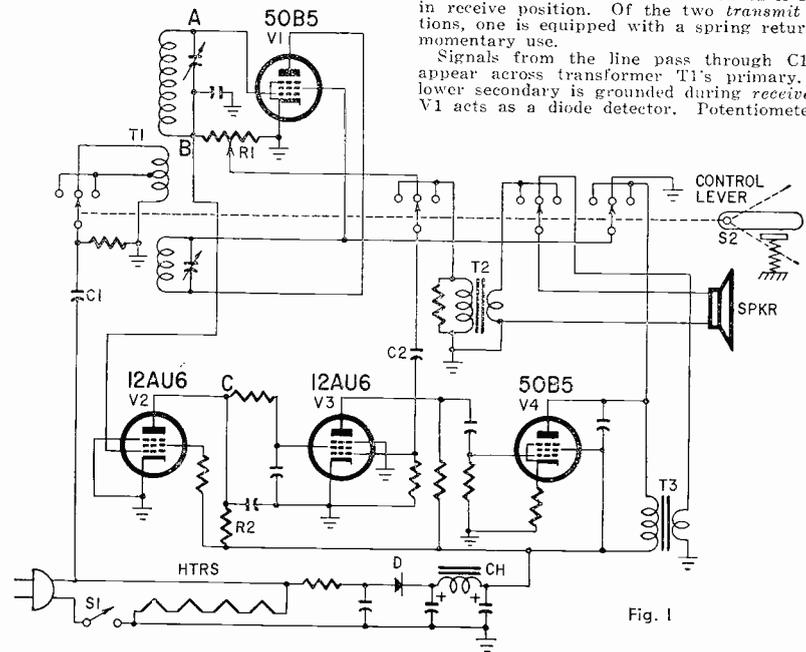
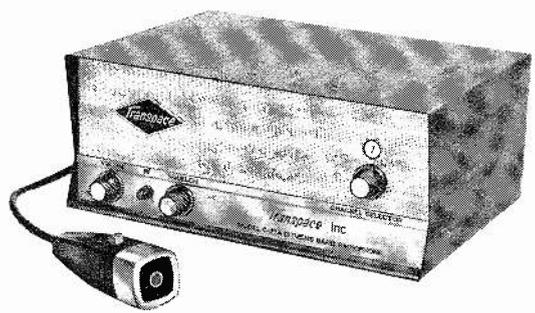


Fig. 1

Transpace
— 6 channel Citizens' Band radiophone



You get every top feature in a TRANSPACE — the set that gives you the full possibilities of Class "D."

Six-channel operation. Choose up to 6 channels, by means of an illuminated front panel selector. The dial is direct reading — no interpolation needed.

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One-microvolt sensitivity for maximum reception... 37 db selectivity.

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No retuning — the Transpace maintains full sensitivity and power output when you switch channels.

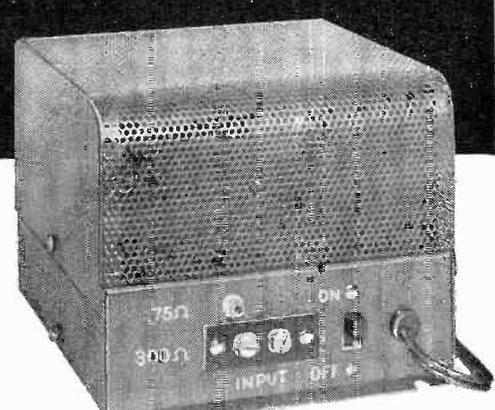
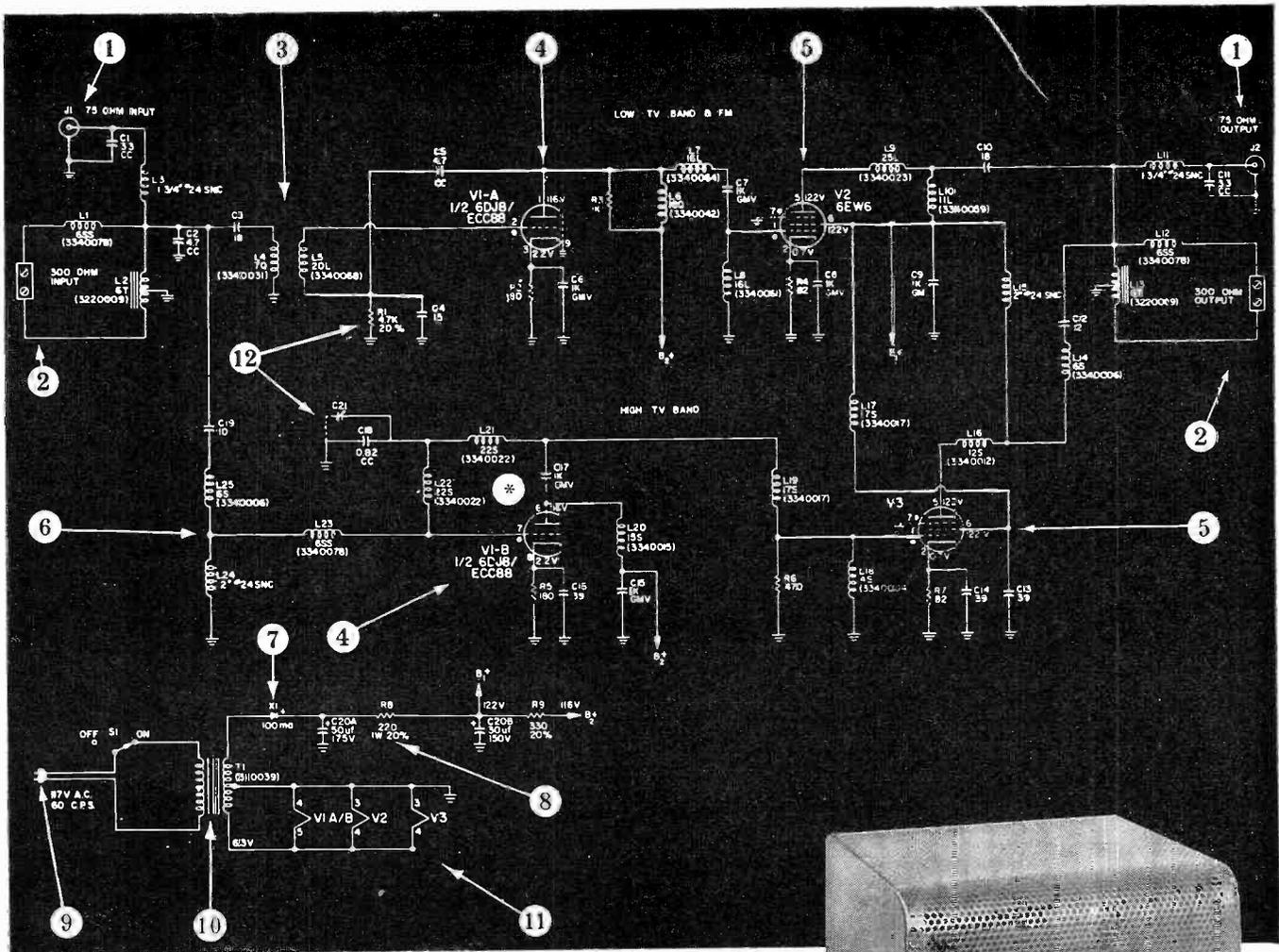
Rugged construction—withstands the roughest mobile use. Super-tough vinyl finish.

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- ⑫ Separate high and low bands of amplification consistent with maximum gain and wide band response.

*U. S. Patent 2,761,023—triode neutralization circuit

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U.S. PATENT 2,775,309

There are hundreds of United States Patents on loudspeakers. Most of them relate to minor improvements; a few have changed the face of the speaker industry.

AR's patent on the acoustic suspension speaker system has had far-reaching effects. A very large number of speakers has been produced under the patent by AR and its licensees, and speaker design in general has been given a new direction. In our opinion this patent has proved to be the most significant issued in the speaker field since 1932, when Thuras was awarded a patent on the bass-reflex enclosure.

The basic idea of the acoustic suspension system is that the speaker works against an elastic pillow of air sealed into the cabinet instead of against mechanical springs of its own. This design makes possible vastly improved bass reproduction (particularly from the point of view of lowered distortion), and simultaneously dictates small cabinet size.

The acoustic suspension principle is now used in four AR models—the AR-1, AR-2, AR-2a, and AR-3, priced from \$89 to \$225. We invite you to listen to these speakers at your dealer's, or, if you live near New York City, at the AR Music Room in Grand Central Terminal.

Literature on AR speakers is available for the asking.

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MILLER FM high fidelity tuner — top performance at a moderate price

Miller has designed every quality feature into this tuner, to bring you big value.

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SPECIFICATIONS: A six-tube unit, it has a tuning range of 86 to 110 Mc. Typical sensitivity is 1.0 μV for 20 db quieting; 2.1 μV for 30 db quieting. Typical selectivity: 200 kc at 6 db. Frequency response: 15 to 25,000 cps. Distortion is less than 1/2% at rated output, and warmup drift is negligible. Size: 9" wide, 4" high and 7" deep.

Model 580 — in attractive 2-tone cabinet . . . PRICE: \$69.50
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PATENTS (Continued)

is the volume control. With no signal, point B is at ground potential and there is no bias on V2. It conducts, generating a large drop across R2 to lower V3's screen voltage. The tube blocks and mutes the speaker. A signal makes B negative to block V2. Full screen voltage appears at V3 and the signal is heard in the speaker.

When transmitting, the speaker acts as microphone. The audio goes through T2, C2 and V3, V4. T3's primary is the modulation choke. V1 oscillates because of feedback between upper and lower secondaries of T1.

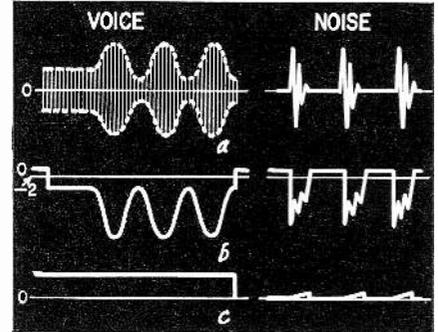


Fig. 2

Fig. 2 shows why the circuit can distinguish between voice and noise. Noise pulses are momentary and decay rapidly. During noise, B goes negative for short intervals only, so V2 conducts to some extent. The waveforms of Fig. 2 are shown for points A, B, C.

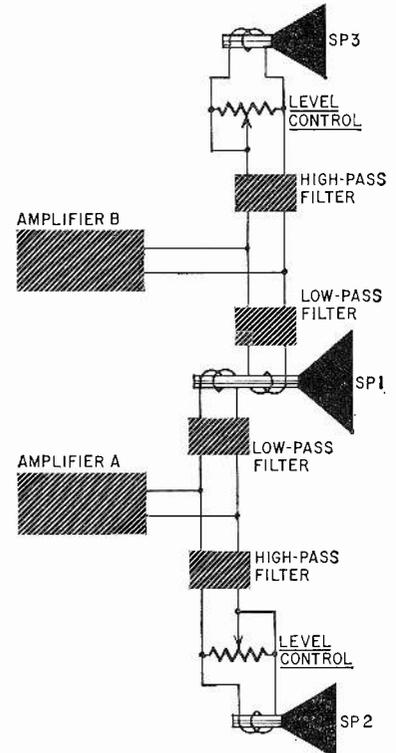
SIMPLIFIED STEREO

Patent No. 2,904,632

Sidney E. Levy, White Plains, N. Y. (Assigned to University Loudspeakers, Inc., White Plains, N. Y.)

Most stereo listeners have noticed that low frequencies are not directional. It is difficult—in a room of ordinary size—to determine the direction from which they come. It is therefore sufficient to use a single low-frequency speaker or woofer. Treble notes are more directional, so two tweeters must be used for stereo.

In the diagram, SP1 is the woofer. It is



wound with two voice coils, one for each amplifier. Note the low-pass filters.

The tweeters, SP2 and SP3, are energized through high-pass filters, each reproducer being connected to a separate amplifier.

This produces a stereo system using only a single woofer. Since these speakers are much larger and more expensive than tweeters, the saving is considerable. (The system has been commercialized under the trade name *Tridimensional*.)

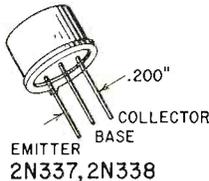
END

NEW TUBES and SEMI-CONDUCTORS

BUT for a couple of transistors and group of diode rectifiers, vacuum tubes rule this month's column. There are octal and 9-pin miniature vertical amplifiers and oscillators; and a couple of 23-inch picture tubes.

2N337, 2N338

Two high-frequency silicon n-p-n transistors that can be used as af or rf amplifiers or in high-speed switching



circuits, are grown-junction devices with a diffused base. Both are suitable for insertion in printed boards by automatic equipment.

Maximum ratings of these G-E transistors at 25°C are:

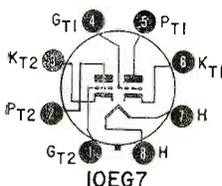
V_{CB0}	45
V_{EB0}	1
I_C (ma)	20
P_C (mw)	125

Electrical characteristics at 25°C are:

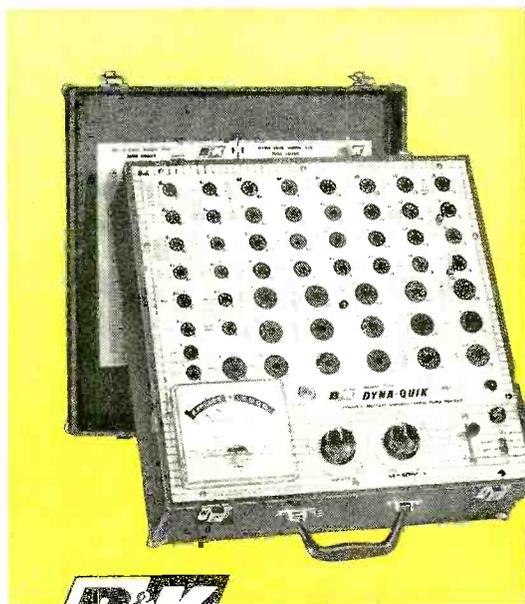
	2N337	2N338
h_{fe} (current transfer ratio) $V_{CB} = 20, I_C = 1 \text{ ma}, f = 1 \text{ kc}$	55	99
f_{ab} (alpha cutoff frequency) $(V_{CB} = 20, I_C = 1 \text{ ma})$	30 mc	45 mc
h_{FE} (Common-emitter current gain) $(V_{CE} = 5, I_C = 10 \text{ ma}, f = 1 \text{ kc})$	35	75

10EG7

This double-triode in an octal base has dissimilar sections. A medium- μ section is intended for use as a vertical deflection oscillator while the second



section has a low μ and is intended for use as a vertical deflection amplifier. The tube has a 9.7-volt heater rated at 600 ma. It has an 11-second controlled warmup for use in TV sets using series heater strings.



