BUDGET Electronics

by the EDITORS of ELEMENTARY ELECTRONICS

1979 EDITION $1.50 CC 02040

BEEF UP YOUR HOBBY DOLLARS

Build a budget test bench

Install your own roof antenna

Cool your home for pennies

Cut car radio repair costs

Boost your CB punch

BUILD A DARKROOM THAT CAN'T BE BEAT

√ Stop action with Thunderbolt

√ Split-second timing from Midget Digit

√ Measure light without a meter

√ Slave flash saves cash

A DAVIS PUBLICATION

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BUDGET Electronics

1979 EDITION

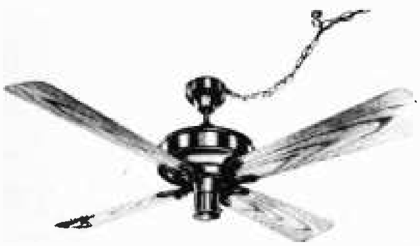
FEATURES

COLUMNS AND FEATURETTES

New Products

Ceiling Fan Kit

A touch of old Casablanca can be added to your den with Heath's new kit, the GD-1238 Casablanca Fan. It is a quiet, efficient way to cool a room in the summer. During the heating season, it can be used to bring heat down from high ceiling areas. Finished in baked bronze enamel with 52-in. simulated wood grain blades, the Casablanca Fan has adjust-



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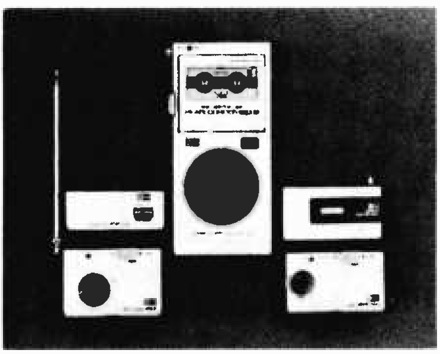
able speed and chain-pull switch operation. An optional Swag-Chain Kit (GD-1238-1) allows the fan to be located anywhere. Also available as an option is a globular glass light (GD-1238-2) that mounts beneath the fan. The light may be operated independently of the fan. For more information about the Casablanca Fan kit which sells for $99.95 (mail order Benton Harbor), write Heath Company, Dept. 350-620, Benton Harbor, MI 49022.

120 Minute Microcassette

The new Olympus Pearlcorder SD2 Microcassette recorder blends complete modularity with 2 hour recording/playback performance in one handsomely styled 12 ounce package. A special tape speed setting gives the pocket sized recorder 120 minute capability with excellent fre-



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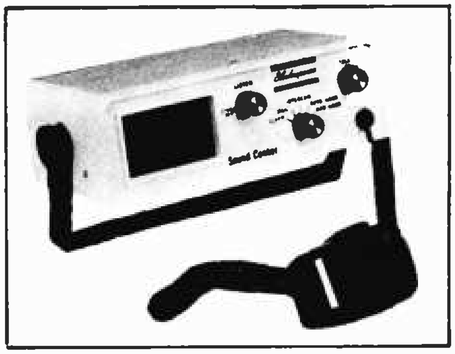
quency response using just one Olympus Microcassette. The SD2 is fully modular. Detachable AM and FM Tuner modules are available to create complete entertainment systems. Now the user can record favorite music, sports, talk shows, etc. Also available is a unique voice actuator module for voice activated recording without manual switch-on. Standard features include an electret condenser microphone and 50 mm dynamic speaker. Side mounted Record, Stop and Pause buttons and 4-way Feature Switch (Cue, Review, Rewind and Fast Forward) create a simple operational format. A host of accessories are available for system expansion including a sensitive tie-clip microphone, external speaker with built-in-amplifier and various adaptors. The basic Pearlcorder SD2 set includes a voice actuator module and is available from all Olympus dealers at only $279.95. For more information, write or call Olympus Corp. of America, Tape Recorder Division, Four Nevada Drive, New Hyde Park, NY 11040 (516) 488-3880.

Organized Sound

Shakespeare Marine Electronics has a deck hailer, called the Shakespeare Sound Center, that is designed to coordinate all on-board communications functions, including high power audio talking and listening from stem to stern, intercom, manual or automatic fog horn sounding and, with optional component connections, an alarm system for bilge leaks, engine fires, or unauthorized en-



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try. It is constructed of corrosion protected aluminum and transistorized electronic parts, with a molded high-impact front panel and vinyl-clad aluminum casing. The Sound Center permits the boat's crew to project and amplify voices to hail people on-board or on passing vessels, docks or bridges. In the listen mode, it can amplify conversations, buoys or noises from nearby craft. Sells for $199.50. Get all the details direct from Shakespeare Marine Electronics, 229 N.W. 14th St., Miami, Florida 33125.

3½ Digit DVOM

The new 3½ digit Model 3300 digital VOM just introduced by the Triplett Corp. features an extra-visible .3-in. high digital LED readout display with Polarity Indication, .5% accuracy and low-power ohms readings. The five function, 22 range Model 3300 offers complete portability with precision measurement capability. The new DVOM sells for only $175.00, complete with long life Ni-Cad batteries and AC Adaptor Charger plus test probes with safety boots. The Triplett Mode' 3300 is a safety-conscious design with no exposed metal parts and it includes a high energy 2A/600 V fuse for ample overload protection. A fused probe provides for both high energy and normal use circuit protection. Over-range is indicated by a blinking display and a low battery warning is included. DC polarity is automatic with indication directly on

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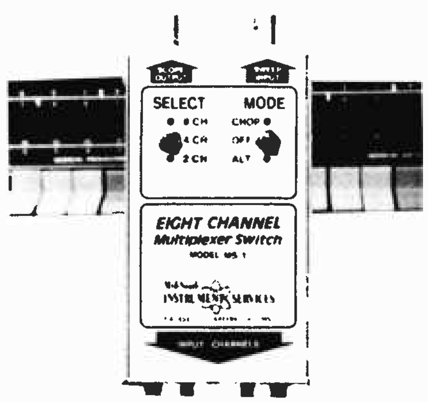
the readout display. Full details on the new Model 3300 DVOM and its complete line of accessories may be obtained at leading electronic distributors, or write to Triplett Corporation, Bluffton, OH 45817 or call (419) 358-5015.

Scope Multiplexer

The MS-1 Multiplexer Switch is an inexpensive, compact adaptor for converting any conventional, single channel oscilloscope into a multichannel logic analyzer for troubleshooting all types of digital logic circuits. The adaptor features two, four or eight channels of displayed data which is switch selectable and it operates in either chop or alternate sweep modes. The design features CMOS ICs for low power consumption, typically less than 6 mA total. With the MS-1, up to eight data lines may be sampled simultaneously while displaying the digital logic levels and timing relationships on a conventional scope. Each input channel is multiplexed through an analog switching device, so that waveforms as well as logic levels are preserved. In addition, the CMOS circuitry is completely compatible with logic families where the



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power supply voltages range from +3.5 volts to +15 volts (RTL, DTL, TTL, MOS, CMOS, and Microprocessors). The MS-1

Multiplexer Switch is available from stock in kit form for $59.95 and also completely assembled for $74.95. Additional information may be obtained by contacting Mid-South Instrument Services, Inc., P.O. Box 1252, Gretna, LA 70053 or call (504) 393-0450.

Budget Scanner

A new Bearcat scanning monitor radio with a handy "touch action" on/off bar allows the user who hears a siren, for instance, to simply touch the bar and hear instantly what's happening. Named the "Bearcat One-Four", the radio can be used to monitor police, fire, emergency, marine, weather and other services for "while it's happening" information. The new Bearcat One-Four also

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features fast scanning action which can search its four channels in just ½-second. Illuminating LEDs are used to flash the channel being received. Each channel is also provided with a lock-out switch for easy by-passing of any channel. Slide bar controls are used for volume and squelch. To match local frequency assignments the radio is available in a choice of low band, high band or UHF versions. All models feature front directed speakers and excellent sensitivity for clear, local reception using the telescoping/fold-over antenna supplied. For use with other antennas, an external jack is provided. The radio operates from standard 117 volts AC. The suggested retail price is $79.95 less crystals. Complete details are available from Bearcat dealers or by writing to Electra Company, P.O. Box 29243, Cumberland, IN 46229.

Dual Trace

The B&K-Precision Model 1432 portable oscilloscope is a compact, portable, dual-trace unit with more features than many lab scopes. Bandwidth of this triggered

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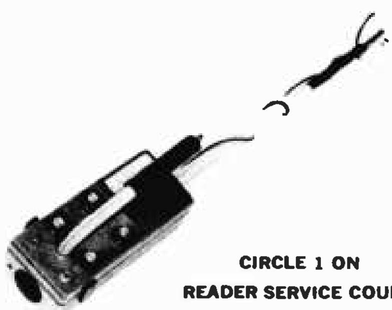
sweep scope is rated at 15 MHz, with a vertical sensitivity rating of 2 mV per division. Usable response extends well beyond 30 MHz. With optional battery pack, the 1432 will perform in almost any field application. A built-in universal power supply provides operation on 117 VAC, 234 VAC, 12 VDC or optoinal internal batteries. Both high- and low-voltage power supplies are fully regulated, maintaining time base and amplitude accuracy over a wide range of input voltages. Unusual features include a capability for the algebraic addition and subtraction of channel A and B input signals, to view distortion products. Nineteen calibrated sweep ranges cover 0.5 microsecond to 1.5 seconds with ±3% linearity. A 5x magnifier extends the sweep range to 0.1 microsecond. Priced at $750, the 1432 comes complete with two lightweight slim-body 10:1/direct probes (includes four accessory tips for each probe and carrying pouch), AC and DC power cables, viewing hodo, and detailed instruction manual. Options include a rechargeable battery pack, carrying case and demodulator probes. The B&K-Precision Model 1432 is available at local disrtibutors. For further information, write to B&K-Precision, 6460 W. Cortland St., Chicago, IL 60635 or call (312) 889-9087.

Metal Location

The GD-1190 "Cointrack" is a new Heath metal locator, named the "coinshooter." Featuring adjustable discrimination and pushbutton tuning, the GD-1190 can be used in areas that, according to Heath, are nearly impossible for many other locators. The search coil unit is waterproof, shaft length is adjustable,



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and collapsible, and the entire unit weighs less than 3½ pounds. A headphone jack is also provided and with the optional Rechargeable Battery Pack, the GD-1190 may be recharged at home or in the car. For additional information about the new metal locator ($149.95 mail order Benton Harbor) or other Heathkit electronic products, write Heath Company, Benton Harbor, MI 49022.

In-Line Preamp

New Telco Products' computer-designed preamplifiers boost receiver sensitivity with ultra low noise. Unique RF sniffer circuit allows the preamplifier to sense when the transceiver is keyed, effectively switching the preamplifier off during the transmit mode. This feature allows the preamplifier to be connected directly into the coax line with no modification to the existing mobile system. Model VHF 144 has 20 dB gain with less than 1.5 dB noise factor. Frequency range 140-180 MHz with 5 MHz band width. Sells for $49.95. Model UHF 450 has 10-12 dB gain with less than .6 dB noise

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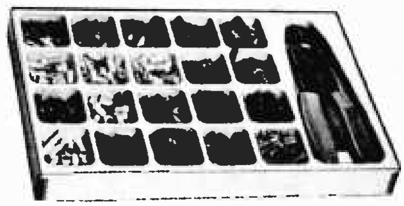
factor. Frequency range 400-512 MHz with 1 MHz band width. Sells for $59.95. For additional information, contact Telco Products Corporation, 44 Sea Cliff Avenue, Glen Cove, New York 11542 or call (516) 759-0300.

Economy Terminal Kit

Vaco's new economical terminal kit No. 89950 comes with a molded tray with separate compartments for the Vaco



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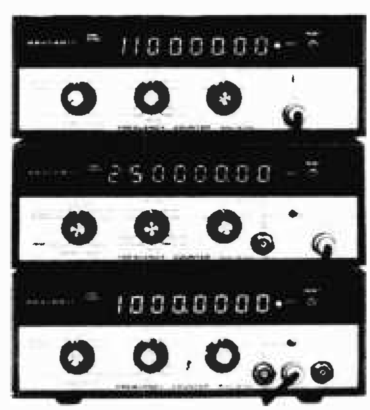
1963 crimping tool and 18 each of 20 of the most popular insulated terminal styles. Included is a handy folder that locates each terminal and explains the uses of the crimping tool. Sells for $35.00. Vaco products are found wherever professional hand tools are sold. Can't find a dealer? Then write to Vaco Products Company, 1510 Skokie Blvd., Northbrook, IL 60062 or call (312) 564-3300.

Trio Counters

Heath Company has introduced three new frequency counter kits; the IM-4110, the IM-4120 and the IM-4130. Input frequencies of the three counters are 5 Hz to 110 MHz, 5 Hz to 250 MHz (in two



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ranges) and 5 Hz to 1 GHz (in three ranges) respectively. The new counters offer excellent accuracy and resolution

(Continued on page 8)

New Products

(Continued from page 7)

for a wide variety of counting jobs including: CB, AM and FM, hi-fi equipment, marine and aircraft radio, military applications, land mobile and more. Additionally, the counters can be used for events, period and period averaging. Eight digit LED readout indicates the frequency counted. A switchable attenuator on the 110 MHz input divides the input signal by one, ten or one hundred to facilitate measurement of large amplitude signals. The time base switch selects the gate time and the resolution of the display. The 4120 and 4130 time bases are controlled by a TCXO (temperature compensated crystal oscillator) with a temperature stability of ± 1ppm and an aging rate of <5ppm/yr. (The 4110's crystal oscillator has temperature stability of ± 10ppm and an aging rate of <10ppm /yr.). The IM-4110 is priced at $189.95, the IM-4120 at $329.95 and the IM-4130 at $529.95. The counters are also available fully assembled and tested at slightly higher prices. For complete details on these frequency counters and other Heath instruments, write Heath Company, Dept. 350-24, Benton Harbor, MI 49022, for a free catalog.

Watch Biorhythm Cycles

Many researchers have suggested that starting from birth humans have built-in biological clocks that vary their physical emotion and intellectual capacities during regular repeated cycles. By simply looking at this unique clock each day, these cycles are shown in digital form exactly where they are in relationship to the individual for which the unit has

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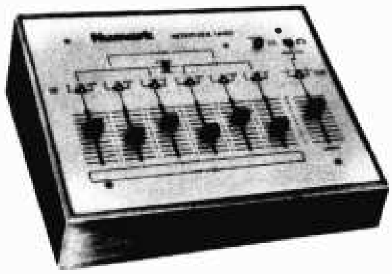
been set. This way, you can actually predict your good and bad days well in advance. It lets you put off important decisions during "off" days or to make important decisions on "high" days. The Personal Biorhythm Digital Clock is available factory wired for only $64.95 each (plus $2.00 for postage and handling per order). It is fully guaranteed and available from Optoelectronics, Inc., P.O. Box 219, Hollywood, FL 33022.

Six Mike Mixer

The Numark Microphone Mixer (Model MX3000) is a sound studio control unit capable of handling any high power amplifier without the use of an external preamplifier. It has six mike inputs; two line



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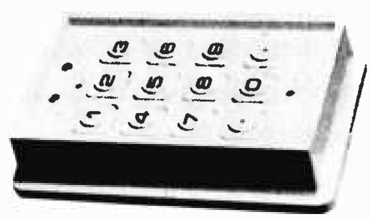
inputs for stereo; individual mike attenuator control switches. Stereo/Mono switches for outputs. Master volume control; Headphone monitor with level control switch. The MX3000 can handle mike inputs from 20 to 18,000 Hz with distortion levels of 0.1% or less and —52 dB hum and noise level. Headphone jack for monitoring unit's output. Powered by 117 VAC, 50/60 line. Sells for $149.95. For more details write to Numark Electronics Corp., 503 Raritan Center, Edison, NJ 08817.

Foolproof Remote Station

An attractive, low-cost coded pushbutton remote control station by Mountain West Alarm Supply Co. eliminates the use of keys and the risk of lock picking. This unit operates momentary contact controls and is usable with many popular



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control panels without complicated wiring hookups or special power considerations. The new D14 pushbutton alarm control features a replaceable, pre-programmed code key which is field changeable. Each time the correct code is entered on keyboard, a solid state momentary switch operates. The keyboard has tactile feedback pushbuttons which are reported to be rugged, yet easy to operate. Uses low input power, less than 2 mA standby at 6 to 24 VAC or DC. Has red and green diode status lights. Unit weighs only 7 ounces, is 4⅞-in. x 3½-in. x 1⅛-in. Case is formed from beige, high impact plastic. Surface mount unit is priced at $53.00 each. For more information, contact Mountain West Alarm Supply Company, Box 10780, Phoenix, AZ 85064.

Electronic Organ Kit

Here's a new kit for the aspiring musician in the family. The Heath TO-1860 is a kit-form version of the Thomas Troubadour 186. Features of the new organ kit include unique Color-Glo keys, preset chords, chord memory, automatic rhythms and more. A "Speakeasy Section" includes automatic arpeggio, automatic strum and "fancy fingers" which automatically plays a counter melody along with the music. The Troubadour also will allow you to play one or any combination of 17 different instrumental voices. Nine fully assembled, tested and tuned circuit boards greatly simplify assembly. The cabinet comes completely assembled of furniture-grade hardwoods, and a matching bench is included. For more information on the TO-1860 organ

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kit, mail order priced at $1,750.00, write for a free catalog to Heath Company, Dept. 350-510, Benton Harbor, MI 49022.

Sound Conditioner

Sound conditioning helps increase the personal comfort level by modifying the severity and annoyance of noises beyond our normal control. Edmund's new Sound Conditioner helps mask unwanted noise while adding restful, interesting background sounds. Used by light sleepers, daytime sleepers and travelers, it electronically simulates the soothing sounds of ocean surf, falling rain and a rushing

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waterfall. The Sound Conditioner contains a five-in. diameter speaker, three modulating controls, on/off volume switch, and a four-sound channel selector that adjusts for most situations and for personal taste. The waterfall sound produces a deep Niagara Falls roar and is intended for blocking out loud noises. Operates on 115/230V AC, 50-60 Hz current. The Sound Conditioner can be ordered by mail (stock no. 72,293) $129.95 postpaid, plus $1.00 for handling, from Edmund Scientific, 7782 Edscorp Bldg., Barrington, NJ 08007.

Small but Good

NLS has added a low cost, miniature, cathode ray oscilloscope to their line of test equipment. The MS-15 Miniscope weighs only three pounds, is physically small at 2.7-in. high by 6.4-in. wide by 7.5-in. deep and sells for $289.00. The vertical bandwidth is 15 megahertz. Internal and external triggering are provided

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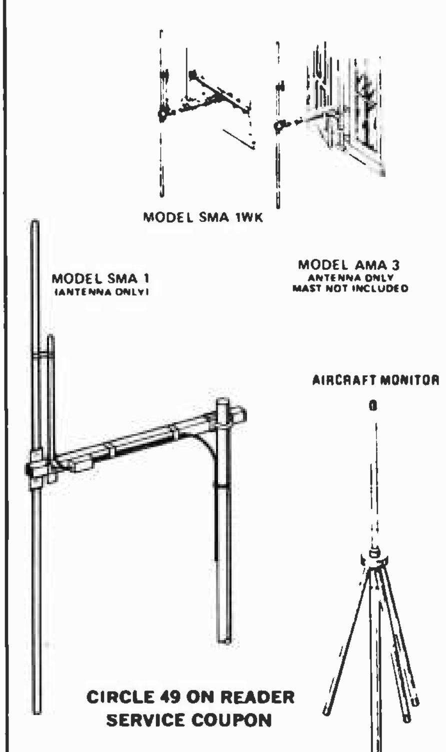
along with automatic- and line-synchronization modes as well as a horizontal input. There are 12 vertical-gain settings from 0.01 volts to 50 volts per division. Twenty-one time-base settings from 0.1 microseconds- to 0.5 seconds-per-division are included. An optional 10 to 1 probe and a carrying case are also available. For more info on the MS-15, write to Non Linear Systems Inc., P.O. Box N, Del Mar, CA 92014.

Scanner-Monitor Antenna

FINCO offers a new and different line of Sanner-Monitor antennas called the SMA



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line and an Aircraft Monitor AMA line. Reading up the SMA series of omni-directional Scanner-Monitor antennas, is the model SMA-1 for operation in the Lo-VHF 30- to 50-MHz, Hi-VHF 148- to 174-MHz, and UHF 450- to 512-MHz frequencies. The unit operates as a ½-wave dipole in the Lo-VHF Band, as a 3/2 wave dipole in the Hi-VHF Band, and as a "J" stub in the UHF Band. ($8.95). The model SMA-1K is identical to the SMA-1, but includes a kit with 65-ft. of coaxial cable with a connector and weather boot on one end. ($17.95). The model SMA-1WK is identical to the SMA-1, but includes 18-ft. of coaxial cable with connector and weather boot on one end and a complete window mounting kit. ($21.95). The aircraft monitor model AMA-3 is an omni-directional antenna tuned for the 108- to 138-MHz aircraft frequencies. The unit operates as a ½-wave omni-directional ground plane. ($20.95). For further information, write The Finney Company, 34 W. Interstate Street, Bedford, OH 44146.

Telescope Designed for Amateurs

A compact, easy-to-use 6-in. f/6 Newtonian telescope, designed by astronomers for amateur and professional ob-

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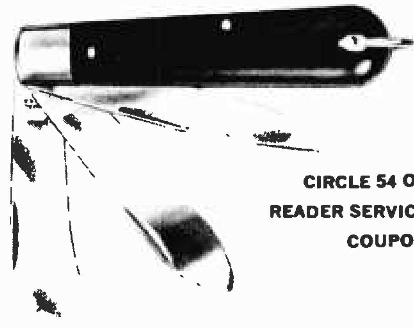
servers alike, is now available from Edmund Scientific. The Telescope features compact portability, superior optics and sophisticated adaptability to many astronomical applications, especially astrophotography. Its lightweight, cast-aluminum alloy equatorial yoke mount and stable tension-tripod base fold compactly for easy storage and transporting. Its 5- to 85-degree latitude adjustment make it suitable for use throughout the world. Capable of revealing stars as faint as 13th magnitude and splitting double stars separated by as little as ¾ second of arc, its superior ⅛ wave optics feature a precision-annealed, aluminized and over-coated 6-in., f/6 parabolic primary mirror and large, fully adjustable, ⅛ wave elliptical diagonal mirror. Its standard equipment includes: synchronous clock drive; self-lubricating, low-friction bearings on both R. A. and Declination axes; fine adjustment declination control; engraved, easy-to-read drum setting circles; standard 1¼-in. I.D. rack and pinion focusing mount; newly designed and ray-traced Edmund 28mm, 33X RKE Eyepiece; quick-release tube and polar angle adjustment knobs; and a unique cradle-design that accepts accessory mounts. The complete Edmund 6-inch f/6 Telescope System (stock no. 3001) sells for $399.00 T.C.C., and is available by mail from Edmund Scientific Co., 7782 Edscorp Bldg., Barrington, NJ 08007. Parts are available for those who would rather do it themselves.

Electricians Pocket Knives

A new line of electricians pocket knives has been introduced by Vaco. These



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handy, heavyduty pocket knives are made of the cutlery steel blades. They are tempered and hold their edge under hard use. Their extra strong construction features riveted shackles with steel and brass bodies. Grip-textured plastic handles resist cracking or chipping. The handy two-bladed model has a standard 2½-in. long spearpoint blade and a 2½-in. screwdriver tip blade with cutting edge. Sells for $6.25. The versatile three-bladed model has a curved 2⅜-in. sheepfoot slitting blade plus a 2½-in. spearpoint blade plus a 2½-in. screwdriver tip blade and both models lock open for safer, more efficient use. Sells for $7.50. These new Vaco knives, as well as all Vaco tools, are fully warranted. For further information, write to Vaco Products Company, 1510 Skokie Blvd., Northbrook, IL 60062.

Hole Cutting Kit

Drill burr-free holes for easy mobile CB antenna installation or for electrical and hobby uses with the unique Conecut Kit from GC Electronics. The kit (3420) contains two drill bits (No. 1 drills holes from ¼-in. to 13/16-in; No. 2 from ⅝-in. to 1-3/16-in.), cutting compound and assortment of fiber hole gauges, all in a convenient vinyl pouch. Holes can be

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drilled in almost any thin material with the Conecut drill bits—steel, sheet metal, tubing, conduit, plastic or formica. Pilot holes or center punch marks are unnecessary, even on curved surfaces. Sells for $34.95. For more information, write to GC Electronics, 400 South Wyman, Rockford, IL 61101. ■

Got a question or a problem with a project—ask Hank! Please remember that Hank's column is limited to answering specific electronic project questions that you send to him. Personal replies cannot be made. Sorry, he isn't offering a circuit design service. Write to:

Hank Scott, Workshop Editor
BUDGET ELECTRONICS
380 Lexington Avenue
New York, N.Y. 10017

Builds from Scratch

Is there a company that will sell you PC boards and parts lists to build a microcomputer?

—T. B., Hawthorne, NY

Don't know what level computer hobbyist you are so I'm giving you the names of three companies you should write to for catalogs.

Heath Company, Dept. EE, Benton Harbor, MI 49022.

South West Technical Products Corp., 219 W. Rhapsody, San Antonio, TX 78216.

Electronic Systems, P.O. Box 212, Burlingame, CA 94010.

Shortwave Problem

About two months ago I sent for a QSL reply to Radio Havana, Cuba. I have not heard from them and I was wondering if they send replies? Also, thank you and ELEMENTARY ELECTRONICS *for all the DX and SWL information.*

—G. P., Houston, TX

Yes, Radio Havana Cuba, like most of the major shortwave broadcasting stations, will QSL listener reports. But sometimes replies are delayed two or three months. Chances are you will have received your reply by the time you read this. If not, perhaps your report was misplaced or lost, either in the mails or at the station. Try another report. The address is Radio Havana Cuba, Box 7062, Havana, Cuba. For information of all aspects of DXing, check out Don Jensen's *DX Central* column in ELEMENTARY ELECTRONICS magazine.

Flat Leads

Hank, I can't find the ribbon cable used by computer buffs in the number of leads and lengths I need. What do I do?

—K. B., Bensenville, IL

Bullet Electronics, P.O. Box 19442G, Dallas, TX 75219 sells 26 conductor multicolored, ribbon cable ten-feet long for $2.95. They may have other specials. Give them a call at (219) 823-3240.

Pulling IC's

My dad said I should not pull IC's out of sockets with my fingers, but to use an IC extractor. Why? My fingers are small enough for the job.

—P. M., Denver, CO

They are, but you will grow up, and so will your fingers. The less stress and bending you put on IC pins, the less chance you have of breaking them. Also, service technicians have been known to prick themselves as the IC flipped in their fingers when extracted from the sockets. Listen to dad, or you'll end up like a serviceman with his finger in his mouth!

Audio Sleeper

I saw some Nikko receivers today for the first time. They looked good and played well in the store. Are they really that good? The model I'm interested in is the NR-1415.

—S. R., Chicago, IL

You bet! We tested that unit for our audio magazine, HI-FI/STEREO BUYERS' GUIDE and found that the FM stereo sensitivity was very good. The amp section delivered 186 watts RMS when the maker modestly called it a 175-watt unit. That's 6% more output than you paid for! Nikko has been around for many years but they have not been very pushy—they just produce quality equipment.

Inland Pirate

There is a gentleman in Lexington, KY that broadcasts on the AM dial with a power of 3 watts and he does not require a license. As I would like to do the same, could you advise if this is legal? If so, is there a company that makes an oscillator or transmitter for this?

—A. B., Jeffersonville, IN

As the old saying goes, "See you in Jail!" your friend in Kentucky will soon be there because he does need a license to own and operate an AM radio station. In fact, he needs a license as an operator. I suggest you address all legal questions to the FCC in order to get the straight facts!

Talk to Him

I get free time on an APL (SV) timeshare computer and would like to get in touch with other users of this powerful language to trade programs and the like. I am also looking for good books on the subject. Any suggestions?

—David Wilkinson
P.O. Box 1004
Donnacona, P.Q., Canada

Okay, David, hope our friends can help you.

He Hears Voices

Got a question for you, Hank. Is there a receiver miniaturized enough to be put in right next to your middle ear by putting up through the eustachian tube?

Reason is I started hearing voices and started thinking I was going nuts. Then a guy with a CB linear near blew my head off. Instant relief. But I would like to know where the jackass that did it bought 'em. So, if you could find out for me, I would appreciate it.

—N. N., Durango, CO

Sounds like you have galena crystals in your head! Did you have any dental work done lately?

Your case is not unusual. It has happened before. However, some doctors may not believe you, so take a portable CB with you and have the doctor's nurse call off names of flowers into the CB where you can't hear it. Once he believes you, then they can look for the remedy.

As for a receiver stuck in your head—no such thing.

One Size Fits All

Is it wrong to use overrated components in a project? For example, I used an 1-A rectifier in a circuit where 50 mA current is required. I used a few one-watt resistors (only because I had them) in place of ¼-watt resistors, etc.

—L. M., Ithaca, NY

No, it's not wrong most of the time! However, you'll find the project being a bit bulkier than it should be. This may be a problem in RF projects. As a rule, I buy only 1-ampere rectifying diodes because they do about 99 percent of the jobs required of a diode. You can save lots of money by making bulk purchases and using what you have and not buying odd-valued parts.

What's Inside

What size resistor is in a standard spark plug?

—E. D., Boulder, NV

A resistor of about 5000 ohms is deeply inserted into the center electrode of a spark plug to minimize radio noise interference.

Wants a Lot for Nothing

My question is why can't diode radios that don't take any source of voltage be used with speakers?

—C. M., Orangeburg, SC

You could drive a 5-inch PM speaker, if your receiver and antenna were near a radio station tower, but at a distance, the power received is measured in microwatts. There's enough to give low volume from a headset, but that's it.

I Like to Solder

Hank, I heard that those new crimp-on antenna connectors aren't much good. Do you agree?

—J. O., Reno, NV

I don't know who you are listening to, but tune him out. The new crimp-on jobs are quite good. I found that some cable assemblies have their center tips soldered and some do not. So, I solder every unsoldered tip I come across. Actually, I never had any problems, but I'm fussy that way.

Best Tune There Is

When can I hear WWV and at what frequencies?

—B. Q., Key Biscayne, FL

The U.S. Government station WWV broadcasts on 2.5, 5, 10, 15, 20, and 25 MHz continuously night and day, except for silent periods of approximately four minutes beginning 45 minutes after each hour. You can use these frequencies to calibrate your shortwave receiver dial. WWV gives time signals, but the method and intervals vary from time to time. If you want to set your LCD watch or calibrate your signal generator, WWV is tops.

He's Still Sane

I was listening to a stereo cassette, rewound the tape to a song's starting point, when my mom called me from the next room. I hit the pause control to stop the tape mechanism, and I got an SSB signal in the headphones. Am I going nuts? What could have caused that to happen? It's only happened that one time and not since.

—B. B., Staten Island, NY

Your still with us, solid as ever. Your report indicates that the high level audio section of your cassette deck is detecting the SSB signal and amplifying it. The nonlinear element doing the detecting is the tape head with ferrous particles from the tape attached in the magnet gap area. Enough said, a basic untuned radio. The same thing happens in high-level mic lines, phono leads, etc. The SSB signal source should be nearby to be detected. It could have been a passing car.

Antique Restorer

Hank, I am active in restoring antique radios not only for myself, but for my friends, also. I need a source of schematic diagrams and technical data that I can call on. I don't mind paying a small fee. Can you help me?

—D. F., Tulsa, OK

Schematic diagrams and service information on specific radio and TV sets are available at a nominal charge from Supreme Publications. Supreme is able to supply such information from its own service manuals, from its extensive files of factory data going back to the 1920's, and from manuals of other publishers. The charge is $1.50 and up, and the usual charge is $2.50. James Lynch told me over the phone, "Each request for material is a challenge to us, and while most items can be easily and quickly filled, at times our Mr. Beitman (who has been connected with diagrams and servicing for 40 years) spends an hour to find a hard one. 'It's fun,' so he says." It is good to know that there is a large organization ready to supply service material on a radio or a TV set you may find hard to repair and for which you do not have a diagram and other helpful service data. Write Supreme Publications, 1760 Balsam Road, Highland Park, IL 60035.

Microprocessor Scanners

Are those new scanners with built-in microprocessors really worth the money they're selling at?

—L.M., So. Plainfield, NJ

Well, I've used two models, one from Electra and one from Radio Shack. Both are great and well worth the money. It's interesting to note that microprocessor scanners add new dimensions for the action-band monitor or listener. The ability to search for new channels you did not know existed is remarkable. You can search, scan and/or monitor over 16,000 channels. Only yesterday, I discovered a monitor channel operated by a commuter railroad. I know when the 8:03 will be late. In fact, in discovering this frequency, I purchased a crystal for my pocket scanner and I keep the conductor informed as to why the train is late!

Lend a Hand, Boys!

We're doing a bit of all right with this part of our column. Readers are telling me that help is coming through the mails. That's wonderful, so keep up the good work.

Δ Earthquake alarm: F. Rivera of 109 Georgette St., Rio Piedras, Puerto Rico 00925 would like to buy one. Send any ads or literature you know of. Also, send some to me, Hank. I'm an easterner, but discovered I live near an old fault line.

Δ Hammarlund HQ-100A receiver, needs second stage coupling transformer—part or advice requested: Terry Duvieith, 3017 Charles Drive, Chalmette, LA 70043.

Δ U.S. Navy OS-8E/U oscilloscope, needs operating manual and/or schematic diagram: Steve Halvorson, 4244 Washington St. N.E., Columbia Heights, MN 55421.

Δ Atwater Kent Model 55C schematic diagram and Philco model 384 schematic diagram: Joseph Buonincontri, 31 Orchard Rd., Maplewood, NJ 07040.

Δ Radio Marine Corp. of America mode AR-8506B receiver, schematic diagram and/or service literature needed: Robert L. Bodine, Jr., 201 W. Azalea Ave., Tampa, FL 33612.

Δ Knight Transistor Stereo Amplifier model KG-870, schematic diagram required: George Martin, 45-57 167th St., Flushing, NY 11358.

Δ Ballast tube 24B875 for Hallicrafters S-52 shortwave receiver urgently needed: Robert E. Musser, R.D. 1, Box 292, New Columbia, PA 17856.

Δ Metz 202 Electronic Flash, needs schematic diagram: Clayton Mitchell, 4326 Sheldon Ave., Baltimore, MD 21206.

Δ Knight-Kit R100 shortwave receiver needs info on obtaining new oscillator and RF coils: Gary Lenarz, 1424 165th Ave., San Leandro, CA 94578. ■

GETTING OUT

Get the most from your signal dollar with these antenna tuning tips.

by James Toth

IF YOU HAPPEN TO BE in jail and have just eagerly flipped this magazine open to this article, then sorry, but it won't help you in spite of the title. But if you happen to be a CB radio enthusiast and are interested in "getting out" in the CB slang sense of the phrase, then you have come to the right place, for here you will find everything you need to know in order to squeeze every last inch of range out of your CB setup.

Here are six things to think about while trying to boost your CB's range.

Antenna Height. First, for maximum range your antenna should be as high as legally possible. It is said that you can talk about one-third farther than the line-of-sight distance between the tip of your antenna and the tip of the other fellow's antenna, and the higher the antennas, the greater the line-of-sight distance. This effect comes from the fact that although light travels in a straight path, radio waves tend to follow the shape of the earth's surface somewhat. Therefore, although someone's antenna may be below the horizon so you can't see it, your radio signals may still reach him if he isn't too far below.

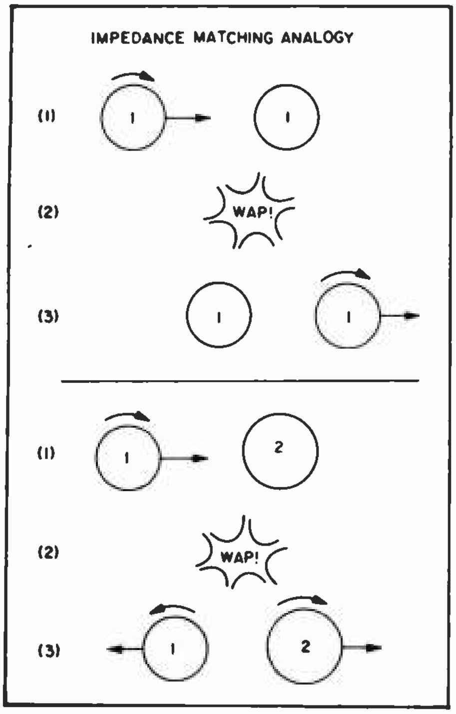
The question, then, is what is the legal maximum height? For omnidirectional antennas (those which radiate equally in all horizontal directions), the height limit for the tip is 60 feet. The limit for directional antennas is 20 feet.

But it is possible to do a lot within these limits if you want to increase your range badly enough. For example, put your antenna on top of a nearby hill instead of right next to your house. But of course, you will need a lot of line for this trick.

Another thing you can do is put your antenna on top of a tall building. If the building is more than 40 feet high, you are allowed 20 feet above the top of it. Obviously, mounting your antenna on top of a good-sized building can put it well above what a neighbor could achieve working from the ground up.

Standing Wave Ratio. Second, there is the matter of SWR or standing wave ratio. A good way to visualize this is through a physical analogy. Imagine a ball bearing rolling along. Since it is moving, it possesses some energy of motion (kinetic energy). Suppose this ball bearing were to collide with another ball bearing which had equal mass and was stationary. Upon collision, the rolling bearing's kinetic energy will be totally transferred to the formerly stationary bearing. The transfer of kinetic energy will be 100 percent, but only

GETTING OUT



Impedance matching can be represented by the transmission of energy from one rolling ball to another stationary one. If both have equal mass the first will stop and the second take off at equal speed (in a frictionless system). If the second ball is more massive, as illustrated in the three bottom drawings, the first ball will bounce back just as RF will bounce back if an antenna is improperly matched to the transmitter and line.

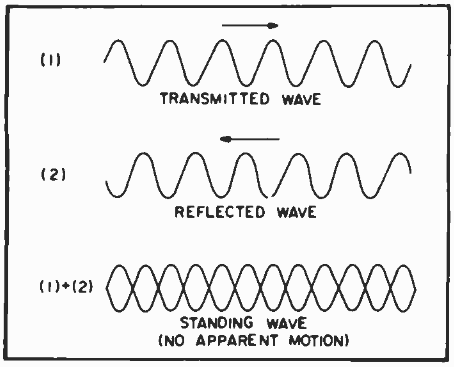
because the bearings are of the same mass. It reminds one of head-on collisions between billiard balls.

In electronics, impedance (like resistance) plays the role that mass played in the ball bearing analogy. Ideally you want 100 percent energy transfer from the transmitter to the antenna, but this can happen only if the impedance of the transmitter and that of the antenna match. Otherwise, some of the energy is reflected back from the antenna to the transmitter.

What you have then is waves traveling from your transmitter to your antenna and from your antenna to your transmitter, both at the same time. The two sets of waves interact to form standing waves, which decrease the efficiency from maximum and could damage your radio to boot.

The presence of such waves can be detected by an instrument which measures standing wave ratio. This quantity is a number which you want to be as low as possible.

Here are some sample SWR readings together with what they will do to your



These diagrams show how the transmitted wave and the reflected wave interact to form a standing wave that decreases the efficiency of your transmission.

radiated power:

3:1 generally is considered to be the highest SWR a CB radio can live with. And really, that is too high, too. 1.5:1 or less is more like it.

So buy yourself an SWR meter (they're inexpensive) and check your radio from time to time. If the SWR is too high, getting it down to size usually is just a matter of changing the length of the antenna, provided it is not a fiberglass one.

The procedure for checking a mobile antenna's SWR goes like this: Check the SWR on the highest channel, and then check it on the lowest channel.

SWR	Percent Reflected Power	Radiated Power
1:1	0%	4.00 watts
1.5:1	4%	3.84 watts
2:1	11%	3.56 watts
2.5:1	18%	3.28 watts
3:1	25%	3.00 watts
∞:1	100%	0.00 watts

Ideally, these two numbers will be the same and as low as possible. If the SWR on the highest channel is higher, this indicates the antenna is a bit too long and must be shortened. If the SWR on the lowest channel is higher, then the antenna is too short and must be extended a little. When the two SWR's are identical, then the SWR on the middle channel should be as low as it is going to get, hopefully near 1:1.

Changing the SWR of a base antenna is another story. There is no convenient little screw to allow you to manipulate the length. If a base antenna's SWR is too high, there is probably something wrong with it or the line leading to it, like bad or wet connections or broken wires. Use your own ingenuity to figure out just what is messed up.

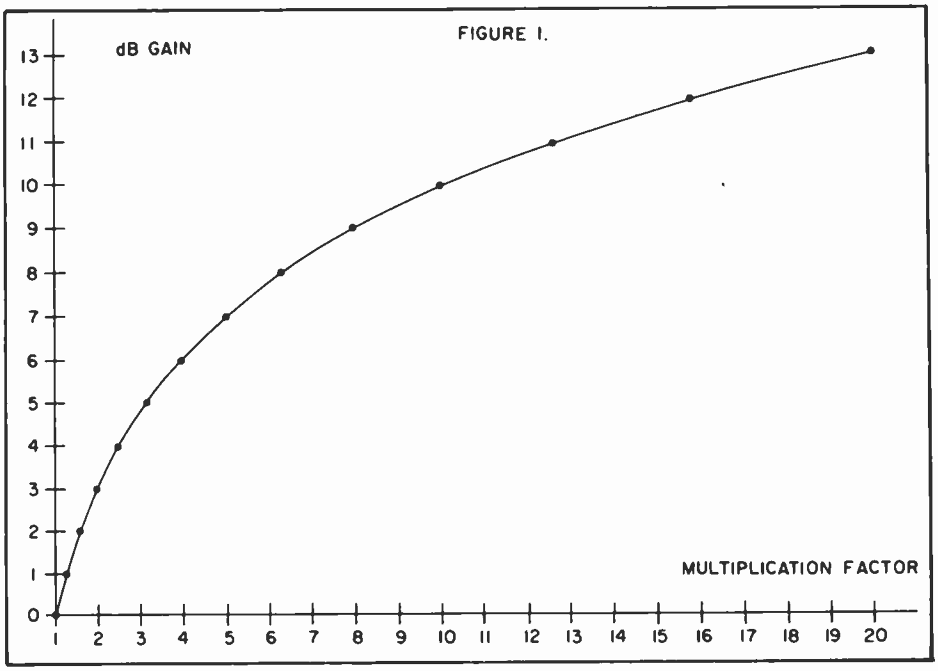
Antenna Gain. Third, there is the fact that all antennas are not created equal. There are those which radiate the legal 4 watts and that's it, and there are those which radiate 4 watts but seem as though they have more effective radiated power (ERP). By mathematically relating the real power output with the ERP we can derive the antenna gain which is normally measured in dBs or decibels.

An easy way to visualize this is to try the following simple experiment: Look at a low-power electric lightbulb, say 10 watts. Your eyes are perceiving 10 watts of light power. Now, hold up a mirror next to the bulb so that you now see two bulbs side by side. Your eyes perceive 20 watts of light power. If you put up a second mirror to see three images you will see 30 watts even though the bulb is still only putting out 10 watts. The ratio of ERP to power is three to one and the ERP multiplication factor is three.

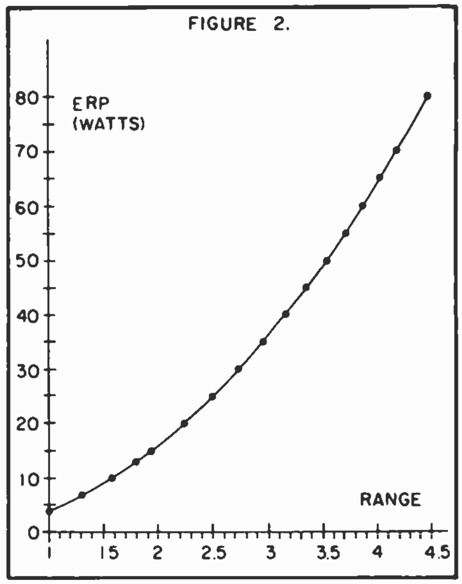
All antenna gain measurements work in much the same way but instead of a 10-watt bulb we use a "standard dipole" antenna. The power received from a test antenna is compared to the power received from the "standard dipole" and the ERP multiplication factor and gain is determined by applying the mathematical equation that is explained elsewhere in this article.

This equation, if reduced to a more

One of the most important factors in attaining a good standing wave ratio is to have an antenna of the proper length. Some antennas such as the Avanti Racer, shown here, have tunable tips so they can be fine tuned without the need for cutting. The antenna should be tuned on the middle frequency of the set, and the SWRs of the outer limit frequencies should be of equal value.



This graph can be used to determine the dB gain if you know the multiplication factor or the multiplication factor if you know the gain. For example; a 12 dB gain will equal a multiplication factor of 15.5. This is much more convenient than the formula.



By using this graph your probable range can be determined if you know your effective radiated power (ERP). For example: If your set has a range of 5 miles with no gain (ERP 4 watts for CB), increasing the ERP to 35 watts will up your range to 15 miles (Range factor of 3, times 5 miles).

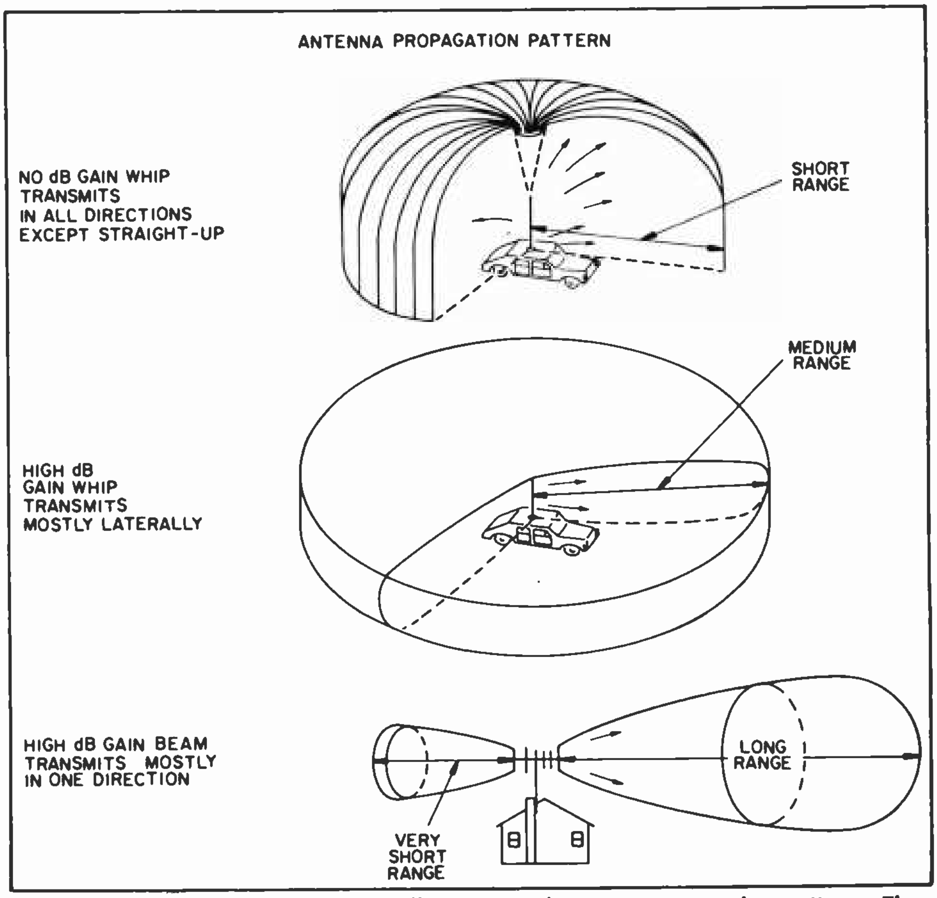
readily useable graph form, looks like figure 1. The graph can be used to find an antenna's multiplication factor (and hence ERP) whenever its dB gain is known. If you know the dB gain, just go up to that number on the dB gain axis, then go straight across until you hit the curve, and then drop down to the multiplication factor axis and read off the antenna's multiplication factor. That number times 4 will get ERP.

