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OCTOBER 1969

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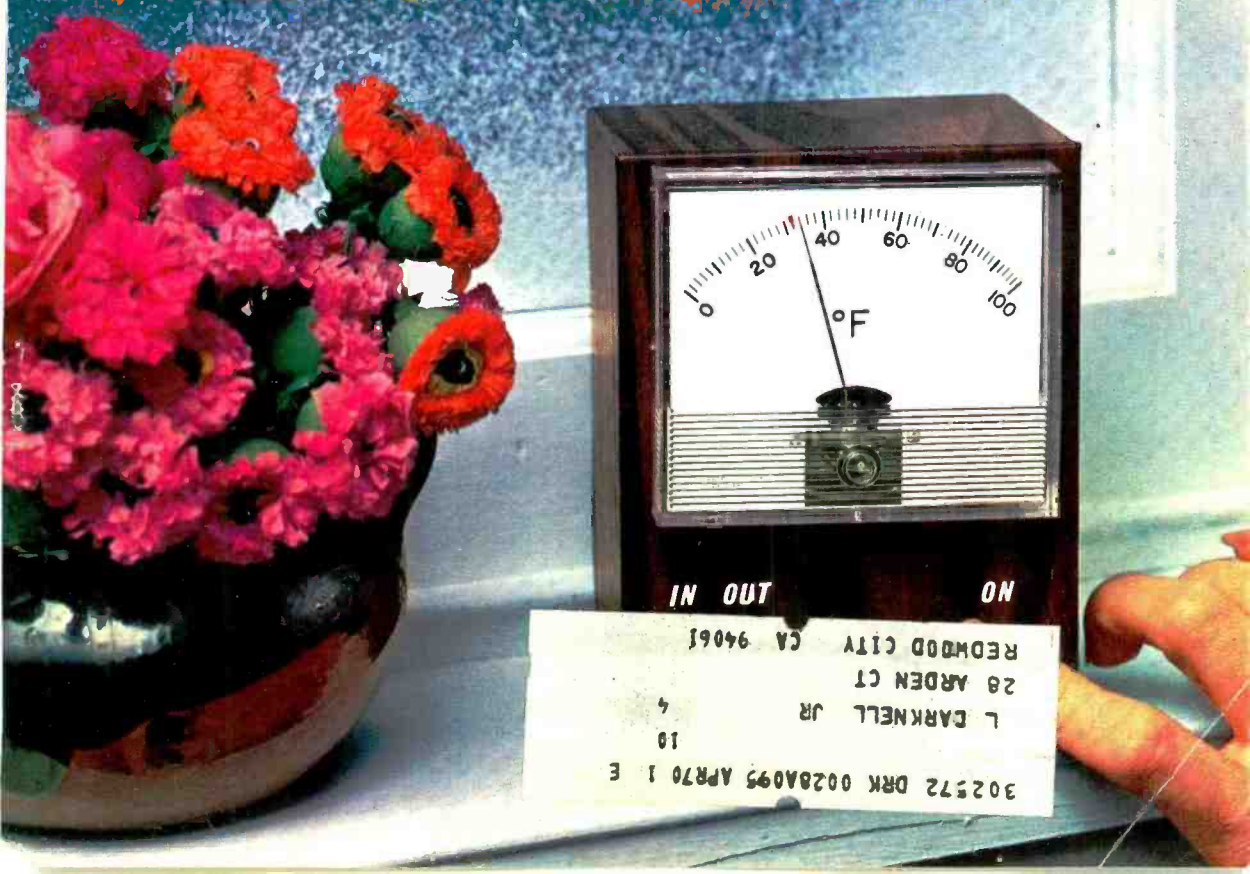

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POPULAR ELECTRONICS

VOLUME 31 NUMBER 4 **OCTOBER, 1969**

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

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FEATURE ARTICLES

DEPARTMENTS

POPULAR ELECTRONICS is indexed in the Readers' Guide to Periodical Literature

This month's cover photo by Justin Kerr

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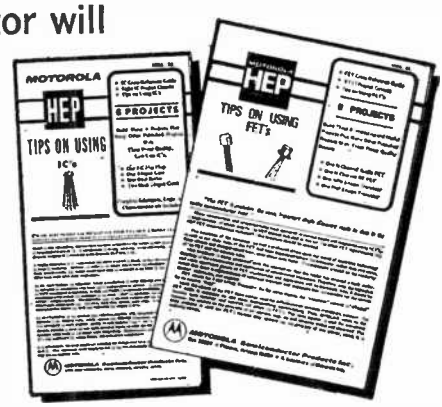

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CIRCLE NO. 23 ON READER SERVICE PAGE

letters
FROM OUR READERS

OLD MODEL, NEW MODEL NUMBER

In the Bill of Materials for "A Bigger Than Life Speaker System" (May 1969) an Olson Electronics Model S-971 deluxe three-way speaker is specified. The latest Olson catalog lists the Model S-785 as a deluxe three-way speaker. Is this the speaker required for this project?

JAY ALLEN ROSEN
North Hollywood, Calif.

When specifying parts in our articles, we try to provide up-to-the-minute part and model numbers. The Model S-785 speaker was the speaker listed in the Olson catalog at the time of publication of the article. However, Olson is marketing the same speaker as the Model S-971, so that was the one we gave. Presumably you can order the speaker by either model number.

A LOOK BACK INTO RADIO HISTORY

The feature article, "What Ever Happened to Atwater Kent?" (July 1969) caught my attention. I worked for the advertising company in Philadelphia that handled the Kent account in those early days.

The very early Kent products were chiefly parts for homemade sets, though the company must have been making the breadboard sets then as well. My duties brought me into contact with the Kent advertising manager and, just once, with Mr. Kent himself. We rode in one of his innumerable cars, and I recall that Mr. Kent mentioned his belief that we would soon see the end of the four-cylinder car.

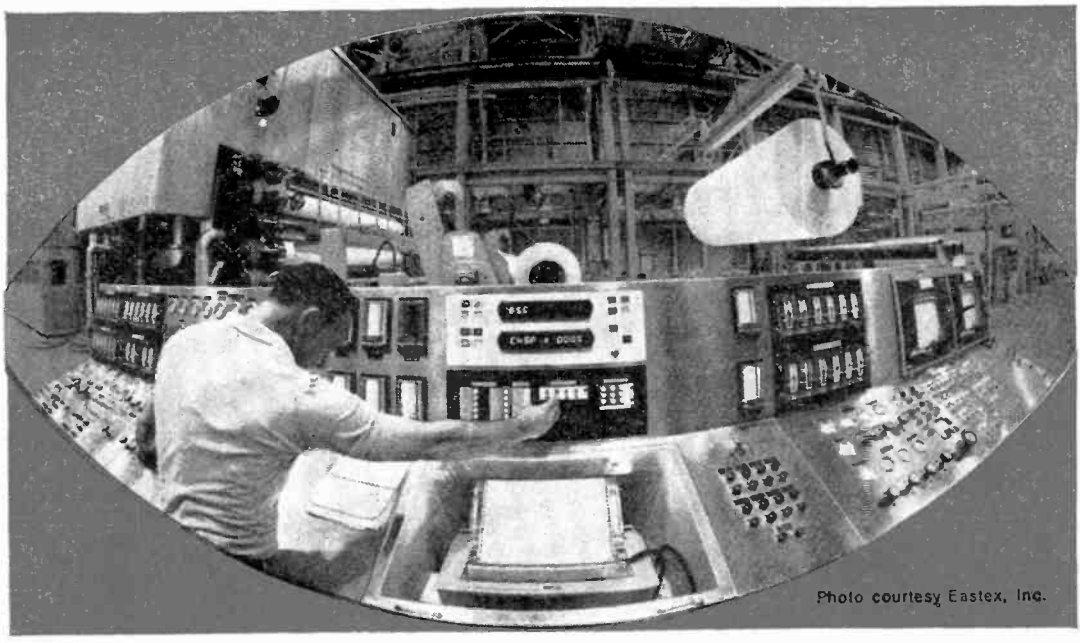
In April 1923, the *Literary Digest* and the *Saturday Evening Post* carried ads for Atwater Kent radios. We weren't spending money on professional modeling talent in those days, so Mr. Alexander H. Davisson, Jr., and I modeled for the photo that appeared in the ad. I am also sending a copy of this ad to Mr. Atlee.

GEORGE T. STREET, JR.
Lansdowne, Pa.

RADIO RELICS

Enjoyed the article on Atwater Kent (July 1969, p 33) and have been wondering if there is a group of people, or a club, interested in collecting old radio receivers. I have a small collection (13 receivers) from the 1930's.

DUANE THORNTON
St. Charles, Mo.



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LETTERS (*Continued from page 8*)

There is a club for people interested in collecting old radio equipment. Unfortunately, it has a limited membership (500) and only accepts new members as vacancies occur. To get on the "waiting list" (or learn more about the club), send a self-addressed envelope to: Antique Wireless Association, 69 Boulevard Parkway, Rochester, N.Y. 14612. Include information about your collection(s) and interests.

NASA FREQUENCIES

Can the radio messages to and from the various space programs launched by NASA be received in our homes directly?

RICHARD MOSER
Marion, Va.

There are numerous problems here. If you are referring to the Apollo program, the answer is 99.99% "no." The lunar walk communication was on about 235 MHz but apparently was not heard direct (on earth), but was relayed through "Tranquility Base" and converted to a signal in the S band (2000-plus MHz). Various unmanned satellites do transmit on frequencies between 136-137 MHz. These transmissions are not distinguishable according to satellite (no calls) except by frequency and time of orbit. The signals are all weak and cannot be heard without special antennas or extra r.f. (low noise) amplification ahead of a VHF receiver.

LOOKING GLASS

In regard to the D. J. Holford article (August 1969, p 51), the "Looking Glass" network is the 15th Bomber Wing. It is airborne at all times ready for a retaliatory strike in case of attack.

(UNSIGNED)
Vandenberg AFB, Calif.

The National Geographic magazine said in Vol 128 No. 3 (p 291) that "Looking Glass" remains on day and night vigil and could direct nuclear retaliation should SAC headquarters be destroyed.

DANIEL BARTEK, JR.
Binghamton, N.Y.

PYRAMIDAL TV/FM ANTENNA

Thanks go to George Monser for his article on the TV/FM antenna in your July 1969 issue (p 27). My material cost came to $9.88 not including the lead-in. I used a wooden mast and eliminated the standoff blocks. A second antenna will be for my daughter's house.

Results? Real good! Locals 6, 8, 10, 12, 15, and 39; plus Los Angeles (80-90 miles away) 2, 3, 4, 5, 7, 9, 11, 13, 24, 28, and 34. Receiver is Sylvania color with Belden 8290 lead-in, no rotor.

HAROLD SECOR, WB6PJG
San Diego, Calif.

Just finished making the TV/FM antenna—it's the fourth in this neighborhood.

R. MCWILLIAMS
Park Forest, Ill.

Go on a quality kick

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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.

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CIRCLE NO. 26 ON READER SERVICE PAGE

LETTERS

(*Continued from page 10*)

THE TREND TOWARD "LO-FI"

In recent years, the trend toward tape cartridges and cassettes and away from record discs and reel-to-reel prerecorded tapes seems paradoxical. I can understand the logic behind using the new types of music reproduction systems in a car; as of now it seems the only practical way of getting relatively high-fidelity music under mobile conditions. What I can't understand is the logic that suggests that cassettes and cartridge tapes can provide really great sound.

First of all, the playing speeds are too slow to squeeze in the full range of frequencies produced during a live performance—for the cartridge, it's only 3¾ in./s, and for the cassette it's only 1⅞ in./s. And with as many as eight tracks on a very narrow tape width, what must happen to the signal-to-noise ratio? This compounds the problem of tape alignment, which is bad enough with only four tracks on a ¼" magnetic tape! The Dolby system can probably take the woes of low-speed tape playing, but is the extra expense really worth it?

It doesn't make sense to shell out $8 on a cassette or cartridge that can't equal the quality and performance of a $5 record disc. Could it be that the so-called hi-fi industry is attempting to turn us into a bunch of "hi-fi Babbitts?"

MIKE POOLE
Notre Dame, Ind.

We wonder (your last question).

OUT OF TUNE

"Build the PPFL" (August 1969). The silicon controlled rectifier called for in the Parts List is a General Electric Type C106G2. General Electric has discontinued this model. In this project, and in most others where the C106G2 is called for, General Electric's Type C106A2 can be substituted. It is readily available from Allied Radio—and many other suppliers—at a price slightly above $1.00.

"Build Op Tach" (March 1969). In a letter in our July issue, a fluorescent light method of calibrating the "op tach" was proposed. This will work but the repetition rate is 7200 times/min not 3600. Since 60-Hz power has two maximum peaks the fluorescent fires 120 times/sec.

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ELECTRONICS library

QUIET

RTL COOKBOOK

by Don Lancaster

Well known to POPULAR ELECTRONICS readers for his many high-quality projects that have appeared in these pages, Don Lancaster, in his first full-length book, explains the principles and uses of resistor-transistor-logic (RTL) integrated circuits. The text provides the experimenter with an understanding of RTL in IC circuits as they are used in everyday electronics projects (including those projects that have from time to time appeared in this magazine). The technician is shown through step-by-step analysis how these circuits work and how they are maintained. The book also provides the engineer with circuits that can easily be added as building blocks to larger systems. We especially recommend this book to anyone who understands electronics but wants to update his knowledge with digital principles.

Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, Ind. 46268. Soft cover. 256 pages. $5.25.

104 SIMPLE ONE-TUBE PROJECTS

by Robert M. Brown

As its title implies, this book is a collection of useful and easy-to-build vacuum tube(!) projects for those people who have a supply of tubes they do not know what to do with. All of the projects presented are inexpensive to build—no more than $5 each if you have to buy parts—and employ only one tube. The projects include a VLF receiver, DSB converter for CB radios, modulation scope, grid dip meter, SSB detector, and many more. Each project is a section in itself, with a schematic diagram, parts list, and short descriptive text.

Published by Tab Books, Blue Ridge Summit, Pa. 17214. 192 pages. $6.95 hard cover; $3.95 soft cover.

RCA TRANSISTOR, THYRISTOR, & DIODE MANUAL, SC-14

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(*Continued on page* 116)

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Circle No. 75 on Reader Service Page 15 or 115

Just listed by *Xcelite, Inc.*, is their four-page, full-color Catalog 166 Supplement, describing and listing specifications on all professional hand tools and sets added to the company's line since the publication of the latest general catalog. Included in the listing are fixed-handle screwdrivers for slotted, Phillips, and Allen hex-type screws; fixed-handle, hollow-shaft nutdrivers; a compact interchangeable-blade Allen hex-type set in a pocket-size plastic case; etc. Also listed are metric tools.

Circle No. 76 on Reader Service Page 15 or 115

Crystal Bulletin available from *K-W Industries, Inc.*, contains a list of quartz crystals in the range from 50 kHz to 200 MHz. Complete dimensional data and ordering information for standard and custom crystals are included, along with the completely revised chart listing specifications on military types.

Circle No. 77 on Reader Service Page 15 or 115

A 24-page booklet, titled "Recording Basics," written to help the reader improve sound quality of home tape recordings can be obtained from the *3M Company*. The illustrated booklet offers tips on proper selection of magnetic tapes, recording techniques, and recording procedures, all in non-technical language. It also defines various types of tape recorders and illustrates the proper techniques for editing and splicing magnetic tapes.

Circle No. 78 on Reader Service Page 15 or 115

Catalog No. 103L (48 pages) available from *International Correspondence Schools* describes 17 electrical engineering programs, refresher courses for graduate engineers, and practical electrical courses. The catalog explains the exact makeup of the ICS electrical engineering courses and the scope of the programs and gives synopses of the texts. In addition, articles describe careers in electronics and electrical engineering.

Circle No. 79 on Reader Service Page 15 or 115

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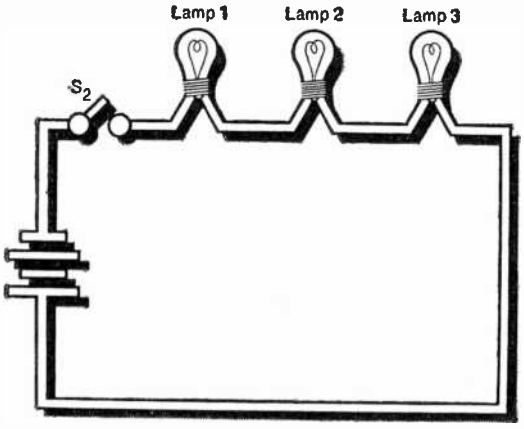
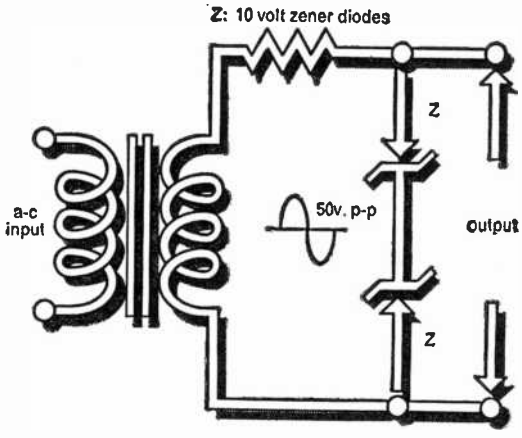


This one is relatively simple:

When Switch S_2 is closed, which lamp bulbs light up?

Note: If you had completed only the first lesson of any of the RCA Institutes Home Study programs, you could have solved this problem.



This one's a little more difficult:

What is the output voltage (p–p)?

Note: If you had completed the first lesson in the new courses in Solid State Electronics, you could have easily solved this problem.

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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 115.

AUTO TUNE-UP METER

Capable of measuring dwell, r/min, and d.c. voltage on any four-cycle, 3-, 4-, 6-, or 8-cylinder engine with standard ignition system, the *Heathkit* Model ID-29 solid-state Auto Tune-Up Meter is a real steal at less than $30 for the kit. Both dwell and r/min measurements can be made without having to reconnect the test leads between steps, and the meter can be used interchangeably on both 6- and 12-volt systems. The ID-29 connects directly to the primary side of the ignition coil for both dwell and tach measurements, receiving both signal and power from the engine under test. For breaker point settings, the dwell angle is read directly from the large 4½" meter. The built-in voltmeter is handy for chasing down faults in the electrical system. The ID-29 can be calibrated using standard a.c. house current. The instrument is housed in a rugged black polypropylene case with carrying handle.

Circle No. 80 on Reader Service Page 15 or 115

FM MONITOR RECEIVERS

Sonar Radio Corp. is marketing a pair of high-quality, ruggedly built FM monitor receivers. The Model FR-104 is designed for the low band between 25 and 50 MHz, while the Model FR-105 is a high-band 150-175-MHz receiver. Both models have dual limiter and Foster-Seeley discriminator; quadruple-tuned r.f. stage for greater image rejection; temperature-compensated, noise-free squelch; six crystal-controlled frequencies; military epoxy-glass circuit board; and built-in 2" x 6" speaker. Technical specifications—maximum frequency separation: ±1 MHz for FR-104, ±3.5 MHz for FR-105; sensitivity: 0.3 μV for 20-dB quieting; squelch sensitivity: 0.18 μV minimum; selectivity: 6 dB ±6 kHz/60 dB ±30 kHz (FR-104/FR-105); audio output power: 1.5 watts at 4 ohms; power consumption: 4.4 watts at 13.8 volts d.c./17.5 watts at 117 volts a.c.

Circle No. 81 on Reader Service Page 15 or 115

CASSETTE PLAYER RECORDER

Three new portable cassette player/recorders which can be operated on line power, on batteries, or adapted for mobile use are from the *Ampex Corporation* and are now available. The Models include the "Micro 32," which includes an AM/FM receiver; "Micro 24," a deluxe model; and "Micro 14," with plug-in dynamic microphone that can be attached to an extension cord for remote operation. The Micro 32 and Micro 24 have 1-watt power output, 5" speaker, automatic battery charger circuit, remote control facilities, and earphone. The Micro 14 also has a 1-watt power output, bi-directional speaker, extension cord, etc. All three models have pushbutton cassette function controls, manual or automatic recording level control, and recording level/battery condition meter. Technical specifications—frequency range: 100-10,000 Hz; signal-to-noise ratio: 42 dB; rewind/fast forward time: 90 seconds maximum.

Circle No. 82 on Reader Service Page 15 or 115

ELECTRIC GUITAR SYSTEM

Innovex (division of Hammond Corp.) has developed a sophisticated electric guitar system consisting of the "Condor SSM" (Sound System Modulator), "Condor SS (Sound System), and "Condor" electric guitar. The SSM offers a new concept in sound reproduction. It has a room rocker to create a shift in sound color; a phaser that produces tremolo or vibrato loud in one channel, soft in the other channel; a patented reverberation system; echo, volume, treble, and bass controls; and remote control. The SS has two 15"speakers and a horn tweeter; phase inversion cabinetry; special damping materials; remote control a.c. power relay; and short-circuit protection. The guitar features the Condor pickup which provides a microphone for each string.

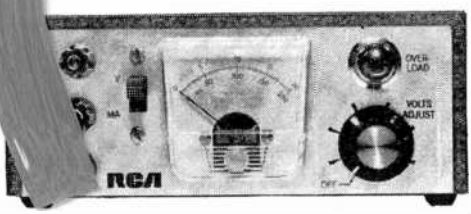
Circle No. 83 on Reader Service Page 15 or 115

REVERBERATION AMPLIFIER

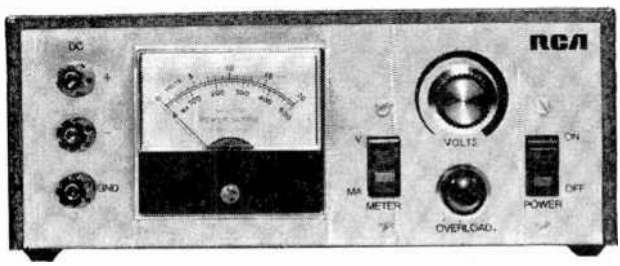
A solid-state, double-scatter reverb amplifier is being marketed by *Pioneer Electronics U.S.A. Corp.* as the Model SR-202. The feeling of depth provided by the reverb system supplies concert-hall presence without the audible distortions usually associated with equipment of this type. The reverb time can be manually adjusted as desired, and the amount of depth used can be set to fit the particular recording and environmental acoustics. An easy-to-view

smooth

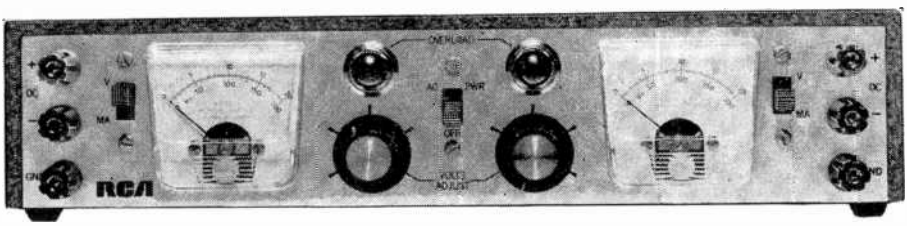
A WP-700A, 702A, 703A and 704A constant voltage dc power supplies are all
d-state. A negative feedback circuit maintains constant output voltage with low
ble – regardless of varying line. In fact, at rated load, these supplies are so smooth
"they hardly cause a ripple."
ey are versatile bench-type units—ideally suited for use in circuit design, servicing,
ustrial, and educational applications.
put voltage of the WP-700A and WP-702A is continuously adjustable from 0 to
olts at current levels up to 200 mA.
put voltage of the WP-703A is continuously adjustable from 0 to 20 volts at current
ls up to 500 mA.
put voltage of the WP-704A is continuously adjustable from 0 to 40 volts at
ent levels up to 250 mA.
our power supplies have built-in electronic short-circuit protection – and a front
el overload-indicator that signals approach to maximum rated current level.



WP-700A: $40.00* (five or more) $48.00* (less than five)



WP-703A: $49.00* (five or more) $58.00* (less than five)
WP-704A: $49.00* (five or more) $58.00* (less than five)



*Optional Distributor Resale Price.

WP-702A: Siamese Twins of WP-700A, but electrically isolated $73.00* (five or more) $87.00* (less than five)

For further information write: RCA Electronic Components, Commercial Engineering, Department J-133W, Harrison, N. J. 07029.

Look to RCA for instruments to test/measure/view/monitor/generate

CIRCLE NO. 42 ON READER SERVICE PAGE

PRODUCTS (*Continued from page 22*)

light panel is coupled to the manually adjustable reverberation control, supplying both aural and visual control of reverberation. Technical specification—input signal: 3 volts maximum at 1 kHz with reverb at minimum; harmonic distortion: less than 0.2% at 1 kHz, with output level at 330 mV and reverb time at minimum; frequency response: +2 dB, 20-35,000 Hz.

Circle No. 84 on Reader Service Page 15 or 115

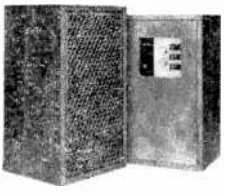
RHYTHM INSTRUMENT

A complete electronic rhythm section, the "Rockmate" Model X-92, that plays through any guitar or music amplifier is available from *Olson Electronics, Inc.* The instrument allows the user to select from five basic rhythm patterns, then adjust tempo to suit his mood. He can also add a solo drum beat if desired. The rhythm patterns available include fox trot, after beat, jazz, rock, rock beat, fore beat, and rock-a-ballad. The Rockmate operates on self-contained battery, or it can be line-powered with the addition of an optional a.c. power supply.

Circle No. 85 on Reader Service Page 15 or 115

THREE-WAY SPEAKER SYSTEM

A new concept in speaker design, with a resulting midrange that has outstanding transient response and a sharp reduction in distortion, is incorporated in the *Sansui Electronics Corp.* Model SP-1001 speaker system. This new three-way, three-speaker system has several exclusive features, among them pushbutton input connectors and electronic crossover terminals for hookup of bi- or tri-amplification systems. A special step-down attenuator utilizing a 12 dB/octave network makes it possible to change output levels, in 3-dB steps, of the midrange and tweeter independently. Technical specifications—speakers: 10" cone woofer, 6½" cone midrange, 1" domed tweeter; maximum input: 40 watts IHF; impedance: 8 ohms; sound pressure level: 100 dB; frequency range: 35-20,000 Hz; Crossovers; 600 and 5000 Hz.



Circle No. 86 on Reader Service Page 15 or 115

AUDIO-LIGHTING FAMILY

The *EICO Electronic Instrument Co., Inc.*, recently expanded its line of "Sound n' Color" audio-lighting products with the introduction of a complete line of color organs, sound/color translators, and electronic strobe lites. The color organ line includes: Model 3440 three-channel system; Model 3445 four-channel system; Model 3450 large-size four-channel system; Model 3450 three-channel light display/receiver (less electronics); and Model 3480 combination three-channel color organ and two-way speaker system. The Model 3465 three-channel and Model 3460 one-channel systems make up the sound/color translator line. The high-intensity strobe lite line includes the Model 3475 sound-actuated system and the Model 3470 electronic strobe lite. All sound n' Color products are available in kit or wired form.

Circle No. 87 on Reader Service Page 15 or 115

A.C. LEAKAGE TESTER

Simpson Electric Company recently introduced the Model 229 current leakage tester for 120-volt a.c. appliances and other electrical equipment in accordance with U.S. Standards Committee proposed specifications. Performance of the tester approximates the normal perception curve within ±1.0 dB, and the meter measures leakage currents as small as 5 μA. Operation is simple, and all ranges are protected from damage if accidentally subjected to line voltage. Technical specifications—a.c. current ranges: 0-0.3, 1, 3, 10 mA; a.c. voltage: 0-150 volts; accuracy: ±2% at 60 Hz; resolution: 5 μA on 0.3-mA range; accuracy-versus-frequency: approximates Dalziel's "percentile 50 threshold of perception within ±1 dB;" input impedance: 1500 ohms, shunted by shaping network, on all ranges; input resistance: 500,000 ohms.

Circle No. 88 on Reader Service Page 15 or 115

MULTI-ANTENNA ROOF TOWER

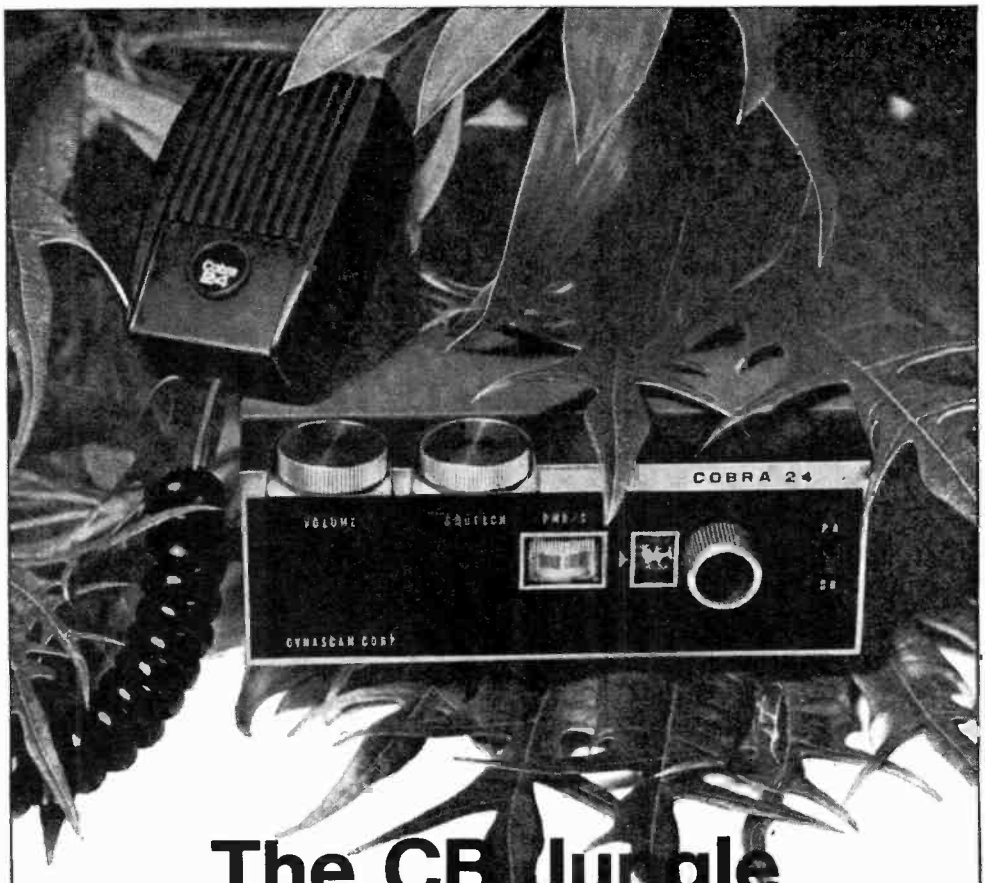
The Model TRM-716 is a new 7½′ single-mast, multiple-antenna tri-mount roof tower designed by *South River Metal Products Co., Inc.* Areas where multiple antennas are oriented to different compass points are particularly suited to this new tall tri-mount tower. The mast, integrated into a special triangular base assembly, permits two or three antennas to be mounted quickly and securely. The one-piece base assembly opens like an umbrella and is secured into position with a single wing nut. Both the mast and base assembly are made of heavy-gauge steel tubing, galvanized for long life under changing weather conditions.

Circle No. 89 on Reader Service Page 15 or 115

HI-FI/STEREO HEADPHONE KIT

The *Knight-Kit/Koss* Model KG-802 stereo headphone kit offers wide-response hi-fi/stereo sound at substantial savings over fac-

(*Continued on page 118*)



The CB Jungle is suddenly still...

There's a new Cobra Lurking!

The new Cobra 24: with more power, intelligence, and beauty than any of the others in its class!

The Cobra 24 preys on the others' weaknesses. With *more talk power*—a full, legal-limit 5-watt input and exclusive Dynascan DYNA-BOOST Speech Compression. And a selective dual-conversion superhet receiver with ceramic filter to give outstanding selectivity and gain.

And *more intelligence*—it always gets the message through crisp and sharp, even when others are garbled and unclear. Crystal-controlled transmit and receive on all 23 channels. (No extra crystals to buy!)

And *more beauty*—a striking, no-nonsense exterior. Designed for attack...with a push-to-talk mike, automatic noise limiter, and positive or negative ground operation without internal wiring changes, featuring reverse polarity protection. There's a PA/CB switch with adjustable volume. And the illuminated channel selector and "S" meter makes even night transmission easy. Beautiful, with all silicon transistor, F.E.T. and integrated circuit. It uses 12 volt DC; AC adapter available. Meets FCC requirements. It even comes with its own mounting bracket.

See your dealer or write us for full details.

Cobra 24 **Net $169.95.**

Product of DYNASCAN CORPORATION
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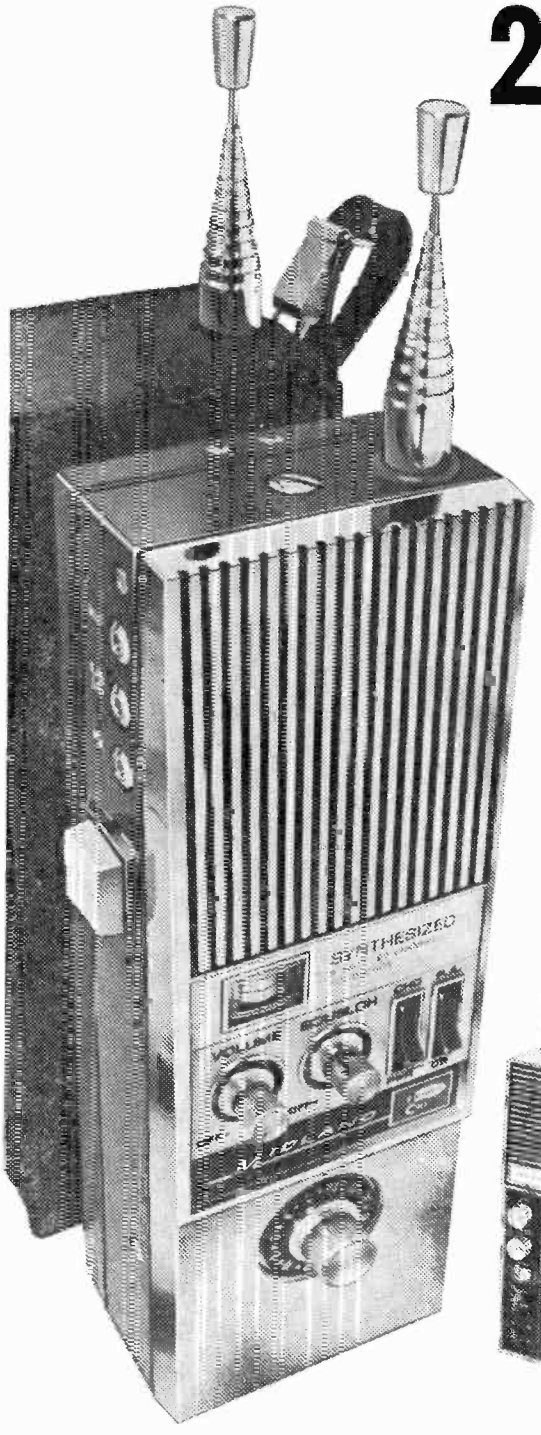
CIRCLE NO. 6 ON READER SERVICE PAGE

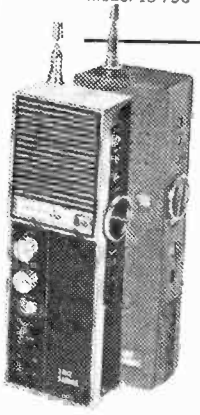
23 Portable Channels for 149.95



Plus: **5 Watts—maximum FCC Power. Midland Integrated Circuit** for ultimate solid state efficiency. **Isolated Chassis** for efficient operation in cars and trucks. **3-Way Meter** monitors battery, power and signal strength.

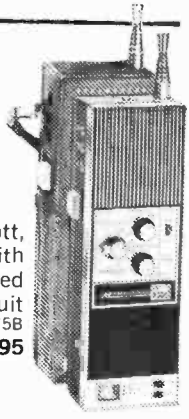
Midland once again demonstrates its leadership in the CB field! This hand-held synthesized transceiver has all the power and channel capabilities of deluxe base/mobile units. Dual conversion superhet receiver has tuned RF, 6 IF's. High-level class B push-pull modulation. Jacks for: AC adaptor/battery charger, external antenna, external mike, PA speaker, earphone/external speaker. All crystals supplied for immediate 23-channel operation. With telescoping antenna, leather case.

Model 13-790



5-Watt, 6-Channel Transceiver
Model 13-770
$79.95

Super 5-Watt, 6-Channel with Integrated Circuit
Model 13-775B
$99.95



Prices shown are suggested retail, each unit.

MIDLAND®
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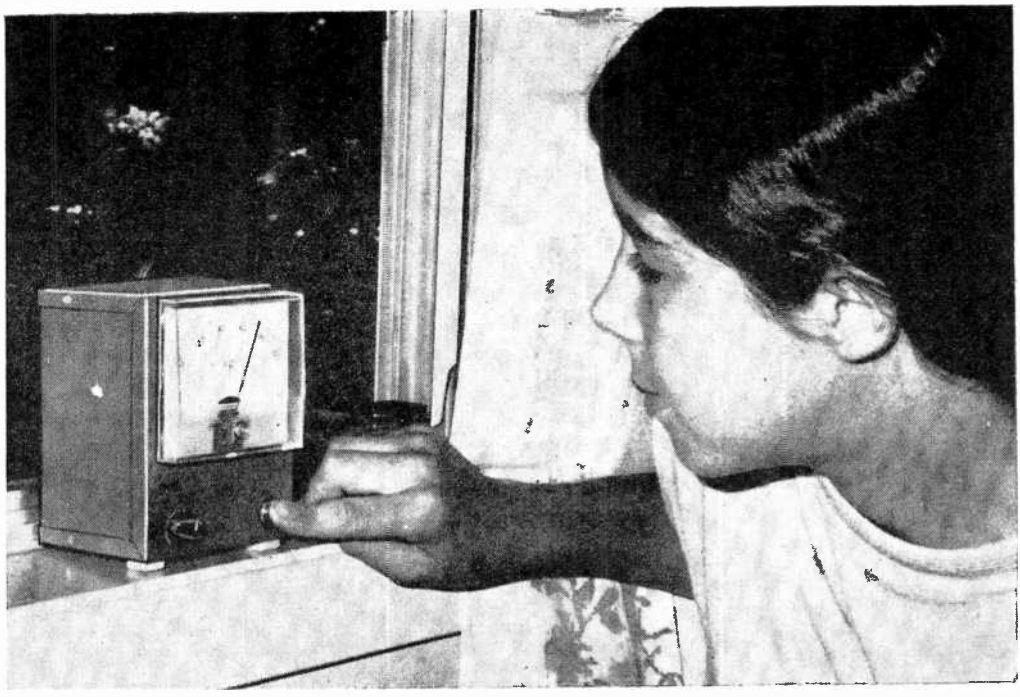
FOR FREE BROCHURE, write: 1909 Vernon, North Kansas City, Mo. 64116 or 5055 Alcoa, Vernon, Calif. 90058

CIRCLE NO. 21 ON READER SERVICE PAGE

Indoor/Outdoor



All-Electronic Thermometer

HELP SAVE MERCURY METAL—GO ELECTRONIC!

BY C.P. TROEMEL

UNLESS YOU happen to live "up in Central Park" or "in the Chicago Loop" the temperature reports that come over the radio are not really enough to prepare you for what you will find when you step out your front door. So everyone wants an outdoor thermometer. Unfortunately, just hanging a standard thermometer outside a window is not always the best solution—either you can't see it or it's in a protected spot that doesn't give true indications. Similarly, if you use the conventional outdoor-indoor bulb-type thermometer with remote sensing, you must locate the bulb in the best place you can and then carefully bring a long copper capillary tube into the house through a window frame or wall.

It is possible, however, to have an outdoor-indoor electronic thermometer that is accurate, easy to build, and easy to install. The sensing element in this thermometer is a resistor (Sensistor®) with a positive temperature coefficient—that is, its resistance increases linearly as the surrounding temperature increases. The connection between the sensor and the temperature readout is made with flexible twin-conductor cable (zip cord, 300-ohm twin-lead, etc.) so that the sensor can be in any location, inside or out.

Construction. The circuit of the thermometer is basically a simple resistance bridge as shown in Fig. 1. Any number of sensing units may be used and you can locate them anywhere you like. Two (one indoors and one outdoors) are shown in Fig. 1. Use a multi-contact selector switch for *S1* to choose the sensor

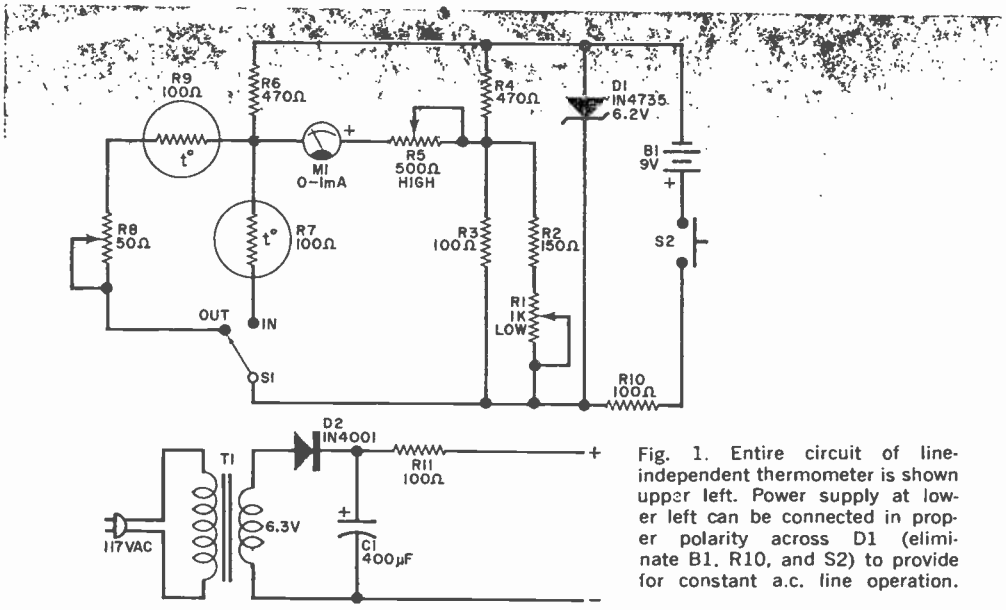


Fig. 1. Entire circuit of line-independent thermometer is shown upper left. Power supply at lower left can be connected in proper polarity across D1 (eliminate B1, R10, and S2) to provide for constant a.c. line operation.