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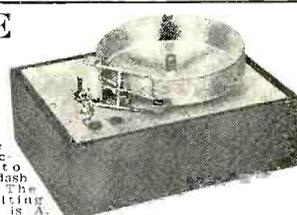
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NEW TUBES & SEMICONDUCTORS (Cont'd)

Design maximum ratings of this Sylvania tube are:

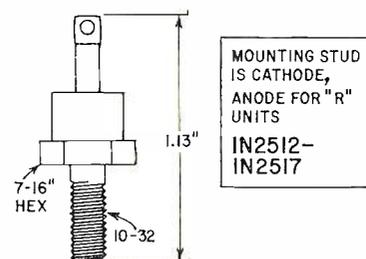
	Osc Section	Ampl Section
V_p	330	330
V_p (pos pulse)	—	1,500
V_G (neg pulse)	400	250
P_p (watts)	1.5	10
I_k (av ma)	22	50
I_k (peak ma)	77	175
R_G (self-bias) (megohms)	2.2	2.2

Average characteristics are:

V_p	250	150
V_{G1}	-11	-17.5
I_p (ma)	5.5	45
g_m (μ mhos)	2,000	7,500
μ	17.5	6.0
R_p (ohms approx)	8,750	800

1N2512, 13, 14, 15, 16, 17

These medium-current diffused-silicon rectifiers are designed to operate over ambient temperatures in the range of -65 to 165°C. The series is particu-



larly suited to rectifier applications where high inverse voltages, high forward conductance, very low leakage current and high rectification efficiency are required. Units with reverse polarity (anode to stud) carry suffix R.

Maximum ratings of these Raytheon diodes are:

	1N2512	-13	-14	-15	-16	-17
PIV	100	200	300	400	500	600
I_{av} rect (30°C) (amps)	4	4	4	4	4	4
I_{surge} (1/120 sec) (amps)	30	30	30	30	30	30
$I_{rev leak}$ (μ a)	2	2	2	2	2	2

23CP4, 23EP4

Two 110° rectangular glass picture tubes whose bi-panel construction eliminates the need for a safety-glass window in the receiver. These RCA tubes use an envelope that is not much larger than conventional 21-inch 110° tubes, but provides a larger picture that has nearly straight sides and corners that are only slightly rounded.

Identical in overall dimensions, the two tubes differ mainly in the type of electron gun used. The 23CP4 has a regular type of straight gun while the 23EP4 has a straight gun which operates at low G2 voltages in cathode drive circuits. Both types use magnetic deflection and low-voltage electrostatic focus.

The bi-panel construction provides an integral protective panel. The panel is sealed to the face of the tube. It eliminates air separation between the picture tube and the protective window. This improves contrast by reducing

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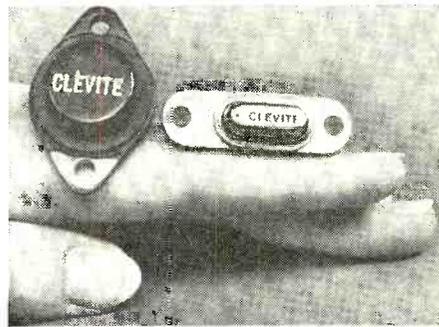
NAME.....
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reflections and eliminates the need for a dust seal.

Both tubes have aluminized screens, a 1½-inch neck and a glass-button 8-pin base.

Half-sized transistors

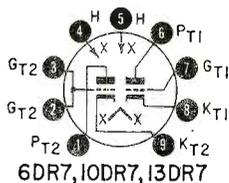
Power transistors, only half the size and weight of present versions, have been developed by Clevite. They claim their new transistors will facilitate the



introduction of portable, battery-powered hi-fi stereo equipment. The new units, named Spacesavers, are available in eight 3-amp switching units. Other types will become available shortly.

6DR7, 10DR7, 13DR7

A series of 9-pin miniature double triodes with dissimilar sections—a hi-mu section for use as a vertical deflec-



tion oscillator and a low-mu section for use as a vertical deflection amplifier. The 6DR7 has a 6.3-volt 900-ma heater, the 10DR7 a 9.7-volt 600-ma heater, and the 13DR7's heater is rated at 13 volts, 450 ma.

Average characteristics of this series of Sylvania tubes are:

	Osc section	Ampl Section
V _P	250	150
V _{G1}	-3	-17.5
I _P (ma)	1.4	35
g _m (μmhos)	1,600	6,500
μ	68	6
R _P (approx ohms)	40,000	925

Heats sinks and mounting clips

Two more manufacturers are turning out heat sinks and mounting clips for transistor applications. Selling them for industrial and OEM use, the Industrial Division of the Bircher Corp. produces a line of beryllium transistor clips that cover almost every transistor case. They also make a line of heat sinks for power transistors.

Another firm, Monadnock Mills, makes a group of anodized aluminum insulators wafers for use with power transistors. These units insulate power transistors from a chassis, without destroying the heat-sink function of the chassis. END

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Saves users money. Stops wasteful, short-life, dry battery replacements. PONY lasts as long as 100 or more regular dry batteries. Gives thousands of hours of life. Directly interchangeable with miniature 9-volt batteries used in transistor radios.

Improves tone quality. Maintains proper tone and volume over a longer period with less noise. Gives more paying pleasure.

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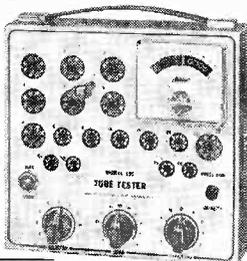
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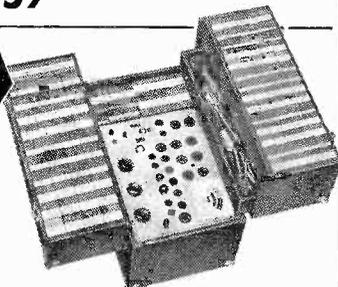
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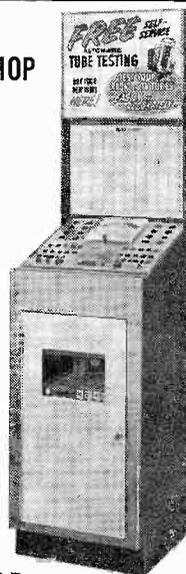
Model AD-1 CRT Adapter available... makes Mercury Tube Testers highly accurate picture tube testers of all black and white picture tubes (including the new \$3.95 short neck 110 degree RCA type) for emission, shorts and gas content. Dealer Net...

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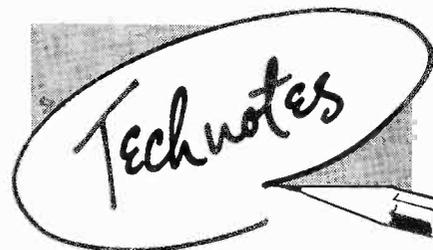


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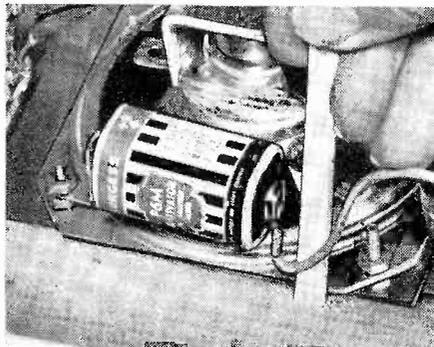
ZENITH CHASSIS 16Z21

Symptom: Sudden loss of raster, odor similar to burning transformer.

Cure: Check for a shorted 12DQ6-GT horizontal output tube. In several cases the customer was able to turn the set off quickly enough to save the flyback. Check the flyback carefully to be sure that it has not overheated enough to cause future trouble. Fusing the transformer with a 0.25-amp slow-blow fuse minimizes damage caused by shorted 12DQ6's.—John B. Ledbetter

SHORTED-BATTERY CHECK

Some transistor radios have one battery terminal at chassis potential, while the other terminal with flexible lead is located very close to the chassis.



It is easy to ground this second terminal accidentally to the chassis and end up with a dead battery. Make sure the lead shown is as far away from the chassis as possible.—Harry Leeper

CBS CHASSIS 1021-2

A number of these sets develop compression at the top and bottom of the raster. All components related to the vertical sweep section were checked and double-checked. Tube substitution was tried without effect.

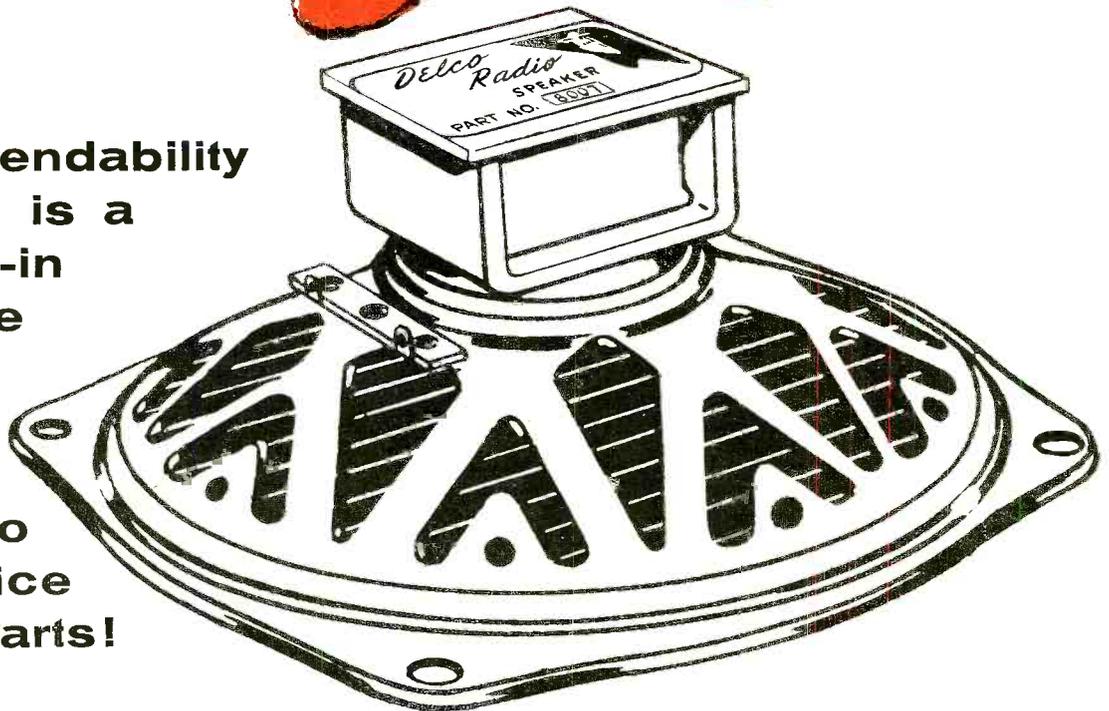
While attempting to adjust the height



and linearity controls, we noticed that they were fully advanced. All other settings gave abnormal compression at the top and bottom of the raster. Finally we decided to replace the 6AH4, used



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Delco's popular 8-inch "Hi-Fi" speaker, No. 8007, provides the most power and tonal range for the money. Designed for replacement use and high fidelity audio systems, it's a good, fast seller with price and quality appeal.

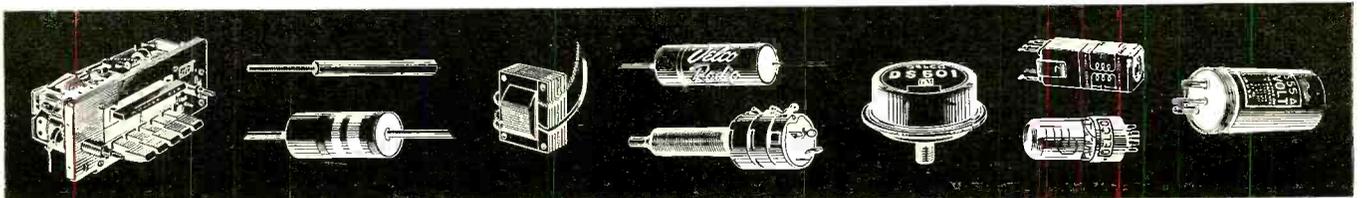
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TECHNOTES (Continued)

as a vertical output tube, with a 6V6-GT. The following socket changes are required:

The blue and black leads connected to pins 3 and 4. A jumper was installed between pins 1 and 5 for the grid connection. (Pins 3 and 4 may have to be connected through a 68-ohm resistor to isolate the screen from the plate.) This modification solved the problem and resulted in perfect control over vertical linearity and size.—*Walter Fernald*

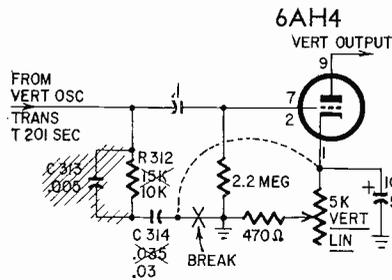
(Many technicians do not like to change tubes or tube sockets in a re-

ceiver. They know the difficulty involved in making the change and during future servicing. A simpler modification has been suggested and is said to give good results. Replace C313, R312 and C314 with a series combination consisting of a 10,000-ohm 1/2-watt resistor and a .03-µf 600-volt capacitor. The capacitor connects at the junction of R310, C315

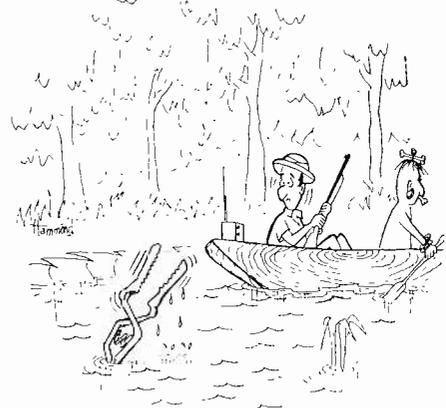
MOTOROLA 17P3-1

Complaint: Intermittent vertical jitter with occasional 2-inch reduction in height.

