ELECTRONICS WORLD

AUGUST, 1961

50 CENTS

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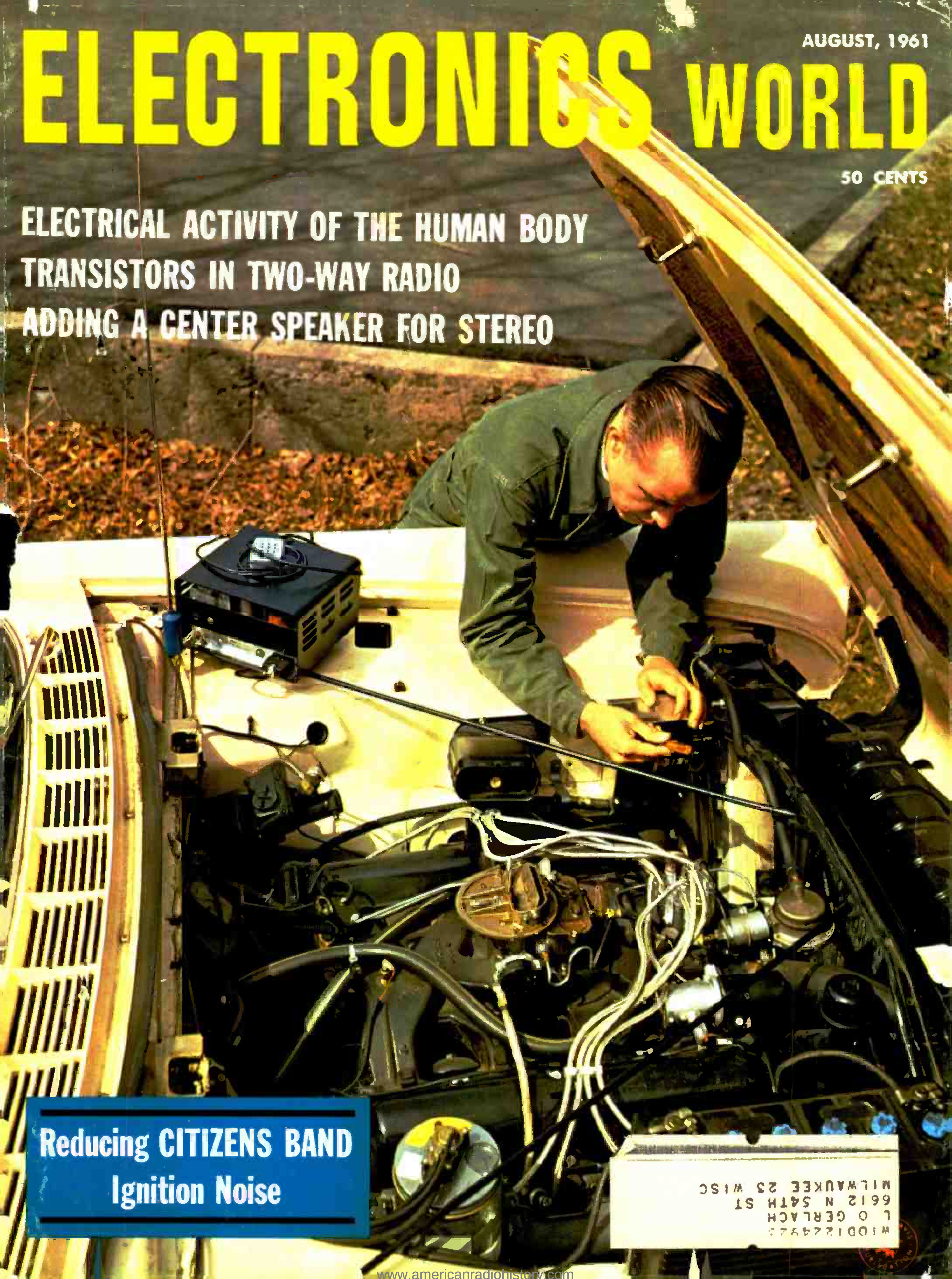

Reducing CITIZENS BAND Ignition Noise

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ELECTRONICS WORLD

AUGUST, 1961

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First in radio-television-audio-electronics

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INDUSTRIAL AND GENERAL ELECTRONICS

HIGH FIDELITY AND AUDIO

SERVICING—TV, RADIO, ETC.

TEST EQUIPMENT

COMMUNICATIONS AND AMATEUR

ELECTRONIC CONSTRUCTION

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DEPARTMENTS

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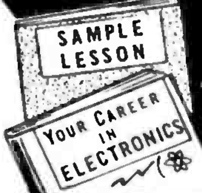

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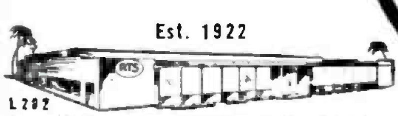

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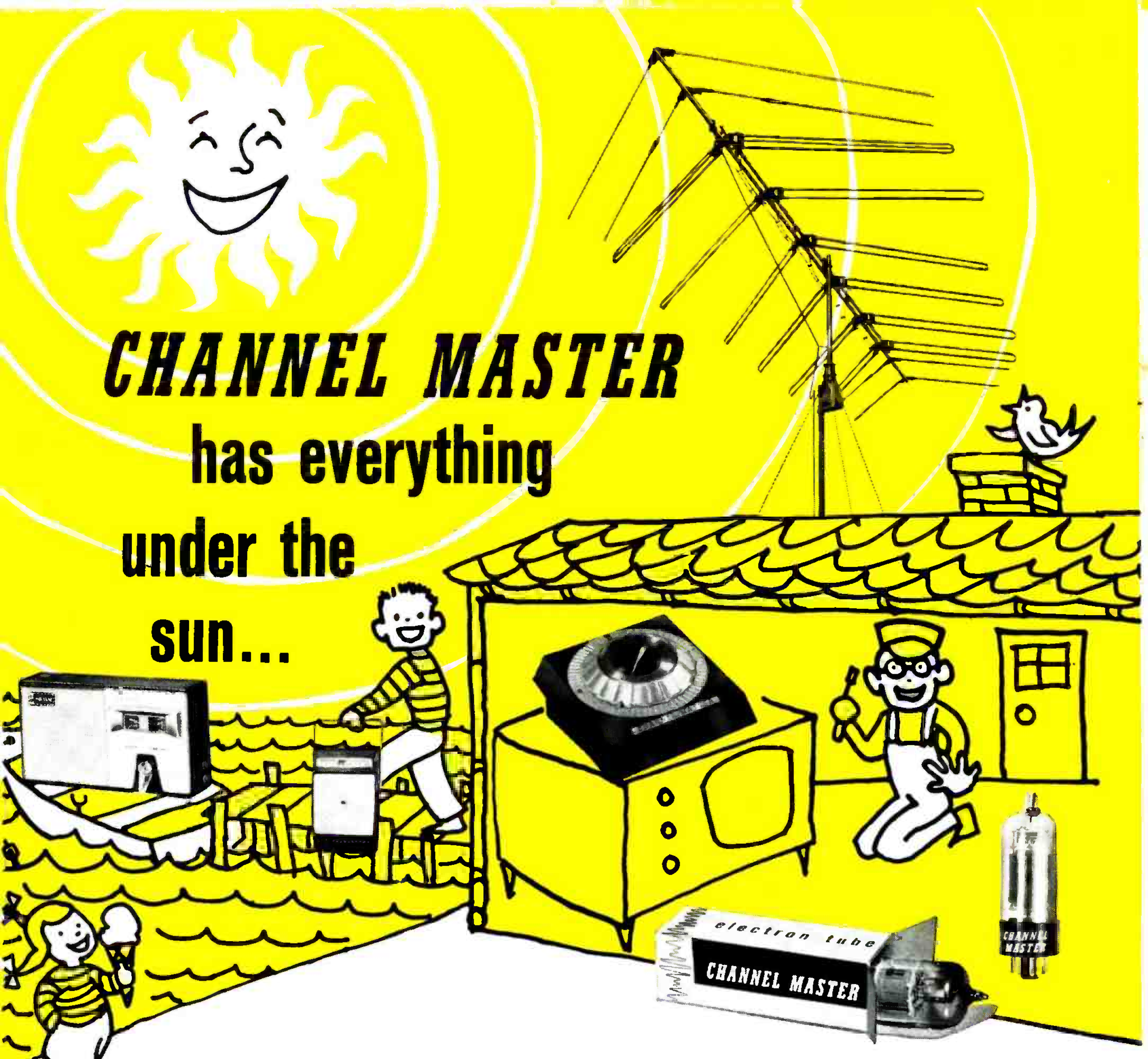

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Summertime is "easy living" time. People have more leisure hours in which to enjoy radio and television. That's why they'll want radios and TV sets that are in top operating condition...and Channel Master has everything you need to do the job better.

Replace winter-worn antennas with one of the powerful Super T-W's. Convert old-fashioned manual rotators to fully automatic operation with the new Channel Master Automatic Rotator Control Consoles. Perk up TV set performance by replacing weak or worn out tubes. Show your customers how their leisure hours can be more enjoyable when they own Channel Master portable radios.

There aren't any summer sales doldrums when you sell the Channel Master line because Channel Master has everything you need to keep summer sales simmering.

CHANNEL MASTER works wonders in sight and sound

ELLENVILLE, NEW YORK

...for the Record

By **W. A. STOCKLIN**
Editor

Hirsch-Houck Labs Joins ELECTRONICS WORLD

TO work on a technical publication like ELECTRONICS WORLD with almost 250,000 circulation—mostly men professionally interested in electronics—is challenging. There never is a dull moment nor does a day go by but some thought is given to improving the contents of our magazine. The formula is simple. All we have to do is publish the most authoritative material, presented in the most interesting manner possible so that every one of our readers finds our publication useful and enjoyable! On the other hand, to deny that we have problems or that we have our good and bad days like everyone else would be foolish.

During the past six months, we have conducted quite a few reader surveys with one objective in mind—to determine which articles and what subjects are of most interest to our readers. The results of these surveys came quite close to our expectations with "Mac's Service Shop," "New Products Section," and our own "Lab Tested Product Reports" leading the field in monthly features. Of these three, our "Lab Tested Reports" is the only feature that has caused us exceptional problems and headaches. As anyone would expect, to be able to test amplifiers, speakers, microphones, tuners, and, in some cases, test equipment is not a simple task. We never could find a single laboratory that could handle all of these products. We had various facilities—tuners would go to one laboratory, speakers to another, and amplifiers and test equipment would occasionally be sent out but, for the most part, such evaluations were handled by our staff during evenings and weekends. Needless to say, because of these problems, we have always been on the lookout for a single laboratory capable of handling all of the products—not just any laboratory—but one that had highly qualified engineers capable of judging the quality of audio equipment not only from test results, but from an aesthetic standpoint as well.

It is with great pleasure we are now able to announce that, beginning with our October issue, all of our hi-fi product evaluation will be handled by *Hirsch-Houck Laboratories*. We welcome two men—Julian Hirsch and Gladden Houck—to our magazine. Julian and Gladden are widely known for their accurate and impartial technical reports on hi-fi equipment. Not only does this new association relieve us of a lot of problems, but it makes available to us the facilities of a well-equipped laboratory. To our readers it means that we will be able to continue publishing authoritative product reports, but in much greater depth than before.

Logo To Change

Starting with the September issue, the ELECTRONICS WORLD cover logo will look different. It will appear in upper and lower case type with both words the same height. We have always felt that both the words "Electronics" and "World" are of equal importance and should be the same size, but with block lettering as it now appears it would have been difficult to read. Our new logo type face (see page 8) solves this problem.

The addition of the *Hirsch-Houck Laboratories'* facilities is just one of many examples of how ELECTRONICS WORLD is constantly improving its authoritative coverage. The new logo presents a more attractive appearance and makes it easier for you to identify your favorite electronics publication. —30—

NEW-simply great knight-kits®
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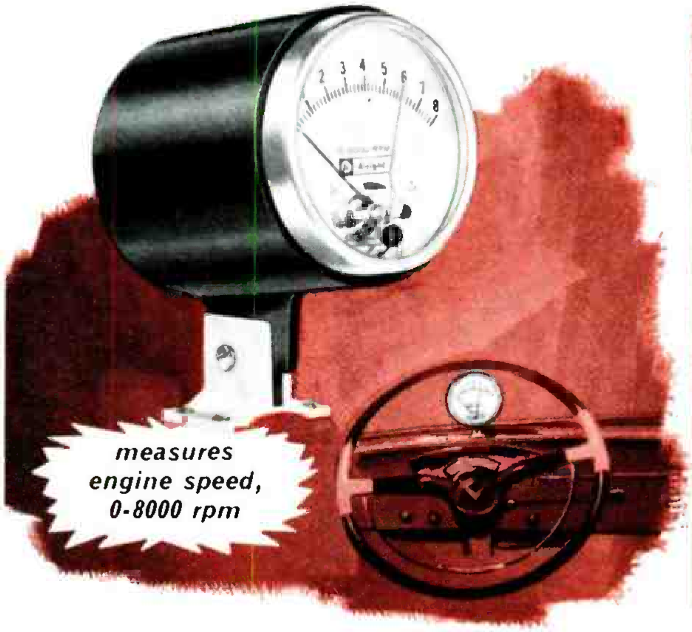
talk of the kit world...only at ALLIED



New Money-Saving Electronic Tachometer Kit

3% Accuracy Regardless of Temperature or Voltage Variations

Until Sept. 15 **$19.95** No Money Down

Another KNIGHT-KIT *first*—a precision tachometer in money-saving, easy-to-build form. Helps you drive at your best engine speed efficiency, like the professionals. Transistor switching and Zener diode regulator contribute to exceptional 3%-of-full-scale accuracy, regardless of voltage or temperature changes. Operates with 4, 6 or 8 cylinder automotive engines; simple installation. Ideal also for outboard marine engines using battery or magneto ignition system from 2 cycle 2 cylinder and up. Big illuminated D'Arsonval meter; 0-8000 rpm scale; separate reference pointer may be preset to any desired speed. For 12-volt systems only. With cables, mounting hardware, wire and solder. Shpg. wt., 2 lbs.

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

Deluxe Wireless Intercom System Kit at Lowest Cost

Works Anywhere Without Wires — No Installation!

PAIR **$37.90** No Money Down

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

20 YX 272-2. Complete 2-Station System. NET **$37.90**
83 Y 941. Additional Station. NET EACH **$18.95**

SEE DOZENS OF GREAT *knight-kit* BUYS in

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Make your money-saving selections from page after page of great KNIGHT-KIT values and special offers! Save most on the best in build-your-own Stereo, hobby, instrument and Ham kits. Also see terrific closeouts on tape recorders, phonos, records and tape; specials in radios, cameras, TV accessories, Citizens Band radio, amateur gear, P.A., test instruments, tools and electronic parts. Send coupon today!

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SAVE AS NEVER BEFORE on everything in Electronics—hundreds of special bargains—dozens of new products! Write for this big value-packed Sale Book today!

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$.............. enclosed

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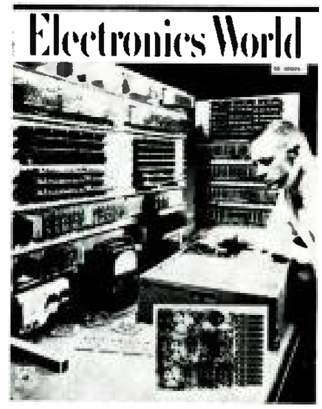
COMING NEXT MONTH



COMPUTERS & THE SEMICONDUCTORS THAT MAKE THEM WORK
Transistors and semiconductor diodes are making computers smaller and more efficient. Here is a rundown on how and where they are used. A computer glossary for the technician is included.

IMPEDANCE MATCHING IN P.A. SYSTEMS
Practical help for the sound installer and sound technician in this first of a three-part series. Information on matching speakers to low-impedance lines is included in this article.

MARINE ELECTRONICS MAINTENANCE
Part 1 of a two-part series covering the special business and technical problems involved in tackling marine electronic service work, along with a detailed study of the equipment used and troubleshooting methods employed in servicing depth sounders.

ELECTRONICS & BIOLOGY
Electronics is being used as a tool in the study of biology—and biology is supplying tools for electronics. The results of this mutual effort are described for the benefit of technicians who work with such equipment.

DOMESTIC TRANSISTOR REPLACEMENTS IN IMPORTED RADIOS
A practical chart for the technician. Dozens of makes and models are covered, along with the domestic transistor which may be used as a replacement in each stage of the set.

THE "SIMPLE-TALKIE"
An ultra-simple hand-held trans-receiver for the ham who can use a very short-range talk-back system. Power input is 10 mw. and the range is several hundred feet.

TRANSISTORIZED CB CONVERTER
Details for building a two-transistor converter for the car's broadcast radio that permits it to pick up Citizens Band signals.

BELOW THE BROADCAST BAND
The design of a sensitive low-frequency converter to be used with a communications receiver or broadcast set to cover the important frequencies from 10 to 530 kc. These frequencies are used for world-wide communications for submarines, aircraft beacons, weather and time information, and marine communications.

All these and many more interesting and informative articles will be yours in the September issue of ELECTRONICS WORLD ... on sale

August 15th

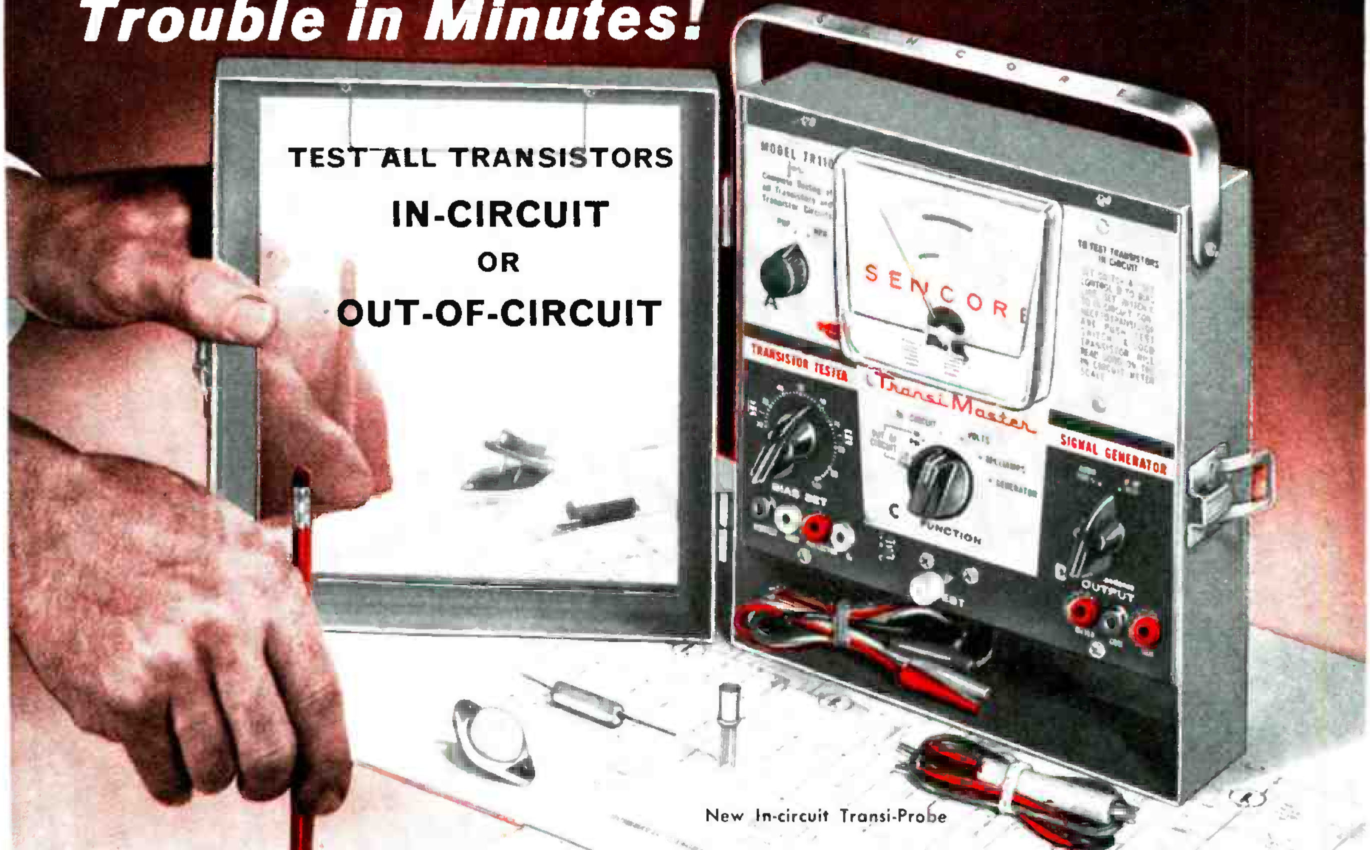
ELECTRONIC NAME QUIZ

By **WILLIAM E. BENTLEY**

WE all recognize an "internal combustion propelled vehicle" as an automobile, but how about common electronics words when fancy names replace the familiar terms? Take a try at the ten below, then check your answers with the more common names on page 72.

1. A bi-laterally conductive avalanche device.
2. An electro-mechanical synchronous modulator-demodulator.
3. An astable twin-triode source of waves rich in odd-order harmonics.
4. A transfer resistor.
5. A vacuum-tube device characterized by less than unity voltage gain.
6. A two-terminal conductive device possessing a resistance equal to its impedance.
7. A corrective technique based on re-injection of out-of-phase waves.
8. An electrostatically controlled vacuum device that displays rectilinear coordinate information.
9. An electro-mechanical acoustic device characterized by a fibrous diaphragm.
10. A resistive device that requires 10 revolutions to provide extreme values.

Analyze Every Transistor Circuit Trouble in Minutes!



New In-circuit Transi-Probe

It's a . . . COMPLETE TRANSISTOR TESTER • SIGNAL TRACER
VOLTMETER • BATTERY TESTER • MILLIAMETER

Transistors are tested in-circuit with a new unique AC GAIN check and out of circuit with an accurate DC GAIN and LEAKAGE check. Set-up chart included for reference only

Now you can . . .

- **Test all transistors in-circuit** with a new unique AC GAIN check. It works every time and without the use of the set-up booklet.
- **Test all transistors out of circuit** with the AC GAIN check or with a more accurate DC current gain and leakage check.
- **Read current gain (beta) direct** for experimental, engineering work or for matching transistors.
- **Check diodes** simply and accurately with a forward to backward ratio check.
- **Signal trace** from speaker to antenna with a special low impedance generator. No tuning, adjustments, or indicating device needed for transistor radio trouble shooting. Just touch output leads to transistor inputs and outputs until 2000 cycle note is no longer heard from speaker. (Generator output monitored by meter.) It's a harmonic generator for RF-IF trouble shooting and a sine wave generator for audio amplifier trouble shooting.
- **Check batteries** under operating conditions as well as the voltage dividers with a special 12 volt scale.
- **Monitor current** drawn by the entire transistor circuit or by individual stages with a 0 to 50 Ma current scale. A must for alignment and trouble shooting cracked boards.

Benefit from these Sencore extras

- Lists Japanese equivalents.
- Automatically determines NPN or PNP.
- Mirror in detachable cover to reflect opposite side of printed board.
- Special clip to fit between batteries for current check.
- Transi-probe for making in-circuit transistor checks.

Color	modern two tone gray
Size	8" x 7⅝" x 3"
Weight	only 5 lbs.
Meter	0 to 3 Ma, 3½", 5% tolerance, modern plastic
Batteries	two size "C" cells

Model TR-110 ONLY 49⁵⁰

Sencore Sam says, "If you'd like to get rid of those batteries during repair time, get the Sencore PS103 Battery Eliminator. It's the best and it's only $19.95."

ALL PARTS ARE SENCORE MADE IN AMERICA

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ADDISON, ILLINOIS

Within the Industry

JUSTIN L. ALBERS has been appointed vice-president, distributor operation services for the *RCA Sales Corporation*, succeeding Robert M. Ryan who has retired.

A former assistant dean in the School of Commerce at St. Louis University, Mr. Albers joined the firm in 1956 as a field sales representative. Prior to joining the company, he held executive marketing positions with *Stromberg-Carlson* and *Capehart-Farnsworth*. He also served in the U.S. Air Force with the rank of Captain.

* * *

ELECTRONIC REPRESENTATIVES ASSOCIATION has added a director of education to its national office staff at 600 S. Michigan Ave., Chicago 5, Ill.

Robert J. Morgan, who will work under the direction of the association's executive director William C. Weber, Jr., will be directly responsible for the operation of the four business management institutes sponsored by ERA and will coordinate the business session portions of the group's annual convention and management conference.

Mr. Morgan was assistant manager of the Aurora, Illinois Chamber of Commerce before joining the ERA.

* * *

SIDNEY FLEISCHMAN is the new sales manager of *Precision Apparatus Company, Inc.*, subsidiary of *Pacotronics, Inc.* A veteran of over twenty-five years in the electronics field, he will be in charge of marketing and sales for the division's test instrument line. He will also handle sales to the government and special contracts.

He joined the firm from *Eby Instrument Company* where he served as general manager and marketing manager. He was also associated with *Superior Instruments Co.* as well as *Pilot Radio* and *Jefferson-Travis*.

* * *

UTAH ELECTRONICS CORPORATION is the new name of **UTAH RADIO AND ELECTRONIC CORPORATION** reflecting product diversification by the Huntington, Indiana firm . . . **FANON ELECTRONIC INDUSTRIES, INC.** has announced acquisition of **MARK SIMPSON MANUFACTURING CO., INC.**, Long Island City manufacturer of intercom equipment . . . **BOGUE ELECTRIC MFG. CO.** has established a military electronics division at Redondo Beach, Calif. . . . **ENGLISH ELECTRIC CORPORATION** has been incorporated in the state of Delaware as a wholly owned subsidiary of **THE ENGLISH ELECTRIC COMPANY LIMITED** of London. The U.S. subsidiary has offices at 750 Third Ave., New York City . . . **SANGAMO ELECTRIC COMPANY** has purchased a controlling stock interest in **MICROSONICS, INC.** of Hingham, Mass., manufacturer of delay lines . . . **RADIO MERCHANDISE SALES, INC.** has changed its name to **RMS ELECTRONICS, INC.** . . . **GENERAL INSTRUMENT CORPORATION** has acquired **PYRAMID ELECTRIC COMPANY** and announced the formation of a new capacitor division with four manufacturing plants . . . **I.D.E.A., INC.** has changed its corporate name to **REGENCY ELECTRONICS, INC.**, thus capitalizing on the company's well-known product tradename . . . Production of the **GLOBE ELECTRONICS DIVISION** is being consolidated with that of **GC ELECTRONICS** in Rockford, Illinois. Both firms are divisions of **TEXTRON ELECTRONICS** . . . **FANON ELECTRONIC INDUSTRIES** has formed a new subsidiary, **FANON TRANSISTOR CORPORATION**, which will manufacture high-power *n-p-n* silicon mesa transistors.

* * *

L. DONALD COLE has been promoted to the post of manager of marketing services for *CBS Electronics*, the manufacturing division of *CBS*. He replaces Roy Juusola who has been transferred to the firm's Lowell semiconductor operations.

Mr. Cole was formerly sales service manager for *CBS Electronics* which he joined in 1954. He is a member of the EIA Receiving Tube Marketing Data Committee and of the American Management Association.

A native of Winchester, Mass., he received his degree in business administration from Nichols College.

* * *

ALLIED RADIO CORPORATION has opened a new store at 5312 N. Port Washington Road, Milwaukee, Wisconsin. The 12,000-square-foot facility also has a large parking lot for customers in an adjacent area . . . **GENERAL ELECTRIC COMPANY** will build a computer laboratory in the International Science Center at Sunnyvale, California . . . **FEDERATED PURCHASER** has established an international division with headquarters in New York . . . **MOTOROLA INC.** has opened a 307,000-square-foot addition to its semiconductor products division

(*Continued on page* 14)

LAFAYETTE is America's Citizens Band Headquarters

Complete Portable Communications for Everyone

NO LICENSES, TESTS OR AGE LIMITS

HE-29

LAFAYETTE 9-TRANSISTOR CITIZENS BAND "WALKIE TALKIE"

42.95
2.00 Down
2 for 82.95

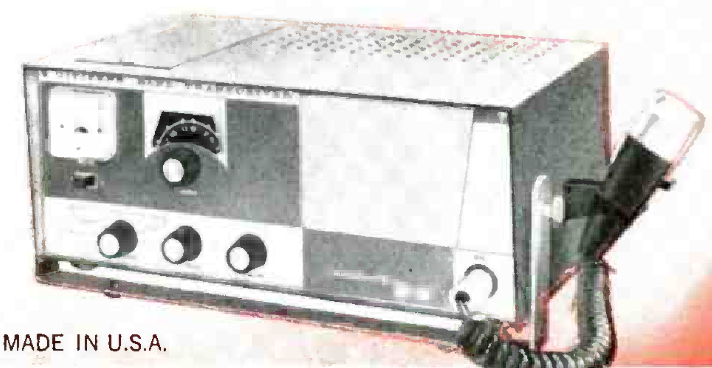
- Completely Wired—Ready to Operate
- Fully Transistorized — 9 Transistors plus 1 Diode
- Uses Inexpensive Penlight Batteries • No License, Tests or Age Limits • Comes with Leather Carrying Case, Earphone, Antenna, Batteries and Crystals

As simple and easy to use as the telephone—and twice as handy. Receives and transmits up to 7 miles under favorable conditions, or 1.5 miles under average conditions. Weighs only 18-oz. and slips into your pocket. Push-to-talk button operates built-in speaker as sensitive microphone.

Complete with Leather Carrying Case, Earphone, Antenna, Batteries, and Crystal

LAFAYETTE HE-20A *Deluxe* CITIZENS BAND TRANSCEIVER

ONLY **109.50**
5.00 Down



MADE IN U.S.A.

Now With Added Deluxe Features—

- Pi-Network for Greater Power Output • Calibrated "S" Meter • 14 Tube Performance, 3 Diodes • Built-in 12 Volt Power Supply for Mobile Use • Complete with Matched Crystals for Channel 9

A highly efficient 2-way communications system operating over a distance of up to 20 miles or more depending on terrain. Features 4 crystal-controlled transmit positions and 4 crystal-controlled receive positions. Tuneable superhet receiver covers all 23 assigned channels. Other highlights include dependable push-to-talk ceramic mike & relay, adjustable squelch control, automatic series gate noise limiter and illuminated dial.

LAFAYETTE HE-15A SUPERHET Citizens Band TRANSCEIVER

ONLY **59.50**
5.00 Down

MADE IN U.S.A.

- Completely Wired—Not A Kit • 5 Crystal-Controlled Transmitting Positions • Tuneable Receiver Over Full 23 Channels • High Output Crystal Microphone • Complete with Transmitting Crystal for Channel 9

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

HE-19	Telescoping Whip Antenna	Net 3.95
HE-16	Power Supply for 12 Volts	Net 10.95
HE-18	Power Supply for 6 volts	Net 10.95

HE-800WX

LAFAYETTE ALL-IN-ONE CITIZENS BAND MOBILE ANTENNA

The Scoop Buy for Citizens Band Mobiles

6.95

- Chrome Swivel Base • Stainless Steel Spring • 102½" Stainless Steel Whip for Optimum 11-Meter Performance

Chrome swivel ball mount base designed for mounting on any surface. Stainless steel spring holds rod in properly adjusted position and prevents rod damage from shocks and blows. Stainless steel whip for maximum resiliency and strength.

NEW! LAFAYETTE RADIO FIELD INDICATOR

- Continuously Indicates Transmitter Output
- Rugged 200 ua Meter Movement
- Requires No Electricity, Batteries or Transmitter Connection

Check the performance of marine, mobile or fixed transmitter. Features a 200 ua meter movement with variable sensitivity control. Earphones can be plugged in for an aural check of output. Antenna extends from 3¼" to 10¾". Magnet on bottom plate allows easy mounting on car dash or metal surfaces. Size, less antenna, 3⅛W, 2¼H, 2"D.

A Must for All Ham and CB Operators

TM-14

6.95

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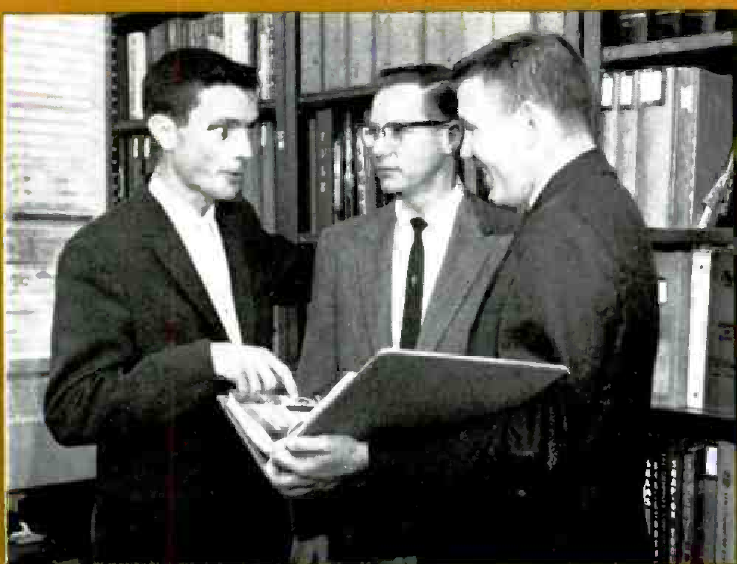
EMPLOYERS ARE QUICK *to recognize the value of your enrollment in CREI Home Study Programs—to your company as well as to yourself. Often promotion comes before you complete your studies. Here Engineer Robert Blanks discusses CREI with Director Wayne G. Shaffer of Vitro Laboratories.*

YOUR LIVING IS BETTER *when you prepare yourself for—and get—desired promotions and advancements through CREI Home Study Programs. CREI alumnus Robert Blanks, shown relaxing on his front lawn with his dog, is understandably proud of his fine home in a comfortable suburban neighborhood.*



YOU EARN NEW RESPECT. *Your CREI acquired knowledge helps you form new associations, makes you more valuable on the job. Engineer Blanks talks with Technician Robert I. Trunnell, a CREI Home Study alumnus and John H. Scofield Mathematician, a current CREI Home Study student—all of Vitro Laboratories.*

YOUR WHOLE FAMILY BENEFITS *from your CREI Home Study Program. Everyone in Engineer Blanks' growing family pitched in to provide him with free time at home to pursue his CREI studies. Now they share in his success.*

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My educational and electronics experience qualifications are:
(All information held in strict confidence)

Employed by ______
Type of present work ______
Education: Years High School ______ Other ______
Electronics Experience ______
Name ______ Age ______
Address ______
City ______ Zone ______ State ______
Check: ☐ Home Study ☐ Residence School ☐ G.I. Bill

facility in Phoenix, Ariz. . . . **MITRONICS, INC.** has moved into its new factory at Murray Hill, N.J. . . . **RADIO SHACK CORPORATION** has opened its sixth unit at South Shore Plaza in Braintree, Mass. . . . **LEAR, INCORPORATED** has announced a $3,500,000 plant expansion program at its instrument division in Grand Rapids, Mich. . . . **ALLEGRI-TECH, INC.** of Nutley, N.J. has opened a 20,000-square-foot plant at the East Millsdale Industrial Park, Burlingame, California . . . **KOESSLER SALES COMPANY** has moved its San Francisco offices to new and larger quarters at 2803 Geneva Ave. . . . **HOWARD W. SAMS CO., INC.** and **BOBBS-MERRILL CO., INC.** have moved their New York offices to 3 West 57th Street . . . **NAVIGATION COMPUTER CORPORATION** has moved to the Valley Forge Industrial Park, Norristown, Pa. . . . A new plant for the production of welded components for the electrical-electronics industry has been opened by **SYLVANIA ELECTRIC PRODUCTS INC.** at Warren, Pa. . . . **DELCO RADIO DIVISION** is building a new 150,000-square-foot manufacturing plant for semiconductor products at Kokomo, Ind. . . . **ARCO ELECTRONICS, INC.** has dedicated a new headquarters plant in the Lake Success Business and Professional Park, Great Neck, N.Y.

* * *

GLENN E. RONK has been appointed director of marketing at *Cornell-Dubilier Electronics Division*.

In this new post he will supervise the marketing managers, at the firm's six plants, who have responsibility for application engineering, product planning, pricing, advertising and sales promotion, order service, and associated marketing functions.

Mr. Ronk, who was graduated from USC *magna cum laude* in engineering, will maintain offices in Newark, N.J. at the company's corporate headquarters.

* * *

H. T. HARWOOD is the new director of public relations for *Shure Brothers, Inc.* He was formerly advertising manager of the firm . . . **LOUIS H. ARICSON** has been named chief executive officer of the *Weston Instruments Division* of *Daystrom* . . . **REAR ADMIRAL WILLIAM L. FRESEMAN** (USN, Ret.) has been named assistant to the president of *Radio Engineering Laboratories, Inc.* . . . *Pioneer Electric & Research Corporation* has named **JOHN W. BULLOCK** to the post of sales manager . . . **ALLAN W. GREENE,** president of *Heath Company*, has been elected a corporate vice-president of the parent firm, *Daystrom, Inc.* . . . **B. BRADLEY OSTHUES, JR.** has been appointed vice-president and general manager of *Servo Dynamics Corporation*, a wholly owned subsidiary of *National Company, Inc.* . . . **ROBERT E. JOHNSON** has joined *Shallcross Manufacturing Company* as vice-president and sales manager . . . **REGINALD A. YOUNG** has been named manager of the subminiature receiving

(*Continued on page 86*)

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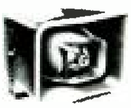
the only way your customers can enjoy genuine outdoor high fidelity!

with University's MUSIC/AIRE™

weatherproof high fidelity speaker systems



MODEL MLC

MODEL BLC

One quick demonstration of a Music/Aire and your customers will never again settle for the restricted range and tone of a portable when they go outdoors. Each Music/Aire is a genuine coaxial, with separate woofer and tweeter. They deliver wide-range, full-bodied sound to any desired area . . . wide or narrow, shallow or deep. And they can be left out in rain or shine . . . they're immune to everything but superb sound! For details, see your rep, or write Desk S-8. University Loudspeakers, Inc., White Plains, N. Y.

MLC ideal for moderate-size areas. Front loaded folded horn. 12¾" x 9⅛" x 10⅝" deep. $34.50

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And the WLC . . . finest outdoor system made . . . for heavy duty installations. $150.00

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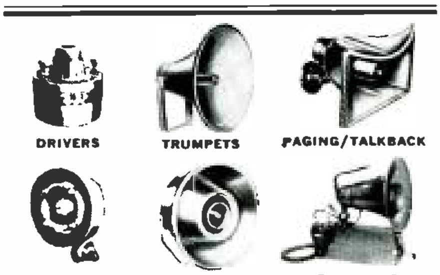
OUTDOOR HIGH FIDELITY LOUDSPEAKERS REPEAT SOUND SUCCESS OF '57

UNIVERSITY—THE WORLD'S LARGEST MANUFACTURER OF PUBLIC ADDRESS SPEAKERS

For every public address installation, University's complete line of drivers, trumpets, paging/talk-back and many special purpose speakers assures you of the exact speaker required to do the job as specified, at minimum cost and without waste. For complete information, write Desk S-81, University Loudspeakers, Inc.. 80 So. Kensico Avenue, White Plains, N. Y.

Wherever highest quality reproduction of voice and music is essential — with wide-angle coverage at high output levels, full frequency response and complete protection against the weather — that's where you'll find University up front. Not only at Washington's Capitol Plaza, but at auditoriums, parade grounds, stadiums and concert halls throughout the world. For all University's weatherproof speakers are *genuine dual-range systems*, with separate bass and treble drivers — resulting in full-bodied lows, cleaner highs, greater efficiency, less distortion and superior acoustic projection.



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Spot News

Latest Information on the Electronic Industry

By ELECTRONICS WORLD'S WASHINGTON CORRESPONDENT

GIRL RECEIVES 200,000TH CITIZENS RADIO AUTHORIZATION—The 200,000th Citizens Radio Service permit was recently issued to a young girl in Spenard, Alaska, operating station 23Q0106. The Commission was told that the two-way radio will be used for contact between car and home and also to keep in touch with relatives in the neighborhood who have no telephone. CB is the Commission's fastest growing individual radio service numerically—only two years ago 50,000 were using CB and a year ago (at the end of May), the number exceeded 117,000.

PORTABLE FM RADIO USE PROHIBITED ON PLANES—FM sets whose oscillators operate within or very near the v.h.f. aircraft band (108-118 mc.) have been banned from all civil aircraft. In issuing the ruling, the FCC said that interference has been found to affect v.h.f. radio navigation systems, causing the appearance of a "red flag," indicating navigation instrument trouble to the pilots.

NEW BANDS SOUGHT FOR SPACE-AGE COMMUNICATIONS—The next ten years will face such heavy demands for world-wide space-program channels that clusters of new bands will have to be found. In an effort to appraise this critical situation, the Commission has issued proposals that would provide satellite space service for communications, space research, and meteorological purposes; also initial requirements for an aeronautical mobile route service operating in a space environment and telemetry, command, guidance, and tracking functions tied to such services. Developed in consultation with the Office of Civil Defense Mobilization and the Interdepartment Radio Advisory Committee, and other interested government agencies, the program calls for a total of about 3000 mc. of spectrum space between 3700 and 8400 mc. Reviewing the reasons for some of these needs—as in the case of broadcasting—Washington said it is probable that communication satellites will be used to relay aural and television programs and, accordingly, will require special higher frequency channels. Commenting on the meteorological satellite status, the Commission said that two types of satellites are under study—polar or quasi-polar orbiting types and the so-called synchronous orbiting models. For these, three types of transmission are planned: from Command Data Acquisition station (CDA) to the satellite(s) during periods when the satellite is within line-of-sight of the CDA station; from the satellite to the CDA station on command during the time the satellite is within line-of-sight of the CDA station; and continuous transmission from the satellite. In one instance to meet these requirements, two channels (90-kc. wide) will be required for a digital and slowed-down video transmission from satellite to ground, and these channels would be in the 137-138 mc. band. The transmitters would have up to a possible maximum of 50-watts output. By 1965, existing telecommunications facilities throughout the world—submarine cables and high-frequency radio circuits—will be so taxed, Washington warned, that it will fall upon earth-satellite relays to save the day.

EARTH-SPACE RADIO COMMUNICATIONS RESEARCH AUTHORIZED—Westinghouse has received permission to operate an experimental radio station to bounce signals off the moon and passive (non-radio-equipped) earth satellites for basic research and study of space communications. The earth station will be located near Linthicum (Ann Arundel), Maryland and reflected signals will be received by the same station. The authorization, which extends to November 1st, specifies operation on the center frequency of 550 mc., with power of 2000 watts maximum into the antenna.

KENNEDY SCIENCE AIDE WARNS OF TECHNICAL MANPOWER DEFICIT—Dr. Jerome B. Wiesner, the President's special assistant for science and technology, has warned that the nation is producing only about half the top-level scientists it needs. Speaking before the EIA assembled in convention, Dr. Wiesner said the country needs between 12,000 and 15,000 scientists yearly in contrast with the present output of about 6000. He estimated that the national demand for engineers and scientists would total between 2 and 2½ million in 1970. A member of the faculty at MIT for more than 16 years, Dr. Wiesner is on leave as Director of MIT Research Laboratory of Electronics. He was the recipient of EIA's 1961 Medal of Honor for his contributions to the advancement of the electronics industry.

-30-

LETTERS FROM OUR READERS

DIODE EQUALIZING RESISTORS

To the Editors:

I read the article "Diodes Are Different" in a recent issue of ELECTRONICS WORLD with considerable interest as I have recently used silicon diodes in a modulator I constructed.

However I do not agree with the necessity of using equalizing resistors across silicon diodes in series to prevent their breakdown. It is true that the back resistance of diodes varies greatly, even with diodes of the same type. Thus the diode with the highest back resistance will have the highest voltage across it. But this voltage cannot become great enough to damage the rectifier if the total peak inverse voltage does not exceed the sum of the p.i.v.'s of the individual diodes. This is due to the fact that as the p.i.v. across an individual diode increases, a point will be reached where an avalanche condition takes place. Under this condition the inverse resistance of the diode decreases, thus causing the voltage across it to decrease while also increasing the voltage across the other diodes. This avalanche condition will damage a diode only if it occurs long enough to overheat the semiconductor. The voltage equalization takes place fast enough to prevent this damage.

Thus we see that while the equalizing resistors will not hurt anything they are really unnecessary.

RONALD FREIMUTH
Crandon, Wisconsin

We are still getting quite a bit of reader mail on Author Hazlehurst's article on the use of diodes. Here is his response to a question raised by Reader Freimuth.—Editors.

Dear Mr. Freimuth:

Your viewpoint is an interesting one, and while your description of events may be sound, I cannot agree with your conclusion that shunting resistors do no good. It is heat that is the enemy of diodes and one that alternately avalanches and then conducts at full capacity is doomed to the destruction cycle of which I spoke in my article. This view is not that of a lonely experimenter sitting in his basement with his imagination and his soldering iron. At companies where there is some knowledge of this matter, the engineers consider it good practice not only to shunt each diode in a string with a 500,000-ohm resistor, but also a .01-μf capacitor

There is a real principle involved here, and that is what is good engineering *in a given situation.* As a long-time radio ham, a hi-fi enthusiast, and a non-practicing graduate electrical engineer, I have over the years seen some fearful and wonderful concoctions, from an engineering point of view, put together by eager beavers who are long on enthusiasm and short on technical knowledge. It is a constant source of amazement to me to see how many seem to perk along quite well. I sometimes think this may be one factor that makes it possible for the untutored to play a significant role in the advancement of the art.

The reason for this, of course, is that so many components, or even systems, are operating at a fraction of breakdown levels. But when you start to operate right at maximum ratings, you can't fool with it. There are a lot of diode strings in this country (maybe you have one in your modulator) operating without equalizing resistors and avalanching along merrily. Maybe the ambient temperature is low. Maybe they are operating, on the average, at half capacity. Or maybe the guy just has an effective St. Christopher medal (and unusually balanced diodes). But I'm afraid that doesn't prove much.

If you have trouble with the power supply in your modulator, take a chance and use some equalizing resistors—it might save you some money.

J. H. HAZLEHURST
Kenilworth, Illinois

* * *

TEST EQUIPMENT DISTORTION

To the Editors:

The Product Test Report of a recent issue of ELECTRONICS WORLD carried this statement:

"Incidentally, we have subtracted the residual distortion of our test equipment in order to arrive at these figures *(of distortion of the equipment tested).* This may or may not be valid depending on the nature of the residual distortion."

The product reviewer's doubts as to the validity of the results obtained by this method are well founded. The problem is that the distortion components created by the test oscillator, the amplifier under test, and the distortion meter will add in phase for each distortion component separately. Unless the phase and magnitude of the individual distortion components are known for the test oscillator, the distortion meter, and the distortion meter output, it is not possible to obtain results with absolute accuracy.

Consider these examples: The over-all distortion between test oscillator and distortion meter is 0.1%. An amplifier of known 0.5% distortion is connected between the two instruments. Depending

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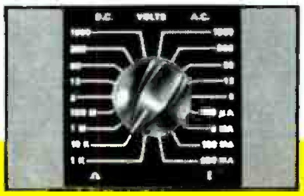

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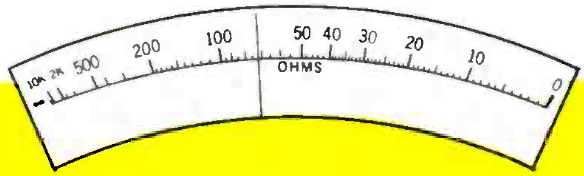

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V O Matic 360

AUTOMATIC VOLT-OHM-MILLIAMMETER

- Individual Full-Size Scale for Each Range
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- Only One Scale Visible at Any Time
- No Multiplying . . . No False Readings
- Meter Protected Against Extreme Overload
- Mirrored-Scale for Precise Readings

WITH BURN-OUT PROOF METER

EASIEST—FASTEST—ERROR-FREE READINGS

Once you set the range switch properly, *it is impossible to read the wrong scale.* Readings are easiest, fastest of all—so easy the meter "practically reads itself." Eliminates reading difficulties, errors, and calculations.

All scales, including the ohms scale, are *direct reading*. You do not have to multiply. Saves time and trouble. Gives you the right answer immediately. Ohms-adjust control includes switch that automatically shorts out test leads for "zero" set.

Every scale in the V O Matic 360 is the same full size . . . *and only one scale is visible at any one time*, automatically. Supplemental ranges are also provided on separate external overlay meter scales.

This new-type automatic VOM is another innovation by B&K that gives you features you've always wanted. Outdates all others.

Net, $59.95

Includes convenient stand to hold "360" for correct viewing in 4 positions.

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Ranges:

DC Volts	— 0 - 3, 15, 60, 300, 1000, 6000 (20,000 Ω/v)
AC Volts	— 0 - 3, 15, 60, 300, 1000, 6000 (5,000 Ω/v)
AF (Output)	— 0 - 3, 15, 60, 300 volts
DC Current	— 0 - 100 μa, 5 ma, 100 ma, 500 ma, 10 amps
Resistance	— 0 - 1000 ohms (3 Ω center)
	0 - 10,000 ohms (50 Ω center)
	0 - 1 megohm (4 k Ω center)
	0 - 100 megohms (150 k Ω center)

Supplemental Ranges: 18 separate external overlay meter scales for:
DC Volts— 0 - 250 mv **Capacitance**—100 mmfd to 4 mfd
Audio Power Output—up to 56 watts **DB** (decibels)
Peak-to-Peak AC (sine) Volts— 0 - 170, 850

Polarity Reversing Switch and **Automatic Ohms-Adjust Control**

Frequency Response AC: 5 - 500,000 cps

Burn-Out Proof Meter: Protected against overload and burn-out

Complete with 1½-volt and 9-volt batteries and test leads

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upon the phase of the distortion components, the distortion meter reading will be anywhere between 0.4% and 0.6%. Therefore, the over-all distortion measurement is accurate to ± ⅕ of the reading because the ratio of actual amplifier distortion to test equipment distortion amounts to 5:1. The above shows the maximum error in distortion measurements tolerable as specified in the Amplifier Test Standard IHFM-A-200 as published by the Institute of High Fidelity Manufacturers.

A severe measurement problem arises when ultra-low distortion values are to be measured. It is extremely difficult to hold test equipment distortion reliably below 0.03% over a narrow band of frequencies with 0.1% a more typical value. Yet, amplifiers of good design operated at relatively low output levels will exhibit distortion of the same order of magnitude. Unless special and very time consuming techniques are used, it is not possible to obtain very low distortion figures of amplifiers with any accuracy. Using conventional techniques, total distortion readings lower than test equipment distortion may be obtained because of partial distortion cancellation.

If it is not required to obtain the absolute accuracy in distortion measurements, it is always worthwhile to list separately the over-all distortion results and the distortion of the test equipment at the levels and frequencies used. This way the confidence level of the measurements is established and the results can be interpreted.

DANIEL VON RECKLINGHAUSEN
Chief Research Engineer
H. H. Scott, Inc.
Maynard, Mass.

Naturally, we could not take the space in a product report to give all the reasons outlined above, but we are sure our readers are interested in the serious problems that exist in taking measurements on very low distortion equipment.
—Editors.

* * *

STEREO DIMENSION CONTROL

To the Editors:

Your recent article "A Dimension Control For Stereo" (April 1961 issue) showed a circuit using a dual 500,000-ohm control with both sections center-tapped and with a linear taper. Where can I obtain such a control for use in the circuit?

W. K. VANDWANDER
Altoona, Pa.

To the Editors:

I have constructed the stereo dimension control that was described in one of your recent issues and it works exactly as claimed. I am well pleased with its performance.

However, I had to do a bit of improvising since I was unable to locate the dual 500,000-ohm ganged center-tapped potentiometer as shown in Fig. 4. I tried several electronics parts dealers and none of them carried the part in stock.

I ended up using two 250,000-ohm ganged pots connected in series for each of the 500,000-ohm controls that were shown. The junction of each pair of 250,000-ohm pots was connected to ground and the two sliders in each pair were then connected to a double-pole, double-throw switch. This switch allowed me to insert two of the four 250,000-ohm elements into the circuit as required.

This arrangement works as well as the one you described, but I have three controls to handle instead of the single control discussed.

HAROLD G. HEINAMAN
Pittsburgh, Penna.

Our large volume of mail on the article indicates that a good many of our readers want to experiment with this circuit. The dual-tapped 500,000-ohm control cannot be obtained readily in assembled form. However, both Centralab and IRC offer parts from which such a control can be easily assembled. For example, the IRC "Concentrikit" dual-volume control may be assembled from two base elements numbered B19-133X. Or it might be possible to use two IRC Q19-133X controls that are mechanically ganged together.—Editors. —30—

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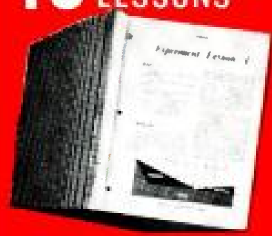

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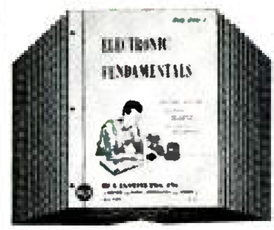

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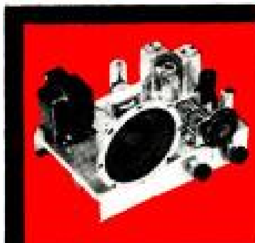
PLUS ALL THIS AT NO EXTRA COST...

15 KITS

to build a Multimeter, AM Receiver and Signal Generator. Kits contain new parts for experiments, integrated so as to demonstrate what you learn in the lessons and to help you develop technical skills. Each kit is fun to put together!

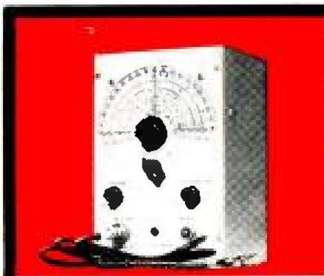
MULTIMETER

A sensitive precision measuring instrument you *build* and *use* on the job. Big 4½" meter with 50 microamp meter movement. 20,000 ohms-per-volt sensitivity d-c, 6,667 a-c.



AM RECEIVER

Have the satisfaction of building your own radio receiver with this high-quality 6-tube superheterodyne set. Big 5" speaker, fine tone!



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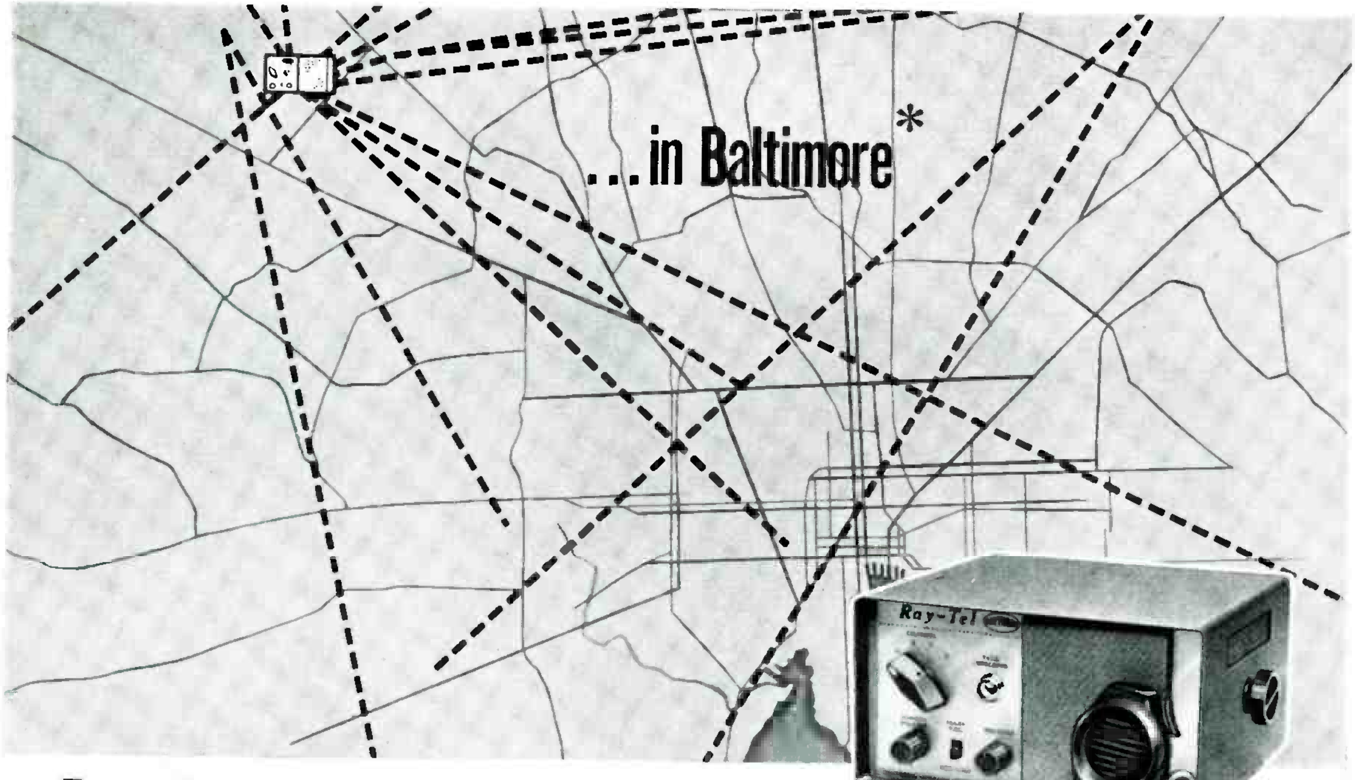

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BETTER PERFORMANCE, INCREASED RANGE

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"My base station and car are equipped with Ray-Tel. I use this system primarily for business purposes, and I am extremely pleased with the excellent performance and range of both units."

And here's why Mr. Lubin gets performance — because Raytheon spares no expense to give you quality features that defy comparison with other models. Check these features before you buy:

In the **RECEIVER: Sensitivity** — better than 1 μv, not more than 8 KC at 6 db. **ANL** (Automatic Noise Limiter) — series valve type. **Squelch** — no bleed-through. **AVC** (Automatic Volume Control) — prevents overload. **Audio** — at least 2.5 watts at less than 10% distortion.

In the **TRANSMITTER: Power Output** — certified at 2.8 watts. **Modulation** — close to 100%. **Microphone** — rugged carbon button. **Electronic Switching** no troublesome relays. **Pi Network Output** — easy efficient loading. **Standby Switch** — saves battery.

And in **CONSTRUCTION: Tube Clamps, Inspected Solder Joints, Adequate Tie Points, Double Impregnated Transformer, Plated Braced Chassis, Locking Rivets** — guards against corrosion, **Epoxy Coating** — for lasting protection.