PARTS LIST

B1—9-volt battery
C1—400-μF, 15-volt electrolytic capacitor
D1—1N4735, 6.2-volt, 1-watt zener diode
D2—1N4001 diode
M1—0-1-mA meter. 100 ohms maximum resistance. (If a more sensitive meter is used, increase the value of R5.)
R1—1000-ohm potentiometer
R2—150-ohm, ½-watt resistor
R3—100-ohm, ½-watt resistor
R4,R6—470 ohm, ½-watt resistor (must be closely matched)
R5—500-ohm potentiometer
*R7,R9—100-ohm Sensistor (Texas Instruments TM¼)**
R8—50-ohm miniature potentiometer
R10,R11—100-ohm, ½-watt resistor
S1—S.p.d.t. switch (see text)
S2—S.p.s.t., normally open pushbutton switch
T1—Filament transformer, 6.3-volt secondary
Misc.—5" x 4" x 3" metal enclosure, rubber grommet, aluminum for L-bracket, elastic band, knob, terminal strips, lengths of twin-conductor cable, mounting hardware, etc.

**Available from Newark Electronics Corp., 500 N. Pulaski Rd., Chicago, Illinois 60624, Cat. No. 12F055, $4.*

you want to read. If the thermometer is to be located in a fixed position in the house, you can use the line-operated power supply shown in the schematic. If you want a thermometer free of power lines, use the internal battery. In either case, the zener diode, *D1*, must be in the circuit.

If you use a battery, you will need pushbutton switch *S2* to turn on the thermometer to make a reading. If you use the line-operated supply, the meter will indicate temperature at all times. Current drain is only about 20 mA so there is no harm in having it on constantly.

The first step in assembling the thermometer is to modify the meter scale to read degrees Fahrenheit. Gently remove the plastic cover from the meter face. The original 0-1-mA scale division markers can be used. Remove the old numerals using a typewriter eraser. Then, using Datak press-on lettering (available at most art stores), renumber the scale divisions as shown in Fig. 2, making the 32°F (freezing) mark red if desired. Replace the face cover.

The thermometer is assembled in a 5" × 4" × 3" metal cabinet. The meter and switches *S1* and *S2* (if they are used) are mounted on the front panel. After the meter is installed, make sure that the needle rests on the zero mark. If it does not, adjust the meter zero screw at the axis of the meter movement.

The high- and low-range calibration potentiometers (*R5* and *R1*, respectively) are mounted on a small L-bracket on the bottom of the chassis (see Fig. 3). An elastic band is wrapped around the L-bracket to hold the battery behind the potentiometers. If used, remote-sen-

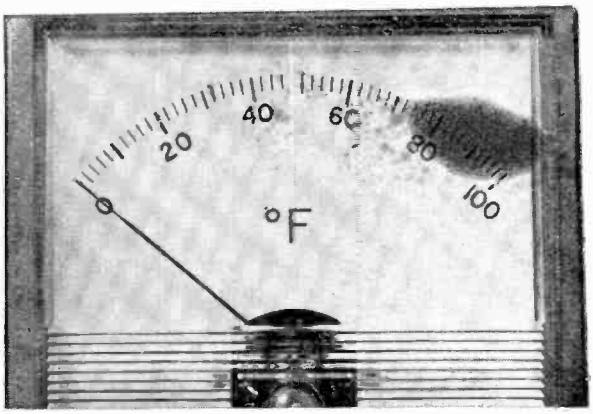
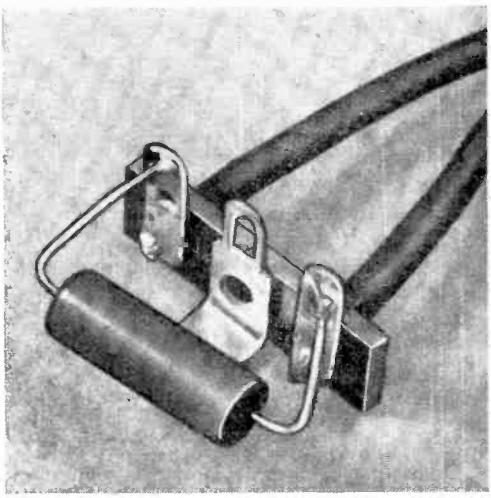


Fig. 2. Use the original scale markings, but renumber scale to indicate between 0 and 100; affix °F marking under scale.

sor trimming potentiometer *R8* is mounted on a two-lug terminal strip (neither lug grounded) fastened to the front panel under one of the meter mounting nuts. A three- or four-lug terminal strip can be mounted under the other meter mounting screw to serve as a connector for the sensor cables.

Drill a hole in the top of the chassis for the sensor cables. Put a rubber grommet on the hole to protect the cables. Then wire the circuit point-to-point following Fig. 1. Check that *R4* and *R6* are within a few per cent of each other in resistance values. At the same time, measure the resistance of both sensors, being careful not to heat them with your fingers. Use the higher valued sensor for the indoor unit (*R7*).

Since the sensors are encapsulated, they are not affected by rain, snow, etc. A good way to mount the sensors is to put them on small two-lug terminal strips which can be attached to almost any surface. Lengths of conventional twin-conductor cable (such as 300-ohm TV twin lead) can be used to connect the sensors to the thermometer. Be careful not to get more than a few ohms of resistance in the sensor circuit. Assume that most wire has a resistance of about ½ ohm per 100 feet (one wire, one way). Calibration is performed with the sensors actually connected to the necessary lead lengths.



Three-lug terminal strip provides most convenient method of connecting a sensing resistor to cable.

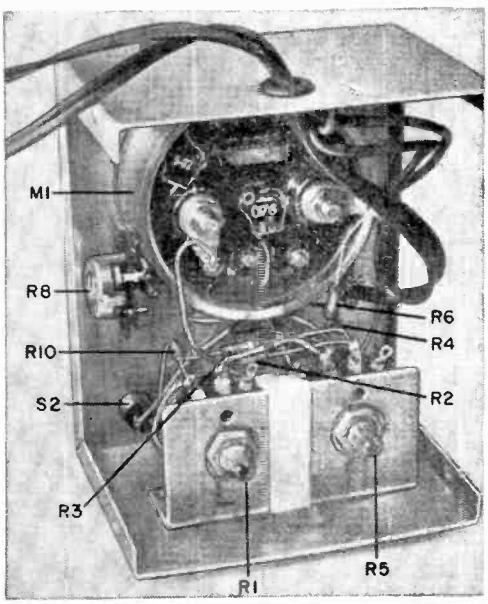
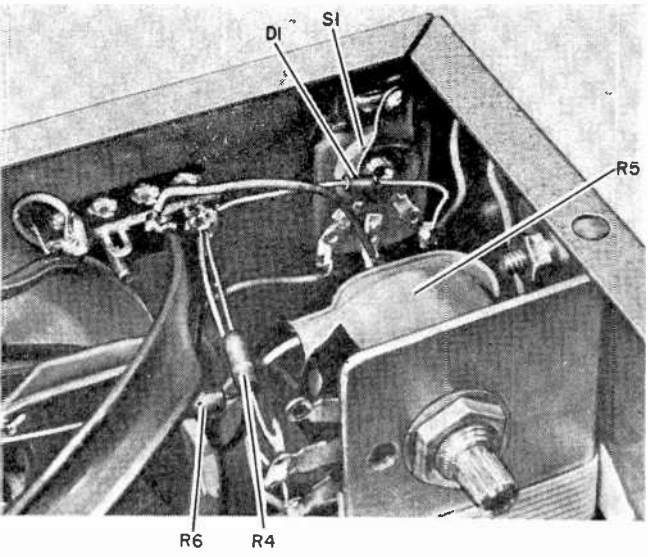


Fig. 3. Wiring is point-to-point. An elastic band secures B1 against the rear surfaces of R1 and R5.



Selector switch S1 (at top) is for two-sensor operation. If more sensors are used, substitute a switch with the appropriate number of positions.

Calibration. To calibrate the thermometer, you will need an accurate bulb thermometer covering the range from 0° to 100°F. With *S1* in the indoor position and the indoor sensor connected to the length of cable that will actually be used, wrap a small piece of wire around the sensor and the bulb thermometer to hold them in close thermal contact, making sure you can see the bulb-thermometer scale graduations.

Place the sensor-thermometer combination in a cold environment that is as close to 0°F as possible (refrigerator freezer) and allow the temperature to stabilize for 10 or 15 minutes. Turn on the electronic thermometer and compare its indication with the temperature as indicated by the bulb thermometer. Adjust *R1* until the meter agrees with the bulb thermometer. Remove the sensor and thermometer from the cold area and allow them to come up to room temperature.

Now place the sensor-thermometer combination in a hot environment that is as close to 100°F as possible (kitchen oven) and allow the temperature to stabilize again. Adjust *R5* until the meter indicates the same temperature as the bulb thermometer. Repeat the low- and high-temperature adjustments until the controls do not have to be touched up. If the low-temperature adjustment is made at exactly 0°F, the high-temperature adjustment need only be done once. Put a drop of glue on both potentiometer shafts to keep them from being moved accidentally. If you prefer maximum accuracy at some specific temperature, seek an environment that is exact-

HOW IT WORKS

The positive temperature coefficient resistor used as a sensor for the electronic thermometer is actually a semiconductor (silicon) device whose resistance versus temperature curve is extremely linear. Unlike the conventional thermistor, its resistance increases in proportion to an increase in temperature.

As shown in the schematic, the sensor forms one arm of a conventional Wheatstone bridge that is made to balance at 0°F. The resistance of the parallel combination of *R3* and *R1* plus *R2* is made to equal the resistance of *R7* at that temperature. In this condition, there is no voltage drop across the bridge so that no current flows and the meter indicates zero.

When the ambient temperature surrounding *R7* rises, the resistance of *R7* increases in proportion. This unbalances the bridge so that the voltage at the junction of *R6* and *R7* is higher than at the junction of *R4* and *R3*. Current then flows through the milliammeter, whose meter face has been calibrated in degrees Fahrenheit. If the ambient temperature surrounding *R7* decreases, its resistance decreases, less current flows through the meter and the needle drops. The circuit is designed so that zero current through the meter is 0°F—however, as pointed out in the text, any other temperature can be used.

Potentiometer *R1* is used to adjust the low (0°F) end of the meter scale, while potentiometer *R5* adjusts the high (100°F) end.

The power supply is regulated to prevent input-voltage variations from affecting the thermometer calibration.

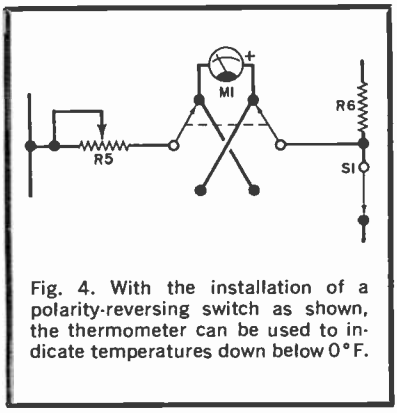
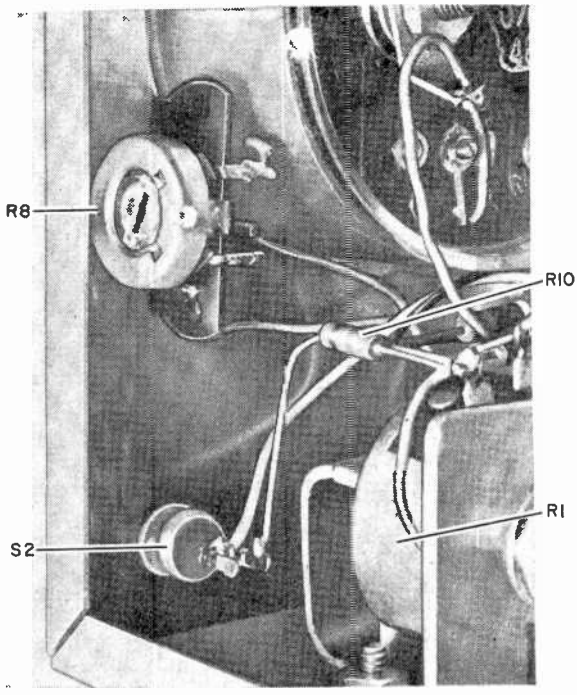
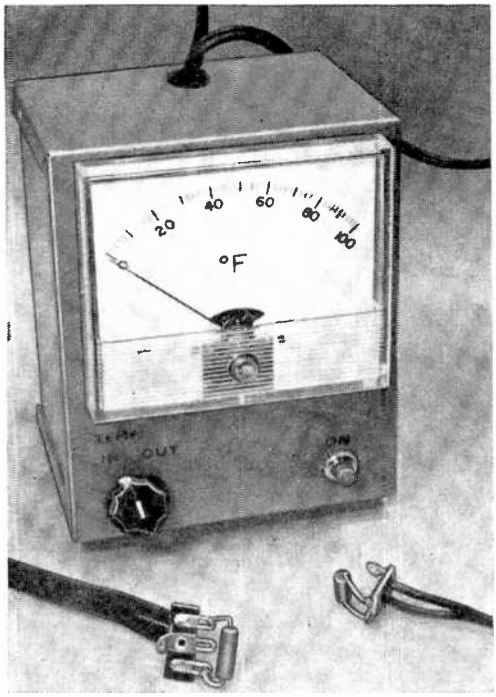


Fig. 4. With the installation of a polarity-reversing switch as shown, the thermometer can be used to indicate temperatures down below 0°F.



Potentiometer R8 should be mounted on a two-lug, ungrounded terminal strip. Terminal strip is held under the meter corner hardware.



Power line (if used) and sensor cables should enter top of the cabinet through grommet-lined hole.

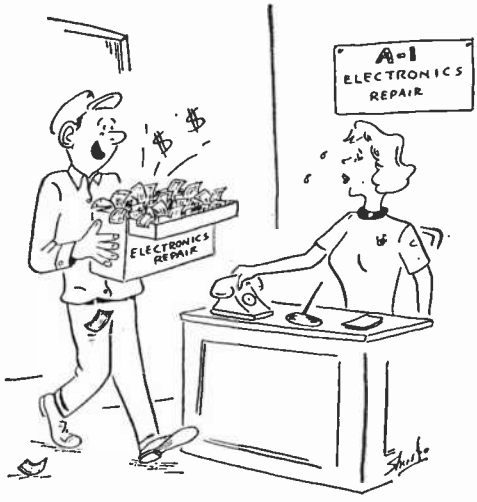
ly the temperature that you want (as indicated on the bulb thermometer) and adjust either the high or low control to get the correct indication on the meter.

Once the thermometer has been calibrated for the indoor sensor, connect the outdoor sensor to its required length of cable and repeat the low-temperature calibration, using *R8* to make the necessary adjustment. Calibration of the outdoor sensor for the high end is not possible now but the accuracy will not be greatly affected.

Modifications. If you want to measure below 0°F, build the meter-reversal circuit shown in Fig. 4 and calibrate the thermometer accordingly. To measure above 100°F, change the meter scale markings and calibrate using the desired temperatures. If the meter cannot be brought on scale, increase the value of *R5*.

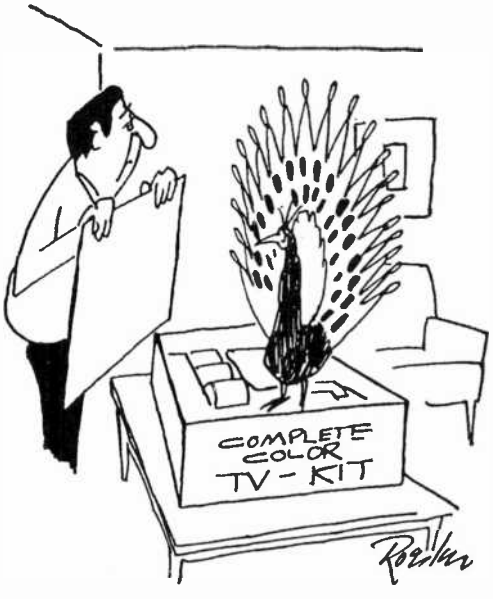
To add more sensors, change selector switch *S1* accordingly and connect the sensors just as *R8* and *R9* are in Fig. 1. The added trimmer potentiometers are mounted in the cabinet and adjusted as described above for *R8*. -30-

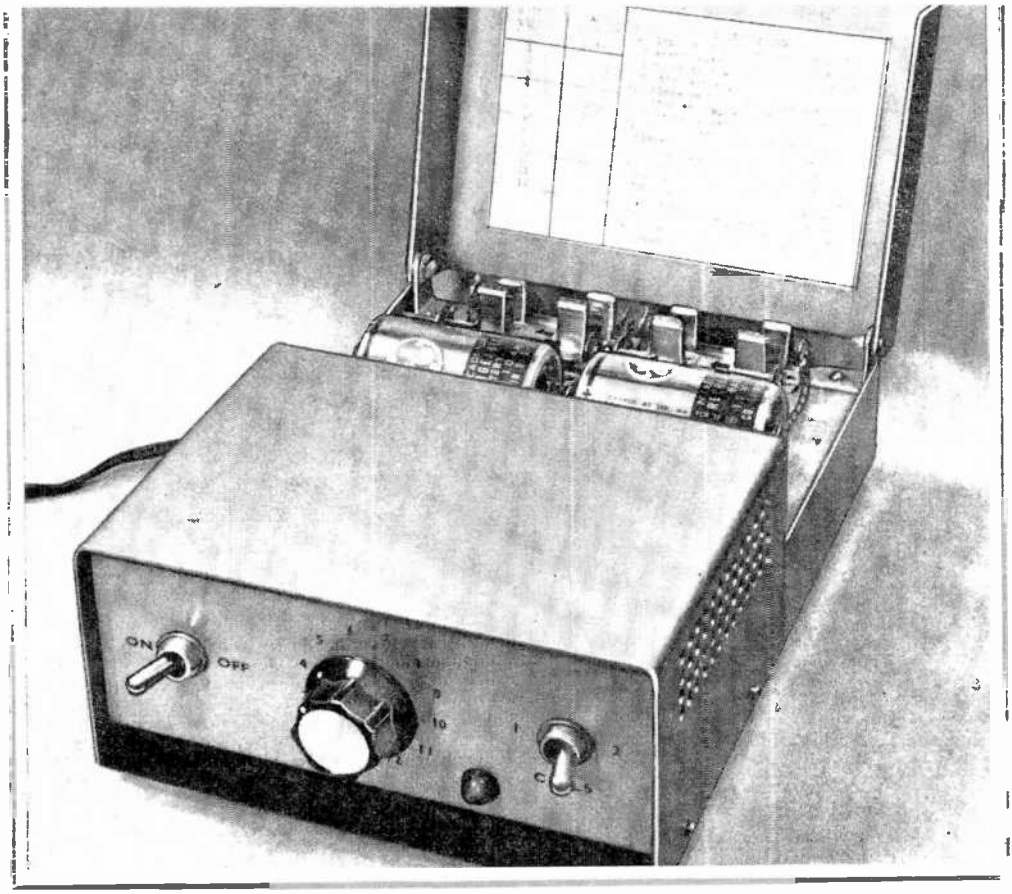
Popular EleComics



Boy, was this a good day for television . . .
Everything went wrong!

I guess you weren't ready
for me to plug it in.





AA-C-D Battery Charger

BUILD A CONSTANT-CURRENT CHARGER FOR NICKEL-CADMIUM CELLS

BY A. A. MANGIERI

EVERY DAY another new piece of battery powered equipment is introduced on the market. There are radios, tape recorders, instruments, flashlights, toys—you name it—and you probably have several of them in your home. You have also been struck by the amount of money spent on replacing worn-out batteries. Did you ever consider buying rechargeable batteries and doing the "revitalizing" yourself?

Although the purchase price of rechargeable batteries is higher than that of conventional zinc-carbon flashlight batteries, the fact that they can be recharged and used so many times makes their end cost substantially lower.

To recharge a rechargeable battery, you can build the constant-current battery charger described here for a very modest price. It has fixed charge rates, covering nearly all types and ranges of cells—with capacities from 45 to slightly over 500 mA.

This charger has built-in clips for holding AA, C, and D cells or a simple connector and cable arrangement can be used to recharge groups of cells (up to six) without removing them from the equipment in which they are installed. Besides the larger cells, the "button" type found in subminiature equipment can be recharged. Metering and a variable charge-rate control can be included.

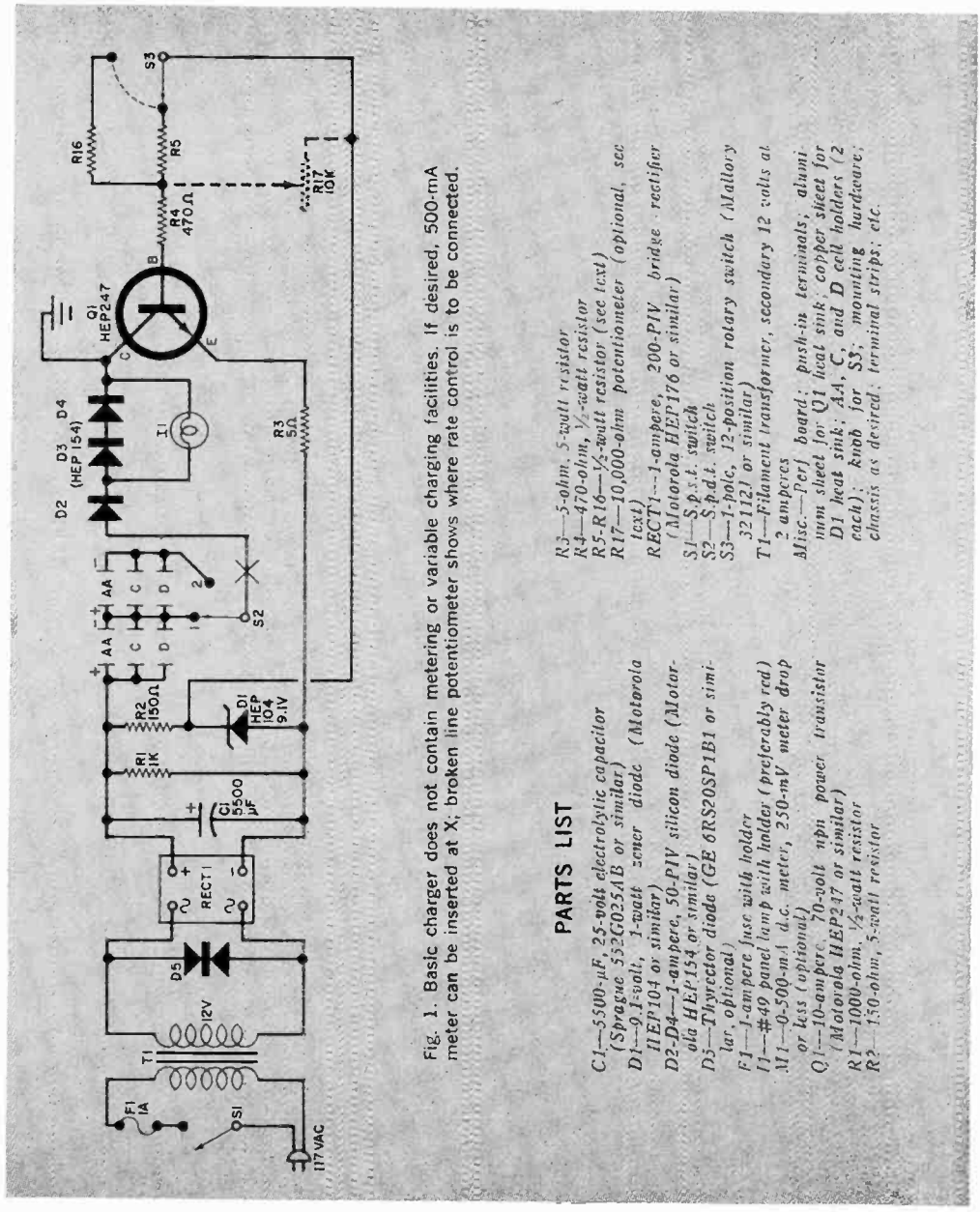


Fig. 1. Basic charger does not contain metering or variable charging facilities. If desired, 500-mA meter can be inserted at X; broken line potentiometer shows where rate control is to be connected.

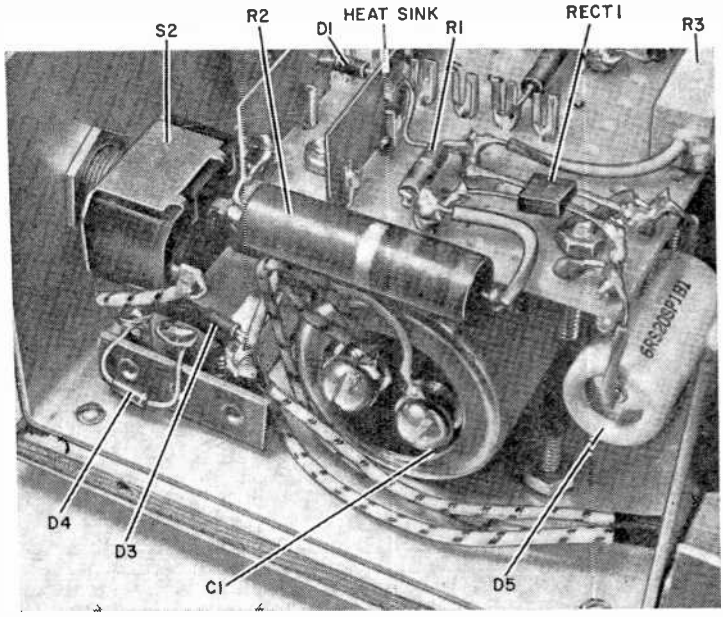
PARTS LIST

C1—5500-µF, 25-volt electrolytic capacitor (Sprague 55ZG025AB or similar)
D1—9.1-volt, 1-watt zener diode (Motorola HEP104 or similar)
D2-D4—1-ampere, 50-PIV silicon diode (Motorola HEP154 or similar)
D5—Thyrector diode (GE 6RS20SP1B1 or similar, optional)
F1—1-ampere fuse with holder
I1—#49 panel lamp with holder (preferably red)
M1—0-500-mA d.c. meter, 250-mV meter drop or less (optional)
Q1—10-ampere, 70-volt npn power transistor (Motorola HEP247 or similar)
R1—1000-ohm, ½-watt resistor
R2—150-ohm, 5-watt resistor
R3—5-ohm, 5-watt resistor
R4—470-ohm, ½-watt resistor
R5-R16—½-watt resistor (see text)
R17—10,000-ohm potentiometer (optional, see text)
RECT1—1-ampere, 200-PIV bridge rectifier (Motorola HEP176 or similar)
S1—S.p.s.t. switch
S2—S.p.d.t. switch
S3—1-pole, 12-position rotary switch (Mallory 32112J or similar)
T1—Filament transformer, secondary 12 volts at 2 amperes
Misc.—Perf board; push-in terminals; aluminum sheet for Q1 heat sink; copper sheet for D1 heat sink; AA, C, and D cell holders (2 each); knob for S3; mounting hardware; chassis as desired; terminal strips; etc.

About Rechargeable Batteries. There are two principal types of rechargeable batteries on the market—nickel-cadmium and alkaline. Of the batteries listed in the table, those made by Burgess, Eveready and General Electric are nickel-cadmium; the Mallory units are alkaline. (Note that the latter are *rechargeable* alkaline batteries—there are other alkaline batteries that are not rechargeable.)

Rechargeable nickel-cadmium and alkaline batteries are not interchangeable in most applications—particularly not in those containing built-in rechargers (electric toothbrushes, knives, etc.).

Mallory recommends that their rechargeable alkaline batteries be recharged on specially designed voltage-limited chargers; however, by following the precautions given at the end of the article, you can use this charger on alkaline batteries.



A clamp must be used when mounting C1 to the chassis. When tightening clamp hardware, be careful to avoid puncturing plastic jacket that encloses this capacitor.

Construction. Almost any type of mechanical assembly can be used for the charger. The photos show the commercial looking design built by the author. Although he used a metal chassis, secured to a wood base, the only metal actually required is a few square inches of aluminum and copper for heat sinks. If you use a closed container, make sure that enough ventilating holes are provided to prevent heat damage during prolonged operation.

The schematic of the charger is shown in Fig. 1. Most of the components are mounted on a small piece of perf board using clips to hold them in place. Note that zener diode *D1* is placed between a pair of thin copper plates ½" × 1" to provide a heat sink. Capacitor *C1* has an insulated jacket and should be mounted with a clamp to avoid puncturing the jacket.

Mount the battery holders on a nonmetallic surface (preferably wood) so that they do not touch and are sufficiently separated so that batteries can be installed and removed with a minimum of effort. Note that the author used a symmetrical arrangement in mounting the battery holders—with a D, C, and AA holder on each side. When wiring cell selector switch *S2*, be sure that, with the switch to the left, the left row of holders is selected and vice versa.

CHARGING TIMES AND CURRENTS

Manufacturer	Type	Capacity (mA-Hr)	Charge current (mA)	Charge time (Hr)
Burgess	CD6-AA	450	45	14-16
	CD7-D	2500	250	14-16
	CD11-D	3000	300	14-16
	CD10-D	4000	400	14-16
Eveready	CH450-AA	450	45	14
	CH400-AA	500	50	14
	CH1.5-C	1500	150	14
	CH4-D	4000	400	14
General Electric	GC-1-AA	500	50	15
	GC-2-C	1000	100	15
	GC-3-D	1000	100	15
Mallory	SA-15-AA	300	13.5	30-36
	SA-14-C	1000	40	30-36
	SA-13-D	2000	80	30-36

MAGIC FIGURES

Nickel-cadmium batteries are usually sold with a rating clearly printed on the side of the battery. This rating is either in terms of a 10-hour discharge at "X" mA or in a "total" battery charge of "Y" mA-Hr. To recharge, you use the same discharge rate (if the 10-hour figure is given) or divide the mA-Hr by 10 to obtain the idealized recharging rate. To this you add the magic figure of 40%. Thus a 200 mA-Hr nickel-cadmium battery would be recharged at 20 mA for 14 hours (or 15 if specified by the manufacturer as shown in table).

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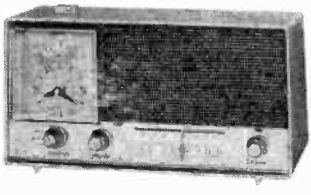

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GRA-295-4, Mediterranean Cabinet shown **$124.95***

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

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

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

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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.

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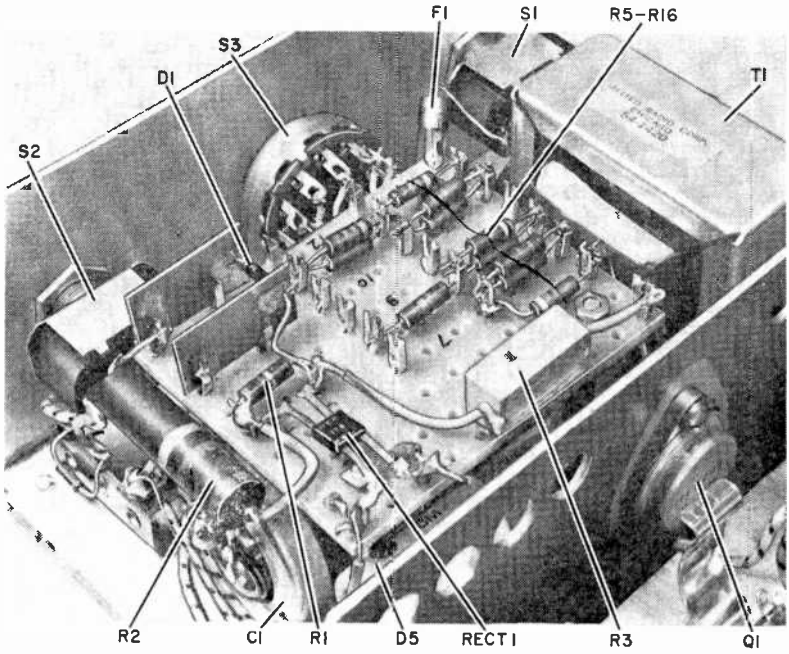


All components not on the chassis can be mounted on a piece of perforated phenolic board. Flea clips facilitate the connections.

The author used a 12-position switch for *S3*. This provides enough of a variety of charging currents for most applications. Resistors *R5* through *R16* provide base bias for the transistor and thus determine the charging rates. Their resistances must be chosen to account for variations in the characteristics of the transistor. If desired, you can use only a few rates to suit your immediate needs (or if you are using only one type of battery) and add others as your needs change. The Table gives a number of charging rates for the common AA, C, and D cells. The charging rate and time for a cell are usually marked on its jacket. Note that physical size is not an indication of the required charging rate.

To select resistors *R5* through *R16* (if you are going to use this many intervals) allow the equipment to warm up for about 20 minutes at normal room temperature (75 to 78 degrees F). Insert a fresh carbon-zinc D cell in one of the D-cell holders and clip a milliammeter across the other D-cell holder. When *S2* is in the 2 CELL position, the meter and the battery will be in series with the rest of the circuit. First use a 5000- or 10,000-ohm potentiometer for the base bias resistors and set it to its highest resistance. Slowly rotate the potentiometer until the milliammeter indicates the desired charging rate. Turn off the power and remove the potentiometer. Measure the resistance of the potentiometer to determine the fixed resistor to be used for that charging rate. Since you may wind up with non-standard resistance values, it is best to use a resistor with a slightly larger value and put a second resistor of higher value in parallel to get the required value. You should be able to set the desired charging current to within five percent of the target value.

If you use the optional meter circuit, then potentiometer *R17* is the base bias resistor and the charging current is read

RECHARGING ZINC-CARBON BATTERIES

A fully discharged zinc-carbon battery will be unable to accept a recharge. To put anything back into a zinc-carbon battery you must interrupt its service life before it has dropped below the level of 1.0 volt. This is tricky since the battery may not have displayed any indication that its useful life was ending.

Recharge zinc-carbon batteries immediately after removal from service. The rate of recharging should be about 120% the average rate of discharge and the charge period should be 12 to 16 hours. Put recharged batteries back into service immediately and don't expect to recharge zinc-carbon batteries more than 4 times—if that.

HOW IT WORKS

The battery charger is basically a d.c. power supply (*T1*, *RECT1*, and *C1*) which is placed in series with the battery to be charged. A power transistor (*Q1*) maintains the series current flow at a predetermined level. The transistor chosen for this application has little change in collector current for moderately large changes in both collector voltage and load current, once its base bias has been set. This bias (and hence the collector current) is set by the relatively stable d.c. voltage determined by zener diode *D1* and the series base resistors.

Switch *S2* selects either one bank of cell holders or both banks in series. Charge indicator *I1* and diodes *D3* and *D4* provide visual indication of charge over the range of 45 to 500 mA. Diode *D2* prevents slow discharge of cells left in the charger for storage. Thyrector diode *D5* suppresses any voltage transients that might enter the circuit from the power line.

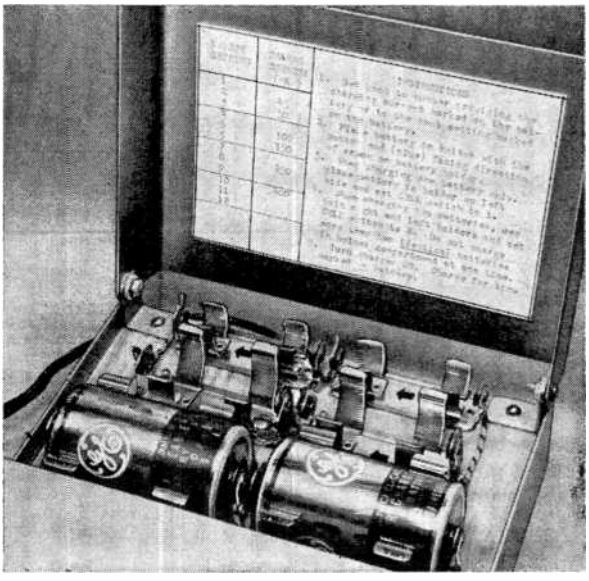
Two optional components may be added to the charger. A 0-500-mA meter can be inserted at point X in Fig. 1 to measure current flow, and a 10,000-ohm potentiometer can be inserted as shown by the dotted lines for variable control of recharging current.

appropriate battery holder. To charge two *identical* cells, set *S2* to the 2 CELL position and insert both cells in their holders, one on each side. Do not attempt to charge cells in parallel. It will damage the charger.

The charger can handle up to six identical cells connected in series. For this, make up a charging jack and cable to go between the charger and the batteries.

Recharge cells as soon as they appear to be weak in service. This avoids excessive discharging which tends to reduce the cycle life of the cell. Normally, a cell should be recharged when its voltage drops to about 1.1 volts at a load current equal to one-tenth the cell's rated mA-hour capacity at the normal 10-hour discharge rate.

Rechargeable alkaline cells may be recharged (at the recommended rate) with



Three time-saving ideas are shown in the photo at right: Battery holders are arranged symmetrically; large black arrows indicate directions of positive poles; and chart gives directions for use of charger.

directly off the meter for each application. In this case, increase the value of *R4* to limit the highest charging current to 650 mA.

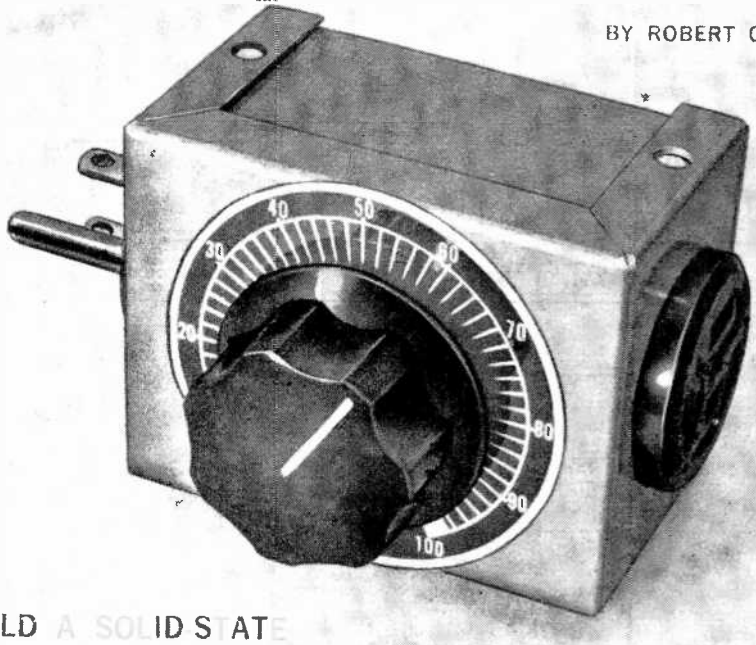
Applications. Make up a chart showing the correct setting of *S3* for each type of rechargeable cell you have, including the recommended charging time. This information is usually indicated on the package or the battery itself. Paste this chart on the charger so that you can refer to it when necessary. To charge one cell, set *S2* in the 1 CELL position and use the

a few precautions: Be sure to turn off the charger at the end of the charge period to avoid cell damage. Recharge cells when cell voltage drops to 1.1 volts. Never discharge a cell below 0.9 volt or cell damage will result.

Alkaline cells are supplied fully charged. If it is necessary to recharge a partially discharged cell, clip a voltmeter across the cell and recharge it until the voltage reaches 1.65 to 1.75 volts. Or, discharge the cell to 1.1 volts and recharge for the full recommended time.

-30-

BY ROBERT C. ARP, JR.



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VARI LE TRANSFORMER

USE A TRIAC FOR SMALL SIZE AND LOW COST

A VOLTAGE-LEVEL control for a.c. is one of the most useful electronic devices you can have around the house. It can serve as a speed control for motor-driven appliances; a heat control for soldering irons; or an incandescent light dimmer.

An ordinary variable autotransformer is commonly used as a voltage-level control. However, such transformers are expensive, bulky, and not very portable. A solid-state circuit, built around a triac, eliminates these objections. It costs about $8 in parts, fits into the smallest metal utility box, and weighs only a few ounces.

Aptly called a "Solid-State Variable Transformer," the voltage-level control described in the following pages does everything a conventional variable transformer can and does it more efficiently. There are no hysteresis losses, IR losses are at a minimum, and it operates cool.

Construction. Keep foremost in your mind that the Solid-State Variable Transformer is used to control potentially hazardous a.c. line voltages. Do not substitute parts for those specified in the Parts List. Take extra care when wiring the circuit and do not attempt to power the circuit until after you perform the ohmmeter checkout given in the last section of this article.

Begin construction by machining the utility box to provide mounting holes for *R1*, *P1*, and *SO1* as shown in Figs. 2 and 3. Note that all mounting holes are to be centered in the respective sides of the box.

The quickest and neatest method of making the cutouts for *P1* and *SO1* is to punch them out with a Greenlee No. 732 keyed radio chassis punch (orient the

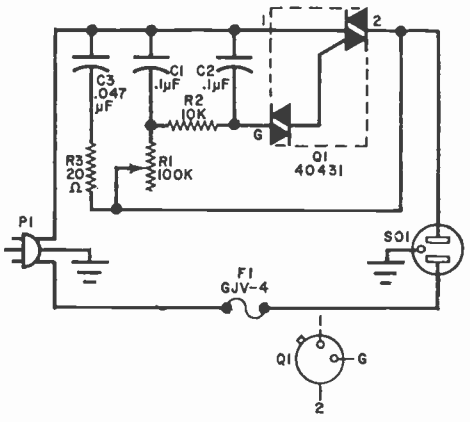


Fig. 1. Triac Q1 actually consists of four-layer diode at G and triac between 1 and 2.