Cure: After all regular causes of this fault checked out OK, we were desperate. Grasping at straws, we replaced the 17CFP4 picture tube. This cured the set. Apparently there was an intermittent breakdown between the final screen and the anode or control grid.—*Barrie W. McClintock* END



ceiver. They know the difficulty involved in making the change and during future servicing. A simpler modification has been suggested and is said to give good results. Replace C313, R312 and C314 with a series combination consisting of a 10,000-ohm 1/2-watt resistor and a .03-µf 600-volt capacitor. The capacitor connects at the junction of R310, C315



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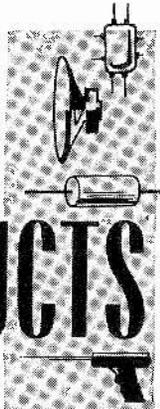
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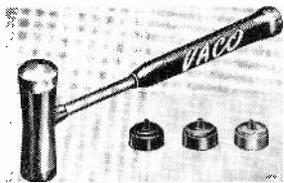
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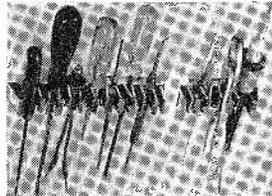
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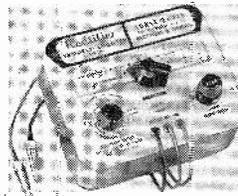


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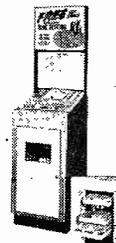
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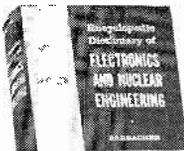
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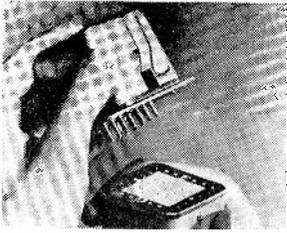
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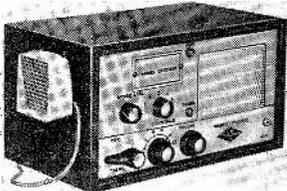
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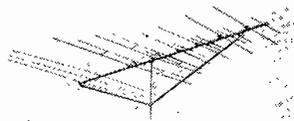
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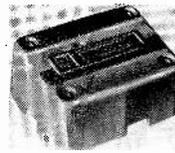
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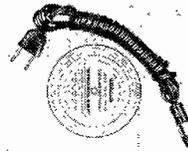
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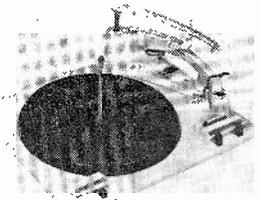
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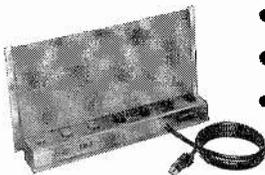
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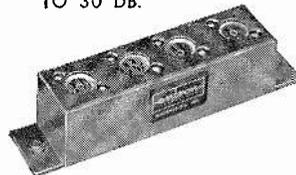
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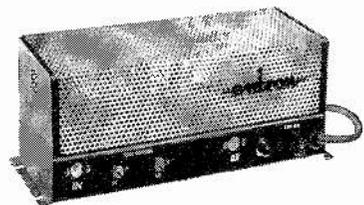
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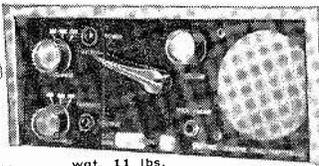
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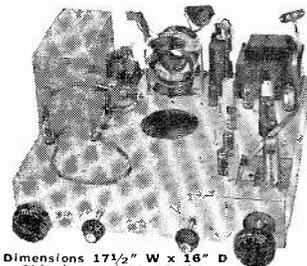
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- 50 - ASST. MICA CONDENSERS some in 5¢ . . . \$1
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- 10 - ASST. VOLUME CONTROLS less switch . . . \$1
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- 100 - VOLUME CONTROL HEX NUTS . . . \$1
- 20 - ASST. PILOT LIGHTS popular types . . . \$1
- 10 - PILOT LIGHT SKTS. bayonet type, wired . . . \$1
- 50 - ASST. TERMINAL STRIPS 1, 2, 3, 4 lug . . . \$1
- 10 - ASST. RADIO ELECTRO. CONDENSERS . . . \$1
- 5 - ASST. TV ELECTROLYTIC CONDENSERS . . . \$1
- 25 - ASST. MICA TRIMMER CONDENSERS . . . \$1
- 2 - ELECTROLYTIC COND. 40/40-300v . . . \$1
- 30 - FP CONDENSER MOUNTING WAFERS . . . \$1
- 3 - ELECTROLYTIC CONDENSERS 80-400v . . . \$1
- 3 - ELECTROLYTIC COND. 50/30-150v . . . \$1
- 10 - HV TUBULAR CONDENSERS .007-1600v . . . \$1
- 10 - HV TUBULAR CONDENSERS .001-6000v . . . \$1
- 10 - HV TUBULAR CONDENSERS .005-3000v . . . \$1
- 35 - MICA COND. 20-5 mmf & 15-25 mmf . . . \$1
- 35 - MICA COND. 20-50 mmf & 15-68 mmf . . . \$1
- 35 - MICA COND. 20-100 mmf & 15-270 mmf . . . \$1
- 35 - MICA COND. 20-470 mmf & 15-680 mmf . . . \$1
- 35 - MICA COND. 20-820 mmf & 15-1000 mmf . . . \$1
- 35 - MICA COND. 20-2200 mmf & 15-2400 mmf . . . \$1
- 35 - MICA COND. 20-3300 mmf & 15-4700 mmf . . . \$1
- 35 - MICA COND. 20-6800 mmf & 15-10000 mmf . . . \$1
- 35 - CERAMIC COND. 20-5 mmf & 15-10 mmf . . . \$1
- 35 - CERAMIC COND. 20-25 mmf & 15-47 mmf . . . \$1
- 35 - CERAMIC COND. 20-56 mmf & 15-82 mmf . . . \$1
- 35 - CERAMIC COND. 20-100 mmf & 15-150 mmf . . . \$1
- 35 - CERAMIC COND. 20-270 mmf & 15-470 mmf . . . \$1
- 35 - CERAMIC COND. 20-1000 mmf & 15-1500 mmf . . . \$1
- 35 - CERAMIC COND. 20-2000 mmf & 15-5000 mmf . . . \$1
- 50 - 100Ω 1/2 WATT RESISTORS 5% . . . \$1
- 50 - 470Ω 1/2 WATT RESISTORS 10% . . . \$1
- 10 - ASST. WIRE'ND RES. 5, 10, 20 watt . . . \$1
- 3 - AUDIO OUTPUT TRANS. 50L6 type . . . \$1
- 3 - AUDIO OUTPUT TRANS. 6K6 or 6Y6 type . . . \$1
- 3 - I.F. COIL TRANSFORMERS 454 kc. . . \$1
- 3 - I.F. COIL TRANSFORMERS 10.7 mc. FM . . . \$1
- 4 - OVAL LOOP ANTENNAS as-st hi-gain types . . . \$1
- 3 - LOOPSTICK ANT. now ferrite adjustable . . . \$1
- 12 - RADIO OSCILLATOR COILS 456 kc. . . \$1
- 3 - 1/2 MEG VOLUME CONTROLS with switch . . . \$1
- 5 - 50K VOLUME CONTROLS with switch . . . \$1
- 10 - SURE GRIP ALLIGATOR CLIPS . . . \$1
- 1 - GOLD GRILLE CLOTH 14" x 14" or 12" x 18" . . . \$1
- 5 - SETS SPEAKER PLUGS wired . . . \$1
- 10 - SETS PHONE PLUGS and PIN JACKS . . . \$1
- 2 - \$2.50 SAPPHIRE NEEDLES 10,000 playings . . . \$1
- 5 - DIODE CRYSTALS 2-IN21 2-IN22 1-IN261 . . . \$1
- 3 - DIODE CRYSTALS 1-IN60, 1-IN64, 1-IN69 . . . \$1
- 2 - SELENIUM RECTIFIERS 1-03ma & 1-150 ma \$1
- 15 - ASST. TV COILS sync, peaking, width, etc. \$1
- 5 - TV CRT. SOCKETS with 18" leads . . . \$1
- 5 - HI-VOLT. ANODE LEADS with 18" leads . . . \$1
- 10 - TV CARTWHEEL CONDENSERS 10kv . . . \$1
- 1 - LB. SPOOL ROSIN CORE SOLDER 40/60 . . . \$1
- \$15 - "JACKPOT" TELEVISION PARTS . . . \$15

HANDY WAY TO ORDER—Simply tear out advertisement and pencil mark items wanted (X in square is sufficient); enclose with money order or check. You will receive a new copy of this ad for re-orders.

ON SMALL ORDERS—Include stamps for postage, excess will be refunded. Larger orders shipped express collect.



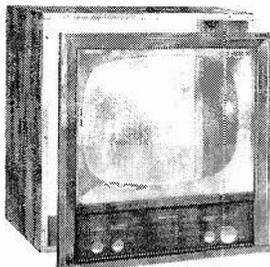
Dimensions 17 1/2" W x 16" D
Shipping weight 40 lbs.

BUILD YOUR OWN DX-16 TV CHASSIS

- ★ 70° or 90°—operating all 17", 21", 24" and 27" CRT's.
- ★ Produces a 16-Tube Chassis with 30-Tube performance.
- ★ Latest Intercarrier Circuitry and Multi-section Tubes.
- ★ Standard Neutrode Tuner for Selectivity & Fine Definition.
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- ★ 12" Speaker or Twin-cone 6" x 9" Speaker.
- ★ LIFE-SIZE step-by-step Building Instructions included.

COMPLETE KIT with Westinghouse Tubes \$93.49

4-6CB6, 6US, 6TS, 6C4, 12BH7, 6SN7, 6BD6, 6W4, 6K6, 1X21, 5U4, 6BN4, 6GC8, incl. in the Tuner (less CRT)



BUILD YOUR OWN CABINET FOR TV CHASSIS

Comparable to the type that Top Mfrs. use on high priced TV sets.

CABINET KIT with 90% of the job done, includes—
FRONT SECTION in Solid Mahogany, Walnut or Blond Korina. TOP, SIDES, BACK, MASK, SAFETY GLASS, ETC.
AND EASY-TO-FOLLOW ASSEMBLY INSTRUCTIONS

Front, Top and Sides supplied in a beautiful Piano Finish • Knob panel undrilled • For matching Mask specify type or number of CRT used. Same price—Mahogany, Walnut or Blond. (Shipping weight 36 lbs.)

21" CABINET KIT 26" H, 25" W, 22" D \$26.97

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Model M-1 Compact—only 4 3/4" x 3 3/8" x 1 1/8"

CHECKS: TV—RADIOS—TUBES—ELECTRICAL APPLIANCES
FUSES—BULBS—MOTORS—HOUSE WIRING—BELLS—ETC.

Plugs into any outlet . . . Checks quickly . . . Saves time & money . . . Every mechanic should own one.

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Special quantity price to Distributors, Dealers and Exporters

TUBULAR CONDENSERS—85°C TOP QUALITY—Equally as good for Radio or TV work

.0047-400v, .01-400v, .02-400v, .047-400v, .001-600v, .0047-600v, .01-600v, .02-600v, .03-600v 5¢ ea.
.1-400v, .25-400v, .47-400v, .047-600v, .1-600v, .25-600v, .001-1000v, .0047-1000v, .01-1000v, 8¢ ea.
.039-1000v, .047-1000v, .1-1000v, .007-1600v, .03-1600v, .05-1600v, .005-3000v, .001-6000v, 14¢ ea.

ELECTROLYTIC CONDENSERS—85°C 1-50v, 1-150v, 2-450v, 4-150v, 8-150v 19¢ ea.

20/20-150v, 50/30-150v, 40-150v, 10-450v, 20-450v, 30-450v, 40-450v, 60-450v, 80-450v 34¢ ea.

CARBON RESISTORS—Regular factory stock in Stackpole, I.R.C. Speer, etc.

1/2 WATT 10% 10, 39, 47, 100, 120, 150, 270, 330, 390, 470, 560, 680, 820, 1k, 1800Ω 2¢ ea.
1/2 WATT 10% 2700, 3300, 3900, 4700, 5600, 6800, 8200, 10k, 15k, 18k, 22k, 27k, 33kΩ 2¢ ea.
1/2 WATT 10% 39k, 47k, 50k, 56k, 68k, 82k, 100k, 120k, 150k, 180k, 220k, 270k, 330kΩ 2¢ ea.
1/2 WATT 10% 390k, 470k, 560k, 680k, 820kΩ 1, 1.2, 1.5, 2.2, 6.8, 10, 15 MEGΩ 2¢ ea.
1 WATT 10% 3.3, 10, 39, 100, 120, 150, 330, 470, 560, 680, 820, 1k, 1800, 2700, 4700Ω 3¢ ea.
1 WATT 10% 6800, 10k, 15k, 18k, 22k, 27k, 33k, 39k, 47k, 68k, 82k, 100k, 150k, 470k, 680kΩ 3¢ ea.
2 WATT 10% 18, 22, 82, 100, 180, 2200, 3900, 4700, 6800, 8200, 18k, 22k, 100k, 470kΩ 4¢ ea.

WIREWOUND RESISTORS 5-5w, 16-10w, 20-10w, 47-5w, 100-5w, 140-5w, 220-5w.16¢ ea.

280-10w, 390-5w, 470-5w, 500-10w, 680-10w, 820-5w, 1K-5w, 1K-10w, 1500-5w, 2K-10w 16¢ ea.
2500-5w, 3K-10w, 4700-5w, 5K-10w, 6K-10w, 7K-10w, 8200-5w, 10K-5w, 15K-5w, 22.5K-12w 16¢ ea.

CERAMIC CONDENSERS 1, 2, 3, 5, 6, 10, 22, 25, 47, 50, 51, 56, 82, 100, 120, 150 mmf 3¢ ea.

CERAMIC CONDENSERS 220, 250, 270, 330, 470, 1k, 1200, 1500, 2k, 5k, 6800, 10k mmf 3¢ ea.

MICA CONDENSERS 5, 25, 50, 60, 68, 75, 100, 120, 150, 220, 270, 330, 470, 510 mmf 3¢ ea.

MICA CONDENSERS 560, 680, 820, 1k, 1500, 2k, 2500, 3300, 4700, 6k, 6800, 8k, 10k mmf 3¢ ea.