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RAYTHEON

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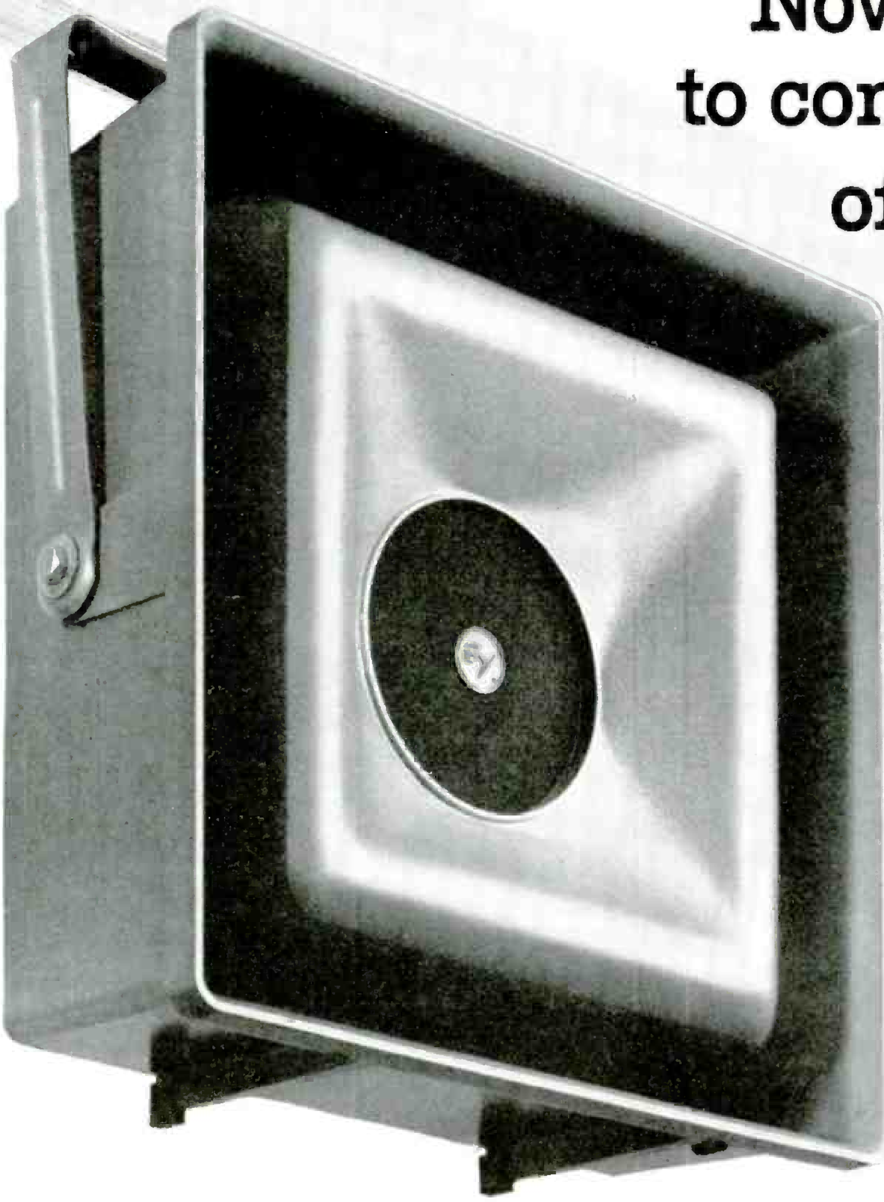

The more you enjoy outdoor living, the more you'll enjoy the Electro-Voice Musicaster—world's finest weather-proof loudspeaker system.

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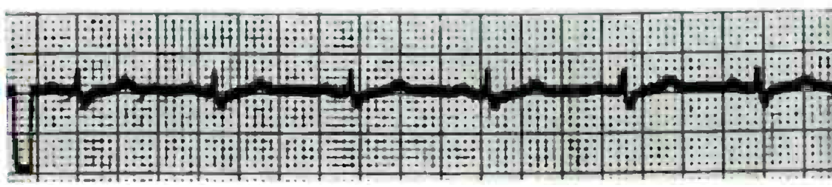
Electrical Activity of the Human Body

By ED BUKSTEIN / Author, "Medical Electronics"

Life and electricity are closely related. Here is the nature of some of the signals that are generated within the body along with activity of heart, brain, muscles.



IN A WAY that is not yet completely understood, *life* and *electricity* are so closely related that electrical activity may prove to be the essence of being alive. With a voltmeter of sufficient sensitivity, for example, you can measure the potential in the hark of a tree or the root of a plant (which, in some inexplicable manner, seems to vary with the phases of the moon). It has been known for well over a century that nerve and muscle tissues generate small but measurable voltages. Today, in every well-equipped hospital and clinic, electronic instruments are used to measure and record these potentials. Such recordings are of great value in diagnosis and research studies.

We are inclined to think of pulse modulation, logical switching networks, and feedback control systems as relatively recent developments. But nature has been using these techniques for many thousands of years. One of the body's servomechanism systems, for example, adjusts the pupil of the eye in accordance with changes of light level. You can see this automatic control at work by standing in front of a mirror in a darkened room. If you now switch on the lights, you will see the pupils automatically become smaller to limit the amount of light entering the eyes.

The human brain represents about two per-cent of the total body weight, but this two per-cent tells the other 98 per-cent what to do and when to do it. The brain functions as a supervisory control unit, analyzing the input information it receives from the sense organs, making decisions and issuing orders in the form of control signals to the muscles and glands of the body. Without the controlling influence of the brain, the body would be a wilderness of uncoordinated cell activity.

The structurally delicate brain, enclosed in the hard protective shell of the cranium, contains literally billions of nerve cells. Each of these cells, because of its chemical composition, generates a minute amount of voltage. The individual cells are electrically interconnected so that cells can communicate with each other. As a result, the electrical activity of one cell can act as a trigger to influence a neighboring cell. This neighboring cell can, in turn, fire one of its neighbors, etc. Neighboring cells are connected by means of a *synaptic junction*, a kind of chemical rectifier which allows electrical impulses to pass through in only one direction (suggestive of the switching diodes used in the logic circuits of an electronic computer). The nerve pulses coming into the brain from the sense organs therefore fire a selected pattern of brain cells. This pattern gives meaning to the input signal. Excitation of a given pattern of cells, for example, may correspond to a Beethoven sonata. A theorem of geometry may excite another pattern of cells. The sound of a ringing telephone or the pleasant smells from the kitchen at dinnertime excite still other sets of cells.

Anatomists have mapped out the motor areas of the brain by means of electrical stimulation of the exposed brain during surgical procedures. Voltage applied by means of a small probe to one part of the brain may cause the movement of a wrist; stimulation of another area may move only a finger; other areas control the legs, toes, eye lids, etc. Stimulation of the area associated with hearing will produce the sensation of sound even though no actual sound may be present. Likewise, stimulation of the sight areas will produce the

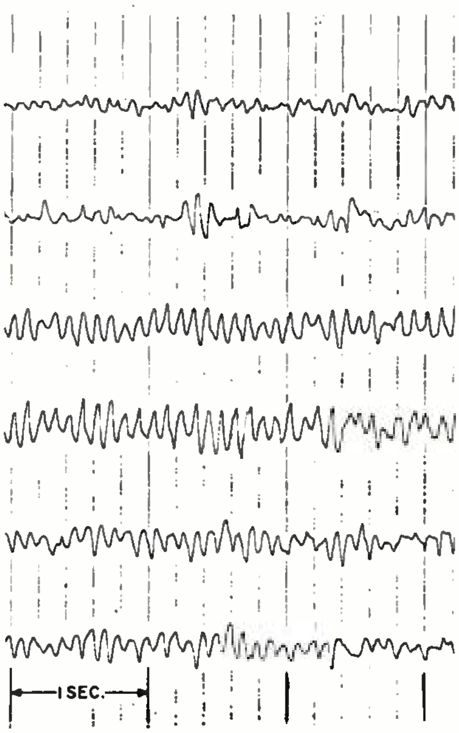


Fig. 1. Normal electroencephalogram is approximately sinusoidal and varies in both amplitude and frequency. Basic frequency, 8-12 cps, is known as alpha rhythm.

illusion of lights. Interestingly, electrical stimulation may sometimes awaken memories which the patient had long forgotten.

The electrical activity which goes on continuously in the brain can be monitored by means of small metal electrodes placed on the scalp. The voltage picked up by the electrodes is only about 50 microvolts in amplitude and a high-gain amplifier is therefore required, as shown in Fig. 2. The amplified signal controls a lightweight pen that writes on a moving strip of paper. This recording is the *electroencephalogram*—the waveform of the brain. The electroencephalogram is roughly sinusoidal in shape and varies in both amplitude and frequency as shown in Fig. 1. The basic

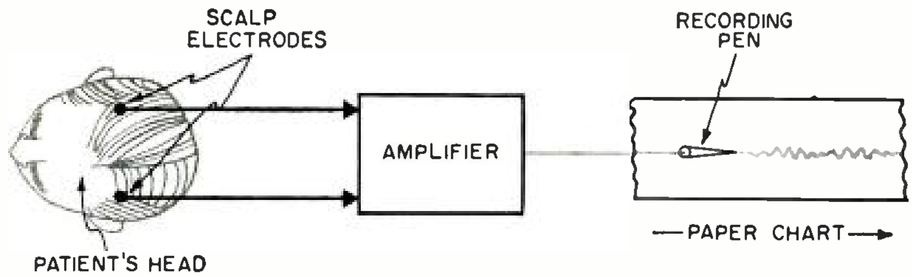


Fig. 2. The electrical activity of the brain produces waveforms which can be monitored by means of scalp electrodes. Recorded waveform is an electroencephalogram.

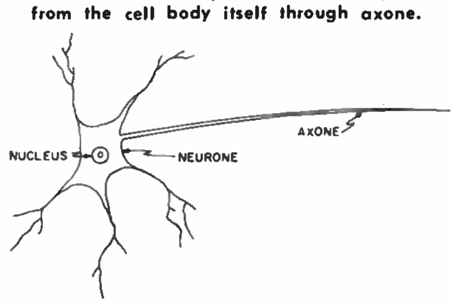
rhythm of the brain is in the range of 8 to 12 cycles per second and is known as the *alpha* rhythm. The functional meaning of the brain waveforms and the electro-chemical mechanisms by which they are generated are still matters for conjecture, but the electroencephalogram is nevertheless useful diagnostically. Brain tumors, for example, can be localized by means of the unusual electrical activity in the corresponding area, and certain brain disorders produce recognizable waveforms.

A single-channel instrument is shown Fig. 2, but most clinical and research electroencephalographs (EEG) have at least six or eight amplifiers and a like number of recording pens. This permits simultaneous recording of waveforms from many areas of the scalp, corresponding to different lobes of the brain.

Nerve Impulses

The nervous system is the communications network of the body. Handling an enormous volume of traffic, this network is "on duty" twenty-four hours a day, seven days a week. Pulse waveforms traveling through the nerve fibers control our thoughts and our emotions, regulate our heartbeat and respiratory rates, and command our reflex actions and glandular secretions. As you read these words, nerve impulses are racing through the optic nerves to your brain. Nerve cells in the brain respond to these incoming pulses to give meaning to the patterns of ink on this page. As your eyes scan each line of print, an *end-of-line* signal is flashed to your brain. The brain responds by sending out pulses to contract your eye muscles, returning your vision toward the left. At the same time, a *vertical* pulse tilts your eyes slightly downward during the right-to-left retrace, in preparation for the next line of print. When your eyes reach the last word on the page, an *end-of-page*

Fig. 3. Typical nerve cell is irregular in shape and has tubular extension known as axone. Nerve pulses follow a path from the cell body itself through axone.



signal causes your brain to dispatch pulses to your arm and hand muscles. Actually, an *anticipating circuit* will tense your arm muscles before your eyes reach the last word on the page. As you turn the page, other pulses in a negative feedback network limit the extent and speed of your arm movements. Without such negative feedback, the initial contraction of your arm muscles would literally rip the page right out of the magazine.

All of these control signals are subordinate to a higher level of *decision making* circuits. As a result, the eyeball sweep circuits and the end-of-page arm control circuits can be inhibited by the presence of pulses in the higher level circuits. Pulses at these higher levels may be arriving from the sensory nerves carrying messages such as "phone is ringing—activate leg muscles" or "I'm thirsty—stop reading and get water." Interestingly, these higher level circuits can be inhibited by still higher levels which might initiate command pulses meaning "disregard the telephone" or "get water later." All of this nervous activity is, of course, only a small part of the total traffic pattern. Concurrently, nerve pulses in appropriate fibers are triggering the heartbeat, controlling the breathing rate, and adjusting the eye pupils.

Fig. 5 shows in highly schematic form, the basic connection of the sensory and motor nerves. The sensory nerves are the conducting pathways between the sense receptors and the brain. Sense receptors are varied in function and widely dispersed throughout the body. Examples are the taste buds of the tongue, the light receptors of the eyes, the heat, cold, and touch receptors in the skin, etc.

The incoming pulses in the sensory nerves are analyzed by the brain, and the brain may choose to either disregard them or to take some action. If the finger is placed on a warm surface, for example, the heat receptors in the finger will dispatch pulses to the brain. If the surface is only moderately warm, the incoming pulses to the brain will occur at a low repetition rate and the brain may disregard them. If the surface had been hotter however, the pulse frequency would have been higher. In this case, the brain would send pulses to the arm muscles in order to pull back the finger. If the surface is very hot, an interesting switching action occurs to prevent serious damage to the finger. The high pulse frequency, corresponding to the high temperature, opens an emergency gate which has the characteristics of a high-pass filter. As shown in Fig. 5, the emergency gate bypasses the brain and activates the arm muscles directly. This is a time-saving procedure which pulls back the finger in less time than would have been required for the brain to analyze the incoming pulses. Such *reflex* actions frequently protect the body from serious damage.

Most of the nerve cells of the body are located in the brain and spinal cord. It is estimated that there are about 14×10^9 of these cells. A typical shape of the nerve cell as shown in Fig. 3. The cell body, known as a neurone, is rather irregular in shape and has a long tubular extension known as the axone. The axone is the nerve fiber, and the fibers of many cells may run side by side like a multiconductor cable. The individual nerve fibers are extremely small in diameter, typically about a thousandth of an inch, and range in length up to about three feet.

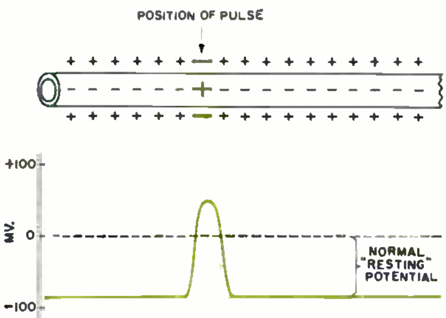


Fig. 4. Nerve pulse travels along fiber as an in-rush of positive ions into the normally negative interior. Interior of fiber therefore becomes momentarily positive as the nerve pulse passes along.

Superficially, the nerve fiber resembles a coaxial cable. The tubular membrane is filled with a jelly-like conducting substance, and the outside of the membrane, corresponding to the outside conductor of a coax, is bathed by conducting body fluids. The nerve fiber however, is much more than a mere passive conductor. Experimental evidence shows that the nerve impulse, after traveling the length of the fiber, suffers no loss of amplitude. It is more accurate therefore to regard the nerve fiber as a cable having a built-in power supply and the ability to regenerate and reshape the pulse from point to point along its length.

By analogy, the nerve fiber can be likened to a large number of thyratrons connected in cascade so that the output pulse of each thyratron triggers the next thyratron. The output pulse of the last thyratron would therefore be as great in amplitude as the output of the first one. The analogy is further strengthened by the all-or-none response of both the nerve fiber and the thyratron. An input pulse will not fire a thyratron unless its amplitude is as great or greater than a certain minimum amplitude. An input pulse greater than this minimum required value however, will not produce a larger value of

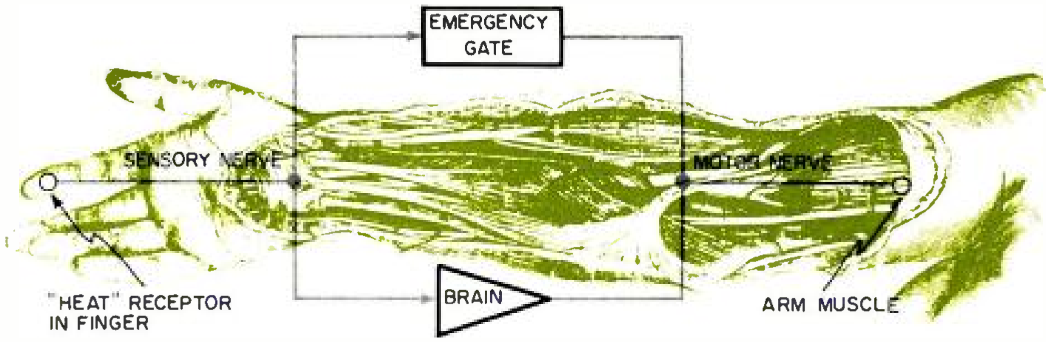


Fig. 5. Sensory nerves carry input information to the brain, then the brain sends pulses to muscles through motor nerves. Gate bypasses brain in emergency reflex.

plate current than would be produced by the minimum-value pulse. (In the same sense that a rifle bullet will not travel faster if you pull the trigger harder, the thyratron either ionizes or it doesn't.) The nerve fiber behaves in a similar manner. If the electrical stimulation is below the threshold value, the nerve will not fire. Increasing the stimulation above the threshold value however, will not increase the amplitude of the pulse propagated along the nerve fiber. There is a further similarity between the nerve fiber and the thyratron in that the thyratron requires a finite time to de-ionize (assuming, of course, that some means is provided to produce de-ionization). Likewise, the nerve fiber once excited will not respond to a second stimulating pulse until it has had time to recover from the effect of the first pulse. This interval during which the nerve will not respond to further stimulation is known as the refractory period.

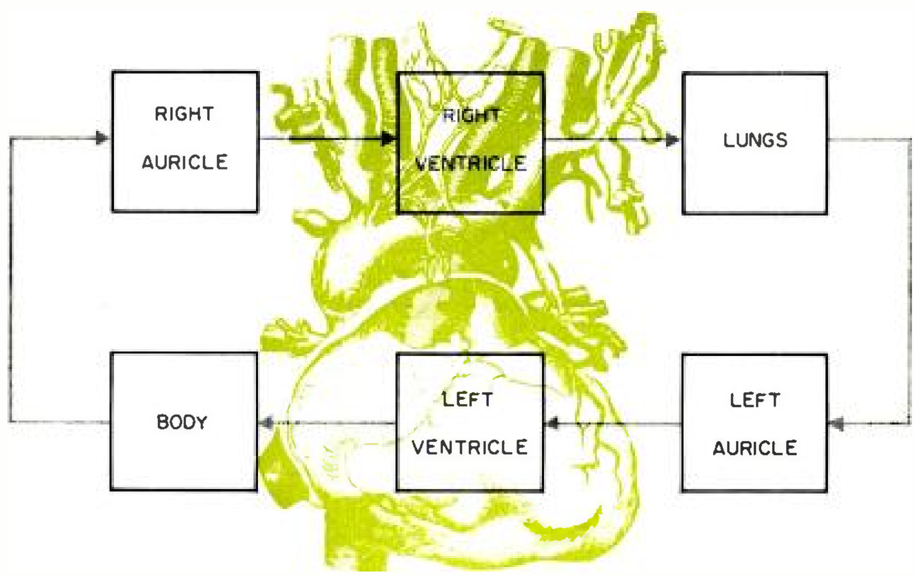
As shown in Fig. 4, the tubular membrane of the nerve fiber functions as an insulator to separate the negative ions inside from the positive ions outside. The inside of the fiber is therefore electrically negative with respect to the outside. This potential difference has been measured by means of micro-electrodes and is typically about 80 to 100 millivolts. Biologists describe the membrane as being *selectively permeable,* meaning that the positive ions (sodium) cannot penetrate the membrane and therefore remain on the outside. The negative ions on the inside are produced by the chemical activity within the fiber.

When the nerve fiber is electrically stimulated by a sense receptor, the membrane becomes permeable to sodium ions at the point of stimulation. The positive ions now rush through the membrane to the interior. As a result of this *sodium current,* the interior of the fiber becomes positive with respect to the exterior. The chemical mechanism which alters the permeability of the membrane is not yet understood, but it is known that the action is regenerative: the sodium current makes the membrane more permeable, and the increased permeability permits a greater flow of sodium current. Furthermore, the inward rush of sodium current produces an increase of permeability of the adjacent section of membrane. Consequently, the point of sodium in-rush progresses along the length of the fiber. This nerve impulse travels along the fiber at a speed which may reach several hundred miles per hour. A typical shape of the nerve pulse, which is about 130 millivolts in amplitude, is shown in Fig. 4.

Muscle Potentials

During the latter part of the 18th cen-

Fig. 6. Block diagram of human heart and circulatory system. Right side of heart pumps blood to lungs for oxygen; left side distributes oxygenated blood to body.



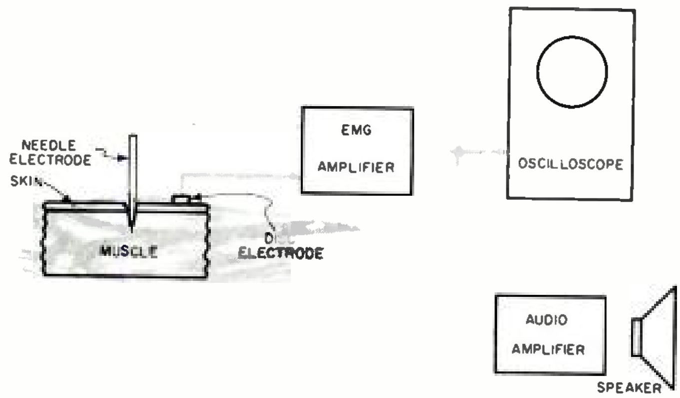


Fig. 7. Muscle potential picked up by electrodes is amplified and displayed on oscilloscope. Speaker provides audible output.

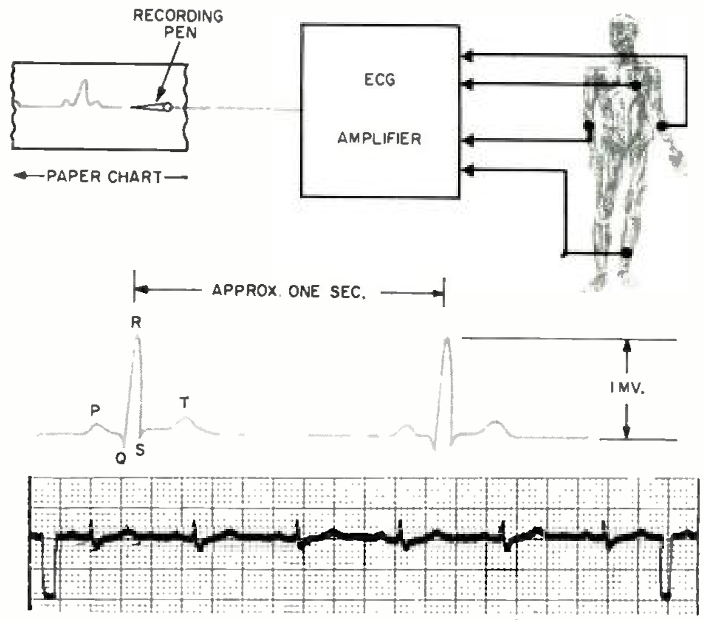


Fig. 8. Heart-generated voltage can be picked up by means of electrodes placed on the skin. The electrocardiograph (ECG) records waveform of the beating heart. Lower trace is an acual ECG waveform. Negative pulses are used for calibration.

tury, Luigi Galvani accidentally discovered that a frog's leg twitched when suspended by a copper hook on an iron railing. Galvani attributed this to "animal electricity," but his contemporary, Alessandro Volta, insisted that the muscular contraction resulted from the voltage generated by the dissimilar metals (a controversy which led to the development of the electric battery). In modern medical practice, electrical stimulation of muscle tissue is used as a method of diagnosis. A variety of pulse and sine-wave generators is available to the medical profession for use in producing muscular contraction. In cases of muscular disorder, this technique often permits the doctor to determine whether the muscle is at fault or if it is not receiving a proper supply of pulses from the motor nerves.

Of at least equal interest to the diagnostician is the fact that a contracting muscle produces an electrical output. The study and recording of these muscle potentials is known as electromyography (EMG). Instrumentation is accomplished as shown in Fig. 7. A needle-shaped electrode is inserted through the skin into the muscle to be studied. An additional disc-shaped electrode is placed on the skin near the needle electrode. The voltage picked up by the electrodes when the muscle contracts is amplified and displayed on an oscilloscope.

The contraction of a single muscle fiber produces a pulse waveform of approximately one millisecond duration and 0.01 to 0.3 millivolt amplitude. The needle electrode however, usually contacts a whole group of muscle fibers known as a *motor unit*. The resulting waveform therefore consists of an irregular series of pulses some of which may be overlapping.

As shown in Fig. 7, an audio amplifier and loudspeaker are used to make the muscle potentials audible. The resulting *crackling* sounds are meaningful to the diagnostician trained in this type of work.

The Electrocardiogram

The contraction of any muscle is accompanied by electrical activity, and the heart muscle is no exception. The voltage developed by the beating heart can be detected by means of small metal electrodes strapped to the surface of the body. A typical waveshape (electrocardiogram) is shown in Fig. 8.

The heart is an electrically triggered mechanical pump which circulates the blood and its many vital components to all parts of the body. Each time it receives a triggering pulse, the heart contracts and squeezes the blood out through the arteries. During the interval between contractions, the heart refills with blood in preparation for the next squeeze. The heart has four chambers: two *auricles* for receiving the blood and two *ventricles* for discharging the blood into the arteries. A valve which opens at the proper time during the heartbeat cycle allows the blood to transfer from auricle to ventricle.

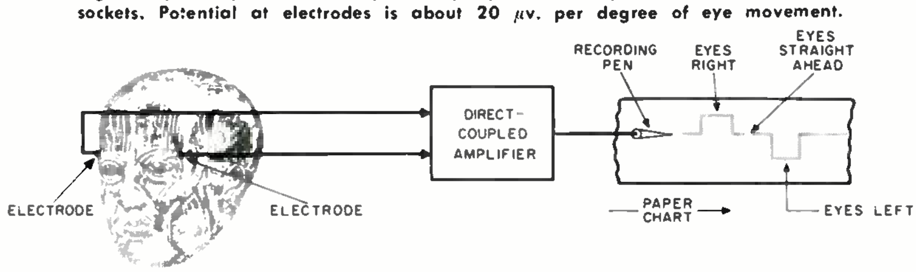
A block diagram of the heart and circulatory system is shown in Fig. 6. The right side of the heart pumps blood to the lungs to pick up oxygen, and the oxygenated blood then returns to the left side of the heart. From here the blood is pumped through the circulatory system to distribute the oxygen to the tissues of the body. The blood now returns to the right side of the heart to be pumped to the lungs again for more oxygen.

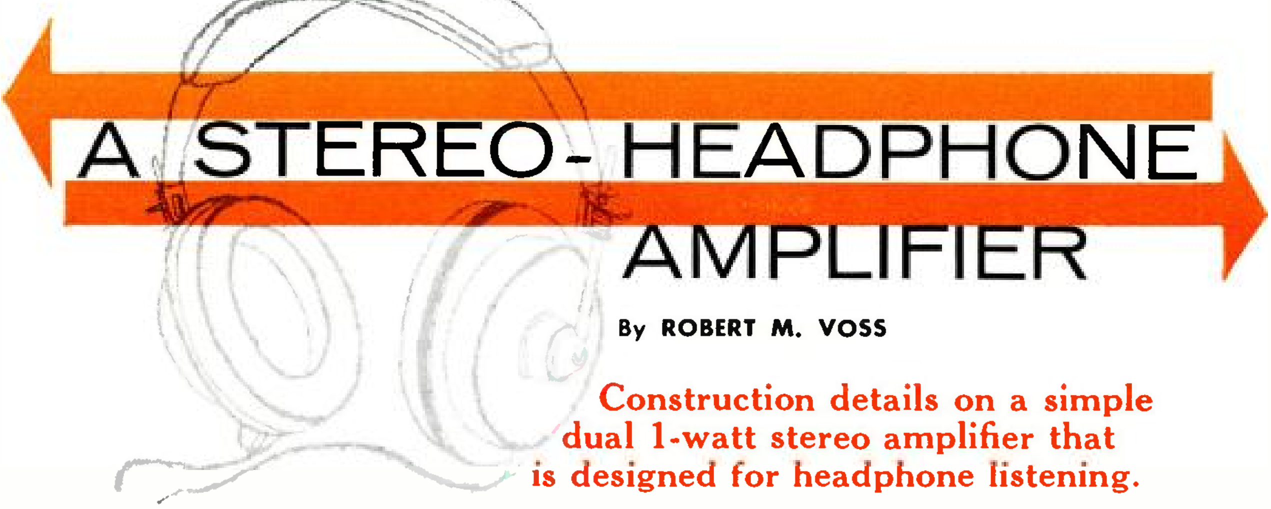
The electrocardiograph amplifier (see Fig. 8) must have excellent low-frequency response because the basic frequency of the electrocardiogram is the heartbeat rate, about one beat per second. Higher frequency components are also present because of the non-sinusoidal shape of the waveform. The *P* wave of the electrocardiogram is produced when the auricles contract; the *QRS* peak corresponds to contraction of the ventricles; and the *T* wave is associated with refilling of the ventricles. The exact shape of the electrocardiogram varies with a number of factors including the position of the pickup electrodes on the body. There is sufficient uniformity among healthy individuals however, so that the cardiologist can associate distortions of the waveform with specific structural or functional defects of the heart. As a matter of established standards, the pickup electrodes are placed on the right arm, left arm, and left leg. A recording taken between the two arms is known as lead I; right arm to left leg is lead II; and left arm to left leg is lead III. Chest electrodes are also used for recording the so-called *precordial* leads.

The heart-generated voltage varies not only with respect to time but also with respect to position. The electrical activity starts in the *sino-auricular node*, an area of highly excitable tissue in the right auricle. Nerve pulses from the brain excite this node and therefore determine the heartbeat rate. From the right auricle the electrical activity spreads to the left auricle and then, through a conducting pathway, to the ventricles. As a result, a wave of voltage

(*Continued on page* 73)

Fig. 9. Eyeball potentials are picked up by electrodes placed on skin near eye sockets. Potential at electrodes is about 20 µv. per degree of eye movement.





A STEREO-HEADPHONE AMPLIFIER

By ROBERT M. VOSS

Construction details on a simple dual 1-watt stereo amplifier that is designed for headphone listening.

THE FIRST convincing stereo demonstration the author ever heard was *via* headphones and, as a result, headphone stereo has always been one of the author's favorite means of listening to recordings.

Some time ago, the author was struck by the waste of power involved in using a 70-watt stereo power amplifier to drive phones—not only was over 1/3 of the output being lost in the isolating resistors, which were necessary to reduce the power amplifier noise to a tolerable level, but the output stage was converting 90 watts of input to heat and delivering peaks of only milliwatts to the headphones.

Circuit

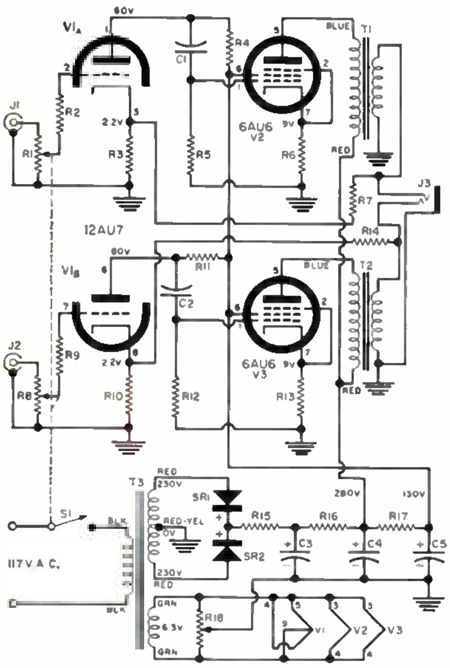
For this reason, the author decided to develop a power amplifier more in line with headphone requirements. The final circuit is shown in Fig. 1. It consists of two separate voltage-amplifier—power-amplifier configurations, operating from a common silicon-diode power supply. The power transformer specified in the parts list is one that happened to be on hand; actually any transformer capable of delivering 25 ma. or more at the required voltage will do.

The use of 6AU6's as power amplifiers is not common, but in low-power circuits such as this they perform admirably. They exhibit high power sensitivity, high plate efficiency, and have low screen-current requirements. In this circuit, each 6AU6 will deliver a little more than a watt at mid-frequencies. When both are used, the total output is a little less than 2 watts.

The input stages use 1/2 of a 12AU7 as the voltage amplifier for each side. Feedback is returned from the output to the input cathodes. A dual 500,000-ohm audio-taper pot is the volume control. Although not a matched stereo control, the unit the author used provided astonishingly accurate tracking—from inaudibility to full gain no change in relative volume could be detected. But, as any hi-fi "fanatic" knows, the human ear is a woefully inaccurate instrument, so if you prefer your sound reproduction on an oscilloscope or a meter rather than on headphones, by all means use a matched control.

The power supply is exceptionally well filtered, as is necessary when dealing with powers of this magnitude, especially with single-ended output stages. A further precaution against hum is the hum-balance control in the heater circuit. If hum persists, connect the slider

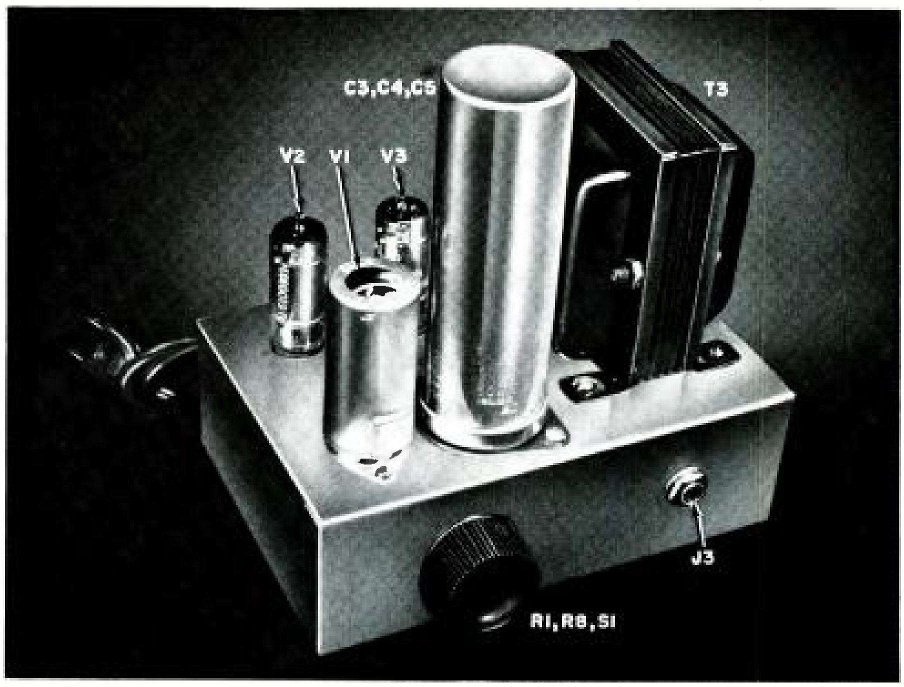
(*Continued on page 74*)



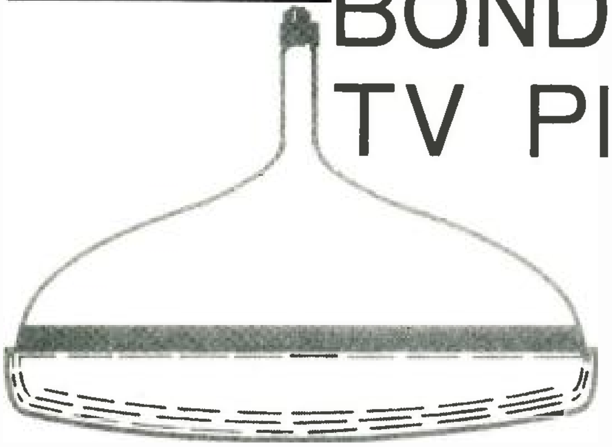
R1, R8—Dual 500,000 ohm audio-taper pot (see text)
R2, R9—10,000 ohm, 1/2 w. res.
R3, R10—1800 ohm, 1/2 w. res.
R4, R11—39,000 ohm, 1 w. res.
R5, R12—470,000 ohm, 1/2 w. res.
R6, R13—75 ohm, 1/2 w. res.
R7, R14—3900 ohm, 1/2 w. res.
R15, R16—470 ohm, 1 w. res.
R17—15,000 ohm, 1 w. res.
R18—100 ohm pot ("Hum Balancing")
C1, C2—.05 µf., 400 v. capacitor
C3-C4-C5—20/80/40 µf., 450 v. elec. capacitor
J1, J2—RCA-type phono jack
J3—Two-circuit phono jack
S1—S.p.s.t. switch (ganged with R1, R8)
SR1, SR2—Silicon diode (Author used 420 volt, .75 amp. Sarkes Tarzian F-6 or 1N2484; lower current units may be used)
T1, T2—Output trans. 25,000 ohms to 4 ohms, 2-3 watts (Triad S-13X or equiv.)
T3—Power trans. 230-0-230 v. @ 25 ma.; 6.3 v. @ .9 amp. (Stancor PC-8418 or equiv.)
V1—12AU7 tube
V2, V3—6AU6 tube
1—2" x 4" x 6" (or larger) chassis

Fig. 1. Special attention is paid to keeping the hum level low because of the minute power levels employed for headphone listening.

The 2" x 4" x 6" chassis used by the author required a pretty close fit of parts.



BONDED-SHIELD TV PICTURE TUBES



By **LYLE EVANS,** Sylvania Electric Products Inc.

Many special features of this CRT type are not widely known, although they concern viewers and service technicians, as well as manufacturers.

SINCE the introduction of the first television receivers, it has been customary to provide a plate-glass safety shield built into the front of the cabinet. The only deviation from this practice until recently has been the use of molded-plastic shields in portable sets, for weight reduction. During the last year, a wholly new series of tubes has been introduced which, as one of many desirable features, eliminates the necessity for providing the plate-glass safety shield.

These are the new 19-inch and 23-inch, square-cornered, rectangular picture tubes with matching implosion shields laminated to the tube face with a layer of thermosetting resin especially designed for the application. These tubes have already gained wide acceptance in the industry because of their increased strength, safety, and improved picture performance.

Basically, there are two types of "bonded-shield" tubes. One employs a pressed-glass implosion shield formed in such a way as to curve around the face of the picture tube, thus providing a natural pocket for inclusion of the resin. Such a tube is shown in Fig. 1. A second approach is shown in Fig. 2, in which a flat sheet of plate glass, similar to that normally used as the separate safety shield in front of the TV receiver, is cut and sagged to match the contour of the tube face. In this case, the glass does not curve around the side of the tube, therefore, a plastic band is used to hold the implosion plate at the proper distance from the tube face to allow for the resin layer. Both tubes have been made commercially but, at present, the first version has proven to be more popular.

The new 19- and 23-inch designs have resulted in the first major improvement in viewing performance in many years, on more than one count. Part of this is due to the fact that the faceplates have much more nearly rectangular shapes than their predecessors do. This change was incorporated as a result of a poll conducted to determine consumer preference. The average viewer is accustomed to rectangular shapes for viewing areas. Windows, mirrors, movie screens, and picture frames are some of the elements he is accustomed to looking at or through that adhere to rectangular form. The extent of this change can be seen in Fig. 3, where faceplates of the old and new shapes are compared, with one superimposed on the other.

This squaring off of the corners also results in additional viewing area, so that portions of the picture formerly lost can now be seen. In the case of the 23-inch tube, this has recovered 20 additional square inches of usable viewing surface as compared to a conventional 21-inch CRT. The amount of transmitted picture information that is not reproduced thus becomes negligible.

The reduction of the overscan of the raster (required by less rectangular picture tubes) has also brought with it an improvement in available contrast. Why this is so is not immediately obvious, but the gain is nonetheless significant. Electrons in the overscanned beam strike the bulb walls instead of the faceplate. A certain percentage of these are reflected back to the phosphor screen, producing low-level excitation of certain areas in addition to the desired excitation by the primary beam. This contaminates the desired information, particularly when areas that should be black are excited. With overscan reduced to an insignificant level, a truer picture is reproduced, in addition to one with better contrast. Fig. 4 indicates the improvement in contrast ratio of a 23-inch CRT over its 21-inch predecessor.

Another bonus of the new tube is its flatter face. Curvature of the viewing screen restricts the angle over which the viewing audience may be distributed and tends to distort the image for those who are not facing the screen head on. This curvature has been made necessary by the physical requirements of the tube. The addition of another element, the laminated implosion shield, in front of the faceplate has made it possible to flatten out the surface considerably. This can be noted in Figs. 1 and 2.

Use of the laminated implosion plate offers many additional advantages. It

Fig. 1. The glass shield is formed to curve around the faceplate of the tube.

Fig. 2. A fairly flat plate may be used and held in position by a plastic band.

Fig. 3. Superimposed faceplates of 21- and 23-in. tubes. Note corners of latter.

definitely makes the tube stronger and therefore safer. Nevertheless, if the tube should implode, the attached safety plate is a significant factor. The shield will not break away, and the faceplate will be held firmly to it by the resin layer rather than break up into flying particles. If this should happen in the cabinet, the resulting difference in terms of receiver damage is important. To the technician, handling the tube outside of the set, this difference is also significant.

Elimination of a separate, glass plate has also eliminated two reflecting surfaces. This is due to the fact that the transparent resin developed for making the bond has approximately the same index of refraction as the glass used, so that light passes through glass-resin-glass with no internal reflections from the two glass surfaces that are in contact with the resin layer. Fig. 5 shows that, with a separate plate, there are four reflecting surfaces: the inner and outer surfaces of the faceplate and the inner and outer surfaces of the safety plate. The laminated tube, on the other hand, has only two reflecting elements: the inner surface of the faceplate and the outer surface of the attached shield. Thus the reflection of ambient light is greatly reduced.

This reduction results in another substantial increase in available contrast and also in available brightness. A further improvement in contrast is achieved by tinting the safety shield. The latter is thus a gray filter having a 50-per-cent transmission characteristic. The filtering improves contrast by reducing the amount of ambient light that passes through the safety shield and reflects back from the tube. Fig. 6 compares measurements of contrast ratio between laminated and non-laminated tubes under varying conditions of ambient light.

An annoying feature of receivers using the earlier-type tubes has always been the accumulation of dust and dirt on the tube face and the inner surface of the separate safety shield due to electrostatic attraction. This has meant considerable loss in light output with time, and has necessitated the periodic removal of the safety shield for cleaning purposes. With laminated tubes this is no longer the case. The only exposed surface is out front for easy cleaning by the housewife.

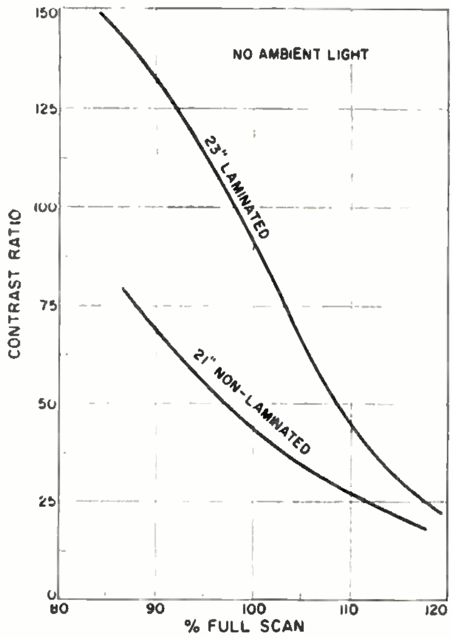


Fig. 4. Rectangular shape of 23-in. tube permits improvement in available contrast.

It has already been pointed out how construction reduces annoying specular reflections from room lights and windows considerably. There is a trend toward further reduction in a new line of tubes in which a diffusing, anti-glare coating is applied to the outer surface of the safety shield. This coating breaks up reflections from the front surface of the shield to the extent that images of lamps, drapes, windows, and other surrounding objects are virtually eliminated from the tube's viewing surface.

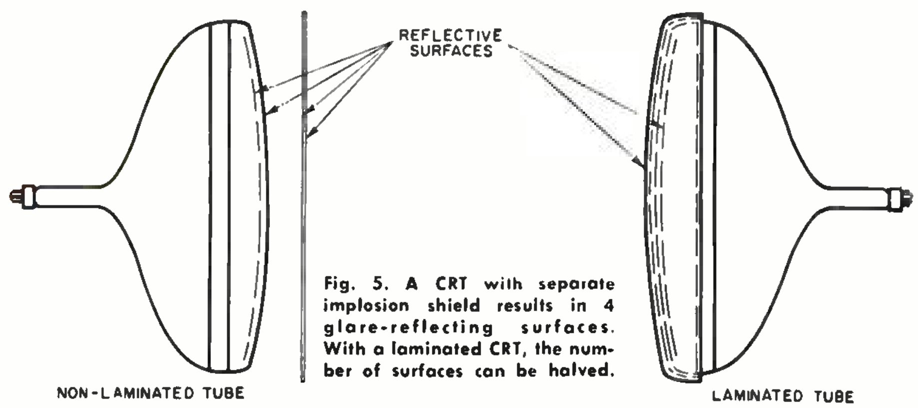


Fig. 5. A CRT with separate implosion shield results in 4 glare-reflecting surfaces. With a laminated CRT, the number of surfaces can be halved.

Processing Techniques

The significant improvements realized with the use of a bonded-shield tube, which are real, have been made possible by the development of the epoxy-resin lamination method for attaching the shield. The prepared tube and its separate shield are first cleaned and then mounted in a specially designed jig. These two elements are carefully spaced so that, after the resin is introduced, a minimum thickness of .06 inch will be maintained over the entire tube face. This jigged assembly is then heated to 200°–250° F. and the epoxy resin is then dispensed into the predetermined cavity between the tube and the panel.

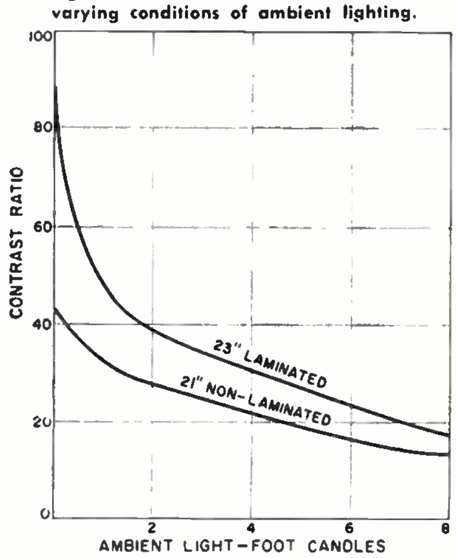
The epoxy resin, like other similar materials, requires the addition of a hardener to effect a thermosetting cure. Since the resin begins to cure immediately after the hardener is added, this intermixture cannot be accomplished too far in advance. A special dispenser is used that accurately meters the proper proportions of resin and hardener, and also mixes them intimately just prior to their introduction into the tube assembly. In addition, the resin is maintained at 200° F. This substantially increases the rate of cure, minimizing processing time.

After the resin has been added, the assembly is held in the jig for 20 to 30 minutes. While this is not sufficient time for complete curing, the tube may be removed safely from the jig and handled. In a few hours, the tube itself is cool, but the curing process continues. Approximately 24 hours are required for complete curing.

Aside from maintaining correct temperature and correct proportions of resin and hardener, there are other precautions to be observed. Poorly mixed materials may result in resin defects. Care must be taken to prevent the inclusion of air bubbles or small foreign particles, since the over-all quality of the screen area must be just as good as that of a non-laminated tube. In addition, special testing and control procedures have been developed to insure that the resin will cure with the proper elongation and tensile-strength characteristics.

In addition to advantages already noted, the tube offers new styling possibilities to the set manufacturer. Freed of the need for adding a separate safety plate, he has more flexibility in developing methods for mounting the tube. He can also achieve a still further reduction in the depth of the set. Advantages to the viewer, in terms of improved picture quality, have already been noted. The bonus to the service technician, in terms of a safer tube to handle in the shop, completes the circle of benefits. This single development has something important to offer to all who are concerned with the set. -30-

Fig. 6. Effects of bonded shield under varying conditions of ambient lighting.



SERIES B+ CIRCUITS

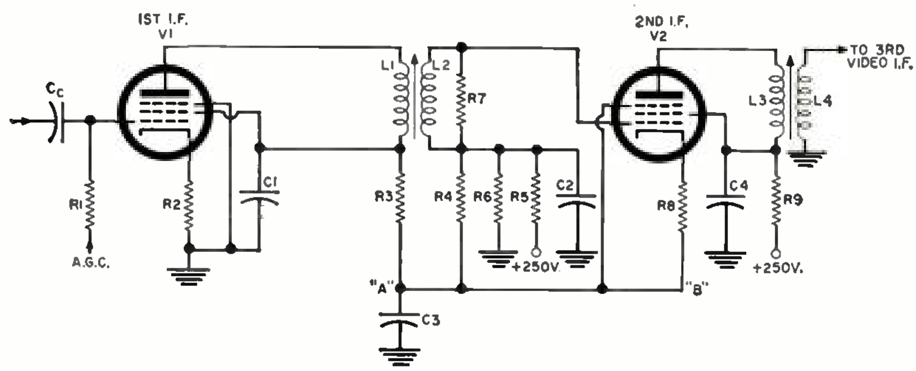


Fig. 2. Improved version of circuit in Fig. 5A provides better a.g.c. action.

A GREAT proportion of the TV receivers made and sold in recent years uses one version or another of the series "B+" type of circuit, also called the stacked "B+" or shelf-type supply. With some variations of the principle being more common than others, readers who can recognize one type readily may not be so well aware of others. Because of this and because the peculiarities of such arrangements have great bearing on the particular patterns of symptoms when faults develop, the stacked circuits are well worth investigation.

With the exception of some low-voltage, portable models, the "B+" in most modern TV receivers is normally in the region of 250 volts. On the other hand, video i.f. amplifiers and some other circuits are designed to function with

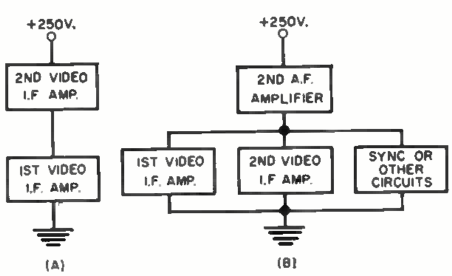


Fig. 1. Two frequently met methods for stacking circuits, in block diagram form.

lower d.c. voltages, in the order of 125 volts. To obtain the lower level of "B+," a series dropping device is needed in the higher "B+" line. Resistors are conventionally used for such voltage dropping, and almost always do the job in older TV sets. However, the power dropped across them is wasted power drawn from the supply, and the heat they dissipate tends to shorten the life of nearby circuit components.

By using a circuit that otherwise performs some normal function in the receiver (or more than one such circuit) as the voltage dropping element, the designer eliminates the resistor and overcomes the drawbacks mentioned. This arrangement allows the manufacturer to use a smaller power transformer or otherwise reduce requirements in the main power supply, thereby reducing weight and cost of the set.

One of the simpler arrangements of this type is shown, in block-diagram form, in Fig. 1A. The voltage across a video i.f. amplifier tube is commonly about 125 volts d.c. Here two such stages are in series across the 250-volt "B+" line. Each of these stages is designed to pass the same amount of cathode current, so the series connection is practical. In this condition, voltage division of the full "B+" will be equal, with about 125 volts developed across each circuit.

A more elaborate version is shown in Fig. 1B. Here the audio-output stage, which handles considerable current, acts as one half of the divider. The other half consists of several circuits in parallel, each of which draws less current individually. Commonly the first two video i.f. amplifiers, as shown, are in the lower half of the divider along with one or more other stages, like the sync circuits. The total plate and screen-grid current of each i.f. stage might be in the order of 15 ma. and the sync circuits may draw 10 ma. Cathode current for the audio-output tube would then be approximately 40 ma., with about the same voltage across each stage.

The actual circuit of a two-stage stacked i.f. amplifier appears in Fig. 5A. Electrons representing the total current flow in the circuit, indicated by arrows, travel up through R_2, in the cathode of V_1, divide into the plate and screen-grid currents of this stage, then re-combine in R_3, and travel on through R_8. Emitted from the cathode of V_2, they again divide into plate and screen-grid currents for the latter tube, then re-combine at R_9.

Resistors R_2 and R_8 are the cathode bias resistors for V_1 and V_2 respectively. R_3 and C_1 form the plate-decoupling circuit for V_1, thereby preventing the signal-current variations in this stage from reaching V_2 and affecting its operation. R_9 and C_4 perform a similar function with respect to V_2, keeping its signal variations from reaching the "B+" line.

Suppose that this circuit were broken at point *X*, that point *A* were connected to a separate source of low "B+," that point *B* were connected to a normal "B−" point, and that the power-supply connection to R_9 were also from some low-voltage point. The circuit is shown with these changes in Fig. 5B. Two conventional video i.f. amplifiers become apparent. Thus in the stacked arrangement, C_3 makes point *A* appear as ground for i.f. signals, permitting the two circuits to handle signal independently as though they were wired in the normal fashion. This fact is important to remember in servicing: the voltages on V_2 should be measured with reference to point *B*. In this connection, note that the V_2 grid is also returned to the simulated ground point, which is about 125 volts positive as far as d.c. is concerned. The absolute voltage at this grid is less important than the potential difference between grid and cathode.

The a.g.c. voltage is applied to V_1 of Fig. 5A in the normal way, through resistor R_1. Note that there is no separate a.g.c. connection for V_2. Actually, the single connection controls the gain of both stages. When a.g.c. voltage becomes more negative, as when a strong signal is being received, the plate current of V_1 is decreased. This decreases the cathode current available for V_2, which is in series, in turn decreasing gain of the latter stage.

One disadvantage of this arrangement is that voltage and current conditions in the two stages become so highly dependent on the condition of the tubes that a defect in one can cause considerably more maloperation than would normally be the case. Suppose, for example, that V_2 should become weak. Effectively, this increases the tube's resistance. The voltage drop across it will also increase, leaving less for V_1 and preventing the latter from functioning

By DARWELL H. WEBSTER

"Active" voltage dividers, used widely and with variety in TV, have oddities.

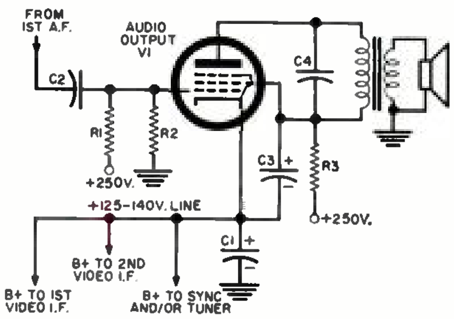


Fig. 3. A method for stacking audio-output stage with other TV circuits.

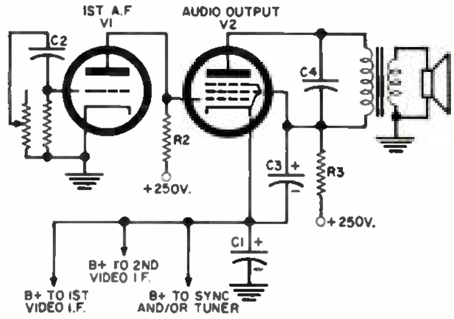


Fig. 4. Another stacked audio circuit eliminates a resistor and a capacitor.

properly. The low emission of one tube then impairs the over-all gain of the i.f. strip, apparently reducing receiver sensitivity. The effect is similar to that of excessive a.g.c. voltage.

A Circuit Variation

To improve a.g.c. action and compensate for differences in emission that may exist between the two tubes, the circuit of Fig. 2 was developed. R_5 and R_6 form a voltage divider and regulator that keeps the control-grid voltage of V_2 reasonably constant.

When a.g.c. voltage is applied to the grid of V_1, the latter's plate current will decrease, increasing the drop across the tube and thus increasing its plate voltage as the result of divider action in the series string. So far, behavior is the same as that in the circuit of Fig. 5A. This increased voltage at point *A* also occurs at point *B*, effectively increasing the cathode voltage for V_2. In the case of Fig. 5A, this change has relatively little effect, because the V_2 grid voltage, also dependent on point *B*, keeps in step with the cathode voltage. However with V_2 grid voltage stabilized, as in Fig. 2, the change in cathode voltage alters tube bias so as to reduce current through V_2 (in fact, through both tubes) to a greater extent than occurs in the earlier circuit. This results in highly effective a.g.c. action.

As to the effect of a weak tube, suppose that emission in V_2 has decreased. The fixed grid voltage will prevent an excessive voltage drop across this tube by changing the grid-cathode bias and forcing the stage to conduct more. Specifically, as the voltage drop across the tube begins to increase, the cathode voltage is reduced, and approaches the relatively fixed grid voltage. This reduced bias encourages the tube to conduct more, increasing its gain and permitting V_1 to conduct closer to its normal current. This compensation does not occur in Fig. 5A, where bias is determined only by cathode resistor R_8. (For further information on servicing such i.f. circuits, see the author's "Speed-Checking I.F. Systems" in the May 1961 issue of this publication, on page 38.)

Series Audio-Output Tubes

Fig. 3 shows the circuit of an audio-output stage that acts as the series dropping device for several lower-voltage circuits, as outlined in Fig. 1B. The "clamping" voltage for the grid, which will be a few volts lower than the cathode voltage, is established by the divider consisting of R_1 and R_2. This potential determines the approximate voltage that will appear on the low "B+" line. As in the case of the i.f. circuit in Fig. 2, the fixed grid voltage tends to compensate for variations in the emission capability of the output tube.

Another method used for biasing the audio-output tube, when the latter is part of a series "B+" system, appears in Fig. 4. Here grid voltage for biasing is obtained directly from the plate of the first audio amplifier. This first-stage tube and its plate-load resistor act as the needed voltage divider. The arrangement eliminates the separate divider resistors of Fig. 3, R_1 and R_2, and the coupling capacitor, C_2.

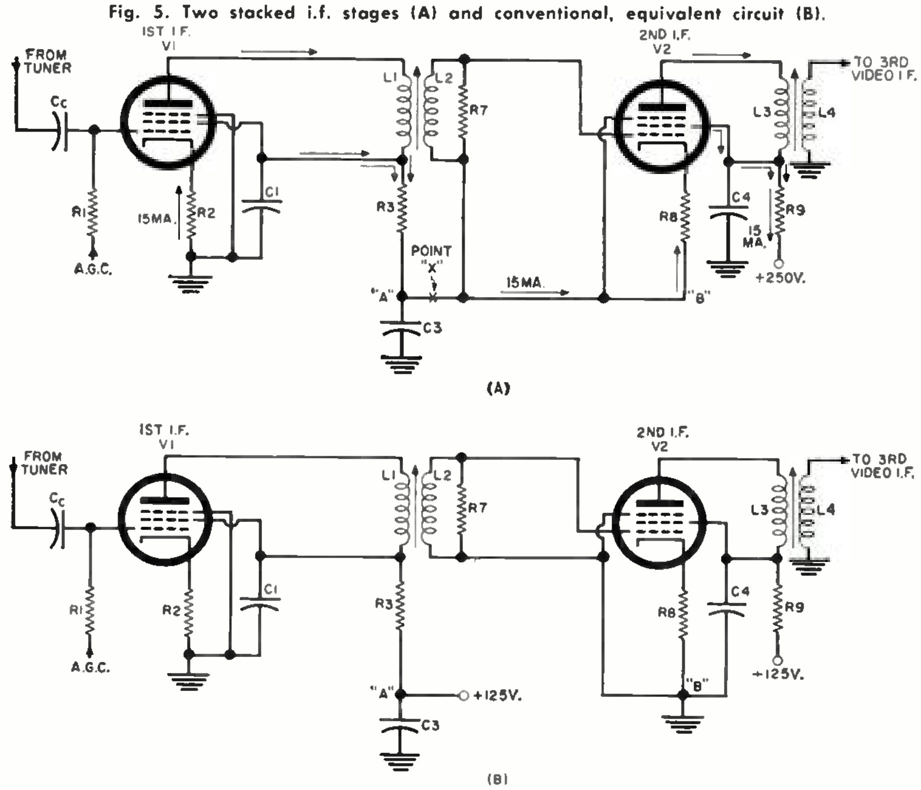
In each circuit (Figs. 3 or 4), C_1 acts as a decoupling capacitor that prevents audio-signal variations through the output tube from reaching those circuits using the 125-140 volt line.