ERP and Range. So now you know just what your ERP is. What does this mean in a practical sense? If your ERP is, say, three times the basic 4 watts, does this mean you can talk three times as far?

No, it doesn't. You will be able to talk farther, but not three times as far. To find out exactly how much farther, consider the following:

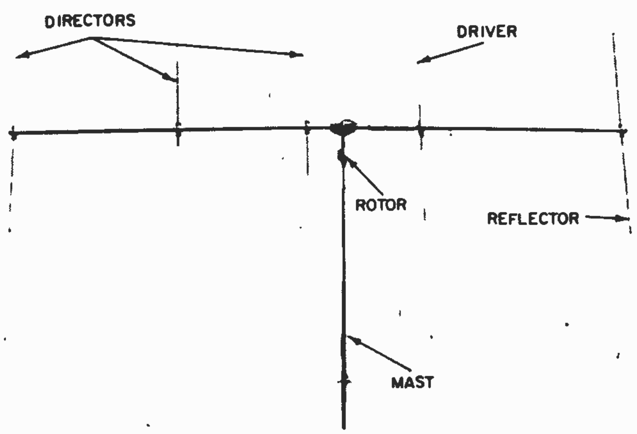
Suppose that at some distance R some radio signal comes in just as strong as some other radio signal at some other distance r. For the two signals to come in at the same strength, their intensities (power per unit area) must be the same, but the ERP must be greater for the signal to travel distance R. By turning this all around mathematically it is possible to discover how much farther a signal will reach (in terms of r) if you know the ERP. Again the mathematics are shown elsewhere in this article and can be reduced to the graph form as shown in Figure 2.

On the graph, the range of an antenna whose ERP is only 4 watts is taken as 1. The range of other antennas will then be so many times this distance.

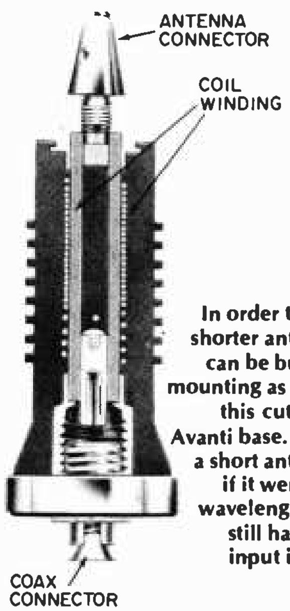


These three drawings are simplified illustrations of antenna propagation patterns. The top diagram is of a unity gain whip antenna—RF propagates equally in almost every direction. The middle antenna is a whip with some gain such as a 5/8 wave VHF antenna or an antenna with an effective ground plane. It will transmit more of its radiation horizontally rather than waste it trying to reach birds. There are thousands of different types of beam antennas but they all try to achieve the results shown in the third drawing—to put the RF out in one direction with as little wasted energy as possible. These antennas also receive directionally. At short ranges they transmit and receive in all directions.

GETTING OUT



This beam antenna is more commonly called a five element yagi. It has one driven element, one reflector and three drivers. With a yagi the ratio of the interelement spacing to the wavelength is vital to the efficiency of the unit. An electric rotor is needed to aim the unit in the desired direction.



In order to achieve a shorter antenna a coil can be built into the mounting as is shown in this cutaway of an Avanti base. This makes a short antenna act as if it were a quarter wavelength long and still have the right input impedence.

One of the most important gadgets for anyone serious about getting out, is a standing wave meter such as this Micronta unit by Radio Shack. By comparing the transmitted and reflected power the standing wave ratio can be determined, and you can see how efficient your antenna is at getting out!!

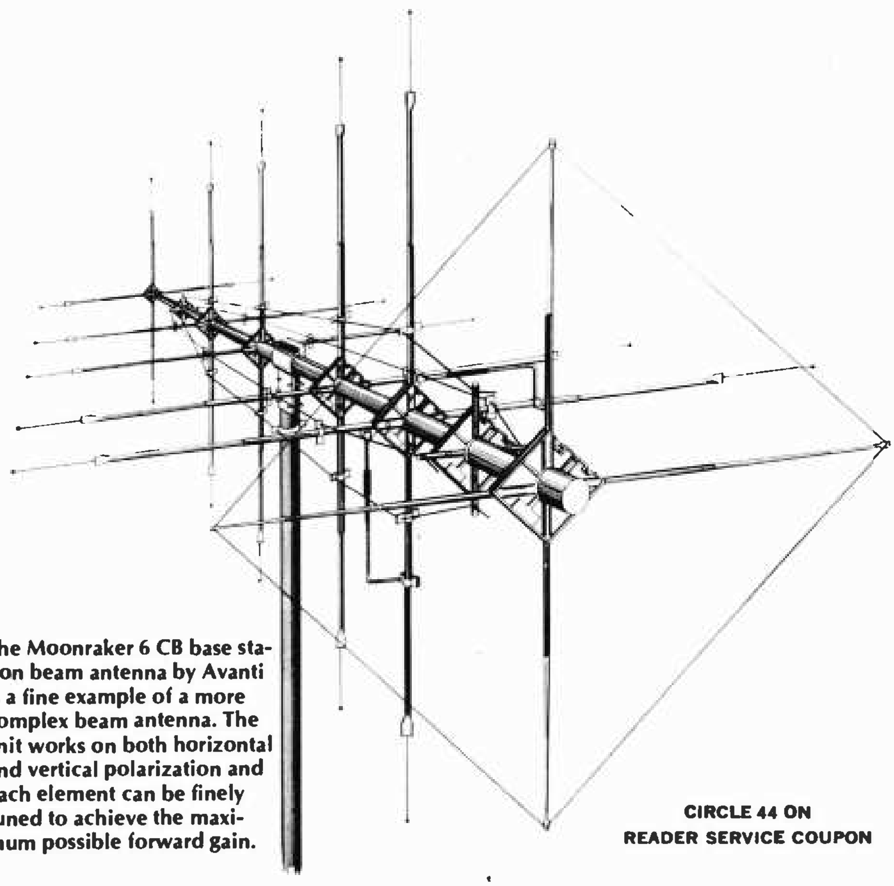
For example, the original question was, if an antenna's ERP is 12 watts, how much farther should you be able to talk than with just the basic 4 watts? The answer is readily attained using the graph. Go up the ERP axis until you find 12, then go straight to the right until you hit the curve, and then drop down to the range axis and read off the relative range. In the case of .12 watts you get 1.73, which means you can talk 1.73 times as far as with an antenna with no dB gain.

Beams. But there is just so much dB gain which can be built into an omnidirectional antenna, no matter how clever the designer is. If you want more than five or so dB gain, then you have to move on to a directional antenna, a beam.

A beam gets its super dB gain from taking the idea behind omnidirectional antennas with gain and taking it one step further. An omnidirectional antenna with no gain takes your 4 watts and sprays it all over the place, a lot of it skyward. The skyward part is of no use to anyone, so if it could be eliminated, there would be more to spray out parallel to the ground where it is needed—there would be a gain in useful power, a dB gain.

But even if all your power were sprayed out parallel to the ground, a lot of it still would be wasted. Since gen-

(Continued on page 116)



The Moonraker 6 CB base station beam antenna by Avanti is a fine example of a more complex beam antenna. The unit works on both horizontal and vertical polarization and each element can be finely tuned to achieve the maximum possible forward gain.

BUILD SELECT-A-SPEED MOTOR CONTROL

Beginner's project that provides choice of speeds for electric drill and other AC devices.

by the Electronic Assembly Class
Central High School, Bridgeport, Connecticut

We have all become conditioned to expect rapid transportation via fast cars, streamlined trains and supersonic jets. We've learned to expect instant . . . cash, credit, headache and stomach relief, rebates, replays and foods. No wonder we seldom think of speed in terms of anything less than maximum. 'Twould seem practically un-American.

However, those of us who have to work with non-ferrous metals, with plastics, or hard woods, find it important to get intermediate ranges of speed (rpm) with portable electric drilling equipment. The Select-A-Speed motor controls described here accomplish this goal. The smaller model continuously varies the rpm of portable ¼-inch electric drill motors, and the larger unit provides incremental speed changes using a switching arrangement, a feature not previously seen on a control of this kind.

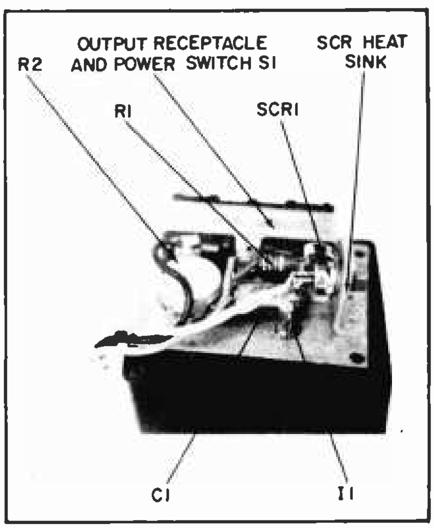
How It Works. The heart of these units, a silicon controlled rectifier (SCR) is a four-layer device whose construction is shown in the diagram. Alternate half-cycles provide the forward bias to cause the conduction, which occurs when the gate is properly triggered. The RC time constant, provided by the resistance and the capacitance controls the rate of charge of C1. Here's how the circuit acts.

C1 will discharge through I1 when the charge on C1 is equal to the ionizing potential of I1, thus providing the gate with a signal. Once triggered, conduction is sustained until the negative half-cycle reverse-biases the SCR at which time conduction ceases until the cycle is repeated. As more resistance is introduced the RC time constant is increased. The resulting increased phase shift further delays the time at which the gate is triggered. This causes the SCR to conduct for less time, and the available load power is thus diminished.

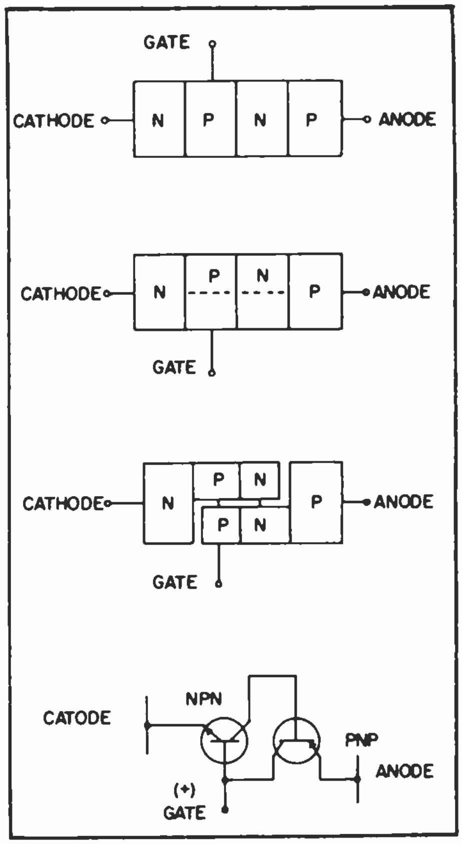
Can Control Many Devices. This versatile unit also functions well as a temperature-control device for pencil-type soldering irons, and also regulates the intensity of conventional desk lamps as well as photo-floods.

In addition it works well to control the speed of electric sewing machines and other small motor-driven hand tools. However, you *must not* try to use it to control devices which have transformers in them, such as soldering guns (pencils are OK), high intensity lights, etc. Of course it won't work at all with fluorescent lights, because lower voltage won't be sufficient to work the starter.

Any number of switch positions may be incorporated. One prototype of ours had ten. Whether you opt for three,



View inside speed control which is continuously variable. Note SCR heat sink.



Silicon-controlled rectifier is a four-layered device. Simplification is shown at top. Gate voltage cuts off current between cathode (left) and anode (right). At bottom is a schematic diagram showing the SCR acts as though it were two transistors, an NPN and a PNP, together. Positive voltage on gate (of NPN) causes that "transistor" to conduct.

SELECT-A-SPEED

four . . . or ten, the option merits consideration. Having this choice eliminates sharpening drill bits so frequently as would be required without speed selection. Utilizing too high a speed for a given material is similar to "running in place" . . . neither gets you anyplace; both are dulling! Operating at speeds less than those recommended tends to cause breakage and invite physical harm to one's person.

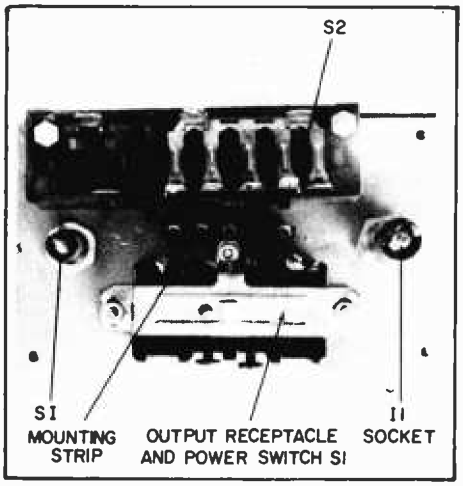
The resistors may be of any wattage and their ohmic resistance figured on the basis of the speeds most useful to you. We actually found the resistor values for optimum operation by using a resistance substitution box.

Parts placement is not critical. The controlling SCR should definitely be heat-sinked. Be sure that the SCR is electrically insulated from the sink or chassis. It is necessary to use silicone grease to insure proper heat transfer. Don't exceed the wattage rating of the SCR!

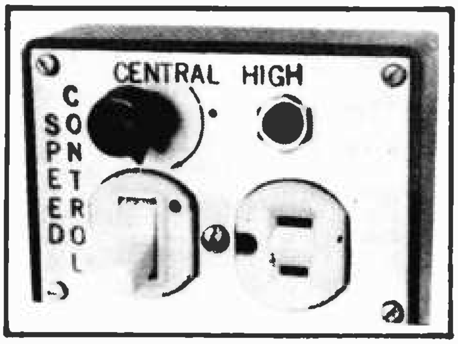
All switches used in our prototype models were bought through a source of surplus supplies. Each was modified to meet our particular needs. Incidentally, we noted no appreciable difference in speed between conditions of load and no load.

A photograph of the waveforms was taken across the load with the SCR as the controlling device. The SCR was apparently conducting during 90 degrees.

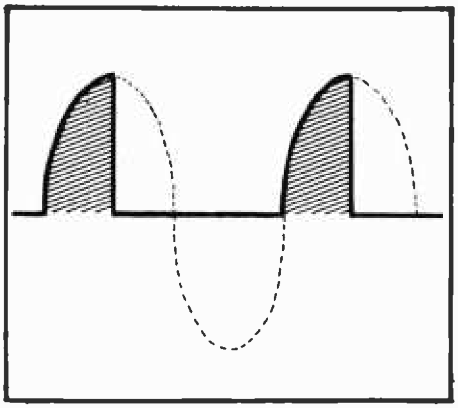
The industrial electronics class of the Career Education Department of Bridgeport Central High School worked on this project. Special credit is due Anthony D'Andrea, Torcato Caldas, Brad Hechler, and Chris Shamiss. Class instructor, under whose supervision this project was completed, is Edward M. Allen. ■



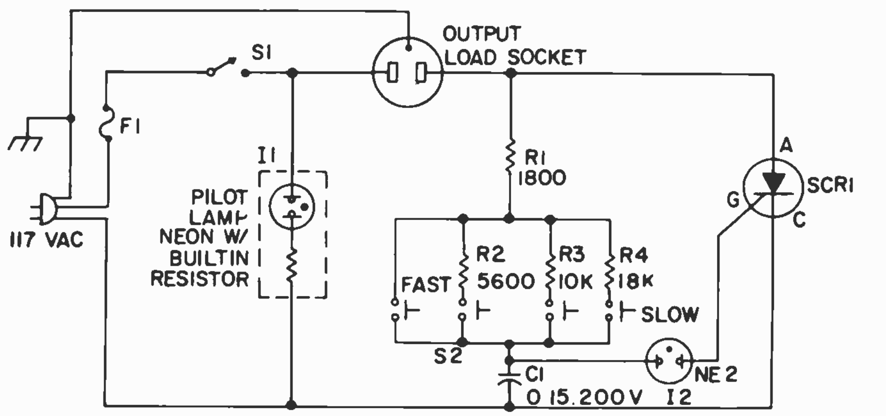
View inside 4-speed control shows pushbutton switch at top. Similar to fan controls.

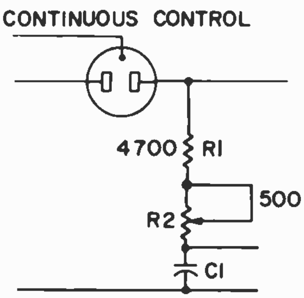


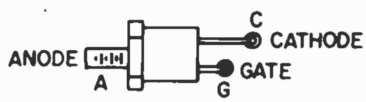
Variable-speed unit uses potentiometer for smooth, continuous control.



Oscilloscope screen shows portion of AC sine wave during which SCR permits current to flow (cross-hatched parts).







PARTS LIST FOR 4-SPEED CONTROL

C1—0.1 to 0.2-uF, 200-V DC (or better) capacitor

I1—Indicator light, neon, with resistor built into holder, 117 VAC

J1—Outlet socket and toggle switch, duplex unit, 117 VAC (from electrical or hardware store).

Q1—Silicon-controlled rectifier, 200 VDC or better, 8A (Motorola HEP-R1243 or equiv.)

R1—1800 ohm, ¼- or ½-watt resistor

R2—5,600-ohm, ¼- or ½-watt resistor

R3—10,000-ohm, ¼- or ½-watt resistor

R4—18,000 or 20,000-ohm, ¼- or ½-watt resistor

S1—part of J1, above

S2—4-position pushbutton switch, heavy duty electrical (10A or better). From electrical or hardware store (similar to switches used on large fans, blenders, etc.)

Misc.—Aluminum utility box, 6-in. x 3- or 4-in. x 2-in. or more

PARTS LIST FOR CONTINUOUSLY-VARIABLE CONTROL

Substitute the following parts in the 4-speed control list above:

R1—4700-ohm, ¼- or ½-watt resistor

R2—50,000-ohm potentiometer, linear taper

Note: omit R3 and R4.

The chances are excellent that...

You have a talent other people are willing to pay for!

You're "handy" around your house, have the ability to fix things, and "make them work right"...that's why there may be a rewarding career for you in Electronics.

A career in Electronics?

Absolutely. Because you're interested in *things*. How they work. Why they work. How to take them apart and put them back together. Plus . . . you've got a head for detail work.

Your chances are excellent

With the right kind of *specialized* technical training, you can have a challenging, financially rewarding future waiting for you in Electronics. Think of the career opportunities . . . computers, aerospace, 2-way radio communications, radio/TV broadcasting, medical electronics, to name just a few.

And, surprisingly, you don't need a college degree!

All you need to do to qualify for one of these exciting career fields is to build upon the technical aptitude you already have . . . just put your hands and your head to work with a CIE Electronics career course.

You learn by doing

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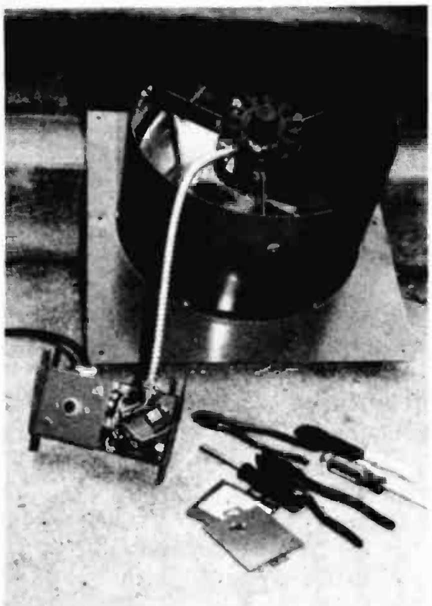
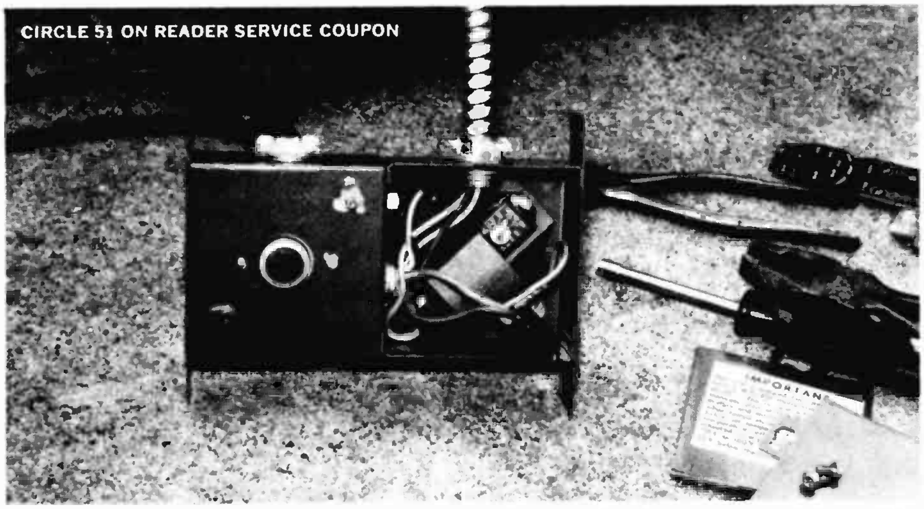


Here we see the thermostat wired to the fan motor. The high-temperature protective unit turns the fan off in case of a fire.



Normally, the two thermal detectors are mounted near each other, but separately. In this installation the modules were physically joined in order to make mounting in the cramped space easier. Both boxes, of course, can and are closed by means of metal plates.

INSTALL AN ATTIC FAN

by Jorma Hyypia

YOU CAN CUT the cost of air conditioning dramatically, or in some cases get along very nicely without air conditioning of any kind, just by installing an attic fan to reduce underroof heat build-up which can reach 140 degrees or more. Typically, when the attic temperature is at this high level, an air conditioner must operate constantly just to mainain a 72-degree comfort level in the living quarters below this blanket of heat. Install a fan, and that attic temperature could drop to as low as 95 degrees under the same summer heat-wave conditions! Only intermittent air conditioner operation would be required to maintain the same 72-degree in-house temperature.

Installation of an attic fan is a relatively simple do-it-yourself job that usually requires only cutting a hole in the gable or roof of the house, installing the fan unit, and making simple electrical connections. Even when the fan must be placed in a more "difficult" location—as in an air shaft of the kind shown in this article—installation poses no special problems.

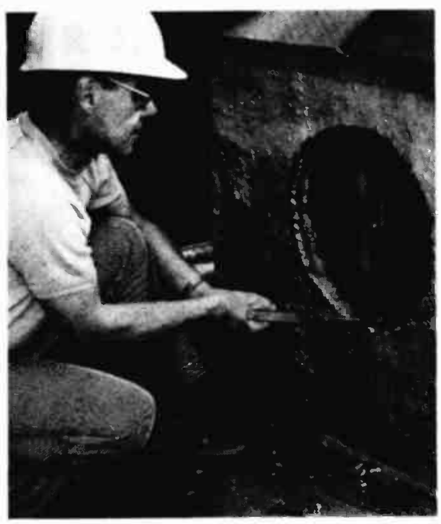
Fans For All Seasons. Attic fan manufacturers offer many different models to answer all possible needs. The unit shown here is a NuTone fan, Model WF-57, which moves 2090 cubic feet of air per minute and can effect ten complete air changes per hour in an attic having a volume of 12,540 cubic feet. You may not need a fan as powerful as this, so start your project by estimating the volume of your attic area, then choose a fan that is strong enough to change the air ten times per hour. NuTone, for example, has two other gable-mounting units that are rated at 1550 and 650 cubic feet per minute respectively. Also offered are roof-type fans rated at 730, 1020 and 1250 CFM.

Specification sheets provided by fan makers give additional information including motor horsepowers (typically from 1/15 to 1/5 H.P.), sizes of fan blades (16-inch diameter in the unit shown), general construction and materials, overall sizes, and size of the wall or roof cutout required. Look for a unit made of zinc coated steel and aluminum for long service without corrosion problems.

The powerful, deluxe model WF-57 features an automatic thermostat that is factory-preset for 110°, but that is user-adjustable from 70° to 160°F. Whenever the attic temperature reaches the preset temperature, the fan goes into operation automatically.

The thermostat is contained in a standard 4-inch square junction box

Don't let stray nails or fragments lie about on the roof. If you step on one, then there goes your roofing materials!



When we came to an obstructing stud, we used a keyhole saw to remove it, but you could use just about any small saw.

Position the cardboard template to mark the size and position of the desired cutout. Use a saber saw, or drill holes on the line.

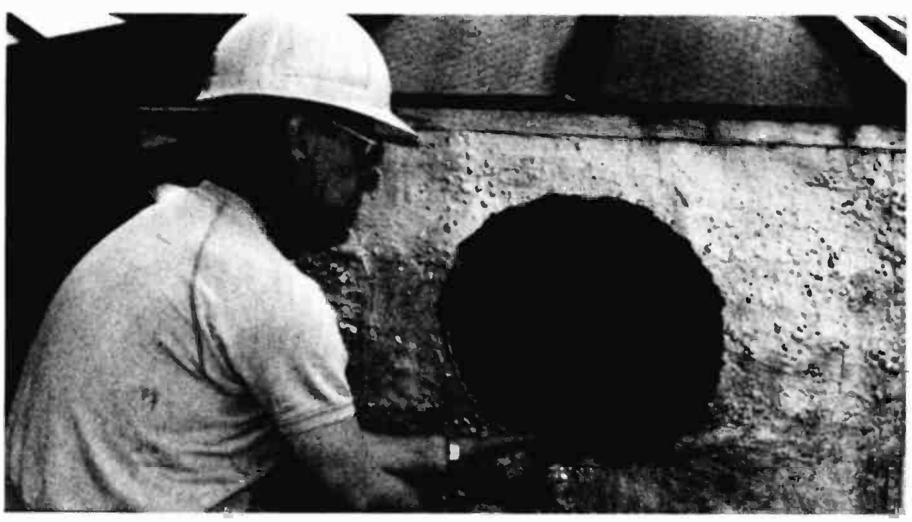
The cardboard template is pulled free and we see the drilled holes. A hammer and chisel finally freed the outlined disc.

A stud and interior plaster had to be removed. We hammered away splinters and used an old drill bit to do the remainder.

AND *COOL THE LOW-COST WAY*

that is mounted near the fan. From this box you run a power cable to an On/Off switch in your living quarters. You can eliminate the automatic control if you wish, but in any case we strongly recommend that you install an optional heat sensor that turns the fan off if attic temperatures go *too high*. This would happen in the event of a fire—the one time you would definitely *not* want the fan to blow air through your attic! The heat sensor is simply wired in series with the automatic control, if used, and the master switch in your living quarters.

These fans operate off regular 120-volt, 60 Hz house current, and draw so little current that you can safely connect to any normal house branch that is not already grossly overloaded with electrical appliances. If all your electrical circuits are in heavy use, it might pay to run a separate branch circuit from your circuit breaker board to power the fan. The one-fifth horsepower motor shown turns quietly on its ball-bearing mountings at 1050 RPM, and features automatic reset thermal protection.



Use a circular rasp to smooth down any rough edges. Make certain you have taken away enough previously that this part of the job isn't harder for you than it should be! The rasp will take care of the final touch, just make sure you get the proper rasp.

Cutting In The Fan. Wall and roof cutouts range from 11 inches to 17¾ inches square for gable models and from 11 inches to 14½ inches in diameter for roof models. As shown here, you can mount the gable-type fan into a circular rather than square hole if you prefer. In this illustration the round opening was preferable because it required removal of less wall surface.

Be sure that the fan of your choice is adequately protected from inclement weather, especially heavy rains, and from cold winds during winter months. Model WF-57 has an automatic louver that closes when the fan is not in use, and opens whenever the unit is activated. Other types of rain baffles are used on roof-style fans. Incidentally, if yours is a relatively small attic—say 5,000 cubic feet—you can obtain a fan that mounts directly *behind an existing attic louver*, so no holes need to be cut into either the gable or roof. NuTones Model GF-56 is an example of this type of unit.

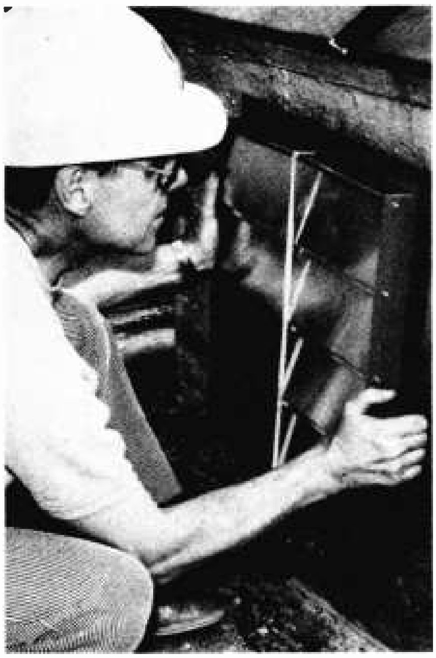
And bear in mind that if you install a louvered fan into a cutout in a gable wall having a regular ventilating louver, that original house louver must be blocked off to prevent a kind of "short circuit" of air flow that would greatly reduce the efficiency of the fan. You want air to enter the attic through louvers that are as far removed from the fan as possible.

Chances are that your installation

ATTIC FAN

job will be much easier than that encountered during the fan project shown here. To cut a hole into this air shaft meant going through an outer wall, then a tough inner wall consisting of plaster on wire lath. In a more typical gable installation there is no inner wall to complicate matters. Moreover, you can do some hole-shaping and electrical wiring more easily from inside the attic, than if you must install these same components in an air shaft.

The step-by-step photographs are in

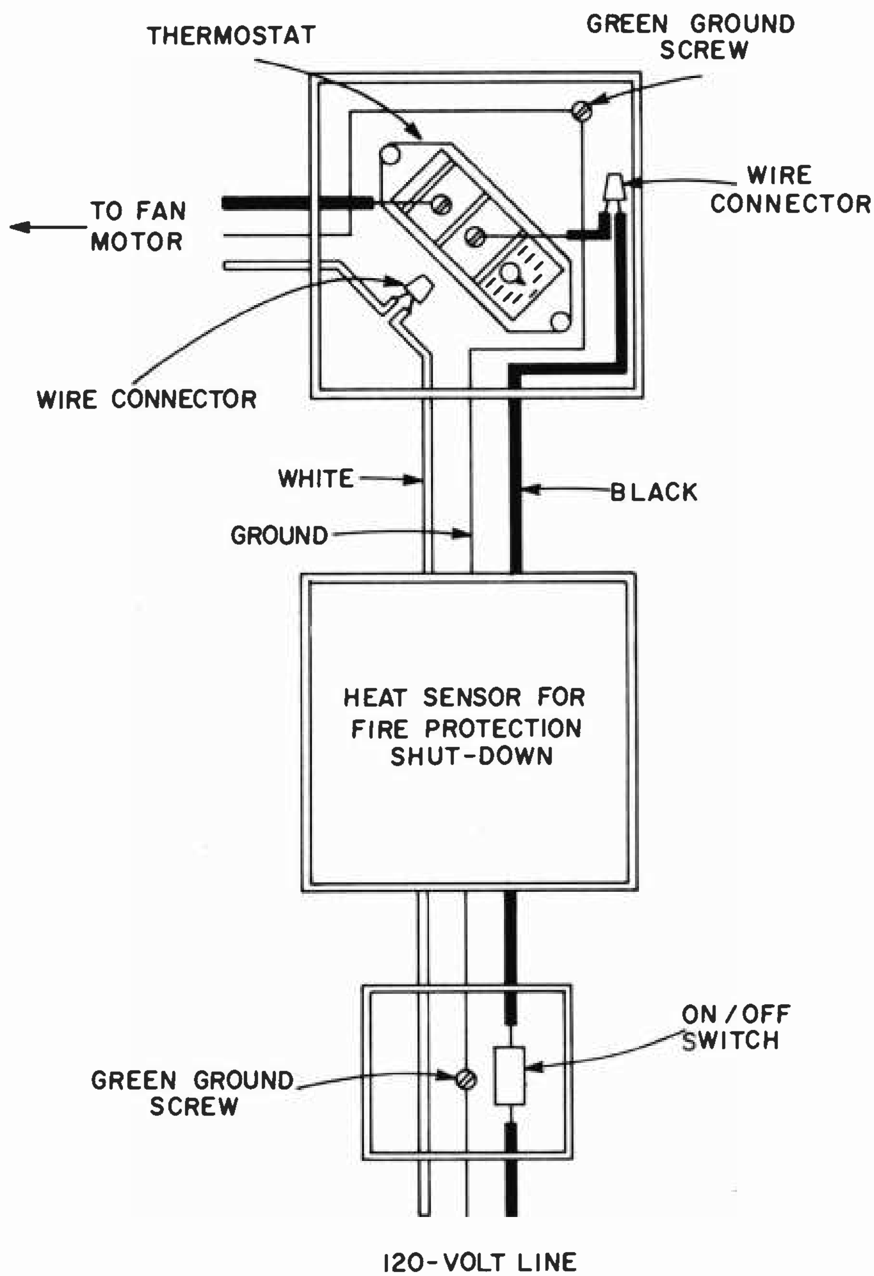


The fan fits! However, thermostats must be secured to the inside of the air duct and a wood frame made to support the fan.

the main self-explanatory. You start by selecting the best location for the fan, making sure there's nothing behind the spot (electrical cables or plumbing) that could cause major problems. Cut the hole, using whatever available tools are best for the particular conditions. Bear in mind our repeated caution to promptly sweep up nails and other trash that could damage a flat rooftop if left underfoot; get careless, and your fan unit may be completely water-tight while your roof starts leaking!

Provide whatever kind of framing is recommended by the manufacturer of your fan. In this case only a simple wooden frame was needed to interface the fan unit and air shaft wall. Just be sure to thoroughly caulk or otherwise weatherproof all joints. You can add additional rain protection—as was done by this installer—if you wish: just be sure that any added baffles do not obstruct free air flow.

Wiring The Attic Fantastic. As the diagram shows, wiring is about as simple as any electrical job you might do around the house. Basically, be sure that all wiring is made so that it com-



Follow this basic plan for hooking up your own attic fan and budget-cool your hot summer days. Note the heat sensor between the fan and the 120-volt line on/off switch; this is a most important part. If it senses too high a temperature—a fire—off goes the fan!

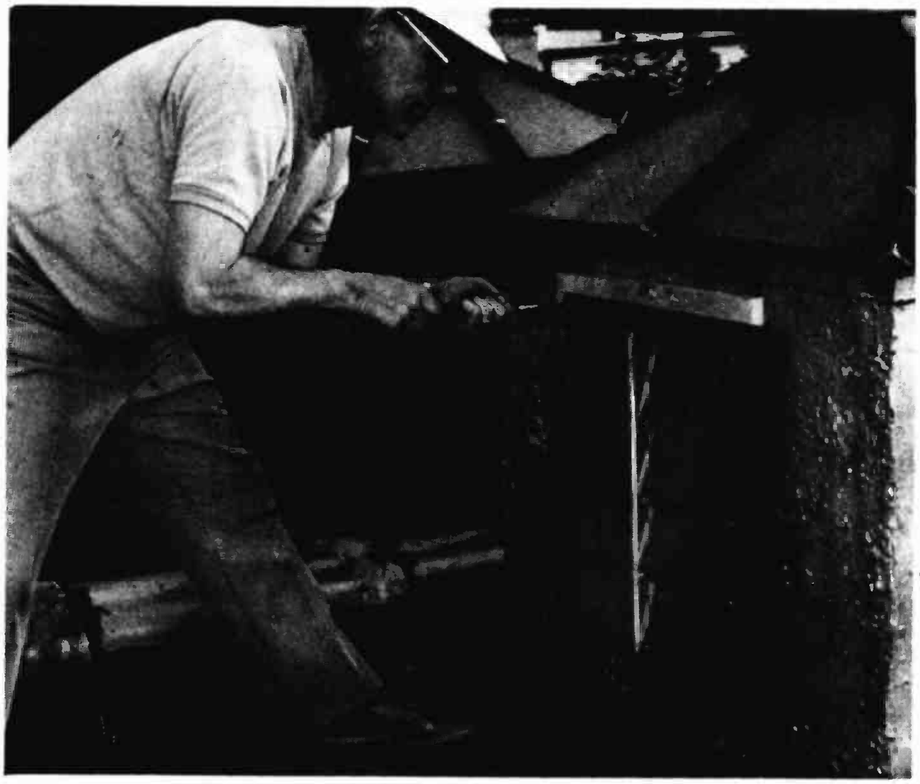
plies with local codes (or you might have trouble with insurance claims in the event of a fire), and ground the fan and switches as indicated.

The thermostat can be damaged easily, so remove it from the junction box if you nail the box to studding; if you mount with screws, removal of the thermostat is not necessary.

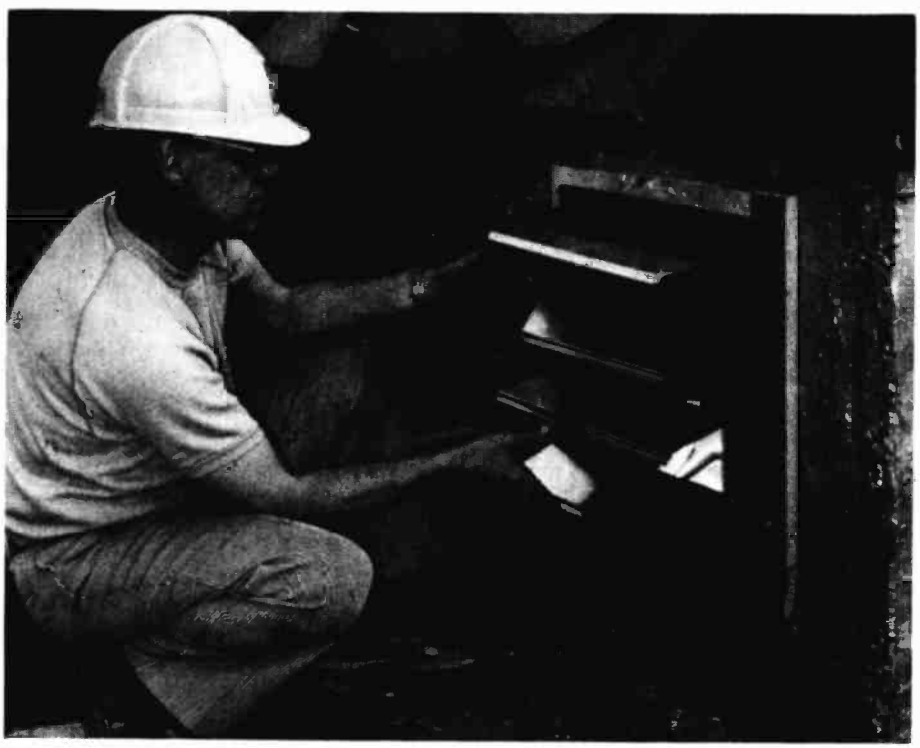
Study the wiring diagram to see how easily the connections are made. The black wire coming from the fan motor goes to one terminal of the thermostat, and a short length of black-insulated wire is added to the second terminal to permit connection of the power cable black wire by means of a wire nut. The white wire coming from the motor is also connected to the power cable by a wire nut; note that the white wire is *not* attached to the thermostat. The third (ground) conductors coming from the motor and in the power cable are both attached to the green ground screw inside the thermostat box.

Some folk just run the power cable to a switch in the living quarters of the house, and then to a regular AC power supply. We *strongly* feel that this is penny-pinching foolishness and urge that you spend a few more bucks for the optional heat sensor that will turn the fan off in case you have a fire in the attic. The unit comes with wiring instructions.

Before making your first test, recheck all wiring to make sure that black-insulated conductors connect only with other black conductors all the way from the power source, through the switch box and sensor units, to the motor. Similarly, white wires should connect only with other white wires. Also be sure that you have a continuous ground line from the motor, through the sensor and switch units, to the box from which you take the required AC power ■



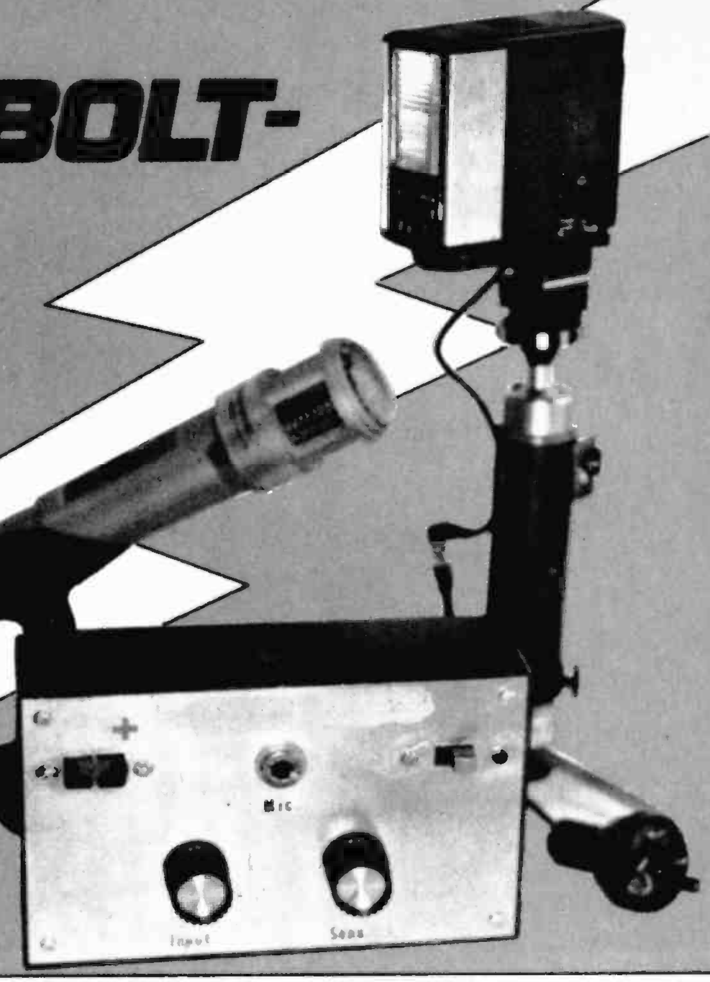
A pre-cut frame made of ³/₄-inch thick wood is slipped behind the fan and secured to the wall with 2-inch long, No. 8 wood screws. The frame strengthens the wall. Now is a good time to remember a previous hint—remove all that trash off the roofing!



Check the operation of the self-opening louvres. Be sure that they do not bind, scrape or stick. Remove any bits of material that might cause sticking, after all you want to make certain they open everytime. Who wants to go on the roof more than they have to?

A rain shield prevents water leaks. Slope the top and paint the outer surface with roof patch material to seal all watertight.

THUNDERBOLT-For Stop-Action Photos



Quick as lightning, this sound-activated flash switch responds to get your picture.

by Frank I. Gilpin

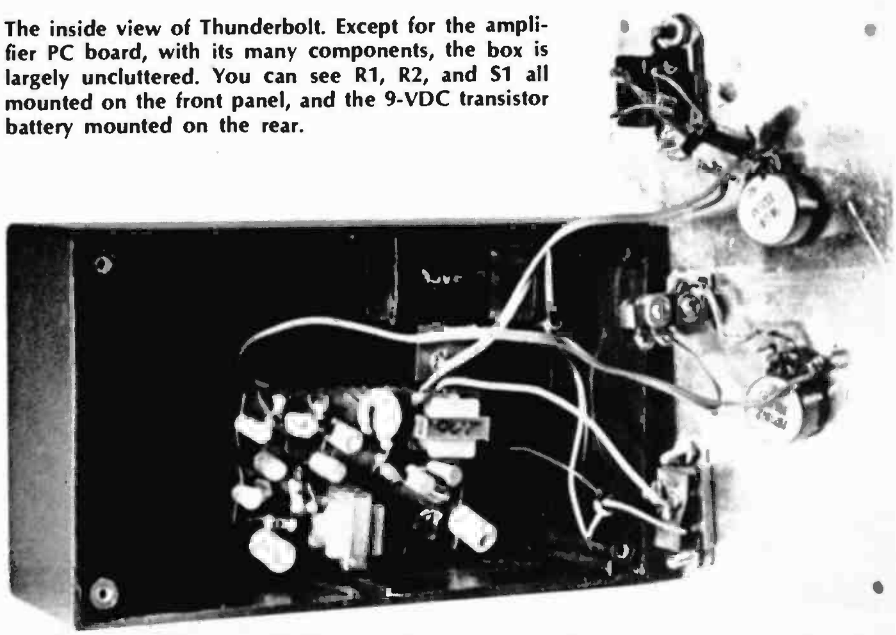
HOW WOULD YOU LIKE TO CAPTURE the sphere-capped minaret of a drop of water at the precise moment it strikes the surface of a pool, or a bursting balloon with the piercing dart still in mid-air? All you need is this easily-constructed, sound-activated, electronic flash—Thunderbolt.

Sound-activated switches have been around a long time. The first one I built 18 years ago weighed 25 pounds and would have cost nearly $100 if I hadn't cannibalized some old radios for the parts and tubes . . . remember tubes? When I built Thunderbolt a few months ago it cost five dollars and weighed in at about eight ounces. What made the difference? Solid-state components, including a silicon-controlled rectifier, make it lighter and cheaper—and it works much better and faster.

How It Works. Sound picked up by a microphone is boosted by an amplifier which feeds the signal in the form of a rectified pulse (via R3 and D1) to the gate and cathode of the SCR. The SCR is internally like three diodes connected (alternately) in series—positive-negative-positive—so it acts like a conventional rectifier in the reverse direction. Thus, the SCR's forward conduction is controlled by operating the "switch," or *gate*. Since the sound we are picking up is a single, sudden sound of short duration, it acts like a pulse, when magnified by the amplifier, and it causes the SCR to conduct. An electronic flash unit connected across its anode and cathode "sees" this conduction as a direct short so it flashes.

In practice, you will find a wide latitude of application techniques possible. You can control the microphone's sensitivity so it will respond only to certain higher level sounds, if the ambient noise level is high. Additionally, you can select the time at which an event is photographed by varying the distance between the event and the mike.

Various Applications. Let's say, for example, the event to be photographed is a coin dropping into water. By placing the mike very close to the container of



The inside view of Thunderbolt. Except for the amplifier PC board, with its many components, the box is largely uncluttered. You can see R1, R2, and S1 all mounted on the front panel, and the 9-VDC transistor battery mounted on the rear.

water, and by turning up Thunderbolt's sensitivity control, you can freeze the coin as it first touches the water. On the next shot, repeat the event, but place the mike farther away from the point of impact. The sound must now travel farther to reach the mike and the flash will go off at a later stage in the splash sequence.

By repeating this process, you can get a series of shots to cover the entire sequence from the coin first touching the water, to the final catapulted droplet falling back into the water. It could be a club flattening a golf ball, a dart bursting a balloon, a hammer shattering a light bulb, or a (patient) athlete diving into a swimming pool. Any event which produces a sound, faint or deafening, can be recorded on film at the decisive moment chosen by you.

The great advantage of Thunderbolt is that it is totally electronic, as opposed to the electromechanical heavyweights of a few years ago. The older devices depended on mechanical relays and electromagnets to close a switch. This mechanical energy transfer added milliseconds to reaction time. Even that is a significant interval when you are planning to break up into sequences such events as bursting firecrackers and shattering lightbulbs. Once the sound gets to Thunderbolt's mike the reaction time approaches the speed of light. That's about as fast as you're going to get—in *this* world.