PARTS LIST

C1, C2—0.1-μF, 200-volt tubular capacitor
C3—0.047-μF, 200-volt tubular capacitor
F1—Buss No. GJV-4 fuse
P1—Three-line a.c. plug (Amphenol No. 160-11)
Q1—Triac (RCA 40431)
R1—100,000-ohm, ½-watt linear taper potentiometer
R2—10,000-ohm, ½-watt resistor
R3—20-ohm, ½-watt resistor
SO1—Three-line a.c. receptacle (Amphenol No. 160-10)
1—Bud No. CU-2100-A metal utility box
Misc.—Ohmite Type 5000 dial plate (optional); control knob for R1; 2-each three-lug terminal strips (H.H. Smith No. 830, or similar); 1½"-long x ¼"-diameter heat-shrinkable tubing for F1; hookup wire; solder; etc.

keys toward the bottom of the box). However, if you do not have access to a chassis punch, simply cut out a 1 11/64"-diameter hole at each of the proper locations. Apply a liberal bead of epoxy cement around the entire perimeter of *P1* and *SO1*. Then insert the plug and receptacle into their respective cutouts, orienting the rounded prong and hole toward the top of the utility box, and snap into place the retainer rings.

After allowing sufficient time for the epoxy cement to set, drill a 3/8"-diameter hole through the top of the box for mounting control *R1*. Then, before setting *R1* in place, wrap one turn of 16-gauge solid bare wire around the mounting threads of the control, leaving 2" leads at each end. Insert *R1* into its mounting hole, slip on the optional dial plate, fasten down the control, and fasten down the panel knob.

Now, locate the ends of the solid wire previously wrapped around *R1*. Connect the ends of this wire to the green-coded contacts on *P1* and *SO1*. Snip away any excess wire and the *right* lug of *R1*.

Temporarily remove the silver-coded screw from *P1*, and use this screw to mount a three-lug terminal strip on the rear of the plug. In like manner, use the brass-coded screw on *SO1* to mount an identical terminal strip on the rear of the receptacle.

Slip the 1½" length of shrinkable plas-

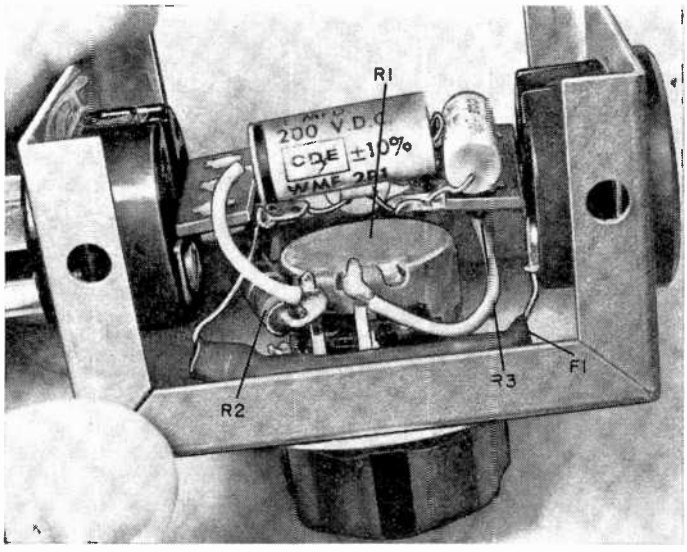


Fig. 2. Lug 3 at right of R1 is not used and should be removed to eliminate possibility of short circuits. Also, two terminal strips mount directly on rear of receptacle and plug.

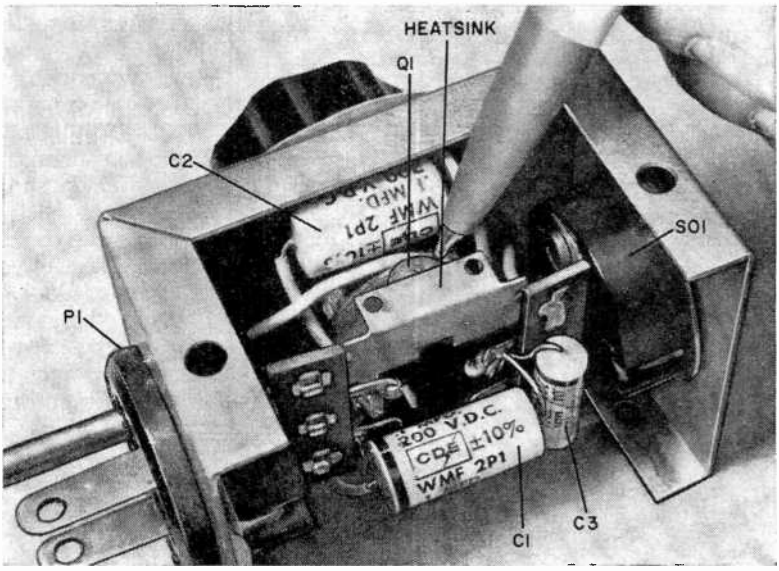


Fig. 3. Once Q1 is properly soldered to heatsink according to directions, set heatsink tabs onto lugs of terminal strip; solder in place.

tic tubing over the fuse, centering it over the body of the fuse, and apply heat until the tubing shrinks snugly around the fuse. Connect one lead of the fuse to the silver-coded contact of *SO1*, the other lead to the solder lug common to the silver-coded contact on *P1*.

Now solder *R2* to the left terminal of *R1* and the center lug of the terminal strip mounted on the rear of *P1*. Slip a 1¼″ length of plastic insulation over each lead of *C2*. Leaving just ¼″ of bare lead exposed, clip off the excess lead lengths. Now, referring to Fig. 3, place *C2* against the top of the utility box, just above *R1*, and solder one lead to the center lug on the left terminal strip and the other lead to the center lug of the right terminal strip.

Solder a 2″ length of insulated hookup wire from the center lug of *R1* to the lug common to the brass-coded screw on the *SO1* terminal strip. Then connect *R3* between the two outer lugs, and *C3* from the center lug to the outer lug (near the silver-coded contact of *SO1*) of this same terminal strip.

Connect another 2″ length of insulated hookup wire from the brass-coded screw on *P1* to the center lug on the *SO1* terminal strip. Cut one lead of *C1* to 1″ in length, the other lead to 1¼″ in length. Then slip a 1″ length of plastic insulation over the 1¼″ lead, and connect this lead to the left lug on *R1*. Solder the remaining lead of *C1* to the center lug of the *SO1* terminal strip.

Place the solder circle that comes with the triac in the heatsink (sometimes referred to as a heat spreader). Then force the triac between the tab and rear wall of the heatsink, being careful to prevent the Gate and No. 1 lead of the triac from touching the heatsink. Solder the case (terminal 2) of the triac to the heatsink.

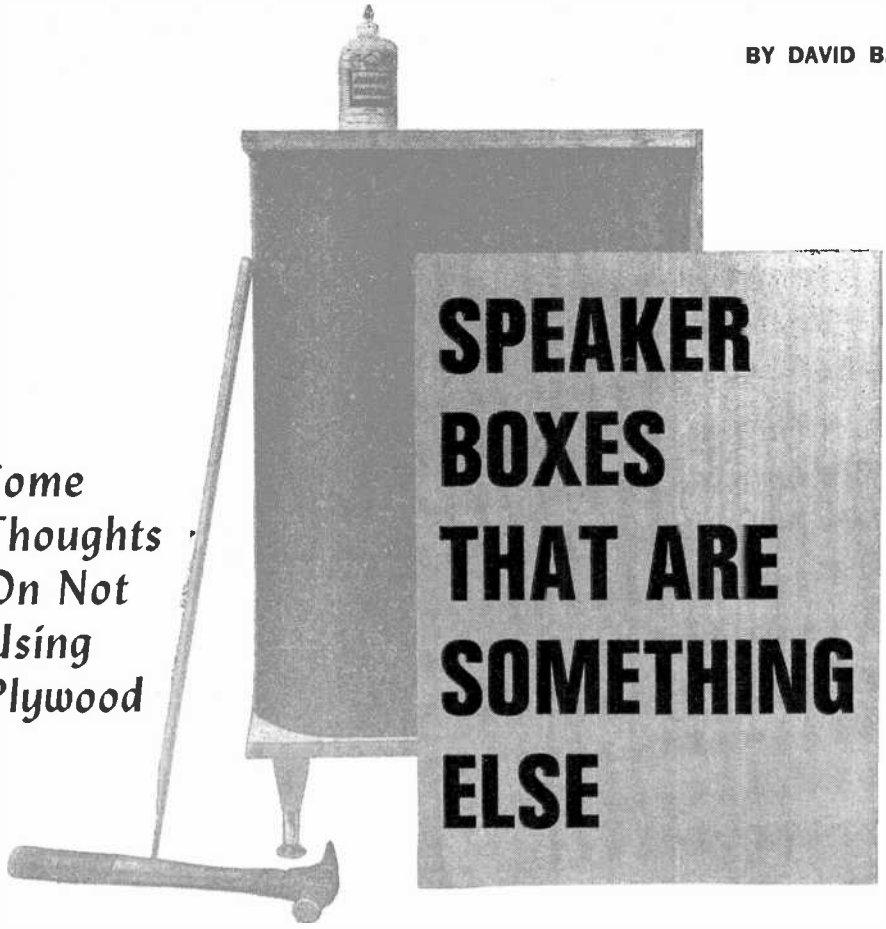
Now, liberally tin with solder the upper lugs of both terminal strips (see Fig. 3), place the triac assembly on these lugs as shown, and heat the heatsink to solder the triac assembly firmly in place. Finally, solder lead No. 1 from the triac to the center lug of the *SO1* terminal strip, and the Gate lead to the center lug on the *P1* terminal strip. Check to make sure that neither lead is touching the heatsink, case of *R1*, or each other.

Final Check and Use. Before powering the Solid-State Variable Transformer, check out the circuit with an ohmmeter as follows. With *R1* set for minimum resistance, and the ohmmeter's range switch set to X100K, touch the probes of the ohmmeter to the brass-coded screws on *SO1* and *P1*. Initially, there should be a well-defined deflection of the meter pointer toward the low resistance end of the scale. Thereafter, the pointer should slowly drift back toward the infinity index of the meter scale.

Now, touch the probes to the green-

(*Continued on page* 117)

BY DAVID B. WEEMS



SPEAKER BOXES THAT ARE SOMETHING ELSE

Some Thoughts On Not Using Plywood

WHETHER by design, accident, or habit, plywood has become the common working material of hi-fi enthusiasts who build their own speaker enclosures. Considering that plywood is stronger than solid lumber of equal thickness and that it is available in large, flat sheets, it is not a bad choice.

Unfortunately, the cost of plywood has skyrocketed over the years—so much so that many hi-fi'ers are beginning to have second thoughts about building their own enclosures. Plywood, however, is not necessarily the only, nor maybe even the best, material for constructing speaker enclosures. There are many other materials that, while not as strong as plywood, have better acoustical damping and resonance characteristics.

If this comes as a surprise, considering that most factory-made enclosures are made of plywood, rest assured that it is an acknowledged truth. Manufacturers use plywood for two basic reasons. First, labor—not materials—is the greatest expense involved in building an enclosure. Second, some of the substitute materials would not look good in advertising copy. The buying public has come to accept and expect plywood; so plywood enclosures are what they get.

In this article, your attention will be called to some of the better plywood substitutes. Equipped with this information and other pertinent data, you should be able to choose a material that will allow you to cut drastically the cost of your next speaker enclosure project.

Enclosure Basics. The purpose of any speaker enclosure is to isolate the speaker from the room so that sound produced at the rear of the speaker does not interfere with the sound coming from the front. Any material which interrupts the transmission of sound from

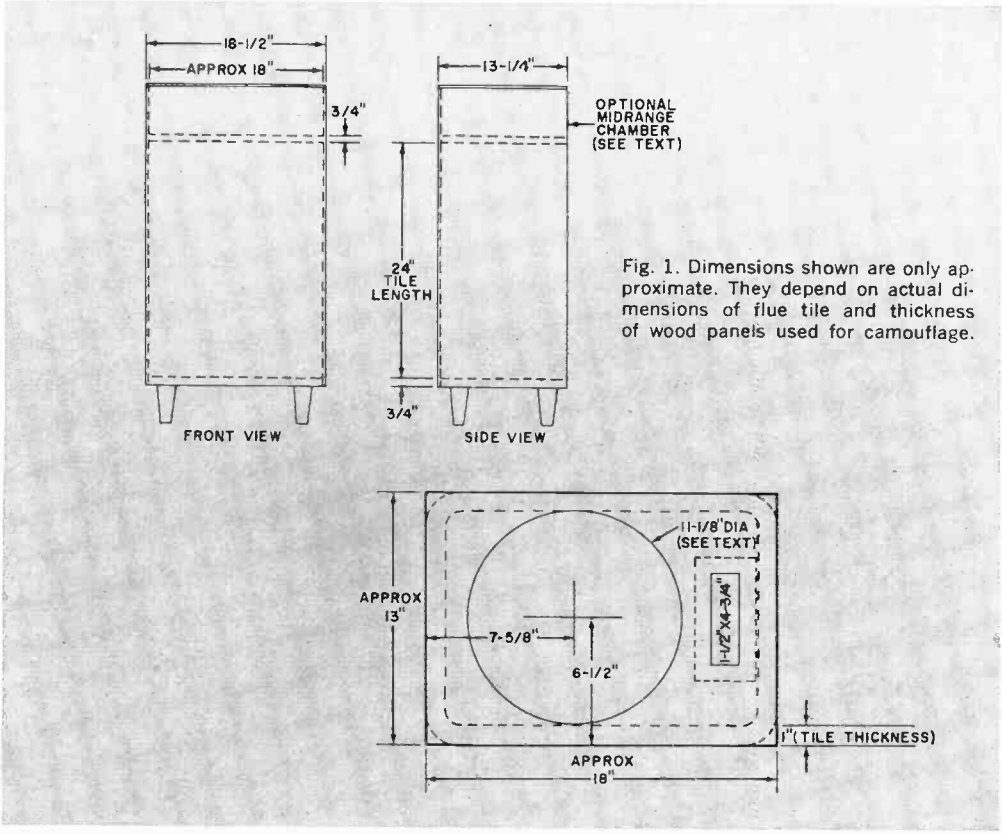


Fig. 1. Dimensions shown are only approximate. They depend on actual dimensions of flue tile and thickness of wood panels used for camouflage.

rear to front will serve the purpose. Only one qualification is necessary to the rule: the material must not vibrate. Vibration of the enclosure walls uses up energy that should go into the production of sound. Worse, it has resonances of its own, resulting in a rough system response curve.

There are actually two resonant characteristics in every enclosure; that of the enclosed air, called "Helmholtz" resonance, and wall resonance. Fortunately, you can avoid the worst effects of each by careful planning of the shape of the enclosure.

On all counts, a cube-shaped box is bad. The path length of sound reflected by opposing walls in such a symmetrical enclosure is the same in all three directions, and five of the six walls have essentially the same resonant frequency. The speaker changes the resonance of the wall on which it is mounted. Five nearly identical walls can add up to some nasty "booming" effects, especially if they are thin and undamped. Consequently, the first rule in enclosure design is to have a minimum of three different-size walls.

The rectangular box, with its three pairs of different-size walls, is the traditional choice of enclosure builders. Even here, the ideal is to have no two walls with the same resonant frequency. The speaker mounting and its opposing walls present no problems in this area; they naturally have different resonances, although they are identical in outline. All you do is brace *one* wall of each of the remaining two wall pairs to obtain the desired six different resonances.

Another design goal is to make the resonant frequency of the walls as high as possible. In light of the fact that many speaker manufacturers strive to lower the resonance of their speakers, this might at first appear to be a strange approach. There are, however, several good reasons for raising the resonant frequencies of the walls. First, the higher the resonance, the easier it is for the walls to absorb objectionable sound. If the frequency can be raised enough, ordinary acoustical damping material

(such as fiberglass, cotton batting, etc.) in the enclosure will help to cancel resonance effects. Also, there is the bonus that the same methods used to raise the resonance of the walls will increase wall damping.

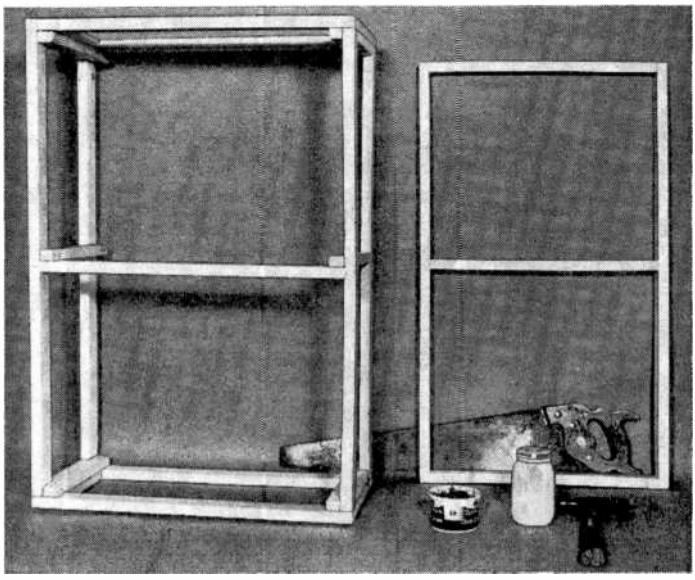
The resonant frequency of a wall panel is dependent on its size, thickness, stiffness, shape, and (if used) damping material. Consequently, if other factors are equal, a panel of small area has a higher natural resonance than a large panel. This explains why relatively thin materials that are unsuitable for large enclosures can be satisfactory for small enclosures. Thick, stiff walls of unequal length and width tend to have high resonant frequencies, but don't overdo the unequal length and width trick or you will end up with a "pipe" effect, and air column resonance within the enclosure will become a problem. For all practical purposes, the longest internal dimension should be less than three times the shortest dimension.

Substitute Materials. When choosing substitutes for plywood, the denser the better. You have probably seen or heard of excellent speaker enclosures made of concrete, brick, and ceramics. (Aluminum and steel meet the density requirement, but both tend to "ring" and should be avoided.) For example paper is denser than wood. So, you might start with a sheath of paper, a quart of glue, and a lot of patience and end up with a pretty good enclosure. But there must be a more practical approach.

A common material that has greater density than plywood and which is already being used as a plywood substitute goes under such names as particle board, chip board, etc., implying that it is made of wood chips and sawdust bound into board form with a resin glue binder. The boards are available in different sizes and thicknesses, the most common being 8′ × 4′ with thicknesses of ½″, ¾″, and 1″. Size for size and thickness for thickness, these boards are considerably less expensive than plywood. Lacking a grain, they are less resonant but less strong than plywood.

Chip board is essentially a semi-finished material. It is cut to size and glued and screwed or nailed together in the same manner as plywood. The only extra step is that it must be finished (painted or covered with a wood-grain plastic veneer or contact material).

The remaining plywood substitutes, with one exception, are laminated materials. If you like the unusual, there are several materials that are more convenient than gluing together sheets of paper. One of these is the corrugated paperboard shipping carton. Of particular value here are the heavy cartons rated as two- and three-ply paperboard that are used to ship large or extra heavy items. A check with your local hardware,



Laminated enclosure walls require wood frame made from pine for support and bracing.

plumbing, or appliance dealer might turn up paperboard of sufficient size that can be laminated to make enclosure walls.

As a point of fact, enclosure walls made of laminated paperboard are roughly comparable in performance to plywood walls of equal thickness. The only problem is that they are more difficult to join at the corners. One method of construction, as shown in the photo on page 47 is to nail and glue the laminated walls to a pine frame. Finishing can be with wallpaper.

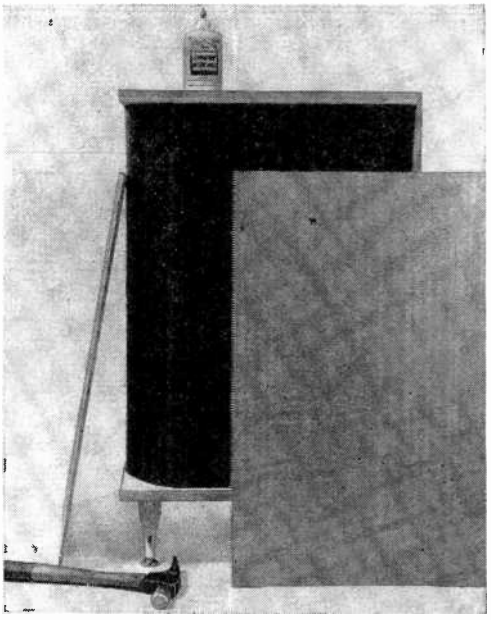
Almost any plywood enclosure can be improved by cementing another material, such as celotex or asphalt roofing felt, to the interior walls.

The use of a combination of materials, such as celotex, gypsum wallboard, and thin plywood was discussed in the "Club Sandwich Reflex" speaker system in the November 1962 issue of POPULAR ELECTRONICS. Materials for "sandwich" enclosures need not have great density, particularly if the ratio of stiffness-to-mass is high. One such material is styrofoam. However, it is almost transparent to low frequencies, which defeats the purpose of the enclosure. This also rules out the use of a styrofoam-only enclosure.

G. A. Briggs, the well-known speaker authority with the Wharfedale Wireless Works Ltd., mentions in his "Cabinet Handbook" that he has used a material like styrofoam as a core between ⅛"-thick layers of hardboard on one side and plywood on the other side to obtain a very lightweight enclosure that is virtually resonance-free.

Select laminated materials and you can probably duplicate an enclosure at a fraction of the cost of using plywood. Simply follow the published design you want to copy, substituting the laminated material for plywood. Just be sure to plan it so that the interior volume of the enclosure remains the same. This means that if you use a frame for mounting the wall panels, you must compute the cubic displacement of the frame and make suitable adjustments in the sizes of the walls to maintain the design volume.

One remaining plywood substitute worthy of mention is ceramic tile. And in calling out its relative merits, a construction project was devised, the details for which follow.



Once plywood end plates are secured to flue tile, glue and nail front and sides to the end plates.

A Flue Tile Speaker System. Several years ago, experimenters in England started putting speakers into lengths of sewer pipe. (An example of such a speaker system was published on these pages under the title "Drain Pipe 8" in June 1962). Although purists criticized these systems because the low frequency radiation was so distinctly separated from the highs and referred to them as "resonant columns," they actually sounded better than they looked.

Another perhaps more practical tile enclosure form is the ceramic flue tile. These tiles are available in various sizes and they are easily adapted to speaker enclosures of usable dimensions, even if the weight of the completed system is a bit unwieldy. Plywood is used in such enclosures very sparingly at the top and bottom open ends of the tile. Further stiffening of the plywood ends can also be obtained by running a threaded rod through the enclosure ends and tightening it down with nuts.

In their freedom from wall vibration, flue tile enclosures are a purist's dream, but they are a decorator's nightmare. One such system, called "Another Ceramic Tile Enclosure (POPULAR ELECTRONICS, April 1963), produced very

good sound but certainly won no awards for appearance.

With a little imagination, you can camouflage the flue tile. The method employed in the project illustrated in Fig. 1 is to extend the plywood plates at the open ends of the tile to a rectangular shape just large enough to accommodate the outer perimeter of the tile. Thin finished wood panels can then be nailed to the plywood ends to hide the flue tile.

You can start construction by cutting two pieces of ¾" plywood to the sizes needed for the end plates. Set one plate aside temporarily, and referring to the bottom drawing in Fig. 1, cut the openings for the port and speaker. (For a 12" woofer, cut an 11⅛" opening; for an 8" speaker, cut a 7" opening.) Then prepare two 1½"-long and two 6¼"-long sides from 1¾" × ¾" pine for the port. Glue and nail these pieces to the bottom plate over the port opening.

The enclosure is easily assembled with the liberal use of silicone rubber caulking compound. Aside from mechanically joining the two dissimilar materials—wood and ceramic—the caulking compound provides an excellent air seal.

Assembly is best accomplished as follows. First, apply a liberal bead of caulking compound to the lip of the flue tile. Invert the tile onto the blank plywood top plate, and carefully square the two pieces in relation to each other. Allow the compound to set solid as the weight of the tile bears into the silicone rubber.

When the caulking compound has completely set, invert the assembly. Cut a piece of acoustical fiberglass wool to size and cement it to the inner surface of the top plate. Then cement a fiberglass wool liner around the inner surfaces of the tile. This damping material is necessary to reduce the reflections that would otherwise be caused by the hard, relatively smooth interior surfaces of the tile.

Next, repeating the instructions given above for the top plate, caulk the bottom plate to the open end of the flue tile. After allowing sufficient time for the caulking compound to set, use a sharp knife to pare away any bleed-over silicone rubber that might interfere when the thin wood sides are attached later.

Again invert the assembly, and front-mount the woofer in its cutout as shown in Fig. 2. Bring the speaker cable out through a hole drilled in the bottom plate, and fill the hole with caulking compound.

Now, connect the speaker cable to your amplifier and feed in some music that is heavy on the bass. If the sound is not just right for your taste, drop cut-up pieces of fiberglass wool into the enclosure (through the port) until you are satisfied. Then turn off the music and disconnect the speaker cable.

All that is left to do is camouflage the tile and add a midrange speaker and/or tweeter, if desired. If you plan to incorporate the midrange speaker and/or tweeter, determine how much longer to make the side and front wood panels. Then cut the sides and front to size (the rear of the system does not need a panel, nor should there be a panel at the rear of the midrange speaker/tweeter chamber). Nail and glue the panels to the end pieces of the woofer chamber. Then cut to size and nail and glue a top plate in place.

Finally, wire the midrange speaker and/or tweeter together, and connect a suitable crossover network between the two chambers to make a "system" that can be connected to your amplifier. That's it! -30-

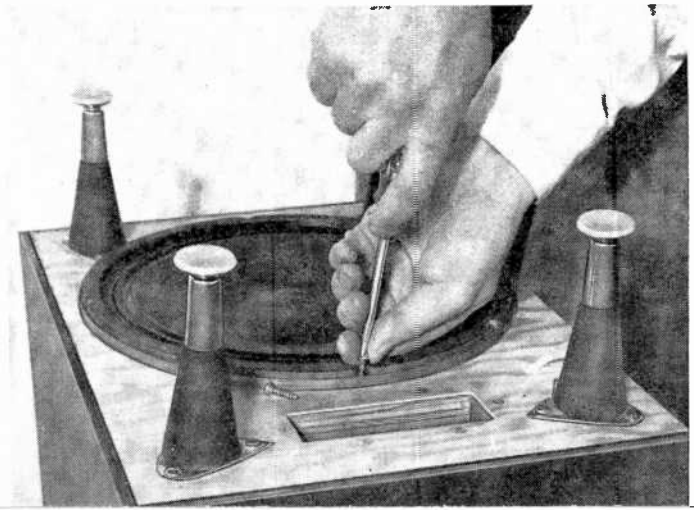


Fig. 2. Because speaker board is fixed by caulking compound, it is necessary to front-mount woofer. Staple or tack grille cloth over speaker cone to protect it against dust and pets.

What Does An Op Amp Do?

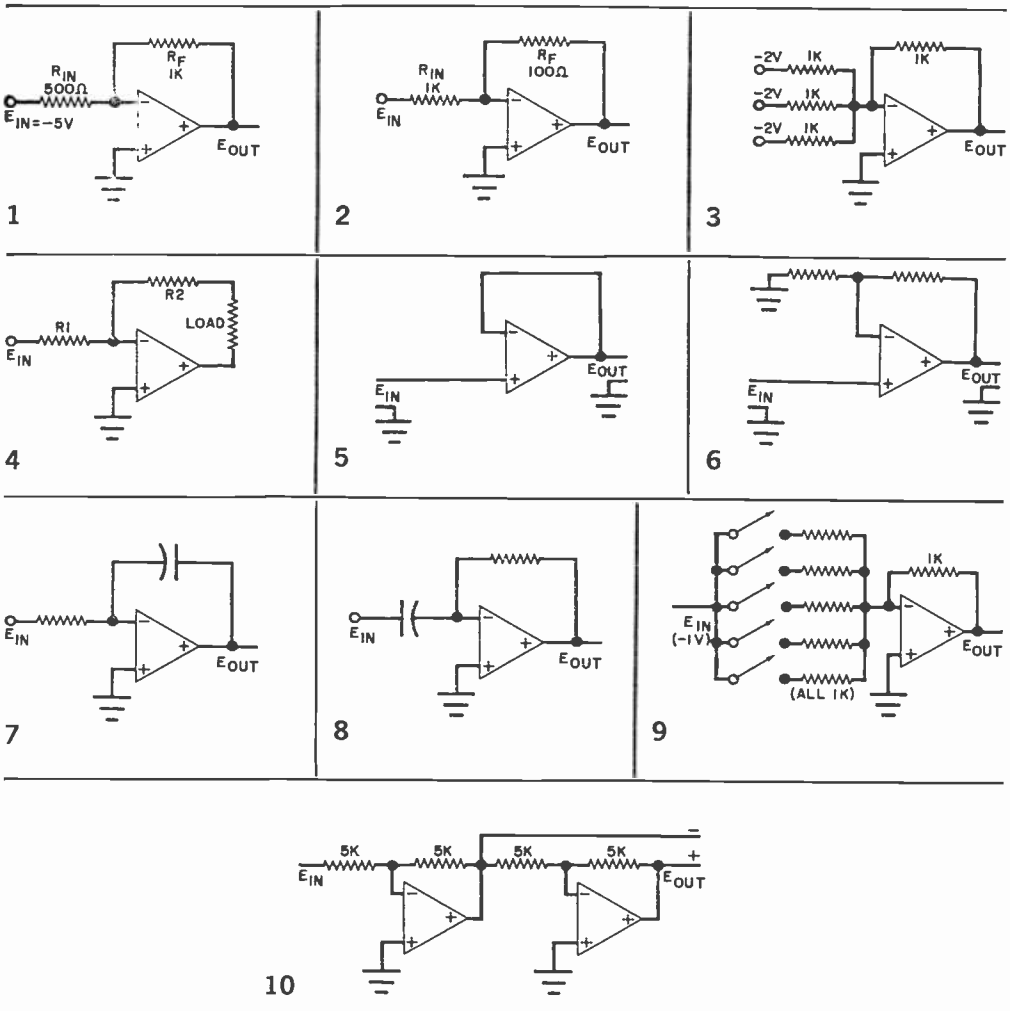
BY JOHN SEGINSKI

THAT versatile building block, the operational amplifier, is the mainspring of much of today's most advanced electronic equipment. In computers and automatic control systems, for example, they are indispensable, and they can be made to function in a number of different ways—precision voltage sources, current sources, and voltage adders, to name only a few.

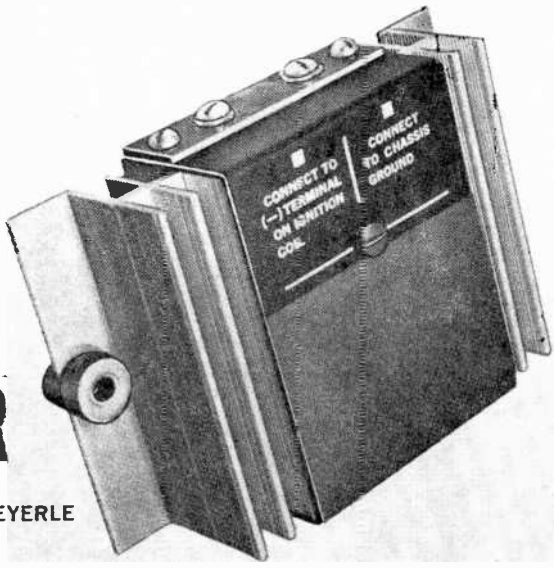
The operational amplifier, or op amp, is an extremely high-gain amplifier with a very high input impedance. The actual gain of a specific circuit is determined by feedback resistors connected around the amplifier. Various characteristics can be achieved by connecting other components and other op amps in the circuit. The numbered sentences and equations that follow refer to the circuits below. Test your knowledge of op amps by filling in the blanks.

1. E_{OUT} = _____
2. Gain = _____
3. E_{OUT} = _____
4. This is a _____ generator.
5. Gain = _____
6. This is a _____ voltage amplifier.
7. This is an _____.
8. This is a _____.
9. When switches are closed one by one, a _____is generated.
10. The outputs are _____.

(*Answers on page* 113)



Build a DWELL EXTENDER



BY GEORGE MEYERLE

ELECTRONIC ASSIST TO YOUR IGNITION SYSTEM

MANY SCHEMES have been proposed in the last ten years for improving electronically the efficiency of the ignition system of the internal combustion (automobile, boat, etc.) engine. Such proposals, whose basic purpose is to improve overall performance and reduce fuel consumption, are all based on the principle of increasing the spark energy at high engine speeds (see Box). Many of these spark improvement systems have value—whether they are simple switching transistors or elaborate, relatively complex capacitive-discharge circuits. Unfortunately, they also have varying disadvantages of some type.

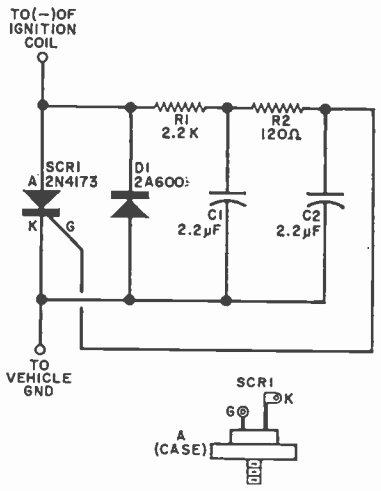
The "Dwell Extender" described here increases spark energy at high engine speeds by lengthening the dwell time electronically and requires only two connections to the existing system. The patented circuit, shown in Fig. 1, can be used in any car or boat with a negative ground. It can be installed or removed in a matter of minutes and is applicable to any number of cylinders, provided a coil-and-breaker-point system is used. It cannot be used on engines having a magneto ignition or a positive-ground.

What can be expected of this unusual system? Truthfully, not very much if you have a new car that is properly tuned up and if you don't drive at high speeds. However, if your car has a lot of mileage on it and you want additional "zoom" for passing or accelerating on a hill, the Dwell Extender can provide an improvement in your car's performance.

The use of this system in your car will also save you some gasoline due to more efficient burning; and you will find that problems resulting from worn points are reduced since they no longer play such an important part in the ignition system. Spark plugs will last longer too.

Construction. It is important that you use the silicon controlled rectifier (SCR1) called for in the Parts List. It is capable of withstanding the temperature extremes existing near the engine and it can take the reverse voltages that occur when the points open. Similarly, the capacitors must be of the solid tantalum type which can withstand the temperature extremes.

The components are actually mounted



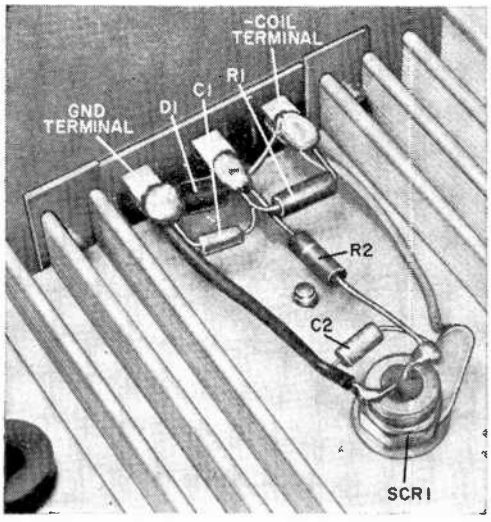
PARTS LIST

C1, C2—2.2-μF, solid tantalum capacitor (Sprague 164D or similar)
D1—2-ampere, 600-volt PIV rectifier diode (Solitron Devices 2A600)
R1—2200-ohm, ½-watt resistor
R2—120-ohm, ½-watt resistor
SCR1—Silicon controlled rectifier (Motorola 2N4173
Misc.—SCR mounting hardware (Motorola MH475 or similar); heat sink (Wakefield 400 or similar); three-lug screw-type terminal strip; metal for U-brackets; length of #14 twin-conductor cable; two crimp-on lugs; rubber grommets (2); mounting hardware; etc.
Note—A pre-tested SCR with mounting hardware at $4.50; a pre-tested diode at 30¢; and two tantalum capacitors at 60¢ each are available from Mctrotec Industries, 1405 Old Northern Blvd., Roslyn, N.Y. 11576. Also available from the same source are: a gold anodized heat sink with covers, shock mounts, and terminal strip at $3.95; a complete kit of parts at $9.50; and a finished, wired unit encapsulated in a heavy-duty cylindrical heat sink at $19.95, all postpaid. The finished unit has a 2-year guarantee.

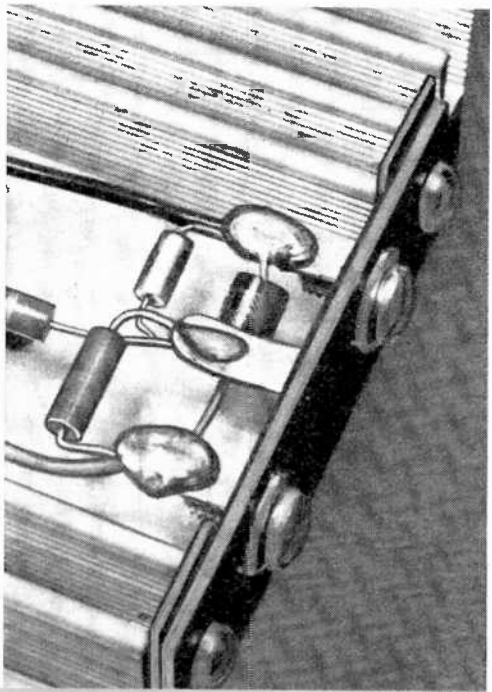
Fig. 1. Be sure to use the components specified so that the finished device can withstand both engine-space heat and any switching transients.

on the heat sink (or similar) prescribed in the Parts List. Drill a hole in the center of the heat sink for *SCR1*. Mount the SCR with an insulating (mica) washer around the stud on each side of the heat sink and a soldering lug making contact with the case of the SCR on the wiring side of the heat sink. You may also have to use some type of insulating tubing around the stud where it passes through the heat sink to avoid any contact between the two. When you have the SCR mounted, use an ohmmeter to check that there is no contact between the case (anode) of the SCR and the heat sink.

Fig. 2. Install the SCR so that it is completely insulated from the metal heat sink. Mount a large solder lug between the case and insulator to make the anode contact. All wiring is point to point.



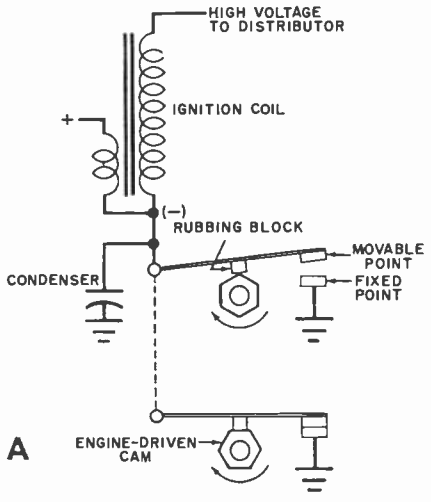
The three-screw terminal is mounted on a U-shaped cover that snaps over the heat sink. Remove center screw and cover the outside hole with a piece of tape. The lug is used as a wiring support only.



SPARK ENERGY

The efficiency of an internal combustion engine depends, in the final analysis, on the mixture of gasoline and air that is introduced into the cylinder and the successful ignition of that mixture by an electrically induced spark. If we assume that the carburetor is doing its job of providing the proper fuel mixture, then obtaining the right spark energy to fire it is the best way to improve efficiency.

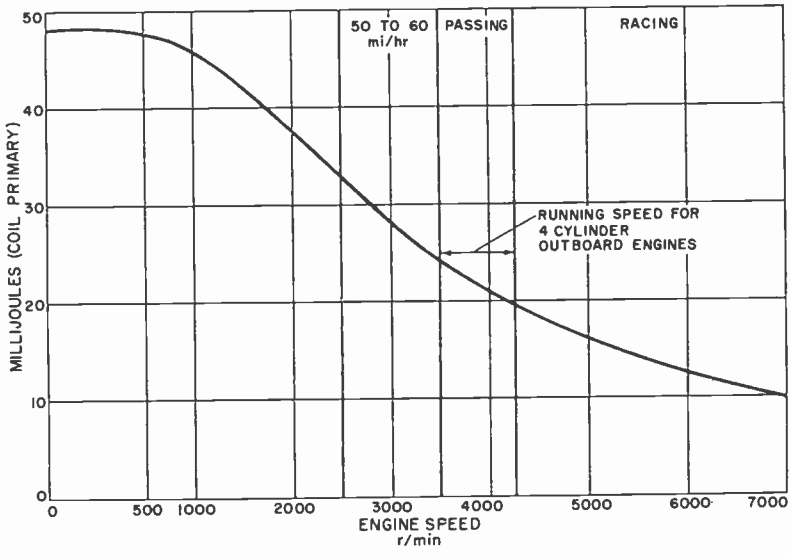
To provide a spark, the majority (about 98%) of conventional engines use the Kettering system, which was developed about 50 years ago (see Fig. A). In this system, battery current is allowed to pass through the primary of an autotransformer (ignition coil) when the breaker points are closed. The opening and closing of the points are timed by an engine-driven cam that is designed to open the points whenever a spark is required by a cylinder. When the points are closed, the current flowing through the coil builds up a magnetic field which saturates the coil. When the points open, the current flow stops and the magnetic field collapses. As the field collapses, the magnetic lines of force cut the turns on the other portion of the autotransformer, inducing a very high back e.m.f. This voltage is applied through the distributor to the appropriate cylinder to ignite the gas-air mixture. The time that the points remain closed is called the dwell time and is specified in degrees of dwell for the particular engine.