Troubleshooting

The special service problems of series "B+" circuits grow out of the fact that a defect in one tube or stage in the system can affect performance of one or

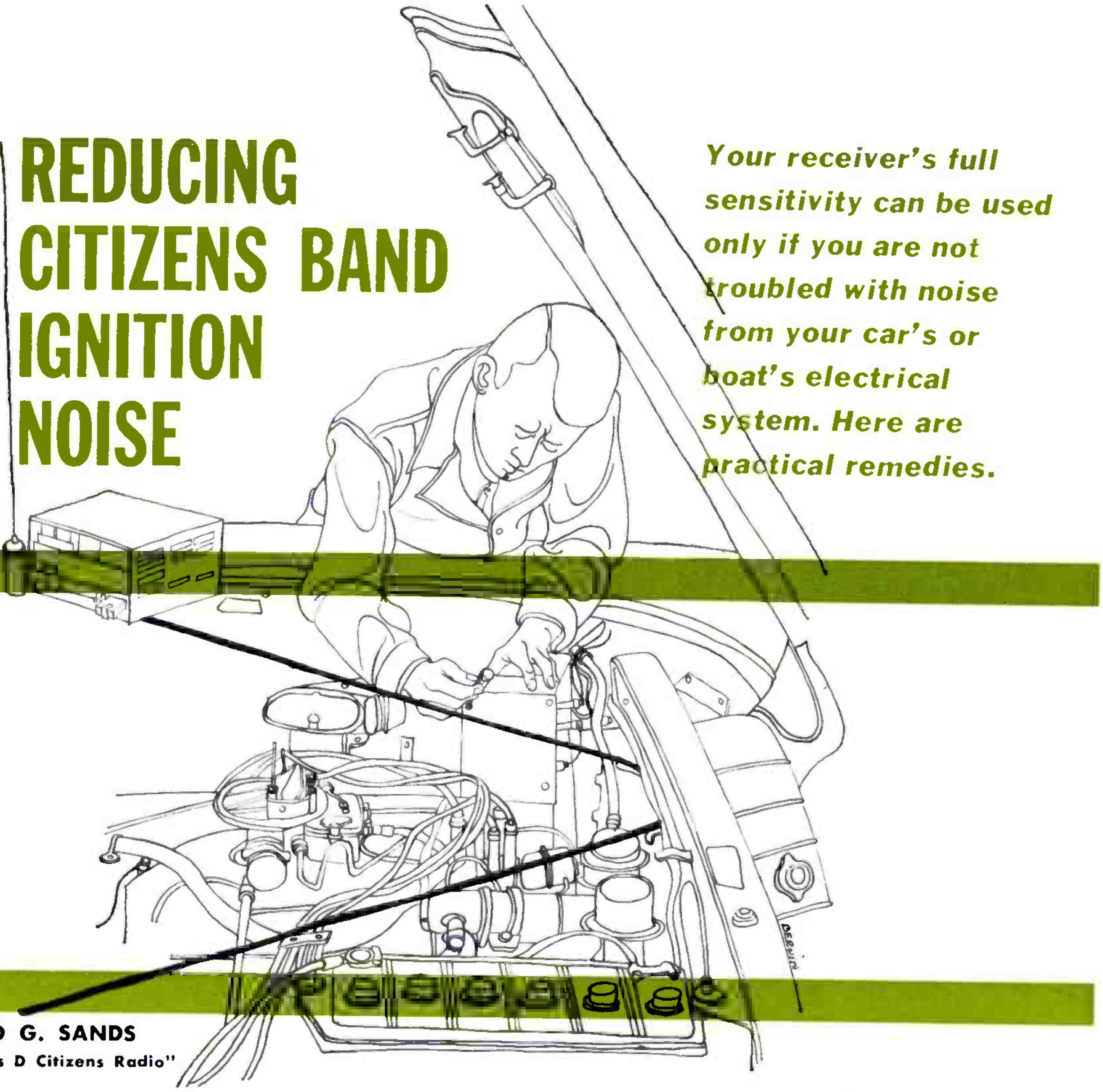
(*Continued on page 87*)

Fig. 5. Two stacked i.f. stages (A) and conventional, equivalent circuit (B).



REDUCING CITIZENS BAND IGNITION NOISE

Your receiver's full sensitivity can be used only if you are not troubled with noise from your car's or boat's electrical system. Here are practical remedies.



By **LEO G. SANDS**
Author, "Class D Citizens Radio"

IGNITION noise is one of the prime factors limiting the range of Citizens Band radio in mobile installations. The range would be considerably greater if the full sensitivity of receivers could be utilized but what use is it to have a receiver with one-microvolt or better sensitivity if the ignition noise level is several microvolts?

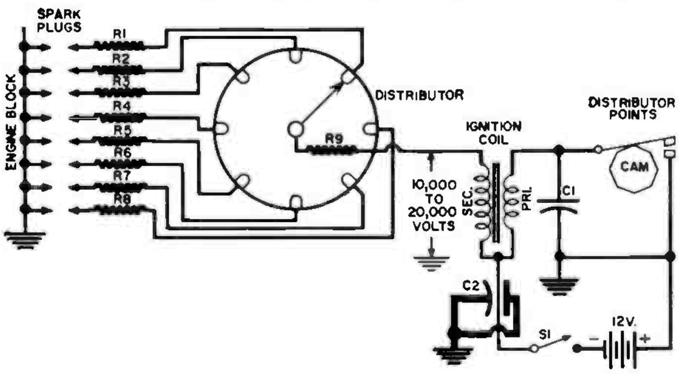
Unfortunately, the automobile ignition system creates and radiates radio-frequency energy whose level is maximum at frequencies close to the 27-mc. band. This is bad for the CB operator.

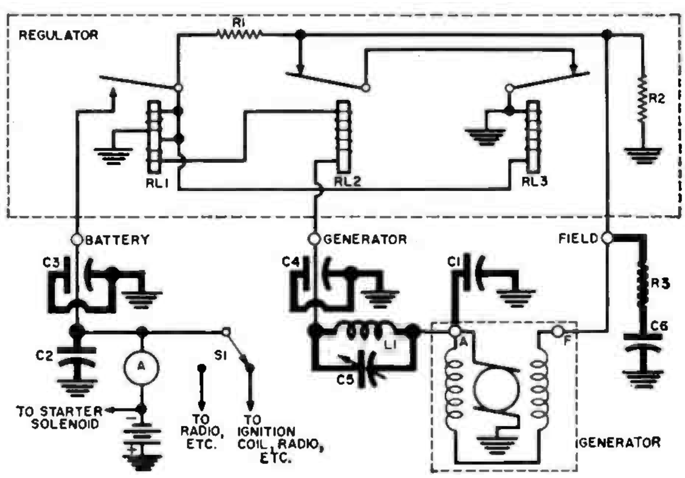
You can do something about suppressing noise generated by your own car, but there is nothing you can do about stopping the noise generated by other cars. You will, however, experience less noise from other cars if your receiver incorporates a noise limiter.

Sometimes the noise-suppression procedures that are followed when a standard AM broadcast-band auto radio is installed will suffice—but not always. It is common to install spark-plug suppressors at all of the plugs and a suppressor in the distributor rotor ignition coil lead in order to reduce ignition noise. Also, a filter capacitor is usually installed across the armature terminal of the car's generator to reduce generator-produced noise. If these measures do not stop the noise, coax or conventional capacitors are also installed at the hot (battery) primary lead of the ignition coil, the ammeter, dome light, and dashboard instruments to bypass to ground the ignition noise signals picked

Fig. 1. (Below) Ignition-system circuit for 8-cylinder car.

Fig. 2. (Right) Regulator and generator circuit. The 3 relays are the cut-out, current regulator, and the voltage regulator.





up and re-radiated by the vehicle's low-voltage wiring.

Ignition noise exists because each of the four, six, or eight spark plugs in the engine are small, but potent, "spark transmitters"—which are still fondly remembered by old-time hams and ship radio operators. In addition, there is another spark transmitter under the distributor cap.

A very high-potential pulse, ranging from 10,000 to 20,000 volts, is generated every time the distributor points open. The points, shown in Fig. 1, are opened and closed by a cam at a rate determined by the speed of the engine. When the points close, d.c. flows from the vehicle's battery through the ignition switch, S_1, distributor points, and the primary winding of the ignition coil—setting up an intense magnetic field which envelopes the ignition-coil secondary. When the points open, the d.c. flow in the primary winding ceases abruptly, causing the magnetic field to collapse and inducing a potential in the secondary winding of the ignition coil.

The e.m.f. induced in each turn is in series-aiding with the e.m.f. in the other turns. The high voltage results not only because of the very high turns ratio of the windings in the ignition coil but because of the sharp magnetic kick caused by sudden cessation of current flow through the primary.

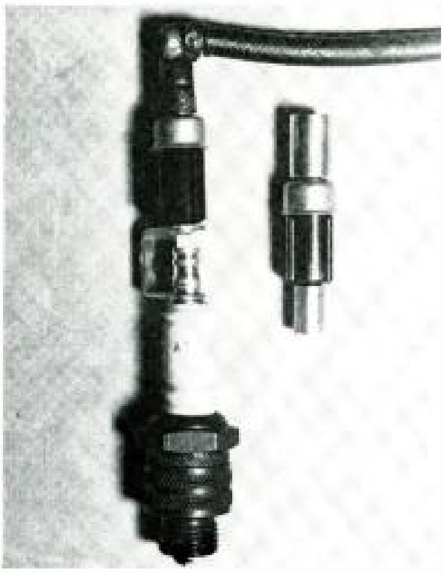
The ignition-coil turns ratio ranges from 40:1 to 100:1. As a straight transformer, the 12 volts would be stepped up from 480 to 1200 volts but because of the inductive kick, the voltage is actually ten to twenty times greater.

The voltage across the secondary is so high that it causes a discharge across two series-connected spark gaps. It jumps across the air space between the distributor rotor and one of the electrodes of the distributor and through the pressurized vapor between the points of a spark plug.

Each of these gaps looks like a very high impedance until the dielectric (air or vapor) breaks down and an arc is formed across the gap. Then, each gap looks like a low impedance and, for the very short duration of the spark, the current flow is large and a magnetic field is developed around the ignition wires. Thus we have a spark transmitter whose resonant frequency is determined by the inductance and capacitance of the ignition circuitry.

Suppressors

A high voltage is required to cause a



spark to jump across a gap; the current can be infinitesimal. For this reason, we can reduce the current to reduce the noise-radiating field, without reducing the effective voltage. Even if a 1-megohm resistor (R_1) is connected in series with the spark gap, as shown in Fig. 3A, the source voltage, E_1, will be equal to E_3, the voltage across the gap. There will be no voltage (E_2) across R_1 because there is no current flow before the gap breaks down and is arced across.

But, this ideal gap condition does not exist. As shown in Fig. 3B, there may be leakage resistance across the gap (dirty spark plugs). This leakage resistance, R_2, is in series with R_1 and the voltage applied to the spark gap, E_3, is

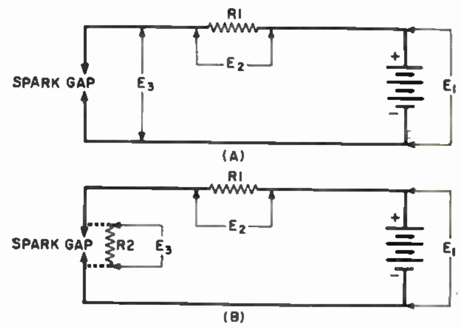
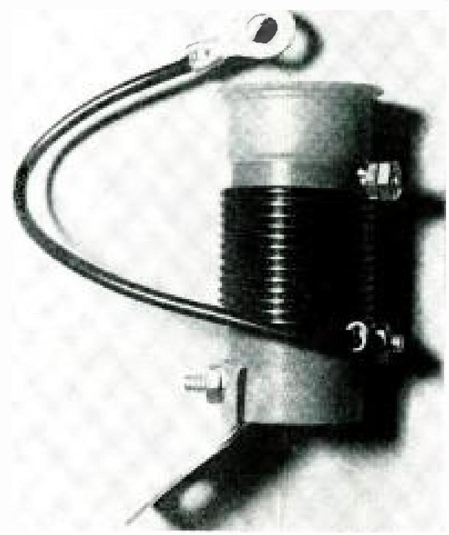


Fig. 3. (A) Suppressor resistor does not reduce voltage significantly when spark plugs are clean. (B) With dirty or fouled plugs there is a reduction of gap voltage.

◀ Spark plug with suppressor attached. The suppressor resistor at the right is of the universal type and may be used at the spark plugs or in the hot secondary lead of the automobile's or boat's distributor.

Generator-whine suppressor for CB. The lugged lead connects to the generator (armature) output terminal. The generator output lead is connected to the screw at the other end of the coil. The strap at the bottom is for mounting. Inside the phenolic tube, around which the coil is wound, is a variable trimmer capacitor for tuning the circuit to parallel resonance. The circuit response is broad enough so that one setting at the transmitter's operating frequency suffices for whole band.



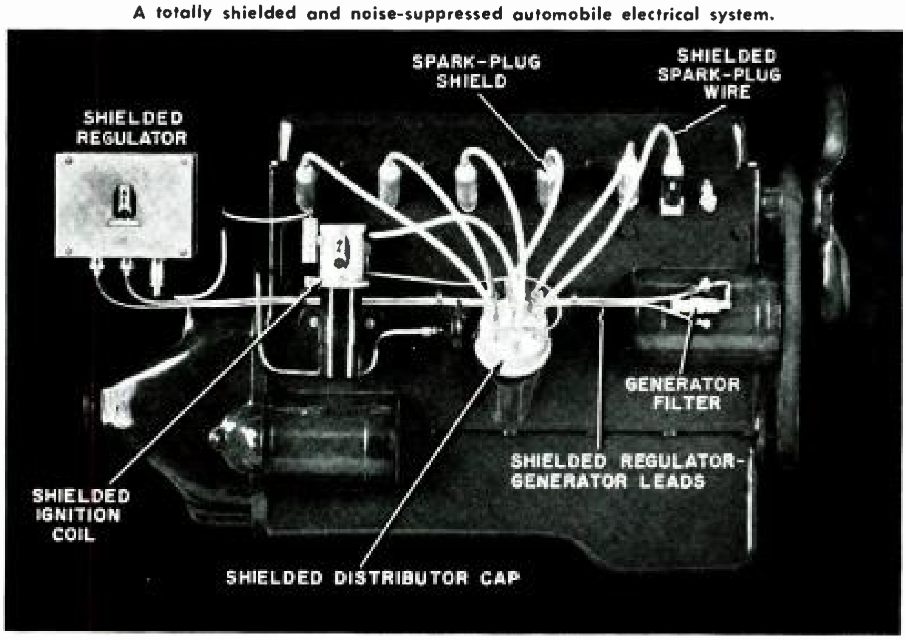
equal to the voltage E_1 minus E_2.

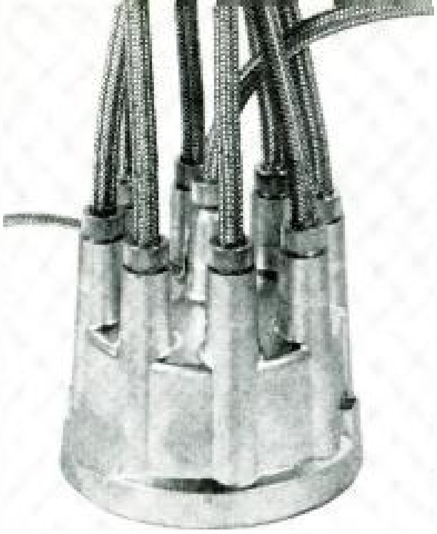
It is for this reason that the distributor suppressor is usually a 7500-10,000-ohm resistor and each spark-plug suppressor has a resistance of about 5000 ohms. The total 15,000-ohm resistance in series with the two gaps (distributor and one spark plug) has negligible effect, except when spark plugs are badly fouled.

It is the general consensus that the use of spark-plug and distributor suppressors does not interfere with engine performance nor increase fuel consumption.

To reduce the direct radiation of ignition interference, suppressors can be installed on each spark plug and at the distributor. These suppressors consist of a resistor encased in a tubular insulating housing with terminals on each end to fit the spark plugs or distributor

A totally shielded and noise-suppressed automobile electrical system.





Shielded distributor cap and ignition wires.

to the ignition cables. Instead of suppressors, spark plugs which have built-in resistors can be substituted or, alternatively, special ignition cables with built-in resistance (provided in many new cars) can be used. Series resistance in the ignition circuits has two effects. It reduces the radiated field by limiting current and broadens the resonance (lowers the "Q") of the wiring.

Additional Remedies

In addition to the high-voltage ignition system, electrical noise is caused by the vibrating contacts within the current-voltage regulator, the brushes and commutator of the generator, the opening and closing of the distributor points, and the charging and discharging of the distributor capacitor (C_1 in Fig. 1).

For an ordinary auto radio, generator "whine" is adequately suppressed by installation of a 0.1- to 0.25-μf. capacitor between the frame of the generator and the output terminal of the generator which is connected internally to a brush that contacts the armature. In Fig. 2, this capacitor is shown as C_1.

However, for Citizens Band reception, this may not be adequate. A parallel-resonant wavetrap (L_1 and C_5) may be connected in series with the generator output lead, as shown in Fig. 2. These wavetraps are available commercially under *G-C*, *Globe*, *Johnson*, and other tradenames. Typically, L_1 consists of 13 turns of No. 10 enameled wire, wound on a 1-inch diameter phenolic tube. The coil is shunted by a variable trimmer capacitor (C_5), with a maximum capacity of 50 $\mu\mu$f.

With the engine running and the receiver on (unsquelched), C_5 is adjusted for minimum generator whine. When tuned correctly, L_1-C_5 serve as a very high impedance at the CB operating frequency. The trap is used in conjunction with C_1 to cut out generator whine when using the regular auto radio.

The noise caused by the vibrating contacts of relays RL_1, RL_2, and RL_3 (Fig. 2) of the regulator may be minimized by connecting a 0.1- to 0.25-μf. capacitor (C_2) between the grounded cover of the regulator and its battery terminal and another capacitor (C_3) between the cover and the generator terminal of the regulator.

Filters are usually not connected to the field terminal of the generator or regulator because of possible damage to the regulator relay contacts. But a circuit that is sometimes recommended for connection here is a resistor (R_3) with a value of 3.9 to 6.8 ohms and a series mica or ceramic capacitor (C_6) of around 200 $\mu\mu$f., as shown in Fig. 2, between the regulator cover and its field terminal.

Shields for fitting over spark plugs. Resistor plugs may be used for noise suppression. One of shields has been cut away (at right).

Filter Capacitors

Ordinarily, capacitors used for noise suppression are paper types enclosed in a metal cylinder, as shown in Fig. 4A. The protruding wire is for connection to the "hot" side of a circuit and the mounting lug of the capacitor enclosure is fastened to the generator or the regulator cover, firewall, or other grounded surface. To be effective, the lug must make firm contact with clean metal (paint or grease removed) or to the mounting bolt. Suppressor capacitors with two leads (one to ground), as shown in Fig. 4B, do not have to be mounted rigidly.

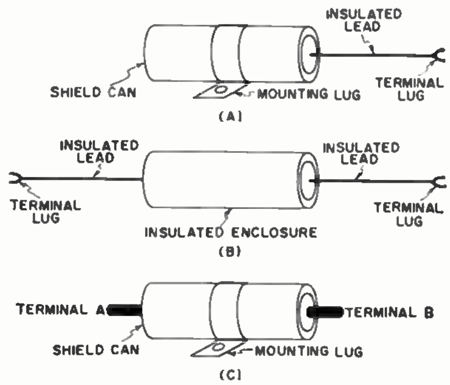
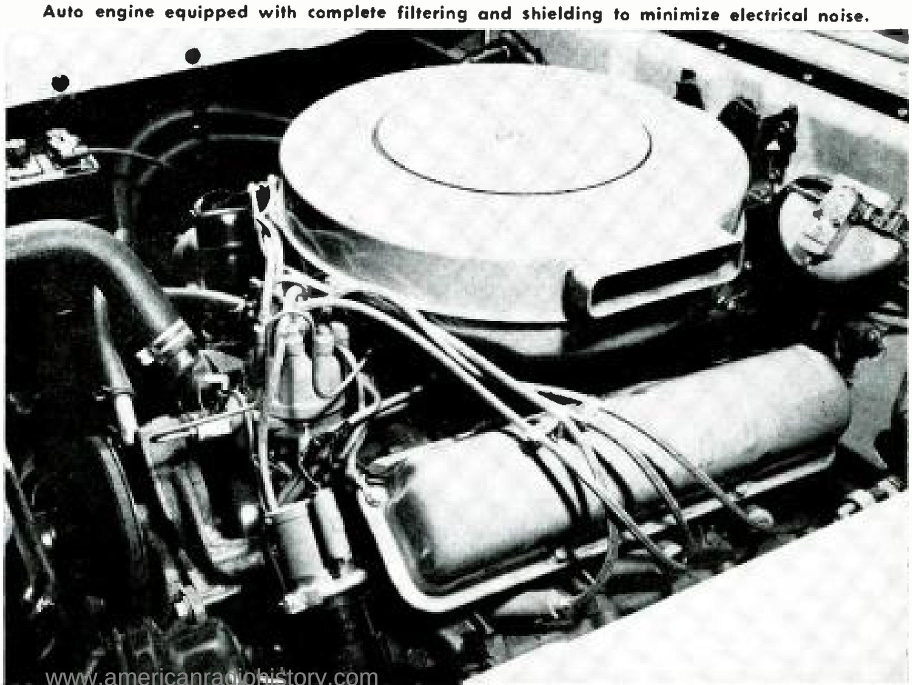


Fig. 4. (A) Conventional capacitor suppressor. (B) Insulated capacitor suppressor for ammeter and other instruments. (C) A coaxial or feedthrough capacitor.

Although these standard auto-radio noise suppressors are adequate for AM broadcast-band reception, they may not be adequate for CB reception. This is due to the fact that standard paper capacitors possess inductance as well as capacitance. This inductance has no significant effect at relatively low frequencies, but may be so great at 27 mc. as to offset the bypassing effect of the capacitor. Sufficient bypassing at both broadcast-band frequencies and at 27 mc. can often be achieved by shunting ordinary capacitor suppressors with a

(*Continued on page* 96)

Auto engine equipped with complete filtering and shielding to minimize electrical noise.



THIS MONTH'S COVER

AN installation of a Hallett shielded ignition system has just been completed on car's engine shown on this month's cover. The shielded leads between car's distributor and spark plugs, as well as the shielded ignition-coil cover, are clearly seen in the photo. The technician is just screwing down the cover on the shielded voltage-regulator box prior to testing out the effectiveness of the noise suppression with Citizens Radio transceiver at left.

(Cover photo by Jacques Saphier)

Electronic Overload Relay

By JOHN POTTER SHIELDS

Construction of a simple electronic device that removes power from a drill or other appliance that is overloaded.

HOW MANY times have you wished for a simple electronic device you could connect, say, to your drill press which would automatically remove the power from it should the drill bind or if you should unhappily get your tie caught in the works? Or, how about connecting this gadget to your circular or bandsaw so that if the blade should strike a nail, power will be removed immediately, saving the blade? Well, the "Electronic Overload Relay" to be described is capable of performing such tasks as well as a host of others around the home workshop, lab, or radio-TV service shop. In the latter case, it can come in very handy in keeping an eye on those elusive "dogs" while you are out of the shop on a regular service call.

The unit is a load-sensing device which is connected in series with the equipment to be protected. In the case of a drill press or saw, any slight increase in motor load, such as that caused by a binding drill or a nail in the piece of wood being sawed, will be reflected as a slight increase in the current drawn by the motor. This current increase is sensed by the overload relay which immediately removes operating power from the device being protected.

Fig. 1 is the schematic diagram of the "Electronic Overload Relay." T_1, a 2.5-volt filament transformer is used here as a "current transformer." Half of the 2.5-volt secondary is used as the sensing winding and is connected in series with the load to be protected. The transformer's primary is connected between the control grid of V_1 and ground. Resistor R_5 across the primary of T_1 serves to reduce the developed voltage to a point suitable for proper operation of the thyratron V_1.

In use, normal operating current drawn by the load through the low-impedance secondary of T_1 develops a voltage proportional to the secondary current in its primary winding. This a.c. voltage is applied to the control grid of the thyratron. The cathode of V_1 is connected to the arm of the "Sensitivity" control, R_4. With normal load current flowing in the secondary of T_1, R_4 is adjusted so that the cathode of V_1 is slightly more positive than the peak positive half-cycle applied to the control grid of V_1 from the current transformer. Since in this case the grid of V_1 is more negative than the cathode, it will not conduct or fire and the relay will not be energized.

If the load current should now increase, the voltage developed across the

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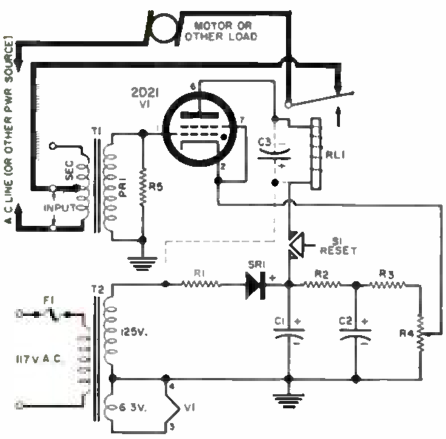
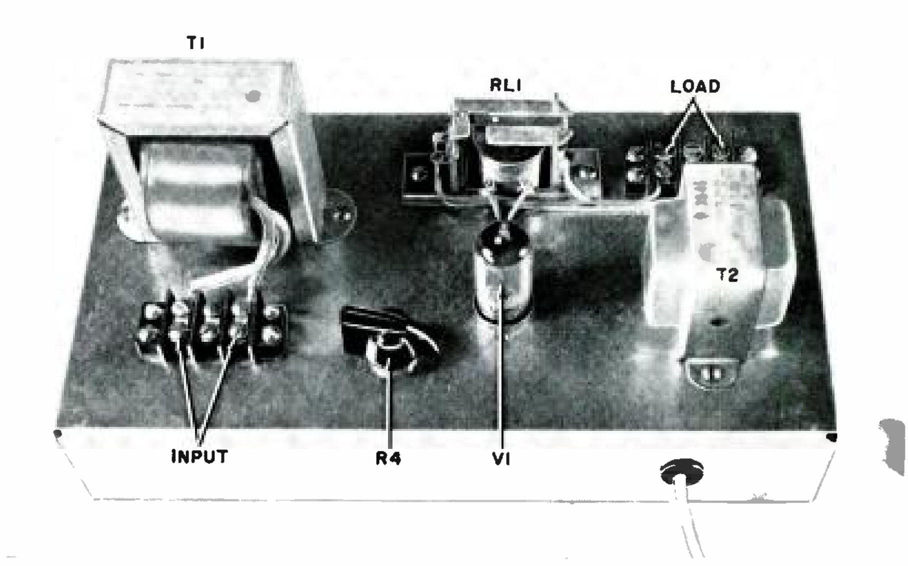


R_1,R_3—47 ohm, 1 w. res.
R_2—1000 ohm, 1 w. res.
R_5—47,000 ohm, 1 w. res.
R_4—20,000 ohm wirewound pot
C_1,C_2—20 µf., 150 v. elec. capacitor
C_3—8 µf., 50 v. elec. capacitor (for a.c. operation only)
T_1—Fil. trans. 2.5 v. c.t. (current rating depends on maximum load current desired. Stancor P-6133, 2.5 v. @ 5 amps used by author)
T_2—Power trans. 117 v. pri.; 125 v. @ 15 ma.; 6.3 v. @ .6 amp. (Stancor PS-8415 or equiv.)
RL_1—S.p.d.t. relay, 5000 ohm coil (Potter & Brumfield LB5-5000 or equiv.)
SR_1—65 ma. selenium rectifier
S_1—Normally open push-button (see text)
F_1—1 amp fuse
V_1—2D21, 2050, or 502-A thyratron

Fig. 1. Circuit diagram of the overload relay. One-half of the low-voltage secondary of a filament transformer is inserted in series with the appliance motor or other load. When the current rises, the thyratron tube conducts and energizes the relay. This opens the motor circuit.

All the components are mounted on a small, open chassis. The knob protruding from the top of the chassis is the sensitivity control. Sensitive relay must be used.



ADDING A CENTER SPEAKER FOR STEREO

By GERALD J. HEALY

Methods that may be used to derive a third channel for greater stereo spread, eliminating "hole-in-the-middle."

WITH the advent of stereophonic reproduction there came problems of re-creating, as accurately as possible, the original geometric location of the sound sources. Most of the initial work was done in the recording field. The major objective was to eliminate the "ping-pong" effect of early stereo recordings. This was accomplished through the use of various microphone techniques and different recording methods such as the use of three-track master tapes. The three tracks contained left-, center-, and right-channel information. In cutting the master disc, the center channel is carefully mixed with the left and right channels. The result has been records and tapes with greatly improved center-channel "fill."

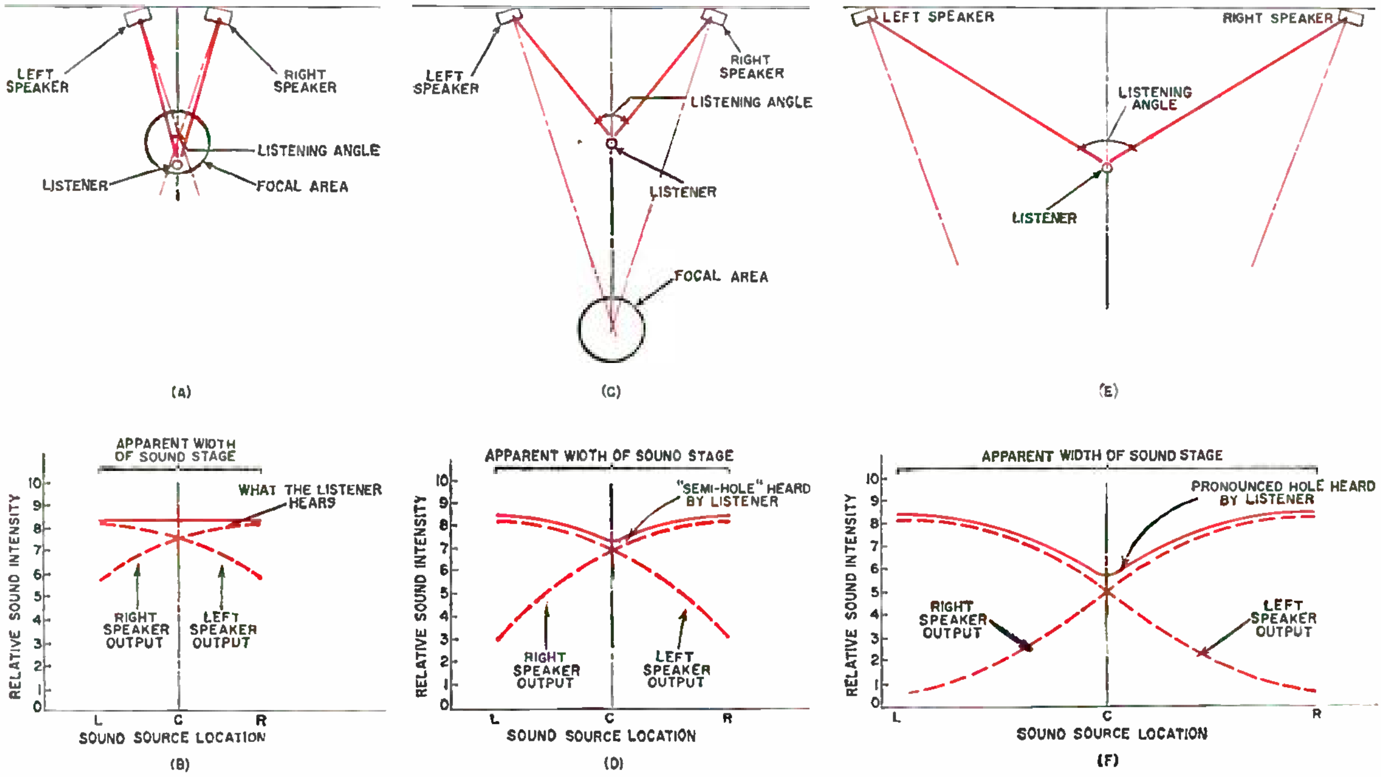
The spotlight then shifted from recording to reproduction, for here there existed an annoying dilemma—how to get wide-stage stereo without a "hole-in-the-middle." To understand this problem fully, a more complete knowledge of two-speaker stereo is necessary. See Fig. 1. In order to reproduce a uniformly balanced sound stage, the speakers have to be placed close together such that the listening angle is not too great (Figs. 1A and 1B). This produces a relatively large focal area, but the sound stage is narrow. As the listening angle increases, the sound stage seems wider. This is accomplished by either bringing the listener closer to the speakers or by separating the speakers. However, as the listening angle is increased, a "hole" tends to develop in the center due to the focal area moving behind the listener (Figs. 1C to 1F). This happens if the speakers maintain the same angle with respect to the wall. To maintain the original listener-focal area orientation, the speakers have to be toed-in as the listening angle increases, since balanced stereo can be heard only in the focal area. Note also that the greater distance between the speakers and the listener reduces the amount of sound received at the focal area.

The size of the focal area is determined by the directional characteristics of the speaker systems employed. As the speakers are separated, the size of the focal area may tend to decrease due to the absorption of the middle and high frequencies—those which give stereo its greatest directivity. Once the listener moves out of this area, the center of the sound disappears, with a resulting "ping-pong" effect or even a complete loss of stereo directivity.

Center Channel

The solution to this problem seems to lie in the derivation of a center channel whose output depends on the information of both left and right channels. The maximum power delivered to this center channel occurs when both left and right channels contain the same information, which happens only when the source is in the center, between left

Fig. 1. (A,B) Narrow-stage stereo has no "hole-in-middle" but listening area is fairly restricted. (C,D) Wide-stage stereo has a slight reduction of sound in the center location. (E,F) Extremely wide-stage stereo is characterized by a pronounced "hole."



and right. As the source moves to the left away from center, the contribution from the left channel would be approximately the same level as when the source was in the center but the contribution from the right channel would drop off as the source was moved farther to the left. The over-all effect would be a reduction in the output level of the center channel. See Fig. 2. This same thing holds true if the sound source moves to the right. When this center-channel speaker is combined with a widely separated two-speaker system, the sound stage has good continuity. See Fig. 3.

The earliest method of obtaining a center channel was to mix the preamplified and equalized left- and right-channel signals electrically. The resulting signal was fed to a third amplifier and speaker system. The mixing circuit was designed so that a high degree of channel separation was maintained. The

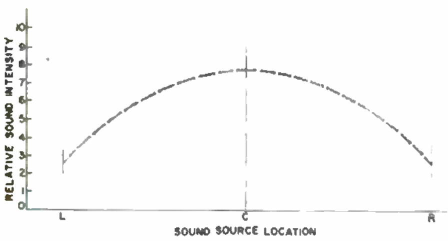


Fig. 2. Power-output requirement of the derived center-channel loudspeaker.

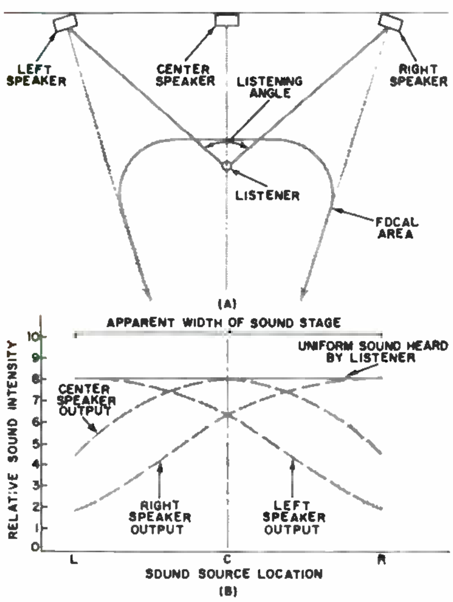


Fig. 3. Three-speaker wide-stage stereo.

major drawback to this method was the expense of a third, high-quality amplifier. The ideal solution is to obtain the necessary signal at the speaker output terminals, as shown in Fig. 4. Unfortunately, this produces a "difference" signal if the phase of both channels is the same. To produce the required "sum" signal, the phase of one of the channels has to be shifted by 180 degrees. This can be accomplished in several ways—four such methods will be discussed here.

Reversing Phase

The first method is to reverse the ground and "hot" lead connections on one channel of the stereo cartridge being used. This can be done only with a four-terminal cartridge that does not have a built-in common ground. *Note: This will not work with three-terminal cartridges.* The only drawback to this method is that it restricts the system to phonograph records—no third channel can be obtained from tapes or radio (AM-FM and/or FM-FM multiplex). If this method is chosen, connect the

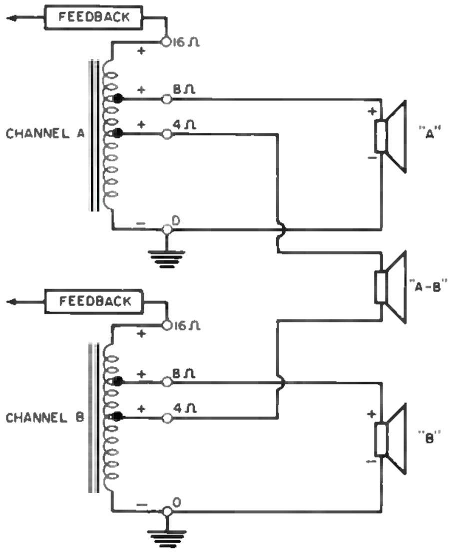


Fig. 4. Derived "difference" channel.

speakers as shown in Fig. 5A. Note the speaker polarity, especially that of the reverse-phase channel. A level control may be required on the center- or left- and right-channel speakers for best results.

The second method is no doubt the easiest; however it applies only to preamps which employ electronic phase reversal (as opposed to the most common method of speaker-phase reversal). In this type of preamp, the output

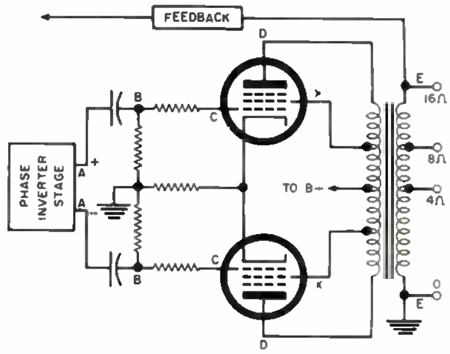


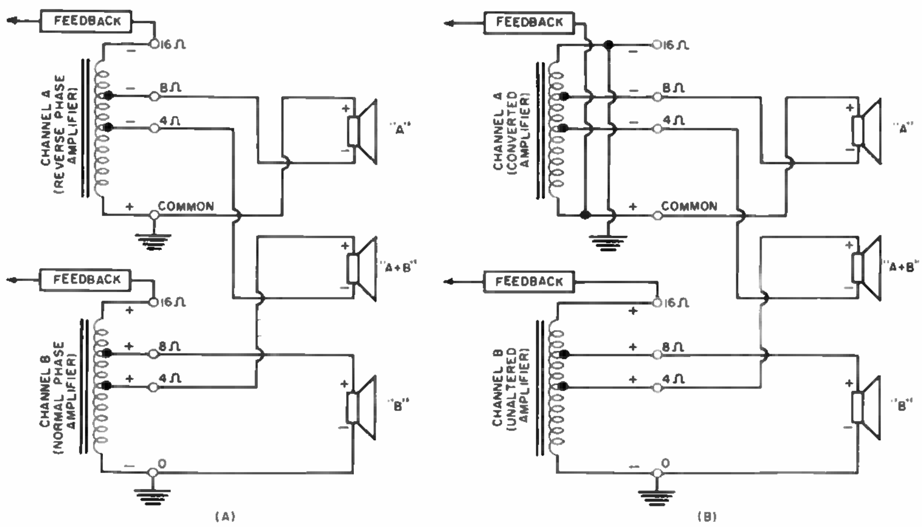
Fig. 6. Generalized circuitry of the "Ultra-Linear" type of push-pull power output stage.

is taken from either the plate or the cathode of the output tube; hence all that is necessary is to operate the preamplifier in the "reverse phase" mode. See Fig. 5A for proper speaker connections. Remember to observe the speaker polarities shown.

The third method applies to systems which employ two separate power amplifiers. If these amplifiers are made by different companies or if two different models made by the same firm are being used, it may then be possible to obtain a third channel without any circuit changes. This can happen only if the number of tube functions of one amplifier, with respect to the other, produces an 180-degree out-of-phase signal of one channel with respect to the other. To check this, connect the center-channel speaker system to the 4-ohm taps on each amplifier, as shown in Fig. 5A. Play a *mono* record with the system operating in the *stereo* mode. Adjust the volume of one channel above and below that of the opposite channel. If the signals are in-phase, there will be an audible null due to mutual cancellation at the point of equal signal strength. If no such null occurs, then the required out-of-phase relationship

(*Continued on page* 88)

Fig. 5. (A) Center channel from out-of-phase amplifiers and (B) from converted amplifier. Speaker impedance matching is not very critical, and it is advisable to experiment with various speaker taps to alter the sound levels produced by the various speakers. Actually, each output transformer is operating with two paralleled loads on it. Hence, the output impedances are half the values indicated at the transformer taps for speakers "A" and "B." In the case of the center channel, note that the two 4-ohm windings are in series, producing an impedance of 8 ohms. But again, because of the paralleled loads, the actual output impedance for "A + B" is just half this value.



Shock-Proof Record-Player Suspension System

By **EBER W. GAYLORD**
Carnegie Inst. of Technology

Using simple mechanical engineering principles, here is how to build a system to isolate the record player from the most severe shocks encountered in the home.

RECORD turntables or changers are usually supported by springs or elastic mounts provided by the manufacturer. These mounts isolate the record player from acoustic feedback by the loudspeakers. However, to prevent acoustic feedback, it is only necessary to isolate the record player from frequencies higher than the lowest frequencies produced by the speaker; in many record players these mountings are much too stiff to protect the record player from the effects of shock caused by people dancing, children playing, and, in the case of particularly flimsy floors, people walking near the record player. These shocks can result in record-destroying groove-jumping and annoying disturbances in the sound.

This article will describe a record-player suspension system that will isolate the record player from the effects of the most severe shocks that would normally be encountered in the home. The suspension system accomplishes this by providing extreme flexibility to motion of the turntable in all directions, *i.e.*, vertical, horizontal, and rotational. Only a few parts are needed for its construction. These parts include pulleys, strong cord or fishline, steel pegs, and extension springs—all of which can be found in a well-stocked hardware store. The unit has a simple mechanism for leveling the turntable, a necessity when a balanced tonearm is not used.

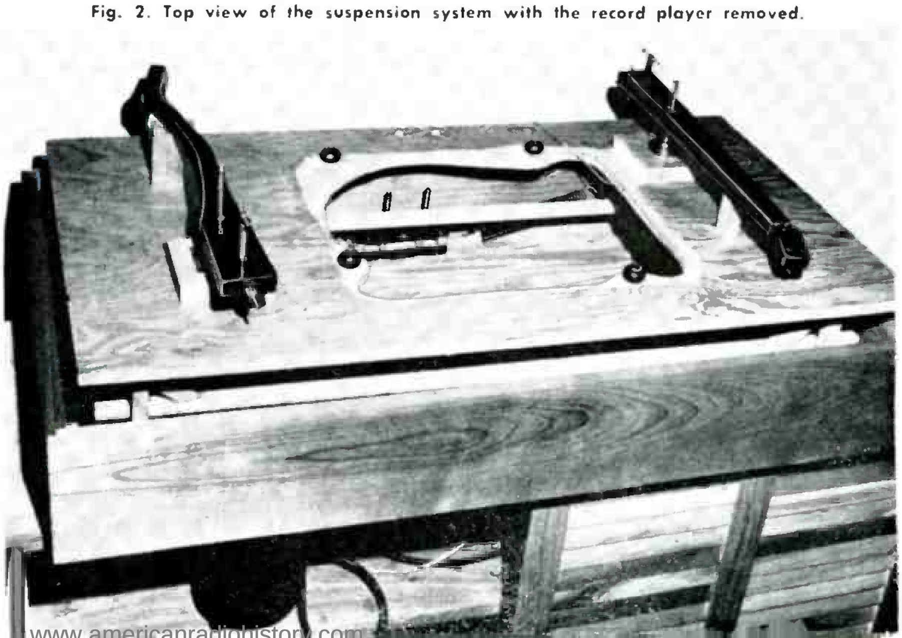
Principle of Operation

The suspension system isolates the record player from shock by permitting the record-player cabinet, or whatever structure the record player is mounted on, to move suddenly through large displacements, such as $1/8$ of an inch, without transmitting any appreciable motion or jar to the record player. In essence, the suspension system makes the record player behave like a seismograph; if the floor were to be suddenly jarred by an earthquake, one could notice it by observing the relative motion between the record player and the suspension system cabinet.

A very simple criterion may be used to determine how flexible the suspension system must be: this is to specify the natural frequency of free oscillation of the suspended record player when it is disturbed into motion, *i.e.*, the frequency at which the record player swings back and forth or bobs up and down. Analysis and experience have shown that a natural frequency of 2 cps or less will give adequate shock protection. At this low frequency, any vertical or horizontal oscillation of the record player will not produce forces between the needle and the record large enough to disturb the

Fig. 1. Over-all view of record-player mounting arrangement described in the article. A pair of home-built tonearms complete the author's playback system.

Fig. 2. Top view of the suspension system with the record player removed.



sound, cause groove jumping, or harm the record. Moreover, the small amount of friction in the suspension system will quickly damp out these oscillations. Natural frequencies much lower than 2 cps, corresponding to a more flexible suspension, are usually not necessary and they may become impractical due to space limitations and difficulty in getting extremely soft springs that are capable of supporting the weight of the record player.

Design

The suspension system illustrated in Figs. 1 through 6 consists of a cradle that is suspended at each corner by 80-lb.-test Dacron fishing line running over ball-bearing pulleys. The other ends of the cords are fastened to extension springs. The other ends of the springs are anchored by cord to the steel pegs in the record player leveling windlasses. The record-player mounting board rests on four posts extending up from the cradle. The flexibility of the system is achieved through pendulum action in the horizontal direction and through spring action in the vertical direction.

The cradle can be made of thin strips of oak, or other strong wood, and glued together with a good glue.

The leveling windlasses, shown in Figs. 4 and 5, consist of ½-inch diameter steel pegs clamped in a wood block by steel straps. The pegs are kept from rotating by the clamping friction. Their action is similar to that of the pegs of a violin. A slot is cut in the upper ends of the pegs to accept a screwdriver. Any corner of the record player may be raised or lowered by inserting the screwdriver through properly placed holes in the record-player mounting board and rotating the pegs.

The natural frequency of oscillation of the record player in the horizontal direction is $f = 3.12/\sqrt{l}$ cps, where l is the length in inches of the portion of string A-B (Fig. 6) between the pulley and the cradle. A minimum length of 2 inches will give a frequency of about 2.2 cps. If space permits, longer lengths will provide better isolation.

The Springs

The choice of springs depends on the total weight of the suspended record player, mounting board, and cradle. The greater this weight, the heavier and stiffer the springs must be.

Determine the total suspended weight and divide this quantity by 4 to get the approximate load carried by each spring. Call this quotient W. For example, the total suspended weight for the *Thorens* turntable used by the author was about 20 pounds, so $W = 5$.

Now specify a spring on the basis of its spring constant, called K pounds per inch. K is given by the formula: $K = W f^2/9.75$, where f is the natural frequency. For example, with $W = 5$ pounds and f = 2 cps, $K = 5 \times 4/9.75 = 2.05$ pounds/inch.

Enough space must be provided in designing the system to allow for the stretch of the spring due to the sus-

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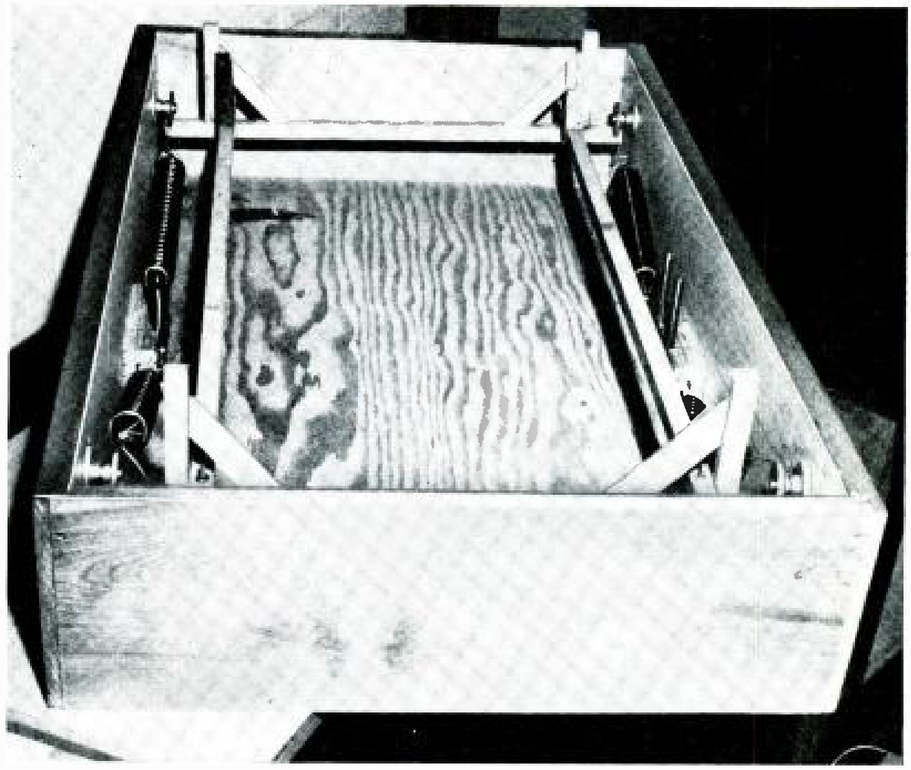


Fig. 3. Inside view showing the arrangement of the four suspension springs.

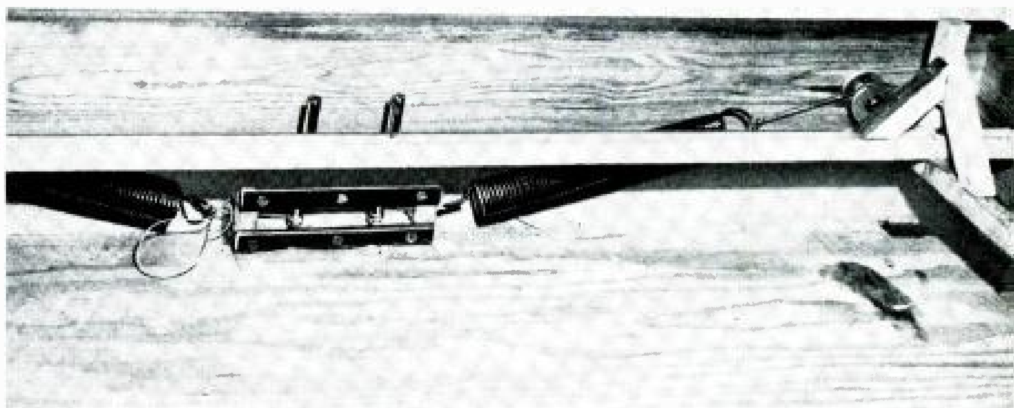
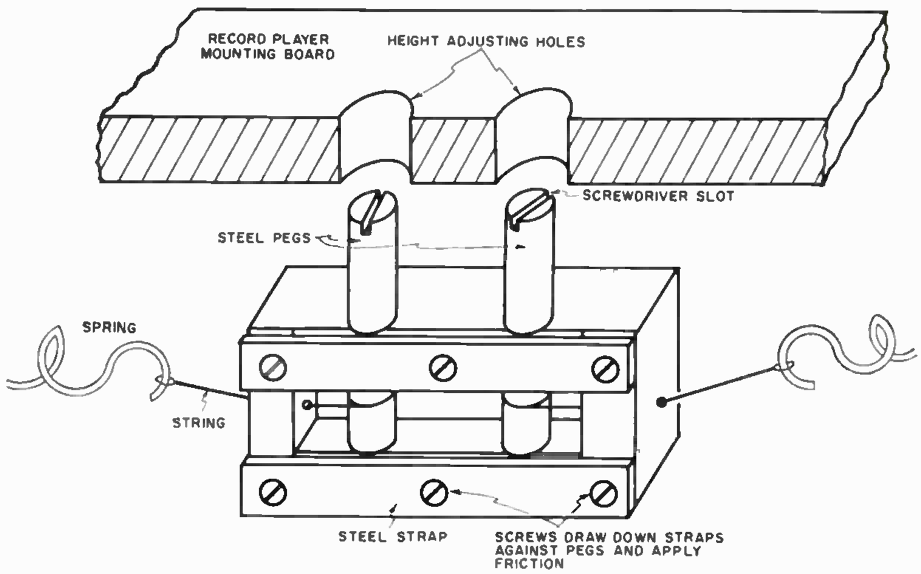


Fig. 4. Close-up of the leveling windlass with its two height-adjusting screws.

Fig. 5. Details of the leveling windlass. Two of these assemblies are required.



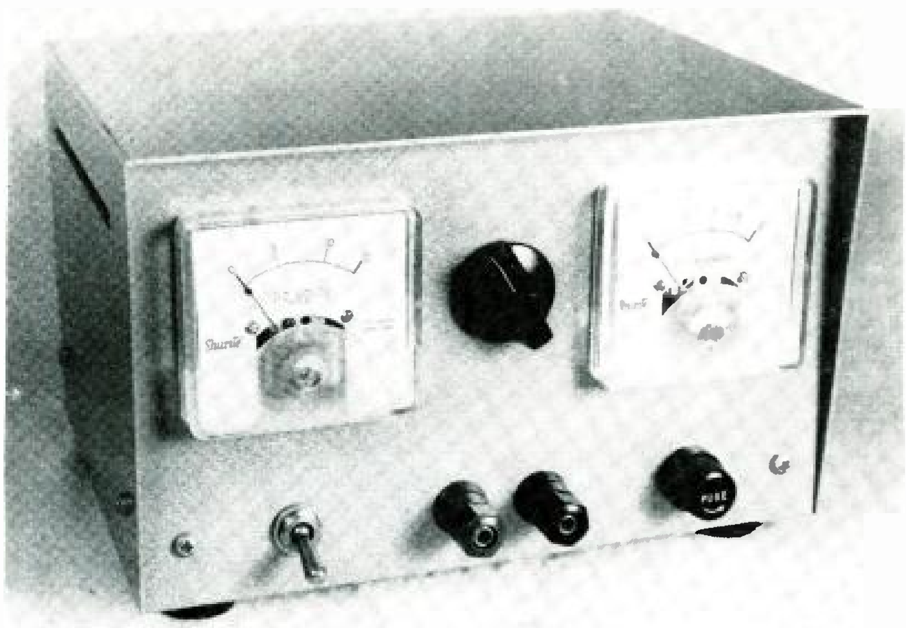


Fig. 1. The supply was mounted in a special case that offers several advantages.

MULTI-PURPOSE LOW-VOLTAGE SUPPLY

By CHARLES CARINGELLA

Regulated, variable output to 14 volts and 5 amperes with low ripple is useful for powering transistor circuits and eliminating or charging batteries.

THE DAY OF the time-honored battery eliminator, with its high a.c. ripple, is dwindling rapidly. The popularity of transistorized radios, including those used in automobiles whether they are of the hybrid variety or not, has imposed a new requirement on service shops. The need for a versatile, variable source of low d.c. voltage is evident. It may sometimes be called upon to deliver fairly high current, but it now must do so while keeping a.c. ripple at a low level.

The bench supply described here will do that at moderate cost, making a worthwhile addition to the service shop, and it will also find use in the laboratory or on the experimenter's bench. For example, in addition to powering transistor circuits, it can provide d.c. power, on an experimental basis, for a variety of portable or mobile equipment. It also provides enough output to give an automobile battery a healthy, overnight charge.

The author's completed version, in Fig. 1, provides continuous control and metering of output voltage and current. Stepdown transformer T_1 (Fig. 3) supplies 18 volts a.c. to a full-wave bridge rectifier made up of four silicon diodes, SR_1 to SR_4. Each of these will pass 5 amperes, which is the maximum output rating of the entire supply. The peak-inverse voltage ratings of the 1N1450 types used also meet the circuit requirements safely.

The zener diodes, CR_1 and CR_2, serve as a reference for regulating the supply and also determining its maximum output voltage. The potential across each of these is nominally 6.8 volts. With the two in series, nearly 14 volts is obtained, and it remains constant despite fluctuations in input a.c. or output load.

The same end can be achieved in other ways, but the use of the two diodes was considered to be well worth their cost in terms of convenience and reliability. A small battery or string of series cells adding up to the maximum output voltage, used in place of CR_1 and CR_2, would serve the same purpose. However, they would have to be checked and replaced from time to time. An alternate scheme is shown in broken lines (detail *A*, Fig. 3). This network could be used to replace the diode pair (broken lines) in the main schematic. If this is done, R_1 and R_1 form a simple voltage divider, and C_3 maintains the voltage at a somewhat constant level. However, regulation will not be as good as in the other methods. The choice is up to the user, based on his needs.

In any case, the reference voltage is applied between the base of transistor V_1 and the positive side of the rectified supply. Since this stage is an emitter follower, the emitter output, developed across R_2, is held to within a few tenths of a volt of the base potential. Since R_2 is a potentiometer, the voltage it selects for application to the base of V_2 is regulated although variable. This control is thus the supply's voltage adjustment. V_2 is also an emitter-follower stage, so output across R_3 closely follows the input voltage at the base.

Emitter output of V_2, in turn, is coupled to the bases of V_3 and V_4, these two transistors being in parallel to provide the desired current output from the last stage. In effect, the last two transistors also function together as an emitter follower, but the external load now serves as the emitter resistor. Essentially then, the regulator circuit is a three-stage, cascaded current amplifier, with each stage supplying more current than the one preceding it. The four *Motorola* power transistors, Type 2N554, are relatively inexpensive, currently selling for not much more than a dollar each.

The circuit is also very effective in reducing power-supply ripple. This is extremely low—in the millivolt region—even when the supply is delivering maximum current. The same results could be achieved with conventional filtering methods, but the inductor and capacitor required would be large and expensive.

Simultaneous monitoring of voltage and current in the output is provided with two separate meters. Fuse F_2 pro-

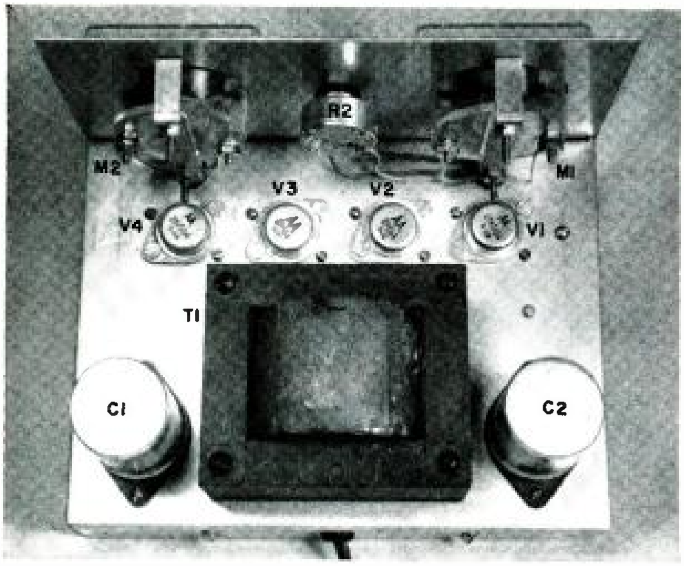


Fig. 2. Most major components are seen in top chassis view.

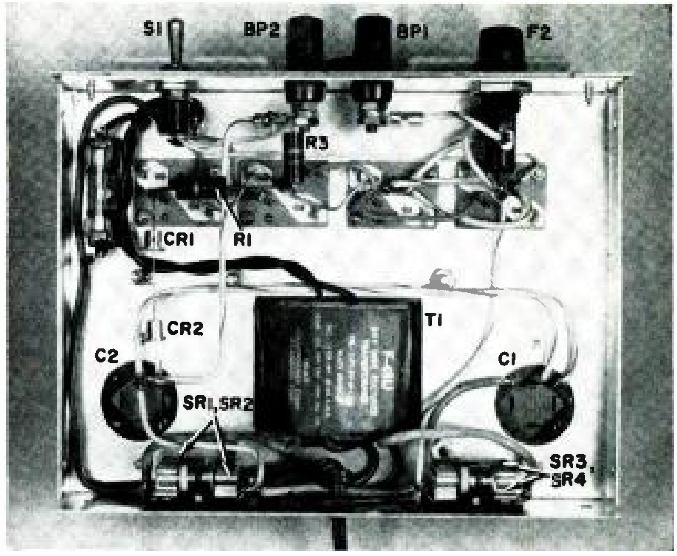


Fig. 4. All diodes and wiring appear in bottom chassis view.

tects the circuit under test as well as the regulator transistors in the event of a short. Its value will be discussed later.