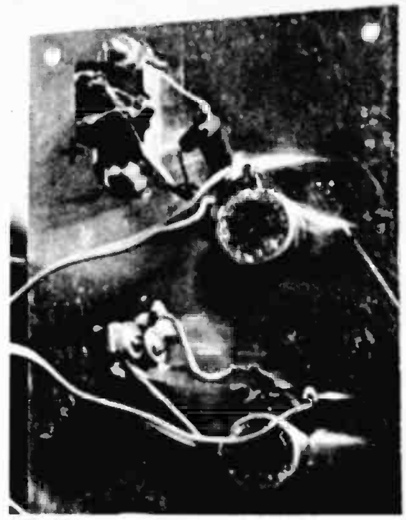
Putting Thunderbolt together is easy, because the most complicated part—the amplifier—is a module, ready to wire into a circuit with just a few simple connections and a handful of other parts.

Building It. Begin by selecting an amplifier. Almost any inexpensive module will do as long as it has an output transformer. Note that most modern transistor amps don't have an output transformer. Radio Shack and Lafayette Electronics sell suitable amp modules for less than six dollars apiece. Any amp capable of delivering a couple hundred milliwatts is sufficient. I scavenged the amp for my Thunderbolt from an old, discarded portable tape player. You can find many of these old reel-to-reel relics in second-hand stores for a dollar or two. Goodwill and Salvation Army Thrift Shops are a good hunting ground. All you need do with these old units is carefully trace and identify the input and output leads and the battery supply leads. If you get a unit that's fairly intact, it may even have volume and tone control pots which are of the correct value for your Thunderbolt.

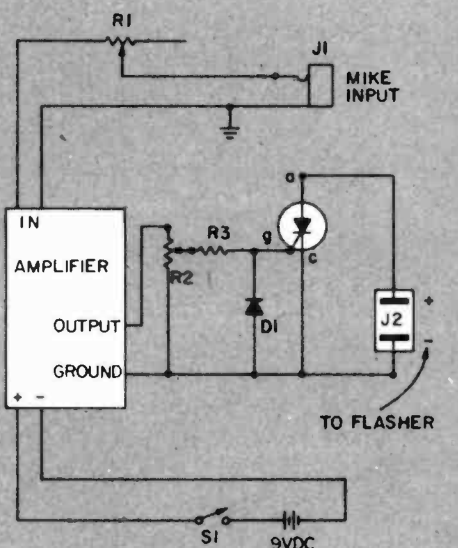
The cabinet I show in the parts list will accommodate almost any transistor amp you select. You could even get ambitious and build a simple transistor amp. Most any old tube amp will also work fine, though it'll be quite bulky.

Just which mike jack, you use will depend on the plug on the microphone you use. It may be a standard phone jack, or the miniature type—whatever, as long as it matches your mike plug. When you have all the parts in hand, arrange them on the cabinet's front panel and mark the panel for the mounting holes to be drilled. Parts placement is not critical, but the leads to R1 and R2 should be kept short. If you locate S1 close to the *sensitivity* control, R2, then you can use point-to-point wiring for the SCR, D1 and R3. They are rigid enough to be self-supporting if the leads are kept short; otherwise a tie-point terminal can be used. Follow the schematic and wiring illustrations carefully and you'll have no trouble. You must use shielded (co-ax audio cable) for the input connections from R1 to your amp.

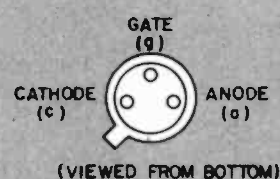
Hookup To Flashgun. After making all the connections, double check your work. Be sure you have connected the SCR's three leads correctly and check the polarity of D1. When you are sure everything is in order, you'll need to make a connector cord for your flash unit. Insert the PC plug of your flash extension cord into the flash unit's sync cord. Both ends of some brands of extension cords look almost alike and you don't want to cut off the wrong end. With one end plugged into your flash unit to make sure, cut off the other end close to the plug. Strip off the insulation and carefully separate the braided



Closeup of the front panel, showing the way SCR1 is mounted directly on S1, and D1 and R3 attached to R2.



Schematic diagram for Thunderbolt. As you see, most of the components are encapsulated in the amplifier, which is described fully in the text. Virtually any amplifier will do, as long as it produces a couple hundred milliwatts. The diagram below shows the connections to SCR1.



PARTS LIST FOR THUNDERBOLT

R1—10,000 ohm potentiometer
R2—5,000 ohm potentiometer
R3—2,200 ohm half-watt resistor
D1—PIV 50 volts Rectifier Diode
J1—To suit your mike. (see text)
J2—AC chassis-mount receptacle
S1—SPST slide switch
SCR—Silicon Control Rectifier (General Electric C5G or equivalent in TO-5 type case.)
Misc.—Wire, solder, two control knobs, chassis box (see text), a PC type extension cord for electronic-flash sync cord, and an AC plug. Total cost for all parts should not exceed $12, excluding chassis.

You'll find Thunderbolt to be one of the most useful photographic accessories. It's easy to build, both at the worktable and on the pocketbook, and is a truly fun project. Before you know it, you'll be happily strobing away roll after roll.

shielding from the inner conductor of the co-ax cord. There is little or no standardization in the photo industry, so you can't be sure that the inner conductor of any given sync cord is connected to a positive voltage when plugged into a flash unit. Some units have a positive ground and some have a negative ground. In order to make sure your Thunderbolt will work with any flash unit, you need a plug which can be reversed for any polarity match. You may have more than one flash unit and they may not be the same, hence the adaptor cord.

Plug one end of your modified cord into Thunderbolt and the other into the flash unit's sync cord. Set the *sensitivity* control, R2, at the center of its rotation and *input* control, R1, fully counter-clockwise. Plug in a microphone and apply power to both the switch unit and the flash unit. The flash may fire once or twice by itself before it settles down. If the flash unit keeps firing as fast as it recycles, reverse the plug in J2 to get the correct polarity match.

With the polarity established, whistle or hum into the mike as you slowly turn R1 clockwise. The flash should go off. From this point, it's a matter of see-sawing controls R1 and R2 back and forth until you get the hang of your mike's sensitivity. The best way to discover what your Thunderbolt can do is to use it in a closely controlled test set-up. This procedure is easier with an assistant, so recruit a friend.

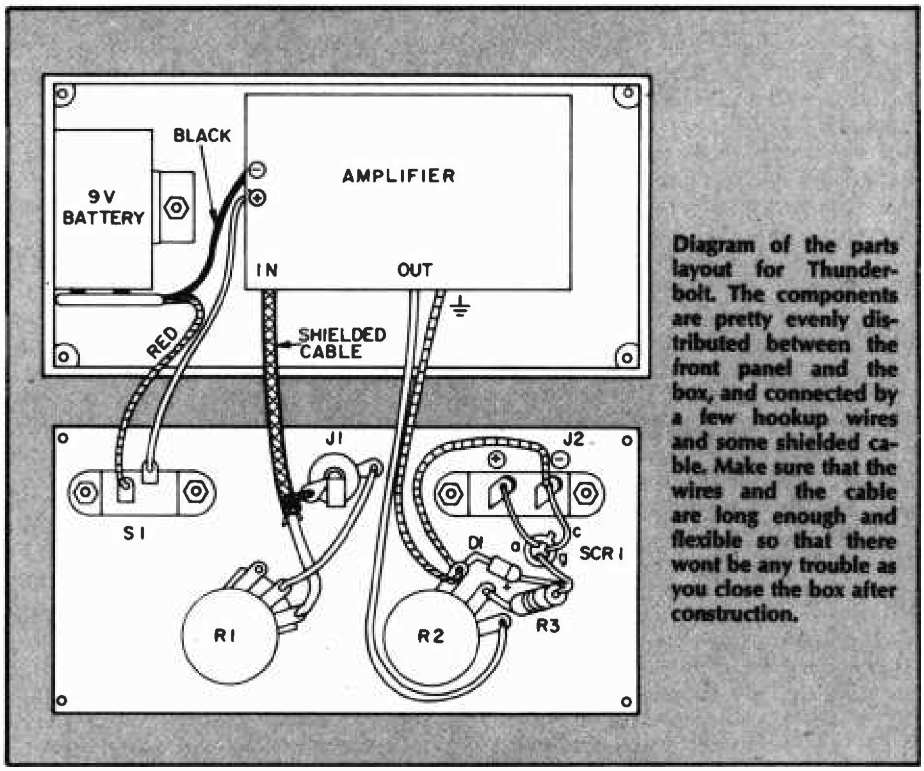


Diagram of the parts layout for Thunderbolt. The components are pretty evenly distributed between the front panel and the box, and connected by a few hookup wires and some shielded cable. Make sure that the wires and the cable are long enough and flexible so that there wont be any trouble as you close the box after construction.

Against a dark background, set up a clear glass, or bowl, of water. Place the mike as near to the bowl as possible without it getting into the picture area. Position the flash on a tripod and aim it at the bowl. The camera, also tripod mounted, should be aimed at the bowl at a 45 degree angle to the flash. Focus on the surface of the water and compute your f-stop as you normally would for a flash shot using the flash's guide number divided by its distance to the subject. (For instance, if the manufacturer's recommended guide number for your flash is 45 when used with ASA 25 film and your flash is placed five feet from the subject, divide 45 by five. Since the answer is nine, choose the f-stop closest which is f-8).

Set the camera's speed control on "B" as you would for a time exposure. Attach a locking type shutter release cable to the camera and position your assistant close to the bowl, but out of the camera's field of view.

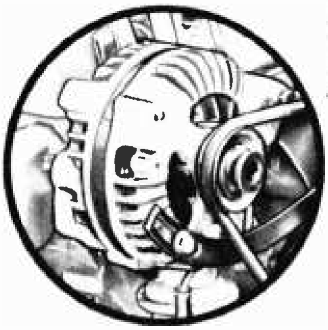
Turn off all the lights in the room and open the lens with the shutter release cable, but *do not* remove the lens cap yet. With your assistant poised over the bowl, ready to drop a coin into the water, turn on the flash unit and the switch unit. The flash may go off, triggered by the sound of its own switch, which is why you've left the lens cap on. Wait for the flash to recycle, then snap your fingers. It should go off again. When it recycles, remove the lens cap and give your assistant a visual signal to drop the coin. As the coin hits the water, the flash will go off and you can close the shutter and replace the lens cap.

On the next shot, move the mike a foot or two farther away and repeat the process. On successive shots, move the mike exactly the same distance farther away. You should have a complete sequence after about six to eight shots.

The film should be a very slow film, that is one with a very low ASA number, such as Plus-X by Kodak, which has an ASA of 125. If you have a set-up which requires you to have more room illumination in which to work, use an Othro type film which is insensitive to red light. With this film, you can use a fairly bright red light in the room without affecting the film image while the lens is open.

Once you've done a series such as the water bowl and coin, you will know what Thunderbolt can do for you and how to predetermine its sensitivity to a given sound. When you have all its parameters for operation understood and set up, you can start thinking of things to do with Thunderbolt. Its applications are virtually limitless, since the principle of stopping sound-producing motion is an especially fascinating one. You can use it indoors in ordinary ways, such as the coin and bowl technique, or you could even use it for crime detection, by fixing it at night on a window or door you expect an intruder to come through. Any sound he makes will take his picture. Good luck! ■

This is one of the things you can do with Thunderbolt. You can use it to capture any sound-producing motion instantaneously, as long as the object to be photographed is within the range of your electronic flash gun.



ALTERNATOR TESTER

Your alternator may be building for a big breakdown without your knowing it. This simple circuit lets you check it out.

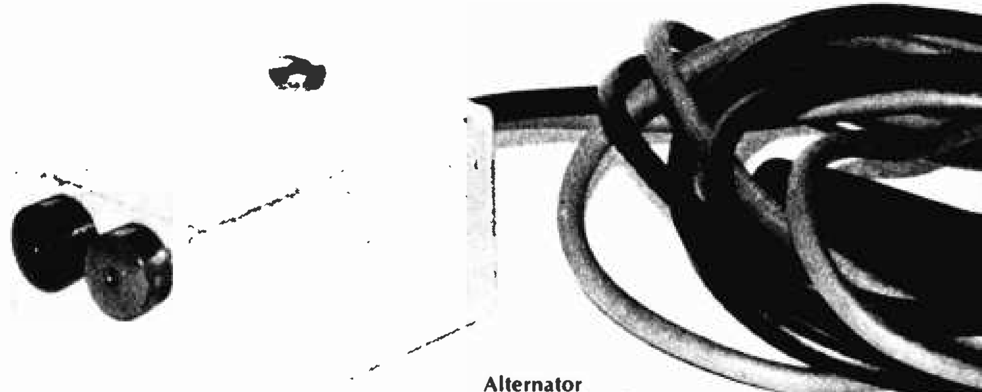
by Anthony Caristi

AUTOMOBILES have been coming off the production lines with alternators instead of generators for some 13 years now, and these units have proven to be reliable and superior to the ones they replaced. Being alternating current machines, they are inherently more complicated than generators and require slightly more sophisticated testing procedures to indicate their condition. This problem is brought about by the fact that automotive alternators are three phase machines, with full wave rectification of the output to produce direct current as required by the automobile and its battery. The schematic shows a typical automotive alternator connected to its three-phase full-wave rectifier circuit.

Rectification is accomplished by six high-current silicon diodes in the alternator, and this is where the problem comes in. Many of the troubles encountered with automotive alternators are due to failure of one or more of the diodes, either by opening or shorting. Neither of these conditions will result in an inoperative alternator, and no doubt some of the automobiles on the road today have just such a problem. A shorted diode is the more serious of the two conditions, since it will result in the loss of about 50 per cent of the output capability of the alternator. Such a condition is easily detected by an ordinary output test on the alternator. However, an open diode is another matter. This condition will result in loss of only a few amperes of output capability of the alternator due to the fact that only one half of one phase of the machine is disabled. Some of this lost capacity is carried by the other two phases, which will be overloaded when the alternator is required to produce full output as demanded by the automotive electrical system. Such a condition may well result in further failure of more diodes. An ordinary output test of an alternator with an open diode generally will not detect any malfunction. Because of those testing problems, another test method to determine the condition of alternators has been developed, and the construction of the Alternator Tester is the subject of this article.

The ability of Alternator Tester to detect defective diodes, both open and shorted, depends on the fact that the output ripple voltage of an alternator with a defective diode rises dramatically higher than that produced by a normally-operating alternator. When the pulsating DC waveform output voltage of an automobile alternator is measured the magnitude of the ripple voltage is about 0.2 to 0.5 volts, peak-to-peak. When one of the diodes in the alternator fails the ripple voltage increases to 1-volt peak-to-peak or more. The Alternator Test measures the peak-to-peak ripple voltage so that the condition of the alternator can be determined.

Construction Details. In order to keep construction costs low, the Alternator Tester was designed to be used with an ordinary VOM or VTVM as the indicating device. Since the output impedance of the test instrument is close to zero, any meter of at least 1000-ohms-per-volt sensitivity can be used. The circuit is constructed on a small printed circuit board and fitted into a metal or plastic cabinet. Two tip jacks are mounted in the cabinet which serve as the connection to the VOM. A pair of test leads is brought out through a grommet and these provide the DC power to operate the circuit

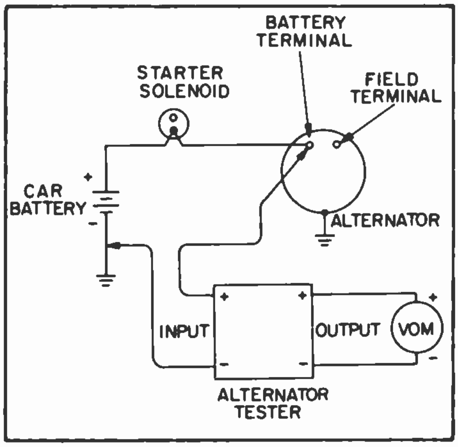


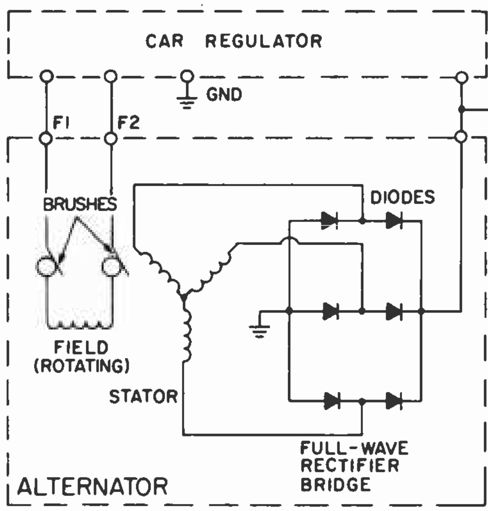
Alternator Tester completed and installed in its compact metal cabinet, shown with its test leads.

as well as the connection to the alternator output (battery) terminal where the ripple measurement is to be made.

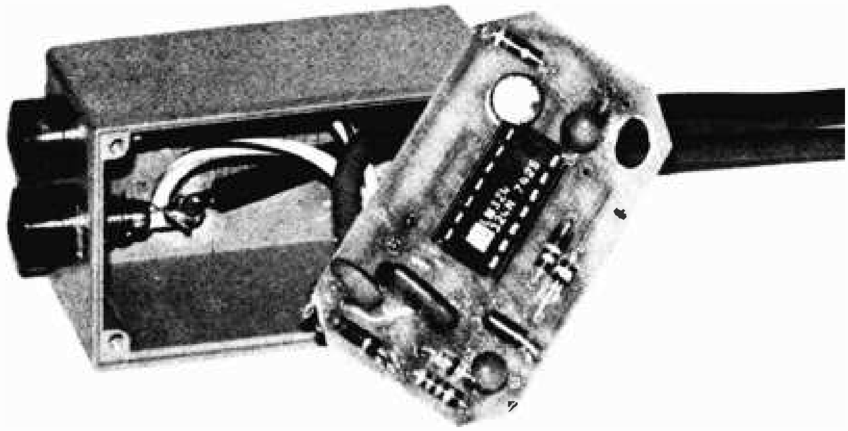
About the Circuit. The Alternator Tester is basically a peak detector circuit which responds to the peak-to-peak value of an AC voltage fed to its input terminal. Power to operate the circuit is derived from the output of the alternator on the same lead which feeds the ripple voltage to the input of the peak detector. The DC output of the alternator is blocked by C1, which allows only the ripple voltage to pass through.

Operational amplifier IC1A and IC1B are connected together to form a peak detector circuit. The ripple voltage from the output terminal of the alternator is fed to the positive input of IC1A after the DC voltage of the alternator is blocked by C1. D1 clamps the ripple voltage to ground, so that it varies between zero and some positive value. Op amp IC1A charges C4 to the peak value of the ripple voltage. Op amp IC1B is a voltage follower which feeds back the peak value of the ripple voltage to the negative input of IC1A. This stabilizes the circuit so that the voltage appearing at the output of IC1B holds to the peak-to-peak value of the ripple voltage fed to the input of IC1A. Capacitor C4 is prevented from discharging through IC1A by D2, and can discharge only through R4 at a rate much slower than the ripple frequency of the alternator. This holds the meter reading constant between voltage peaks of the alternator. Amplifier IC1C has an adjustable gain of slightly more than unity to compensate for the slight error (loss) caused by D2, as well as providing a means for calibration of the instrument. Voltage follower IC1D

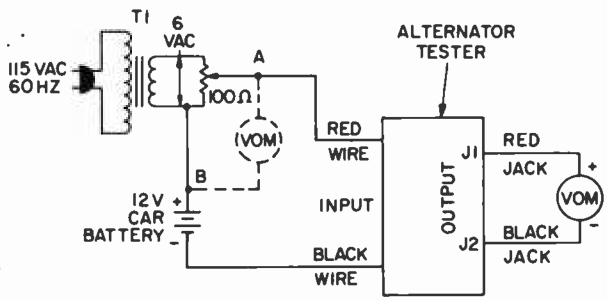




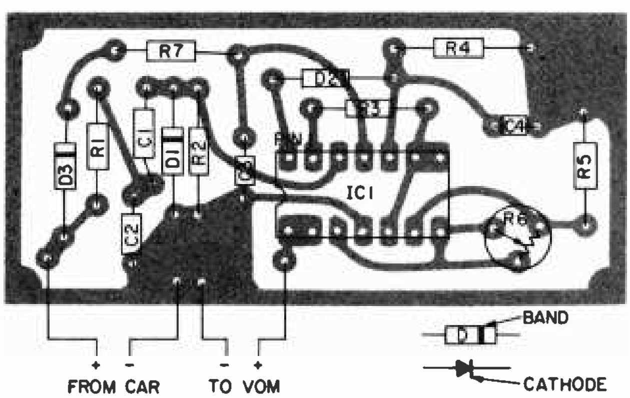
Typical automotive charging circuit. Latest model alternators have solid-state regulator circuit built into alternator frame.



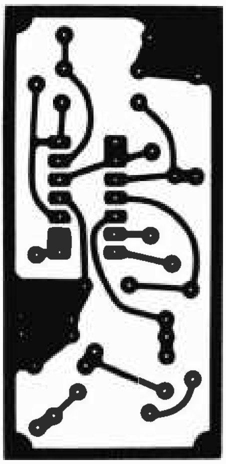
Alternator Tester opened, showing printed circuit board. Comparison with this early version of printed circuit board reveals improvements made by the editors.



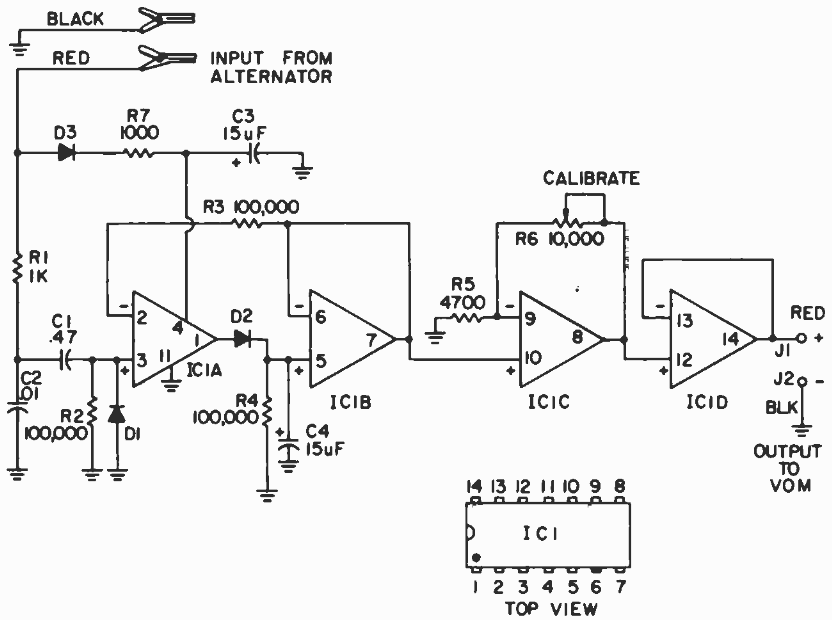
Calibration of the Alternator Tester.



This shows the parts placement on the printed circuit board. Shown larger than actual size for clarity.



This pattern shows the printed circuit board (foil side up) for the Alternator Tester. You can construct the unit on a perf board if printed circuit board fabrication seems too much touble.



With the three-phase output of automobile alternators, which is rectified by a six diode full-wave rectifier, it is possible for the output of the system to appear normal even though one diode is open. With this circuit a mechanic can test the rectifier output and discover the increase in the ripple voltage that would be caused by such a failure.

PARTS LIST FOR ALTERNATOR TESTER

C1—0.47 uF ceramic capacitor
C2—0.01 uF ceramic disc capacitor
C3, C4—15 or 22 uF, 25 VDC tantalum capacitor (Allied Electronics 852-5671 or equiv.)
D1—1N34A, 75 VDC, 5 mA germanium diode (Allied Electronics 578-0034 or equiv.)
D2, D3—1N487, 75 VDC, 100 mA silicon diode
IC1—LM324 (Quad 741) operational amplifier (James Electronics, or equiv.—address below)
J1, J2—red, black tip jacks (Allied Electronics 920R0181, 2, or equiv.—address below)
R1, R7—1,000-ohm, ¼-watt resistor
R2, R3, R4—100,000-ohm, ¼-watt resistor
R5—4,700-ohm ¼-watt resistor
R6—10,000-ohm potentiometer (Allen Bradley Type A, Radio Shack 271-218, or equiv.)
Misc.—2¾ x 2⅛ x 1⅝" utility box, hardware, 14-pin IC socket, printed circuit board or printed circuit kit, red, black test leads with alligator clip termnials.
Allied Electronics' address is 401 E. 8th St. Fort Worth, TX 76102.
James Electronics' address is 1021 Howard Ave., San Carlos, CA 94070.

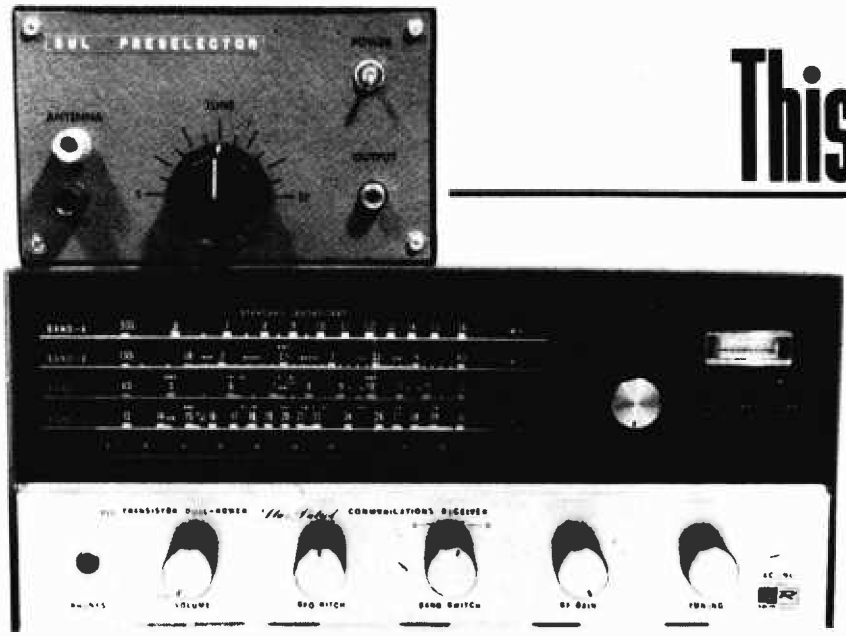
provides an extremely low output impedance to drive any meter of 1000-ohms-per-volt or more. Power for the circuit, about 2 mA, is taken directly from the alternator output terminal. Diode D3 prevents damage to the circuit in the event of any reverse polarity connections.

Calibration of The Instrument. Calibration of the Alternator Tester is accomplished by feeding an AC voltage of known amplitude between the input terminal and ground, and adjusting R6 for the correct meter reading. The calibrating AC voltage input can be measured by the AC voltmeter function of the VOM, which reads RMS volts. To convert RMS to peak-to-peak voltage multiply the value by 2.83. The calibration circuit uses a 6-volt filament transformer and potentiometer as a source of low voltage AC. To calibrate the instrument connect the filament transformer, potentiometer, and alternator test circuit as shown, using any twelve volt DC supply for power. (Be sure there is no ripple voltage on the output of the supply, since this will cause an error in the calibration.) Set the VOM to read AC volts, and connect it between points A and B as shown. Set the potentiometer so that the VOM reads 0.35 volts RMS. This is equivalent to 1 volt peak-to-peak. Disconnect the VOM, set it to a 1.5 to 3 volts DC scale, and connect it to the output terminals of the Alternator Tester. Calibrate potentiometer reading of 1 volt. This completes calibration of the Alternator Tester.

Alternator Testing. The testing of an automotive alternator consists of two parts. The first test is the output test, which determines if the alternator can deliver the full current that it was designed to produce. Bear in mind that the following procedure tests both the alternator and voltage regulator at the same time, and failure of the alternator to deliver rated output also may be caused by a defective voltage regulator. Before making the following tests inspect the connections to the alternator and battery to be sure they are tight. A loose or bad connection between the alternator and the battery may cause an excessive ripple measurement even though there are no defective diodes in the alternator.

The alternator output test requires the use of only the VOM which is set to read DC volts on a 0 to 15 volts or greater scale. Connect the VOM directly across the battery, observing correct polarity. Start the engine and turn on the headlights (high beam), windshield wiper, blower motor (high speed), and radio. Race the engine to a moderate speed (about 2000 RPM) and note the reading of the meter. A properly operating charging system should maintain at least 13.5 and not more than 15 volts across the battery. Voltage readings below 13.5 indicate a defective alternator or voltage regulator. Voltage readings above 15 indicate a defective voltage regulator. Some automobiles have voltage regulators which can be adjusted. Refer to the service manual for your car for voltage regulator tests and adjustments. If the above test indicates satisfactory performance proceed to the ripple voltage test, using the connections shown in the testing diagram. Note that the posi-

(Continued on page 114)



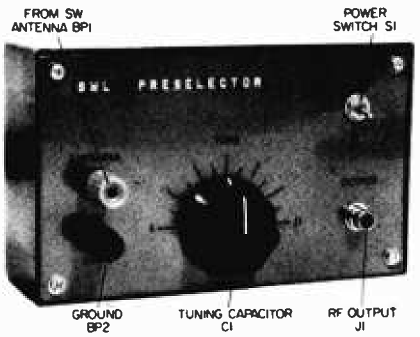
This Piggyback SWL

Add 20 dB of valuable signal-grabbing power

by Herb Friedman W2ZLF

BACK BEFORE EVERYTHING came in transistorized subminiature packages, virtually all serious SWLs and radio amateurs used a preselector ahead of the main receiver. No, not a *preamplifier*, we said a *preselector*. A preamplifier simply provides amplification, usually over a broad range of frequencies. With early single-conversion receivers, and the new solid-state high performance, budget-priced, single-conversion receivers, a preamplifier amplifies the image signal interference along with the desired signal. But a preselector, that's a whole 'nother thing. A preselector is a tuneable, high-Q preamplifier that passes only the desired signal frequency, and usually provides considerable attenuation at the image frequency.

Unfortunately, preselectors have so much gain and sensitivity they had to be built like the Rock of Gibraltar in a cabinet almost as large as the rock itself in order to avoid self-oscillation. Many preselectors were as large as the boat anchors we used to call receivers, so like those old tube-type boat anchors, the preselector went the way of the Dodo.



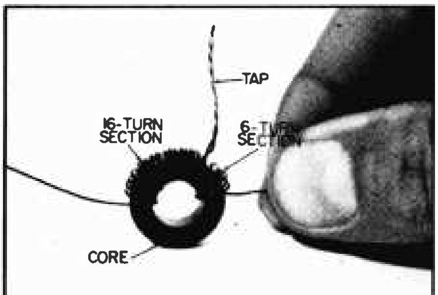
Plastic cabinet may be used but the front panel should be aluminum or other metal. Input (BP1) and output (J1) connections must be kept apart.

But a preselector can still give a receiver a good solid kick in the antenna terminals, often digging out signals where you thought none existed. And the preselector can still reduce image interference in those inexpensive solid-state receivers that have terrific sensitivity and great stability, but poor image rejection because they're only single-conversion. What's that? You've got no room for a big boat anchor? Who mentioned anything about size? Using up-to-date technology and components, the same as you've got in that new receiver, you can build a rock-stable preselector that's got more selectivity than those old monsters, will work off an ordinary transistor radio 9-volt battery (or a lightweight line-powered supply) and will provide enough extra front-end selectivity to practically *squash* image interference in single-conversion receivers. Best of all, you can make the whole thing so small it can be glued right to the back of a sub-miniature tuning capacitor—hence the name—"Piggyback Preselector." The unit shown in the schematic and photographs provides from two to three S-units extra sensitivity (about 12 to 20 dB extra gain), depending on the particular receiver it's used with.

The Design. Input coil L1 is homebrewed on a toroid form. Since toroids have exceptionally high Q the input tuning is razor sharp—sharp enough to attenuate the image frequencies. In fact, if this unit is tuned to 10 MHz while the receiver is tuned to 20 MHz virtually no signal will pass through the preselector into the receiver. On the other hand, when the preselector is tuned to the desired frequency it can really snatch signals up out of the noise level.

Don't worry about static signals blowing Field Effect Transistor Q1 because it's a special type with built-in protection diodes from the gates to the source and drain. In normal operation the diodes are inactive, and Q1's input impedance is extremely high and does not load down L1. Transistor Q2 acts as a matching device and power amplifier, providing a low impedance output for the input of the associated receiver.

Both L1's input impedance and the preselector's output impedance have been adjusted so the unit delivers good performance with every combination of antenna and receiver. While it might be



A toroid coil is the easiest home-brew because neatness doesn't count. If the turns aren't spaced just so, or the turns unwind a bit as you make the coil, it won't make any difference. Just spread the turns so they take up about one-half of the form. Don't spread turns to take up entire form.

Preselector Will Make You a Pro in One Evening

possible to get slightly improved overall performance by specific tailoring of the input and output for a given antenna type and receiver, we make no recommendations and suggest you build the model as described with no changes or substitutions. Only if you cannot obtain the specified Q1 should you try a substitute, and a 40673 is suggested. The 40673, however, might require some experimentation with the values of R1 and R2. The correct values provide approximately 5 mA to Q1 and 1 mA to Q2. Bear in mind, however, that we suggest the unit be assembled exactly as described.

The unit shown covers the SWL frequencies from approximately 5 to 21 MHz, actually reaching the top of the 15-meter amateur band. To get optimum coverage of the 15-meter band one turn can be removed from L1 (we'll explain this later). This modification will provide a greater 15 meter adjustment range for tuning capacitor C1.

C1 is a sub-miniature tuning capacitor with a *long shaft* and a plastic dust cover over the stator and rotor plates. (It is available from Radio Shack as No. 272-1341. Do not substitute a similar capacitor that has a calibrated tuning knob and lacks the dust cover. The shaft on the specified capacitor also provides the panel mounting while the dust cover is the support for the rest of the project.)

Construction. We built the entire preselector, except the transistor radio battery which supplies the power, on a special type of perf board which has circles on the back of each hole to facilitate soldering and securing the components in place. We recommend, however, that you make a printed circuit board from the layout shown, unless you are somewhat experienced in point-to-point wiring. The location of the components on the circuit board is shown in another drawing.

You'll have no special assembly problems as long as you follow the parts layout shown in the photographs. The unit will be completely stable and free of birdies and dead spots as long as the input is at one end of the board and the output is at the other end. But if you re-arrange the layout and get the input and output within an inch or so of each other it will almost certainly oscillate, and fail to work.

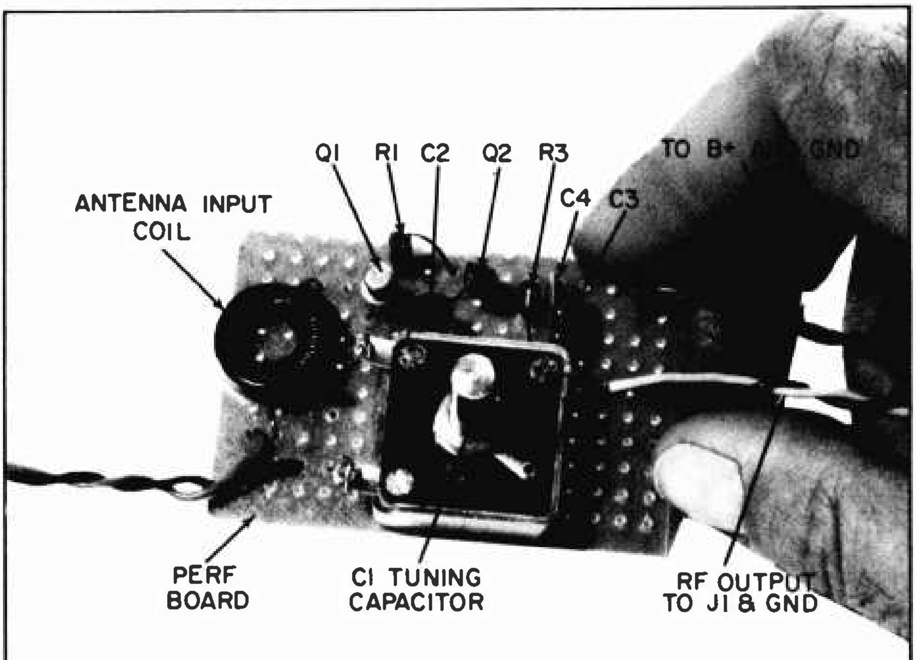
Mark off the approximate location of the tuning capacitor on the circuit board and then complete the board assembly, including the power, input and output wires. These can be about six inches long.

Toroid Assembly. L1 presents no winding problems as even sloppy assembly will work—that's the nice part about toroid coils. Use solid, enameled #24 copper wire to wind the coil. Clamp about three feet of wire in a vise and pull gently on the free end until the wire goes dead slack. By thus taking the spring out of the wire you make it so it won't unwind as you make the coil. Wind six turns, tightly, around the toroid core and bring the end out about two inches. Fold the wire back to the core, forming the ground tap, twist the wires a few times to secure them, and then wind sixteen additional turns *in the same direction as the first six*. Using a knife or razor, scrape the insulation from the wire ends and the tap. Then tin the wires and the tap with solder. Spread the turns so they are roughly equal-spaced, using about one-half the total core. Do not spread the turns to take up the entire core, as is usually suggested. This time, half way is best.

This coil will give frequency coverage with this tuning capacitor about 5 MHz to 21 MHz—just about to the top of the amateur 15 meter band. If you want to be able to tune through 15 meters with tuning capicitor C1, eliminate one turn of the coil's longer winding—make it 15 turns. Do not make any changes to the initial six turn winding. This is the antenna winding and remains the same.

Board. Construction. Assemble the perf board circuit as shown—everything except C1. Using silicone rubber adhesive such as G.E.'s RTV, cement the circuit board to the back of C1. After the adhesive has set (overnight), connect C1 across L1's secondary. Make certain C1's rotor, which connects to the tuning shaft, is wired to L1's grounded tap. Use an ohmmeter to determine C1's ground (shaft) terminal if you can't tell by looking. But don't guess; if you guess wrong the tuning will change when you remove your hand from the tuning knob.

Okay, it's all wired. What will you do with the piggyback preamplifier? Since the total current drain is about



The completed preselector ready for installation in a cabinet. The circuit board cements to the back of the tuning capacitor. Note that L1 is flat against the board and all wiring to other parts is also installed on the board. Board may be perf-type shown, or, recommended for beginners, the printed circuit type described in text.

5 mA you can use an ordinary transistor radio battery for a power supply and shove the whole thing into a plastic utility cabinet as shown. Just as long as the front panel is aluminum (or other metal) a plastic cabinet can be used.

If you don't like using battery power you can use a slightly larger cabinet and assemble the power supply shown in the schematic. But remember, you only need a 5-mA capacity, so keep T1 small. If you end up using a standard filament transformer for T1 the cost might exceed several years' supply of batteries.

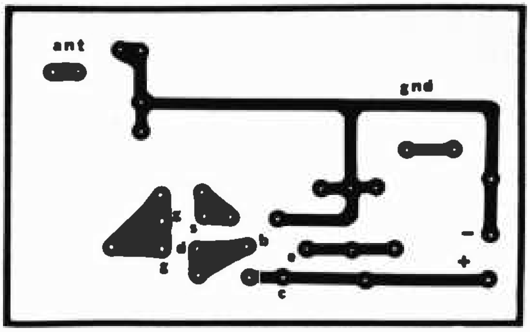
Final Connections. Use some kind of coaxial output connector for J1. Even a standard phono jack can be used. Use coaxial cable such as RG-58 or RG-59 between the preselector and receiver and keep it as short as possible.

If you have a *longwire* or *random* antenna use 5-way binding posts for the input (remember, the antenna post must be insulated from the panel). If you have a coaxial antenna system eliminate the ground binding post and substitute a coaxial connector for BP1. This connector can also be the phono type.

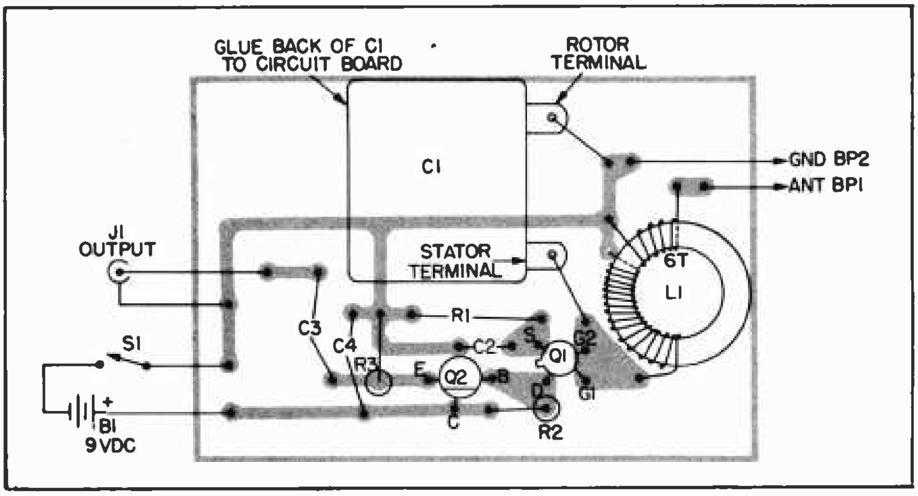
Calibrate! The tuning is so sharp the preselector must be tuned near the desired frequency or you might not hear anything at all in the receiver. Use whatever calibrations on the panel you find necessary to put the preselector tuning inside the ballpark.

After a signal is tuned in on the receiver, peak it with the preselector. If the receiver has an antenna trimmer or tuning control make certain you also peak the signal with the trimmer.

If some local signals come in strong enough to overload the unit, just detune it slightly to reduce its sensitivity and get rid of the overload. ■



Full-size layout for printed circuit board (foil side up) is shown here.



If you use the printed circuit board shown above you can locate the various components on the board by means of this drawing. Parts side is shown.

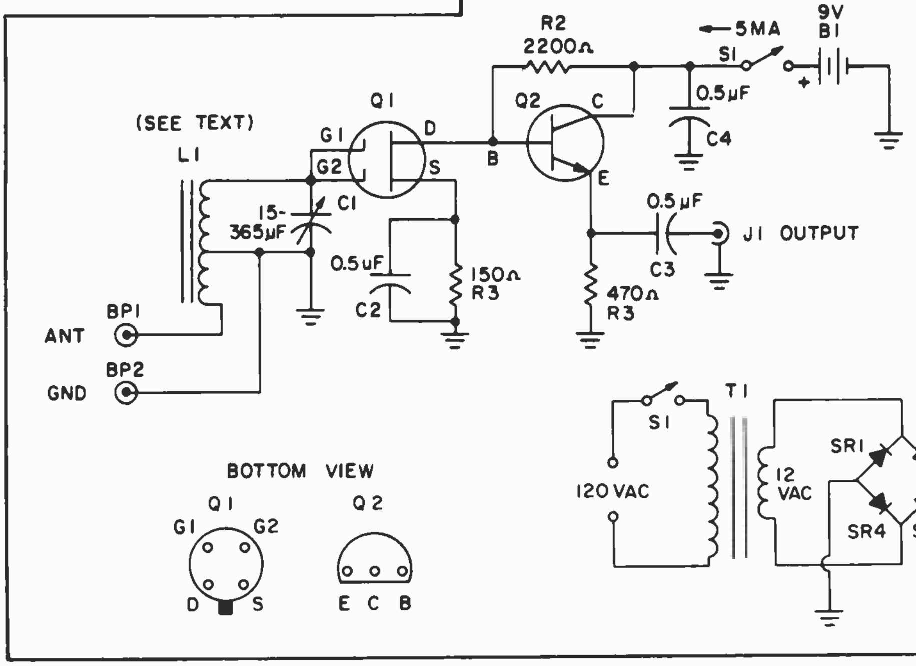
PARTS LIST FOR PRESELECTOR POWER SUPPLY

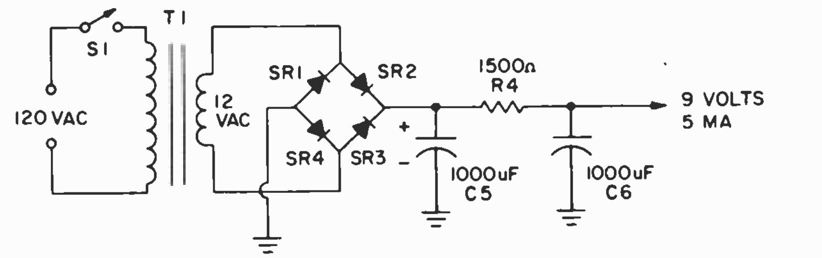
C5, C6—1000 uF 15 VDC capacitor
R4—1500 ohms, ½-watt resistor
SR1 through SR4—Silicon rectifier bridge, 50 PIV
T1—Power transformer 12-VAC secondary

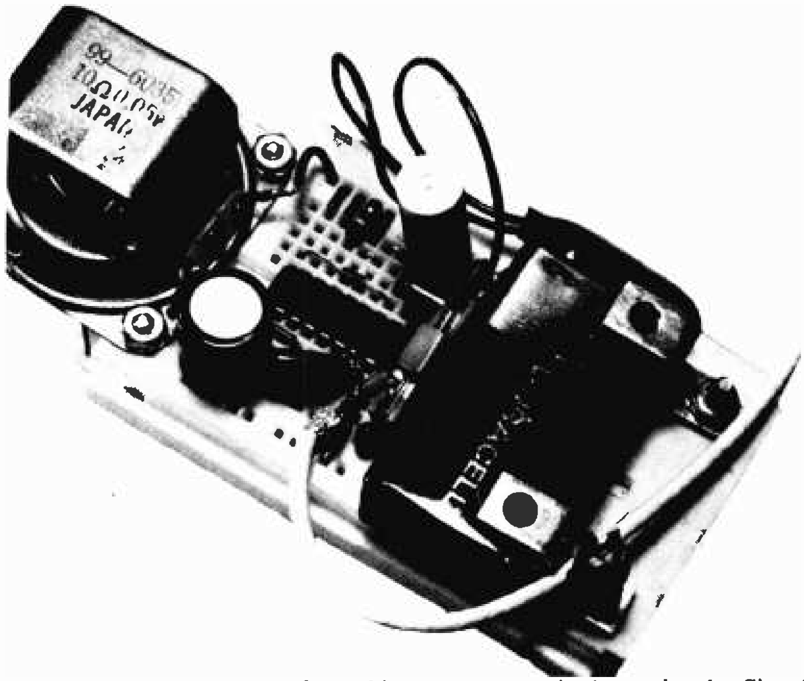
PARTS LIST FOR SWL PRESELECTOR

B1—9VDC transistor radio battery
BP1, BP2—5-way binding posts
C1—365 pF subminiature variable tuning capacitor
C2, 3, 4—0.01 or 0.5 µF ceramic disc capacitors, 100 VDC
J1—Phono input jack
L1—Amidon T68-2 toroid coil form, $1.75 postpaid from Amidon Associates, 12033 Otsego St., No. Hollywood, CA 91607.
Q1—FET with internal protective diodes, RCA type 40822* or RCA-40673*
Q2—2N3394 transistor
R1—150 ohms ¼- or ½-watt resistor
R2—2200 ohms, ¼- or ½-watt resistor
R3—470 ohms, ¼- or ½-watt resistor
S1—SPST switch

*Available at industrial distributors of RCA solid-state products.







SIGNAL CHASER

Save on repair dollars with this pennywise project.

by Martin Weinstein WB8LBV

One of the secrets of trouble-shooting is to start at those circuit areas where there is no trouble, then to back your way through the circuit until. you've reached the point where it isn't working. The same trick can work frontwards, letting you trace a signal through a circuit until you reach the point where it disappears.

Here's a handy aid for troubleshooting in the frontwards fashion, a signal tracer with a great deal of input sensitivity called Signal Chaser.

Built-in Demodulator. An ordinary amplifier could help you find signals in the AF (audio frequency) range, but the Signal Chaser can do more. D1, a 1N914 diode, acts as a demodulator, much like the diode in a simple crystal-set-style radio, to demodulate AM (amplitude modulated), RF and IF signals directly to audio (or whatever the carrier is modulated with). On FM and PM (frequency modulated and phase modulated) signals, the diode acts as a slope detector, giving a suitable, if low-fidelity, audio output.