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- ★ 3 TRANSMITTERS
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- ★ AMPLIFIER
- ★ SIGNAL TRACER
- ★ SIGNAL INJECTOR
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- ★ No Knowledge of Radio Necessary
- ★ No Additional Parts or Tools needed
- ★ Excellent Background for TV
- ★ School Inquiries Invited
- ★ Attractively Gift Packed

FREE EXTRAS

- SET OF TOOLS • RADIO & ELECTRONICS TESTER • ELECTRIC SOLDERING IRON • TESTER INSTRUCTION MANUAL • MEMBERSHIP IN RADIO-TV CLUB • CONSULTATION SERVICE • HI-FI GUIDE
- QUIZZES • TV BOOK • FCC AMATEUR LICENSE TRAINING
- RADIO BOOK • PRINTED CIRCUITRY • PLIERS-CUTTERS
- ALIGNMENT TOOL • WRENCH SET • CERTIFICATE OF MERIT
- VALUABLE DISCOUNT CARD

WHAT THE "EDU-KIT" OFFERS YOU

The "Edu-Kit" offers you an outstanding PRACTICAL HOME RADIO COURSE at a rock-bottom price. Our kit is designed to train Radio & Electronics Technicians, making use of the most modern methods of home training. You will learn radio theory, construction, servicing, basic Hi-Fi and TV repairs, code, FCC amateur license requirements.

You will learn how to identify radio symbols, how to read and interpret schematics, how to mount and layout radio parts, how to wire and solder, how to operate electronic equipment, how to build radios. Today it is no longer necessary to spend hundreds of dollars for a radio course. You will receive a basic education in radio, worth many times the small price you pay, only \$26.95 complete.

THE KIT FOR EVERYONE

The Progressive Radio "Edu-Kit" was specifically prepared for any person who has a desire to learn Radio. The "Edu-Kit" has been used successfully by young and old in all parts of the world, by many Radio Schools and Clubs in this country and abroad. It is used for training and rehabilitation of Armed Forces Personnel and Veterans throughout the world.

The Progressive Radio "Edu-Kit" requires no instructor. All instructions are included. Every step is carefully explained. You cannot make a mistake.

PROGRESSIVE TEACHING METHOD

The Progressive "Edu-Kit" is the foremost educational radio kit in the world, and is universally accepted as the standard in the field of electronics training. The "Edu-Kit" uses the modern educational principle of "Learn by Doing." Therefore, you will construct radio circuits, perform jobs and conduct experiments to illustrate the principles which you learn.

You begin by examining the various radio parts included in the "Edu-Kit." You then learn the function, theory and wiring of these parts. Then you build a simple radio. With this first set, you will enjoy listening to regular broadcast stations, learn theory, practice testing and troubleshooting. Then you build a more advanced radio, learn more advanced theory and techniques. Gradually, in a progressive manner, and at your own rate, you will find yourself constructing more advanced multi-tube radio circuits, and doing work like a professional Radio Technician.

Included in the "Edu-Kit" course are twenty Receiver, Transmitter, Code Oscillator, Signal Tracer, Signal Injector, Square Wave Generator and Amplifier circuits. These are not unprofessional "breadboard" experiments, but genuine radio circuits, constructed by means of professional wiring and soldering on metal chassis, plus the new method of radio construction known as "Printed Circuitry." These circuits operate on your regular AC or DC house current.

In order to provide a thorough, well-integrated and easily-learned radio course, the "Edu-Kit" includes practical work as well as theoretical troubleshooting in addition to construction; training for all, whether your purpose in learning radio be for hobby, business or job; progressively-arranged material, ranging from simple circuits to well-advanced in Hi-Fi and TV. Your studies will be further aided by Quiz materials and our well-known FREE Consultation Service.

THE "EDU-KIT" IS COMPLETE

You will receive all parts and instructions necessary to build 20 different radio and electronics circuits, each guaranteed to operate. Our Kits contain tubes, tube sockets, variable, electrolytic, mica, ceramic and paper dielectric condensers, resistors, tie strips, coils, hardware, tubing, punched metal chassis, Instruction Manuals, hookup wire, solder, selenium rectifiers, volume controls and switches.

In addition, you receive Printed Circuit materials, including Printed Circuit chassis, special tube sockets, hardware and instructions. You also receive a useful set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio & Electronics Tester. The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator, in addition to the F.C.C.-type Questions and Answers for Radio Amateur License training. You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector, and a High Fidelity Guide Quiz Book. Everything is yours to keep.

J. Statistis, of 25 Poplar Pl., Waterbury, Conn., writes: "I have repaired several sets for my friends, and made money. The "Edu-Kit" paid for itself, I was ready to spend \$240 for a course, but I found your ad and sent for your Kit."

UNCONDITIONAL MONEY-BACK GUARANTEE

The Progressive Radio "Edu-Kit" has been sold to many thousands of individuals, schools and organizations, public and private, throughout the world. It is recognized internationally as the ideal radio course.

By popular demand the Progressive Radio "Edu-Kit" is now available in Spanish as well as English.

It is understood and agreed that should the Progressive Radio "Edu-Kit" be returned to Progressive "Edu-Kits" Inc., for any reason whatever, the purchase price will be refunded in full, without quibble or question, and without delay.

The high recognition which Progressive "Edu-Kits" Inc., has earned through its many years of service to the public is due to its unconditional insistence upon the maintenance of perfect engineering, the highest instructional standards, and 100% adherence to its Unconditional Money-Back Guarantee. As a result, we do not have a single dissatisfied customer throughout the entire world.

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- Send me FREE additional information describing "Edu-Kit."

Name.....

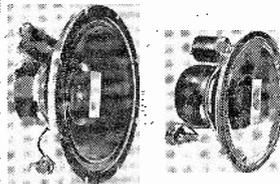
Address.....

Progressive "EDU-KITS" Inc.

1186 Broadway, Dept. 163-G
Hewlett, N. Y.

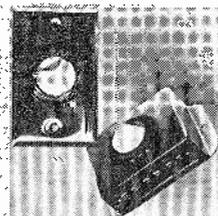
NEW PRODUCTS (Continued)

TWO-WAY SPEAKER made in Britain. Horn tweeter, mid-range radiator and L-pad high-frequency control. 12-inch model *KN-812A* with 3½-lb magnet,



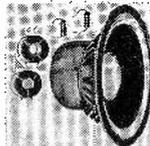
30 to 20,000 cycles. 15-inch model *KN-815A* with 6¼-lb magnet, 20 to 20,000 cycles.—Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.

SPEAKER-SELECTOR switch, stereo or monophonic, has circuitry that matches impedances. Stereo control No. 30-388 is wall-plate



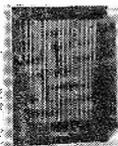
type, also monophonic types, wall-plate or surface mounting. Housings brushed brass.—Audiotex Mfg. Co., Dept. FR, 3225 Exposition Pl., Los Angeles, Calif.

DUAL VOICE-COIL stereo woofers for 3-channel system. 8-inch *SK-139* and 12-inch *SK-133* both have 2-inch voice coils, 2-lb magnets. 350-cycle crossover network *KT-161* lets you



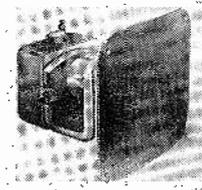
combine bass from 2 channels in 1 woofer.—Lafayette Radio, 165-08 Liberty, Jamaica 33, N. Y.

LOUDSPEAKER SYSTEM designed for corner placement can also be used in non-corner locations. *Cornwall* system has 3



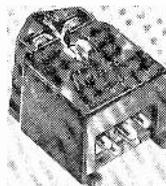
drivers. Occupies 7 cubic feet. Smooth bass response to 35 cycles. Useful as second- or third-channel speaker in stereo systems.—Klipsch and Assoc., Inc., Hope, Ark.

CONE TWEETER No. A35T. Response 3,000 to 18,000 cycles. Having sealed acoustic rear chamber, this direct radiator requires no horn. Built-in 4-μf



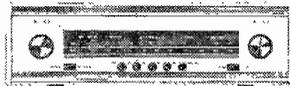
capacitor, 2.5-oz magnet housed in heavy yoke. No other network components necessary. Power capacity 25 watts.—Audax, Inc., Div. of Rek-O-Kut Co., Inc., 38-19 108th St., Corona 68, N. Y.

MAGNETIC STEREO CARTRIDGE. Extremely high vertical compliance and high output (30 mv per channel). Model *AG3400*: flat response from 50 to



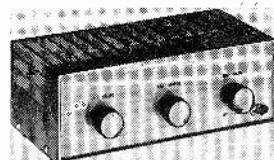
18,000 cycles. Stylus pressure 3 to 5 grams. Mu-metal shielded throughout. Channel separation better than 22 db at 1,000 cycles.—North American Philips Co., High Fidelity Products Div., 230 Duffy, Hicksville, N. Y.

STEREO TUNER. Separate FM—AM reception and adapter for FM multiplex. Model *S-2200* has 2 tuning indicator lights to insure accurate tuning. High-Q



bridged-T whistle filter for AM, 0.95-μv sensitivity for 20-db quieting of FM. Interchannel hush (squelch) eliminates "hash" between FM stations.—Sherwood Electronic Laboratories, Inc., 4300 N. California Ave., Chicago 18, Ill.

STEREO AMPLIFIER model AM-150. Response 50 to 12,000 cycles. 6 tubes, ac-dc circuit. Dual 8-ohm output, for use with



high-output crystal or ceramic stereo cartridge. 3 controls, sand-gold finish with contrasting black.—Olson Radio Corp., 260 S. Forge St., Akron 8, Ohio.

MATCHED MICROPHONES for stereo taping in 2 types. Paired *Ceramikes* acoustically matched within 2 db, 1-piece die-cast metal case contains



rugged rubber-encased ceramic transducer. *CM-T10*: 50-13,000-cycle response at -62-db level. More sensitive *CM-T11*: response 50-8,000 cycles at -55 db. Table stands are also available.—Sonotone Corp., Elmsford, N. Y. END

All specifications on these pages from manufacturers' data.

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—	1AX2	.62	—	4BZ7	.96	—	6BC7	.94	—	6K6	.58	—	12A27	.86	—	12U7	.62
—	1B3GT	.79	—	4CB6	.59	—	6BC8	.97	—	6S4	.48	—	12B4	.63	—	12V6GT	.53
—	1DN5	.55	—	4CS6	.61	—	6BD6	.51	—	6SA7GT	.76	—	12BA6	.50	—	12W6	.69
—	1G3	.73	—	4DE6	.62	—	6BE6	.55	—	6SK7GT	.74	—	12BD6	.50	—	12X4	.38
—	1J3	.73	—	4DK6	.60	—	6BF6	.44	—	6SL7	.80	—	12BE6	.53	—	17AX4	.67
—	1K3	.73	—	4DT6	.55	—	6BG6	1.66	—	6SN7	.65	—	12BF6	.44	—	17BQ6	1.09
—	1L6	1.05	—	5AM8	.79	—	6BH6	.65	—	6SQ7	.73	—	12BH7	.73	—	17C5	.58
—	1LA6	.69	—	5AN8	.86	—	6BH8	.87	—	6T4	.99	—	12BK5	.70	—	17CA5	.62
—	1LC6	.79	—	5AQ5	.52	—	6BJ6	.62	—	6T8	.80	—	12BL6	.56	—	17D4	.69
—	1LN5	.59	—	5AT8	.80	—	6BK5	.80	—	6U8	.78	—	12BQ6	1.06	—	17DQ6	1.06
—	1R5	.62	—	5BK7A	.82	—	6BK7	.85	—	6V6GT	.94	—	12BY7	.74	—	17L6	.58
—	1S5	.51	—	5BQ7	.97	—	6BL7	1.00	—	6W4	.57	—	12BZ7	.75	—	17W6	.70
—	1T4	.58	—	5BR8	.79	—	6BN4	.57	—	6W6	.69	—	12C5	.56	—	19AU4	.83
—	1U4	.57	—	5CG8	.76	—	6BN6	.74	—	6X4	.39	—	12CA5	.59	—	19BQ6	1.39
—	1U5	.50	—	5CL8	.76	—	6BQ5	.65	—	6X5GT	.53	—	12CN5	.56	—	19T8	.80
—	1X2B	.82	—	5EA8	.80	—	6BQ6GT	1.05	—	6X8	.77	—	12CR6	.54	—	21EX6	1.49
—	2AF4	.96	—	5EU8	.80	—	6BQ7	.95	—	7AU7	.61	—	12CU5	.58	—	25AU4	.87
—	2BN4	.60	—	5J6	.68	—	6BR8	.78	—	7A8	.58	—	12CU6	1.06	—	25BQ6	1.11
—	2CY5	.71	—	5T8	.81	—	6BS8	.90	—	7B6	.69	—	12CX6	.54	—	25C5	.53
—	3AL5	.42	—	5U4	.60	—	6BU8	.70	—	7Y4	.69	—	12DB5	.69	—	25CA5	.59
—	3AU6	.51	—	5U8	.81	—	6BY6	.54	—	8AU8	.83	—	12DE8	.75	—	25CD6	1.44
—	3AV6	.41	—	5V6	.56	—	6BZ6	.54	—	8AW8	.93	—	12DL8	.85	—	25CU6	1.11
—	3BA6	.51	—	5X8	.78	—	6BZ7	.97	—	8BQ5	.60	—	12DM7	.67	—	25DN6	1.42
—	3BC5	.54	—	5Y3	.46	—	6C4	.43	—	8CG7	.62	—	12DQ6	1.04	—	25EH5	.55
—	3BE6	.52	—	6AB4	.46	—	6CB6	.54	—	8CM7	.68	—	12D57	.79	—	25L6	.57
—	3BN4	.63	—	6AC7	.96	—	6CD6	1.42	—	8CN7	.97	—	12DZ6	.56	—	25W4	.68
—	3BN6	.76	—	6AF3	.73	—	6CF6	.64	—	8CX8	.93	—	12EL6	.50	—	25Z6	.66
—	3BU8	.78	—	6AF4	.97	—	6CG7	.60	—	8EB8	.94	—	12EG6	.54	—	35C5	.51
—	3BY6	.55	—	6AG5	.65	—	6CG8	.77	—	10DA7	.71	—	12EK6	.56	—	35L6	.57
—	3BZ6	.55	—	6AH6	.99	—	6CM7	.66	—	11CY7	.75	—	12EZ6	.53	—	35W4	.52
—	3CB6	.54	—	6AK5	.95	—	6CN7	.65	—	12A4	.60	—	12F5	.66	—	35Z6GT	.60
—	3CF6	.60	—	6AL5	.47	—	6CR6	.51	—	12AB5	.55	—	12F8	.66	—	50R5	.60
—	3CS6	.52	—	6AM8	.78	—	6CS6	.57	—	12AC6	.49	—	12FM6	.45	—	50C5	.53
—	3CY5	.71	—	6AN4	.95	—	6CU5	.58	—	12AD6	.57	—	12K5	.65	—	50DC4	.37
—	3DE6	.62	—	6AN8	.85	—	6CU6	1.08	—	12AE6	.43	—	12SA7M	.86	—	50EH5	.55
—	3DK6	.60	—	6AQ5	.50	—	6CY5	.70	—	12AF3	.73	—	12SK7GT	.74	—	50L6	.61
—	3DT6	.50	—	6AR5	.55	—	6CY7	.71	—	12AF6	.49	—	12SN7	.67	—	117Z3	.61
—	3Q5	.80	—	6AS5	.60	—	6DA4	.68	—	12AJ6	.46	—			—		
—	3S4	.61	—	6AT6	.43	—	6DB5	.69	—	12AL5	.45	—			—		
—	3V4	.58	—	6AT8	.79	—	6DE6	.58	—	12AL8	.95	—			—		
—	4AU6	.54	—	6AU4	.82	—	6DG6	.59	—	12AQ5	.52	—			—		
—	4BA6	.51	—	6AU6	.50	—	6DQ6	1.10	—	12AT6	.43	—			—		
—	4BC5	.56	—	6AU7	.61	—	6DT5	.76	—	12AT7	.76	—			—		
—	4BC8	.96	—	6AU8	.87	—	6DT6	.53	—	12AU6	.50	—			—		
—	4BE6	.54	—	6AV6	.40	—	6EU8	.79	—	12AV7	.60	—			—		
—	4BN6	.75	—	6AW8	.89	—	6EA8	.79	—	12AV5	.97	—			—		
—	4BQ7	.96	—	6AX4	.65	—	6EB8	.94	—	12AV6	.41	—			—		
—	4BS8	.98	—	6AX7	.64	—	6BGT	.58	—	12AV7	.75	—			—		
—	4BU8	.71	—	6BA6	.49	—	6J5GT	.51	—	12AX4	.67	—			—		