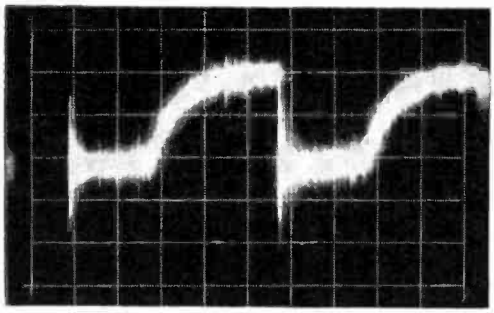
A

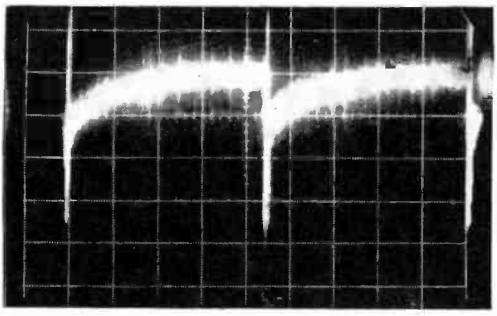
An ignition system of this type always works (unless something is drastically wrong) but it does have disadvantages, which result primarily in the loss of performance at high engine speeds. This is because, as the engine speeds up, the amount of time that the points remain closed is proportionally reduced. When the engine speed reaches two thousand r/min or more, the points are closed for such a short time that the magnetic field within the ignition coil does not build up to maximum. This results in a much lower "thinner" spark voltage for ignition. As a result the energy in the coil primary drops dramatically as shown in Fig. B. Because the higher engine speeds are used in accelerating and passing, "sluggishness" is noted in many engines when this situation occurs. Since the fuel doesn't burn properly, the condition also wastes gasoline and the spark plugs get fouled up, causing an even further drop in performance.

The purpose of most ignition-improvement systems is to overcome the "droop" in spark energy at high engine speeds.

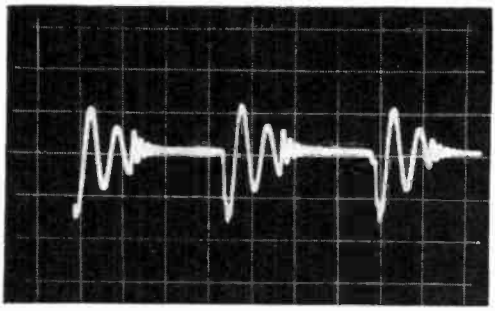


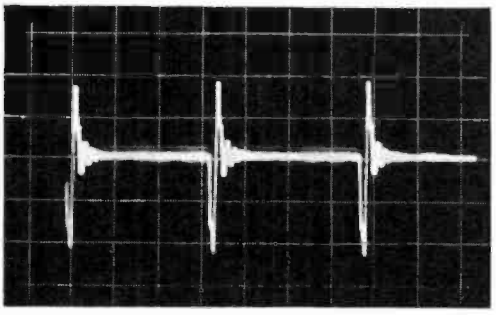
B





Primary current in the ignition coil without (top) and with (bottom) the Dwell Extender. Calibration is 5 ms per division horizontal, and 2.5 amperes per division vertical. Note the longer time that ignition coil current flows using Dwell Extender.





Secondary voltage of the ignition coil without (top) and with (bottom) the Dwell Extender. Calibration is 1 ms per division horizontal and 10 kV per division vertical. Note the reduced ringing and the higher voltage using the Dwell Extender.

Prepare a U-shaped metal cover to fit over the top of the heat sink and project down over the two sides. Cut out one end of the cover so that a three-lug terminal strip can be mounted on it as shown in Fig. 2. The two outer lugs serve as wiring connections for the internal components and for connection of the external leads. The center lug is used as a standoff insulator for internal wiring which is point-to-point.

Once the circuit is complete, spray the interior with a non-corrosive lacquer to provide protection against moisture. Make another U-shaped cover to fit over the bottom of the heat sink and cover the electronic components.

Drill holes in the ends of the heat sink for mounting and insert rubber grommets in the holes to provide protection against shock and vibration.

Clearly identify the two external connections. Mark them "CHASSIS GROUND" and "(—) TERMINAL OF IGNITION COIL."

Installation. Select a suitable mounting spot for the Dwell Extender—away from the heat of the engine and radiator. The location can be on the sheetmetal wheel covering, the firewall, or even inside the car (or boat). Make sure that rain or snow (or spray if used on a boat) cannot reach the device. A maximum of six feet of wire can be used to connect the circuit to the ignition coil.

(*Continued on page* 112)

HOW IT WORKS

When the points are closed, the Dwell Extender is shorted out so that the SCR is non-conducting. During this time, the current through the coil (through the closed points) builds up the magnetic field. When the points open, the back e.m.f. from the collapsing field around the coil creates a voltage high enough to fire the spark plug. However, the instant that the points open, the positive voltage from the battery is applied directly to the anode of the SCR and, through an *RC* network, to its gate. About 100 microseconds after the points open, the positive pulse reaches the gate, firing the SCR. This closes the points electrically. Shortly afterward, they close mechanically.

The result is that the coil is being charged for almost the entire duty cycle except for the 100 microseconds to allow for spark to occur. The magnetic field built up in the coil is thus stronger and a much larger spark is available at the distributor. In fact, the spark energy is almost doubled at high engine speeds. Diode *D1* bypasses the negative spike that occurs when the points open.

BY JAMES BONGIORNO

ULD Sine Wave Generator

5 TO 60,000 Hz WITH ULTRA LOW DISTORTION

THERE IS a certain aura of "rightness" about test equipment. Whether we buy a piece of commercial test equipment or assemble a kit, we always assume that the instrument is relatively absolute, that it does what it is supposed to do, and that the readings it provides are correct. We take it for granted that any detectable errors are in the device being tested. It is also customary to assume that a test instrument is more accurate than the device being tested.

Everyone (who has thought about it) knows, of course, that a perfect test instrument doesn't exist and that even very accurate instruments are expensive. However, there is no reason why the electronics experimenter should not use the very best equipment that he can find or build.

In the past, POPULAR ELECTRONICS has presented some remarkably accurate digital test instruments, which, in spite of their relatively low cost, had accuracies that rival those of commercial gear. Described in this article is a low-cost, top-quality ultra-low-distortion audio generator for the serious audio hobbyist and electronics technician. The specifications shown in the table compare favorably with some of the best available audio generators. (See box on Residual Distortion)

The circuit for the generator is shown in Fig. 1. Like any test instrument, the quality of performance depends on the accuracy of the bridge components (in the lower half of Fig. 1). To provide for ease of dial reading a dual log-taper potentiometer is specified. The bridge capacitors are relatively expensive. The two capacitors with the smaller values (*C10* and *C11*) are polystyrene having tolerances of 0.5%, while the two larger units are metalized Mylar with tolerances of 1%.

The Author

After many years as a professional musician, Jim Bongiorno's interest in basic electronics led him into the field of servicing electronic organs and hi-fi equipment. After working his way up the technical ladder, he is now Chief Engineer, engaged in research and development at Lambert Laboratories, Westfield, N.Y.

The dual log-taper potentiometer (*R-26*) must track within 1 dB to produce the frequency response and amplitude stability given in the specifications table. Conventional, over-the-counter dual pots do not track this closely. However, one

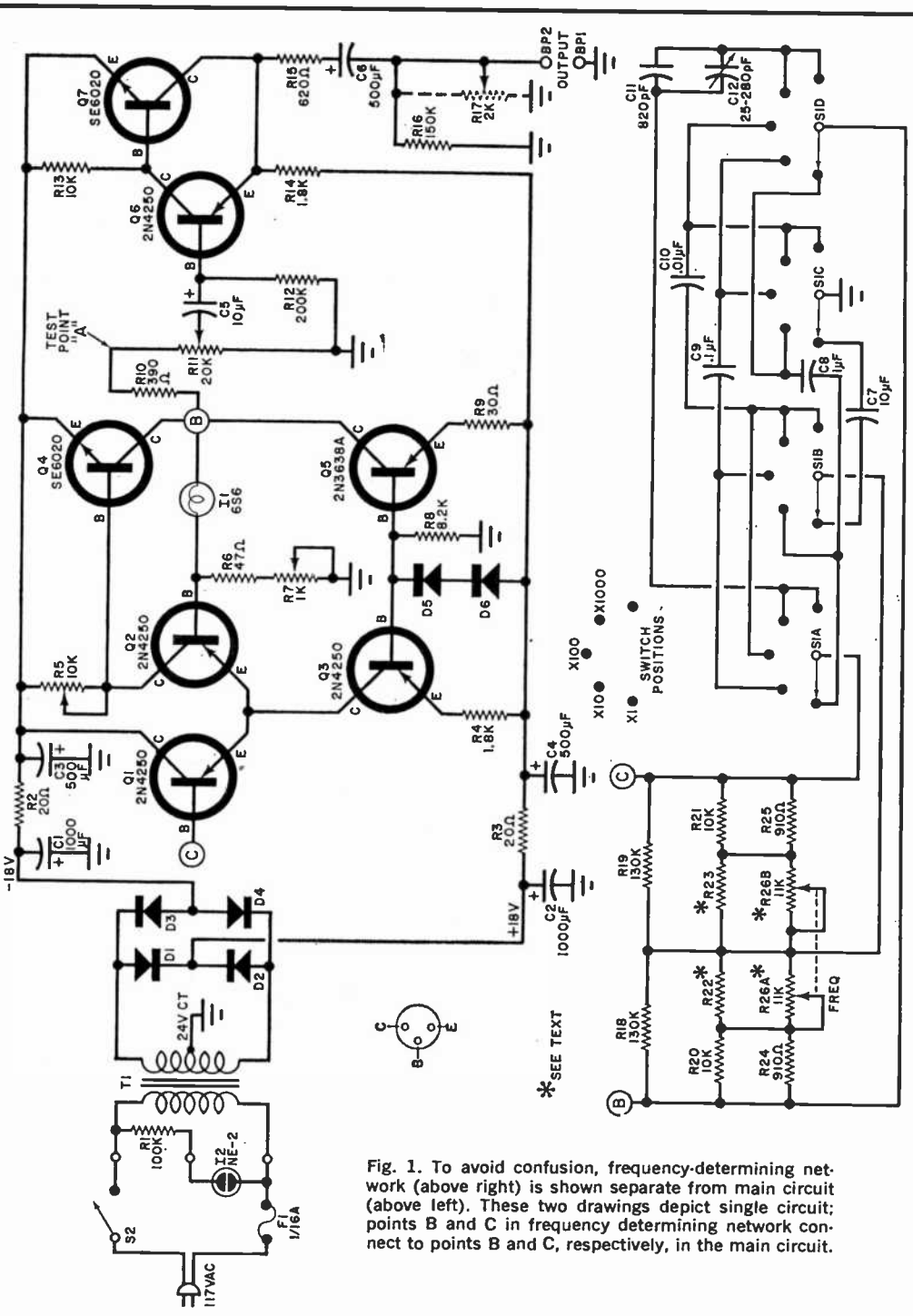


Fig. 1. To avoid confusion, frequency-determining network (above right) is shown separate from main circuit (above left). These two drawings depict single circuit; points B and C in frequency determining network connect to points B and C, respectively, in the main circuit.

is available through the source given in the Parts List. Special close-tolerance capacitors are also available from the same source.

Obviously, if you do not want your generator to have the accuracy shown in the table you can use conventional components with broader tolerances.

PARTS LIST

BP1, BP2—Five-way binding post, one red, one black
C1, C2—1000-μF, 25-volt electrolytic capacitor
C3, C4—500-μF, 25-volt electrolytic capacitor
C5—10-μF, 15-volt electrolytic capacitor
C6—500-μF, 15-volt electrolytic capacitor
*C7—10-μF, 200-volt, 1% Mylar capacitor**
*C8—1-μF, 200-volt, 1% Mylar capacitor**
*C9—0.1-μF, 60-volt, 0.5% polystyrene capacitor**
*C10—0.01-μF, 60-volt, 0.5% polystyrene capacitor**
C11—820-pF, 60-volt, 5% polystyrene capacitor
C12—25-280-pF trimmer capacitor
D1-D6—100-mA silicon diode (any type)
F1—1/16-ampere fuse and holder
I1—115-volt, 6-watt lamp (GE6S6 or similar)
I2—NE-2 neon lamp
Q1, Q2, Q3, Q6—Transistor (Fairchild 2N4250 or 2N5087)*
Q4, Q7—Transistor (Fairchild SE6020A or RCA 40459)
Q5—Transistor (Fairchild 2N3638A or 2N4354 or RCA 2N4037)

R1—100,000-ohm
R2, R3—20-ohm
R4, R14—1800-ohm
R6—47-ohm
R8—8200-ohm
R9—30-ohm
R10—390-ohm
R12—200,000-ohm
R13—10,000-ohm
R15—620-ohm
R16—150,000-ohm
R18, R19—130,000-ohm, 1%
R20, R21—10,000-ohm, 1%
R22, R23—see text
R24, R25—910-ohm, 1%

All resistors ½-watt, 5% unless noted

R5—10,000-ohm trimmer potentiometer
R7—1000-ohm trimmer potentiometer
R11—20,000-ohm linear taper potentiometer
R17—2000-ohm linear taper potentiometer (optional)
*R26—Dual log potentiometer, 10% (nominally slightly greater than 10,000 ohms)**
S1—4-pole, 5-position rotary switch (Centralab PA1012 or similar)
S2—S.p.s.t. switch
T1—Power transformer; secondary, 24 volts, 0.085 amperes (Stancor P-8394 or similar)

Misc.—Heat sink for Q4 and Q5 (Wakefield NF207 or similar); 4" x 5" x 6" steel cabinet; line cord; knobs; frequency dial*; press-on lettering; mounting hardware; etc.

*Etched PC board @ $4.00, dual potentiometer (R26) @ $6.25, set of four bridge capacitors @$12.00, matched differential pair of 2N4250 @ $1.25, calibrated dial @ $6.00, and selected SE6021 @ $0.75 are available from Lambert Laboratories, 48 Washington St., Westfield, N.Y. 14787. A complete kit of parts is available for $48.50 from the same source, postage paid.

Construction. The audio generator, including the power supply, is built on a printed circuit board whose actual-size foil pattern is shown in Fig. 2. You can make your own board or buy one as listed in the Parts List. Assemble the components on the board as shown in Fig. 3. Be sure to observe the correct polarities of the electrolytic capacitors and the semiconductors. The arrangement shown in Fig. 3 must be followed to reduce hum to a low level. Place heat sinks on transistors *Q4* and *Q5*.

The prototype generator was constructed in a 6" × 5" × 4" metal enclosure. The front panel was laid out as shown in the photographs. Mount the frequency control potentiometer (dual *R26*), range switch (*S1*), level control (*R7*), output binding posts, power on-off switch (*S2*), and power-on indicator (*I2*) on the detachable front panel. Mount the capacitors on the range switch (*S1*), then wire in the various frequency determining resistors. Make sure that these are wired correctly or *Q5* will burn out.

Set *R5* (on the PC board) to its approximate center of rotation and temporarily wire the circuit as shown in Fig. 1. Connect a scope to test point "A" and turn the generator on. You should observe a sine wave on the scope. There is a possibility that *R7* (on the PC board) may be set for too low a resistance. In this case, adjust *R7* through its complete range observing on the scope that the output goes from zero to a clipped sine wave. Set *R7* so that a clean sine wave of exactly 5 volts r.m.s. is obtained.

Bridge Component Calibration. As previously stated, the frequency and amplitude accuracies of the generator are only as good as the components. This is particularly true of the decade capacitors associated with *S1*. You can select these from random capacitors using an accurate RLC bridge to measure the absolute values and, if necessary, paralleling small value capacitors to arrive at a desired value.

The frequency control dual potentiometer (*R26*) must be calibrated (see below), but first using a very accurate ohmmeter determine its total end-to-end resistance. It should be a little over

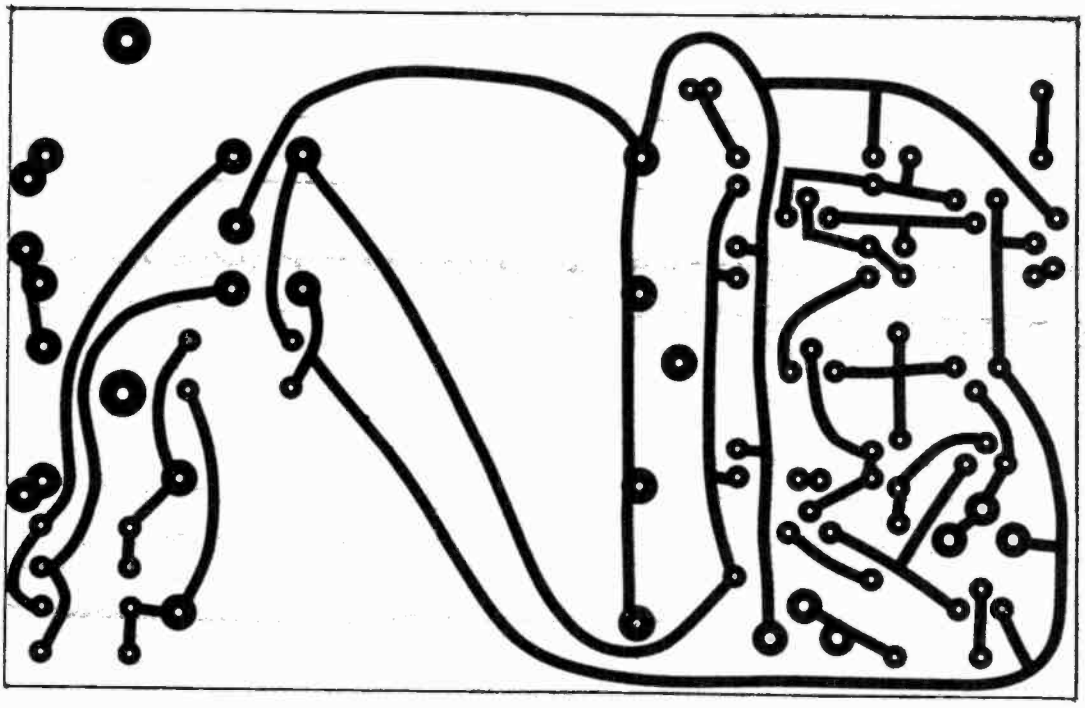


Fig. 2. Printed circuit board speeds assembly. To make your own board, copy actual-size foil pattern.

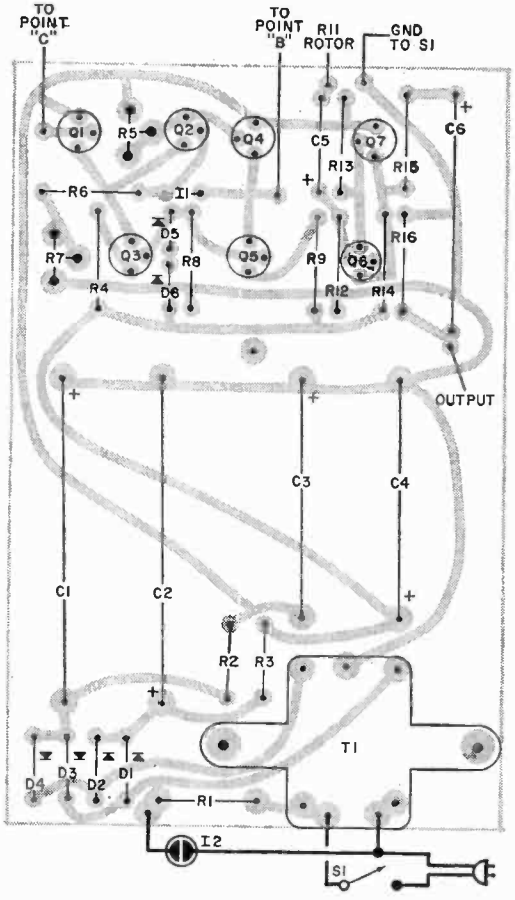
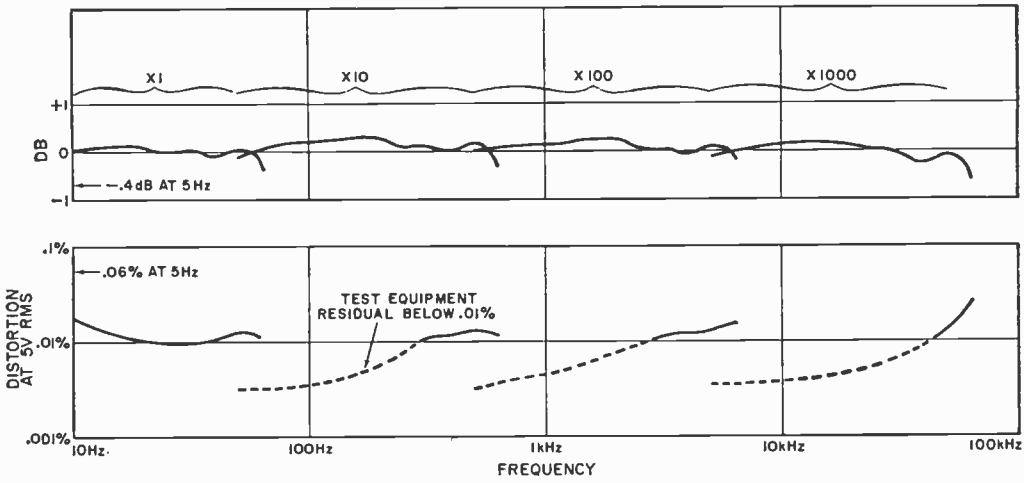


Fig. 3. Be particularly careful to observe the correct transistor, diode, and capacitor polarities when mounting the parts on the printed circuit board.

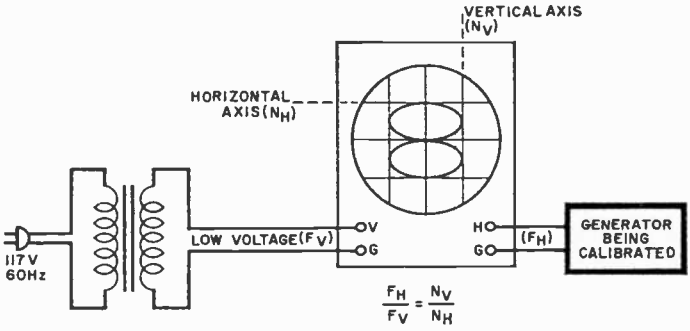
10,000 ohms. Connect a larger-value resistor across the potentiometer to bring the total resistance down to exactly 10,000 ohms.

After the potentiometer value has been adjusted, wire it into the circuit and set the range switch (*S1*) to the $\times 1000$ position. Center the rotor of the frequency potentiometer. Adjust output level control *R11* to give a 5-volt r.m.s. output.

If you have access to a distortion analyzer, set the audio generator to the $\times 1000$ position and the frequency potentiometer about one third of the way up (approximately 20 kHz). Connect the generator to the distortion analyzer and allow both to warm up and stabilize. Null the analyzer for a minimum meter indication. Slowly adjust *R5* for a meter minimum. It should be about 0.01%, which is about the residual distortion in most commercial analyzers.



Frequency response (upper) and distortion (lower) curves are typical when close-tolerance components are used in frequency-determining network.



LISSAJOUS PATTERNS

One of the easiest and most accurate methods of determining the frequency of an unknown audio generator is to use an oscilloscope to compare its frequency with that of a known source. The circuit arrangement is shown in the diagram.

The vertical input is taken from the low-voltage secondary of a filament transformer connected to the power line, while the horizontal input is from the audio generator output. This discussion assumes a 60-Hz power line; however, the theory can be used with any other line frequency.

The scope horizontal input should be switched to external input. With the scope and both frequency sources on, adjust the scope controls for an equal vertical and horizontal display. Adjust the controls so that the top of the display just touches one horizontal graticule of the scope screen while the vertical portion of the display just touches a vertical graticule.

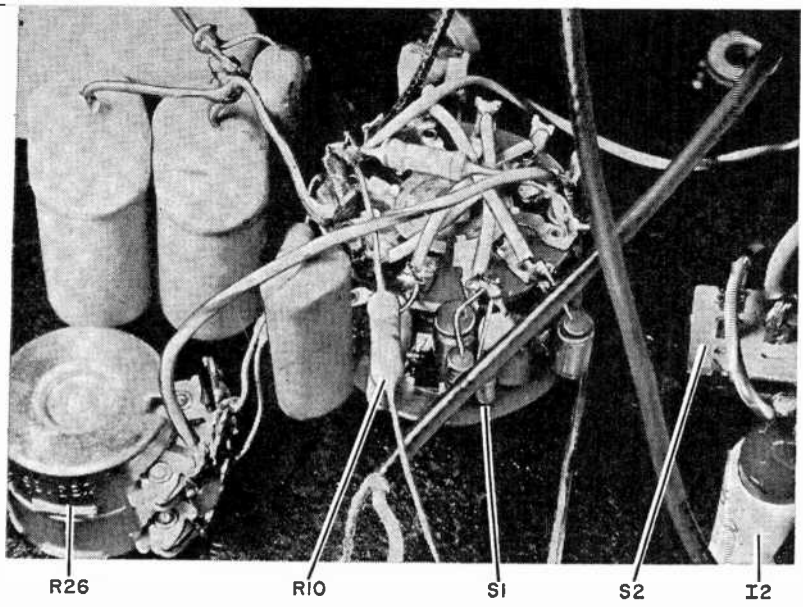
Adjust the audio generator frequency control until a circle is formed on the screen. At this point, the audio generator frequency is equal to the reference frequency. Note that the circle makes one contact with each vertical and horizontal graticule—resulting in a 1:1 ratio.

As the audio generator frequency is reduced, the displayed pattern makes many changes, and at certain points, the pattern becomes stationary. These stationary patterns occur at various reference-to-unknown frequency relationships. By counting the number of horizontal and vertical points of contact during stable pattern intervals the unknown frequency can be determined. Thus, if F_H is the reference frequency, F_V the unknown frequency, N_V the number of contacts on the vertical axis, and N_H the number of contacts on the horizontal axis, then

$$F_H/F_V = N_V/N_H$$

Thus the dial of the generator can be calibrated.

For example, assume one contact on the horizontal axis and three contacts on the vertical. Then, $60/x = 3/1$. So $3x = 60$ and $x = 20$ Hz. Again, assume two contacts on the horizontal axis and three on the vertical. Then $60/x = 3/2$; $3x = 120$; and $x = 40$ Hz.



Take your time when wiring range selector switch S1 (shown at center) to avoid making costly error. If the frequency determining components are not wired in just right, transistor Q5 might burn up.

RESIDUAL DISTORTION

The expression "less than 0.1% distortion" is quite popular with hi-fi manufacturers in describing their products. Sometimes it is desirable to know how much less than 0.1% and what type of distortion is referred to. The residual distortion of this audio generator is less than 0.02% across the audio range; and if you take the time and trouble to trim up certain components, the distortion factor can be reduced to about 0.005% and it will be mostly second and third harmonics.

HOW IT WORKS

The system can be considered to be an operational d.c. amplifier with very high open-loop gain. Transistors *Q1* and *Q2* form a differential input pair using *Q3* as a constant-current source. Transistor *Q4* is the output driver, while *Q5* acts as a constant current load for *Q4*. This approach was used instead of a resistor to reduce the distortion and produce a higher output swing. Bias for the two constant-current stages (*Q3* and *Q5*) is provided by diodes *D5* and *D6*. The use of a differential amplifier eliminates the need for a highly regulated power supply since the amplifier requires only a simple positive and negative supply to ground.

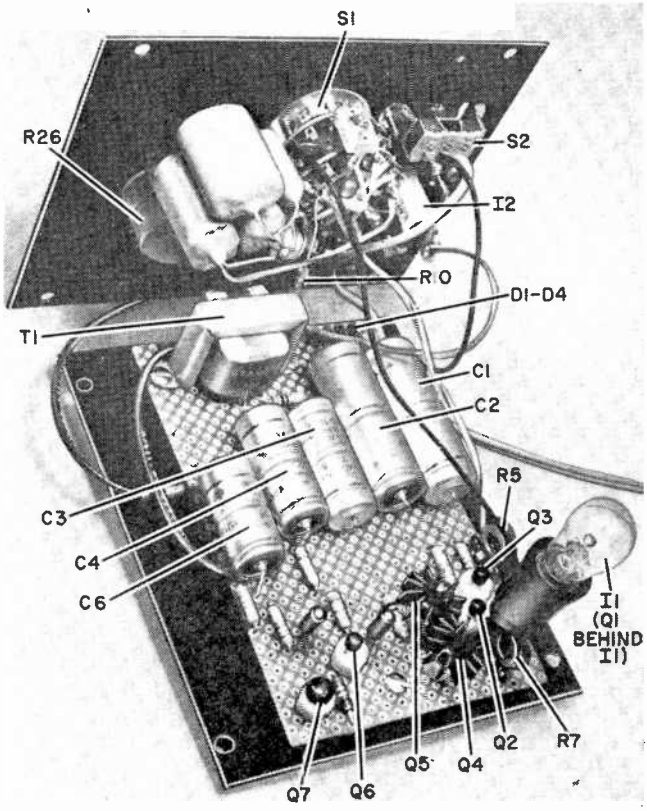
The bridged-T network (dashed line box in schematic) is connected in the negative feedback loop while a conventional low-watt incandescent lamp (*I1*) is used in the positive feedback loop. This makes the range switching arrangement a little unusual, but it saves the cost of three expensive 1% capacitors. However, each range capacitor must be an exact decade multiple for greatest dial accuracy and amplitude linearity.

The bridged-T configuration was selected because it gives better overall performance when compared to the commonly used Wein bridge. Both noise and distortion are reduced. Because this bridge has zero phase shift at only one frequency, the oscillator has an output only at this frequency. Since the bridged-T is a minimum-transmission network, it must be inserted in the negative feedback loop of the amplifier. The Wein bridge, on the other hand, is a maximum-transmission network and must be used in the positive feedback loop. Since there is a loss of ⅔ in a Wein bridge, the negative feedback loop would have to have a gain of three to make up for the loss. Because the negative feedback loop (in this case) is not frequency sensitive, the amplifier gain at all frequencies can never be less than three. In the bridged-T approach, however, the negative feedback loop contains the frequency-selective network which has a loss of ⅔ at one frequency and no loss at other frequencies. This means that an amplifier with unity gain can be used with more feedback.

A conventional low-power incandescent lamp (*I1*) is used to control the positive feedback. When such a lamp is operated at low power levels, it has a very nonlinear response—a necessity in this circuit.

Since the oscillator portion is d.c. coupled, there are no low-frequency time constants or roll-offs other than the lamp characteristic. This assures a positive start when power is applied.

The output of the oscillator is coupled to a super emitter follower (*Q6* and *Q7*) that is used to isolate the oscillator from loading. The output can drive loads down to 100 ohms with very little increase in distortion.



Interconnections between components mounted on front panel and rear panel mounted circuit board should be long enough to permit either panel to be lifted clear of case mounting lip by at least 2" when other panel is in place. Perf board is in prototype rather than PC type.

AUDIO GENERATOR SPECIFICATIONS

Frequency range: 5 Hz to 60 kHz in four decade ranges.

Frequency response: ±0.5 dB, 7.5 Hz to 60 kHz; −0.4 dB at 5 Hz.

Distortion: Less than 0.02% maximum between 15 Hz and 50 kHz rising to 0.035% at 60 kHz and 0.06% at 5 Hz.

Amplitude stability: Practically unmeasurable over short term.

Frequency stability: Better than 0.05% (short term).

Output level: 5 volts r.m.s. open circuit; 2.5 volts r.m.s. into 600 ohms.

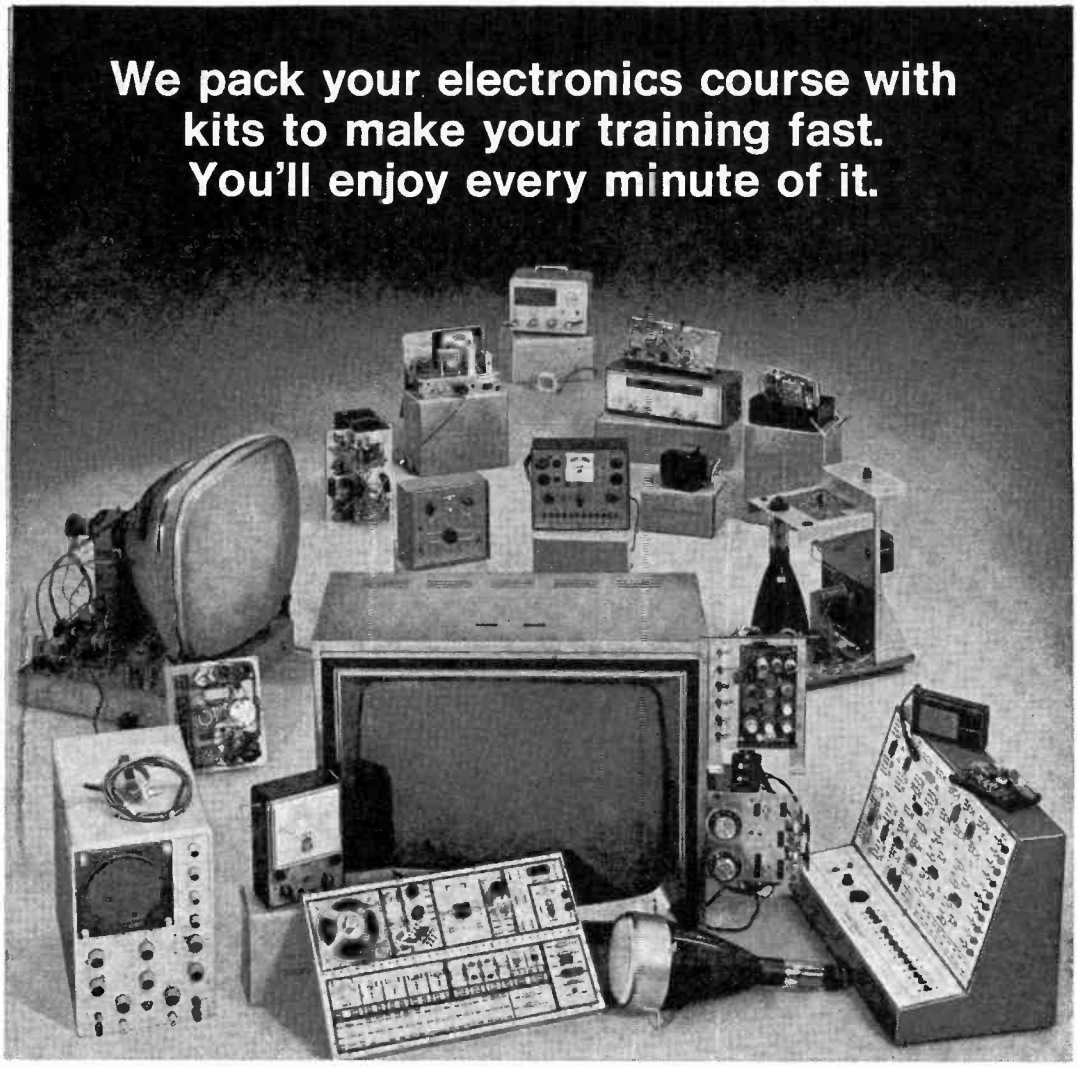
Total hum and noise: Better than −100 dB below 5 volts r.m.s.; better than −100 dB at any setting when using optional 2000-ohm output control.

Calibration markings on sweep-frequency control dial (left in above photo) are obtained by interpreting Lissajous patterns produced by 60-Hz line and oscillator output frequencies fed into an oscilloscope.

Frequency Dial Calibration. Once the dial has been mounted on the frequency potentiometer, mark the two extremes of rotation. With the audio generator coupled to the vertical input of an oscilloscope, connect a low-voltage, 60-Hz source to the horizontal input. (This voltage can be obtained from any low-voltage filament transformer). Place the generator range switch on the ×1 position and use Lissajous patterns to calibrate the dial at 60, 30, 20, 15, 12, 10, 7.5, 6, and 5. (see Box on Lissajous Patterns)

If you have a power supply that has 120-Hz ripple, use this ripple as the horizontal input and you can get the 40 indicator. Of course, if you have a first class audio generator at hand, calibration is much easier—simply tune for circles on the CRT. Any type of press-on lettering can be used for both the frequency dial and the other front-panel identification.

-30-



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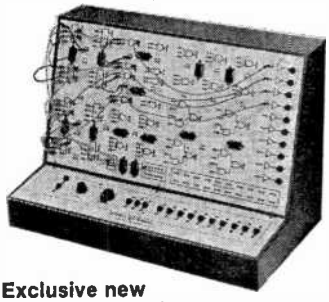

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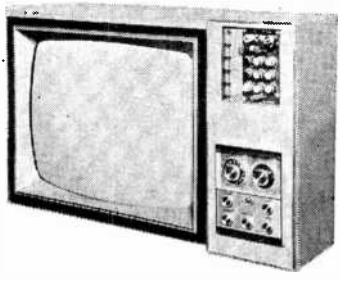

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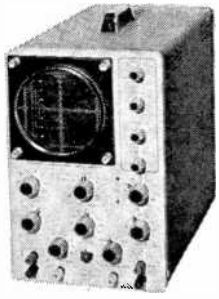

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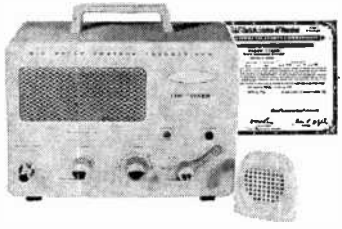

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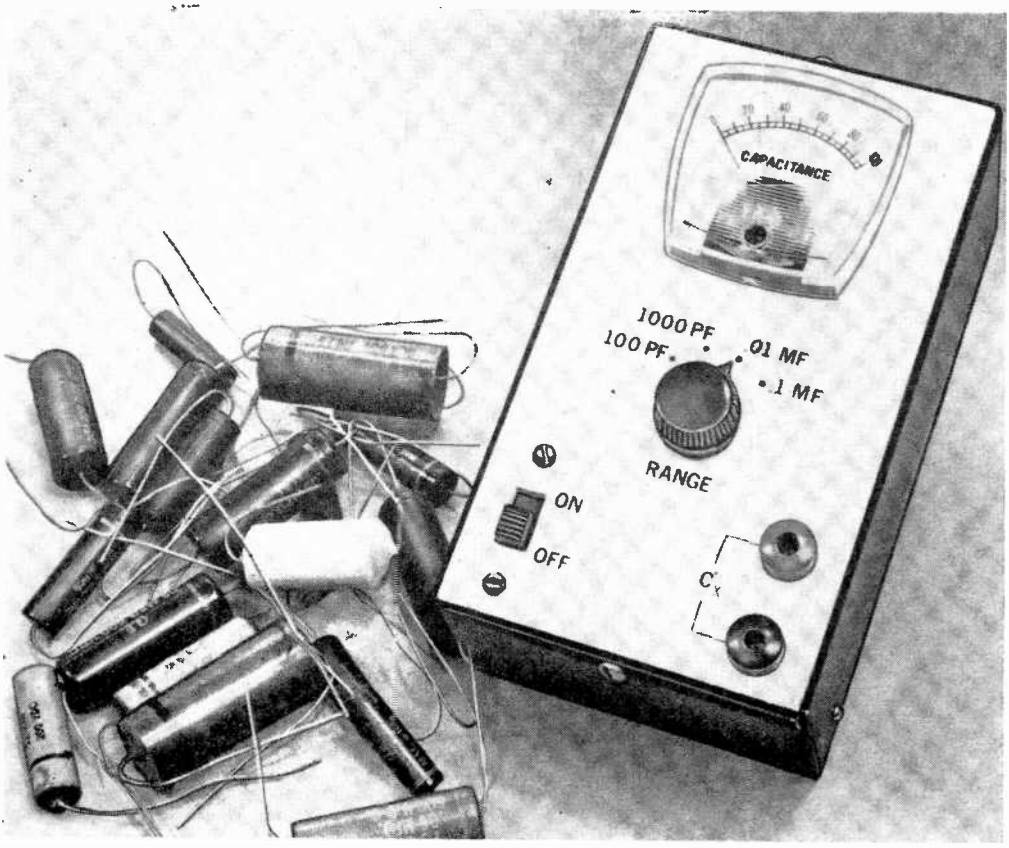


Build a CAPACITANCE METER

CHECK YOUR JUNK-BOX CAPACITORS

BY STANLEY SULA

THE electronics experimenter is notorious for collecting parts from almost every source imaginable, including war surplus bargains and items cannibalized from defunct electronic gear. Among the odds and ends collected is usually a considerable number of capacitors of intermediate values and doubtful "goodness." Many reasonably accurate capacitance measuring instruments are available for checking these items, but most are too expensive for once-in-a-while use. However, for an investment of about $15 for parts, you can build a capacitance meter that measures capacitance values between a few picofarads and 0.1 microfarad. This range covers most small tubular and virtually all disc, mica, and variable capacitor values—the major types that are used in circuits.

The heart of the capacitance meter is a stepped-frequency multivibrator circuit. The output of the circuit is coupled through the capacitor under test to a sensitive metering circuit. The deflection of the meter pointer provides a direct readout of the capacitor value, interpreted according to the position of the range switch. Zener diode regulation insures stability throughout the entire life of the built-in battery supply.

Construction. Parts layout is not critical. However, for compactness and ease of assembly, it is suggested that you follow the layout illustrated in this article. The circuit was assembled on a 5" × 2¾" perforated board which was then mounted inside a standard 5¼" × 3" × 2" aluminum chassis box. The cover of the box

accommodates all of the components that are not directly mounted on the circuit board.

Begin construction by machining the top half of the box as shown in Fig. 2 to provide mounting holes for the meter, jacks, and power and range switches. Temporarily set the box aside.

Next, mount the individual components on the board, using "flea" clips where necessary, as shown in Fig. 3. You can begin by mounting the battery clip. Then mount the miniature potentiometers, bending the tabs to fit the holes in the board. Finish up by mounting the transistors and diodes, capacitors, and resistors in that order. When all components are mounted in place, double check your wiring, paying particular attention to diode and transistor polarity and to the absence of accidental short circuits where wires cross; then solder all connections.