Construction

The instrument was housed in a case measuring 5 inches by 6 inches by 8 inches. This new-style enclosure, manufactured by *L. M. Bender Co. (LMB)*, was chosen because it comes as a welcome departure from familiar types. It permits access to any part of the chassis without removal of the front or back panels. The case also makes an excellent heat sink for the transistors. It is constructed entirely of aluminum and its six sides, all making good thermal contact, help to conduct heat from the transistors into the air. Transistors V_3 and V_4 alone will dissipate up to 60 watts at certain voltage and current output conditions.

Fig. 2, a top view of the chassis, shows the locations of major components. Wiring can be seen in Fig. 4. This is not critical except that heavy leads should be used to carry current in certain, critical parts of the circuit. These include wiring from the negative side of the bridge to the collectors of V_3 and V_4, from the positive side of the bridge to positive terminal BP_2, and in that part of the circuit involving the emitters of V_3 and V_4, fuse F_2, meter M_2, and BP_1. Use No. 18 hookup wire or heavier.

The vertical mounting brackets on the *Triad* power transformer were removed to permit compact mounting in the enclosure. A rectangular hole was cut in the chassis and the transformer was mounted horizontally with the bolts that originally held the brackets. The green lead on this component is a 17-volt tap, not used. It may be cut close to the transformer, taped, and curled under the wiring, out of the way.

The entire circuit is isolated from the chassis. This enables equipment with negative or positive ground to be serviced with equal convenience. Be sure to observe all indicated polarities. Since the collector of the power transistor is connected to its case, the latter must be isolated from the chassis. This is accomplished with a thin, Teflon washer, which provides electrical insulation yet maintains good thermal contact with the chassis for heat removal. The mounting kit specified in the parts list includes the necessary washer, socket, and hardware. Mount the transistors after the sockets have been wired and soldered, then check between each transistor case and the chassis with an ohmmeter for possible shorts.

Check-Out and Performance

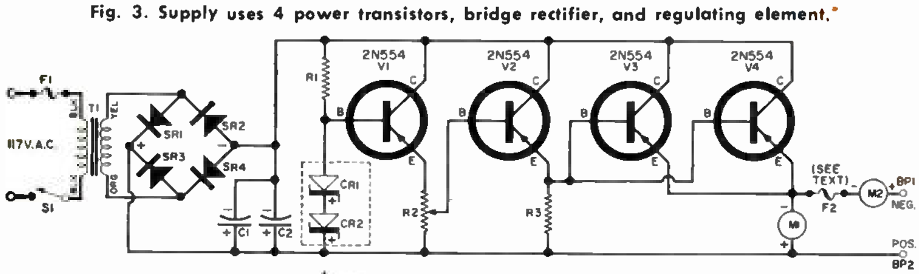
Before the power supply is put into use, it should be checked without a load. Turn on the power switch and manipulate control potentiometer R_2. You should be able to vary the voltmeter reading from 0 to 14 volts but the ammeter, of course, should not indicate. If the voltmeter deflects to full-scale and the reading cannot be adjusted downward, check the transistors for shorts. If ripple is measured with a v.t.v.m., about 1 volt should be read across C_1 and C_2 and about 10 millivolts at the output terminals. (When the supply is operating at full capacity, ripple will be approximately 100 millivolts.)

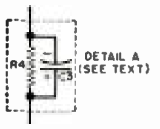
Next place a test load across the supply. A 5-ohm, 20-watt wirewound resistor will serve the purpose. With it, output voltage can be adjusted up to 10 volts. Transistors V_1 and V_2 will get warm. V_3 and V_4 will get very hot—in fact, too hot to hold.

The operating value for fuse F_2 may be conveniently changed for each application, the choice being governed by the load. For instance, when working on a small transistor radio, a value of 100 milliamperes or less could be used. Charging a car battery would require a fuse of several amperes. Although 5 amperes can be handled, a continuous load of 4 amperes should not be exceeded for maximum transistor life

Voltage regulation is quite good. At a setting of 6 volts with the load drawing 4 amperes, the drop is .5 volt. At 12 volts, the drop is .8 volt for a total of 11.2 volts at 4 amperes. -30-

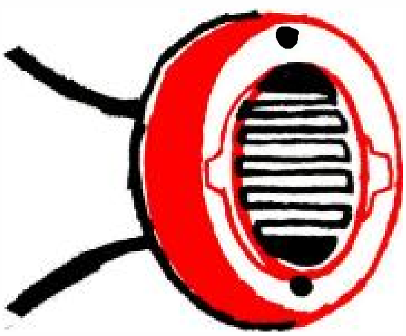
Fig. 3. Supply uses 4 power transistors, bridge rectifier, and regulating element.

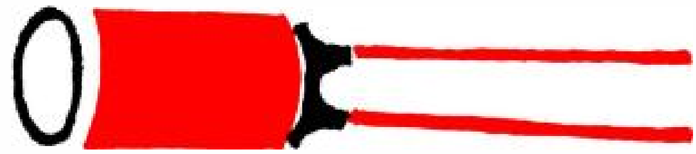




R_1—220 ohm, 1 w. res.
R_2—100 ohm, 5 w. linear taper pot (Centralab WN-101)
R_3—100 ohm, 2 w. res.
R_4—220 ohm, 1 w. res. (see text)
C_1, C_2—1000 μf., 25 v. elec. capacitor (Mallory WP-059)
C_3—500 μf., 25 v. elec. capacitor (Mallory WP-057, see text)
SR_1, SR_2, SR_3, SR_4—1N1450 silicon rectifier, 5 amp., 100 p.i.v.
CR_1, CR_2—Zener diode (Motorola 1M6.8Z)
T_1—Stepdown trans. 18 volts @ 6 amps (Triad F-48U)
M_1—0-15 v. d.c. meter (Shurite Model 850)
M_2—0-5 amp d.c. meter (Shurite Model 850)
F_1—1 amp fuse
F_2—See text
S_1—S.p.s.t. toggle switch
BP_1—5-way binding post (Superior DF30BC, black)
BP_2—5-way binding post (Superior DF30RC, red)
V_1, V_2, V_3, V_4—2N554 power transistor (Motorola)
1—LMB No. W-1C utility enclosure
4—Power transistor mounting kits (Motorola MK-10)
4—Silicon rectifier mounts (similar to fuse clips)

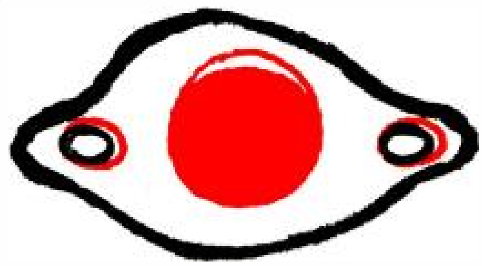
Novel Uses For Photoconductive Photocells





By JOHN POTTER SHIELDS

Construction of a simple light-operated relay, an automatic night light, and a daylight alarm are all possible with inexpensive cadmium sulphide photocells.



SEVERAL years ago a number of inexpensive cadmium sulphide photoconductive photocells were put on the market and have since found wide industrial and domestic application. Due to their small physical size and extremely rugged construction, they can be used in many environments where the conventional gas or high-vacuum tube photocell would be totally unsatisfactory. In addition, the sensitivity of the cadmium sulphide (CdS) photocell is much greater than gas or high-vacuum tube types so that, in many instances, no amplifier is required between a CdS cell and the relay or other device to be controlled.

Characteristics

The CdS photocell may be considered, for all practical purposes, as a light-sensitive resistor; the resistance of the average unit varying from many megohms in total darkness to several hundred ohms under conditions of high illumination, such as in bright sunlight. In most cases, the current through the CdS cell is proportional to the amount of illumination to which the cell is exposed. It should be noted that cells by different manufacturers will vary somewhat in this respect.

The spectral response of the average CdS photocell is such that its sensitivity is excellent throughout the visible light range and extends slightly into the infrared region. The spectral response peak, at approximately 6800 to 7000 Angstroms, can be seen in Fig. 1 for a typical cadmium sulphide photocell.

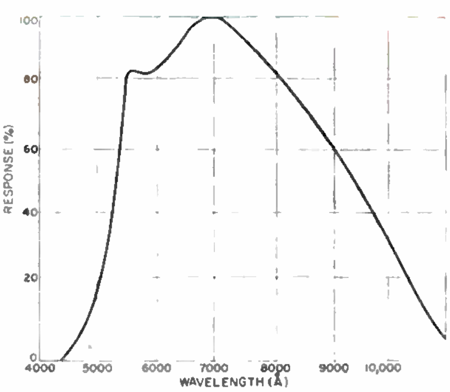


Fig. 1. Spectral response of typical CdS photocell—Polaris Type MAJ-1.

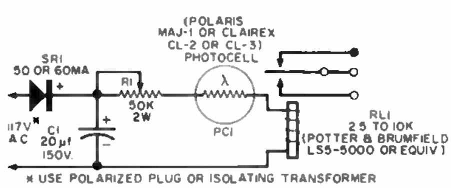
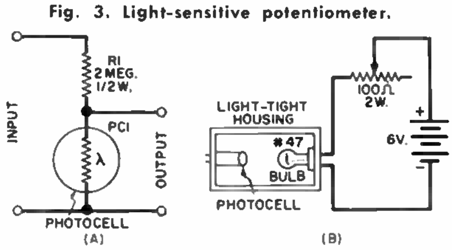


Fig. 2. A photocell-operated relay.

Fig. 3. Light-sensitive potentiometer.



As is the case with most good things, CdS cells have their limitations. For example, the frequency response of a CdS cell is so poor as to make it practically useless in such applications as optical sound-track reproduction and "light-beam" communications. These cells also possess what might be termed an "inertia effect." When a CdS cell is exposed to intense illumination which is then suddenly removed, a finite time is required for the cell's internal resistance to change to its original value. This effect is less pronounced as the intensity of illumination is decreased, therefore for maximum speed of response, as little illumination as possible should be used.

As is the case with any resistive device, the CdS cell has a maximum dissipation rating—generally expressed in fractional wattage at a given ambient temperature. Therefore, in designing equipment employing these cells, both the ambient temperature in which the circuit will be operating and the maximum electrical power which they can dissipate must be considered.

Most CdS photocells have an internal capacitance of between 8 and 20 $\mu\mu f$, which allows their use in wide-band video circuitry as would be the case if one were to be employed in an automatic contrast control circuit of a TV set.

Practical Uses

Now for a look at some practical applications for the CdS photocell. As a starter, Fig. 2 shows one of the most obvious applications for a CdS cell—a photocell-operated relay. As can be seen from the schematic, the circuit is simplicity itself, requiring only a selenium rectifier (SR_1), a sensitivity control (R_1), a filter capacitor (C_1), a CdS photocell (PC_1), and a relay (RL_1). The relay coil resistance should be between 2500 and 10,000 ohms. In operation, SR_1 and C_1 provide a source of low-ripple d.c. which is applied to the sensitivity control, R_1, the CdS cell, and the relay coil—all of which are connected in series. The sensitivity control is adjusted so that when light strikes the cell, dropping its resistance, sufficient current will flow through the relay coil to energize the relay. Since the current drain of this circuit is quite small, a 90-volt "B" battery can be used to operate the circuit if, at any time, portable application is desired.

A rather unique application of the CdS photocell is as a "light-sensitive potentiometer," as shown in Fig. 3A. Here a 2-megohm fixed resistor (R_1) is connected in series with the CdS cell (PC_1). The input signal is applied across both R_1 and PC_1. The output is taken from their junction and the low side of PC_1, which is also common to the input. Assuming that the dark resistance of the CdS cell is 10 megohms, then the output voltage will be 83 per-cent of the applied input voltage when the cell is not illuminated. If the cell is now sufficiently illuminated so as to drop its resistance to, say, 200 ohms, then the output voltage will be only 1/10,000th of the applied input signal.

This type of potentiometer has many useful applications. For example, it can be combined with a light bulb in a small housing to form a complete potentiometer control assembly, as shown in Fig. 3B. This type of assembly could find application where it is desired to insert a pot in a high-impedance circuit; the pot being controlled from a point remote from the circuit.

As an example, Fig. 4 shows such an assembly used as a volume control in a typical radio receiver. The CdS cell and associated resistor, R_1, replace the conventional volume control. The "control lamp" is connected by a piece of ordinary two-conductor "zip cord" to a simple rheostat and battery located at the desired point of control. The obvious advantage of this setup is that no high-impedance signal appears on the control cable; allowing the use of an unshielded cable of almost unlimited length. Incidentally, this same type of control setup

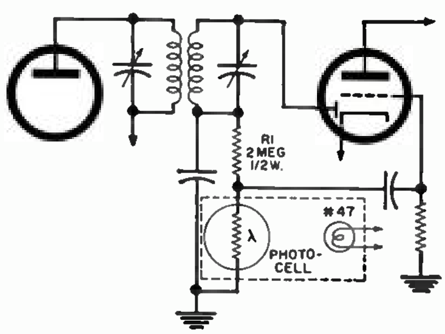


Fig. 4. Light-operated volume control.

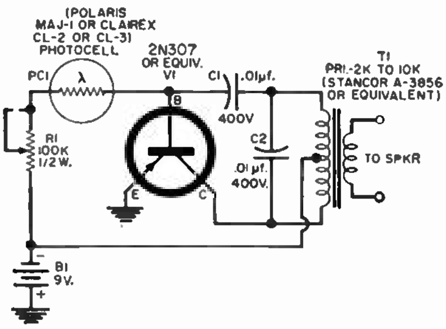


Fig. 5. An "electronic alarm clock."

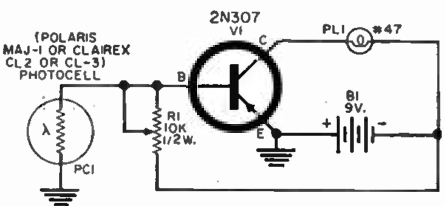


Fig. 6. Automatic night-light circuit.

would be ideal for use with a stereo system where it is always advisable to have the volume and balance controls located by the listener's side.

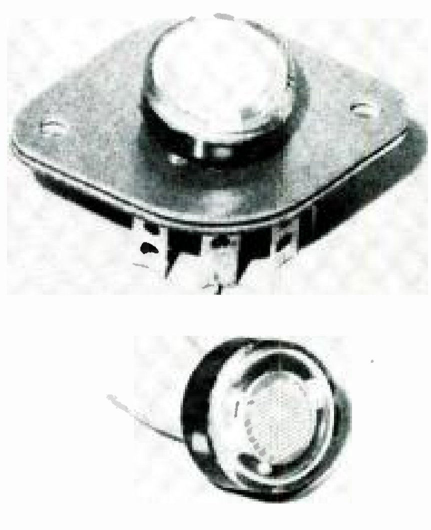
An a.c. supply may be used to excite the light bulb in the circuit of Fig. 4 if the cell is not placed in a circuit which is followed by large amounts of amplification. The reason that an a.c. supply may often be used in many circuits is that the light bulb filament possesses a certain thermal lag, that is, during each alternation of applied current, the bulb's filament doesn't have time to cool off completely. A low-voltage (2.5 volt) bulb is to be preferred over a higher voltage bulb as its filament is heavier and, as a result, has a greater thermal lag.

Another, although not quite so obvious, application of the photocell-light bulb combination is in instances where it is desired to use the CdS cell as part of a high-potential circuit, while keeping the control circuit at or near ground potential. Since the bulb and cell are completely isolated electrically, this type of operation would present no problem.

Other Novel Uses

Fig. 5 shows a rather novel application of a CdS cell. Transistor V_1 is connected in a series-fed Hartley oscillator circuit consisting of T_1, C_1, C_2, R_1, and PC_1. The base bias of V_1 is determined by R_1 in series with the CdS cell, PC_1. When PC_1 is not illuminated, its internal resistance is in megohms so that V_1 can draw no base-bias current—preventing it from oscillating. If PC_1 is illuminated, its resistance will drop sharply allowing V_1 to break into oscillation by virtue of now obtaining base-bias current. A small speaker can be connected to the secondary of T_1 to reproduce the tone. This gadget can be used as an "electronic alarm clock"—sounding a soft tone at the arrival of daylight. R_1 can be adjusted to vary the amount of illumination that is required to trigger the oscillator.

Fig. 6 is another circuit which can be adapted to use as an automatic night light. A #47 pilot light is connected in the collector circuit of V_1. The CdS cell, in conjunction with R_1, form a voltage divider network which supplies base current to V_1. When PC_1 is not illuminated, its resistance is extremely high, thereby shunting very little current to ground. As a result, V_1 receives sufficient base-bias current to conduct; lighting the pilot light. When PC_1 is illuminated, its resistance drops to a point where it shorts the transistor's

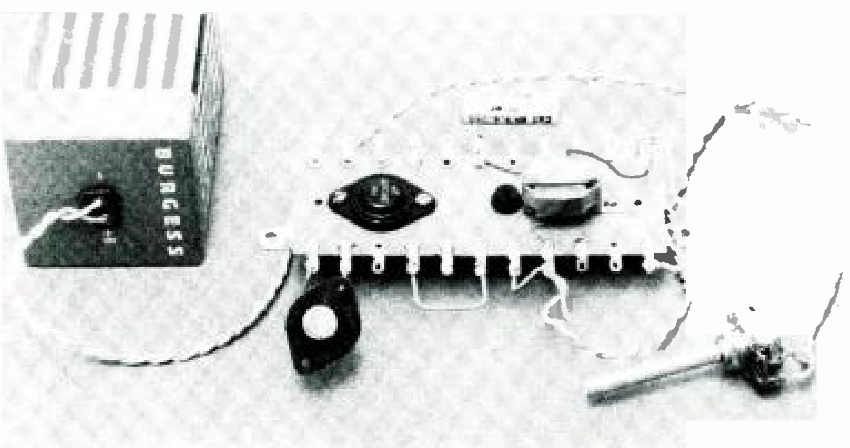


Some typical CdS photocells along with improvised tube-socket mounting.

base current to ground, causing it to cease drawing enough current to light the bulb.

Needless to say there are countless other applications for CdS photocells. The examples given here are meant merely as illustrations and are not intended to stifle the imaginations of the readers. -30-

The author's breadboard test setup for evaluating CdS photocell circuits.



RELAYS MAKE LOGIC CIRCUITS

With tubes, transistors, assorted diodes, and magnetic devices to choose from, relays still hold their own. Here's how they work.

By **KENNETH BRAMHAM**

WHEN SOMEONE mentions computer logic elements, we tend to respond by thinking of such "glamorous" components, developed in recent years, as semiconductors or magnetic devices. Magnetic cores, rods, and tape; transistors and Esaki diodes; MAD (multi-aperture devices); paramatrons; delay lines—these capture the imagination so much that they make one forget about vacuum or gas tubes and completely overshadow such a commonplace as the electro-mechanical relay.

Yet the relay, which was used before the mentioned devices came into prominence, is still the workhorse of the data-processing and control industries. The service technician is wrong to write it off as an antique because of the trend toward newer devices in large computers and telephone installations. In fact, he is more likely to encounter relays than any other devices. Relays are actually being used more than ever before in remote controls, machine-tool operation, office equipment, and computer input equipment. Consider even the modern, giant, "electronic brains," made possible by the latest advances, used in banking and accounting processes. It is a safe bet that several relays will have to operate before an input is received by the first transistor. What relays can do and how they are used are therefore important concerns.

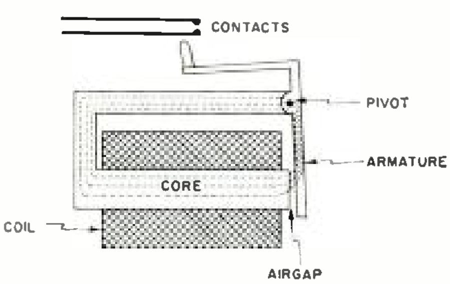


Fig. 1. Electromagnetic energy pulls in relay armature, which switches contacts.

The principle of relay operation is simple. Current is made to flow in a coil when a voltage is applied. This current produces a magnetic field in an iron core (Fig. 1) around which the coil is wound and in a movable armature. The only gap in the magnetic circuit, as shown, occurs between the core and the armature. Most of the energy in the field (magnetic flux is indicated by the broken lines) is concentrated at the air gap, so that the light armature is attracted to the heavy core. If the armature is mechanically coupled to a contact or switch assembly, its motion will make the switch contacts transfer. In the case of Fig. 1, armature motion will close the normally open switch contacts.

Advantages & Disadvantages

At first thought, relays would seem to have a serious handicap when compared to other devices as logic elements. Others can amplify, or provide us with gain. It is not immediately obvious that a relay can do as much. We are familiar with the gain of a tube circuit as being the ratio between a change of input voltage and a greater change of output voltage. However, a relay may be operated by a small current in its coil. It can then control a much larger current through its contacts. This may be said to provide current gain. (Like the transistor, the relay is a current-sensitive rather than a voltage-sensitive component.)

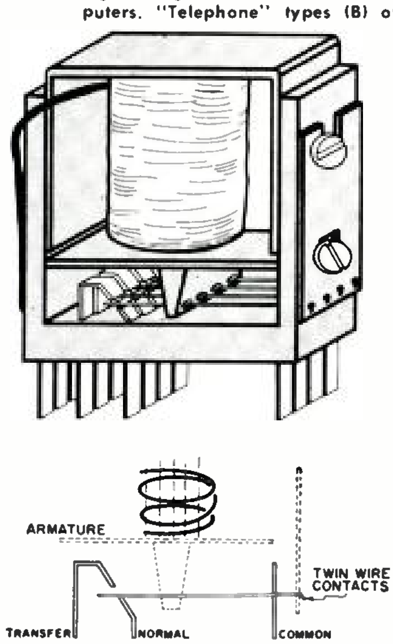
The relays dealt with here are also "two-state" devices; that is, they are either "on" or "off," with no degrees of operation in between. They do not have leakage current in the "off" state (as do transistors) nor resistance in the "on" state (as do tubes). Every relay requires a given, minimum current in its coil (input current) to attract the armature and transfer the contacts, just as a tube needs an input pulse of minimum amplitude to be triggered into conduction.

Let us consider what these characteristics mean in terms of "gain" and efficiency. Take a typical relay that may require an input of 50 ma. (50 volts across a 1000-ohm coil) and that has eight sets of contacts. These contacts will have infinite resistance when open and negligible resistance when closed. Each set can handle two amperes—a current gain of 40 (2/.05). If all eight sets of contacts are used, there is a total gain of 320!

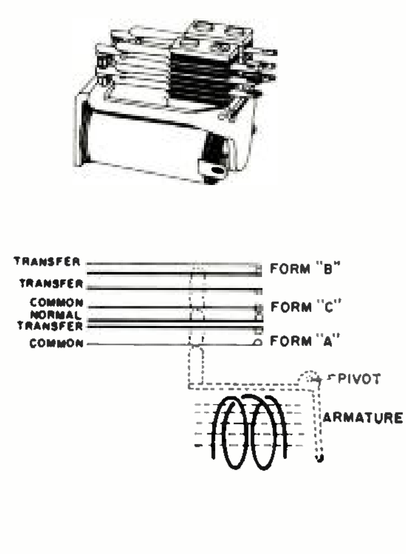
Comparison with that other current-sensitive device, the transistor, is interesting. For comparable operation, eight transistor circuits would be required, each capable of handling two amperes with an input current of 6.25 ma. (.05/8 = .00625). Normally each of the eight circuits would require at least two stages of amplification. This makes a total of 16 transistors, plus associated resistors and capacitors in the external circuits, instead of one relay.

Furthermore, we have been considering a simple case, in which we only want to switch the output circuits on (or only switch them off). This function parallels the action of a single-throw switch. Suppose we wanted to choose between two current-handling outputs in each section. We would need 32 transistors along with associated circuit components. A single relay with eight sets of

Fig. 2. High-speed wire contact relays (A) are used in office equipment and computers. "Telephone" types (B) offer a wide choice of combinations of contacts.



(A)



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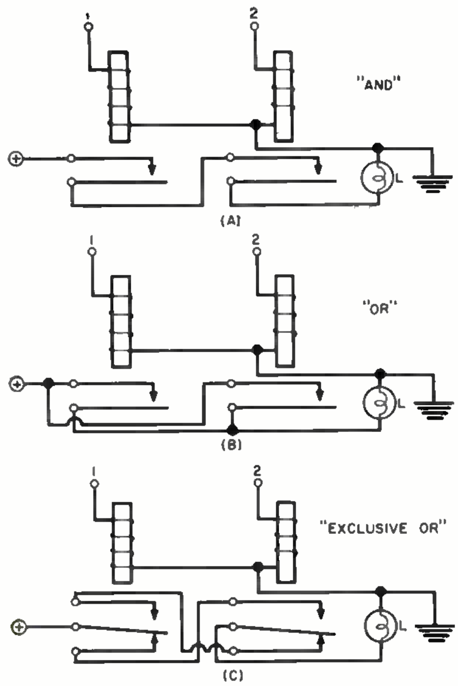


Fig. 3. Basic logic elements with relays.

contacts will still do the job, if the contacts are of the *C* type. In these, one contact, which moves with the armature, may swing to either of two other fixed contacts between which it is located. This duplicates the action of a double-throw switch.

Relays also have drawbacks when compared with other devices. Operating speed is a disadvantage that rules out the use of relays in high-speed computing; but, in applications where 5 to 10 milliseconds of switching time can be tolerated, relay logic circuits can be used to advantage. Other problems result from the inductance of the coils. The inductive kick produced when the coil current is interrupted must be suppressed, if damage to contacts is to be avoided. Adequate suppression often results in greatly increased switching time and adds to the design problems. Without suppression, if it is required to break a relay coil circuit with the contacts of another relay, much heavier contacts must be used than would be the case with full suppression. In any case, relay contacts rated to carry a given current will be rated to make or break at a much lower current.

Contact bounce is another disadvantage of many relay types. This is caused by the mechanical characteristics of the contact springs and will often cause a series of short pulses in the output circuit before a static condition is reached. This is seldom a problem when the output is taken to another relay coil, as the short pulses will not affect the switching time of a relatively slow-operating relay. If this pulsing output is taken to a high-speed transistor circuit, however, some special circuitry may be needed to give a clean signal.

Using the Relays

Those who are familiar with basic logic elements, such as those described in recent articles in this publication, will be interested to see how these may be built from simple relays. Actually, there are dozens of relay types to choose from. Only two are shown in Fig. 2, the wire-contact type (A) and the "telephone" type (B). The top illustrations are for physical appearance, the lower ones give an idea how they work.

Only *C* type contacts are available on the wire-contact relay, but as many as 12 sets may be found. When the coil is not energized, one circuit is closed through the "Normal" contact. With coil current, the other circuit is made through the "Transfer" contact as the wire is attracted upward.

Just a few of the many types of combinations are shown for the telephone relay. The movement of the single armature in Fig. 2B will close a pair of contacts (single-throw) on form *A*, transfer from one circuit contact to another on form *C* (double-throw), and open another circuit on form *B* (single-throw). Because of the restrictions imposed by wire-contact and other types of relays, we will show only logic circuits that can be made with *C* contacts, although all contacts will not always be in use.

Three basic logic elements, the *and*, *or*, and *exclusive or* configurations, are shown in Fig. 3 as they would be developed with relays. These are the simplest cases. The actual number of relays used can be many more than the two shown in each case. In each example, output is indicated by the lighting of lamp *L*.

In Fig. 3A, the contacts of one relay

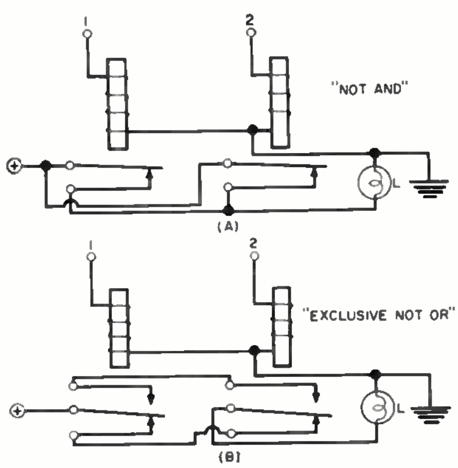
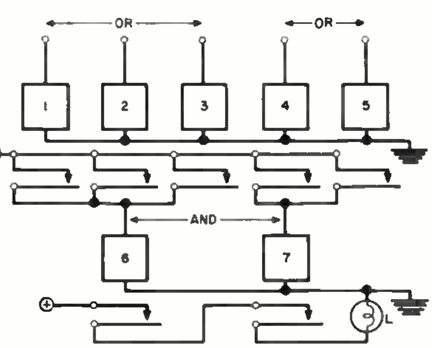


Fig. 4. The complimentary circuits for two elements in Fig. 3 are also possible.

Fig. 5. Building complex circuits: this arrangement takes 31 possible input combinations, produces output on 21 of them.



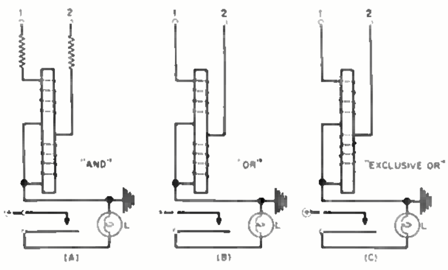


Fig. 6. One relay having two coils can simplify any of the circuits in Fig. 3.

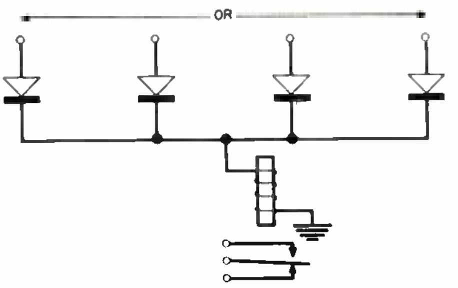


Fig. 7. If diodes are used, several inputs can be fed to a single-coil relay.

are in series with the contacts of the other. For output to be produced (for voltage to be applied to the lamp through a completed path), both relays must be energized. In Fig. 3B, relay 1 contacts parallel relay 2 contacts. Energizing either one (or both) will light the lamp. The *exclusive or* circuit of Fig. 3C has an interesting arrangement: the normally open contacts of one relay are in series with the normally closed contacts of the other, and *vice versa*. The path from the applied voltage to the lamp is complete only when either relay, but not both, is energized.

The complement of an *and* circuit is *not and*; the circuit for this is shown in Fig. 4A, where the light is seen to be normally on and is disconnected only when relay coils 1 and 2 are energized simultaneously. Similarly, the complement of *exclusive or* is shown in Fig. 4B; the light being disconnected when either relay, but not both, is operated.

In all the circuits shown, a light bulb has been used to indicate an output. In practice, this output may be used to operate almost any electrical device. Quite often the output of one logic circuit is used as an input to another logic circuit. The diagram of Fig. 5 shows the output from two *or* circuits (one with two inputs, the other with three) used as an input to an *and* circuit. (To simplify the diagram all relay coils are shown as rectangles containing an identifying number. This is common practice in relay logic diagrams.) Out of a possible 31 combinations of two or more inputs, 21 will give an output to the light.

Only simple relays have been discussed to this point; however, there is a variation of these relays that is widely used and often reduces the number of relays needed for a logic element. This is the double-coil relay. Construction is identical with the simple, single-coil version except for an additional wind-

(*Continued on page 90*)

HOW TO SELECT AN FM TUNER

By **JEROME M. GILISON**

Basic coverage of the specifications and features that are important to the user in picking a hi-fi FM tuner.

WHEN faced with the awesome task of choosing an FM tuner, the music enthusiast has often felt completely lost amidst the complex jargon of technical specifications and performance characteristics that seem to be the exclusive property of audio salesmen and electronics engineers. All too often the prospective buyer will throw up his hands and rely on the advice of the salesman or an "initiated" friend, only later realizing that his brand new tuner is lacking a feature that would be particularly useful under his listening conditions. This is especially unfortunate because this all-too-common calamity can easily be avoided with just a little preparation before entering the hi-fi emporium.

Specifications

The technical specifications all have very practical "common sense" meanings—expressed in technical shorthand—that indicate the type of performance you might expect under different operating conditions. Sensitivity ratings, for example, are often used to compare different tuners. These ratings indicate the ability of a tuner to receive weaker stations without bringing in, at the same time, an annoying background of noise. Thus the number you see in print is the *minimum* received signal strength which will permit a given degree of *quieting*, or freedom from background noise. If Tuner "A" is rated at 1.5 microvolts for 30 db of quieting (the most meaningful quieting level) with a standard 300-ohm antenna, this means that Tuner "A" will provide an enjoyable music signal with only 1.5 microvolts received at the antenna. Generally speaking, the sensitivity rating for 30 db of quieting with a 300-ohm antenna is the most useful basis of comparison and the prospective buyer should be alert to spot 72-ohm antenna ratings for specialized applications (which are exactly *half* the 300-ohm rating), and ratings for 20 db of quieting, which are lower but also include more noise. Of course, the lower the sensitivity figure, the more sensitive is the tuner.

The Institute of High Fidelity Manufacturers Inc. (IHFM), an industry-wide group, has established two new sensitivity ratings which are now used by practically all tuner manufacturers. These are *usable sensitivity* and *volume sensitivity*. The usable sensitivity test is designed to measure the internal noise (including hum and distortion) generated by the receiver itself, while the volume sensitivity is a measurement of a tuner's ability to provide a listenable signal from weak stations. (*Editor's Note: Usable sensitivity is measured with a −30 db, or 3%, ratio between the tuner's output with and without modulation. Volume sensitivity is measured with a −20 db ratio between the tuner's output with a strong modulated signal, and the output with a weak modulated signal.*) Due to the tremendous advances which have been made in tuner sensitivity over the past decade, however, the usable sensitivity test is the more stringent requirement for most tuners on the market today. What this means, in effect, is that today's tuner is so sensitive to radio signals that it will perform satisfactorily as long as the input signal is higher than the internal noise generated in the receiver tubes and components.

The important factor, however, is the amount of sensitivity that you will actually need in your own area. There is simply no sense in parting with extra cash for a highly sensitive tuner when all the stations you will care to receive can be picked up with ease on a less expensive model. Probably the best way of deciding how much sensitivity you need is to determine the number and location of stations you would like to receive. If your list includes some "must" stations at a distance of over 100 miles, you will probably need a highly sensitive tuner and, in most cases, a specialized outdoor antenna. If your most distant "must" station is located between 50 and 100 miles from your home, a tuner in the more moderate sensitivity range with an outdoor antenna will probably suffice. Local stations should present no problems, at least in regard to sensitivity, to just about all tuners of hi-fi standing now on the market. Of course, *these distances are very approximate*, for the peculiarities of FM transmission could place your domicile squarely in the midst of a "dead" zone while your neighbor is enjoying booming reception from distant places on his low-fidelity table model. If you are particularly interested in distance reception, the most sensible procedure would be to test the tuner of your choice in your home before making a final purchase.

Of course, even in the largest metropolitan areas, highly sensitive tuners can add significantly to the pleasure you derive from FM listening. Many a listener in such an area has been delighted to discover a station just to his taste in a distant city that might have remained beyond his range with a less sensitive unit. Thus the sensitivity rating must be considered along with the applications you have in store for your tuner, before a decision is made.

The AM noise rejection figure is an indication of the tuner's ability to suppress atmospheric static and car ignition noises. If a tuner has good limiting action and thus a high degree of freedom from such interference, this will be indicated by a higher AM noise rejection figure. You should keep in mind that high tuner sensitivity is usable only if it is accompanied by sufficient limiting action.

Another important specification when judging the reception provided by FM tuners is the capture ratio. This ratio

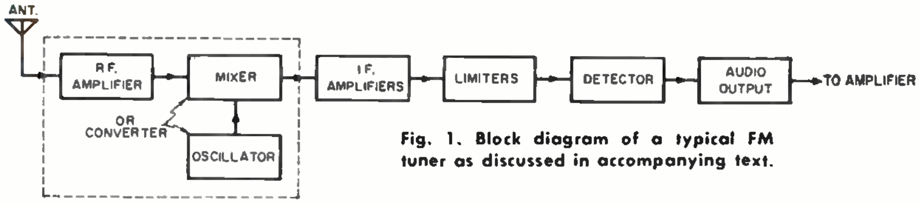


Fig. 1. Block diagram of a typical FM tuner as discussed in accompanying text.

indicates the degree to which a tuner can suppress a weaker station *on the same frequency* as the station you desire. A low capture ratio is particularly important in metropolitan areas where the FM band is crowded. With a sufficiently low capture ratio, you should rarely be troubled with even the faintest whisper of an advertising jingle in the background of a soul-satisfying program of Beethoven or Brubeck. Other indicators of a tuner's ability to eliminate unwanted FM signals are: image rejection, alternate-channel rejection, and adjacent-channel rejection. All of these numbers, expressed in db, have one thing in common—the higher they are, the more selective the tuner is.

All tuners worthy of the name "high-fidelity" should provide an audio response that is essentially flat (± 1 db) from below 50 to 15,000 cps, the usable range transmitted by FM stations. In addition, they should limit harmonic distortion to within 3% over this range. You will find that these figures are, in fact, maintained by just about all component FM sets now on the market.

Circuit Features

These few performance specifications are more than adequate as a basis of comparison in selecting an FM tuner. For a more complete assessment of an FM tuner's performance, however, you should be acquainted with some of the more common design features of the sets most often found on the seemingly endless shelves of the average hi-fi salesroom. The FM signal, after being picked up by the antenna, first encounters the tuner "front-end" (see dashed box in Fig. 1) where it is amplified and separated from other signals close to it in frequency. Since the signal from the antenna is typically measured in *millionths* of a volt, the most important requirement for a front-end is that it not introduce any internal noise of its own which would then be amplified along with the weak signal and appear as a rushing noise or hiss in the tuner output. From the standpoint of both high amplification and low noise, one of the best types of front-end design is the cascode type, which is generally found in the more expensive models. This design uses two triodes (which are the least noisy type of tube) usually within a single-tube envelope. Less sensitive tuners will use a single stage of amplification in the front-end or, in rare instances, omit the amplifier entirely.

As shown in Fig. 1, the FM signal is next fed to the mixer or converter stage (also part of the front-end) where it is changed to a lower intermediate frequency (i.f.), standardized at 10.7 megacycles. This can be accomplished by two low-noise triodes, one a mixer and the other an oscillator, or by a pentode-triode converter combining the two functions. This stage should be covered with metal shields to prevent the unavoidable radiation from interfering with the operation of the tuner or other equipment nearby.

The signal is next sent to the i.f. amplifier for a further increase in strength

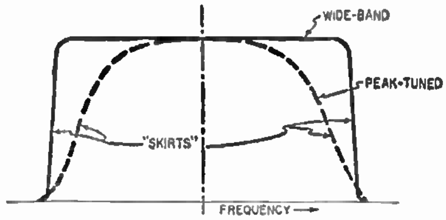


Fig. 2. Typical i.f. response curves.

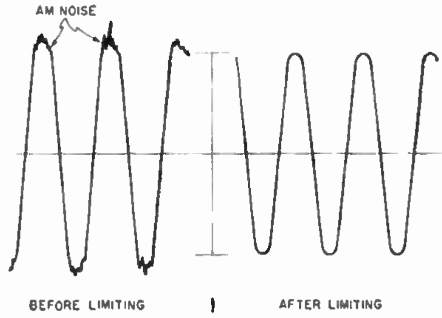


Fig. 3. The action of a typical limiter.

and for elimination of any remaining interfering signals. Generally, the greater the number of i.f. amplifying stages, the better the performance of the tuner will be. This is due not only to the increased gain (amplification) afforded by the extra stages but by the *decrease* in gain needed from each individual stage to achieve a usable output. The additional i.f. stages thus make it possible to increase the stability and thus lower the over-all distortion.

An increasing number of FM tuners these days feature wide-band design. The advantages of wide-band design of the i.f. amplifier are shown in Fig. 2. By providing constant amplification for a broad range of frequencies, the wide-band tuner greatly reduces distortion, especially on loud transients. The steep slope of the "skirts" of the i.f. response curve aids in eliminating unwanted signals. The narrow-band peak-tuned tuner (dotted line) does not provide the same freedom from distortion because the amplification is non-linear over a portion of the response curve.

After passing through the i.f. amplifier stages, the signal is then fed to the limiters, which remove the peaks of the transmission, thus removing AM interference (Fig. 3) such as static and car ignition noise. Here, again, the number of stages can serve as a general indication of the tuner performance. A well-designed tuner will include several different types of limiters so that the amount of limiting action will depend on the strength of the received signal. This variable limiting action permits each stage to operate in its own best limiting range. Some limiters double as i.f. amplifiers on weak signals.

At this point, the signal is ready for conversion to an audio output. This is done either by a ratio detector or a Foster-Seeley discriminator. The ratio detector has come into increasing use because of its distortion-free operation over an extremely wide band. It also provides additional limiting action for strong signals. The only disadvantage of the ratio detector is that the strength of the audio output varies with the strength of the radio transmission, but this defect is normally compensated for by the addition of limiters and automatic volume control (a.v.c.) in the i.f. section. The Foster-Seeley discriminator is being used less and less by tuner manufacturers but it does have the advantage of producing a relatively constant audio output for both weak and strong stations.

In most tuners, the audio signal from the detector is fed to one or more audio amplifiers and a volume control is provided. The final stage is the cathode or plate follower, which permits long lengths of cable to be used between tuner and amplifier without loss of fidelity.

Additional Features

Although we've covered the main points in the typical FM tuner design, there are several additional features which should definitely be considered when purchasing a tuner. The first and one of the most important is automatic frequency control (a.f.c.). There exists today a difference of opinion amongst tuner designers concerning the relative merits and demerits of including a.f.c. —a controversy which is reflected in the fact that some of the better tuners on the market today do not include it. The argument against a.f.c. is that it is just an added complication which is not needed if the tuning sections are temperature-compensated to prevent drifting. The argument for a.f.c. is to the effect that although a.f.c. should not be needed to prevent drifting in a well-designed tuner, it is still indispensable for convenient and accurate tuning to the exact center-channel and minimum-distortion position.

The need for a.f.c. is actually augmented in a wide-band tuner because with such a tuner the peak indication on even the most accurate tuning meter is so broad that it is literally impossible to find the center-channel position. Thus a.f.c. is used, *after* bringing in the station, to correct manual tuning errors. You will probably find a.f.c. an added convenience in most cases—and a switch is provided to turn it off if you should have any problems in receiving a particular station.

Another important feature is an accurate tuning meter or indicator. Generally, a meter is preferable because of its added convenience and increased visibility. However, several of the newer indicator tubes have improved characteristics, such as expanded-scale indication for weaker stations, and can be used without any significant loss in convenience.

Suppression of inter-station noise is another feature well worth having in an FM tuner. This noise can easily become a tranquility-shattering roar if the volume level is not turned down while tuning. The least satisfactory method

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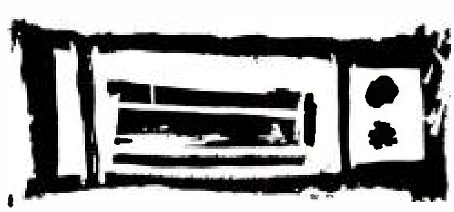

MAC'S service shop

Big Nickel's Worth

BARNEY had been out paying his utility bills during his lunch hour, and now he was back in the service department ruefully counting his change.

"You know, Mac," he said to his employer, "we might as well quit making the nickel. Even *I* can remember when it used to buy a candy bar, a cold drink, or a telephone call; but now it won't buy anything—at least anything worth a darn."

"Oh I don't know," Mac demurred. "It will still buy a whole hour of TV entertainment."

"You're just talking about the electricity the set uses," Barney hooted. "Figure in the original cost of the set and the expense of maintaining it and see how far your nickel goes."

"I *am* figuring in these things—or rather the *Kimble Glass Co.*, a division of *Owens-Illinois* and the *A. C. Nielsen* market research organization, took them into account. Their findings were published in *Sylvania News* and make mighty interesting reading for a service technician. Here," he said as he handed Barney a piece of chalk and waved him to the circuit-doodling blackboard at the end of the bench, "you write down the figures I give you so you can add them up.

"First," he continued, "it's estimated the average TV set costs $269 new and will last from 9 to 13 years. Let's be conservative and say 9 years. Even though the set may still be serviceable at the end of 9 years, enough receiver improvements will probably have been developed to make the owner want a new receiver. Anyway, put down $29.89 as the annual cost of just owning a set, whether you use it or not.

"Next, estimates of the cost of keeping a set going for a year range from $12.70 to $40.36. That $40.36 maintenance figure seems plenty high to me from our own experience, but let's use it.

"The Edison Electric Institute estimates the average TV receiver consumes 325 kilowatt hours of electricity a year at an average cost of 2.5c per kwh. Write down $8.13 as the annual cost of current for the set.

"Let's not leave anything out. Your TV set is insured under your fire and comprehensive policy and should bear its portion of the cost. At a rate of 27¢ per hundred dollars of valuation, the set will cost 73¢ a year for insurance.

"Finally, the average American family moves every five years; so they will make one and four-fifths moves in the nine year period. The average cost of a long-distance move is $350, and the part of this absorbed by the TV set is $8 to $10. So let's put down $2.00 as the annual cost of horsing your TV set around. Now add those figures."

"I get $81.11," Barney announced after some very scientific pecking on the blackboard with the chalk.

"OK, now divide that by 1853 hours the average TV set is in use in a year. That means it's used a little better than an average of five hours a day."

"I get a freckle less than 4.38 cents! Well what do you know? TV viewing *does* cost less than a nickel an hour. That's mighty low-cost entertainment. Only girl-watching is cheaper."

"Oh you dreamer!" Mac chuckled. "In the long run, girl-watching is one of the most expensive forms of entertainment. Ask any married man. But I was surprised, too, at the low cost of TV viewing. However, I think it's only fair to add on to the *Nielson* figures the cost of local household goods taxes as applied to the TV receiver; but even after that is done, the cost is still less than a nickel an hour—and don't forget we took the largest figure in every case in figuring the cost."

"Of course," Barney mused, "the cost per hour would go up pretty fast for the fellow who used his set only an hour or so a day; but there aren't many of those. I know lots of women who turn on their sets at the start of the *Today* show and never turn them off until the close of the *Jack Paar* show. On top of that, they stay up for the late-late show a couple of times a week. Since several of the costs are fixed and do not go up with usage of the set, the cost per hour of viewing for these people would be still lower."

"Right. I was quite interested to see that it was estimated almost half of that nickel-an-hour cost would eventually find its way into the cash registers of the service technicians. I still think that estimate is too high, but even if we did receive 2½¢ an hour for keeping a TV set going, it would be darned low-cost maintenance on a very complicated device. I only wish I could keep my power-mower, my outboard motor, or my car running for 2½¢ maintenance per operating hour. Why I'll bet I pay twice that to keep my electric razor working."

"I'm with you, man," Barney agreed. "Say, not to change the subject, what am I going to do with this radio set? It belongs to a sightless elderly woman who depends on it for practically all her entertainment. Since she cannot operate an unfamiliar radio satisfactorily, I promised to have it back to her in jig time. I supposed the trouble was tubes, capacitors, or some other simple thing; but that's not the case. The oscillator will not work, and after having gone over the oscillator circuit very carefully, eliminating one part at a time—and that's not easy on this printed circuit chassis—I'm forced to conclude something is wrong with the oscillator coil. No winding is open, and there are no shorts between windings, but one of the windings must have some shorted turns."

"So why don't you put in a new coil?"

"It's not that simple. This coil is a special, designed to solder right into the printed circuit. Our service data does not recommend any replacement other than an exact duplicate secured from the manufacturer. Even if the distributor has a coil in stock and does not have to back order from the manufacturer, it will probably take two or three weeks to get the coil. At least our experience with that distributor in the past makes me think so. In the meantime, that old lady's world is going to be pretty bleak."

"Hm-m-m," Mac said as he looked down at the little oscillator coil. "This would seem to be one of the few cases in which some rough-and-ready first-aid type of servicing might be warranted. At least it's worth a try. Stick the ends of these test leads into the #2 and #7 pin receptacles of the octal socket of the tube tester and set it up for an ordinary octal tube test. Let's try a 6.3 filament voltage to start. That will give me 6.3-volts a.c. across the test leads. Now we touch the leads to the ends of the cathode winding of the oscillator coil, like so. See, the wax is starting to melt on the winding. We let it 'cook' just a trifle longer and then move over to the winding across the tuning capacitor. The resistance here is higher; so step that filament voltage up to 7.5 volts. Now the wax on this winding is melting, too. We remove the test leads, allow the coil to cool for a minute or so, and then switch on the receiver—keeping our fingers crossed!"

To Barney's amazement, the radio came on instantly and played perfectly normally.

"We were lucky," Mac said as he

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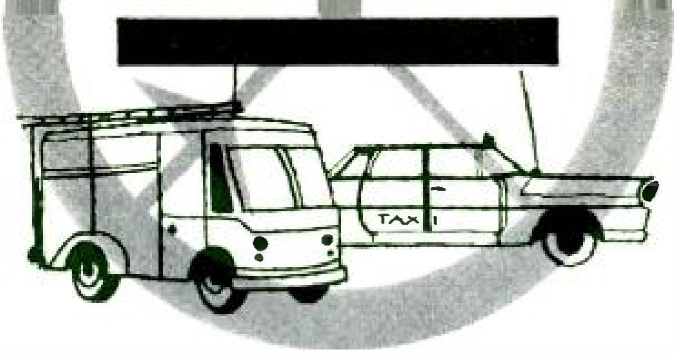


TRANSISTORS IN TWO-WAY RADIO

Part 1 BASIC CIRCUITS

By **EDWARD M. NOLL**

Compactness and low power needs make transistors ideal for use in commercial land-mobile equipment.

THE transistor has been most welcome in the field of two-way land-mobile radio communications. Since compactness and minimum power drain are paramount in the design of mobile equipment, the hybrid transistorized receiver and, subsequently, the all-transistor receiver soon were forthcoming. Next, the transistor found its niche in battery-operated power supplies (replacing the vibrator) and in transmitter audio systems. Finally, transistors spread to the radio-frequency and modulator sections of the transmitter. All-transistor, hand-held transceivers are now widely available.

Transistor as R.F. Oscillator

The modern transistor functions well as an oscillator up into the hundreds of megacycles. Stable and economical crystal-oscillator circuits generate high-frequency signals, the outputs of which multiply up to the two popular two-way radio bands, 25-50 mc. and 150-174 mc. (The band from 450-470 mc. is also available for land-mobile radio.) Self-excited transistor oscillators that can be frequency-modulated directly and have good center-frequency stability are now in use.

Three typical crystal-oscillator circuits are shown in Fig. 1. To obtain the necessary feedback for exciting the crystal, a split-capacitor or tapped-inductor feedback arrangment is often used. The amount of feedback into the crystal circuit is determined by the position of the tap on the coil or the reactance ratio of the split-capacitor combination. The circuit of Fig. 1C uses a tetrode transistor crystal oscillator. As in the case of a screen-grid vacuum-tube crystal oscillator, there is better isolation between output circuit and crystal—improving frequency and output stability of the circuit.

For high-frequency operation, overtone crystals are used in appropriate oscillator circuits, as shown in Fig. 2. A common-emitter circuit is shown in Fig. 2A. This crystal circuit is similar to the Pierce vacuum-tube crystal oscillator. The collector tank circuit is tuned to the

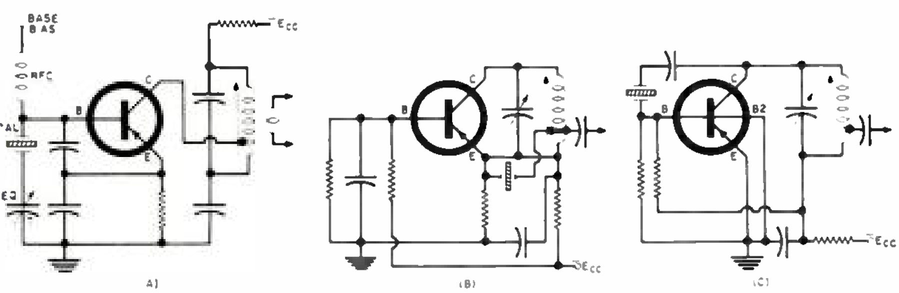
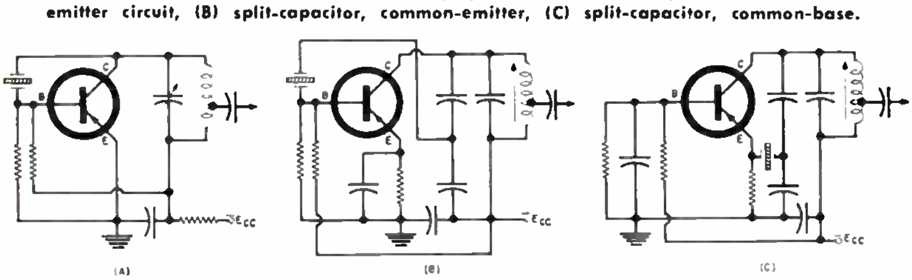


Fig. 1. Basic crystal oscillators. (A) Split capacitor, (B) tapped coil, (C) tetrode.

Fig. 2. Common transistorized circuits employed with overtone crystals. (A) Common-emitter circuit, (B) split-capacitor, common-emitter, (C) split-capacitor, common-base.



desired overtone output frequency. To obtain optimum feedback for overtone operation, a split-capacitor feedback arrangement is usually more effective. Common-emitter and common-base circuits are shown in Figs. 2B and 2C.

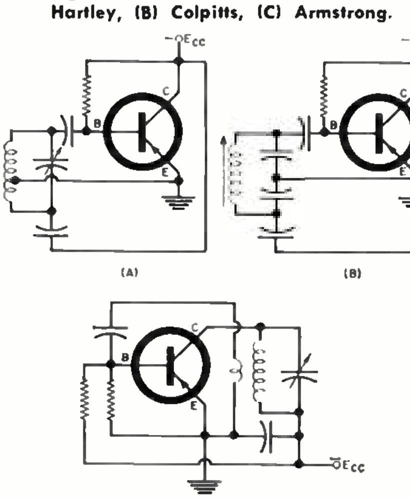
The output resonant tank of the transistor crystal oscillator is in the collector circuit. A transistor crystal oscillator can be tuned by inserting a meter in either the emitter or collector circuit. When the tank circuit is tuned through resonance, the collector and the emitter currents dip, in the same way the plate current dips in a vacuum-tube oscillator when the plate tank circuit is tuned through resonance.

The transistor crystal oscillator is brought to proper operating condition by adjusting the base bias. When the crystal stage is not oscillating, this bias is usually adjusted until 3 or 4 ma. of emitter current flows. When the crystal circuit goes into oscillation, as the tank capacitor is tuned through resonance, the emitter current will dip. As the load is increased on the output of the crystal oscillator, the emitter current will again increase. It is apparent that the emitter or collector current reading is used in the same manner as the plate-current reading of a conventional vacuum-tube crystal oscillator to establish proper operating conditions.

In commercial two-way radio equipment, the proper operating conditions for the crystal oscillator have been established by the design of the unit. Usually it is only necessary to adjust a small trimmer capacitor associated with the crystal, as shown in Fig. 1A. It permits the crystal oscillator to be set to some precise frequency. Very tight frequency tolerances must be maintained and, therefore, it is necessary to include a frequency control.

Inasmuch as the transistor is a low-impedance device, it is customary to use some form of tapped inductor in the collector tank circuit. By so doing, a high-"Q" coupling arrangement can be set up between stages and, at the same time, proper match can be made out of the low impedance of one transistor and/or into the low-impedance input of the following transistor. The position of the tap is very important to both the efficient operation of the oscillator and the development of the necessary drive for the succeeding radio-frequency stage.

Fig. 3. Self-excited oscillators. (A) Hartley, (B) Colpitts, (C) Armstrong.



Self-excited oscillators also have applications in two-way radio systems. In low-power units, self-excited and/or crystal oscillators are amplitude- or frequency-modulated. Again the transistor self-excited oscillators have vacuum-tube counterparts. Hartley and Colpitts types are shown in Figs. 3A and 3B while a feedback coil arrangement is shown in Fig. 3C. This style is more commonly used as a transistor receiver local oscillator than as a transmitter oscillator.

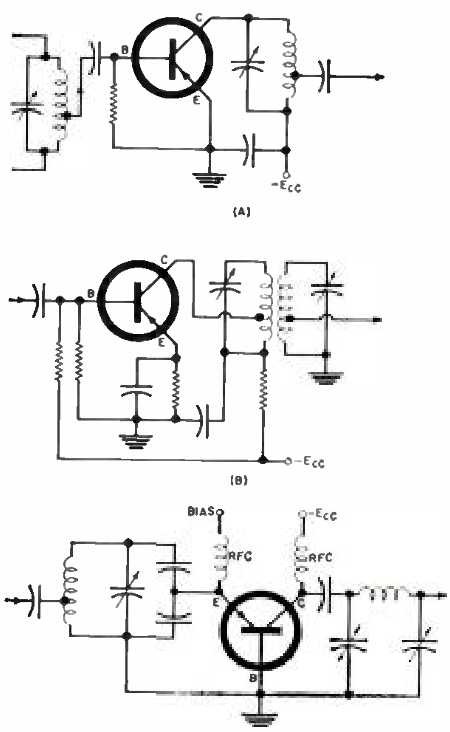
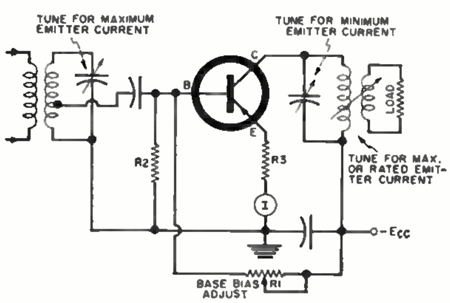


Fig. 4. Typical class-C amplifiers.

Fig. 5. Metering and tuning of the transistorized class-C amplifier stage.



Transistor Class C Amplifier

A transistor circuit can function as a reliable and stable class C amplifier. Although of low power output they operate well as straight-through amplifiers or multipliers. In communication services the frequency of the crystal must often be multiplied at least 12 times. For this purpose, a series of transistor stages may be used as compact and efficient multipliers.

Several typical class C transistor stages are shown in Fig. 4. The common-emitter circuit is perhaps more prevalent at the lower frequencies and is similar, in some respects, to the conventional vacuum-tube grounded-cathode class C stage. At very high frequencies (up to several hundred megacycles), the grounded-base circuit is popular. This method of connection is similar to the vacuum-tube grounded-grid amplifier. At very high frequencies the common-base circuit can usually be operated with a higher d.c. collector voltage because of the lower breakdown voltage between collector and base, hence output and efficiency are somewhat higher. Pi-network tanks can be used for matching and harmonic suppression (Fig. 4C).

The input impedance to the class C transistor stage is low, consequently the base is connected to a low-impedance point of the tank circuit of the preceding stage, as shown in Fig. 4A. The transistor r.f. stage can be signal-biased or may employ a combination of signal-bias and external or self-bias. In the circuit of Fig. 4A the amplifier is signal-biased by the flow of base current through the base resistor.

In the arrangement of Fig. 4B, some external bias is developed by the resistor voltage-divider combination in the base circuit which connects to the supply voltage. Some self-bias is also developed across the emitter resistor. This component is filtered by the emitter capacitor. Stability, output, and efficiency are improved in many transistor circuits by this combination of signal and other bias.

As mentioned previously, the oscillator efficiency can be adjusted properly by controlling the base-to-emitter bias. In certain class C stages, the base biasing can be adjusted to the most favorable operating conditions for a given excitation amplitude. The higher the collector voltage, up to a safe operating limit, the higher the output of the transistor r.f. amplifier.

Transistor stages are usually tuned by inserting a d.c. meter in the emitter circuit, as shown in Fig. 5. If a base bias adjustment is included, it is varied with no r.f. excitation applied, until the proper forward bias is obtained, as indicated by the amount of emitter current. Usually the correct base bias is set by selecting the right values for fixed resistors R_1, R_2, and R_3. The r.f. excitation is now applied and the base resonant circuit is adjusted for maximum emitter current. This operation is similar to the adjustment of a vacuum-tube class C stage for which the grid tuned circuit is resonated for maximum grid current. As in the case of a vacuum-tube stage, the excitation from the previous stage is now regulated until a specific amount of emitter current flows when the base tank circuit is tuned to resonance.

