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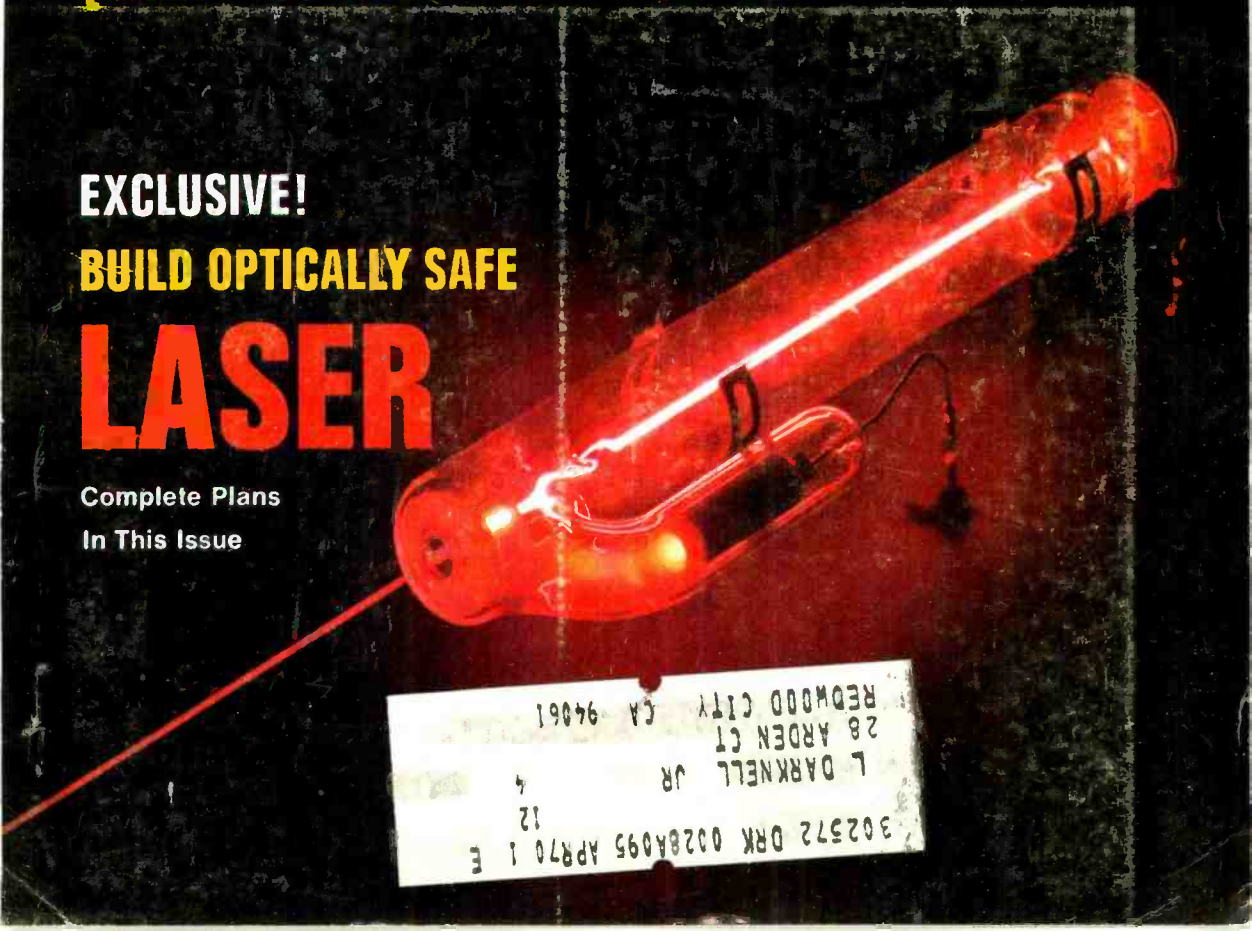

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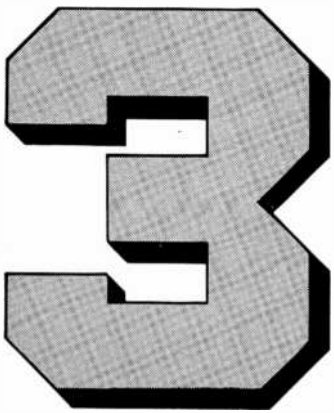

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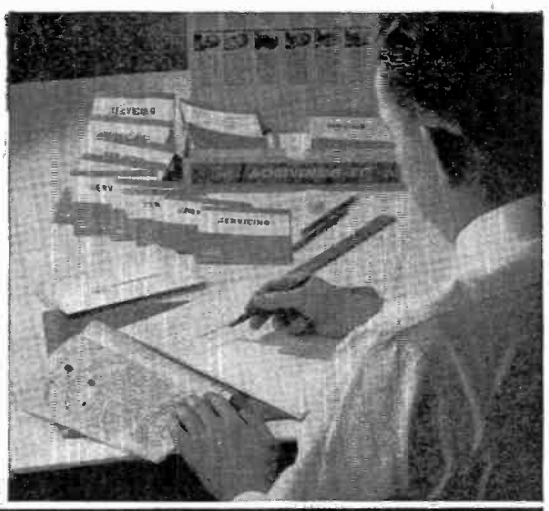

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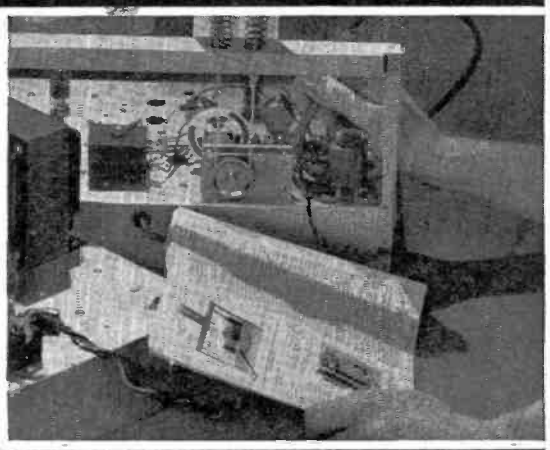

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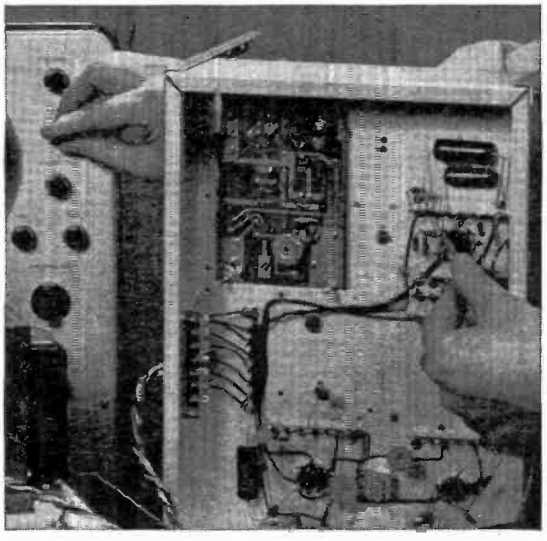

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VOLUME 31 NUMBER 6 **DECEMBER, 1969**

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This month's cover photo by Bruce Pendleton

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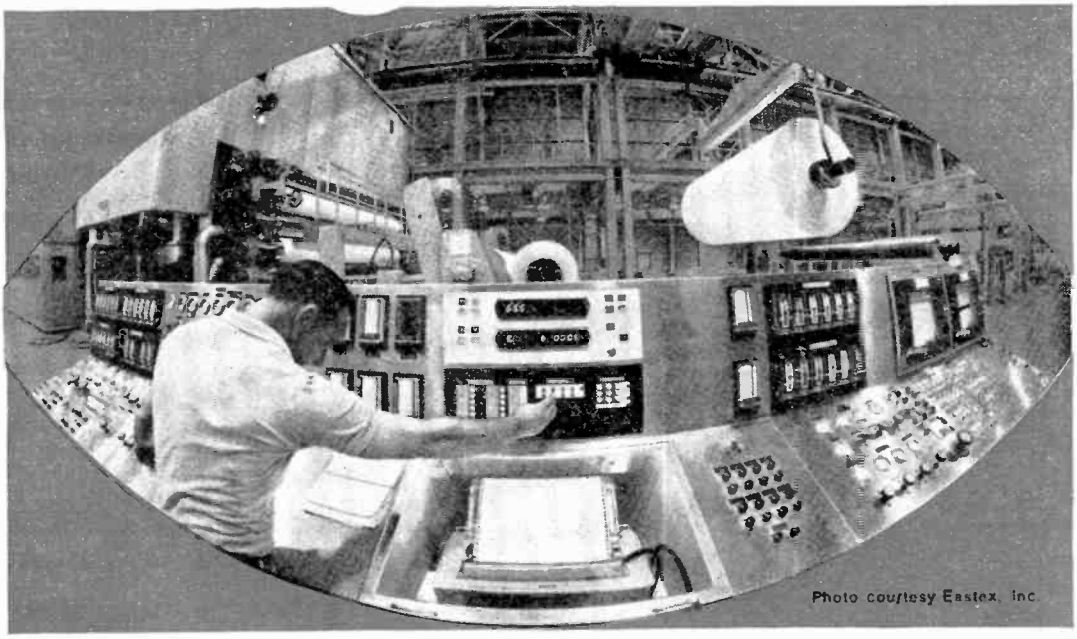

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letters

FROM OUR READERS

PLEASE THINK BEFORE WRITING

I have been intrigued by the 7-segment DCU and am eagerly awaiting a digital "real time" clock. However, looking at the "Indoor/Outdoor All-Electronic Thermometer" (October issue, page 27), I wonder why you don't convert it so that it has a digital readout?

Name Withheld

Just like any magazine, POPULAR ELECTRONICS *likes to hear from its readers. Unfortunately, a portion of the reader mail pertains to matters where the answer is obvious. In this instance, a reader seeks to combine two incompatible projects. True, such a project could be developed, but just like the digital clock it would end up costing the builder in excess of $100 to duplicate. And, if the reader had given this more thought, he would have seen that the thermometer is an analog device, while the 7-segment readout is digital. A conversion circuit is expensive. Understanding this basic element would have saved everyone time and postage.*

OOPS! NO BUZZER

I am reluctant to open an old subject, but those who have tried reader Leonard H. Zandel's "Lights On" alarm (January issue, page 8) probably found it wasn't so foolproof after all. The basis of his circuit was to have a path for the buzzer through the distributor —which he calls "ignition load." But the distributor points are not always closed when the car comes to a stop. A fair percentage of the time the points are open and the alarm circuit is also open so the system doesn't work.

CARLOS H. CASTRO
Philadelphia, Pa.

LISTEN ON 2182 KHZ

Jerry Reese says in his "Two-Way Reactions" column in the October issue that there were no local warnings about the Lake Erie

July 4th storm. This is certainly not so since WMI, Lorain, Ohio on 2182 kHz transmitted a safety message prior to the storm. They were very emphatic about the degree of severity of the storm which could be expected in that area.

I am a member of the "Marine Monitors" and would appreciate hearing from others that concentrate on and are interested in this type of listening.

LESLIE F. FULTZ
110 High Street
Pomeroy, OH 45769

THANK YOU

My son, A. Atwater Kent, Jr. tells me that he could not have put together such an interesting story about my husband as your Frank Atlee. My entire family is most grateful to you for having published this very nice article.

MABEL L. KENT
(Mrs. A. Atwater Kent)
Wilmington, Del.

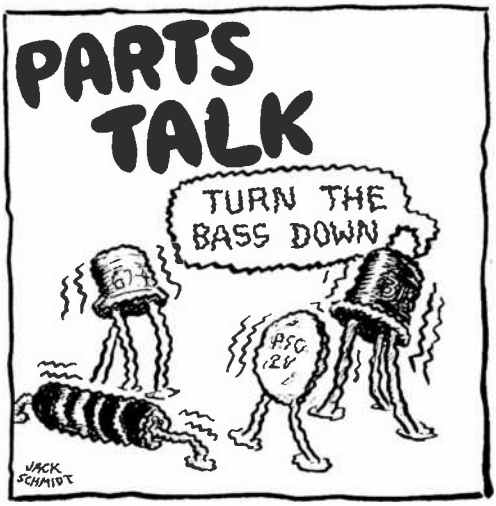
The Frank Atlee story appearing in the July issue has received many plaudits, but none as nice as the one above. We hope that our story, "What ever Happened to Atwater Kent?" will be read and enjoyed for many days to come.

OP AMP, GEE!

The John Seginski quiz (October issue, page 50) is great—if you know what an "Op Amp" is in the first place. How do you expect readers to answer that quiz?

J. G. O'SHEA
Pittsburgh, Pa.

Reader O'Shea has a valid point. The quiz was accidentally published before our tutorial story on Operational Amplifiers. The story is now scheduled for publication in the February issue of POPULAR ELECTRONICS.



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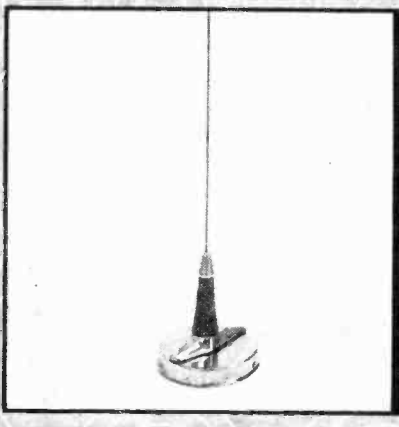

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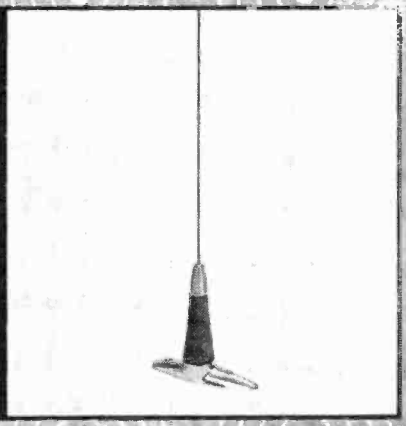

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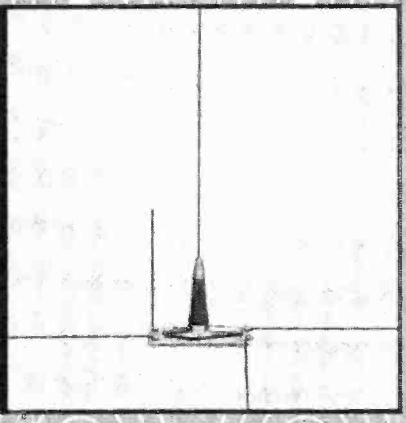

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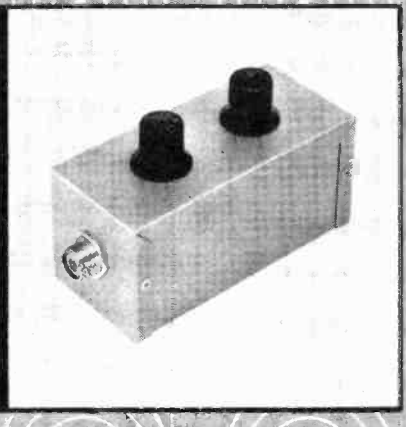

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by Matthew Mandl

Up-to-the-minute and for the first time at the technical institute level, this book explains logic circuits using diagrams, logic maps, and truth tables, and discusses parallel methods with Karnaugh maps and Venn diagrams. Emphasis throughout is on electronic aspects as they relate to the design of computer logic circuits, industrial control switching, and allied areas of usage. The result is a thorough presentation of circuit simplification principles and basic logic-design factors for combinational and sequential circuits. Each chapter ends with a series of review questions.

Published by Prentice-Hall, Inc., Englewood Cliffs, N.J. 07632. Hard cover. 229 pages. $12.50.

ELECTRONIC POWER SUPPLIES

by Joseph Grabinski

This is another in the Electronic Technology Series, written for use in junior colleges but eminently suited for self teaching and as a supplement to correspondence study. Like the others in the Series, this book is excellent. It is divided into six sections, covering such subjects as: single-phase rectifier circuits; polyphase rectifiers; magnetic amplifiers, gaseous tube circuits; controlled rectifiers; and regulators. Each topic is discussed in detail and each chapter concludes with review questions (an answer key for odd-numbered questions is provided). The only prerequisites are an understanding of a.c. and d.c. circuits, familiarity with basic solid-state and vacuum-tube diodes, and a knowledge of algebra, trigonometry, and elementary calculus.

Published by Holt, Rinehart, and Winston, Inc., 383 Madison Ave., New York, N. Y. 10017. Soft cover. 223 pages. $3.95.

ELECTRICAL FUNDAMENTALS FOR TECHNICIANS

by Robert L. Shrader

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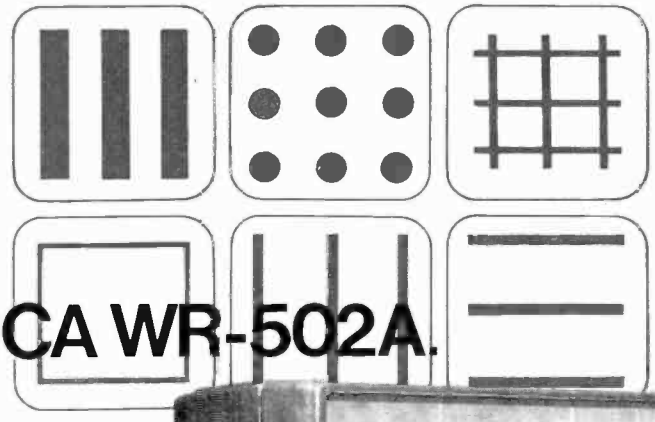

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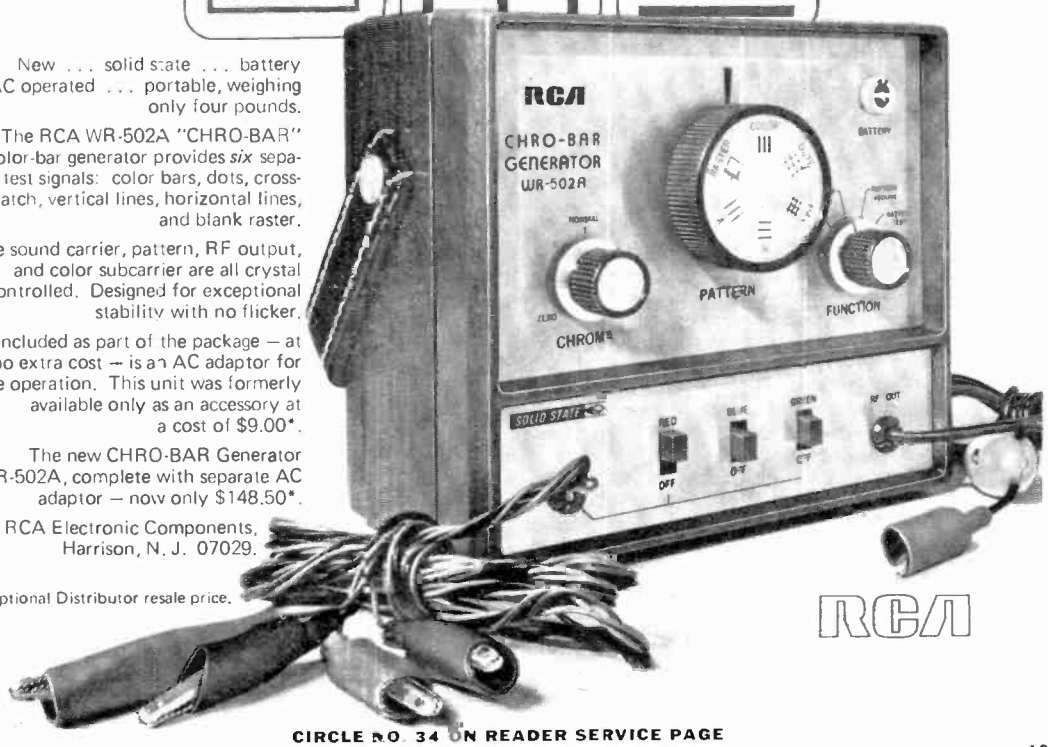

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LIBRARY (*Continued from page* 12)

in earlier chapters. From there, the text takes up electronic theory, and the mathematics of electronics. Throughout, the text is handled in a semi-programmed style to provide an immediate check on comprehension of the material covered. This format lends itself to any method of study (resident or home). The book ends with a series of much appreciated appendices; so no extra math tables are needed.

Published by McGraw-Hill Book Co., 330 West 42 St., New York, N.Y. 10036. Hard cover. 479 pages. $10.95.

FM FROM ANTENNA TO AUDIO

by Leonard Feldman

The fidelity and noise-free qualities of FM reception are known and enjoyed by many people, but just how these qualities are achieved—the principles and circuitry of FM broadcasting and reception—are perhaps less well known. This book, therefore, presents a complete description of FM reception, with special emphasis on FM principles and receiver circuitry. The first two chapters discuss the FM signal and its effectiveness in reducing co-channel and adjacent-channel interference. The remaining chapters are devoted to the receiving system, from the antenna to the audio output. The final two chapters deal with receiver measurements and alignment procedures. Throughout the book, the text is clarified with the liberal use of schematic diagrams, tables, and graphs.

Published by Howard W. Sams & Co., 4300 West 62 St., Indianapolis, Ind. 46206. Soft cover. 159 pages. $3.95.

USING YOUR TAPE RECORDER, Second Edition

Even with the rapidly growing popularity of the tape recorder, the average recorder owner still does not know much about this handy electronic device and does not make full use of its capabilities. This newly revised book has been written to help the owner and to guide the prospective buyer in making his selection from the many types of recorders available. Written by old hands in audio and recording, the book presents technical material in simple language directed at the nonprofessional and hobbyist. New in the second edition is a chapter that describes the various types of recorders and their uses, including a discussion of the new cassette and automatic-reversing recorders. The material given in the book is practical and eminently suited to both the beginner and the old hand.

Published by Allied Radio Corp., 100 N. Western Ave., Chicago, Ill. 60680. Soft cover. 112 pages. 75 cents.

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TAKE ONE new literature

To obtain a copy of any of the catalogs or leaflets described below, simply fill in and mail the coupon on page 15 or 113.

VACO Products Company, manufacturers of quality hand tools recently announced the availability of their 1970 Catalog of Hand Tools for industry, production and assembly line, maintenance, service, and home work shop use. Catalog No. SD-76 consists of 24 pages listing hundreds of sizes and styles of screwdrivers, nut drivers, ratchet tools, pliers, wrenches, electrical testers, etc.

Circle No. 75 on Reader Service Page 15 or 113

A new catalog listing chemical products designed exclusively for the electronics service industry has been issued as Catalog No. 6970 by *Chemtronics Inc.* The eight-page listing covers tuner sprays, contact and control cleaners, insulating sprays, lubricants, circuit coolers, and a variety of other servicing aids.

Circle No. 76 on Reader Service Page 15 or 113

Catalog No. 189, available on request from *Poly Paks,* is jam packed with listings for spare electronic parts. Poly Paks' famous "one dollar paks," and subassemblies. Among the items listed are solid-state rectifiers: transistors; integrated circuits; solar and photocells; resistor, capacitor, and coil assortments; batteries; meter movements; and a five-transistor fiber optics and infra-red amplifier kit. The catalog is a treasure-trove listing for the hobbyist and experimenter.

Circle No. 77 on Reader Service Page 15 or 113

The 1970 edition of the *Sears, Roebuck and Co.* Home Entertainment and Electronics Catalog, No. 39AL-7166, features an expanded selection of Sears' own Silvertone line as well as equipment from other brand-name manufacturers. The 68-page catalog devotes a total of 32 pages to stereo components and lists more than 1000 separate items, both electronic and non-electronic. New products listed include the first cassette player/recorder, long-distance walkie-talkies, and assemble-yourself audio kits. Other listings include decorator telephones, eight-track recording equipment, musical instruments, PA and intercom systems, etc.

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NEW PRODUCTS

Additional information on products covered in this section is available from the manufacturers. Each new product is identified by a code number. To obtain further details on any of them, simply fill in and mail the coupon on page 15 or 113.

LOUNGE CHAIR HI-FI LISTENING ROOM

It may look like a space-age passenger seat with matching ottoman, but the *LEE* "Music Chamber" is actually an optimized hi-fi/stereo listening room. The Music Chamber is essentially two "infinite baffled" speaker systems formed into a partially enclosed lounge chair. The self-contained speaker systems direct most of the acoustical energy into the resulting enclosure. To a listener seated in the chair, the stereo separation is said to border on the absolute, but with enough blend from slight reflections inside the enclosure, the "ping-pong" effect is minimized. In effect, the listener is isolated from the local environment in his own cocoon of sound. The speaker complement includes one 8" high-compliance, extended-range speaker per side, nominally rated at 8 ohms impedance. Power handling capacity of the Music Chamber is 20 watts IHF.

Circle No. 79 on Reader Service Page 15 or 113

CAPACITIVE-DISCHARGE IGNITION SYSTEM

A new heavy-duty capacitive-discharge ignition system, called the "Tiger SST," is being produced by *Delta International, Ltd.* New techniques in circuit design have reduced the number of components needed as compared to older designs, greatly enhancing the reliability and efficiency of the system. The Tiger SST is said to extend spark plug and breaker point life to 100,000 miles and increase gas mileage by as much as 15%. The Tiger SST is available both factory wired and in "Simpli-Kit" form.

Circle No. 80 on Reader Service Page 15 or 113

LOW-COST "PROFESSIONAL" AM/FM TUNER

Three FET's and two r.f. amplifier stages are featured in the *Pioneer Electronics U.S.A. Corp.* Model TX-900 AM/stereo FM tuner. The result is unusually high selectivity and sensitivity, plus elimination of cross-modulation. Signal-to-noise ratio is approximately 60 dB at 30% modulation; and, for inadequate signal inputs, a special noise filter can be used to eliminate unwanted multiplex broadcast noise. Stereo performance is emphasized through the use of a time-switching demodulator in the multiplex circuit. Additional selectivity is provided in the i.f. strip through the use of two crystal filters in the four-IC circuit. Interchannel noise is completely muted through the utilization of a continuously adjustable muting control. On both bands, a bright spot indicator lights up to indicate signal reception, while precise tuning meters assure perfect tuning.

Circle No. 81 on Reader Service Page 15 or 113

METRIC HAND TOOLS

A wide selection of precision hand tools for driving fasteners made to metric dimensions is now being produced by *Xcelite Inc.* The line includes 18 midget, regular, and hollow-shaft, fixed-handle nutdrivers in a hex size range from 3 mm to 17 mm. Set No. 99-PS-41-MM consists of seven hex sockets, interchangeable blades with hex sizes from 1.27 to 5 mm, plastic handle, and 4" extension. Set No. 99 PS-51-MM contains 10 interchangeable nutdriver shanks with hex openings from 4 to 11 mm, handle, and 4" extension. (All hex sockets and blades in these two sets can be obtained separately for use with the Xcelite Series 99 handle.)

Circle No. 82 on Reader Service Page 15 or 113

AUDIO SIGNAL GENERATOR

Field effect transistor circuitry is featured in the *Leader Instruments Corp.* Model LAG-54 audio signal generator. The generator produces sine and square waves over a frequency range of 20 Hz to 200 kHz. The sine waves are generated by a Wein-Bridge oscillator, while the fast-rise-time, very symmetrical square waves are shaped by a Schmitt trigger. Technical specifications—3-volt r.m.s., 600-ohm impedance sine wave output; less than 0.5% distortion at mid-range; amplitude is flat to within ±0.5 dB referred to 1 kHz; 5-volt peak-to-peak from 20 Hz to 20 kHz square-wave output; 105-125 volts, 50-60 Hz at 5 VA input power required.

Circle No. 83 on Reader Service Page 15 or 113

HI-FI COMPONENT COMPACT

The Model 1045 stereo compact is the intermediate model of a new line of stereo/hi-fi component compacts recently introduced by *Benjamin Electronic Sound Corp.* Featured

Go on a quality kick

You can afford it with these Outperformers

You give up nothing — except a high price — when you buy these quality performance Pioneer hi-fi units. Designed for the discriminating budget-minded buyer, they contain advanced engineering features and looks that put them in the class of much more expensive stereo components.

SA-500 INTEGRATED STEREO AMPLIFIER — The perfect starter unit for a stereo system, the all solid state SA-500 produces 44 watts of music power. Even at the highest crescendo, distortion is less than 0.5%. Four inputs plus outputs for speakers, tape recording, loudness contour and a headset jack make it tops in versatility. $99.95

TX-500 AM-FM TUNER — All solid state, its multiplex circuitry provides wide channel separation with excellent frequency response. An FET front end, combined with years-ahead design, assures high sensitivity and superb image rejection. Containing advanced features that place it on a par with more expensive units, it is priced at $99.95.

SR-202 REVERBERATION AMPLIFIER — The most dramatic new component in years! No matter what your system is, the SR-202 adds dimension and greater realism to your stereo sound than you can realize. The SR-202 increases the natural quality of your recordings and tapes. Reverberation can be added to an audio amplifier using one or two tape recorders, a record player, or a tuner. In fact, a total of 15 equipment combinations are possible. $95.00

These three Pioneer Outperformers are each housed in a handsome cabinet with brushed chrome facing and Brazilian rosewood end pieces. Hear them in action at your local Pioneer dealer.

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CIRCLE NO. 31 ON READER SERVICE PAGE

PRODUCTS (*Continued from page 22*)

with the 1045 are the famous Miracord Model 50 record changer with ELAC Model 244 stereo magnetic cartridge and diamond stylus; two EMI Model 62 two-way speaker systems; and a Benjamin Stereo FM/AM receiver rated at 140 watts EIA. The top-of-the-line Model 1050A features the same record changer, an ELAC Model 344 cartridge, two EMI Model 105 three-way speaker systems, and a 220-watt Benjamin stereo FM/AM receiver. The economy Model 1025 employs a Miracord Model 610 record changer, ELAC Model 244 cartridge, two EMI Model 55 speakers, and a 70-watt Benjamin FM multiplex-only receiver.

Circle No. 84 on Reader Service Page 15 or 113

TRANSISTOR/FET TESTER

Sencore, Inc., recently announced the availability of their new portable Model TF17 in-or-out-of-circuit transistor/FET tester. The new model is similar to and performs the same functions as the company's deluxe Model TF151 tester. It checks bipolar transistors in- or out-of-circuit for a.c. beta, and out-of-circuit for ICBO leakage. It also checks field effect transistors (MOS, dual-gate, and new enhancement types) in- or out-of-circuit for gain, and out-of-circuit for leakage. An increased current check for high-power transistors and a special test for critical r.f. transistors are provided as standard features. The TF17 tester comes with Sencore's own reference book that lists more than 12,000 transistors and FET's and all the information needed to test them.

Circle No. 85 on Reader Service Page 15 or 113

METAL DETECTOR/LOCATOR

Kits Industries Inc. is currently marketing their Model MD-90 "Treasure Seeker" heterodyne-type metal detector/locator kit. When assembled, the solid-state circuit of the MD-90 is housed inside a rugged metal case, which is then mounted on a two-piece aluminum handle. The pickup head is molded of high-impact plastic, and a comfortable rubber hand grip and adjustable angle brackets are featured for user comfort. All mechanical parts are cut, drilled, and finished. A printed circuit board and comprehensive instruction manual, as well as battery, are included in the kit.

Circle No. 86 on Reader Service Page 15 or 113

AM/FM CASSETTE/RECEIVER COMBINATION

An 82-watt AM/stereo FM receiver and a professional stereo cassette recorder have been combined in a single component to make up the *H.H. Scott, Inc.*, Model 3610 "Casseiver." The receiver section employs Scott's silverplated, FET front end that virtually eliminates drift and provides a 2.5-μV sensitivity and 80-dB cross-modulation rejection. The tone controls also employ FET circuitry to provide a wide range of control. Integrated circuits are used both in the i.f. strip to provide a 2.5-dB capture ratio and improved selectivity, and in the preamplifier section for higher gain and reduced distortion. The time-switching multiplex demodulator circuit provides 30 dB of separation. Epoxy-glass circuit boards and solderless connectors are also featured. The cassette mechanism is powered by a precision synchronous a.c. motor which cuts out annoying wow and flutter.

Circle No. 87 on Reader Service Page 15 or 113

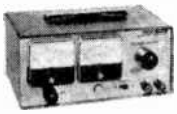
VOLTAGE REGULATOR FOR APPLIANCES

The Model D-111 voltage regulator available from *Perma-Power* is specially suited for use with color TV receivers and home appliances rated at 400 watts or less. It is specifically designed to cope with the TV problems caused by high line-voltage transmission in the 130-volt range, to prevent early tube burn-out and shortened component life. This is accomplished by a switching network that lets the D-111 constantly drop 10 volts, correcting over-voltage faults. The regulator can also be set to boost the line voltage by 10 volts, or be switched out of the power circuit.