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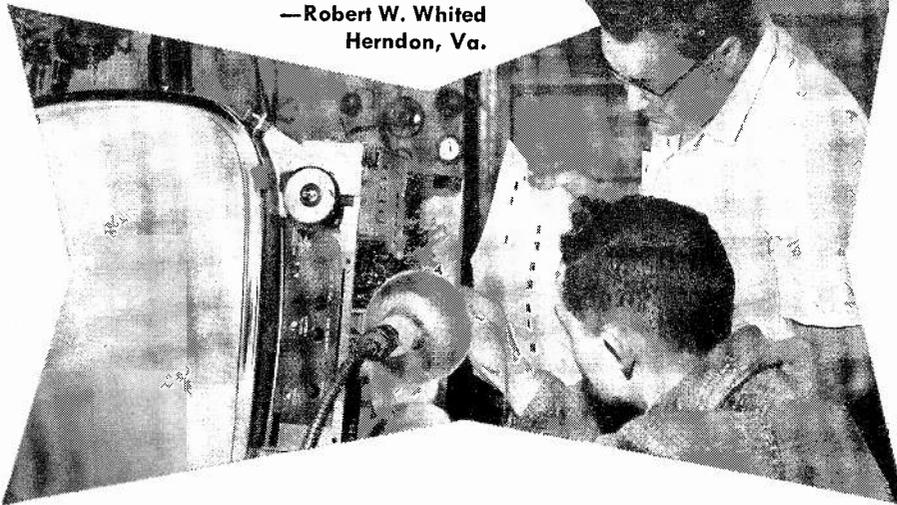
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TECHNICIANS'

NEWS

AGAINST FACTORY SERVICE

The National Appliance & Radio-TV Dealers (NARDA) is against factory service, according to the Television Service Association of Michigan. The Executive Committee of NARDA says "the members feel that such a policy deprives the consuming public of the right of free choice of agencies to service its appliances and may tend to create a monopoly."

Frank J. Moch, executive director for the National Alliance of TV & Electronic Service Associations, warns technicians that company service warranties are a serious threat to their businesses. Several manufacturers, according to Moch, stated that competition will probably force them to include service warranties with their sets. He urges all technicians to "among other things write to their Senators and Representatives demanding legislation to prevent factories from killing off independent service."

SALES TAX INVESTIGATION

The *Vanguard*, official publication of the Tri-State Council of TV Service Associations (Pennsylvania, Delaware, New Jersey), reports that 37 names were submitted to the State Sales Tax Department of Pennsylvania for investigation. The state has a law that requires retailers to collect sales tax on TV servicing. The Pennsylvania association asked their members to submit the names of any "illegitimates" who were doing business without paying taxes to the Tax Department.

NO LAW BROKEN?

An Alexandria, Va., judge dismissed fraud charges against the owner of a service shop who charged a policeman \$37.20 for a new fuse and tube. The owner of a nearby service shop said he charges \$2.10 for the tube and 20c for the fuse. The judge said:

"I don't think any law has been broken. It's a sickening story that people can be fleeced like this. A dirtier trick I've never heard of. It's a shame something can't be done to break it up."

TV SAFETY GROUP

The Empire State Federation of Electronic Technicians associations has created a committee to investigate safety problems in modern TV receivers. Designating the program "Operation TV Safety," ESFETA asks that technicians:

Keep children and customers at a safe distance while servicing sets.

Do not defeat electrical interlocks.
Replace cabinet back after servicing.

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Check antenna installations for dangers such as grounding, nearness to power lines and rusted or improper mounting.

Check potential between metal cabinets and ground for dangerous voltages.

Watch out for shock hazards.

Why Aren't You on the List?

RADIO-ELECTRONICS is publishing a list of all of the known television service associations in North America. Every now and then some association will write in and ask us why it has not been listed. We can list you only if we know about you. We have had difficulty in getting the names and addresses of associations. In spite of numerous letters, we have not been able to get any information from a number of states known to have service organizations. These include Arkansas, Connecticut, Florida, Minnesota, Missouri, New Hampshire, Oklahoma, Rhode Island and Texas. Word from these states is anxiously awaited.

If your association has not been listed or if you know of any that have not been listed, let us know about it. Send a postcard with the name and address of president or secretary to: Associations Editor, RADIO-ELECTRONICS, 154 W. 14 St., New York 11, N. Y.

MASSACHUSETTS

ELECTRONIC TECHNICIANS GUILD OF MASSACHUSETTS (ETG)

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Newtonville 60, Mass.

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Woburn

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ASSOCIATION OF PITTSBURGH

Tom Ging, Secretary

3239 Ashlyn Avenue

Pittsburgh 4, Pa.

ETG ON TV?

The Electronic Technicians Guild of Mass., Boston Chapter, announces a tentative plan to appear on WHDH-TV's Dateline Boston program (channel 5) about the first week in June. It will be a demonstration type program featuring TV service techniques and tips.

ACTRA OFFICERS

The Alameda County Television & Radio Association installed officers for 1960. They are: Claire W. Lanam, president; Stephen L. Strong, first vice president; Frank Lozano, second vice

president; John A. Edwards, treasurer; Melvin J. Dumolt, representative to the California State Electronics Association. Directors are Lewis E. Hall, Roy E. Brown, L. M. Bacon, Allan Crawford, William R. Howard, Roy Pine, Norman W. James, Hal McGee, Milton M. Siegel, Sam Ditto and Dick Soone.

FTRSA ELECTS OFFICERS

The Federation of Television-Radio Service Associations of Pennsylvania Inc. elected and installed its 1960 officers: Wayne E. Prather, president; Charles Ross, vice president; John Ruch, recording secretary; L. B. Smith, financial secretary; Leon J. Helk, corresponding secretary.

RATE INCREASE

Service shops in the Santa Clara area plan to raise their rates as much as 15%. Russell J. Hamm, president of the Radio-TV Association of Santa Clara Valley (Calif.) said that rates in the San Francisco area were about 15% higher than the Santa Clara area. Mr. Hamm said that the increased time spent on servicing printed circuits and the \$3-an-hour wage rate make the change necessary.

LICENSE COMMISSION

A Board of Commissioners was appointed to administer the Kansas City Television and Electronics Service License Ordinance. The men appointed are: C. L. Foster, Avery Fouts, Don Ellis, Don Day and John Gardner. All five are connected with electronics, three being active members of the servicing industry.

The commission has to examine and license all men who service or expect to service television or related electronic equipment.

TUBE-CHECKER PROBLEMS?

TSA (Iowa) Beacon advises, "Don't look for any immediate solution to the tube-checker problem. Do keep your eyes and ears open and if you see a tester (in a drugstore) in your area, see what brand of tubes he is selling.

"Find out if the customer can return a tube if it does not help the trouble. Keep track of the operation to see if it is legitimate. If off-brand tubes are sold, report it to your NATESA director. NATESA has a wad of information on these things and the picture is starting to clear up."

ARTSNY ENCOURAGES WIVES

The Associated Radio-Television Servicemen of New York (City) featured a novel event at their recent annual dinner dance and installation of officers. A beautiful jewel box was presented to Mollie Goldfarb, wife of Phil Goldfarb, treasurer and long-time active member, and to Elsie La Presti, wife of Peter La Presti who during the past year was corresponding secretary. The presentation was in appre-

IMPORTANT NEW SAMS BOOKS



"101 More Ways to Use Your Scope in TV"



Here is the sequel to Bob Middleton's first book on the subject, prompted by the insistent demand of readers for still more of the unique and practical help found in the popular "101 Ways" series. This working guidebook for the service technician or for any scope user, stresses the proper interpretation of observed waveforms. Specifies equipment needed, connections required, procedure and evaluation of results for each use. Special notes supplement the uses described. Profusely illustrated. \$2.50

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This book derives from the author's own experiences in helping his teenage son understand this fascinating subject and rewarding hobby. (Jay Stanley, the writer, is a frequent contributor to leading electronics magazines.) Profusely illustrated, the book includes 15 chapters which progressively introduce the newcomer to the basic fundamentals of constructing electronic devices, such as a "one-hour radio," a pocket radio, a home broadcaster, short-wave tuner, etc. The book is unique in that all the projects described make use of transistors rather than vacuum tubes. This is without doubt the most readable, up-to-date and best book of its type available. 192 pages; 5 1/2 x 8 1/2", hard-bound. \$3.95



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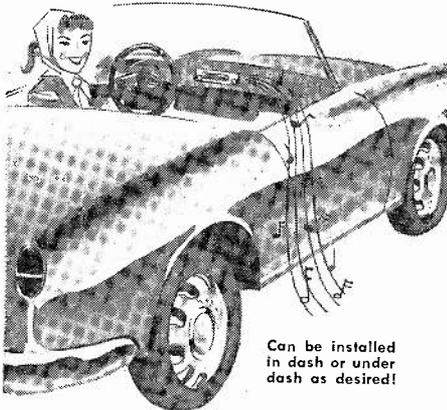
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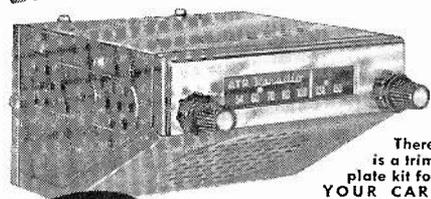
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ARTSNY president Ed Eisen presents jewel cases to Mrs. La Presti (left) and Mrs. Goldfarb, in recognition of their services to the Association.

of their assistance to and encouragement of their husbands in association work.

The affair, held in Brooklyn's Farragut Inn, was well attended, nearly 40 persons being present. There was no formal program—though short addresses were made by some of the officials—and social activities were carried on till after 1 a.m.

BBB TO CHECK

Aaron A. Knopf, general chairman

of the organizing committee of the Long Island Better Business Bureau, reports that a special effort will be made during the coming year to improve advertising and selling practices among television sales and servicing firms in Nassau and Suffolk counties (New York), according to *Guild News* of the Radio Television Guild of Long Island. A considerable number of complaints were made last year to local district attorneys and the New York City Better Business Bureau the *Guild News* states. The Long Island BBB will distribute pamphlets designed to educate the public about industry practice, and make daily checks on advertising and selling practices in an attempt to stamp out unfair competitive tactics.

GROUP LISTS WHOLESALERS

The *Newsletter* of the Independent TV Service Dealers Association of Los Angeles County is listing "ITVSDA-Approved Jobbers"—"These wholesalers have given ITVSDA assurance in writing that they do not make a practice of selling to anyone other than holders of valid resale permits and industrial accounts." Jobbers who follow such a policy are urged to send the Association a letter to that effect so that his name can be added to this list. The names will continue to be listed in each issue, pending verified complaints against anyone so listed. **END**

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- TUBE SPECIALS: 3BP1 with matching socket @ \$1.50 for both tube & socket, 2G1 Ray, or K-1AN BX \$1.20. 6198 Vidicon tube @ \$85.00.
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 - 141-12 (1/4" x 1200') 7" Reel size @ \$2.95.
 - 140-9 (1/4" x 900') 5" Reel size @ \$2.50.
 - 140-18 (1/4" x 1800') 7" Reel size @ \$4.25.
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- Professional Closed-Circuit TV Cameras. For homes, schools, banks, industry, etc. approx. \$700.00 (brochure avail.). New factory stock.
- RCA Remote TV Control—For comfort & convenience (controls volume & picture. For 1965 & earlier R2A TV sets. Only \$13.95 w/manual). List avail. of sets and will accommodate.
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- Battery for above xmtr. Furnishes 300 VDC plate & 6.3 VDC filament. Submersible type. \$4.95.
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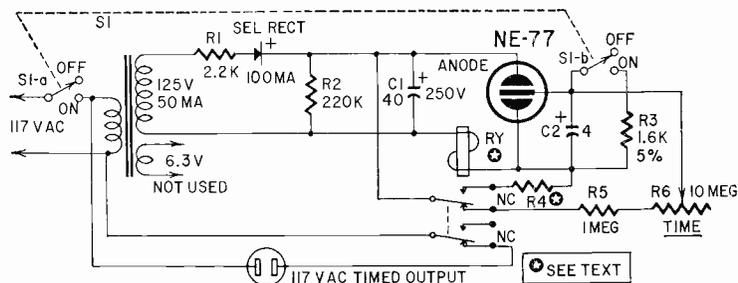
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The NE-77 is a three-electrode neon lamp that acts like a cold-cathode thyratron. (See "New Neon Bulb Acts Like

a Thyratron," RADIO-ELECTRONICS, October, 1958.) The red dot on its tiny glass envelope identifies its anode.

The values for C2 and R6 may be any combination that will allow the maximum timing period desired. Those shown in the diagram allow a timing period ranging from 4 to 40 seconds.

A comparatively inexpensive relay that works very well in this circuit is a Potter & Brumfield 24-volt DC DPDT type GA11D, but almost any relay may be used that has DPDT contacts and a coil resistance of 200 ohms or more.

Resistor R4's value depends on the relay used and should pass a current equal to approximately 30% of the relay operating current. The wattage of R1 and R4 depends on the amount of

relay hold current used. All other resistors are 1/2 watt.