High Impedance Input. The one feature of this circuit that really makes it shine when compared to most signal tracers is its high impedance input. The input impedance of the Signal Chaser is close to 10-Megohms. This is due to the use of a JFET (Junction Field Effect Transistor) for Q1. Q1, a Siliconix 2N5458 or similar P-channel JFET, is configured as a high-to-low impedance converter with an input impedance determined mostly by the value of R2, 10-Megohms. Capacitor C1 blocks DC but passes AF, RF and IF signals. Resistor R1 limits the input current to Q1.

A high input impedance means that for a given signal voltage, very little current is drawn by the Signal Chaser. This means that under almost all conditions, the Signal Chaser cannot load down the circuit you are troubleshooting.

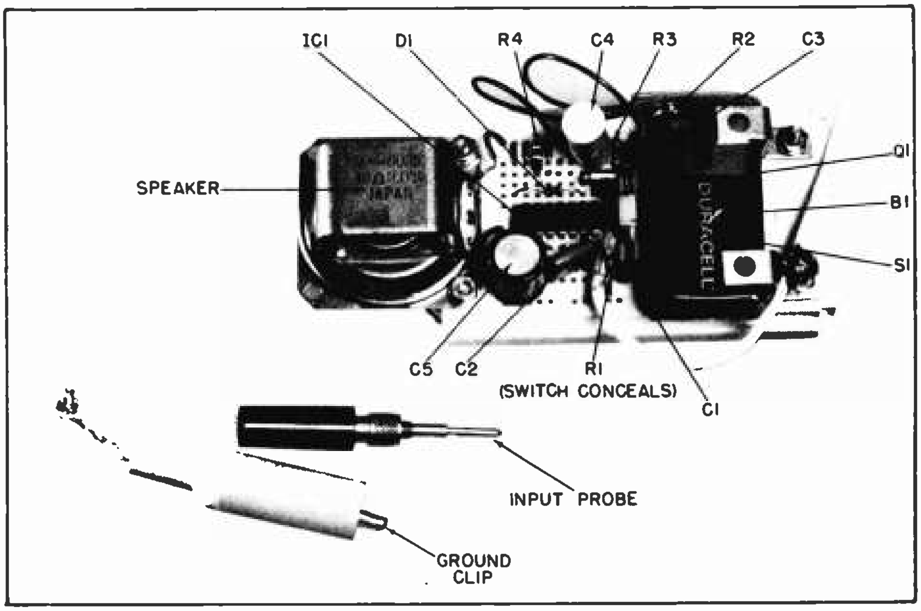
Speaker Size Output. The output of Q1 alone would be enough to drive a high impedance earphone, but keeping one in your ear while busy probing a suspect circuit can be, to say the least, inconvenient.

Instead, the output of Q1 (after demodulation) is coupled to the input of IC1, an LM38ON audio amplifier. IC1 provides enough drive to power even low-impedance speakers, around 8-ohms, to a good, healthy volume.

Capacitor C5 provides DC decoupling between the speaker and the output of IC1.

Breadboard-Easy Consruction. The entire circuit can be built up on a small solderless breadboard like the one shown (a Continental Specialties Corporation "Experimentor Socket," model EXP350, about $5.50) almost in less time than it takes to tell about it.

I've used three tricks here I would especially like to share. For one, I used a pair of zig-zag mounting brack-



Our Signal Chaser was built using a solderless breadboard and, as you can see, it made for a neat component arrangement. If you follow this photo, be certain you don't forget about R1, which connects to the Gate of Q1 and to C1—it's really there, it's just hard to make out in the picture! Signal Chaser should go together quite quickly, so if you start it after lunch you should be chasing your first signals before the dinner bell.

CHASER

ets (from the local Radio Shack) as battery hold-down clips. The mounting holes in the CSC EXP350 helped make this especially easy. At the far side of the breadboard, the mounting holes there happened to match exactly the holes on a small speaker I had on hand, and I was quick to take advantage of it. My third trick was to solder stiff wire (resistor leads I cut off some of the resistors in the circuit) to the breadboard end of the shielded probe cable. You may also want to use "headers," available from several sources and many parts stores for under a dollar a strip.

The rest of the assembly is fairly straightforward. Follow the lead of my layout, as shown in the photograph, when you lay out your own Signal Chaser—whether on solderless breadboard, a PC board or whatever method you use.

Understanding Solderless Breadboards. In case you haven't tried solderless breadboards before, you may not know how easy they are to work with. The holes in the face of the breadboard are arranged on .1" centers (1/10th of an inch apart), which happens to be the lead spacing on standard DIP (dual inline package) integrated circuits and most other modern components.

The center channel (.3" wide) is just right for IC's to straddle. On each side of the center channel are groups of five holes (columns, if you view the breadboard as widest on the horizontal, with the center channel running left to right). Behind each group of five holes is a spring clip with slits between the hole positions to allow a lead inserted into any one hole to be grasped firmly and independently, and interconnected with anything grasped at any other position in the group.

Each five-position terminal can be interconnected with any other by simply using hookup-wire jumpers.

The separate rows (at the top and bottom) are connected across their entire lengths and can be used for power or signal busses. I use them to carry the battery plus and minus lines.

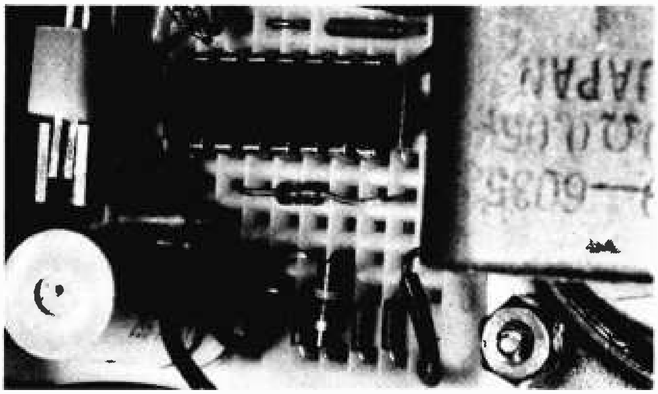
Using the Signal Chaser. For most run-of-the-mill signal tracing, clip the probe cable shield to a circuit ground near the area you're testing and touch the probe to each side of the signal path near each active or passive device in the signal path. Start at the front end and work your way to the output, if you like—but skipping a few stages on the chance they'll work can also help you localize a problem.

The high impedance of the Signal Chaser input means high sensitivity, which lends it to some useful applications.

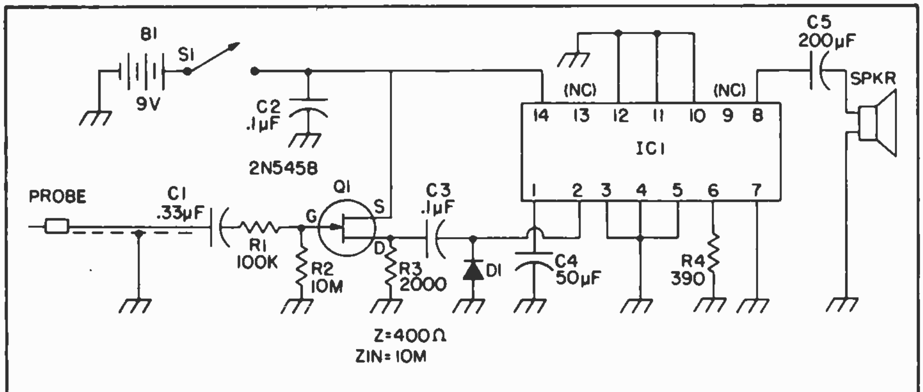
You can attach a coil of wire or a magnetic tape head to the input to inductively probe circuits and devices. You can "listen" to the magnetic stripe on the back of your credit cards, amplify a telephone conversation or pick off the signal on your transmitter's modulation transformer.

Or attach a photocell to the input and listen to the sounds of light bulbs, LED readouts, the sun, street lights and then some.

Signal Chaser—not only a good introduction to solderless breadboarding, but once it's built you may find it to be one of the handiest gadgets in your electronic bag of tricks-of-the-trade. Have fun and chase those signals—and those problems—down! ■



Signal Chaser has a high impedance input that is close to 10-Megohms. It will draw very little current and so will not usually load down the circuit under test.



PARTS LIST FOR SIGNAL CHASER

B1—9-VDC battery
C1—.33-uF capacitor
C2—.1-uF capacitor
C3—1-uF capacitor
C4—50-uF capacitor
C5—200-uF capacitor
D1—1N914 diode
IC1—LM380N audio amplifier
Q1—2N5458 JFET (Juntion Field Effect Transistor)
R1—100,000-ohm resistor, ¼-watt
R2—10-Megohm resistor, ¼-watt
R3—2000-ohm resistor, ¼-watt
R4—390-ohm resistor, ¼-watt
S1—SPST switch
SPKR—8-10-ohm speaker
MISC—Breadboard (Continental Specialties model EXP350 or similar) or other method such as PC board; probe; insulated clip; battery holder/clip; wire; etc.

Solderless breadboard materials is arranged with the holes about 1/10 inch apart. As you can see, this just fits the spacing of the IC's leads and of most modern components.

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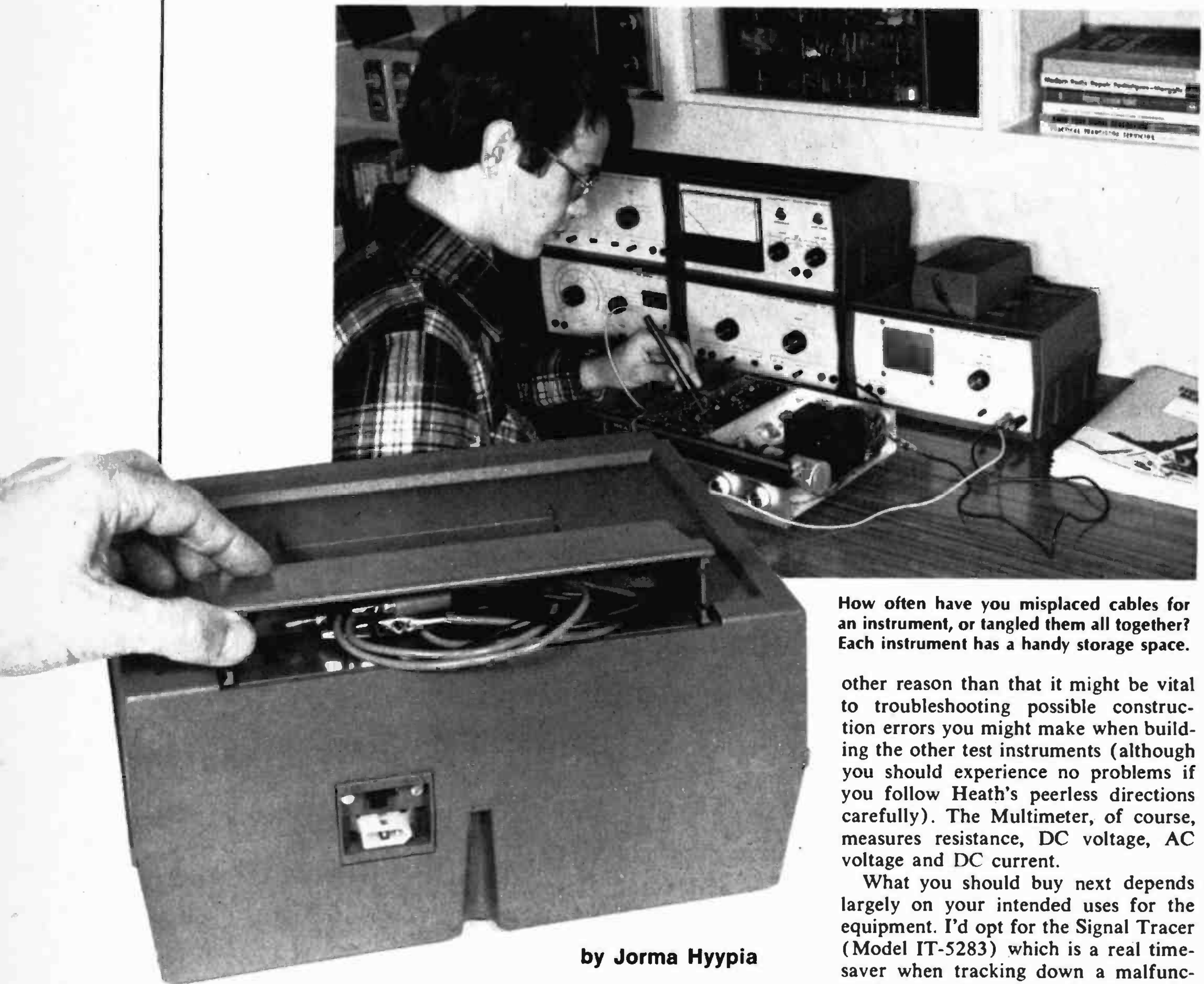
BUILD A BUDGET

Heathkit's new instruments make



How often have you misplaced cables for an instrument, or tangled them all together? Each instrument has a handy storage space.

by Jorma Hyypia

As we accumulate ever increasing numbers and varieties of electronic equipment in our homes, everything from kitchen appliances to elaborate hi-fi audio equipment and even hobby computers, we compound the basic problems of keeping everything in operating order without suffering budget-crushing repair bills. One answer is to do at least part of our own troubleshooting, leaving only the tough-nut jobs for professional repairmen.

The Five Choices. But for that you need reliable equipment as well as know-how. Many who would be willing—in fact eager—to learn how to troubleshoot electronic and electrical equipment have not done so because of the high cost of test equipment, but that no longer need be a deterrent. Heath Company has come out with a much-needed line of basic test instruments and at truly affordable prices. Each of the five matched units described in this article costs only $39.95, plus any applicable tax, in kit form. A handy, optional AC power pack costs $27.95.

If you can't or don't want to buy *all* of the instruments at one time, start with the Multimeter (Model IM-5284) because it is basic to all kinds of troubleshooting. It is a "first' if for no other reason than that it might be vital to troubleshooting possible construction errors you might make when building the other test instruments (although you should experience no problems if you follow Heath's peerless directions carefully). The Multimeter, of course, measures resistance, DC voltage, AC voltage and DC current.

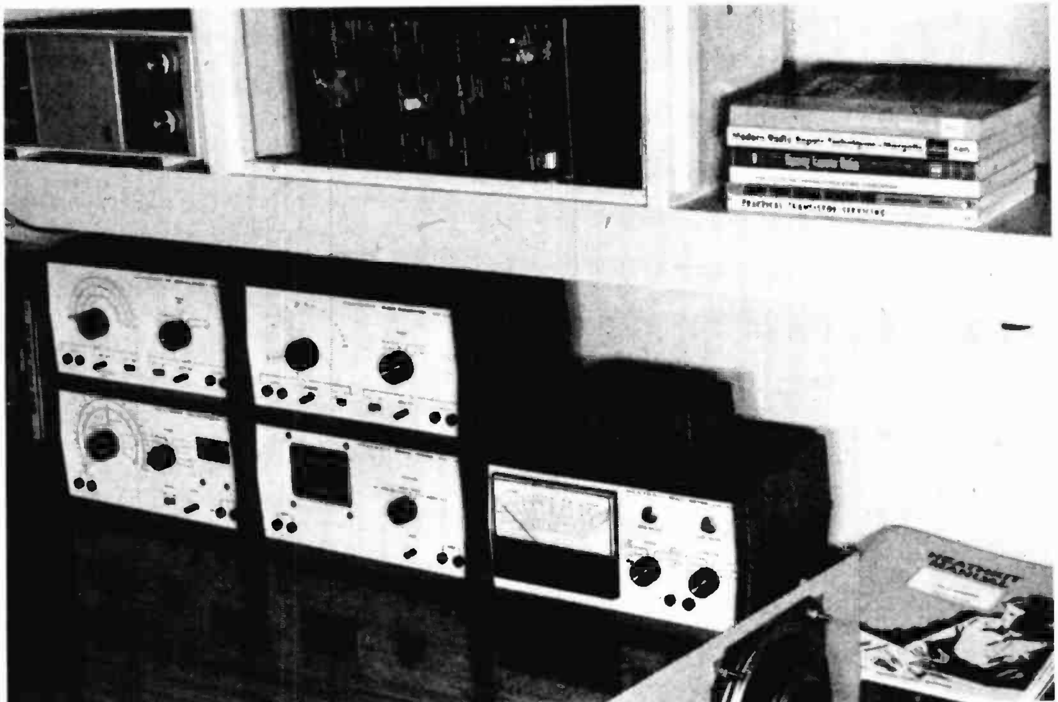
What you should buy next depends largely on your intended uses for the equipment. I'd opt for the Signal Tracer (Model IT-5283) which is a real timesaver when tracking down a malfunctioning stage in a piece of audio equipment. The unit also functions as an *audible* voltmeter that is especially handy for tracing logic circuits because its sound tones vary in pitch as measured voltages change—more about that later.

Your third choice might be the Audio Oscillator (Model IG-5282) because it too is applicable to troubleshooting a broad variety of electronic gear, including radios and TV sets. It puts out both sine wave and square wave signals for checking stage gain, distortion, frequency response and harmonic distortion.

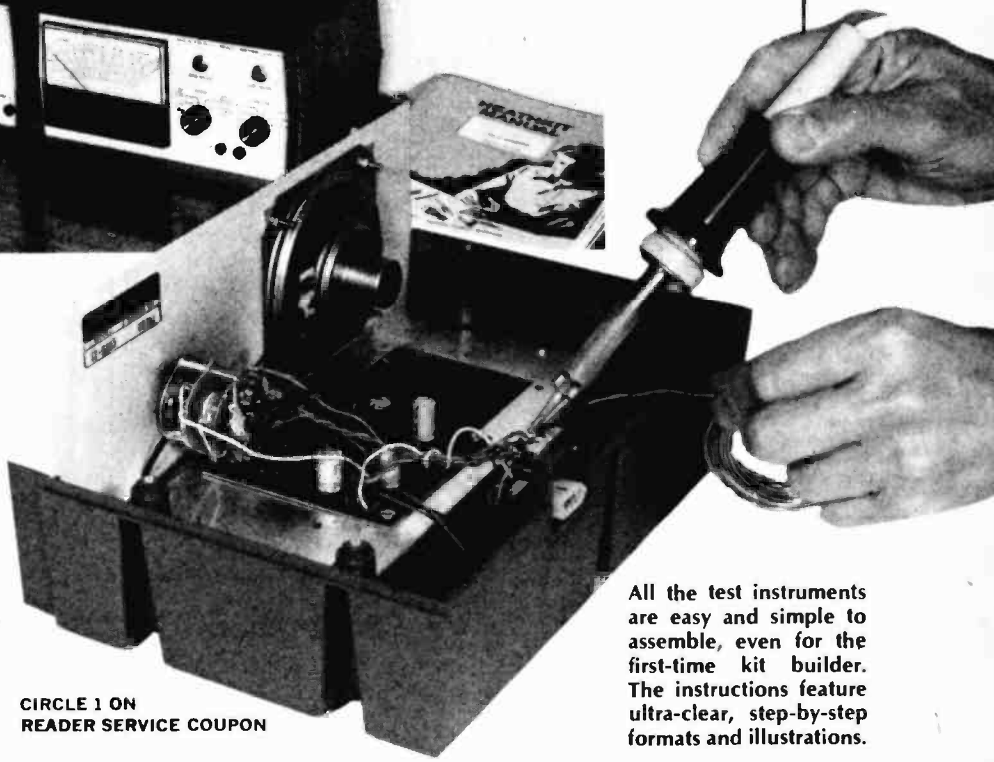
Consider the RF Oscillator (Model

TEST BENCH!!!

testing gear easy on the wallet.



The test instruments may be stacked any convenient way, in pairs as shown here or a stack. The plastic cases will interlock.



All the test instruments are easy and simple to assemble, even for the first-time kit builder. The instructions feature ultra-clear, step-by-step formats and illustrations.

CIRCLE 1 ON READER SERVICE COUPON

IG-5280) as your fourth acquisition, especially if you want to align AM radios and troubleshoot tuned stages of FM and TV receviers.

The RLC Bridge (Model IB-5281) measures the values of resistance, inductance and capacitance of electronic components. The instrument would be especially useful to electronics experimenters and hobbyists who have need to determine the electrical characteristics of "junk box" components that have missing or obliterated identifying marks and values.

Now let's take a closer look at each of these instruments to see what you would get for your money, and what you might do with each of them.

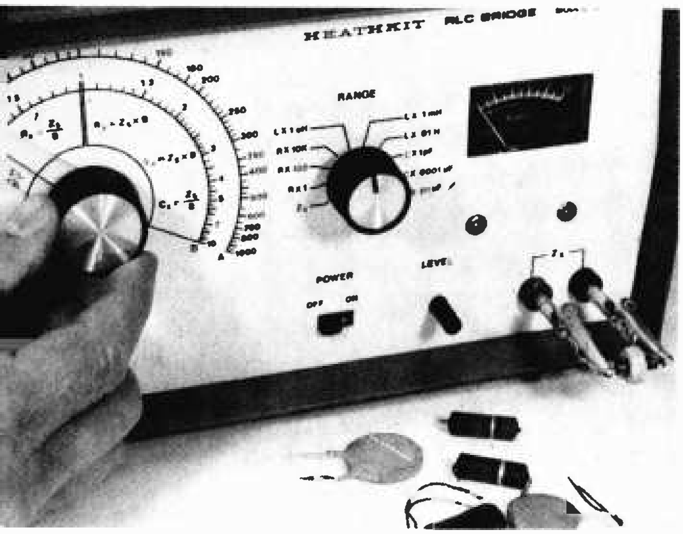
Multimeter. This instrument combines the functions of a high input-impedance voltmeter, an ohmmeter, and a milliammeter, with all measurements indicated by a large, 4½-inch meter with 100 degree movement.

Each function has four ranges. The DC voltmeter measures from zero to 1, 10, 100, and 1000 volts full scale with an accuracy of ± 3% of full scale; the input resistance is 10 megohms on all ranges. The AC voltmeter offers the same four voltage ranges, with an accuracy of ± 5% of full scale. The input resistance is 1 megohm on all ranges, input capacitance is about 100 pF (40 pF on 1000 V range), and the frequency response is ± 1 dB from 10 Hz to 1 MHz (from low source impedance). The DC milliammeter reads from zero to 1, 10, 100, and 1000 Ma full scale with ± 4% accuracy of full scale. The resistance reading multipliers are 1, 100, 10K, and M. Ten ohms is at center scale, and the ohmmeter reads with ± 3 degrees of arc accuracy.

In addition to reading resistance of various electrical and electronic components or component systems, the ohmmeter is very useful as a continuity tester to determine whether there is a complete path in a circuit through which electric current can flow. It can help you to quickly and easily find breaks in many household electrical devices such as electric irons, heating pads, waffle irons, lamps, extension cords, toasters and many other items. These of course are all "power off" tests, with the appliance disconnected from its normal power source.

The DC voltmeter can be used for such simple chores such as checking the batteries of a portable radio or

BUDGET BENCH!



The RLC bridge is especially handy for those who must measure resistance, inductance and capacitance of junk box parts. This photo shows an unknown coil being measured for its inductance by simply clipping it to the alligator clips on the lower right corner of the RLC bridge's front-face panel.

other battery-powered device, testing automobile electrical circuits, or for more complicated jobs—such as comparing voltages in hi-fi audio equipment against manufacturer specifications during troubleshooting. The AC voltmeter might be used to find the fault in a doorbell circuit or any other AC-powered device, and to a limited degree is useful in audio troubleshooting. Of course all of these functions, including the milliammeter, are out-and-out necessities for those engaged in any kinds of general electronic hobby or experimental work.

Signal Tracer. This instrument is one of the most effective tools you can own for rapid troubleshooting in radio and TV circuits. It is basically a hi-gain amplifier having a diode-equipped probe which acts as an RF detector. A relaxation oscillator provides an audible volt/ohmmeter function. The instrument is of the "untuned' variety for simplicity of operation.

By setting the function switch to *Signal Tracer* position, and clipping the black lead to the chassis or ground circuit of the radio or TV under test, the probe can be used to trace a signal through various stages until a dead stage is found. You set the probe to RF detection initially, then switch to DC after the traced signal has gone through the detector. You can also use the instrument to spot intermittent or faulty volume controls or coupling capacitors. Bear in mind that the signal tracer will detect the presence as well as absence of a signal. For example, it's common practice to use a high capacity by-pass capacitor in the audio output circuit. If the capacitor is open, there will be a definite indication of a signal at the by-pass capacitor, whereas a good capacitor would pass the signal to ground.

By placing the probe switch in the DC position, and the function switch in the *Audible V/Ohms* position, you have an "audible voltmeter" that will surely produce a "why didn't I discover this before" reaction the first time you use it. In this mode, the instrument not only reveals where in a circuit under test signals are present or absent, but also indicates, by changes in pitch of the audible tone, relative high and low voltages. As voltage increases (or resistance decreases) the frequency of the tone increases; and as the voltage decreases (or resistance increases) the frequency (pitch) of the tone goes down. The device responds to voltages from about −3 to +20 VDC, and to resistances from zero to 5 megohms.

The audible voltmeter is especially convenient when you would rather not have to take your eyes off the circuit under test to look at a dial or readout on a voltmeter or ohmmeter; you just listen! Theres much less chance of a probe tip slipping to short-circuit delicate components.

In service work it is sometimes necessary to remove the chassis of a radio or TV from its cabinetry and disconnect the speaker. The Heathkit Signal Tracer can be used as a substitute speaker because the speaker is completely disconnected from the internal circuitry when the function switch is in the *Off/Spkr Sub* position. Speaker packs on the front panel make it easy to connect a radio or TV set to this speaker.

You'll find many off-beat uses for this versatile instrument. You can use it to check a phono turntable for any irregularity in mechanical operation, such as turntable wow or thump, or any objectionable noise transmitted through the phono cartridge. You can also use it to test microphones and musical instrument pickups.

Audio Generator. The sine wave generating circuit in this instrument is a Wien-type oscillator. The frequency output is 10 Hz to 100 kHz in four ranges; the sine wave output voltage is 0 to 3 volts rms while the square wave output voltage is 0 to 3 volts peak.

Gain and distortion checks are probably the most common types of sine wave tests you will make using this generator; in either case, you can test a single amplifier stage separately, or the amplifier system as a whole. You simply connect the generator output to the input of the amplifier to be tested, feed a signal of known amplitude (voltage) into the amplifier, and measure what comes out by means of a voltmeter or oscilloscope to determine the voltage gain provided by the amplifier. Frequency response tests are made by determining the gain at various frequencies. To test for distortion, simply compare oscilloscope waveforms representing the generator output and how it looks after passing through the amplifier.

Square waves are very useful for testing amplifiers because one square wave can perform several tests simultaneously—simply because a square wave actually consists of many superimposed sine waves. By using a square wave, you can test a circuit at many different frequencies at the same time. The Heathkit manual explains how the frequency response of an amplifier, from 10 Hz to 100,000 Hz, can be checked by setting the square wave output to only two frequencies—100 Hz and 10kHz.

By observing, with the aid of an oscilloscope, changes in the shape of the input square wave after passage through the amplifier, you immediately see whether low-frequency response is good or bad, and whether some of the higher harmonics might be missing.

You can use the sine wave *and* square wave outputs of the generator at the same time without detrimental effects to either waveform. For example, when making stage gain measurements on an amplifier with an oscilloscope, connect the sine wave output of the generator to the input of the stage being measured, and the square wave output to the external sync connector of the oscilloscope. You then can measure a number of amplifier stages without readjusting the oscilloscope sync controls, regardless of how small or how large the signal happens to be.

There are many other applications for this versatile audio generator. It can be used to measure the input impedance of an amplifier or other circuit, for example. Or it can be used as an audio signal source during signal tracing with the Heathkit Signal Tracer instrument. The electronics hobbyist who likes to build and experiment with all kinds of gadgets can surely find many other uses for this generator.

RF Oscillator. A Hartley oscillator is used to generate the basic RF frequency range from 310 kHz to 32 MHz in four bands, and separate oscillator circuitry is used to extend the output to 110 MHz in a fifth band. There's also an additional band of calibrated harmonics extending from 100 MHz to 220 MHz. The output voltage is about 100 mV (open circuit), and internal modulation is 1,000 Hz. For added convenience, there's also an audio frequency output signal of 1,000 Hz with an output voltage of 2 volts rms (open circuit).

It's possible to use this RF oscillator as an RF signal source for peak alignment of tuned circuits in some FM radios and tuners. But a better method of aligning FM equipment is by means of sweep alignment (for which you need a different type of generator); in that case this RF oscillator may be used as a marker generator.

Despite this limitation, there are many other useful applications for the oscillator. For example, the instrument is what you need to align any AM radio. The radio speaker itself, or a suitable voltmeter like the Heathkit Multimeter shown in this article, may be used as the output indicator. The voltmeter is preferable to the speaker because it will indicate smaller changes in the output signal. The Heathkit manual tells where to connect the voltmeter (different places depending on whether you use the AC or DC section of the meter) and in general how to go about aligning the radio.

The RF oscillator is also very valuable when using a "signal injection" method of troubleshooting weak or dead electronic devices including radio and TV receivers, hi-fi amplifiers and the like. In this method, a signal produced by the oscillator is coupled into various stages of the defective equipment, one stage at a time, until the defective stage is located. For example, to find the faulty stage of an AM receiver, the 1,000 Hz audio signal from the oscillator would first be connected to the base of the output transistor and then be moved back to the audio transistor. If normal sound is heard from the speaker in both cases, you'd switch to use of a modulated RF signal to check the remaining stages of the radio. Once the defective stage is located, a search for the individual defective component within that stage would be sought. Further tests using the 1,000 Hz audio signal, for example, might indicate that there's an open coupling capacitor between two amplifier stages.

RLC Bridge. The internal electronic configuration of the RLC bridge is basically the same as the familiar Wheatstone Bridge you studied in your high school or college physics course except that a fixed, internal component standard (Zs) is used in place of the usual calibrated potentiometer. The standard, used in conjunction with a range switch, selects a suitable multiplication factor and a certain frequency appropriate to the component being tested.

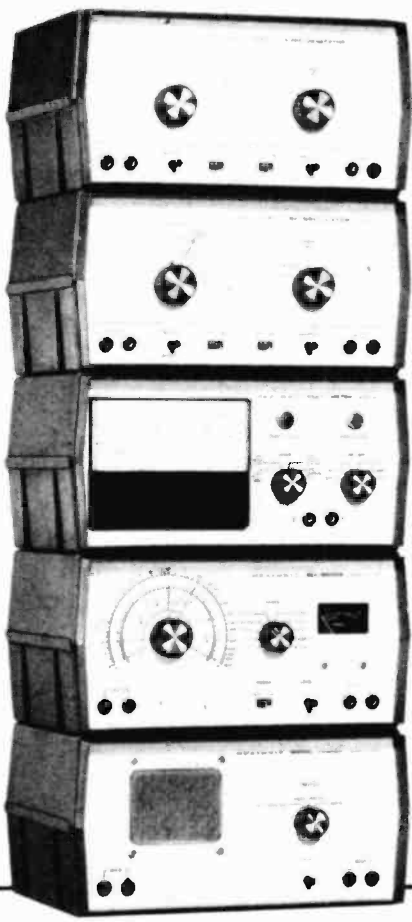
When you insert an unknown component of value Zx you balance it electrically against the same kind of reference component in the RLC bridge, then read the value of the unknown from the circular scales. The bridge uses an AC rather than DC source because capacitors and inductors cannot be tested with DC. The required AC is generated by a Wien bridge oscillator which provides three output frequencies (1000, 100 and 10 Hz) which the range switch selects.

To measure the inductance of a coil, just fasten it to alligator clips plugged into the Zx jacks on the front panel, set the range switch at one of the three *L* positions, then turn the *balance* knob until the null meter indicates a minimum reading (which may not be zero). If no null can be obtained, switch to an *L* range that makes the meter responsive, then read the value of inductance from the appropriate balance scale.

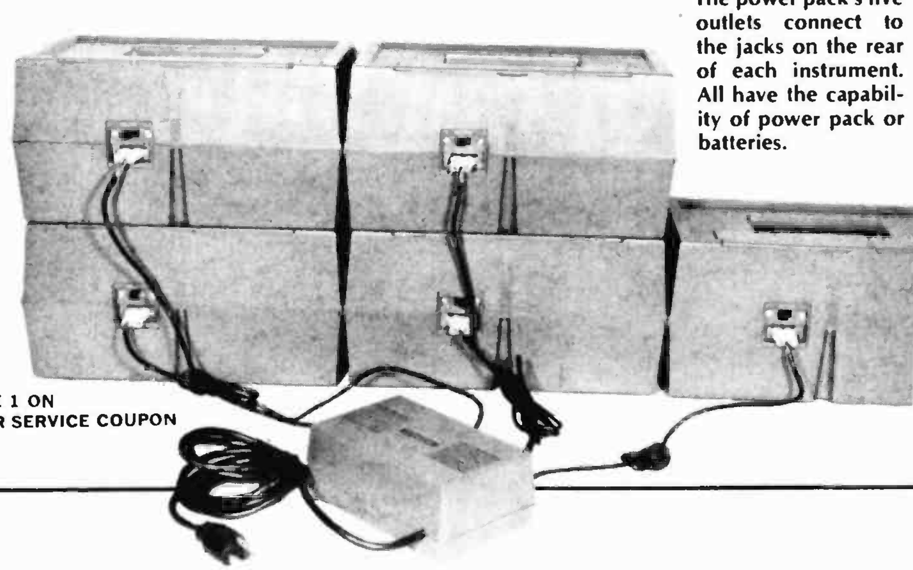
The same procedure is used to measure resistance or capacitance, except that the range switch is turned to the appropriate *R* or *C* position.

It's also possible to compare the unknown component with an external standard plugged into the Zs terminals on the front panel by setting the range switch in the Zs position. This convenience can be used, for example, to quickly compare resistors to find

(Continued on page 114)



Heath's new line of test instruments are a handsome addition to any bench. Circle 31 for info.

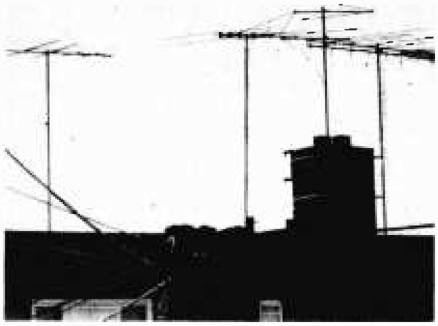


The power pack's five outlets connect to the jacks on the rear of each instrument. All have the capability of power pack or batteries.

CIRCLE 1 ON READER SERVICE COUPON

Budget installs a...

Save big bucks by doing



Avoid antenna crowding by installing it as far away from other antennas as possible.

by Jorma Hyypia

DO-IT-YOURSELF INSTALLATION of a high-quality TV antenna can be far less expensive than having the cheapest antenna on the market installed by a professional worker. The job is quick and easy, especially if you can work on a flat roof as shown here.

Some cities have exact regulations about the maximum allowable heights of TV antennas, so check with your local authorities or just keep your antenna at the same level as others in the neighborhood. If there are other antennas on the roof, avoid togetherness as much as possible; place your antenna as far from others as you can, and where it can be pointed toward major transmitter towers with least obstruction by other antennas, chimneys, large trees or other buildings.

If possible, locate the legs of your tower over roof joists (tap the roof and listen for a "solid" sound). Mark locations of the lag screw holes, then drill pilot holes. Test your drill bit on a piece of scrap wood to be sure the pilot holes won't be too large for a tight fit. Also, before drilling, use a plumb-bob to be certain that the tower stands straight. Add shims under one or two legs, if necessary, to correct any bad lean and to stabilize the tower on an uneven roof surface.

Weatherproofing. Paint the drilled holes and contact surfaces on both the roof and feet of the tower with roof patch compound obtained from a building supply or hardware store. Get the smallest can of compound sold; you don't need much.

Reposition the tower, then hand drive the lag screws part way into the holes; tighten the screws only after all three have been driven in most of the way. To complete the weatherproofing job, paint the screw heads and feet of the tower with more roof-patch compound.

Before continuing with installation of the antenna, remove all unneeded materials, waste and tools from the roof, including boxes, cans, the old antenna and mast you might be replacing, and the power or hand drill you won't need anymore. You are less likely to damage the rather delicate new antenna during installation when working on a clean roof.

If you are working on a peaked roof, the antenna must be unpacked and assembled on the ground. But if you have a flat roof, remove the antenna from its box on the roof if there is plenty of free working space. You can use the box to stow the old antenna for easier removal from the rooftop.

Do not unfold the antenna elements until you are actually ready to proceed with the mounting. The elements are of seamed tubing that is quite rugged, unless you step on it or bang it hard against a chimney or other obstruction. The antenna will last for a long time under normal conditions, although wind action and roosting birds —especially large ones like vultures— will eventually cause damage.

Follow the printed directions that come with the antenna so that you unfold the elements in the proper order and make any other adjustments that may be required. Secure the antenna to the mast only after all elements have been unfolded and snapped into place. A good ratchet wrench makes the job

Drill pilot holes for the lag screws and make sure the tower is straight and steady.

Use roof patch compound to prevent rainwater leakage through the pilot holes.

Drive home the lag screws by hand only after all three are most of the way in.

Put roofing compound over the tightened screws to keep them secure and leakproof.

A hard hat protects against falling antennas, roosting pigeons and satellites.

ROOF ANTENNA

this simple job yourself

DANGER!! Keep all antennas clear of power lines!

of fastening the antenna to the mast easier. Avoid over-tightening the nuts and bolts.

Caution! Antenna elements are most often broken during this phase of installation, when the antenna is fastened to the mast but not yet installed on the tower. So handle the antenna/mast assembly carefully.

To obtain the best signal transmission from the antenna to your TV receiver, use 75-ohm coaxial cable. Use a matching transformer to match the antenna's 300-ohm impedance to the 75-ohm impedance of the coax line. This transformer is connected at the antenna. A small connector on an F-type transformer joins to a standard 75-ohm F-connector on a cable that can be purchased pre-assembled. A rubber boot on the antenna slips over the connector to minimize corrosion by snow, ice, rain and air pollutants. It is a good idea to coat the connector and nearby cable with silicone sealer. Tape the transformer to the mast or antenna main beam to prevent its movement by wind.

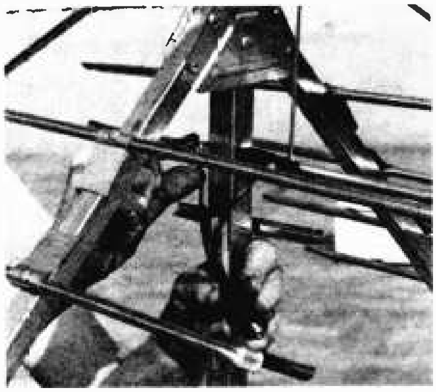
Black plastic electrical tape can be used to secure the coax cable to the mast. It's important to prevent the cable from moving about freely, thereby putting strain on the connections. Paint or spray lacquer on the connection terminals, on the antenna, to further minimize rust and other corrosion. Attention to such details is the secret of a no-trouble antenna installation.

Mount the antenna and mast on the tower, using shims between the mast and tower, if necessary, to get the mast vertical (check with a plumb bob or carpenter's level if you have one, otherwise sight by eye from several different directions).

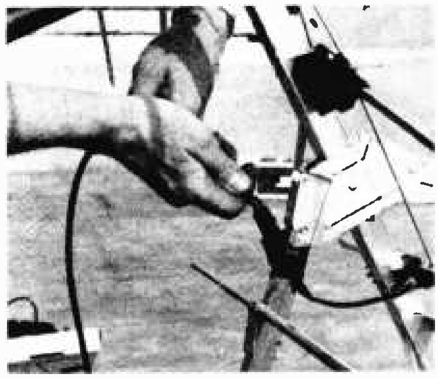
Feed the coax cable down to your TV set, using recommended stand-offs and a matching 75- to 300-ohm transformer at the TV set if the receiver does not have a 75-ohm input terminal. Try to keep the cable away from metal rain gutters, downspouts, power lines and other metallic or electrical obsructions. To complete the job properly, add a good lightning arrestor and earth ground, using heavy gauge aluminum wire sold for that purpose by radio/TV supply stores. A good ground protects your antenna, TV set, home and your family at very low extra cost.

Warning! If there are any power lines on or near the roof, do not allow the antenna, mast or tower to accidentally touch them. Hundreds of people have been electrocuted, in the past few years, by bumping antennas into power lines.

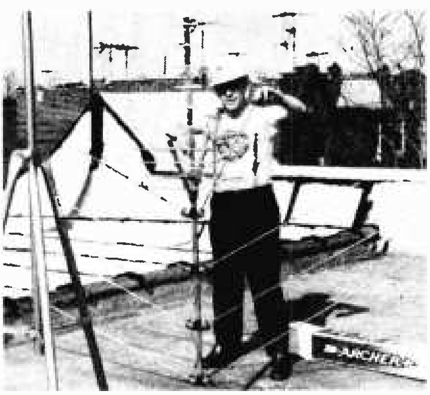
The last step is to aim the TV antenna at the TV transmitter tower. In this installation the alignment was easy because the transmitting tower was within view. Where the transmitting tower is not visible, adjust the antenna direction while someone else monitors the quality of the TV image. Do not assume that other TV antennas on the roof are necessarily aligned correctly; those near this installation were up to 30 degrees off! If you are very close to a transmitting tower, and the signal is strong enough to overload your TV receiver, it may be necessary to orient the antenna 180 degrees away from the transmitter direction. ■



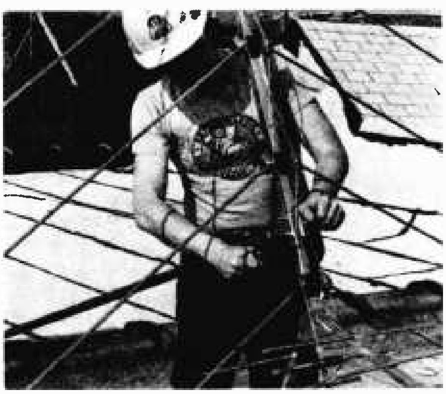
For best results use 75-ohm coaxial cable and an impedance-matching transformer.



Seal all connections and secure the coax to the mast with plastic electrical tape.

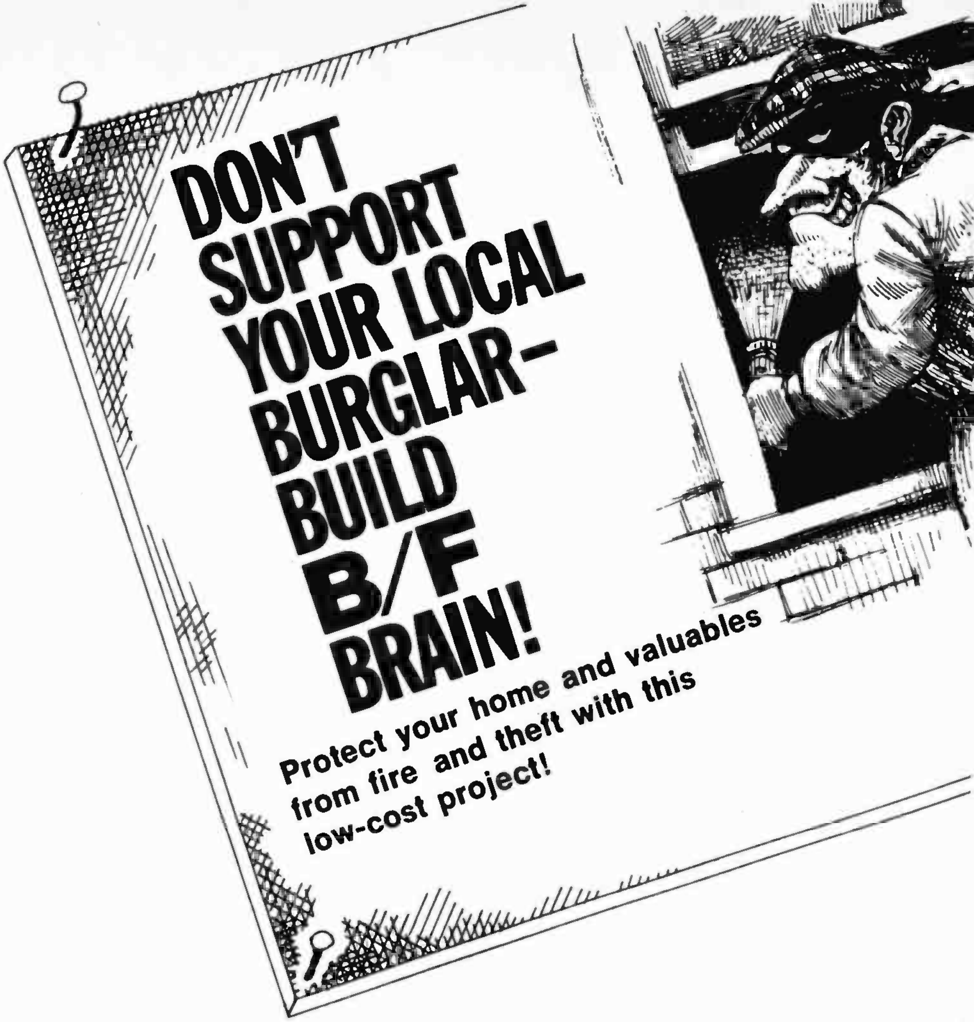


Unpack the antenna on the roof and unfold the elements only when you are ready.



Secure the antenna to the mast. Most damage to the elements occurs at this time.

Aim the antenna at the TV transmission tower. Follow the directions in the text.



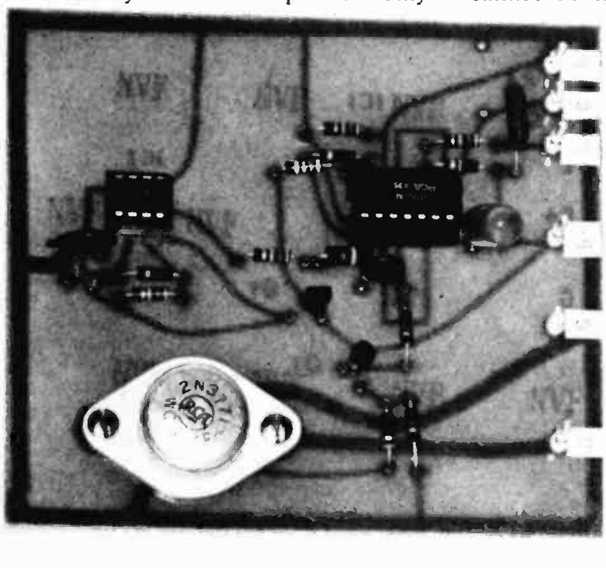
☐ It's an unfortunate sign of our times, but the burglar alarm is becoming a necessary part of home electronics. Robberies of homes is one of the fastest increasing crimes. In many cases homes are left vacant during the day when both husband and wife work, leaving an unprotected home to the mercy of thieves. If you haven't been victim of such a crime yet, consider yourself lucky. Better yet, consider electronic protection of your home.

There are many burglar alarms available for the home. However, a good alarm system may cost as much as $500 when installed by professionals. Even the do-it-yourself units available from electronic supply houses or discount stores cost $100.00 and more.

There's no need for you to spend this kind of money to achieve home security if you are handy at building electronic circuits. B/F Brain can do the job a at fraction of the cost of a do-it-yourself kit, and will be just as effective and reliable as any on the market. By using modern electronic technology an extremely simple circuit has been designed which produces excellent performance at very low cost. The circuit uses two integrated circuits which cost less than $2.00.