Circle No. 88 on Reader Service Page 15 or 113

DUAL-METER POWER SUPPLY

Short circuit protection, continuous output voltage and current monitoring, and all-solid-state circuitry are featured in the *EICO Electronic Instrument Co., Inc.*, Model 1025 power supply. The output voltage of the supply is continuously variable from 0 to 30 volts. Maximum continuous load current is 150 mA in the 0-12-volt range, 200 mA in the 12-24-volt range, and 300 mA from 24 to 30 volts. Maxi-



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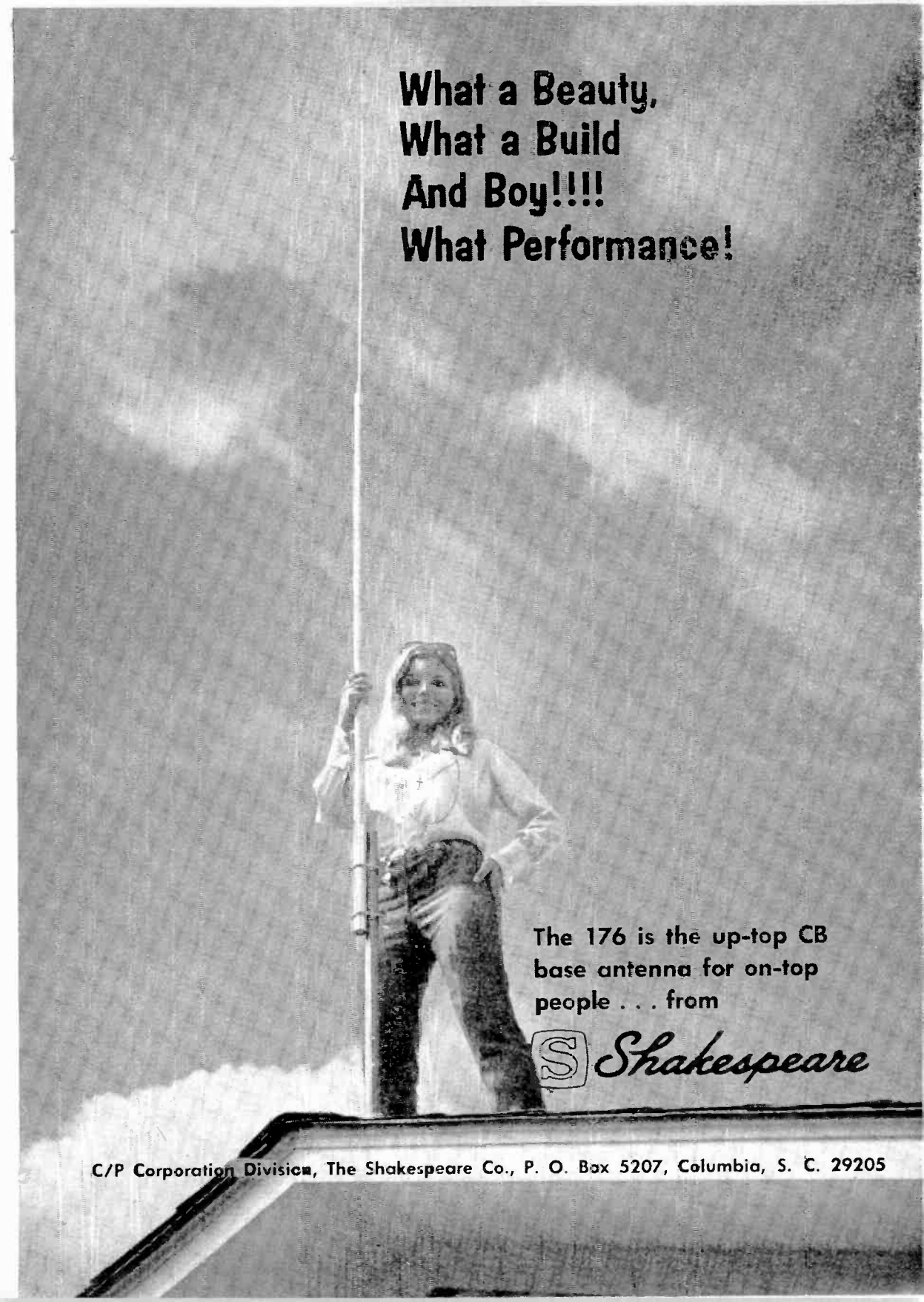
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What Performance!
The 176 is the up-top CB
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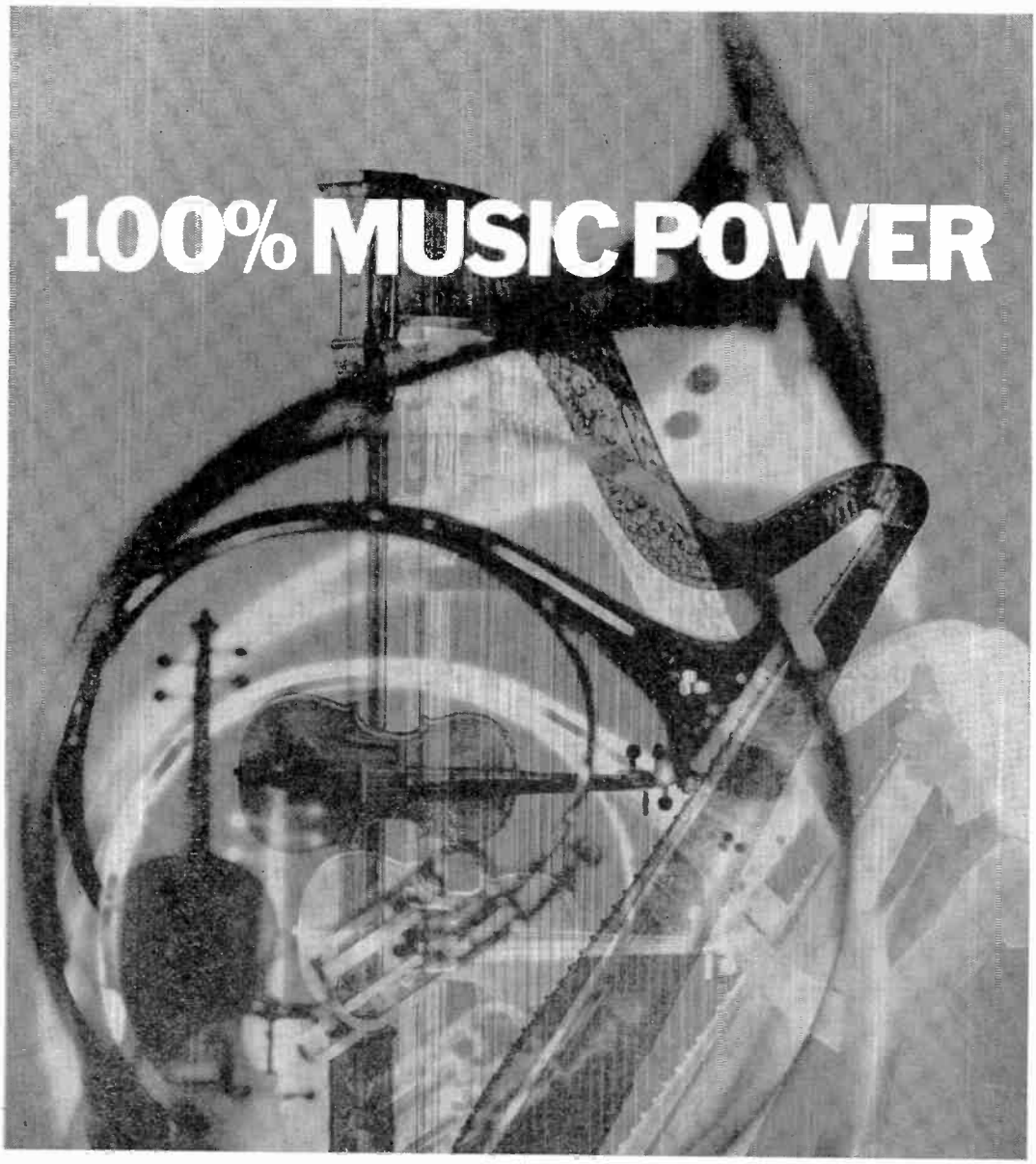

PHOTOGRAPH BY FRANZ EDSON

Words are inherently limited in stimulating the emotions aroused by music. This is especially so in describing how high fidelity components perform.

With cartridges, for example, we speak of flat frequency response, high compliance, low mass, stereo separation. Words like these enlighten the technically minded. But they do little or nothing for those who seek only the sheer pleasure of listening.

We kept both aspects in mind when developing the XV-15 series of cartridges. We made the technical measurements. And we listened.

We listened especially for the ability of these cartridges to reproduce the entire range of every instrument. With no loss of power. That's what it takes for a cartridge to recreate the most subtle nuances that distinguish one musical instrument from another. An oboe from an English horn. A trumpet from a cornet.

We call this achievement "100% music power."

When you play your records with an XV-15, you won't be concerned with even that simple phrase.

Instead, you'll just feel and enjoy the renewed experience of what high fidelity is really all about.

PICKERING

THE NEW PICKERING XV-15/750E. PREMIER MODEL OF THE XV-15 SERIES. TRACKS AT ½ TO 1 GRAM. DYNAMIC COUPLING FACTOR OF 750 FOR USE IN FINEST TONEARMS. $60.00. OTHER XV-15 CARTRIDGES FROM $29.95. PICKERING & CO., PLAINVIEW, L.I., N.Y.

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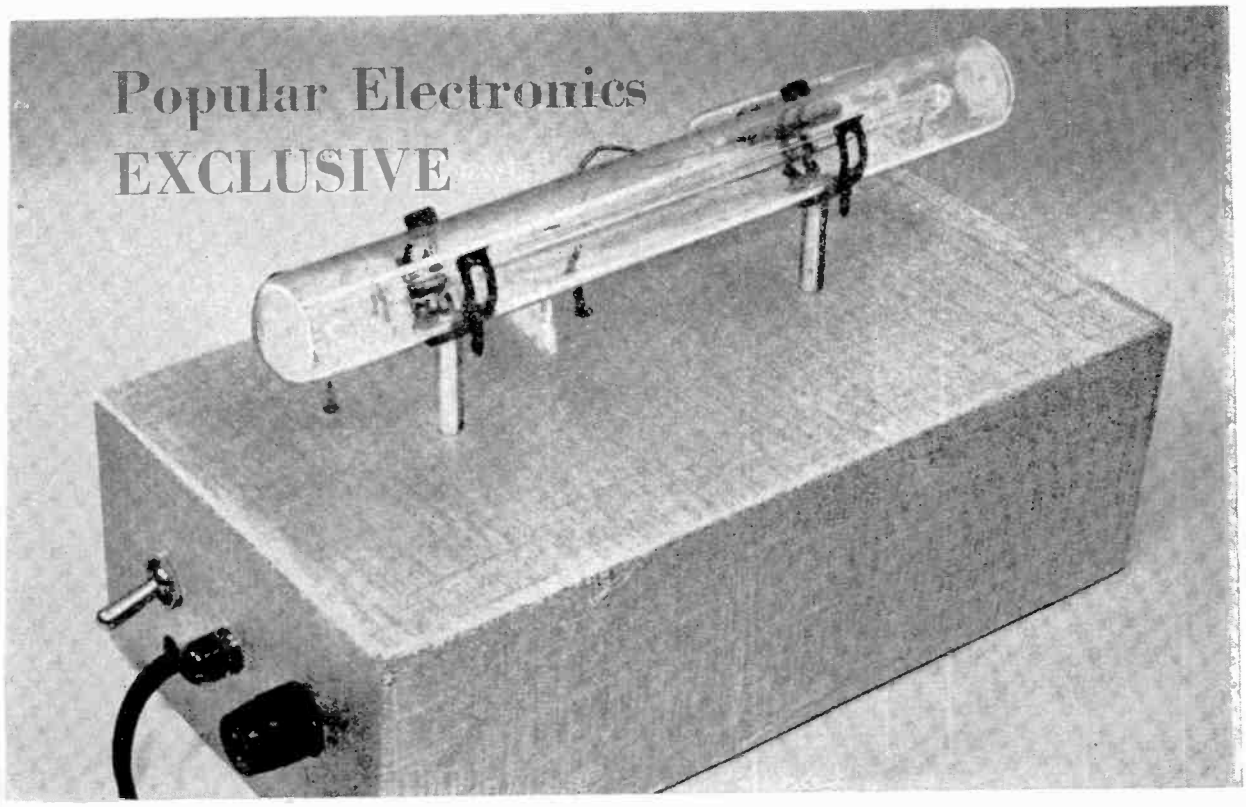


Experimenters' Laser

SAFE, PRACTICAL LASER FOR HOME OR SCHOOL

BY C. HARRY KNOWLES

UNTIL NOW, the experimenter has found three things wrong with lasers: (1) they were expensive; (2) they were dangerous; (3) they were hard to get. That's why lasers have been used primarily by research laboratories and not by the ordinary electronics hobbyist.

In the last year or two, relatively low-cost laser assemblies have been available for use by schools, small research labs, and machinery manufacturers. However, many of these lasers bordered on the danger line with light outputs that could cause retinal damage to the eye if the laser were not handled properly.

With interest in lasers at an all-time high, it was inevitable that research would eventually produce a laser whose output was reduced to the point where the beam was no longer dangerous to the eye and whose price did not require a "government grant" to support experimentation. The result is the safe, low-cost laser described here. Priced at $49.50, this laser generates a modest 0.5 milliwatts at 6328 angstroms. The laser tube itself is available from a mail-order supplier (see Parts List) and the necessary high-voltage power supply may be assembled in a few hours.

Laser Basics. Without delving into the mathematics and quantum theory involved in the operation of a laser, the best way to describe the device is to

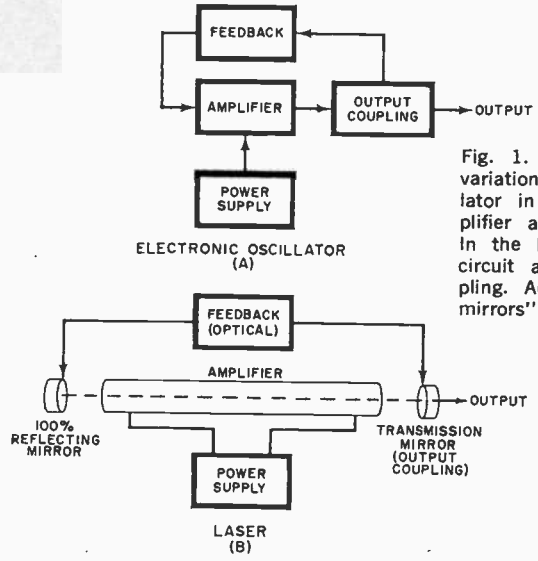


Fig. 1. The laser is essentially a variation of a conventional oscillator in that it has both an amplifier and a feedback mechanism. In the laser, part of the feedback circuit also forms the output coupling. Actually, "it's all done with mirrors"—made up in a special way.

compare it with a conventional electronic r.f. oscillator—the principles of operation of the two are quite similar.

As shown in Fig. 1A, an electronic oscillator has four main parts: an amplifier, a resonant feedback network, an output coupling port (including the antenna), and a power source. Figure 1B shows the corresponding parts of a laser. Here the amplifier can contain a mixture of gases or liquids, or it can be solid state. The laser described in this article contains a gaseous mixture of helium and neon.

When the laser's power supply delivers enough energy to cause a discharge in the gas tube, the neon atoms are elevated to a high energy state by colliding with the helium atoms. When the neon atoms drop back to their lower energy state, they give up energy at certain wavelengths. In this case the wavelength is 633 nanometers or 6328 angstrom units (in the deep red portion of the visible spectrum). As this light energy is propagated within the glass tube, it scatters helter-skelter in all directions. Some of the light is lost through the side walls of the glass tube, but the portion that travels down the center of the tube strikes other excited neon atoms within an internal glass capillary tube creating more light energy of the same wavelength.

Eventually the light strikes a mirror at one end of the laser and most is reflected back down the capillary tube. With a mirror at each end of the tube, the process continues—the beam bouncing back and forth until it builds up enough intensity to pass through one of the mirrors, which is only partially coated. The other mirror is 100% reflective and does not allow any part of the beam to escape in that direction. Thus we see how the laser gets its name —Light Amplification by Stimulated Emission of Radiation. It is important to note that this amplifier, and the critically spaced and designed optical feedback system, has a very narrow bandwidth around the 6328 A wavelength.

In the helium-neon laser, light amplification is only 1.02 on each pass of the beam from one mirror to the other. Thus all losses must be kept below 2%. Very special care is taken in fabricating the laser and in coating and aligning the two mirrors. The gas mixture is pure, containing no contaminants. The transmission mirror is coated to allow 0.8% of the generated light to escape. Thus, as intense as the beam emitted appears to be, it is less than 1/100 as intense as the beam between the mirrors. It will be noted that lasing occurs only in the precision capillary tube that delineates the exact path between the mirrors.

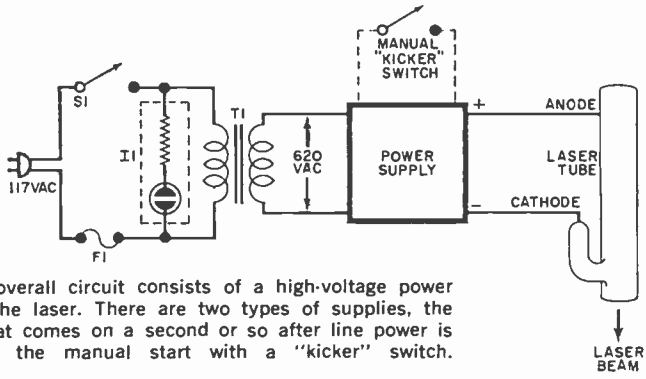


Fig. 2. The overall circuit consists of a high-voltage power supply and the laser. There are two types of supplies, the automatic that comes on a second or so after line power is applied, and the manual start with a "kicker" switch.

PARTS LIST
COMPLETE LASER

F1—1-ampere fuse with holder
I1—117-volt neon indicator and holder (can use NE-2 and 33,000-ohm resistor)
S1—S.p.s.t. switch
T1—Power transformer, 620-to-650-volt secondary

Note—The laser tube is available from Metrologic Instrument Inc., 143 Harding Ave., Bellmawr, N.J. 08030 for $49.50 plus $1.25 postage. A complete laser housing including an aluminum extruded case, steel base, power switch, pilot light, and all mounting hardware is also available from the same source for $15.

Properties of Laser Light. There are four unique characteristics of laser light that make the device itself such a useful tool. These are: directionality, coherence, intensity and monochromaticity.

The directionality of laser light is due to the fact that only the light that is on the axis between the mirrors can escape from the laser. The other light contributes nothing to the output beam. Thus, the laser light emerges inherently well collimated and highly directional, and thus useful for applications where an enormous concentration of light in a given direction is important.

The coherence (phase) of the light is due to the very high-Q resonant feedback network within the optical amplifier. Only light whose multiples of a half wavelength fits exactly between the mir-

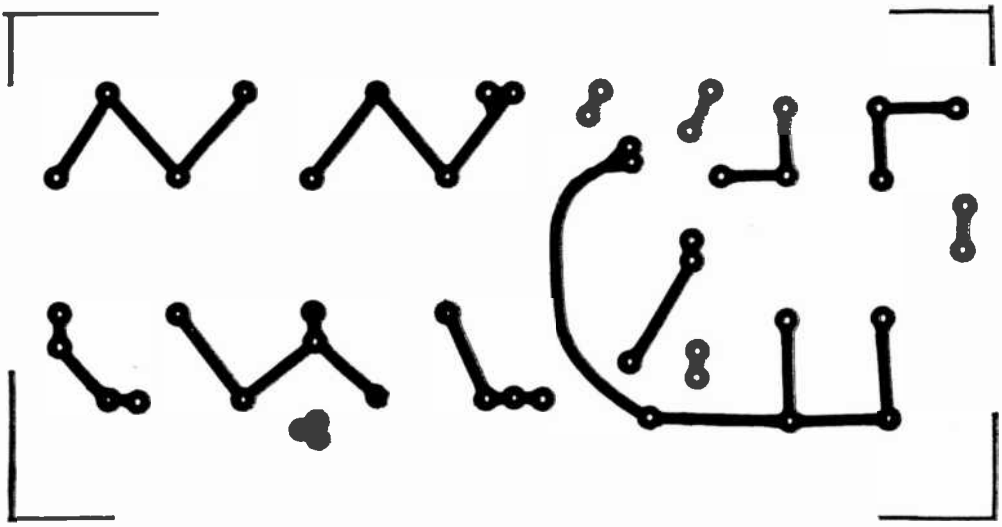
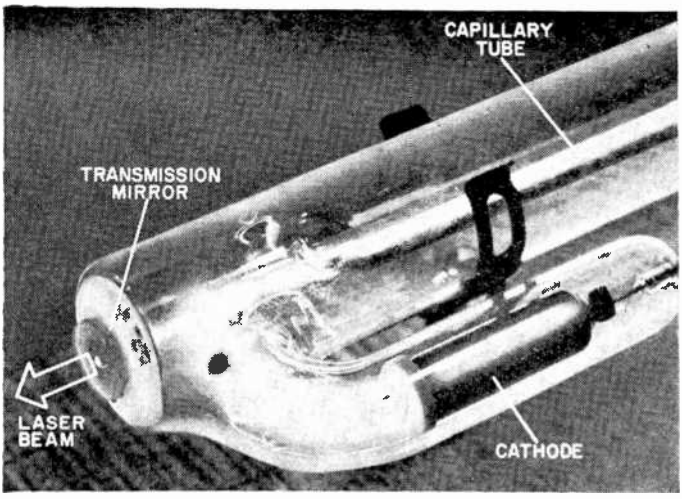


Fig. 3. Actual-size foil pattern for automatic start supply. Drill mounting holes at the four corners.



Close up of "business end" of the laser. Note use of capacitor clamps to secure laser in place. Make sure that exit optics are clean and laser is rigidly mounted on a chassis.

rors is allowed to propagate. Thus, standing waves are established between the mirrors and each light particle is in step with all the others—creating phase coherence.

Intensity and monochromaticity go hand in hand. Since the laser builds up energy of only one frequency, all the power in the laser beam is at that frequency. The spectral energy of the 6328 A light produced by the laser approaches the intensity of the similar frequency emitted by the sun.

Monochromaticity (one color) is a result of the narrow pass band of the amplifier, plus the selectivity of the resonant feedback mirrors. The pass band of the laser described here is about 1200 MHz at a frequency of 4.8×10^{14} Hz (a Q of 4×10^5 in the amplifier section). In addition, the filtering of the resonant mirrors reduces the output to lines whose frequencies are separated by one half the speed of light divided by the distance between the mirrors. In our laser, this is about 620 MHz. These lines are extremely narrow—less than 1 Hz wide. Thus, the laser can have a monochromaticity purity of better than one part in 10^{15}. This permits very sharp filtering for laser communication to reduce background noise and provide an extremely high signal-to-noise ratio.

Construction. Before assembling the laser, a power supply must be built. You can use a supply that fires the laser automatically shortly after the line voltage is applied to the supply, or you can use a supply with a momentary contact switch to turn the laser on. In either case, once the laser fires, it remains on until the line power is removed.

The high-voltage source for both power supplies is a 620-volt transformer as shown in Fig. 2. The automatic supply can be assembled on a printed circuit board using foil pattern shown in Fig. 3 and the circuit in Fig. 4A. Assemble components as shown in Fig. 5. The switched power supply can be built on a perf board as shown in Fig. 6 using circuit in Fig. 4B.

Once a power supply has been built, mount it in the metal enclosure (using short spacers) along one of the long walls. Mount the associated power transformer on one of the shorter walls. Mount power switch *S1*, pilot light assembly *I1*, and fuse (in fuseholder) *F1* (see Fig. 2) on the short wall opposite the transformer. Make a small hole to accommodate the line cord, and put a rubber grommet in the hole to protect the cord. If the switched supply is used. mount the pushbutton switch in any convenient location.

The glass laser tube is supported by a pair of conventional electrolytic capacitor clamps, which are mounted on two spacers about an inch long. Mount the two spacers about 4½" apart on the long center line of the top of the metal enclosure and straddling the short center line. Mount a two-lug terminal strip (none grounded) inside the chassis

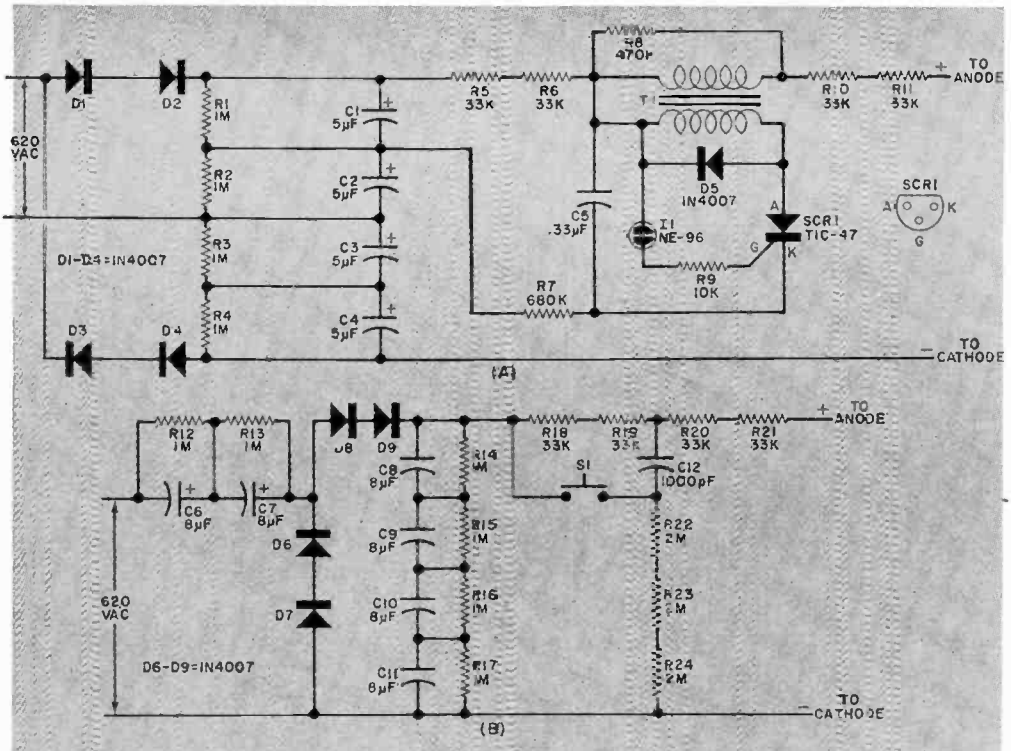


Fig. 4. You can use either of two power supplies—the automatic shown at (A) or the manual start shown at (B). As with all high-voltage power supplies, take great care once they have been turned on

PARTS LIST (POWER SUPPLY)

C1-C4—5-μF, 450-volt electrolytic capacitor
C5—0.33-μF capacitor
C6-C11—8-μF, 450-volt electrolytic capacitor
C12—1000-pF, 1600-to 2000-volt capacitor
D1-D9—1N4007 diode
I1—NE-96 pilot light
R1-R4, R12-R17—1-megohm, ½-watt resistor
R5,R6,R10,R11,R18-R21—33,000-ohm, 2-watt resistor
R7—680,000-ohm, ½-watt resistor
R8—470,000-ohm, ½-watt resistor
R9—10,000-ohm, ½-watt resistor
R22-R24—2-megohm, ½-watt resistor
SCR1—C106B2 (GE) or TIC-47 (Texas Instruments) silicon controlled rectifier
S1—Normally open pushbutton switch, 2000-volt insulation (see photo page 32)
*T1—Ignitor coil, 20:1 ratio**
Note—A complete power supply (automatic) including a PC board and all components is available from Metrologic Instrument Inc., 143 Harding Ave., Bellmawr, N.J. 08030, for $17.50 plus $1.00 postage.
**Conventional ignition coil, critically damped using a resistor across the secondary to produce a single spike. A flashtube trigger transformer (Amelo 21T-55, Allied Cat. No. 60 F 9387) may be substituted.*

using the hardware for the laser mounting spacer that is closest to the controls.

Gently slide the laser tube into the clamps being careful to avoid the exhaust seal protruding from one side. Install the tube so that the cathode end (with the glass extension bulb) is toward the transformer end of the chassis.

Connections to the two leads on the laser must be made with clips, not solder. Bend the ends of both leads so that they point toward the top of the metal enclosure. Mark the enclosure at the two points where the leads are aiming. Remove the laser tube and drill holes at the two points. Make the holes large enough to accommodate an insulated power lead.

Once the equipment has been assembled, wire the circuit as shown in Fig. 2. Cover the negative high-voltage lead with insulation (plastic tubing will do) and feed it through the hole under the cathode of the laser tube (the end with the glass bulb extension). Allow this lead to protrude through the top of the metal chassis for about an inch. Make a

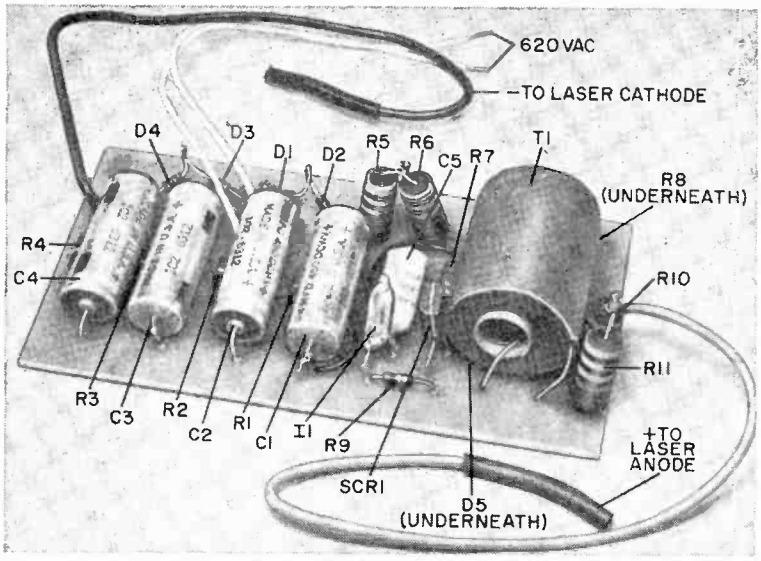


Fig. 5. Component installation on the automatic supply PC board. Transformer T1 is an ordinary ignition coil that has plastic case removed.

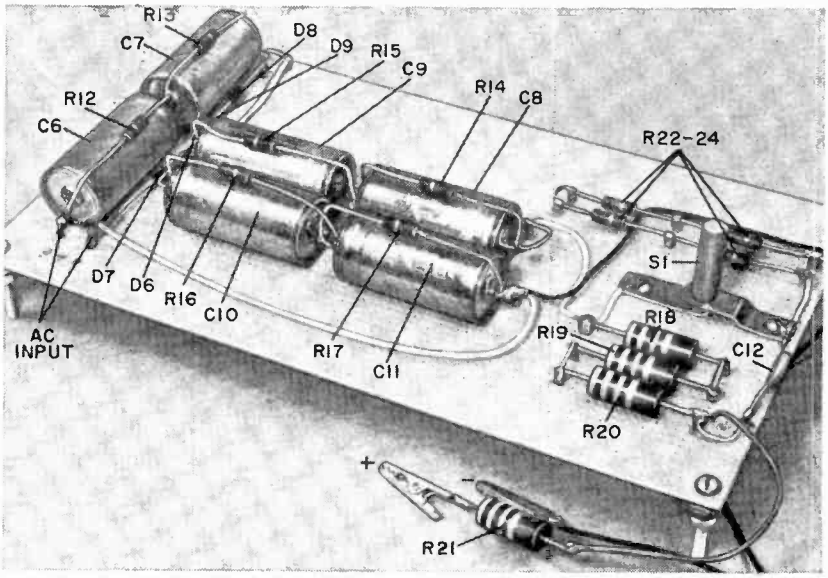
similar lead for the positive side of the supply and feed it through the hole to the laser anode.

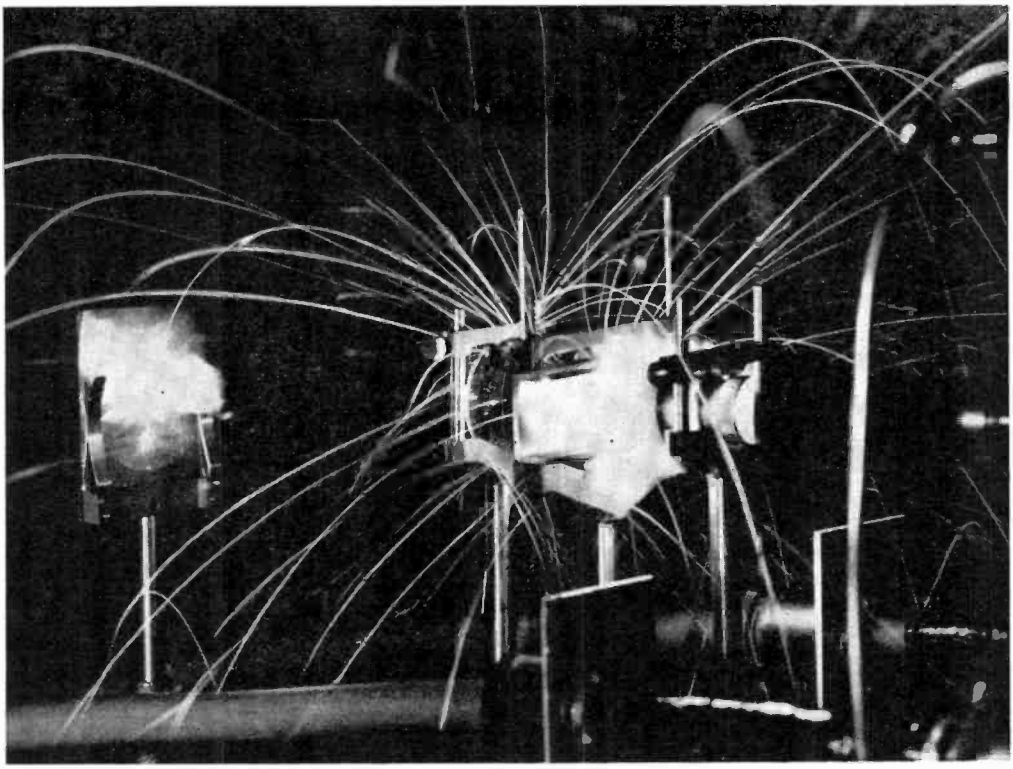
Remove two pins from an old miniature tube socket and solder them to the leads from the power supply. Install the glass laser tube in the capacitor clamps making sure that the cathode end faces away from the controls. Orient the tube so that the cathode extension bulb is horizontal. Connect the power supply leads to the laser leads to make tight friction fits. Center the laser on the metal chassis.

Operation. Being careful not to aim the laser beam (coming out of the cathode end) at a shiny surface, turn on the line power. If you are using the automatic power supply, the laser will give a couple of short light bursts and then lase con-

(*Continued on page* 110)

Fig. 6. Switch S1 is made from two lengths of phosphor-bronze strip, one as fixed and the other as movable contact. Use a small piece of wood or plastic for pushbutton.





THE LIVELY LASER

IT KEEPS BUSY FINDING PROBLEMS TO SOLVE

BY JOHN P. ROBINSON, JR.

THE NUMBER of uses that can be found for a highly directional, extremely intense, coherent beam of light is staggering. The most recent—and most highly publicized—was in conjunction with the lunar landing of the Apollo 11 crew. Carefully placed on the lunar surface was a laser retro-reflector which will enable astonomers to determine not only how far the moon is from the earth, but to check the "wobble" of the lunar body in its orbit.

Only a laser with its enormous light concentration could have made this experiment possible. A beam of laser light can be focused to spread about one-third of an inch for each mile. The moon is about 238,350 miles away and the laser beam, on striking the surface of the moon, illuminates an area about one mile in diameter. By comparison, the beam from the best available radar transmitter would have enlarged to 200 miles in diameter and—if it could have been constructed—a beam from a powerful searchlight would have spread over 12,000 miles in diameter at that range.

Metalworking Tools. Possibly one of the greatest and most unique applications for laser beams will be in the cutting and welding of extraordinarily hard metals. Holes that are as small as 1/15,000 of an inch or as large as one-half inch can be drilled with ease. Holes can easily be drilled through diamonds, the hardest material known to man. In only a couple of minutes, minute holes can be drilled through diamonds so that the diamond itself may be used as a wire-drawing die to fashion extremely fine wire.

Another trick in the laser bag is in the

This detection system uses a gallium-arsenide pulsed laser and an image converter viewing tube to find targets up to 300 feet away in complete darkness. Developed by Laser Diode Laboratories.

balancing of a gyro motor while the rotor is spinning at speeds up to 30,000 r/min. The pre-1960 method involves stopping the rotor, drilling a small indentation to correct the balance and then firing up the rotor to full speed. Because this process might be repeated several times, it took literally hours to finally balance this delicate mechanism. With a laser beam, balancing can be accomplished in minutes. Auxiliary electronic equipment is used to locate the positions of the "unbalancing" metal while the gyro is spinning at top speed. Then a pulse laser is fired at the spot to vaporize some of the metal until a perfect rotor balance is achieved.

The construction industry is finding many uses for the narrow, directional beam of the laser. Bridges, tunnels, and any other construction project involving a long critically aligned surface (including the wings of large aircraft) may be unfailingly positioned with the aid of a laser. San Francisco engineers are using helium-neon lasers to ensure the alignment of the walls of a long aqueduct. At Stanford University, lasers were used to align the two-mile long linear accelerator tunnel which is used for 20-billion electron volt experiments.

Miracles in Medicine. One of the most publicized uses of lasers is in the medical field where they have been successfully employed in delicate eye surgery. Previously, a detached retina required complex surgery and a long recuperative period. Now one pulse from a laser and the retina is "spot welded" back in place. A few patients have even driven themselves home in their own cars immediately after the operation.

Melanomas, cancers of the skin, have been destroyed with the use of a pulse laser. The mechanism of how this is accomplished is not yet fully understood. A large number of competent medical workers are exploring this field with the latest laser equipment. Great emphasis is being placed on the non-thermal effects of laser beams while simultaneously attempting to develop a relationship to the post-radiation regression of tumors.

Even the dentist's drill may be replaced by a laser beam. One manufacturer doing research on the laser drilling

TYPES OF LASERS

Helium-Neon. Helium-neon lasers are typically of low power, but they are especially useful where stable single-frequency operation is important. Such systems usually operate at wavelengths of 6328 angstroms, 1.15 microns (11,500 A) or 3.39 microns (33,900 A) depending on resonator design.