To operate the timer, turn TIME con-

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- HI-FI
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Completely self-contained:

- Uses One Pen-lite Battery
- Transistor Powered
- Inductive Sensitivity Couples to circuits without leads
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THE NEW MOSQUITO Pat. Applied For TRANSISTORIZED SIGNAL INJECTOR

Pen size, precision instrument, weighs only one ounce. Ideal for electronic servicing and testing. Used by engineers, technicians and service men for rapid signal substitution in development work and trouble shooting. Order through your distributor or use handy coupon below for immediate delivery.

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Six Months Guarantee!! No Rejects!
NEW & Used Gov't & Mfgs. Surplus!**

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0A2	.80	6B16	.09	12AT6	.59	18B5	1.00
0B2	.63	6BK7	.12	12BE6	.59	18D26	1.10
0C3	.69	6BL7	1.25	12AU6	.69	4-65A	16.00
0D3	.53	6BN6	.08	12AU7	.69	2D21	2/81
0Z4	.61	6CQ7	.12	12BE7	.73	2D22	2/85
1A7	.89	6BZ7	1.25	12BA6	.65	717A	5/81
1B3	.78	6C4	.43	12BA7	.99	4-125	29.00
1R5	.78	6C5	.69	12BE5	.59	250	35.00
1S4	.78	6CB6	.69	12BE6	.59	4E27	7.00
1T4	.78	6CB6	1.49	12BF6	.59	4PR60	29.50

Send \$5 for Catalog!

1U4	3/51	6H6	3/81	12BH6	.99	4X150G	\$15
1U5	.73	6J5	.52	12BY7	.98	4X250	35.00
3Q4	.98	6J6	.48	12BZ7	.99	4X500	38.00
3Q5	.61	6K6	.59	12CU6	1.45	5BP4	4.98
1K2	.86	6K7	.39	12DA7	.94	5BP4	4.98
3S4	.68	6L6	1.19	12SC7	.89	35T	4.00
3V4	.83	6S5	.59	12SH7	.89	100T	7.00
5R4	.98	6S8	.99	12SJ7	.75	316A	5/81
5U4	.99	6SA7	.69	12SK7	.94	388A	3/81
5V4	.89	6SB7	1.19	12SQ7	.84	416B	16.00

Wanted Surplus Electronics from schools & Gov't

5Y3	.59	6SC7	.89	198G6	2.14	80T	42.00
6B4	.59	6SG7	.79	1978	1.16	807	1.00
6AC7	.70	6SH7	.69	25BQ6	1.39	809	3.00
6AC7	.70	6SK7	.89	25C6	1.45	81A	4.00
6AH6	.99	6SW7	.72	25V4	.77	812	3.00
6AK5	.69	6SL7	.89	25Z5	.63	813	9.00
6AL5	2/8	6SN7	2/81	25L6	3.75	814	3.45
6AQ5	.63	6SQ7	.71	EL34	3.43	815	2/75
6AS7	3.00	6SR7	.79	EL37	2.49	826	.59
6AT6	.47	6T8	.98	35L6	.69	8298	8.00

Wanted: 500 Tubes Top \$\$\$

6AU4	1.10	608	.98	35W4	.49	832A	7.00
6AU5	1.19	6V6GT	.70	35Y4	.69	866A	2.75
6AU6	.69	6W4	.79	35Z5	.63	1625	5/81
6AX4	.79	6W6	.89	50AS	.69	1615	4.00
6BA6	.59	6X4	2/81	50B5	.69	5879	.98
6BA7	1.00	6X5	.49	50C5	.69	5881	2.70
6BD6	.59	6Y6	.69	50L6	.69	5505	3.50
6BE6	.59	7N7	.89	KT66	3.29	5654	1.00
6BG6	1.50	12AL5	.59	75	.89	5894	12.00
6EH6	.71	12AQ5	.75	80	.59	7193	10/81

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FULL WAVE BRIDGE RECTIFIERS. ONE YEAR GTD!

AMP.	18VAC	36VAC	72VAC	144VAC
CONT.	14VDC	28VDC	56VDC	112VDC

1AMP	\$ 1.30	\$ 2.00	\$ 4.90	\$ 9.45
2AMP	2.15	3.00	6.25	12.30
3AMP	3.00	4.00	8.60	16.75
6AMP	4.15	6.00	11.75	23.10
10AMP	6.10	12.15	26.30	48.90
15AMP	9.30	19.00	40.00	66.60
24AMP	15.00	29.45	57.50	108.45



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All Kits Contain Most Popular Values & Sizes

Kit 2 Eng. Parallel Rules	Kit 5 Sub-Min Tubes
Kit 35 Precision Resistors	Kit 40 Standoff Insulator
Kit 10 Switches	Kit 35 Power Resistors
Kit 75 Resistors 1/2 1/2W	Kit 75 Mica Condensers
Kit 150 Carbon Resistors	Kit 5 Crystal Diodes
Kit 25 Panel Lamps	Kit 100 Ceramic Cond.
Kit 12 Electrolytic Cond's	Kit 10 Germanium Diodes
Kit 56 Tube Sockets	Kit 5 FTZ3 Xtal Holders
Kit 65 Tubular Cond'sers	Kit 8 Silicon Diodes
Kit 500 Lugs & Eyelets	Kit 5 Microswitches
Kit 10 Bathub Oil Cond's	Kit 4 Ass'd Rectifiers
Kit 5 lbs. Surprise Pkgs.	Kit 2 PNP Transistors
Kit 10 Xmttr Mica Cond's.	Kit 4x50 Ft Hookup Wire
Kit 3 Phone/Patch Xfms	Kit 2 Veeeder Counters
Kit 3 Searchlights	Kit 2 Computer Toroids
Kit Circular Slide Rule	Kit High Gain XTAL Mike
Kit 12 Algtr Clip Asst'd.	

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NEW SILICON 500MA RECTIFIERS

GENERAL PURPOSE 400 PIV at 250 MA
SPECIAL 2 FOR \$1 25 FOR \$10

rms/piv	rms/piv	rms/piv	rms/piv
35/50	70/100	140/200	210/300
30c	45c	50c	65c

rms/piv	rms/piv	rms/piv	rms/piv
280/400	350/500	420/600	490/700
78c	\$1.00	\$1.26	\$1.50

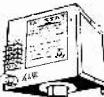
rms/piv	rms/piv	rms/piv	rms/piv
560/800	630/900	700/1000	770/1100
\$1.59	\$1.89	\$2.58	\$3.12

Use in F.W. Bridge or F.W.C.T. up to 750ma or 27 Pins for 1.5A. (\$5 or more we pay postage 48 states.)

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"TABSTAT" KIT or BUILT!

Output 450 & TAP 250VDC at up to 150 MA/Up to 70 Watts 60% efficiency; ripple 0.2%; low idle current one amp silicon rectifiers, oil condensers, toroid frame, fused & short-circuit proof. Regulation 3% at 20 100% load! Small in Size! Quiet! Light wgt! Low priced qtd "TABSTAT" TR1243CB built \$38. Pre-Assembled U-Built Kit TR1243CB only \$23. "TABSTAT" 250VDC @ 100MA/12V in TR1243CB \$30. Kit TR1243CK \$27. 6V Inpt TR6125CB \$30. Kit TR625CK \$27.



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XMITTING MICAS (006 @ 250VDC) 5 for \$1
DC METER 4" ROUND 0-1MA \$5 @ 2 for \$8
CO-AX CNECTRS PL259A 45c @ 3 for \$2
HYV DTY 115V/60CY SECTNS TWO for \$5
DC METER 500MA/3" RD SPECIAL \$49.00
TS31AP WE/USN SCOPE L/N \$13 SOCKET \$1.00
\$29B SOCKET 95c
NEW VARIAC or EQUAL 0-135V/7.5A \$15.30
NEW VARIAC or EQUAL 0-135V/3A \$10.65

NEW Selenium Radio & TV Rectifiers! GTD.

65ma 45c @ 6 for \$2; 100ma 45 @ 12/\$5;
250Ma 65c @ 10/\$6; 300Ma 88c @ 10/\$8;
500Ma \$1 @ 10/\$8; 25/\$18

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Send 25c PHONE: RECTOR 2-6245 for Catalog

NOTEWORTHY CIRCUITS (Continued)

trol R6 to the desired time and throw S1 to ON. This slowly allows capacitor C2 to charge. The speed at which this charging takes place depends on the setting of R6. When the voltage across C2 reaches the triggering voltage of the NE-77, the lamp fires, causing C1 to discharge through the relay. The relay closes, disconnecting the 117-volt line from the output receptacle, at the same time closing the normally open contacts that connect the holding current to the relay. Throwing S1 to off lets the relay return to its normal state and at the same time places R3 across capacitor C2, insuring its complete discharge. This sets up the timer for the next timing period.—James Martin

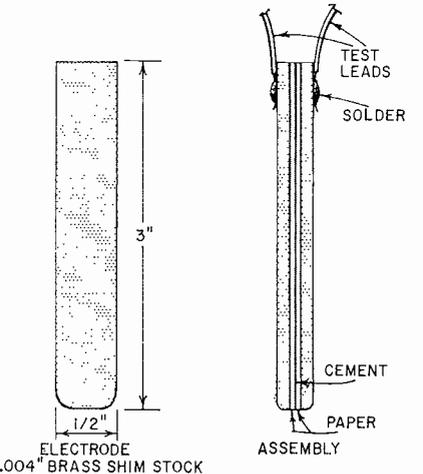
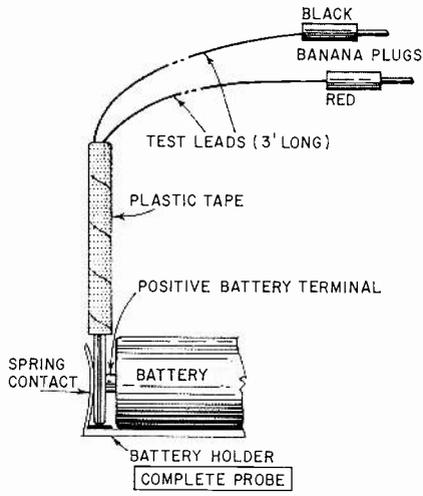
BATTERY-CURRENT PROBE

Measuring battery current drain in transistor portable radios is a simple but effective way to detect abnormally high- or low-resistance paths in the circuitry. If the normal operating battery drain is known, and the measured current is higher or lower than this value,

This handy battery-current probe has been a time and temper saver for this test. It slips easily between the battery and the contact of the battery holder or between batteries in series. This eliminates removing batteries and frustrating attempts to connect test leads to them. The test may be made as easily as a voltage measurement, without disconnecting any receiver circuits.

The probe consists of two thin metal plates, electrically insulated and connected to the input of a suitable milliammeter or multimeter by convenient lengths of test lead.

The electrodes are cut from 4-mil brass shim stock and tin-dipped. Test leads are soldered to one end of each plate. The other ends of the test leads are terminated with banana plugs. The brass plates are insulated with paper and cemented together with epoxy resin. The positive electrode is identified by a dab of red paint. The upper end of the probe was wrapped with enough plastic electrical tape to make a comfortable handle.—Dale F. Betz END



50 Years Ago
In Gernsback Publications

HUGO GERNSBACK, Founder

Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of Modern Electrics on file for interested readers.

- In April, 1910, Modern Electrics**
- Policing the Ether, by James M. Murdock.
 - French Wireless Cars.
 - Calculation of Condenser Capacity, by H. W. Secor.
 - New Duddell Oscillator.
 - Curious Frequency Meter.
 - Variometer for Amateurs, by M. H. Hammerly.
 - How to Receive and Transmit at the Same Time, by Hallam Anderson.
 - The Duplex Aerial.



the technician knows whether to look for a shorted or an open circuit element. Shorts and opens appear frequently in transistors. In fact, the majority of failures in transistors are shorts and opens. Therefore, the battery-current test has proved very useful.

"It's a remote-control for my TV. I shut off the set at home so my wife can start preparing dinner."

BUSINESS and PEOPLE

Electro-Voice, Inc., Buchanan, Mich., is packaging its replacement phonograph needles in styrene plastic containers which display the individual needles through a transparent window. The company is also marketing its



matched microphones for public address and home stereo recording systems in pairs at no extra cost. The paired microphones are carefully balanced within close tolerances.

Centralab, Milwaukee, Wis., has redesigned and simplified all its stock product packages. The number of pack-



age sizes and shapes has been reduced by more than 50%, with many of the bothersome smaller sizes being eliminated.

Standard Coil Products Co., Melrose Park, Ill., now has its TV tuner replacements listed in Howard W. Sams Photofact folder service, thus becoming the first TV tuner manufacturer to partici-

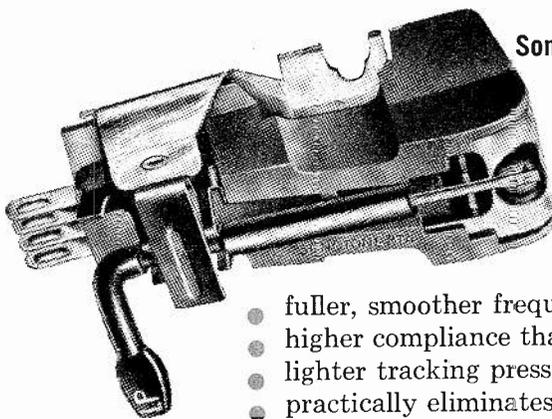


pate in the service. Standard Coil's distributor sales manager A. H. (Buzz) Forbes is shown behind the stack of the tuner specifications prepared for the Photofact service.

Cornell-Dubilier Electric Corp., South Plainfield, N. J., is using a unique 30-30 promotion to dramatize its aim to get sales action on its new Electomite miniaturized electrolytic capacitors.

Now... from Sonotone—

4 Big Improvements in the quality stereo cartridge



Sonotone 8TA cartridge replaces 8T as industry standard

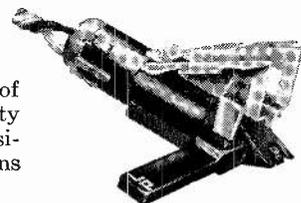
The new Sonotone 8TA cartridge gives greater than ever stereo performance... has 4 big extras:

- fuller, smoother frequency response
- higher compliance than ever before
- lighter tracking pressure
- practically eliminates dust pile-up

ONLY \$1450*

Sonotone 10T unitized stereo at lowest price ever

New 10T cartridge sells at record low price of \$6.45.* And it covers the complete high fidelity range. 10T's unitized construction makes it easiest to install, easiest to replace. Low price means more sales—more profits.