Works Open or Closed. B/F Brain has several desirable features. It may be used as a closed circuit in which all points of entry into the house are protected by a loop of conductive foil and normally-closed switches. There is no limit to the length of the loop or number of switches which may be employed, since they are connected in series. This allows protection of any number of doors and windows, and additional points for protection can be added at any time without any changes in the alarm itself. This type of installation has a distinct advantage over ultrasonic systems which protects only the room in which they are installed.

Provision has also been made to use normally-open switches as desired, in addition to the series circuit of conductive foil. Thus it is possible to add foot-operated switches in hallways and doorways and as additional protection. This also permits the burglar alarm to be used in an automobile, where the opening of a door, which normally activates the dome light switch now also operates the alarm. Once the alarm is activated by opening or closing a circuit, it cannot be turned off by just restoring the disturbed circuit to its original condition (i.e. closing the door or window). A reset switch must be pressed, otherwise the alarm will continue to sound.

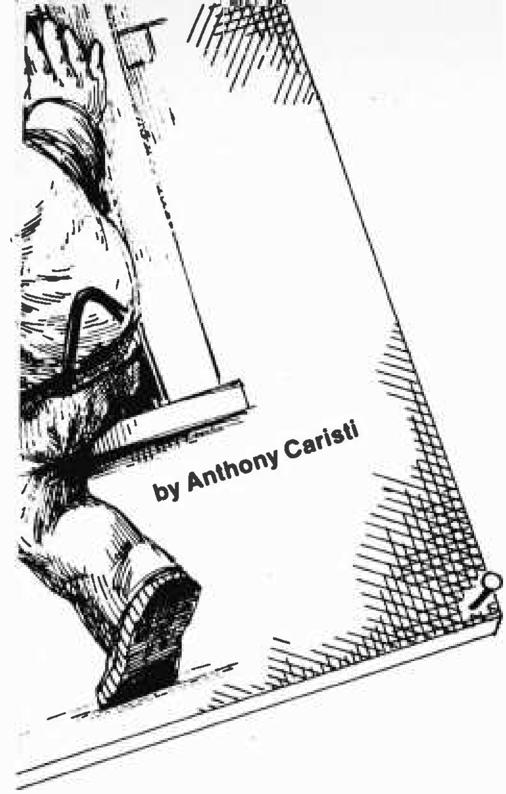


Photograph at left shows completed board with the two ICs. Large power transistor at lower left is Q2 which drives alarm speaker. Six terminals at right edge of board connect to speaker, foil loop, switches, Reset switch, and power source.

Works For Fires, Too. B/F Brain becomes a fire sentry as well, simply by buying easily-available fire sensors and installing them wherever you feel they are necessary. Again, there is no limit to the number of sensors which can be added to the circuit. Both open- and closed-circuit sensors may be used.

Inexpensive Alarm. There is no need to purchase an alarm bell. Any inexpensive eight-inch or larger, 3.2-or 4-ohm speaker will do the job nicely. The alarm circuit produces a 12-volt peak-to-peak square wave which will deliver 9 watts of power into a 4-ohm load. This will produce sufficient sound for most applications. If desired, more power may be obtained simply by increasing the supply voltage to the speaker. For example, if a 24-volt supply is used, the power delivered to the speaker will increase by a factor of 4, to 36 watts. B/F Brain produces an up-and-down wailing sound which will command lots of attention, even at the 9-watt level.

Window Protection. Conductive foil for windows and doors is relatively inexpensive. A 150-foot roll of ⅜-in.



wide tape costs only three or four dollars. This tape has an adhesive backing and it is not necessary to use the full width of tape. By cutting the tape in half you provide greater sensitivity to glass breakage and a more pleasing appearance. One roll of tape will easily do any average size home.

Timer Delay. An optional feature of the circuit is provision to add a capacitor to produce a delay of several seconds. This feature will allow you to arm the alarm circuit before going out, and then leave the house by a protected door. It also permits you to enter the house through a protected door without sounding the alarm, since you can shut the circuit off before the alarm sounds.

The basic circuit is shown first. This is the complete alarm circuit, constructed on a small printed circuit board.

Also shown is a layout of the foil pattern of the board, viewed from the copper side. We also show the component layout as viewed from the top of the board. Note that Q2, the power output transistor, does not have any heat sink. None is required since Q2 operates as a switch and not a class-A amplifier. When Q2 is conducting it is in a saturated state. This means that the collector-to-emitter voltage is about 0.3 volts. Thus, the total dissipation in Q2 is 0.3 volts times 3 amperes or 0.9 watts. The average dissipation of Q2 is half of this, since it is cut off for half of each cycle when the alarm circuit is delivering power to the speaker.

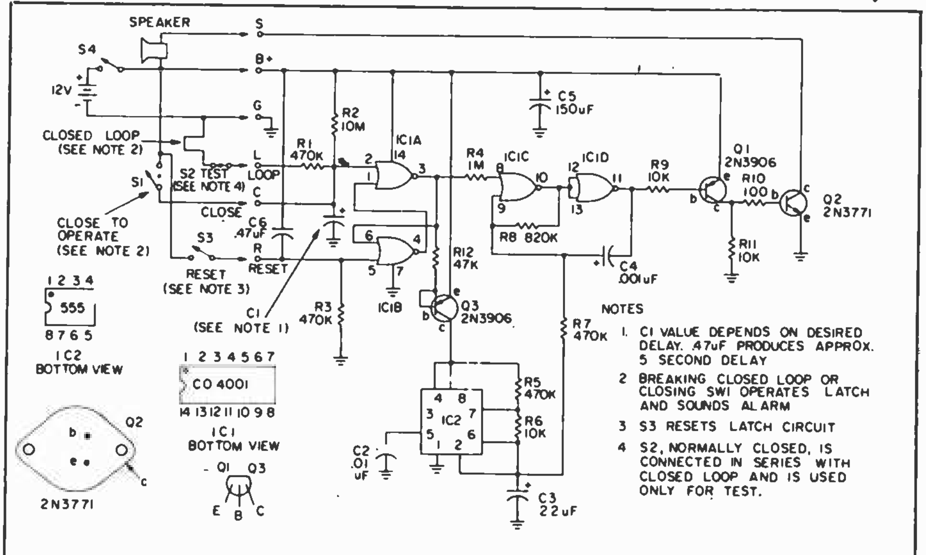
Note the series of six connections located at one side of the board. These are the required connections to the *Power Supply*, *Speaker*, *Open-circuit*, or *Closed-circuit* loop, and *Reset* control. It is recommended that sockets be used for the integrated circuits. This makes it easy to solder to the board without endangering the integrated circuits with the iron's heat. It also will permit you to remove each IC in the event the circuit ever needs servicing. Once an IC is soldered into a printed circuit board it is extremely difficult to remove. Be sure to insert the ICs into the sockets (or board) in the correct direction. Pin 1 of each IC is marked on the IC itself, as well as on the copper foil side of the printed circuit layout.

About the Circuit. B/F Brain uses two integrated circuits. IC1 is a four-section, 2-input NOR gate constructed in COS/MOS (Complimentary-Symmetry / Metal-Oxide Semiconductor) form. The advantage in using COS/MOS integrated circuits is the extremely low current drain of the chip. The CD4001 chip IC used in this circuit draws only 5 microwatts of power from the 12-volt supply.

A NOR gate is a digital building block which obeys the following rule: If the voltage at either input terminal (or both input terminals) exceeds 70 percent of the supply voltage, the output voltage falls to zero. If the input voltage to both input terminals is less than 30 percent of the supply voltage, the output voltage rises to the supply voltage. Input voltages between 30 and 70 percent of the supply voltage have no logic definition and are not considered legitimate voltages when they're applied to the input terminals.

IC1A and IC1B are connected in a configuration called a *Bistable Latch*, or *Flip-flop*. This circuit can rest in either of two states: Pin 3 at 12 volts and pin 4 at zero volts, or pin 3 at zero volts and pin 4 at 12 volts. The voltages fed to the input terminals, pins 2 and 5, determine which state the circuit rests in. The normal input condition for the bistable latch is approximately zero volts at both input terminals. Pin 2 is held to about 0.5 volts by means of R2, R1, and the closed loop circuit of conductive foil between terminal L and ground. Pin 5 is held to zero volts by means of resistor R3. Under this condition the output voltage at pin 3 is 12 volts. In order to flip the voltage. at pin 3 to zero volts, the voltage at input terminal pin 2 must approach 70% of the supply voltage, or 8.4 volts. This would be caused by the closed loop at terminals L to G being opened, or a connection between terminals C and B+. When either of these conditions exists, even for a few microseconds, the output voltage at pin 3 is flipped to zero. Removing the voltage at pin 2 will have no further effect on the circuit. It can be restored only by applying a voltage to pin 5 through the reset switch.

More on Circuit Operation. Capacitor C1, between pin 2 of IC1A and ground, controls the amount of time delay between the opening of the loop circuit and the activation of the alarm. When the loop circuit is closed, the voltage across C1 is held to about 0.5 volts through the voltage divider action of R2 and R1. When the loop is opened, C1 begins to charge through R2. The latch circuit will change state when the voltage at pin 2 approaches 8.4 volts. Thus, the amount of time delay is



Complete schematic of system shows the NOR gates, IC1A through IC1D, which are part of the CO 4001 integrated circuit. Circuit may be assembled on perf board if desired. Be sure to use IC sockets unless you're experienced soldering directly to ICs.

B/F BRAIN!

determined by the value of C1, and will be about five seconds for a .47 uF capacitor. If no delay is desired, C1 may be deleted from the circuit.

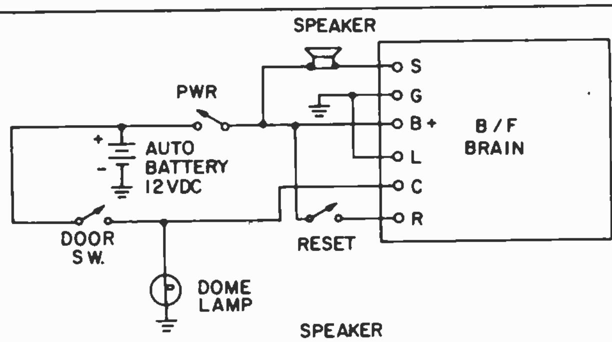
IC3C and IC3D are considered in a configuration which operates as an astable (free running) multivibrator. DC feedback through R8 and AC feedback through C4 allows the circuit to oscillate at a frequency (about 1500 Hertz) determined by the RC time constant. However, the oscillator circuit will operate only if there is no input voltage at pin 8, IC1C. Thus, the latch circuit of IC1A and IC1B controls the operation of the oscillator.

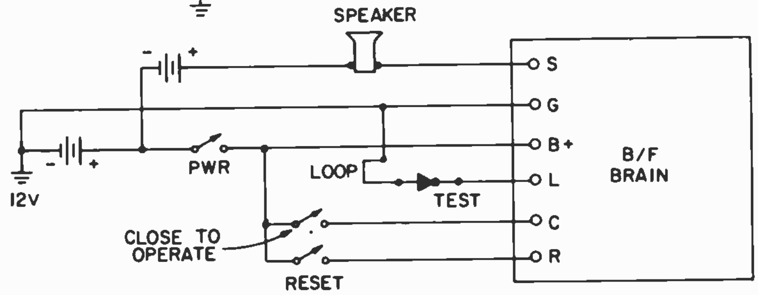
The Timing Circuit. IC2 is a timing circuit which is connected to operate as an oscillator. The frequency of oscillation for this circuit is about two Hertz, and is determined by the RC time constant of R5, R6, and C3. The voltage across C3 is a sawtooth varying between 5 and 9 volts. This voltage is fed to IC1C, causing the basic frequency of the alarm oscillator to vary up and down to produce the familiar siren effect.

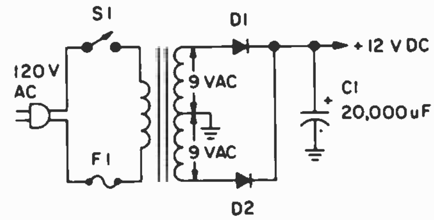
To keep the standby current drain of B/F Brain low, the supply voltage to IC2 is normally cut off by Q3. Since, in the quiescent state, the voltage at pin 3, IC1A, is +12 volts, Q3 has no forward bias and is cut off. When the latch circuit changes state Q3 receives forward bias through R12, turning on IC2.

Output Circuit. A two-transistor circuit is used to drive the speaker. When the alarm circuit is in its resting state, the voltage at pin 11 of IC 1D is +12 volts. Thus, Q1 has no forward bias and is cut off. Q2 base current is zero, and it too is cut off. The circuit of Q1 and Q2 therefore does not draw any current from the supply. Once the circuit of IC1C and IC1D is activated, the output voltage at pin 11 IC1D becomes a 12-volt (peak-to-peak) square wave. This causes Q1 and Q2 to switch on and off at the 1500 Hertz rate. Q2 drives the speaker with the 12-volt square wave, producing 9 watts of audio power. A square wave output is actually more desirable than a sine wave, since it is rich in harmonics. This produces a more natural-sounding siren.

If higher output power is desired, the speaker can be returned to a voltage higher than 12 volts. This will produce a peak-to-peak voltage across the speaker an amount equal to the higher voltage. Such a connection is shown







PARTS LIST FOR B/F BRAIN ALARM

R1, 3, 5, 7—470,000-ohm, ½-watt resistor
R2—10-Megohm ½-watt resistor
R4—1-Megohm, ½-watt resistor
R6, 9, 11—10,000-ohm, ½-watt resistor
R8—820,000-ohm, ½-watt resistor
R10—100-ohm, ½-watt resistor
R12—47,000-ohm, ½-watt resistor
C1—see text
C2—.01-uF capacitor
C3—2.2-uF, 15-VDC electrolytic capacitor
C4—.001-uF capacitor
C5—150-uF or larger, 20-VDC electrolytic capacitor
C6—.47-uF, 35-VDC capacitor
IC1—CD40001 COS/MOS Integrated circuit
IC2—555 timer integrated circuit
Q1, 3—Motorola 2N3906 PNP general purpose amplifier transistor
Q2—NPN power transistor, Motorola 2N3771, 40 or more volts, 10 or more A.
Misc.—Alarm bell; fire sensors; window foil; window foil connectors; contact switches; perf board or printed circuit board kit; solder, wire, hardware, etc.

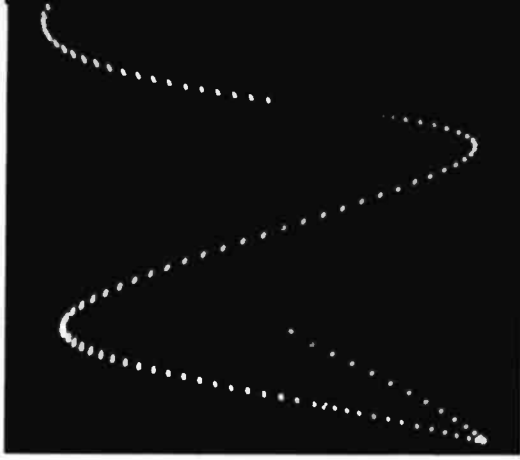
When used as an automobile burglar alarm the B/F Brain is wired to the dome-light switches inside the door frames. An outside alarm-disarm switch has to be installed —make sure it is hard to find and very securely installed. You could install fire sensors on the auto system as well but the accident that might be caused by the sudden blare of an alarm would be far more serious than any fire. Perhaps you can redesign the system with fire detectors and a light-on-the-dash warning system— you might try putting a relay on the ignition system that would switch the speaker system off and turn a warning light circuit on. With the B/F Brain at its heart, almost any combination of switches and sensors will work at home or on the road.

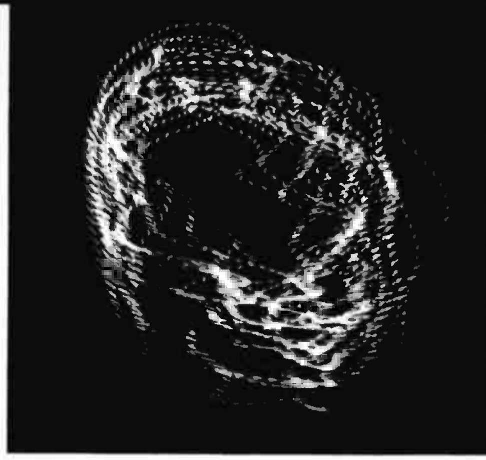
in the schematic. If you use this circuit be sure to feed the higher voltage only to the speaker, and not the alarm circuit. The maximum allowable supply voltage to the CD4001 chip is 15 volts.

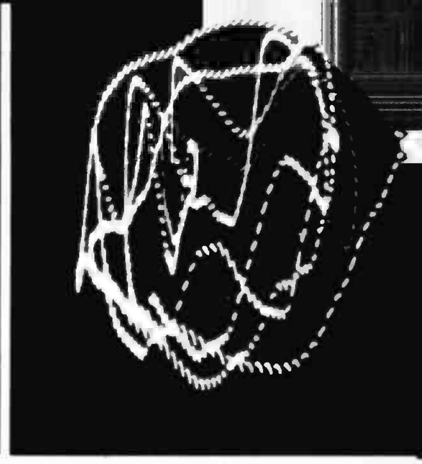
Power Supply. The full-load current of the alarm is about ¾ amperes, but this is only when the circuit has been tripped. Under normal operating conditions the standby current is less than 10 microamperes since only the COS/MOS integrated circuit, R2, and R1 are drawing current. The extremely low current drain makes it practical to use eight D cells connected in series to provide 12 volts. Such a power supply will last more than a year (providing the alarm does not go off). Battery operation provides several advantages including, freedom to locate the alarm anywhere, prevention of a burglar from defeating your alarm by shutting off electrical power, and prevention of false alarms due to line voltage interruptions or surges, and low cost.

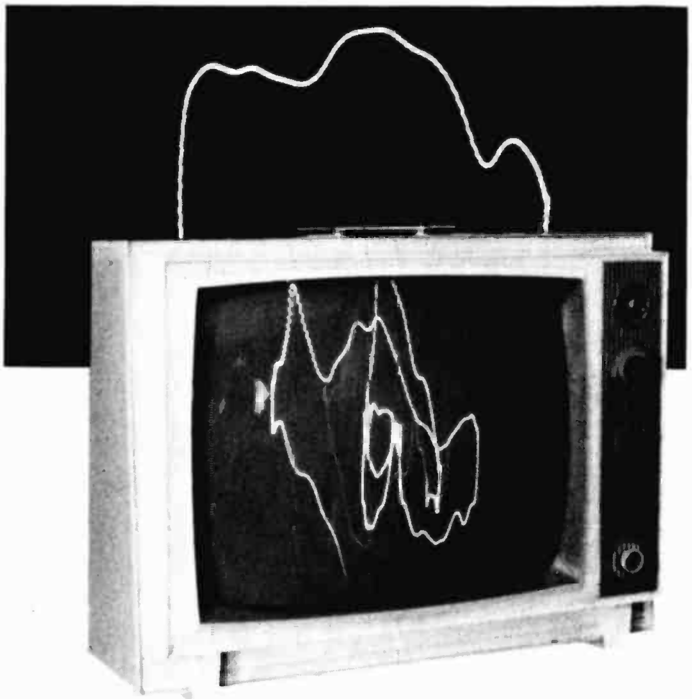
DC or AC Power. It is recommended that alkaline cells, Eveready type E95 or equivalent, be used. These cells can deliver more current than ordinary cells and they last much longer. They cost

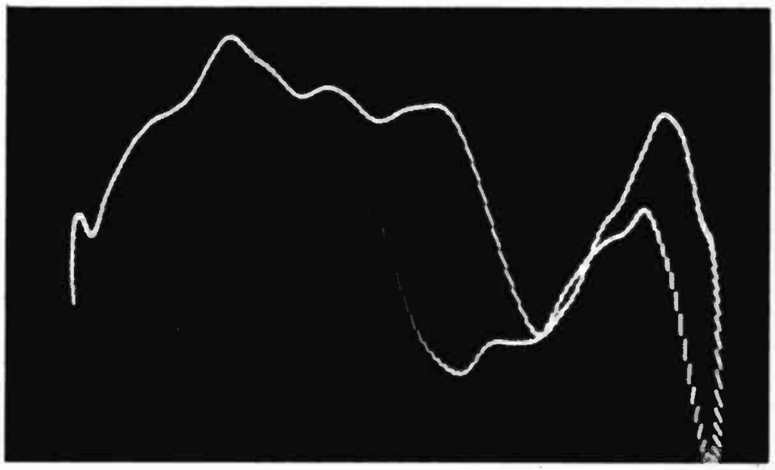
(Continued on page 119)











LISSY, THE TV LIGHT PEN

Lissajous patterns cheaply make a boob tube into a groove tube!

by Dean Hock

☐ Are you an avid stereo enthusiast looking for a new way to experience your favorite music? Have you tried conventional "color organs" and found them fun for a few minutes, but dull as dishwater thereafter? Have you perhaps seen an oscilloscope hooked up with a microphone on its input and watched in fascination as the sound waves dance on the screen in perfect synchronism with your voice?

If you'd like something new to stretch your visual sense and expand the aural connection with your eyes, look no further. *Lissy*, the adapter which turns any beat-up old TV set into an oscilloscope for stereo sound, displays myriad sound patterns on the receiver screen. Its *Lissajous* patterns respond to both right and left-hand stereo signals—although it can also work with just one channel—providing an infinitely-variable light/sound display for your friend's pleasure and amazement.

What's a Lissajous? Let's go back to basics for just a minute, and review what a Lissajous figure is. Those of you who read our Basic Course in the March/April issue (*Using the Oscilloscope*, pages 83-88) will recall that Lissajous figures are 'scope displays of *two* signal inputs to the display screen —not just the usual vertical input signal which we use when we want to measure the amplitude of a voltage or watch how its amplitude changes with respect to time (the most common use of the oscilloscope).

With signals going to both the vertical *and* the horizontal inputs of an oscilloscope we can measure the relationship with respect to time (it's called *phase*) between the two signals.

For example, if a known signal is applied to the horizontal input and an unknown signal is applied to the vertical input, the resulting Lissajous pattern shows the phase relationship of the two signals.

Lissajous patterns can also be used to measure frequency. A known frequency is applied to the horizontal amplifier and an unknown frequency is applied to the vertical. By counting the number of tangency points at the top and at one side, a ratio of unknown-to-known frequency can be obtained. By multiplying the ratio times the known frequency, you can determine the frequency of the unknown.

A Simple Pattern. The drawing shows a Lissajous pattern for two sine waves. Numbers have been assigned to corresponding voltage points on the two signals. Extensions of these points are brought to the screen. The intersection of corresponding numbered lines is the position of the electron beam at that instant of time. In this case the two sine waves are in phase.

In the figure below, voltage/time relationships are different; corresponding voltage points are 45° apart. Therefore the waveforms are 45° out of phase.

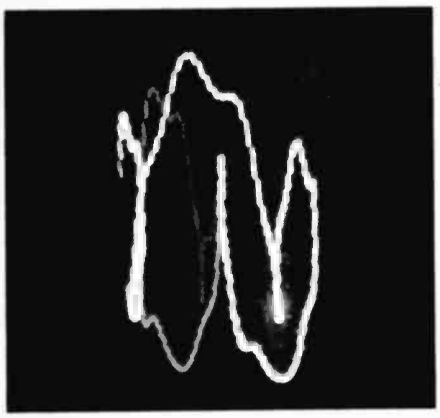
Lissy's Pictures. A continually shifting Lissajous pattern results when the phase relationship between the two input signals is constantly changing. The more complex the pattern (resulting from a frequency ratio having large numbers, such as 17/13) the harder it is to interpret. But since were not trying to *analyze* Lissy's pictures, we can just lean back and enjoy. *(Please turn page)*

LISSY TV LIGHT

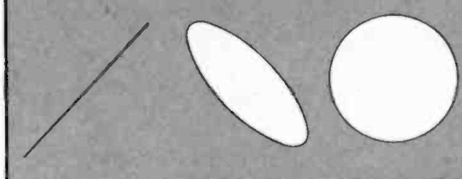
How Lissy Does It. By connecting the parts of an old TV set so that the output from one channel of a stereo set (for example, the left) drives the electron beam of TV tube vertically, and the output of the stereo set's right channel drives the beam horizontally, we can use the TV set to display Lissajous figures created by the signals from the two stereo channels. What we do is make the old TV set/stereo amplifier combination into an uncalibrated oscilloscope. Then we feed it the two signals without worrying what they mean.

Putting It Together. Begin with an old television set. You can use one in which the tuner, IF, and sound sections do not work since they will not be used. You'll also need an extra deflection yoke from another old set. Most of the older tube-type black and white sets have yokes the same size. As long as the extra yoke will fit over the neck of the set's picture tube it can be used. A junked TV is the best place to look. You must also have a stereo set with amplifiers capable of producing 12-15 watts of output power per channel. Even better is a spare (second) stereo set. This will insure better results and will also allow you to adjust the tone, volume and balance controls to the TV set without upsetting your listening pleasure, by changing the volume setting while you listen.

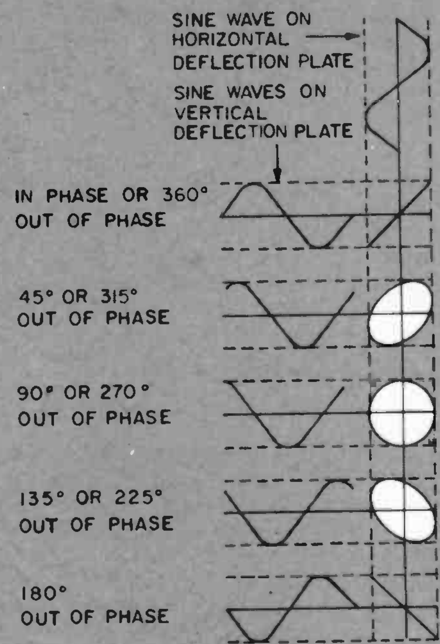
Begin by removing the back from the old TV set. Disconnect the socket from the rear of the picture tube. Loosen the clamps holding the deflection yoke and slide it off the neck of the tube. Do not disconnect any of the wires from the

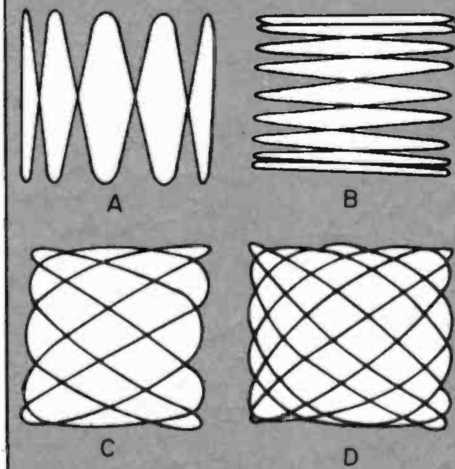


These patterns appear from moment to moment on the TV screen when it's being driven by signals from music. To see what they really look like you'd have to have motion pictures.



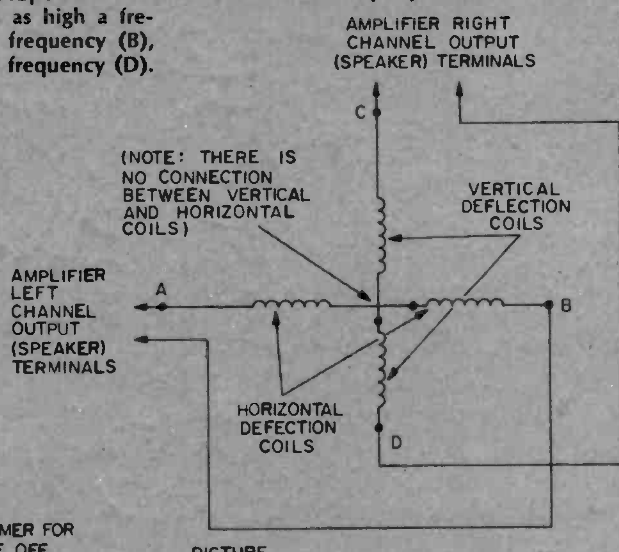
Simple Lissajous figures like these result from putting the same (or almost same) signal voltages on horizontal input and vertical input of oscilloscope (or TV picture tube).



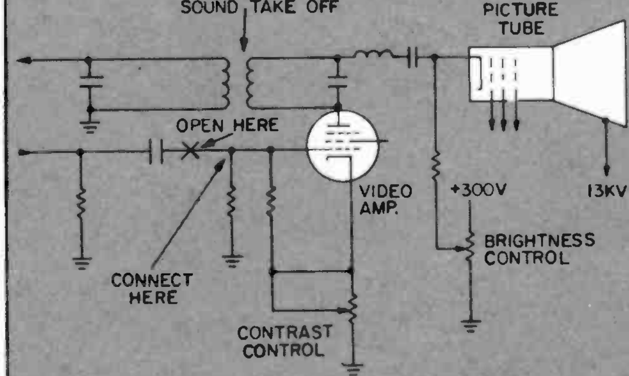


These more-complex Lissajous patterns are created by feeding a simple sine wave to the horizontal input of a scope and sine waves of exactly five times as high a frequency (A), one-ninth the frequency (B), 3/5 frequency (C), and 5/6 frequency (D).

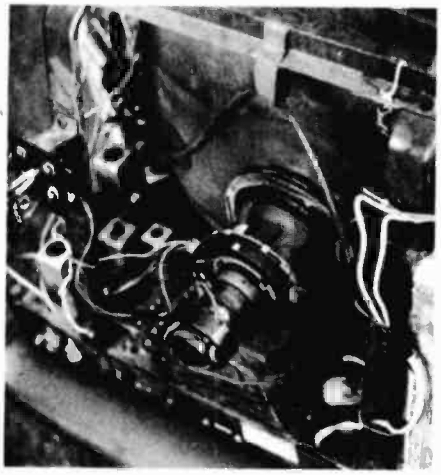
If your two stereo channels put out exactly the same signals (or you put a mono signal into both) you should get a straight (diagonal) line on the screen. If not, adjust gain of one channel. Other Lissajous patterns like these will result from out-of-phase signals. Music waveforms are extremely complex compared to the signals used to derive simple patterns shown here.



The added deflection yoke from second TV set is connected as shown above to the two stereo channels of an amplifier or receiver. Using a separate amp (from the one you listen to) is recommended, but not essential.

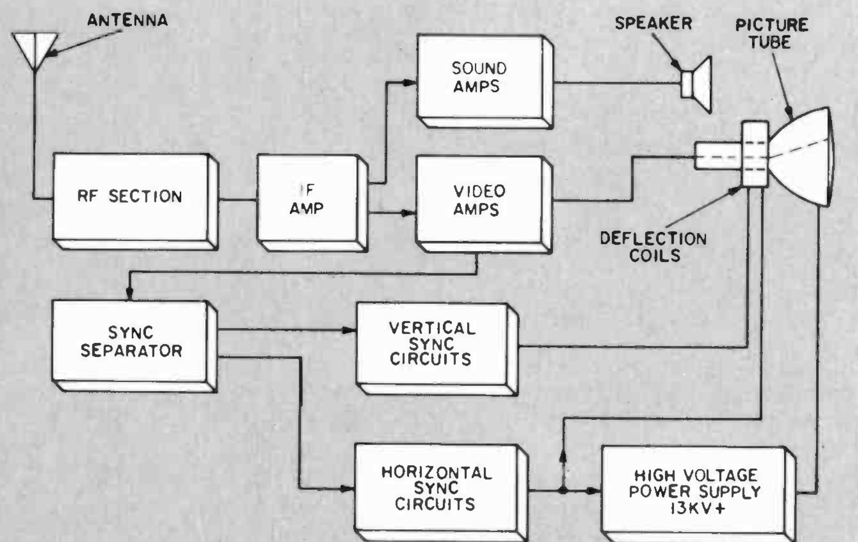


This schematic shows a typical video amplifier tube for TV sets six to 15 years old. Disconnect the video input signal on the grid side of the grid-coupling capacitor and connect your Lissy oscillator at the same point to make Lissy do extra tricks.

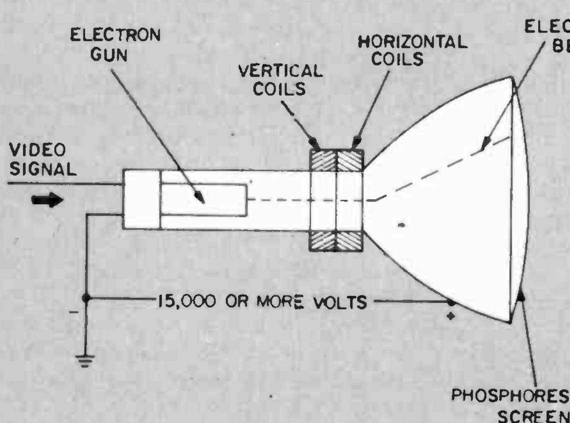


Here's how the back of author's set looks with the new picture tube yoke (deflection coils) on neck of picture tube. Original deflection yoke is removed from tube but kept hooked up because it's also used in the circuit which generates high voltage for picture tube. It's tied out of way at upper right, atop high voltage cage.

Closeup of picture tube neck shows large circular positioning magnet which some sets have behind yoke. Be sure to replace any magnets your set had into their original position after you replace the yoke.



Simplified block diagram of TV set shows how vertical and horizontal sweep currents are derived from the synchronizing signals sent from the transmitter. Vertical and horizontal sweeps feed vertical and horizontal deflection coils.



Typical TV picture tube and its horizontal and vertical-deflecting coils. Old deflection yoke is still used in Lissy because it's part of the circuit which produces thousands of volts required to attract the stream of electrons from the electron gun to the screen.

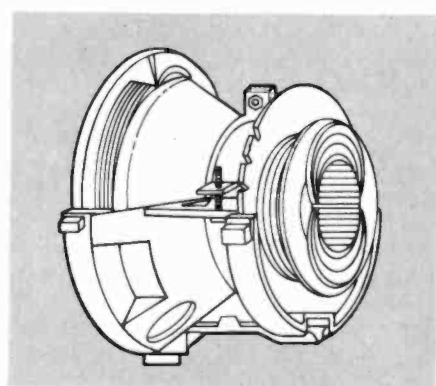
yoke since it is part of the circuit for putting the beam on the screen. Secure the old yoke to the chasis of the TV somewhere out of the way, taking care in seeing that it does not short circuit.

Preparing the Deflection Yoke. There are two coils in the deflection yoke of a TV set. One is called the horizontal and one the vertical.

Each of these two coils is divided into two sections, and we must eliminate any extra parts such as a small resistor or capacitor which are often connected to one or both of the yokes. They are usually connected to the midpoint of the horizontal coil or vertical coil. Simply remove any resistor or capacitor connected to any parts of the yoke, and if this separates the two sectional parts of either the horizontal or vertical coil, put a jumper between the two sections. Check with a voltmeter to be sure which terminals are connected (through the two coils) together. Mark them in some way so that you'll know which two leads of each coil are connected together (through each coil). Solder 2 three-foot lengths of speaker wire to the terminals of the vertical and horizontal coils.

Putting It Together. Take the yoke and slide it on to the neck of the picture tube securing it with a clamp. Return the socket to the back of the tube along with any magnets that may have been removed. Put the magnets back exactly where they were. (Adjust to center beam, later.) Route the speaker wire out the back of the TV set as you put the cover back on. Run wires from the speaker outputs on your stereo to the TV set and connect the two sets of wires together using a terminal strip.

You are now ready to test out Lissy. Leave your stereo off and turn on the TV set. After warmup a small dot should be visible in the middle of the screen. Adjust the magnets, if any, to



Most old TV sets have deflection yokes which look like this. Large end (left here) goes snug up against the flare of the picture tube. May require loosening of screw which secures clamp around coils.

LISSY TV LIGHT

center the beam. If necessary turn the brightness control up or down. Now turn on the stereo set and turn up the volume slowly until you start to notice the dot moving. By adjusting the balance control you should be able to make the dot move about an equal amount horizontally and vertically. It may be necessary to disconnect the speakers in order to move the beam enough. Adjust the brightness for a pleasing light level without burning the screen phosphor. Low bass notes will show up as rotating circles. Each tone has its own pattern which intensifies with the volume.

Now that you are finished sit back and enjoy the added dimension of the music TV in a dark room. It will provide you with many hours of listening and viewing pleasure.

More Fun With Lissy. Once your Lissy is working you may want to add an extra circuit which will strobe the moving pattern on and off, making a more unusual and interesting light display. By connecting the output of an oscillator to the grid of the TV set's video amplifier tube you can turn on and off the electron beam in the picture tube. This will produce dots and dashes as the beam is moved around on the screen. The effect is quite pleasing. A stop-action type of display (called "strobe") is only one interesting improvement you'll see.

The added circuit is a simple two-transistor oscillator. The switches and potentiometers allow you to select different dot line lengths and frequencies. By connecting the output of the oscillator to the grid of the video amplifier you force the tube alternately into conduction and cutoff.

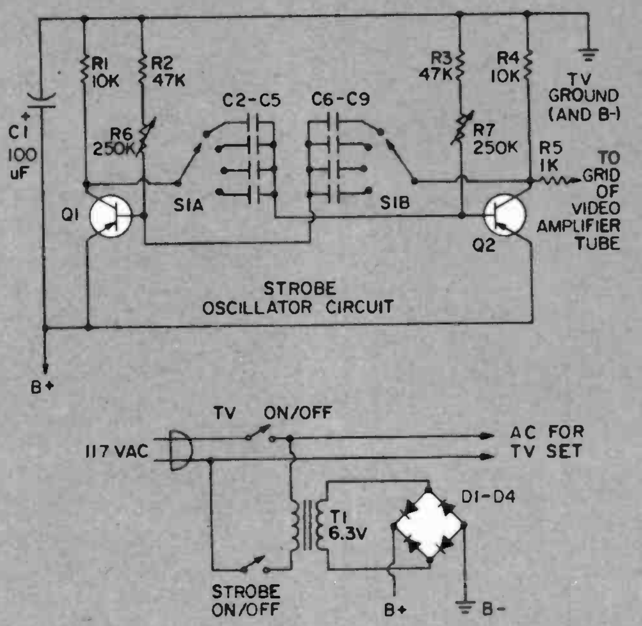
The oscillator and power supply are not critical and can be constructed any way that is convenient, as long as safe construction practices are used. The circuit in the prototype was built on a terminal strip using point-to-point wiring and then mounted inside the TV. Almost any general purpose PNP transistors can be used for Q1 and Q2.

If you can't get a schematic of the TV set you are using the best way to locate the video amplifier tube is to look at the tube placement chart (usually on the side or back of the TV) and find the tube which is labeled *Video Amp*. If the video amp tube also contains other elements in the glass envelope you will have to trace down that part of the tube which has its plate connected to the sound trap transformer (usually a metal can type) and its cathode connected to the contrast control. This may vary slightly in your set.

Once you have found the video amplifier cut one of the leads of the capacitor going to the grid and replace it by connecting the oscillator output to the tube in its place, (see the schematic). Connect the negative lead on the oscillator's power supply to the TV common ground.

Fire Her Up. Now you are ready to test the circuit. Look it over for any wiring errors. Set the potentiometers to maximum resistance and set the rotary switches at the .01 uF capacitors. Turn on the TV set and allow it to warm up. Get a music display on the screen. Turn down the brightness control until you can no longer see the raster (white lines). Turn on the strobe oscillator and adjust the brightness control as needed. The display should be chopped up into little line segments. By adjusting the controls you can get different line lengths and frequencies—anything from star-like dots to a pulsating array of stopped action traces.

Now you can lean back and enjoy your Lissy—the TV light organ which will amuse and amaze your friends for many evenings ahead. ■



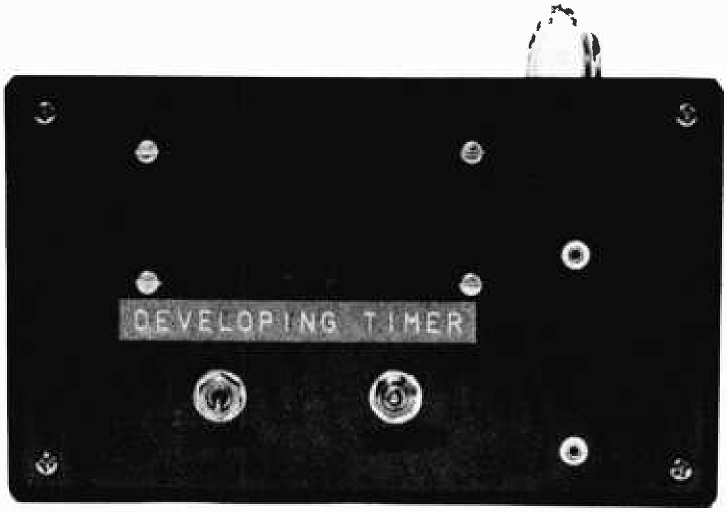
PART LIST FOR LISSY—THE TV LIGHT ORGAN

TV receiver—which has light (raster) on the picture tube. It need not have a working tuner or IF section, nor sound.
Picture tube deflection yoke—in working condition. (Most are—this is a part that rarely fails in TV sets.)
Speaker wire—8-10 ft.
Stereo amplifier or receiver—preferably 12-15 watts or more per channel.
Misc.—Solder, wire, switches, etc.

PARTS LIST FOR STROBE CIRCUIT FOR LISSY

C1—100-uF, 16-VDC electrolytic capacitor
C2, 6—.002 or .22-uF capacitor
C3, 7—.01-uF capacitor
C4, 8—.1-uF capacitor
C5, 9—1-uF capacitor
D1, 2, 3, 4—rectifier diodes, 30 PIV or better, any amperage
R1, 4—10,000-ohm, ¼-watt resistor
R2, 3—47,000-uF, ¼-watt resistor
R5—1000-ohm, ¼-watt resistor
R6, 7—250,000-ohm potentiometer (or 500,000 if 250,000 not available)
S1—Single-pole, 4-position (or more) rotary switch
Q1, 2—General-purpose PNP silicon transistors, HEP-242 or similar
T1—Power transformer, 117 VAC primary, 6.3 VAC secondary, any amperage

You can call Lissy's designs Lissajous patterns, but your friends will call them "out-of-sight"! The twisting, convoluted, ever-changing, swirling designs are truly a visually exciting wonder which can't fail to draw the viewer's eye into almost hypnotic attention. You can convert almost any old television from a boob tube to a groove tube with just a little effort, and at almost no cost at all. Just an evening's work, and your place will be jumping like never before.



MIDGET DIGIT -IT'S THE BIG TIME

This little device can save expensive headaches.

by Herb Friedman

☐ At first thought a digital time clock that only indicates to nine-minutes fifty-nine-seconds might not appear to have any particular value; yet commercial models sell for up to $150, so there must be something in 9:59 that's commonly overlooked.

Actually, the 9:59 digital clocks are really timers with push-button reset to zero while running, and a hold control that permits several short time intervals to be accumulated.

Radio stations, recording studios, and tape fans use them to time records and program segments when preparing tapes. More importantly, photo hobbyists use the 9:59 time clock when developing color film and prints.

Here's a typical use: Assume you're using the Besseler color system to make color prints. The first developer needs two minutes, the second developer needs one-and-a-half minutes. You set the timer running, pour the developer into the tank and then roll the tank to start the developing. At the instant your hand rolls the tank your other hand hits the reset switch on the timer. The timer resets to zero and starts counting. At two minutes you dump the first developer and the time clock keeps running. You pour in the second developer and roll the tank. At the instant the tank is rolled you hit the reset switch, the timer returns to zero, and you follow the timing to one minute and thirty seconds.

Until the moment you need to reset to zero you can simply ignore the timer and concentrate on developing. If you want to totalize developing time you simply press the hold switch after each procedure. At the end you'll have a total elapsed time to 9:59.

The reason commercial 9:59 timers run upwards of $100 to $150 is because they are jam-packed with integrated circuits. Most models were designed when IC technology was still in its infancy. By using a modern clock module that utilizes large-scale integration you can now build a slightly better timer than the commercial model for about $20 to $25, and all the parts are available at most parts stores.

In fact, our Midget Digit can also be used as a Black and White enlarger exposure timer because the red glow of the 0.5-inch LED digits won't fog B&W paper.

Building Midget Digit. The timer consists of a twelve hour LED display, digital electronic clock module, a DPDT spring-return switch (or a push-button switch), a SPST toggle switch for hold, a power transformer for the clock module, and any cabinet you care to use. Though the clock module is the standard twelve hour type, by connection of the switches to existing terminals you can time minutes and seconds without making any modifications to the module.

The first step is to prepare a cabinet for Midget Digit. Use anything you prefer: a plastic cabinet, a Minibox, a utility case, etc. Don't worry about a protective red filter for the clock's LEDs; it's already part of the clock module.

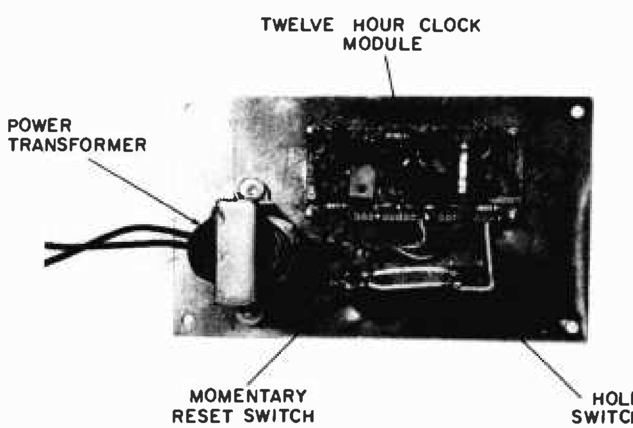
Before installing the module in the cabinet install a set of fine wire jumpers from terminals 24 to 14, and 14 to 7. We say fine wire because you can't squeeze two ends of standard #22 hookup wire into the #14 terminal.

All terminals, from 1 through 24, run along the bottom edge of the module and the instructions supplied very clearly indicate which terminal is what number. Just double check your count before soldering. The terminals are plated-through so you can solder to either side of the module's printed circuit board.

To avoid shorting the module's wiring to a metal panel use an ⅛-inch spacer or stack of washers between the panel and the module at each mounting screw.

The color-coded wires for the matching power transformer had absolutely no relationship to the instructions on the transformer itself. We don't know if this is true for all transformers in all stores, or just the ones in our local store. So follow this procedure: The black wires are 120 VAC; the two red

(Continued on page 120)



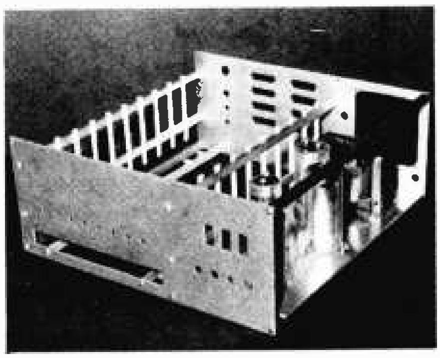
The Midget Digit is built around a standard twelve hour clock module. The module consists of a small printed circuit board with an oversize red filter that conceals several relatively large 0.5-inch LEDs. Though the LEDs are rather bright when on, they will not normally fog B&W enlarging paper.

COMPUTER NEW PRODUCTS

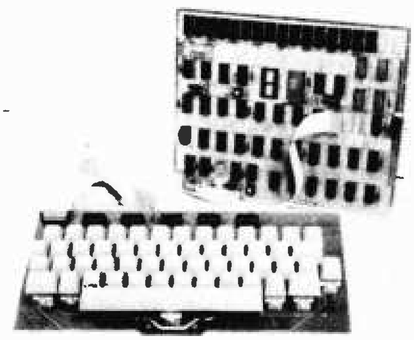
Here in one place BUDGET ELECTRONICS presents the latest advances in the fast-moving field of home and hobby computers.