A major application is in optical alignment tools. These types are being used increasingly in construction work—bridge building, etc. Most small He-Ne lasers have a beam diameter of 1 to 3 millimeters, which is expanded to about one inch. A fan-shaped beam has been designed so that a reference plane is produced rather than a line.

Carbon Dioxide. The limiting efficiency of approximately 25 per cent is the highest known for any gas laser system; also, the highest unclassified continuous-wave output power is in excess of 8 kW. The system operates at a wavelength of 10.6 microns in either the continuous-wave, pulsed, or Q-switched modes. With the introduction of O_2, He, H_2, argon, and H_2O to a high-power CO_2-N_2 system, the power is further increased by depopulating the lower laser level. The CO_2 laser is attractive for terrestrial and extraterrestrial communications because of the low absorption window in the atmosphere between 8 and 14 microns. This system can also be used for metal cutting and welding. The CO_2 is extremely versatile because one can easily produce a high degree of coherency, high continuous-wave power, or high peak powers through the use of Q-switching techniques. Of major significance from the hazard standpoint is the fact that CO_2 radiation at 10.6 microns can be present in enormous power, yet is invisible to the human eye.

Argon. This ionized gas laser system operates at wavelengths of 4880 A, 5145 A, or 4579 A in either continuous-wave or pulsed mode. Power generation is greatest when operating at 4880 A and 5145 A. Highest CW powers achieved have been on the order of 100 watts for one minute.

Solid-State Crystalline. The solid-state laser continues to find wide application. Of the ions with which laser action has been produced, perhaps Nd^{3+} in garnet or glass and Cr^{3+} in aluminum oxide have the greatest general interest. A most attractive host for the neodymium ion is garnet (yttrium aluminum garnet, YAG, or yttrium iron garnet, YIG) because the 1.06-micron laser transition line is sharper than in other known host crystals. Frequency doubling to 5300 A using lithium niobate crystals produces powers approaching the power available in the fundamental at 1.06 microns. In addition to frequency doubling, an interesting development which raises some questions about potential hazards is the production of picosecond (10^{-12} sec) pulses such as those obtained through modulation of the internal losses in the YAG-Nd system at the correct mode-locking frequency. Also, through the use of electro-optic materials such as KDP, barium strontium niobate or lithium tantalate, "tuning" or scanning for laser frequencies over wide ranges may be accomplished.

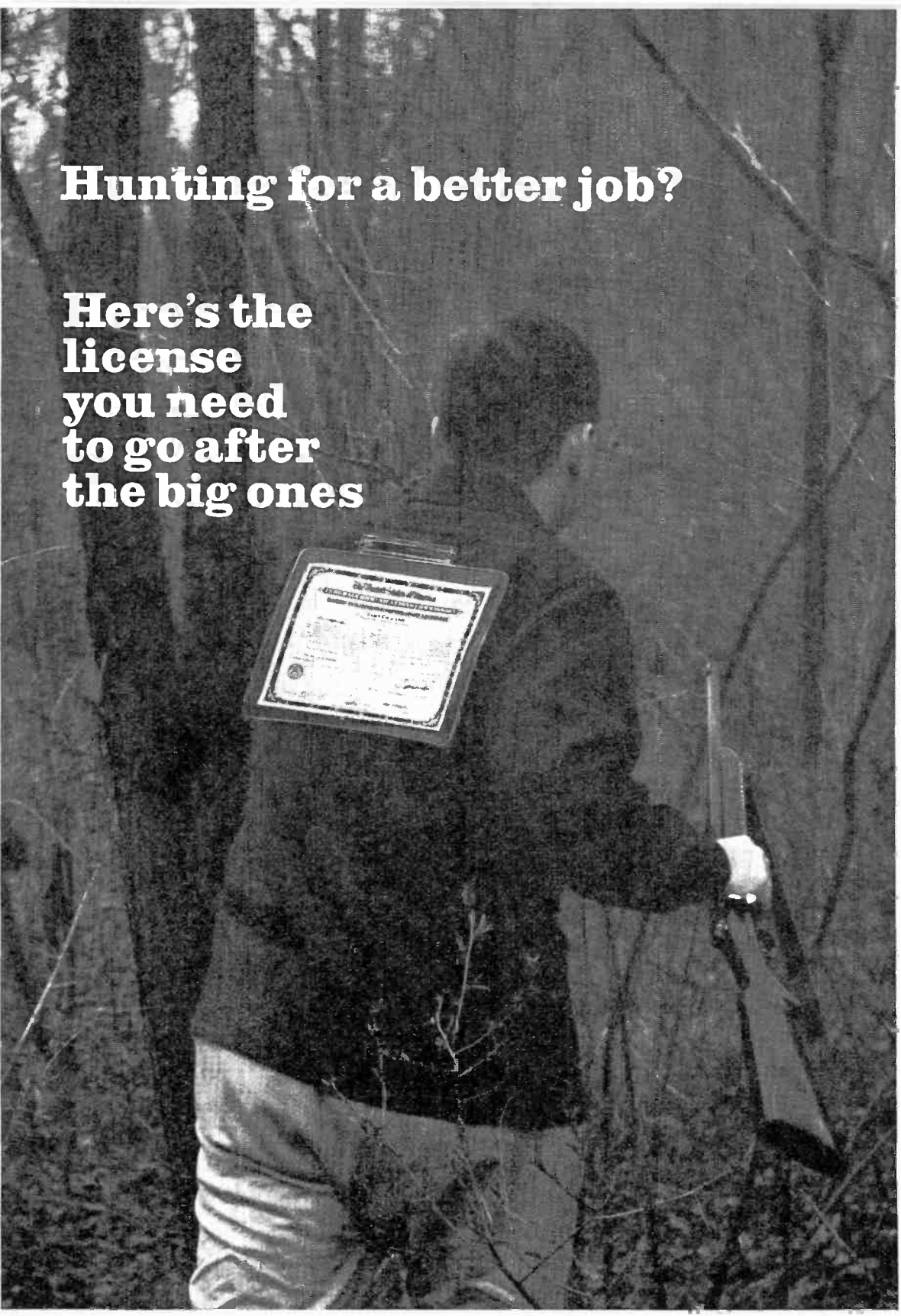
For example, a lithium niobate oscillator pumped at 5300 A by a Q-switched, frequency-doubled YAG-Nd laser, can operate over a range of 0.59 to 5.0 microns. These developments, particularly those involving the generation of multiple laser wavelengths or rapid scanning through wide ranges, require special consideration of the design of eye-protection devices. It should be noted that the Nd^{3+}-glass systems have produced the greatest laser powers known to date—well in excess of 100 joules per pulse or greater than 10^{10} Q switched. The ruby laser operating at a wavelength of 6943 A is especially well suited for high-power single-pulse operation where energies in excess of 10 joules per pulse may be realized.

Semiconductors. The best-known example of an injection laser is the gallium-arsenide type whose operation depends on a pn junction. This device operates at a wavelength of 8400A but it should be noted that the wavelength range of all available types of semiconductor lasers is approximately 4560 A to 51,000 A. Generally speaking, the semiconductor is moderately low power in continuous-wave operation (milliwatts to several watts) and has a typically broad beam divergency (about 15 to 20°), unlike gas lasers which do not usually exceed a few milliradians. Certain semiconductor lasers are pumped by multi-kilovolt electron beams (for example, CdS at 4900 A) which may introduce the additional question of ionizing radiation hazard.

of teeth reports that the reflected laser light changes color as the decay is removed.

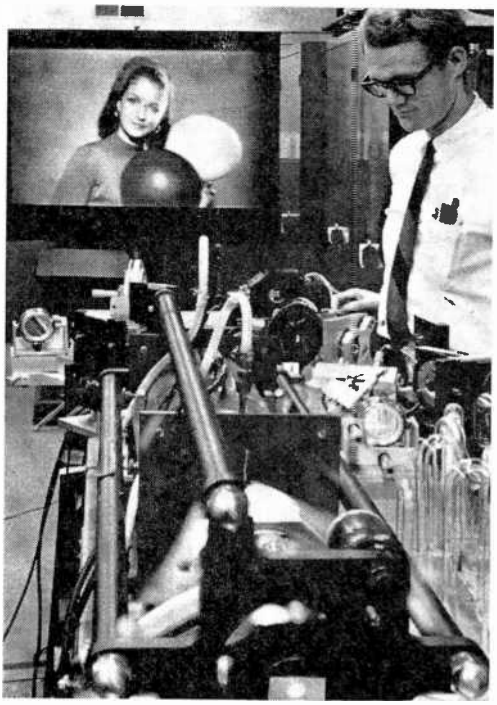
Similar to the dentist's laser drill is a micro-surgical knife which will not only cut delicate tissues with ultra precision, but also cauterize as it cuts. Micro-surgical treatment of glaucoma using a laser to remove a portion of the iris of the eye is showing great promise. In cosmetic medicine, doctors at a Cincinnati hospital have successfully removed a tattoo from a patient's arm. Because the laser beam penetrates translucent skin without harm, it can reach below the skin's surface where it will vaporize the darker pigment of the tattoo.

In one unusual application, an English tailoring firm has started to cut cloth with a carbon-dioxide laser. It is claimed


Hunting for a better job?
Here's the license you need to go after the big ones

that the use of the laser ensures a clean, heat-sealed cut with no fraying. A variation of this technique has also been used by electronic component manufacturers to "trim" the values of glass-encapsulated carbon-film resistors.

Fantastic Holography. An extremely interesting use of lasers is in the area of holography—which will be discussed on these pages in detail in the January 1970 issue. A hologram is an optical image resulting from the shining of a coherent light source (like a laser) through a special photographic negative. Unlike the flat, two-dimensional image one sees from a conventional piece of photographic film, the hologram is in true three dimensions. No special glasses or viewing screens are required. In fact, the viewed image seems to be suspended in air. What makes it so special is that you can look around the image and see its sides, just as you could if the original were actually suspended in front of the observer. It is undoubtedly possible that completely new filming techniques will result from holography.



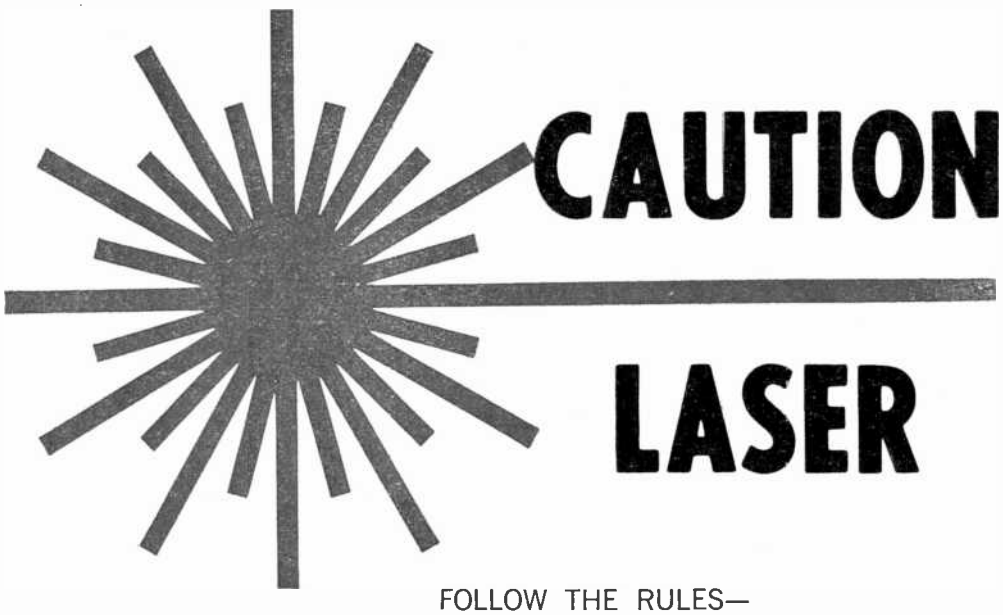
Using three lasers (one for each basic color) and mechanical scanning methods, the projection system shown here provides a bright, 58" wide by 31" high TV display. Video comes from a conventional color TV receiver. The system is being developed by General Telephone and Electronics Laboratories.

Research is also taking place to use three different laser beams (one red, one blue and one green) to produce a very large, bright television viewing screen. Such screens would be useful for public TV viewing in theatres. A system of this type will be shown at the Osaka, Japan World's Fair.

Lasers will also revolutionize the entire communications industry. It is quite conceivable that, within the next decade, lasers will have supplemented or largely replaced many of the microwave communications links scattered throughout the world. The use of laser beams in such a fashion will enable each microwave link to carry literally thousands more signals. In fact, it is technically impossible, but theoretically predictable that a laser could be modulated with all of the radio frequency spectrum and still have plenty of room left over.

Laser beams will also be used for deep-space communications. Just like the enormous dishes used for radio frequency satellite communications, a laser beam can be directed so sharply that its ultimate accuracy is limited only by the optics and precision of the telescope used in aiming it. Thus, a laser used in conjunction with some of the larger astronomical telescopes would ensure—at least one way—communications to the edge of the solar system.

What Of The Immediate Future? Lasers are getting smaller and generating higher power. Sylvania Electronics recently demonstrated a very small laser with an internal heat exchanger to cool the gases in the lasing area. This cooling technique can help produce enough beam power to cut hard metals and refractory materials. This development may foreshadow the introduction of low-cost tools for the metalworking industry. It also indicates that we may soon see small but extremely powerful communication links between urban areas and greatly simplified intercontinental TV and telephone relay networks. -30-



FOLLOW THE RULES— AND THERE'S NO PROBLEM

BY LEWIS B. LLOYD

PART OF ANY new scientific development (especially where electromagnetic radiation is involved—atomic, radio, or light) is the possibility that hazards to human safety may exist. The laser is no exception and, as the presence and use of lasers become more widespread, the importance of the possible hazards is receiving more and more attention.

The dangers involved with the laser are particularly important because they can be so easily overlooked. (Though to date there has been no major laser injury.) Many people fail to appreciate the fact that a simple beam of light can be dangerous. They seem to forget that the output of a weak laser directed at a small spot can be 100,000 times as intense as the same area on the surface of the sun.

Obviously, since the human skin and especially the eyes are very sensitive to light, the application of such an intense light to these photosensitive surfaces can cause permanent damage. Most important, where a laser is concerned, distance does not contribute to safety. At 10 miles, the beam from a 6-inch parabolic-reflector searchlight spreads out to approximately 1760 feet; however, at the same distance, an ordinary laser beam diverges less than four feet—and thus retains its extremely high intensity.

Another hazard connected with the laser is that specular reflections off a smooth surface can also be dangerous. Obviously, then, mirrors, bench tops, shiny tools, rings, wristwatches, etc. can be likened to "secondary lasers" and must be treated with the same caution as the actual laser.

Helium-Neon Laser. The helium-neon laser described in the article in this issue of POPULAR ELECTRONICS is widely used in alignment and fine measurements in a number of industrial and research activities. With a maximum light output of 0.5 milliwatts, it is considered to be little more dangerous than a white point-source light of comparable intensity. However, since laser effects have been virtually unexplored and because adequate data on chronic exposure do not exist. some general safety rules should be followed in working with this or any other laser. These rules should be followed even though the POPULAR ELECTRONICS laser output is considered to be far below the level of possible danger to the eyes.

Laser Safety Rules. Follow these rules at all times:

1. NEVER look directly into a laser

THE THIN RED LINE

The light output of a helium-neon laser is many thousands of times brighter than that of a high-pressure mercury arc lamp. That is why you should never stare directly into the beam.

A laser beam is visible for a considerable distance, even in daylight. At night, depending on the clarity of the atmosphere, the beam is visible (on axis) for many miles. The small laser described in this issue has been tested to slightly less than one mile.

In a typical gas laser, the beam is only a couple of millimeters in diameter when it leaves the laser and diverges (enlarges) at a rate of approximately one part in 2000. Typically, a laser beam would produce a circle about 1 foot in diameter at 2000 feet. Lenses can be used to reduce the circle size and to increase the range.

The laser beam can be reflected around corners using front-surface mirrors. It will also pass through fiber optics. In both of these applications, the laser beam retains its coherency.

beam (on axis) either with the naked eye or through binoculars or a telescope at a distance. Remember that a laser beam usually cannot be seen unless there are airborne particles (smoke, dust, etc.) to provide scattered reflecting surfaces. With some lasers, the beam cannot be seen even under these conditions.

2. DO NOT rely on tinted glass, sunglasses, or other eye-protective devices unless the filtering medium has been specifically designed to attenuate the wave-length of the laser in question. There is no one type of filter glass that protects at all laser frequencies.

3. NEVER leave an activated laser unattended. An unsuspecting person may accidentally look into the beam. A warning sign or audible signal should be used to indicate when a laser is operating.

4. For general experimenting, room lighting should be high (about 200 foot candles) to keep the eye pupil small and reduce the possibility of retinal damage due to inadvertent exposure.

5. Unless the experiment is fully protected, NEVER shine a laser beam on a specular surface since reflections may approach direct beam intensities. Such reflections are difficult to predict and can make off-axis viewing as potentially dangerous as direct on-axis viewing. Special care must be taken with watch crystals, metallic watch bands, rings, tools, glassware, door knobs, screw heads, etc. The floor, bench tops, cabinets, should be covered with a dark, light-diffusing material.

6. BEWARE of electrical hazards. All of the possible danger in a laser is not confined to the light beam. The laser power supply can also cause physical damage if high-voltage terminals are contacted. Remember that high-quality filter capacitors retain a charge after the system has been shut down. Capacitors should be discharged before attempting any adjustments to the laser tube or associated electronics. A protective cover should be placed over the laser tube (except for the end where the beam is emitted) to prevent accidental contact with the high-voltage leads. Adequate grounding should be provided for all metal chassis and other hardware.

7. DO NOT operate a laser in rain, snow, fog, or heavy dust. Here again, potentially dangerous secondary specular radiation can result.

8. DO NOT inadvertently or intentionally track vehicular or airborne traffic with a laser beam.

9. Set up a safe laser operating procedure. Make up a check list and follow it precisely each time the laser is used.

10. If a flash-tube pulsed laser is used, the flash tube should be shielded. If it isn't, avoid looking directly at the flash tube when it fires. Intense white light, ultraviolet, and infrared radiation occur at the instant of firing. Overexposure to ultraviolet can cause blindness.

Until a great deal more is known about the biological effects of a laser beam—even those of "safe" lasers—treat all laser beams with the greatest of respect. -30-

THE SMALL RED DOT

When a laser beam is aimed at a light-colored surface, there will not be a clearly defined spot. The spot seems to take on a "graininess" and to "dance" in place. This is caused by a complex afocal interference pattern that exists between the observer and the diffuse surface. The eye of the person looking at this spot tends to relax and he focuses behind the spot if he has normal eyesight (emmetropic) or is far-sighted (hyperopic). If he is near-sighted (myopic), the focus occurs in front of the surface. Because of parallax, if the observer moves his head from side to side, the granular pattern appears to move with him if he has normal eyesight or is far-sighted and opposite to the head motion if he is near-sighted. (All of this is obviously without the viewer's using corrective lenses.)

Rally Round the Reflex

BY DAVID B. WEEMS

Part Two

Note: Part I of this article, describing various phases of reflex speaker enclosure design, appeared in the November issue of POPULAR ELECTRONICS.

LAST MONTH we noted that choosing the frequency to which an enclosure is to be tuned is not as simple as it might seem. Traditionally, the free-air resonant frequency of the loudspeaker is used. There are certain situations, however, in which this practice produces poor bass performance.

For example, in Table II, the University models 312 and 315C have claimed resonances of 16 and 17 Hz, respectively, and yet are suggested as usable in enclosures that are tuned to 50 Hz. The tuning to 50 Hz was probably the principal decision in the design of these enclosures. The University enclosures listed are the correct size to permit the system to be tuned to 50 Hz with a port area equal to effective cone area. But why 50 Hz? Hugh Morgan, Consultant for Research and Development at University Sound, tells us what would happen if such a system were tuned to the speaker's free-air resonance:

> "Since reflex operation enhances response only 2-3 octaves above resonance, the resultant curve would peak at resonance and then sag badly in the important 70-150-Hz area, above which the main cone output would begin to 'catch up' to the combined speaker-port resonance area output. Musically, this would be a rather un-listenable system. It would appear to have poor bass. This is characteristic of very low-resonance speakers when classically reflexed."

Note that in the design of the reflex enclosures recommended by Hugh Morgan, the old objective of controlling the cone at resonance was secondary to obtaining uniform low frequency response in the musically important ranges. In other words, the output from the port is placed at those frequencies which are most needed to complement the response of a particular loudspeaker. To choose the port tuning on such a basis, the designer should have access to response curves of the loudspeaker.

Another reason for challenging the practice of tuning every enclosure to the free-air resonance of the speaker is given by T. W. Richardson of the James B. Lansing Technical Service Department:

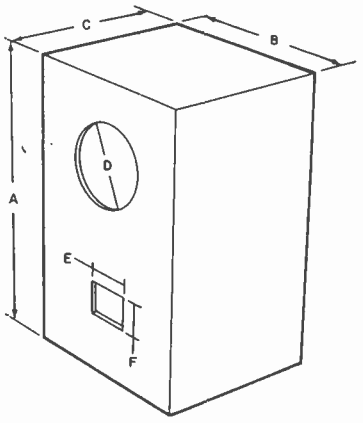


Fig. 3. "Universal" enclosure recommended by T. W. Richardson for "orphan" loudspeakers. Tune enclosure to 40 Hz. Use ¾" plywood, well braced, and glued and screwed together with glue blocks inside the corners. Volume should be at least 5 cu. ft. Typical values for A, B, and C would be 30", 21", and 14.5" respectively. If tuning equipment is not available, try 4 in. for E and 3½ in. for F.

TABLE II—BASS REFLEX ENCLOSURES FOR POPULAR LOUDSPEAKERS

MANUFACTURER AND MODEL	OPTIMUM VOLUME (cu ft)	TUNING SPECIFICATIONS	RECOMMENDED DAMPING MATERIAL	COMMENTS
Altec Lansing				
All models	Not specified	See comments		Enclosures tuned to free-air resonance of speakers. Complete instructions given in "Speaker Enclosures: Their Design and Use," Altec Lansing, 1515 S. Manchester Ave., Anaheim, Calif. 92803. Price $1.00.
James B. Lansing				
LE8T/PR8	2	Use PR8 passive radiator	Acoustical fiberglass, Kimsul, Tufflex, or felt rug padding.	These values were chosen as "best compromise" between space requirements and optimum-performance larger enclosure. Note: 2 cu ft is maximum for LE8T with PR8. Minimum volumes are: LE8T—0.75; LE12C—2.2; and D130—2.5 cu ft. Information on enclosures of all sizes recommended is given in publication CF802, "Loudspeaker Enclosure Construction Manual," a very useful booklet for use with any PBL speaker. Order from James B. Lansing Sound, Inc., 3249 Casitas Ave., Los Angeles, Calif. 90039. Price 50¢.
LE8T	3 to 5	13 sq in., 3" tunnel 15 sq in., 3" tunnel		
LE12C	4 to 6	15 sq in., 6" tunnel 20 sq in., 5" tunnel		
D130	4.5 to 6	25 sq in. 35 sq in.		
Jensen				
SG80	1 (1775 cu in.)	3" I.D. x 4" long duct	Fiberglass	Enclosures tuned to free-air resonance of speakers. Volume is selected for optimum transient response rather than lowest bass cutoff or maximum output. Information for enclosure construction is packed with each Jensen speaker.
DL220	4 (6940 cu in.)	3" I.D. x 5" long duct		
SG223	8.3 (14,400 cu in.)	4¾" I.D. x 5½" long duct		
University				
Diffusicone 8	8	28 sq in.	Tufflex for lining. Spun glass wool as air space damper.	Models 312 and 315C are not designed for "classical" reflex operation, but enclosures here would give good performance, arbitrarily tuned at 50 Hz (see text). Avoid narrow slot shapes for these ports. Information for smaller enclosures packed with these and other University speakers.
312	10	78 sq in.		
315C	17	133 sq in.		

"For one thing, the resonance changes as soon as the speaker is put into a box. And it is this system resonance that determines where a port should be tuned for maximum bass radiation."

Richardson also mentions that you should know the kind of response your speaker has before deciding where to put the port frequency. He also says that it may be desirable to tune for other purposes than maximum bass radiation.

"For example, in most JBL bookshelf systems, the port is tuned considerably below the closed-box frequency. In these models we are primarily interested in reducing distortion and limiting cone travel at very low frequencies rather than trying to get maximum bass efficiency."

The Next Step. What course should the builder of speaker enclosures at home follow? Obviously, where they are applicable, he should follow the instructions of the manufacturer. But, if you want to produce an enclosure of unusual size or one that is in any way different from the manufacturer's recommendations, you can improvise and yet be consistent with his practice. First, estimate the tuning frequency of the manufacturer's recommended enclosure by reference to a published chart. Then tune your new enclosure to the same frequency. The results should be on the target—if not right in the bull's-eye.

Of course, these instructions are of no help if you are the owner of a nameless speaker or one that is supplied without enclosure information. Or if you have no test equipment. For you, T. W. Richardson has some advice:

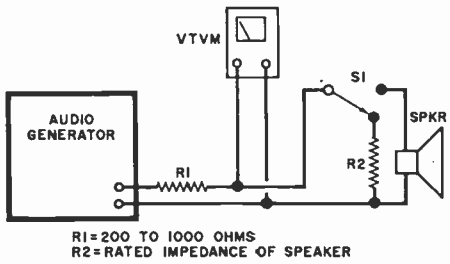
"If I were a home constructor, building an enclosure for an "orphan" loudspeaker, I would tune the port to about 50 Hz, period! If I had no equipment to check port resonance, I would use a published enclosure design—one as large as possible—with preferably 5 cubic feet or more of internal volume."

G. A. Briggs, the English authority, says:

"If the user has no technical equipment for checking resonances and resonance frequencies, I think the best plan would be to have a vent with a sliding panel so the area could be adjusted to the best position on a listening test.

"If we are dealing with small enclosures—about 1 cubic foot—my own preference is for the slotted back, which helps to cut down resonances. And I would prefer a smooth response to resonant peaks which some people like to have as bass improvement."

Mr. Briggs's compact is detailed in Fig. 4, and a "full-size" enclosure such as that recommended by Mr. Richardson is shown in Fig. 3. Listening tests on several speakers in a box tuned to 40 Hz indicated very satisfactory results. In some cases, it appeared to be desirable to tune the enclosure to a



R1 = 200 TO 1000 OHMS
R2 = RATED IMPEDANCE OF SPEAKER

HOW TO RUN AN IMPEDANCE CURVE.

To run and plot an impedance curve, follow the test hook-up shown in the diagram. Assuming you have an 8-ohm speaker, in which case *R2* should equal 8 ohms, the procedure is as follows.

1. Set the audio generator frequency to 200 Hz.
2. With the switch turned to *R2*, adjust the generator output so that the VTVM (or other a.c. voltmeter) has a reading of 8 or 80 units (for example 80 millivolts). The exact value isn't important, but choose a reading that is about half the meter scale allowing enough switchable range above it for the meter to record the peaks.
3. Switch *S1* from the resistor to the speaker.
4. Maintain constant output and sweep the generator down the scale from 200 to 20 Hz, stopping at the following frequencies to take readings: 200, 175, 150, 125, 100, 90, 80, 70, 60, 50, 40, 30, 20.
5. Repeat the sweep and watch for peaks. Record the frequency and reading for each peak or valley. For example: you may have recorded a reading of 40 at 80 Hz and also at 70 Hz. But on the rerun you note that there is a peak of 50 at 75 Hz. Since the exact position of the peak is of some import, it should be recorded.

Note that although your readings are a.c. voltage readings, you may consider them to be impedance values in ohms.

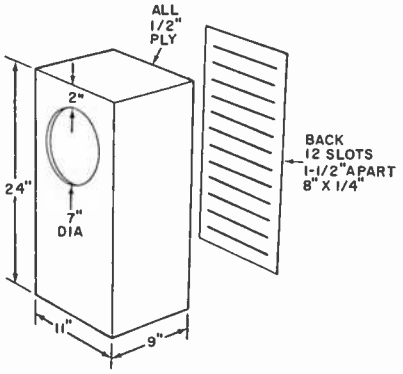


Fig. 4. Compact (1 cu ft) enclosure for 8" speakers has all sides lined with 1" absorbent material. Back is lined with soft cloth. Slots may be made by cutting strips of ½" plywood to proper width and mounting them on a frame width ½" spacing. Or cut a row of 10 holes ½" in diameter to give about the same area as the 8" x ¼" slot.

slightly high frequency—45 or 50 Hz. To allow for this possibility and follow Mr. Briggs's suggestion of a sliding panel, you might enlarge the port of the enclosure in Fig. 3 to E = 7" and F = 4½". Then install a sliding panel or temporarily screw a panel to the baffle to vary the port size.

The best results in most cases will occur when the area of the port is between 14 and 25 sq in. Note that, if we follow the rule of thumb given earlier to determine enclosure size by port area (port area equal to at least 30% of the effective cone area), this enclosure is as suggested by Mr. Richardson, at the low limits for 12" speakers. Of course, even smaller enclosures may be tuned to 40-50 Hz by means of a duct behind the port.

Damping Material. Another decision that the enclosure builder must make is: what kind and how much padding should be used. Here's what the experts say about the kind:

Novak: "The advantage of fiberglass is its ready availability and the fact that it is obtainable in many densities. The acoustic resistance is a function of density.

"Any material consisting of loosely packed or woven fibers will probably work well. The properties of fiberglass have been thoroughly documented and it is, therefore, the material that is most often used."

Richardson: "Almost anything that is absorbent to sound and not too bulky or flaky *can* be used to line loudspeaker enclosures. This includes acoustical fiberglass, Kimsul, Tufflex, felt, rug padding, old blankets, cotton waste, and what-have-you. However, best results will be obtained with the first three items."

Morgan: "We have found Tufflex to perform very well as lining material and spun glass wool to be effective as an air-space damper and volumetric expander."

Mr. Morgan points out that different systems may use padding for different purposes and says that the characteristics of the padding should match the purpose.

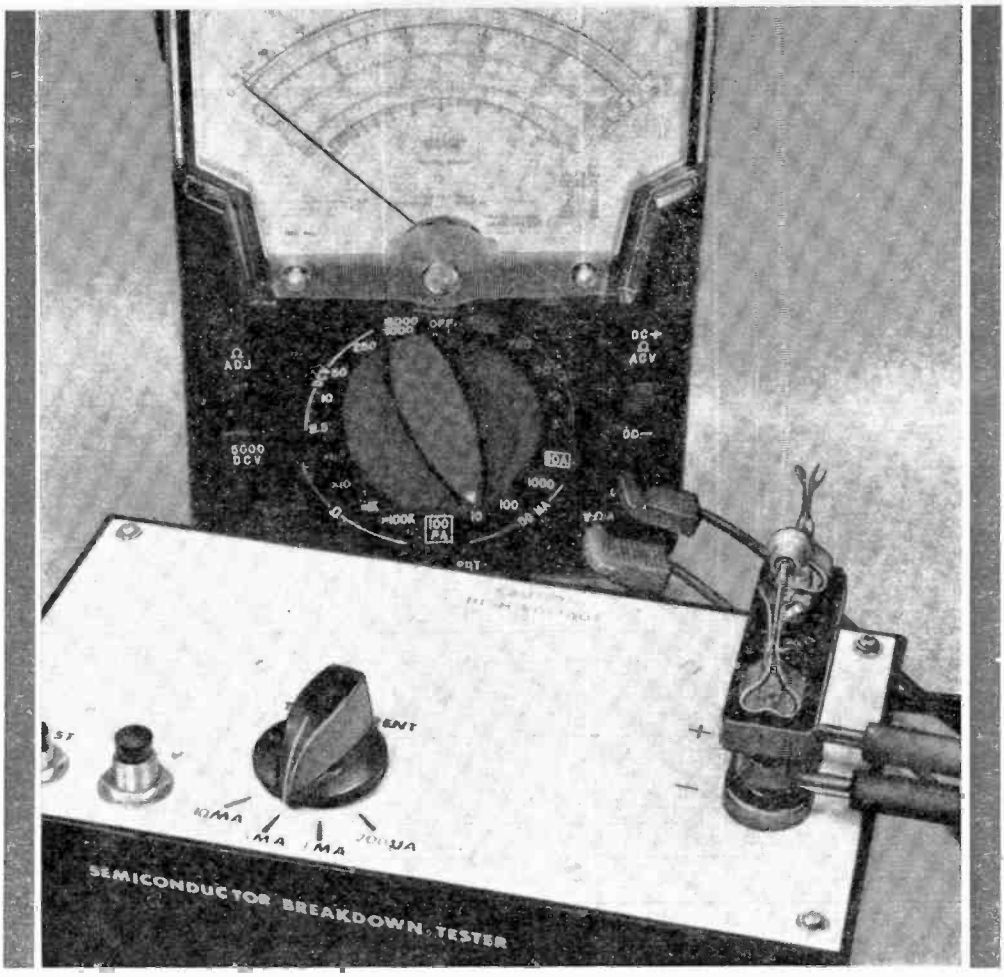
As to how much padding to use: the usual purpose of padding is to act as a boundary reflection damper and common practice (as recommended by JBL) is to line a minimum of 50% of the inside walls of the enclosure. T. W. Richardson says:

"The only function of this padding is to absorb some of the mid-range energy that otherwise might be reflected back through the cone or out through the port opening and introduce unwanted peaks. With 50% lining, you have a padded side facing an unpadded side.

"For example, line the top, back, and side. Once you start using more damping material than that, the mid-range will begin to sound less 'live.' The exact location and amount of padding are not overly critical unless you are a perfectionist."

Some experimenters, utilizing "stuffing" as an air-space damper, have recommended filling a bass reflex enclosure with damping material. Novak, while admitting that the practice smooths the impedance curve, reduces phase shift and improves loading, questions it because it absorbs power. He does recommend acoustic resistance to cure hangover by means of a fiberglass collar over the speaker. Richardson says that hangover almost always occurs at the frequency of the upper impedance peak and points out that damping the port itself will not help this particular problem but only reduces the advantages of the ported enclosure. Morgan is skeptical of the practice for home experimenters, on the

(*Continued on page* 115)



SEMICONDUCTOR BREAKDOWN TESTER

CHECKING PIV WITHOUT DAMAGE

BY JOHN DEHAVEN

If you are a typical electronics experimenter, you most likely have a collection of semiconductors of questionable characteristics—some of them even unmarked. Of course you can check diodes for front-to-back ratios, opens, and shorts with an ohmmeter; and you can check transistors for gain and leakage if you have a transistor checker. But how do you check them for the important breakdown voltage? If you don't know that a device will withstand the voltage of the circuit in which you want to use it, you might as well forget the whole thing.

You can find the answer easily if you build the breakdown tester described in this article. The tester will check all diodes and transistors up to 300 volts (except MOS field-effect transistors) and the only other equipment you need is a voltmeter. Many other devices may be tested also.