Base input excitation and resonant tuning are generally accomplished with the collector tank circuit de-tuned from its resonant setting. The collector plate tank circuit is now tuned through resonance as indicated by a dip in the emitter current. This is similar to the dip in plate current when the plate tank circuit of a vacuum-tube stage is tuned to resonance. However, in the case of the transistor r.f. stage, the *same meter* is used in the *same place* for both base and collector tuning. The emitter current reading suffices for the tuning of both input and output circuits of a transistor r.f. stage.

When a load is coupled to the output of the transistor r.f. stage, the emitter current will increase. In like manner the plate current of a vacuum-tube class C stage increases with the application of a load to its plate tank circuit. As the load on the transistor r.f. stage is increased, the emitter current rises toward an optimum value. If the load placed on the collector tank circuit reflects a reactive component it is necessary to re-tune the collector tank circuit for emitter current dip. Optimum tuning is attained when the collector tank circuit is tuned to exact resonance at the same time that the coupling to the load is such that the desired value of emitter current flows.

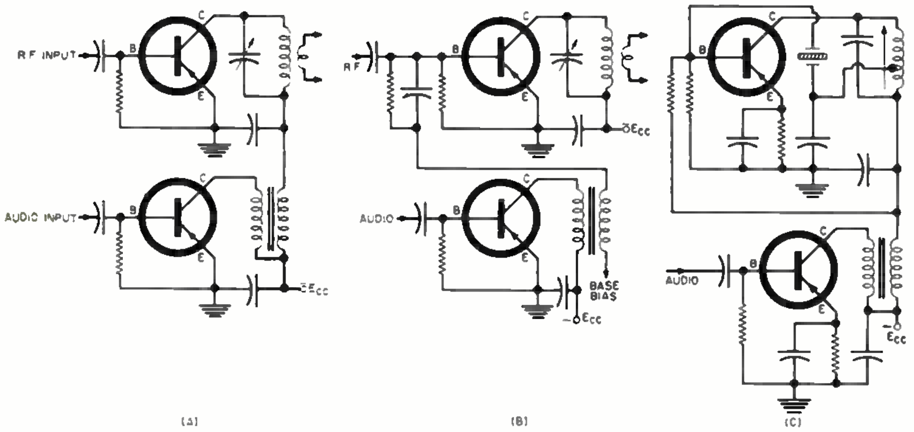


Fig. 6. Typical methods utilized to achieve amplitude modulation of transmitters.

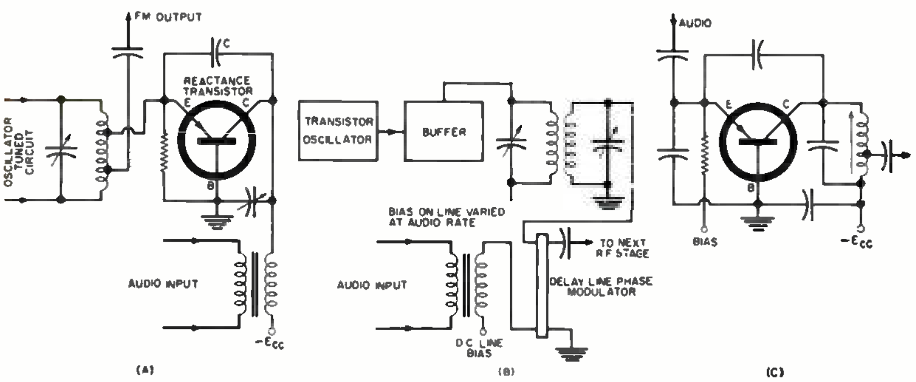


Fig. 7. Typical methods utilized to produce frequency modulation of transmitters.

AM Modulation

In the most common method of transistor AM modulation, as shown in Fig. 6A, the collector voltage is modulated in much the same way as the plate voltage of a vacuum-tube class C stage is modulated. Inasmuch as the collector voltage has a linear influence on the peak collector current, the r.f. power output of the transistor r.f. stage follows the modulation and a reasonably high level of modulation can be attained.

As shown in Fig. 6B, it is also possible to modulate the base bias. The base current bias has an influence on the output of the transistor and, over a fairly wide range, the output varies linearly with relation to the base current bias. Thus, if the base current can be varied at an audio rate, the r.f. output of the transistor stage will be modulated in amplitude.

A transistor crystal oscillator can be amplitude-modulated, as shown in Fig. 6C. The oscillator is similar to the Pierce type with feedback into the base circuit. Proper level of feedback and favorable impedance relations are established using a tapped inductor. Collector modulation is used.

FM Modulation

Frequency modulation can be accomplished by reactance-modulating a transistor self-excited oscillator, as shown in Fig. 7A, or by phase-modulating the output of a transistorized buffer stage, as shown in Fig. 7B. In the first arrangement the emitter-base circuit of the reactance modulator is connected across a part of the tank circuit inductor. A changing collector voltage causes the emitter current to vary with the modulation. Since this current is in quadrature relation to the r.f. voltage across the tank circuit, frequency modulation results. Capacitor *C* and the transistor parameters establish the correct quadrature relation between the r.f. voltages.

The delay-line phase modulator takes advantage of the phase shift between incident and reflected waves at the input end of a section of artificial transmission line. A suitable length of line results in a quadrature relationship (90 degrees). Any change in the termination at the far end of the line can have an influence on the phase of the resultant. A change in the termination can be accomplished by application of a d.c. bias to the line. If this bias is made to vary at an audio rate, as shown in Fig. 7B, the magnitude of the reflected component will vary correspondingly. Thus the phase of the resultant wave at the input of the line will follow the audio (incident and reflected waves are in quadrature) and frequency deviation will result.

An arrangement for direct frequency modulation of a self-excited oscillator is shown in Fig. 7C. The emitter capacitance (emitter to base) of a transistor varies with the emitter current. This change of capacitance is felt across the collector tank circuit. An audio signal that causes a change in emitter current will cause a corresponding change in the frequency of the oscillations across the collector tank circuit. A frequency-modulated oscillator output is developed.

Transistor Receiver Mixers

Two common mixer arrangements are shown in Fig. 8. Crystal-controlled instead of tunable local oscillators are used in many two-way radio receivers. The receiver is fixed-tuned to the transmit frequency of the base station. Some receivers permit reception on two or more channels and include an appropriate crystal switch. Inasmuch as the local oscillator injection frequency must be very high to match the incoming v.h.f. or u.h.f. signal, a multiplier system must follow the oscillator. Thus it is the output of the multiplier that must be injected into the mixer.

In the circuit arrangement in Fig. 8A, a low impedance loop is coupled near

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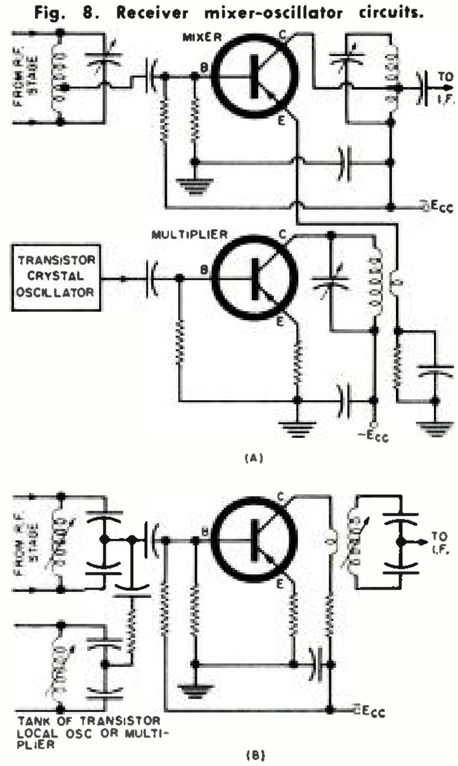
Fig. 8. Receiver mixer-oscillator circuits.



Transistorized Converters for 10 to 20 Meters

By **DONALD L. STONER, W6TNS**

Extend the range of your receiver with these home-built single-band converters for the 10, 15, and 20 meter ham bands as well as for the 11-meter band for CB operators.

DID you ever try to tune the 2-mc. wide 10-meter band on a receiver dial scale that was just ⅜-inch long? To hold a "QSO" under such conditions is virtually impossible. Anyone who accomplishes such a feat should be awarded a medal of some sort!

This is only one of the problems encountered in high-frequency work. The performance of most communications receivers will fall off at the high-frequency end of the receiving range. This is particularly true on the 10- and 15-meter bands. The long leads necessary in the band-change system and the less-than-optimum *LC* ratios in the tuned circuits, tend to reduce the efficiency of the receiver at these frequencies. Receivers which use an absolute minimum of tubes have no reserve of gain. As the tubes age slightly, the high-frequency bands go dead.

A converter, on the other hand, allows the amateur band to be stepped down in frequency to a range which provides more bandspread and sensitivity. In addition, a converter permits compact construction. This not only reduces lead lengths but eliminates the inefficient bandswitch. Since it is a single-band device, the converter is optimized on each band. The construction cost is low enough to make separate plug-in converters for each band quite practical.

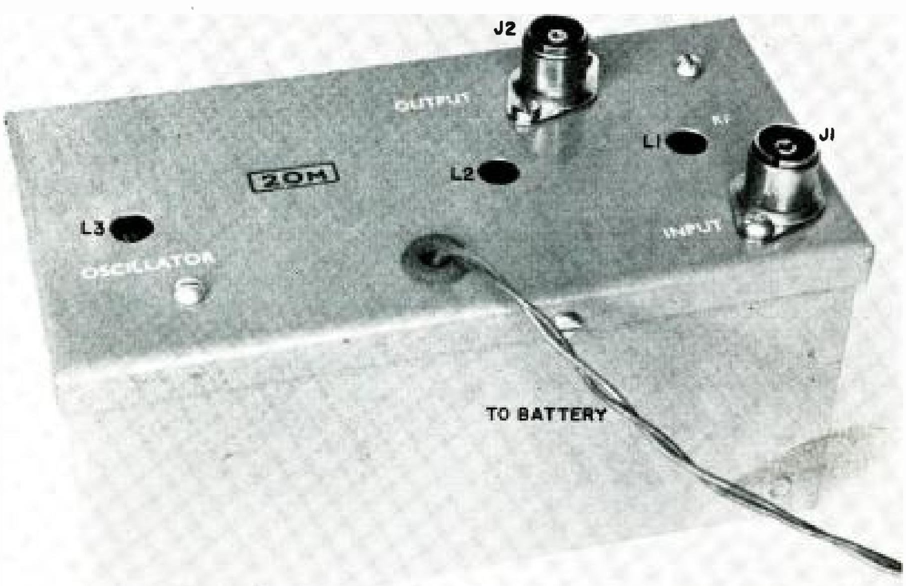
The converter to be described is particularly useful in conjunction with surplus receivers such as the BC-312 and BC-348 series. The receiving range of these "rock-solid" military units only goes to 18 mc. A 15- and 10-meter converter will extend the range for coverage of all high-frequency ham bands.

Theory of Operation

The purpose of a converter (any converter) is to change the frequency of the incoming signal to an *intermediate frequency* where it can be easily amplified. In the 20-meter converter, the incoming 14-mc. signal beats with a 10.5-mc. oscillator signal to produce a 3.5-mc. i.f. Signals at 14.5 mc. will be heterodyned to 4 mc.

Operation of the 15-meter converter (21.0-21.5 mc.) is similar, except a 17.5-mc. crystal is used. The 10-meter converter (28.5-29.0 mc.) employs a 25-mc. crystal. In all cases the i.f. is 3.5 to 4 mc., the amateur 75- and 80-meter bands.

The author's 20-meter home-built converter. Holes provide access to adjustments.



The antenna coil, L_1, is coupled to the r.f. amplifier through a capacitive divider system (C_1 and C_2). This method provides a correct impedance match without using extra taps on the coils. The r.f. amplifier transistor (V_1) is an *RCA* "drift" type 2N384 or an *Amperex* OC169. Their outstanding performance is what "makes" the converter. Resistors R_1 and R_2 form a forward-bias network and resistor R_3 provides the necessary d.c. stabilization. The amplified signal appears across coil L_2 and is coupled to the mixer (V_2) through another capacitive divider (C_4 and C_5). The collector of V_1 is tapped part way down the coil to provide the greatest selectivity.

In the mixer stage, resistors R_4 and R_5 form the bias network and R_6 provides emitter stabilization. These component values differ from the ones used in the r.f. stage, since the mixer operates on the non-linear portion of its characteristic curve.

The oscillator energy from V_3 is coupled to the mixer through a 150-$\mu\mu$f. capacitor, C_7. The crystals used in the oscillator circuit are of the third-overtone type to provide the greatest stability with the least expense. Crystals other than these (particularly the type mounted between metal plates) may have spurious tendencies. The oscillator will "free-run" (self-oscillate) if a capacitor is substituted for the crystal or if the crystal pins are shorted. Since the plates in the older type of crystals form an excellent capacitor it may be sufficient to produce spurious signals. Suitable third-overtone crystals provide excellent performance and oscillate without trouble the moment the tuned circuit (L_3) is set near the correct frequency.

Construction

One version of the converter was built on a strip of terminal stock to demonstrate how little effort is needed to construct the device. With this type of construction the components are simply mounted and easy to get at. Even more important, you don't have to stand on your head and manipulate a right-angle screwdriver to work on the unit. Without a metal shield between the r.f. amplifier and mixed coils, undesired coupling can occur in spite of the low-impedance circuits; therefore, parts must be placed about as shown in the photo.

The terminal-strip "chassis" measures 4¾" x 2" and contains a double row of 12 lugs to which the various components are connected. Three other solder lugs are bolted to the center of the strip to accommodate the base connections of the three transistors. From the left, in the inside view photo, the components are mounted in the following order: r.f. amplifier coil L_1, transistor V_1, mixer coil L_2, transistor V_2, transistor V_3, the crystal, and the oscillator coil L_3. The output coil, L_4, was not mounted on the strip but is secured in one corner of the 5" x 2½" x 2½" aluminum chassis box used to shield the "chassis." Several of the capacitors are mounted under the terminal strip and are not visible in the photograph.

Adjustment

Connect an r.f. probe and v.t.v.m. to the collector of the oscillator transistor V_3. Adjust the slug in L_3 for maximum voltage as indicated on the meter. Connect an antenna to the converter and the converter to a receiver tuning 3.5 to 4 mc. Tune in a station and peak the converter slugs for maximum signal strength. The crystal oscillator should be re-adjusted by moving the slug in L_3 until the oscillation ceases, as indicated by the signal suddenly dropping out. At this point back off on the slug until it has little effect on the frequency of oscillation. You may note that when the slug is set near the point where oscillation ceases, very large frequency excursions are possible. This point is undesirable for it indicates an unstable oscillator condition. It will also be noted that when the coil is detuned a great distance from the crystal frequency, the oscillator may be inclined to "take off" on its own accord. If moving the slug causes a series of signals to appear on the receiver, establish that the oscillator frequency is controlled by the crystal. If the components specified are used, the constructor should have no difficulty in duplicating the compact amateur-band converters that are illustrated and described here.

Operation

The receiver should tune the range 3.5 to 4.0 mc. These two extremes are the end of each band and the calibrations will remain true on all bands (3.5 mc. = 14.0, 21.0, and 28.5 mc., etc.). It will only be necessary to convert these figures mentally. The converters should be mounted in a metal box in order to prevent feedback and signal pickup.

Mobile Use

These compact converters are ideally suited to mobile work. The entire unit may be packaged in a container only a little larger than a pack of cigarettes. It may be dropped, vibrated, or subjected to large variations in supply voltage. You need not worry about heat, which once was the Achilles heel of transistor circuits. The converter may be operated in a car that has been standing in the sun for a long time. Power consumption is so small that dry cell batteries, if used to supply power, will

(*Continued on page 81*)

20 METERS

L_1—23 t. #26 en., closewound, tapped 4 t. from bottom end
L_2—Same as L_1, but tapped 12 t. from bottom end
L_3—14 t. #22 en., closewound
Xtal.—10.5-mc. third-overtone crystal (See text)

15 METERS

L_1—14 t. #22 en., closewound, tapped 2 t. from bottom end
L_2—Same as L_1, but tapped 8 t. from bottom end
L_3—8 t. #22 en., closewound
Xtal.—17.5-mc. third-overtone crystal (See text)

10 METERS

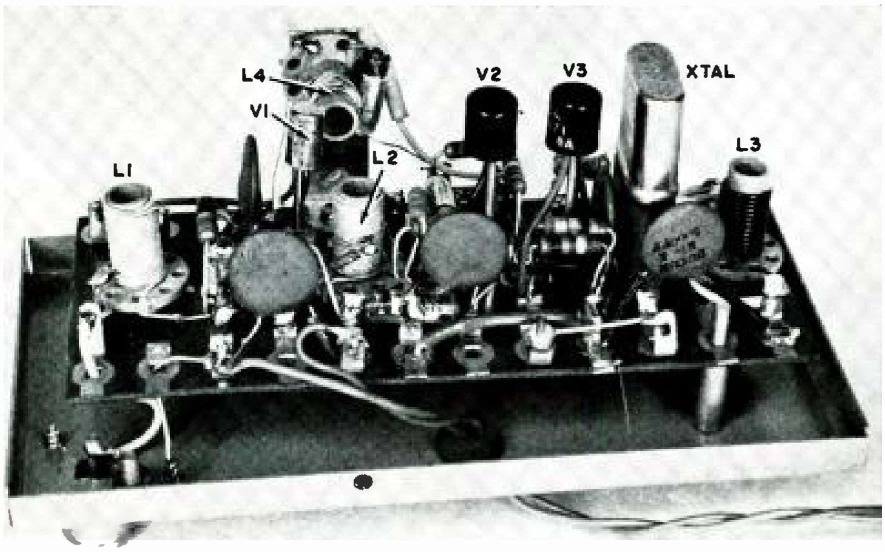
L_1—10 t. #22 en., closewound, tapped 2 t. from bottom end
L_2—Same as L_1, but tapped 5 t. from bottom end
L_3—4 t. #22 en., closewound
Xtal.—28.0-28.5 mc.: 24.5 mc. third-overtone crystal
28.5-29.0 mc.: 25.0 mc. third-overtone crystal
29.0-29.5 mc.: 25.5 mc. third-overtone crystal
29.5-30.0 mc.: 26.0 mc. third-overtone crystal

CITIZENS BAND (11 Meters)

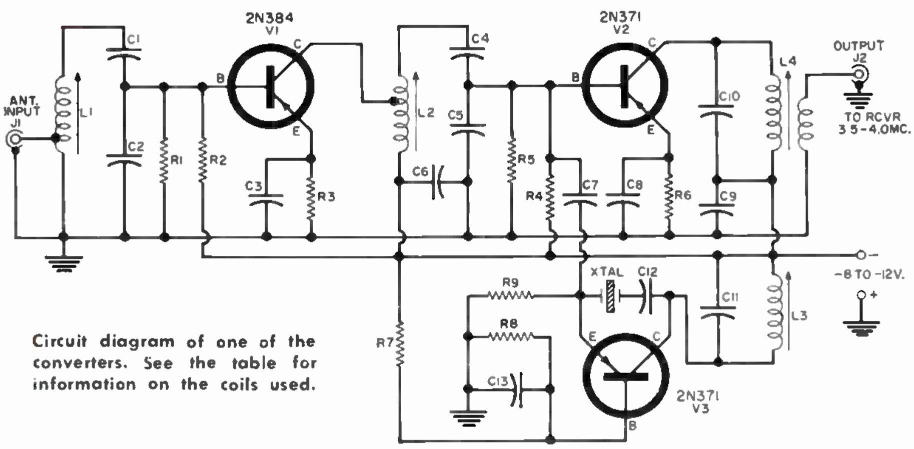
L_1,L_2,L_3—Same as for 10 meters
Xtal.—23.4 mc. third-overtone crystal (See text)

All coils are wound on ¼" slug-tuned forms such as the J. W. Miller #4500.

Table 1. Complete coil-winding and crystal data for various ham and Citizens bands.



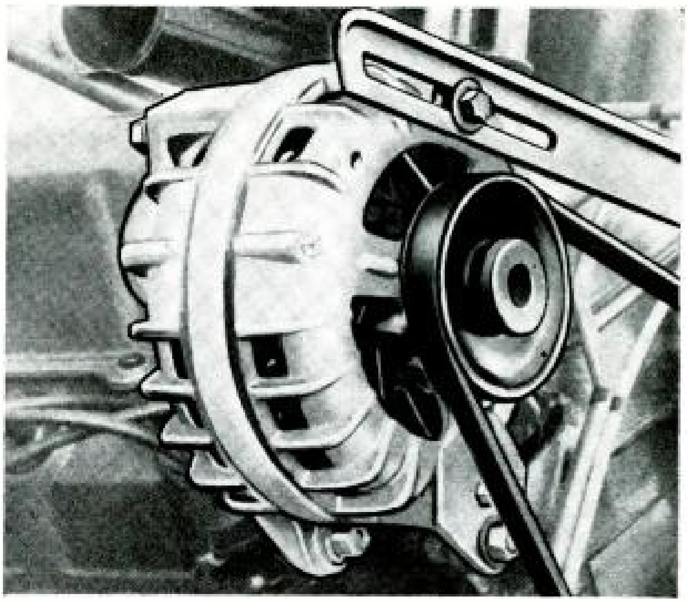
The converter ready to be installed in its housing. Note the added i.f. coil, L_4, just above the mixer coil. The access hole for this adjustment is on side of box.



Circuit diagram of one of the converters. See the table for information on the coils used.

R_1,R—10,000 ohm, ½ w. res.
R,R—39,000 ohm, ½ w. res.
R—1000 ohm, ½ w. res.
R—82,000 ohm, ½ w. res.
R—5600 ohm, ½ w. res.
R—470 ohm, ½ w. res.
R—2200 ohm, ½ w. res.
C_1,C,C—50 μμf. disc or mica capacitor
C,C,C—150 μμf. disc or mica capacitor
C,C,C,C,C—.005 μf. disc ceramic capacitor
C—100 μμf. disc or mica capacitor
C—15 μμf. disc or mica capacitor
L_1,L,L—See Table 1
L—15 t. #36 en., scramble wound to ¼" on ¼" slug-tuned form. Output link winding 12 t. #36 en. wound over top of primary
J_1,J—Coax jack
Xtal.—Third-overtone crystal (see Table 1)
V_1—"p-n-p" transistor (RCA 2N384 or Amperex OC169)
V_2,V—"p-n-p" transistor (RCA 2N371 or Amperex OC169)

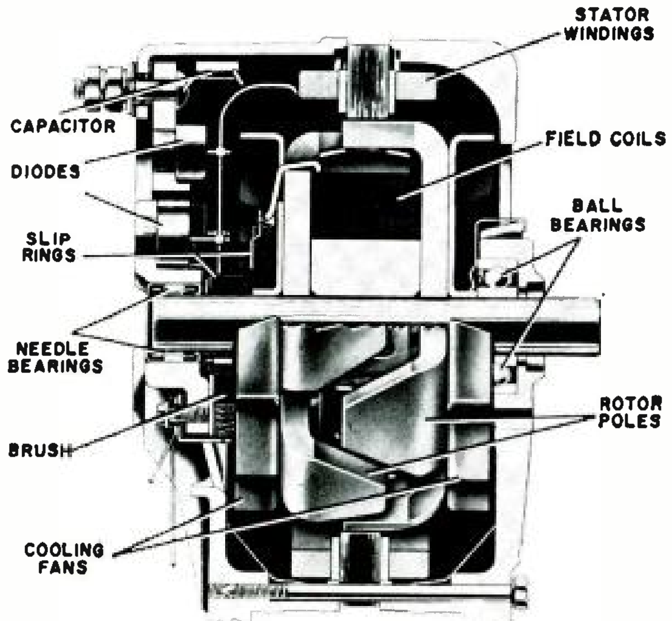
Transistorized Regulator For Auto Alternator



Appearance of the Chrysler alternator discussed by author.

By **HARRY W. LAWSON**

The advantages of the new alternators for cars are increased with this all-electronic control circuit that eliminates vibrating contact problems, reduces radio interference, provides tighter voltage control.



Cross-section of alternator with its built-in rectifiers.

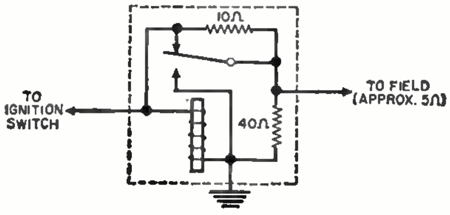
EDITOR'S NOTE: *This article is presented by the author as an example of what can be done by the application of semiconductors to the electrical problem areas of the automotive industry. Since the circuit as described here was designed to prove the feasibility of such a device, the reader is cautioned to first avail himself of the required semiconductors, resistors, and capacitor—or at least determine the costs thereof—before attempting construction. As specified and at small-quantity prices, the transistors and diodes will run about $40.00. This does not take into account the cost of the precision resistors and the tantalum capacitor. Although this high cost could be reduced somewhat by less expensive, five-ampere substitutions for the two power transistors and rectifier diodes and by the use of less precise resistors and a less expensive capacitor, the over-all performance of the regulator may not be quite as good as that obtained by the author.*

ONE important recent advance in automotive electrical systems is the introduction, by *Chrysler Corporation*, of the alternator as standard equipment on its entire line of cars. This feature is the result of ingenious engineering and production techniques which are attested to by the glowing field service reports reaching the factory. The author is here presenting a further refinement of the system in the form of a transistorized regulator. Before discussing details of the regulator circuit, a description of the alternator and its normal control system would be in order.

Why an Alternator?

Why use an alternator rather than the usual two-pole d.c. generator? The answer to this can best be obtained by describing the *Chrysler* alternator itself. Basically, the device consists of a rotating twelve-pole d.c. field energized by the battery *via* the contacts of the voltage regulator. The fixed stator surrounding this rotating field contains three displaced windings—positioned and connected to provide a three-phase, alternating-output voltage at the three leads emerging from the stator. These three leads are then connected to a three-phase, full-wave bridge rectifier made up of six silicon rectifiers located in the end bell casting of the alternator. The advantages of this arrangement over the two-pole d.c. generator are many, including the following:

Fig. 1. Original electromechanical regulator.



1. Due to the multi-pole field and much more efficient use of magnetic materials, the generated voltage is higher at lower rpm and hence the alternator is able to charge at idling speeds.

2. Since commutation is now accomplished by silicon rectifiers, the ever-present, high-current brush commutator problem is practically eliminated. The only remaining brushes carry the very low current of the d.c. field and this is now *via* slip rings rather than a rough commutator.

3. The use of silicon rectifiers, besides replacing the function of the commutator, also prevents discharge of the battery back through the alternator when its voltage output is less than that of the battery. This, then, eliminates the need for the troublesome cut-out relay contained in the usual generator regulator housing.

4. Since the alternator is first an a.c. generator and second a source of d.c. *via* the rectifiers, the self-inductance of the stator windings offers more and more impedance to the flow of current at higher speeds. Suitable winding design, as related to speed range, provides a current-limiting action, thus completely eliminating the need for an over-current control relay as is usually required.

5. The more efficient use of magnetc materials and aluminum die-casting results in a considerable saving of weight—on the order of 40 per-cent or better—as compared to the d.c. generator equivalent.

6. The elimination of a commutator drastically reduces the amount of radio-frequency interference (RFI) emanating from the d.c. generating system.

7. Finally, the problem of voltage and hence charging current control now becomes a matter of controlling the field current as a function of battery voltage exclusively. Since the alternator is basically an a.c. generator, its output voltage will be a remarkably linear function of speed and field current.

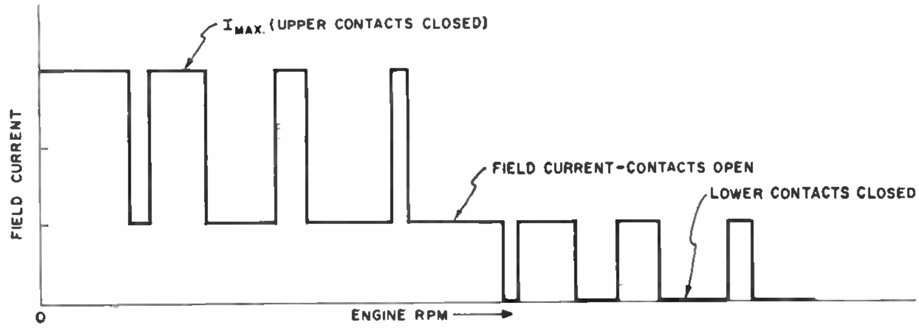


Fig. 2. Simplified field-current waveforms produced under various conditions.

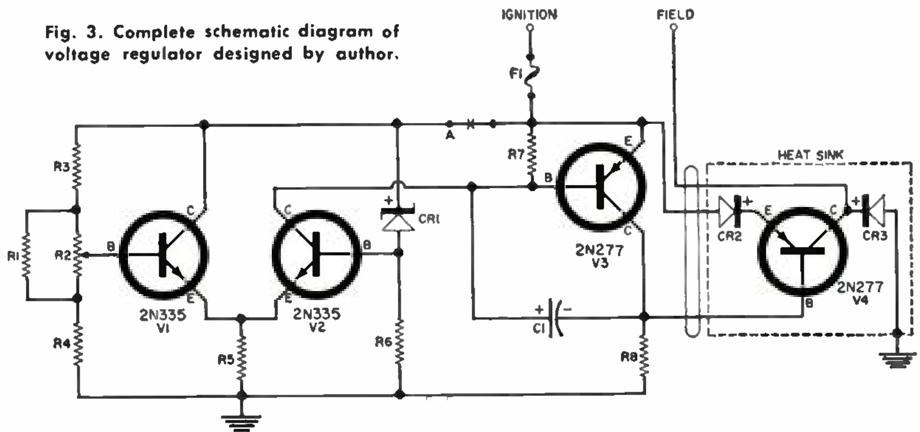


Fig. 3. Complete schematic diagram of voltage regulator designed by author.

R_1—10 ohm, 1 w. wirewound res. ±3%
R_2—20 ohm wirewound res. (Daystrom 300-0011-20, see text)
R_3—31 ohm, 1 w. wirewound res. ±3%
R_4—75 ohm, 3 w. wirewound res. ±3%
R_5,R_6—1000 ohm, 1 w. wirewound res. ±3%
R_7—47 ohm, ½ w. res. ±10%
R_8—125 ohm, 10 w. wirewound res. ±5%
C_1—220 µf., 10 v. tantalum capacitor (Aerovox Type ST-12 or equiv.)
CR_1—1N749A zener diode (Texas Instruments)
CR_2,CR_3—1N1341 or equiv.
F_1—4 amp fuse
V_1,V_2—"n-p-n" transistor (2N335)
V_3,V_4—"p-n-p" power transistor (Delco 2N277)

Note: The 3% resistors specified above are military types, obtained from an industrial source. It is possible to use standard 5% wirewound resistors in the circuit. The 1-watt resistors may be IRC Type BW-1 5% units having values of 10, 30 (rather than 31), and 1000 ohms. For the 75-ohm, 3-watt resistor, an Ohmite or Sprague 5-watt, 5% 75-ohm wirewound unit may be used.

Relay Regulator

This leads us to the purpose of this article—the control of the alternator field as a function of battery voltage. Here the problem is somewhat more difficult than that of the d.c. generator since the dynamic range (ratio of maximum to minimum) of field-current control is greater. *Chrysler* accomplishes this by using the usual voltage-sensitive relay but in a two-range, dual-contact configuration rather than the single contact. A typical alternator regulator is shown in Fig. 1.

In operation the upper contact is closed under idle conditions with battery voltage too low to pull this contact open, thus providing full field at idle. As engine speed is increased, generated voltage increases as does the battery voltage, causing the upper contacts to vibrate and hence reduce field current and system voltage by inserting the 10-ohm resistor periodically in series with the field. As speed continues to increase, the percentage of time that the upper contacts remain closed decreases until at some point in the range the relay armature is suspended between the two sets of contacts. The field current at this point is determined by the 10-ohm resistor and the voltage of the battery.

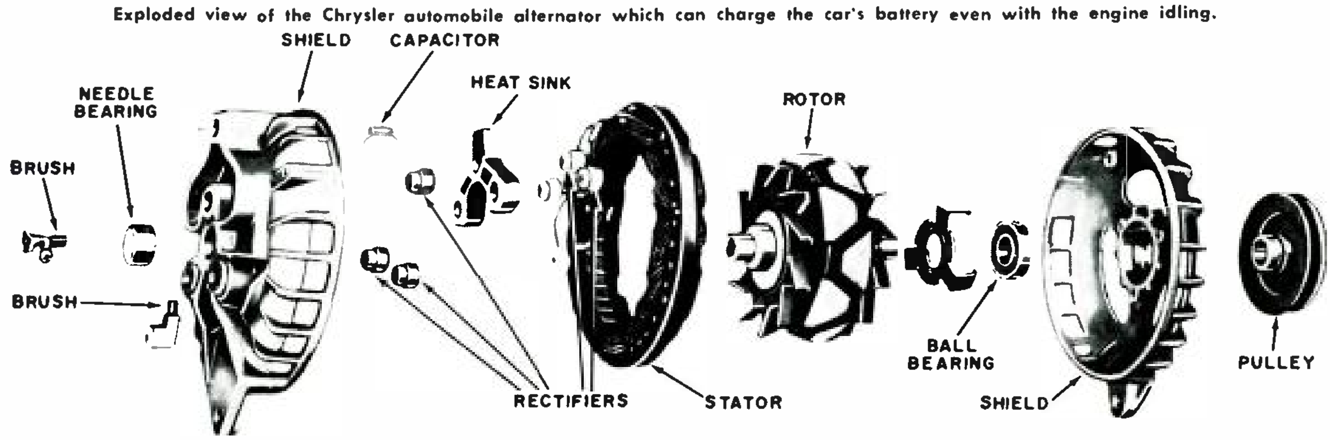
Needless to say, this is an unstable transition stage and still further increases in speed cause closure of the lower set of contacts. Now, however, lower contact closure means reduction of field current to zero, resulting in a lower contact vibrational-type operation. Here, also, the contact closure percentage varies with speed, but in an opposite direction from that occurring with the upper contacts. In other words, at very high speeds the per-cent contact open time is very small. Fig. 2 depicts contact operation as a function of engine speed.

This electro-mechanical regulator does perform quite well considering the range to be covered and the economics involved. It is also fairly difficult to beat the efficiency of vibrating contacts—but vibrating contacts are, as they always have been, a source of trouble themselves as well as a source of RFI. It is also difficult with vibrating points to maintain control at the extreme regions of contact operation either in the opening or the closing mode.

Solid-State Regulator

The solid-state regulator to be described was designed and built by the

Exploded view of the Chrysler automobile alternator which can charge the car's battery even with the engine idling.



author as a means of eliminating contact and/or adjustment problems as well as radio-frequency interference. An added attraction is the much tighter limit of battery voltage over the entire speed range since the field current is controlled smoothly from maximum to zero.

No attempt was made at this time to "methodize" this unit into a low-cost production item but considerable leeway in component selection is possible. Those critical areas requiring particular attention will be pointed out but, needless to say, since this is a mobile construction, proper measures should be taken to insure vibration and temperature survival.

Fig. 3 is the schematic diagram of the regulator with the components used by the author. Referring to the diagram, V_4 is the series-pass transistor controlling the current to the field. It, along with CR_2 and CR_3, is mounted on an external heat sink (*Delco* type) located in a spot removed from such items as exhaust manifolds. It is interesting to note that dissipation of V_4 is not greatest at the maximum field current (just under 3 amps) but rather at the mid-range where the voltage drop across the field is equal to that of transistor V_4, resulting in a maximum dissipation of about 10 watts. Diode CR_3 serves to protect the pass transistor V_4 from the inductive kick produced in the field when the ignition switch is turned off. Diode CR_2, carrying the full field current, provides additional operating voltage for driver transistor V_3 and insures that the pass transistor V_4 can be cut off at high ambient temperatures.

The remainder of the circuit is constructed in a 2"x2"x4" aluminum box mounted a few inches away, *via* a three-wire cable, from the heat sink and near the original-equipment electro-mechanical regulator. Transistor V_3 is the driver for V_4 and a base-current swing of 3 ma. to 5 ma. on this transistor enables full "on" to full "off" control of V_4. Resistor R_8 provides a path for I_{co} at high temperatures. Capacitor C_1 is necessary to prevent oscillation of the system since the regulator and alternator form a very high gain loop. Tantalum is desirable here for low temperatures.

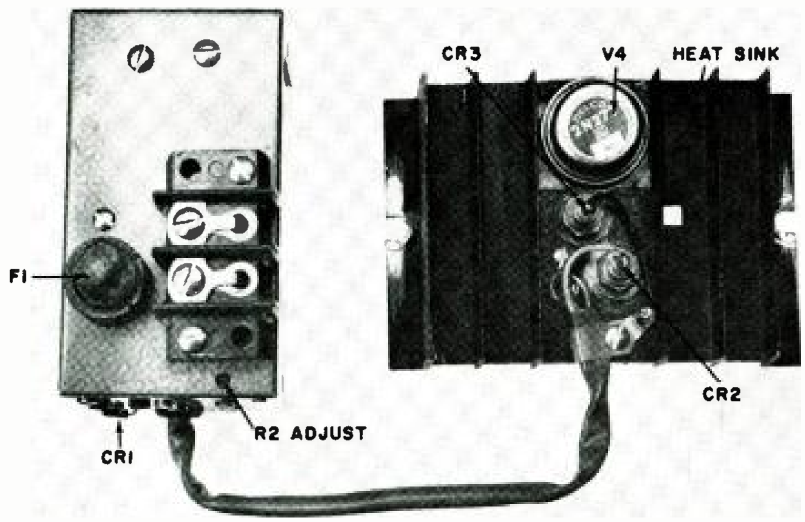
The heart of the control-sensing circuit is contained in the balanced, differential amplifier made up of transistors V_1 and V_2. Special consideration was given to the design of this amplifier to insure that there would be no temperature drift problems. To obtain this, all associated resistors should be wirewounds. The voltage control potentiometer, R_2, merits special attention since it must not shift under vibration or temperature extremes. The 20-ohm pot used by the author proved ideal in this application but almost any good wirewound pot of the rotary type could be used. The rectilinear trim types should be avoided in this circuit application.

The zener reference diode requires special comment not only because it establishes the basis of voltage reference but because it also controls the system temperature coefficient to match that specified by *Chrysler Corporation*. It is for this reason that the differential amplifier was designed to be essentially temperature drift-free in order that the known diode coefficient of about -0.04% per degree centigrade be the controlling factor.

Operation is quite simple under the conditions of a given required battery voltage with engine speed increasing. For a given initial field current, an increase in engine speed raises battery voltage and therefore charging current. An increased battery voltage increases the base current of transistor V_2 directly. The base current of V_1 also increases but by an amount less than that of V_2, due to the resistor sensing network made up of R_1, R_2, R_3, and R_4. The net result, due to the common emitter resistor R_5, is that V_1 collector current decreases and V_2 collector current increases. Since the collector current of V_2 is the base current of V_3, an increase in the base current of V_3 causes the collector current to V_3 to increase as well. If, as in this case, current in resistor R_6 is relatively constant and made up of the collector current of V_3 and the base current of V_4, an increase in the collector current of V_3 must therefore reduce the base current of V_4 and, accordingly, its collector current, which is the field current of the alternator. The voltage output of the alternator is therefore reduced to a value very close to the original—how close depending on the regulator gain which, in this case, is very high.

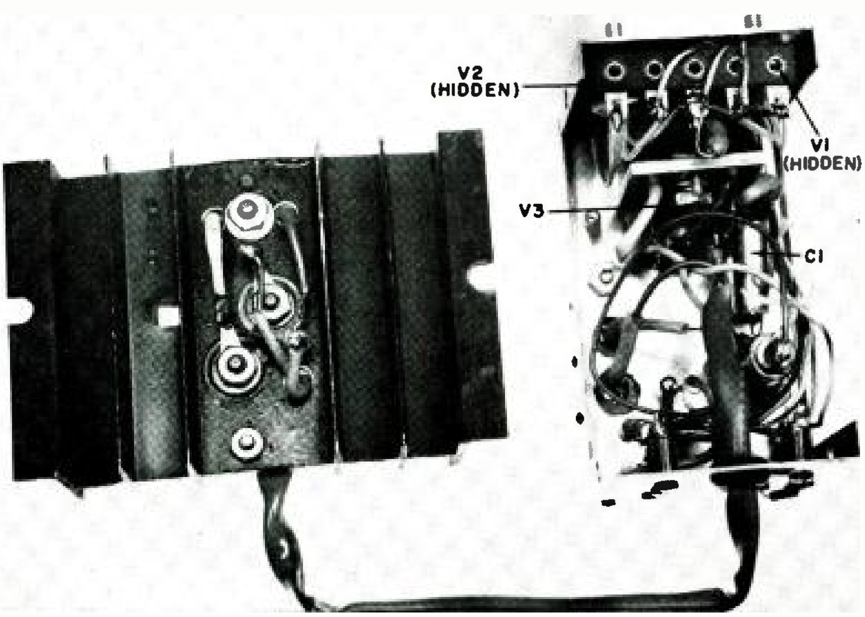
The photograph of the author's unit should require little explanation other than to point out that transistors V_1 and V_2 have been mounted, although not absolutely necessary, in heat sinks primarily for mechanical rigidity. They should, however, be located near each other to eliminate any possible temperature differential between them. Reference zener CR_1 has been mounted by its own leads

(*Continued on page* 97)



Complete voltage regulator designed by author. Note use of heat sink at right.

Underside of the transistorized regulator. Lead dress is not at all critical.



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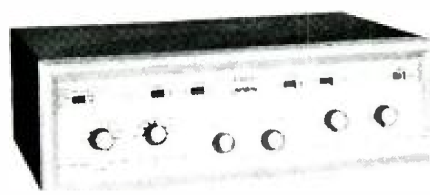

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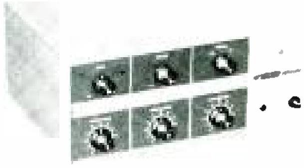

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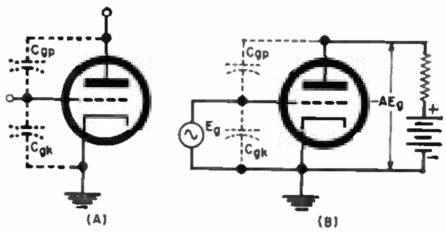


Fig. 1. (A) Triode interelectrode capacities and (B) equivalent amplifier circuit.

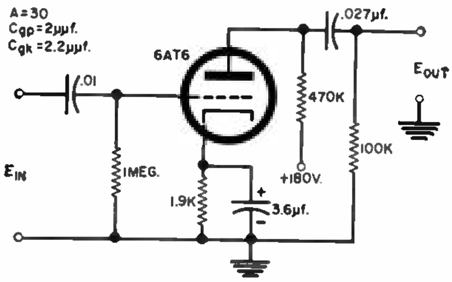


Fig. 2. Typical triode amplifier circuit.

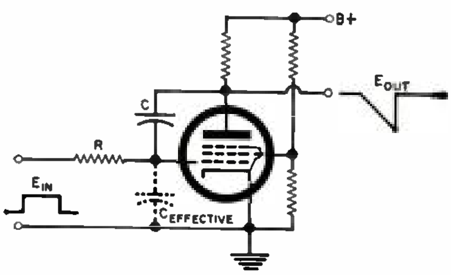
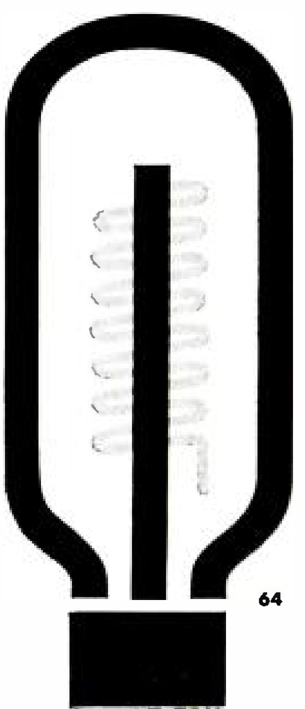


Fig. 3. The Miller sweep-generator circuit.

MILLER EFFECT & ITS USES



By LEE BISHOP

Meaning of this important electron-tube effect along with some interesting new uses for an old principle.

MANY of the latest electronic techniques are but applications of well-known and long-established principles. Parametric amplifiers fit this category, as do artificial capacitances produced by amplification. Devices of the latter category are applications of the principles first described and calculated by J. M. Miller back in 1919.

While the Miller equation can be found in any standard text, its derivation has become obscured to the point that it is almost impossible to find it anywhere. Because of the valuable insight the derivation of this equation provides the technician in analyzing tone controls, sweep generators, analogue computers, and other current devices, the Miller equations have been "re-discovered" in the following paragraphs.

What It Is

An unfortunate combination of the effects of tube interelectrode capacitances is responsible for the Miller Effect. Fig. 1A shows the capacitances involved. Looking into the tube's input circuit, the grid-to-cathode capacitance is immediately encountered, of course. This capacitance will act to short to ground any high frequencies in the input signal, thereby decreasing the gain of the stage at the higher frequencies. When a signal is applied to the input circuit, an amplified version appears at the plate of the tube. This amplified signal is 180 degrees out-of-phase with the signal on the grid and, since grid-to-plate capacitance couples the plate to the grid, the amplified signal is coupled into the grid circuit where it will also act to decrease the input signal. The effect is the same as if the grid-to-cathode capacitance has been increased. This is an extremely important consideration.

The next thing to be considered is just how much the input capacitance has been increased. In order to develop an equation, consider the circuit of Fig. 1B. The total input capacitance is thought of as being made up of two capacitances, the Miller capacitance caused by the feedback and the actual physical C_{gk}. Now the charge on a capacitor can be expressed by the well-known equation:

$$Q = CE \quad \text{.....(1)}$$

where: Q is the charge in coulombs; C is the capacitance in farads; and E is the voltage in volts.

Therefore, the charge on C_{gk} will be:

$$Q_1 = C_{gk}E_g \quad \text{.....(2)}$$

where E_g = a.c. grid voltage.

Now the charge on C_{gp} will be:

$$Q_2 = C_{gp}[E_g - (-AE_g)] = C_{gp}E_g(A+1) \quad \text{..(3)}$$

where A = stage gain.

Since the preceding stage must supply charging current to both capacitances, the charges appear additive at the input.

Therefore:

$$Q_{in} = Q_1 + Q_2 = C_{gk}E_g + C_{gp}E_g(A+1) \quad (4)$$

As Q_{in} is the total charge of the input capacitance C_{in}, this capacitance is related by:

$$Q_{in} = C_{in}E_g \quad \text{.....(5)}$$

Combining Eq. 4 and Eq. 5 gives:

$$C_{in}E_g = C_{gk}E_g + C_{gp}E_g(A+1) \quad \text{......(6)}$$

Simplifying, results in:

$$C_{in} = C_{gk} + C_{gp}(A+1) \quad \text{....(7)}$$

Eq. 7 is the well-known Miller equation. This equation shows very clearly that the total effective input capacitance is determined not only by tube and distributed capacitances, but also by the gain of the stages. Understanding and using this equation provides the technician with a powerful tool in analyzing the operation of many modern circuits.

In order to get an idea of the magnitude of the Miller Effect, consider the circuit of Fig. 2. The stage gain for this particular circuit is 30. The tube capacitances are shown in the diagram. Applying these values to the Miller equation shows the effective input capacitance to be:

$$C_{in} = 2.2 + 2(30+1) = 64.2\ \mu\mu f.$$

The tube has an input capacity of only 2.2 $\mu\mu$f. but, when used in the circuit shown, the effective input capacity is 64.2 $\mu\mu$f. Actually the C_{gk} is a very minor part of the total. Miller Effect has accounted for 62 $\mu\mu$f. The equation points up very clearly the shortcomings of high-gain triode amplifiers at the higher frequencies.

Applications

The Miller Effect has been put to good use in the sweep generator circuit of Fig. 3. The plate-to-grid capacitance in this case is augmented by the use of a physical capacitor and stage gain has been increased by the use of a pentode. The effective capacitance from control grid to ground is the capacitor C multiplied by the gain of the stage.

For a positive-going square-wave input of the desired sweep duration applied to the control grid through R, the plate voltage waveform will be a negative-going saw-tooth. The positive signal at the control grid will tend to increase the plate current. The discharge of C, caused by the plate going negative, tends to reduce the plate current.

The behavior of this circuit can be predicted by using the Miller equation to estimate the size of the Miller capacitance between grid and ground. The Miller capacitor thus calculated is then considered to be charging to the gate voltage through resistor R for the duration of the gate. The waveform in the plate is the predicted grid waveform inverted and amplified by the stage gain. This circuit has the advantage of being able to produce very linear sweeps with very small values of R and C.

It is not generally realized that a Miller sweep circuit can be used to provide linear sweeps whose amplitude is on the order of 25 times that of the sweep generator plate voltage. The trick here is to use an inductance in the plate

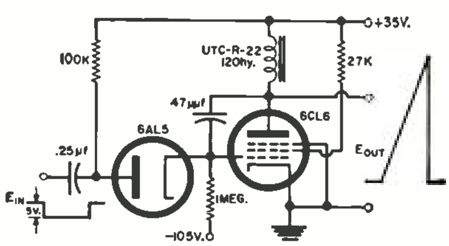


Fig. 4. Precision sweep generator with high-amplitude output saw-tooth waveform.

circuit. The collapsing field around the inductor provides the high voltage and the Miller capacitance provides the linearity. An actual circuit capable of producing linear sweeps of 1000 volts peak amplitude and extreme linearity with only 35 volts of "B" supply is shown in Fig. 4.

The Miller Effect finds universal application in analogue computers performing the calculus operation of integration. Assume, for example, that it is desired to convert speed to distance. The simple circuit of Fig. 5 is capable of doing this. If the voltage applied to the left side of resistor R were proportional to speed, and the RC time constant of the circuit were sufficiently long, the charge on the capacitor at any given instant would be representative of the distance traveled at that instant.

Unfortunately, with reasonable capacitance values, the charging rate would be far from linear as time increased. By using a sufficiently long RC—at least 10 times the period of the integration—the accuracy of the integration can be improved considerably and the charge on the capacitor at any given instant would be a better analogue of the distance traveled. The problem here is to find a large enough capacitor. One

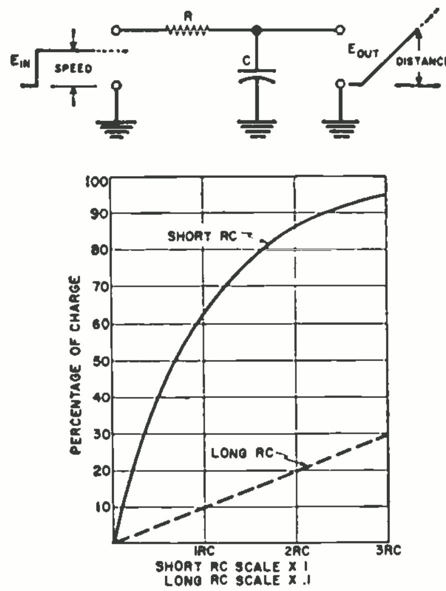


Fig. 5. Relationships in integrator circuit.

of the correct size for the average application would fill half a room.

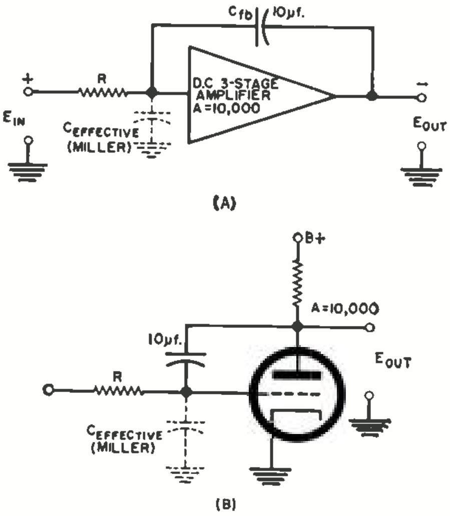
In practice, this large capacity is built up electronically with a device known as an integrating amplifier. The integrating amplifier and its Miller equivalent is shown in Fig. 6. In cases of this nature, where high amplifier gains and large feedback capacitors are used, the C_{gk} and the 1 can be dropped from the Miller equation because they are negligible. The equation for the Miller capacitance produced by an integrating amplifier then becomes:

$$C_{Miller} \cong C_{fb} G$$

where C_{fb} is the feedback capacitor and G is the amplifier gain. For the amplifier of Fig. 6, the Miller capacity would be 100,000 microfarads.

The Miller principle, although dating back to 1919, is as pertinent today as it was then. Many new and unusual circuit configurations use and will continue to use it. The devices illustrated here have been selected to review the effect and develop a method of analyzing circuits using the principle of amplified capacitance. -30-

Fig. 6. (A) Integrating amplifier arrangement along with (B) the Miller equivalent.



Non-Interference Seals for TV and FM Sets

FCC reminds all prospective purchasers that sets must comply with specified radiation limitations.

MOST TV and FM receivers and tuners act as miniature radio stations and radiate radio signals from their local oscillators and sweep circuits. Unless the receiver or tuner is carefully constructed and well-shielded, it can cause interference, not only to neighborhood receivers but also to sets used in commercial, police, fire, and aircraft communications.

To minimize this possibility, FCC regulations limit the amount of permissible radiation and require that TV and FM receivers and tuners manufactured after Dec. 31, 1957 have a seal or label affixed stating that they meet the radiation limits. Manufacturers and distributors are authorized to affix such a seal or label but only after the set has been tested for compliance.

The owner of the set is responsible for complying with FCC requirements. However, the Commission recognizes that the user cannot usually test the set to determine whether it meets the requirements. It therefore feels that the manufacturer or distributor should assume this obligation to his customers and affix the required seal so that the purchaser of the set is assured that it conforms with radiation requirements.

The Commission is receiving excellent cooperation from United States and foreign set manufacturers in this program. Most manufacturers are testing their receivers and tuners to insure that they comply with the regulations and are affixing the required seal or label as proof of compliance. However, some sets are being sold which do not carry the seal. It is possible that many of these may meet the radiation limits set up by the FCC, but that the manufacturers either have not made the prescribed tests or have not affixed a seal showing compliance.

The FCC notes that operation of a set manufactured after Dec. 31, 1957 which does not have such a label attached is prohibited by the rules. The Commission suggests that a buyer insist that the seal be attached to the receiver before a purchase is made. By so doing, he also will insure the continued cooperation of set manufacturers in the program. The owner of an unlabeled set which causes interference to his neighbor may be required to take remedial action or to stop using the interfering set. -30-

Electronic Overload Relay

(Continued from page 39)

current transformer's primary will also increase, making the grid of V_1 more positive on each positive half-cycle than the cathode, causing V_1 to fire, and energizing the relay. Since V_1 is a thyratron and its plate supply is d.c., once fired it will continue to conduct until the "Reset" switch is activated.

In the unit shown in the photographs, it was desired to have the relay open once the overload condition has been removed so V_1 was supplied with a.c. by connecting the "low" end of the relay to the power transformer's secondary (T_2) as indicated by the dashed lines in Fig. 1. In this case, no reset switch is required since once the overload is removed, V_1 will cease to conduct on the first negative half-cycle of applied plate voltage.

The power supply is conventional, using a small power transformer, T_2, in conjunction with a selenium rectifier SR_1, and a pi-section filter consisting of C_1, C_2, and R_2.

Construction

The overload relay shown in the accompanying photos was constructed on a somewhat oversize chassis as it was to be used for demonstration purposes. The unit can be made considerably smaller, if desired, with no sacrifice in performance since there are no large heat-generating components such as wirewound power resistors, etc. to cause ventilation problems.

Any plate-circuit relay with a coil resistance of between 2500 and 5000 ohms will be satisfactory. Also, a 2050 or 502-A thyratron can be substituted for the 2D21 with no circuit changes other than the base connections. While ½-watt resistors are shown in the unit in the photos, it is recommended that 1-watt resistors be used as indicated in the parts list if the device is to be operated for a long period of time.

Adjustment

Installation and operation of the overload relay is extremely simple. Connect the secondary of the current transformer (T_1) in series with the load to be monitored. With the load drawing normal operating current, adjust the "Sensitivity" control to a point where V_1 just does not "fire." An increase in load current will now trip the overload relay.

As an example of the unit's extreme sensitivity, the author, who had one of the gadgets permanently connected to his drill press, was able to trip the relay by merely applying light pressure to the rotating drill chuck with one finger when the relay was adjusted for maximum sensitivity.

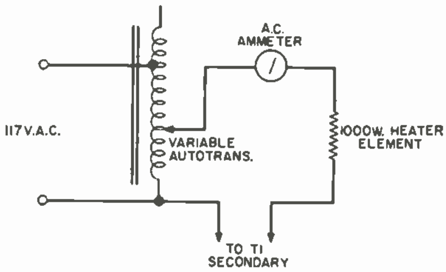
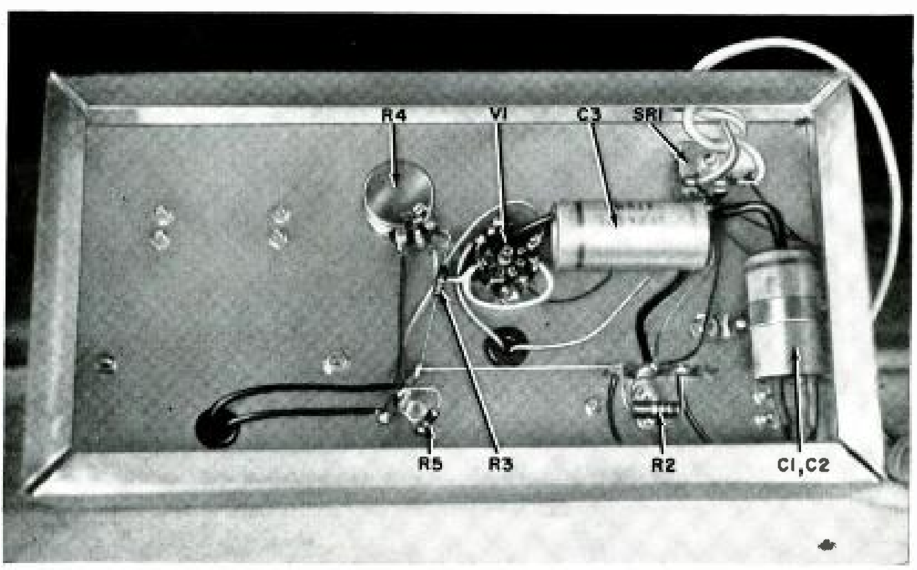


Fig. 2. Calibrating circuit used to determine the exact values of current required to trip the electronic overload relay at various sensitivity settings.

Fig. 2 gives details for those who wish a more precise method of calibration. The variable autotransformer is adjusted for the desired trip points—for example, 1 amp, 2 amps, 3 amps, etc.—as indicated by the ammeter, and at each point the "Sensitivity" control's position can be indicated on a suitable scale. It should be noted that the current drawn by the load should not exceed the secondary current rating of the filament transformer used. For example, if a 5-amp filament transformer is used, the load current should not exceed five amperes. —30—

Under-chassis view shows the simplicity of construction. If the constructor can tolerate a little crowding, a chassis about half the size shown may be utilized.



A. E. S. *Gigolo* II

WE CHALLENGE COMPARISON

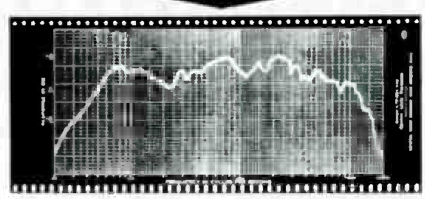
REGARDLESS OF PRICE OR SIZE

Here, at A. E. S. we have made comparison tests with every bookshelf speaker system available to us, and found the Gigolo II to be by far the most outstanding performer. In the words of our Engineering Department, quote: "This system cannot be improved upon."

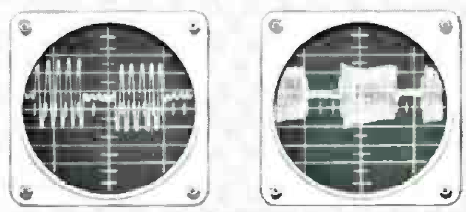
These are the facts:

To explain these technical specifications to the average layman, in language that can be easily understood, all these figures and curves show that the Gigolo II is more properly suited for use in some type of professional application, where large surges of power and extreme frequency reproduction would be needed, rather than for use in the home.