SPECIFICATIONS

	8TA	10T
Frequency Response	Smooth 20 to 20,000 cycles. Flat to 15,000 with gradual rolloff beyond.	Flat from 20 to 15,000 cycles ± 2.5 db.
Channel Isolation	25 decibels	18 decibels
Compliance	3.0 x 10 ⁻⁶ cm/dyne	1.5 x 10 ⁻⁶ cm/dyne
Tracking Pressure	3-5 grams in professional arms 4-6 grams in changers	5-7 grams
Output Voltage	0.3 volt	0.5 volt
Cartridge Weight	7.5 grams	2.8 grams
Recommended Load	1-5 megohms	1-5 megohms
Stylus	Dual jewel tips, sapphire or diamond.	Dual jewel tips, sapphire or diamond.

*including mounting brackets

Sonotone makes only 6 basic ceramic cartridge models... yet has sold over 9 million units... used in over 662 different phonograph models. For finest performance, replace worn needles with genuine Sonotone needles.

Sonotone PROG. PAT. Electronic Applications Division, Dept. C2-40
ELMSFORD, NEW YORK



Leading makers of fine ceramic cartridges, speakers, tape heads, microphones, electronic tubes.
In Canada, contact Atlas Radio Corp., Ltd., Toronto

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Trouble - shoot every type of circuit in ALL transistorized equipment! 525 pages; hundreds of illustrations; 120 check charts! **\$5.95.**

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Locate mechanical and electronics troubles fast. Covers all makes. 320 pages; 450 photos; 58 check charts! **\$3.95.**

Pin-Point TV TROUBLES IN 10 MINUTES

Find the exact sound or picture trouble in any TV set from 700 possibilities! 300 pages; 300 diagrams, check charts! **\$3.95.**

Pin-Point COLOR TV TROUBLES IN 15 MINUTES!

Covers every type of color TV and picture tube! 550 pages; 362 check charts, diagrams, picture patterns! **\$5.95.**

Simple Check Chart System Saves Time

These amazing practical handbooks with an ENTIRELY NEW METHOD, show you how to find the trouble in ANY TV, record changer or transistor circuit FAST! Index tells you where to look; famous Check-Charts help you pin-point the exact trouble in minutes! These on-the-job books quickly pay for themselves in profitable new business and valuable time saved!

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Just mail coupon for free trial. After 7 days send only low price or return books and pay nothing! If you keep all 4 books, send only \$3.00 after 7 days, and \$3.00 a month until \$19.80 plus postage is paid.

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Send for FREE TRIAL OFFER of all 4 Pin-Point books and get FREE book, "Bigger Profits in TV" whether you keep series or not!

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RECORD CHANGER TV (\$3.95 plus post-
(\$3.95 plus postage) age)

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plus postage) plus postage)

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Address.....

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Check here if enclosing full price; we pay postage, 7-day money-back guarantee.



Winchester 30-30 repeating carbines will be awarded to outstanding distributors during the campaign. Ray Leary, C-D general sales director, is shown "covering" the capacitor market with a 30-30, as Bill Schoneberger (left), sales manager, and Bob Riegel, merchandising manager, look on.

Matthew L. Devine (left), has been elected president of Amphenol-Borg Electronics Corp., Broadview, Ill., suc-



ceeding Arthur J. Schmitt, (right), who will continue as chairman of the board and chief executive officer. George W. Borg remains chairman of the executive committee. Devine had been on the board of directors since April, 1956, and

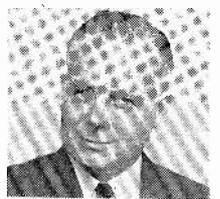
is also a member of the executive committee. He had been a partner of Cresap, McCormick & Paget, management consultants. R. Fred Meinicke (right), has been appointed sales manager of the Amphenol Distributor Div. He has been with the company since 1950 in various distributor sales positions.



Perma-Power, Chicago, designed a new 12-pack dispenser carton for its TV tube brighteners.



Hermon H. Scott, president of H. H. Scott, Inc., was elected chairman of the board of directors of the Institute of High Fidelity Manufacturers. Ray V. Pepe, James B. Lansing Sound, Inc., was elected vice president and director, and will act as president until the special election to fill the vacancy. Saul Marantz, Marantz Co., and Donald Plunkett, Fairchild Recording Equip-



PROFESSIONAL technicians use *Dave Rice's* OFFICIAL ORDER BOOKS for every TV-RADIO service call



This is the businesslike approach to service record keeping. Triplicate forms serve as order form, invoice and office record, with spaces for complete information on every job. Separate listings for receiving tubes, pix tube, parts, serial numbers, labor and tax charges, signatures, etc. 75c a book, \$6.50 for dust-proof box of 10. In stock at your distributor. Write for your free folder describing Dave Rice's OFFICIAL ORDER BOOKS, including an actual size sample copy of the handy order form.

For customer's prices on every replacement part, plus flat rate and hourly service charge data, regional and national, Dave Rice's OFFICIAL PRICING DIGEST, listing over 63,000 items. \$2.50.

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Plastic Pouch Fits Tube Caddy or Tool Kit

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INTERNATIONAL RESISTANCE COMPANY
DISTRIBUTOR SALES DIVISION
414 N. 13th STREET • PHILADELPHIA 8, PA.

ment Corp., were named to the board of directors. Raymond E. Ward, Shure Brothers, was also elected to the board, but with qualification depending on the election of the president.

Robert Wolfe has been named sales manager of the new Centralab Variable Resistor Sales Div., Milwaukee, Wis. He is well known in the electronics industry and was most recently with *Electronics World* magazine.



Oden F. Jester joined the sales division of Shure Brothers, Inc., Evanston, Ill., to handle special assignments. He was formerly with Standard Coil Products Co., Inc., Thordarson-Meissner, and Utah Radio & Electronic Corp., among others.



John W. (Jack) Merritt is back as distributor sales manager of Howard W. Sams & Co., Indianapolis. He had been coordinating the marketing-advertising department activities of Bobbs Merrill Co., Inc., and other associated Sams subsidiaries. Tom Surber will continue as assistant sales manager.



Francis J. Chamberlain is the new general sales manager of Clarostat Manufacturing Co., Inc., Dover, N. H. He will head all sales and sales promotion activities of the company and its subsidiary, Campbell Industries. He has been acting sales manager since early last year.



Robert A. Donner joined Telectronic Corp., Long Island City, N. Y., subsidiary of Telectro Industries Corp., as sales manager. He comes from American Audion Corp., where he had been general sales manager.



Larry Epstein joined Bogen-Presto Div. of Siegler Corp., Paramus, N. J., as sales and merchandising manager on high-fidelity and professional equipment. He comes from United Audio Products, and was previously with University Loudspeakers and RCA International.

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TELTRON SMASHES PRICES ON TUBES for '60!

GIFT OFFER
ONE 6B6GC tube will be shipped FREE with any \$10.00 or more order accompanying this ad.

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By popular demand we are repeating this fabulous FREE GIVE-AWAY. You get this EICO tube tester or kit - 625K ABSOLUTELY FREE when you purchase \$195.00 worth of receiving tubes from TELTRON within 60 days. Tube tester may be purchased outright for \$34.95 PREPAID. Send for FREE list of other EICO test equipment & HI FI components that we distribute.



FREE GIVE-AWAY. You get this EICO tube tester or kit - 625K ABSOLUTELY FREE when you purchase \$195.00 worth of receiving tubes from TELTRON within 60 days. Tube tester may be purchased outright for \$34.95 PREPAID. Send for FREE list of other EICO test equipment & HI FI components that we distribute.

MOST PARTIAL LIST MOST OFTEN USED TUBES

02A	.45	6BA8	.49	9U8	.79
1B3GT	.62	6BC5	.59	10DE7	.48
1S5	.51	6BC8	.48	12AB5	.44
174	.51	6BE6	.46	12AF6	.44
1U4	.51	6BG6	.48	12AT6	.47
1U5	.51	6BGGG	.48	12A7	.34
1X2	.62	6BH6	.48	12A7T	.43
2A4	.62	6BJ6	.45	12AU6	.73
2B4	1.02	6BK6	.51	12AV6	.48
3AUG	.58	6BK7	.75	12AV7	.61
3BC5	.58	6BL7GT	.78	12AX4GT	.70
3BN6	.58	6BN4	.48	12AX7	.63
3BZ6	.90	6BN6	.44	12AZ7	.61
3CB6	.45	6BQ6GT	.83	12AZ7T	.65
3DT6	.45	6BQ7A	.85	12BA6	.52
3V4	.51	6BY5C	.85	12BE6	.46
4BC6	.48	6BZ6	.45	12BH7	.61
4CQ7	.69	6C4	.49	12BQ6	.65
4CB6	.75	6C6	.45	12BY7	.63
5A8	.59	6C6G	.51	12C0R6	.65
5AN8	.59	6CF6	1.63	12C0G	.43
SAT8	.64	6CG7	.45	12D85	.63
5AV8	.54	6CH8	.54	12D06	.63
5A8S	.54	6CJ7	.54	12E85	.59
5J6	.68	6CS6	.44	12SA7	.44
5T8	.61	6CUG	.45	12SK7	.45
5U4G	.43	6D6E	.95	12S7GT	.45
5U4GR	.45	6D6GT	.43	12SQ7	.56
5U8	.59	6D6	.89	12T6GT	.38
5V4G	.43	6E6	.49	12U6GT	.43
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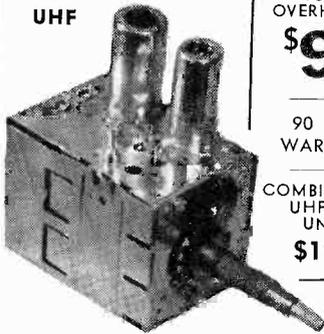
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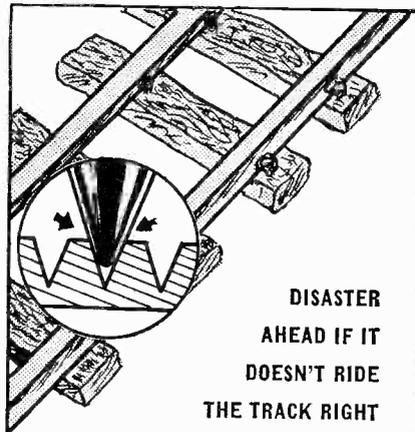
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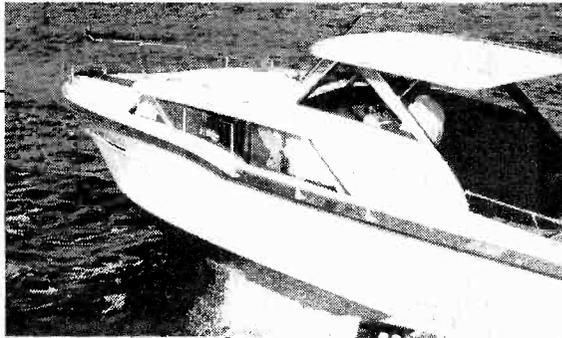
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BASIC ELECTRONICS (Vol. 6.), by Van Valkenburgh, Nooger & Neville, Inc. John F. Rider, Inc., 116 W. 14 St., N. Y. 11, N. Y. 6 x 9 in. 136 pp. \$2.90.

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THE TRANSISTOR ERA, edited by C. C. Gee and Charles A. Marshall. Heywood & Co. Ltd., Drury House, Russell Street, Drury Lane, London, W.C.2, England. 11½ x 8¾ in. 95 pp. 5 shillings.

Prepared in magazine style, this book is a guide to British transistors and associated semiconductor devices. It presents some basic semiconductor fundamentals, contains a buyers' guide to transistors and associated products, and discusses the position of semiconductors in today's world. A complete listing of British transistors is also included. —LS

TELEVISION ANTENNA HANDBOOK, by Jack Darr. Howard W. Sams & Co. Inc., 1720 E. 38 St., Indianapolis, Ind. 5½ x 8½ in. 248 pp. \$3.95.

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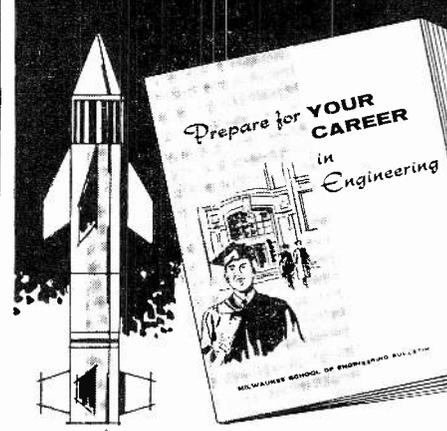
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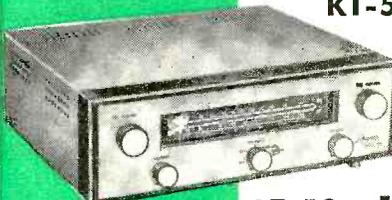
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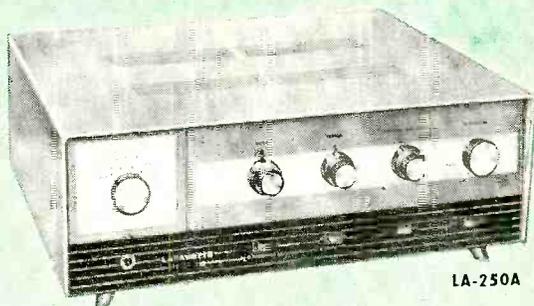
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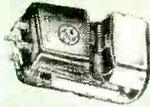
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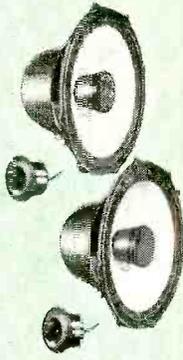


GARRARD RC121/11



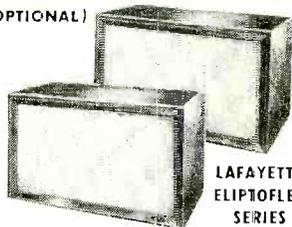
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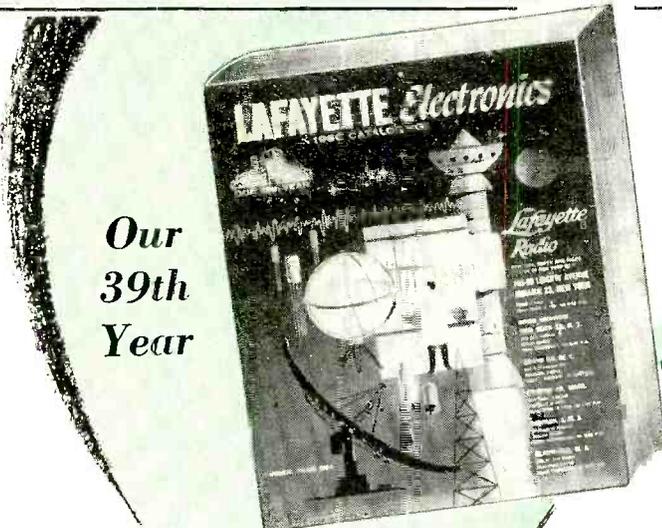
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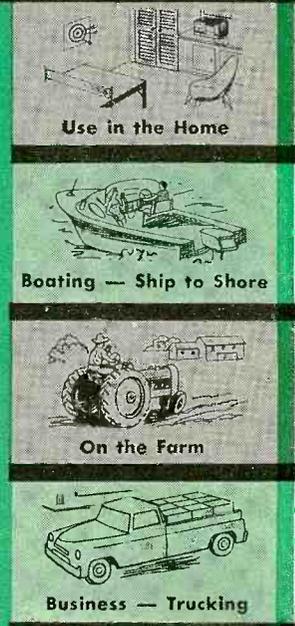
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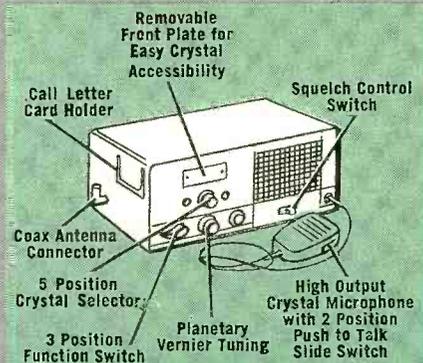
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go into characteristics of basic antennas, antenna rotators, on-location tests, tools and equipment, roof-top techniques and safety, unusual installations, servicing the antenna system and other aspects of antennas that affect the service technician.—LS

PRINCIPLES AND APPLICATIONS OF RANDOM NOISE THEORY, by Julius S. Bendat. John Wiley & Sons, Inc., 440 Fourth Ave., N. Y. 16, N. Y. 5 3/4 x 9 in. 431 pp. \$11.