No semiconductor junction is destroyed just by "breaking it down." Destruction of a junction in a circuit is usually caused by high current or by heating due to high power dissipation. In this tester, sufficient voltage is applied to the device to break it down, but the current (and, therefore, power dissipation) is limited to protect the device. Protection is also insured by the fact that many devices will withstand

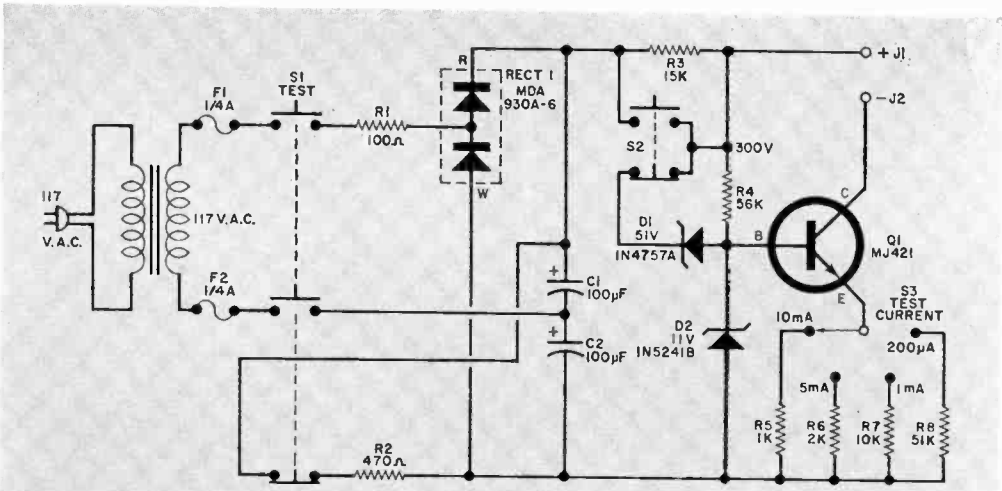


Fig. 1. Operating voltage is applied only when S1 is depressed. Constant-current source (Q1) limits current flow through the semiconductor tc a safe value.

PARTS LIST

C1,C2—100-μF, 200-volt electrolytic capacitor
D1—IN4757A, 51-volt zener diode
D2—1N5241B, 11-volt zener diode
F1,F2—¼-ampere, 3AG fuse with dual holder
J1,J2—Dual red/black universal binding post (H.H. Smith 269RF or similar)
Q1—Transistor (Motorola MJ421) with TO-5 heat sink (Wakefield 150)
R1—100-ohm, 1-watt resistor
R2—470-ohm, 1-watt resistor
R3—15,000-ohm 5-watt resistor (Ohmite 200-5¼ or similar)
R4—56,000-ohm, 2-watt resistor
R5—1000-ohm, 5% resistor
R6—2000-ohm, 5% resistor
R7—10,000-ohm, 5% resistor
R8—51,000-ohm, 5% resistor
RECT1—400-volt voltage doubler (Motorola MDA930A-6)
S1—3-pole, d.t. pushbutton switch (Switchcraft 1009 or 4009)
S2—S.p.d.t. pushbutton switch (Switchcraft 1003 or 4003)
S3—S.p. 4-position rotary switch (Acro 3215J or similar)
Misc.—7¾" x 4 11/16" x 2⅜" plastic utility box with metal cover, line cord, terminal strips, capacitor clips, test leads, mounting hardware, test clip adapter (Grayhill 2-2), etc.

five to ten times their continuous power dissipation rating for the brief time that it takes to press a button and read a meter. The test method used here is similar in principle to that used by industry to measure these parameters.

Construction. The circuit of the breakdown tester is shown in Fig. 1. Layout is not important and any type of enclosure may be used. You could even put it in an existing transistor tester if there is room. The prototype shown in the photos was built in a 7¾" × 4 11/16" × 2⅜" bakelite box with an aluminum panel for the controls. Interior layout of the prototype is shown in Fig. 2. Terminal strip construction was used because of the small number of components.

Transistor *Q1* should have thermal grease between the heat sink and the transistor and the sink should be mounted so that it is electrically isolated from the chassis. You can use a spacer cut from an old circuit board for the insulation. The dual binding post (*J1* and *J2*) called for in the Parts List is fully insulated when properly mounted.

Identify the red terminal as positive (+) and the black terminal negative (−). If individual binding posts are used, be sure they are on ¾" centers to match the optional test clip adapter. No portion of the circuit should be in contact electrically with the case. An isolation transformer (*T1*) is used as an additional safety measure.

A pair of leads with banana plugs on one end and insulated alligator clips on the other may be used for test connections or you can assemble the test clip adapter shown in the photos. The adapter is very valuable for sorting diodes or transistors with long leads.

TABLE I—POWER IN TEST DEVICE

Voltage range	Test current	Power
0-50	200 μA	0-10 mW
	1 mA	0-50 mW
	5 mA	0-250 mW
	10 mA	0-500 mW
0-300	200 μA	0-60 mW
	1 mA	0-300 mW
	5 mA	0-1.5 W
	10 mA	0-3.0 W

The cost of the tester can be reduced by using devices with 10% tolerances for *D1*, *D2* and *R5* through *R8*, although current values will be slightly off. To select 10% devices for *D1* and *D2*, delete the "A" and "B" suffixes from the type numbers given in the Parts List. It is not advisable to use a substitute for *Q1*, although the Motorola MJE2252 (at a higher price) will work and the MJE340 can be tried. Both of these devices require different heat sinks, however. Any pair of silicon rectifiers rated at 400 volts or more may be used in place of *RECT1*.

Checkout. Supply a.c. power to the tester and connect a d.c. voltmeter (minimum 20,000 ohms per volt on the 300-volt scale) to the test terminals. When the TEST button is depressed, the meter should indicate about 50 volts. This is the maximum voltage applied to a device with only the TEST button depressed. It is determined by zener diode *D1* and should not vary throughout the life of the tester.

When the TEST and 300 V buttons are depressed simultaneously, the observed voltage should be around 300 volts, the actual value depending on the supply-line voltage. Current values may be verified by connecting a milliammeter to the test terminals. Read the currents produced for the various positions of the TEST CURRENT switch. They should be very close to nominal if the specified components have been used. The values may be trimmed, if necessary, by adjusting the values of resistors *R5* through *R8*. Minor deviations will be of little consequence in the operation of the tester.

Operation. It is convenient to attach the voltmeter probes under the nuts of the output terminals, leaving the banana jacks free for the test clip adapter or test leads. A suitable test current is selected on *S3* (see Tables I and II) and then, *after* the operator has removed his hands from the device being tested and the test connectors, the TEST button is depressed.

If the junction being tested is inadvertantly connected "backwards" so that the junction is forward biased, a very low voltage will be indicated. This technique can be used to determine the polarity of an unknown device and to measure forward voltage drops at various currents.

Precautions. The tester will produce 300 volts at the test terminals; therefore do not touch the device under test or anything connected to it with either pushbutton depressed. Do not use a metal-encased voltmeter having its common lead connected to the case. The case of

TABLE II—TEST CONDITIONS

DEVICE	CONDITION
Diodes	
Silicon, glass or epoxy, top-hats, etc. to 1A	200 μA
Silicon, power	5 mA
Germanium, most junction types	200 μA
Germanium, point contact	1 mA (50V only)
Zener, up to 1W, less than 50V	5 mA*
Zener, up to 1W, over 50V	1 mA**
Zener, over 1W	10 mA**
4-layer	200 μA
3-layer trigger, under 50V	5 mA
3-layer trigger, over 50V	1 mA
Transistors	
Silicon, small signal, under 1W	200 μA
Silicon, power, 1 to 10W	1 mA
Silicon, power, over 10W	5 mA
Germanium, small signal, planar	1 mA
Germanium, small signal, alloy or unknown	1 mA (50V only)
Germanium, power	10 mA
Junction FET	200 μA
Thyristors	
SCR, gate breakdown	200 μA
SCR, forward and reverse blocking	1 mA
Triac, forward and reverse blocking	10 mA
4-layer diode	200 μA

*To 10 mA for Zz
**To 5 mA for Zz

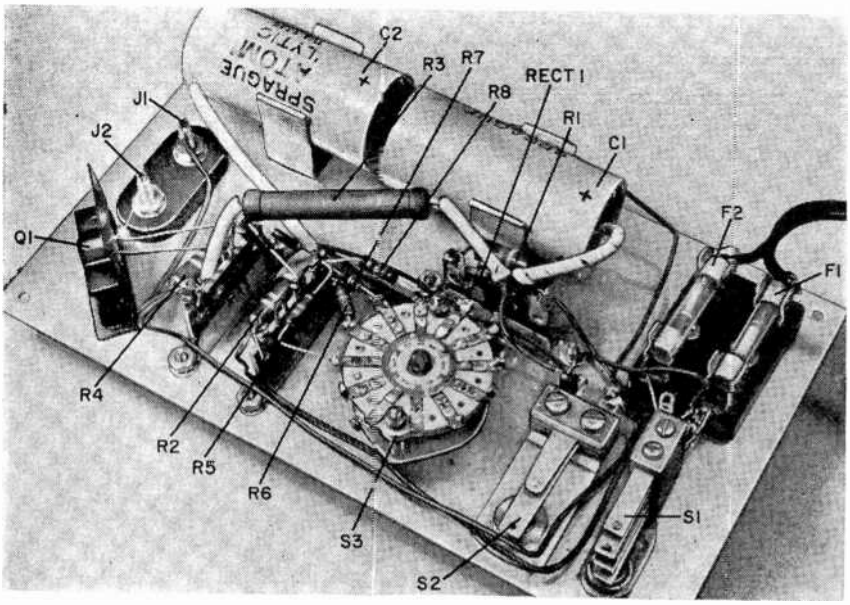


Fig. 2. Other than the power-line isolation transformer, all components are mounted on front panel. The transistor is mounted on a heat sink which is insulated from chassis.

the voltmeter could become "hot" when the TEST button is depressed. Do not "linger" on either pushbutton; develop the habit of depressing the buttons only long enough to read the meter. Although most devices will withstand the output of the tester for prolonged periods, some of them may overheat. Be careful to use an appropriate current and voltage range for the device you are testing; currents larger than necessary only increase the chances of overheating (see Table II).

Testing Diodes and Rectifiers. In general, peak inverse voltage (PIV) ratings of silicon diodes and rectifiers with ratings up to 1 ampere may be tested using the 200-μA range. Rectifiers with high ratings (those with a mounting stud or other provision for cooling) should be tested on the 1-mA range. Germanium diodes may often be tested on the 200-μA range, up to 300 volts. Some may have excessive leakage (particularly small point-contact diodes of the 1N34 type) and require use of the 1-mA range, up to 50 volts.

Zener diodes. Zener breakdown voltage (V_z) should be tested with the 5-mA range for diodes of 1 watt or less, and less than 50 volts. Small zeners of higher voltage ratings should be tested on the 1-mA range. Power zeners should be tested on the 10-mA range. The regulation quality of a zener may be estimated by changing the current among the above selections. A high-quality zener exhibits very little change in voltage for different currents. This quality of a zener is indicated by Z_z, the zener impedance which is the ratio of the change in voltage to the change in current. The smaller the zener impedance, the better the zener. If a voltmeter of high resolution is used, Z_z can be measured by changing the current and observing the resultant change in voltage.

The zener diode characteristic may often be found in conventional diodes and rectifiers. The primary difference is that the breakdown voltage of the zener is closely specified (V_z is essentially the same as PIV). Any diode may be used as a zener at its breakdown voltage if its Z_z is sufficiently low. Base-emitter junctions of transistors often make excellent low-power zeners when reverse biased.

Transistors. The "worst case" test for bipolar transistors is BV_{CEO} (breakdown voltage, collector to emitter, with base

HOW IT WORKS

Transistor *Q1*, which has a minimum BV_{CEO} of 325 volts, zener diode *D2*, and an emitter current resistor selected by *S3* form a constant-current source that attempts to drive a fixed current through any device connected between *J1* and *J2*. A drop of about 10 volts is provided across the emitter resistor by *D2* and the V_{BE} drop of *Q1*. This fixes the emitter current at a predetermined value; and if h_{FE} is large and leakage is small, the collector current is fixed at a value only slightly less than that of the emitter.

Power is supplied through a simple line-operated voltage doubler consisting of *T1*, *RECT1*, *C1*, and *C2*. The d.c. output varies slightly with line voltage, but it can be expected to be close to 300 volts. Switch *S1* is a momentary pushbutton switch which breaks both sides of the line for safety reasons when not depressed. This switch automatically discharges the high-voltage supply through *R2* when it is released. Resistor *R1* limits the inrush currents to safe levels when *S1* is first depressed.

The combination of *R3* and *D1* limits the available output voltage to about 50 volts unless the 300 V pushbutton, *S2*, is depressed. When *S2* is depressed, the full 300 volts from the supply is applied to the test connectors.

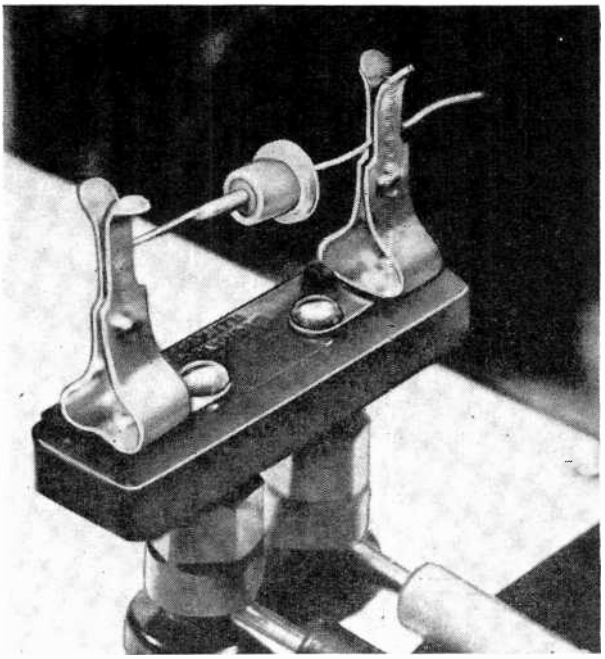
When testing semiconductor breakdown, the power dissipated in the device under test is a paramount consideration. In this tester, the power is under control at all times, being the product of the current and the voltage produced by the tester. The amounts of power developed for the various switch settings are given in Table I. The amount of time power is applied to the device under test is low, which provides the necessary margin of safety.

While the lowest possible current is desirable to minimize power dissipation, the lowest usable current must be higher than the leakage current of the device under test. The four values of current were selected to provide safe, reliable testing of the widest variety of device without great expense.

The lower current limit of 200 μA was chosen for compatibility with a 20,000-ohms-per-volt meter. Such a meter draws 50 μA of current at full-scale deflection. This reduces the actual test current through the device under test to 150 μA. A TVM or other high-input-resistance voltmeter with 10 megohms input impedance will draw only 5 μA on the 50-volt range and 30 μA on the 300-volt range at full deflection.

open), which is measured with normal operating polarity applied to the transistor (positive collector and negative emitter for *npn*, vice versa for *pnp*) and with the base disconnected.

To be exact, the actual parameter measured here is V_{CEO} (sustained) which is not very different from BV_{CEO} unless the transistor has an extreme "hook" characteristic. Some devices have a negative-resistance characteristic after breakdown so that the sustaining voltage drop in the V_{CEO} mode is somewhat less than the actual breakdown voltage. The tester will indicate the sustaining voltage. If it is important to measure BV_{CEO} for a device with a substantial hook, it may be done using the technique prescribed for breakover voltage tests on thyristors. You are always "safe" in an application,



This test jig can be made from scrap plastic, a couple of spring clips, and a pair of banana plugs. In this way, semiconductors with long leads may be tested. This approach is also useful when a large number of devices need to be individually tested or sorted.

however, if the sustaining voltage is not exceeded.

Occasionally, an application may require measurement of other breakdown voltages, such as BV_{EBO} (emitter to base in reverse direction, collector open), BV_{CBO} (collector to base, emitter open), BV_{CES} (collector to emitter, base shorted to emitter), and BV_{CER} (collector to emitter, base connected to emitter through a resistor). However, if the applicability of any of these characteristics is in doubt, use the BV_{CEO} value to be on the safe side.

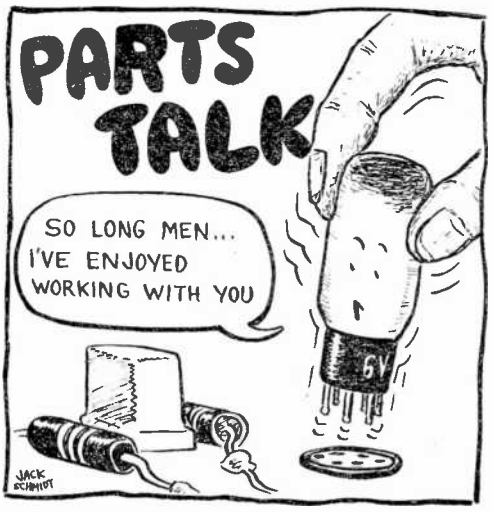
All small-signal silicon transistors can be tested with the 200-μA range. Silicon power devices should be tested with the 5-mA range. Germanium transistors have higher leakage, so small-signal germanium units should be tested on the 1-mA range. It is not advisable to use the 300-volt range for unidentifiable germanium transistors (especially if the package is obsolete) because they may be alloy units with low power dissipation capabilities. Germanium power devices may be tested on the 10-mA scale. Occasionally, you may encounter a germanium power device whose leakage I_{CEO} is greater than 10 mA so BV_{CEO} cannot be measured. The best, and safest, alternative is to measure BV_{CES} or BV_{CBO} and derate 30%.

Junction field-effect transistors may be tested for BV_{GSS} (gate to source, drain shorted to source), the worst-case gate breakdown test for this device, using the 200-μA range. For FET's, BV_{DSX} (drain to source, with gate biased to cut off) may be measured using an external battery or power supply to provide the gate bias. The 200-μA range is suitable for this test. For MOSFET's, BV_{DSX} can be measured using the same procedure. Handle these devices with care. *Do not* test MOSFET's for gate breakdown—the gate must never be broken down, no matter how small the current.

Thyristors (SCR's, 4-layer diodes, and triacs). The gate-to-cathode junction of an SCR may be tested directly, using the 200-μA range. The reverse blocking voltage of an SCR or a 4-layer diode may be measured directly using the 1-mA and 200-μA ranges, respectively. Forward blocking voltage (or breakover voltage) of a thyristor may be measured if a variable power-line transformer is part of your bench equipment. Connect the tester to the variable transformer and set the latter for zero output. Connect the thyristor and meter to the test terminals (cathode to negative, anode to positive). Depress both the TEST and 300 V pushbuttons and slowly increase the variable transformer voltage. When the breakover voltage is reached, the indication on the meter will drop suddenly to a very low value. Release the pushbuttons immediately. If you did not notice the exact breakover voltage, you can read it again after first disconnecting the thyristor. Use the 200-μA range for 4-layer diodes, 1-mA for SCR's and 10-mA for triacs in this test. Triacs must be tested in both directions by this method.

Testing Other Devices. The sustaining voltage of a 3-layer trigger diode or other "hook" device may be measured directly using the 5-mA scale for devices under 50 volts and 1 mA for devices over 50 volts. Breakover voltage can be measured by the variable-transformer method used for thyristor tests. The voltage will decrease only a few volts at breakover, going down to the sustaining value.

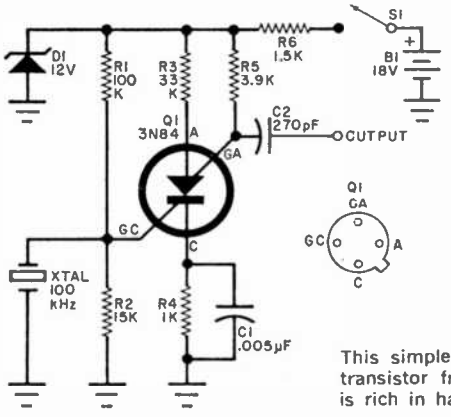
Gas diodes, from voltage regulator tubes to neon bulbs can be tested in the same manner as "hook" devices. Select a current close to operating conditions and use the 300-volt range. -30-



SCS FREQUENCY CALIBRATOR

LOW-COST, GENERAL-PURPOSE CALIBRATOR FOR SCOPE OR RECEIVER

BY B. W. BLACHFORD



This simple circuit operates just as well as a multi-transistor frequency calibrator. The output waveform is rich in harmonics and covers the short-wave range.

PARTS LIST

B1—18-volt battery (two 9-volt cells in series)
C1—0.005-μF ceramic disc capacitor
C2—270-pF mica or polystyrene capacitor
D1—12-volt, 400-mW zener diode
Q1—Silicon controlled switch (General Electric 3N84)
R1—100,000-ohm (see text)
R2—15,000-ohm
R3—33,000-ohm
R4—1000-ohm
R5—3900-ohm (see text)
R6—1500-ohm
All resistors ½-watt 10% tolerance
S1—S.p.s.t. switch
XTAL—100.000-kHz crystal

EVERY ELECTRONICS experimenter and shortwave listener needs a frequency calibrator. The experimenter can use one as a source of high-level, relatively standard frequencies and also to calibrate his oscilloscope trace when observing special waveforms. The SWL with a low-cost receiver uses a frequency calibrator to find out where he is tuned to the short waves and to check his dial calibrations.

The conventional design for a frequency calibrator uses transistors in a crystal oscillator and shaper circuit. By using the silicon controlled switch (SCS), one of the transistors can be eliminated and the circuit complexity can be simplified considerably.

How It Works. The SCS is a four-layer device and is similar to the SCR (silicon controlled rectifier) except that all four layers are brought out to terminals. (See "Getting to Know the SCS," POPULAR ELECTRONICS, September 1969, p. 75.) It has high turn-on sensitivity when a positive-going signal is applied to its cathode gate (GC). With proper circuit design it can be made equally sensitive to turn-off with a negative-going signal applied to the same gate.

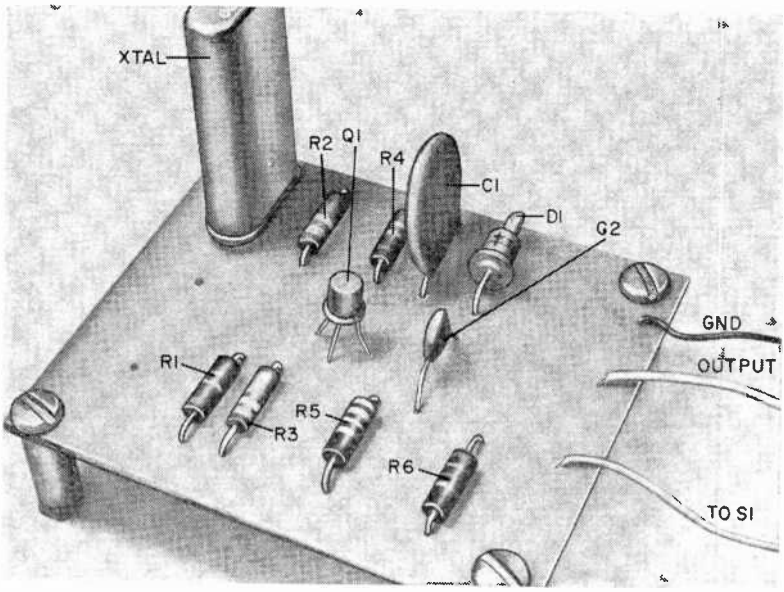
In the circuit for this frequency calibrator, when power is first applied, *C1* is in a discharged state so that the cathode of the SCS is at ground. Resistors *R1* and *R2*, operating as a voltage divider, allow a positive potential of sufficient

amplitude to be applied to the cathode gate and turn on the SCS. The resulting current flow through *R4* creates a voltage drop across *C1* so that the capacitor starts to charge up. As it does, the cathode of the SCS becomes more and more positive with respect to the cathode gate (equivalent to making the cathode gate negative with respect to the cathode), and a point is reached where the SCS is turned off. Then *C1* discharges through *R4* and the cathode of the SCS returns toward ground potential. As it does, the point is soon reached where the potential on the cathode gate again triggers the SCS on, and the cycle is repeated.

Without the crystal, the circuit oscillates at a frequency determined primarily by the value of *C1* (about 50 kHz for the circuit shown here). The latter being applied to the cathode gate of the SCS. The switching impetus provided by the crystal improves the squareness of the output waveform considerably, even though the operating frequency is doubled.

It is interesting to note that a signal of triangular shape is available across capacitor *C1*.

Construction. Any type of reliable construction technique can be used in building the frequency calibrator. The photo shows a simple printed circuit approach. The device can be mounted on four spacers for installation directly in a receiver or in a separate metal enclosure. If it is to be operated individually, a pair of 9-volt batteries must be added. The power on-off switch should be mounted in a convenient location.

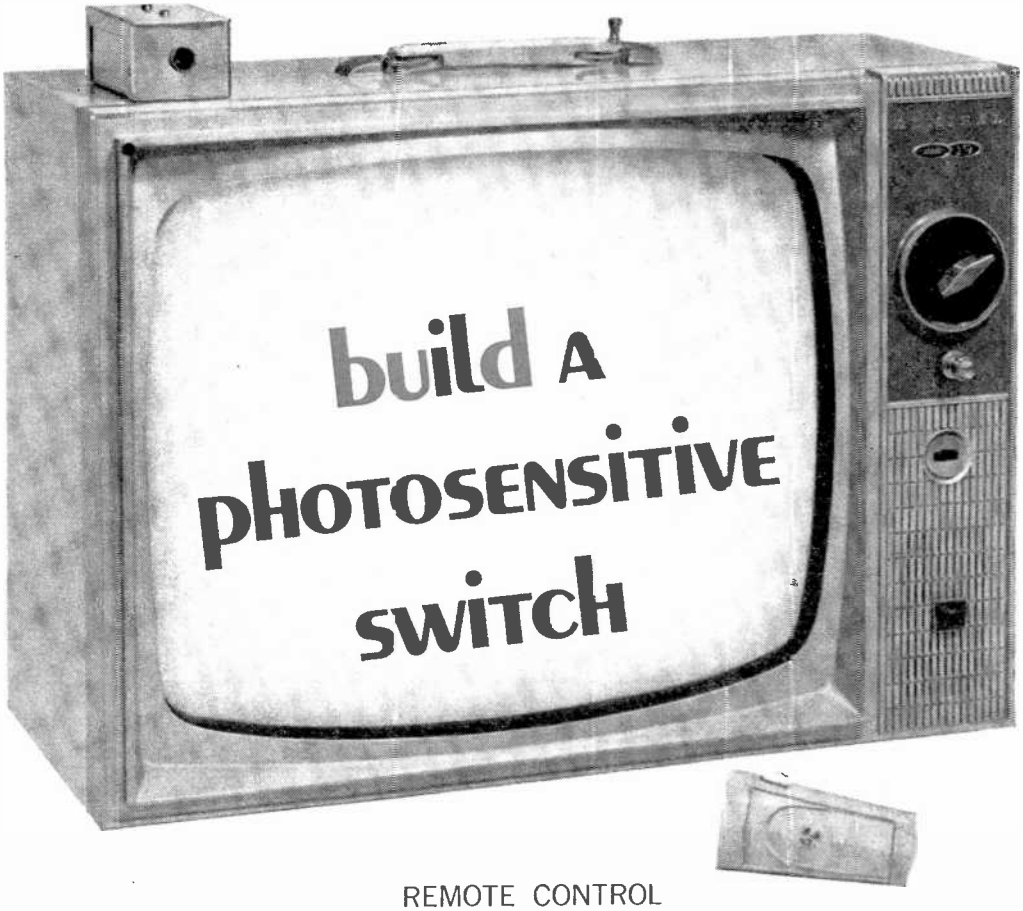


Although circuit can be built on a simple printed circuit board, almost any type of construction may be used. In fact, it can be made small enough to fit within the receiver (including the batteries) and loosely coupled to receiver antenna.

output is a rectangular wave but the waveshape is poor because the oscillation frequency is too high for reliable self-triggering of the SCS.

With the crystal in the circuit, the natural oscillation is locked onto the frequency of the crystal, the output of the

Because of variations in component tolerances, some improvement in performance may be realized by slight changes in the values of resistors *R1* and/or *R5*. Too drastic a change, however, can cause the circuit to stop oscillating, with the SCS locked either on or off. -30-



REMOTE CONTROL FOR MANY APPLICATIONS

BY H. R. MALLORY

REMOTE CONTROL comes in handy in many applications around the house and workshop. It silences loud or disturbing TV commercials, turns on garage lights when a car enters the driveway, turns on lights in a remote building, and so forth—anything you can't or don't want to get up and do yourself. There are also many ways of activating remote controls—sound, light, r.f., etc.

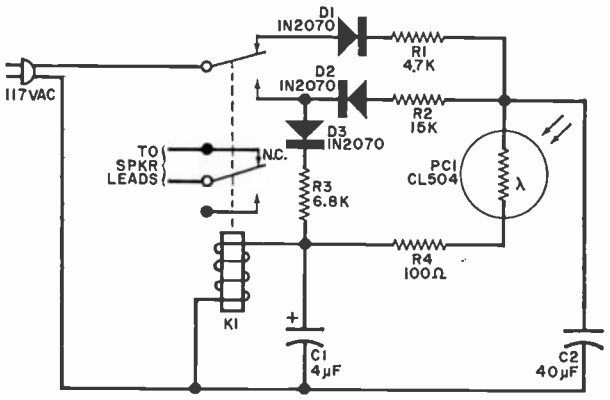
If most remote control systems sound too complex for your needs and construction capabilities, here's one that is simplicity itself and easy to build. This photoresistive switch is activated by a common flashlight and, unlike most light-controlled devices it is bistable—one flash of light turns it on, and it remains on until another flash turns it off.

Construction. The circuit of the switch is shown in Fig. 1. It can be built in a separate metal box (4" × 2⅛" × 1⅝" will do) or you can build it inside your radio or TV cabinet. For the unit shown in the photographs a tube socket was mounted on one end of the chassis for the external connections with a matching plug for the wiring.

The photographs also show one way to assemble the components though this is not critical. Just be sure that the photoresistor is placed so that light can be shown on it directly.

Only two construction details are important: mount the photoresistor in a length of opaque tubing so that only light from directly ahead can activate the cell (not ambient room light); and, if you can't get the capacitor for *C2*

Fig. 1. To make non-polarized capacitor for C2, connect two 80-μF, 150-volt electrolytics in series positive lead to positive lead; or connect a pair of 40-μF, 150-V electrolytics in series positive lead to positive lead and connect a diode across each capacitor with the anode to the negative end and cathode to the positive end.



PARTS LIST

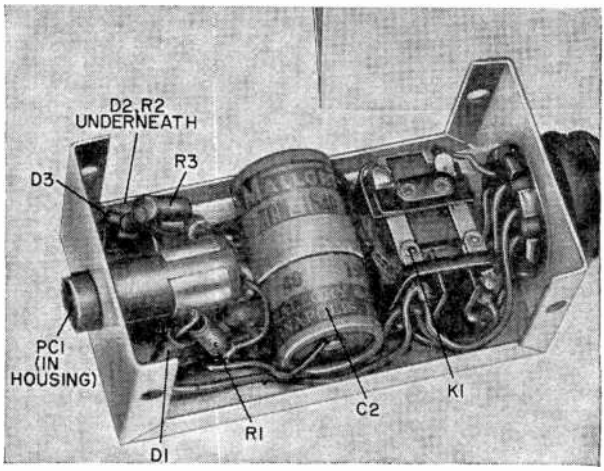
C1—4-μF, 150-volt electrolytic capacitor (Mallory TT150x4 or similar)
C2—40-μF, 150-volt, non-polarized electrolytic capacitor (Mallory TCN1540 or similar, see text)
D1-D3—1N2070 diode (400-PIV, 750-mA)
K1—117-volt relay (Brumfield KA11AY or similar)
PC1—Photoresistor (Clairex CL504 or similar)
R1—4700-ohm, 1-watt resistor
R2—15,000-ohm, ½-watt resistor
R3—6800-ohm, 1-watt resistor
R4—100-ohm, ½-watt resistor
Misc.—4" x 2⅛" x 1⅝" metal enclosure, tube socket and matching plug (optional), tube for photoresistor, mounting hardware, etc.

HOW IT WORKS

When power is applied, capacitor *C2* is charged up through *D1* and *R1* to approximately 75 volts with the upper terminal (as shown in Fig. 1) positive. When light strikes photoresistor *PC1*, its resistance drops and the charge on *C2* flows off through low-resistance *R4* to the relay coil. When the relay is energized, the incoming power is switched to the circuit containing *D3* and then to the relay coil so that it remains energized.

With the relay locked in, *C2* is now charged up in the opposite direction through *D2* and *R2*. (This is why *C2* must be non-polarized.) Now when the light beam is flashed onto the photoresistor, the reverse charge from *C2* is applied to the relay coil so that it is de-energized.

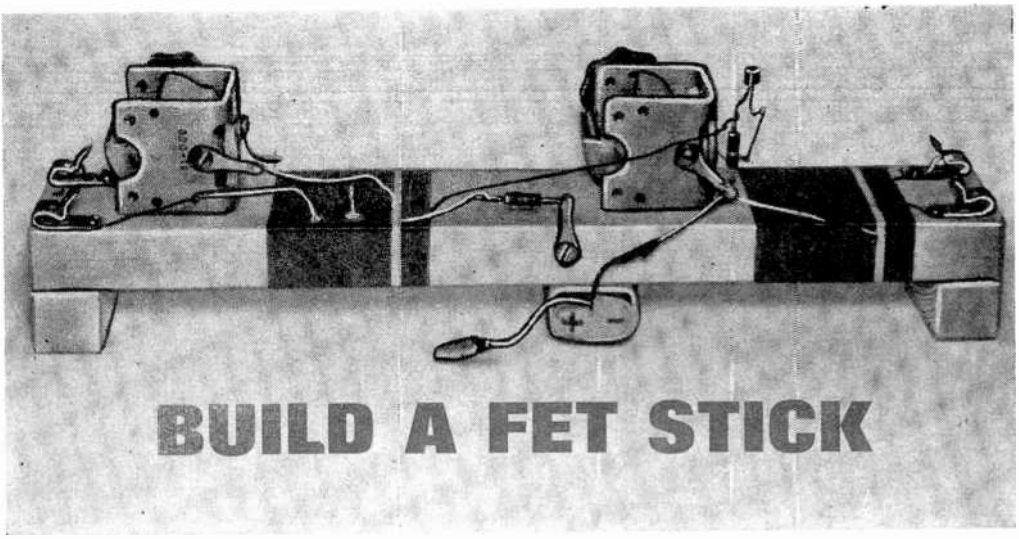
The switch can handle many different kinds of loads, as long as the power rating of the relay contacts is not exceeded.



Most any method of housing can be used. It is important that PC1 is "hidden" in light-tight tube.

called for in the Parts List, use two 80-μF, 150-volt electrolytics connected in series with the two positive ends connected together.

Operation. Mount the chassis at a convenient spot and aim the photoresistor in the desired direction. Connect the relay contacts to the device to be controlled. In the case of a TV set, open one lead going to the speaker from the output transformer, and connect the two ends to the normally closed relay contacts. The TV sound will be normal until the flashlight beam strikes the photoresistor. You can also mount the switch in the rear of your garage so that when the headlight beam strikes it, it turns on the overhead garage lights. —30—



BUILD A FET STICK

R.F. AMPLIFIER EXPERIMENT

BY ART TRAUFFER

IN EXPERIMENTER CIRCLES, any time a new electronic device is introduced it stimulates a wave of creativity. The field effect transistor is no exception and has, in fact, received more than its share of attention. But in this article, concentration is on the use of the FET in an r.f. amplifier in a specific project.

The "FET Stick" is a novel yet practical and extremely simple broadcast band radio receiver project. It has been specifically designed to use and demonstrate the FET as an r.f. amplifier. The project gets its name from the major device used and the fact that the entire circuit is built on a piece of pine lumber—literally a stick.

Construction. Prior to building the FET stick, select an 11″ length of 1″ × 2″ clear pine (actual dimensions ¾″ × 1⅝″). After making sure that the pine is perfectly dry, sand it smooth on all sides, and apply two coats of shellac. Nail on 1″ × 1″ pine legs.

Starting 1″ from the left end of the pine board (viewed as shown in the photo), close-wind *L1* (see Fig. 1) with 25 turns of #28 enameled wire. Anchor the first and last turns with plastic cement to prevent unravelling. Now, spaced ⅛″ from the right end of *L1*, close-wind another 102 turns of the wire to make *L2*.

Measure 6½″ from the left end of the board, and close-wind another 25 turns to make *L3*. Finally, spacing it ⅛″ from the right end of *L3*, wind *L4* with 102 turns of wire; twist three taps, evenly spaced and about 1″ long, across this winding. Then to hold the taps rigid, bead them with plastic cement, starting ¼″ from the top and working down to the windings.