Video-to-UHF Interface—ATV Research has designed this special computer video-to-UHF RF Interface Modulator so that ordinary color or monochrome TV receivers can be used in lieu of costly video monitors. Most microcomputers radiate switching harmonics into the low-band VHF channels (2-6) to cause image degradation. The Micro-Verter is said to overcome this problem by operating in the UHF channels above 14, beyond the normal range of switching harmonics. The device is tunable over a minimum of four channels, and is designed to interface directly with Apple II as well as most other microcomputers. Comes complete with video cable and RF output stub coupler. Requires no direct connection to antenna terminals, except in special cases. RF is coupled directly into UHF tuner input via a 1 cm stub coupler on the back of the modulator. Power requirements: +5V, ±1V. Current: 1 ma minimum, 2 ma maximum. Self-powered with four AA pencell type batteries. Operating life in excess of 1000 hours or near shelf-life of batteries. Other claims: excellent frequency stability and precise channel adjustment provisions. No assembly required other than installation of batteries (not supplied). Price of model MVX-500 is $35. Circle 78 on Reader Service Coupon for more info.

Keyboard for Display Video Boards—MicroAge says this new MKB-2 Keyboard is designed for use with the new 64 and 80 character display video boards, and combines popular keyboard features with an affordable price. Included as standard equipment are a numeric key pad, upper and lower case, cursor control keys, 2-key rollover, and auto repeat on all keys. The unit is assembled in a heavy duty steel case with parallel interface, strobe or pulse, on-board regulation (5v, 12v), complete with standard DB25S connector and black double-injection molded keys. List price: $149, Circle 82 on Reader Service Coupon for more info.



S-100 Cardframe Kit—Objective Design's "starter set" for construction of an S-100 cardframe and power supply follows the design included in the Crate Design Information Packet and allows a beginner or advanced computerist to construct a durable cardframe with room for 22 cards. The "relatively low" cost of $154.50 provides the complete kit, including power supply. Or you can get the cardframe kit without power supply for $89.50 plus 5% U.S. and Canadian shipping. The kit contains front and rear panels prepunched for maximum versatility, support bars, structural bars, motherboard supports, a set of ten card guides, chassis plate, and +/−16 volts at 2 amps power supply with 110, 120, and 130 input taps. Panels include cutouts for switches, power cords, connectors, and motherboard extensions. No motherboard or fan is provided although the cardfame accepts most popular versions of the S-100 motherboard. The frame permits addition of a front panel, cover, and bottom plate (not provided). Circle 73 on Reader Service.



540 Video Display—The video display interface used in Ohio Scientific's Challenger IIP is now offered fully assembled as an accessory for any system made by the company. The 540 video display features a 32 row by 64 column display of the standard 64 character ASCII font in 5x7 dot matrix form. Standard features include programmable formatting of the display for 32x32 or 32x64. There's also a keyboard port which can be used with a standard ASCII keyboard or with OSI's new programmable keyboard. The 540 also optionally supports a graphics character generator which features lower case and about 170 special characters for plotting and gaming. The 540 add-on unit retails for $249, and the graphics character generator will cost $29. Circle 66 on Reader Service Coupon. ■

Sirius II Home Computer—This Sirius II Home Computer "breaks the $2,000 price tag with features usually found in systems costing much more" according to the manufacturer, Digital Sport Systems. The suggested retail price is $1,850 for which you get a "unique combination" of two micro processors, the Mostek Z80 (for main computations), and a Fairchild 3870 that handles all keyboard and TV interface overhead. Also included: 32,768 characters of read/write memory, RS-232 interface for I/O, 8,192 character PROM board with 1,000 character monitor supplied, mini-floppy disc drive, a 64 key keyboard with alpha/numeric and graphic capabilities, and TV interface. Other feaures include: a full disc operating basic interpreter, monitor and software programs. Circle 52 on Reader Service Coupon for more info on the Sirius II.

CB NEW PRODUCTS

e/e puts together in one neat package some of the newest CB rigs, antennas and accessories for you to use in CB contacts this year!

Monitor and CB Skyhook

Avanti's Interceptor antenna, Model AV-601 is a unique CB antenna designed for the monitor buff. The Model AV-601 pulls in signals throughout both the low band and very high frequencies (VHF). Lightweight, it installs easily on a mast. The AV-601 covers 25-50 MHz and 140-175 MHz frequencies which includes the CB band signals—transmitted or received. This Avanti base station

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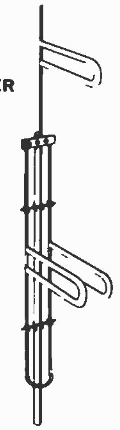

antenna sells for $29.95. For more information, write to: Avanti Research and Development, Inc., 340 Stewart Avenue, Addison, IL 60101.

New Viking

E. F. Johnson Company has introduced a new 40-channel mobile CB; the Viking 230, which is a full-power, mobile unit with frequency synthesizer. The Viking 230 features a noise blanker and an automatic noise limiter to reject electrical and impulse-type noise. Also, a local/distance range control allows the user to adjust for better reception of weak, distant signals or strong, nearby signals. Built-in amplified speech compressor eliminates the need for a power microphone because the unit delivers full modulation and full power levels automatically for maximum transmit range. The unit has LED channel display with brightness control, LED meter, squelch, microphone, and P.A. function. The U.S.-made radio carries Johnson's one-year parts and labor warranty which is honored at over 1,000 authorized

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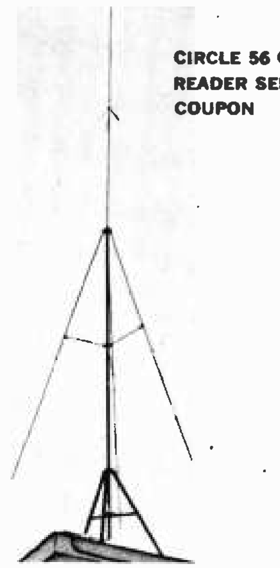
service centers nationwide. Suggested retail price for the Viking 230 is $169.95. Get all the facts direct from E. F. Johnson Company, 299 10th Avenue, S. W., Waseca, MN 56093.

CB Antenna Installation

The major advantage of the Channel Master Golden Hawk Tripod Kit is that all of the major components come preassembled. The preassembled, high-performance Golden Hawk CB antenna is ready for mounting on the mast just 60 seconds after removal from the carton. The Channel Master Golden Hawk CB antenna has a maximum SWR of 1.3:1 across 40 channels and average gain of 5 dB. It's made of sturdy aircraft aluminum and has a heavy-duty, machined-aluminum support-block. The antenna has a gold EPC weather-resistant coating and was designed for years of high-performance CB operation. Channel Master's new Golden Hawk Tripod Kit consists of a Golden Hawk CB base station antenna (model 5050); a gold EPC coated, three-foot tripod mount including pitch pads and lag bolts, two 5-ft. sections of heavy



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fittings. The kit has everything that's needed for a complete, professional CB antenna installation. Suggested retail price of the Golden Hawk Tripod Kit (model 5051) is $79.95.

Deluxe AM/SSB

A deluxe Citizens' Band base transceiver for both AM and single sideband (SSB) operation is the top-of-the-line TRS Challenger Model 1400 which incorporates much of the accessory equipment required to maximize transmitter performance and includes dual speakers that eliminate the need for an accessory speaker. The TRS Challenger Model 1400 covers all 40 CB channels on either standard AM or on lower or upper sidebands for increased operating range. The built-in SWR and output power meters of the Model 1400 enable the operator to achieve maximum transmitting efficiency. Large, precision-built meters afford extremely accurate signal strength, radio output power and SWR readings. For operator convenience, the Model 1400 includes a bright LED channel readout, LED operating mode indicators and an "On-the-Air indicator lamp. Solid-state design features of the TRS Challenger Model 1400 base station include phase-locked loop frequency synthesis for precise reception and transmission, MOSFET front-end design to bring in weak signals with minimal background noise, and high quality multiple lattice type dual IF ceramic filters to reduce interference from adjacent channels. Two

CIRCLE 55 ON READER SERVICE COUPON

output speakers provide superior sound quality. Transmitter section specifications for the Model 1400 include an output power of four watts on AM and 12 watts PEP on single sideband. Receiver specifications include an AM sensitivity of 0.7 microvolts for 10 dB (S+N)/N and an SSB sensitivity of 0.3 microvolts. Selectivity is rated at –55 dB for both AM (±10 kHz) and SSB

Base Microphone

The Superex new power base station microphone, the electret condenser M-611, has an extra large "push-to-talk" paddle enabling more efficient communication in critical applications. To the right of this paddle is an interlock control if continuous transmission is desired. The mike is an omnidirectional design with an FET pre-amp, and a transistor output amplifier stage. The output gain is controlled by a high quality linear potentiometer which is damped for smooth and precise adjustment. A self-contained C cell

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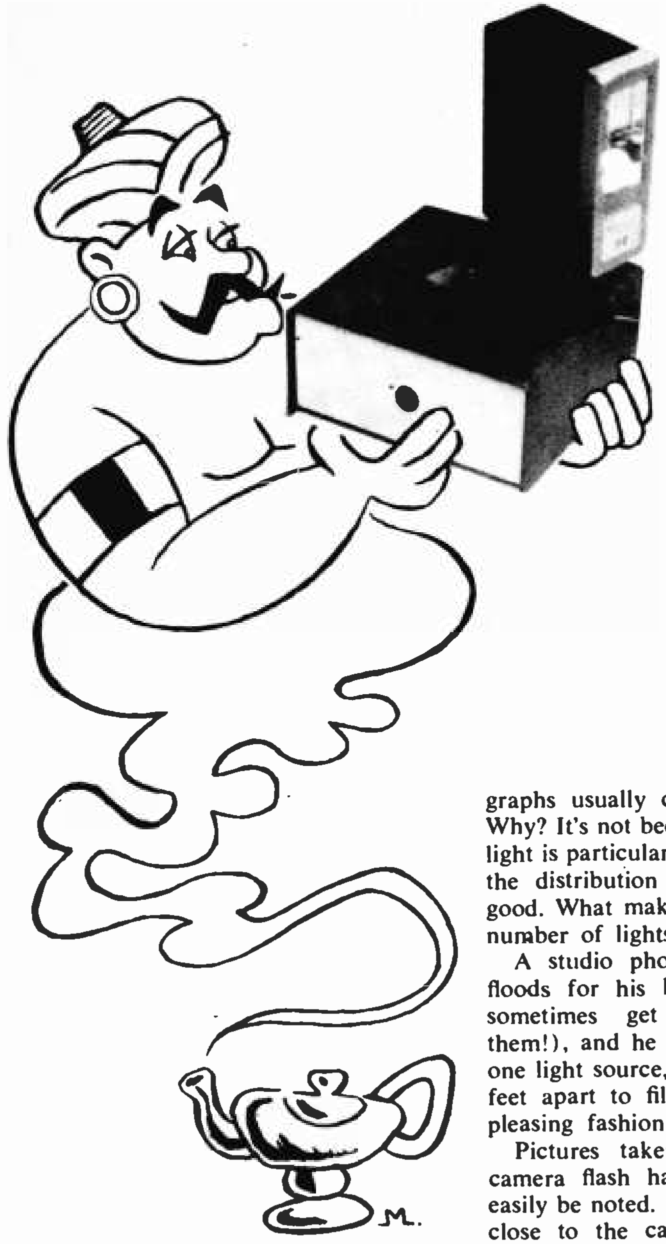
(supplied) provides the power for the M-611. An additional feature of the M-611 is that the mike stem can be quickly removed via a special connector and be interchanged with a variety of mike designs. Plug in modules offered include a "Lapel Mike" and an "Acoustic Tube Mike Headset." This unique system offers the user maximum application flexibility. The M-611 is manufactured in the U.S. by Superex and is suggested for resale at $44.95. For additional information, write to Superex Electronics Corp., 151 Ludlow St., Yonkers, NY 10705. ■



LET LIGHT/JINN SERVE UP SNAPPIER SNAPSHOTS

This cable-free slave flash uses only two resistors, one LASCR, one choke, and an optional diode bridge.

by C. R. Lewart

GREATLY IMPROVE your flash pictures by using the flashgun on your camera to control one or more "slave" flashes by means of our Light/Jinn—a magical genie which has no cables to the master flash, but triggers from the light of the camera flash—at your command. You can use two or more Light/Jinns at the same time, but the greatest improvement in your flash pictures will come with the addition of the first Light/Jinn to your regular on-camera flash. The time delay between the master and slave flashes is on the order of 1 millisecond (1/1000 sec) so that you can take pictures at the shortest exposure times your camera permits.

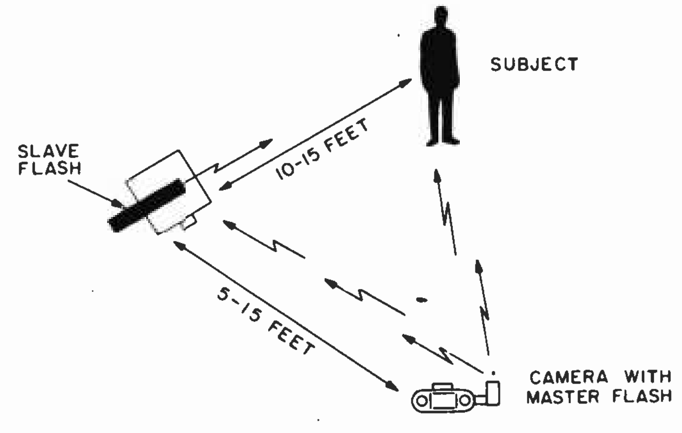
Multiple Flash is Better. If you compare most ordinary flash pictures to other shots taken with photofloods (high intensity incandescent lamps, such as are often used for motion pictures, as well as for professional still pictures) the single flashgun-illuminated photographs usually come out second best. Why? It's not because the quality of the light is particularly inferior, but because the distribution of that light isn't as good. What makes the difference is the number of lights used.

A studio photographer uses photofloods for his lighting (those models sometimes get awfully hot under them!), and he always uses more than one light source, spaced at least several feet apart to fill in the shadows in a pleasing fashion.

Pictures taken with a single, on-camera flash have defects which can easily be noted. If you have subjects up close to the camera they often look washed-out or overexposed, and the shadows are usually harsh and too contrasty, particularly if the subject is near a wall or other large background. Automatic flash units, coming into wider use now, can control some of these problems partially. But the automatic flash can't fill in the shadows it creates. Using bounce flash (aiming the flash at a white ceiling) provides more even illumination, although most on-camera flash units can't readily be aimed at the ceiling. And with bounce flash you must open the lens diaphragm to compensate for the lower overall light level. This decreases the depth of field, which can be another problem. Furthermore, bounce flash with color film can put the color of the ceiling or wall, if not white, into the subjects' faces. All in all, taking flash pictures with a single flash is something you'll learn to avoid wherever possible.

Adding just one more flash, if it's properly placed, will give you shadowless pictures, with greater depth, more modeling of subject's features, and

Adding another flash at the side of subject improves pictures by wiping out harsh shadows. Slave flash triggers on light from camera flash.



clearer details. Or, in other words, your pictures will be a lot closer to studio photographs.

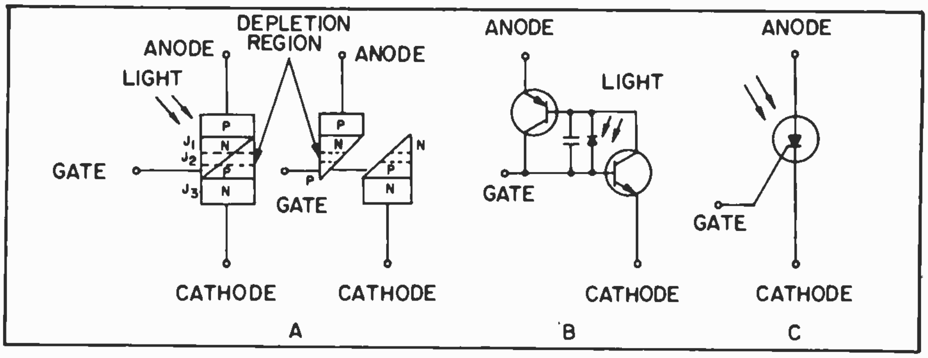
Better Flash Shots. To take such pictures you need one more flash unit and some way to support it, and of course some way to make it fire at the same time as the main flash. The first flash unit mounts in the usual way on the camera (or slightly off it, with an extending bar), while the second flash, which now becomes the "main" light (the primary source of illumination), is placed near the subject and interconnected to flash at the same time as the first flash, in synchronism with the shutter opening.

The usual way to synchronize the two flashes with the shutter is to use a long connecting cord—if your camera or first flash has a receptacle for it (most do not).

Get Rid of Cables. Long cords can lead to problems. They can come loose at either end or both; they can be tripped over; and their length is either too long for most shots, or not long enough for some. But these problems can all be eliminated if you use a flash connected to the main unit by *light!* That's right. You can use the light from the first flash to set off the second one. It takes less than a millisecond (1/1000 of a second) for the second flash to fire. Since you'll be using a 125th or 250th of a second shutter opening, the camera will think both flashes go off at the same time, and the effect is exactly as though they do.

The project is simple to build and inexpensive—the basic parts cost less than $5. Light/Jinn requires no power source; it "borrows" its energy from the flashgun it operates. It also is an improvement over many previously-described similar circuits, because Light/Jinn will not be triggered by even a strong beam of ambient light falling on its sensor. Only another flashgun, or direct sunlight can trigger it. In addition this project will familiarize you with one of the most modern optical semiconductor devices, the *Light Activated Silicon-Controlled Rectifier*, or LASCR for short. The unique properties of this device can lead you to other electro-optical projects which also can be built simply and inexpensively.

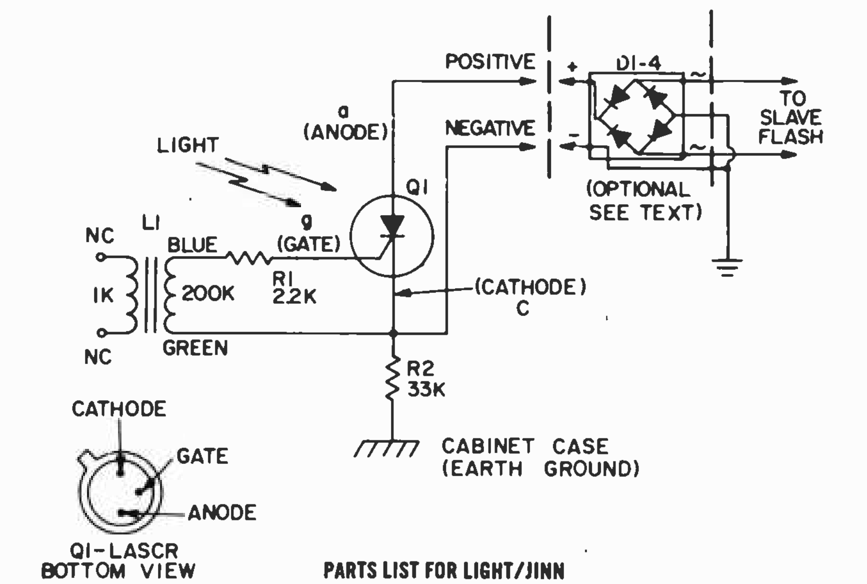
What Is An LASCR? Its tongue-twisting name, Light Activated Silicon Controlled Rectifier, explains its function. It is an SCR (silicon controlled rectifier) operated by light falling on its sensitive area. The LASCR is the brain of our project, the understanding of which, though not essential for successful completion of the project, should nevertheless interest you.



Operation of the LASCR (light-activated silicon-controlled rectifier) is shown above. It's equivalent to combined NPN and PNP transistors, as shown in A and B, above.

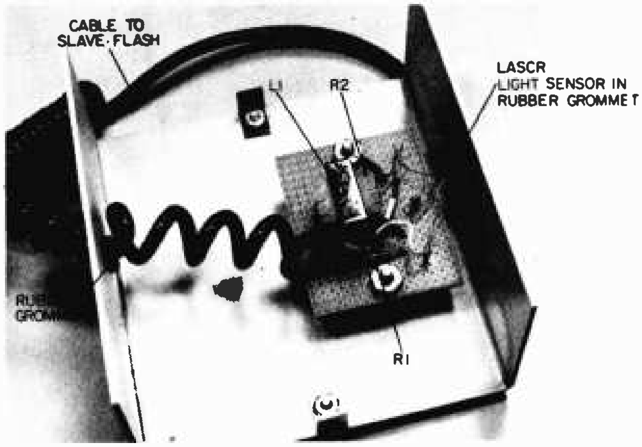
Refer to the three small drawings (above the schematic diagram) marked A, B, and C, for a description of how the LASCR works. With positive voltage applied to the anode, junctions J1 and J3 are forward-biased, and they will conduct if sufficient free charge is present. Junction J2 is reverse-biased however, and it blocks current flow. Light entering the silicon creates free hole-electron pairs in the vicinity of the J2 depletion region which are then swept across J2. As light increases the current in the reverse-biased diode will increase. The current gains of the NPN- and PNP-equivalent transistors also increase with current. At some point the current gain exceeds unity and the LASCR starts conducting.

Slave Flash Circuit. The LASCR is sensitive both to visible and invisible light, and will normally trigger at as low as 200 foot-candles. To limit its response so it responds only to another flash, we put the inductance of a small audio choke L1, and resistor R1 between the gate and cathode terminals of the LASCR. This novel approach prevents the LASCR from being triggered even by strong ambient light. For steady ambient light the inductance of the transformer behaves like a very small resistor and prevents the LASCR from firing by bleeding the charge generated by



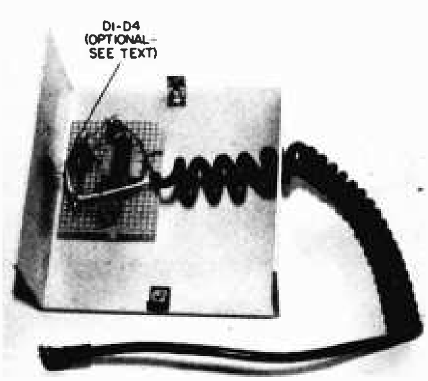
PARTS LIST FOR LIGHT/JINN

D1-4—Diode rectifier bridge module, 400 V, 6A
L1—Small audio transformer, 200K/1K
Q1—Light-operated silicon-controlled rectifier, 200 V, 1.6 A
R1—2200 ohm, ¼- or ½-watt resistor
R2—33,000 ohm, ¼- or ½-watt resistor
Misc.—Case, aluminun, 4-in. x 2-in. x 1½-in. or larger, two rubber grommets, ⅜-in. O.D., flashgun support bracket, flashgun extension cable to match receptacle on flashgun.



Light/Jinn with cover removed showing all the parts except optional diode bridge rectifier. Top cover has flash mount.

light directly to ground (the cathode). A sudden burst of light coming from an electronic or other flash makes the inductance of the transformer appear as a high resistance which causes the LASCR to conduct, triggering Light/Jinn. Finally, resistor R2 connects the circuit to the cabinet and lowers the



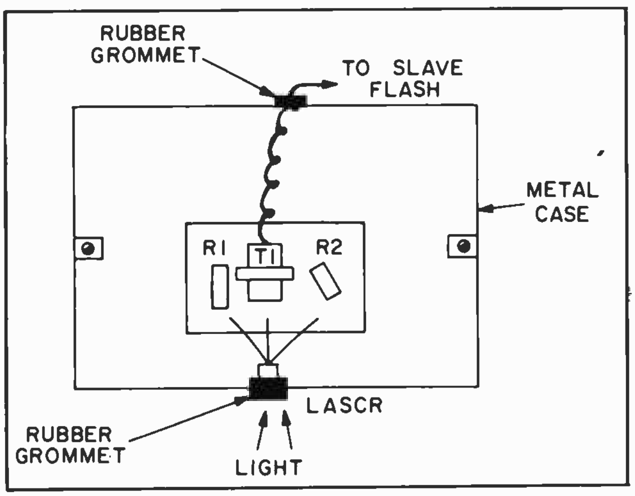
This photograph shows the unit including the diode bridge rectifier, which is needed if Light/Jinn will be used with flash units whose polarity is unknown.

possibility of flashes caused by static electricity.

An inexpensive audio frequency choke is most readily obtained by using an ordinary audio transformer and leaving the secondary unconnected.

Construction. Although the actual components of the simple circuit for Light/Jinn take very little space we selected a good-sized box (4-in. deep by 4½-in. wide by 2-in. high) to provide a substantial stand for the slave flash. A flash gun mounting shoe and flash gun extension cable can be obtained in most photo supply stores. Mount the flashgun shoe on top of the cabinet. Cut off and throw away the male jack on the flash gun extension cable and strip the two wires leading to the female jack. If the flash gun you are planning to use for Light/Jinn has a "hot" shoe you will not need the extension cable. You should now determine which wire is positive. In most, but not all, flash guns the positive is the one which leads to the inner part of the jack (the center lead). If you plan to use Light/Jinn with a slave flash whose polarity you do not know, add the bridge rectifier (labeled "optional") at the right hand of the schematic. Then the polarity does not matter.

Using Light/Jinn. Mount the second flash unit on Light/Jinn, connect it to the cable extension, and charge the gun from its built-in batteries (or AC). It may flash once or twice by itself, but then it should stabilize. If it keeps going off spontaneously check the circuit for mistakes. If the wiring looks OK you may have to try another LASCR. This is because they have different sensitivities, and some trigger more easily than others.



Drawing at left shows there is much spare space in the metal enclosure. This is because the box must be large enough to provide a substantial mounting base for the flash unit.

For the best pictures set Light/Jinn five to ten feet to one side of the subject, with the sensor (LASCR mounted in rubber grommet) pointing directly at your camera, and Light/Jinn's flash unit pointing directly at the subject. Make sure that neither the slave flash nor its reflections are in the picture. Test the setting by looking in the camera viewer and releasing the master flash before taking a picture. If Light/Jinn does not go off, point the LASCR at the camera or move it closer. Light/Jinn can be set 10-15 feet away from the camera depending on the strength and direction of the master flash. If your camera has various flash settings (X, M, F) use the setting recommended for the master flash (X for electronic flash, M or F for flash bulbs).

The key to success in multiple flash photography is correct placement of the flash units. If you follow the basic rules for good studio photography you'll be able to take much improved flash photographs. The basic studio setup calls for just two lamps. In our setup the basic, on-camera flash becomes the "fill" light, and the second, added flash unit becomes the main light source. This is often called the *key* light, and its placement is critical to the production of a good photograph.

The key (off-camera) flash must be mounted on a chair, tripod, or something similar, such as a chair back or bookcase. If all else fails have a friend hold it for you. Putting this light high, and off to one side, about 45 degrees, will provide both depth and modeling. The on-camera flash, being much further away from the subject than the key flash, will be much weaker, and need not be considered when figuring the correct camera aperture.

Since the key light is the only one that matters (in figuring the exposure) the calculation is quite straightforward. You just divide the number of feet from the key flash to the subject into the flash guide number. This gives the approximate *f* stop for the key flash mounted on Light/Jinn.

Caution. A charging flashgun may develop as high as 200 Volts, so keep the cabinet closed when the circuit is in operation. Also, do not get the flash gun close to your eyes, because when it is charged it may go off accidentally due to static electricity pulses. ■

LONE RANGER LIGHT METER

LED readout saves meter cost, and is more rugged too.

by Walter Sikonowiz

☐ Lone Ranger is a photographic light measuring instrument without the usual (needle-and-scale) mechanical meter. Instead, it uses light-emitting diodes (LEDs for short) to tell you what lens opening to use. In addition to cutting the cost by more than 50 percent, eliminating the meter has other advantages. The chance of damage from dropping is much less. People with no knowledge of photography can easily use this exposure indicator once taught the significance of the displays.

Finally, because the readout is on LEDs, it's always easy to see, even in low light where an ordinary meter's needle might be hard to read accurately.

This comparator-LED light meter is ideal for the serious beginning or intermediate photographer because most people shoot with the same speed film most of the time. And if you do use two or three different speed films, it's easy to apply a conversion factor to the Lone-Ranger's lens-opening scale.

It's a one-speed-range photographic light meter which tells you at what f-stop diaphragm opening to set your 35 mm or other precision camera lens. It provides readings for setting your camera lens opening between f-stops as large as 2.8 and as small as 32. These are based on the most popular black-and-white film for 35 mm use, Plus-X, a widely available fine-grain film.

Photo Basics. First before showing how the meter works, let's review some basic photography. The photographer is concerned with three numbers when making an exposure: 1) the ASA rating (the speed) of his film, 2) the f-stop of the lens aperture, and 3) the speed of the shutter. Let's see how these factors interrelate. Suppose you take a correctly-exposed picture under light of intensity **I**, with f-stop **n** and exposure time equal to **T.** If the intensity suddenly jumps to **2I**, you must compensate by either reducing the aperture (multiplying the f-stop by 1.4) or by rèducing the exposure time by half—**T/2.** And if the light intensity is reduced by half you would compensate either by making the f-stop 1.4 times larger, or by increasing the exposure time to **2T.** This assumes, naturally, that the film's speed (ASA) remains constant.

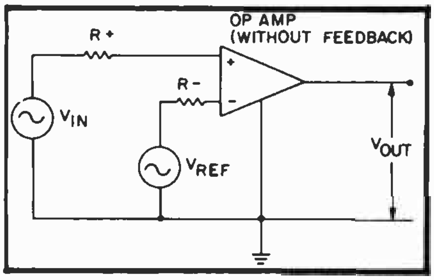
Now suppose that a correctly-exposed photograph is made under light of intensity **I**, with f-stop = **n**, and exposure time = **T.** To take the same picture with a film whose ASA rating is twice that of the original, you'd compensate by making the f-stop = **1.4 n** or by making the exposure time = **T/2.** To take the same picture with a film whose ASA rating is half that of the original film, make the f-stop = **n/1.4**, or make exposure time = **2T.** Now let's look at an electronic circuit to measure the ambient light.

Use a High-Gain Amplifier. Suppose we take a high-gain differential amp and place a known voltage on one input, an unknown on the other. Since we're using the amp open-loop (without the usual feedback), only a small voltage difference at the two inputs is required to send the output either to saturation, or to cut-off. Specifically, if the voltage at the non-inverting (+) input is a few millivolts greater than that on the inverting (−) input, the output will go high. Likewise, if the voltage on the inverting input is the greater, the output will go low.

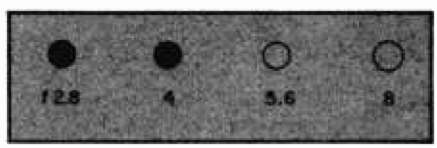
There are limitations to the size of the voltages which may be compared. For the LM339, input voltages should be less than supply voltage (V)− 1.5V. Furthermore, these input voltages should be much greater in magnitude than a few millivolts, to swamp out measurement errors due to the inherently imperfect nature of the comparator itself. Between these extremes a comparator can give a very accurate answer to the question, "Is the unknown voltage above or below the reference voltage?"

The LM339 incorporates four comparators on a single chip. If one input of each comparator reads some common, unknown, voltage, while the other four inputs connect to different reference levels, then the size of the unknown voltage can be estimated by observing the output states of the comparators.

Figure 1 shows the LM339 as the

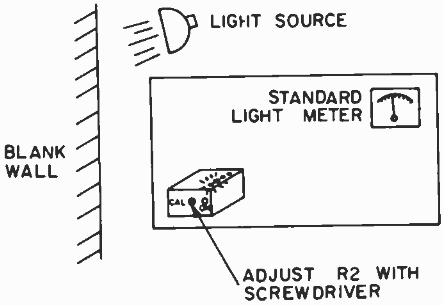


Operational amplifier without feedback has extremely high gain. It can be used to compare an input signal voltage (unknown) with a known (reference) voltage, and indicate clearly (by its output's going to saturation, or by staying at its initial (very low) voltage that the unknown voltage is either below or above the reference voltage. This makes it a "comparator."



This is the way the LED readout of the Lone Ranger would look if the amount of light being measured was enough for a camera opening of F-stop 5.6. The two LEDs at the left are dark, the two on the right are lit up.

heart of a light meter. All the inverting inputs go to the junction of PC1 and R1, and thus sense a voltage whose magnitude increases as the intensity of the light being measured increases. C2 bypasses any interference caused by fluorescent lighting in the vicinity. The non-inverting input of each comparator goes to a reference voltage,



This is the setup you use to calibrate the Lone Ranger light meter. You'll need to borrow an old-fashioned (analog) light meter for this procedure.

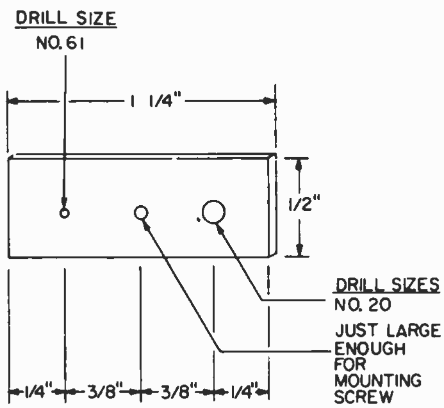
with section A connected to the lowest reference voltage and section D to the highest. Consequently, in very dim light all four comparator outputs will be at cutoff, hence all four LEDs will be extinguished.

As the light intensity increases, section A will be the first to change state (rise toward saturation) and thus cause LED1 to light. At higher intensities LED1 and LED2 will both be turned *On*. The reference voltages I used were chosen to correspond to differences in lens aperture of one f/stop. Thus, a display like the one shown here would indicate that the correct photographic exposure is between f/4 and f/5.6.

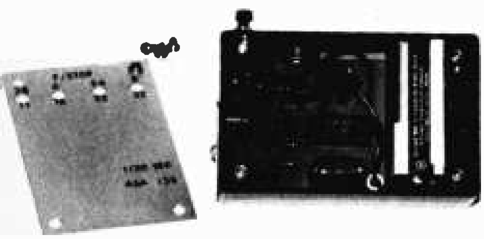
Extending the Meter's Range. Notice that in contrast to the continuous readout of an analog meter, this comparator system of voltage measurement indicates proper exposure as being between two levels. In order to get better resolution (more detailed information as to lens opening) we would need more comparators. We would also need more comparators if a larger measurement range is desired. To accomplish such a range expansion we could add another LM339—inputs 4, 6, 8, and 10 would go to the junction of PC1 and R1, while pins 5, 7, 9, and 11 would go to new (added) reference voltages. However, there is a cheaper method of range expansion. We simply install a variable aperture in front of the photocell. In this way the measurement range of the photometer is doubled to 8 stops, by using two apertures whose areas are in the ratio of 16:1. This is the scheme I adopted for Lone Ranger.

The total measuring range of this instrument thus spans from f/2.8 to f/32 with ASA 125 film (such as Plus-X) at a shutter speed of 1/30th second. Later on we'll discuss the simple mathematical conversion necessary to allow use of the light meter with different film speeds and different exposure times.

Building Lone Ranger. Actual construction of the Lone Ranger meter is non-critical, but will require some care because of its small size. A printed circuit board was used in my Lone Ranger prototype, and although it is not neces-

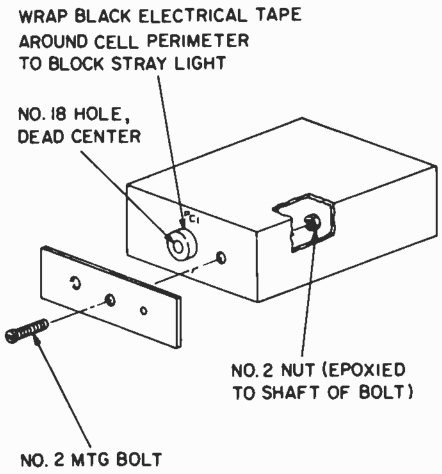


Dimensions of the range-extender for Lone Ranger are shown above. It's a simple piece of aluminum with two different-size holes in it. The middle hole is for mounting the strip to the front of Lone Ranger.



Here's how author's Lone Ranger looks inside. To keep it small, make a printed circuit board like his. Perf board is OK too, but requires bigger box.

sary that you use the printed circuit, it would be wise to copy the same general layout as the prototype. My Lone Ranger is housed in a 3¼ x 2⅛ x 1⅛-inch plastic minibox. If you use the same box, note that the mounting post in the upper-right-hand corner must be removed to make room for S1. A soldering gun with a cutting tip was used to slice out the mounting post, leaving three posts to hold down the metal cover of the box. If you are inexperienced in small-scale construction, by all means use a larger box. Regard-



Here are the details for mounting the range extender to the front of the case, and for taping around the photocell to keep it from receiving stray light which can cause misreading of the ambient light.

less of the box size used, however, the following construction details given will still apply.

When the board has been completed, mount the IC socket, trimmer R2, and all resistors and capacitors. Next, solder the negative lead from the battery clip to its hole near pin 12 of the IC socket. Solder a 2-in. length of flexible wire to the hole indicated in the upper-right-hand corner of the board. This wire will later be connected to S1. Now mount the photocell so that its light-sensitive face is perpendicular to the board and facing toward its upper border. Finally, mount the four LEDs into the circuit board, but be sure to observe proper orientation. The tops of the LEDs should all extend the same distance above the board—about ⅞-in. if you have a cabinet of the same depth. Now plug IC1 into its socket and set the board aside temporarily.

The range selector is just a simple aluminum plate (about 18 gauge) with the dimensions shown in the diagram. Note that two holes, one #20 and one #61, must be *carefully* drilled. Further note that the plate must be absolutely flat. Don't cut it out with tin snips. Use a nibbling tool or hacksaw, which will cut the aluminum without distorting it. Now use a file to round off all the edges, and then buff it with steel wool. This will make the range selector rotate readily when you're out shooting.

More On Construction. The drawing of the cabinet shows how to mount the photocell relative to the range selector. When the proper holes have been drilled, mount the range selector with #2 hardware and tighten until the fit is just snug. Use a drop of epoxy to

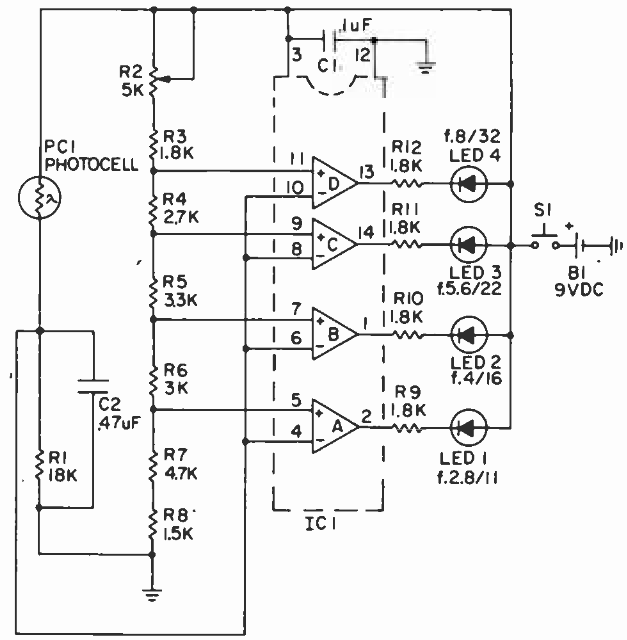
Lone Ranger light meter is about the size of a good lens, as shown here (Pentax Rokkor f=1.7, 50 mm).

lock the nut to the shaft of the bolt, and let the cement dry.

S1 may be placed wherever it is convenient. Be sure to drill a hole to allow calibration-adjustment of trimmer R2 from the outside. Now locate and drill four holes in the cover to allow the LEDs to be visible. The exact location of these holes will depend upon the dimensions of your case and the dimensions of your board. Simply insert the board into the bottom of the box and measure how far from the sides each LED's center is located. Transfer these dimensions to the cover and drill four #22 holes.

Mount the board in the cabinet so that the photocell lies directly behind and flush against its mounting hole. If you used the same size box as I did the ¼-in. spacers will be needed between the board and the bottom of the case to allow the LEDs to protrude slightly through the thin metal cover. After the board has been securely mounted, take a ¼-in. wide, 1½-in.-long strip of black electrical tape and wrap it around the perimeter of the

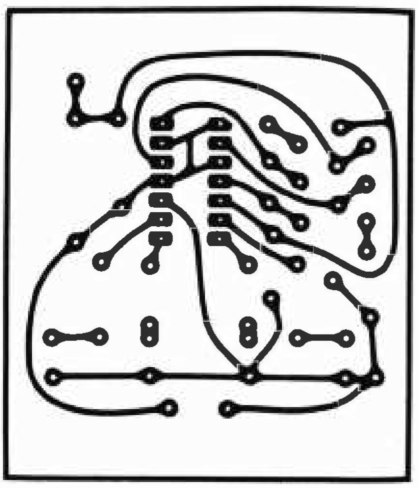
(Continued on page 119)



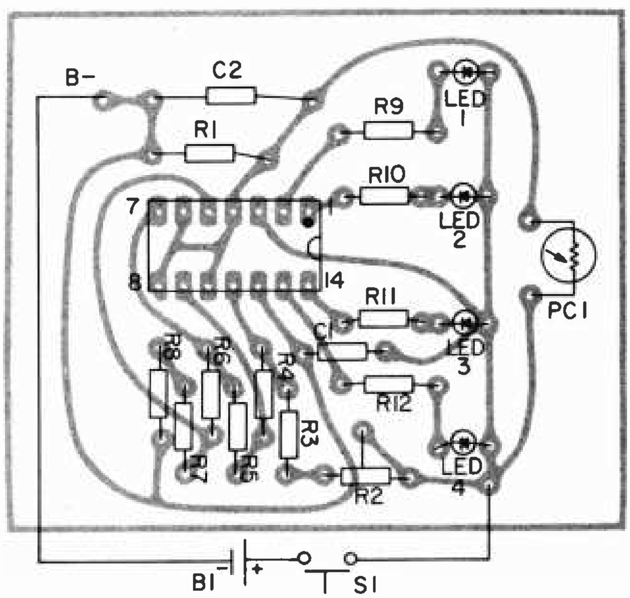
LONE RANGER PARTS LIST

C1—.1-uF capacitor
C2—.47-uF capacitor
IC1—Quad comparator integrated circuit LM 339
LED1, 2, 3, 4—Light-emitting diodes
PC1—Cadmium sulfide photocell
R1—18,000-ohm, ½-watt resistor
R2—5,000-ohm potentiometer, printed circuit board-mounting
R3, 9, 10, 11, 12—1800-ohm, ½-watt resistor
R4—2700-ohm, ½-watt resistor
R5—3300-ohm, ½-watt resistor
R6—3000-ohm, ½-watt resistor
R7—4700-ohm, ½-watt resistor
R8—1500-ohm, ½-watt resistor
S1—SPST momentary on switch
Misc.—Minibox 3¼-in. x 2⅛-in. x 1⅝-in. (or larger), socket for IC1, 9-VDC transistor radio battery, clip for battery, wire solder, printed circuit board kit, etc.

A light meter without the meter. Sure enough, Pardner, if it's the Lone Ranger you're talking about. The circuit enables you to build a meterless light meter to solve your F-stop woes. The Lone Ranger uses Light Emitting Diodes to tell its story, rather than an all too breakable meter. It's absolutely great for the beginning and intermediate shutterbug to use for great picture results. Next time someone asks you, "Who was that masked meter?" you'll know it was the Lone Ranger!

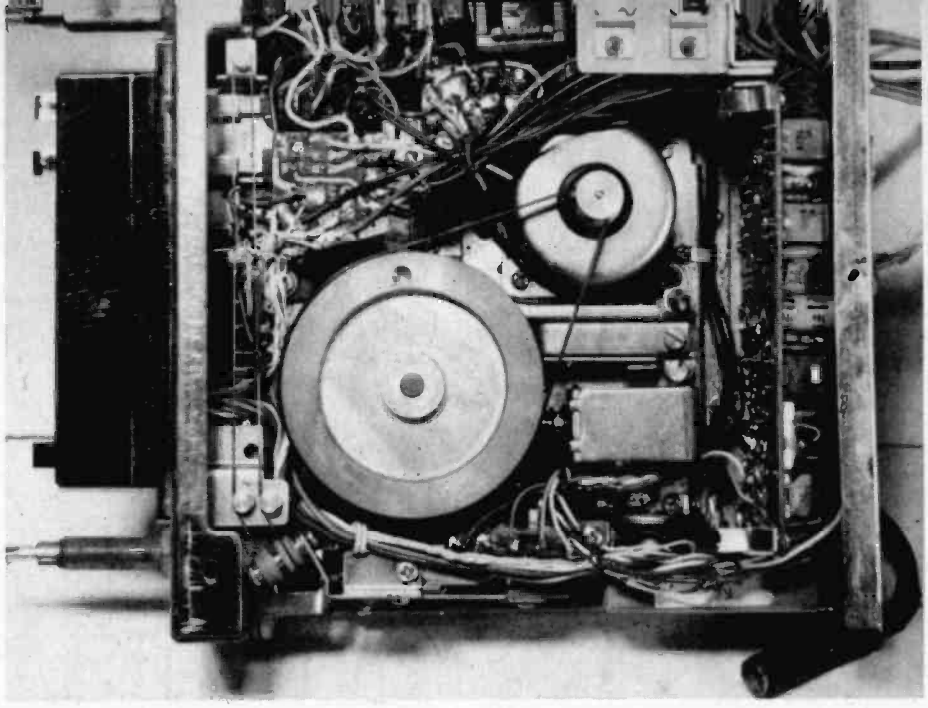


This is a full-size template for the printed circuit board, if you want to make yours just like the author's. See the text for suggestions on making printed circuit boards if this is your first.



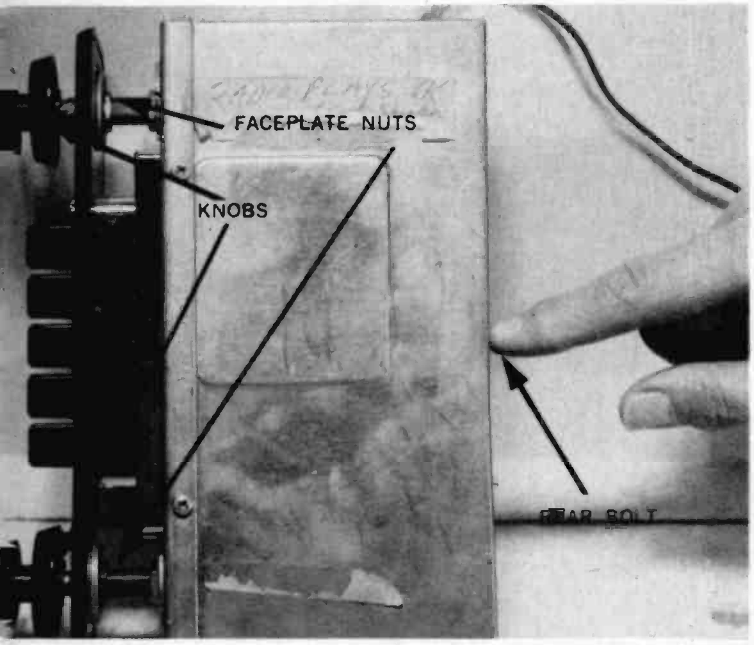
Placement of parts on Lone Ranger's printed circuit board. If you use perf board instead you can put the parts wherever you want, but you'll find this general arrangement most convenient.

TEN



Ninety percent of auto radio repair problems don't require a trained technician with thousands of dollars worth of test equipment. Many car radio problems concern mechanical connections—a broken wire, loose capacitor or a broken dial cord—others are caused by defective power supplies or overheating parts. What ever the problem it can almost always be fixed without taking it into a shop and running up a big bill—just learn these tricks-of-the-trade and get down to business.

An auto radio, however, can be very tricky to work on. Sometimes it includes FM as well as the standard AM, not to mention FM multiplex, 8-track, cassette and even CB. When all of this is jammed into a seven-inch wide package it can be pretty confusing to figure out what is what, so you don't want to make things harder than they need be.



1. Before removing the radio make sure the troubles are definitely in the unit itself. You may have a blown fuse, defective speaker, antenna or bad wiring connections. First thing: locate and check the fuse. The fusebox is normally under the dash and to the left of the steering wheel. When a tape player is included in the radio you will find it in the plug or harness. If you can't find it trace the largest wire out of the radio and see where it goes. The color of the "A" lead wire may be black, red or blue.