Analysis and control of noise are important in radio, radar, automatic control, etc. This book, for advanced seniors and college graduates, treats noise as a continuous phenomenon rather than a series of discrete disturbances. A working knowledge of math, circuit theory and servomechanisms is assumed.

Power spectra, probability, autocorrelation, analog counter technique and zero crossing are among chapter headings. Some of this information appears in book form for the first time.—IQ

HOW TO GET THE MOST OUT OF YOUR VOM, by Tom Jaski. (GL No. 85), Gernsback Library, Inc., 154 W. 14 St., New York 11, N. Y. 5 1/2 x 8 1/2 in. 224 pp. \$2.90.

The volt-ohm-milliammeter is the most common of all test instruments. This book shows how to realize fully its possibilities. It makes it easy to design new ranges, repair and improve one's vom, as well as make measurements other than E, I and R.

The basic meter is described first—pointer balancing, scale changing, etc. This is followed by ohmmeter circuit design, calibration, shunts and multipliers. Both kits and commercial VOM's are discussed.

Other important topics are measurement of L, C, turns ratio; illumination and temperature; how to read db scales; protective devices for the meter. Several unusual VOM instruments are included for the build-it-yourself reader.—IQ

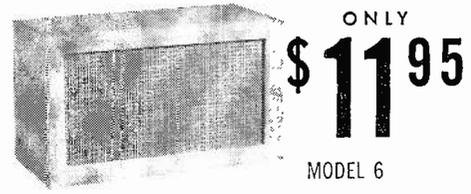
HOW TO INSTALL & SERVICE AUTO RADIOS (2nd Edition, Revised), by Jack Darr. John F. Rider Publisher Inc., 116 W. 14 St., N. Y. 11, N. Y. 5 1/2 x 8 1/2 in. 159 pp. \$3.25

A detailed account of auto-radio service jobs that the electronic technician has to handle. Written in an authoritative manner, the latest techniques for installing and servicing the latest auto radios are presented. The five major sections of the book are: Installing Auto Radios; Servicing Auto Radios; Transistorized and Hybrid Auto Radios; 6- to 12-volt Conversions; and the Auto Radio Service Shop.

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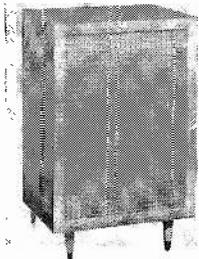
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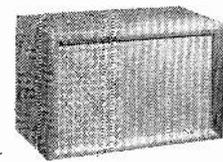
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Acoustic Research Inc.	112
Airex Radio Corp.	127
All American Kits	104
Allied Radio Corp.	16, 17, 27, 106
American TV & Radio Co.	126
Amperex Electronic Corp.	72
ARKAY International Inc.	140
Astatic Corp.	Inside Back Cover
Audion	107
B & K Mfg. Co.	109, 113, 115
Barry Electronics Corp.	126
Bell Telephone Labs.	38
Bionder-Tongue Labs.	139
Bonafide Radio	118
Bosco Electronics Inc. (Don)	127
Brooks Radio & TV Corp.	121
Burroughs Corp.	98
Burstein-Applebee Co.	133
CBS-Electronics	25
Capitol Radio Engineering Inst.	74, 75, 76, 77
Carston Studios	107
Castle TV Tuner Service	132
Centralab Div. of Globe Union	12
Century Electronics Co., Inc.	84, 85
Chemical Electronic Engineering	15
Cleveland Inst. of Radio Electronics	11
Colordaptor	105
Coxne Electrical School	95, 114, 130
Delco Radio Div. of General Motors	117
DeVry Technical Inst.	7
Dressner	118
Duotone	132
Dynaco Inc.	87
Dyna-Empire	82
Electro Products Labs.	114
Electro-Sonic Labs.	86
Electronic Chemical Corp.	72
Electronic Instrument Co.	29, 30
Electronic Measurement Corp.	110
Electronic Publishing Co.	130
Electro-Voice, Inc.	9
Entron Co.	120
Fisher Radio Corp.	24
General Electric Co.	20, 21
Grainback Libros	132
Gratham School of Electronics	15
Harman-Kardon	13
Heald Engineering College	132
Heath Company	65, 66, 67
Hi-Fidelity Center	126
Hindustan Industries	139
Hudson Specialties Co.	103
Indiana Technical College	105
International Business Machines	96, 97
International Resistance Corp.	130
JFD Electronics	69
Jensen Industries	139
J. W. Electronics	101
Key Electronics Co.	139
Kingston Electronics Corp.	78
Lafayette Radio	136, 137, 138
Lektron Inc.	118
Mercury Electronics	116
Melroe Co.	112
Moss Electronics	90, 91
National Radio Inst.	3, 113
National Schools	5
Ohmatsu Electric Co. Ltd.	82
Olsen Radio Corp.	108
Opportunity Adlets	131, 133
Oxford Components, Inc.	114
Paco Electronics Co.	10
Perma-Power Co.	93
Picture Tube Outlet	126
Prentice-Hall, Inc.	119
Progressive "Edu-Kits" Inc.	122
RCA Electron Tube Div.	Back Cover
RCA Institute	22, 23
RCA Test Equipment	18
Radio Shack Corp.	127
Radi-Tel Tube Co.	123
Rek-O-Kut Co.	83
Rinehart & Co.	81, 102, 108
Sams & Co. (Howard W.)	124, 125
Scott Inc. (H. H.)	26
Seco Mfg. Co.	94
Sensorex	101, 103, 105, 107
Somotone Co. p.	129
Sprague Products Co.	11
Spraberry Academy of Radio-TV	16
Sylvania Electric Products	99
TAB	128
Tanzian (Suzanne) Inc.	139
Teleplex Co.	113
Teltron Electrical Co.	131
Transpac	114
Triplet Electrical Instrument Co.	Inside Front Cover
Tung-Sol Electric Co.	8
Turner Co.	95
Uertz Co. (Glenn R.)	93
Vaco Products Co.	118
Vidair Electronics	139
Weston Electrical Instrument Corp.	126
Winegard Company	71
Workman TV, Inc.	108
Xcelite, Inc.	86
Zalytron Tube Co.	119

SCHOOL DIRECTORY PAGE 135

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For business . . . for fun . . . and the security of an emergency telephone wherever you go

NEW ARKAY SQ-9 'SKY-VOX' CITIZENS BAND TRANSCEIVER

fully pre-wired and prealigned front end

KIT \$79⁹⁵ ONLY

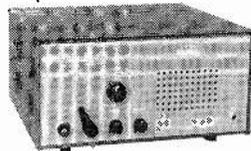
Factory wired \$119.95

Advanced circuitry and design with specifications you'd expect to find in units costing many times more . . . PLUS:

- Nothing else to buy — Ready to operate 12V DC, 110V AC
- Crystal controlled Superhet receiving circuit
- Crystal controlled oscillator, Pentode RF amplifier transmitting circuit
- Multi-Channel operation
- Automatic noise limiter
- Audio Squelch
- Comes complete with microphone and 1 set of crystals.

For business or fun, in your home, office, car or truck, this newest method of communication has no equal at any price. It's like having a direct line to your home or place of business from wherever you happen to be — and there is no tuning necessary! If you can flip a switch you're on the air.

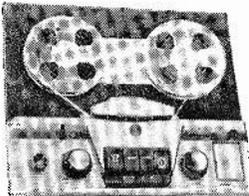
In the tradition of other outstanding ARKAY units the ARKAY SQ-9 Citizens Band Transceiver offers you the finest in two-way communications at the lowest possible price.



NEW ARKAY-HARTING MS-5 STEREO RECORD-PLAYBACK TAPE DECK

\$129⁹⁵

Build a permanent collection of your favorite music



Records and plays back in STEREO and 4 track monaural

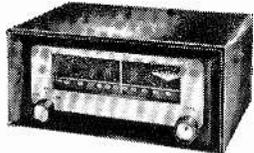
Now you can afford the satisfaction and pride of owning a professional quality tape deck. The MS-5 features amazing simplicity of design and operation, yet is engineered to broadcast standards. Compare it to tape decks costing over \$200!

With all the features you'd expect in a professional quality stereo tape deck . . . PLUS:

- 5 push button operation and drop-in loading
- Automatic interlock prevents accidental erasure
- Double shoe brakes for split-second non-slip stops
- All metal tape fingers for longer tape life
- Oversized capstan insures constant tape speed
- 2 speed Stereo and monaural operation

ARKAY HFT-7 FM-AM Tuner

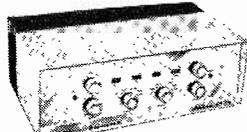
Another Golden '60 component with the Lifetime Guarantee



KIT \$32⁰⁰ \$49.95
Wired

ARKAY CS 28-watt Stereophonic Dual Amplifier-Preamp

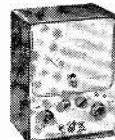
Another Golden '60 component with the Lifetime Guarantee



KIT \$64⁹⁵ \$99.95
Wired

ARKAY VT-10 Vacuum Tube Voltmeter

Another Golden '60 component with the Lifetime Guarantee



KIT \$25⁹⁵ \$47.95
Wired

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330 MICROPHONE SERIES
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SIZE

never before such quality of performance and
versatility of application at such low price

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The Dynamic Models 335H (high impedance) and 335L (low impedance) operate with highest quality characteristics in TV and radio broadcast usage, in professional or home recording, public address, almost unlimited other lavalier, hand or stand applications.

The Ceramic Model 331 is a voice range unit specifically engineered for excellence in communications applications, 27 megacycle citizens' band use, and paging.

Ceramic Model 333 is a wide-range microphone offering a similarly high new level of perfection for tape recording, P. A. Systems, etc.

Crystal Model 332, with satin chrome body and cap, black grille, is already famous through widespread use. Performance throughout the series is of the highest order. **THUS, THE GREATEST NEWS OF ALL CONCERNING THESE NEW ASTATIC UNITS IS THEIR AMAZINGLY LOW COST!** Check out these new Astatic Microphones at your first opportunity.



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Model	Type	Output	Frequency Range	Impedance	Finish	List Price
331	Ceramic	-56 db	300- 5,000	High	Black Body and Grille, Chrome Cap	\$17.90
333	Ceramic	-58 db	30-12,000	High		17.90
335H	Dynamic	-56 db	50-12,000	High	TV Grey Body, Chrome Cap and Grille	26.50
335L	Dynamic	-57 db	50-12,000	Low		23.50

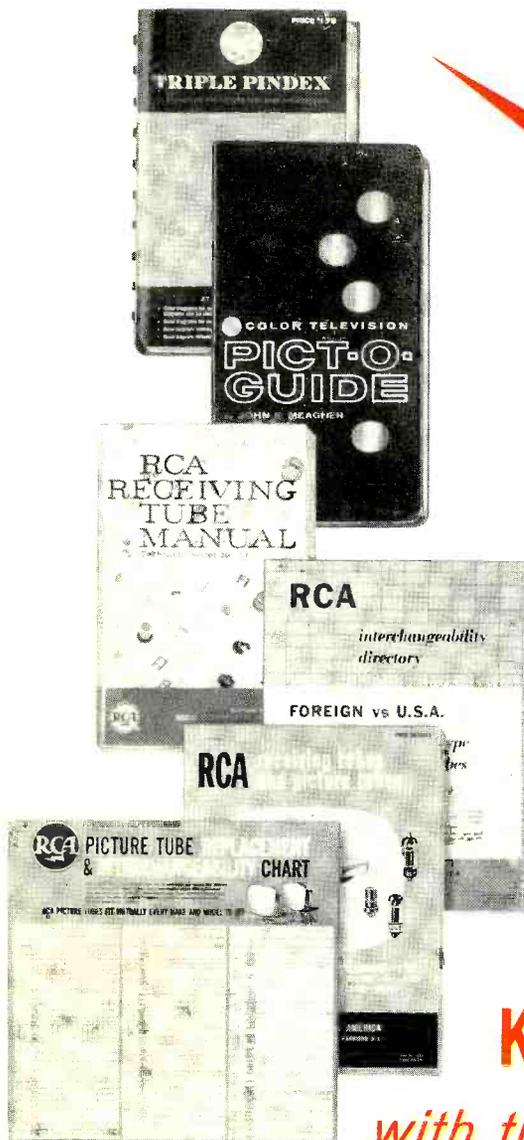
NOTE: Model 331 has momentary-on, spring-return switch, is furnished with hang-up bracket. Cable provides for audio and relay connections. All other models have slide switch with "lock-on" position, are complete with lavalier and stand adaptor with 3/8"-27 thread.

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