Screw fasten the Fahnestock clips close to the two ends of the board (1-4 in the schematic diagram and photo). Then cement *C1* and *C2* to the board as shown. Screw-fasten a solder lug to the frame of *C1* and connect one end of *R1* and the far lead of *L2* to this lug. Cut the other lead of *R1* to a ½″ length and form an almost closed hook.

Connect and carefully solder the source lead of *Q1* to the free end of *R1*. Then scrape away the insulating enamel from the near end of *L3* and solder this wire to the drain lead of *Q1*. Solder the gate lead of *Q1* and the near lead of *L2* to the insulated solder lug on the side of *C1*. Make sure when soldering to *Q1* that the leads of the FET are properly heat sinked to prevent heat damage.

At the center rear of the board, mount another solder lug and to it, solder one end of *R2*. Bend *R2* so that it parallels the top of the board and points toward *L3*. Solder the free end of *L3* to the free end of *R2*.

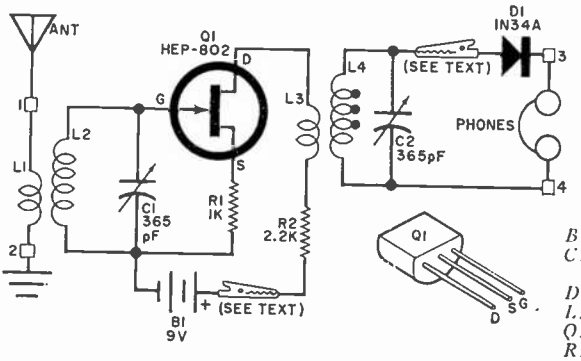


Fig. 1. Alligator clips connected to D1 anode and B1+ leads allow individual adjustment of selectivity and sensitivity. Blocks numbered 1 to 4 indicate the Fahnestock clips.

PARTS LIST

B1—9-volt battery
C1, C2—365-pF tuning capacitor (Radio Shack No. 272-1343, or similar)
D1—1N34A germanium diode
L1, L2, L3, L4—See text
Q1—Motorola HEP-802 field effect transistor
R1—1000-ohm, ½-watt resistor
R2—2200-ohm, ½-watt resistor
4—Medium size Fahnestock clips
1—11"-long piece of 1" x 2" pine (see text)
Misc.—Control knobs (2); battery connector; #6 solder lugs (3); 6-32 x ¼" machine screws (2); ½" wood screws (7); 1⅝" x 1"-square pine for legs (2); sandpaper; shellac; plastic cement; misc.

Next, solder the cathode end of *D1* to the right rear Fahnestock clip (3 in Fig. 1). Solder a small alligator clip to one end of a 4" length of stranded hookup wire; the other end goes to the anode end of *D1*. Again, use proper heat-sinking to prevent heat damage.

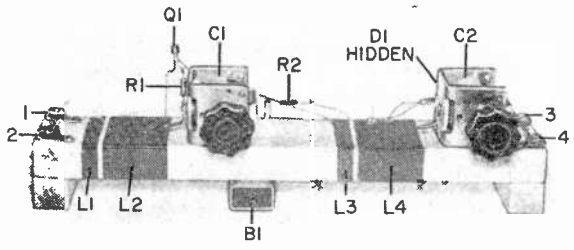
Scrape away the enamel from the unconnected leads of *L1-L4*. Solder the near and far leads of *L1* to the left front and left rear, respectively, Fahnestock clips. Screw-mount the remaining solder lug to the frame of *C2* and solder the far lead of *L4* to it. Then solder both the near lead of *L4* and the right front Fahnestock clip (4) to the insulated solder lug on the side of *C2*.

Finally, mount *B1* on the underside of the board. Snap on its connector, and solder the negative, black, lead to the solder lug at the junction of *L2*, *C1*, and *R1*. Then solder a small alligator clip to the positive lead of the battery.

Operation. In using the FET Stick, best results are obtained when an outdoor antenna, at least 50'-long, and a cold water pipe ground are used. However, good results can also be obtained with even a coiled bed spring antenna.

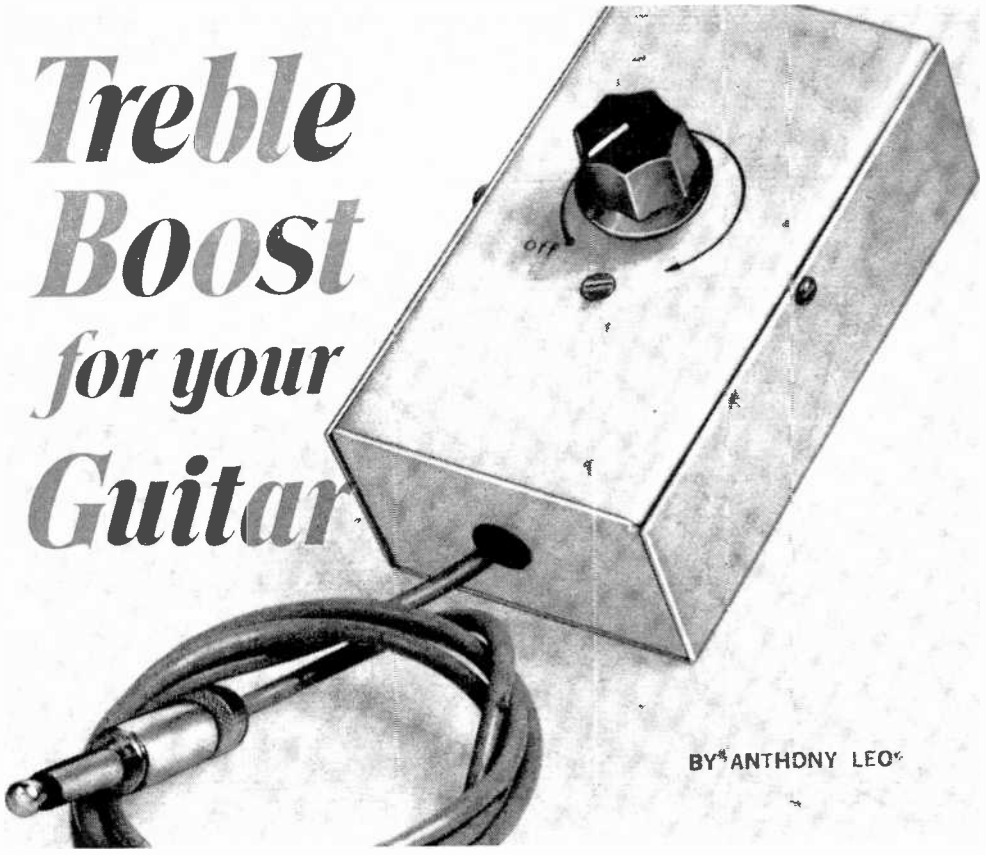
To operate the FET Stick, first apply power by clipping the alligator clip that is soldered to the positive lead of *B1* to the solder lug connected to *R2*. (Note: for increased sensitivity, especially on weak stations, you can connect the alligator clip to the other side of *R2*.) Then connect your antenna, ground, and headphones to the appropriate Fahnestock clips and the alligator clip on *D1* to one of the taps on *L4*. (Experiment with the proper tap to use for any given station, since tap selection determines selectivity.)

Now, while listening through the headphones, adjust *C1* and *C2* until you have the station you wish to hear. Capacitor *C1* has the greatest effect on tuning, while *C2* is used for selectivity. With a little practice, you will soon be tuning in stations with the same ease as you would with any other AM broadcast radio. —30—



Circuit components mount on length of pine lumber, which doubles as coil form for L1-L4. Clips 1 and 2 go to antenna and ground; 3 and 4 are for phones.

Treble Boost for your Guitar



BY ANTHONY LEO*

Blast 'em with another 20 dB

IN POP MUSIC groups, the predominant instrument is usually the electric guitar—either a bass or a rhythm guitar, with the latter played as a simple accompaniment or as the lead instrument. When it is the lead instrument, a great deal of treble boost is required of the rhythm guitar either to highlight the melody section or for special effects.

Often, the necessary boost is within the range of the amplifier and the guitar tone controls. However, there are occasions when a large amount of additional treble boost is desired. At times like these, you need a special treble boost preamplifier.

The independent treble boost preamplifier described in this article is just the thing for the pop music guitarist. It provides 20 dB of boost at 3000 Hz with reference to 300 Hz. With a minor alteration, an extra 6 dB can be obtained.

The circuit of the booster preamp is simply a one-transistor amplifier stage (*Q1* in the schematic diagram) whose response to incoming signals is continuously adjustable in the treble range. Control of treble boost is provided by potentiometer *R4*.

At bass frequencies, *R4* in the emitter circuit of *Q1* introduces sufficient degenerative feedback to maintain stage gain at slightly more than unity. As the incoming signal from the guitar through

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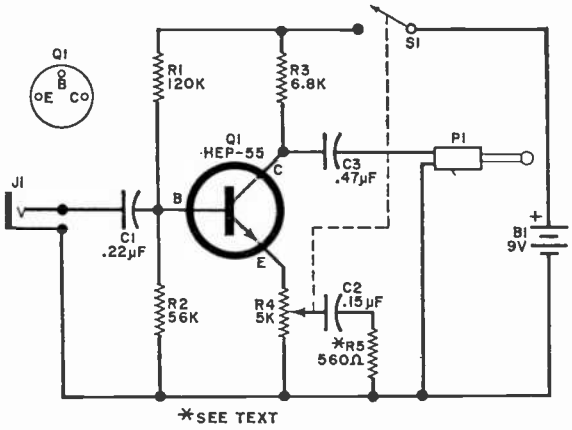


Basic circuit includes R5 which limits maximum gain to 20 dB. Up to 6 dB extra gain can be had by eliminating R5 and connecting C2 directly to negative bus.

PARTS LIST

B1—9-volt transistor battery
C1—0.22-μF, low-voltage capacitor
C2—0.15-μF, low-voltage capacitor
C3—0.47-μF, low-voltage capacitor
J1—Jack (see text)
P1—Plug (see text)
Q1—Transistor Motorola HEP55
R1—120,000-ohm, ½-watt resistor
R2—56,000-ohm, ½-watt resistor
R3—6800-ohm, ½-watt resistor
R4—5000-ohm switched linear potentiometer
R5—560-ohm, ½-watt resistor (see text)
S1—S.p.s.t. switch (part of R4)
1—4¼" x 2⅜" x 1½" aluminum utility box
1—Dual five-terminal tag strip or terminal board
Misc.—Shielded microphone cable; battery clip; hardware; metal spacers; control knob; solder; etc.

jack *J1* increases in frequency, the resistance of the emitter circuit is progressively shunted by the impedance network made up of capacitor *C2* and resistor *R5*. Assuming the frequency of the incoming signal continues to rise and that *R4* is set for maximum resistance, the gain of the stage continues to increase until at about 3000 Hz it levels off at 20 dB. At this point, the gain of the stage is limited only by the value of resistor *R5*.

As the resistance of *R4* is decreased, stage gain drops proportionally from a maximum to some intermediate level. Hence, if treble is too "bright" at one setting of *R4*, it can be compensated for by changing the setting.

Constructing the treble boost preamplifier should present no problems. The circuit is simple, and since all components are relatively small in size, it can be housed in a very small aluminum chassis box. A convenient size for the box is 4¼" × 2⅜" × 1½".

For convenience, mount *J1* at one end of the box, and bring out the shielded microphone cable to which output plug *P1* is connected through a rubber-grommet-lined hole in the other end of the box. (Select the jack and plug to conform with the requirements of your particular guitar and amplifier.) The potentiometer can then be mounted on the top of the box.

When assembling the project, first mount the battery holder at one end of the underside of the top half section of the utility box. Slip the battery into the holder. Then mount a tag strip or terminal board over the battery, using long enough spacers to provide clearance between the board and battery.

Now wire the components to the tag strip or terminal board, following carefully the schematic diagram. Be sure to wire the transistor and battery leads to the proper points in the circuit, and exercise caution when soldering the transistor into place. Apply just enough heat for the solder to flow; as soon as the solder flows, remove the heat.

(*Continued on page* 92)

The Stereo Scene

by Charles Lincoln

TESTING INSURES PERFORMANCE

WE WENT to the H. H. Scott plant in Maynard, Massachusetts, to dig out the history of a representative, top-grade American stereo unit, the Scott 342C stereo receiver. Seeing how that unit was conceived, developed and produced took us straight inside the high-fidelity industry.

This is the second of two installments of our report on that inside view. Last month, we discussed the origins of the 342C. We described how it was conceived, designed, breadboarded, and built in pilot models.

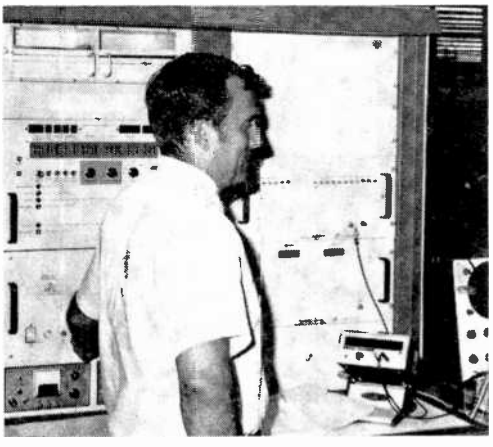
As we watched the final design of the receiver move down the assembly line, we learned how such units are produced in quantity—and that's the story in this installment of The Stereo Scene.

If we had any doubt of the fact that a stereo receiver is one of the most complicated products being sold directly to the consumer today, seeing the long, intricate production process would have cleared away the doubts. Not only is the device complex in design and construction, it must meet almost incredible performance standards—it must come up to the mark in as many as 40 different major aspects of performance. And with the multitude of parts and subassemblies that it contains, there are literally hundreds of different chances for a failing mark.

In the Beginning. Of course, every manufacturer, no matter what his product, must control at some level the quality of the materials that go into the product. But the intensity, complexity, and volume of the input checking process we found are unusual.

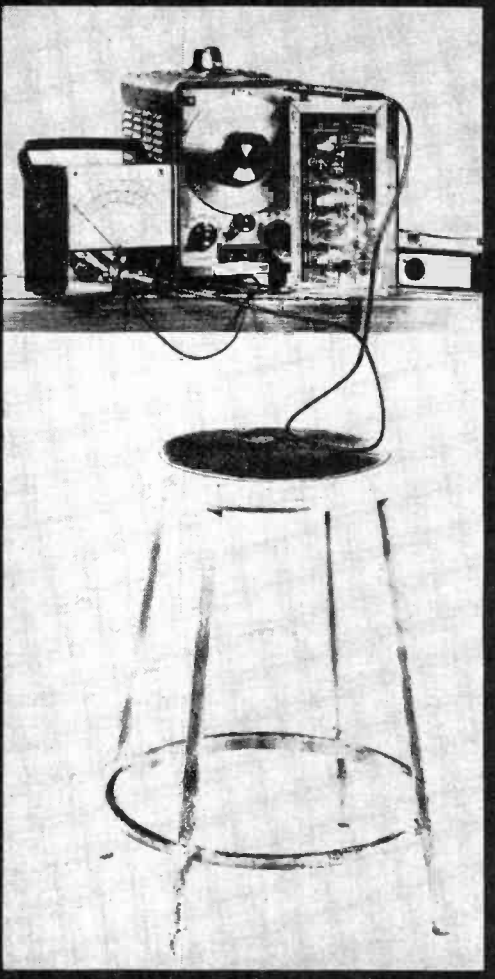
For example, in Scott's "input quality control" there are: a fixture for checking tandem volume controls to make sure they track over the whole range; a small, specialized computer that checks any type of semiconductor; a semi-automated checker for preamp transistor noise level; and automated testers for capacitors and resistors. In some cases, the parts are checked on a sampling basis; in others, if there has been any sign of trouble, every piece is checked.

One of the most complex incoming parts tests, is that performed on integrated circuits (IC's). Since an IC makes up one whole section of the receiver and contains the equivalent of 20 or 40 components, it must meet a set of complex operating specifications. To check out every IC by standard methods, using a signal generator, an oscilloscope, and other meters would be an economic impossibility. However, every IC must be tested. To do the job, a medium-sized computer (cost in six figures) was designed—in large part by Scott engineers. The IC is snapped into a fixture that automatically makes contact with the necessary terminals and the computer runs through the



Using a special-purpose, high-speed digital computer, Scott engineers completely test each IC and plug-in module before they go to production lines.

Someone should develop an easy way to learn electronics at home



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operating checks in a few seconds. If anything is wrong, the computer signals with a red light and prints out a description of what is wrong. The computer can also be programmed to check the performance of all the plug-in modules of the 342C.

Three Production Lines. Production of the 342C starts in three separate lines: one for the printed circuit plug-in modules, one for the r.f. tuning section (called a "can" because it is enclosed in a metal shield), and one for the main chassis.

Component leads for the modules are trimmed and bent in a semi-automatic machine and then inserted by hand. After inspection, the board is dip-soldered and then reinspected and any excess leads are trimmed off. The special computer is then used to check every aspect of the board's operation. About 40 or 50 tests are conducted in 10 seconds. If a board gets a red light on any of the tests, it is repaired or scrapped, depending on the seriousness of the defect.

The r.f. cans are assembled, aligned, and tested on another production line. It is worth noting that, by this stage, the parts on the modules and in the r.f. cans have probably been checked three or four times—either as separate components or as part of the subassembly.

On the assembly line for the main chassis, the front-panel controls, the power supply, and the output transistors are connected to each other and to the sockets for the plug-in modules. In most of these connections, the wire-wrap method is used instead of soldering. Made with a powered hand-tool, wire-wrap connections are much more dependable than hand soldering. Their use is new in the high-fidelity industry.

Each receiver gets a listening test at several stages during production. This insures that only properly working units get passed down the line.

Six Checking Stations. Once the chassis is fully operative, it must still go through six stations. It is not fully assembled until it has passed the first three.

Clean and careful assembly of components means a properly working receiver. Each girl installs one or two components on a slowly moving belt that carries the receiver chassis.

As receiver progresses down production line, more extensive tests are performed. Here, electronic equipment checks it for correct circuit operation.

In the first check, power is applied to the chassis and the FM circuit is checked. Twenty separate instrument tests measure all of the important aspects of FM performance. The second check covers the AM portion of the circuit in the same way. At the third station, 60 separate tests are performed to determine that the audio section is operating properly.

If the chassis fails to meet specifications in any of these tests, it goes immediately to a troubleshooting bench to find out what is wrong.

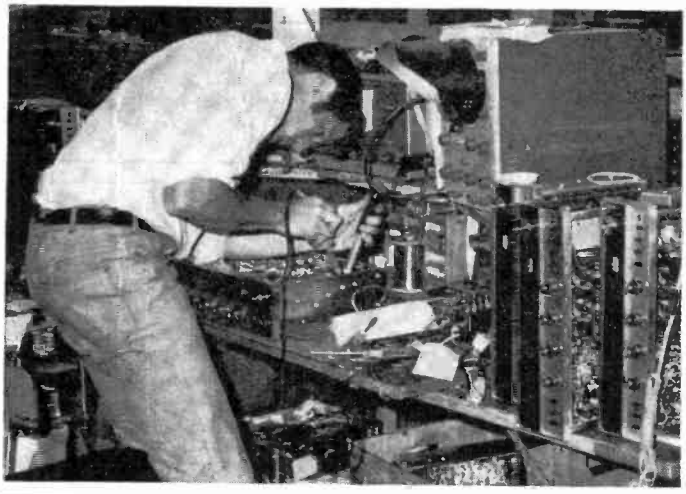
Final assembly comes at the fourth of the six stations. Then at the fifth station, an operator puts on a pair of headphones, connects AM and FM antennas to the unit, plugs in a source of audio program material to each input, and proceeds through a systematic listening test of every part of the unit's performance. All of the controls are checked. An experienced listener with a systematic program of tests quickly spots any deviation from normal.

The listener-tester in the fifth station is part of the manufacturing division. At the sixth, and final, station, the listening test is repeated in full by a member of the quality control division. It has long been considered good practice by manufacturers of complex products to have quality control independent of manufacturing. That way, the final quality control doesn't wilt under the hot breath of manufacturing, which naturally wants to push out as many units as possible.

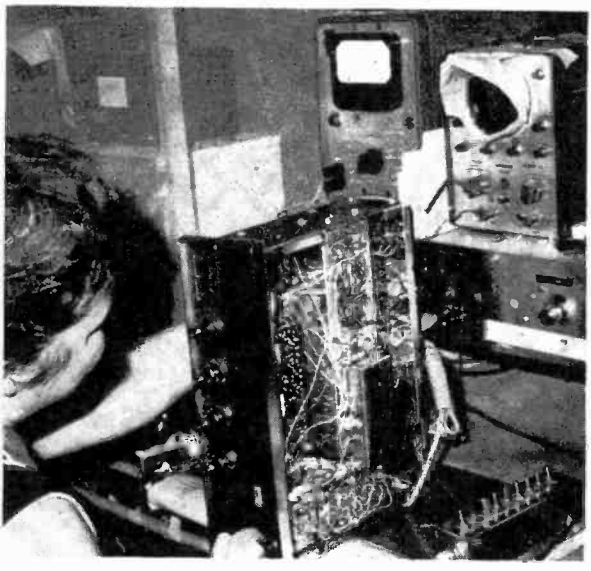
Supposedly the 342C is now ready to be shipped. It is given one more test, however. In racks right next to the packing department, every unit gets a "burn-in"—a simulated life test. An over-voltage on the power supply gives the unit the equivalent of about 100 hours of use in a half an hour.

While the unit is operating under the

Once electronic instruments have given receiver the required tests, another listening test makes sure that all is OK.



If a receiver should fail one of the dozens of tests, it is removed from the line and examined in depth to determine what the problem is. In many cases, a technician can make a diagnosis and repair minor troubles. If anything drastic is wrong, receiver is pulled out and comprehensive tests are made at engineering level to prevent further occurrences.



stress of the high-voltage supply, a square wave is applied to the audio input to produce full power at the output. The unit is also connected to an FM antenna so that an operator can make sure the r.f. and i.f. sections are operating properly. After 20 minutes of a steady supply voltage, the supply goes on and off automatically for ten minutes. The sharp voltage transients uncover any weaknesses that do not show up with a constant supply.

A burn-in test is the best defense the industry has found for "out-of-the box failure," a breakdown that occurs soon after the buyer unpacks his new unit and turns it on. Units that pass the burn-in are packed and shipped—and that's how you get your new stereo receiver.

The process is long and complex, but it insures you of a quality product that is typical of the industry today. —30—

This is the torture chamber for all receivers. Called the "burn-in" rack, each receiver gets a simulation of 100 working hours under full input and output conditions to make sure that it is ready for shipment to the dealer.

the product gallery

REVIEWS AND COMMENTARY ON ELECTRONIC GEAR AND COMPONENTS

COLOR BAR/DOT GENERATOR (Heathkit Model IG-28)

THE GROWING popularity of color TV has stimulated the appearance on the market of a flood of color bar/dot generators. Although some of these instruments are decidedly unacceptable with regard to their lack of operational features and poor pattern quality, the majority are good. Only a very few, however, are good enough on all counts to qualify as excellent. The Heathkit Model IG-28 Color Bar/Dot Generator (Heath Co., Benton Harbor, Mich. 49022), in the opinion of this reviewer, is an excellent instrument, and here is why.

The IG-28 generator is a product of modern digital IC logic techniques. It contains a divider chain (15 JK flip-flops in eight IC packages) which counts down from a crystal-controlled 190.08-kHz master clock oscillator to 60 Hz. The accuracy and stability of this divider chain, consequently, depend on the accuracy and freedom from drift of the crystal—not on tricky adjustments that have to be "touched up" periodically to prevent inaccuracies.

There are, in addition, two four-gate IC's in the logic circuit. These serve as horizontal line and horizontal and vertical sync shapers, and sync mixer. The use of IC's in these functions results in display patterns that are well defined and free from flicker and ripple (even the keyed-rainbow color bars can be set for virtually undetectable creeping).

Aside from the master clock oscillator, there are 4.5-MHz sound carrier and 3.56-MHz chroma oscillators. Both oscillators are crystal controlled for maximum accuracy and stability.

The r.f. and video output circuits are located on a board that is separate from the main divider circuit board. Featured in the r.f. output circuit is a coil that is an etched pattern on the circuit board.

The control complement of the IG-28 includes: a pattern switch; chroma level; video − to +/power; r.f. level; channel selector; 9×9/3×3 display switching (see Technical Specifications directly to right); r.f./video select switch; and individual gun-shorting switches. A single coaxial cable, terminated in alligator clips, serves as a common output for both video and r.f. The four-conductor cable that provides access to the TV receiver's ground and CRT grids is terminated in four lead-piercing alligator clips.

The features that combine to give the IG-28 an "excellent" rating cover a wide range. Among them are a pair of front-panel-mounted a.c. receptacles that are "live" at all times when the IG-28 is plugged into an a.c. outlet; a sync output jack; individual ground and CRT grid output jacks for oscilloscope observations and vectorscope hookups; vernier channel selector dial; epoxy-glass circuit boards; and a distinctly styled, rugged metal cabinet.

Add up all of the above features and throw in a well-written, illustrated assembly manual that contains a wealth of servicing information, and you have a combination that can only add up to excellent—especially at the cost of only $79.95 for the kit, $114.95 for the factory-wired version.

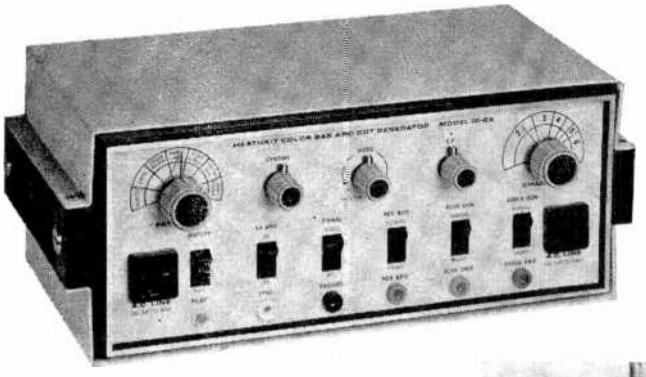
Assembling the kit with the aid of the assembly manual is a breeze. No tools other

TECHNICAL SPECIFICATIONS (Heathkit IG-28)

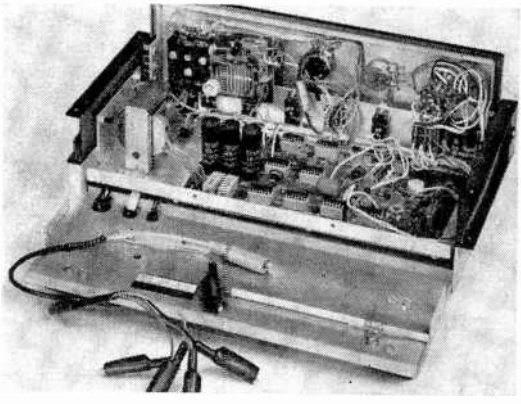
R.f. output level: variable to 50,000 μV on any TV channel 2-6
Video output level: greater than ± 1 volt peak-to-peak
Sync level: greater than 3.5 volts peak-to-peak for servicing sync circuits without video, or for TV receivers with separate video and sync demodulators.
Control grid outputs: three—red, green, blue—for vectorscope display chroma signal and demodulator phase adjustments
PATTERNS:
Purity: snow-free raster
Dots: 110/9 dots* for convergence adjustments
Crosshatch: 11 vertical and 10 horizontal/three each vertical and horizontal lines* for convergence and linearity adjustments
Horizontal lines: 11/3 lines* for vertical linearity and pin-cushion adjustments
Vertical lines: 11/3 lines* for horizontal linearity and convergence adjustments.
Color bars: ten/three standard color bars* for demodulator phase adjustments and color circuit servicing
Gray scale: wide crosshatch pattern with six shades of brightness for screen and drive adjustments
*Numbers indicated are for display switch in 9x9/3x3 positions. Numbers for 9x9 are for receivers with no over-scan.

than a soldering iron (with a micro-point tip), combination cutters/long nose pliers, and a screw driver are needed. In fact, included with the kit are a nut starter, solder, an Allen wrench, an insulated alignment tool, and an IC "puller." Assembly can be performed in less than 8 hours. But do not push it; you can accidentally create a solder bridge if you work too fast.

Circle No. 94 on Reader Service Page 15 or 113



HEATHKIT COLOR BAR/DOT GENERATOR



Inside, layout of IG-28 color bar/dot generator is roomy. Special tools provided for assembly and alignment of kit fasten to rear of case with Fahnestock clip (lower right in photo at right). To facilitate quick troubleshooting and repair, if ever necessary, integrated circuits mount to the board via molded sockets.

HIGH-POWER INTEGRATED AMPLIFIER (EICO "Cortina" Model 3150)

THERE ARE some very practical reasons behind the demand of hi-fi buffs for high power in audio systems. One reason is that many top-quality speaker systems are inefficient, requiring high driving power. Then, too, a high-power amplifier is better capable of handling music transients and supplying the enormous power required for crisp reproduction of bass notes. And just as important is the fact that a high-power amplifier, operated at or below the midpoint setting of the volume control (low output power), will produce less distortion than a low-power amplifier that is operated with its volume control practically wide open.

There is no need to sacrifice power if your budget is limited. The EICO (EICO Electronic Instrument Co., Inc., 283 Malta St., Brooklyn, N.Y. 11207) "Cortina" Model 3150 integrated solid-state amplifier, selling for $149.59 in kit form ($225 wired) puts high power within the reach of most budgets.

For our subjective listening tests, we connected the 3150 to a pair of AR-4X speaker systems. With the volume control set for one-quarter full, the 3150 produced more than enough volume for a better-than-average-size listening room. Hence, there was plenty of reserve power available, and the low volume setting assured low distortion. Listening to various types of program material, ranging from solo to full orchestra and across the entire audio spectrum, the reproduction was crisp and very life-like. Prolonged listening did not produce listener "fatigue."

During the testing, particular attention was given to transients and bass response. The 3150 handled the transients effortlessly, without slurring or mushing the sound. Even the really deep bass notes were as fresh and close to perfect as at a live performance.

The attractive front panel of the 3150 amplifier contains a full complement of controls, including high- and low-cut filters, volume/loudness switch, and speaker system and phone selector switch. Located on the rear apron are all of the input and output sockets and jacks normally found on better-quality amplifiers, plus switched and unswitched a.c. accessory receptacles.

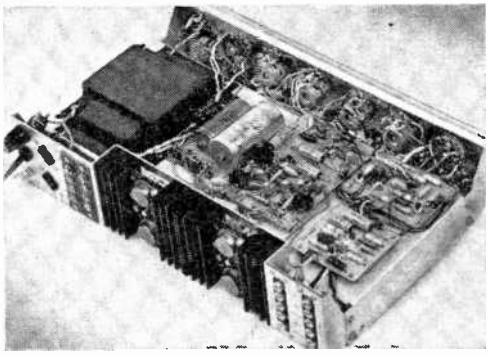
We did not build the 3150 kit, but a look inside the wired amplifier and past experience in building EICO kits convinces your reviewer that assembly should not present any problems. Most of the small components mount on six printed circuit boards. Massive heat sinks, used on the output transistors mount directly to the rear apron of the chassis, out of the way of the circuit boards, and even the power supply is easy to wire.

Circle No. 95 on Reader Service Page 15 or 113

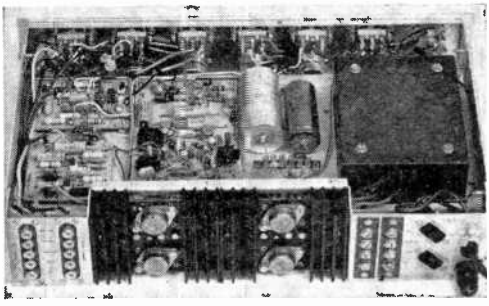
EICO

3150

AMPLIFIER



In top view (above) of interior of 3150 amplifier are shown circuit boards and components—including power supply filter capacitors—for one channel. Underside view (below) shows identical circuitry for second channel. Both views show massive output transistor heat sinks, auxiliary a.c. receptacles, and input and output connector layouts.



TECHNICAL SPECIFICATIONS
(EICO 3150 Amplifier)

IHF music power output: 150 watts into 4-ohm load; 100 watts into 8-ohm load
Frequency response: 10-30,000 Hz ±1.5 dB
Harmonic distortion: less than 0.15% between 50 Hz and 15kHz at 40 watts continuous power/channel; less than 0.15% between 20 Hz and 20 kHz at 35 watts/channel (both into 8-ohm load)
Hum and noise: 80 dB below rated output
Channel separation: 50 dB
Sensitivity: 4.2 mV into magnetic phono input; 280 mV into all other inputs
Power bandwidth: 10-20,000 Hz at 0.5% distortion
Damping factor: 35 minimum into 8-ohm load
Rise time: 3.8 μsec
Tone control: ±15 dB at 10 kHz treble; ±15 dB at 50 Hz bass; −6 dB at 50 Hz low-cut filter; −7 db at 10 kHz high-cut filter
Balance control range: 17 dB
RIAA equalization: ±0.5 dB, 30-15,000 Hz
I.m. distortion: less than 1% at full output
Input impedance: 47,000 ohms magnetic phono; 110,000 ohms, all other inputs

Hams Tackle a Hurricane

BY DON WATERS

MANY PEOPLE + MANY HOURS = HELP FOR THE HOMELESS

HURRICANE CAMILLE, described later as "the worst natural disaster ever to hit the Western Hemisphere," struck the Mississippi Gulf Coast on Sunday afternoon, August 17, 1969. In just a few short hours it left in its wake an estimated 400 people dead, 43,000 homes destroyed or damaged, and 650 small businesses wiped out or crippled. From Waveland, Mississippi, a few miles east of New Orleans, to Biloxi, Mississippi, the devastation was almost incredible. Whole sections of homes and small businesses in Waveland, Pass Christian, Gulfport and Biloxi literally disappeared. In between, piles of rubble and debris were left, with, here and there, apparently whole structures capriciously left unscathed. Telephone lines and other communications facilities, of course, virtually ceased to exist.

Hams spent many hours on air sending messages to bring aid and supplies to former occupants of homes such as this one located in Pass Christian.

Even before Camille struck, hams were ready. At Keesler Air Force Base, near Biloxi, servicemen who are members of the base amateur radio club had rounded up spare equipment and a supply of gasoline for their portable generators, and eight hams (including Captain Jerry W. Stewart, K5CFQ, 2nd Lieutenants Casimir V. Bak, K3SHD, and Douglas Henry, WB6AIT, Sgt. Loren C. Burkett, K3RFC, A/1C Robert E. Bartov, Jr., WA4UEY, and Airmen James Giesinger, K3QQN, Robert S. Tarleton, WA2ICV, and Jeffrey T. Bassett,) prepared to stay at the club station, K5TYP. Despite the collapse of the club's "indestructible" 70-foot main antenna tower, the group was able to maintain communications with emergency centers along the coast, the New Orleans Weather Bureau, outside military headquarters, and area disaster relief agencies. The first four emergency supply planes to arrive on Monday were guided in by the hams.

Edward J. Meyer, Jr., WA5TPS, operates from Navy communications van manned by hams in Waveland.

Meanwhile, several hundred civilian amateurs in the Mississippi area, Louisiana and from as far away as Florida and Ohio were mobilized for action. Charles Lawshe, K5GEI, of Gulfport, and Tom Braidwood, W5BW, of Biloxi, provided communications for Civil Defense units, dispersing rescue teams and directing re-

At Bay St. Louis communications center, Gene Madere, K5MDG, sends message for Red Cross worker.

lief supplies into the area. On August 25th—eight days later—these two men "secured" their station and went to see about their own homes! Ed Mehnert, W5LLB, of Biloxi, got his family off to Mobile, Alabama, and for several days handled messages and emergency traffic, in between carrying on his own rescue operations, searching for lost or missing people, evacuating injured, and so on. Gene Hannan, W5MQ, managed to maintain his home station in Lakeshore, Mississippi, handling Red Cross messages and other emergency traffic.