Buy or fashion two L-brackets from ¾" × ¼" × 18-22 gauge aluminum or brass stock as follows: Bend the two strips at the center to form ¾"-long legs at right angles to each other. Drill a hole through the center of each leg of each L-bracket. Now mount the brackets on alternate corners of the circuit board with #6 hardware.

Referring to Fig. 4, orient the top of the chassis box as shown. Mount the parts in their respective cutouts, and wire *D1* into place. Set the circuit board beside the box top, and connect and solder insulated hookup wire from the junctions indicated by two component numbers (C4/R6, etc.) to "flea" clips along the bottom edge of the board. Then, complete the wiring, checking your work frequently with Fig. 1.

Fold the circuit board into the top of the box (as shown in Fig. 3), and mark off the mounting holes for the L-brackets

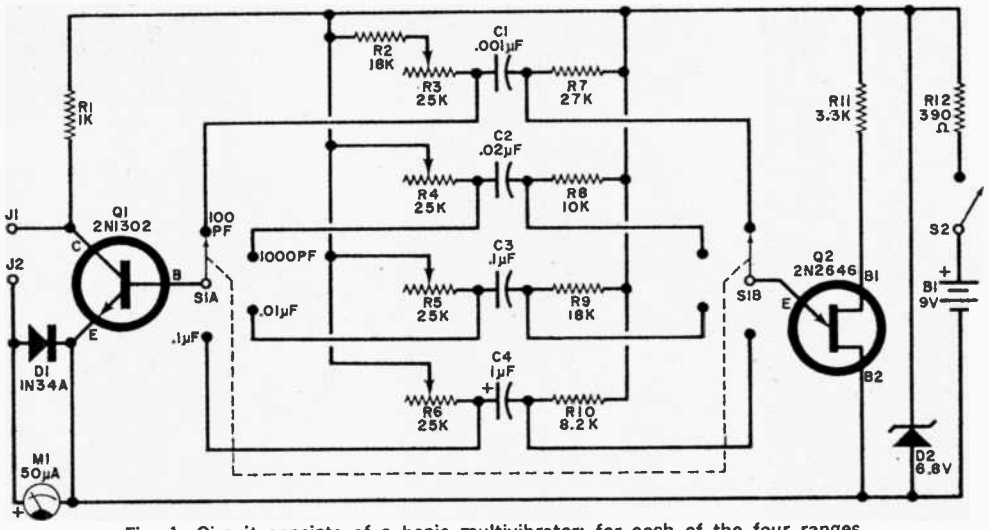


Fig. 1. Circuit consists of a basic multivibrator; for each of the four ranges, a different frequency-determining network can be switched in as required.

PARTS LIST

B1—9-volt transistor battery
C1—0.001-µF, 25-volt Mylar capacitor
C2—0.02-µF, 25-volt Mylar capacitor
C3—0.1-µF, 25-volt Mylar capacitor
C4—1-µF, 15-volt electrolytic capacitor
D1—1N34A diode
D2—6.8-volt, ½-watt zener diode
J1,J2—Banana jack (or substitute five-way binding post)
M1—0-50 µA microammeter
Q1—2N1302 transistor
Q2—2N2646 unijunction transistor
R1—1000-ohm
R2,R9—18,000-ohm
R7—27,000-ohm
R8—10,000-ohm
R10—8200-ohm
R11—3300-ohm
R12—390-ohm
All resistors ½-watt, 10%
R3,R4,R5,R6—25,000-ohm miniature potentiometer (Mallory No. MTC253L4 or similar)
S1—Four-position, two-pole rotary switch
S2—S.p.s.t. slide (or toggle) switch
1—5¼" x 3" x 2" aluminum utility box
Misc.—Perforated phenolic board; "flea" clips; battery holder; banana plugs (2); 1 brackets; control knob; calibration capacitors (see text); hookup wire; solder; hardware; etc.

on the sides of the box. Make sure that there is adequate clearance between the circuit board and box-mounted components and the circuit board and rear section of the box. When satisfied, drill the holes for and mount the circuit board L-brackets to the box with #6 hardware.

Calibration and Use. The simplest method of calibrating the capacitance meter is to use four high-tolerance, good-quality capacitors as "standards." The tighter the tolerance of these standard capacitors, the more accurate will be the calibration of the instrument. Select one capacitance value for each of the four ranges available with the meter. These capacitors should be 100-pF, 1000-pF, 0.01-μF, and 0.1-μF values to provide full-scale deflection of the meter pointer when each range is accurately calibrated.

Set the range switch to 100PF, and connect the 100-pF standard capacitor to *J1* and *J2*. Do not use test leads on this range; even the relatively small capacitance of the two leads can be enough to add as much as 20 pF to the true value of the capacitor. (This drawback can be put to good advantage in measuring the capacitance of coaxial cables, test leads, etc.). Switch on the power and adjust the setting of *R3* (see Fig. 3) for a full-scale deflection of the meter pointer.

Repeat the above calibration procedure for the remaining ranges and their appropriate standard capacitors. Adjust *R4* for the "1000 PF" range, *R5* for the ".01 MF" range, and *R6* for the ".1 MF" range.

ABOUT THE CIRCUIT

The operation of the Capacitance Meter (shown schematically in Fig. 1) is based on the principle that the maximum amount of a.c. current passed by a given capacitor is directly proportional to the capacitance value. In the case of the Capacitance Meter described in this article, the a.c. applied to the capacitor under test is in the form of a square wave provided by the *Q1-Q2* multivibrator circuit.

The output of the multivibrator is taken from the collector of *Q1*. From here it is passed through the capacitor under test (connected between *J1* and *J2*) and meter *M1* to the negative circuit buss. The meter, in turn, measures and indicates the maximum amount of a.c. current passed by the test capacitor, converting the current reading directly to a reading on its reworked scale.

Since the different ranges are all multiples of ten, range switching via *S1* is accomplished by changing the operating frequency of the multivibrator. Switch *S1* simply switches in and out of the circuit various combinations of resistors and capacitors.

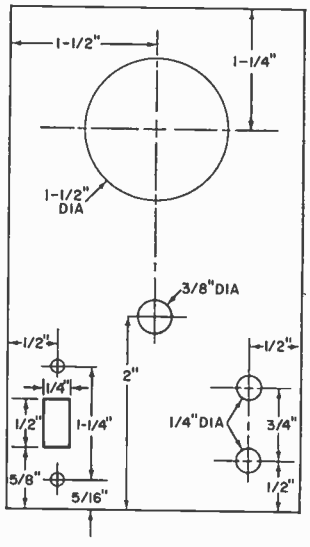
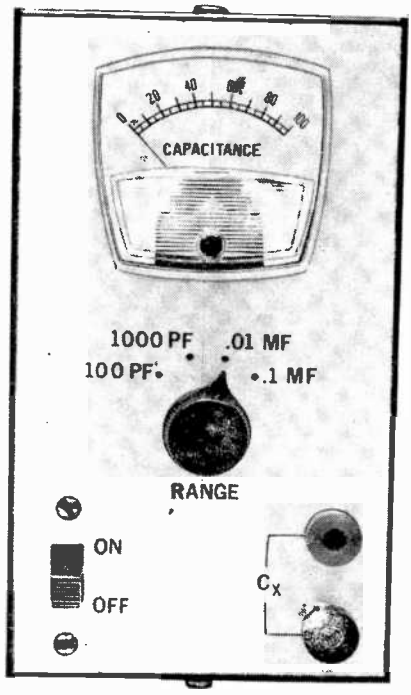


Fig. 2. To accommodate jacks, switches, and meter movement, machine top of box as shown.

Before mounting the meter movement, rework its scale to indicate a range of 0 to 100.



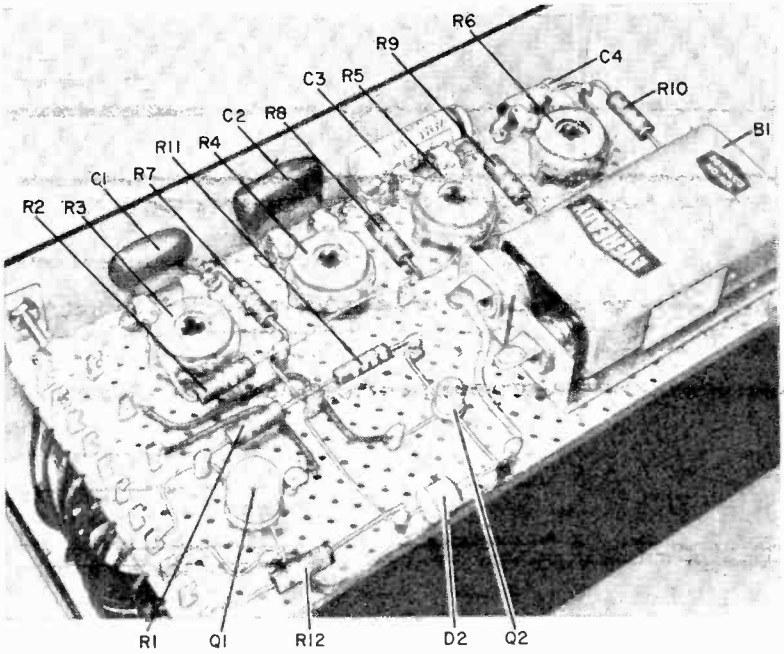


Fig. 3. To speed assembly time and keep project neat, use flea clips for component mounting. Note also common buss wire soldered to the cases of potentiometers.

In all cases, the calibration controls must be set to provide full-scale pointer deflection when the appropriate capacitor and range are used. Failure to obtain full-scale deflections means that you will have to experiment with the value of *R7*, *R8*, *R9*, or *R10*—depending on the range affected.

Avoid touching the exposed leads of the calibration capacitors and capacitors under test as your body capacitance is sure to produce a measuring error—especially noticeable on the lower ranges of the capacitance meter. Also, never attempt to check a capacitor while it is

(*Continued on page* 110)

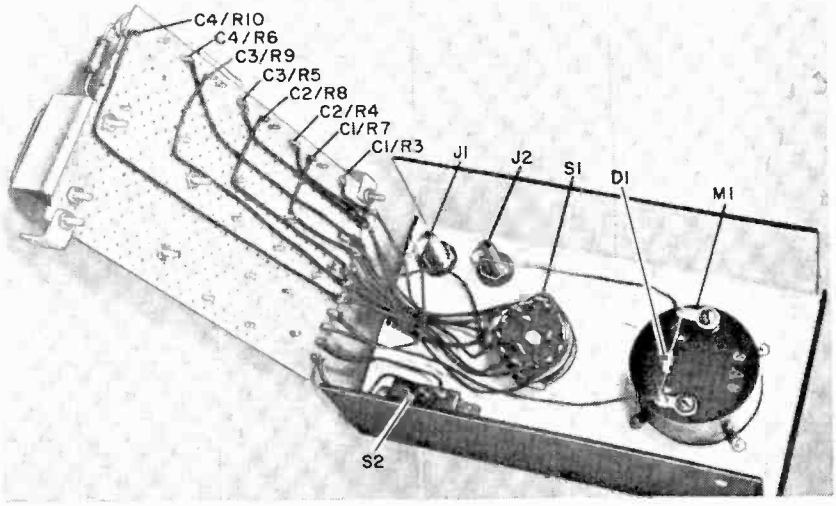


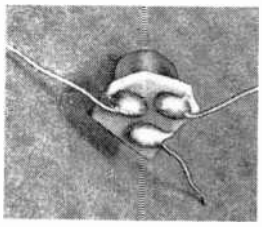
Fig. 4. To simplify wiring on bottom of board, connections labelled with two numbers designate component junctions to be located by observing the component side of board.

PARTS/METHODS/IDEAS/GADGETS/DEVICES

tips & techniques

SALVAGE TRANSISTORS SAFELY FROM COMPUTER CIRCUIT BOARDS

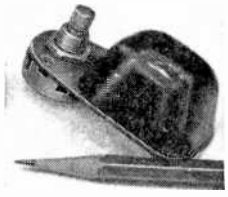
Computer circuit boards sold by many surplus parts dealers, although an excellent source of high-quality components, have one great failing—all components have very short leads. Worst of all are the transistors on such boards. Conventional desoldering practices for salvaging these solid-state devices leaves you with a transistor with mini-leads that are no good for breadboarding. Since it is definitely not good practice to solder lead extensions directly to the remaining lead stubs of the transistor (the applied heat will almost certainly damage the transistor), the only worthwhile alternative is to use a nibbling tool to cut away the board around the transistor. Then you can solder lead extensions to the solder pads on the underside as shown. *—Andy Rosen*



ELIMINATE LEAD BREAKAGE IN POTTED ELECTRONIC MODULES

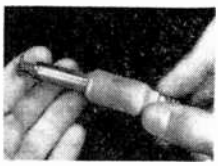
One of the more common hazards associated with using electronic modules is the tendency for the leads to break off, rendering the module useless. However, if you mount the module on a scrap piece of printed circuit board that has been etched and drilled to accommodate it, you can eliminate the problem. If possible, make the board slightly larger than the base of the module so that it can accommodate such outboard components as suggested by the manufacturer (see photo). Then, after all leads are soldered in place, apply a bead of epoxy cement around the entire base of the module where it touches the circuit board.

—A.G. Wood



HOMEBREW TRANSISTOR AND IC DESOLDERING TIPS

Successful removal of transistors and IC's from printed circuit boards requires melting the solder pads of all leads simultaneously. Besides the commercially available tips for this purpose, any standard 10-24 screw can be used with the Type 4045 Ungar high-heat cartridge. A 10-24 screw with a $\frac{7}{16}$"-diameter flat head is ideal for removing transistors and IC's in TO-5 cases; a smaller diameter head, or one of the $\frac{7}{16}$" heads filed to a $\frac{1}{8}$" × $\frac{3}{8}$" rectangle, is better for plastic in-line integrated circuits. A bit of Ungar anti-sieze compound ruboed into the threads of the screw before each use keeps the do-it-yourself desoldering tips easy to interchange. *—John Brosemer*

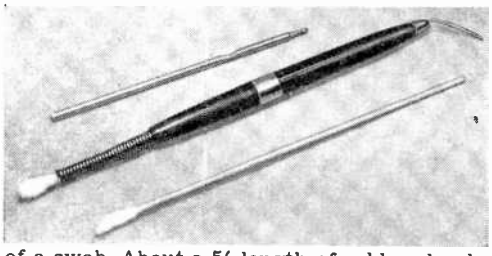


PAPER BAG RETRIEVES "LOST" KIT PARTS

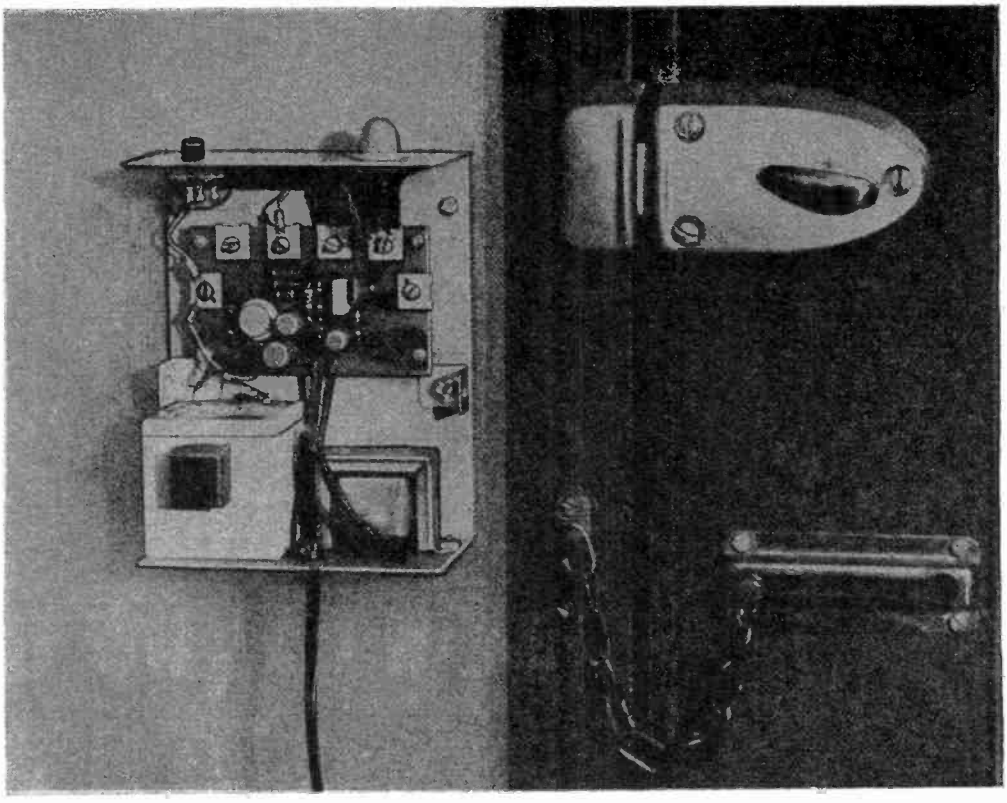
Since most electronic kits consist mainly of small parts and components, it is easy to lose one or more items during unpacking. However, you won't accidentally throw away any small parts with the packing material or during construction if you tape a large brown paper bag to the end of your workbench with top even with edge. Now, as you unpack and build your kit, toss the packing materials into the bag. Keep the bag taped to the end of your workbench until the kit is completely built. (If it is an extra-large kit with a lot of packing material, use two or more paper bags.) If you come up a part or more short, 99 times out of a hundred, you will find them in the waste bag. *—Stephen E. Maziarz*

MAKE HANDY SOLDERING AID FROM DEFUNCT BALL POINT PEN CASE

A handy soldering aid for printed circuit work can be fashioned from one of those old ball-point pen cartridges you normally throw out, some solder, and a cotton swab. First, remove and discard the cartridge; then cut off or ream out the top of the pen case to accept a single-layer coil of solder wound on the stick



of a swab. About a 5' length of solder closely wound on the swab supplies a full load. Feed the free end of the solder from the end opposite the swab through the tip opening in the pen case. Now you are prepared to go to work. Hold the soldering iron or gun in one hand and the soldering aid in the other hand. Dip the cotton swab into water. Solder a connection. Then touch the soldered joint with the wet swab for fast cooling. As the solder gets used up, simply pull on it and continue soldering. *—L.B. Frisch*



BUILD THE HOMESTEADER

PROFESSIONAL BURGLAR ALARM PROTECTION AT LOW COST

BY DAN MEYER

THERE ARE many types of burglar (or intrusion) alarms that you can build—involving proximity switches, infrared beams, breakable wires, etc. They all have their points, but why not use the system that the professionals use? On the windows of most stores and commercial establishments, you will see strips of silvered tape around the edges and, on doors and windows, pressure- or magnetically operated switches.

In such a system, the conductive tape and switches are connected in series and a weak current is flowing through them. When any portion of the loop is either broken or grounded, an alarm sounds. This has been found to be a reliable, easy-to-set, easy-to-use system. The "Homesteader" described here is equivalent to most commercial alarms costing several hundred dollars if installed by a professional. Depending on how many places are to be protected, you can build this system for under $40.

Construction. The circuit for the Homesteader alarm is shown in Fig. 1. It can be assembled on the printed circuit board whose foil pattern is shown in Fig. 2. Once the board has been fabricated or purchased, install the components as shown in Fig. 3, taking care to observe the polarities of the electrolytic capacitors and semiconductors. Choose a suitable metal enclosure to house the alarm (about 4½" x 5½" x 2"). You should be able to mount it on a wall.

Mount *I1*, the a.c. power-on indicator and *S1*, the alarm switch, on the upper surface of the enclosure. Attach the

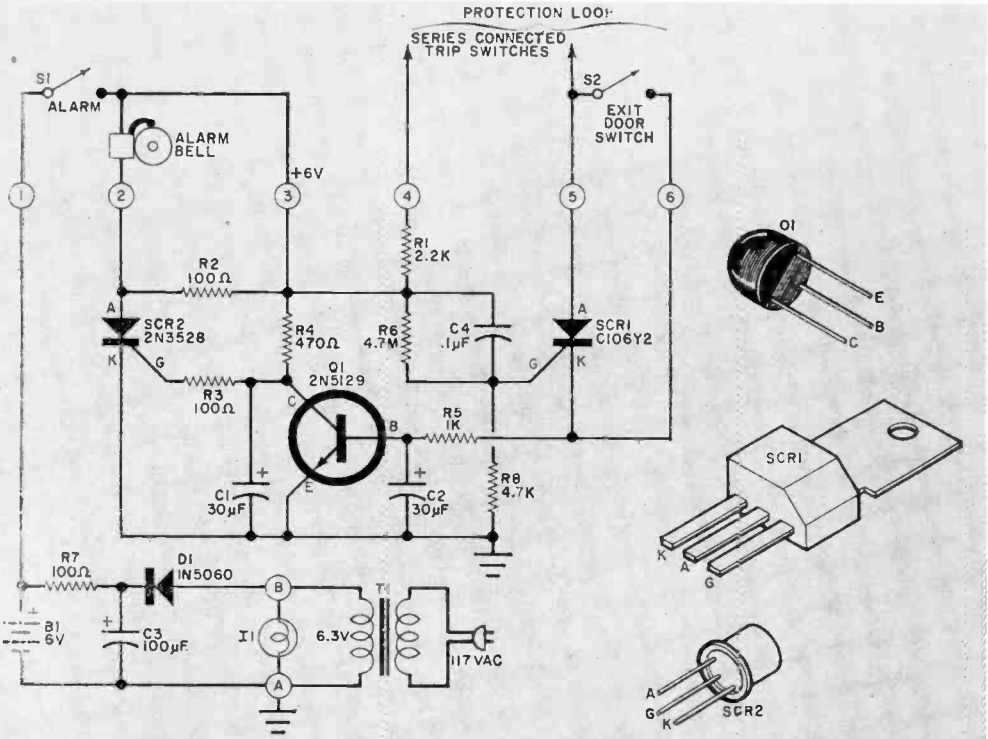


Fig. 1. Alarm system is equipped with fail-safe protection. You can eliminate battery B1 to allow a.c.-only operation. However, if line power fails, the alarm will not sound when an intruder trips an alarm switch.

PARTS LIST

B1—6-volt, 1-ampere rechargeable battery (Centralab RP-6101 or similar)
C1—30-μF, 16-volt electrolytic capacitor
C2—30-μF, 6-volt electrolytic capacitor
C3—100-μF, 16-volt electrolytic capacitor
C4—0.1-μF Mylar capacitor
D1—1-ampere silicon rectifier (1N5060 or similar)
I1—6-volt pilot lamp and holder
Q1—2N5129 transistor
R1—2200-ohm
R2,R3,R7—100-ohm
R4—470-ohm
R5—1000-ohm
R6—4.7-megohm
R8—4700-ohm
(All resistors ½-watt)
S1—S.p.s.t. switch
S2, etc.—Magnetic or other long-life switch
SCR1—Silicon controlled rectifier (GE C106Y2)
SCR2—2N3528 silicon controlled rectifier
T1—Power transformer; secondary 6.3 volts at 600 mA (Knight 54F1416 or similar)
Misc.—Frangible conductive tape, tape cement, interconnection wire, magnets for switches, a.c. line cord, 6-volt alarm bell (or similar warning device), suitable chassis, mounting hardware.

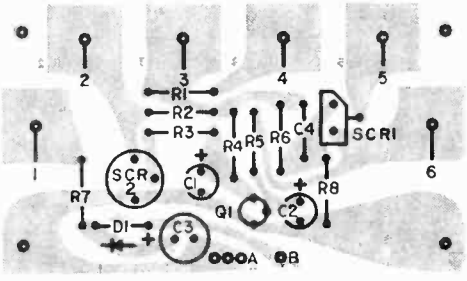
Note—An etched and drilled fiberglass PC board with connection clips (#163) is available for $2.85 from Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio, Texas 78216. A complete kit of parts including battery, punched cabinet, and three magnetic switches (#163CP) is also available from the same source for $25.45.

transformer, *T1*, and the rechargeable battery to the bottom panel. The PC board is mounted on the enclosure using screws and small spacers as shown in the photographs. Note that the author used small metal plates and screws to make connections to the six contacts on the PC board. These are optional.

If you cannot locate the small rechargeable battery called for in the Parts List, you can substitute an automobile or motorcycle storage battery or an Edmund Scientific Co. (600 Edscorp Bldg., Barrington, NJ 08007) 6-volt, 4-ampere-hour rechargeable battery (#70942, $15.00). For short-term use, you can also connect in series an Edmund #60634 ($4.80) and #40986 ($1.50) rechargeable batteries (or similar units of other manufacturers). Batteries other

Fig. 2. If you decide to make your own printed circuit board, follow actual-size etching guide shown.

Fig. 3. Mount components on circuit board as shown; then double check polarities of SCR's, transistor, and electrolytic capacitors.



than the one called for in the Parts List will require a different type of mounting. Of course, if you do not want to use a battery, which gives you protection in case your a.c. line is cut, the battery can be eliminated.

(*Continued on page* 114)

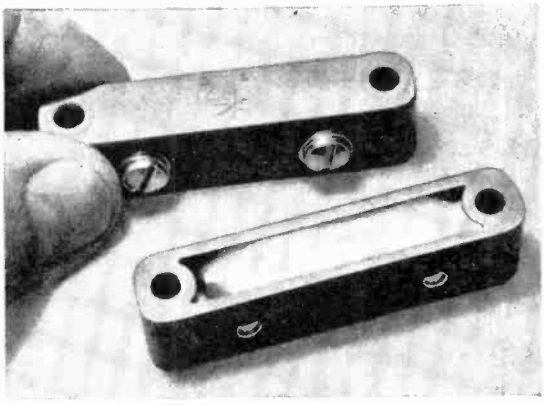
HOW IT WORKS

When switch *S1* is turned on and all external window and door switches in the protection loop are closed, transistor *Q1* is held in a saturated condition by the low current (approximately 2 mA) supplied to its base through the protection loop. The collector voltage of *Q1* is near zero in this condition. If the protection loop is opened, or grounded, base bias is removed from *Q1* and it cuts off. The voltage at the collector of *Q1* and the gate of *SCR2* then rises and the SCR turns on. The current flow through the SCR causes the alarm to sound off. The SCR does not turn off until *S1* is opened to remove the d.c. supply.

The exit door switch makes the system more convenient to use. With all of the protection loop closed except the exit door, *SCR1* fires when *S1* is turned on. This SCR, which is in parallel with the exit door switch keeps *Q1* saturated and the alarm off while the exit door is being closed. Thus you can turn on the alarm system before you leave the house and it remains quiet while you are leaving. When the exit door switch is finally closed, *SCR1* turns off, but *Q1* remains saturated.

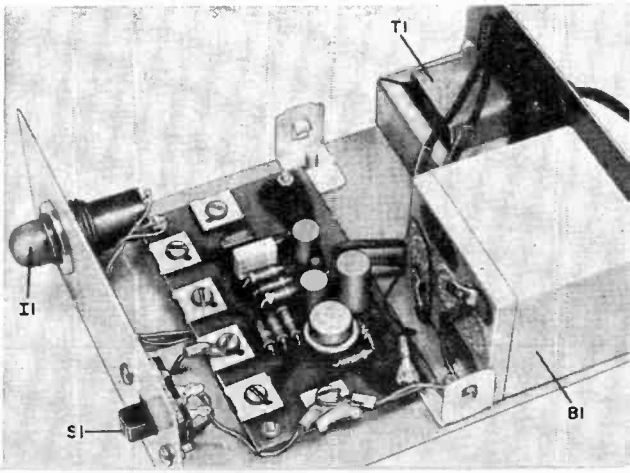
Note that although only three trip switches are shown in the schematic, many more can be used in the protection loop (which also includes any conductive tape on window panes) as long as they are all connected in series.

The 6-volt rechargeable battery is included to keep the system operative even if the a.c. power line is cut. The battery is kept trickle charged as long as the a.c. line is plugged in. No primary-power on-off switch is included so that only one switch has to be turned on to activate the system.



Place switch and magnet into separate plastic housings and seal in place with Silastic.

Metal contacts (Tinnerman nuts) and screws are optional. Connections can be soldered.



The Stereo Scene

by Charles Lincoln

ALL OF A SUDDEN, IT'S 1970!

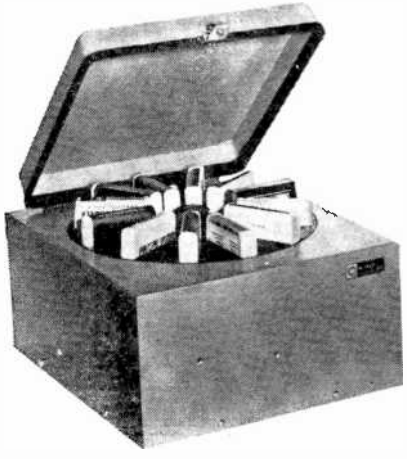
THE NEXT TIME you pass a grandfather's clock and you hear it belting out rock-and-roll music, don't bat an eyelash. That's just another example of how grandpa is being updated—with built-in speakers, a tape recorder, a stereo receiver—maybe even a turntable tossed in for good measure.

The next time you're driving with a friend and he presses a switch on his dashboard and the music suddenly changes from Tijuana Brass to the brass of Tchaikovsky's Sixth Symphony and you *know* that was no radio, just keep on looking sophisticated. In the trunk of his car is an eight-track carousel-type automatic cartridge changer —the latest gimmick on the cartridge Stereo Scene from Qatron.

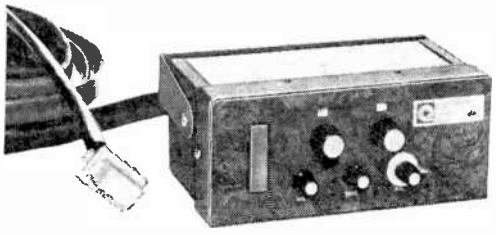
Or maybe you're tooling along with another buddy and he hands you a cartridge-shaped gadget and says, "Load this with a cassette from the glove compartment." Don't let him know you don't know what he's talking about. It's probably an Inmont cassette-to-eight adapter and he's exercising his choice of cassette over eight-track.

And the next time you're visiting your local Hi-Fi Boutique and you see this long, low-slung table-top cabinet with a cutout in the front, make believe you know that behind the cutout is an eight-track cartridge player nestled below a mini-changer that's snuggled next to an AM/FM/FM stereo receiver with 20 watts per channel output. Also don't let on about the speakers —which you don't see facing you. They're there—facing *upward*, but the sound is coming from all around the open ends of the cabinet. You knew all along that the speakers of this Telex-Phonola combo were firing against inverted, funnel-type diffusers to push the sound out at all angles.

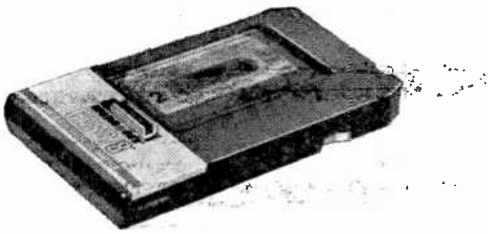
The foregoing are hot examples of what you'll be seeing and hearing—along with a lot of other representatives of advances in hi-fi technology—on the Stereo Scene this fall. Many of them won't be as dramatic, but they will certainly be important and they show that the Stereo Scene is forever changing—like the patterns on the color organs that you'll also see in your wanderings.



The eight-track stereo tape changer Model 48A by Qatron Corp. (12000 Old Georgetown Rd., Rockville, Md. 20852) is mounted in trunk of your car with a control console attached to the dashboard. It can provide a continuous program of 12 hours without repetition. Model for the home is also available.



Competition is Advantageous. One of the big reasons for the continuing changes is the heavy competition that exists between suppliers, both domestic and foreign. Be glad about this! It means two things: product innovations (new features that make stereo products more interesting and useful) and prices that keep getting better all the time. For instance, that tape recorder you bought last month for $250 couldn't have been touched five years ago for less than $400; and the one you got then would have had fewer features, a poorer frequency response and poorer signal-to-noise specs. And we'll predict that 1971's stereo buyer will be paying more like $200 for the equivalent of today's $250 recorder. That's the way producers are chomping at prices to outdo their competitors.



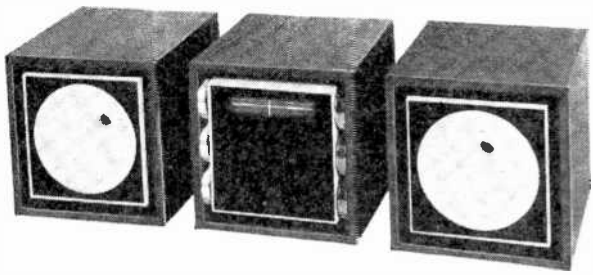
Inmont (Channel Mktg. Inc., 26 Springdale Rd., Cherry Hill, N.J. 08034) adapter permits playback of cassette in eight-track cartridge player.

This year's product innovations are mostly a matter of new shapes and forms and variations on existing forms. Last year, for example, Sony "discovered" the cube; and made it into a radio. That radio sold like hotcakes. This year, there's a whole new bunch of radios and stereo ensembles shaped like cubes; and most of them are selling like hotcakes. Cylindrical shapes are also getting a lot of attention this year.

A year or so ago Zenith came up with omnidirectional speaker systems for a new compact stereo outfit. Although they've been around for at least five years in full-size systems (under brand names like Empire), suddenly there's a dozen brands of circle-sounding speakers in the stores as part of the *compact* Stereo Scene. You see them in the form of upright boxes firing at diffusers; and you see them in octagonal, hexagonal and just plain cylindrical shapes. You also see them integrated into the ends of cabinets that house the makings of a hi-fi rig, as in models from Zenith and Telex-Phonola.

Also coming on strong are "balls of sound" —speakers shaped like spheres, some totally round, some lopped off a bit and bearing names like "orbital". These come in the JVC-Nivico, Telefunken, Clairtone, and Panasonic lines. We see these as the next big gimmick of the Stereo Scene in the speaker category. Why? Because they make a lot of sense. They give you "sound-all-around." They're good looking. They fit into most any kind of decorating scheme. And they're a refreshing departure from the box shape that's been with us all these years.

Boxes in for Changes. Manufacturers of box-shaped speakers are aware that changes are in order and they've been fancying up their wares too. Last year's boxes now sport new trimmings, mouldings and carvings— many in the Mediterranean style that is so hot on the design scene today. Flashy fabrics are making their way to the fronts of speaker systems to give them pazzazz. And so are intricate plastic and metal grille materials, wrought into all sorts of intriguing and exciting patterns. Some have psychedelic overtones; look at them one way and you see one pattern, turn your head a bit and you see another one.



Craig Corp. (2303 E. 15th St., Los Angeles, Calif. 90021) uses popular cube shapes in compact Model 1504 three-piece AM/FM stereo table radio.

The traditional shape of so many consoles is also getting an overhaul in today's Stereo Scene. "Make it look like something else" seems to be the motto of a lot of companies. In addition to the grandfather's clock (from Lakewood Industries) mentioned earlier, this year there are captain's desk stereos (Electrohome), vertically and horizontally styled room-divider stereos (Sylvania, Electrohome), chest-shaped stereos (General Electric, Electrohome), cube-shaped stereos (Packard-Bell), fireplace-shaped stereos (Lion, Delmonico, etc.), tea-cart-shaped stereos (Phono-Sonic), and even a hex-shaped stereo console (Masterwork). Al-

though the trend is to housings that take up less floor space, one company (Arvin) has gone the other way and come up with a console stereo ensemble measuring just three inches shy of nine feet!

What about portable phonographs? "Make 'em skinnier, color 'em bright, and make 'em do more" seems to have been the aim of on-the-ball manufacturers. This category has been somewhat overshadowed by tape recorders in the past year or so, but there's still life in it. Consider the colors of the plastic coverings: parrot green, bluebell, rose red, cinnamon, and dandelion (RCA); and the patterns: flowers, stripes, polka dots, and plaids (Emerson). Don't forget also the sets that incorporate features such as cartridge tape players (Motorola), FM stereo tuners (several), or built-in "light shows" (Decca).

When it comes to tape recorders and compact, modular stereo ensembles, the word from the brass to the designers has been "pretty them up, load them with functions and features like never before, and make sure the price is right." The end result has been a kind of spillover of categories. For instance, when is a three-piece stereo radio a table-model radio and when is it a compact stereo system? Is a three-piece ensemble that contains a stereo radio and a cassette tape deck a radio or a tape recorder? And what do you call it if you add a fourth unit, a mini-changer? One manufacturer said customer prospects might relate terminology to dollars. "If you see a three-piece stereo radio priced at $125 or less, it's a stereo radio. If it's over $125, it's a compact system." Needless to say, the Stereo Scene this year is loaded with multi-function ensembles of all types and maybe the best bet is to forget what they're called and concentrate on what they do.

Audio components this year look pretty much like they did last year, and the year before, and the year before. But here and there, if you look closely, you'll see that some turn-type controls have to be replaced by slide types. Instead of giving a twist, you give a push to change the volume, balance, bass, or treble. Instruments with such controls have a trim, "pro" appearance which many buffs find appealing. Some of the more intrepid manufacturers have gone the "black glass" route in terms of panels or panel segments. Look at some units and all you see is an expanse of tinted glass or plastic. But flip a switch and you see a tuning dial, meter, or some other form of indicator behind the tinted front, along with, perhaps, a feed slot for cartridges or cassettes.

Some Changes are Invisible. The really important changes are invisible: integrated circuits are now widely used in audio components; modular construction is also employed; and power ratings have been upped. (Some power ratings now border on the ridiculous. Most people who buy big-power sets don't use nearly all of the power for reproducing sound. What they bought was "Let's-beat-the-Joneses power.") The use of IC's has made the new audio products more reliable and has helped improve their specs in some ways. The basic change has been in refinements and in a subtle, but noticeable, improvement in performance and reliability.

Aficionados of the Stereo Scene will see a lot of new portable cartridge playback equipment in the stores this fall. It comes in all shapes and sizes, and in one-, two-, and three-piece groupings, with brand names such as Lear, Muntz, Stereo-Magic, Belair, Soundtech, etc. "The word from the top" to designers and engineers has been to make these sets more versatile and more portable; and "the word" has been carried out to the *n*th degree. Consequently the sets can be toted most anywhere and they play anywhere since they run on either batteries or house current. They're small enough not to break your arches in carrying them.

Four units of this Packard-Bell (12333 W. Olympia Blvd., Los Angeles, Calif. 90064) can be grouped together as shown here or separated around room.

The Panasonic (Matsushita Electric Corp., 200 Park Ave., New York, N.Y. 10017) compact system Orbitone Model RS252S uses spherical speakers.

As an extra added attraction in players for automobiles, Tenna Corp. has come up with a scheme to discourage "Light-Finger Mike" and "Swipe-Em-Quick Joe" from lifting players out of cars. "The Untouchables," Tenna's new players, automatically cause the horn to sound continuously if the wrong person tries to get at them. Other protection systems are on the way.

Another thing you'll see is the start of a trend toward making eight-track a recording as well as a playback medium. You'll find at least a half a dozen cartridge recorders at your local hi-fi emporiums from companies such as Telex, Lear, Muntz, Midland, Panasonic and JVC-Nivico. And as the year advances, there'll be more. They will be reasonably easy to operate—one, from Muntz, lets you roll your own four *and* eight-track cartridges.

Also crowding the Stereo Scene will be a bunch of new home cartridge players. Some will be decks for use with your current hi-fi rig or console stereo that has inputs for tape; some will be single-unit self-contained models with built-in side or front speakers; and some will be in the form of ensembles that might also contain a radio tuner and/or phono turntable. The idea behind all of this is that you should be able to enjoy in your living room the same tapes you play in

(*Continued on page* 102)

Hexagonal shape is used by Electrophonic (9200 Atlantic Ave., Ozone Park, N.Y. 11416) to give its speaker system a fresh look. Model is TG2773.

the product gallery

REVIEWS AND COMMENTARY ON ELECTRONIC GEAR AND COMPONENTS

SINE-SQUARE AUDIO GENERATOR (Heathkit Model IG-18)

WHAT SOME test instruments lack in performance they attempt to make up in an impressive physical appearance. Other instruments with unerring stability and accuracy look like they were designed for field use in a combat zone. The *Heath Company* (Benton Harbor, Mich. 49022) has recently reengineered certain items in its line of test gear and has simultaneously repackaged them in highly stylized, truly functional cabinets. Among many other things, the frequently inconvenient top-side handle has been eliminated and the new instruments can be stacked without tumbling off your lab bench.

In keeping with Heath's good name in test gear, all of the items are priced within easy reach of the serious hobbyist/experimenter. One of the newer items we recently assembled and tested was the Model IG-18 solid-state sine-square-wave audio signal generator. It is the 1970 replacement for the vacuum-tube Model IG-82.

Priced at $67.50 in kit form ($99.50, factory wired), the IG-18 has the performance characteristics and versatility you would expect in laboratory equipment selling for $500 or more a few years ago. The generator is an excellent, rock-stable signal source for serious audio experimenting and hi-fi equipment testing and repair. Packaged in its low-silhouette, heavy-gauge metal case, the instrument has the look and feel of professional equipment.

Inside, it has good design all the way. For example, forget about the ordinary bridge-T frequency-determining circuit. The IG-18 employs a differential amplifier and controlled feedback to produce sine waves and a Schmitt trigger, keyed by the sine-wave signals, to produce square waves. The entire system is feedback stabilized for operation over prolonged periods of operation. Frequency selection is determined by an unusual switchable notch filter.

The control complement is realistic. Frequency output is selected simply by setting the tenths, units, tens, and multiplier controls to the desired output frequency. Then the first three switch settings indicate within 5% accuracy the output frequency times the multiplier selected on the fourth switch. Separate controls are provided for the sine- and square-wave output amplitudes; switched for coarse, potentiometer controlled for fine.

Also located on the front panel is the output volts/dB meter, power indicator lamp, and two sets of five-way binding posts (one for sine- and the other for square-wave outputs). One very helpful and welcome feature of the IG-18 is the fact that both the sine- and square-wave outputs are "live" at all times. Both can be used simultaneously and each can be amplitude controlled separately. Of course, both outputs operate at the same frequency.