But, for those people who feel they must impress their audiophile friends by having the most outstanding performing system in his group, or the type of person who wants to have that certain feeling of psychological satisfaction which comes with owning that special piece of audio equipment, we offer the Gigolo II, so you may compare and prove this to yourself, or it may be returned on our purchase price money back guarantee.



RESPONSE CURVE



700 CPS TONE BURSTS 3500 CPS

SPECIFICATIONS:

Frequency response	29-16000 cps ±8 db
Harmonic distortion	less than 2% 50-15000 cps
Impedance curve	within −0% +100% of 8 OHMS
Intermodulation distortion	Negligible
Free air resonance	35 cps
Recommended power	15-60 watts

Following test equipment was used to determine the above specifications:

- Hewlit Packard distortion analyser
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- Tektronix Oscilloscope

Response curve run at continuous 25 Watt input.

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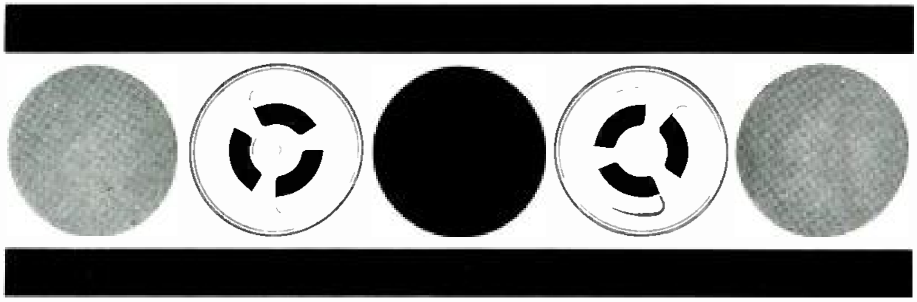

RECORD & REEL REVUE

By **BERT WHYTE**

I AM SURE many readers have, at one time or another, been exposed to monophonic or stereo sound reproduced by the very best equipment available. I mean the cost-is-no-object, size-is-no-object type of system, heard in an ideal acoustic environment. You probably marveled at the realism obtained from the best records and tapes and most probably wished that this fabulous outfit was yours to enjoy. Yet, you can go home and listen to your much more modest system and derive considerable satisfaction therefrom. You *know* that it is inferior to the "dream" system that you heard, but such is the adaptability of the ear plus the influence of your own surroundings, that many of the deficiencies are canceled.

This is an honest reaction and forgivable. On the other hand, there are some individuals who refuse to admit the imperfections in their systems. Now these people are perfectly capable of discerning the finer points of the "dream" system, but they are unwilling to apply the same logic to their own set-ups. This is either because they haven't got the money to upgrade, and this makes them mad, or someone has sold them a bill of goods proclaiming that they already have the very finest, the *ne plus ultra*, in loudspeakers, amplifiers, etc.

All this is by way of a prelude to some interesting figures concerning musical instruments. These statistics were compiled many years ago during the great experimental era of *Bell Labs*. Recently these figures were revised in the light of present knowledge and I am sure you will find some of them most revealing. It was found that a large bass drum, played *fortissimo*, had a peak output of 25 *acoustic* watts, which incidentally is even greater than a pipe organ output in the low frequencies. With this drum it was found that the maximum peak energies occurred in the 250-500 cycle band of frequencies. With another bass drum of similar size, played by a different musician, the peak output was only 0.63 *acoustic* watt, but this time with maximum peak energies in the 62.5-125 cycle band. Why the discrepancy? Most likely it is due to differences in drumhead tension and type of skin and rigidity of body construction which would affect the resonance. High drumhead tension produces a higher total output and a higher frequency bandwidth at peak energy. A lower skin tension would tend to produce less total output and a lower frequency band of peak energies. It should also be noted that there was considerable acoustic output from the first drum between the 500-1000 band and the 1400-2000 band.

Now, moving to the other end of the musical scale, we find 15-inch cymbals played *fortissimo* with an *acoustic* output of 15 watts. Believe it or not, strong energy peaks are then produced as low as 125 cycles, but as expected, the peak energy levels occur in the 8000-11,300 cycle range.

Not unexpectedly the triangle and piccolo have their maximum peaks in the higher frequencies from 2000 up. Quite surprising, however, was the trombone with an acoustic output of 6.6 watts, but with maximum peak energy in the 2000-2800 cycle band. Now except for the aforementioned instruments, we have such instruments as the bass viol, bass saxophone, bass tuba, trumpet, french horn, clarinet, flute, and piano with relatively low acoustic outputs and with maximum peak energies in the 250-500 cycle band.

It was also found that a 75-piece orchestra in a theater or hall environment had an output of 27 acoustic watts with maximum peak energy again in the 250-500 cycle band.

What is the significance of all these figures? After taking into consideration that most of the measurements on the instruments were taken on the direct axis in what amounted to free-field conditions, and therefore the effect of hall reverb and reflection and the distance from point source was not determined, it is still obvious that the power requirements for a reproducing apparatus to handle these outputs with low distortion is enormous. Hence the use in home systems of very wideband amplifiers capable of handling high wattage peaks with low distortion is perfectly valid.

Still more to the point is the question of loudspeakers. The very biggest speaker systems extant, even the highest efficiency horn-loaded types, are capable of perhaps 4 or 5 *acoustic* watts output. Even when taking reverb and reflection into account, under certain conditions it would be necessary for the speaker to be capable of an output approaching 20 acoustic watts in order to reproduce, at low distortion, an accurate facsimile of the music.

Note also from the foregoing, that a majority of instruments have their maximum peak energy production in the frequency range below 500 cycles. This is near or below the crossover points of most speakers and would be considered in the "woofer" range. The subject is very involved and those who would like to pursue it further are directed to the exhaustive study by Sivian, Dunn, and White, first published in the January 1931 issue of the "Journal of the Acoustical Society of America" with the later revision published by the IRE.

In summation, it is obvious that we are still a long way from achieving facsimile perfection in reproduced sound. It is also equally obvious that since so much energy is in what would normally be considered the "woofer" range, the best we can do today towards achieving optimum reproduction is to use the king-size horns, etc. with their higher outputs. This is in direct opposition to the current popularity of the "bookshelf" type speakers, but perhaps here we have a strong argument, in that no matter how clever the design, they are generally of low efficiency, of low acoustic output, and hence the reason why the really big speakers still sound the best.

Of course, there are many other factors influencing speaker quality, but it would appear that the application of this data is very basic and very important.

GOULD
WEST POINT SYMPHONY
BENNETT
SYMPHONIC SONGS FOR BAND
WILLIAMS, C
FANFARE AND ALLEGRO
WORK
AUTUMN WALK
Eastman Wind Ensemble conducted by Frederick Fennell. Mercury SR90220. Price $5.95.

If a convention of red hot audiophiles . . . the truly dedicated sound nuts . . . were ever held and they were asked to name their favorite conductor, I feel certain that Fred Fennell would win hands down. There is little doubt that his recordings are generally prized as demonstration pieces among those who like their decibels *LOUD* and clear!

Their enthusiasm is well founded. Dr. Fennell is an extraordinarily talented musician, who is as astute in his choice of material as he is in its delineation. He has molded his band into an instrument of massive sonority coupled with razor-sharp precision of ensemble. This has been compounded with some of *Mercury Records'* best engineering, carried out in a hall with exceptionally felicitous acoustics.

This present recording is in the Fred Fennell tradition . . . a sonic blockbuster replete with fresh musical ideas from some of our best contemporary composers.

The Gould piece highlights the tremendous weight and sumptuous tone of the brass and woodwind choirs in the first movement and gives full play to the percussion as well in the second and final movement entitled "Marches."

The score calls for the use of a

"marching machine" in the final movement, to simulate the sound of marching feet. It was decided to go a step further in realism by actually marching the 120 members of the Eastman Band to obtain the desired effect. It is amusing to relate that the precision cadence marching that you hear on this disc was finally realized by having the band "march" their feet while seated! Seems as how there was always somebody out of step when the engineers were trying to pick up the sound of the marching in the normal fashion. "Autumn Walk" completes the first side tunefully and less athletically.

The Robert Russell Bennett work is in three sections: "Serenade," "Spirituals," and "Celebration," and is programmatic as indicated in Bennett's unique blending of eclecticism and originality. As always, his orchestration is colorful, bold, and brilliant, and affords the band quite a workout.

The "Fanfare and Allegro" of Williams is absolutely stunning in its impact. Some may find the music rather contrived and overblown, but it would be hard to deny its tremendous vigor . . . it's a real rouser! This will undoubtedly be the section most played by the hi-fi buffs. There are great brazen chords from trumpets and trombones, *fortissimo* explorations of the upper frequency strata of the woodwinds, the coruscating energy of huge cymbal crashes, and snare drum, tympani, and bass drum shots of awesome explosiveness. The dynamic range is vast, the stereo effects impressive in their verity. This is music meant to be played *loud* over a king-size system in a big room.

As a vehicle for testing the abilities of a stereo system, this imposes formidable demands which will be met without distortion, only by the very finest of equipment. As a lease-breaker, this should intimidate, if not terrify, any landlord.

COPLAND
CONCERTO FOR PIANO & ORCHESTRA
Earl Wild, piano, with Symphony of the Air conducted by Aaron Copland.
MENOTTI
CONCERTO IN F FOR PIANO & ORCHESTRA
Earl Wild, piano, with Symphony of the Air conducted by Jorge Mester. Vanguard VSD 2094. Price $5.95.

Once again thanks are due to *Vanguard* for venturing into the world of the "moderns" wherein so much worthwhile music lies unrecorded. Copland's "Concerto," nicknamed the "Jazz" concerto, does indeed have inspiration, if not downright derivation from the jazz idioms of the middle '20's. Underlying these obvious references, however, is the strongly angular and inimitable writing that is Copland. A novelty yes, and most certainly not a piece you hear every day, but as expertly traversed by Wild and given authenticity under the direction of Copland himself, it emerges as a thoroughly listenable, if somewhat dated, synthesis of the jazz, folk, and classic elements so beloved of the *avant-garde* composer of that era.

The Menotti piece is of fairly recent origin (1945) and is worlds away from Copland's score. It is a rather odd, but entertaining amalgam of the classic and romantic, leavened with some very "modern" dissonances. It is an exciting score and the type which usually gains popularity, given sufficient exposure. This recording should go far in achieving that end.

Both works are given the advantage of superior engineering. All is quite clean and nicely balanced. Stereo effects were good as to directionality and depth, but unless I'm mistaken this was made on a two-channel stereo machine and, as a result, the middle "fill" is somewhat less than obtains with a three-channel master. Wide dynamics and frequency range, beautifully handled acoustics, and quiet surfaces were plus values.

LISZT
HUNGARIAN RHAPSODIES #2 & #3
ENESCO
ROUMANIAN RHAPSODIES #1 & #2
London Symphony Orchestra conducted by Antal Dorati. Mercury SR90235. Price $5.95.

A few months ago the catalogue was bare of any stereo recordings of the Enesco "Rhapsodies," a peculiar thing considering their popularity. But like almost everything else in this record world, it never rains . . . it pours. This is the third stereo recording of the Enesco in recent weeks and I'll be darned if all the other discs didn't couple it with "Hungarian Rhapsodies" as well!

As far as I am concerned they can quit right here . . . this is music that Dorati really knows how to project and his vivid, spirited performances go a long way in alleviating some of the banal writing contained in these scores.

The *Mercury* stereo is exemplary . . . fine directionality, good phantom middle, and a nice depth perspective. Dorati gets some splendid playing from the London men, especially in the strings. Dynamic range was very wide and the disc is remarkably clean in general.

BERLIOZ
OVERTURES (Roman Carnival, Beatrice & Benedict, Corsair, Benvenuto Cellini, Royal Hunt & Storm)
Boston Symphony Orchestra conducted by Charles Munch. Victor LSC 2438. Price $5.95.

Munch has been a controversial figure during his tenure with the Boston Symphony, at least with the critics if not with the public. Many of his interpretations have been deprecated . . . but few of even the most die-hard critics will deny Munch's extraordinary mastery of Berlioz. Here he is really in his element, as witness his great performance of the "Requiem" and "Harold in Italy." So it is with these "Overtures."

Rarely have these old war horses been performed with such zestful vigor, such dynamic contrast, and such an exquisite sense of balance and proportion. For some, the tempi may be a bit on the fast side, but this approach lends an electric excitement to the works that fairly sweeps you along. This is especially so in the "Roman Carnival," where under the Munch baton the music moves forward with tremendous impetus.

Soundwise, this is one of the results of some *Victor* experiments with a new set-up in Symphony Hall. Instead of the orchestra being disposed on the stage, they are now seated much farther out in the hall and with the revised mike set-up, the balance is much improved in the direction of clarity of inner voices and over-all instrumental definition, coupled with a more spacious and depth-producing acoustical climate. The most noticeable improvements are in the bright, clean sound of the first and second violins, considerably more sonority from the celli and basses, increased presence in the brasses and woodwind.

Stereo direction is more obvious without being exaggerated, but I must say that although the three-channel technique is used for mastering, the phantom center channel, as heard from the disc, was not as well projected nor as much in balance with the right/left elements as one could desire. But this is a minor quibble, and it must be reckoned that this is one of the best recordings of Berlioz "Overtures" now available.

SCHULLER
SEVEN STUDIES ON THEMES OF PAUL KLEE
FETLER
CONTRASTS FOR ORCHESTRA
Minneapolis Symphony Orchestra conducted by Antal Dorati. Mercury SR 90282. Price $5.95.

More music by contemporary American composers, performed by Dorati who has always championed new music, especially of American origin. Before going any further let me say that this disc is being reviewed mostly for the Fetler work. I have nothing against Mr. Schuller and indeed admire the structural complexities of his score . . . but . . . man, this cat's music is way, way *out*. It is so full of atonality and dissonance that I feel sure you dear readers would lynch me if I recommended it on a purely musical basis.

The Fetler score is by no means free of many of the same influences in the Schuller piece, but it is more of an integrated work and much more listenable.

Its main attraction lies in the powerful and brilliant orchestration. This is productive of some great sonorities and the Minneapolis men display their virtuosity with this difficult music.

The most striking feature of this disc is the remarkable sound captured by the *Mercury* engineers. It has every element needed to generate excitement . . . sizzling strings, great huge brass chords, bright perky woodwind, and a veritable artillery barrage of percussion in great variety. The dynamic range exhibited near the finale is probably as wide as anything yet put on a stereo disc.

All in all, the impact of this sound is overwhelming. Stereo lends its particular virtues and is well done throughout the score. Modern music, yes, and perhaps not to everyone's taste, but if you want a real *tour de force* in stereo sound reproduction, don't miss this!

MENDELSSOHN
SYMPHONY #3 ("Scotch")
OCTET IN E FLAT & SCHERZO
Boston Symphony Orchestra conducted by Charles Munch. Victor LSC 2520. Price $5.95.

More Munch and Boston, this time in the lovely "Scotch" Symphony of Mendelssohn. Here his performance is perfectly respectful . . . he takes few liberties, his tempi are just, the balances excellent . . . but somehow it just doesn't generate either warmth or excitement. The level of inspiration that characterized the Berlioz pieces, just isn't there. Nor is this as successful soundwise as the Berlioz disc. Mind you, it still represents a fairly good sounding recording . . . the first and second strings are superbly clean and bright, the woodwinds crisp. But there seems to be too much weight in the celli and basses, especially near the finale, and at the same time, not enough weight in some of the more declamatory passages for french horn and trumpet. The phantom center still is not quite as well projected as in some other *Victor* recordings.

Thus the potted palm for the best "Scotch" Symphony must remain with the recent *London* recording conducted by Peter Maag. The filler on this disc, the "Octet and Scherzo," is another matter. Although presumably made at the same session, these are lovely things, recorded with bright clarity and compelling presence. All of which leads me to believe that the scoring of a work determines whether this new set-up in Symphony Hall can be properly utilized. The Mendelssohn is a heavier, thicker-textured work than are the Berlioz scores and this could well account for the differences in sound.

THE UNITED STATES OF AMERICA
Presented by Stan Freberg. Music arranged and conducted by Billy May. Capitol Mono W 1573. Price $3.98.

I don't often review something like this, but I think it is so hilarious that it deserves mention. Stan Freberg is well known for his particular brand of zany satire and here he has outdone himself. In fact he may have done too well, as it seems that many radio stations refuse to play the album. This is small thinking . . . so it pokes fun at us. Americans have always had the capacity to laugh at themselves and admit to some of our merely human failings and foibles.

I find nothing vicious, nor "pinko," nor in bad taste in the album. It is an uproarious satire in the form of a very clever and tuneful musical-comedy-in-miniature. I couldn't begin to list all the credits due the participants, but, believe me, this was quite a production.

Freberg himself acts out most of the parts as well as singing the many numbers in the show. The material is always witty, often urbane, and very sophisticated with a sort of Madison Ave./Hollywood touch that is most amusing. As far as I am concerned the highlights of the show are the opening Columbus scene, the bittersweet satire of the song "Take an Indian to Lunch This Week," and the Ben Franklin scene.

As you can see, this is all early American history and actually this is supposed to be the first volume of four which will take us from this point up through present times. In fact, this first album is subtitled "The Early Years." Alas, word is that if the radio boys will not relent and afford the album more exposure, this will also be the last album!

The Billy May arrangements are very well done and the sound is of top hi-fi quality throughout the disc. A dilly party item, that will offend no one of either sex, or open mind, this is well worth the attention of anyone who has a sense of humor and who enjoys good satire.

TAPE TOPICS

This is one of the quietest periods in the tape world that I can remember. Rumors of all sorts of developments continue to fly around—most of them insubstantial. In spite of denials, the betting still favored introduction of the *CBS/3M* tape cartridge at the Parts Show and, because of this, most people in the field are moving cautiously.

The summer season is usually slack on releases but, except during the great tape drought in the early stereo disc days, this has been very lean pickings. Last month two tapes arrived . . . period! I have heard that pending the outcome of the *CBS/3M* deal, there will be an effort to upgrade, in quality, the present 4-track tapes and that a number of companies, not now associated with the tape machine industry, will offer some interesting innovations if the market remains stable.

As I have said before, I believe there are two distinct tape markets . . . a mass market and a quality market. They can co-exist and even at the point of diametrically opposed systems. All we can do at present is wait and see which way the ball bounces. At any rate, I don't personally believe we will ever again have a virtual abandonment of tape—as happened in 1958.

MUSIC FOR TRUMPET & ORCHESTRA
Roger Voisin and Armando Ghitalla, trumpets, with Unicorn Concert Orchestra conducted by Harry Dickson. Kapp KT49000. Price $7.95.

It is too bad that this tape has some flaws which keep it out of the top rank, for there are some superb performances here of some wonderful music. Voisin gives us a virtuoso account of the famous Haydn "Concerto for Trumpet and Orchestra in E Flat." He is equally facile and effective in company with Ghitalla in Vivaldi's "Concerto for Two Trumpets and Orchestra in C," and both team up in Jeremiah Clark's great "Trumpet Voluntary" (often attributed to Purcell). Three Purcell pieces fill out the tape.

The playing is all of very high order and, in general, from a musical viewpoint, there is little to fault. It is in the sound department where this falls from grace. The trumpets are projected too far out of balance with the orchestra and play at a very high level. Overload distortion becomes quite noticeable especially in the higher registers. The string body has a rather wiry tone.

It appears to have been a two-channel original and, as such, the middle is on the weak side. The trumpet in the Haydn was on the left side and its power often overbalanced the right channel. The over-all level of the tape was down from what I find normal with my rig, necessitating a boost and, of course, resulting in an increase in tape hiss.

ROSSINI
OVERTURES (Barber of Seville, William Tell, Semiramide, Silken Ladder)
New Symphony Orchestra of London conducted by Kenneth Alwyn. London Richmond Stereo RCH40001. Price $5.95.

This is a real sleeper! An offering on the "cheap" *Richmond* subsidiary label of *London*, it is as good as many tapes in the top-price category. Alwyn is no Toscanini, but his performances, if more rough hewn, are lusty and boisterous and easy to take.

The sound is generally quite clean, with good definition and balance and broad acoustics to lend depth. Stereo direction was excellent and center fill good. Some fine string and brass sound and a monster bass drum which is played with vigor and really shakes the foundations. Only quibble . . . rather noticeable tape hiss and some obtrusive crosstalk. For the money, a good buy.

GIULIANIA
CONCERTO FOR GUITAR & STRINGS
ARNOLD
CONCERTO FOR GUITAR
Julian Bream, guitar, with Melos Ensemble. Victor Stereo FTC2049. Price $8.95.

A lovely pair of concertos for guitar—quite opposite in time and feeling, but both gems of their type. Bream is a sensitive, perceptive artist, eschewing some of his contemporaries' flamboyance for solid musicianly readings.

The sound is exemplary throughout, the guitar always articulate and in fine balance with the orchestra. Stereo effects were good and the high level tape was very quiet and free from crosstalk.

—30—

ANSWERS TO QUIZ

Appearing on Page 8

1. A zener diode.
2. A chopper, when connected across the input and output of an amplifier.
3. A free-running multivibrator.
4. An easy one: a transistor!
5. A cathode-follower stage.
6. A non-inductive resistor.
7. Negative feedback, of course.
8. An oscilloscope cathode-ray tube.
9. Right, a loudspeaker.
10. A ten-turn helical potentiometer.

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International's exciting **New** Compact transceiver for the Citizens licensee who desires quality workmanship and engineering plus the best possible circuit for the money invested. Field tested full 5 watt transmitter contained in the higher price Executives. Certified tolerance .005%. Tunable superheterodyne receiver covering all 23 channels. Three position crystal control transmit channel selector. Manual transmit-receive control. Noise limiter. Available accessories include four separate power supplies — 6 vdc, 12 vdc, 24 vdc or 115 vac, push-to-talk relay kit, squelch kit, and 12 position transmit channel selector. **Complete with 1 transmit crystal, matching microphone and external speaker, but less power supply.**

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Stereo-Headphone Amplifier

(*Continued from page* 31)

to a point a bit positive of ground to eliminate heater-cathode breakthrough.

Construction & Performance

The photos show the top and under-chassis views of the amplifier. The chassis measures 2" x 4" x 6" and construction is extremely compact. By all means, use a larger chassis if you want to have a little more room in which to maneuver.

Maximum power output is shown in Fig. 2. Although it falls off rather rapidly at low frequencies, it is more than sufficient, even on the bottom, to drive the headphones to a painful level before distortion becomes audible. The response curve (taken at a much lower power level), like the power curve, drops off at the low end because of the tiny output transformers and single-ended output, but it is within + .5, −2 db from 40 to beyond 20,000 cps.

When wiring the amplifier, follow good audio practice (twisted heater leads, grid leads well away from power lines, etc.), insulate the output jack from the chassis, use a ground bus, and ground only at the input jacks. A bottom plate may reduce hum somewhat, but it is not always necessary. If either amplifier oscillates, the feedback around it is positive rather than negative, so reverse the leads from the output transformer secondary. Since these leads are not color-coded, trial and error is the only way of establishing the proper phase relationship.

The completed amplifier sounds surprisingly good. On most program material headphone reception was not too different from that obtainable with the 70-watt stereo amplifier. When driven either by a crystal or ceramic stereo cartridge (a few hundred millivolts will drive it to a usable output), or by a stereo preamp, the effect is most rewarding. A switch to parallel the outputs of a stereo program source will, when opened, convince the most diehard audiophile of the superiority of stereophonic sound. —30—

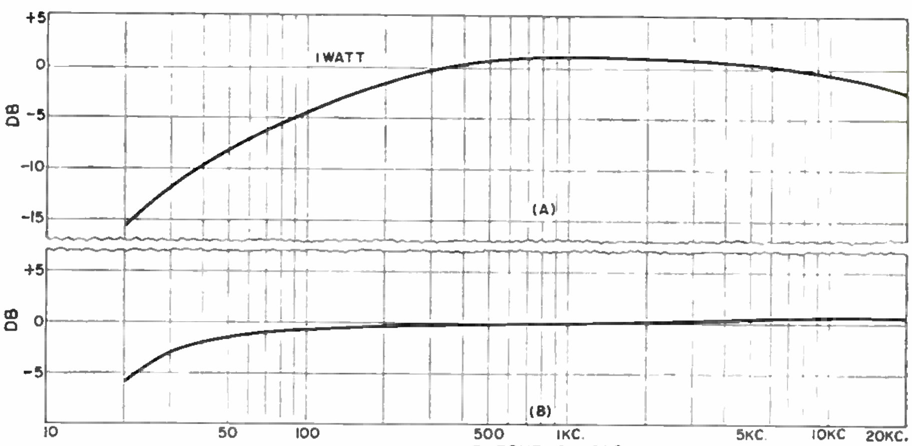
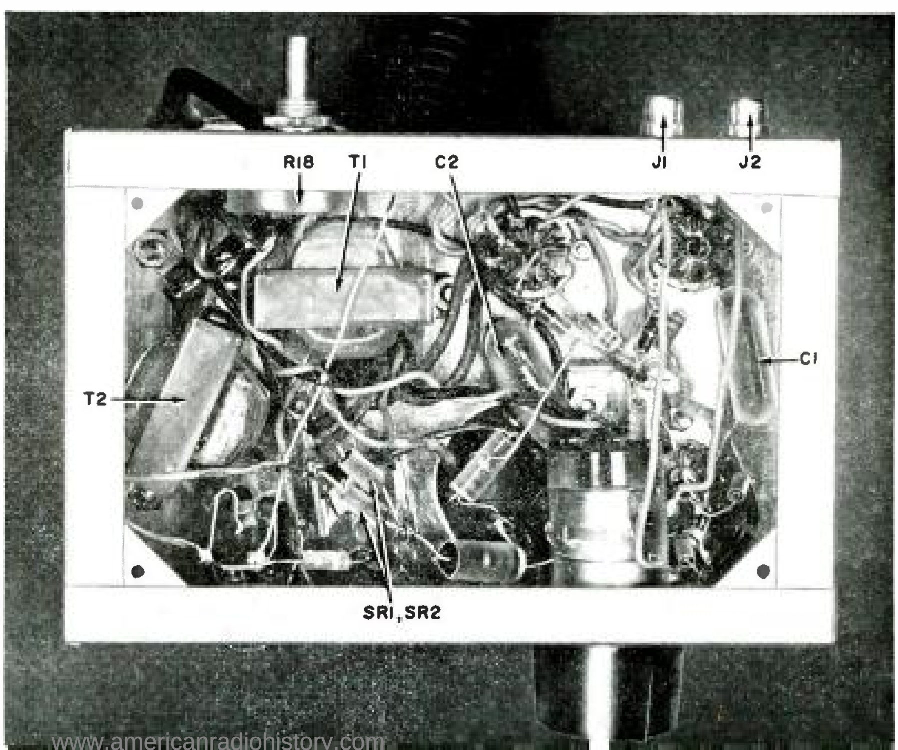


Fig. 2. Curves show the (A) power response and (B) frequency response of each channel. The frequency-response curve was taken at an output far below 1 watt. Measured crosstalk was —45 db, while hum and noise measured 60 db below 1-watt output.

Under-chassis view shows the placement of the two output transformers. The use of a slightly larger chassis would have permitted a little more room to work in.



Electrical Activity of Body

(*Continued from page* 30)

sweeps around the heart in the manner of a true rotating vector.

In one type of heart defect known as a *block*, the conducting path between the auricles and the ventricles is interrupted. Under these conditions, the ventricles go "out of sync" and may contract at a different rate than the auricles. In a recent experiment, a transistorized amplifier has been successfully used to bridge the interrupted pathway and carry the triggering pulse from the auricles to the ventricles.

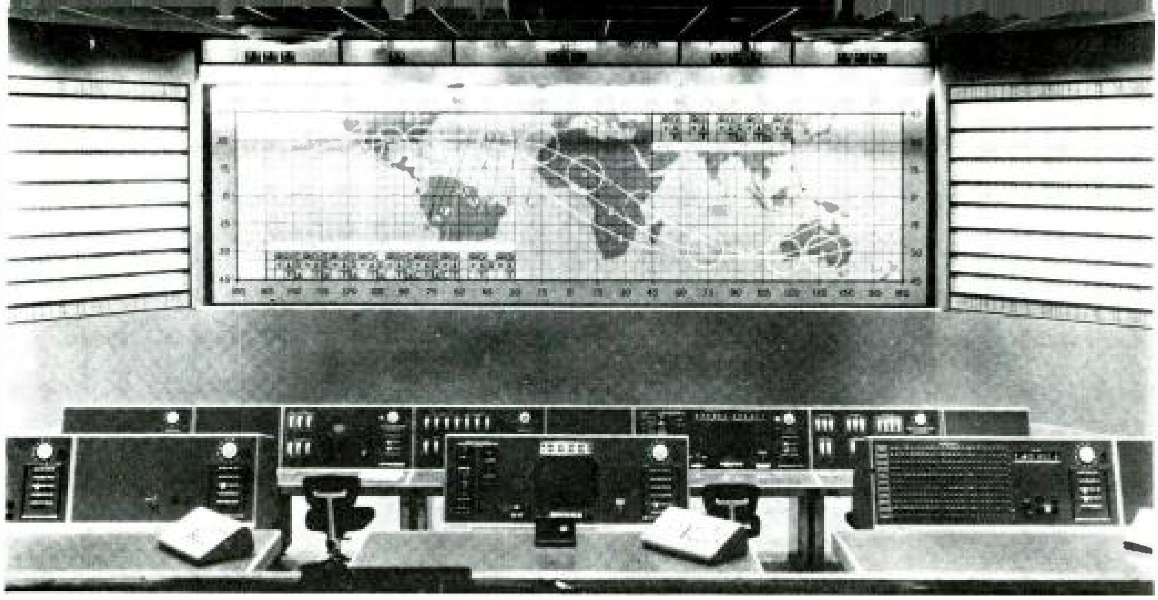
Eyeball Potentials

Recently, some rather interesting and informative experiments have been conducted involving the measurement and recording of the eyeball potentials. The eye is a polarized sphere: the front surface being positive with respect to the back. It is not convenient to attach electrodes to the eyeball itself, but fortunately the eye is surrounded by partially conductive fluids and tissues which can serve as connectors. The electrodes can therefore be placed on the skin near the eye sockets as shown in Fig. 8. When the eye is looking straight ahead, both electrodes are at the same potential and there is no input to the amplifier. When the eye looks either left or right however, the positive surface of the eye moves closer to one of the electrodes, and the negative back surface moves closer to the other. The difference of potential between the electrodes is amplified and deflects the recording pen across the paper chart. For the average person, the electrode potential varies at a rate of about 20 microvolts per degree as the eye is positioned right or left.

The recording of the eyeball potentials, known as electro-oculography (EOG), is useful for determining the condition of the eye muscles and for studying reading habits. It has been suggested that the eyeball potentials might be used to control a servomechanism in an automatic tracking device.

Conclusion

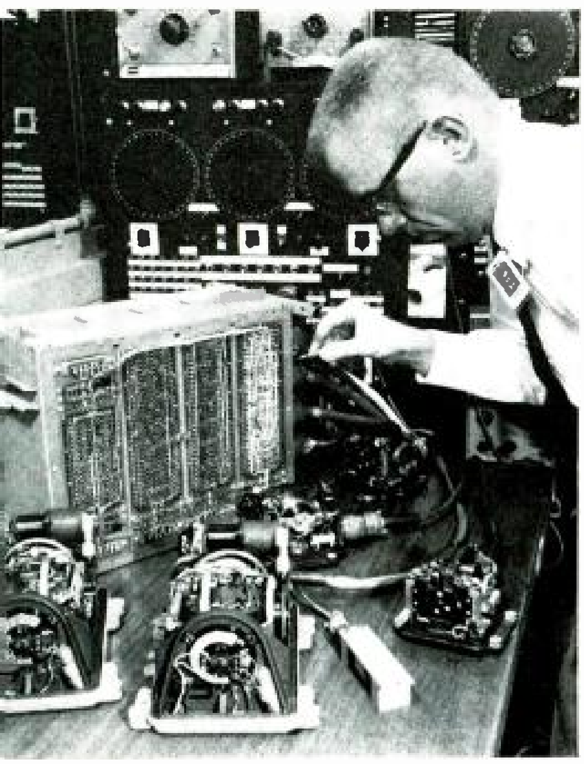
While much remains to be learned regarding the electrical behavior of the tissues of the body, it has become entirely obvious that such electrical activity is both a cause and effect in the life process. The study of body-generated potentials has resulted in faster and more accurate techniques for diagnosis and treatment. It is not inconceivable that electrodes attached to various portions of the anatomy may someday supply the input information to a "diagnostic" computer. The computer would then compare these voltage patterns with those stored in its "typical symptoms" memory. The result of this comparison would then be fed to an electric typewriter that would print out the diagnosis and suggested course of treatment. —30—



recent developments in electronics

Display for Astronaut

This control display system for Project Mercury's Control Center at Cape Canaveral was the nerve center for our recent successful man-in-space shot. Data flowed into the 50 by 60 foot operations room from the astronaut's capsule, from 18 world-wide data stations, and high-speed computers. The large map shows the capsule's path and the location of the tracking stations. Trend charts, at both sides, record all critical parameters. Closed-circuit TV monitors in the ceiling and on the consoles monitor launch-pad activities and missile take-off. The display system was designed and built by *General Dynamics/Electronics* at San Diego, Calif.



Stabilizer for Spacecraft

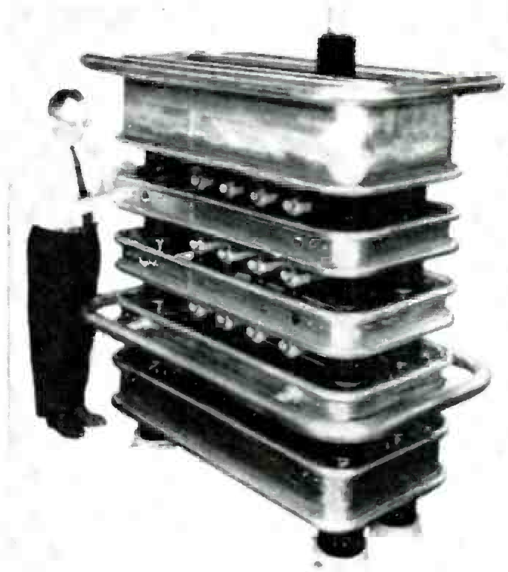
The first U.S. astronaut depended on this complex electronic system to stabilize his capsule during flight and to return him safely to earth. This attitude stabilization and control system for the Mercury capsule includes the five gyroscopes in foreground and the electronic computer being checked by the engineer. The unit literally flew the astronaut in space from the time the capsule separated from its booster through the re-entry phase. For a brief period of time, manual rather than automatic control was exercised by the astronaut. *Minneapolis-Honeywell* developed the automatic pilot for *McDonnell Aircraft Company*, prime contractor to the National Aeronautics and Space Administration for the Mercury capsule.

Space Transmitter Amplifier Tube

A pair of pencil tubes, similar to the *RCA*-5876 being shown below, were used in the power-amplifier stage of the two-way radio in the Project Mercury spacecraft. The thin, 2" long tubes boosted power output of the *Collins*-designed u.h.f. transceiver from ½ watt to 2 watts.

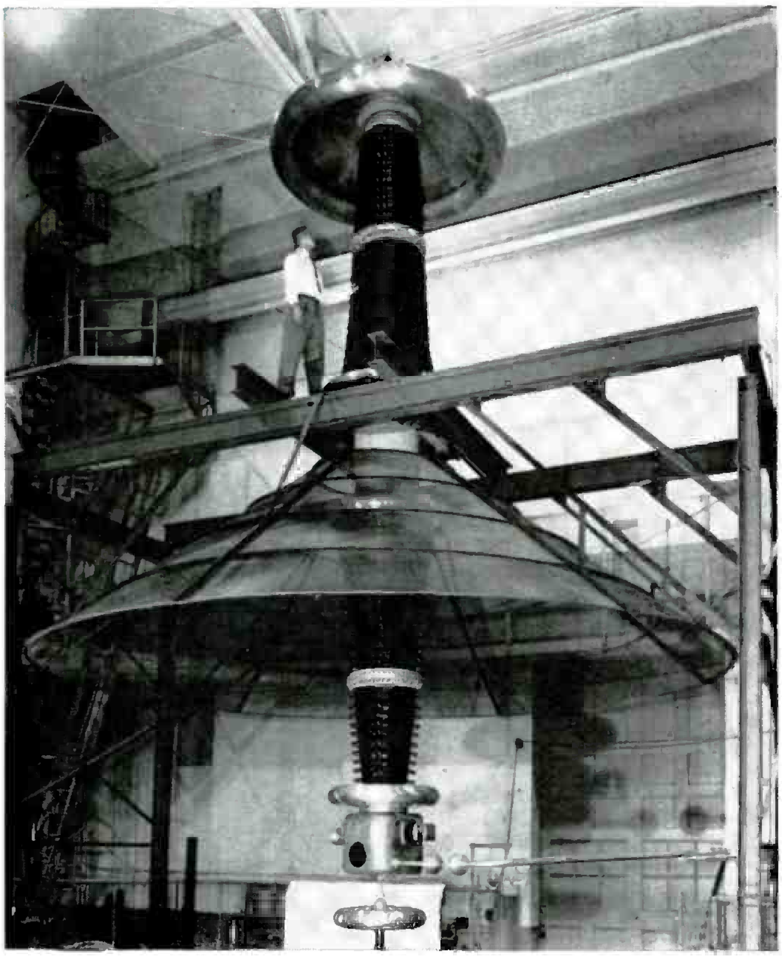
Giant High-Voltage Resistor

A large corona-free high-voltage power resistor, made up of five stacked resistor modules is shown at the right. The giant resistor, rated at 150,000 volts, is for use with radar power supplies as a bleeder and a sensing device. All parts of this *Westinghouse* resistor are designed to eliminate any concentration of high-voltage stresses which may cause break-down and create electrical interference.



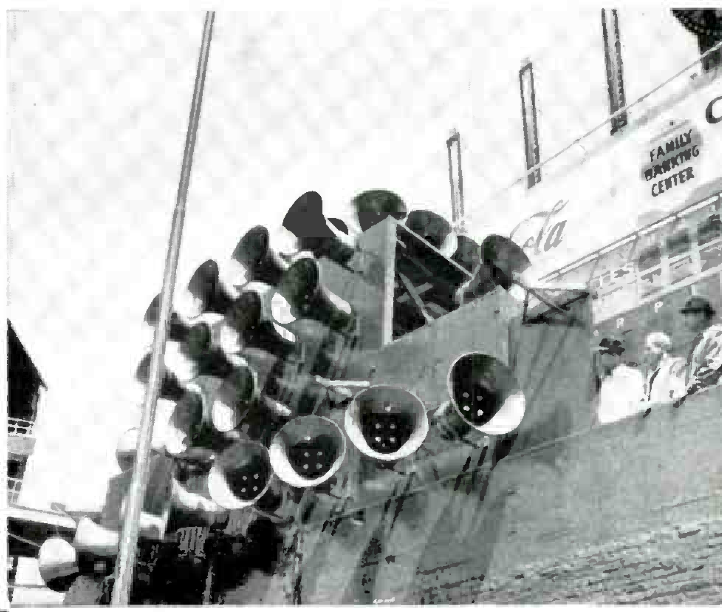
Largest Radio Antenna Insulator

One of six of the world's largest radio antenna insulators now being used at the U.S. Navy's Cutler, Maine radio station is shown after completing tests at the *G-E* Insulator Dept.'s laboratory in Baltimore. Tests proved the 26-foot-high insulator bushing to be corona-free when operating at 500,000 volts, 60-cps a.c. Filled with sulfa-hexafluoride gas for insulation, the bushing is mounted through a conical opening extending through the thickness of the transmitter roof.



3000-Watt P. A. System

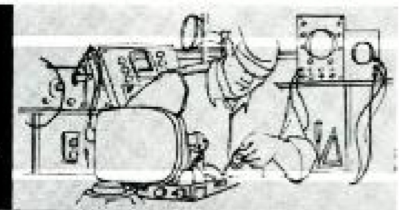
The new sound system for the scoreboard at Chicago's Comiskey Park has no less than thirty 100-watt horn speakers powered by an equal number of 100-watt heavy-duty, commercial p.a. amplifiers. This sound system, manufactured by the *Dukane Corp.*, is the largest sound system of its kind in a major-league ball-park. The unit has its own generating system which is employed in the event of a power failure.

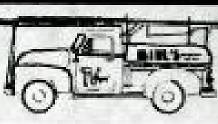


Electronic Track Coach

Japan's Olympic trackmen will benefit from controlled pace practice in their build-up for the 1964 Olympic Games in Tokyo as they match speed and endurance against *Toshiba's* "electronic coach." The "coach" runs on a rail laid along the inside of the track at Tokyo's National Athletic Stadium. Speed can be set in advance and controlled by magnetic tape, or it can be changed by remote control. The pace setter is equipped with a radio receiver and loudspeaker to broadcast instructions. A portable transmitter is supplied for use with the "coach."

SERVICE INDUSTRY NEWS





THE ANNUAL convention of the National Alliance of Television and Electronic Service Associations, a regular mid-summer event in Chicago, will be held at the Pick-Congress Hotel in that city this year. For most interested parties, this will be a three-day affair running from Friday, August 18, through Sunday, August 20. However a meeting of the executive council will precede it Thursday night, August 17. Reflecting NATESA's growth and present strength, total convention expenditures are expected to exceed $350,000, or more than $170 a minute. The NATESA plea for the cooperation of all participants in making certain that every event starts exactly on time is understandable.

In addition to many new items, much of the business of the spring directors' conference, held in Albuquerque, N. Mex., will be carried forward. At the latter, the official acceptance to membership of 13 new groups was announced, together with the re-instatement of a formerly delinquent affiliate. Another bid was made to accept employed technicians to membership, but was voted down. Other subjects aired and acted on included factory and captive service, TV station liaison, u.h.f. TV, sales practices on picture tubes, wholesale-retail practice, and customer relations. Vern La Plante reported on a method for countering false advertising. Frank Moch gave advance warning of a new service racket claiming to be able to analyze any TV trouble in 2 minutes using a "mystery analyzer," featured in big ads.

Manufacturers receiving "Friends of Service Management" awards included *Finney, Raytheon, Sprague, Sylvania,* and *Tung-Sol*, for their cooperation with independent service. Broader relations within the industry were discussed, with great hope expressed for the role of the Industry Advisory Panel. On behalf of the latter, Mauro Schifino, president of NEDA, and Frank Moch, executive director of NATESA, jointly issued a call to 25 industry leaders to attend an all-industry conference, for the purpose of dealing with matters of mutual interest and concern. Invitations went out to individuals prominent in set manufacture and distribution, parts distribution, representation, sales management, independent and factory service, and other segments of electronics.

Service and the Law

People who like to reduce everything to black-and-white simplicity will have a hard time with the stand of Frank Gronert, editor of "TESA Beacon," on a legal proposal made in his home state, Iowa. The legislature is considering extension of the sales tax, already applicable to parts used in service, to labor charges as well. The "TESA Beacon" does not like the idea. Associations in other parts of the country have welcomed such proposals—or apparently similar ones—when promulgated locally.

A favorable attitude toward such legislation occurs where it is felt that it will help established and reputable service shops meet unfair competition by twilight operators. Where the latter have no regular places of business and escape the expenses imposed on their established competitors, they have the advantage of being able to undersell their services. Strictly enforced tax laws that require registration of the business, usually accompanied by zoning and other requirements for legal operation, flush these people out into the open. They must choose between abandoning their businesses or operating under the same conditions imposed on others.

The history of the Iowa proposal follows another line of development. Apparently advanced for the chief purpose of getting in new revenue, it grew out of a broader tax measure originally suggested several years earlier. At that time, the sales tax was to be extended to all services. An outcry by physicians won a quick exclusion of doctors' bills. In rapid succession, lawyers, dentists, and others who render services raised objections and won exclusions. The present version seems to apply to auto and TV repair work primarily.

Nevertheless, Editor Gronert's objections are not confined to the discriminatory character of the measure. He feels that existing loopholes in sales-tax legislation and its enforcement have already given an unfair advantage to improperly established competitors, who can evade tax collections and payments imposed on shops working in the open. Unless these loopholes are first corrected, the legitimate dealer's handicap may increase. When the law involves itself with electronic service, matters can become quite tricky.

Courts Take Action

Head-on clashes between the law and individual service operators, in two different parts of the country, also raise interesting legal questions. TESA of Oklahoma, in its monthly "Antenna," reports on a war being waged by the local BBB and the county attorney on TV-service racketeers. Receivers in good, carefully checked operating condition, except for specifically introduced defects (the deliberate misadjustment of a control) were used as bait. Service firms called in were those on which consumer complaints had been received. As a result, two technicians and the employer of each were arrested and charged with obtaining money under false pretenses. In each case, the TV set was picked up and returned with allegedly inflated charges for labor and parts.

In a somewhat different situation, a TV repair technician in Kansas City, Mo. was found guilty and fined on the complaint of a customer in whose set he had replaced nine tubes on a service call. Two of the tubes were unquestionably defective. Concerning the other seven, the court felt that there was no appreciable difference in receiver performance whether they were left in the set or replaced by new ones. Other service technicians testified for both sides.

The defendant insisted that performance was still below standard after he had replaced the two wholly defective tubes, that he had wished to take the set to his shop for further work, that he had attempted to improve performance by replacing seven additional tubes that he had checked and judged to be weak or otherwise contributing to the below-standard performance. Protesting innocence, and proper handling of the call, he filed an appeal through his attorney.

Without the record of evidence available to the court, no technician can presume to review a court's judgment. Every technician, however, will draw one moral or another from these cases, depending on how he feels about legislation pertaining to service in general and licensing in particular. Licensing "antis," where they feel justice has not been done, will claim that a licensing law increases the chance of persecution; where they feel justice has been served, they will say that existing laws are sufficient. The "pros" will state that licensing can protect legitimate operators from unjust decisions and be more effective against the questionable ones.

Only one thing is certain: since service technicians will be brought into court from time to time whether under special or existing general legislation, some methods for assuring competent, technical evaluations of such situations must be developed in the interests of justice.

New Life in Houston

Charles A. Barclay, newly elected president of Radio and Television Technicians' Society of Houston, Texas, has announced his intention of injecting new life into his group, along with other new officers, and of gaining for it the recognition it has missed in the past. Elected with him were Joe Novosad, vice-president; Keith Brady, secretary; and Steve B. Ebner, Jr., treasurer. This slate of officers was installed at a meeting in late May. —30—

Selecting an FM Tuner

(*Continued from page* 51)

of noise suppression is to use a filter which merely reduces the noise level. Second-best is the audio squelch circuit which can be recognized by the rather disturbing thumping noise which it produces just before cutting off the noise. A more recent variant of this device employs a mechanical relay to eliminate the thumping and to quicken the reaction time.

The most useful procedure, however, is to cut off the signal in the i.f. section before it ever reaches the audio stages. By doing this, the deficiencies of audio squelching are eliminated and, in addition, the suppression feature will be effective for FM multiplex.

Naturally, anyone at all interested in stereo should be sure that the set he buys includes a multiplex output. A multiplex output will be needed for the connection of a separate adapter. Several tuners now on the market have provisions for adding a plug-in adapter directly to the tuner chassis. In other cases it will be possible to obtain an FM tuner with the multiplex feature built right in without requiring any separate adapters.

A "Local-Distant" switch may also be helpful, especially in areas close to FM transmitters where the danger of overloading is the greatest. Flipping the switch to the "Local" position cuts down the signal level and thus prevents overload distortion, or imaging. This feature is more important on the highly sensitive tuners because the possibility of overload is greater.

There are a few other convenience features which may prove quite handy, although they are overlooked by many tuner buyers. These include such items as a separate output for a tape recorder, heavy flywheel action on the tuning knob, a front-panel volume control and "on-off" switch, auxiliary power outlets, and a logging scale on the tuning indicator (for quicker location of a desired station). None of these will affect the performance of the tuner but they may make it a bit more comfortable to "live with." Along these lines, it goes without saying that the tuner must be attractively styled and fit the room decor.

In selecting an FM tuner, as with any high-fidelity component, the most important consideration is to match the features of each model with the particular application you have in mind. Looked at in this way, there is no "best" tuner and no "worst"—there are simply a variety of models and features, some of which may fit your requirements better than others. Probably the best procedure is to decide on the essentials—price range, performance specifications, and features—before entering the many-splendoured showroom of your local dealer. In this way, you can avoid a great deal of wasted time and confusion, and also bring into your home a tuner that suits your particular requirements. —30—

Transistorized Converters

(*Continued from page* 57)

last about as long as "shelf life." At 12 volts the converter draws only 3.8 ma. and at 8.4 volts the current is only 2.6 ma. The gain is higher of course with a 12-volt supply.

Citizens Band

The converter may be used in the Citizens Band (26.96-27.255) by winding the 10-meter coils and using a 23.4-mc. third-overtone crystal. There are no other circuit changes required. The converter will receive the frequencies between 26.9 and 27.4 mc. with a 3.5-4.0-mc. i.f.

Modifications

A 2N371 may be used in place of the more expensive 2N384 r.f. amplifier without circuit changes. It will provide fair gain on 20 meters, but the performance will be somewhat degraded on 15- and 10 meters. A 2N371 is recommended for the mixer and oscillator since the circuit demands made on these transistors are considerably reduced.

A diode could be inserted in the "B−" supply lead to prevent possible damage of the transistor if the battery were accidentally reversed.

The converter may be used with other i.f.'s simply by inserting the appropriate crystal. To receive frequencies other than the bands listed, it is necessary to insert the proper crystal (the oscillator frequency will always be 3.5 mc. below the lowest frequency to be received) and re-adjust the coils.

If coil-form diameters are changed, it may be necessary to use a grid-dipper to put the coils on frequency. Always leave the transistors in the circuit (with voltage applied) when making dipper measurements because the transistors complete part of the tuned circuits.

To test the performance of the completed unit, a 15-meter converter was connected to an 80-meter receiver and compared to one of the best known (and most expensive) receivers on the market. There was no detectable difference in performance between the two units. Measurements were made comparing the sensitivity, signal-to-noise ratio, and frequency drift. A later comparison with the vacuum-tube version of the converter showed that the stability of the transistor version was superior. When the supply voltage was reduced from 8.4 to 3.5 volts (more than a 50% change), the oscillator frequency moved only 20 cycles. A 20-volt change in the supply to the tube converter (a 15% change) caused the oscillator to shift approximately 100 cycles, or more than 5 times the transistor version.

In the matter of warm-up drift, the transistor converter is far superior to the vacuum-tube device, for it hasn't any! It will be a long time before we can expect such performance from tube circuits in an application like this. —30—

INVITATION TO AUTHORS

Just as a reminder, the Editors of ELECTRONICS WORLD are always interested in obtaining outstanding manuscripts, for publication in this magazine, of interest to technicians in industry, radio, and television. Articles covering design, servicing, maintenance, and operation are especially welcome. Articles on Citizens Band, audio, hi-fi, and amateur radio are also needed. Such articles in manuscript form may be submitted for immediate decision or projected articles can be outlined in a letter in which case the writer will be advised promptly as to the suitability of the topic. We can also use short "filler" items outlining worthwhile shortcuts that have made your servicing chores easier. This magazine pays for articles on acceptance. Send all manuscripts or your letters of suggestion to the Editor, ELECTRONICS WORLD, One Park Avenue, New York City 16, New York.

Shock-Proof Suspension System

(Continued from page 43)

pended weight plus some additional amount for motion of the suspension system. Call the spring stretch due to the suspended weight x; then $x = W/K$ or $x = 9.75/f^2$. In terms of the previous example, $x = 2.44$ inches for 2 cps. This means that if the unstretched length of the spring were 6 inches and $x = 2.44$ inches, you must have enough space to accommodate 8½ inches of spring. Most extension springs have some initial tension so that x may be a little less than the value given by the formula just cited.

If a variety of extension springs is available, a simple experimental procedure may be used to select the desired spring. First apply sufficient force or weight to the spring to overcome its initial tension and open up the coils. Then load the spring with P additional pounds of weight and measure the additional stretch due to P, say s inches. The spring constant will be $K = P/s$. For example, if $P = 2$ pounds and $s = 1$ inch, then $K = 2$ pounds/inch. Another way of going about this is to add a load of K pounds and see if the spring stretches approximately 1 inch. If it does, then this spring has the desired spring constant.

Of course the spring selected must be strong enough to support the suspended weight without taking a permanent set. Because of variations in the strength of spring materials, no precise rule, outside the "try it and see" method, can be given. However, you can use this approximate and fairly conservative formula for selecting the spring on the basis of its actual weight. The weight of the spring should not be less than: $m = 0.1\ W^2/K$ ounces, where W = load carried by the spring and K is the spring constant. Any spring that weighs more than m will be strong enough. Example: if the supported load is $W = 5$ pounds and $K = 2$ pounds/inch, then $m = 0.1 \times 25/2 = 1.25$ ounces.

It is advisable to get the springs for the suspension system before building the cabinet so that proper space and a proper arrangement for them can be provided.

Other Construction Notes

Sufficient clearance, between 3/16" and ¼", should be left between the record player mounting board and its outside housing to allow for relative motion between the two.

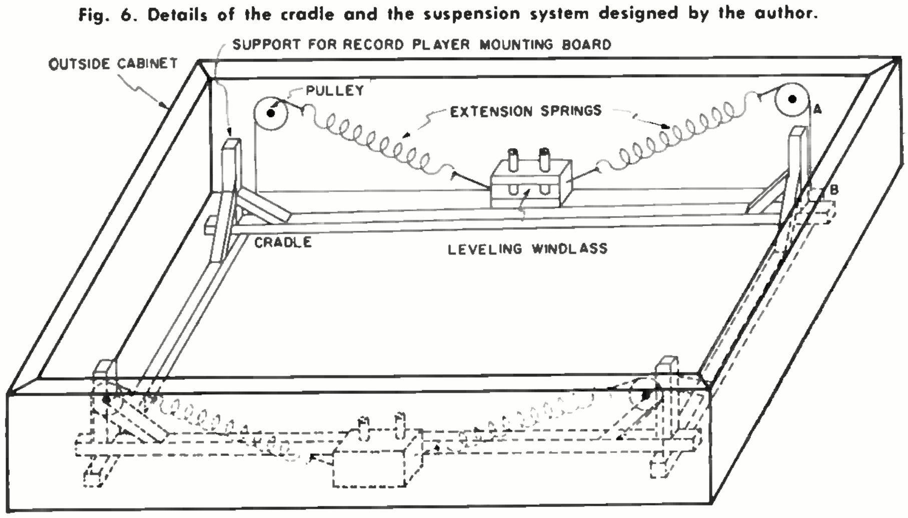
In mounting the record player on the suspension system, the elastic mounts provided by the manufacturer should be used in addition to this suspension system since they will continue to serve their purpose of isolating the record player from acoustic feedback and can only improve on the isolation provided by this suspension system.

The outside dimensions for the housing or cabinet of the suspension system are not included because these must be determined by household space considerations, the size of the springs, and the dimensions of the record player. The turntable for which the system described was designed is unusually heavy, thus the suspension system is heavier and bulkier than one that could be designed for a lighter, more compact record player.

In summing up, the important feature of a shock isolation system is that the suspension be very soft in all directions. The natural frequency of oscillation is the criterion of how soft the suspension is and how good a shock isolator it is. The lower the natural frequency the better. The system described here is simple and makes it possible to get very good shock isolation, especially in the horizontal direction where it is usually needed most—but it is not the only way of doing the job. The author built a rather complicated combination torsion-bar, pendulum suspension that worked very well. Hence you can design your own system such as, for example, hanging your record player in pendulum fashion from four vertical springs that would be concealed in the cabinet.

With the described system you should be able to jump several inches from the floor in front of the record player and land fairly hard without hearing any disturbance in your hi-fi system, even with needle pressures as low as 1½ to 2 grams.

Fig. 6. Details of the cradle and the suspension system designed by the author.



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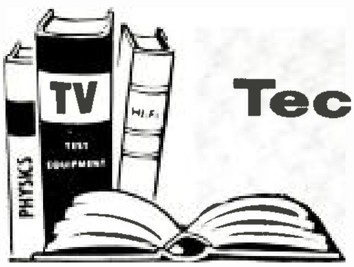


Technical BOOKS

"HI-FI—STEREO HANDBOOK" by William F. Boyce. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 288 pages. Price $3.95. Soft cover.

This is a revised and enlarged edition of a volume which originally appeared in 1956. Prepared as a guidebook for both experienced audiophiles and beginners, this volume covers mono and stereo sound; fidelity, sound, and distortion; stereo techniques; program source equipment; amplification and control; loudspeakers; baffles and enclosures; and systems design— selection and installation.

A large collection of diagrams and photos of equipment amplify the text material.

* * *

"ELECTRONIC DRAFTING HANDBOOK" by Nicholas M. Raskhodoff. Published by *The Macmillan Company*, New York. 395 pages. Price $14.75.

Designed specifically for those in the electronics industry, this comprehensive manual presents the specialized skills required in this newest branch of engineering drawing.

The author shows how to prepare every kind of electronic drawing: schematics, wiring diagrams, working installation drawings of electronics and communications systems and equipment, tube-base diagrams, interconnection, and outline drawings.

The text is crammed with practical examples and, in addition, the author covers typical drafting-room practices, techniques of drafting, and checking procedures. An extensive reference section completes the text and makes this a one-volume "library" for the practicing draftsman.

* * *

"CITIZENS BAND RADIO" by Allan Lytel. Published by *John F. Rider Publisher, Inc.*, New York. 150 pages. Price $3.90. Soft cover.

This is a manual for the user and/or the prospective user of the CB service. It not only covers the background of this service but discusses the design features of different types of transmitting and receiving equipment. Specific commercial models are analyzed in detail with particular emphasis being placed on single-channel and multi-channel equipment.

The installation and repair of CB equipment is also covered, along with a discussion of FCC rules and regulations applicable to the CB service.

* * *

"HOW TO LOCATE AND ELIMINATE RADIO & TV INTERFERENCE" by Fred D. Rowe. Published by *John F. Rider Publisher, Inc.*, New York. 157 pages. Price $2.90. Soft cover.

This is a revised and up-dated second edition of a practical manual for the radio and TV service technician, written by the chief investigator of the Radio Interference Division of Northern California's Electrical Bureau. Based on long experience in tracking down and eliminating radio and TV interference, the author discusses the new and improved components available and their application to the problem of interference. This volume is suitable for electric power technicians and amateur radio station operators as well as radio-TV service technicians.

* * *

"SILICON ZENER DIODE AND RECTIFIER HANDBOOK" compiled by Applications Engineering Department. Published by *Motorola Inc.*, Phoenix, Ariz. 179 pages. Price $2.00. Soft cover.

This volume is divided into nine chapters and covers the characteristics of silicon zener diodes, comparisons of gaseous tubes and zener diodes, regulated power supplies, surge protection, a.c. and d.c. amplifiers, temperature compensation and impedance cancellation, zener diode applications, diffused-junction silicon rectifiers, and specifications and testing methods.

A table providing electrical characteristics of the firm's complete line of zener diodes is included at the end of the text, making this a complete manual to these components and their application.

* * *

"FILTERS AND ATTENUATORS" edited by Alexander Schure. Published by *John F. Rider Publisher, Inc.*, New York. 84 pages. Price $2.25. Soft cover.

This is Vol. 36 in the Electronic Technology Series and covers filters and attenuators of all types. The author discusses their functions, the variety of types, circuits, and applications. Audio and video filters, wave filters, and specialized filter types are all covered in separate chapters. Both mathematical and narrative presentations are made on each type.

* * *

"TRANSFORMERS" edited by Alexander Schure. Published by *John F. Rider Publisher, Inc.*, New York. 86 pages. Price $2.00. Soft cover.

This 37th volume in the Electronic Technology Series is a basic handbook on all types of transformers as used in electronic equipment. Power and audio transformers are given rigorous treatment while there is a detailed discussion of special devices such as saturable reactors, voltage-regulating transformers, video transformers, pulse transformers and baluns.