From New Orleans, twenty-five amateurs went to the Gulf cities of Waveland, Bay St. Louis, Pass Christian, Gulfport and Biloxi to operate, while another 47 amateurs remained at home stations to act as relay centers. Similarly, eighteen Baton Rouge amateurs went to the Gulf Coast while about fifty manned the home Civil Defense operating center; and from Monroe, La., eight amateurs went to the Gulf area.

Tom Morgavi, W5FMO, of Metairie, La., was a prime mover in the amateur team from New Orleans that operated at several emergency centers in the disaster area. For ten days he worked eighteen hours a day, while his wife, Helen, WA5OVX, manned the home station to relay messages. This group also included Angelo Clorioso, W5KSI, Fred Korson, W5HUT, Warren Bourgeois, WA5WPV, Robert Rondeau, WA5YIZ, John Klein, WA5VVB, and Stanley Pulitzer, W5JYK. Bob Rondeau and John Klein, both teenagers, operated key

Huge ocean-going freighters deposited on beach at Gulfport are grim reminders of storm's force.

emergency centers for ten days under exhausting conditions.

A group of lady hams, members of the YL International Single Sidebanders, including Mrs. Elsie McGraw, WA4LQO, Mrs. Eleanor Hornor, K4RHL, and Mrs. Phyllis Craig, K4CRU, initiated plane loads of food, clothing and medical supplies which were flown in for distribution by the Red Cross and Salvation Army.

On August 27, 1969, the following message was sent by the Director of the American Red Cross in New Orleans: "The Red Cross appreciates very much the work of radio amateurs who supplied our only means of communicating in the Gulf Area. We now have telephone contact and the amateur stations may be secured." -30-

Eugene Hannan, W5MQ, Lakeshore disaster center, seems to be saying that the temperature was hot.

ENGLISH LANGUAGE NEWS BROADCASTS FOR THE MONTH OF DECEMBER

ROGER LEGGE

TO EASTERN AND CENTRAL AMERICA

TIME EST	STATION AND LOCATION	FREQUENCIES (MHz)
7:00 a.m.	Peking, China	11.685, 15.095
7:15 a.m.	Melbourne, Australia	9.58, 11.71
	Montreal, Canada	9.625, 11.72
7:30 a.m.	Stockholm, Sweden	15.315
7:45 a.m.	Copenhagen, Denmark	15.165
6:00 p.m.	Montreal, Canada	9.625, 11.945, 15.19
6:30 p.m.	Quito, Ecuador	15.11, 17.88
6:45 p.m.	Tokyo, Japan	15.445, 17.825
7:00 p.m.	London, England	6.11, 9.58, 11.78
	Moscow, U.S.S.R.	7.15, 9.665, 9.685
	Peking, China	15.06, 17.673
	Sofia, Bulgaria	9.70
7:30 p.m.	Johannesburg, South Africa	9.705, 11.875, 15.22
	Stockholm, Sweden	5.99
7:50 p.m.	Brussels, Belgium	6.125
	Vatican City	6.145, 9.615, 11.725
8:00 p.m.	Berlin, Germany	5.955, 9.73
	Budapest, Hungary	6.234, 9.833, 11.91
	Havana, Cuba	9.525
	Madrid, Spain	6.14, 9.76
	Melbourne, Australia	15.17, 17.775
	Prague, Czechoslovakia	5.93, 7.345, 9.54, 9.63
	Rome, Italy	6.01, 9.575
8:30 p.m.	Berne, Switzerland	6.12, 9.535, 11.715
	Cologne, Germany	6.075, 9.735
	Tirana, Albania	6.20, 7.30, 9.50
9:00 p.m.	Hilversum, Holland (via Bonaire)	11.73
	Lisbon, Portugal	6.025, 9.68, 11.935
	London, England	6.11, 9.51, 9.58
	Moscow, U.S.S.R.	7.15, 9.685, 9.70
	Peking, China	15.06, 17.715

TO WESTERN NORTH AMERICA

TIME-PST	STATION AND LOCATION	FREQUENCIES (MHz)
7:00 a.m.	Tokyo, Japan	9.505
8:00 a.m.	Stockholm, Sweden	15.315
5:30 p.m.	Tokyo, Japan	15.235, 17.825, 21.64
6:00 p.m.	Melbourne, Australia	15.17, 17.775, 21.74
6:30 p.m.	Johannesburg, South Africa	9.705, 11.875, 15.22
7:00 p.m.	London, England	6.11, 9.51, 9.58
	Madrid, Spain	6.14, 9.76
	Peking, China	15.095, 17.673, 21.735
	Prague, Czechoslovakia	5.93, 7.345, 9.54, 9.63
	Seoul, Korea	15.43
7:30 p.m.	Berlin, Germany	5.955, 6.08
	Stockholm, Sweden	5.99
	Tirana, Albania	6.20, 7.30
8:00 p.m.	Budapest, Hungary	6.234, 9.833, 11.91
	Havana, Cuba	9.525, 11.76
	Lisbon, Portugal	6.025, 9.68, 11.935
	Moscow, USSR (via Khabarovsk)	11.85, 15.18, 17.88
	Peking, China	5.095, 17.673, 21.735
	Sofia, Bulgaria	9.70
8:30 p.m.	Kiev, USSR (Mon., Thu., Sat.)	7.15, 9.665
8:45 p.m.	Berne, Switzerland	6.12, 9.72
	Cologne, Germany	6.145, 9.545
9:00 p.m.	Havana, Cuba	11.76
	Hilversum, Holland (via Bonaire)	9.715, 11.73
	Tokyo, Japan	9.505
10:00 p.m.	Moscow, USSR (via Khabarovsk)	9.735, 11.85, 15.18
10:30 p.m.	Havana, Cuba	11.93

SOLID STATE

By LOU GARNER, Semiconductor Editor

THE SHIFT TO SOLID STATE

Attending the 3rd Annual Instrumentation Fair held during September at the Washington Hilton hotel, we conducted an informal survey of the instruments displayed by over 350 manufacturers. Over 90% of the products used solid-state circuitry, with roughly 30% featuring integrated circuits rather than discrete component designs. As might be expected, almost all the digital instruments—nearly 95%—employed IC's. On the other hand, vacuum-tube circuitry was used in some of the oscilloscopes and other CRT products on display, as well as in a few of the microwave test instruments.

Interviewing manufacturers' representatives, we found that even those firms now using vacuum tubes planned a switch to solid-state circuitry when they become feasible economically as well as technically. It was generally agreed, however, that a complete shift to solid-state designs would have to await the development of an inexpensive semiconductor display device with performance characteristics comparable to those of the cathode-ray tube.

Transistor and IC testers were exhibited by a number of firms. One of the most interesting, in our opinion, was the moderately expensive Model 800 Transistor Tester developed by Miracle-Hill Electronics, Inc. (320-B Martin Ave., Santa Clara, California 95050). Using internal IC logic circuits, this unit could automatically select and identify a transistor's electrode terminals, identify its general type (germanium or silicon), identify its electrical type (*pnp* or *npn*), and, further, measure and indicate its d.c. leakage, collector breakdown voltage and d.c. beta (gain). If one could afford the tab —a little under five hundred dollars—it would be ideal for sorting bargain transistors!

Reader's Circuit. Almost all multi-band receivers are capable of picking up CW (code) signals, but these can't be heard unless converted into an audible tone. In commercial and amateur communication sets, this conversion is accomplished by means of a beat frequency oscillator (BFO). Unfortunately, this feature is omitted in many of the short-wave sets designed for the average consumer. Recognizing this, reader R. W. Stanford, WN9BBU (309 Wyoming St., Bethalto, Ill. 62010), has submitted the simple BFO circuit shown in Fig. 1. Inexpensive and easily assembled, it can be used with any superhet receiver having a 455 kHz i.f.

Referring to the schematic, reader Stanford's design is essentially a modified Hartley oscillator using a *pnp* transistor (*Q1*) in the common-emitter configuration. An i.f. transformer's tapped primary winding (*T1*) and *C2*, furnish the feedback to start and

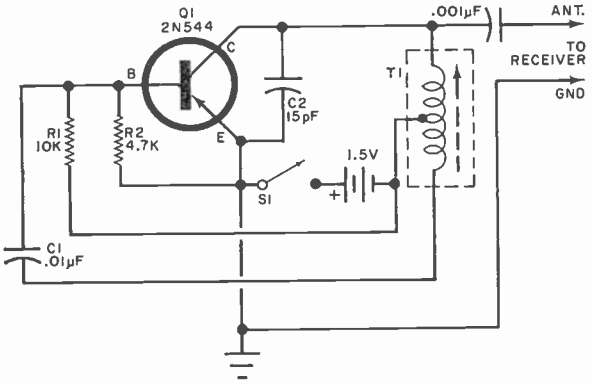


Fig. 1. This outboard BFO should prove useful to many listeners with receivers lacking provision to receive CW. Output connections go directly to receiver.

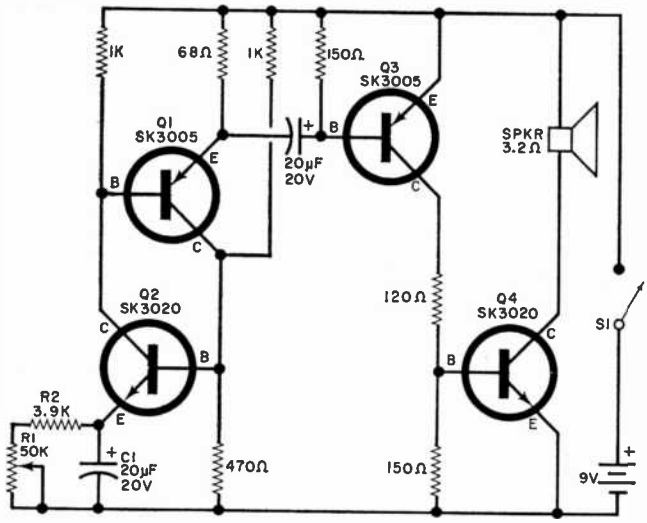


Fig. 2. Electronic metronome has a variable output pulse rate which is adjusted by R1. Transistors Q1 and Q2 form a relaxation oscillator, the output of which is converted to audio in amplifier composed of Q3-Q4.

sustain oscillation, with this signal coupled back to *Q1*'s base through d.c. blocking capacitor *C1*. Stabilized base bias is established by voltage divider *R1-R2*.

In operation, the BFO provides a fixed signal at a frequency close to the receiver's i.f. value. The two signals are combined in the receiver, with the resulting difference, or "beat," frequency falling within the audio range, thus providing an audible output.

All the parts needed for the project are available through both local outlets and mail order firms. Virtually any 455-kHz i.f. transformer equipped with a tapped primary winding (the secondary is not used) may be used for *T1* (typically, Miller type 2067 or Calectro type D1-823). The power supply is a conventional flashlight cell.

The BFO may be assembled on perf board, on etched circuitry, or on a small chassis using point-to-point wiring, as preferred, for neither parts placement nor the wiring arrangement is critical. After checkout and test, the wired circuit might be installed in a small case as a general purpose accessory or, if there is adequate space, mounted permanently in the cabinet of the receiver with which it is used.

In practice, the BFO's output signal is coupled loosely to the receiver's antenna-ground system. Once a CW station is tuned in, *T1*'s slug is adjusted for the desired audio pitch (tone).

Manufacturer's Circuit. Serving to establish the basic "meter," or cadence of a musical rendition, the metronome is an essential learning tool for the budding musician. The classical instrument is a spring-powered clockwork mechanism mounted in a pyramidal box and controlled by an adjustable inverted pendulum. A modern solid-state version is illustrated schematically in Fig. 2. Abstracted from RCA's *Hobby Circuits Manual* (publication No. HM-90), this project can be assembled easily.

Referring to Fig. 2, *Q1* and *Q2* are connected as a fast-acting regenerative switch which acts as a relaxation oscillator, delivering signal current pulses to the two-stage audio amplifier *Q3-Q4*. Direct complementary coupling is used in both the pulse generation and amplifier sections, with the output transistor, *Q4*, direct coupled to a PM loudspeaker's voice coil. The instrument's pulse repetition rate depends on the *RC* time constants of the circuits controlling *Q1-Q2*'s switching interval and hence upon the capacitors and their respective resistive discharge paths. In operation, *C1*'s discharge time is established by *R1*, in series with fixed resistor *R2*, thus providing an adjustable control over the output pulse rate.

Standard components are specified for the metronome circuit with, naturally, RCA transistors used as the active devices. Except for potentiometer *R1*, which should have a linear taper, all resistors are half-watt types.

While a "clean" layout is preferred to minimize possible wiring errors, neither parts placement nor lead dress should be overly critical and, therefore, the individual builder can use any construction method for project assembly, including breadboard, perf board, or etched wiring. All d.c. polarities should be observed, naturally, and care should be taken not to overheat transistor leads during installation.

Even though it's not essential for some applications, many users prefer a calibrated instrument. In this event, a suitable dial for *R1* (equipped with a pointer-type knob) should be mounted on the unit's case. Afterwards, various dial settings can be

(*Continued on page* 98)

SHORT-WAVE LISTENING

By **HANK BENNETT**, W2PNA/WPE2FT
Short-Wave Editor

NEWS ITEMS FROM AROUND THE WORLD

Andorra. The American SWL Club states that there has been apparently no resumption of broadcasts on short-wave from *R. Andorra*. In this column last month we mentioned that word had been received indicating operations on 5995 kHz at 2300-0300 but no reports of actual reception have been found in the bulletins of various radio clubs, either domestic or overseas.

Biafra. For several months the U. S. Post Office has refused to forward mail to Biafra, thus preventing monitors from sending reports to that country. It has been learned that reports for both *Radio Biafra* and *Voice of Biafra* may be sent to P. C. Chigbo, Office of the Special Representative, Republic of Biafra, B. P. 8861, Abidjan, Ivory Coast.

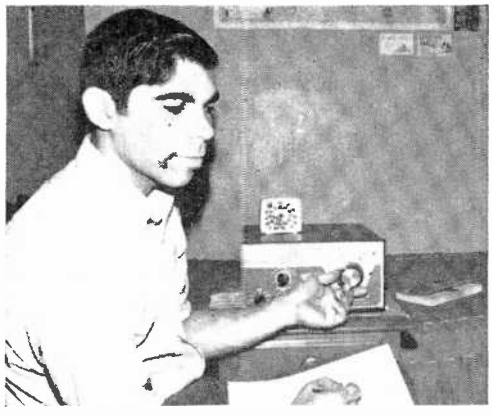
Seychelles. The *Far East Broadcasting Corp.* has reportedly been conducting test transmissions from this country. A previously published schedule listed experimental transmissions on 15,165 kHz at 0030-0300 and 1300-1630, on 17.755 kHz from 1300-1630 and on 21,640 kHz from 1700-2000 with a power of 3000 watts and beamed to India, Pakistan and Ceylon. It was also stated that "high-powered" transmissions would start soon. Since this information came in, we've learned that the *FEBC* has shipped an older 30-kW transmitter to Seychelles for use as a relay station for the Indian subcontinent. This is probably the "high-powered" transmitter referred to earlier. It is thought, at press time, that this new unit is on the air, at least on 15.165 kHz. Watch for it, this may be your chance to log this rare country.

England. The *British Broadcasting Corp.* has again made available its World Service Award Scheme, in which those who so desire may obtain a specific verification card rather than one of the usual acknowledgement cards. You must be a member in order to avail yourself of this service. If you are not a member, write and request membership information directly from the *BBC*, London, England.

Canada. BROADCASTING Magazine reports that the Canadian Radio-TV Commission has approved a request of the *Canadian Broadcasting Corp.* to increase the power of its short-wave transmitters at Sackville, New Brunswick, from 50 kW to 250 kW.

Israel. The attractive young lady who is Communications Officer at the New York City Israeli Consulate office has informed one of our Monitors that *Kol Israel* has had to delete its experimental transmission to N.A. on 9009 kHz at 0400 due to budgetary reasons. She added, however, that while it lasted, the station received many good reports from all areas of the United States.

Box 333. Participants in the POPULAR ELECTRONICS DX Awards Program will be glad to know that a new level has been added to the Country Award—125 countries. Many monitors have expressed dissatisfaction at the large jump from 100 to 150 countries. Those who have previously obtained a 125 Country Letter of Certification are urged to drop us a postcard for their 125 Country award seal. The same rules apply



A newcomer to the hobby of SWL'ing is Edward Adelson, Pittsburgh, Pa. Shown is his R. L. Drake SW-4A receiver. He also has a Mosley SWL7 antenna.

for this new level. Anyone desiring a copy of the regulations and/or a copy of our Country List may obtain them by sending a request with return postage to Hank Bennett, P.O. Box 333, Cherry Hill, N.J. 08034.

CURRENT REPORTS

The following is a resume of current reports. At time of compilation all reports were as accurate as possible, but stations change frequency and/or schedule with little or no advance notice. All times shown are Greenwich Mean Time (GMT) and the 24-hour system is used. Reports should be sent to Short-Wave Listening, P. O. Box 333, Cherry Hill, N. J. 08034, in time to reach us by the fifth of each month; be sure to include your WPE identification and the make and model number of your receiver.

Afghanistan—*R. Afghanistan*, Kabul, was logged on 4775 kHz at 1400-1428 in English to Europe; news and weather at 1400, a political talk at 1408, and music from 1410, at which time the signal rapidly fades. It goes into Pushto at 1430.

Alaska—In addition to the item given last month, KYAK, Anchorage, has moved to 650 kHz and increased its power to 50 kW. Now the most powerful station in Alaska, DX'ers should listen for it. This channel is a clear channel with only WSM, Nashville, Tenn., and KORL, Honolulu, Hwaaii, operating there on unlimited hours.

Albania—A new frequency for Tirana is 9910 kHz, found here at 0020 in English talk; s/off at 0027.

Australia—*R. Australia*, Melbourne, is very good on 17.620 kHz, to 0500 s/off in their English beam to Africa and Madagascar with news, music, stock reports, sports results and many time checks. French follows this English xmsn. Also heard well is the English beam to southeast Asia and the British Isles at 0645-0815 on 9560 and 11.710 kHz.

Belgium—"Belgium Speaks" in English is aired at 0500-0100 on 11,715, 9615 and 6125 kHz. "Belgians Over The World" is broadcast at 0915-1005 on 11,715, 9615 and 9550 kHz.

Bolivia—CP110, *R. Norte*, Montero, is noted on 4871 kHz daily after 2200 with lengthy L.A. pop tune periods and anmt's in Spanish.

Brazil—ZYE22, *R. Educadora de Braganca*, Braganca, 4948 kHz, has a religious period at 2100; the ID is given together with a gong on the hour. ZYN7, *Ceara Radio Club*, Fortaleza, is fair on 15,165 kHz when logged at 0230 with commercials

(*Continued on page* 102)

DX STATES AWARDS PRESENTED

To be eligible for one of the DX States Awards designed for WPE Monitor Certificate holders, you must have verified stations (any frequency or service) in 20, 30, 40, or 50 different states in the U. S. The following DX'ers have qualified for and received their state awards.

TWENTY STATES VERIFIED

Michael Wheeler (WPE7CSY), Portland, Ore.
Robert Ewig, Jr. (WPE3HKF), Conneautville, Pa.
Robert Sygiel (WPE2QBD), Clifton, N. J.
Terry Schenk (WPE4JME), Winter Park, Fla.
P. L. Christian, Jr. (WPE1HLB), Middletown, R. I.
Jon Herranen (WPEØFEL), Milana, Minn.
Dennis Williams (WPEØETS), Wichita, Kansas
Donald Weber (WPE8IPJ), Westlake, Ohio
Mike Mickes (WPE7CVF), Gooding, Idaho
Thomas Jasinski (WPE9HVL), Mokena, Ill.
Richard Knight (VE2PE1LC), Montreal, Que.
Arthur Skopec (WPE2PQJ), Whitestone, N. Y.
Frank Howell (WPE4KAS), Tennille, Ga.
Gary Krupp (WPE3GZN), Schwenksville, Pa.
Gregory Martin (WPE8KFL), Wyoming, Mich.
Herbert Schwab (WPE4JVH), Memphis, Tenn.
Craig Jakubs (WPEØFHG), St. Louis, Mo.
Everett Watson (WPE9IUF), Granite City, Ill.
George Wacker (WPE3HPY), Philadelphia, Pa.
Steven Reed (WPEØFIT), Neosho, Mo.
Terry Moorby (VE3PE2OI), Sharbot Lake, Ont.
Tom Rownd (WPE8JWK), Wheeling, W. Va.
Jim Kehoe (WPE9IUQ), Chillicothe, Ill.
Edward Tafel (WPE2QBG), Syracuse, N. Y.
Frank Childress, Jr. (WPEØFIK), Ballwin, Mo.
William Anton (WPE4JMB), Memphis, Tenn.
David Johnson (WPE4KAR), Norfolk, Va.
Harry Hines, Jr. (WPE2OFS), Newark, N. J.
Mark Waldman (WPE5FBD), Kilgore, Texas
Mrs. Ray Bradley (WPE8KGU), Columbus, Ohio
Lee Cook (WPE4KBY), Selma, Ala.
William Coleman (WPE4JNW), Jacksonville, Fla.
Robert Olson (WPE4JZF), Winston-Salem, N. C.
Mrs. Mildred Marshall (WPEØFIR), Devils Lake, N. D.
Mike Hardester (WPE6HIM), Modesto, Calif.
David Berman (WPE3HTK), Randallstown, Md.
Scott Brockway (WPE2QJP), Rome, N. Y.
Rex Wilson (VE3PE2OV), Kitchener, Ont.
Gary Nuthals (WPE9JNA), Green Bay, Wisc.
Joseph Breton (WPE1HKW), Methuen, Mass.
Rick Pranitis (WPE9JJP), Rolling Meadows, Ill.
Ben Freet (WPE3HOD), Waynesboro, Pa.

THIRTY STATES VERIFIED

Jerry Posner (WPE2OML), Teaneck, N. J.
Ernest Doane (WPE1DTE), Lynn, Mass.
Thomas Feeney (WPE1GZC), Newport, R. I.
David Simon (WPE2PQP), Brooklyn, N. Y.
Jay Miller (WPE4JQV), Memphis, Tenn.
Jerry Heien (WPE9BOD), Berkeley, Ill.
Michael Northam (WPE7CME), Beaverton, Ore.
Ronnie Clark (WPE4JRX), Savannah, Ga.
Norm Shacat (WPE1GTP), Malden, Mass.
Arnold Rosett (WPE3HIF), Philadelphia, Pa.
Edward Smith, Jr. (WPE4JSG), Savannah, Ga.
J. R. Hawkins (WPE8GDP), La Vergne, Tenn.
Gary Fredricks (WPE7CGG), Eugene, Ore.
Edward Nemeroff (WPE2QGR), Brooklyn, N. Y.
Thomas Porzio (WPE2PXI), Nutley, N. J.
Montie Fisher (WPE5ESZ), Oklahoma City, Okla.
Lee Cook (WPE5EXJ), Biloxi, Miss.
Dan Biederman (WPE2QHO), Scarsdale, N. Y.
Scott Joslyn (WPE6GSN), Manteca, Calif.
Ronald Richmond (WPE9JIH), Alexandria, Ind.
Ron Budziack (WPE9JHK), Cicero, Ill.
Michael Lynch (WPE2OEA), Auburn, N. Y.
Martin Tarnowsky (WPE2PZD), Montvale, N. J.
Thomas Lamphere (WPE2QDB), Johnson City, N. Y.

FORTY STATES VERIFIED

B. Hughes (G2PE6D), Worcester, England
David Whatmough (VE3PE2IB), Hamilton, Ont.
Michael Rasmuson (WPEØFBO), St. Louis Park, Minn.
Eugen Floda (WPE2OFH), Bronx, N. Y.
Clarence Hagerman (WPE2NRU), Delaware, N. J.
Steve Kennedy (WPE4IAX), Sarasota, Fla.
Edward Bassett (WPE9EHF), Toledo, Ill.
John Sheriff (WPE3HQS), Monroeville, Pa.
Robert Combs (WPE2PJU), APO, New York, N. Y.
Mark Morrow (WPE5EVB), San Benito, Texas
John Long (WPE3DYU), Chicago, Ill.
Bill Migley (WPE8JEL), Lancaster, Ohio
Mike Diekhoff (WPEØETY), Lincoln, Nebr.
Gordon Cash (WPE4HFF), St. Petersburg, Fla.
Gerald Larocque (WPE1GED), Greenfield, Mass.
Douglas Tabor (WPE7CMY), Layton, Utah
Lee Cook (WPE5EXJ), Biloxi, Miss.

FIFTY STATES VERIFIED

Frank Moczukewski (WPE9JAU), Chicago, Ill.
Joel Resnick (WPE2LMZ), New York, N. Y.
Robert Combs (WPE2PJU), APO, New York, N. Y.
Kevin Krueger (WPE9JDI), West Allis, Wisc.
Russell Hawkins (WPE8GDV), La Vergne, Tenn.
Lee Cook (WPE5EXJ), Biloxi, Miss.

TWO WAY REACTIONS

BY G. H. REESE, KCN6990

CLEANING UP CAMILLE

AT LEAST 2000 Citizens Two-Way Radio operators participated in a huge communications link in the clean-up following Hurricane Camille last summer. CB radio was used to carry rescue messages and direct the movement of needed supplies and personnel when telephone service was out of operation.

It is estimated that a minimum of 20,000 messages were handled by CB. More CB'ers would have participated had their stations been left intact—winds of 200 miles per hour and flooding tidal waves carried off many an antenna.

Nonetheless, REACT teams, independent CB clubs and unaffiliated citizens cooperated in a magnificent effort. Using channel 9 as the key emergency channel, almost everyone worked together to keep urgent messages flowing. As a result, a series of CB networks were linked into one communications chain that stretched from Mobile, Alabama, to New Orleans, Louisiana, a distance of approximately 150 miles.

On August 15, the U.S. Weather Bureau's Hurricane Center in Miami reported that Hurricane Camille was headed toward the Florida Peninsula. Civil Defense authorities in the threatened areas along the Gulf Coast spread the warning and started evacuation of people in the most vulnerable dwellings.

At this time the Blue Angels REACT in Pensacola, Florida, assisted in providing local CD officials with communications for the evacuation effort. Their mobile communications vehicle was set up at a roadblock at the Inter-Coastal Waterway. It was used as a relay station for mobile units evacuating people from the island and beach areas. Other groups were similarly engaged in the evacuation activity.

On August 17, Camille overshot Florida and struck the Mississippi Coast with all its fury. The Pensacola group was called in to assist at the SeaBee base at Gulfport. Six team members drove over in the team's mobile communications rig. They worked in cooperation with Navy MARS (Military Affiliated Radio Service) at the base.

Gateway REACT in Metairie, Louisiana, a suburb of New Orleans, moved almost immediately to help fellow CB'ers in Waveland, Miss. By noon on the 18th, Frank Shepley, KBW2201 and Bill Henry, KCK-6191 had moved a 3500-watt generator to Waveland. Thus Deputy Sheriff Albert John Grass, KMR3143, and A. N. Grass, KHR-0690, were among the first to get back on the air after the storm.

Caravan REACT, Ocean Springs, Miss., cooperated with Civil Defense and the Air Force, Red Cross and Salvation Army agencies to set up rescue operations in the

Members of Caravan REACT Rescue, Ocean Springs, Miss. discuss emergency communications following Hurricane Camille. L. to r. are Robert W. Bohnson, Dep. Director, Ann Welch, and Ed. W. Adams, (Dir).

Biloxi area. Air Force personnel who were licensed CB operators were made available to help in the emergency. Team President Edward W. Adams was appointed Director of the CB Network by the local Civil Defense Director. The local network, known as "Biloxi Net Control," worked out of the police station at first, but was moved into the Old Biloxi Hotel where CD Headquarters were set up.

Contact was maintained with other CB "networks" to relay messages up and down the crippled coast. To the west, in Gulfport, was "The Open Gulf Watch." Messages were relayed to Bay St. Louis, Waveland, and New Orleans. Eastward, the Biloxi Net contact "D'Iberville Command" which was a relay point on the way to Mobile, Alabama.

Mr. Adams reports, "Although Biloxi Net was primarily a communications-controlled network, we ran a considerable delivery service for the Salvation Army and Red Cross units and also maintained CB operators at various feeding and supply stations in the Biloxi area, around the clock. Many of these volunteers were on duty over 20 hours at a time for more than three weeks. Over 60 people were carried to the hospital by these units when other means were unavailable."

Midway REACT in Waynesboro, Miss., north of the stricken area, established "Operation Locate." Publicized over the local radio station, the plan was to relay messages into the disaster area to locate relatives of people who lived in the Waynesboro area. The members also helped locate evacuees and escort them to private homes and shelters, aided motorists in distress and provided many other services.

Ala-Flora REACT in Altmore, Ala., collected and delivered needed supplies to Gulfport and Biloxi. Two days after Camille hit, they brought in a 2200-gallon tank truck of fresh water where badly needed.

In addition to emergency communications for rescue and relief operations, Lauderdale County REACT in Meridian, Miss., assisted in the "We Care" telethon broadcast on August 23 over WHTV. In response to stars Bob Hope and Hank Locklin, money and merchandise to aid Camille's victims poured in. The REACT emergency van was located outside the studios and was used to dispatch mobile units to pick up the donations. It is estimated that Lauderdale County REACT handled 950 different messages, collected over $10,000 in cash contributions and loaded over 5 tons of clothing and other donated merchandise while driving a total of 3200 miles in a single week!

The generosity of Citizens Two-Way Radio operators is not limited by geography. In Camden, New Jersey, Captain Lewis T. Lewis of the Christian Salvation Mission Army Rescue Workers and the Camden City REACT Rescue Workers, undertook a major relief drive for hurricane victims and personally delivered the supplies.

American Red Cross conducted classes in first aid for members of Capital City CB Club (Atlanta, Ga.). Here Dave Harris and wife, Shirley, get advice from Red Cross instructor Arthur Kaplan, at right.

We don't have all the reports on the Camille story as far as CB is concerned. It is clear, however, that a great need was met by thousands of interested operators. A disaster of this magnitude may never strike your community, but you can be prepared to meet it through an organized emergency team. Organized, "in-business" groups are the most effective in a crisis. They are ready to go. Find out how your CB club can become a REACT team. Write to REACT National Headquarters, 205 West Wacker Drive, Chicago, Illinois 60606.

Reciprocity on the Way? Did you know that, as a licensed Citizens Radio operator in the U.S.A., you can obtain a tourist's permit to operate your mobile unit in Canada when you visit there? Unfortunately, a

(*Continued on page 87*)

AMATEUR RADIO

By HERB S. BRIER, W9EGQ
Amateur Radio Editor

STORMS AND SHARKS MAKE TROUBLE

OVER 100 people were killed and another 80 are unaccounted for as Hurricane Camille—driven by 190-mile-per-hour winds —struck the Gulfport-Biloxi area of Mississippi and parts of Alabama and Louisiana during the night of August 17. Pass Christian, Mississippi, was completely destroyed, and virtually all normal means of communications were wiped out. While the storm was still raging amateur radio stations were transmitting emergency messages from the area. Within a matter of hours, the New Orleans office of the Federal Communications Commission had declared two 20-meter frequencies and approximately eight 75-meter frequencies emergency channels for handling communications with the disaster areas. Additional groups were handling emergency communications on all amateur bands between 3.5 and 148 MHz.

The following report is based largely on the personal observations of W9EGQ; so it covers only a miniscule portion of the amateur work in the disaster. One of the first and busiest stations on the air from the area was K5TYP, Keesler Air Force Base, Mississippi. K5TYP handled only highest priority messages concerning supplies, and rescue personnel were flown to the area in "flying box cars" while keeping radio contact with K5TYP.

Bill Bringer, K5CSJ, Gus Michael, K5AJK, and helpers came in from New Orleans. Gus set up K5AJK at Hancock General Hospital, Bay St. Louis. He handled orders for penicillin, vaccines, bandages, milk, water, and other supplies. He also ran phone patches between hospital doctors and consultants in New Orleans. Bill set up K5CSJ at the Gulfport Airport, handling vital messages, including one order for drinking water that a New Orleans brewery filled with 15,000 bottles of water. Ben Hudson, W5MCC, Grand Island, La., operated from the Gulfport disaster headquarters from early morning and throughout the night starting the morning after the storm. Members of the Twin City Hams Club, Monroe, La., then took over and operated from the headquarters under the club call letters of WA5WKP almost continuously for the rest of the week.

Most of the call letters of the individual amateur stations we heard operating in the disaster areas were so garbled (possibly by us) that it is impossible to identify them properly. We did note that Don, WA5FDP threw open his home to anyone wishing to send a message to anyone outside the disas-

AMATEUR STATION OF THE MONTH

Joe K. Winner, WB8AST, Beckley, W. V. very often provides the 50th state for hams seeking a Worked All States Award. Running 40 to 60 watts into an EICO 723 transmitter and receiving on a Mosley CM-1, he has worked 39 states and 12 countries on 40 meters. He has a 30-wpm certificate and an Advanced license. We are sending WB8AST a 1-year subscription for winning this month's Amateur Photo Contest. You can enter by sending a clear photograph (preferably black and white) of you at the controls of your station and some details of your amateur career to Amateur Photo Contest, Herb S. Brier, W9EGQ, P.O. Box 678, Gary, Indiana 46401.

ter area. He (and other stations) accepted incoming health and welfare messages and attempted to deliver them by whatever means available.

We congratulate the hundreds of amateurs who cooperated to get the messages through and apologize for not being able to mention all their call letters.

Expedition "Ra." On May 25, Thor Heyerdahl and a crew of six set sail from Safi, Morocco in a basket-like papyrus reed raft named "Ra". The journey was designed to prove that the ancient Egyptians could have drifted westward across the Atlantic. This would explain the similarities between the cultures of ancient Egypt and Mexico. The "Ra" was a reproduction of an ancient Egyptian raft—with a major exception. It was equipped with a 60-watt SSB station. Under the callsign LI1B, the raft kept in daily contact with Dick Ehrhorn, W4ETO, Seminole, Florida and LA5LG, Norway, and many other amateurs. Only one schedule was missed during the 3-month trip that ended 700 miles from the island of Barbados.

Violent storms crippled the "Ra" and sharks forced the crew to stop jumping overboard to make repairs. W4ETO ran phone patches between U.S. President Nixon and U.N. Secretary General U. Thant and Thor Heyerdahl; and LA5LG did the honors for the king of Norway.

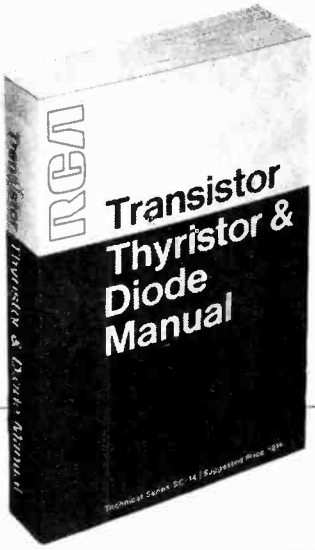
License Suspensions. On August 4, the Federal Communications Commission ordered the suspension of the licenses of three McKeesport, Pa., amateurs for related violations of the amateur regulations. The Advanced class license of Paul Allen Kelly, WA3AYC, was ordered suspended for the remainder of the license term (March 12, 1973) for procuring Keith A. Pederson, WA3HAE, to take an Advanced class examination for Technician class licensee, William F. Horvath, WA3CAD. Pederson's license was ordered suspended for six months, and Horvath's license was ordered suspended for the rest of his license term (October 12, 1969). The alleged violation took place at the Commission's Detroit office on February 12, 1969, and the three men had two weeks to turn in their licenses or appeal the suspension orders.