Assembly time for the IG-18 is about 8½ hours. The instruction manual is clear and well illustrated and contains a good section on trouble shooting. Once built, the temporary use of a VTVM and oscilloscope is needed to adjust bias, feedback, waveform, symmetry, and meter calibration. This takes only 15 minutes.

Circle No. 94 on Reader Service Page 15 or 115

GENERATOR SPECIFICATIONS

SINE-WAVE OUTPUT

Frequency range: 1-100,000 Hz
Output voltage ranges: 0-0.003, 0.01, 0.03; 0.1, 0.3, 1, 3, 10 volts
Internal load (first six ranges): 600 ohms
dB ranges: −62 to +22 dB; −12 to +2 dB on meter; −50 to +20 dB in 10-dB steps; +2 dB maximum into 600-ohm load
Output variation: ±1 dB, 10-100,000 Hz
Output impedance: 0-1000 ohms, 10-volt range; 800-1000 ohms, 3-volt range; 600 ohms, 1-volt and lower ranges
Distortion: less than 1%, 10-20,000 Hz
Circuit type: differential amp with complementary pair output; notch filter frequency select.

SQUARE-WAVE OUTPUT

Frequency range: 5-100,000 Hz
Output voltage ranges: 0-0.1, 1, and 10 volts peak-to-peak into 2000-ohm or higher load
Output impedance: 52 ohms on 0.1 and 1 volt ranges; up to 220 ohms on 10-volt range
Rise time: less than 50 nanoseconds

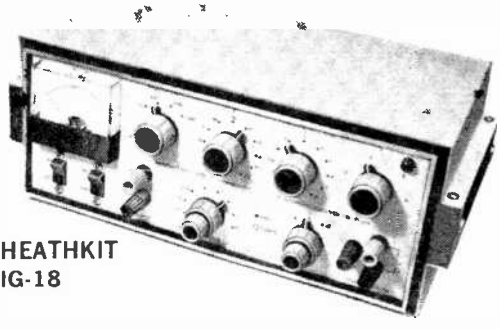
TEMPERATURE-CONTROLLED SOLDERING TOOL (Weller Model GT-7A)

YOU DON'T have to have a prolonged kit or project building session to know how fatiguing using a soldering iron or gun can be. Nor do you have to become fatigued if you have a *Weller Electric Corp.* (100 Wellco Rd., Easton, Pa. 18042) Model GT-7A soldering tool on your workbench. Called the "Tempmatic," the new soldering tool combines the advantages of a lightweight pencil and the fast warm-up time of a gun, and has tip temperature control as well—all in a tool that weighs only seven ounces.

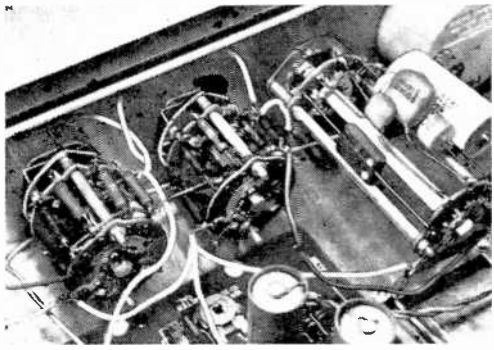
The Tempmatic is actually a two-piece tool, consisting of a comfortable pistol-type handle and a replaceable plug-in heat cartridge. The handle contains an ejector button for removal of the plug-in "powerhead" heat cartridge, the power line connector, and a handy trigger-type switch. The #7A powerhead supplied with the tool has a plated, long-life $\frac{3}{16}$" chisel tip and a heating element that limits tip temperature to approximately 700°F. An optional powerhead, the #6B, with a $\frac{1}{8}$"-reach conical tip that operates at 600°F is also available, with a full range of powerheads planned to meet the demands of virtually any type and size of soldering job.

The GT-7A (with #7A powerhead) tool is priced at $9.95, while replacement and extra powerheads sell for $6.95 each.

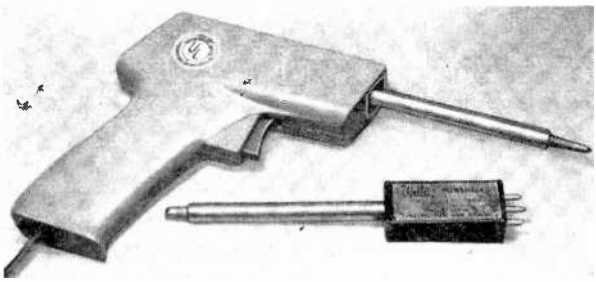
Circle No. 95 on Reader Service Page 15 or 115



HEATHKIT IG-18

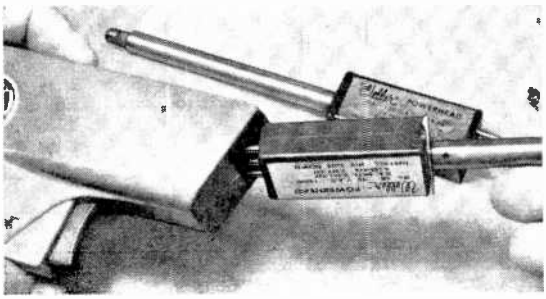


Frequency-determining network components are located on easy-to-wire rotary switches for tenths (not shown), units, tens, and multiplier (left to right).



WELLER GT-7A

The Powerhead heat-cartridge/soldering-tip assemblies snap easily into and out of the tool handle for easy replacement. A slide catch located on top of tool handle releases the cartridges quickly.



ENGLISH LANGUAGE NEWS BROADCASTS FOR THE MONTH OF OCTOBER

Prepared by ROGER LEGGE

TO EASTERN AND CENTRAL NORTH AMERICA

TIME-EDT	STATION AND LOCATION	FREQUENCIES (MHz)
7:00 a.m.	Stockholm, Sweden	15.315
7:15 a.m.	Melbourne, Australia	9.58, 11.71
7:45 a.m.	Copenhagen, Denmark	15.165
8:00 a.m.	Peking, China	15.095
8:15 a.m.	Montreal, Canada	9.625, 11.72, 15.325
7:00 p.m.	London, England	6.11, 9.58, 11.78, 15.14
	Montreal, Canada	9.625, 11.945, 15.19
	Moscow, U.S.S.R.	9.685, 11.87, 11.96
8:00 p.m.	Peking, China	15.06, 17.673
	Sofia, Bulgaria	9.70
8:30 p.m.	Johannesburg, South Africa	9.705, 11.875
	Kiev, USSR (Mon., Thu., Sat.)	9.685, 11.735
	Stockholm, Sweden	11.915
8:50 p.m.	Brussels, Belgium	6.125
	Vatican City	9.615, 11.785, 15.285
9:00 p.m.	Berlin, Germany	9.73, 11.89
	Budapest, Hungary	9.833, 11.91
	Havana, Cuba	9.525, 15.285
	London, England	6.11, 9.58, 11.78
	Madrid, Spain	6.14, 9.76
	Prague, Czechoslovakia	5.93, 7.345, 9.54, 11.99
	Rome, Italy	9.575, 11.81
9:30 p.m.	Berne, Switzerland	6.12, 9.535, 11.715
	Bucharest, Rumania	9.57, 11.94
	Cologne, Germany	6.075, 9.735
	Tirana, Albania	6.20, 7.30, 9.50
10:00 p.m.	Hilversum, Holland (via Bonaire)	11.73
	Lisbon, Portugal	6.025, 11.935, 15.125
	Moscow, U.S.S.R.	9.685, 11.735, 11.87
	Oslo, Norway (Sun.)	11.735, 11.85
	Peking, China	15.06, 17.673

TO WESTERN NORTH AMERICA

TIME-PDT	STATION AND LOCATION	FREQUENCIES (MHz)
8:00 a.m.	Tokyo, Japan	9.505
9:00 a.m.	Stockholm, Sweden	15.315
6:30 p.m.	Tokyo, Japan	15.195, 17.825, 21.64
7:00 p.m.	Melbourne, Australia	15.32, 17.84, 21.74
7:30 p.m.	Bonaire, Neth. Antilles	15.345
	Johannesburg, South Africa	9.705, 11.875
8:00 p.m.	London, England	6.11, 9.58, 15.26
	Madrid, Spain	6.14, 9.76
	Peking, China	15.095, 17.673, 21.735
	Prague, Czechoslovakia	5.93, 7.345, 9.54, 11.99
	Seoul, Korea	15.43
	Taipei, Taiwan	15.125, 15.345, 17.89
8:30 p.m.	Berlin, Germany	11.84, 11.97
	Stockholm, Sweden	11.705
	Tirana, Albania	6.20, 7.30
9:00 p.m.	Budapest, Hungary	9.833, 11.91
	Havana, Cuba	9.525, 11.76
	Lisbon, Portugal	6.025, 11.935, 15.125
	Moscow, USSR (via Khabarovsk)	15.18, 17.865, 17.88
	Oslo, Norway (Sun.)	9.55, 11.86
	Peking, China	15.095, 17.673, 21.735
	Sofia, Bulgaria	9.70
9:30 p.m.	Kiev, USSR (Mon., Thu., Sat.)	9.665, 11.735, 11.96
9:45 p.m.	Berne, Switzerland	9.72, 11.715
	Cologne, Germany	6.145, 9.545
10:00 p.m.	Havana, Cuba	9.525
	Hilversum, Holland (via Bonaire)	9.715, 11.73
	Quito, Ecuador	15.255
	Tokyo, Japan	15.105
11:00 p.m.	Moscow, USSR (via Khabarovsk)	15.18, 17.865, 17.88
11:30 p.m.	Havana, Cuba	11.93

TWO WAY REACTIONS

BY G. H. REESE, KCN6990

PLANNING A GROUP

CITIZENS Two-Way Radio enthusiasts are gregarious, helpful people. They often organize clubs through which they meet other such people. They realize the potential of their radio equipment and are prepared when some emergency situation puts them to the test. The groups that are prepared for the unusual emergency situation through prior planning, such as REACT teams are most helpful.

This prior planning should include the following:

1. Establish a regular monitoring schedule.
2. Develop a working relationship with local police, fire and civil defense authorities. This means an awareness on the part of officials of the interest, availability and capability of CB groups. It also provides CB'ers with an understanding of their role in the chain of command when their services are utilized.
3. Adopt procedures for handling emergencies and train members in their use.
4. Obtain equipment necessary for use in emergencies and become efficient at using it.

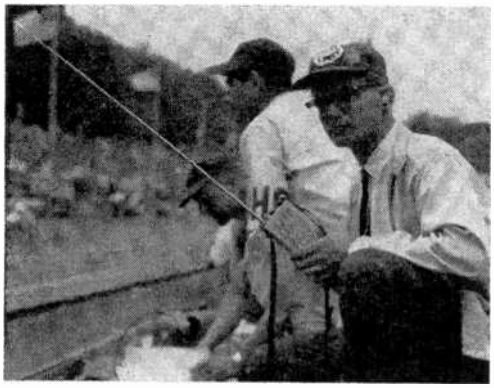
Preparedness Pays. The beneficial results of preparedness are reflected in the many instances in which organized CB'ers have performed uniquely valuable service to the public.

For example, CB radio was recently instrumental in the prevention of injury in Cascade Park, Elyria, Ohio, the site of an annual Fourth of July fireworks display. This year, about 3,500 people were assembled to view the spectacle about 7:30 P.M.

A report of high winds tearing away the antenna of Jack Kelley in Lorain, Ohio prompted William Graw, KNW9905, in Elyria to investigate. Graw, a civil defense official and leader of Lorain County REACT Team, called a special U.S. Weather Bureau number in Cleveland and learned that there was a tornado over Milan and it was expected to touch down in Lorain County. No warnings had been given locally—only a threat of showers.

Graw reported the severe weather warning to Donald Yoder at Cascade Park by CB radio. Yoder, a member of Lorain County Emergency Communications, Inc., was manning a mobile unit at the park. Yoder told officials at the park of the danger. After a hasty conference, Randy Shunk, secretary of the Elyria Chamber of Commerce, used the public address system to disperse the

Denver Metro REACT Team uses completely equipped van and generator to assist the local civic agencies and authorities in many good works.



Using walkie-talkies, the Akron REACT Team members provide safety communications for the annual National Soap Box Derby, which is held in that city.

crowd. Without alarming them, he pointed to threatening clouds overhead and suggested they leave the park, particularly the deep gorges.

After a few ground displays were ignited to satisfy the crowd's desire for fireworks, most of the 3,500 men, women and children left the scene. Minutes later, about 8:10 P.M., high winds swept the area, blowing over trees and seriously damaging the park. Those winds found the park with only a few persons in it because alert CB'ers used their communications tools to get the warning to the proper officials in time.

This incident is a reminder of how organized local CB'ers can cooperate in an emergency for the good of the entire community. Stories of almost every recent disaster carry with them some example of the helpful use of Citizens Two-Way Radio.

When a record nine-day snow storm hit Payson, Arizona, shutting down the power, water and telephone service for five days and closing the main highway for three days, the local REACT team and other CB'ers from all over Arizona cooperated to provide emergency communications. Big-hearted people in Phoenix contributed food and other necessities which were sent into Payson through a campaign organized by CB'ers. Many people will never forget the service performed when downed telephone lines left Citizens Two-Way Radio as the only means of communication.

When the "Silver Bridge" over the Ohio River collapsed a couple of years ago, members of Gallia County CB Radio, Inc. coordinated rescue communications at the scene for thirteen days and nights. With their mobile base station established in a trailer on the Ohio side, additional radios provided communications to the West Virginia side and to amphibious ducks, boats and cranes engaged in the rescue operations.

And when floods ravaged Fairbanks, Alaska in August, 1967, CB radio provided reports on highway washouts and relayed communications requesting medicine, food, and rescue support in outlying areas. Finally, when telephone communications went out, CB was the chief means of communication. A network was set up by the Midnight Sun CB Club at the request of the Civil Defense authorities. Reporting the whereabouts of persons stranded away from home, coordinating airdrops of food and supplies, and routing traffic were some of the functions performed by club members during this emergency.

Community Projects. In addition to emergencies, CB'ers provide unique assistance in many civic and community projects. For example, in Indianapolis recently, the Indiana Citizens Band Association, Inc. participated in the American Cancer Society Telethon. ICBA volunteers provided telephone operators, plus radio dispatched cars to pick up contributions throughout the county area.

Four Points Radio Club of Chicago recently provided communications for the 12th annual Des Plaines River Canoe Marathon. Four Pointers were stationed at various locations along the 25-mile route to monitor the race. As each numbered canoe passed his station, the monitor reported by radio. Thus, the canoes could be checked for location and condition. Accidents were reported and first aid and canoe pick-ups requested.

(*Continued on page* 111)

South Suburban REACT (Midlothian, Ill.) serves the Chicago suburban area from this elaborate base station. In addition to monitoring Channel 9, two-way communications are established with local, state, and county sheriff police. Team also monitors fire department communications and U.S. Weather Bureau.

SHORT-WAVE LISTENING

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

QATAR BROADCASTING SERVICE

AN INFORMATIVE letter from Taher Shihabi, Deputy Director of Broadcasting tells more about the Qatar Broadcasting Service. Mr. Shihabi says that the station bearing the callsign *Qatar min el Doha* is a three-transmitter organization and, at press time, is currently operating on 9570 kHz. This, the first of the three transmitters, is rated at 100 kW and feeds into a quadrant (?) antenna array. Facilities are available for frequency changes to 6135, 7150, 9550 and 11,710 kHz.

The second transmitter is rated at 50 kW and feeds into a quarter-wave tower; a medium-wave outlet, it operates on 674 kHz.

The third transmitter is rated at 10 kW and serves as a stand-by transmitter for the medium-wave unit. It utilizes a "T" antenna.

Service areas include territory in the Middle East within a radius of 2500 kilometers (about 1560 miles) for the short-wave transmissions, and Qatar and neighboring Arab countries on the medium-wave outlet.

The schedule shows operations daily at 0300-0600 (to 0735 Friday) and 1300-1900. Programming is listed as being mainly governmental in nature, with local, regional and foreign news, education, music and drama. The only language employed at present is Arabic.

The station is owned by Shaikh Ahmed bin Ali Althani and went on the air on June 25, 1968. Reception reports are not requested; however, when they are received they are answered by confirmation letters. Reports should be detailed, as vague reports cannot and will not be answered. No QSL cards are available at present. Send reports to Qatar Broadcasting Service, P. O. Box 1414, Doha, Qatar.

Mystery Stations and Others. Numerous reports are being received concerning a new time-signal station operating on 6100 kHz. All reports indicate best listening time to be around 0500-0730. Your Editor has not yet heard any Morse identification but there is a voice announcement in Spanish or Portuguese which ends with the word "Nacional". One SWL club lists it tentatively as the Portuguese Naval Observatory, presumably in Lisbon. Any positive information will be appreciated.

Speaking of time stations, William Matthews, WPE3GWQ, of Houston, Pa., received a QSL letter from JAQ56, a time station in Oyama, Japan, in which it was stated that the station ceased operations on April 30, 1969. JAQ56 had been on the air since 1957 with 10 kW and a directional antenna beamed to Europe, with transmissions daily at 1215-1230. It was on 16,170 kHz.

Danny Edwards, WPE4JDJ, is one of our enthusiastic monitors of utility stations, especially those operating with Morse code. He is asking for help in obtaining the addresses of the various radio networks for the European countries. Danny further asks: "Whatever has happened to those mysterious point-to-point stations J8S and AØL? Has anyone ever found out who they were and where they were located?" Your Editor has heard both of these stations on many occa-

Twenty-five verifications from 18 countries is the record of Lindy Smith, WPE4DON, Haines City, Fla. He has a Knight R-100 and plans on a Heath GR-81.

sions and every attempt to learn their locations has proven futile. Often their signal strength was such as to make a person believe that they were local. If anyone can answer Danny's questions, please write him at 4556 Indiana Avenue, Chesapeake, Virginia 23320.

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 Your Short-Wave Editor by the fifth of each month; be sure to include your WPE identification and the make and model number of your receiver.

Angola—CR6RV, *R. Clube do Moxico,* Luso, last noted on 5137 kHz, has moved to 5192 kHz where they are heard with a Portuguese program at 0543 *A Voz do Angola,* Luanda, 5960 kHz, is heard at 0500 s/on with IS, anthem, and ID in Portuguese. CR6RF, *R. Clube de Benguela,* 5042 kHz, opens at 0545 with a full ID in Portuguese and a complete program summary. Eight reports to them have proven futile for a QSL.

Antilles, Netherlands—Here is the complete schedule for *Trans World Radio,* Bonaire: Arabic and Armenian to the Middle East at 0445-0515 on 25 and 31 meters; Eastern European languages to Europe at 0430-0445 on 25 and 31 meters; English to the Far East at 0030-0120 on 25 meters, 0225-0350 to N.A. on 19 meters and 1100-1235 (1230-1500 Sunday only) to N.A. on 19 meters. All of the following are to South America except as noted: French at 2200-2215 on 19 meters; German at 0030-0100 on 25 meters, 0900-0930 on 49 meters and 2330-2355 on 19 meters; Portuguese at 0800-0900 on 49 meters and 2300-2330 and 2355-0010 on 19 meters; Russian at 0100-0130 on 19 meters and at 0400-0430 (to Russia) on 25 and 31 meters; Spanish at 0010-0025, 0130-0220, 2220-2300 and 2355-0010 on 19 meters, 0900-0930 on 49 meters, 0930-1100 on 31 meters and 2330-0020 (to Central America) on 31 meters. Available frequencies: 19 meters: 15,140, 15,345 and 15,350 kHz; 25 meters: 11,745, 11,790 and 11,820 kHz; 31 meters: 9545, 9605, 9695 and 9730 kHz; 49 meters: 6110 kHz. A test broadcast to South Africa has been noted on 6095 kHz at 0402, after s/on, and they are requesting reports.

Ascension Island—*BBC Atlantic Relay* noted on 9510 kHz to the Americas at 2200 with news, "The World Today", "London Newspaper" and folk music.

Australia—VLX9, Perth, is good at times on 9610 kHz at 1100-1215. VLM4, Brisbane, 4920 kHz, was

(*Continued on page* 103)

DX ALL-ZONE AWARDS PRESENTED

To be eligible for one of the new DX All-Zone Awards designed for WPE Monitor Certificate holders, you must have verified stations in 10, 20, 30 or 40 of the world radio zones. The following recently received their awards.

10 ZONES VERIFIED

Michael Wheeler (WPE7CSY), Portland, Ore.
Ronald Boestfleisch (WPE2NRJ), College Point, N. Y.
John Mac Donald (WPE2QOV), East Orange, N. J.
Frank Gorman, Jr. (WPE8KAY), Cincinnati, Ohio
David La Cure (WPE9CSX), Aurora, Ill.
Scott Brockway (WPE2QJP), Rome, N. Y.
Martin Miron (WPE8JTN), Warren, Mich.
Craig Seufert (WPE1HNS), Newtown, Conn.
Mitchell Hyman (WPE2OPK), Rosedale, N. Y.
Edward Sue (WPE1HMA), Brookline, Mass.
Craig Jakubs (WPEØFHG), St. Louis, Mo.
Rimas Sakalas (VE3PE2KK), Hamilton, Ont.
Jay Miller (WPE4JQV), Memphis, Tenn.
Mark Maersch (WPE3HEK), Severna Park, Md.
Gary Cooper (WPE7CQV), Nampa, Idaho
John Flynn (WPE2NME), Brooklyn, N. Y.
Stanley Newman (WPE2PJS), Brooklyn, N. Y.
Joseph Breton (WPE1HKW), Methuen, Mass.
Mike Mickes (WPE7CVF), Gooding, Idaho
David Perry (WPE2QFK), Pleasant Valley, N. Y.
Paul Moeller (VE3PE2NQ), Harrow, Ont.
Mike Lynch (WPE2QEA), Auburn, N. Y.
Timothy Gjenvick (WPE9ILO), Brookfield, Wis.
Bruce Roberts (WPE4KAH), Waynesboro, Va.
Rick Schiffer (WPE3HLL), Franklin, Pa.
Harry Hines, Jr. (WPE2OFS), Newark, N. J.
Arthur Skopec (WPE2PQJ), Whitestone, N. Y.
Charles Stroud (WPE4JZU), Paducah, Ky.
Paul Roddy (WPE5EYH), Edna, Texas
Don Moman (VE6PE8C), Clive, Alta.
David Lubar (WPE9JFD), Elmwood, Ill.
Diana Loomis (WPE6HLT), Sherman Oaks, Cal.
David Peters (WPE6HDM), Modesto, Cal.
Joel Bahl (WPE9JFY), Hometown, Ill.
Benny Loveless (WPE9JLO), Frankfort, Ind.
Donald Appling (WPE7CNG), Spokane, Wash.
Gary Mc Nelly (WPE9IRG), Cohokia, Ill.
Steve Hope (WPE5EZG), Houston, Texas
William Coleman (WPE4JNW), Jacksonville, Fla.
David Purdy (WPE2PEC), Canandaigua, N. Y.
William Groves (WPE4KAV), Covington, Ky.
Eugen Floda (WPE2OFH), New York, N. Y.
Charles Schwerin (WPE8HYH), Bay City, Mich.

20 ZONES VERIFIED

Robert French (WPE8FGH), Bellaire, Ohio
Jeff Utter (WPE6HDJ), Carlsbad, Cal.
Bob Estand (WPE5FAV), El Paso, Texas
George Sprout (WPE3GMW), Reading, Pa.
Kendall Porter (WPEØEVD), Overland Park, Kan.
Robert Asbury (WPE2PYT), Williston Park, N. Y.
Parks Redwine (WPE4HCO), Fayetteville, Ga.
Alan Harris (WPE8JQY), Oak Park, Mich.
Gary Cooper (WPE7CQV), Nampa, Idaho
James Pogue (WPE9HLJ), Farmland, Ind.
Michael Plihcik (WPE2JDF), Elmhurst, N. Y.
Brian Begg (WPE2JPR), New Brunswick, N. J.
James Daley, Jr. (WPE4JVR), Atlanta, Ga.
Robert Rothberg (WPE2QQO), Long Beach, N. Y.
Clarke Thacher (WPE9IXP), Mishawaka, Ind.
Rev. John Pejza (WPE6HCP), Ojai, Cal.
Ron Budziack (WPE9JHK), Cicero, Ill.
Arthur Martin (WPEØEJY), St. Paul, Minn.
Eugen Floda (WPE2OFH), New York, N. Y.
David Simon (WPE2PQP), Brooklyn, N. Y.
Francis Wheeler (WPE6HLK), Sacramento, Cal.
William Blue (WPE7CTW), Seattle, Wash.
Fred Lynch (WPE9JHD), Girard, Ill.
David Johnson (WPEØELO), Denver, Colo.
Rick Heavey (WPE8IYR), Detroit, Mich.
Leslie Nice (WPE5DRL), Dallas, Texas
Allan Keizer (WPE2QCS), Brooklyn, N. Y.
Marshall Brooks (WPE2POW), Rochester, N. Y.
Frank O'Donnell (WPE6HFD), La Habra, Cal.
Scott Brockway (WPE2QJP), Rome, N. Y.

30 ZONES VERIFIED

C. Vernon Hyson (WPEØCNF), Somerville, N. J.
Richard Davis (WPEØAKR), Denver, Colo.
Richard Pistek (WPE9HOA), Chicago, Ill.
Jack Winther (WPE6BJD), Moraga, Cal.
F. R. Cook (VE3PE1WX), Willowdale, Ont.
Gary Ligon (WPE4JAX), Cliffside, N. C.
David Conder (WPE9IHV), Centralia, Ill.
Donald Gross (WPE7CQX), Roseburg, Ore.
Charles Matterer (WPE6DGA), San Leandro, Cal.
Jack Bacon, Jr. (WPEØFDJ), Bloomington, Minn.
Marion Lilienthal (VE3PE2DO), Waterloo, Ont.

AMATEUR RADIO

By **HERB S. BRIER,** W9EGQ
Amateur Radio Editor

OPERATION PHONE PATCH

READERS of this column are well aware that Senator Barry Goldwater (R—Ariz.) is one of the country's greatest proponents of amateur radio. As further evidence, here is a story reported by William Eccles, K7MJG, in "Ham Monitor," which is edited and published by Bob Lange, WØILB, in Salina, Kansas.

Barry, K7UGA/AF7UGA, and ten of his amateur friends decided to assist in the running of phone patches from Southeast Asia to the U.S. so that servicemen could talk to their families and friends back home. The Armed Services assign men, equipment, and Military Affiliate Radio Service (MARS) frequencies to handle calls at their end of the line. To help out here at home, Barry supplied two Collins 75-S3C receivers and 32-S3 SSB/CW exciters; a 30-S1, 2-kW, PEP linear amplifier; and a 77-foot-high rotating "Christmas-tree" antenna containing 4-element, full-size beams for 10, 15, 20, and 40 meters.

After getting their station on the air and joining the Air-Force MARS (to work areas where amateur radio or amateur third-part traffic is forbidden), Barry and his friends found that they needed more help. So they

AMATEUR STATION OF THE MONTH

Larry, WA9UMU, and Ralph, WA9UDZ, Evans, 8657 N. Point Dr., Milwaukee, Wis. 53217, have an impressive amount of equipment to share. In just over a year, Larry (above) has worked over 171 countries, with 140 confirmed, using a Swan SSB/CW transceiver and three antennas—a Hy-Gain TH-6-DXX beam, 18-HT vertical for 80 meters, and a home-built phase vertical array for 40 meters. Other equipment includes another Swan transceiver, Knight-Kit R-100 receiver, Hallicrafters HT-40 and Heathkit DX-60B transmitters, EICO electronic keyer, Hallicrafters SX-71 receiver, professional tape recorder, etc. We are sending a 1-year subscription to POPULAR ELECTRONICS to WA9UMU for winning this month's Amateur Station of the Month photo contest. You can enter by sending a clear photo (preferably black and white) of yourself at the controls of your station with some details about your amateur career to Amateur Photo Contest, c/o Herb S. Brier, W9EGQ, Amateur Radio Editor, POPULAR ELECTRONICS, P.O. Box 678, Gary, Indiana 46401.

recruited another 15 amateurs to join the group. They also found that the amateur beams didn't work too well on MARS frequencies far from the amateur bands. So Barry obtained a Hy-Gain, military-type, wide-band, log-periodic rotary beam. When it was mounted on the mast with the other beams, however, the performance of the new beam was poor so they ordered a 71-foot, Tri-ex "sky needle," which was installed with the new Hy-Gain some distance from the original antennas.

A 3.5-kW, PEP, linear amplifier was also acquired and modified for use on the MARS channels. In addition, Barry purchased another complete station—Drake T-4X transmitter, R-4B receiver, and Henry 2K-B amplifier—for normal contacts and phone patches.

Between August 1967 and April 1969, the group handled 21,000 phone patches and they have been running at the rate of 2000 to 2500 a month since then!

Since Barry returned to the Senate last fall, the group has been re-organized into the "Bash-Hal-Ne-Ae" (Navajo Indian for "metal that talks") Amateur Radio Club to carry on the work. He still underwrites the expenses, however, and sits in on the activities when he has a chance.

Of course, this is not the only amateur station working with MARS to donate many hours a week running phone patches—there are hundreds of them. If you wonder why you don't hear some of the well-known, big-signal men on the DX "pileups" these days, it's because they are spending all of their time phone patching on the MARS channels.

Senator Barry Goldwater, K7UGA/AF7UGA, and the men that keep the station on almost constantly to run phone patches from servicemen overseas.

Million-dollar TVI Suit. On May 29, after a series of legal maneuvers, the $1,000,000 suit filed against Ansel "Grid" Gridley, W4GJO, by a neighbor for alleged television interference (even though Grid's equipment was given a clean bill of health by the Federal Communications Commission) was remanded for trial to the Sarasota Circuit Court by the Tampa Federal court. Grid and his attorneys have appealed the ruling.

The importance of the appeal to all radio licensees—amateur, broadcast, CB, business radio, etc.—is that, if the higher courts should uphold Judge Lieb's ruling, their operations will be controlled by local courts, rather than by federal law and the Federal Communications Commission. The Sarasota Amateur Radio Association, Inc., P. O. Box 3323, Sarasota, Florida 33578, is acting as trustee for contributions from amateurs and others to help defray the costs of fighting this vitally-important case—and costs are already well over the $2000 mark!

Lloyd Holm, WN8ZZL, Farmington, Mich., has worked 28 states and three countries on 40 meters with a Hallicrafters HT-40 and National HRO combination.

Inconclusive Returns. Examining the results of the 1969 Florida QSO Party in *Florida Skip* allows one to prove almost anything he might wish about amateur operating trends. In brief, the number submitting logs increased 18 per cent over last year, but CW logs decreased five per cent. On the other hand, CW logs still exceeded phone logs by a 3:2 ratio. Furthermore, the 10 highest Florida CW operators outscored the high phone men by 11 per cent. Outside of Florida, however, the high phone men outscored the high CW men by 20 per cent! Logs were received from 11 countries, by the way.

Detroit to Moscow. George H. Goldstone, W8AP, writing in "Reflected and Directed" in the June issue of the Detroit Amateur Radio Club *DARA Bulletin,* counters the action of one U.S. amateur who refuses to work Russian amateurs (because Russia aids North Vietnam) with the following: "All the reports of U.S. hams who have

(*Continued on page* 99)

SOLID STATE

By LOU GARNER, Semiconductor Editor

THE AGE OF AQUARIUS OR SOLID STATE?

ACCORDING to astrologers, we are entering the 2500-year-long Age of Aquarius. From a technological viewpoint, however, we are well into the Age of Solid State, for, almost daily, new semiconductor-operated products are introduced into every phase of human activity. Linemen, doctors, construction workers, machinists, office personnel, and many others are now using complex electronic equipment.

Before too long, telephone linemen may be using a futuristic space-age "gun" similar to the unit shown in the photo. Developed by the Bell Telephone Laboratories (BTL), the instrument can be used to locate pin-point breaks in overhead cables. Older telephone cables often are pressurized with dry air to prevent water damage should the sheath be broken. If the sheath is punctured, there is an almost inaudible hiss containing energy at ultrasonic frequencies. The new device, complete with sights for aiming, uses highly directional parabolic reflectors to direct this faint sound into the ultrasonic microphone. Here, the signal is detected, then "translated" to audible frequencies and amplified by solid-state circuitry before being fed to the headphone.

In the medical area, thousands of heart patients who once would have been bedridden are now leading useful, normal lives, their hearts triggered by electrical signals from implanted solid-state "pacemakers." The near-deaf have access to miniature hearing aids a fraction of the size of vacuum-tube models, but more efficient and much more powerful than the early units. Solid-state laser "canes" and sonar-like instruments are being developed for the blind.

Metal-working shops are using solid-state instruments to control precision lathes, milling machines, drills, and other machine tools to increase production efficiency. The technique . . . called "numerical control" . . . permits the precise, but rapid, duplication of complex parts in accordance with programmed instructions prerecorded on magnetic or punched paper tapes.

Carpenters, plumbers, electricians and other construction workers are using variable-speed, semiconductor-controlled power tools, while architects, civil engineers, and contractors employ computers in their design work, electronic instruments to test materials, and two-way radios for field communications. Both industrial and automobile mechanics can choose from a variety of solid-state diagnostic instruments, including vibration detector-amplifiers, stop-motion and speed measuring stroboscopes, and comprehensive engine analyzers.

Banks, libraries, realtors, manufacturing firms, restaurant chains, etc., are using solid-state data processing equipment and computers for payroll records, billing, inventory control, cataloging, and production scheduling, while more and more offices are installing automated typing and production systems.

Looking to the future, the present trend is likely to continue at an even faster pace, as engineers develop new types of equipment using less expensive, but more efficient devices and as semiconductor manufacturers continue to introduce increasingly versatile solid-state integrated circuits.

Reader's Circuit. Originally designed for use in a privately published project manual, the lie detector circuit illustrated in Fig. 1 was contributed by its developer, Marshall

Solid-state sensing "gun" with parabolic reflector can be used to spot punctures in telephone lines.

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Dudley (2711-25 Sutherland, Knoxville, Tennessee 37919). Easily assembled in one or two evenings or on a weekend, the completed project may be used for experiments, demonstrations, or party games.

As a general rule, a person's skin resistance drops during periods of emotional stress, as when telling a lie. Marshall has relied on this human characteristic in developing his instrument, which is essentially a modified non-linear ohmmeter, designed for maximum response to resistance changes relative to a preset value.

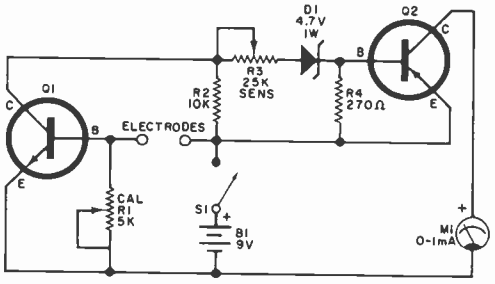

Fig. 1. Basic circuit of lie detector is a non-linear ohmmeter with the base bias of Q1 determined by the changing resistance of the subject's skin.

Referring to the schematic diagram, the unit consists of a direct-coupled complementary amplifier, *Q1-Q2*, a reference diode, *D1*, a d.c. power source, *B1*, and an indicating device, meter *M1*. Calibration (bias) and sensitivity controls, *R1* and *R3*, respectively, are provided to permit adjustments for different individuals, while electrodes attached to the subject's fingers serve to monitor skin resistance.

In operation, *Q1*'s base bias is determined by a voltage-divider made up of *R1* and the test subject's skin resistance. The resulting collector current of *Q1* develops a voltage drop across load resistor *R2* which, in turn, can serve as a base bias source for *Q2* if of sufficient amplitude to overcome *D1*'s breakdown voltage. Sensitivity control *R3* and bias control *R1* are preset while the subject is calm so that *R2*'s voltage drop just equals *D1*'s rating. Afterward, any decrease in skin resistance results in a corresponding increase in *Q1*'s base bias and, therefore, in *R2*'s voltage drop, thus applying a base bias to *Q2* through *R3* and *D1*. With base bias applied, *Q2*'s collector current increases sharply, causing the meter's needle to deflect upward.

Marshall has specified standard components in his design. Both *Q1* and *Q2* are general purpose small-signal *npn* and *pnp* transistors, respectively, such as International Rectifier types TR-09 and TR-05.

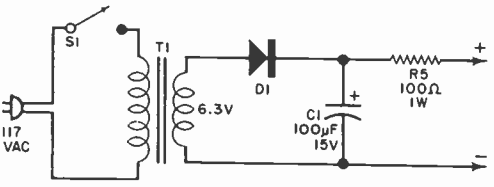

Fig. 2. This power supply circuit can be used to replace the battery in the lie detector in Fig. 1.

With neither parts positioning nor wiring arrangement critical, the lie detector circuit may be assembled on a suitable etched circuit board, on a small chassis, on perf board, or even breadboard fashion, if preferred for experimental purposes. The electrodes are small copper discs about the size of pennies soldered to lengths of flexible hook-up wire. The completed instrument may be housed conveniently in a commercial, sloping-front meter case.

The battery and switch may be replaced by a line-operated power supply such as illustrated in Fig. 2.

Although the lie detector's adjustment procedure is fairly simple, each step is important for optimum performance. First, adjust *R1* and *R3* to minimum resistance. Moisten the subject's index and middle fingers of one hand. Attach a copper disc electrode to each moistened finger, securing with plastic tape. The tape should be tight enough to insure good contact, but not so tight as to cut blood circulation. Close *S1* and advance *R1* until the meter's needle jumps from zero to full-scale. With the subject calm, readjust *R1* for a meter reading of from one-tenth to one-third full-scale. Next, adjust *R3* slowly, watching for meter movement, as you ask the subject questions which may excite him emotionally. With *R3* properly adjusted, the meter should read full-scale only when the subject is excited or telling a lie. Some experimentation may be needed to achieve the proper setting.

Manufacturer's Circuit. With a range of from 10 to 100 seconds, the solid-state timing circuit shown in Fig. 3 is suitable for use in photography, scientific experiments, and a variety of other applications. It is one of a dozen hobby projects featured in the new CALECTRO HANDBOOK (published by GC Electronics, Inc., 3225 Exposition Place, Los Angeles, California 90018). A combination reference manual and catalog, the booklet includes hints on selecting loudspeakers and microphones, tips on using various components, suggestions for installing antennas, and a unique built-in Ohm's law slide-rule: Among the other projects described are several receivers, a light-controlled relay, AM and FM wireless micro-

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IC'S ARE HERE TO STAY AND THE NEXT FEW YEARS WILL SHOW A MASSIVE TRANSITION IN INDUSTRY AND CONSUMER PRODUCTS TO COMPLETE INTEGRATION.

Based on this assumption, this brochure has been prepared for the novice as well as professional user of Integrated Circuits (IC's). It includes tips on wiring, soldering, cross referencing, and eight simple projects using the IC's contained in the Motorola HEP HEK-1 kit.

A lengthy discussion of IC construction will not be covered in detail, as this information can be found in many IC textbooks. However, in order to be better able to know the advantages and limitations of these microcircuits, the reader should know what is contained in the basic IC and how these devices differ from other solid state components.

As the name implies, an Integrated Circuit is a collection of many different components. The quantity and types of components vary from one IC configuration to another. A particular IC could contain ACTIVE components (transistors, diodes) and PASSIVE components (resistors, capacitors). If all the components of the circuit are contained on the same "CHIP" or substrate, the unit is said to be "MONOLITHIC" (single crystal). The monolithic type is the most common and the least expensive to build. Other construction types are: thin film, thick film, hybrid, multi-chip. A discussion of these types can be found in almost any book that deals with the subject of IC's.

As an illustration of the extreme size reduction possible with Integrated Circuits, consider the new Motorola 4-bit memory core, which contains 524 different components on a chip 50 mils x 70 mils. The average IC is much smaller, usually 40 mils square (1 mil = .001"). As the above example indicates, the race is on to see how much circuitry can be crowded into the smallest space. This effort is known in the trade as LSI (large scale integration). Manufacturers are already starting to produce IC's that contain FETS, tuning diodes, and even power transistors!

It is unfortunate, but many people are resisting the change-over from discrete (individual) components to IC's. This resistance could largely be due to the fact that people tend to shy away from circuits they are not familiar with.

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The advantages of IC's over discrete components greatly outweigh the disadvantages. Size and weight reduction are obvious advantages but cost savings should also be considered. Refer to the schematic of the HEP 583, which contains 21 transistors and 27 resistors. If you had to buy all these parts individually and build this unit using a breadboard or printed circuit board you would indeed feel the pinch on both your pocketbook and your time. Other disadvantages that are not so obvious are as follows:

REPETITION: If you need a circuit containing twenty J-K flip flops, it would be a difficult task to build 20 of these, each containing 21 transistors and 27 resistors. This adds up to 420 transistors and 540 resistors! With IC's, only 20 TO-5 packages are necessary. Here is where cost, size, and time advantages come through again.

REPEATABILITY: Because of the way IC's are constructed with components located in close proximity to each other, tolerances are much finer and parts are better matched, thus making up a device that functions as a complete unit. Power drain is lowered, there is less spurious noise pick-up, and there is less noise generated within the unit.

RELIABILITY: Many manufacturers are turning to IC's because of their high reliability. Devices built under almost clinical conditions are bound to be better than a circuit built on a work bench. Referring to an example given previously, consider that building the electrical equivalent to the HEP 583, using the 21 transistors and 27 resistors, it would be necessary to make 80 to 90 solder connections, a real source for potential trouble.

In addition to the advantages listed, replacement is simple. Schematics are easy to read, especially for the beginner. Areas yet to be conquered in the construction of IC's are: How to build inductors, large value capacitors, and high value resistance on an IC chip. It is presently necessary to connect these components externally.

GROUPS and SUBGROUPS

Broadly speaking, IC's can be divided into two categories, DIGITAL and LINEAR. IC's were born out of research for the space program where, for many years, their application was strictly in the field of DIGITAL work. ie, small computers on space craft where weight and power reductions were essential. Only in the last few years has the linear IC begun to blossom.

Table I shows some of the sub-groups to be found in IC's. The applications listed in Table I will be discussed later.

To further complicate matters, DIGITAL IC's are classified into logic families. The families and their construction are shown in table II.