* * *

"STEREOPHONIC SOUND" by Norman H. Crowhurst. Published by *John F. Rider Publisher, Inc.*, New York. 133 pages. Price $2.90. Soft cover.

This is a second edition of a basic text originally published in 1957. This volume has been revised and up-dated to include the most advanced state of the stereo art.

Included is comprehensive information on the 45/45 disc, stereo tape and playback units, component performance, and how to select a stereo system best suited to the individual needs of the listener.

HAMFESTS SCHEDULED

THE Southwest Virginia Civil Defense Network is sponsoring its first annual "Lonesome Pine Hamfest" on Saturday and Sunday, July 22 and 23 at the Southwest Virginia 4-H Center in Abingdon, Virginia.

Representatives from five states are expected to attend. One feature of the event will be an all-night marathon on July 22nd on 80 meters.

Complete details on this hamfest are available from the chairman, James M. Cole, K4HRO, 240 Gillespie Drive, Abingdon, Virginia.

* * *

THE Maryland Emergency Phone Net will hold its annual picnic at Braddock Heights, Maryland on Sunday, July 23rd. Braddock Heights is located approximately four miles west of Frederick, Md. on Alt. U.S. 40.

Registration fee is one dollar which includes soft drink tickets for the family. Two door prizes will be awarded and, in addition, a rummage sale and auction will be held. A program has been planned for the XYL's and Junior Ops. Families are asked to bring their own picnic lunches.

The Picnic portable station will be on 3820 kc. along with 2 and 6 meters for the benefit of mobiles.

Further details are available from Henry B. Ray, W3JNX, First Place, Greenwood Acres, Annapolis, Maryland.

* * *

THE East Coast V.H.F. Society, Inc., will hold its Third Annual Old Style Picnic and Hamfest, starting at 10 a.m., on Sunday, August 13th at Saddle Brook Park, Saddle Brook, N.J. (rain date is August 20th). Registration is free, as are picnic, recreational, and parking facilities.

Prize contests, drawings, games, displays of equipment, and other events have been planned for all ages. Food and soft drinks will be available at a nominal charge for those not bringing picnic lunches.

Radio facilities on 2, 6, and 10 meters will be available for general hamming and for talking-in mobileers who may have difficulty finding this well-known recreational spot.

Contact John W. Johnson, W2YIA, 51 Birch Road, Dumont, New Jersey for any additional information required.

—30—

The text is lavishly illustrated and carries an extensive bibliography for those wishing additional information on specific phases of the subjects touched on by the author.

* * *

"SERVICING TRANSISTOR RADIOS" by Sams Staff. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 160 pages. Price $2.95. Soft cover. Vol. 8.

This latest volume in this publisher's series covers 51 transistor radios produced in 1959 and 1960. Sets by *Admiral, Arvin, Continental, Coronado, General Electric, Hitachi, Kowa, Lafayette, Muco, Motorola, Philco, RCA Victor, Realtone, Regency, Roland, Silvertone, Sony, Superex, Toshiba, Truetone, Westinghouse*, and *Zenith* are covered in this volume.

Like the previous volumes, this book carries schematics, dial-cord stringing arrangements, cabinet and chassis photos, alignment instructions, parts lists, and replacement data.

* * *

"TV TUBE SYMPTOMS & TROUBLES" by Robert G. Middleton. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 96 pages. Price $1.50. Soft cover.

This volume contains over 150 photographs of actual TV picture troubles with the author's explanations to help the user identify the tube or tubes causing the trouble. In addition, the text explains what each section of a TV set is supposed to do and the result when it fails its job.

A ten-page tube trouble chart lists the most common troubles, together with the specific tubes that should be replaced to correct that particular fault.

* * *

"RADIO & TV ALIGNMENT HANDBOOK" by Warren J. Smith. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 147 pages. Price $2.95. Soft cover.

Written by a practicing service technician for his fellow service technicians, this is a thoroughly practical handbook to help speed the job of aligning any radio or TV receiver.

The text covers determination of the need for alignment, equipment required, how to set up the equipment, alignment procedures, and evaluating results. Complete coverage of alignment is included—v.h.f. and u.h.f. tuner alignment and adjustment of color TV circuits, as well as AM and FM broadcast receiver alignment.

* * *

"HOW TO SOLVE PHYSICS PROBLEMS" by Edwin M. Ripin. Published by *John F. Rider Publisher, Inc.*, New York. 120 pages. Price $1.80. Soft cover.

This book is designed as a review text for high-school and college physics students and features a "dimensional technique" involving some 200 physics problems which are solved with minimum need for the student memorizing formulas.

There is a comprehensive chapter on electricity and magnetism in addition to six more chapters covering other phases of physics. —30—

1

Sets of the Seventies

Some of the electronic products that technological advance may put in your hands a decade from now.

CREATED last year, the *RCA* Advanced Design Center was assigned the task of exploring future consumer electronic needs and projecting products accordingly. The center consults with technological experts and a panel of authorities in industrial design, interior design, anthropology, and architecture.

Its first eight "Sets of the Seventies" reflect anticipated electronic advances and changes in the way of living. Improved display devices may make possible shallow, large-screen color sets. The unit of Fig. 1 will house an all-band, international stereo receiver on one side. Rotating it on its stand, top to bottom, reveals (inset) an independent, world-wide color TV.

The executive on the go will mix business and pleasure in a single attache case. He can open it (Fig. 2) and insert a pre-recorded tape cartridge for an audio-visual presentation in color. Alone, he can watch TV or taped "movies," listen to radio or taped "records." During the weekend, he can dictate to the "Home-Office Intercom" (Fig. 3), then broadcast the tapes to his secretary's office receiver on Monday. A triumph of miniaturization, the color TV and stereo AM-FM set of Fig. 4 will fit into a pocket for use anywhere.

Other designs include a book-size, TV-radio with clock timer that provides automatic turn-on and program preselection; a receiver that doubles as an audio-visual home intercom (electronic baby watcher); and a thin color set that may be mounted on its own stand furniture-like or hung on a wall. —30—

2▲ 3▼ 4▶

Radio and Electronics Convention in Australia

Five major television manufacturers "Down Under" to spend over $3-million during the year 1961.

SOME indication of the importance of the radio and electronics industry in Australia is provided by estimates of the value of TV and radio tube output for the 12 months which ended June 30, 1960 (the latest period for which official figures are available).

Television began in Australia in 1956. The estimated output in TV for the year was £A45,000,000 ($101-million), and in radio was £A9,000,000 (over $20-million). A recent survey indicates that five major manufacturers planned to spend £A1,400,000 (over $3-million) in TV production during 1961.

Earlier figures for TV sets produced in Australia were 126,000 for 1956-57, 285,000 in 1957-58, 319,000 in 1958-59, and 441,000 in 1959-60. Radio production figures were 356,000 sets, 380,000, 378,000, and 405,000, in the respective years. These figures were quoted at the recent Radio and Electronic Engineering Convention held recently in Sydney, Australia.

The convention was organized by the Australian Institution of Radio Engineers. More than 500 delegates (or about a quarter of the Australia-wide membership of 2200) attended. The Institution began in 1925 with a membership of 100.

More than 100 technical papers were read. Guest speaker was Dr. Rudy Kompfner, Director of Radio and Electronic Research at the *Bell Telephone Laboratories*, New Jersey. Thirty-five organizations and private companies exhibited a range of manufactured products representing the latest scientific advances in radio and electronics.

Also present at the convention were Mr. H. B. Wood, Technical Director of *Standard Telephones and Cables Pty. Ltd.* and Mr. C. W. Davidson, the Australian Postmaster-General. Mr. F. W. J. Orr is the president of the Australian Institution of Radio Engineers.

An exhibition feature was a model of Australia's new radiotelescope, now under construction at Parkes, New South Wales, and second only in size to the giant radiotelescope at Jodrell Bank, England. Its steerable parabolic-reflector antenna will have a diameter of 210 feet and it will stand 200 feet high. The telescope will supplement the radio astronomy observations of the Australian Commonwealth Scientific and Industrial Research Organization's Radiophysics Division at Sydney.

Another prominent display was a demonstration of special electronic test instruments which were designed specifically for use with industrial-television systems. —30—

Within the Industry

(*Continued from page 14*)

tube plant of *Sylvania Electric Products Inc.* in Burlington, Iowa . . . **ALVIN BARSHOP**, sales manager of the *Granco Division* of *DuMont Emerson Corporation*, has assumed the same post with the firm's newly acquired *Telectro Division* and will administer both jobs simultaneously . . . **LESLIE H. WARNER** has been elected president of *General Telephone & Electronics Corporation*, succeeding **DON G. MITCHELL** who has been elected vice-chairman of the board . . . **JOHN A. O'HARA** is the new marketing manager of *Bell Sound Division* . . . **SIDNEY HARMAN** has been appointed executive vice-president of *Jerrold Electronics Corporation* as a result of the earlier merger of *Jerrold* and *Harman-Kardon, Inc.* . . . **BERT GEDZELMAN** has been named national sales manager for *Audio Dynamics Corporation*.

* * *

DR. ALLEN B. DUMONT has been named an honorary member of the American Institute of Electrical Engineers, the highest honor awarded by the worldwide society of electrical engineers.

He is the 48th person to be made an honorary member of the Institute since its organization in 1884. Others so honored include such distinguished scientists as Lord Kelvin, Cyrus Field, Guglielmo Marconi, Herbert Hoover, Thomas A. Edison, Elihu Thomson, and Edwin H. Armstrong.

* * *

REAR ADMIRAL RAWSON BENNET (USN Ret.), formerly chief of naval research, has been elected a senior vice-president of *Sangamo Electric Company* and appointed director of engineering . . . *Oak Manufacturing Co.* has elected **EDWARD D. CHALMERS** vice-president, engineering and **EDWARD J. MASTNEY**, vice-president, advanced engineering and manufacturing . . . **ED WEISL** is the new national distributor sales manager for *United Catalog Publishers, Inc.* . . . Directors of *Hazeltine Corporation* have elected **R. L. BEAM** executive vice-president of the firm. He is executive vice-president and operating head of the *Hazeltine Electronics Division*, largest affiliate of the electronics firm . . . Appointment of **EDGAR POLLACEK** as supervisor of sales for industrial selenium rectifiers has been announced by *Radio Receptor Company* . . . **MICHAEL W. CHITTY** is the new chief engineer for *Reeves Soundcraft*... *Company, Inc.* . . . **LARRY EPSTEIN** has been appointed sales manager for the new commercial sound products division of *Harman-Kardon*. —30—

Series "B+" Circuits

(*Continued from page* 35)

more of the other related stages and can first be recognized through this effect. Because the pattern of such changes depends on the specific relationships among the affected circuits and because this pattern varies with different configurations, a fixed, automatic technique for fault finding is not practical. Understanding how the circuit works is the most helpful starting point. However, tracing what happens in the case of some possible defects is very useful.

If R_2, R_3, R_5, or R_9 in Fig. 5A should open, for example, the current path from "B+" to ground would be interrupted. Both V_1 and V_2 would be prevented from functioning at all. Voltage readings beginning at R_9 and proceeding down through V_2 and then V_1 to ground could isolate the point at which the circuit has opened.

If R_6 in Fig. 2 should open, V_2 would overconduct and increase the voltage at point *B* to a level almost as high as that of the high "B+" line. There would be little or no a.g.c. action and the symptoms might be of the type associated with a.g.c. faults.

If R_5 in Fig. 2 were to open, V_2 would be excessively biased, with its control grid at or near ground potential. This would drastically cut current flow in V_2 and thus also in V_1, through which the same current flows. However V_1, still attempting to conduct properly, would have a lower "resistance" than V_2. As a result, the voltage at point *B* would be much lower than normal.

Resistors R_1 and R_2 in Fig. 3 would affect the 125-140 volt line in much the same way as R_5 and R_6 in Fig. 2 affect the lower "B+." If R_2 were to open (or C_1 were to short), the first noticeable symptom might be that the plate of the audio-output tube would show signs of overheating or internal sparking. Although voltage readings would be different in each case, the grid would be excessively positive with respect to the cathode in either and the tube would overconduct. It is not uncommon for C_1 to become intermittent. This can result in noisy audio and, depending on the stages supplied from the low "B+" line, intermittent video or unstable sync.

In Fig. 4, the audio-output tube will overconduct if the first audio amplifier (V_1) should stop emitting. Symptoms would be similar to those listed for an open R_2 in Fig. 3. In either Fig. 3 or Fig. 4, an overheated rectifier tube can result if C_2 is shorted.

These examples scarcely exhaust all possibilities. If there is one useful, general rule for series-type "B+" circuits, it is this: voltages for any stage in such a system should be measured with reference to the specific "B−" point as it is seen by that circuit. If, after this, standard localization procedures are used, little trouble should be encountered. -30-

Adding a Center Speaker

(*Continued from page 41*)

already exists and no further changes are necessary. Be sure to check the polarity of all three speaker systems. One channel should be the reverse of the other. The polarity of the center-channel speaker can be checked only by experimentation. Try reversing the leads; use the connection which produces the loudest and most uniform sound. An incorrect connection may produce "dead spots," depending on room acoustics.

If sources other than records are used, or the preamplifier employed does not provide electronic phase reversal, or only an in-phase signal can be obtained from two separate power amplifiers, then the following alterations should be made.

This fourth method involves reversing the phase relationship of the push-pull output stage. The following means of making this change will be covered: (1) "Ultra-Linear" and standard push-pull amplifiers *not* employing printed circuits in the power output stage, and (2) amplifiers utilizing printed-circuit power stages.

In amplifiers with conventionally wired circuits, reversal is achieved by merely interchanging the connections at any one of the point-pairs *A-A*; *B-B*; *C-C*; or *D-D*, as shown in Fig. 6. Fig. 6 is a generalized "Ultra-Linear" power stage. If the amplifier being altered is of this type and points *D-D* are chosen, then the connections at *X-X* should also be interchanged. The next step is to interchange the connections at points *E-E*. This is essential because, if omitted, the amplifier may go into oscillation due to the positive, rather than negative, feedback.

In printed-circuit amplifiers, the changes can, in most instances, be made only at points *D-D* (and *also X-X* for "Ultra-Linear" amplifiers). Again, *do not forget* to reverse the connections at *E-E*.

(Editor's Note: Still another method of obtaining an in-phase third channel, but not tried by the author, is by the use of a 1:1 phase-reversing transformer. The basic arrangement is like that shown in Fig. 4 except that one of the 4-ohm outputs is applied to the primary of this transformer. The secondary voltage, reversed in polarity, is then applied to the center speaker in series with the other 4-ohm output. One manufacturer of such a transformer, Electro-Voice, Inc., supplies complete information on the proper interconnections with the unit itself. It is designated as Model XT1 stereo mixer transformer.)

Connecting the Speakers

With these changes the amplifiers are now ready to have the speaker systems re-connected. It will now be necessary to reverse the speaker connections to the newly altered channel, as shown in Fig. 5B. The center-channel speaker system is connected to the 4-ohm taps on each amplifier. Experimentation showed this to give the best balance between Channel A and Channel B in the author's hi-fi system. A level control may have to be placed on the center-channel speaker system or, in some instances, a level control will have to be installed on the left- and right-channel speaker systems rather than on the center channel. This is determined by the amplifiers used, room acoustics, and the speaker-system impedance and efficiency. This can only be determined by experimentation. Any "L-pad" or

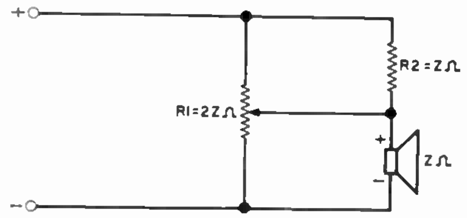


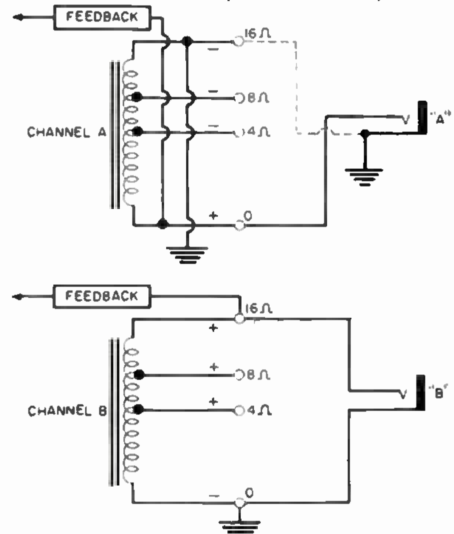
Fig. 7. Simple attenuator pad circuit.

"B-pad" may be used. The circuit for a "B-pad" is shown in Fig. 7.

If earphones are to be used in which a common ground occurs at the earphone jack, then the circuit in Fig. 8 should be used. It is of the utmost importance that the ground connection be properly made. If incorrectly connected, the feedback loop of one channel will be grounded.

The foregoing method was chosen because it did not upset the over-all feedback network of the amplifier and worked for all in-phase sources. The conversion was performed on a stereo amplifier kit. The results were excellent—not only was the stereo listening area increased but the depth of sound was more pronounced, with an improvement in the geometric location of the individual instruments. As expected, the sound spread was very uniform from left, past center, to the right. Anyone who adds a third channel by one of these methods will be well rewarded for his efforts. —30—

Fig. 8. Circuit for stereo earphones. For common-ground connection, only three wires are needed. Without a common ground connection, four hook-up wires are required.



Transistors in Two-Way Radio

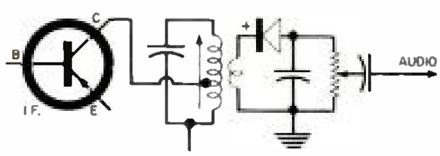
(*Continued from page 55*)

the multiplier tank circuit. Injection of local signal is made into the emitter circuit of the mixer. Capacitive coupling into the base circuit is shown in Fig. 8B. Note that low impedance coupling is achieved by using split-capacitor resonant circuits. Inasmuch as transistor circuits have low impedance inputs, tapped inductors, split capacitors, and low-impedance link coils are common throughout transistor equipment.

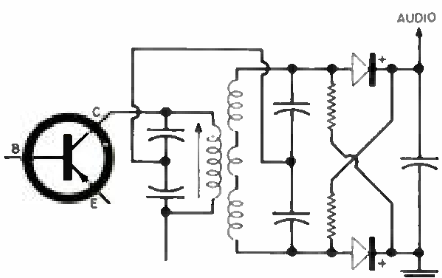
The transistor i.f. stages have the same approximate circuit configuration as that of the mixer except that input and output tuned circuits are adjusted to the intermediate frequency of the receiver.

Demodulators for Receivers

In two-way radio equipment with superheterodyne receivers, semiconductor diodes are used in both AM and FM demodulators. A single diode is used for AM demodulation, as shown in Fig. 9A.



(A)



(B)

Fig. 9. Semiconductor demodulator circuits for (A) AM and (B) FM 2-way radio receivers.

A low-impedance link is used to pick up the AM-modulated signal from the collector tuned circuit of the last i.f. stage.

A semiconductor discriminator is shown in Fig. 9B. The quadrature component is coupled by way of the double-tuned transformer at the output of the last receiver i.f. stage. Observe that the direct-coupled component (no phase shift) is conveyed from the collector of the i.f. stage to the discriminator input by way of the connection between split-capacitor pairs.

Audio stages in transistor receivers are conventional *RC*-coupled grounded-emitter configurations, while the audio-output stage may be either a single-ended or a class B push-pull stage similar to many that have been described in this publication.

In next month's article, we will go into the practical circuits used in commercial two-way radio equipment.

(*Concluded next month*)

Relays in Logic Circuits

(Continued from page 49)

ing on the core. If both windings are identical and wound in the same direction, the result is a two-input *or* circuit in a single relay (Fig. 6B). If either coil is energized, the relay contacts will transfer.

A dual-coil *and* circuit is shown in Fig. 6A. In this circuit, a resistor is added in series with each coil to reduce the current in each below the point where the relay will transfer. However, the fields produced by the coils are additive. Thus, when coil 1 and coil 2 are both energized through the resistors, the total flux will be sufficient to transfer the relay.

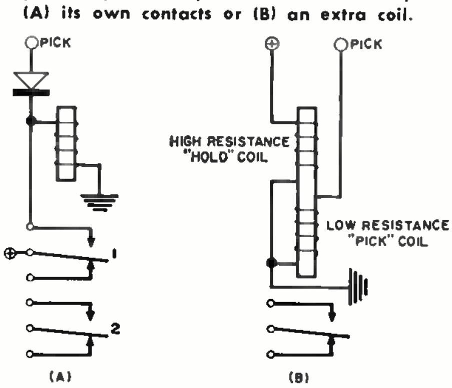
In the *exclusive or* circuit of Fig. 6C, the two coils are connected so that the resulting fields are in opposition. Consequently, if either coil is energized, the relay will transfer; if both coils are energized, their fields will cancel and the relay will not transfer. Other double-coil relay types using non-identical coils will be discussed later.

Diode *or* circuits, perhaps the most familiar of all logic elements, are often the most economical to use. Fig. 7 shows a four-input *or* circuit that uses only one relay and four diodes. A positive voltage applied to any of the four diodes will transfer the relay and produce an output. The diodes serve to isolate the input connections, so that a positive voltage applied to one will not appear at the others. While the example shown uses only four inputs and therefore only four diodes, 10 or 20 diode inputs are not uncommon in practice.

Holding Circuits

A logic circuit is often required to operate with only a short input pulse, but remain active after the pulse disappears. This is accomplished with a "holding circuit." Figs. 8A and 8B show two widely used holding circuits. In the first, a pulse applied to the "pick" connection energizes the coil and transfers the contacts. A voltage is now applied to the coil through contacts 1 and the relay remains transferred. The other pair of contacts (2) operates the output circuit. A diode is included in the pick circuit to prevent the positive holding voltage from appearing on the pick connection while the relay is held. As only a fraction of the current needed to transfer a relay will hold the relay once it is transferred, a resistor may be included in the holding circuit. This has the advantage of reducing the energy that must be dissipated by the coil during the holding period. The result is cooler operation and faster drop-out when the hold voltage is removed.

Fig. 8. Two ways in which a relay can be picked by a short pulse and then held by (A) its own contacts or (B) an extra coil.



The circuit in Fig. 8B uses a double-coil relay. The relay is transferred by a pulse applied to the pick coil and held by the current in the hold coil. If identical coils were used, as in the double-coil relays discussed previously, the hold coil could also pick the relay. However, a much higher resistance coil is used for holding and the current in this coil is not sufficient to transfer the contacts, but only to hold them once they have been picked by the heavier current in the pick coil. A diode is not required in the pick circuit, as no voltage appears across the pick coil while the relay is being held. This circuit gives a fast pick, because the magnetic field in the hold coil aids that in the pick coil, and a fast drop-out because minimum energy must be dissipated when the holding voltage is removed. It also dispenses with the extra set of contacts.

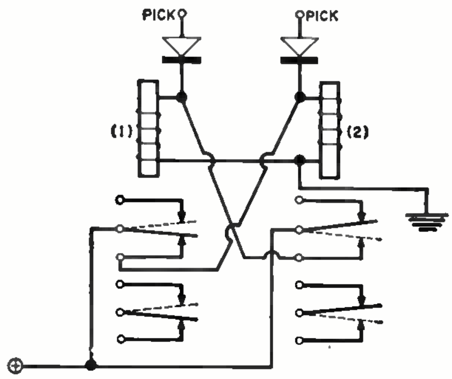


Fig. 9. The familiar flip-flop circuit, widely used in binary counting and other functions, can be made up of two relays.

Holding circuits make possible another relay logic element, the flip-flop, or bi-stable element. This one has two possible states and will remain in one state until a pulse is applied to switch it to the other. The relay flip-flop circuit in Fig. 9 uses two relays, each with a holding circuit wired through the contacts of the other. When relay 1 is picked (broken lines), relay 2 drops and its contacts hold relay 1. When relay 2 is picked (solid-line position), relay 1 drops and its contacts hold relay 2. These are the two states of a bi-stable flip-flop.

Capacitors are often added to relay circuits to introduce a time delay. Two such circuits are shown in Fig. 10. The circuit in Fig. 10A uses a relay, a resistor, and a capacitor to make a free-running (astable) element. The output is a square wave with a frequency determined by the combined *CLR* values. In this circuit, the supply voltage is applied, through the resistor and relay contacts, to the coil and large-value capacitor in parallel.

Since the uncharged capacitor across the coil initially acts as a short circuit, most of the voltage first applied through the upper set of contacts is dropped across the resistor, and the relay is not energized. However, full positive voltage appears at the output.

As the capacitor charges, voltage across the relay coil increases. When it reaches a given level, sufficient current flows through the coil to make the contacts transfer. This disconnects supply voltage from the output, through the lower set of contacts.

With this second condition achieved, the capacitor begins to discharge through the coil. This keeps the relay energized until the capacitor can no longer supply enough current through the coil for this purpose. The holding time is thus determined by the characteristics of coil and capacitor. Contacts are then switched back to the original condition, and the cycle of operation continues as described. The output waveform is shown below.

The delay provided by a capacitor is also used in the circuit of Fig. 10B. In this case, input of brief duration (such as an unwanted transient) cannot pick the relay. When input is first applied, the capacitor, as in Fig. 10A, first acts as a short circuit across the coil, preventing the latter from pulling in the relay at once. After a period of delay (determined by the *CLR* values), the relay will be energized, if an input is

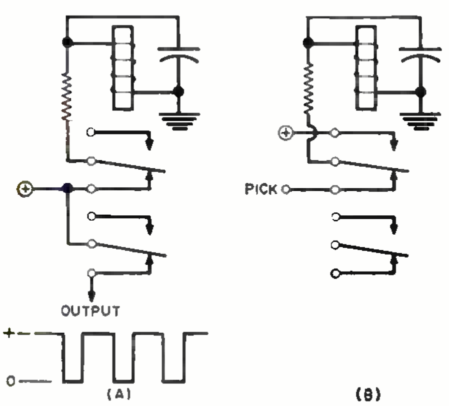


Fig. 10. Delay provided by added capacitor makes more circuits possible. One (A) is a free-running square-wave generator.

still being supplied. Once the relay is pulled in, the holding circuit (voltage applied through the upper contact) keeps it in this condition. This makes it possible to pick a relay reliably through its own contacts. Such capacitor-delayed relay circuits are useful in overcoming timing problems.

Although only the basic relay circuits have been discussed here, they provide the basis for understanding the more complicated ones that may be encountered, which are generally built up from the simple ones. Many electro-mechanical control devices are in use today, and many more will be built in the future before more "glamorous" components approach the economy of relays. –30–

Mac's Service Shop

(Continued from page 52)

pulled the leads from the tube checker. "When we heated the windings, they expanded and shifted enough to remove the short; then the wax set and held the turns in the non-shorting position. Sometimes it will work; other times it won't. Under ordinary circumstances, it's not even worth trying; but in this instance, it will allow the woman to have her all-important radio while we are obtaining a new coil. Be sure and explain the circumstances when you return the set to her. Actually I doubt if the coil would give trouble if we left it in; but to be sure, we'll replace it."

"Say, I couldn't be more surprised if our preacher revealed a knowledge of safe-cracking!" Barney exclaimed as he gave Mac a quizzical look. "How come you know about this sort of thing?"

"During the war a service technician had to learn a great many quick-and-dirty ways of keeping a radio going," Mac explained. "Many parts simply could not be had, and it was necessary to do the best you could in repairing the bad part. I hate to think of all the man-hours expended in trying to find a good way to repair a broken tube filament inside the envelope during this period. Some claimed to have done it, but I was never convinced. It makes me wince to recall some of the service techniques to which we stooped."

"Tell me more. Let's see if I wince," Barney urged.

"Well, we used a neon transformer putting out 5000 volts or so across the ends of an open winding in an i.f. or output transformer to create a visible arc across the broken ends of the winding. This arc could be seen through the wax or the insulating paper and pinpointed the break. If it was located close to the accessible outside end of the winding, we carefully unwound turns until we reached the break, soldered the broken ends together, and then rewound the turns we had removed. When the break occurred near the inside of an output transformer primary, it was sometimes possible to pick out the wire of the winding at a point above the break and make this the new inside terminal of the winding. Of course, this cut an unknown number of turns off the winding and changed the impedance ratio of the transformer; but quite often it worked —after a fashion.

"But let me make it crystal clear things such as these were desperate remedies for desperate situations. There is absolutely no excuse for such sloppy servicing these days. Excellent replacement parts are readily available and should be used. When a defective part is encountered, the service technician should ask himself these two questions: (1) Can this part be repaired so it will be as good as new? (2) If such is the case, will the cost of making the repair be substantially less than the cost of a new part? Unless you can give an unhesitating 'Yes' answer to both questions, the old part should be discarded and a new one installed."

"I read you five by nine," Barney answered; "and along that same line, I might mention a lively discussion I had with a young service technician who happened to be sitting next to me at the baseball game Sunday. He argued that radio and TV sets had lots of parts in them they didn't need. He said, by way of illustration, that he often cut loose shorted bypass capacitors and found the set worked perfectly without them. This was not always the case, he admitted, for sometimes the set would oscillate or motorboat without a new capacitor; but he claimed the more expensive the receiver was, the more unnecessary bypass capacitors and isolating resistors it used. He argued these were put in just to increase the cost of the receiver and said he didn't bother to replace them if he couldn't see anything wrong with the way the set performed without them. I told him I was convinced every part had a job to do and that we always replaced every bad part we encountered. What do you think?"

"You know the answer to that without asking," Mac answered grimly. "Believe me, electronic manufacturers figure their costs right down to the penny, and they don't put in a single half-watt resistor or .05-μf. capacitor unless it contributes something to the performance of their product. It's true that quite often you can cut out a bypass and not notice any difference in the reception of a particular type of program material from a single station at the moment; but if you tune around, you may well find a birdie showing up at some point on the dial that is not heard when the bypass is in place. Or it may be there's a change in tone quality not noticed on voice transmissions but easily apparent in the reception of music. And we both know filter capacitors can do a fair job of bypassing when they're new—and some of the cheaper sets rely heavily on this fact—but when the filters age and their power factor changes, much of this bypassing action may be lost. If paper bypasses are used where they should be, the aging of the filter capacitor will have no noticeable effect on reception until its filtering action is impaired; but if the bypasses are absent, the receiver will become unstable long before this happens, and—"

"OK, OK!" Barney interrupted. "You've made your point. This is a hospital for radio and TV receivers, not a first-aid station. We repair them, not just patch them up."

"I couldn't put it better myself," Mac admitted. "Shall we operate, Doctor?"

—30—

DECAL HINT

By ELWOOD C. THOMPSON

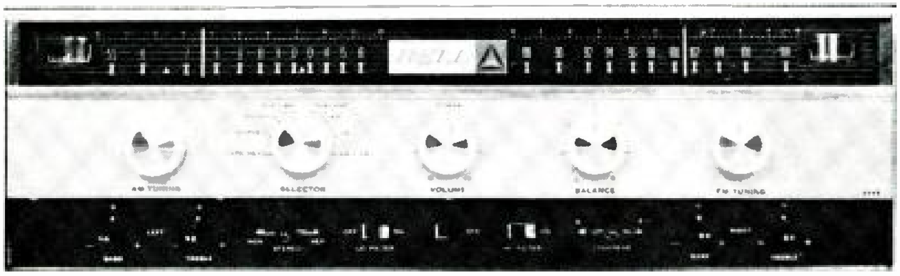
AFTER affixing decals to any finished equipment, apply a few drops of lacquer thinner at the edge of the decal (flowing under the decal to the other edge) to dissolve the film residue base.

This gives the decal an etched, professional appearance. After drying, two or three coats of clear Krylon make decals stand out. —30—

Product Test Report

ELECTRONICS WORLD LAB TESTED

Bell 2445 Tuner-Amplifier
Eico ST96 Stereo AM-FM Tuner
Lafayette KT-174 V.T.V.M. Kit



Bell 2445 Tuner-Amplifier

ONE of the most convenient ways to "go stereo" is by means of a tuner-amplifier combination, such as the *Bell* 2445, which we have just checked. Here in a single integrated component is a sensitive FM tuner, an AM tuner, a stereo preamp, and a stereo power amplifier—all on the same chassis and powered by a single power supply. It is only necessary to add a pair of speakers, a record player and/or a tape machine, and your stereo system is complete. With all the operating controls and switches on a single component that is not much wider and only a little deeper than an individual tuner or amplifier, it would be hard to beat such a setup for operating convenience.

We first checked out the tuner portion of the Model 2445. Both FM and AM sections have separate edge-view tuning meters, slide-rule dials with convenient logging scales, and extremely well-calibrated tuning ranges. The FM circuitry is fairly typical of present high-quality FM tuners. It uses a cascode r.f. amplifier, four stages of i.f. amplification (three of which also serve as limiters), a ratio detector, and a cathode-follower for the audio output. Dial calibration was within .06 mc. at 88 mc. and within .1 mc. at 108 mc. Performance tests were made in accordance with IHFM standards and the following results were obtained:

Usable sensitivity: at 90 mc., 1.8 μv.; at 98 mc., 1.5 μv.; at 106 mc., 1.8 μv.

Volume sensitivity: at 90 mc., 1.0 μv.; at 98 mc., 1.2 μv.; at 106 mc., 1.2 μv.

I.f. bandwidth: 380 kc. at −3 db.

Detector peak-to-peak separation: 510 kc.

Detector linear portion: 350 kc.

A.f.c. pull-in range: +600 kc., −450 kc. at 98 mc.

Drift with a.f.c. on: none discernible.

Maximum audio output: 1.1 volts r.m.s.

Audio response: ±1 db from 40 to 15,000 (limits of our test) of the standard de-emphasis curve.

The AM tuner portion has an r.f. stage, a conventional pentagrid converter, a single i.f. stage, diode detector, and cathode-follower output. Tuner calibration is within 10 kc. at 550, 1000, and 1550 kc. Usable sensitivity is 2 μv. at 600 kc. and 3 μv. at 1000 kc. Over-all audio response is within 3 db out to 5.5 kc. with the whistle filter disconnected and within 3 db out to 3.5 kc. with the filter inserted.

Next, we turned our attention to the audio-amplifier portion of the unit. The circuit is entirely conventional in every respect. A pair of fixed-bias 7189A tubes in both of the output stages is rated by the manufacturer as delivering 22 watts of music power or 20 watts of sine-wave power per channel. The results of our lab tests on one of the two amplifier channels are as follows:

Sensitivity: tape-head or magnetic phono input, 4.1 mv.; ceramic phono input, .21 v.; tuner input, .38 v.; tape amplifier input, .32 v.; all readings required for the 20-watt output.

Frequency response: At the mechanical mid-positions of the tone controls, output was ±1.4 db at 100 and 30 cps, 3.8 db at 10 kc., and −6.1 db at 15 kc. By re-adjusting the bass and the treble controls a reasonably flat response was obtained. This measurement was taken at 2-watts output.

Tone-control range: Bass control range was −5, +4.8 db at 30 cps, and −12.2, +9.2 db at 100 cps. Treble control range was −18, +10 db at 15 kc.

Phono equalization: Output varied from −3.2 db at 30 cps to +3.5 db at 15 kc. A sub-sonic filter is incorporated in the phono preamp to prevent very-low-frequency turntable noises from overloading the amplifier and interfering with the audio response. Separate high-frequency (5000 cps) and low-frequency (50 cps) filters may also be switched in to limit response, if required.

Harmonic distortion: at 1000 cps, .18% at 2 watts, .19% at 15 watts, 1.55% at 20 watts, and 2% at 20.5 watts. At a frequency of 15 kc., .29% at 2 watts, 1.3% at 15 watts, and 2% at 20.4 watts. At a frequency of 100 cps, .67% at 2 watts, .83% at 15 watts, and 2% at 19.6 watts. At a frequency of 30 cps, 1.23% at 2 watts, 2% at 5.6 watts. Note that it was possible to obtain very close to 20 watts output at 2% distortion over a frequency range from 100 cps to 15 kc.

Intermodulation distortion (60 and 6000 cps, 4:1 ratio): at 2 watts (equivalent sine-wave output power), .89%; at 5 watts, 1.28%; at 10 watts, 1.48%; at 15 watts, 2.35%; and at 20 watts, 8.6%. Although these figures appear fairly high, they may simply be the normal result of the amplifier's somewhat limited low-frequency response. Had we used signal frequencies of 100 and 6000 cps, no doubt our IM distortion figures would have been considerably better.

The *Bell* 2445, a compact and convenient component for hi-fi stereo enjoyment, is available for $329.95, complete in a modern enclosure of walnut vinyl-steel. —30—

Eico ST96 Stereo AM-FM Tuner

THE *Eico* ST96 stereo AM-FM tuner, first tuner of the company's new "Medalist" series, combines many of the features of more expensive units with the appeal of a relatively low-cost kit that can be constructed by the novice. The FM i.f. strip and detector as well as most of the AM portion of the tuner are pre-assembled on two printed-circuit boards. Also the FM front end is completely assembled, sealed, and pre-aligned. This means that the only wiring needed is for the operating controls, the audio section, and the power supply. To make up for this, however, a fairly elaborate mechanical arrangement is used for the two traveling tuning-indicator tubes and the dial-cord stringing. The entire construction required a little more than 8 hours for an inexperienced builder. The tuning-indicators with their exclamation-point-like displays that change length when stations are tuned in, double as dial pointers for the two slide-rule dials.

The selector switch on the front panel not only provides for separate FM, separate AM, and simultaneous AM-FM for stereo simulcasts, but it also has a multiplex position. In this position the tuner is set up for use with a separate FM multiplex adapter. The adapter is connected between the tuner's multiplex output jack (wired into the FM detector ahead of the de-emphasis network) and the inputs of the two audio sections of the tuner. In this way the tuner's FM section, two volume controls, audio voltage amplifiers, and cathode-followers are utilized.

The FM front end is very similar to the imported one-tube front end discussed in our article "Don't Dodge the One-Tube FM Front End" by George Philpott in our August, 1959 issue. The version employed in the *Eico* tuner uses a grounded-grid triode section r.f. amplifier coupled to a triode autodyne detector. Hence, a single twin-triode provides r.f. gain, local oscillation, and mixing. A semiconductor diode takes the place of one of the capacitors that tunes the oscillator circuit. By varying the d.c. voltage applied to this diode when a.f.c. is applied, and hence varying its capacitance, effective a.f.c. is accomplished. Even with the a.f.c. disabled though, the amount of drift was found to be very slight. The FM i.f. strip consists of three stages, with the last two doubling as limiters on strong signals. A wide-band ratio detector follows and this feeds a twin-triode audio voltage amplifier and cathode-follower output tube.

The AM portion of the tuner uses a pentode r.f. stage, a pentagrid converter, and a single i.f. amplifier, followed by a crystal diode detector. The detector output is fed through a 10-kc. whistle filter to a twin-triode audio voltage amplifier and cathode-follower. The two i.f. transformers used have two separate secondaries for wide and narrow response. A built-in ferrite-core antenna is included so that it is unnecessary to use an external AM antenna in most locations.

After the entire unit was wired, it was found to operate properly. The manufacturer claims that the pre-alignment should result in satisfactory performance in most locations. However, it is our feeling that an instrument alignment is needed in order to get the very best performance that the circuit can deliver. If the instruments are available to the builder, he can follow the alignment procedure given in the instruction manual. Or it should be possible to have the tuner aligned at the local service shop where the entire job can be done for a reasonable fee.

After we carefully aligned both AM and FM sections of the tuner, we measured its performance in accordance with IHFM standards. Results obtained on the FM section are as follows:

Volume sensitivity (for 20 db reduction in output): at 90 mc., 2.0 μv.; at 98 mc., 1.6 μv.; at 106 mc., 1.6 μv.

Usable sensitivity (for −30 db noise and distortion): at 90 mc., 2.8 μv.; at 98 mc., 2.5 μv.; at 106 mc., 2.5 μv.

Over-all i.f. bandwidth: 280 kc.

Detector peak-to-peak separation: 510 kc.

Maximum audio output: 2.8 volts r.m.s.

Audio response: ±1 db of the standard de-emphasis curve from 40 to 15,000 cps (limits of our test)

Drift: with a.f.c. disabled, 28 kc. during 15 minute warmup. With a.f.c. on, no drift was observed.

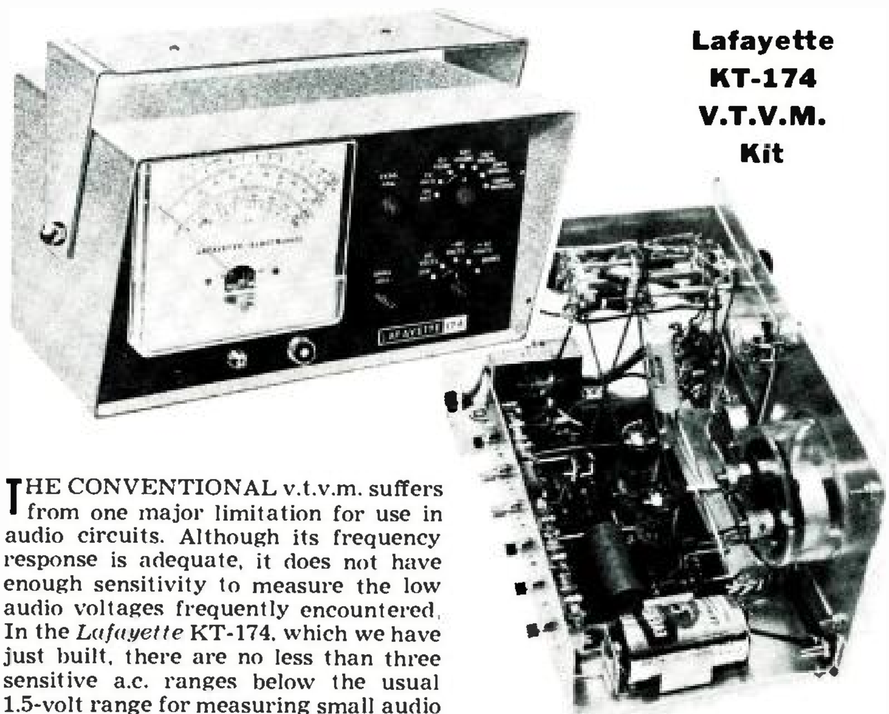
Measurements obtained on the AM section of the Model ST96 tuner are as follows:

Usable sensitivity (for −20 db noise and distortion): at 600 kc., 2 μv.; at 1000 kc., 2.5 μv.

Audio response: ±1 db from 40 to 4500 cps in narrow-band position, and ±1 db from 40 to 8600 cps in wide-band position.

The ST96 is available in an attractively styled gold-satin and brown metal panel and case at $89.95 in kit form and at $129.95, factory wired. -30-

Lafayette KT-174 V.T.V.M. Kit



THE CONVENTIONAL v.t.v.m. suffers from one major limitation for use in audio circuits. Although its frequency response is adequate, it does not have enough sensitivity to measure the low audio voltages frequently encountered. In the *Lafayette* KT-174, which we have just built, there are no less than three sensitive a.c. ranges below the usual 1.5-volt range for measuring small audio signals. These ranges have full-scale readings of 500 mv., 150 mv., and 50 mv., with the lowest division being only 5 mv.

The meter's high sensitivity is achieved by adding a triode voltage amplifier ahead of the usual twin-diode a.c. rectifier that feeds the balanced bridge circuit. Actually the triode, as well as the twin diode, are included in a single tube envelope—a 6BN8 tube. The bridge circuit itself uses a 12AU7, with plenty of inverse feedback for stabilization and linearization. A 200-μa. meter is connected between the two plates of the 12AU7. A selenium-rectifier circuit, with a neon lamp as indicator and voltage regulator, round out the circuit.

In addition to the ranges mentioned above, the meter has the usual 1.5 to 1500-volt a.c. and d.c. ranges, along with the usual resistance ranges. Separate scales are provided for the four lowest a.c. ranges in order to get maximum accuracy, and a convenient db scale is also indicated. The instrument is able to measure peak-to-peak voltages, and separate peak-to-peak scales are provided to read these values.

A v.t.v.m. can be no more accurate than its calibration. This is always a problem with kit-built meters and *Lafayette* has solved it in a rather unique manner. A fresh flashlight dry cell, to be installed later for resistance measurement, supplies the d.c. calibrating voltage. This is used without the necessity of knowing the exact value of the voltage, which may be 1.55 to 1.60 volts, depending on age and brand. This dry cell is connected to the basic meter movement through a precision resistor. The reading obtained can then be related directly to the cell voltage, within an accuracy of 2 per-cent, according to the kit's manufacturer. This value of voltage is then used later in the calibration procedure to set up the proper d.c. reading on the instrument. The flashlight cell supplied with the kit checked out to a value of 1.59 volts using this technique.

The a.c. calibration, unfortunately, is not quite so precise. The power-line voltage is used for this purpose and the constructor is told to adjust the meter reading for 115 volts. (This is the same procedure used for just about all kit v.t.v.m.'s we have encountered.) By using an accurate a.c. voltmeter, this reviewer was able to set up the a.c. scales more closely. In our case, the value of the a.c. line voltage was actually 122 volts. Once the higher a.c. ranges have been calibrated, the secondary voltage of the power transformer is measured (about 130 volts) and applied to a 1000 to 1 divider made up of some of the precision resistors used in the v.t.v.m. Then the low-voltage a.c. ranges are calibrated.

In an effort to improve the a.c. calibration accuracy, a more exact procedure is being suggested in later instruction manuals. Using this technique, the manufacturer claims a calibration accuracy of 2% or better.

Much of the wiring for the kit is printed, but components must be mounted and soldered to the printed board used. No difficulty should be encountered with the construction, but, after all, wiring up a couple of multipole rotary selector switches, eight pots, and a few other miscellaneous parts does take some time. This reviewer completed the whole job, including calibration, in about 14½ hours. The completely detailed and well illustrated assembly manual makes the job simple.

We were quite pleased with the operating and calibrating adjustments. They all worked perfectly and the fact that their final settings were all very close to the mid-settings of the controls speaks well for the design. We were also impressed with the scale-to-scale reading accuracy and with the good line-voltage stability of the instrument. A few spot checks of d.c. and a.c. voltages indicated that the meter met the accuracy specifications of 2% (for d.c.) and 5% (for a.c.).

Since we were particularly interested in the audio response of the meter, we ran a few response curves on it at input voltages of 4 volts, 1 volt, and 100 mv. Response was perfectly flat down to 50 cps. At 30 cps meter reading was down from 1 to 2 db, depending on the value of input voltage, and at 20 cps it was down from 2 to 4 db. In general, as the input voltage was raised, and the range was upped, the low-frequency performance improved. At the high-frequency end, response was perfectly flat up to 200 kc. at 100 mv. input, and up to 50 kc. at 1 and 4 volts input. (Normal tolerances in a frequency-compensating network used may alter these figures somewhat from kit to kit.) Response began to fall off with 100 mv. applied (meter set to 150-mv. range) above 200 kc., reaching a level of −3 db at about 700 kc. On the other hand, with the meter set to the 1.5- to 5-volt ranges to measure 1 and 4 volts, the reading started to rise above 50 kc., reaching a response of +3 db at about 700 kc. We checked response only out to 1 mc.

All in all, the KT-174 has the quality and versatility to make it a very worthwhile addition to any electronics bench. The kit is priced at $39.95, with multipurpose probe and test leads. —30—

W90R98083

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This question is often asked of us by subscribers to Electronics World. You can check the expiration date of your own subscription by reading the code line on the mailing label of Electronics World as follows:

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R980 = (Filing instructions for our use only)

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Reducing Ignition Noise

(*Continued from page* 38)

0.001-μf. ceramic unit, which has very low inductance.

An even better arrangement is to use coaxial capacitors. Instead of conventional suppressor capacitors (C_2 of Fig. 1 and C_3 and C_4 in Fig. 2), coaxial types may be substituted. A coaxial capacitor is a feedthrough type, as shown in Fig. 4C. The lead to the "hot" primary terminal of the ignition coil, for example, is removed and connected to terminal "A" of the capacitor. Terminal "B" is connected to the ignition coil. The current flows through the capacitor from "A" to "B" *via* a conductor which is internally connected to the ungrounded electrode of the capacitor. The grounded electrode is connected to the shield can of the capacitor. Thus, the capacitor is shunted across the circuit. A coaxial capacitor is designed to have very low inductance and thereby effectively passes high-frequency r.f. to ground.

Bonding & Shielding

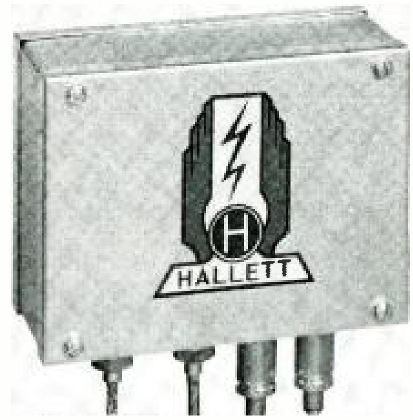
If all of these measures do not reduce noise adequately, try bonding the hood to the firewall and the tail pipe to the car's frame, using one-half-inch wide tinned copper braid.

It may also be necessary to shield the leads between the regulator and the generator, grounding the shield to the generator frame. Or, existing wires may be replaced by shielded cable with inner conductors of adequate size and insulation for the voltage to be carried.

Shield and filter for ignition coil.

Tire static may be eliminated by blowing static powder (*G-C* and other brands) into the tires, using the injector provided with the kit. Wheel noise can be eliminated by installing springs under the hub caps to ground the axle to the wheel. Such springs are available at radio parts jobbers.

If all these measures fail to reduce noise to a sufficiently low level, a shielded ignition system can be installed. Available in kit form from *Hallett* and others, the system includes shielded cables to replace all the ignition wiring plus shields for the ignition coil, distributor, the spark plugs, and the regulator. A kit for a typical car costs about $50.00 and is available from those



This regulator cover provides shielding and filtering. Note 2 coax feedthroughs.

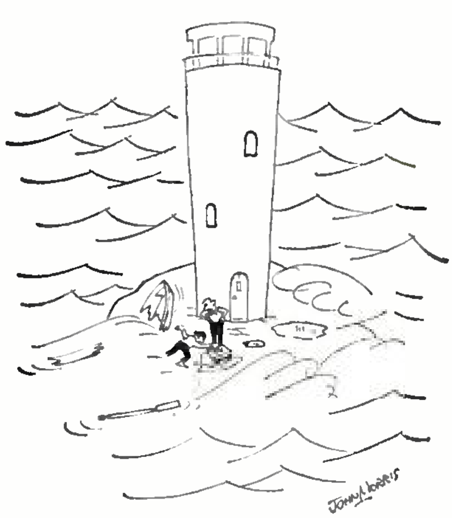
of the larger electronic parts dealers who have industrial departments. Such shielded systems are widely used in military and public-safety vehicles.

To determine if your car needs noise suppression, or to determine if the elimination methods have been effective, turn on the CB set (unsquelched) and listen to the noise with the engine on and the car moving. Then stop the car and turn off the engine and note the difference in background noise level. The most effective test is run when receiving a very weak radio signal.

Although effective noise suppression may take some time and trouble, the results are worth the effort. —30—

TUBE INDEX FOR SECO 107 TESTER

A NEW, 70-page manual, thumb-indexed for quick reference, has been issued by Seco Electronics, Inc. for its Model 107 tube tester. The up-to-date reference lists all domestic, industrial, and foreign tube types. The earlier chart for this tester, FC-3, was designed to fit into a metal list finder. Having outgrown this format, the new index, FC-4, is bound into a 13-ring plastic binder so that it will lie flat when opened to any page. Price of the 1961 index is $2.00. For further information, write Seco Electronics Inc., 5015 Penn Avenue South, Minneapolis 19, Minnesota. —30—



"What kept you?"

Regulator for Alternator

(*Continued from page 60*)

through two grommet holes in the case to insure ambient temperature sampling near the battery where this unit is located.

Testing & Adjustment

Operational testing and coarse adjustment can best be done on the bench before the unit is mounted in the vehicle. Referring to the schematic (Fig. 3), break the lead at point "A" and temporarily connect the sensing-amplifier portion on the left to the output field terminal of the regulator. The circuit resulting from this connection is nothing more than a normal transistor power-supply regulator. Apply +16 to +20 volts d.c. to the ignition terminal. This may be obtained from a battery eliminator or suitable battery combination capable of carrying a 3-amp load. Be sure to observe proper polarity. The output field terminal should be loaded with a 15-ohm, 20-watt resistor to ground.

Monitor the output voltage with an accurate d.c. voltmeter. A meter of the expanded-scale type would be most useful. At room temperature (70 degrees F) a range of from 13 to 15 volts output can be obtained from the extremes of the pot. Adjust the pot for 14 volts after operating the unit under a 15-ohm load for 10 minutes. As a check on regulator gain, reduce the load to 5 ohms and then remove entirely. Output voltage change under these two load conditions should be undetectable on a normal d.c. voltmeter.

For those interested in checking temperature shift, place the unit (with 15-ohm load) in a closed cardboard box and after diligently applying the wife's hair dryer, the output voltage should drop to about 13.9 volts at 95 degrees F. Or, take the unit outdoors at a temperature of 48 degrees. The voltage should be about 14.1 and at 25 degrees F it should read 14.2.

Testing completed, it is now simply a matter of returning the circuit to its original configuration and mounting the unit in the vehicle. The pot should not be disturbed, however, until final checks are made. The ignition and field leads are the only connections other than a good frame ground, which is essential for both regulator case and heat sink. This is best obtained near the base of the existing electro-mechanical regulator which may be left in position for contingencies. The only remaining construction point is the mounting insulation of V_3 and V_4. Thermal conduction from V_4 to the heat sink can be insured by using silicon grease on both sides of the insulating mica.

Once installed, battery voltage and regulator-area temperature should be monitored while the engine is started and run at fast idle for a period of 10 minutes. Battery or regulator input voltage should then be trimmed by pot R_2 to the following values, depending on temperature: 95 degrees F = 13.9 volts; 70 degrees F = 14 volts; 48 degrees F = 14.1 volts; and 25 degrees F = 14.2 volts. Since *Chrysler* allows a ±.3-volt tolerance on these readings, a higher adjust ment within tolerance would be both permissible and desirable in winter.

There are many operational advantages to be gained from this alternator-regulator combination, most of which will be appreciated by the amateur and commercial mobile radio operator. Although not yet completely proved out by field use, longer lamp and tube filament life should be expected, along with less battery "thirst" and improved distributor-point life. These advantages all result from the ability of the solid-state regulator to hold down alternator voltage to specification under turnpike cruising conditions. With nothing more than the car's ammeter, and all alternator-equipped cars have them, it is quite easy to recognize the precise control that the transistorized voltage-regulator has over battery voltage. -30-

TURKEY RUN V.H.F. PICNIC

THE Wabash Valley Amateur Radio Association will again sponsor the Turkey Run (Indiana) VHF Picnic on July 30th, as it has for the past 13 years.

Contact either Ken Mier, K9EFO, 2020 Liberty Ave., Terre Haute, Ind., or Charles Hoffman, W9ZHL, for full details on the event. -30-

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10 easy-to-construct radios described in this new book covering the field thoroughly and completely, progressing in complexity from the simple crystal detector to the superheterodyne receiver. Clearly and fully illustrated. $3.85

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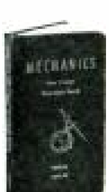
Thirteen articles from **Radio Electronics** which together explain how to make machines that carry out arithmetical operations, solve problems, etc. Relays, tubes and various devices may be used. $2.20



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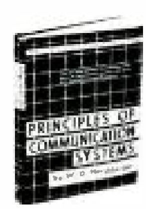
2702 INTRODUCTION TO ELECTRONIC ANALOG COMPUTERS, Warfield

This is the book on computers for professionals engaged in engineering research and development. Simple signal flow graphs stress the topological aspects of analog computers. Basics of the subject and their application. $6.00



3124 PRINCIPLES OF COMMUNICATIONS SYSTEMS, Hershberger

This book explains the characteristics of channels useful in communication — and describes human and other factors that determine the design and limit of any given system. Three kinds of systems are considered in detail: (1) audio systems, (2) television, (3) radar. $8.00

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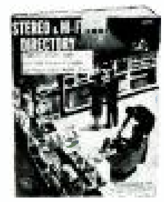

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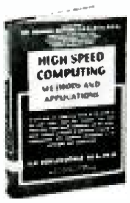

2703 HIGH SPEED COMPUTING, Methods and Applications, Hollingdale
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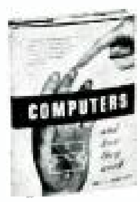
2710 A PICTORIAL MANUAL ON COMPUTERS, Berkeley and Assoc.
Computers and their internal parts in pictures, designed to show you what the thinking machines are and how they are made. $1.25

2711 LINEAR PROGRAMMING AND COMPUTERS, Davis
This book is the ideal introduction to linear programming, explaining the motivations and illustrating them by the techniques. Offers a good start in the field. $1.20

2006 ELECTRONIC EXPERIMENTER'S MANUAL, Findlay
With a few dollars worth of basic tools and this book to guide you, you can explore the wonderworld of electronics experimentation more completely than ever before. 10 big sections, including exciting projects you'll build and use. $4.95



2007 COMPUTERS AND HOW THEY WORK, Fahnestock
A fact-filled guidebook to electronic computers. Covers the history of computers and explains the workings of every major computer system ever used. Must reading for career-minded students and electronics pros who want a more complete knowledge of this important field. $4.95

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New Products and Literature for Electronics Technicians

Additional information on the items covered in this section is available from the manufacturers. Each item is identified by a code number. To obtain further details, simply fill in the coupon appearing on page 112.

SOLDERING GUN HOLSTER

1 **General Electric Company** has added a "holster" type soldering gun holder to its line of service aids especially designed for the radio and television service technician.

The holster will accommodate all popular soldering guns. It can be mounted under a shelf or cabinet, at the edge of a service bench, or on a pegboard tool rack. When mounted on or near the bench, it will serve both for permanent storage and as a convenient out-of-the-way spot to house the gun between soldering operations.

Used in this fashion, the holder reduces bench clutter. It keeps the soldering gun off the work bench and out of the way—thus protecting hands, wires, diagrams, and tools from burns. The holder is formed of aluminum rod. Two clamps and screws are supplied with the holder for mounting.

LEAD-IN WIRE DISPENSER

2 **Saxton Products, Inc.** is now packaging an improved TV antenna lead-in in a durable, self-measuring storage carton which leaves no loose ends to waste, no strands to fall, and no under- or over-estimation of the amount of wire required.

Named the "Lifeline," the unit dispenses 100 feet of wire and also measures it, using a 12" rule imprinted along the edge from which the wire feeds. The extra heavy cardboard of the dispenser is designed to withstand rough handling and an extra slot near the wire feed allows wire to be looped for easy finger pull. The 13" x 13" x 3/4" package is designed for convenient storage.

VOLT-OHM-MILLIAMMETER

3 **The Triplett Electrical Instrument Co.** is now offering a new v.o.m. as its Model 800. Featuring 70 ranges, the new instrument provides maximum reading accuracy by virtue of its longer mirrored scales.

Frequency compensation is provided from 40 to 20,000 cps for more accurate reading at audio frequencies; overload protection is included; sensitivity is 20,000 ohms-per-volt d.c. and 10,000 ohms-per-volt a.c. The large meter has a crystal-clear, shatterproof plastic front and incorporates a self-shielded, high-flux bar-ring magnet for increased ruggedness.

HIGH-VOLTAGE PUTTY

4 **Colman Electronic Products** has developed a high-voltage putty which is especially designed to repair and rebuild tires on flyback transformers. This service product can also be used to stop arcing in yokes, high-voltage cages, and many similar places. Application is made by simply molding the flexible material into and around the area to be insulated. The company claims that the putty will not crack or shrink with age but will continue to protect against corona and arcing.

SINE/SQUARE-WAVE GENERATOR

5 **Paco Electronics Company, Inc.** has recently introduced a combination sine and square-wave generator as the Model G-34.

Covering the range from 6-750,000 cps, the unit provides complete audio signal facilities for a variety of test situations. There is no need for separate generators to attain extensive frequency coverage and the dual-waveform function. Working in conjunction with a scope, it shows at a glance the over-all response characteristics of the amplifier under test.

SOLDERLESS TERMINAL TOOL

6 **Hunter Tool** is now offering a single hand tool that cuts solid or stranded wire, strips off the insulation, and crimps on solderless terminals. The tool is made from spring steel and the cutting edge on the tool is ground. There is a sliding setscrew on one handle of the tool that can be used when a particular setting is desired for continuous stripping of a certain size wire.