On September 24, the FCC modified its order covering the frequency changes scheduled to go into effect on Nov. 22. Under the new order, Extra class CW sub-bands on the 3.5-, 7-, 14-, and 21-MHz bands remain 25 kHz wide, instead of increasing to 50 kHz; and the 50-MHz Extra/Advanced class sub-band remains 50-50.1 MHz, instead of becoming 50-50.25 MHz. The order reaffirms the previously announced increases in 3.8-, 7.2-, 14.2-, and 21-25-MHz phone band frequencies available to Advanced class licensees.

Items From Here and There. *Squelch,* the bulletin of the Anaheim (Calif.) Amateur Radio Association, Inc., reports that after much furor, a new city ordinance permits amateur antenna towers up to 65 feet tall in Orange County. Among the defeated or-

One of the joys of amateur radio is getting to meet in person the DX operators one has worked. Jack Kromer, EL2BI, Monrovia, Liberia, and his wife, Pat, visited John, K9FNP, Tony, W9WIB, and Dave, W9PUB (seated) in Dave's station. Dave's extensive equipment list includes a Collins 75S-1 receiver and 32S-1 transmitter. (Photo: Gary, Ind., Post-Tribune.)

solid state...up to date



More than 100 new pages of latest information added

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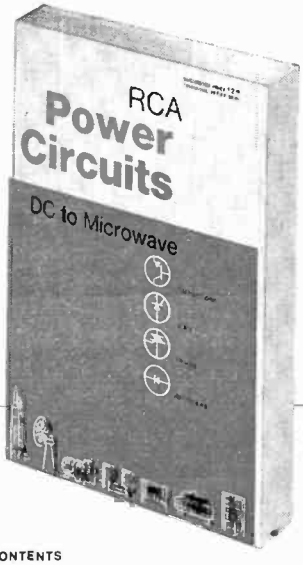

Newly expanded information for the circuit designer

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CIRCLE NO. 35 ON READER SERVICE PAGE

dinances was one that would have limited tower heights to 25 feet. Stan Pryga, W6WJ, editor of *Squelch*, commenting on moving the club's 40-meter net frequency above 7250 kHz to accommodate General class licensees as a result of the new frequency allocations, suggests that it might be wise for some nets to consolidate, rather than for each to attempt to find an interference-free frequency of its own. He points out that the club's VHF (2-meter) net has better coverage over a 50-mile radius than the lower frequency bands.

Is amateur radio becoming an old man's hobby? A recent American Radio Relay League poll says not. It shows that today's amateur newcomer is 24 years old, almost two years younger than his counterpart of 20 years ago; and 36 percent of the newcomers are under 16. Of course, the average age of *all* amateurs is greater than 24, because amateur radio is a lifetime hobby for so many.

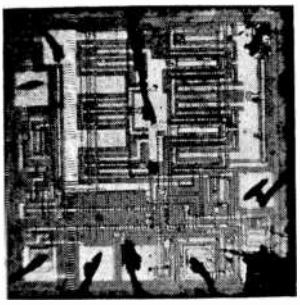
Isabel "Inkie" Scott, WB2AHE, Vineland, N.J., has run 10,000 phone patches for U.S. ice breakers in Antarctica in the past 10 years, using a Drake R-4 receiver, T-4 transmitter, and BTI amplifier. Her husband Bob, WB2AHF, operates his own Hallicrafters SX-101, HT-32 and final amplifier in same shack.

NEWS AND VIEWS

According to **Marty, WA3ERL,** there is a report in *Auto Call* (Washington, D.C.) that K3UZE worked 56 countries on 75-meter phone during the last ARRL DX contest using a 120-foot vertical antenna supported by a gas-filled ballon . . . Another vertical user is **Calvin Cooley, WA3HPS/9,** 2437 Waverly Dr., Gary, In. 46404. Cal's antenna is a Newtronics 4-BTV; he has all states worked, but he can't pry cards out of Montana, South Dakota, or South Carolina; so he would like 40-meter CW skeds with those states with QSL'ers. On the international scene, Cal has worked 50 countries—30 of them confirmed. . . **Kenny Kaae, WN6BYW,** 6667 Woodlake Av., Canoga Park, Ca. 91304, has a Hallicrafters HT-37 transmitter (with a crystal-control adapter, we hope) and receives on a Hallicrafters

MONOLITHIC INTEGRATED CIRCUIT HIGH FIDELITY AMPLIFIER AND PRE-AMP

Enlarged photo of actual silicon chip



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Output	10 Watts peak, 5 Watts R.M.S. continuous
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Phil Haller, W9HPG, receives the 4th Annual Illinois Amateur of the Year Award from Chuck Borkowski, WA9TWA, President of Hamfesters at the 35th annual club hamfest. W9HPG is American radio Relay League Central Division Director. (Photo: W9QKE)

SX-117 receiver. He is on 40 via a dipole and on 15 with a modified CB beam.

Eugene Kramer, WA9TZL, 302 N. Main St., Freeburg, Il. 62243, uses a rotary trap dipole antenna on 10, 15, and 20 meters and an 11-element beam on 2 meters. A Knight-Kit T-60 transmitter and Drake 2B receiver work with the dipole and a Heathkit Twoer feeds the beam. Gene has worked 48 states and 42 countries. He is a member of the Amateur Radio Emergency Corps, an alternate net control for the local Civil Defense net and an amateur meteorologist. . . **Manuel Greco, K2LFG,** 50 4th Av., Atlantic Highlands, N. J. 07716, is an award collector. He has 40 of them and is now working on a trophy awarded for proof of contact with 1000 different Novices. He will be glad to tell anyone interested about it and other awards open to Novices. Manuel has two transmitters—a Lafayette Starflite 90 and a venerable Heath AT-1; his receiver is a Collins 75A-1, and the antennas include a 100-foot endfed wire, 40-meter dipole, and two full waves in phase for 15 meters. Manuel has worked all states, he is now trying for WAS/Novice.

Tom Upshaw, WN5ZEH, 312 East Xavier, Temple, Texas 76501, celebrated getting his license by burning out the power transformer in his transmitter the next day! But the transformer is now replaced, and Tom has worked 50 stations in six states in a month. His transmitter is a Heathkit DX-20, and his receiver is a Hallicrafters S-85 . . .

"Doc" Lester, WA9UCM, 204 N. Park St., Streator, Il. 61364, (who was selected as Amateur Station of the Month for October, 1968) was pleased to receive the following SWL report, "Doc, monitored your QSO with WN8DPU. It was nice to hear a General who is courteous and will send to a Novice in clear code at appropriate speed!!" The SWL had been waiting for his own Novice ticket to arrive. . . **Lewis Brenner, WA3GNL,** 1314 Fanshaw St., Philadelphia, Pa. 19111, got a Novice license that he never used in 1965. He operated on 50 MHz as a Technician in 1967 using a Heathkit Shawnee transceiver and a "halo" antenna. In 1968, he got his General license. Hammarlund HQ-150 receiver, Phasemaster II-B SSB/CW transmitter, and a Hy-Gain 12-AVQ vertical antenna. With this combination, Lew has worked 25 countries—seven confirmed to go with his 18 confirmed states. If all went as planned, WA3GNL now has an Advanced class license and who-knows-what new gear.

Remember, we need your "News and Views" and pictures for your column. Thank you for keeping or putting us on the mailing list to receive your club bulletin. The address is: Herb S. Brier, W9EGQ, Amateur Radio Editor, POPULAR ELECTRONICS, P.O. Box 678, Gary, Ind. 46401. A Merry Christmas and a peaceful New Year to all.

73, *Herb, W9EGQ.*

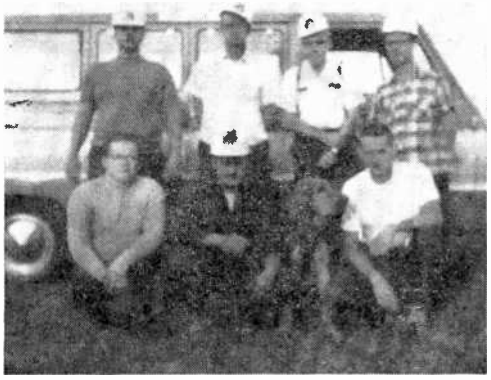
Lewis Brenner, WA3GNL, has good success on 6 meters with his Heathkit Shawnee transceiver and on the lower frequencies, he uses a Phasemaster II-B transmitter with Hammarlund HQ—150 for receiving.

TWO-WAY REACTIONS

(*Continued from page 80*)

Canadian citizen cannot yet get permission, under any circumstances, to operate in the States. The Communications Act of 1934, which established the FCC, forbids licensing anyone who is not a U.S. citizen. So, don't write to the FCC asking them to change the rules. Only Congress can change this rule. But there is a ray of hope, a treaty between the two countries is awaiting Canadian agreement, to be followed by ratification in the U.S. Senate. (A treaty with a foreign power, ratified by the Senate, overrules conflicting domestic legislation.

Right now, the Canadian Foreign Office is the bottleneck. So, all you Canadians who want to use your mobile rigs when you travel south of the border, put the pressure on your officials so we can extend the Good Neighbor Policy both ways across the border.



Emergency squad of CB Rangers, Inc. (Butler, Pa.) bought a $1000 bloodhound to aid in emergencies.

Keep the News Coming. If it seems that we are reporting only news of REACT teams, it is because we seem to get news only from REACT teams. Please tell us what your independent CB club is doing. We are also interested in your experiences as an individual operator. Don't forget to enclose photos. We want to tell the whole story of Citizens Two-Way Radio. Obviously, REACT is a very important factor in the picture, but we want to include everyone. Let us know what you are doing. Send your material directly to: Editor, Two-Way REACTions, REACT National Headquarters. 205 West Wacker Drive, Chicago, Illinois 60606. -30-

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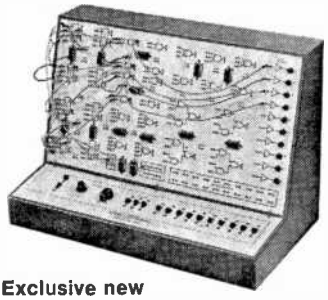

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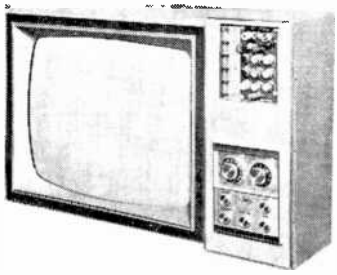

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program designed to make you a complete home-entertainment service technician. Included, at no extra cost, is a color TV that has more features than any set on the market. You also learn all about stereo, hi-fi, multiplex systems, and become a specialist in Color TV Servicing. Kits also include AM-SW radio, solid-state radio, field-effect transistor volt-ohmmeter, electronic tube tester.

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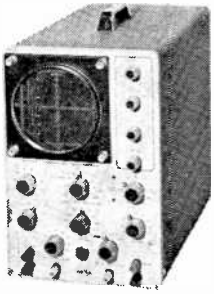

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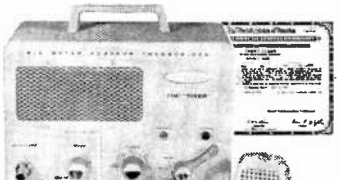

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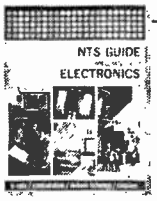

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TREBLE BOOST

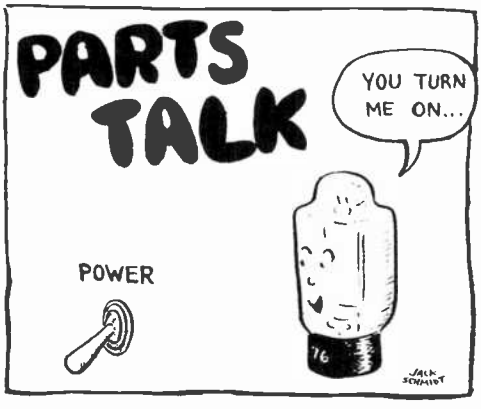
(*Continued from page 60*)

When the circuit is completed, assemble the utility box. Turn the box over and fasten a suitable knob to the shaft of the potentiometer.

To use the booster preamp, plug into *J1* the cable from your guitar and the plug on the booster/preamp's cable into the input of your amplifier. Switch on power (turn the potentiometer knob clockwise until you hear a click) and start playing your guitar.

By experimenting with the setting of the potentiometer control, you can determine the best positions of the control for different occasions and effects. (The maximum stage gain of the treble boost preamp is at this point restricted to 20 dB at 3000 Hz to prevent overloading and consequent distortion of the amplifier input stages. However, if your guitar/amplifier combination will handle it without degrading the sound quality, you can add another 6 dB of gain. To do this, remove *R5* from the circuit, and connect *C2* directly to the negative buss of the circuit.)

Once you familiarize yourself with the use of the guitar treble boost preamplifier, you will wonder how you got along without it at "rock" sessions. And because the booster preamp is an accessory item, when the time comes that you do not need it for special effects, you can disconnect it from the circuit and play your guitar straight through. -30-



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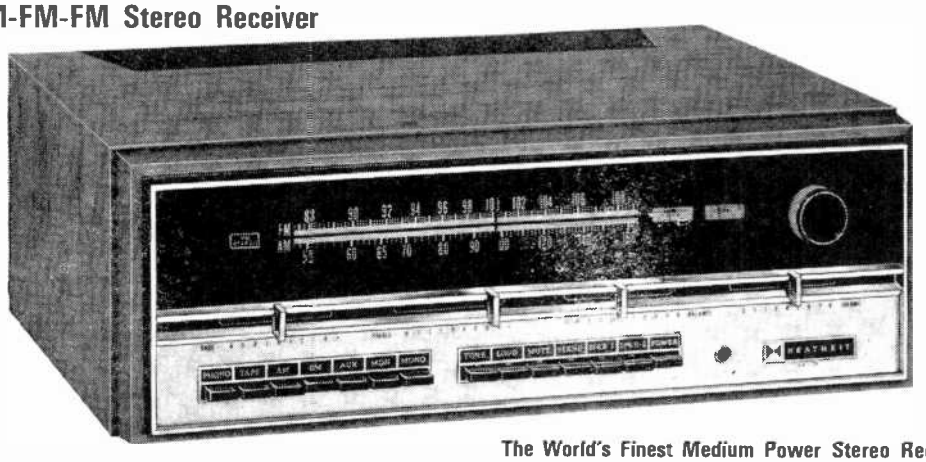

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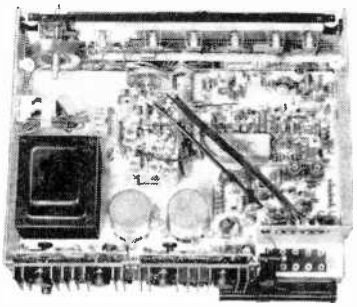

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Kit AR-29, (less cabinet), 33 lbs.....$285.00*
Assembled AE-19, oiled pecan cabinet 10 lbs.....$19.95*

PARTIAL AR-29 SPECIFICATIONS — AMPLIFIER: Continuous power output per channel: 35 watts, 8 ohms. **IHF Power output per channel:** 50 watts, 8 ohms. **Frequency response:** −1 dB, 7-60,000 Hz, 1 watt level. **Power Bandwidth for constant 0.25% THD:** less than 5 Hz to greater than 30 kHz. **Total harmonic distortion:** (Full power output on both channels) Less than 0.25%, 20-20,000 Hz; less than 0.1% @ 1000 Hz. **IM Distortion:** Less than 0.2% (full output, both channels). Less than 0.1% (1 watt output, both channels). **Hum and noise:** (phono input) −65 dB relative to 100 uV signal. **Phono input sensitivity:** 2.2 millivolts (overload 155 millivolts). **FM: Sensitivity:** 1.8 uV or better. **Volume sensitivity:** Below measurable level. **Selectivity:** Greater than 70 dB. **Image rejection:** 90 dB. **IF Rejection:** 90 dB. **Capture ratio:** 1.5 dB. **Total harmonic distortion:** 0.5% or less. **IM Distortion:** 0.4% or less. **Spurious rejection:** Greater than 90 dB. **FM STEREO: Separation:** 40 dB min. @ mid-frequencies; 30 dB @ 50 Hz; 25 dB @ 10 kHz; 20 dB @ 15 kHz. **Frequency response:** ±1 dB, 20-15,000 Hz. **Total harmonic distortion:** 0.5% or less @ 1000 Hz, 100% modulation. 19 kHz & 38 kHz. **Suppression:** 55 dB. **SCA Suppression:** 55 dB. **AM SECTION: Sensitivity:** (using built-in rod antenna): 200 uV/M @ 600 kHz; 300 uV/M @ 1400 kHz (IHF rated). **Selectivity:** Greater than 40 dB alternate channel. **Image rejection:** 60 dB @ 600 kHz; 45 dB @ 1400 kHz. **IF Rejection:** Greater than 50 dB. **Harmonic distortion:** Less than 2%. **Hum & Noise:** −35 dB.

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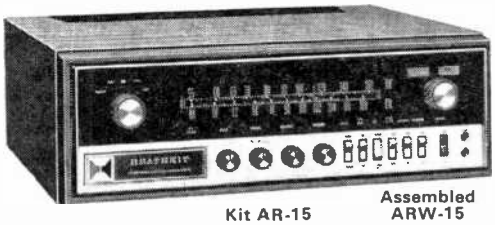

Kit AR-15 **$349.95*** (less cabinet)

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Heath engineers combined the circuitry of the famous Heath AR-14 Stereo Receiver with the precision BSR McDonald 500A Automatic Turntable and put them both in a sliding door walnut cabinet. The result is a stereo compact with component performance: a solid 30 watts music power output ... 12-60,000 Hz frequency response ... less than 1% IM & Harmonic Distortion at full output ... effortless flywheel tuning ... excellent sensitivity & selectivity ... adjustable phase control for perfect stereo separation ... automatic stereo indicator light. The BSR 500A includes features such as cueing/pause control ... stylus pressure adjustment ... anti-skate control ... and comes with a famous Shure diamond stylus magnetic cartridge. Put the top performing, attractively styled Heathkit AD-27 "Component Compact" in your home now. 41 lbs.

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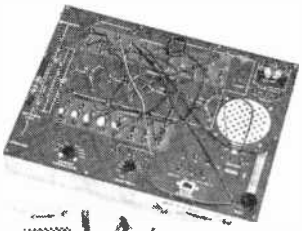

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Kit JK-18 **$19.95***

HEATHKIT GD-107 Portable Stereo Phonograph

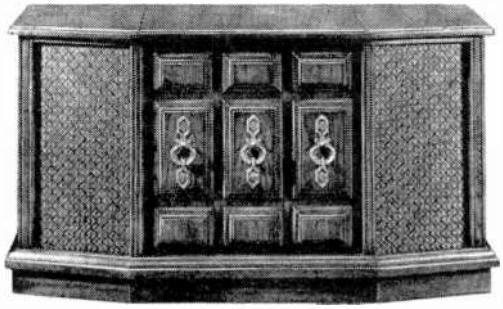
• Automatic or manual stereo and mono play of all speeds and sizes • All solid-state • Includes ceramic cartridge • Twin 4 x 6" speakers for wide response • Handsome avocado green & ivory styling • Easy 3-4 hour assembly • 29 lbs.

New HEATHKIT JR.® JK-18 Electronic Workshop

• 35 easy-to-build, fun-to-use experiments that teach basic electronic circuits • Safe — battery operated • No soldering • Builds radios, transmitters, alarms and dozens more circuits • Simple instructions any youngster can follow • 10 lbs.

There's a Heathkit® Gift

New Heathkit® "Component Credenza"



Mediterranean Styling . . . 30-Watt FM-Stereo Receiver . . . 4-Speed Automatic Turntable . . . Full-Range Speaker Systems

• Combines all solid-state FM stereo receiver, 4-speed automatic turntable with diamond stylus and two full-range, two-way speaker systems into a luxurious Mediterranean cabinet • 15 watts per channel music power output • Full range tone controls • Very low Harmonic & IM Distortion • Excellent channel separation • Transformerless output circuit for minimum phase shift, wide response • Electronically filtered power supply • Stereo headphone jack • Auxiliary input • Filtered tape output • Excellent FM tuner selectivity & sensitivity • 4-stage IF • AFC • Stereo indicator light • SCA filter • High quality BSR McDonald 500A Automatic Turntable with low mass counterbalanced aluminum tone arm plays up to 6 records • Comes with Shure diamond stylus magnetic cartridge • Vernier stylus pressure adjustment • Anti-Skate control • Cue/Pause control • Two ducted-port reflex 2-way speaker systems for performance comparable to fine component-type separate speaker systems • Each system contains 10" high compliance woofer & 3½" ring-damped tweeter for 60-16,000 Hz response • Complete system housed in a magnificent factory assembled Mediterranean cabinet of beautiful oak veneers with solid oak trim • Easy assembly with the famous Heathkit Manual . . . build only the receiver & install the components • The finest value anywhere in quality stereo consoles

Real Stereo Performance Demands Real Stereo Components . . . the kind used for custom-designed systems. The new "Component Credenza", as the name implies, integrates separate components into a single functional unit. Here are those components . . .

Component-Quality FM Stereo Receiver. The heart of the new AD-19 is the famous Heathkit AR-14 FM-FM-Stereo Receiver circuitry. The amplifier produces a solid 30 watts IHF music power. The FM Stereo tuner features 5 uV sensitivity, excellent separation and flywheel tuning. The AR-14 has been rated as the best value obtainable in a medium power receiver.

Component-Quality 4-Speed Automatic Turntable with such professional features as Cue/Pause control, Anti-Skate control, adjustable stylus pressure and famous Shure diamond stylus magnetic cartridge.

Component-Quality Speaker Systems. Two independent, ported speaker systems, each with a 10" woofer and 3½" tweeter deliver 60-16,000 Hz response for remarkable fidelity.

Elegant Mediterranean Oak Cabinet . . . a fine example of cabinet-making, flawlessly executed in oak veneer with solid oak trim. Rigidly constructed using fine-furniture techniques.

The New Heathkit AD-19 "Component Credenza". . . A Masterpiece in sight and sound. Put it in your home now.

Kit AD-19, 158 lbs. **$299.95***

NEW Heathkit GR-78 Solid-State General Coverage Receiver . . . Tunes 190 kHz To 30 MHz In Six Bands

The new GR-78 combines wide coverage, superior performance and portability with sharp styling to provide a remarkable value in general coverage receivers. Tunes AM, CW & SSB signals from 190 kHz to 30 MHz in six switch-selected bands. The all solid-state circuit employs modern FET's in the RF section and 4 ceramic filters in the IF to deliver maximum sensitivity and sharp selectivity. Bandspread Tuning is built-in, and can be calibrated for either Shortwave Broadcast or Amateur Bands. Completely portable . . . comes with a nickel-cadmium rechargeable battery pack and built-in charger that operates from 120 or 240 VAC and 12 VDC. Many built-in features . . . 500 kHz crystal calibrator . . . switchable Automatic Noise Limiter . . . switchable Automatic Volume Control . . . Receiver Muting . . . Headphone Jack and many more. Order yours today. 14 lbs.

NEW Heathkit Deluxe Radio-Controlled Screw-Drive Garage Door Opener Semi-Kit

The next best thing to a personal doorman. The "wireless" factory assembled transmitter operates up to 150 feet away. Just push the button and your garage door opens and the light turns on . . . and stays on until you're safely inside your home. The giant 7 ft. screw mechanism coupled with the ¼ HP motor mean real power and reliability and the adjustable spring-tension clutch automatically reverses the door when it meets any obstruction . . . extra safety for kids, pets, bikes, even car tops. Assembles completely without soldering in just one evening. Easy, fast installation on any 7' overhead track (and jamb & pivot doors with accessory adapter). Order yours now. 66 lbs.

Adapter arm for jamb & pivot doors, Model GDA-209-2, $7.95*

Idea For Every Budget

Heathkit "681" Color TV... AFT... New Brighter Picture Tube For More Vivid Colors, Better Resolution

The new Heathkit GR-681 is the world's most advanced Color TV with more built-in features than any other set on the market. Automatic Fine Tuning on all 83 channels ... power push button VHF channel selection, built-in cable-type remote control ... or you can add the optional GRA-681-6 Wireless Remote Control any time ... plus the built-in self-servicing aids that are standard on all Heathkit color TV's. Other features include high & low AC taps to insure that the picture transmitted exactly fits the "681" screen, automatic degaussing, 2-speed transistor UHF tuner, hi-fi sound output, two VHF antenna inputs, top quality American brand color tube with 2-year warranty. With optional new RCA Matrix picture tube that doubles the brightness, Model GR-681MX only $535.00.

GRA-295-4, Mediterranean Cabinet shown **$124.95***

Heathkit "295" Color TV... New Picture Tube For Brighter, Sharper Pictures

With Optional RCA Matrix Tube ... with the same high performance features and built-in servicing facilities as GR-681 above ... less AFT, VHF power tuning and built-in cable-type remote control. You can add the optional GRA-295-6 Wireless Remote Control at any time. New optional RCA Matrix tube doubles the brightness, Model GR-295MX, $485.00.

GRA-295-1, Contemporary Walnut Cabinet shown **$64.95***

Both the GR-681 and GR-295 fit into the same Heath factory assembled cabinets; not shown Early American style at $109.95*

Heathkit "581" Color TV... Sharper, Brighter Viewing With New Picture Tube... AFT

The new Heathkit GR-581 will add a new dimension to your TV viewing. Brings you color pictures so beautiful, so natural, so real ... puts professional motion picture quality right into your living room. Has the same high performance features and exclusive self-servicing facilities as the GR-681, except with 227 sq. inch viewing area, and without power VHF tuning or built-in cable-type remote control. The optional GRA-227-6 Wireless Remote Control can be added any time you wish. And like all Heathkit Color TV's you have a choice of different installations ... mount it in a wall, your own custom cabinet, your favorite B&W TV cabinet, or any one of the Heath factory assembled cabinets.

GRA-227-2, Mediterranean Oak Cabinet shown **$109.95***

Heathkit "227" With New Picture Tube For Increased Brightness & Better Resolution

Same as the GR-581 above, but without Automatic Fine Tuning ... same superlative performance, same remarkable color picture quality, same built-in servicing aids. Like all Heathkit Color TV's you can add optional Wireless Remote Control at any time (GRA-227-6). And the new Table Model TV Cabinet and roll around Cart is an economical way to house your "227" ... just roll it anywhere, its rich appearance will enhance any room decor.

GRS-227-5, New Cart and Cabinet combo shown. **$54.95***

Both the GR-581 and GR-227 fit into the same Heath factory assembled cabinets; not shown. Contemporary cabinet $64.95*

Heathkit "481" Color TV with AFT

The new Heathkit GR-481 has all the same high performance features and exclusive self-servicing aids as the new GR-581, but with a smaller tube size ... 180 sq. inches. And like all Heathkit Color TV's it's easy to assemble ... no experience needed. The famous Heathkit Color TV Manual guides you every step of the way with simple to understand instructions, giant fold-out pictorials ... even lets you do your own servicing for savings of over $200 throughout the life of your set. If you want a deluxe color TV at a budget price the new Heathkit GR-481 is for you.

GRA-180-1, Contemporary Walnut Cabinet shown **$49.95***

Heathkit "180" Color TV

Feature for feature the Heathkit "180" is your best buy in color TV viewing ... has all the superlative performance characteristics of the GR-481, but less Automatic Fine Tuning. For extra savings, extra beauty and convenience, add the table model cabinet and mobile cart. Get the value-packed GR-180 today.

GRS-180-5, Table Model Cabinet & Cart combo **$42.50***

Both the GR-481 and GR-180 fit the same Heath factory assembled cabinets; GRA-180-2, Early American Cabinet $94.95*.

Add the Comfort And Convenience Of Full Color Wireless Remote Control To Any Rectangular Tube Heathkit Color TV ... New Or Old!

Kit GRA-681-6, for Heathkit GR-681 Color TV's. **$64.95***

Kit GRA-295-6, for Heathkit GR-295 & GR-25 TV's. **$69.95***

Kit GRA-227-6, for Heathkit GR-581; GR-481 & GR-180 Color TV's **$69.95***

Now There Are 6 Heathkit® Color TV's To Choose From

2 Models In 295 Sq. Inch Size

NEW Kit GR-681 With AFT **$499.95*** (less cabinet)

Kit GR-295 **$449.95*** (less cabinet)

2 Models In 227 Sq. Inch Size

NEW Kit GR-581 with AFT **$419.95*** (less cabinet)

Kit GR-227 NOW ONLY **$379.95*** (less cabinet & cart)

2 Models In 180 Sq. Inch Size

NEW Kit GR-481 with AFT **$359.95*** (less cabinet)

Kit GR-180 NOW ONLY **$329.95*** (less cabinet & cart)

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*Mail order prices; F.O.B. factory. Prices & specifications subject to change without notice. CL-371

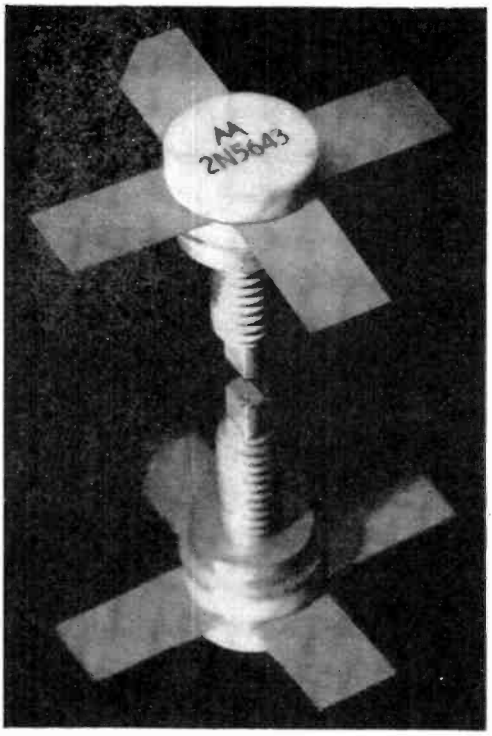
CIRCLE NO. 22 ON READER SERVICE PAGE

SOLID STATE

(*Continued from page 76*)

marked in terms of *beats per minute* using either a stop watch or a regular watch with a sweep-second hand as the basic calibration standard.

New Devices. Motorola Semiconductor Products, Inc. (P.O. Box 955, Phoenix, Arizona 85001) has announced a number of interesting new devices, including a low-cost integrated circuit audio amplifier, three families of UHF/VHF power transistors, and a monolithic wide-band r.f./i.f. amplifier.



The 2N5643, part of new series of Motorola UHF/VHF power devices, can furnish up to 40 watts on FM. Construction provides overload protection.

The new IC audio power amplifier is capable of 1-watt output with less than 0.4% total distortion from 20 Hz to 20 kHz. Designated type MC1454, the new unit is electrically equivalent to the previously introduced MC1554 except for a narrower operating temperature range. Suitable for both direct- and capacitively-coupled loads, its voltage gain can be selected through exter-

nal connections to meet a variety of application requirements. The MC 1454G is hermetically sealed in a long-lead version of the standard TO-100 metal case.

Known as Balanced-Emitter Transistors (BET's), Motorola's three new families of UHF/VHF power devices feature an interesting construction which provides built-in protection against overloading due to load mismatch or circuit detuning. This feature is obtained by constructing the devices of many small transistors in parallel, with a tiny thin-film Nichrome resistor in series with each of the many emitters, dividing the total collector current equally. If the current injected by any emitter tends to increase, the voltage drop across its resistor reduces the forward bias for that emitter-base junction, thus decreasing the injected current and maintaining a safe operating level.

The new devices are packaged in a ceramic Stripline Opposed-Emitter (SOE) package which features low-inductance ribbon leads. Two emitter leads, one on each side of the package, simplify circuit design and tuning, and permit the construction of broadband amplifier circuits.

The new UHF/VHF families include the 2N5635-2N5637 series, which can provide up to 20 watts CW output, up to 500 MHz with a 28-volt supply; the 2N5641-2N5643 series, which can furnish up to 40 watts FM output and are suitable for AM or SSB use up to 250 MHz; and the 2N5589-2N5591 series, which are capable of up to 25 watts output at frequencies as high as 175 MHz in FM operation at 13.6 volts.

Featuring an extremely wide (over 60 dB) AGC range, the Motorola type MC1590 monolithic wide-band r.f./i.f. amplifier is designed for use in HF and VHF communications receivers, including navigation and aircraft equipment. It offers high power gain (40 dB minimum at 60 MHz) and can operate as a general-purpose amplifier at frequencies as high as 200 MHz. Hermetically sealed in an 8-lead TO-99 metal can, the MC 1590G needs only a single 6- to 15-volt power source.

RCA Electronic Components (415 South 5th St., Harrison, N. J. 07029) has introduced two new developmental IC devices—a 100-watt hybrid power amplifier and a monolithic photo detector/amplifier.

The audio power amplifier, type TA7625, includes two output power transistors, 8 diodes, 23 thick-film resistors, 7 capacitors, and 9 small signal transistors, all on a single base plate. With an input signal of only 0.5-volt r.m.s. across 20,000 ohms, it can deliver 100-watts r.m.s. output at 7 amperes peak current.

Potentially useful in a variety of control

systems, the photo detector/amplifier, type TA5371B, contains a photosensitive element of two Darlington pairs in parallel and a power amplifier element with two outputs, one for normally on and the other normally off applications. Packaged in a TO-5 case with a glass top, the TA5371B has a 100-mA output current capability.

On the microwave front, TRW Semiconductors, Inc. (1100 Glendon Ave., Los Angeles, California 90024) is offering several high-performance devices, including a series of broadband power amplifiers capable of providing the performance of traveling-wave-tube circuitry and a new group of high-gain microwave transistors.

Rated at 10 watts minimum output across each band, the power amplifiers have the following characteristics: type PA-3940 covers the band from 1.0 to 1.5 GHz with 6 dB gain; type PA-3941, 1.5 to 2.0 GHz with 5 dB gain; and type PA-3942, 2.0 to 2.3 GHz with 4 dB gain. All three units have an efficiency rating of 25% and require a 28-volt d.c. source.

TRW's three new microwave transistors are designed for applications at frequencies up to 2 GHz with 28-volt power supplies. The type 2N5766 is rated at 1-watt output, the type 2N5767 at 2.5 watts output, and the type 2N5768 at 5 watts output. The units can operate with better than 30% efficiency in properly designed circuits and are assembled in hermetically sealed ceramic stripline packages.

With an eye towards the service technician and experimenter markets, Sylvania Electric Products, Inc. (1100 Main St., Buffalo, N. Y. 14209) has introduced two new lines . . . one is a group of 60 general-purpose semiconductor devices which can be used as replacements for some 28,000 commercial units, while the other is a family of linear IC's designed specifically for hobbyist applications. A 67-page Semiconductor Replacement Guide/Catalog, Publication No. ECG212B, cross-references the 60 Sylvania devices to 28,000 JEDEC and manufacturers' part numbers. The firm has also introduced a compact solid-state repair kit, the ECG303, which contains a copy of the Replacement Guide and a selection of 24 of the most commonly used semiconductor devices in the line.

Blister packaged for rack display, each linear IC in the hobbyist line is furnished with a booklet which provides a complete description, schematic, electrical characteristics, and a number of suggested applications. The line includes the ECG 370 AGC/Squelch Amplifier, the ECG 371 RF/IF Amplifier, the ECG 372 AM IF Strip, the ECG 703 RF/IF Amplifier-Oscillator-Mixer, and the ECG 716 Audio Amplifier. The latter device is a general purpose unit capable of delivering up to 250 mW power to an 8-ohm loudspeaker at any of several voltage gain levels.