TABLE I

LINEAR	DIGITAL
Differential Amps	Adders
Power Amps	Drivers
Audio Amps	Gates
Video Amps	Expanders
RF/IF Amps	Buffers
Operational Amps	Inverters
Sense Amps	Flip Flops

TABLE II

RTL	Resistor Transistor Logic
mW RTL	Low Power Resistor Transistor Logic
DTL	Diode Transistor Logic
VTL	Variable Threshold Logic
HTL	High Threshold Logic
ECL	Emitter Coupled Logic, also called Current Mode Logic
T^2L	Transistor Transistor Logic - more than one emitter to device.

(NOTE: that VTL and HTL are forms of DTL)

Table III shows the familiar characteristics of each line. Motorola manufactures complete lines in each family listed. To signify Motorola, you may see RTL written as MRTL, ECL as MECL, etc. A quick glance at Table III will show that no one logic family has a clearcut advantage over any other family. For example, MECL is high frequency and internal noise immunity, where mW RTL has low power dissipation, etc.

TABLE III

Logic	Form	Delay Time	Freq. of Flip Flop (mHZ)	Power Dissipation (MW)	Noise Internal	Immunity Noise Ext
RTL	R_T	24	8	12	Fair	Fair
mW RTL	R_T	45	1 - 3	2.5	Fair	Fair
DTL	D_T	30	10	9	Fair	Good
VTL	D_T	50 - 60	1	12 - 80	Good	Excellent
ECL	Current Mode	6	30	35	Excellent	Fair
T^2T	T_T	10	20	15	Good	Good
HTL	D_T	200	3	45	Good	Excellent

MOUNTING IC's AND BREADBOARDING TECHNIQUES

IC's can be mounted on perforated board or printed circuit board by either soldering to terminals or by using sockets. Sockets are definitely recommended, especially for the hobbyist who will, generally, use the IC over and over in different applications. Constant soldering and unsoldering of the leads weaken them and could cause the wires to be broken, or internal damage could result due to excessive heat from the solder iron.

The HEP 580 thru 583 (devices included in this IC kit) are mW MRTL's. This logic family is considered the easiest for the hobbist, experimenter, and IC novice to "cut their teeth" on.

The HEP 584, 570, 571, 572 are MRTL's - also a good family for the beginner. The HEP 553, 554, 556, 558 are MECL's, - not the easiest to work with, but the best logic family for high frequency and noise rejection.

IC PACKAGING

Integrated circuits can be found in a variety of packages. At the present time, there are more than 120 case types made by some 70 companies around the world. Of these many case styles, three types are dominent. (In terms of quantity of devices on the market, in a given case type, about 90% of their quantity can be found in some variation of one of these three case types). As yet, no definite standardization has been set up among the manufacturers regarding packaging, pin numbers, and locations, so carefully check the basing before you plug that IC into the socket.

CASE 93

TO-91

TO-99 (8 PIN)
TO-100 (10 PIN)

USE A LOW WATTAGE SOLDERING IRON! 25 to 40 watts is a good range. Excess heat could "kill" the IC.

KEEP COMPONENT LEADS SHORT! Excess lead length could cause spurious or parasitic oscillations or no operation at all.

If you are using a power supply, (other than a battery), it is a good idea to "bypass" the power leads. That is, connect a .05 or .1 mfd capacitor from the power input to ground at or near the input terminal of the IC.

POWER SUPPLIES

For projects using 1 or 2 IC's -- batteries are usually the best supply. On larger projects, an a-c supply is better.

The power supply requirements for the various logic functions have been standardized and are, in general, as follows:

MRTL	3V ± 10% (2.6 to 3.3V) and 3.6 ± 10% (3.24 to 3.96V)
MwMRTL	" " " "
DTL	4V ± 10% (3.6 to 4.4V)
MDTL	5V ± 10% (4.5 - 5.5V)
MVTL	±4V to ±10V (8 - 20V)
MECL	5.2V ± 20% (4.16 - 6.24V)
MT^2L	5V ± 10% (4.5 - 5.5V)
MHTL	18V

Obviously batteries in some of these odd voltage ranges are not available, however, experimentation has shown that on some lines the manufacturers are being much too conservative. For example in the HEP-580 series, many of the devices were found to work well from 1.5 to 12 volts! Very few did not-- but after all, they are only rated from 2.6 to 4 volts (approximately). This makes it possible to use many of these IC's over a wide voltage range. Usually an IC rated at 3.2 volts minimum works well on 3 volts and one rated at 5.5 volts maximum, works at 6 volts.

IC's can be connected in one of two ways, using one or two supplies. The dual or split supply is most common in linear circuits. (See following example:)

RF SIGNAL INJECTOR

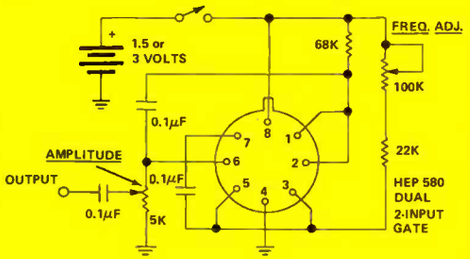
[redacted] (general audio and RF testing). Inject a signal into the various stages - starting with the AUDIO STAGE and working toward the FRONT end. Check stage just prior to point where signal is lost.

FEATURES:

Output Square Wave Variable in Frequency From About 200 CPS to 2000 CPS (Approximate)
Signal Variable in Amplitude From 0 to 1 Volt.

PARTS LIST:

1 HEP 580 Dual 2-Input Gate
3 0.1 μF Ceramic Disc Capacitor
1 22K Resistor ¼ or ½ watt 10%
1 68K Resistor ¼ or ½ watt 10%
1 100K Linear Potentiometer
1 5K Linear Potentiometer
1 ON-OFF Switch (can be part of 5K Pot)
1 1.5V Cell (A cell or larger) or 2 - 1.5V Cells (3 Volts)
Output Jack (as desired)
Vector Board and Terminals
1 HEP 454 IC Socket



FREQUENCY STANDARD

USES:

An accurate frequency standard - 100kHz fundamental + 50kHz output (divided down) - square wave out is strong in harmonics over wide frequency range. Can be used to accurately align and check frequency settings of recievers.

FEATURES:

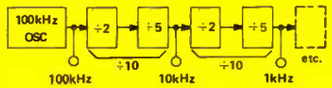
Simple to operate, self-contained, compact.
100kHz and 50kHz output, with provisions for other frequencies.

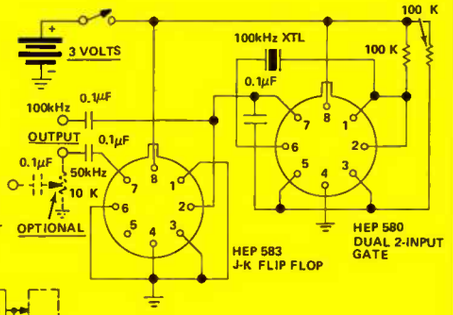
DPTIDNAL PARTS:

1 10K Pot. (linear) (Gain Control)
1 0.1μF Capacitor

PARTS LIST:

1 HEP 580 Dual 2-Input Gate
1 HEP 583 J-K Flip Flop
3 0.1μF Capacitors Disc Ceramic
2 100K Resistors ¼ or ½ watt 10%
1 ON-OFF Switch (can be part of gain cont)
1 3 Volt Battery (2 - 1.5V Cells)
Output Jacks (as desired)
Vector Boards and Terminals
2 HEP 454 IC Sockets
NOTE: Using the other "DIVIDE BY" circuits shown in text material under heading of IC Flip-Flops, any desired frequency can be obtained.
Example:





PRECISION TACHOMETER

USES:

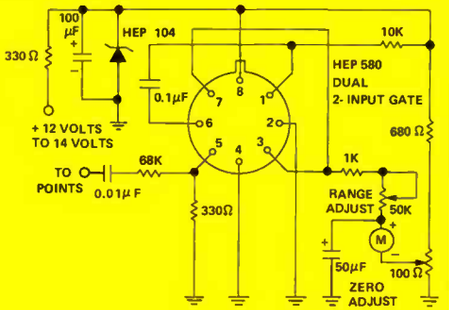
Tachometer can be used on automobile, boat, motorcycle, etc.

FEATURES

Very flexible circuit - range and number of cylinders - compensated for by 1 adjustment.

PARTS LIST:

1 HEP 580 Dual 2-Input Gate
1 HEP 104 Zener Diode (9.1V)
2 330Ω ½ watt 10% Resistor
1 10K ¼ or ½ watt 10% Resistor
1 680Ω ¼ or ½ watt 10% Resistor
1 68K ½ or ¼ watt 10% Resistor
1 1K ½ or ¼ watt 10% Resistor
1 100 μF Capacitor Electroylic 15 Volts (or higher)
1 50 μF Capacitor Electroylic 10 Volts (or higher)
1 0.01 μF Capacitor Disc Ceramic
1 0.1 μF Capacitor Disc Ceramic
1 100Ω Potentiometer (trimmer)
1 50K Potentiometer Linear (range adjust)
1 50μA meter
Vector Board and Terminals
1 HEP 454 I C Socket



OPERATION FOR CALIBRATION

Connect lines to ground, 12 Volts, and points with engine turned off but ignition switch "on". Zero meter with Zero Adjust. To set range - check auto speed using a tach from a service station or garage.

(Range maximum can be whatever you desire. And calibrate the rest of the scale accordingly.)

As an arbitrary adjustment, most automobiles idle at about 600 RPM - with engine idling - adjust Range pot until needle is in approximately the 600 RPM position.

4-INPUT MIXER

USES:

Mix any audio signals (low level) - microphones, phonograph, etc.

FEATURES:

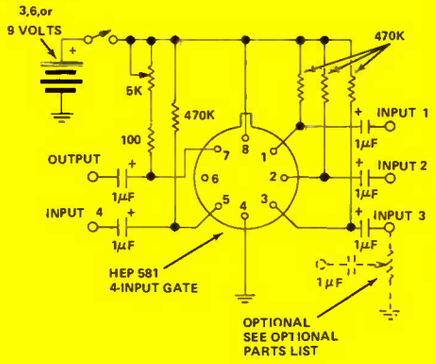
Input: 0.3V Pk to Pk max (for 6V supply)
Output: 3V Pk to Pk max (for 6V supply)
Frequency Range: DC to 50kHz

PARTS LIST:

1 HEP 581 4-Input Gate
5 1μF Capacitors Electrolytic 10 Volts (or higher)
4 470K Resistors ¼ or ½ watt 10%
1 5K Potentiometer (trimmer)
3 Volt Battery (2 - 1.5V Cells) or 6 Volt Battery (4 - 1.5V Cells) or 9 Volt Transistor Radio Battery
Input and Output Jacks (as desired)
1 ON-OFF Switch

OPTIONAL PARTS:

4 10K Potentiometers (audio taper)
4 1μF Electrolytic Capacitors 10 Volts (or higher)



ADJUST 5K POT FOR MAX UNDISTORTED OUTPUT

NOTE: Potentiometers can be added to inputs as shown, if so desired.

ELECTRONIC SIREN

USES:

Burglar and intrusion alarms, automotive thefts and tamper alarms, toy sirens for bicycles.

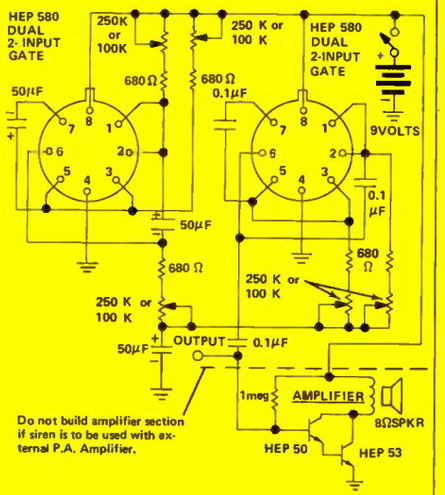
FEATURES:

By slight changes in pot. setting - a wide variety of siren sounds can be obtained.

PARTS LIST:

Siren
2 HEP 580 Dual 2-Input Gates
5 680 Ω Resistors ¼ or ½ watt 10%
5 250K or 100K Potentiometers (trimmers)
2 50 μF Capacitors Electrolytic 10 Volts (or higher)
3 0.1 μF Capacitors, Disc Ceramic
1 ON-OFF Switch
9 Volt Battery (transistor radio)
Output Jack (if external amp is used)
2 HEP 454 IC Sockets
Vector Board and Terminals

AMPLIFIER
1 1 meg Resistor ¼ or ½ watt 10%
1 HEP 50 NPN Transistor
1 HEP 53 NPN Transistor
1 8 Ω Speaker 1½ to 2½ inches diameter
2 Transistor Sockets



AUDIO SIGNAL GENERATOR

USES:

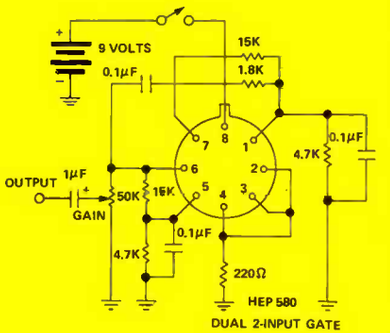
General Audio Testing

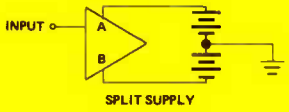
FEATURES:

Output Adjustable From 0 Volts to Approximately 2 Volts PK-PK. Sine Wave Output Fixed Frequency Approximately 1000 CPS.

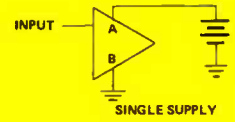
PARTS LIST:

1 HEP 580 Dual 2-Input Gate
3 0.1 μ F Capacitors Disc Ceramic
1 1 μ F Capacitor Electrolytic 10 Volts (or higher)
2 15K Resistors ¼ or ½ watt 10%
1 220Ω Resistors ¼ or ½ watt 10%
1 1.8K Resistors ¼ or ½ watt 10%
1 ON-OFF Switch (may be part of Gain Adjust).
1 50K Potentiometer (audio taper)
1 9 Volt Transistor Radio Battery
Output Jacks (as desired)
Vector Board and Terminals
1 HEP 454 IC Socket





SPLIT SUPPLY



SINGLE SUPPLY

There are some applications where the split or dual supply is advantageous but generally it involves more complicated circuitry.

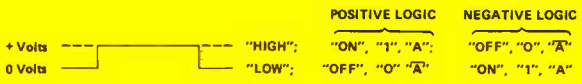
The novice in IC's is likely to be a novice in the area of computer logic also. The logic symbols are to digital IC's what schematic symbols are to resistors, capacitors, etc.

Some of the more common types are shown below:

These symbols have recently been standardized by the government. Prior to that time, each manufacturer had his own set of symbols.

Most computers work on the binary principle. Binary stands for "two"--two states or conditions, which are either ON or OFF, (HIGH or LOW).

Consider the condition where we have zero or near zero volts at the input to a gate, flip-flop, amplifier, etc; it is an OFF condition. If this voltage goes positive, let's say, to 1 or 2 volts it is now in an ON condition. There are two types of logic: Positive and negative. See below:



The common function in digital IC's are:

GATES - control the passage of signals.

BUFFERS (AMPLIFIERS) (DRIVERS) amplify power of signals to be able to drive more units.

INVERTERS - reverses the logic from + to - or - to +

EXPANDERS - affords additional inputs to a gate, example: allows 3-input gate to be converted to a 7-input gate.

ADDERS - provides the SUM and CARRY operations on two input signals.

SHIFT REGISTERS - provides bistable storage.

FLIP-FLOPS - provides division or COUNT. One Flip-Flop divides by 2, provides 1 change in state output for 2 changes in state input.

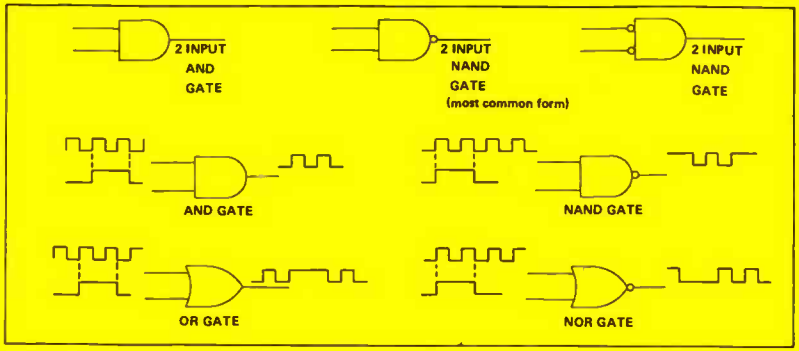
From the standpoint of the hobbyist, only 3 functions are of interest; the Gate, the Amplifier, and the Flip-Flop.

GATES

This function comes in a wide variety of configurations. There are 2, 3, 4, or more inputs and 4 categories as follows:

AND: when all inputs go to "1" output will go to "1"
NAND: output will be "1" except when all inputs go to "1"
OR: when any input goes to "1" output will be "1"
NOR: output will be "1" except when any input goes to "1"

NAND and NOR differ from AND and OR in that inversion has taken place. Refer to the following illustrations. (note the small o at the input or output of some of the examples. This o indicates that inversion has taken place).



Gates can be connected to operate in a wide variety of applications other than those for which they were designed. Some applications are:
Free - running (astable) multivibrator; bi-stable (flip-flop); "One Shot" multivibrator; amplifier, dc and ac; audio mixers.

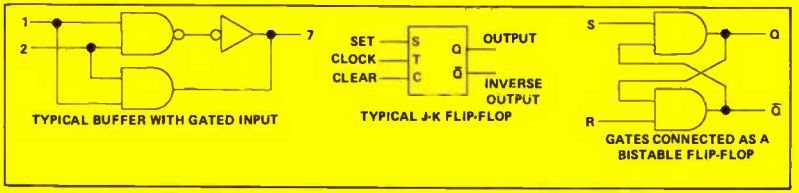
Occasionally the time arises when the hobbyist-experimenter needs something in the way of gates other than what he has or what is available. For example, you need a 3-input gate and you have a 4-input gate; simply ground one input. Ground two inputs to obtain a 2-input gate. If you have a dual 2-input gate, such as the HEP-580, and you need a 4-input gate, tie pins 6 and 7 together and this becomes the output; inputs are then on pins 1, 2, 3, and 5.

AMPLIFIER

In digital work it is referred to as a Buffer. Its original use is to increase "fan-in" or "fan-out capability. That is, the number of other units than can be connected in parallel to the input (fan-in) or output (fan-out). By adding proper external biasing it is possible to connect this unit to LINEAR (audio-RF) usage.

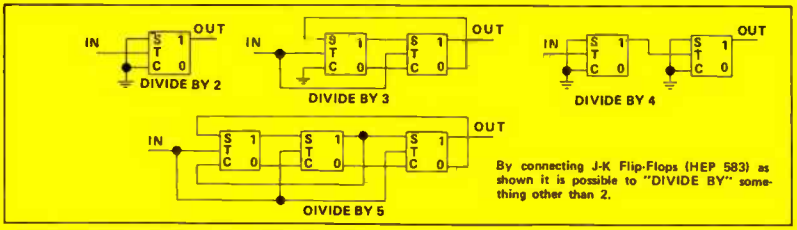
FLIP-FLOP

There are a number of types of flip-flops available. As mentioned previously, a flip-flop (multivibrator) can be "made up" by cross connecting two gates. The R-S Flip-Flop is one example. The J-K Flip-Flop is similar but has the added function known as "clock input" shown as "T" on the logic block.

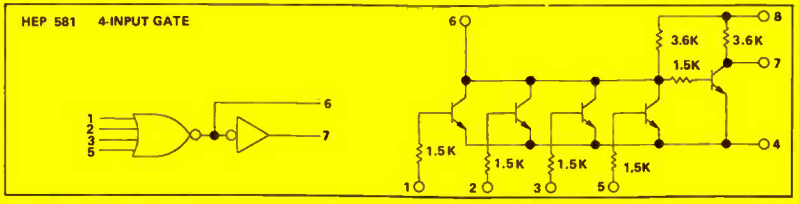


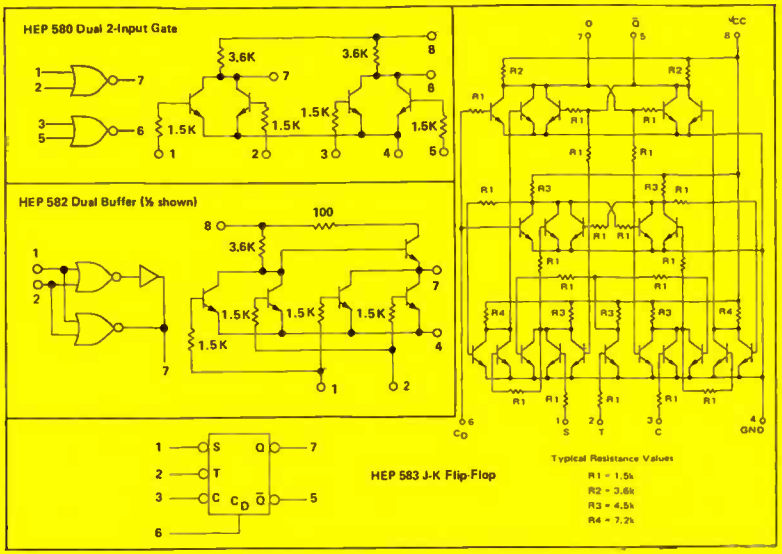
Fundamentally, flip-flops divide by two. By proper connection, division by 3,4,5 etc. can be obtained. using a few IC's as follows:

LOGIC DIAGRAMS



Schematic and logic diagrams of the HEP IC's that are contained in the HEK-1 Experimenters Kit and are used in the projects of this brochure are shown in the following illustrations:





IC CROSS REFERENCE FOR HOBBYIST EXPERIMENTERS

Type to be Replaced	See Note	HEP Re-placement	Type to be Replaced	See Note	HEP Re-placement	Type to be Replaced	See Note	HEP Re-placement
CA3002		590	MC811G		581	SN17811L	1	581
CA3003		590	MC811F	2	581	SW303F	2	553
CA3004		590	MC814G		584	SW303T		553
CA3013		591	MC814F	2	584	SW304F	2	554
CA3014		591	MC817P	1	570	SW304T		554
MC303G		553	MC824P	1	570	SN17810L	2	556
MC303F	2	553	MC876P	1	572	SW306T		556
MC304G		554	MC881G	1	582	SW308F	2	558
MC304F	2	554	MC882G	1	583	SW308T		558
MC306G		556	MC890P	1	572	SW353F	2	553
MC306F	2	556	MC899P	1	571	SW353T		553
MC308G		558	MC910G	1	580	SW354F	2	554
MC308F	2	558	MC910F	1,2	580	SW354T		554
MC353G		553	MC911G	1	581	SW356F	2	556
MC353F	2	553	MC911F	1,2	581	SW356T		556
MC354G		554	MC914G	1	584	SW358F	2	558
MC354F	2	554	MC914F	2	584	SW358T		558
MC356G		556	MC981G	1	582	U3F991129X	2	581
MC356F	2	556	MC982G	1	583	U3F99142 1X	2	584
MC358G		558	MC1302G		592	U3F991422X	2	584
MC358F	2	558	MC1302P	2	592	U5B99102 1X		580
MC710G		580	MC1303P	2,3	592	U5B991029X		580
MC710F	2	580	MC1314G		591	U5B991129X		581
MC711G		581	MC1550G		590	U5B99142 1X		584
MC711F	2	581	MC1554G		593	U5B991422X		584
MC714G		584	PA713		590	U5B991429X		584
MC714F	2	584	PA7601		590	U5B992329X	4	572
MC717P	3	570	PL990029	4	571	U5B992329X	3	583
MC724P		570	PL991021	1	580	U5F99112 1X	2	581
MC776P	3	572	PL991029		580	U5D770339X		590
MC781G		582	PL991129		581	U5D990029X	4	571
MC782G		583	PL991429		584	U5D990029X	3	582
MC790P		572	PL992329	4	572	μL900	4	571
MC799P		571	PL992329	3	583	μL911	3	581
MC810G		580	SN17810L	1	580	μL914	(4)	584 (570)
MC810F	2	580	SN17910L	1	580	μL923	4	572

Note 1: Temperature range is narrower.

Note 2: Case Difference

Note 3: Milliwatt vs Medium power may require slight circuit value variations to optomize performance.

Note 4: Plastic replaces 2 metal units. (Case Difference)

LINEAR IC'S

Linear IC's must be of particular interest to the TV-radio repair technician. Broadly speaking they are all amplifiers, the specific difference being in the power output, impedances, etc. For example, the HEP 592 is a complete stereo pre-amp, the only thing required externally being the potentiometers. The HEP 590 can operate as an RF or IF stage. Experimentation with linear IC's is very straight forward and many circuits have been published that lend themselves very well to the HEP 590, 591, 592 and 593 devices.

ULTRA HI-GAIN AMPLIFIER

USES:

AMPLIFIES ANY AUDIO OR LOW FREQUENCY RF SIGNAL.
CAN BE USED AS AN OSCILLOSCOPE PREAMP TO INCREASE THE SCOPES SENSITIVITY.

FEATURES:

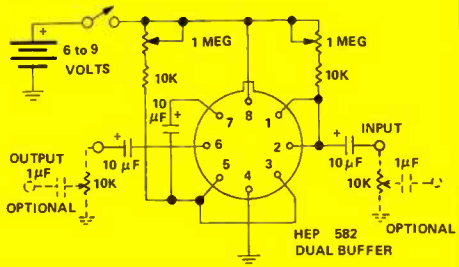
Input 0.0004 Volts Pk - Pk (Typical)
Output 2.5 - 6 Volts Pk - Pk (Typical)
Gains Obtainable From 5000 to 10,000
2ma Drain Current Typical (at 9 Volts operation)

PARTS LIST:

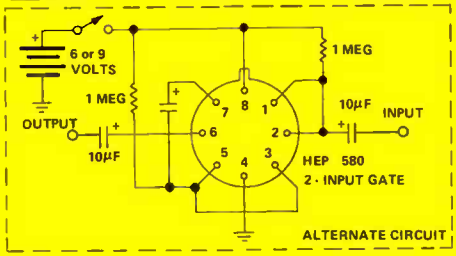
1 HEP 582 Dual Buffer
3 10μF Capacitors Electrolytic 10 Volts (or higher)
2 10K Resistors ¼ or ½ watt 10%
2 1 meg Potentiometers (trimmers)
1 ON-OFF Switch (could be part of gain cont.)
1 6 Volt Battery (4-1.5V Cells) or 9 Volt Transistor Radio Battery
Input and Output Jacks (as desired)
Vector Board and Terminals
1 HEP 454 IC Socket

OPTIONAL PARTS:

10K Potentiometer (Gain Control)
1 μF Capacitor Electrolytic 10 Volts (or higher)



ADJUST 1 MEG POTS FOR MAX UNDISTORTED OUTPUT



SINE TO SQUARE WAVE CONVERTER

USES:

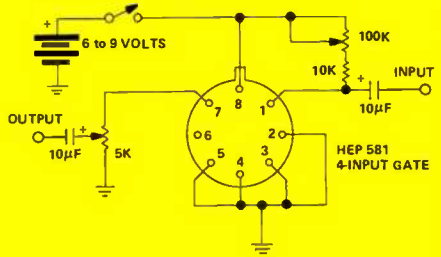
Converts any signal generator (audio), with output greater than 2 Volts peak to peak, to a high quality square-wave generator.

FEATURES:

Input 2 Volts to 30 Volts Pk-Pk
Freq Range: DC to 30 kHz
Adjust 100 K Pot. for Symetrical Wave Form.

PARTS LIST:

1 HEP 581 4-Input Gate
2 10μF Electrolytic 10 Volts (or higher)
1 10K Resistor ¼ or ½ watt 10%
1 15K Linear Potentiometer
1 100K Linear Potentiometer (Trim Pot)
1 6 Volt Battery (4-1½V cells) or 9V Transistor Radio Battery
1 ON-OFF Switch (can be mounted on 5K pot)
Input and Output Jacks (as desired)
Vector Board and Terminals
1 HEP 454 IC Socket



Experimenters
Hobbyists
Servicemen

Whatever your direction, let RCA show you the way

...with RCA's New Linear IC Variety Pack—KD2117

Here's a great way to extend your integrated circuit know-how—Kit KD2117 provides a basic introduction to practical applications of these intriguing devices and an inexpensive way to build useful projects. The pack includes 2 KD2114 transistor arrays; 1 KD2115 audio amplifier; 2 KD2116 transistor arrays. Also, instructions for 12 useful circuits, schematics, parts lists, etc.

...with New Crystal and Zener Diodes

In addition to its quality line of SK replacement transistors, rectifiers, and integrated circuits, RCA now offers 4 zener diodes and 5 crystal diodes!

...with RCA Hobby Circuits News, HCN-3900

This is an exciting new publication loaded with interest for hobbyists and experimenters...published periodically.

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Your RCA Distributor can be your one-source headquarters for Experimenter's Kits, Hobby and Experimenter Manuals, Hobby Circuits News, and RCA's Solid-State Replacement Guide, SPG-202G, a cross reference for almost 13,000 solid-state devices that RCA's SK's replace. Available from your RCA Distributor. RCA Electronic Components, Harrison, N.J. 07029

RCA

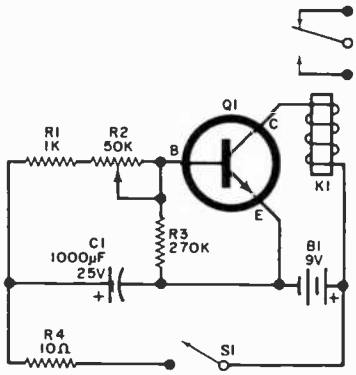

Fig. 3. Solid-state timing circuit has a range of 10 to 100 seconds determined by the setting of R2.

phones, amplifiers, a CPO, and a line-operated regulated d.c. power supply, with both schematic and pictorial diagrams provided in each case. Priced at a nominal fifty cents per copy, the booklet is available from any of the more than 800 CALECTRO distributors across the nation.

Referring to Fig. 3, the circuit features a low-leakage *npn* silicon transistor, *Q1*, as a common-emitter current amplifier controlled by a common RC timing network. A s.p.d.t. electromagnetic relay (K1) serves as *Q1*'s collector load.

Without base bias, *Q1*'s collector current is extremely small and the relay remains open. When *S1* is closed momentarily, *C1* is charged rapidly by *B1* through current limiting resistor *R4* and, thereafter, can serve as *Q1*'s base bias source until discharged. With bias applied, there is a corresponding large increase in *Q1*'s collector current, actuating *K1*. The relay remains closed for a period proportional to *C1*'s discharge time which, in turn, depends on the network's *RC* time constant . . . that is, *C1*'s value and the total resistance in its discharge path, *R1*, *R2*, and *R3*, shunted by *Q1*'s base-emitter impedance. With fixed resistors used for *R1* and *R3*, *R2*'s setting determines *C1*'s discharge time and hence this resistor serves as the circuit's timing range control.

Conventional parts are used in the project. A CALECTRO type K4-506 silicon transistor is used for *Q1*. Relay K1 is a 1000-ohm sensitive type (CALECTRO No. D1-962).

With neither layout nor lead dress critical, the timer is well suited to both breadboard and perf-board construction techniques, with the former preferred for demonstration or experimental applications. If desired, the unit may be housed in a small metal or plastic box for laboratory or darkroom work. Various settings of *R2* may be calibrated by using a stopwatch (or even a regu-

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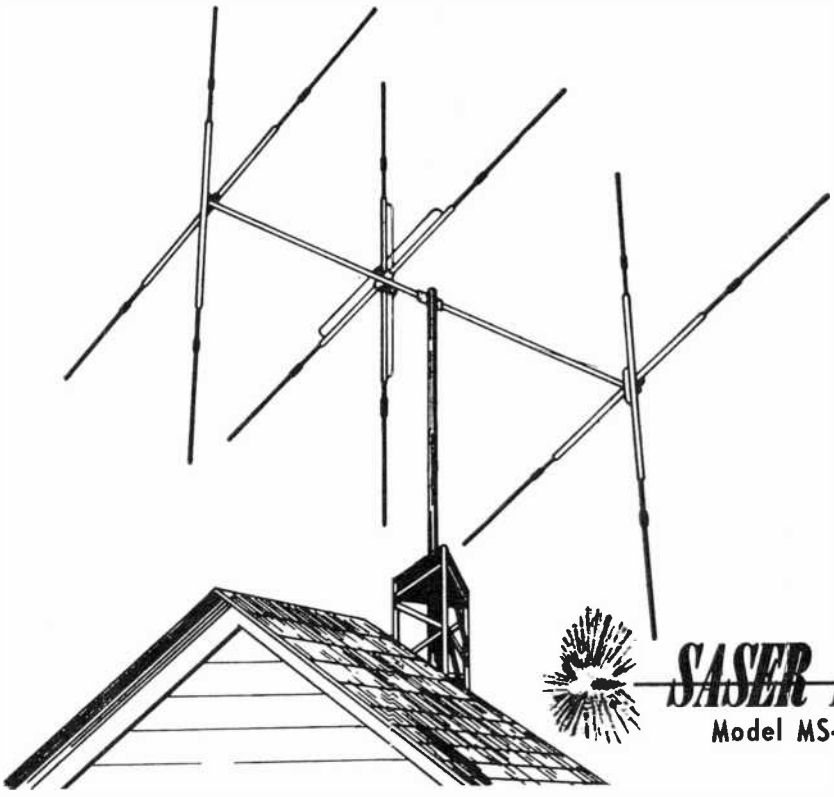

SASER BEAM
Model MS-3D

The Mosley Saser Beam cuts through CB interference like a laser cuts through steel. Switch polarization on this antenna and you cut down noise and interfering signals as much as 25 db. And you can count on its sturdy construction because, although it may look and act like a quad, it's built like a beam, with six crossed elements and no wires. It's miniaturized like a Mosley Mini-Beam to save you space and cash.

Where can you get base station antenna value like this in only 43 cubic yards of air space? See the Saser Beam at your nearest Mosley dealer. For free brochure, with complete specifications and performance data, write factory direct Dept 188.

Mosley Electronics, Inc.
4610 N. LINDBERGH BLVD., BRIDGETON MO. 63042

CIRCLE NO. 22 ON READER SERVICE PAGE

lar watch with a sweep-second hand) as a standard.

In operation, the relay's contacts are used to control an external circuit, such as an enlarger's lamp.

New Devices. Two different technologies are combined in a small vidicon recently developed by RCA Electronic Components (Lancaster, Pa. 17604). Although the device is basically a vacuum tube, it utilizes a silicon diode array photoconductive target to achieve extremely high sensitivity. Tentatively identified as the type C23136 camera tube, the unit features magnetic-focus and magnetic-deflection, offers high resolution, and can withstand temperatures up to 200°C. With a nominal 1″ diameter and an overall length of just over 6 inches, it is ideal for compact camera designs.

Radiation, Inc. (Melbourne, Florida 32901), a division of the Harris-Intertype Corporation, which earlier this year introduced the first off-the-shelf line of radiation-hardened integrated circuits (POPULAR ELECTRONICS, June 1969), has added five new TTL logic circuits to its line. The new devices include a Dual Type D Flip-Flop, a Quad 2-input NAND Gate, a Dual 2-input and/or INVERT Gate, a Dual 4-input NAND Gate, and a Quad 2-input AOI Gate. All the units are in standard TO-86 flat packages with Radiation's special dielectric isolation construction.

A new linear integrated circuit designed to provide the color difference signals in a color-TV set is being offered by the Sprague Electric Company (115 Northeast Cutoff, Worcester, Mass. 01606). Designated type ULN-2114K, the new device employs two fully balanced quadrature detectors and is assembled in compact TO-100 package.

Motorola Semiconductor Products, Inc. (P. O. Box 955, Phoenix, Arizona 85001) has introduced a number of new devices, including two pairs of low-cost plastic encapsulated silicon power transistors, a line of voltage-variable capacitance diodes, and a monolithic voltage/current regulator capable of kilovolt operation.

The new power transistors are designed for use in 20- and 35-watt complementary audio amplifiers. Types MJE205 and MJE105 are 5-ampere, *npn* and *pnp* units, respectively, have a V_{CEO} rating of 50 volts and a power dissipation specification of 65 watts. The corresponding 10-ampere units are types MJE2801 (*npn*) and MJE2901 (*pnp*), with a V_{CEO} of 60 volts and a power dissipation rating of 90 watts.

Designated as types MV2101 through MV2115, Motorola's new line of plastic encapsulated tuning diodes cover the capacitance range of 6.8 to 100 pF nominal, with

typical tuning ratios of 3, measured at reverse voltages of 2 and 30 volts. With Q's as high as 450 minimum, the units are ideal for tuning and AFC applications.

Motorola's new integrated circuit voltage current regulator, type MC/1566L, is designed to control an external power transistor and will operate at any voltage or current level which the power transistor can handle. The unit has automatic crossover, remote sensing, remote programming, and both line and load voltage regulation of 0.01% plus 1 mV, with a current regulation of 0.1% plus 1 mA. Its high voltage capability is achieved by using a "floating" circuit design, with its operating voltage obtained from a separate isolated supply of about 25 volts d.c.

Transitips. You needn't look to special fast-acting fuses or expensive circuit breakers to protect your semiconductor devices from current overloads when testing experimental circuits if you'll borrow a tip from an "old-timer's" notebook. Just use a reliable, low-cost, linear, solid-state component—the common resistor.

The technique is relatively simple if, as is often the case, the protected device is operated at a fraction of its maximum rating in the test circuit. Just connect a resistor in series with one side of the power source, bypassing with a moderately large capacitor.

As an example, let's assume you are checking an audio amplifier stage which requires a current of 1 ampere from a 12-volt source and, further, that your power transistor has a maximum rating of, say, 6 amperes. With a 2-ohm, 100-watt, resistor connected in series with the power source, the supply voltage is reduced by only 2 volts . . . not enough to affect any but the most critical circuits. Should a circuit wiring error or defect occur, however, the *maximum* current is held to 6 amperes for, at this value, the full source voltage is dropped across the series resistor. If circuit behavior is normal, the series resistor can be shorted for final tests.

In general, you can determine the resistance needed by applying Ohm's law. Divide the source voltage by the protected device's maximum current rating to establish resistance value, then multiply the maximum current and voltage values to obtain wattage, using the next higher standard wattage rating. Smaller . . . and less expensive . . . resistors may be parallelled to obtain higher wattage values at minimum cost. In the example given, 5 inexpensive 10-ohm, 20-watt resistors, connected in parallel, replaces a single 2-ohm, 100-watt unit. —*Lou.*

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.*

McMurdo Silver Model 802 receiver and 803 preamp, 1947. Schematics needed. (George B. Publow, Box 590, Picton, Ontario, Canada)

Hallicrafters SX-110 receiver. **Emerson** BJ-200 radio. Operating manuals and schematics needed. (Pete Vinci, 257 Oak St., New Britain, CT 06051)

RCA Radiola III A-1923. Horn type speaker plus WD-11 or UV-199 tubes needed. (Andy Brewer, 4917 Monte Vista Dr., Knoxville, TN 37914)

Eico Model 322 signal generator. Schematic and operating manual needed. (Rene Limue, 515 Dumaulin St., Drummondville, Que., Canada)

Bell Model 2256 amp. and 2255 FM/AM tuner; schematics needed. **GE** Model 704; operating instructions needed. (B.F. Slayman, 4122 Canyon Rd., Lafayette, CA 94549)

Webcor Model EP2611-1 recorder. Schematic needed. (Sid Wistrick, 416 East Charles St., Oelwein, IA 50662)

Simpson Electric Model 480 genescope; **Precision** sweep generator Series E-400. Schematics and operator's manuals needed. (Leslie Shanks, 4810 Alma St., Corpus Christi, TX 78411)

Motorola Model H13-1AH handie-talkie. Any information needed. (Greg Newell, 19749 Elkhart, Harper Woods, MI 48236)

Hallicrafters Model S-39 Sky Ranger. Metal Cabinet needed. (V.E. Lingbloom, Elsie, NB 69134)

Recordio Corp. Model R-602 recorder. Service instructions and schematic needed. (P. Kitchin, 369 Nigel Ave., Vancouver 10, B.C., Canada)

RCA Victor Model 45-EY-2 Victrola. Schematic and parts list needed. (Allan Cronin, 3654 So. Marshfield Ave., Chicago, IL 60609)

Admiral Model =22C5A AM/FM stereo receiver with stereo phono input. Schematic, parts list and source for parts needed. (Dana G. Frisbee, P.O. Box 123, Glens Falls, NY 12801)

Stewart Warner Model R1885 AM-SW. Schematic needed. (Cliff Davis, 1122 Highland Dr., Grand Prairie, TX 75050)

Hickok Model 600 tube tester. Instruction manual and updating information needed. (John Wilson, 10755 Thornview Dr., Sharonville, OH 45241)

DuMont oscilloscope Type 247. Instruction book needed. (M.C. Harman, 1418 Touhy Ave., Chicago, IL 60626)

Hallicrafters Model S-38B SW receiver. Schematic needed. (Larry Rasinski, Rt. #4, Box 76, Little Falls, MN 56345)

Power Instruments Inc. Model 920 show strobe and **Wabash Instruments** Model E-40 high intensity strobe; schematic and parts list needed. (J. Reese Brown III, 25 Berkshire Dr., Warren (Plainfield R.D. #1) NJ 07060)

Westinghouse Model H70ACS1 record player. Working 45 rpm spindle needed. (Margaret T. Foster, 14218 Orinoco Ave., East Cleveland, OH 44112)

Browning Labs Model RV-10A FM mono tuner. **Muntz** TV Model 721TS (1956) VHF only. Schematics and/or manual needed for both. (Daniel Meijer, 1438 Geranium St. NW, Washington, DC 20012)

Bell Model 360 professional tape recorder. Schematic and manual needed. (George R. Swieringa, 821 Kennedy St. NW, Washington, DC 20011)

Philco Model 7019 junior scope, circa late 40's. Instruction manual and schematic needed. (Tony Anderson, Box 17152, San Diego, CA 92117)

Morrow Model 5 BR-2 converter-tuner. Translucent calibrated slide rule dial plate or address of mfg. where it can be purchased needed. (Mack D. Baxter, P.O. Box 397, Marble Falls, TX 78654)

Telmar Model MA-105 walkie-talkie. Schematic and source for crystals needed. (Jeff Corey, 6606 N. Ridge, Chicago, IL 60626)

Pyramid Model CRA-2 capacity resistance analyzer. Manual and schematic needed. (H. R. Day, 1429 E. Griswold Rd., Phoenix, AZ 85020)

United Reproducers Corp. "Peerless Dynamic" field coil speaker, serial No. E 44641. Large coil and 6 terminals; no magnet. Power supply needed, but voltage and specs unknown. (Jeff Peters, 919 St. George Ave., Niagara Falls, Ont., Canada)

Zenith Model J880 AM/FM chassis 8H20Z. Power transformer needed. **Grundig** "Transistor Box 59". Schematic and parts list needed. **Crescent** Model R-25 steno wire recorder. Wire, reels, service data and operating manual needed. (Tom Hirsch, Holt Summit, MO 65043)

Mercury Model 1700 VTVM. Schematic and calibrating instructions needed. **Rutheford** Model 400 citizen's radiophone. Schematic and alignment data needed. (James Murray, 14509 Cameo, Norwalk, CA 90650)

Zenith Model 5-S-119 SW receiver. Source for parts and dial hands needed. (Bob Patton, 2800 Elm, Parsons, KS 67357)

Mobile Communications Co. Model MFM-150 receiver and Model MFM-25-150 transmitter "taxi talkie". Schematics and any additional information needed. (K.A. McCrimmon, 114A Aliso Hall, California Polytechnic, Kellogg, Pomona, CA 91766)

Eico mono tuner. Eico MX99 adapter to convert tuner from mono to stereo needed. (W.E. Bumgarney, Box 62, Arcadia, MO 68815)

AMATEUR RADIO

(*Continued from page* 86)

visited Russian hams give the impression that they are typical hams, personable and hospitable. And if Russian hams are 'our sort of guys,' isn't it possible that a lot of Russians are like Americans?