Designated as the #9900, the unit will handle wire sizes from No. 22 through No. 10 and will crimp No. 12 and No. 10 size wires.

TV-FM SIGNAL AMPLIFIER

7 **Winegard Co.** has introduced a home TV-FM amplifier with gain-control switch which permits the TV set owner to vary the power of the signal received. This makes it possible to use the amplifier in both fringe and close-in areas.

Known as the "Booster-Pack," the unit includes 300- and 75-ohm outputs, a.c. receptacle for TV or FM sets, and full a.c. chassis that is completely shockproof. The amplifier has a flat gain of 16 db on the low band and FM and a flat gain of 14 db on the high band. It will drive up to six TV sets with 8-db gain for each set.

PEN-SIZED SIGNAL TRACER

8 **Don Bosco Electronics, Inc.** is now marketing its new "Stethotracer," a self-contained, transistorized pen-sized signal tracer.

In the absence of a scope, any low-level microwatt audio or modulated r.f. signal can be detected or demodulated then highly amplified (approximately 1000 times) and reproduced through an earphone device at the output stage.

The unit can be used for troubleshooting all types of radios, hi-fi, phonos, p.a. systems, tape recorders, TV sets, etc. It locates hum, oscillations, ground loops, and breaks in printed-circuit boards. It comes complete with earphone, cord, plug, three attenuator probes, one r.f. detector modulator, interchangeable probes, ground clip lead, and battery.

AUTO RADIO CONTROL KIT

9 **Centralab** has packaged 24 most frequently used replacement auto controls into a single, compact auto radio control kit which has been designated as ACK-100.

The units are all exact replacements and are housed in a steel-shelved cabinet that comes with the assortment. The bulk of the controls in the kit are for **Chevrolet, Ford,** and **Plymouth** radios. Also included are replacements for **Automatic Universal** radios used in many American and foreign cars.

LOW-COST DEPTH SOUNDER

10 **Raytheon Company** has introduced a new low-cost depth sounder as its Model DPD-100. Designed to operate from the boat's 12-volt battery, the unit utilizes a flashing red light to indicate water depths from 2 to 100 feet. Secondary scale markers on the dial permit second-revolution readings, doubling the effective range of the unit.

To minimized installation space, the electronic power unit is packaged separately from the indicator. The indicator is just 5⅝" in diameter and 3½" deep. It is hung in a trunnion mount for tilting to any convenient viewing angle. The unit operates on a frequency of 200 kc. and sends out 1200 probing pulses a minute.

SILICON SOLAR CELLS

11 **International Rectifier Corporation** is now offering a new line of silicon solar cells with coversion efficiencies as high as 13 per-cent. These efficiencies are the result of a new collector strip process developed by the company. The cells are now being manufactured with a number of secondary collector strips protruding from the main or primary strip, thus affording better collection of the current from the active cell area.

The new cells, known as "gridded" cells because the collectors form a grid network over the active area of the cell, provide higher operating voltage and lower impedance, resulting in an increase in cell output power up to 20% under given light and load conditions.

SEALED SCHEMATICS

12 **Kenmore Sales Company** is now offering a service to the electronics industry which consists of laminating schematic diagrams to a plaque to provide an indestructible surface which is

impervious to all kinds of stains, abrasions, weathering, yellowing, moisture, etc.

According to the company, there are certain limitations as to the type of paper which can be preserved but no limitation on the size of the wiring diagram, instruction sheets, or parts lists which can be handled.

COLOR CRT BRIGHTENERS

13 **CBC Electronics Company, Inc.** has added two different color picture tube brighteners to its line.

Model CB-2 is a deluxe unit enclosed in a brown metal hammertone case. This unit has a heavy-duty transformer and provides variable voltage control. The Model CB-1 is an economy model for a color picture tube with a fixed voltage output.

RADIATION SURVEY METER

14 **Anton Electronic Laboratories** has recently introduced a new, portable transistorized alpha-beta-gamma meter which is designed to

double as a laboratory and field-survey unit in the 0-50 milliroentgen-per-hour range.

The Model 701 is powered by five conventional 1.5-volt flashlight batteries. The power supply is regulated by a corona discharge VR tube. No warm-up is required and the instrument will operate continuously for 100 hours without need for recalibration or battery change.

The meter is available with two interchangeable probes. The beta-gamma probe consists of a thin-wall Geiger-Mueller tube; the alpha-beta detector has a mica end window. Stainless steel and halogen quenched, both probes are equipped with coil cord cable and jacks. Both meter and headphone monitoring is provided.

REPLACEMENT KIT

15 **Semitronics Corp.** is now marketing a kit of eight U.S.-made transistors and diodes designed to replace more than 95% of the semiconductors used in Japanese and other foreign-built radios.

Kit No. 8JP includes individually tested components plus a complete replacement and interchangeability chart, all housed in a sturdy reusable plastic container. Semiconductors include audio output, detector diode, oscillator mixer converter, i.f. amplifier, audio drive detector, a.v.c. diode, and audio power components.

CONSTANT-VOLTAGE TRANSFORMER

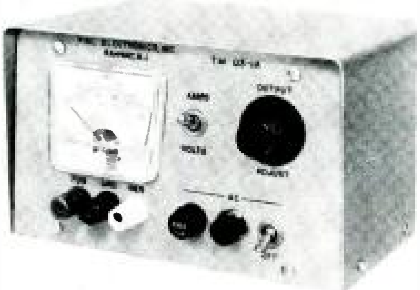
16 **Permavolt Transformers, Inc.** has announced production of a new constant-voltage transformer which has been especially designed for close control of filament, plate, and transistor voltages.

When used in d.c. power-supply applications, the new design is said to offer advantages of reduced filtering cost and size. Output voltage tolerances for input line variations of ±15% are ±3% for standard models. Output tolerances as low as ±½ of 1% can be supplied on a custom basis.

TRANSISTORIZED POWER SUPPLIES

17 **PRL Electronics, Inc.** is now featuring a new line of low-cost transistorized power supplies which is currently being offered in three models.

Featuring line regulation of ±0.1%, load regu-



lation of 0.2% and 1 mv. r.m.s. ripple, the units are housed in transformer-type cans 8½" wide x 5" high x 7" deep. The Model TM-03-1A provides selection of four output voltage ranges 6 volts @ 1 amp, 12 volts @ .5 amp, 18 volts @ .35 amp, and 28 volts @ .25 amp. The Model TM-03-20 is rated for 5 to 32 volts d.c. continuous adjustment at 0 to .25 amp. The Model TM-03-50 is rated at 0-36 volts d.c. continuous adjustment at 0 to .5 amp.

All models contain a single 2% full-scale-accuracy meter to monitor either voltage or current.

DEFLECTION YOKES

Stancor Electronics, Inc. has announced the availability of two new deflection yokes which are exact replacements and require no circuit revisions or replacement of network components. All network components are wired into the yokes.

The Model DY-13A is an exact replacement for **Motorola** Nos. 21D733239 and 24K735873 used in 36 models and chassis. It is a 90-degree yoke with a 24-mhy. horizontal inductance and a 3.3-mhy. vertical inductance. Horizontal resistance is 31 ohms and vertical resistance is 3 ohms.

The DY-15A is intended to replace **Admiral** Nos. 91D117-1 -2 03 used in 269 models and chassis. The unit is supplied complete with a thermistor wired between the vertical coils. It is a 100-degree yoke with an 18.6-mhy. horizontal inductance and a 11.8-mhy. vertical inductance. Horizontal resistance is 35 ohms and vertical resistance is 13.8 ohms.

PORTABLE TUBE CHECKER

18 **GC Electronics Co.** has announced a portable tube checker which will test over 99% of all radio-TV receiving tubes dynamically with just six sockets. In addition it tests picture tubes,

all types of transistors for leakage and power gain, and radio batteries under full load.

According to the manufacturer, it will accommodate new tubes without adding or changing sockets, requiring only a simple chart addition (new charts will be issued as needed).

The tester measures 17" x 6" x 12" and weighs 16 pounds. It comes complete with a TV picture tube adapter.

REPLACEMENT I.F.'S

19 **Vidaire Electronics Mfg. Corp.** has available a complete line of i.f. transformers and oscillator coils for miniature and subminiature type transistor sets. Available are four models in the ¼" x ¼" size and four models in the ⅜" x ⅜" size, comprising the input, interstage, output, and oscillator transformers. All models are completely shielded and are iron-core tuned.

According to the company, these new transformers plus the ½" x ½" units already in the line, will replace approximately 85% of all miniature and subminiature i.f. transformers in use today.

QUICK ANTENNA ASSEMBLY

20 **Tricraft Products Corp.** has developed a new method of quick assembly for outdoor antennas which permits the antenna to snap open in full position without use of wingnuts or screws.

The "All-Snap" feature involves tempered steel spring clips to snap all elements firmly into position in less than a minute. The units stack easily for deep fringe and problem areas. The new "All-Snap" feature is being offered in all models—conical, piggy-back, yagi, FM, turnstile, in-line, and flying-arrow antennas.

FILTERED 12-VOLT D.C. SUPPLY

21 **Electro Products Laboratories** is now marketing a low-ripple, filtered 12-volt power supply which has been specifically designed for servicing

mobile electronic equipment and to serve as a shore d.c. power source for boats.

The Model PS-30 is nominally rated at 12 volts and features ripple of less than 1 per-cent at 30 amperes. Operating on 117 volts, 50/60-cycle input, this unit provides an output current of 30 amperes when operated continuously and up to 50 amperes in intermittent service.

TV REPLACEMENT CONTROLS

22 **Clarostat Mfg. Co., Inc.** has come out with a new line of TV replacement controls which has been tradenamed "Uni-Fite." This new line

supplements the firm's present line of controls by providing additional dual concentric assemblies with a minimum of basic component parts.

The new units are designed for field assembly in minimum time. The assembly is permanently locked together automatically using no tools. Over 200 different replacement controls for TV, radio, and car radio can be assembled from an assortment of 35 rear units, 30 front units, 3 switches, and a selection of shafts.

MINIATURE RADAR DISPLAY UNIT

23 **Westinghouse Electric Corporation** has demonstrated a miniature radar and television display device having roughly the shape, size, weight, and convenience of a telescope. Nicknamed the "Private Eye" because its display is viewed by but one person at a time, the unit is intended as a display device for radar installations

in private aircraft and boats where space requirements and equipment costs are critical.

The essential element of the unit is a high-resolution cathode-ray tube seven inches long whose 0.60-inch-diameter screen is observed through a magnifying eye piece. Because of the ten-fold enlargement that results, the unit is equivalent in function to a six-inch screen observed from a distance of ten inches, according to the company. The complete assembly is 8½ inches long and weighs 20 ounces.

GARAGE-DOOR OPENER KIT

24 **Heath Company** is now offering an electronic garage-door opener in kit form as its GD-20. The easy-to-assemble receiver, transmitter, and mechanism can be installed on any overhead track-type garage door up to 8 feet high. A "high power" transmitter and receiver of special design prevents accidental operation. A foolproof safety device automatically disengages the door upon meeting any obstruction.

The transmitter mounts under the hood of the car; the push-button mounts under the instrument panel; and the antenna mounts under the

car with no drilling. The receiver mounts on the garage mechanism which requires only 2½" clearance above the highest point of door travel.

The mechanism also includes a light which turns on automatically when the door is opened and remains on several minutes after the door closes.

SEMICONDUCTOR TESTER

25 **Molecular Electronics, Inc.** is now marketing an in- or out-of-circuit tester, capable of measuring the salient semiconductor characteristics, as its Model ICT-100.

The new unit will handle transistors, diodes, and germanium or silicon rectifiers and provide information on shorted, open, or leaky components. It will also measure the characteristics of a replacement semiconductor device without the necessity of soldering the device into the circuit.

A direct-reading dial gives clear indication of the condition of the device under test in virtually every common type of circuit.

IGNITION TIMING LIGHT UNIT

26 **Heath Company** is now offering a new ignition timing light accessory, the ID-11, which has been specifically designed for use with the firm's IO-20 ignition analyzer. The accessory plugs directly into the IO-20 and produces a bright white light that shows timing marks even in brightly lighted areas.

The ID-11 has a speed range of 0-1250 flashes per minute (0-2500 rpm for 4-cycle engines of current conventional automobiles). It is housed in a hard rubber pistol-grip case with a 10-foot cable. Measurements are 6" x 7½" x 2". The ID-11 is being offered in both kit and factory assembled versions.

HI-FI—AUDIO PRODUCTS

RANDOM NOISE GENERATOR

27 **H. H. Scott Inc.** has introduced a random noise generator, the Model 811B. This new instrument is a convenient source of "white noise"

for a number of laboratory applications including acoustic and psychoacoustic measurements; measurements on acoustic materials, rooms, and transducers; high-intensity noise and vibration testing; balancing paging and music systems; random stimulation of analogue computers; production testing of transducers, filters, loudspeakers, and enclosures; and calibrating of sound measuring equipment.

The unit incorporates an exclusive internal pink noise filter which gives equal noise power per octave from 20 to 100,000 cps. Output voltage on the pink noise range is 1.5 volt r.m.s. and 2.5 volts on all other ranges. The 811B covers the frequency spectrum from 2 cps to more than 1.5 mc. There is low-output impedance on all ranges.

UNIVERSAL PLUG-IN CARTRIDGE

28 **CBS Electronics** has announced the addition of a "universal" plug-in cartridge to its audio component line.

Designed to play stereo, mono LP, and 78 rpm records with equal fidelity, the CBS-1DS is of the flip-under type of construction and makes use of a 0.7 mil stylus when playing either stereo or LP records and a 3.0 mil stylus for 78 rpm discs.

Easy replacement is one of the special features of this new cartridge. The entire assembly can be removed and a new one plugged in without the use of tools. The active element is a high-output ceramic transducer which is unaffected by either temperature or moisture. The Model 1SS is equipped with sapphire styli while the Model 1DS comes with diamond/sapphire styli.

STYLUS ALIGNMENT TESTER

29 **Prestige Products, Inc.** has developed a unique instrument which simplifies and assures accurate stylus alignment and checks proper tracking angle and overhanging.

Known as the "Stereo-Stylusmaster," the new unit provides an inexpensive way to control: distortion (both electrical and mechanical), crosstalk (channel separation), stylus and record wear, shatter (ability to track heavily recorded passages), and groove jumping.

Instructions for operating the instrument are included in each package.

MONO TAPE RECORDER

30 **Superscope Inc.** has added the **Sony Model** 101-SLO to its line specifically for those requiring increased playing and recording time of their recorders. Operating at 1⅞ and 3¾ ips speeds, the unit is especially suitable for students, lecturers, and businessmen. It features a.c. transistorized operation, dual-track mono recording and playback, a vu meter, tape lifters, and comes with a dynamic microphone.

COMPACT FM TUNER

31 **Allied Radio Corporation** is now marketing a compact, moderately priced FM tuner as the "Knight" Model KN-141.

The circuit includes a bar-type 6FG6 electronic tuning eye indicator and a.f.c. Local reception is provided with a built-in line-cord antenna while terminals are included for connecting an external antenna if required. The unit measures only 2⅝" high, 9¾" wide, and 7⅜" deep. The circuit features a two-stage, grounded-grid r.f. amplifier and ratio detector. Sensitivity is 4 μv. for 20 db of quieting. Audio output is approximately 0.55 volt. Amplifier, tape recorder, and multiplex outputs are included.

TRANSISTORIZED RECORDER

32 **Stancil-Hoffman Corporation** has recently introduced a completely transistorized and improved version of its "Minitape M-5" as the "Minitape M-9."

The new unit weighs only 13 pounds complete in its sturdy, watertight aluminum case. All mechanical and electronic components as well as batteries are housed in this single case, which measures 9" x 12" x 5".

The recorder operates at 7½ ips with 3¾ or 1⅞ ips speeds available on order. Response is 70-10,000 cps ±3 db. The standard model is full-track width but half-track and stereo are available on special order. A single bar knob establishes play, rewind, and mechanically interlocked record. External cabinet controls include start-stop push-button and remote control. Input impedance is 50 ohms.

TAPE CARTRIDGE RECORDER

33 **Bell Sound Division** has demonstrated a new tape cartridge recorder, no larger than a woman's vanity case, that plays and records stereo and weighs less than 18 pounds.

Currently the company is showing three models: Model 601 is a complete monophonic record/playback machine; the Model 602 is equipped for stereo recording and playback through a second amplifier-speaker system; while the Model 603 is completely self-contained and records and plays stereo through its own built-in stereo amplifier. The second speaker, contained in the unit's removable lid, connects to the master unit by an 8-foot extension cord. Two microphones are included with this model.

MULTIPLEX ADAPTER

34 **Fisher Radio Corporation** has announced the availability of the MPX-100 multiplex

adapter—a completely self-contained and self-powered unit.

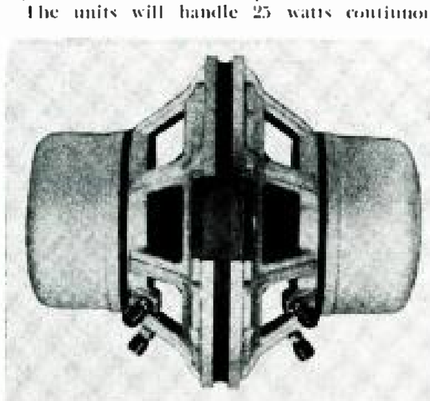
Designed to be used with all of the company's tuners and receivers as well as other tuners and receivers employing FM wideband design and multiplex output facilities, the new unit is made for plug-in installation.

A special circuit feature, the "Stereo Beacon," indicates automatically whether or not the station tuned is broadcasting in stereo.

MATCHED STEREO SPEAKERS

35 **Wilder Engineering Products** has announced the availability of a twin stereo speaker set, Model #808-A. The set consists of two 8" units which are carefully matched and then sealed together for the customer's protection.

The units will handle 25 watts continuous



program material and cover a range of 30-17,000 cps. Resonance is 41 cps and impedance is 8 ohms.

COAX STEREO EARPHONES

36 **Superex Electronics Corp.** has recently introduced a stereo earphone unit which employs separate woofer and tweeter reproducers in each phone and features an adjustable crossover network.

The Model STM phones have a range of 20-20,000 cps and although designed specifically for stereo listening in the home, can be used in tape monitoring, silent-instrument practice, audio analgesia for dental surgery, studio monitoring, etc.

AM/FM TUNER KIT

37 **Heath Company** is now marketing a medium-priced AM/FM tuner in kit form as its Model AJ-11.

The new unit has separate magic-eye tuning indicators which permit accurate tuning of both AM and FM stations. There is a three-position a.f.c. switch, an AM fidelity switch, plus individual flywheel tuning for both AM and FM.

While the built-in AM rod antenna and FM line-cord antenna will be sufficient for most normal operation, separate terminals are provided for external AM and FM antennas. The multiplex signal output jack provides a signal source for multiplex adapters.

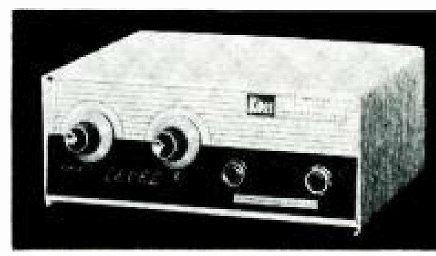
A front-panel-mounted selector switch allows instant selection of FM or stereo. The output level controls are adjustable to fit any preamp. The instrument comes in a luggage-tan vinyl-clad steel case with charcoal grey front panel. Dimensions are 15¾" x 5¼" x 11".

HEADPHONE ACCESSORIES

38 **Koss, Inc.** is now marketing two completely redesigned accessories to aid tape monitoring and general home headphone listening.

The first item is the Model A-1220 stereo amplifier (photo) which is designed as a monitor amplifier so stereo tapes produced outside a studio may be monitored during recording. The unit is transformer-powered and provides 3 watts.

The second unit is the Model T-5 junction box



which provides inputs for two sets of stereo headphones and separate volume controls for right and left ears. The design permits remote control of volume level plus "on-off" speaker switching.

ATTENUATOR PADS

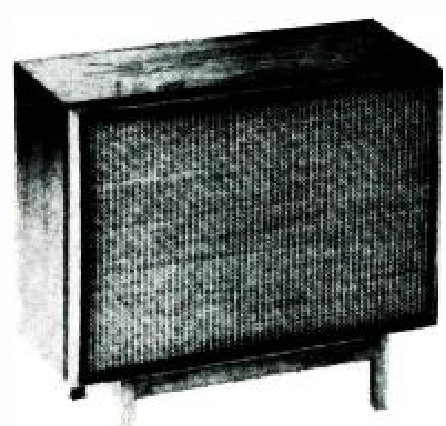
39 **Centralab** is now offering a new line of small-sized "L" and "T" pad attenuators which are rated at 20 watts audio and 5 watts d.c.

Measuring less than 1-3/16" deep from the mounting surface, the pads feature anti-backlash construction. Two wiper contacts are rigidly attached to the shaft so that they will always move in unison. The line is being offered in all frequently used impedance ratings and are individually packaged with a gold anodized dial plate and black setscrew knob.

THREE-WAY SPEAKER SYSTEM

40 **University Loudspeakers, Inc.** has come out with a unique 3-way high-compliance speaker system which features "Select-a-Style" snap-on grilles.

Designed for maximum flexibility when room decor is changed, the grilles and base come in Swedish Modern (photo), Colonial, Italian Pro-



vincial, French Provincial, and Contemporary in a wide variety of finished and unfinished woods.

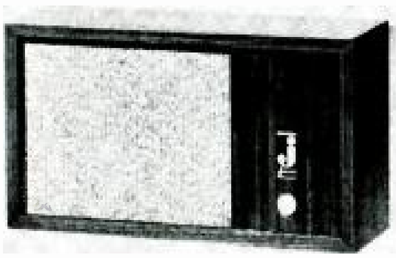
The Medallion XII houses a 12" high-compliance woofer, 8" mid-range "Spherion" super-tweeter, and three-way crossover network. The cabinet (less grille and base) measures 24" x 17" x 11¼". The grille is 1¼" deep and the base is 5" high.

Frequency response is 28-22,000 cps and the system can be driven by any amplifier providing 10 clean watts.

ULTRA-COMPACT SPEAKER SYSTEM

41 **Jensen Mfg. Co.** has added an ultra-compact, two-way speaker system to its line as the Model X-10.

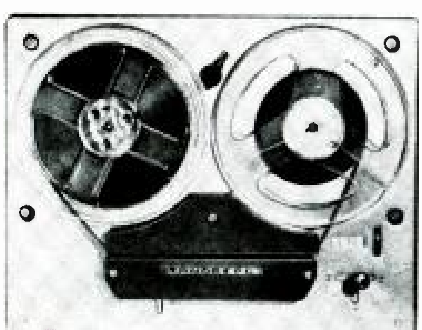
The new unit uses a special miniature long-travel woofer, mass loaded and precisely matched



to its enclosure. The 3" direct radiator tweeter carries response out to 14,000 cps. Designed for use with any amplifier having 4, 8, or 16 ohm outputs, the system is rated at 6 watts. It is housed in an oiled walnut cabinet which measures 7¼" x 13" x 15⅜".

STEREO PLAYBACK DECK

42 **Tandberg of America, Inc.** has introduced the Model 65, a three-speed, four-track stereo playback tape deck. The unit features a playback head for 2- and 4-track stereo and mono



tapes; start-stop button; two outputs for plug-in preamps; facilities for adding record and erase heads; and response at 7½ ips of 30-20,000 cps. The deck measures 16" x 12" x 6" and weighs 16 pounds.

CB-HAM-COMMUNICATIONS

11-CHANNEL RADIOTELEPHONE

43 **Bendix Marine** is now offering a transistorized, high-output eleven-channel radiotelephone for marine service as its "Captain 250."

Of the eleven crystal-controlled channels, two are available for the 4-9 mc. high-seas channels that insure long-range communications under the most adverse conditions. Over-all dimensions are 14" wide, 18" high, and 11¼" deep which includes the transistorized power supply for 12- or 32-volt systems. A separate transistorized power supply is used when only 110-volts a.c. or d.c. current is available. Weight of the unit is 41 pounds.

In addition to the crystal-controlled channels, the unit incorporates a broadcast receiver covering the 550-1600 kc. band. Also available is complete remote control for operation from one or more remote locations with channel-selector switch, volume control, speaker, and microphone. Audio output to the speakers is 6 watts.

NEW CB TRANSCEIVERS

44 **Raytheon Company** recently introduced two new, all-transistor, pocket-sized CB transceivers which are being marketed under the tradename "Ray-ette."

The standard unit, which measures 5-1/4" x 2-3/4" x 1-3/16", features a superregenerative circuit especially adapted for factory and industrial uses where high electrical noise levels interfere with most other communications equipment.

The "Super" employs a superheterodyne circuit for greater sensitivity and high selectivity.

Both units are styled with dark gray, practically indestructible cases of molded high-impact polystyrene. The cases have hydro-etched anodized aluminum face plates. Both are fitted with 46" telescoping antennas with an interlock switch that protects the batteries by assuring that the set is off when the antenna is retracted. An earphone attachment permits private communications.

CB SERVICE EQUIPMENT

45 **M. C. Jones Electronics Company, Inc.** has announced the availability of a new meter which will measure actual r.f. power output in

watts and standing-wave ratio on precisely calibrated scales.

The "MicroMatch" Model 290, by giving readings of output power and s.w.r., aids in troubleshooting, antenna matching, and in providing peak performance from Citizens Band equipment.

HAM ANTENNA ROTOR SYSTEM

46 **Cornell-Dubilier Electronics Division** has announced the availability of a remotely controlled antenna rotor system designed to meet

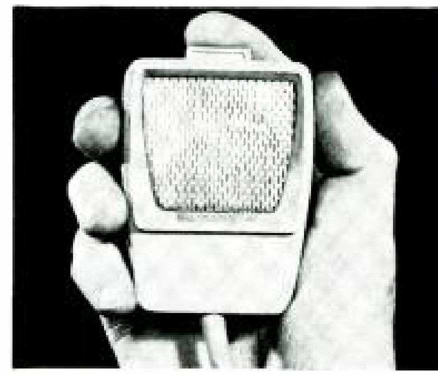
the specific requirements of amateur radio operators.

Designated the "Ham-M," the unit will support a dead weight of 1000 pounds and is ice-, moisture-, and wind-proof. The easy-to-read remote control unit is calibrated in increments of 5 degrees and has a separate transformer to insure accurate orientation of the antenna.

The unit's housing can be mounted on any pipe or mast up to 2-1/16" and can be easily adapted for tower mounting.

CERAMIC CB MIKE

47 **Sonotone Corporation** has put a ceramic microphone, especially designed for Citizens Band service, on the market as its Model CM-30.



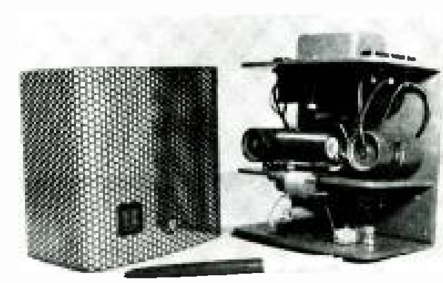
Encased in a lightweight, shatterproof plastic housing, the unit includes a newly designed ceramic transducer which provides coverage of 100 to 6000 cps with sensitivity of −49 db.

The Model CM-30 has a push-to-talk switch and comes with 6 feet of shielded coil cable. It is supplied in neutral tan gray color with a lacquered brass grille.

MOBILE POWER SUPPLY

48 **Minneapolis-Honeywell Regulator Co.** is marketing a new all-transistor mobile radio power supply which is rated at 150 watts. Designed for use in cars, boats, planes, trucks, and buses, the new unit converts standard 12 volt d.c. battery power to the voltage required for mobile transmitters and receivers.

Rated at 130 degrees F ambient, the unit can be mounted in the car's engine compartment if desired. The transistors and other components are protected by a heavy-gauge aluminum case. Its perforated cover has undergone extensive



water spray tests with no arc-over on high-voltage circuits.

Installation dimensions are 6½" x 5½" x 3⅝". Efficiency is 78 per-cent.

8-CHANNEL CB TRANSCEIVER

49 **Sonar Radio Corp.** has introduced its Model E CB transceiver which features eight crystal-controlled receive and transmit channels.

The sensitive 8-tube receiver incorporates a noise limiter and an adjustable squelch with 8 permeability-tuned "high-Q" circuits. Over-all receiver sensitivity is ½ microvolt for 10 db of quieting. Selectivity is 5 kc. at 6 db down. The transmitter operates at a full 5-watt input. A press-to-talk mike permits one hand operation.

The units are designed to operate on 117 volts a.c. and either 6 or 12 volts d.c.

25-54 MC. MOBILE UNITS

50 **Allen B. Du Mont Laboratories** has added two new units to its "Transicom" line of two-way mobile radio equipment.

The Type 125-A is a 50 watt unit which features a complete transmitter/receiver, transistorized power supply, and antenna. The Type 126-A is a 25-watt version which comes complete with

antenna, all installation parts, and accessories. Both of these units are for use in the 25-54 mc. band.

The units are super-compact for under-the-dash mounting and contain special 3" x 5" integrated speakers with audio directed to the driver's ear.

MOBILE TRANSCEIVER

51 Browning Laboratories has added a mobile unit to its line of transceivers for CB service. Called the "Mobilaire," the new equipment utilizes the same circuitry as the firm's R-2700 receiver and "S-Nine" transmitter for CB operation.

The mobile version, which will operate on 6 or 12 volts d.c. or 117 volts a.c., features front-panel selection of any one of four operating channels, selectable squelch, plus "on-off" control. The power supply is transistorized for low battery drain. The unit is supplied complete with a crystal push-to-talk microphone equipped with a retractile cord.

MANUFACTURERS' LITERATURE

1961 ASA STANDARDS

52 American Standards Association has announced the availability of a 1961 catalogue covering 1973 American Standards.

The booklet lists special publications in the standardization field, pamphlets, and standards recommendations of the International Organization for Standardization and the International Electrotechnical Commission.

The listing of American Standards is broken down into various phases of application.

ELECTRONIC WIRE DATA

53 Alpha Wire Corporation is now offering a 52-page catalogue giving complete details on its more than 6000 wire, cable, and tubing stock products for the electronics industry.

Eight new product lines are introduced in the publication, which has been designated as Catalogue No. 62.

TAPE-SYSTEMS GUIDE

54 Viking of Minneapolis has released an 8-page booklet which diagrams a variety of recommended equipment and system connections for hi-fi and stereo tape recording/playback systems.

The range of systems varies from a simple playback-only assembly using a tape deck with a music system preamp through a complete recording/playback system with external recording amplifiers, playback preamps, and monitoring-off-the-tape facilities.

Form 780 covers a total of nine systems.

TEST EQUIPMENT

55 The Triplett Electrical Instrument Co. is now offering copies of its Test Equipment Catalogue No. 42-T which pictures and describes the firm's extensive line of v.o.m.'s, v.t.v.m.'s, signal and sweep generators, transistor testers, an oscilloscope, plus tube testers.

This 8-page catalogue, free on request, includes complete specs, photos, and prices on all models.

TV KITS AND CHASSIS

56 Transvision provides detailed information on its new line of 23", 24", and 27" "Professional" series TV kits and wired chassis in an 8-page catalogue (P-361) which is available on request.

Photographs show top and bottom views of the chassis, complete technical specifications are provided along with a selection of modern cabinets to accommodate the assembled units. —30—

PHOTO CREDITS

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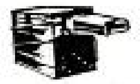
32	Sylvania Electric Products Inc.
37 (top & center)	Jacques Saphier
37 (bottom), 38, 96	Hallett Mfg. Co.
58, 59	Chrysler Corp.
86	Radio Corporation of America
93 (top)	Bell Sound Division
93 (bottom)	Eico
94	Lafayette Radio Electronics Corp.

LORAN R-65/APN-9 RECEIVER & INDICATOR



Used in ships and aircraft. Determines position by radio signals from known xmitters. Accurate to within 1% of distance. Complete with tubes and crystal. Exc. used.
Value $1200.00. Our Price $79.50
Used, less tubes, crystal and visor, but with add'l C.R. tube $29.50
12-Volt Inverter Power Supply. Like New .... P.U.R.
Shock Mount for above $2.95
Circuit diagram and connecting plugs available.
We carry a complete line of spare parts for above.

INVERTER POWER SUPPLY for Loran APN-9 and APN-4. Made by Eclipse—Pioneer Div. INPUT: 24 V DC @ 7.5 A. OUTPUT: 115 V AC @ 10.5 Amps, 800 cycles. Complete with two connecting plugs. BRAND NEW $49.50

LORAN APN-4

FINE QUALITY NAVIGATIONAL EQUIPMENT

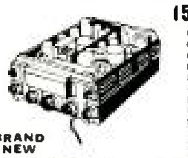
Determine exact geographic position of your boat or plane. Indicator and receiver complete with all tubes and crystal.
INDICATOR ID-6B/APN-4, and RECEIVER R-9B/APN-4, complete with tubes, Exc. used $49.50
Receiver-Indicator as above. BRAND NEW $88.50
12 Volt Inverter Power Supply. Like New .... P.U.R.
Shock Mount for above $2.95
We carry a complete line of spare parts for above.

APN-1 FM TRANSMITTER-RECEIVER

120 to 400 Mc Aircraft Radio altimeter equipment. Tubes: 4-955, 3-12SJ7, 4-12SH7, 2-12H6, 1-VR150; Complete with tubes. Exc. Used. Like New! $6,95
APN-1 Brand New $8.95

FAMOUS BC-645 TRANSCEIVER

15 Tubes 435 to 500 MC

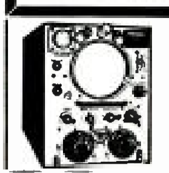


BRAND NEW

Can be modified for 2-way communication. Voice or code, on ham band 420-450 mc, citizens radio 460-470 mc, fixed and mobile 450-460 mc, television experimental 470-500 mc. 15 tubes (tubes alone worth more than sale price!); 4—7F7, 4—7H7, 2—7E6, 2—6F6, 2—955 and 1—WE 316A. Now covers 460 to 490 mc. Brand new BC-645 with tubes, less power supply in factory carton.
Shipping weight 25 lbs. SPECIAL! $19.50
PE-101C Dynamotor, 12/24V input $7.95
UHF Antenna Assembly 2.45
Complete Set of 10 Plugs 5.50
Control Box 2.25

SPECIAL "PACKAGE" OFFER:
BC-645 Transceiver, Dynamotor and all accessories above. COMPLETE, BRAND NEW, While Stocks Last $29.50

LORAN APN/4 OSCILLOSCOPE



Easily converted for use on radio-TV service bench.

Completely Assembled

LIKE NEW! Supplied with 5" Scope, type 5CP1 only $14.50

BC-733 VHF 10-Tube Aircraft Receiver. 6-channel crystal control, Freq. 108.3 to 110.3 Mc. Dual filter range. Easily converted for tracking Sputniks! Exc. Used $9.95

SCR-274 COMMAND EQUIPMENT

ALL COMPLETE WITH TUBES

Type Description	Used	Like NEW
BC-453 Receiver 190-550 KC	$12.95	$14.95
1.5-3 Mc Receiver, Brand New $16.95		
BC-454 Receiver 3-6 Mc	10.45	12.45
BC-155 Receiver 6-9 Mc	11.50	13.95

110 Volt AC Power Supply Kit, for all 274-N and ARC-5 Receivers. Complete with metal case. Instructions $7.95
Factory wired, tested, ready to operate ... $11.50
SPLINED TUNING KNOB for 274-N and ARC-5 RECEIVERS. Fits BC-453, BC-454 and others. Only 49c

BC-457 TRANSMITTER—4-5.3 Mc. complete with all tubes and crystal, BRAND NEW .. $9.75
BC-458 TRANSMITTER—5.3 to 7 Mc. Complete with all tubes and crystal. BRAND NEW $9.75
BC-459 TRANSMITTER—7-9.1 Mc. complete with all tubes and crystal. Exc. Used. $13.95
BC 696 TRANSMITTER 3-4 mc complete with all tubes and crystal. Exc. used $9.95
BC-456 Modulator .... USED 3.45 NEW 5.95
MD7 Modulator, Like New $9.95
ALL ACCESSORIES AVAILABLE FOR ABOVE

SMALL DC MOTORS

All 27.5 DC Input
Overall 3¾"x1¼" Dia.

5069790 100 RPM Delco	$3.95
5BA10AJ52 145 RPM GE	4.25
5068750 160 RPM Delco	3.95
5072735 200 RPM Delco	3.95
5067127 250 RPM GE	4.25
5069800 575 RPM Delco	3.75
5BA10FS226A 575 RPM GE	3.75

2 VOLT BATTERY "PACKAGE"

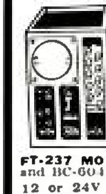
1—2V. 20 Amp. Hr. Willard Storage Battery. Model =20-2. 3" x 4" x 5½" high $2.79
1—2V. 7 prong Synchronous Plug-in Vibrator 1.49
1—Quart Bottle Electrolyte (for 2 cells) 1.45
ALL BRAND NEW! Combination Price $5.45

WILLARD 6-VOLT MIDGET STORAGE BATTERY

3 Amp. Hour. BRAND NEW. 3⅝" x 1 13/16" x 2⅜". Uses Standard Electrolyte .... only $2.95

SCHEMATIC DIAGRAMS For most equipment on this page, each .. 65c

BC-603 FM RECEIVER



20 TO 27.9 MC.
Excellent Used $14.95
BRAND NEW $18.95
10-channel, pushbutton or continuous tuning. Complete with speaker, squelch, and ten tubes: 3-6AC7, 1-6J5, 2-12SG7, 1-6H6, 1-6V6, 2-6SL7.
EXTRA SET OF 10 TUBES FOR ABOVE brand new in original boxes $3.95
FT-237 MOUNTING BASE for BC-603 Rcvr and BC-604 Xmitter. Brand New $5.95
12 or 24V Dynamotor for Above. Exc. Used $4.25 .... Brand New $5.50
BC-683 FM Receiver, 27 to 38.9 Mc. Complete with all tubes. Like New $33.33
4-Section Antenna for BC-603, 683 Receivers. Complete with mounting base. BRAND NEW $4.95
BC-604 TRANSMITTER—Companion unit for BC-603 Rcvr above. With all tubes. BRAND NEW $6.95
4-Section Antenna for BC-604, 684 Transmitters. Complete with mounting base. BRAND NEW .. $4.95
We carry a complete line of spare parts for above.

SPECIAL! BC-603 FM RCVR CONVERTED FOR ANY FREQ.—30 TO 50 MC.

BRAND NEW! Checked out, perfect working condition, ready for operation. Specify Frequency desired (between 30-50 Mc) when ordering $27.50

AC POWER SUPPLY FOR BC603, 683
Interchangeable, replaces dynamotor. Has On-Off switch. NO RECVR. CHANGE NEEDED. Provides 220 VDC @ 80 Ma. 24VAC @ 2 Amps $9.25
Complete 240-page Technical Manual for BC-603, 604 .... $3.15

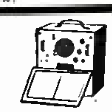
BC-605 INTERPHONE AMPLIFIER for above. BRAND NEW .... Each $4.95

BC-638A FREQUENCY METER 100-156 Mc. Xtal controlled. Rack mounting. For 110V AC operation. Less crystals. BRAND NEW $29.50

BENDIX DIRECTION FINDERS

For commercial navigation on boats.
MN26Y 150-325 Kc; 325-695 Kc; 3-4.7 Mc. Complete with tubes, dynamotor. BRAND NEW $19.50
MN28Y Receiver Control Box .... $ 4.55
MN26C Receiver 150-1500 Kc continuous tuning with 12 tubes and dynamotor. Used .. 18.95
MN26C Receiver as above. BRAND NEW 27.50
MN20E Rotatable Loop for above 4.25
MN52 Azimuth Control Box 2.95
Flexible Mechanical Cable for Above 3.95
MN28C Receiver Control Box 4.95
Other Accessories available from stock.

BC-221 FREQUENCY METER



SPECIAL BUY! This excellent frequency standard is equipped with original calibration charts, and has ranges from 125 Kc to 20,000 Kc with crystal check points in all ranges. Excel. Used with original Calibration Book, Crystal, and all tables—LIKE NEW!
Unmodulated $72.50
Modulated $99.50

BC1206-C BEACON RECEIVER

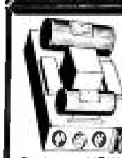
195 to 420 Kc. made by Setchel Carlson. Works on 24-28 volts DC. 135 Kc. IF. Complete with 5 tubes. Size 4"x 4"x 6". Wt. 4 lbs. BRAND NEW $9.99
Brand New, less tubes $5.95
USED, with tubes .. $5.95 USED, less tubes .. $2.95

ARN-5-C AIRBORNE Equipment, to give vertical guidance during landings. 11 tube superhet circuit. Tubes: 28D7, 12SR7, 2-12SN7, 7-6AJ5. 6 Crystals. Exc. Used $12.95

SCR-522 2-METER RIG!

Terrific buy: VHF Transmitter-receiver, 100-156 Mc. 4 channels. Xtal-controlled. Amplitude modulated voice. They're going fast! Excellent condition.
SCR-522 Transmitter-Receiver, complete with all 18 tubes, top rack and metal case. COMBINATION. Exc. Used $29.50

DYNAMOTOR ASSEMBLY



Very fine unit, made by Collins Radio. Consists of TWO Dynamotors mounted on filter base.
Dynamotor #1 INPUT 12VDC @ 3.8A OUTPUT 220VDC @ 100 Ma.
Dynamotor #2 INPUT 12VDC @ 9.9A OUTPUT 400VDC @ 180 Ma.
BRAND NEW, in original packing, shpg wt 29 lbs. OUR LOW PRICE $9.95

MOBILE-MARINE DYNAMOTOR

Model DM35

Input 12V DC. Output: 625 V DC @ 225 Ma. for press-to-talk intermittent operation. Shpg. wt. 14 lbs.
OUR LOW PRICE. BRAND NEW $8.95

OTHER DYNAMOTOR VALUES:

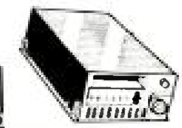
Type	Input	Output	Excellent Used	BRAND NEW
DM-25	12V 2.2A	250V .050A		$4.50
DA-1A	28V 1.6A	230V .100A		3.25
DM-28	28V	224V .07A	2.75	4.75
DM-32A	28V 1.1A	250V .05A	2.45	4.45
DM-33A	28V 5A 28V 7A	575V .16A 540V .25A	1.95	3.75
DM-34D	12V 2A	220V .080A	4.15	5.50
DM-53A	28V 1.4A	220V .080A	3.75	5.45
DM-64A	12V 5.1A	275V .150A		7.95
PE-73C	28V 20A	1000V .350A	8.95	14.95
PE-86	28V 1.25A	250V .050A	2.75	3.85

Please include 25% Deposit with order—Balance C.O.D., or Remittance in Full. 50c Handling Charges on all orders under $5.00. All shipments F.O.B. Our Warehouse, N.Y.C. All Merchandise subject to Prior Sale and Price Change.

G & G RADIO SUPPLY CO.

Telephone: CO 7-4605
Mail Order: 51 Vesey St, New York 7, N. Y.
Retail Sales: 75-77 Leonard St., New York 13, N. Y.

ARC-3 RECEIVER!



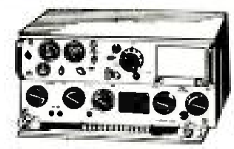
Complete with All Tubes Exc. Used $16.95
Like NEW $21.50
Used $14.95
Crystal-controlled 17-tube superhet, tunes from 100 to 156 MC., AM., on any 8 pre-selected channels. 28-volt DC power input. Tubes: 1-9002, 6-6AK5, 1-12SH7, 3-12SG7, 1-9001, 1-12H6, 2-12SN7, 1-12SL7, 1-12A6.

ARC-3 TRANSMITTER

Companion unit for above, tunes 100 to 156 MC on any 8 pre-selected channels. 9 tubes, crystal controlled, provides tone and voice modulation. 28V DC Power input. Complete with all Tubes: 3-6V6, 2-832A, 1-12SH7, 1-6J5, 2-6L6. Exc. Used .... Only $16.95
Like new condition $22.50
ARC-3 PUSHBUTTON CONTROL BOX $5.95

AN/ART-13 100-WATT XMTR

11 CHANNELS
200-1500 Kc
2 to 18.1 Mc
$58.50



Complete with Tubes
Famous Collins Autotune Aircraft Transmitter, AM, CW, MCW. Quick change to any of ten preset channels or manual tuning. Speech amplifier/clipper uses carbon or magnetic mike. Highly stable, highly accurate VFO. Built in Xtal controlled calibrator. PP811s modulate 813 in final up to 90%, class "B." A Real "HOT" Ham buy at our low price! Orig. cost $1800. Like new $58.50
0-16 Low Freq. Osc. Coil for ART-13 .... 7.95
24V Dynamotor for ART-13 .... 11.95
Same as above less meter 39.50
We carry a complete line of spare parts for above.

BC-433 RADIO COMPASS RECEIVER

200 to 1750 Kc in 3 bands. 28 V DC power supply required. Complete with 15 tubes. BRAND NEW $19.50
BC-434A Tuning Control Box for above $3.95
Remote Control Cables & Plugs for above .. P.U.R.

POWER SUPPLY for BC-620, 659 available for 6, 12 or 24 Volts DC. Specify $8.95

BC-659 TRANSMITTER & RECEIVER

27 to 38.9 Mc. F.M. Two preselected channels crystal controlled. 5 watts. Complete with speaker, tubes. Used .. $10.95
Less tubes, used $5.95

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First come, first served!

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T-28/APT-1 TRANSMITTER 140 to 210 MC BRAND NEW $19.50
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CATHODE RAY TUBE SHIELDS 5", brand new each .... $ 2.95

BC-906 FREQ. METER—SPECIAL

Cavity type. 145 to 235 Mc. BRAND NEW, complete with antenna. Manual included.
OUR LOW PRICE $10.88

SCR-625 MINE DETECTOR
Complete portable outfit in original packing, with all accessories. Brand New $27.50

MICROPHONES

Model	Description	Excellent Used	BRAND NEW
T-17	Carbon Hand Mike		$5.45
T-30	Carbon Throat Mike	$ .34	.74
T-45	Army and Navy Lip Mike		1.25
TS-9	Handset		3.88
TS-11	Handset		3.95
TS-13	Handset		4.25
HS-38	Navy Type		4.75

HEADPHONES

Model	Description	Excellent Used	BRAND NEW
HS-23	High Impedance	$2.19	$4.49
HS-33	Low Impedance	2.69	4.59
HS-30	Low Imp. (featherwt.)	.90	1.65
H-16 U	High Imp. (2 units)	3.75	7.95

TELEPHONICS—600 ohm Low Impedance HEADSETS BRAND NEW, PER PAIR $3.25
CD-307A Cords, with PL55 plug and JK26 Jack .99
Earphone Cushions for above—pair .... .50

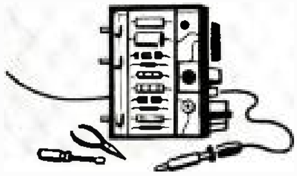
EE-8 ARMY FIELD PHONES

Excellent condition checked out, perfect working order, complete with all parts less battery. Each $12.95

DC AMMETER 0-15 Amps

3½" easy reading scale, 75 divisions. Black plastic case 4½" x 5¼" x 2¼". Rubber covered test clip leads plus black metal carrying case with hinged cover. Brand New $3.99

Send Name, Address on Post Card for FREE BULLETIN of Wonderful Surplus Buys!



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CALENDAR of EVENTS

AUGUST 1-3

Fourth Western Regional Meeting of the American Astronautical Society. Sponsored by AAS. Sheraton-Palace Hotel, San Francisco. Saunders B. Kramer, Lockheed Missiles and Space Div., Sunnyvale, Calif. is general chairman.

AUGUST 16-18

Second International Electronic Circuit Packaging Symposium. Sponsored by the Department of Electrical Engineering and Bureau of Continuation Education, University of Colorado, Boulder, Colo. Information on program available from the Bureau.

AUGUST 18-20

NATESA Annual Convention. Sponsored by National Alliance of Television & Electronic Service Associations. Pick-Congress Hotel, Chicago. Frank J. Moch, Executive Director, 5906 S. Troy St., Chicago 29, Illinois for details.

AUGUST 22-25

1961 Western Electronic Show and Convention. Sponsored by 7th Region of IRE and WEMA. Cow Palace, San Francisco, Calif. Information available from WESCON, 1435 S. La Cienega Blvd., Los Angeles 35, Calif.

AUGUST 30-SEPTEMBER 1

Third Annual AIME Semiconductor Conference. Sponsored by the Metallurgical Society of AIME and the Southern California Section of AIME. Ambassador Hotel, Los Angeles. Pre-registration with J. O. McCaldin, 11601 Montana Ave., Los Angeles 49, Calif.

SEPTEMBER 5-8

16th National Conference of the Association for Computing Machinery & First International Data Processing Exhibit. Statler Hilton, Los Angeles, Calif. B. J. Handy, Jr., Litton Systems, 5500 Canoga Ave., Woodland Hills, Calif., chairman.

SEPTEMBER 6-8

1961 Joint Nuclear Instrumentation Symposium. N.C. State College, Raleigh, N.C. Contact H. S. McCreary, Westinghouse Special Atomic Project, 107 Terrace Court, Pittsburgh 27, on program.

National Symposium on Space Electronics & Telemetry. Sponsored by PGSET of IRE. Albuquerque, N.M. Program details from Dr. B. L. Basore, 2405 Parsifal, N.E., Albuquerque, N.M.

SEPTEMBER 6-13

International Conference on Electrical Engineering Education. Sponsored by ASEE, IRE, AIEE, and Syracuse University. Sagamore Conference Center, Syracuse University, Adirondacks, N.Y. Information from W. R. LePage, Syracuse University, Syracuse, N.Y.

SEPTEMBER 11-15

Sixteenth Annual ISA Instrument-Automation Conference & Exhibit. Sponsored by Instrument Society of America. Biltmore Hotel and Memorial Sports Arena, Los Angeles. Program information from ISA Meetings Manager, Penn Sheraton Hotel, 530 William Penn Place, Pittsburgh 19.

Marine Sciences Instrumentation Symposium. Sponsored by Instrument Society of America & American Society of Limnology and Oceanography. Woods Hole Oceanographic Institution, Woods Hole, Mass. Information from David D. Ketchum, Woods Hole.

SEPTEMBER 13-15

Conference on Technical-Scientific Communications. Sponsored by PGEWS and Philadelphia Section of IRE. Bellevue-Stratford Hotel, Philadelphia. George Boros, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia 4, Pa., program chairman.

SEPTEMBER 13-17

1961 New York High-Fidelity Music Show. Sponsored by Institute of High Fidelity Manufacturers, Inc. New York Trade Show Building, 500 Eighth Ave., New York City. Show hours to be announced later.

SEPTEMBER 14-15

Ninth Annual Engineering Management Conference. Sponsored by PGEM, AIEE, et al. Roosevelt Hotel, New York, N.Y. Details from H. M. O'Bryan, General Telephone & Electronics Labs., 730 Third Ave., New York City, N.Y.

Symposium on Engineering Writing & Speech. Sponsored by Philadelphia Section of PGEWS. Bellevue-Stratford Hotel, Philadelphia. George Boros, 2035 Pine St., Philadelphia 3, for program details.

SEPTEMBER 20-21

Joint Industrial Electronics Symposium. Sponsored by AIEE, IRE, and Instrument Society of America. Bradford Hotel, Boston. For information on reservations, contact D. J. LaCerda, Badger Mfg. Co., 363 Third St., Cambridge, Mass.

OCTOBER 2-4

Seventh National Communications Symposium. Sponsored by PGCS of IRE, Rome-Utica Section. Utica, N.Y. Program information from R. K. Walker, 34 Bolton Rd., New Hartford, New York.

IRE Canadian Electronics Conference. Sponsored by Region 8 of the IRE. Automotive Bldg., Exhibition Park, Toronto, Ont. Details from A. R. Low, c/o IRE Canadian Electronics Conference, 1819 Yonge St., Toronto, Ontario, Canada.

OCTOBER 3-6

Seventh Annual U.S. Army Human Factors Engineering Conference. Sponsored by Army Research Office, Office of the Chief of Research and Development. Institute of Science and Technology, University of Michigan, Ann Arbor. Information from Marshall D. Aiken, Signal Research Office, Office of Chief Signal Officer, Room BD 1024, The Pentagon, Washington 25, D.C.

OCTOBER 9-11

Seventeenth Annual National Electronics Conference. Sponsored by AIEE, Illinois Institute of Technology, IRE, Northwestern University, University of Illinois. International Amphitheatre, Chicago. Information from NEC, 228 N. La Salle St., Chicago 1, Illinois.

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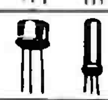
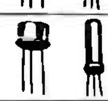
AF ST* AF Driver. Use as: Driver Low Power Output, Code Osc., **DC** Amp., Control, Test Instr., Pre-Amp., Timers, Organ, etc. **39c ea.**

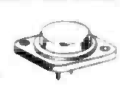
RF ST* as Converter in an American set. Use as: Converter Sq. Wave Gen., **RF** Osc., Amp. Regen. Det., etc. **49c ea.**



IF ST* as 455kc **IF** in an Amer. set. Use as: **IF** Amp., Grid Dip Osc., Electronic Computer, **RF** Osc., Switch, Amp., etc. **49c ea.**



AUTO OUTPUT ST**as Audio Power Output into Speaker. 90% of Auto Radios so Powered. Use as Power Amp., Mobile Power Supply, Voltage Regulator, Osc., **DC** to **DC** Converters. **79c ea.**



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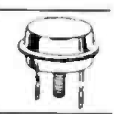

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1G3	.79	6BC8	.97	12AQ5	.52
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1K3	.79	6BE6	.55	12AT7	.76
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1R5	.62	6BG6	1.66	12AU7	.61
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1T4	.58	6BH8	.87	12AV6	.41
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3BC5	.54	6BR8	.78	12BF6	.44
3BE6	.52	6BU8	.70	12BH7	.77
3BN6	.76	6BY6	.54	12BL6	.56
3BU8	.78	6BZ6	.55	12BQ6	1.06
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3BZ6	.55	6C4	.43	12BZ7	.75
3CB6	.54	6CB6	.55	12C5	.56
3CF6	.60	6CD6	1.42	12CN5	.56
3CS6	.52	6CF6	.64	12CR6	.54
3DK6	.60	6CG7	.61	12CU5	.58
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3V4	.58	6CR6	.51	12DE8	.75
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4BN6	.75	6CU5	.58	12DM7	.67
4BQ7	1.01	6CU6	1.08	12DQ6	1.04
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4BU8	.71	6DA4	.68	12DZ6	.56
4BZ6	.58	6DB5	.69	12EL6	.50
4BZ7	.96	6DE6	.58	12EG6	.54
4CS6	.61	6DG6	.59	12EZ6	.53
4DE6	.62	6DQ6	1.10	12F8	.66
4DK6	.60	6DT5	.76	12FM6	.45
4DT6	.55	6DT6	.53	12K5	.65
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5BR8	.79	6S4	.51	12W6	.69
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5EA8	.80	6SL7	.80	17BQ6	1.09
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5J6	.68	6SQ7	.73	17CA5	.62
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5U4	.60	6U8	.83	17DQ6	1.06
5U8	.81	6V6GT	.54	17L6	.58
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6AF4	.97	7A8	.68	25C5	.53
6AG5	.68	7B6	.69	25CA5	.59
6AH6	.99	7Y4	.69	25CD6	1.44
6AK5	.95	8AU8	.83	25CU6	1.11
6AL5	.47	8AW8	.93	25DN6	1.42
6AM8	.78	8BQ5	.60	25EH5	.55
6AQ5	.53	8CG7	.62	25L6	.57
6AR5	.55	8CM7	.68	25W4	.68
6AS5	.60	8CN7	.97	25Z6	.66
6AT6	.43	8CX8	.93	35C5	.51
6AT8	.79	8EB8	.94	35L6	.57
6AU4	.82	11CY7	.75	35W4	.42
6AU6	.52	12A4	.60	35Z5GT	.60
6AU7	.61	12AB5	.55	50B5	.60
6AU8	.87	12AC6	.49	50C5	.53
6AV6	.41	12AD6	.57	50DC4	.37
6AW8	.90	12AE6	.43	50EH5	.55
6AX4	.66	12AF3	.73	50L6	.61
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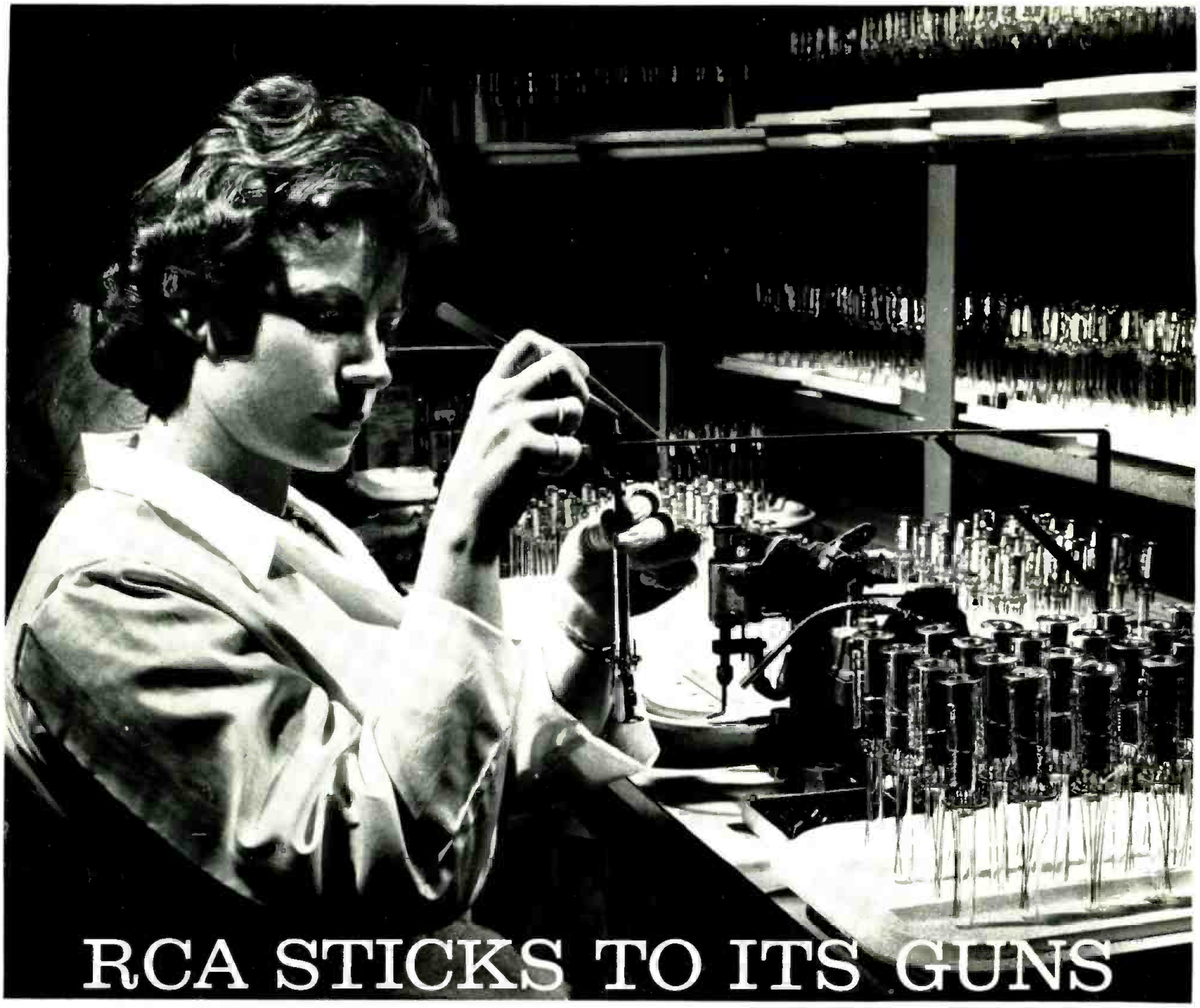

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