A defective speaker may be causing the problem and the type of sound is a clue to the cause. If the music is intermittent then the speaker voice coil wires may be partially broken into. A dropped speaker cone will produce a tinny and mushy sound. Typically on loud volume certain vibrations may be caused by a torn or loose speaker cone. Excessive blatting music may result from a loose voice coil support. You should check the speaker for continuity with ohmmeter or a flash-light battery. When using a small battery just temporarily touch the speaker leads and listen for a clicking noise. If you don't get a new speaker.

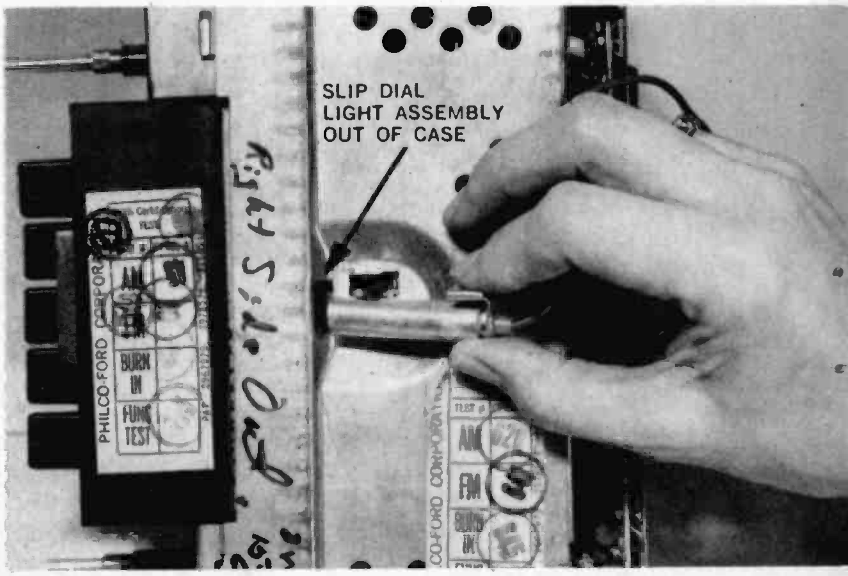
Check the radio wiring for possible loose or broken connections. If the radio is a universal type, mounted under the dashboard, it's likely that the speaker and "A" lead connections are just twisted together. Remove the tape and solder all connections then retape with plastic tape. In case of stereo speakers, with one side intermittent or dead, inspect the speaker wiring to see if it is frayed.

An open or poor antenna connection may cause weak or noisy reception. If radio reception is very noisy, check the bond between antenna base and metal car body. Another source of car noise may be a broken shielded cable where the male plug enters the radio. With antennas molded into the front windshield check for a broken connection at the bottom of the windshield. Be real careful and don't pull on the antenna connection or you may end up replacing the whole windshield. If another auto antenna is handy simply plug it in and hold the base outside the car window. You would be surprised how many antenna problems are identified by this test.

2. Doing without a dial light on a car radio is like fixing a flat tire with a dead flashlight after Friday night's football game. Most car radios must be pulled out to replace the dial light. Before removing the radio check to see if the pilot light may be wired to the dash light control switch. Trace two (black) wires leading to the fuse block or auto wiring harness. A defective plug or poor wiring connection may be the trouble.

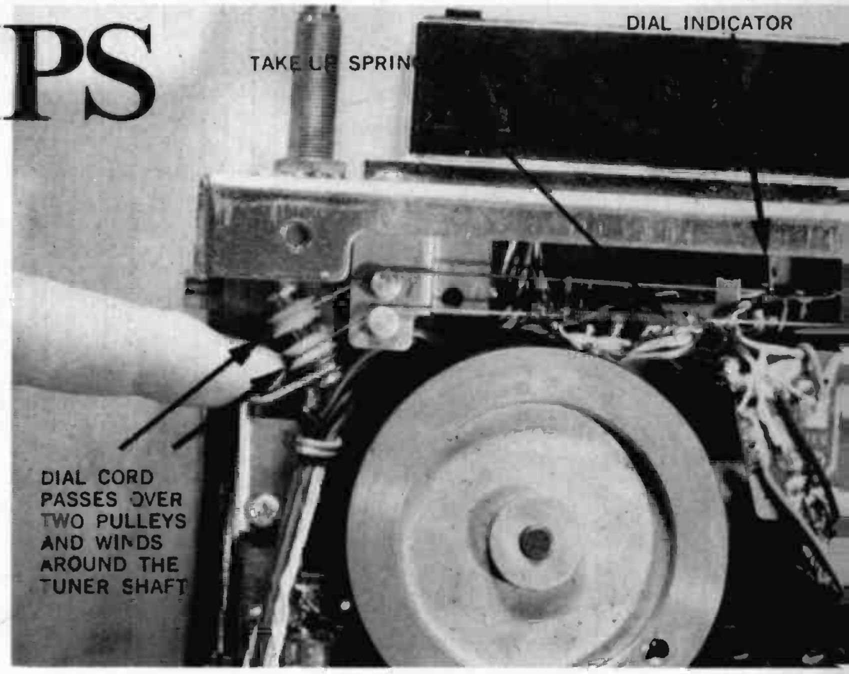
After removing the radio, inspect the front dial assembly to locate the defective dial light. On some radios you unclip the dial light assembly from the radio chassis. Other models mount the dial light close to the bottom of the dial assembly. You may have to remove the whole front dial assembly to get at the dial light mounted behind a white plastic cover. Within some Japanese models, you may find a dial light with long wire leads.

Most American-made radios use a 12-volt bayonet dial light such as an 1891, 1892, 57 or 47. Foreign radios may have screw type bulbs which are sometimes difficult to obtain. They can be replaced with a bayonet type or one with leads. Since all dial lights are 12-volt types you can solder a bayonet bulb in place of a screw type. If not, replace it with one having a 12-volt flexible lead (like those found in tape players) and cement it in position with black silicone cement.



CAR RADIO REPAIR TIPS

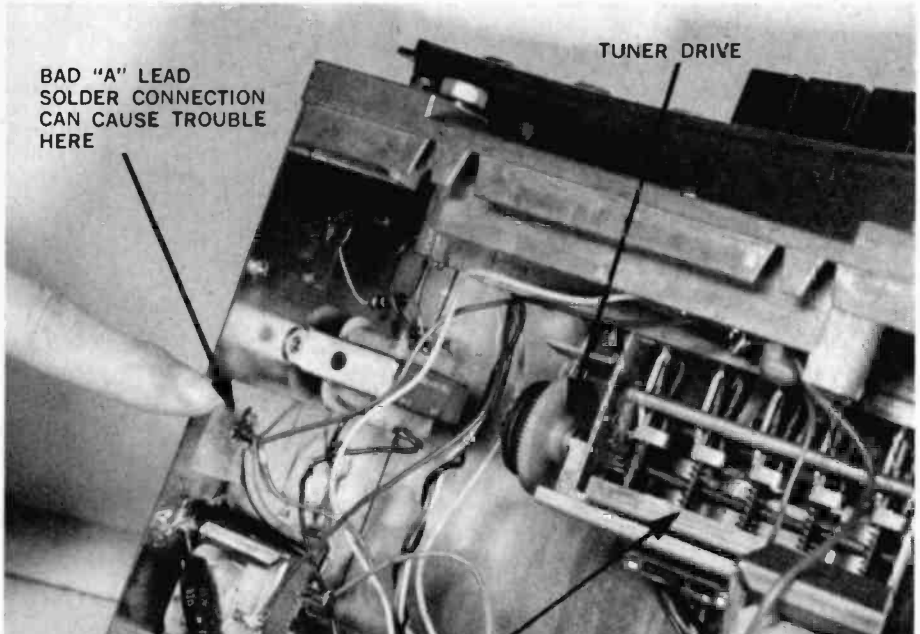
by Homer L. Davidson



3. There are two different types of dial mechanisms found in an auto radio—mechanical and dial cord operations. The mechanical system employs a couple of worm and gear assemblies. The most common problem with mechanical tuning is slippage between the clutch and tuning coil assembly. Clutch tension may be adjusted with a set screw, or liquid rosin and phono-grip may be applied to prevent the clutch from slipping.

You should suspect a broken dial cord if the radio will tune in stations, but the dial pointer doesn't move. You will find two basic dial cord arrangements; a simple one with tuning shaft, two small pulleys and dial pointer; the other with additional small pulleys and dial cord spring. When a spring is not used to take-up the slack, most of the dial cord is wound around the tuning shaft. The small spring keeps the dial string taut around larger pulleys.

Do not attempt to tie a knot in the broken dial cord and make it do. Select a cord of medium or fine dial cord (found in most radio and TV supply houses). If a dial stringing schematic is not handy, draw a diagram the way you found the broken dial wound. Nine times out of ten you have come up with the right method. Remember, when the tuning coil cores are all the way into the coils, your dial pointer should rest at the low end of the dial. Another helpful method is to tie the end of the dial cord to the tuning drum and leave the dial spring to attach at the end of the line.



4. If your car radio won't produce a sound, look at the small fuse. Visually inspect the fuse holder and "A" lead. Most solid-state radios may pull from 1 to 5 amps.

Always replace the defective fuse with one of the same value. You will find this stamped in the metal edge of the fuse. If in doubt, check the correct radio fuse listed in your car manual. Most Japanese car radios will have a 1- or 2-amp fuse for protection. American manufactured auto radios are protected with a 3- or 5-amp fuse. Very large Japanese radios with tape players may be protected with a 3- or 5-amp fuse, while American made radios with tape players may be fused with a 10- or 20-amp fuse.

Trace the hot lead inside the radio to the spark plate and on-off switch. A poor or broken switch connection can put a radio completely out of action. If the dial light is on you know the switch is good. If not, clip a jumper around the switch connection and check for a 12-volt source at this point.

Substitute a new PM speaker. An open voice coil or poor speaker lead may cause problems. If the sound returns after speaker substitution you may want to check out the defective speaker. With the speaker still connected, push down on the cone of the speaker and see if the sound cuts in and out. A poor or broken voice coil lead may cause intermittent sound conditions. Disconnect the leads and check for continuity across the voice coil leads with the ohmmeter. If the PM speaker is defective, replace it with one of the same voice-coil impedance. You may encounter a 3, 2, 4, 8, 10 or 20-ohm speaker on a car radio. Replace a Japanese radio's speaker with an 8-ohm speaker.

When you turn on the radio switch and a click is heard on the speaker, you may assume that the power output transistor and power voltage are normal. An open or shorted power output transistor may not product any sound on the speaker. If the output transistor becomes leaky you should at least hear hum or distortion on the speaker.

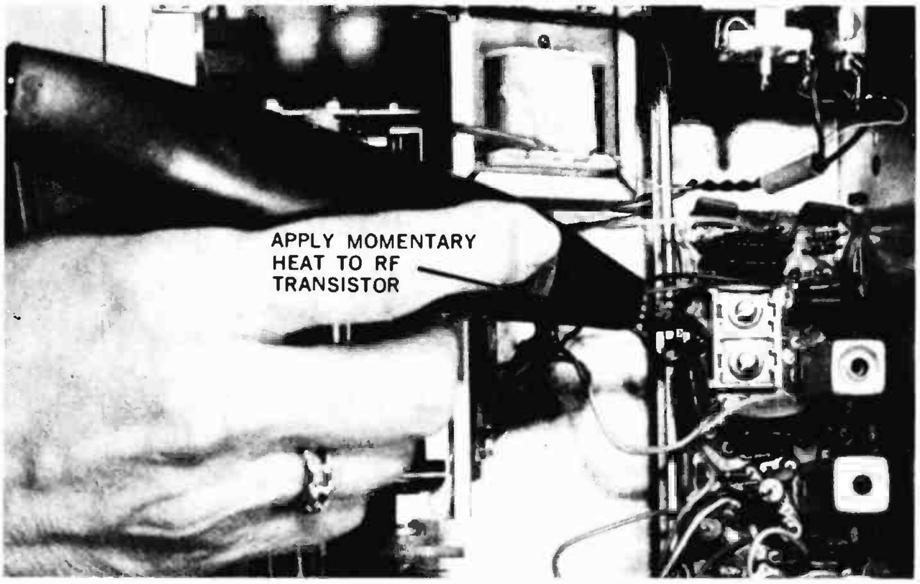
REPAIR TIPS

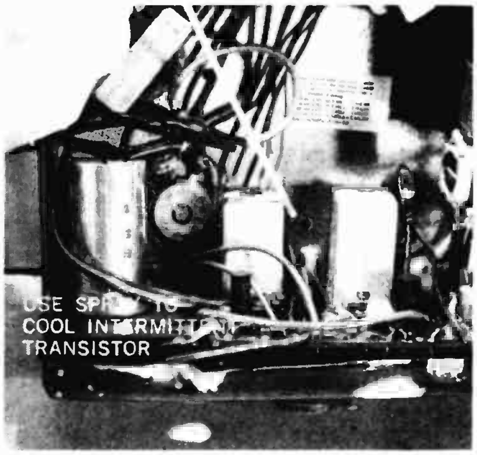
5. Does your auto radio start to play only after it's been turned on for twenty minutes or so? Perhaps, it's real weak in volume and then comes on with a bang! These symptoms are caused by intermittent transistors. Since transistors are solid-state devices, cold or heat may make them become open or leaky. Sometimes after applying heat or cold spray the defective transistor will return to normal operation.

Problems caused by heat and cold usually occur in the RF oscillator and IF transistors. If the radio is cold and does not come on instantly, apply heat to the body of each transistor. Start at the RF transistor and apply heat for no more than a second or two. If left on too long you may damage the transistor. Then move on to the oscillator and IF transistors. Sometimes just moving the suspected transistor may cause it to "pop" on. Apply heat when the radio will not come on and coolant if the unit cuts out or becomes weak after it warms up.

Weak conditions may be caused by transistors, the antenna or bad capacitors. When you can hear every station on the dial but weakly, suspect a defective antenna system or RF transistor.

You have eliminated the antenna system as a possible problem if the same weak condition exists on the workbench. Go to the RF transistor and take voltage measurements. A very high collector and very low, or no, base voltage indicates the transistor is open. You may have the same condition if the emitter bias resistor opens up. Check for broken wires or replace it.

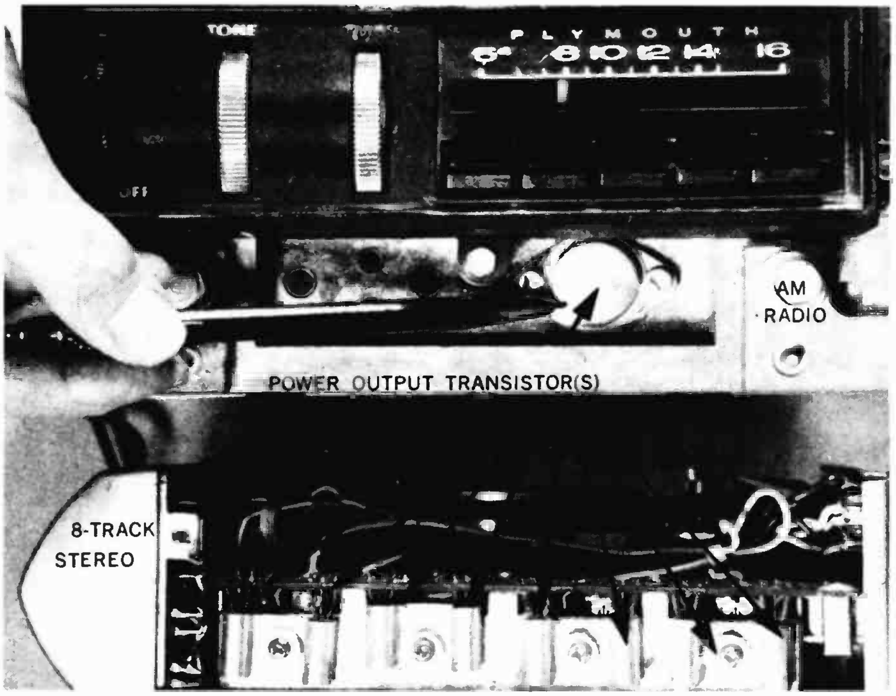




6. A coolant or cold spray is essential for locating intermittent transistors. Your radio may play for several hours before cutting down in volume or maybe it will only do it once a week. But, it always acts up while listening to your favorite song or football game.

You may waste hours and even weeks trying to locate an intermittent transistor if it only happens once a week or twice a day. Play it until it begins to really act up—like every hour or two. Then carefully remove it from the auto and connect it to the workbench. Of course, you must have a 12-volt DC source to operate the auto radio, or you may be able to extend the power leads from the auto to the radio and check it out on the front seat. Always, observe and connect each wire to its hookup.

Try to isolate the intermittent problem. Start at the volume control when the radio is in the intermittent state and notice if the audio section is functioning. Simply hold a screw-driver blade on the center tap of the volume control and you should hear a loud hum. If not, the audio section is intermittent. Then start at the driver transistor and work towards the front of the receiver. Spray each transistor at least three or four times. If the music begins to play you have located the defective transistor. Don't remove that transistor just yet. Let the radio go into the intermittent condition and spray it once more—to make sure the transistor is intermittent. You may also find coolant sprayed upon certain areas of the PC board will bring out those poor, soldered connections.

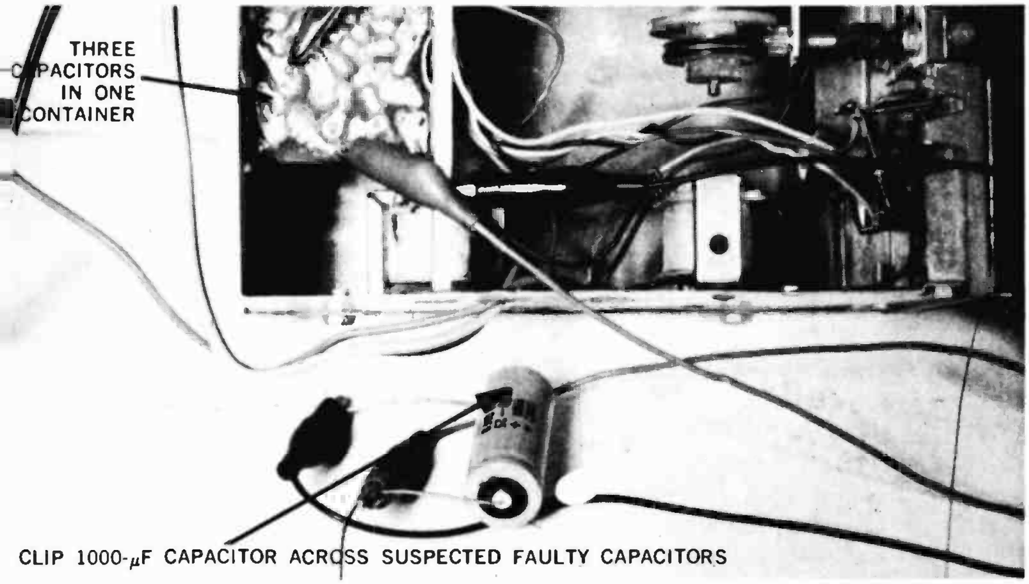


7. You may find one, two or possibly four power output transistors in your receiver. Within the AM radio you may locate one single or two push-pull power output transistors. Generally, four power output transistors are found in the AM-FM-MPX and tape player receivers. If your radio incorporates an eight-track tape player there are eight power output transistors. Just go slow and easy when replacing the defective output transistors.

After locating the defective output transistor check to see if the transistor and mounting screws are insulated from the heat sink with a piece of mica or plastic material. In a push-pull output circuit you may find one transistor insulated from the heat sink and the other mounted directly upon it. Sometimes a single output transistor may be mounted upon the heat sink and the heat sink is insulated away from the radio chassis. Remove only one transistor at a time if both output transistors are being replaced.

Replace the power output transistor with an identical unit. If a piece of mica insulation is found between the transistor and heat sink apply silicone grease to both sides of the insulation. You will find most output transistor replacements enclose an insulator in each package. Remove the old grease and dirt with alcohol and a cloth. Now firmly tighten down both mounting screws. Be careful, too much pressure may bite through the insulation and short out the transistor.

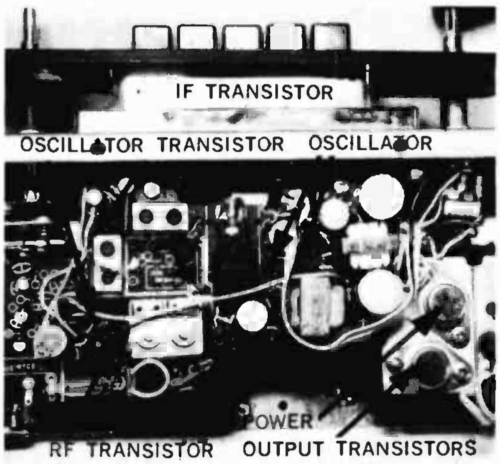
When mounting output transistors with only one mounting screw be sure the three terminals of the transistor go through the correct holes of the insulator. The terminals are then bent at a right angle and fitted into the transistor socket. Make sure the terminals are clear through the socket piece to make a good contact. In many cases these flat type transistors are soldered directly to the audio PC board. You may find this single-hole mounted transistor at the rear heat sink, on the chassis near the volume control or just inside of the front tuning panel.



8. With all those odd noises coming out of the speaker you may think a swarm of bees or mice are trapped inside the radio. Actually, all of these noises can be caused by an open filter capacitor in the power supply. Locate either a filter pack or a single filtering capacitor upon the radio chassis. To find out which one is defective, turn off the power and clip a new capacitor (1000 mfd) across the suspected one. This test will uncover an open capacitor.

When more than one filter capacitor is located in one container, shunt the clips to the tie point (+) and chassis ground. To test a single filtering capacitor, clip the new capacitor across those found upon the PC board. You may find two or three single filter capacitors on the board. Observe correct polarity (+) in testing and replacement. The negative terminal (outside metal case) connects to chassis ground. Clip the new capacitor across each suspected one until the noise stops being very bothersome.

If you locate a defective capacitor in a container with several other capacitors, replace the entire filter network. Replace the defective capacitor with one of the same capacitance and voltage value. If you cannot locate one of the same value, use one with a little higher capacitance and operating voltage.



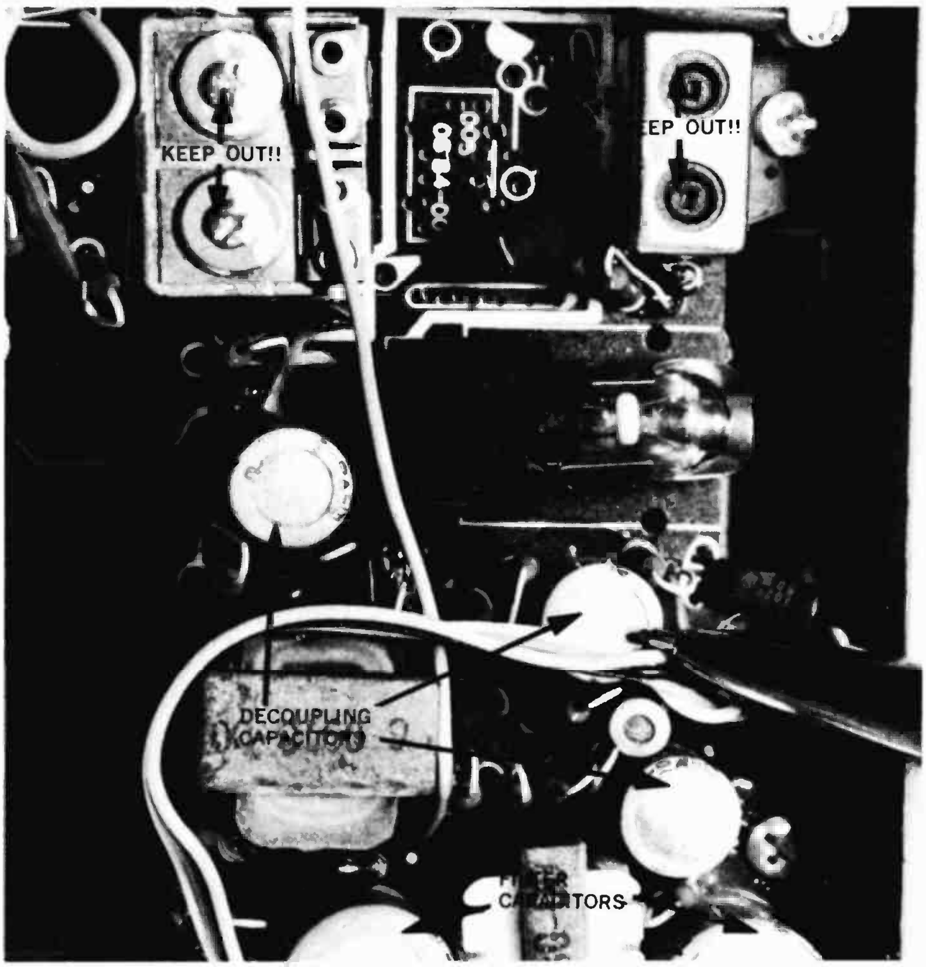
9. Don't be too surprised if your car radio begins to sound like a small gasoline engine. The put-put noise you may hear in the speaker may be a sign that excessive motorboating is occurring in the RF, AF and power supply circuits. Go directly to the filter circuits of the power supply and shunt a large (1000 mfd) electrolytic capacitor across each one. Always, remember to turn off the receiver and clip the capacitor in place to prevent damage to other transistors. Also, observe correct capacity polarity. When the motorboating noise quits, you have located the defective filter capacitor.

If the filter capacitors in the power supply are not causing the motorboating action, shunt smaller electrolytic capacitors in the B+ and decoupling circuits. These (100- to 250-uF) capacitors may be found anywhere in the PC board. Also, check for defective bypass capacitors in the emitter circuits of RF and AF circuits for motorboating problems. Simply shunt a new one of the same value across the suspected capacitor.

Excessive motorboating may be caused by an audio output or AF transistor. Try to isolate the AF or driver transistor by shorting the base and emitter terminals together. Be careful to make sure you are on the right terminals. If motorboating ceases either the transistor is defective or the fault is in the preceding stage. Replace the audio output transistor if suspected of motorboating. Most of these audio output transistors are easily replaced since they are mounted to the heat-sink with a couple of screws.

10. Suspect a defective oscillator transistor when one half of the tuning dial is alive. Usually the high end of the dial is dead but it may be either end. The oscillator transistor is located close to the tuning mechanism oscillator coil and padder capacitors. In some auto receivers it may be marked on the PC board. A transistor test may show that the transistor is good but will not oscillate across the whole broadcast band. Simply remove the transistor and install a new one.

One important thing to remember is to avoid the temptation to put a small screwdriver into the tuning coils and capacitors. It is improbable that you will be able to improve the radio's performance this way. You should never adjust these unless you have the proper test equipment and have been trained in its use. More radios go to the junk pile thanks to well-meaning coil and capacitor adjusters. Most of the time these adjustments are made at the factory and then sealed with wax so they can't vibrate out of tune.



1. Why not build projects you can be proud of, in appearance as well as circuit design? It is neither difficult nor expensive as you'll note when you follow this unit on a step-by-step journey from a blank, machined panel to real artistic beauty.

2. You will need spray and brush-on protective coating, plastic tape, various types of rub-on lettering and designs, and a burnishing tool (the white cylinder) to effect the transfer of the letters from the carrier sheet to a project's front panel.

3. You can't fashion it if you have never seen it before—at least seen it on paper. First, make a sketch and work on the arrangement until you are quite satisfied with it. Using the quadrille paper, as pictured here, makes the job easier.

LOVE THAT

Make your budget project

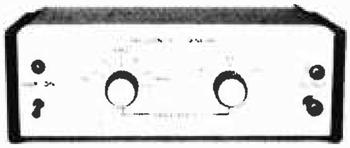
by Randall

When you give birth to an electronic project, don't send it into the world illiterate. As shown in this article, it's easy to apply lettering and designs to give your projects a professional appearance, as well as for functional reasons. This is accomplished by using a product called *rub-on lettering* (or *dry-transfer lettering*), which consists of letters, numbers, or designs with an adhesive on their back side so that they can be affixed to a panel or other surface. The letters come attached to the back of a transparent plastic *carrier sheet*, from which they are transferred to the panel by rubbing or *burnishing*. Follow the photos to see how it is done. The process may seem complicated at first, but with a little experience you will find that the steps go quickly.

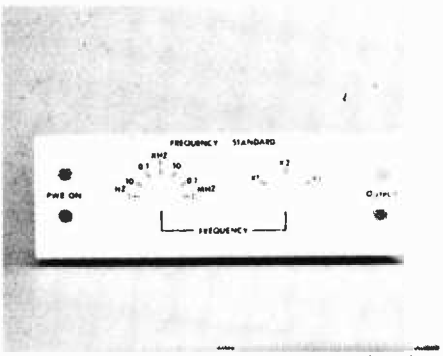
Rub-on lettering is available in various sizes and colors (black and white are the most common). Sets may contain complete words, individual letters or numbers, or a combination of these. Sets consisting of index marks and other designs for rotary switches and dials are also available.

A small set, which should see the average hobbyist through half a dozen projects or more, costs only about two dollars. Your local electronics store probably carries rub-on lettering and related supplies, if not, try the suppliers listed at the end of this article. Rub-on lettering is also available from art, graphic arts, and office supply stores. Although the type they carry is intended primarily for other purposes, it can be used for electronic projects.

In addition to the lettering and a few household items (cellophane or plastic

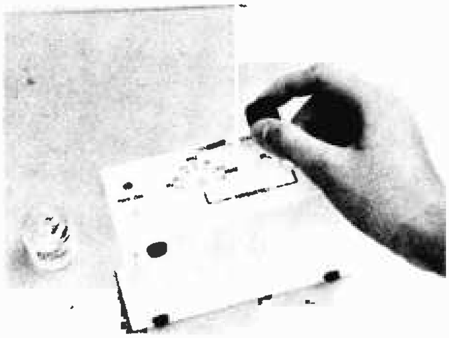


14. And now—the finished project, a delight to the eye! Once you try this method on one of your projects you'll never go back to ugly again. You don't have to be an artist, and it does not add much to the cost. Electronics can be beautiful!

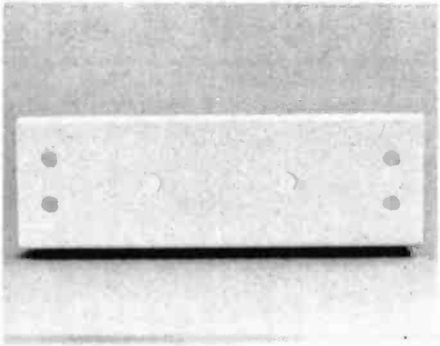


13. Here you see what the panel looks like after the lettering has been completed but before the parts have been mounted. It already has a clean, professional look, more like something out of an assembly-line factory than from your workbench!

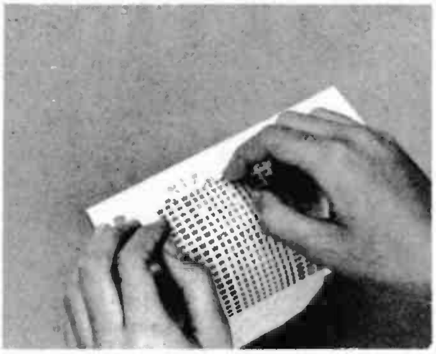
12. You can also buy spray overcoating as pictured here. Spray is more even than the brush-on, but the brush-on can be applied thicker. This method too requires that you carefully check for the compatibility of the overcoat with both letters and panel.



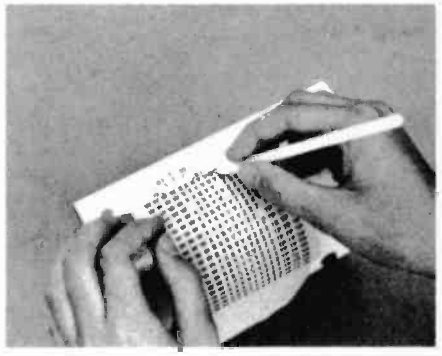
11. You'll want to protect that final panel, and there are two methods you can use. Here we show the brush-on method of overcoating. First, check on a scrap or hidden area for compatibility with both rub-on lettering and the panel finish.



4. Once you know where it is all going to be at, you can begin to machine the panel. Follow your quadrille-paper layout carefully and don't make last minute, poorly planned changes! Then make certain the panel is clean and dry and free of any imperfection.



5. Locate the desired letter (or word, or design) on the carrier sheet, place it in position on the panel and press the sheet against the panel. The back of the sheet is tacky so it will not easily slip. Here we have already applied some of the letters.



6. Transfer the letter to the panel by use of the burnishing tool. Rub over the letter several times, increasing the pressure each time until the transfer is complete. As you do this a slight change in the letter's appearance verifies transfer is working.

LETTERING

look like a million bucks!

Kirschman

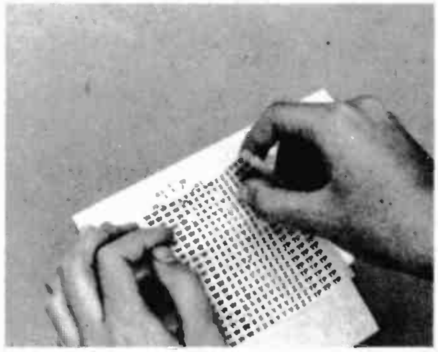
tape, ruler, paper, etc.), you will need a blunt-pointed tool to burnish the letters into place. Tools for this purpose can be obtained where art supplies are sold, or you may be able to find something around the house that will serve the purpose. However, a pencil or ballpoint pen tends to be too sharp, and may also obscure the lettering. The burnishing tool shown in the photos was made from ¼-inch diameter plastic rod sanded round on one end and tapered and rounded to about ⅛-inch diameter on the other end. It could also have been made from a wood dowel.

The panel or other surface to which you intend to apply the lettering should be clean and dry. Any oil, grease, dirt, or moisture will hinder adhesion of the lettering. Soap and water can be used for cleaning, except on bare aluminum. Rinse and dry the panel thoroughly; after wiping off excess water, use a heater or warm oven to dry. Solvents can also be used for cleaning; test first for compatibility with the finish. *Do not* use a heater or oven with solvents. To clean bare aluminum, solvents can be used, or chemical preparations for this purpose are available from paint and hardware stores. After cleaning do not touch the areas where you will apply the lettering.

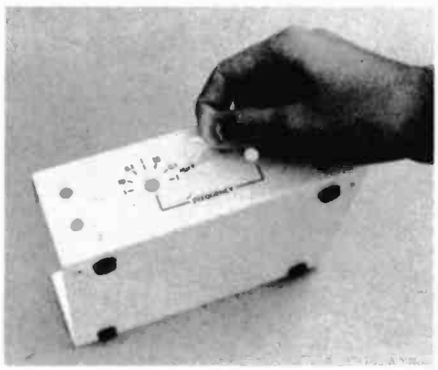
If you use solvents or other chemicals be sure to follow the manufacturer's directions and particularly observe the appropriate safety precautions. Spend a little extra time and effort to be safe and minimize the possibility of injury.

After you have applied the lettering, you will probably want to protect it

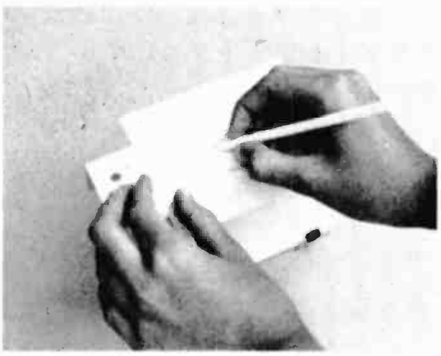
(Continued on page 114)



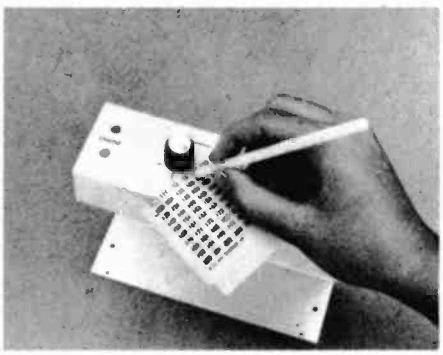
7. Peel the carrier sheet away from the panel, starting from one end and holding the other end in position against the panel. Check that the letter has completely transferred. If it has not, all you have to do is lay the sheet back down and burnish over.



8. Make a mistake? It's no disaster. To remove an error, press ordinary cellophane or plastic tape over the offending letter and then simply lift it off. This may be repeated if needed, until all is clear. An eraser may also be used.



10. Once all lettering is applied, and you are satisfied with it, burnish one more time. Use a backing sheet of slick paper, so the lettering will not stick to the backing sheet, and go over the whole panel. Use the blunt end of the burnishing rod.



9. Positioning index marks is done by temporarily mounting both a switch and its knob. Turn the knob to each position and align the mark with the pointer. As you see here, the number "1" makes a good index mark, certain other letters may be used.

PUTTING HI-FI IN

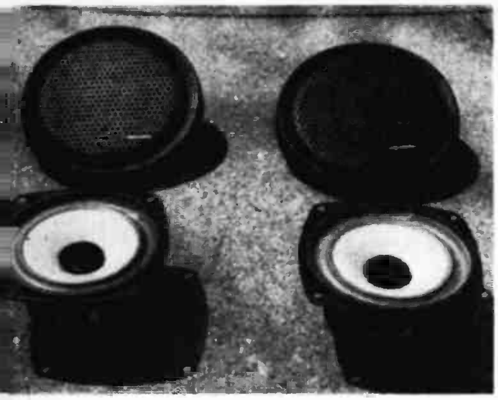


Fig. 1. The basic rear speaker package has the speakers and matching protective grill assemblies. Note the large outer surround on the speaker cones; a pretty reliable guide that these relatively small Radio Shack speakers pack a lot of solid bass.

Fig. 2. You might have to jackknife yourself into the trunk to make a few connections so make certain the trunk is completely empty before you start. Yes, get rid of the spare tire too.

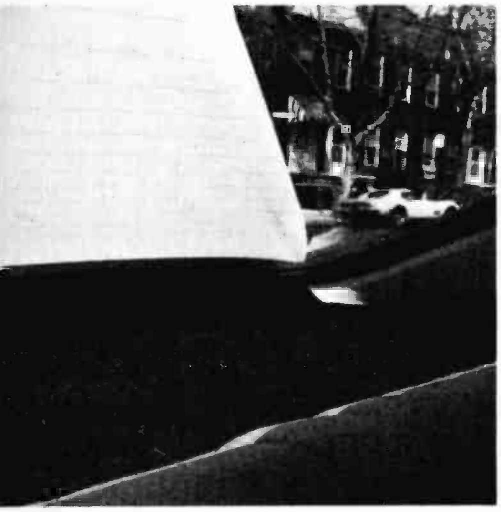


Fig. 3. The rear deck. Concealed beneath that layer of carpeting is a steel deck with the speaker cutouts already prepared at the factory. Even the speaker mounting studs might already be installed.

BESIDES THE OBVIOUS luxury of carpeted floors, leather seats, and leg room for a giant, big fat luxury cars generally have much better sounding radios and tape players. Quite often the luxury car's sound quality begins to approach or equal what we'd accept as hi-fi in our home.

But the secret to a luxury car's better sound is not necessarily that the radio or tape player is any better than what's put into a budget car; rather, the gold-plated Detroit Iron probably has rear deck speakers, and that's what gives it that big sound.

When speakers are mounted on the rear deck the entire trunk becomes a speaker enclosure, and it is a fundamental rule of automobile sound that the larger the enclosure the better the bass. Also, with the speakers facing upwards the highs bounce off the slanting rear windows towards the passengers; the reflection also disperses the highs, creating a "surround-sound" that envelops the passengers in a total experience—as if they were one of the musicians.

Yes, rear deck speakers make any auto radio or tape player sound better, but there's no reason you have to wait for a luxury car in order to enjoy a big, rich sound. We don't know about those cheap foreign imports where everything but the four wheels and a body is left off to keep the price down, but American-made cars are factory-equipped for rear speakers. In most cases a piece of cardboard is all that separates you from rear speakers. You see, here in the U.S. the manufacturer can't be bothered

Fig. 4. Just one speck of dust in the cone from installation will rattle for ever and ever. But if you wrap the speaker in an old pantyhose (or even new pantyhose of the 2-for-a-$1 variety) you'll be able to keep chips out during installation, and the heavier dust—which also rattles—that settles in after the speakers are installed. Leave enough slack in the material so it can be completely wrapped around the speaker when you're finished.

with making one model for the guy who wants rear speakers and a different model for the buyer who doesn't even want a radio. So he makes one basic metal rear deck pre-cut for speakers. If you order the car without speakers the assembly plant covers the metal rear deck with cardboard, hardboard, or fabric, concealing the speaker cutouts. If you order speakers factory installed, the assembly plant simply substitutes a cover that also has speaker cutouts, and installs the speakers. If you get the car without speakers and then decide you want rear speakers the dealer hands a knife to the least skilled man in the shop and tells him to cut out the cover and install the speakers.

To make life just a little bit easier for everyone, many cars are already pre-wired for rear deck speakers even if they haven't been installed at the assembly plant. Again, it's often easier for Detroit car makers to stock one general

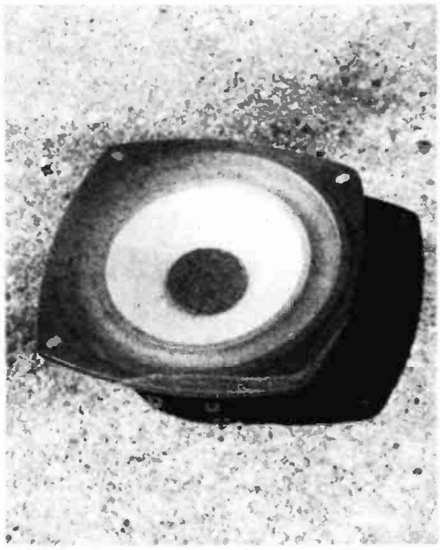
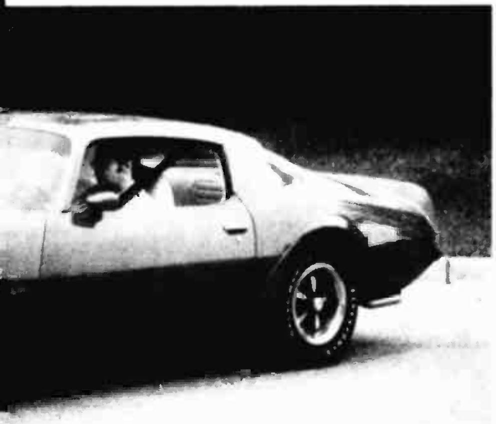


Fig. 5. If you cut and wrap the pantyhose carefully it should look like a factory installation.

THE REAR DECK



purpose wiring harness than several different models. Often, the rear speaker wiring is tucked into a rear quarter panel along with some extra wires for a rear window defogger, trunk lamp, etc. If you have been wise enough to get your car's service manual you'll be able to locate concealed wires by using the schematic and wiring pictorials supplied in the manual's electrical and accessory sections. Even if your car isn't prewired, the manual will tell you where the front-to-rear wiring channel is located. If you know where the channel is located you can run a wire from the trunk to the dashboard in less than 15 minutes. If you don't know where the channel is located, or even if there is one (and there is), you can spend an hour or more trying to get a pair of speaker wires from trunk to dash.

As for the speakers themselves, get the best; the difference in price between good-quality speakers and poor ones is only a few dollars. It won't be worth your time and effort if you save a couple of bucks only to wind up with fourth-rate sound quality.

The best place to find high-quality auto speakers is a local general parts distributor (not an auto-sound specialty shop), or one of the national chains; for it is in these places that you'll get a chance to listen to the actual speaker you'll buy, or at least have easy return privileges if you decide you want a better-quality speaker.

The rear deck speaker kits shown in this article came from Radio Shack. You'll note that although the speakers are small they have a relatively large magnet and an obvious large and soft cone surround. This is the stuff of big bass, even in small speakers, and is the payoff when you've completed the installation. Your only problem is to check the size of the cutouts in the rear deck first, and then get the speakers that match. For example, you might have 5-inch round cut outs, or 4 x 5-inch or 5 x 7-inch oval. Get the right size. Don't try to use a 4 x 5 in a 5 x 7 cutout. Part of the sound quality is determined by the fit of the speaker against the rear deck, so match the speaker to the cutout. Finally, get a complete mounting kit: It will save problems later when you try to match a protective grille to a speaker bought earlier; somehow, it usually doesn't come out right because the holes don't match when you buy one piece here, another piece there.

Okay. Ready? Just follow the photographic illustrations to terrific sound. ■

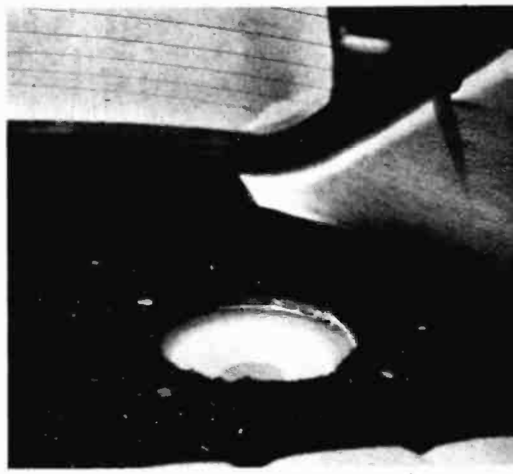


Fig. 10. View from the top. Brush all debris and chips off the pantyhose shield.

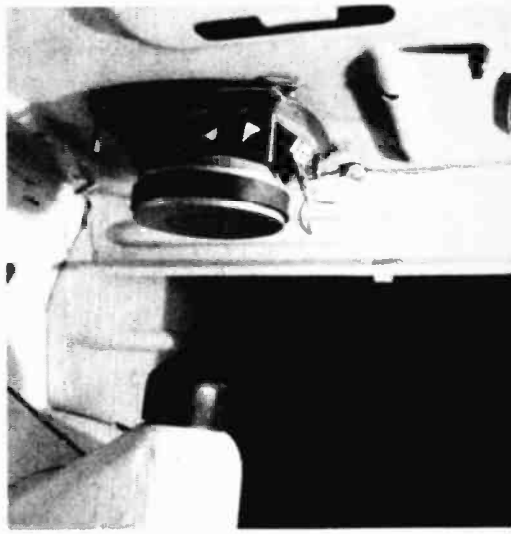


Fig. 9. Connect the speaker wires and route the wires so they are off the floor where they cannot be damaged.

Fig. 6. Cut a hole in the rear deck cover corresponding to the cutout in the steel deck underneath.

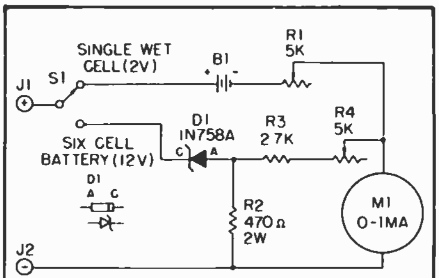
Fig. 7. Here's how it looks from inside the trunk. Note that in this car even the speaker mounting holes are pre-punched. Just drill through the rear deck cover from the trunk side. The metal tabs at the rear hold the speaker wires when they are bent upwards.

Fig. 8. Install the mounting screws—held in place with Tinnerman nuts, or tape—and then carefully fit the speaker over the screws. Snap down the grill and the installation is complete. A neat, professional job that looks like it came straight off the assembly line.

BATTERY MONITOR & CELL CONDITION TESTER

by Charles Green

Electro-chemical action guards against replacement costs.



PARTS LIST FOR BATTERY MONITOR & CELL CONDITION TESTER

B1—1.4-volt mercury cell, Eveready E640
D1—10-volt, ½-watt zener diode (1N758A or HEP Z0220 or equiv.)
J1, J2—binding posts; red, black
M1—1-mA DC meter
R1, R4—5,000-ohm miniature potentiometer
R2—470-ohm, 2-watt resistor
R3—2,700-ohm, ½-watt resistor
S1—spdt rotary or toggle switch
Misc.—plastic chassis box and panel 6 x 3½ x 1⅞-in. (approx.), perf board, push-in clips, plastic mechanical pencils and solder for test probes (see text), wire, etc.