"Somehow, we'd like to reach out to the hearts and minds of Russian hams (and others behind the Iron Curtain). We plan to have special QSL's for Iron Curtain contacts. They are going to be overprinted on the nicest picture postcards of the Detroit area we can find. Believe me, any ham behind the Iron Curtain who gets my QSL card is going to get a first rate picture of a little bit of the United States—in particular, where I live! I'd like to see P. O. Box 88, Moscow, (*address of the Russian QSL Bureau*) flooded with such QSL's from all over the United States to show Russian hams (and any of their friends who looked over their QSL's) what it is like over here. We may not be able to carry on long conversations with Russian Hams (although some of them on 20 meter SSB *do* talk to Americans at some length), but let's remember the old axiom of one picture being worth a thousand words!"

VK/ZL/Oceania DX Contest. Phone, 1000 GMT (4:00 a.m., EST) October 4, until 1000 GMT, October 5. CW, 1000 GMT, October 11, until 1000 GMT, October 12. Some stations may be worked once per band to exchange usual signal reports and requested contest information. Send scores to: J. M. White, ZL2GX, Contests and Awards Man-

ager, New Zealand Association of Radio Transmitters, Inc. (NZART), 152 Lytton Rd., Gisborne, N.Z.

Demagnitizing Screwdrivers. If your screwdriver has picked up enough magnetism to hang on to a screw you are trying to start in a tight corner, Phil Pichette, VE7ADW, suggests in the *Beaver Valley Clicks*, Beaver Valley ARC, Fruitvale, B.C. Canada, that you pull the trigger of your soldering gun and slowly insert the screwdriver blade in the wire tip of the gun and then slowly withdraw the blade. Do not release the solder-gun trigger until the screwdriver is completely outside the magnetic field of the tip; otherwise, you may magnitize rather than demagnetize the screwdriver tip.

NEWS AND VIEWS

John Jensen, VE3DDJ, 391 Sentinel Rd., Apt. 121, Downsview 466, Toronto, Ont., Canada, makes the best of a poor antenna situation with a Webster Band-Spanner mobile antenna mounted outside his window. It is 15 feet high. Feeding it with a Heathkit DX-60B transmitter, John worked 14 U.S. and two Canadian stations his first eight days on the air. Other VE3DDJ equipment includes Heathkit HR-10B receiver, HD-10 electronic keyer, and SB-600 monitor-scope. Of interest to those who have forgotten (or never knew) that 11 meters was once an amateur band—and still is in many parts of the world—John has an 11-meter transceiver and 3-element beam on the Canadian 11-meter amateur band . . . **Mark Dankoff, WN2HVY,** 1629 Clover St., Rochester, N.Y. 14618, says the ham whose idea of a QSO is "The weather here is . . . 73," is his pet peeve. Mark much prefers the chats in which the operators get to know each other. His Knight-Kit T-60 transmitter, Hammarlund HQ-70 receiver, and Gotham vertical antenna have worked 20 states, all confirmed, and all on 40 meters . . . **Tim Vandagriff, WN2GTQ,** (son) and **Clent Vandagriff, WN2GTS,** (father) 88 Boxwood Drive, Rochester, N.Y. 14617, received their Novice licenses together last summer. And if the schedule worked out as planned, they now have their Advanced tickets. Dad has 30 states and three countries confirmed. Tim has 39 states and five countries confirmed. Their antenna sounds interesting—a homebrew, "broadband," 80-, 40-, and 15-meter inverted-V, 45 feet high. The family station consists of a Heathkit DX-60B transmitter and a HR-10B receiver. By the way, father and son both have 20-WPM code proficiency certificates.

Dan O'Connell, WN7LTA, Eugene, Oregon, really went all out when his amateur license arrived. In seven weeks, he worked 43 states and 19 countries. The 19 countries included 65 Japanese contacts, four Russians, and five New Zealanders. Dan uses a Hallicrafters HT-40 transmitter, Hammarlund HQ-110C receiver, and a 40-meter inverted-V dipole antenna on a single frequency on 15 meters. Undoubtedly the reason that Dan's antenna works so well is that he put it up in a cold rain with three feet of snow on the ground! . . . Another lad who knows what a ham license is for is **Dave Dolaway, WN3MDY,** 21 Lorana Ave., Bradford, Pa. 16701. In three weeks, he has confirmed 25 states and four countries mostly on 15 meters. He uses a Johnson Ranger transmitter, Mosley CM-1 receiver, and dipole antennas . . . **Martin Silverton, WN6MVT,** 1464 N. First Ave., Upland, Calif. 91786, started on the air with a borrowed Elmac trans-

mitter until he acquired his own Johnson Ranger. His receiver is a Lafayette HA-350. He operates the three lower Novice bands and has 32 states and four countries worked. Martin's pet peeve is the Extra class operators who insist on sending directly on top of the W1AW code-practice sessions. As he says, "Strange, but it seems they start transmitting as soon as code practice begins. Just a coincidence, of course. Or is it?"

Jim Volstad, WNØTRY, Edina, Minn., really has to crank down the power on his Johnson Valiant transmitter to stay in the 75-watt Novice power limit.

Jim Volstad, WNØTRY, 7221 West Shore, Edina, Minn. 55435, uses a Newtronics 4-BTV vertical antenna on the 80-, 40-, and 15-meter Novice bands. Driving it with a Johnson Valiant transmitter and receiving on a Hallicrafters SX-100, Jim has racked up 37 states and two countries in eight months. He keys with a homebuilt I.C. keyer and will be glad to demonstrate how it works to you, if you need a Minnesota contact . . . **Stirling Whitaker, WN7JHQ,** 315 North Burton, Burley, Idaho 83318, found Friday the 13th to be his lucky day. He passed his General class exam that day. His Novice log contained a record of 33 states worked with an Elmac AF-67 transmitter and a Hallicrafters SX-71 receiver in concert with a 40-meter dipole and a Hy-Gain 18-V vertical on 15 meters . . . From **Ed Gribi, WB6IZF,** Publicity Chairman of the WCARS net on 7255 kHz: WA6TKE/mobile reported an accident with injuries near Salinas, Calif., at 11:50 p.m., local time. Skip was long; so the information was relayed via WA9UWV, WB2RQP, and K4LD to K60AM, Palo Alto, Calif., who phoned the California Highway Patrol. Within 20 minutes of his original call, WA6TKE reported that help had arrived. Also, XE2EP, Baja California, Mexico, relayed the information from the Mexican police to the California authorities that a lost 7-year old American youngster had been found dead in the desert south of Mexicali, Mexico . . . **David Harris, WN1LGE,** 12 Bates St., Lexington, Mass. 02173, had worked 42 stations his first week as a Novice when he passed his General exam. "Keeping his hand in" while waiting for the new ticket to arrive, Dave has worked 25 states, three Canadian provinces, and Angola, Africa, (CR6LK). He uses a Heathkit HX-11 transmitter, a National NC-155 receiver, and separate dipoles for the Novice bands.

Will your "News and Views" or picture be in "Amateur Radio" next month? The first step is up to you. Have you written or sent the picture (preferably black and white)? We also appreciate being put on or kept on the mailing list to receive your club papers and announcements. The address is: Herb S. Brier, W9EGQ, Amateur Radio Editor, POPULAR ELECTRONICS, P.O. Box 678, Gary, Ind. 46401.

73, *Herb, W9EGQ.*

STEREO SCENE

(*Continued from page 77*)

your car. (Incidentally, when you do, you'll discover that the tapes *may* not sound as clear and clean in your living room as they do in the car, where road and engine noise mask their imperfections.)

Many New Cassette Machines. The Scene in cassette tape recorders this year is bright with new machines, most looking like last year's but with some notable exceptions. For example, Ampex, Bell & Howell and Wollensak have gone all out to provide eye-appealing units. You'll find the biggest assortment ever offered, and you may be confused at first because many of the sets fall into the compact category, as mentioned earlier. The best bet is to figure out what you want your recorder to do and then find one that will do it. You'll have a big range of prices from which to pick—again a result of competition among manufacturers.

In reel recorders you'll find a smaller supply on store shelves, the prices generally will be a bit under last year's, and there will be more high-priced units of "pro" calibre (in line with the greater sophistication of "Mr. Stereo Buyer"). Since the industry is in a state of transition, there will be a lot of really hot buys in reel recorders this fall. The hottest will be in self-contained stereo units with built-in or detachable speakers.

As with some of the other products, the important changes in reel recorders are in refinements and subtle improvements. Perhaps the most noticeable trends are those involving automatic reversing and easier tape threading.

All in all, the Stereo Scene this fall and winter is an interesting and exciting one. Go out and see for yourself. -30-

It's Show Time, Folks!

All the latest in stereo systems, components, etc., will be on view October 1 to 5 at the Los Angeles Hi-Fi Show in the Ambassador Hotel. A feature of the Show is a series of seminars on such topics as "Changers, Turntables and Cartridges," "The Stereo Sensation," and "Speakers and Amplifiers."

Canadian stereo fans will be able to make the scene October 16 to 19 when the "Stereo 70" Hi-Fi Home Entertainment Show, sponsored by electron magazine will be held at the Sheraton Mount Royal Hotel in Montreal.

SHORT-WAVE LISTENING

(*Continued from page* 84)

logged at 1046-1115 with piano music and news and at 1300-1320 with BBC news, home news, and classical music.

Belgium—Brussels noted on a new frequency of 11,714 kHz at 2315 with an IS and a multi-lingual s/on.

Biafra—*R. Biafra* noted on 7300 kHz at 0500 with ID, 0529 with drum IS, 0530 time signal, bugle call and news and 0540 with ID. This may vary slightly upward in frequency.

Bolivia—CP110, *R. Norte*, Montero, has returned, after an absence of several months, to 4871 kHz where it is heard after 2300 in Spanish.

Brazil—*R. Marajoara*, Belem, is testing on 4956 kHz with complete ID's being given often; try around 0450.

Jeff Falconer, VE3PE2PG, Clinton, Ontario, has logged 25 countries and 30 states using his Trio 705 receiver driving a 130-foot longwire antenna.

Canada—CFVP, 6030 kHz, 100 watts, relays CFCN, 1060 kHz, Calgary. CFRX, 6070 kHz, Toronto, is often good in the northeastern states during daylight hours. CHNX, 6130 kHz, Halifax, is good at 0115-0200 with music and a religious program. CFCW, Montreal, is very good on 6005 kHz most evenings. (Editor's note: an overseas publication has listed this outlet as CFCW. This is incorrect. CFCW is a medium-wave outlet, 10 kW power, on 790 kHz in Camrose, Alberta. The correct call for the short-wave outlet on 6005 kHz is CFCX. Please amend your logbooks and listings accordingly.)

Chile—If you have trouble logging this country, try for amateur station CE8AE, which often operates around 0700 in the lower end of the 40-meter ham band with xmsn's in single-sideband. Reports, if you're lucky enough to hear him, go to Radio Club of Chile, Box 13630, Correo 15, Santiago, Chile.

China—*R. Peking* was noted on 15.090 kHz at 1400-1555 s/off (broken at 1455-1500) with English news, commentaries and music.

Cuba—In addition to the English language schedule listed last month, *Radio Havana Cuba* also has English to northern Europe at 2010-2140 on 17,855 kHz.

Ecuador—HCJB, Quito, is good on 15.200 kHz at 2245-2259 in Russian and to 2330 in German, beam-

ed to L.A. and Brazil. In parallel was 17,890 kHz but the listed parallel of 15,115 kHz was evidently superseded by this new frequency of 15,200 kHz. HC4RF, *Canal Manabita*, Portoviejo, has moved slightly upward to 4821 kHz where they feature light music to past 0700.

Egypt—New frequencies in use by Cairo include 11,790 kHz, testing from 1830-2300 in Arabic, French, German, English and Italian; 15,090 kHz, testing to N.A. in French and Arabic but announced as being only on 11,815 kHz; this at 0220-0230; and on 21,685 kHz at 1630-1650 with usual native Arabic music and speech.

Temporarily a resident of Kingston, Jamaica, Glenn Little, WPE4IYC, has a 20-state DX Award. He uses a Hallicrafters S-38, Onkyo OS-175, 2X4+ Superhet.

El Salvador—*La Voz del Camerico* (?), YSV, Santa Ana, noted often on 9576 kHz around 1345-1630; may also identify as *R. Comercial.*

England—The European Service of the *BBC* in single-sideband with Russian at 0053, an English ID at 0100, and back into language is on 12,180 kHz. The regular Asian Service to Malaya and Singapore is often good on 15,375 kHz at 2300-2315 with English news and commentary and, from 2315, in Indonesian.

Estonia—A tentative logging is that of *R. Tallinn*, 17,700 kHz, at 1800 with the regular Moscow IS and in a strange language, perhaps Estonian, until 1820, and with music until 2029.

Finland—OIX4, Pori, has English to N.A. at 2300-2330 with news, discussions, DX tips and other features, on 15,185 kHz. At 2330 they go into Finnish.

France—Paris is good on a new frequency of 11,965 kHz from 0030 s/on in Spanish and French to L.A. and from 0215-0230 in French and from 0230 in Spanish. Other channels monitored include 11,915 kHz with English news at 0525 and into French with news and music to 0546 s/off; 15,120 kHz at 1930 with news and music; and on 17,740 kHz at 0525-0545 with English news and light music.

Ghana—*R. Ghana*, Accra, has English to N.A. at 2000 on 9760 kHz; reception here and on parallel 11,850 kHz is generally good.

Holland—*R. Nederland*, Hilversum, has replaced 11,730 kHz with 15,220 kHz at 2125-2250, dual to 15,425 kHz in English to N.A. with world and local news, commentary, editorial information, light music and other features.

Honduras—HRVC, Tegucigalpa, carries English daily at 0300-0400 on 4820 kHz. This station, operated by American Baptists, programs religious features. Other xmsn's are in Spanish to L.A. areas. The medium-wave outlet, heard at times in Southern states, is on 1380 kHz with 1000 watts. Reports go to Box 270, Tegucigalpa.

Indonesia—*R. Republik Indonesia*, Menado, is often noted on 5987 kHz from 0800 to past 1100. This 10-kW station is heard best, of course, on the West Coast.

Iran—*R. Tehran* carries Russian at 1730-1800, Turkish 1800-1830, Arabic 1830-1900, German 1900-1930, French 1930-2000 and English 2000-2030, all on 17,735 and 15.135 kHz. The former is a new frequency for this service.

Ivory Coast—*R. Abidjan*, 11,920 kHz, was logged at 1835 with English and French ID's, English news to 1843 and African music to 1900.

Korea (North)—*R. Pyongyang* was noted on 9613 kHz at 0900 with an IS and anthem, ID in Russian, and into news to 0910. Dual to 11,765 kHz, it was not heard on either of its other parallel channels, 6480 or 7580 kHz.

Malagasy Republic—Tananarive was heard with its IS at 0329 and into usual programming at 0330 on 4960 kHz.

New Caledonia—*R. Noumea*, 7170 kHz, is fair to good in western areas at 1005-1100 with Dixieland

SHORT-WAVE ABBREVIATIONS

anmt—Announcement	kW—Kilowatts
BBC—British Broadcasting Corp.	L.A.—Latin America
	N.A.—North America
EST—Eastern Standard Time	QRM—Interference
GMT—Greenwich Mean Time	R—Radio
ID—Identification	s/on—Sign-on
IS—Interval Signal	xmsn—Transmission
kHz—Kilohertz	xmtr—Transmitter

and classical music selections; news in French is aired at 1055 and s/off is at 1100.

Nicaragua—The new *R. Nacional de Nicaragua*, Managua, continues to be well heard on 11,875 kHz at 1640-1655 with pop music, 1810-1820 with French-Spanish language lessons, 1940-2000 with variety music and ID's and, at times a series of chimes, and at 2100-2230 with classical and light music and news in Spanish. This outlet relays the medium-wave YNM, 615 kHz.

Peru—OAX4V, *R. America*, Lima, 9505 kHz, was logged at 0050-0100, 0200-0208 and 0358-0416 with L.A. music, commercials, frequent ID's and short newscasts. Do not confuse with *R. Continental de Arequipa* on 9452 kHz; this latter station often relays *R. America* even to the point of including *R. America* at the start and close of newscasts.

Poland—*R. Warsaw* has English to N.A. at 0315-0345 Saturday (Friday evening, EST) on 11,870

SHORT-WAVE CONTRIBUTORS

Stanley Mayo *(WPE1GMF)*, Portland, Maine
Arthur Bolduc *(WPE1HQV)*, Biddeford, Maine
Rick Mills *(WPE1HSA)*, Berwick, Maine
C. A. Bugbee *(WPE1UO)*, Manchester, N. H.
Peter Macinta *(WPE2OKB)*, Kearny, N. J.
Gary Becker *(WPE2PFP)*, E. Northport, N. Y.
Steve Celli *(WPE2PSK)*, Baldwin, N. Y.
William Szabo *(WPE2QNF)*, Rochelle Park, N. J.
Robert Arnold *(WPE2QPR)*, Canastota, N. Y.
Rev. Michael Mayer *(WPE2QUT)*, New York, N. Y.
Ronald Shopinski *(WPE3DKA)*, Mt. Carmel, Pa.
Matt Zahner *(WPE3EII)*, Baltimore, Md.
Scott Moeller *(WPE3HLS)*, Villanova, Pa.
Thomas Gongaware *(WPE3HWU)*, Latrobe, Pa.
Dan Ferguson *(WPE4AUL)*, Coral Gables, Fla.
Grady Ferguson *(WPE4BC)*, Charlotte, N. C.
Joey Leonard *(WPE4KAF)*, Winston-Salem, N. C.
Terry Luttrell *(WPE4KBX)*, Columbia, Tenn.
Richard Fortson *(WPE5EWX)*, Edinburg, Texas
Terry Ward *(WPE5EZX)*, El Paso, Texas
Charles Bennett *(WPE5SIV)*, Sumrall, Miss.
Stewart Mac Kenzie *(WPE6AA)*, Huntington Beach, Cal.
Jim Young *(WPE6ENA)*, Wrightwood, Cal.
Winston Klontz *(WPE6EYO)*, Los Angeles, Cal.
Chuck Sadoian *(WPE6HHG)*, Dinuba, Cal.
Bob Wiser *(WPE6HJC)*, Watsonville, Cal.
Nick Chinn *(WPE6HKB)*, San Leandro, Cal.
Bob Brulte *(WPE6HLP)*, Ontario, Cal.
Chris Taylor *(WPE7CWE)*, Puyallup, Wash.
David Williams *(WPE7CWW)*, Astoria, Ore.
Philip Mader *(WPE8JKJ)*, Cleveland, Ohio
Daniel Keahy *(WPE8KHA)*, Detroit, Mich.
Bob Moser *(WPE9ASH)*, Chicago, Ill.
Joseph Gibson *(WPE9CNM)*, Milwaukee, Wis.
Gerry Dexter *(WPE9HDB)*, Lake Geneva, Wis.
Richard Pistek *(WPE9HOA)*, Chicago, Ill.
Richard Slonina *(WPE9JLD)*, Chicago, Ill.
Joseph Wojnowski *(WPE9JMU)*, Worth, Ill.
John Patterson *(WPE9JOL)*, Oswego, Ill.
Curtis Knight *(WPE9JSK)*, Appleton, Wis.
Dave Newkirk *(WPE9JSH)*, Norridge, Ill.
A. R. Niblack *(WPE9KM)*, Vincennes, Ind.
John Beaver *(WPEØAE)*, Pueblo, Colo.
Jim Randles *(WPEØCWK)*, Cunningham, Kan.
Jim Homan *(WPEØEUS)*, Florissant, Mo.
Martin Fossum *(WPEØFJF)*, Cass Lake, Minn.
John Van Engelenhoven *(WPEØFNM)*, Oskaloosa, Iowa
Jack Perolo *(PY2PE1C)*, Sao Paulo, Brazil
John Griffin *(VE6PE7V)*, Calgary, Alta.
Yitzhak Weinbaum *(4X4PE1T)*, Tel-Aviv, Israel
Leo Alster, Rahway, N. J.
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NOT SATISFIED with your present income? The most practical thing you can do about it is "bone up" on your electronics, pass the FCC exam, and get your Government license.

The demand for licensed men is enormous. Ten years ago there were about 100,000 licensed communications stations, including those for police and fire departments, airlines, the merchant marine, pipelines, telephone companies, taxicabs, railroads, trucking firms, delivery services, and so on.

Today there are over a million such stations on the air, and the number is growing constantly. And according to Federal law, no one is permitted to operate or service such equipment without a Commercial FCC License or without being under the direct supervision of a licensed operator.

This has resulted in a gold mine of new business for licensed service technicians. A typical mobile radio service contract pays an average of about $100 a month. It's possible for one trained technician to maintain eight to ten such mobile systems. Some men cover as many as fifteen systems, each with perhaps a dozen units.

Coming Impact of UHF

This demand for licensed operators and service technicians will be boosted again in the next 5 years by the mushrooming of UHF television. To the 500 or so VHF television stations now in operation, several times that many UHF stations may be added by the licensing of UHF channels and the sale of 10 million all-channel sets per year.

Opportunities in Plants

And there are other exciting opportunities in aerospace industries, electronics manufacturers, telephone companies, and plants operated by electronic automation. Inside industrial plants like these, it's the licensed technician who is always considered first for promotion and in-plant training programs. The reason is simple. Passing the Federal government's FCC exam and getting your license is widely accepted proof that you know the fundamentals of electronics.

So why doesn't everybody who "tinkers" with electronic components get an FCC License and start cleaning up?

The answer: it's not that simple. The government's licensing exam is tough. In fact, an average of two out of every three men who take the FCC exam fail.

There is one way, however, of being pretty certain that you will pass the FCC exam. And that is to take one of the FCC home study courses offered by the Cleveland Institute of Electronics.

CIE courses are so effective that better than 9 out of every 10 CIE-trained graduates who take the exam pass it. That's why we can afford to back our courses with the iron-clad Warranty shown on the facing page: you get your FCC License or your money back.

There's a reason for this remarkable record. From the beginning, CIE has specialized in electronics courses designed for home study. We have developed techniques that make learning at home easy, even if you've had trouble studying before.

In a Class by Yourself

Your CIE instructor gives his undivided personal attention to the lessons and questions you send in. It's like being the only student in his "class." He not only grades your work, he analyzes it. Even your correct answers can reveal misunderstandings he will help you clear up. And he mails back his corrections and comments the same day he receives your assignment, so you can read his notations while everything is still fresh in your mind.

It Really Works

Our files are crammed with success stories of men whose CIE training has gained them their FCC "tickets" and admission to a higher income bracket.

Mark Newland of Santa Maria, Calif., boosted his earnings by $120 a month after getting his FCC License. He says: "Of 11 different correspondence courses I've taken, CIE's was the best prepared, most interesting, and easiest to understand."

Once he could show his FCC License, CIE graduate Calvin Smith of Salinas, California, landed the mobile phone job he'd been after for over a year.

Mail Card for Two Free Books

Want to know more? The postpaid reply card bound-in here will bring you free copies of our school catalog describing opportunities in electronics, our teaching methods, and our courses, together with our special booklet, "How to Get a Commercial FCC License." If card has been removed, just mail the coupon at right.

THESE CIE MEN PASSED THE FCC LICENSE EXAM . . . NOW THEY HAVE GOOD JOBS

Matt Stuczynski, Senior Transmitter Operator, Radio Station WBOE

"I give Cleveland Institute credit for my First Class Commercial FCC License. Even though I had only six weeks of high school algebra, CIE's AUTO-PROGRAMMED* lessons make electronics theory and fundamentals easy. I now have a good job in studio operation, transmitting, proof of performance, equipment servicing. Believe me, CIE lives up to its promises."

Chuck Hawkins, Chief Radio Technician, Division 12, Ohio Dept. of Highways

"My CIE Course enabled me to pass both the 2nd and 1st Class License Exams on my first attempt...I had no prior electronics training either. I'm now in charge of Division Communications. We service 119 mobile units and six base stations. It's an interesting, challenging and rewarding job. And incidentally, I got it through CIE's Job Placement Service."

ENROLL UNDER NEW G.I. BILL: All CIE courses are available under the new G.I. Bill. If you served on active duty since January 31, 1955, OR are in service now, check box on reply card for G.I. Bill information.

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PE-89

CIRCLE NO. 10 ON READER SERVICE PAGE

kHz with news, talks, a stamp program and national music.

Rwanda—*Deutsche Welle* relay, Kigali, has been tuned at 1745 s/on in English on 15.435 kHz, 0600 s/on in English on 11,785 kHz, and at 2030 s/on in German on 15.380 kHz. Test xmsn's have been found on 17.865 kHz at 0050 to past 0230 with anmts in German, English, French and another, unidentified, language.

Solomon Islands—VQO4, Honaira, is often good in the west at 1100-1130 with news, British press review and a religious program. This is on 3995 kHz and listeners may experience hamband QRM.

South Africa—*R. RSA*, Johannesburg, is now utilizing 9715 kHz, dual to next-door 9705 kHz, from 2330 s/on in English to Newfoundland and Eastern N.A.

Turkey—*R. Ankara* continues to be fairly well heard on 15.160 kHz in English to N.A. at 2200-2230. Monitoring reports indicate considerable QRM from *Voice of America;* other reporters state the frequency to be now relatively clear of interference.

USSR—Kalinin is reported on 15.470 kHz at 0054 in Russian, at 0106 in Spanish, a horn IS at 0130, in language at 0330 and with music at 0539. Further xmsn's in Russian are said to be at 1850 under the *Radio Peace and Progress* ID. *R. Yakutsk,* Siberia, is noted on 4395 kHz from 1241-1301 in Russian anmt's and classical music. Some sources list this frequency as bearing the callsign RV214, though we've never heard it used.

Vatican City—*Vatican Radio* has another new channel in service, it being 17,800 kHz, as tuned at 2330 s/on in Spanish to L.A. and from 0110 in French. This is in addition to 17,810 kHz.

CAPACITANCE METER

(*Continued from page* 69)

still in a circuit; any resistance, voltage, or other capacitance in the circuit will result in a false reading, and any external voltage might damage the meter movement.

You use the capacitance meter in much the same manner as you would use an ohmmeter to measure resistance. Simply set the range switch to the position desired, connect the capacitor to be tested, and interpret the value from the position of the meter pointer and the range multiplier.

Don't be surprised if many of your capacitors seem way off from their rated values. Many capacitors have much greater tolerances than other electronic components, and some of the less expensive ones may even be rated at +80%, −20% tolerance. This would mean that a 0.01-μF capacitor could have a value anywhere between 0.008 μF and 0.018 μF and still be considered good. Of course, if a different tolerance is stamped on the capacitor case, the final reading should be within those limits. -30-

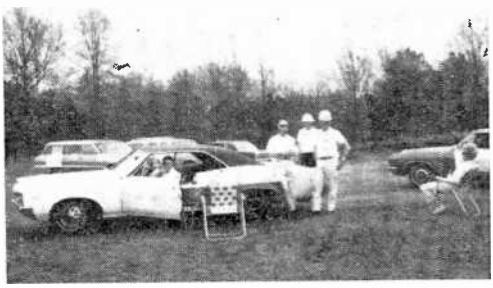
REACTIONS

(*Continued from page 82*)

A total of 53 two-man mobile units plus an 18-foot trailer base station including generator were supplied by the Four Points Club for this operation.

Among the many clubs that assist with parade communications, is the Nutmeg Citizens Radio Association of Bridgeport, Connecticut. They provide communications for the Annual Barnum Festival Parade held on the Fourth of July in Bridgeport.

This time of year, the Nutmeg Club and many others are planning for the annual "Pumpkin Patrol". On Halloween night, CB'ers in cooperation with the local law enforcement agencies patrol the streets of the town and report any suspicious mischief-making goblins. This activity reduces vandalism and leaves the police free to handle more serious police business. Citizens Radio mobile units are located at potential trouble spots, mostly schools. These lookouts spot possible vandals and report them to the police department. The presence of adults in a car usually prevents vandalism.



Capital City Citizens Band Communications, Inc. (Atlanta, Ga.) assists law enforcement authorities controlling traffic during "Atlanta 500" auto race.

CB Who's Who. As Citizens Two-Way Radio grows, we would like to compile a list of prominent people in all areas who use CB. If you know of any such persons, celebrities, political figures, business leaders, entertainers, sports stars, etc., please send us their names and call letters if known. We will put together a list and publish it when appropriate. While you're at it, be sure to send us news of your CB club, or any other news of interest to CB'ers everywhere. Address it to: Editor, Two-Way REACTions, c/o REACT National Headquarters, 205 West Wacker Drive, Chicago, Illinois 60606.

—30—

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Your subscription to POPULAR ELECTRONICS is maintained on one of the world's most modern, efficient computer systems, and if you're like 99% of our subscribers, you'll never have any reason to complain about your subscription service.

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DWELL EXTENDER

(*Continued from page* 54)

Identify the connections on the ignition coil. There are usually three wires: one (large diameter coming from the insulated top of the coil) carries the high voltage to the distributor; one goes to the ignition switch and may be marked (+) or "BATT"; and the third goes to the distributor (where the points are) and is marked (—) or "DIST." This last connection is the one you want. Loosen the nut that secures this lead to the coil and insert the lead from the proper terminal on the Spark Injector. Do not remove any existing wires. Tighten the nut, making sure that all of the leads are making good contact with the coil terminals. Locate a convenient ground screw or nut. Loosen it and insert the ground lead from the Spark Injector. Retighten the screw or nut.

Mount the Dwell Extender in relatively cool place (in this case on sheet-metal wheel housing) using suitable mounting hardware and shock-absorbing rubber grommets at two heat-sink mounting holes. The two-wire connecting cable can use same mounting hardware as the conventional engine wiring system.

Use #14 insulated wire to make these electrical connections. A spade lug can be soldered to each wire to make it easier to connect to the proper points.

When new points are installed or you want to check dwell time, disconnect the Dwell Extender by removing the one wire to the ignition coil. Once the dwell has been checked or reset, reconnect the Dwell Extender lead.

OP AMP QUIZ ANSWERS

(*Quiz is on page* 50)

1. The gain of an operational amplifier as shown can be determined by dividing the value of the feedback R_F by the value of the input resistor R_{IN}. Therefore the gain of the circuit is 1000/500=2. Note that the input connects to the input terminal marked (−) and the output connects to the output terminal marked (+). The circuit is thus an inverting amplifier. Since the input is −5 volts, E_{OUT} is **+10 volts.**

2. The gain of this inverting amplifier is also determined by dividing the feedback resistance by the input resistance. Thus, gain=100/1000=0.1. Since the amplifier inverts, the gain is actually **−0.1.**

3. Operational amplifiers can be used to "sum" or algebraically add the voltages at their inputs. In this circuit, the gain of each input leg is one. The output voltage is the sum of the amplified inputs and is inverted. Thus E_{OUT} is **+6** volts.

4. Operational amplifiers can be used as current generators if the current in the feedback loop is utilized. The load must be connected into the feedback loop as shown in the circuit.

5. The gain of the voltage follower is one. The input impedance of this circuit is very high and the output impedance is very low. The circuit is non-inverting.

6. Notice that E_{IN} connects to the input terminal marked (+) and E_{OUT} connects to the output terminal marked (+). Therefore this is a non-inverting amplifier.

7. The circuit is an integrator because the effective output is that which appears across the capacitor.

8. The circuit is a differentiator because the effective output is that which appears across the resistor.

9. As the switches are closed one by one, the inputs are inverted and summed, one on top of the other in sequence, generating a positive staircase waveform.

10. The first of these two unity-gain amplifiers inverts the input signal. The second inverts the output of the first. Therefore, the outputs are balanced.

HOMESTEADER

(*Continued from page 73*)

Protection Loop. The protection loop is a simple series circuit using switches and/or conductive window tape on the inside surface of the glass. Almost any type of switch can be used—including magnetic types in which the switch is mounted on either the window or window jamb and the operating magnet is mounted so that it operates (closes) the switch when the window is closed. (Magnetic switches are suggested because of their long life.)

The conductive window tape is cemented across or around the perimeter of the glass and terminated in contacts on the window frame. When the window is closed, the contacts are made. If the window is broken by an intruder, the tape shears very easily, opening the circuit and operating the alarm.

Wiring the protection loop may present a problem, depending on the type of construction of the building being protected. If the wires connecting switches, tape, or breakwire contacts cannot be run through the walls or ceiling, they can be routed up a seam in paneling or covered with tape and painted over. The interconnecting wiring can be fine-gauge wire since current flow through the loop is only about 2 mA.

The exit door can be protected with either a magnetic switch (as described above for the windows) or a mechanical, normally open switch that is closed when the door is closed. Besides switches, there are many other ways in which a contact can be made while a door is closed and broken when the door is open. Use your imagination. All you have to remember is that the circuit between terminals 4 and 5 on the PC board must be complete for the alarm to work and the exit door switch must make a complete circuit between terminals 5 and 6.

It is also possible to make a "silent alarm" by replacing the local alarm bell with a remote bell or light. In this way, the intruder will not know that you are aware of his presence, and you can take any action you deem neccessary. —30—

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10 b

LIBRARY (*Continued from page 14*)

cent larger than its predecessor, the new manual is an authoritative reference on bipolar transistors besides giving information on FET's, SCR's, triacs, diacs, etc. Four sections make up the Manual: Text chapters provide basic tutorial information on the operation, application, and testing of semiconductor devices. This is followed by the Technical Data section listing more than 900 devices, technical data, and curves. Next comes a practical Circuits section, covering many useful electronic devices you can build. The remaining section, Other Features, gives dimensional outlines and hardware information.

Published by Commercial Engineering, RCA Electronic Components, Harrison, N.J. 07029. Soft cover. 656 pages. $2.50.

DIGITAL COMPUTER PRINCIPLES, Second Edition

Put together by the Staff of the Technical Training Department, Burroughs Corp., this second edition continues to provide a broad survey of the principles of digital computers and the elements of both large and small computing systems. Extensively revised and reorganized, the book covers not only numbering systems, logic, Boolean algebra, and computer electronics, but also the latest input/output devices and other peripheral equipment. The updated contents include new material on thin-film cryotron memories, IC's, modularity concepts, displays, executive and control programs, multiprogramming, and multiprocessing. Solid-state circuits have replaced the vacuum-tube circuits of the first edition. A more detailed analysis of computer organization is presented and new material on system control concepts has been added.

Published by McGraw-Hill Book Co., 330 West 42 St., New York, N.Y. 10036. Hard cover. 578 pages. $8.95.

KNOW YOUR VOM-VTVM

by Joseph A. Risse

Everyone who uses a VOM or VTVM should have a good working knowledge of its use, care, maintenance, and principles of operation. Hence, this book is designed to provide just such information. It explains the major features common to test meters, and gives you an idea of what features to look for when you are shopping around for a new meter as well as how to make the most of the meter you already have. The first chapter is devoted to the uses of meters in general. Succeeding chapters deal separately with the VOM and VTVM, its operation and use. And the final chapter discusses modern solid-state meters. End-of-chapter review questions and an answer key are provided.

Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, Ind. 46206. Soft cover. 159 pages. $3.50.

VARIABLE TRANSFORMER

(*Continued from page 44*)

coded screws of *SO1* and *P1*; the meter should indicate zero resistance—even on the lowest range setting. The resistance registered between the two brass-coded screws should be zero ohms.

HOW IT WORKS

Referring to Fig. 1, with *R1* set for maximum resistance, the charge across *C2* is not sufficient to cause the integral trigger diode (at terminal *G* of *Q1*) to conduct. Therefore, no pulse is available to trigger the triac (between terminals 1 and 2 of *Q1*) into conduction. Consequently, no voltage can be dropped across a load connected to *SO1* because *Q1* is essentially an open switch.

Now, as the resistance of *R1* is decreased, a point will be reached at which the amplitude of the voltage across *C2* will be sufficient to cause the trigger diode to conduct and fire the triac for a portion of each a.c. cycle. The amplitude of the voltage dropped across the load is thus controlled by the point in each half cycle at which *Q1* triggers on. Decrease the resistance setting of *R1* even further, and you increase the average load voltage amplitude.

To improve circuit performance, *R2* allows *C1* to charge to a higher voltage than does *C1*. This allows the charge on *C2* to be partially restored once during each half cycle of the a.c. power by the charge on *C1*. The RC network consisting of *R3* and *C2* provides stability to the circuit when an inductive load is connected to *SO1*.

To use the Solid-State Variable Transformer, assemble the utility box. (It's also a good idea to anchor the two sections of the box together with sheet-metal screws to prevent the box from coming apart while you're removing it from a wall outlet.) Plug *P1* into a convenient a.c. outlet. Almost any electrical device that consumes less than 360 watts of power (3 amperes) can be operated via the Solid-State Variable Transformer. The only exceptions to the general rule are fluorescent lamps and devices that require a large starting current.

The markings on the control dial plate can be used only as a rough guide because *R1* is not linear at its low-resistance end. The best approach to using the control is to remember the settings most often used by different appliances. Or you can mark your favorite settings right on the dial plate. -30-

PRODUCTS

(*Continued from page 24*)

tory-assembled phones of comparable quality. Comfortable foam-cushioned earcups help seal out room noises, while the adjustable headband can be set for maximum comfort. Large 3½" dynamic elements in the earcups deliver clean, clear sound with full fidelity from very low bass (20 Hz) up to highs of 16,000 Hz. Separate volume controls in each earpiece permit perfect balance setting and make it unnecessary for the listener to leave his chair to adjust amplifier volume. The 4-16-ohm impedance headphone set is supplied with an 8' cord with standard ¼" phone plugs, solder, and full instructions for assembly and use.

Circle No. 90 on Reader Service Page 15 or 115

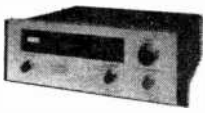
BASIC AUDIO POWER AMPLIFIER

The Model 80 basic hi-fi power amplifier made by *Dynaco, Inc.*, maximizes performance, reliability, and flexibility, even into such reactive loads as electrostatic speaker systems. The Stereo 80 is rated at 40 watts r.m.s. power/channel across the entire audio spectrum with both channels driven simultaneously into 8 ohms. Harmonic distortion is less than 0.5%—i.m. distortion is less than 0.1%—at rated output and is even better at lower levels. The two output channels of the Stereo 80 can be paralleled for 80-watt, 4-ohm monophonic operation when both inputs are simultaneously paralleled. In kit form, the Stereo 80 has factory-assembled and in-circuit tested printed circuit boards which include all critical circuitry.

Circle No. 91 on Reader Service Page 15 or 115

HIGH-PERFORMANCE COMPACT AM/FM TUNER

The use of a field-effect transistor in the front end, plus advanced design techniques in the multi-stage i.f. section makes the Model TX-500 budget-priced AM/FM tuner by *Pioneer Electronics U.S.A. Corp.* a best buy for low-investment, high-quality components. This solid-state stereo tuner utilizes low-noise silicon transistors with multiplex circuitry designed to provide wide channel separation and excellent frequency response. A special noise filter circuit reduces undesirable multiplex broadcast noise. A front-panel control allows the user to switch the filter into and out of the circuit. Technical specifications: 55 dB at 98 MHz FM image rejection; 2.5μV FM sensitivity; 50-dB signal-to-noise ratio. The FM reception is characterized by minimum interference and zero cross modulation.



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Full-frequency, three-dimensional stereo effect throughout any listening room is the big feature claimed for the *H.H. Scott, Inc.*, "Quadrant" Model 100 speaker system. To accomplish this, Scott has mounted a pair of 8" woofers on opposite sides of the enclosure and a 3" mid-range/tweeter (in individual air-suspension chambers) on each of the four sides. The woofers disperse sound through a 180° arc, the mid-range/tweeters through a 90° arc, to provide a full 360° of full-range coverage and eliminate the "point source." Technical specifications: frequency range—38-20,000 Hz; impedance—6-8 ohms; power handling capacity—80 watts; crossover frequency—2000 Hz; crossover network—LC-type with 12 dB/octave; air-suspension enclosure; tweeter level control; minimum amplifier power required—10 watts; recommended amplifier damping factor—10.

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