Transitips. Batteries have a much longer life when used on an intermittent rather than a continuous service basis. Unfortunately, some applications require that battery-powered equipment be left on for relatively long periods. A walkie-talkie used by a surveyor who must maintain regular contact with his base or a monitor receiver used by a field engineer are typical examples.

Recognizing the advantages of intermittent operation, one field engineer friend of ours always provides *two sets* of batteries for each piece of equipment in use. Rather than operate one set continuously until exhausted, he switches back and forth from one to the other at moderately short intervals. Thus, he always has relatively fresh units in use and gains the longer life and lower cost advantages of intermittent operation.

A good tip—remember it!

It's that time again—so, to one and all, Happy Holidays! —*Lou.*

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VARIABLE BALANCE STEREO HEAD PHONE
Unique "Sound Level" control on each earpiece permits adjustment. Frequency range: 20 to 20,000 + cps. 6½' cord with stereo plug. Impedance 4 to 16 ohms.
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Type PR2 • 2.5 volt • 0.50 amp •
Cat. No. E2-430 • Pkg. of 2 $.29 Net
Type PR3 • 3.6 volt • 0.50 amp •
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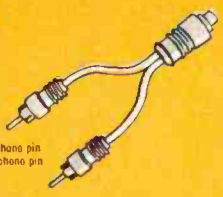
TAPE RECORDER MICROPHONE
Outstanding performance on music and speech for the price. Low impedance matches late model solid state recorders. Removable desk stand; 4½' cord with dual plugs that fit most models. Freq. Response: 100-8k Hz. Output: — 77 dB. Impedance: 200 ohms.
Cat. No. Q4-146 $4.95 Net



AUDIO ADAPTORS
"Y" Audio Adaptor has a phono pin jack on one end and dual phono pin plugs on the other.
Cat. No. Q4-288 $.99 Net

RESISTORS
Attractively packaged 2 per pack, showing values, color codes and formulas.

Type	Rating	Sizes Available	Price	Unit
Carbon	½ Watt —10%	10 Ohm-10 Meg	$.19	Pkg. of 2
Carbon	1 Watt —10%	10 Ohm-1 Meg	.19	Ea.
Carbon	2 Watt —10%	10 Ohm-100K	.25	Ea.
Wire Wound	10 Watt —10%	10 Ohm-15K	.36	Ea.

HOBBYIST'S SOLDERING AND TOOL KIT
Diagonals, long nose pliers, soldering iron and solder, solder aid tool, heat sink, and screwdriver. An ideal gift item.
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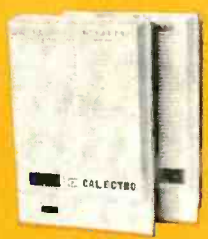
STANDARD 1000 VOLT CAPACITOR
High quality, compact and reliable. Minimum capacity change with varying temperature. Rating: 1000 volts, tolerance: 20%.

Cat. No.	Description	Net	Unit
A1-060	220pf	$.25	Pkg. of 2
A1-061	330pf	.25	Pkg. of 2
A1-062	470pf	.25	Pkg. of 2
A1-063	680pf	.25	Pkg. of 2
A1-064	0.001uf	.19	Ea.
A1-065	0.005uf	.19	Ea.
A1-066	0.01uf	.19	Ea.



TWO STATION WIRELESS INTERCOM
Just plug into any electrical outlet. Completely portable. Expand system anytime with additional units. Two unit system complete in display pack.
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EXPERIMETER'S CIRCUIT BOARD KIT
Contains a 3¼" x 4" perforated board, 15 terminals (No. H-636) and 4 mounting feet w/screws. Build small circuits, hobby and science projects, etc.
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The "GC Calectro Hobbyist Handbook" is available at your nearest Calectro Electronic Supermarket. One is located near you. WRITE TODAY and we'll rush you the name and address of your nearest Calectro Supermarket.

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CIRCLE NO. 18 ON READER SERVICE PAGE

SHORT-WAVE LISTENING

(*Continued from page 78*)

and L.A. pop music. *R. Clube de Vitoria da Conquista;* 3330 kHz (may also operate on 3395 kHz) and *R. Caraja,* Anapolis, 2405 kHz, both operate in Portuguese at 2100-0300. Reports for these two stations and for any other Brazilian station, when the sender does not have the complete address, may be sent to Sr. Camilo Roberto Costa, C.P. 353, Sao Jose do Rio Preto, SP, Brasil. Our thanks to Sr. Costa for providing this service.

Burma—*R. Burma* has classical music, then light instrumental music on 5040 kHz. This English period was noted from 1520 tune-in to 1600 s/off.

Czechoslovakia—On a recent "Magazine of the Air" program over *R. Prague* at 0115 on 9540 kHz, an offer was made to send cardboard cut-outs of Czech, French and U. S. vintage automobiles. The cost: 10 IRC's and please send your request directly to the station.

Egypt—Cairo was found on 9740 kHz at 2200 with English news; this is a new frequency. The station has also been heard testing in five languages to S.E. Asia on 21,710 kHz at 1245. English to Central Africa is aired at 1820-1842 with Arabic lessons on 17,655 kHz. On 9475 kHz Italian to Europe is given at 1830-1930. French until 2030 and German until 2145. English to N.A. is given on this same frequency at 0200-0330. On 17,655 kHz, Swahili to East, Central and Southern Africa is at 1530-1730 and English to the same areas at 1730-1845.

El Salvador—A special delivery letter from YSS. *R. Nacional,* San Salvador, included a pennant marked 6010 kHz, a letter written in Spanish and marked 5980 kHz, and a paper supposedly written by Americans on the El Salvador-Honduras conflict.

England—A new 11-meter outlet of the *BBC,* London, has been found on 25,630 kHz at 1510 with "Radio Newsreel". 1515 with "Listener's Choice" and heard until past 1533.

Germany (West)—*Voice of Germany* was tuned with a short xmsn to N.A. at 1900-1910 on 11,795, 15,405 and 17,705 kHz. Poorly received in the Midwest, the 1900 xmsn on 11,945 kHz was virtually unreadable.

Guatemala—The station listed here last month, *Radiodifusora Popol Vuh,* is claimed by some sources to be *R. Nacional Mazatenango.* Only positive facts: it is on 5070 kHz, it is noted only on Fridays at 2230 to s/off on Saturday at 0130, it is very weak and ID's are few and far between. TGCH, *R. Chortis,* Jocotan, is audible on 3380 kHz nightly from before 0300 until 0405 s/off with U.S. & L.A. pop music and an English anmt at closing.

Haiti—A verification has been received in response to a reception report to *R. Capois La Mort.* The QSL, from 4VOD, *R. Valparaiso,* states that *Capois La Mort* has been silent since 1967. *R. Valparaiso,* Port-de-Paix, is the station operating on 5040 kHz. 4VEH, Cap Haitien, is excellent at 1200 s/on on 9770 kHz. Reports to Box 1, Cap Haitien.

Holland—*R. Nederland,* Hilversum, is scheduled, at press time, in English to N.A. at 2125-2250 weekdays on 15,425 and 11,730 kHz. 0155-0320 daily on 11,730 kHz (Bonaire) and 0455-0620 daily on 11,730 and 9715 kHz (both Bonaire).

India—A tentative logging is that of *All India Radio,* Calcutta, 9530 kHz. Indian-type music was monitored around 1435 and it was extremely weak.

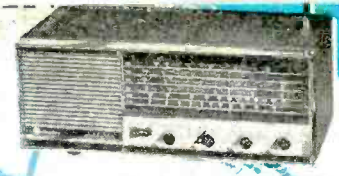
Indonesia—YDQ4, Makassar, noted on 4650 kHz with Oriental music at 1412-1415. ID, and into pop music until 1424. *R. Indonesia,* Sorong, has English lessons, music and local language singing on 4872 kHz at 1000.

Ivory Coast—*R. Abidjan,* 11,920 kHz, has their French International Service at 2300-0000 with pop

CIRCLE NO. 21. ON READER SERVICE PAGE→

S-120A, "Star Quest"

SX-133



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SX-122A

S-240

CR-44A, "Ranger"

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HA-20

CRX-103A,-104,-105A

HA-1A

CRX-101,-106,-10

Send for the new Hallicrafters World Time Dial & Frequency Chart. Only $1 covers chart, handling and postage. Dept. PE

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and light music to 2354, ID and news bulletins to 2357; then their closing anmts. Reports in some quarters concerning Djibouti on this frequency at 0600-0800 are in error; the station is Abidjan. This schedule is daily except Sunday when it runs to 0930 or later.

Japan—*NHK (Nippon Hoso Kyokai)*, Tokyo, was noted on 15,260 kHz, under the *BBC* at 1610 with a talk in English. The 11,900-kHz outlet was also heard at good level at 2030-2100 in English to Europe. *Nihon Shortwave Broadcasting Co.*, Tokyo, is good over JOZ3, 9595 kHz, at 0830 in Japanese, and at 1045-1100 with Japanese language lessons in English. This one verified in nine days.

Korea (South)—*The Voice of Free Korea*, Seoul, is good at 1100-1130 on 9640 kHz with their English General Service.

Kuwait—*R. Kuwait* has been found from 1600-1900 on 15,345 kHz but also noted one day on 15,405 kHz; this English xmsn has news at 1730. Arabic Service with mostly chanting may be found on 11,825 kHz at 1200-1230.

Malaysia—Kuala Lumpur has an all-Malay xmsn on 5965 kHz at 1530-1630 with pop music, news (at 1600) and chanting.

Mexico—A new station, reported to us by phone at press time, is XERMX, *R. Mexico*, 11,718 kHz, noted at 0130-0200 with much native music. Further details are as yet unavailable. One of the smallest QSL's of record is being issued by XERH, Mexico City, 11,880 kHz. The size of a small business card, it has the station information on one side with a stamped message on the reverse and it

A Realistic DX-120 receiver, to which is attached a Murch 86-D dipole antenna, is equipment used by Gary Goltz, Pittsburgh, Pa. He is a member of several short-wave clubs run by overseas stations.

was mailed in an envelope which was just large enough to fit the card. Other notes: XERR is strong in Spanish around 1300 on 15,110 kHz, and XEBR, Hermosillo, 11,820 kHz, is now announcing as *Radio Be Hache* as noted at 2000-2200 in Spanish but with poor modulation and considerable QRM.

Mongolia—Two out-of-the-country reports list reception of *R. Ulan Bator* in English at 1000-1030 with news, commentary and music on 11,860 kHz and at 2200-2230 with heavy QRM from an Arabic-speaking station, on 11,810 kHz.

Nepal—*R. Nepal*, Kathmandu, has sent one of our monitors a "very proper" black and white QSL card, complete in every detail and signed by Chief Engineer K. B. Khatry. The current schedule is listed as 0120-0350 on 7105 kHz (5 kW) and 11,970 kHz (5 kW); 0720-0920 on 7165 kHz (100 kW) and 790 kHz (10 kW); and 1320-1620 on 7165, 11,970 and 790 kHz.

Nigeria—*Voice of Nigeria*, Lagos, has this English schedule: 0600-0730 to West and Central Africa on 7275 kHz, Canada, Europe, and Mediterranean areas on 15,365 kHz, and Central and Far Eastern Asia on 21,455 kHz. At 1530-1700 to Europe, Mediterranean and Canada on 15,365 kHz, East and North Africa and the Middle East on 21,455 kHz and to West and Central Africa on 7275 kHz. At 1800-1930 to Europe, Mediterranean and Canada on 15,365 kHz, West and Central Africa on 7275 kHz, East Africa on 11,770 kHz and to the Middle East on 21,455 kHz. The 0600-0730 xmsn on 15,365 kHz is well heard in some areas with "Morning Melodies" and, at 0700, English news.

Papua—VLT4, Port Moresby, 4890 kHz, is being heard in eastern states at 1030-1130 in all English except for a brief period around 1045; pop music, world and territorial news, "Guest of Honor", and music requests. This one does very well for 10 kW and it isn't even beamed this way! It verified in less than three weeks.

Paraguay—ZPA7, *R. Guarani*, Asuncion, was heard on 15,200 kHz at 1530 with an ID and Argentine tangos.

Peru—OBX5E, *R. Andahuaylas*, Andahuaylas, is audible at times on 4840 kHz after 0100 with Andean music and request periods. It took four reports to get a QSL. OAX7Z, *R. Juliaca*, Juliaca, 5082 kHz (although listed for 5015 kHz), has local news at 0230, then into L.A. pop tunes. Heavy RTTY QRM will make reception difficult.

Portugal—English from Lisbon: to U. S. at 0200-0245 and 0345-0430 on 15,125, 11,935 and 6025 kHz; to Canada at 0300-0345 on 11,840 kHz; to Great Britain, Holland and Scandinavia at 2045-2130 on 6025 kHz; to Australasia at 0730-0900 on 21,495 and 17,880 kHz; to S.E. Asia at 1345-1430 on 21,495 and 17,895 kHz; to Kenya, Uganda and Tanzania at 1815-1915 on 17,895 kHz; and to Nigeria, Ghana and Liberia at 1815-1915 on 21,495 kHz. Medium waves: to Europe at 2245-2330 on 755 and 1061 kHz and at 2300-2345 on 1412 kHz.

Saudi Arabia—Jeddah was noted on 11,855 kHz

at 1730-1930 in all English with pop recordings.

Solomon Islands (Northern)—VL9BA, Bougainville Island, noted on 3222.5 kHz from 0815-0925 with country and western music; listen for the four-note gong or chime IS.

Syria—Damascus is on two new channels: on 7105 kHz at 0305 as heard with an Arab vocal, and 15,270 kHz at 1730-1800 in German and 1930-2100 in English.

Togo—*R. Togo*, Lome, has this schedule: weekdays at 0530-0900, 1200-1400, and 1630-2300, Saturdays 0530-0900 and 1200-2300, and Sundays 0530-2300 in French, English, Hausa and native languages, on 1394 kHz (1 kW), 6155 kHz (4 kW) and 5047 and 7265 kHz (both 100 kW).

SHORT-WAVE CONTRIBUTORS

David Larrabee *(WPE1IIRD)*, Bucksport, Maine
Robert McCarthy *(WPE1IIUJ)*, Westwood, Mass.
Robert Jacobs *(WPE2EH)*, Winslow, Maine
Albert Sauerbier *(WPE2NDA)*, Washington, N. J.
Gary Becker *(WPE2PFP)*, East Northport, N. Y.
John Banta *(WPE2PIIU)*, Bay Shore, N. Y.
John Herkimer *(WPE2PIL)*, Caledonia, N. Y.
Frederick Webster *(WPE2PRD)*, Secaucus, N. J.
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Robert Taylor *(WPE2QSK)*, Waldwick, N. J.
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Marcus Berman *(WPE2QXO)*, Montclair, N. J.
Barry Gelt *(WPE2QZY)*, Flushing, N. Y.
Steven Fix *(WPE2RAS)*, Rochester, N. Y.
Leo Alster *(WPE2RBN)*, Rahway, N. J.
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Peter Romeika *(WPE3HMV)*, Rosemont, Pa.
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Terry Petrarca *(WPE3HUF)*, Derry, Pa.
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Grady Ferguson *(WPE4BC)*, Charlotte, N. C.
Carroll Patterson *(WPE4KHW)*, Decatur, Ga.
Scott Fruehwald *(WPE4KIH)*, Jeffersontown, Ky.
David King *(WPE5EWJ)*, Monroe, La.
Richard Fortson *(WPE5EWX)*, Edinburg, Texas
Terry Ward *(WPE5EZX)*, El Paso, Texas
George Jolly *(WPE5FAN)*, Hitchcock, Texas
Joey Nonnast *(WPE5FAP)*, Kingsville, Texas
James Krempel *(WPE5FEH)*, San Antonio, Texas
Jim Young *(WPE6EN.1)*, Wrightwood, Calif.
Trevor Clegg *(WPE6FAF)*, Fresno, Calif.
Donald Asp *(WPE6HGV)*, Tustin, Calif.
Jeff Leader *(WPE6HNX)*, Van Nuys, Calif.
Bill Hein *(WPE6HON)*, Woodland Hills, Calif.
Chuck Albertson *(WPE7CWI)*, Spokane, Wash.
David Williams *(WPE7CWW)*, Astoria, Ore.
Tom Christian *(WPE7CXG)*, Seattle, Wash.
Robert Shumaker *(WPE8KBE)*, Southfield, Mich.
Gene Moser *(WPE8KIG)*, Coloma, Mich.
George Smith, Jr. *(WPE8KJJ)*, Grand Rapids, Mich.
Gerry Dexter *(WPE9HDB)*, Lake Geneva, Wis.
E. O. Cole *(WPE9HZ)*, Rolling Meadows, Ill.
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John Beaver *(WPE0AE)*, Pueblo, Colo.
C. Vernon Hyson *(WPE0CNF)*, Somerville, N. J.
Steven d'Adolf *(KX6PE1B)*, Kwajalein, Marshall Islands
Jack Perolo *(PV2PE1C)*, Sao Paulo, Brazil
Douglas Stark *(VE3PE2OV)*, London, Ont.
Robert Byers *(VE3PE2PX)*, Gananoque, Ont.
John Bigos, Mt. Clemens, Mich.
Camilio Costa, San Jose do Rio Preto, Brazil
Peter Jones, River Falls, Wisc.
Brad Krohn, Amherst, N. Y.
T. Miles, Victoria, B. C.
Wilfred Moss, Silver Spring, Md.
Jeffrey Muska, Colonia, N. J.
David Parrish, Shelby, Ohio
Henry Seidner, Pearl River, N. Y.
Robert Seidner, Pearl River, N. Y.
Kenneth Shaw, Somerville, N. J.
Edward Svec, College Point, N. Y.
R. Portugal, Lisbon, Portugal
American SWL Club, Huntington Beach, Calif.

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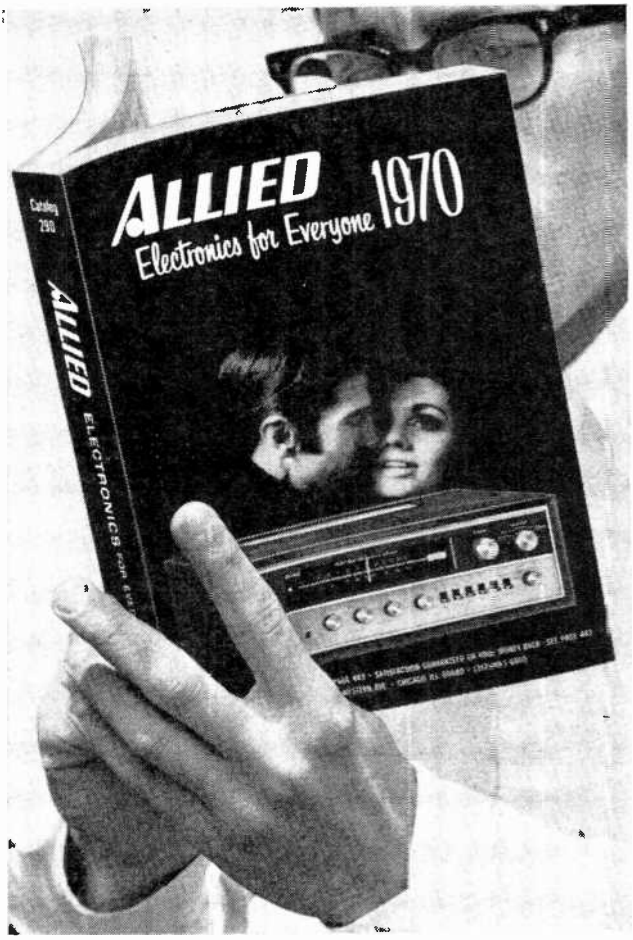

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ALLIED RADIO

CIRCLE NO. 2 ON READER SERVICE PAGE

EXPERIMENTERS' LASER

(*Continued from page 32*)

tinuously. If you are using the switched power supply, depress the pushbutton and then release it to start the laser.

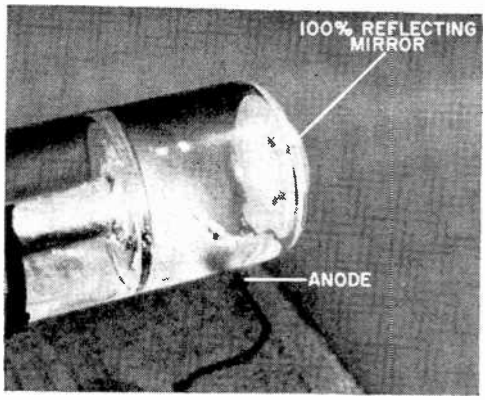
Troubleshooting. If all instructions have been followed carefully, the laser should start immediately. During operation, the glass tube will have the characteristic red glow of a neon lamp. If there is no glow, check the power supply operation by removing the laser tube and replacing it with a load made up of five 33,000-ohm, 2-watt resistors connected in series. Insert a 10-mA d.c. milliammeter in series with the substitute load. If the power supply is operating properly, there should be a load current of 5.5 mA. If not, check the power supply.

If the supply is OK, replace the laser tube, turn on the power, and turn the room lights out. See if there is a periodic red-orange glow discharge through the capillary tube. If the glow is there but the laser tube does not lase, short out either *R5* or *R18* in the supply. It is possible that the voltage is too low to operate the laser.

When the laser does light, it will not burn holes in anything; but remember, DO NOT shine it into anyone's eyes. Although this laser is well below the theoretical threshold of eye damage, the

LASER OPERATING PARAMETERS

Nominal power output: 0.5 milliwatts
Wavelength: 633 nanometers (6328 A)
Mode: random
Polarization: unpolarized
Beam divergence: 1.5 milliradians
Beam diameter: 1 nanometer
Operating current: 5.5 mA d.c.
Approximate operating voltage: 950 volts
Required trigger voltage: 2500 volts
Dimensions: 9.2" x 1" plus cathode bulb



At the anode end of the laser tube, the mirror is 100% reflective to keep light from escaping there.

HOW IT WORKS
POWER SUPPLY

The 1600 volts required to drive the laser is developed in a conventional voltage doubling circuit. In the automatic firing circuit, as capacitor *C1* charges up, and before any current flows through *R5* and *R6* (the laser has not yet fired), capacitor *C5* begins to charge through *R7*. The voltage across neon lamp *I1* is the same as that across *C5*. When this voltage reaches the firing point of *I1* (approximately 130 volts), current flows through *R9* triggering *SCR1* on. Capacitor *C5 then* discharges through the primary of the 100:1 ignition transformer *T1*, generating a high voltage at the secondary. This fires the laser. Current flows through *R5*, *R6*, *R10*, and *R11* to keep the laser lit, simultaneously keeping the voltage across *C5* low enough so that *I1* does not fire. Therefore, as soon as the laser fires, the automatic circuit stops operating.

THE LOW-COST LASER TUBE

The outer glass tube (1" diam) contains a mixture of 85% helium and 15% neon. Although lasing takes place within a 2-millimeter precision-bore capillary tube inside the larger tube, the large tube provides a reservoir of gas to improve reliability. After several thousand hours of operation, some helium starts to diffuse through the tube walls and some neon is absorbed by cathode sputtering. Hence, the larger the volume of gas, the longer the tube life. Another function of the large tube is to provide rigid support for the carefully aligned and sealed mirrors.

There is an electrode at each end of the tube. The cathode, a cold cathode made from a nickel-plated iron shell, is coated on the inside with barium carbonate, a low-work-function electron emitter. With this type of cathode, the laser starts instantly. The anode is a simple stub of nickel wire.

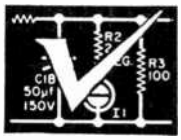
The two mirrors are not conventional. They are made from an uneven number of quarter-wavelength layers of dielectric. Alternate layers are made of a material having a high refractive index (zinc sulfide or titanium oxide); the other layers have a low refractive index (magnesium fluoride or sodium oxy-fluoride). The 100% reflecting mirror is 23 layers thick and the transmission mirror is 13 layers thick. Only in this way can reflectances of 99.9% be achieved for the one mirror. By contrast, the best aluminized mirrors have only about 90% reflectance.

The voltage-current characteristic of the laser tube is not unlike that of a conventional neon voltage regulator tube. The capillary tube gives the laser a high voltage drop and a larger negative resistance. A trigger pulse, over 2500 volts, must be applied to fire the laser. The voltage across the tube then drops into the operating region. Because of the negative resistance in the operating range, a large-value ballast resistor must be used. In the equipment described here, this resistance is about 120,000 ohms. Thus, the power source must provide about 950 volts for the tube and 700 volts for the ballast resistance under operating conditions.

The glass tube itself is made of annealed, high-temperature borosilicate glass. Although it is rugged, it should be handled with care, especially around the metal-to-glass seals at the electrodes. The tube can be mounted in any position and even works underwater if the high-voltage leads are properly insulated.

light is extremely bright and temporarily blinding.

When you look at the laser spot on a wall, note the specular quality (diffuseness) of the spot. This is a characteristic of coherent light. It is essential to the laser's use in holography, which will be described in an article in next month's POPULAR ELECTRONICS. Future issues will cover laser communications and unique instruments which use this low-cost laser. -30-



OPERATION ASSIST

Through this column we try to make it possible for readers needing information on outdated, obscure, and unusual radio-electronics gear to get help from other *P.E. readers. Here's how it works: Check the list below. If you can help anyone with a schematic or other information,* write him *directly—he'll appreciate it. If* you *need help, send a postcard to Operation Assist,* POPULAR ELECTRONICS, *One Park Avenue, New York, N.Y. 10016. Give maker's name and model number of the unit. If you don't know both the maker's name and the model number, give year of manufacture, bands covered, tubes used, etc. State specifically what you want, i.e., schematic, source for parts, etc. Be sure to print or type everything legibly, including your name and address. Do not send an individual postcard for each request; list all requests on one postcard. Because we get so many inquiries, none of them can be acknowledged.* POPULAR ELECTRONICS *reserves the right to publish only those items not available from normal sources.*

RCA Model 4569 Silvertone radio; circa late 1920's. Schematic and parts source needed. (Ed Savela, 172 County Rd. 42, Rosemount, MN 55068)

Jackson Model 106 r.f. signal generator. Operating manual and schematic needed. (Arvin Richardson, Box 389, Ashley, OH 43003)

American Bosch Magneto Corp. Model 28 TRF. **General Electric** Model F86. Schematics needed. (George R. McCann, Jr., 1917 Tilden Ave., New Hartford, NY 13413)

Superior Instruments Model 70 utility tester. Operating instructions needed. (Duane Engel, 2245 Glenwood Dr. NW, Cedar Rapids, IA 52405)

Operadio Corp. portable radio. Uses 45V batteries and 6 tubes (short pin) at least one of which is a Cunningham C-299. **Atwater Kent** Model 55. Schematics, parts source and operating instructions needed for both. (Richard F. Gifford, 34 Northridge Rd., Westfield, MA 01085)

Century Electronics Model 201 condenser-resistor analyzer. Schematic and operating instructions needed. (C.W. Linden, 4268 N. Carruth, Fresno, CA 93705)

Hallicrafters Model **S-76** receiver. Manual, schematic, alignment data and source of parts needed. (Mark Duba, 148 Loomis St., Burlington, VT 05401)

Atwater Kent Model 46 radio; circa 1935. Operation manual, schematic, tube layout chart, source for tubes and parts, cone and voice coil assembly for Type F-2 speaker or complete speaker and any additional information needed. (Jeff Bush, 5 Deane Way, River Plaza, NJ 07701)

Hammerlund Model SP-200-X. AVC transformer, or values, needed. **Hallicrafters** Model S-27. Voltages and currents of power transformer needed. (David L. Miller, 1726 Summit St., Mesquite, TX 75149)

McMurdo Silver Model "Masterpiece V". 20 tubes 140 kHz to 65 MHz. Schematic tube chart and power transformer needed. (William E. Lee, 1980 Clinton Ave., Oroville, CA 95965)

Concertone Berlant 20/20 full track mono tape recorder; serial no. 432746. Schematic, operating manual, parts source for stereo conversion and any additional information needed. (George Herzog, 35 Cedarhurst Dr., W. Henrietta, NY 14586)

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12 b

NEW PRODUCTS

(*Continued from page 24*)

mum ripple at full load is only 0.005%. The Model 1025 is an ideal supply for servicing all types of semiconductor circuits, TV and radio receiver alignment, recharging small batteries, and light electroplating.

Circle No. 89 on Reader Service Page 15 or 113

ELECTROSTATIC STEREO HEADPHONES

Koss Electronics, Inc., recently added the Model ESP-7 to their line of electrostatic headphones. Powered by a separate energizer, the ESP-7 is considerably lighter than its higher priced predecessor, the Model ESP-6. The new model is designed to give a smooth, peak-free frequency response of 35 to 13,000 Hz ±6 dB. A new push-pull electrostatic design in the ESP-7 automatically cancels out all second-harmonic distortion and provides a cleaner signal. Fluid-filled ear cushions are incorporated to provide high ambient noise isolation. And a sponge-foam-lined headband insures maximum comfort. The headset/energizer combination is a low-cost version of the ESP-6.

Circle No. 90 on Reader Service Page 15 or 113

INCREASED VERSATILITY FOR SCANNER

Increased versatility through the use of new control circuitry, permitting instantaneous omni-directional, 360° scanning has been given to *Antenna Specialists Company*'s new Model MR119 "Super Scanner" sector-phased CB antenna. The antenna works omni-directionally with a 2.5-dB gain in all directions. In the locator mode of the control box, the operator can search for and identify mobile and base stations, then switch electronically to the appropriate directional sector in which the Scanner operates as an electronic beam. (Since the beam effect is achieved electronically, no mechanical rotor is needed, and selection of the desired direction is obtained instantaneously.) In the beam mode, the antenna delivers 7.75 dB of forward gain with a 23-dB front-to-back ratio.

Circle No. 91 on Reader Service Page 15 or 113

HI-FI RECORDING MICROPHONES

A series of high-quality, omnidirectional, dynamic microphones specifically designed for high-fidelity live recording is being marketed by *The Turner Company*. The 2300 series consists of two models: the high-impedance 2300, and the 150-ohm 2302. Both mikes pick up sound arriving from all directions, giving a natural and lifelike "presence" that is ideal for recording. Each model has an on/off switch, peak-free 50-15,000-Hz frequency range, and -56-dB output level. The ¾"-diameter machined steel cases, with steel grilles, have a satin chrome finish. A built-in wind screen reduces breath and pop noises. And a professional three-pin connector is used on the detachable 20' cable.

Circle No. 92 on Reader Service Page 15 or 113

EIGHT-TRACK STEREO TAPE PLAYER

The Model GD-28 made by the *Heath Company* is very possibly the only kit-type eight-track stereo tape player around. When assembled, the Heathkit GD-28 makes an excellent background music source, or provides an easy way to get extra enjoyment out of the stereo tape cartridges used in auto stereo systems. The tape player is completely automatic. The user simply plugs in a cartridge. A metal tape splice switches the tape head from one track to the next automatically, or the user can select the track he wants to hear by setting a slide switch located on the front panel of the player; pilot lamps light up to indicate which channel is playing. For easy assembly, the tape player mechanism is supplied preassembled and adjusted. Only the electronics, a six-transistor/two-diode preamplifier, have to be assembled on the supplied printed circuit board.

Circle No. 93 on Reader Service Page 15 or 113

theory that overdamping might result from too much stuffing.

If, against the advice of the experts, you want to try "stuffing" on a pure trial and error basis, you should try to compare your system with one that is identical but not stuffed. For example, if you are building a stereo pair, stuff one and use normal padding in the other. Then compare the two using a monaural or combined stereo program in first one and then the other. Too much stuffing will produce a choked effect in the bass.

Sound Is the Thing. No matter how you solve your speaker enclosure problems, there are a few points worth remembering. First, choose the kind of speaker system you want by listening, not by recommendation or from theory. Specifications may be helpful to the design engineer as guidelines, but they won't tell you what will sound good to your ears. As T. W. Richardson says, "*Any* specifications are *not* better than no specifications. What one is purchasing is sound."

Second, don't forget to ask for help from the company that built your speaker. Some companies have useful booklets available for a nominal cost (see Table II), and almost all furnish some kind of information with the speaker. But if, without test equipment, you apply Company A's methods to Company B's speaker, the results may be unpredictable. In fact, you should not even assume that Company A's plans for any one of its 12″ speakers are applicable to another of its 12″ speakers—unless they say so.

Finally, if you have already built a set of ported speaker enclosures and have broken the rules but like the sound, or if you pushed in some extra stuffing because you thought that made it smoother, don't feel too guilty about it. As G. A. Briggs says, "After all, loudspeakers are made to listen to and not just to conform to theory." And, having made some of the best, he ought to know. —30—

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WEBBER LAB's. Police & Fire Converters. Catalog 10¢. 72 Cottage Street, Lynn, Mass. 09105.

RADIO—T.V. Tubes—33¢ each. Send for free catalog. Cornell, 4213 University, San Diego, Calif. 92105.

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PSYCHEDELIC catalog. Posters, lighting, etc. Send 25¢ for handling to Hole In The Wall, 6055PE Lankershim, North Hollywood, Calif. 91606.

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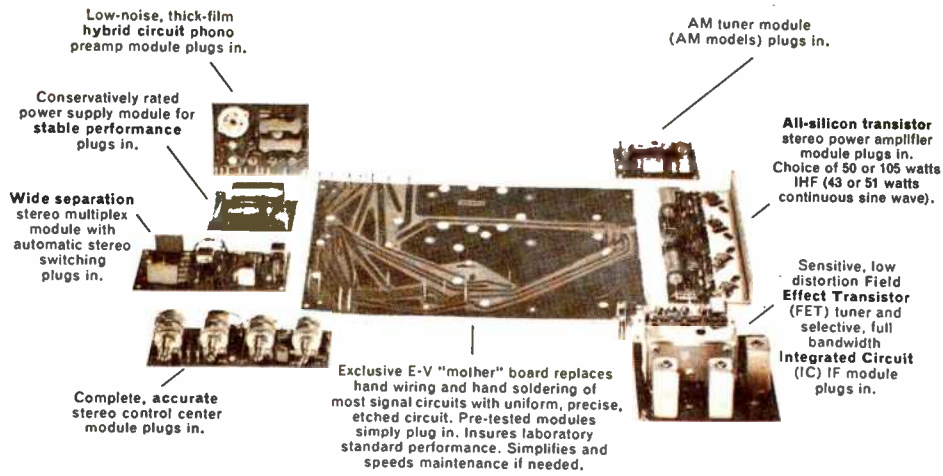

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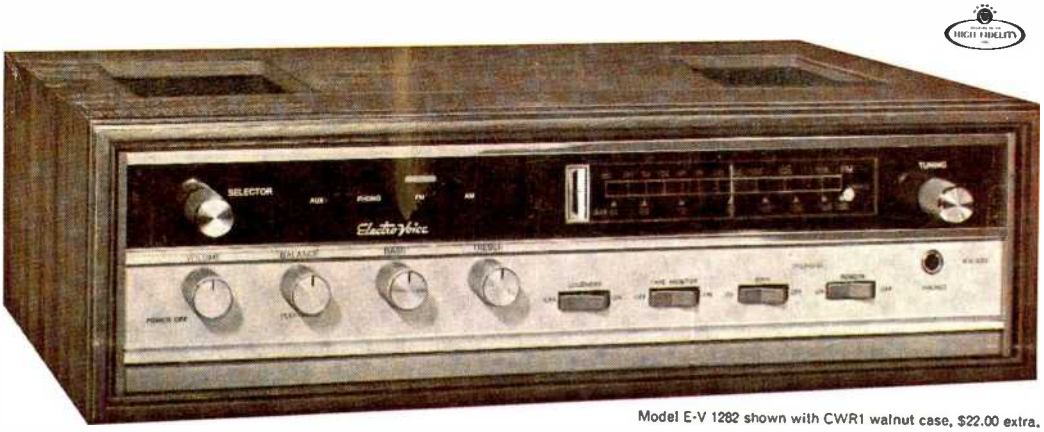

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