ARE YOU ONE OF THE many who are servicing his own car? It pays to make sure that the battery is in good shape to prevent that slow, grinding start when you are in a big hurry. Just adding water at intervals isn't always enough to ensure that the battery will be in top condition when you need it.

With our expanded-scale battery tester you can make periodic tests of your battery to insure that the battery is in good shape. The tester is built in a compact plastic cabinet and includes easy-to-make special probes for the cell electrolytic tests as well as overall battery voltage tests. The construction of the tester is simplified for ease in building.

Tester Circuit. When S1 is set to the "single wet cell" position and voltage is at J1 and J2 (from the test leads), M1 will indicate only when the test voltage at J1 and J2 is higher in value than 1.4-volt battery B1. For example, if the test voltage is 1 volt (positive polarity at J1 and negative polarity connected to J2), the meter will not indicate since the B1 voltage is 1.4 volts. When the test voltage is 1.5 volts, there is a 0.1 volt difference over that of B1, and M1 will indicate a current flow (voltage) in the circuit. The 1.4-volt meter scale marking is equivalent to meter zero.

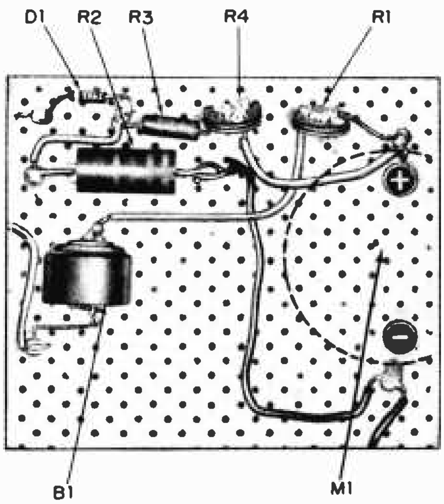
When S1 is set to the "six cell battery" position, zener diode D1 operates similarly to battery B1 in the other position. Since D1 is a 10-volt zener diode, a test voltage higher than 10 volts is required to allow M1 to indicate voltage.

Potentiometer R1 is the calibration pot for the *single wet cell* meter circuit, and R4 is the calibration adjustment for the *six cell battery circuit*. Series resistor R2 provides a minimum current flow through the zener so that it will operate properly.

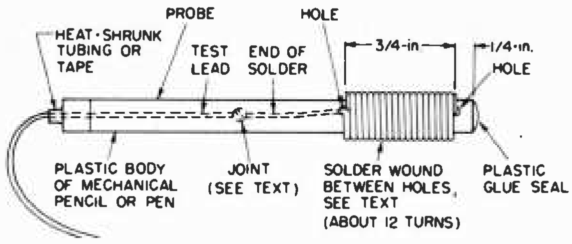
Construction. The Tester is built in a 6 x 3½ x ⅞-in. plastic box with a plastic panel. The box dimensions are not critical, and any convenient size can be used. To minimize possible electrical short circuit hazards, do not use a metal box. Most of the components, are installed with push-in clips on a 3 x 2½-in. perf board with remaining parts mounted on the box panel.

The best way to start construction is to cut out the M1 mounting hole in the panel and install the meter in approximately the same position shown in the panel photo. Then locate and mount S1, J1 and J2. Cut a section of perf board to size, and drill two holes to fit the M1 terminal screws to mount the board. Install the perf board to the meter terminals with two solder lugs supplied with the meter.

Mount the board components with push-in clips at the approximate locations shown in the board photo. Use short leads for best mechanical rigidity, and wire as shown in the schematic. Make sure that D1 and B1 are connected with the proper polarities as



Perf board showing components including location of meter as dashed line. Mercury cell battery will last its shelf life, which is generally two years for a fresh battery. Eliminate D1, R2, R3, R4, and S1 for a dunk-test only meter. 2-V is center scale.



Use the plastic body of a mechanical pencil or modify a set of old VOM leads. Either way, wrap 10 to 18 turns of "wire" solder around the end to serve as the electrolyte contact surface. Shrink tubing makes a neat job. Connect the wire lead and the solder together before trying to put the lead into the hole.

shown in the schematic. Carefully solder B1 to the push-in clips with a minimum of heat, or the mercury cell may be destroyed. If desired, you can use commercial mounting clips for the battery that do not require soldering.

Wire the remainder of the tester circuits and the panel components. Carefully check the wiring and make sure that M1 is connected with the proper polarity.

Test Probe. The tester requires special probes for the electrolyte test. As shown in the drawing, the probes are made from solder wrapped around the end of a plastic tube (we used a plastic body of a mechanical pencil and #18 60/40 rosin core solder).

Begin construction by selecting a pair of mechanical pencils with black and red plastic bodies for your test leads. Carefully cut off the metal pointed end of each pencil and remove the entire mechanical assembly from inside the pencil. Clean out the inside of the pencils so they are completely hollow and have no inside obstructions.

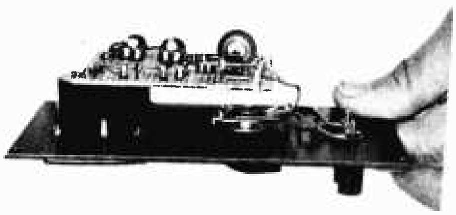
Drill two holes spaced ¾-in. apart approximately ¼-in. from the end of each pencil body, and wrap wire solder between the holes as shown. Insert the ends of the wire solder into the holes to hold the turns in place. The end of the wire solder in the hole toward the other end of the pencil body (the former eraser end) should be long enough to reach through the body end to be carefully soldered onto the test lead. Then carefully push the solder back into the plastic body with a portion of the test lead. Do not try to stretch the wire solder or use too much tension or the solder will break. Carefully insert short plastic sections into the body end to wedge the test lead in place and prevent it from being pulled out, then tape or use heat shrink plastic tubing on the lead end of both test probes. We used hot plastic from an electric glue gun to seal up the open end of the test prod and at the places where the solder is fed into the holes. Do not put any hot plastic over the solder turns.

Calibration. If you have a 1-mA meter for M1 of the same size scale as in our model, and the same type of zener diode specified, you can copy the photo of the meter scale and cement it over the meter scale of your meter. Set S1 to the *single wet cell* (2 volt) range and connect the tester to an exact source of 2 volts DC. Adjust R1 for an M1 indication of 2 volts (at center scale). Then set S1 to the *six cell battery* (12 volt) range. Adjust R4 for a 12-volt center scale indication with exactly 12-volts input to the tester. Make sure that you have connected the right polarity input for these calibration adjustments (J1 connected to positive (+) voltage and J2 connected to negative (−) voltage terminals).

For a more accurate meter calibration (and if you are using a different size 1 mA meter or a different type of 10-volt zener diode) you will need a calibrated variable voltage DC power supply or a DC supply with a potentiometer and a monitor voltmeter. Calibrate both ranges of the tester by adjusting R1 and R4 for midscale indications as in the previous (cemented meter scale) procedure, and then marking the meter scales in accordance with the calibrated DC power supply or the monitor voltmeter. Our model was calibrated from 1.4 to 2.6 volts on the 2-volt range of S1, and from 10 to 14 volts on the 12-volt range.

Operation. Automobile storage batteries consist of a number of 2-volt cells connected in series—three cells for a 6-volt battery and six cells for a 12-volt battery. As shown in the drawing, the tester probes are inserted into the electrolytic filler holes of a pair of *adjacent* (series-connected) cells so that the tester will indicate the voltage between the electrolytes in each cell. This voltage is approximately 2 volts, depending on the condition of the battery cells. The test will show the condition of *the positive plate* in one cell and *the negative plate* in the paired cell. By making tests of each pair of cells along the battery, the overall condition of the battery can be determined. Make sure that you observe proper test probe polarities.

If you are not sure which cell is the correct mate of another cell (since the arrangement of cells under the plastic top of the battery cannot be seen), momentarily place the probe into the electrolyte of a cell and quickly withdraw the probe if the meter (M1) swings sharply upscale, indicating overvoltage. The ¼-in. plastic section at the end of the probes should minimize the possibility of shorting out the cell between the plates, but use care in placing the probes into the battery holes; hold them in your hands—do not just drop them into the electrolyte while taking readings. Place the probes just far enough into the electrolyte to obtain an M1 indication. The probe electrodes may have slight tendency to polarize (act like little miniature storage batteries due to electrochemical action on the solder) and affect the meter indication. To prevent this, slightly agitate the probes in the electrolyte while testing.



Inside the meter. Mount perf board to meter using screws in meter terminals. Solder leads to battery B1 terminals directly or use a battery clip.

Test your storage battery at periodic intervals and note the cell readings. This will give you a performance record to check when you suspect that the battery may be defective. When a battery starts to go bad, it will show up as widely different voltages between cells (usually one cell will start to go bad before the others—not all the cells at once). For best results, make your periodic tests when the battery is in approximately the same electrical state of charge; the battery should be fully charged and have stabilized for some time before making tests. The probes should be washed and dried after each use to prevent corrosion from affecting the readings. The 12-volt scale of the tester can be used with a normal set of test probes to periodically check full battery voltage across the battery terminals. ■

the MOVING COIL

Build our accurate model of a moving coil meter and

LEARNING ELECTRONIC THEORY is dull, dull, dull. Right? Not necessarily. In some cases you can learn a lot and still have a lot of fun. How? Leave your theory textbook behind and build a current-measuring gadget that will allow you to see electronic theory in action.

Moving coil meters are used universally in all types of test instruments to measure DC current because they are highly sensitive, rugged and reliable, and relatively inexpensive. They may also be used to measure AC current by first rectifying the AC with a small meter rectifier.

Our project uses the moving coil principle in a simplified form of indicating meter. You can learn more about this form of meter by building our easy-to-construct project.

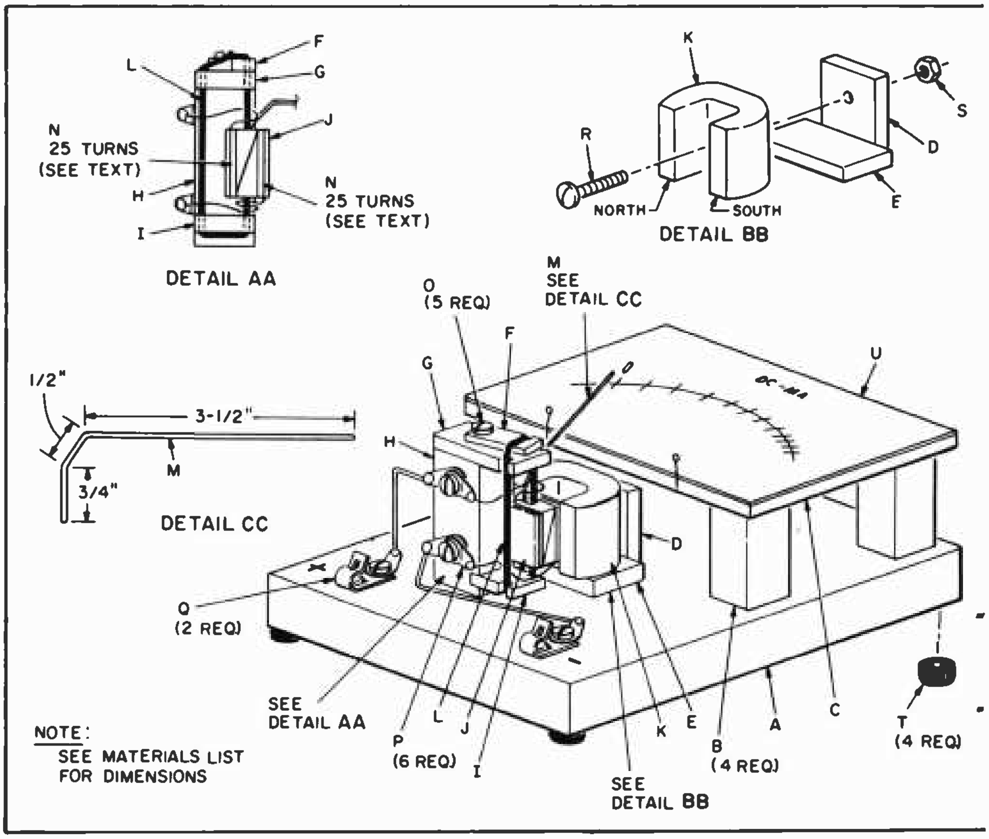
How It Works. The operation of the moving coil type of meter is based on the attraction between a permanent magnet and the magnetic field of a movable coil of fine wire. The coil is pivoted in the center of the space between the poles of the magnet, and has a return spring (to return the meter pointer to zero). This spring is usually of a spiral form in commercial meters, but our meter unit uses a rubberband coil suspension in place of both the pivot and spiral zero return spring.

When DC current flows through the coil, it produces a magnetic field that is attracted to the permanent magnet's magnetic field. This attraction imposes a turning force on the coil, that rotates the coil and moves the attached pointer over the meter scale. The amount of turning force is dependent on the amount of DC current flowing through the coil. The more DC current, the more the coil rotates. The meter is calibrated in DC current indications.

Construction. As can be observed from our photos and drawing, our model of a moving coil meter has been made in a very simplified form to facilitate construction. It's a taut-band moving coil instrument by virtue of the rubber band suspension of the moving coil assembly. We used wood for the various supporting structures because it's easier to work with and most everyone has the few hand tools required.

Size is relatively unimportant. However, we suggest you follow the dimensions and construction details given in the drawing and Parts List. In this way you should have no difficulty in making the meter and you won't have to fiddle with changing the number of turns of wire for the moving coil to compensate for a change in physical size.

You should cut out all of the various pieces of wood and sand them smooth before actually starting to assemble the meter. Mount rubber feet on the bottom four corners of the base (A) and then glue the 4 supports (B) to base (A), as shown in the pictorial drawing. Next cement the scale plat-



In this explicit exploded view, you can see in detail the more varied steps of the Moving Coil Meter assembly. To find the name of each part, refer to the Parts List.

METER

learn exactly how they work—by Charles Green, W6FFQ

form (C) to these supports. We used our electric glue gun, but epoxy cement, Elmer's glue. Pliobond, or similar adhesives can be used with equal success.

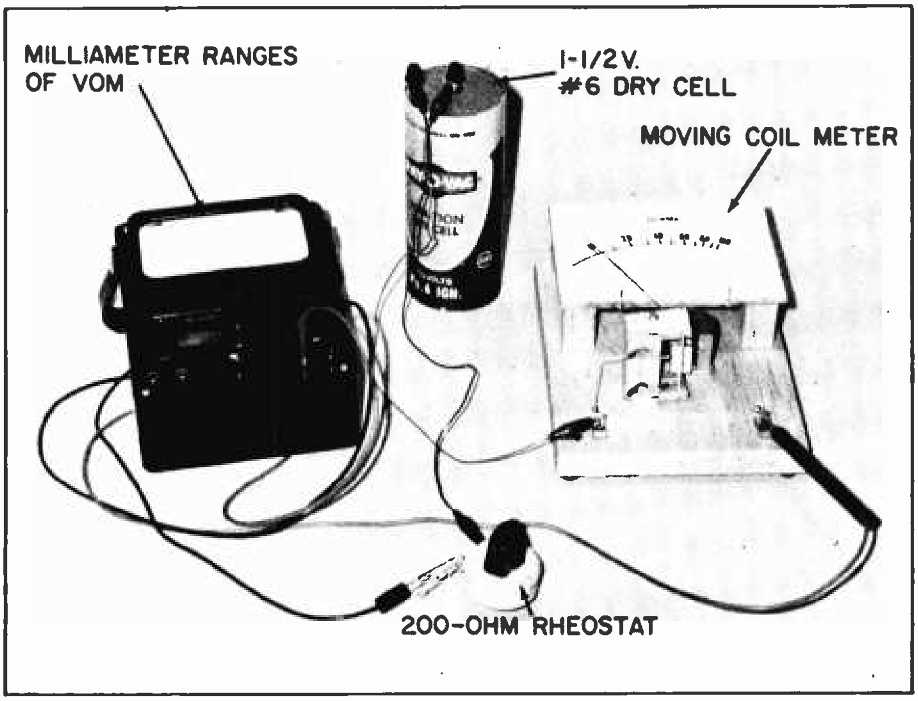
Now you're ready to cement the magnet and moving coil assembly supports to base (A). Pieces D, E, G, and I are made from ¼-inch plywood. First step is to cement D and E in their respective locations and fasten the magnet in place. The magnet used in our unit has a mounting hole. If the magnet you use isn't drilled at the bottom center of the *U* to allow a bolt to go through it to hold the magnet in place, it too can be cemented to D and E.

At this point the main support block (H) should be readied for cementing. But first you must notch it out so that piece I can be properly fastened to it. Hold H on the base (A) near piece E and mark H so that the top of the notch will be even with the top of E. The notch should be about ¼-inch deep. The best way to determine its depth is to hold piece G in position at the top of H and place piece I so that its notched end is even with the notched end of G. Mark the depth of the notch in block H based on the position of the end of piece I that will be inserted in the notch where its end is matched with piece G as mentioned above. Be sure that the notch in block H is cut square so that the surface o. piece I will be square with the surface of block H where I is cemented in place. The notches in the free ends of I and G are required only to hold the rubber band in position. Cement block H in position, and also piece G to block H as shown in drawing.

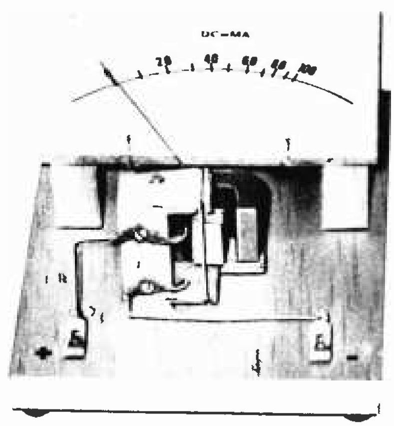
The form block J for the moving coil is made from balsa wood, which is lighter in weight than any other wood and therefore contributes to the sensitivity of the instrument. Cut a notch in the center of J as shown in our drawing. The rubber band (L) is cemented in this notch. We used a rubber band approximately 6¾ x ⅜ x 1/16 inch. The coil is made in two sections by winding 25 turns of #38 enameled magnet wire on one half of J and by repeating this winding process in the same direction on the other half of J. Put a touch of cement to the ends of each coil to hold the wire in place and have 6-inch lengths of the start and finish of the 2-section coil for future connection to it. Mount the coil assembly by stretching the rubber band over pieces G and I, centering it vertically within the height of the pole pieces of the magnet.

Now for a Pointer. Straighten out a 4¾-inch length of #18 gauge bare copper wire and then form it as shown in the drawing. The pointer is cemented into the notch in block J so that it rests near the O end (left side) of the scale platform. Piece F is used to make final O rest position adjustments after a scale has been cemented in position.

Fasten two double solder lugs to block H; these are intermediary connecting points for the two wires from the coil. Form a helix like a hairspring with each of these leads so that they will wind up as the coil assembly moves clockwise. Solder the end of the wire from the top helix to the top lugs and the bottom helix to the bottom lugs. Mount two Fahnestock clips or binding posts along the front edge of the meter baseboard and connect them to the solder lugs on H, using #18 solid base wire. Since meter polarity is determined

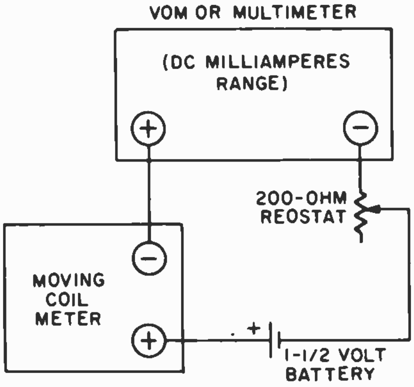


A volt-ohmmeter is very helpful in calibrating the Moving Coil Meter project. If you don't have a VOM handy, try a 0-100 mA milliameter in the same circuit.

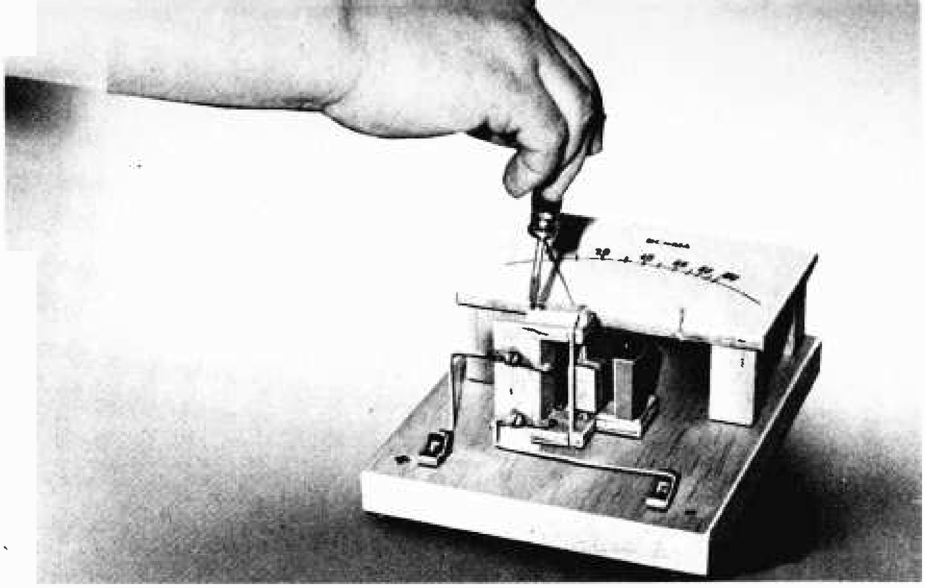


Here's how your finished MCM will look. Its innards are very similar to a bought meter.

MOVING COIL METER



Any 0-100 mA or higher milliameter will test your MCM just as well as a VOM or multimeter, provided its accuracy is fairly good.



To zero the pointer of your Moving Coil Meter project, all you need to do is loosen the screw as shown, and move the wooden block, thus repositioning the coil assembly.

by magnet polarity and the direction of current flow, established by how the coil is wound, the correct polarity markings of the meter should be determined when you calibrate the instrument.

Calibration. In order to calibrate this instrument, you'll need a potentiometer having roughly 20 ohms resistance, a 1½-volt battery and a DC milliammeter, preferably a multi-range one available as part of a VOM.

Now you are ready for the calibration scale that's mounted on the platform C made during the framework construction. The scale is drawn on a piece of heavy white paper (U) which will be cemented to the platform after the calibration marks have been drawn. (Rub-on numerals, such as Datak, make a neat scale.) Temporarily fasten this white paper (U) to platform C, draw an arc as shown in the photo and place a mark on the left-hand side for a zero reference point.

Connect a 1½-volt battery, a 200-ohm potentiometer (used as a rheostat) a multimeter set on DC milliamp ranges (or a milliammeter), and the moving coil meter you have just built, as shown in the calibration diagram.

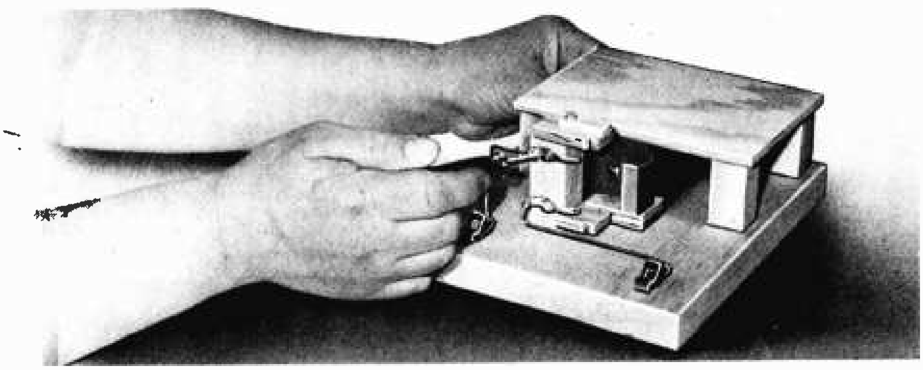
Set the potentiometer for maximum resistance and at the start use the highest milliamp range of the multimeter. If the pointer on your moving coil meter deflects to the left, below the established O point, reverse connections to it and then mark the binding posts + and —. Use the connection diagram to determine their polarity markings after connecting the meter so that the pointer moves to the right.

Slowly turn potentiometer to reduce resistance in the circuit and note the readings of the multimeter milliamp range selected. Mark your moving coil meter with the same readings shown on the milliammeter. We divided the 0-100 scale into 10 mA divisions. In the manufacture of DC moving coil meters spring tensions, spacing and coil weight are carefully controlled so that these meters are linear. For this reason commercial milliammeters have uniform spacing between divisions. Our moving coil meter doesn't have such uniformity because of the variations in the rubber band used for suspension and tension, and because it's difficult to maintain accuracy of positioning the various pieces and to be assured of the strength of magnetic field developed by the magnet. Once you have established the calibration points they can be considered accurate.

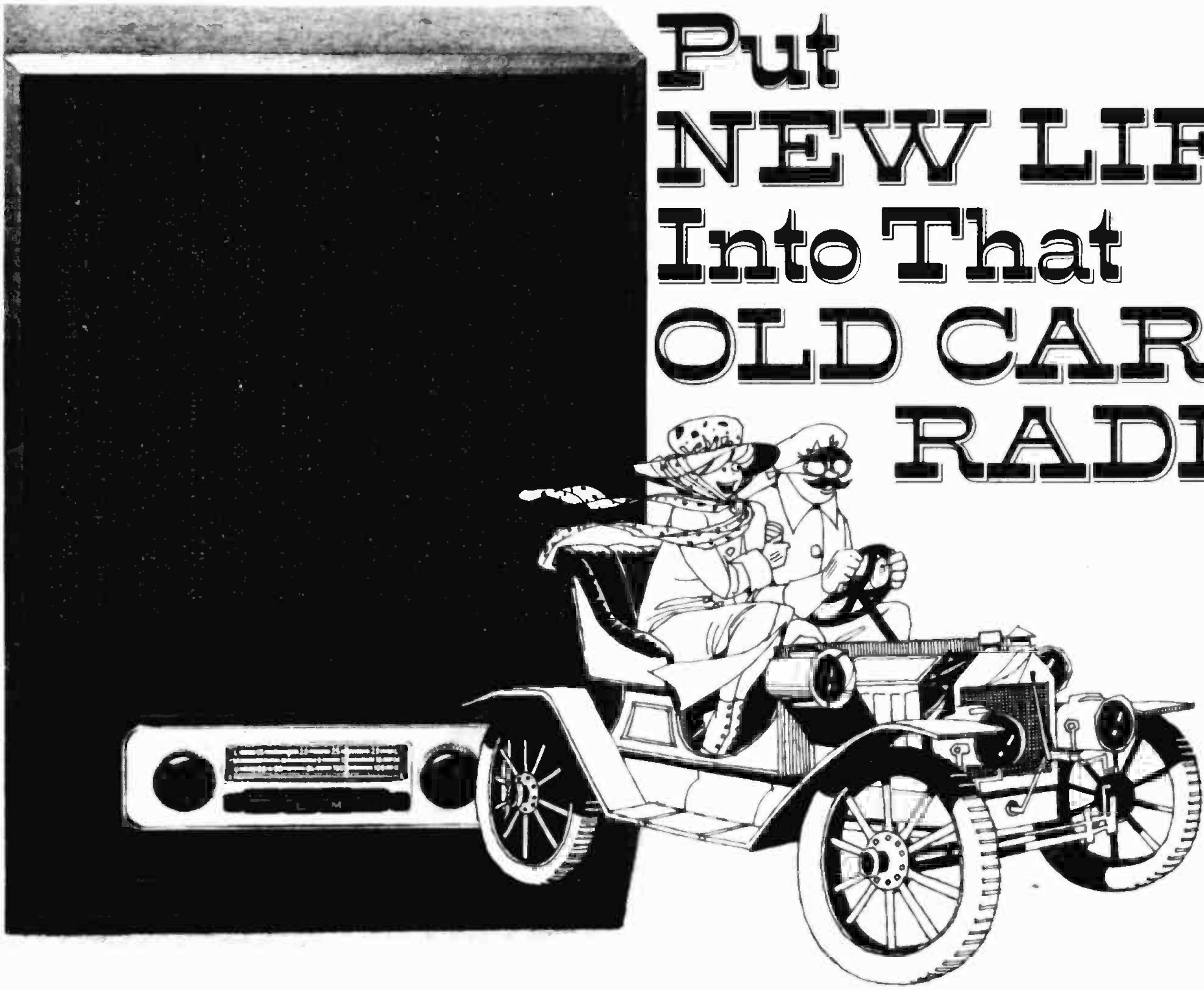
Now that you have marked the scale in pencil you can remove it from the platform and apply the permanent markings. Permanently fasten the scale in position and stand back to admire your work. If you used reasonable care in following the instructions, you'll have good reason to be proud of your handiwork. ■

PARTS LIST FOR MOVING COIL METER

A—6 x 7 x ¾-inch white pine
B—¾-inch square x 1½-inch white pine (4 required)
C—4 x 5 x ¼-inch plywood
D—1¼ x 1 x ¼-inch plywood (see text)
E—1¾ x 1 x ⅜-inch plywood
F—⅜ x 1 x 3/16-inch white pine with end notch
G—¾ x 1½ x ¼-inch plywood with end notches
H—¾-inch square x 2-inch white pine (see text)
I—¾ x ⅞ x ¼-inch plywood with end notches
J—½-inch square x ¾-inch balsa wood with slot
K—Alnico magnet
L—Rubberband (see text)
M—Meter pointer (#18 copper wire—see text)
N—50 turns #38 enameled magnet wire (see text)
O—Five #4 x ½-inch wood or sheet metal screws
P—Solder lugs (6 required)
Q—Fahnestock clips (2 required)
R, S—8-32 x 1 or 1¼-inch machine screw and nut
T—4 rubber bumpers
U—4 x 5½-inch heavy white paper for meter scale
Misc.—Hookup wire, 200-ohm rheostat, 1½-V. battery, VOM or DC milliameter



Assembling this moving coil meter is an excellent project for anyone who is handy with tools—and it teaches you how instrument (panel) meters work to measure voltage, as well as current in most electronic circuits.



Put NEW LIFE Into That OLD CAR RADIO

With a loudspeaker and a simple power supply your old car radio will become a high-quality home receiver. Good for DXing, too.

by Gary McClellan

☐ For years now Americans have bought 10 million or so new cars every year, and most of those cars have radios in them when new. As a result millions of used cars are sold by their original owners each year. Now the price a car dealer will pay, or allow you on a used car is a combination of the so-called "book" value, which he gets from a little blue book, and of the bargaining. He doesn't care whether your used car has a radio or not, and many people, knowing this, take out the car radio before trading in the old bus on a new one. The result is that there are hundreds of thousands of used car radios lying around in garages, attics and cellar storehouses, waiting to be thrown out some year in the annual spring cleaning.

Most of these radios are perfectly good, but won't be used because it's usually too much trouble to install them in a car other than the one they were originally set up for.

But there's no reason such sets can't be put to work as house radios, especially since they will almost always work better than most table model radios, and even most console sets you can buy today. Their tone is as good or better than most home sets—obviously we're not comparing them with high fidelity component sets, which cost many times more than regular table or console radios. Their selectivity and sensitivity is also better than that of most home sets because they have an RF (radio frequency) amplifier stage ahead of the converter stage, and most home sets don't bother with an RF amplifier stage which car sets need.

Going for AM DX? DX fans can have a ball with converted car radios. The sensitivity and selectivity of most car sets, when combined with a good outside antenna can get you AM stations from all over the country. Here in California I've been able to get stations like KOMA, Oklahoma City, WLS Chicago, and many others regularly, at night. For more on AM DXing see ELEMENTARY ELECTRONICS Sept./Oct. 1976 "The Secrets of Split-Frequency DX." White's Radio Log, regularly published in our sister publication, COMMUNICATIONS WORLD, is an excellent source of info on the super DXing you can do on AM radio.

Car Radios Are Better. The typical car radio was built to perform in one of the toughest environments—your car. The set has to work with a ridiculously small antenna, and yet get distant stations. It also must have enough volume to overcome road noise and tone quality to offset the shortcomings of the small, poorly baffled speakers found in most cars. And to top it off, the car radio must perform well over a wide temperature range.

Conversion is easy and inexpensive.

NEW LIFE

All you have to do is add a power supply, antenna, and a good speaker to a car set and you are in business! So if you have an old car radio, or know where you can get one, don't pass it up. You won't know how good radio can be until you convert a car set to home use.

First Get Your Radio. What car radios are best for conversion? Just about any old car radio can be converted to home use, provided it's a *transistor set*. Tube sets will be too old, and more important to us, they use much too much current (to heat up the tube filaments) to be practical for conversion to home use.

You can use an AM-only set, or an FM/AM set. If it's a really recent car radio it may be one which has a four- or eight-track tape player built in, and with a stereo radio section. If it has a tape player you'll have to use a heavier power supply than if it's just a radio receiver, but that's the only other restrictions (besides no tube sets).

Of course the car radio should be a 12-volt unit. 6-volt car radios haven't been made for quite a while, though it's possible you might happen across one. And don't convert one of those fancy car radios which has "signal seeking" (sometimes called "Wonder Bar," because you just touch a little bar to activate it). These sets have a motor inside the set to drive the tuning mechanism and the tuning dial. The motor draws several amperes of current, and would require a heavy power supply costing much too much. In addition, these automatic-tuning units are likely to get out of whack, and they're not easy to repair. In fact many car radios have been consigned to the junk box just because the auto tune failed and it was too expensive to repair.

And another thing. Try to use a radio which has all its knobs and the dial plate. It'll save you the trouble of scrounging around to find matching knobs and a dial escutcheon plate later. However, if you happen to already have a good car radio—for example, one with separate bass and treble tone controls, don't let the absence of knobs hold you back. They *are* available at some specialized stores. And you *can* make up a new escutcheon plate from a piece of scrap aluminum.

Check It Out First. Before you convert the car radio to home operation, be sure it's working OK, or is worth repairing. To do this make up an antenna as shown in the diagram, and connect it and a speaker (just about any speaker will do) and a power supply to the radio as shown.

Hook up a 12-volt battery or battery eliminator to the radio, being careful to hook the positive (red) side, usually marked +, to the "hot" lead of the radio. The negative (ground, or common) nearly always goes to the case of the radio. Check the markings first to be sure.

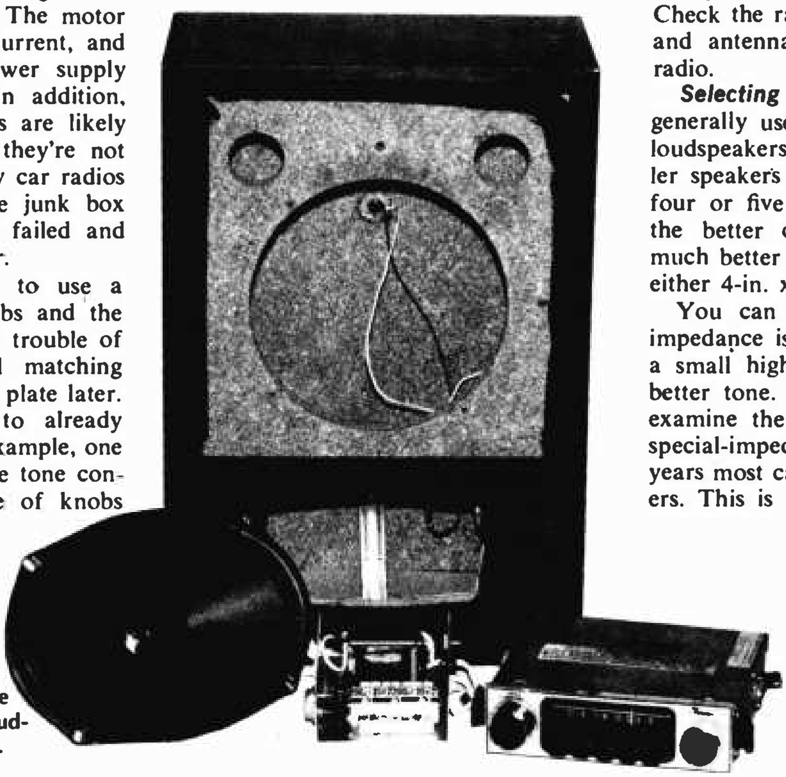
Adjust the antenna trimmer capacitor to get maximum sensitivity. This is done by setting the tuning dial to a weak station around the high end of the dial (1400 kHz is ideal) and adjusting trimmer C2 for maximum volume. The setting of C2 will be different when you connect the final antenna to the set, later. Measure the current drawn by the radio. Most solid state sets draw ½ amp or less—if it draws much more than this we suggest you use a commercial power supply such as those made for CB radios and tape players. Almost any store-bought power supply will work fine in most cases. Make sure that the radio works properly. Clean it off and wipe the dial glass clean. Spray the volume/tone controls with a good control cleaner, and remove the dial lamp. This will save power and allow the power supply to run cooler.

Making the Conversion. Start by building the power supply shown unless you buy one. If you use the commercial power pack mentioned, skip this section. I built my supply on a 4-in. x 3½-in. piece of U-shaped aluminum. The components, with the exception of transformer T1 are all mounted on the sides of the "U", which are about 1½-in. high. You can build yours in the same way, or mount the parts in a commercial chassis instead. Or you can mount the power supply on the top or back of the radio. But just be sure if you do this that you can install the radio in a cabinet. Install the components and wire them up, being careful of the connections of IC1, a voltage regulator. The case is ground so you don't have to isolate the case from the chassis. When you complete the component wiring, add leads at least three feet long so that the power supply may be easily attached to the radio.

You have an option at this point as to how you connect the AC power switch. You may use a separate unit as I did with the second radio shown, or open up the set and use the existing switch. If you choose this method, be sure to carefully remove the existing wires and solder them together. Then connect the AC wires from the power supply. Connect up the ground and 12-volt positive wires to complete the job. Check the radio out again with speaker and antenna. If all's well, install the radio.

Selecting a Loudspeaker. You can generally use any of a wide variety of loudspeakers with a car radio. The smaller speakers supplied with car sets are four or five inches in diameter, while the better ones, which usually have much better tone, are oval-shaped units either 4-in. x 6-in., or 6-in. x 9-in.

You can use one of these, if the impedance is correct, or you can go to a small high fidelity speaker for even better tone. First you should carefully examine the radio to see if it uses a special-impedance speaker. For many years most car sets used 3.2-ohm speakers. This is the nominal value if there



Car radios may be converted for home use using any convenient enclosure, a simple power supply, and a better loudspeaker, as shown at the right.

is no special indication. Many of today's sets use higher impedances, however, such as 10, 20, or even 40 ohms. If the set you're converting is so marked, you can use any one of the multi-impedance speakers listed in the Parts List. If it's not specially marked, use any speaker of 3.2, 4, or 8 ohms. Choose the largest speaker, with the heaviest magnet (and costing the most, generally) for the best tone.

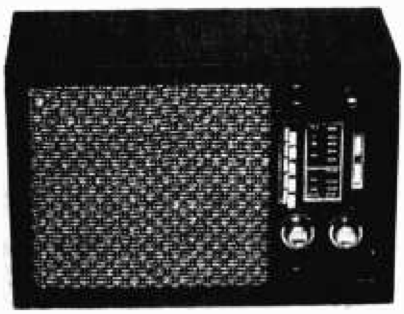
Installation. This is where you get to exercise your creative talents. There are many different places you can mount your converted car radio. You can go my route and install it in a speaker cabinet. This worked great because reject cabinets were available from a local speaker company for $1.00 each. I installed both radios in reject cabinets. I bought speakers to match the cut-outs (8 inches in both cases). Then I added grille cloth to cover the speaker area and installed it. If you do this you will find the going very easy as most of the work has been done for you by the cabinet manufacturer.

Some other places you can put your radio are in a room divider or end table. Or how about the wall in your kitchen? What about under a shelf in a cabinet? The choice is up to you. If you have room for the radio only, you can locate the speaker somewhere else.

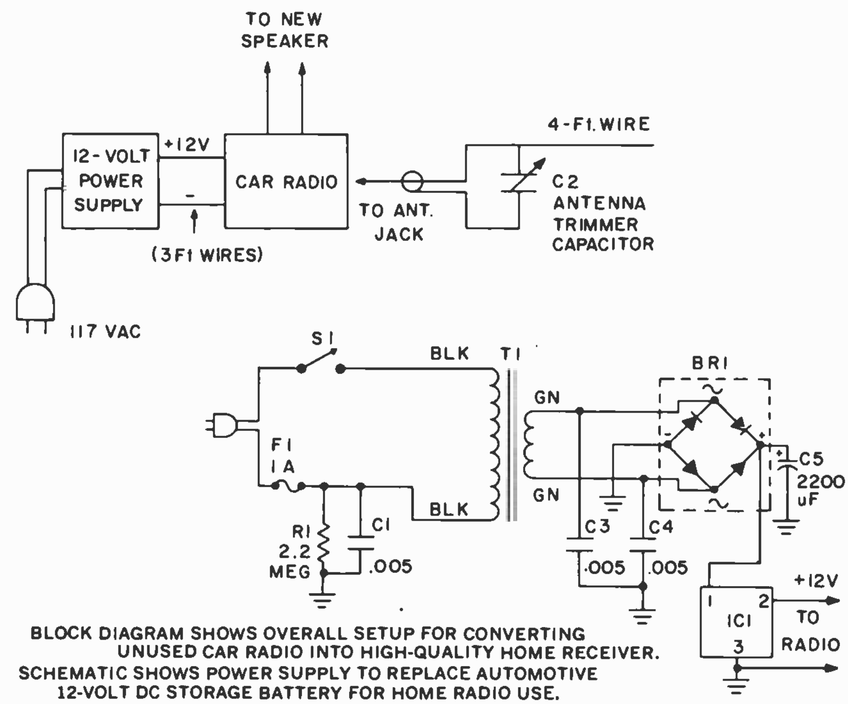
Operation. After you have installed the radio, power supply, and speaker, connect the antenna. Place C2 in a convenient spot where you can get at it. Then turn on the radio and tune in a weak station around 1400 KHz on the dial. Adjust C2 for maximum volume. The antenna lead may be stapled around the back of the cabinet. If you've converted an AM/FM set you might wind several turns of the antenna around the AC cord for better reception. The lead may also have to be carefully positioned for best results on FM. This was necessary for the two radios that are seen here. That's all there's to it! Sit back and enjoy your new radio. You'll be amazed at the performance; it will far outstrip the radio receivers you buy in the drugstores, and the AM sections of all but the best stereo sets, too!

If You Don't Have A Car Radio. If you don't have one, a good place to get car radios is from junk yards and used car dealers. Better yet, check out flea markets, garage sales, and other similar places. You'll generally be able to bargain and get a set for a lower price from the former sources. You shouldn't have to pay over $10.00 for a set. You might get a radio that needs repairs and cut the price even farther. I bought several broken radios for fifty cents each, fixed them, converted them and gave them away as gifts! ■

Another loudspeaker cabinet (cost: $1.00!) houses this converted car radio. Sounds great!



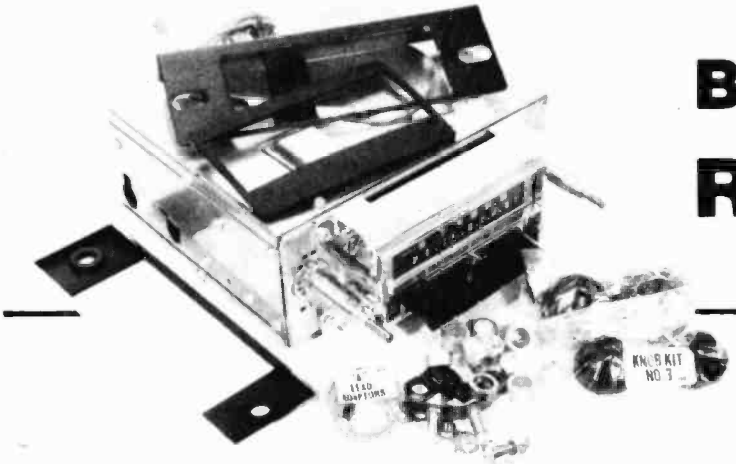
Out of a VW and into a reject speaker cabinet goes this car radio. AM, FM, and short-wave.



BLOCK DIAGRAM SHOWS OVERALL SETUP FOR CONVERTING UNUSED CAR RADIO INTO HIGH-QUALITY HOME RECEIVER. SCHEMATIC SHOWS POWER SUPPLY TO REPLACE AUTOMOTIVE 12-VOLT DC STORAGE BATTERY FOR HOME RADIO USE.

CONVERSION PARTS LIST FOR CAR RADIO

BR1—6-ampere, 50-volts AC or better bridge rectifier.
C1, 3, 4—0.005-uF, 600-volts or better capacitor.
C2—365-500-pF (maximum) trimmer capacitor.
C5—2200-uF, 35-VDC or better electrolytic capacitor.
F1—1-ampere fuse.
IC1—Voltage regulator chip.
R1—2.200,000-ohm ½-watt resistor.
S1—SPST switch.
T1—Power transformer, 117 VAC primary, 12.6-volt, 1.2-amp.
Loudspeakers—Oval car speakers, 4-in. x 6-in. or 6-in. x 9-in. multi-impedance units, 10, 20, 40 ohms, if required—see text.
Misc.—Fuse holder, AC line cord and plug, car radio antenna plug obtainable at radio parts suppliers).



Budget installs a...

RADIO/CASSETTE

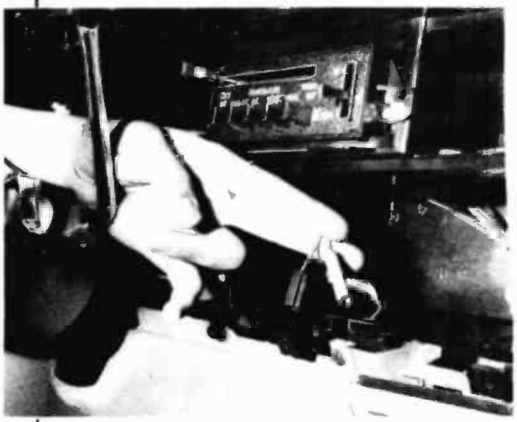
In-dash installation can save

THERE ARE TWO MAJOR WAYS you can save from $100 to $200 by simply installing your auto radio or tape player in the dash so it becomes an integral part of the car, van, or RV. The first way you save money on an in-dash mount is through your insurance. If you've read the latest rider your auto insurance company has buried deep within the incomprehensible legalese that explains the wherebys and wherefores, it is more than likely that equipment for the recording and reproduction of sound aren't covered against theft unless they are a permanent part of the vehicle. As many stereophiles discover after the theft, some insurance companies don't consider four sheet metal screws that secure a mobile bracket to the dash as a "permanent part of the vehicle." But there's no question that a tape player, radio, FM stero, or radio/tape player is *permanent* if it is mounted in-dash.

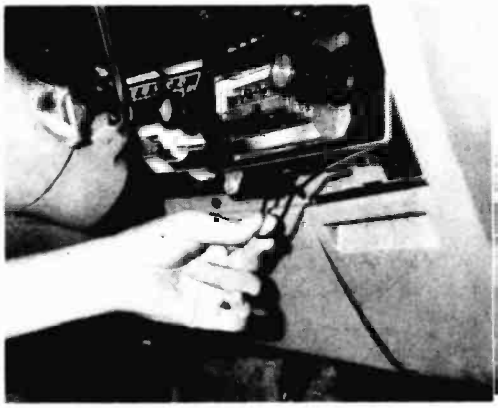
To Save More Money. The way to save even more money—often even up to $200 or more—is to do your own installation at the time you purchase a new car or van. Just look at some typical figures for a new car. An ordinary AM radio costs from $60 to $90 depending on the particular car and dealer. An AM/FM radio runs from about $109 to $190. An AM/FM stereo installation runs upwards from $200, and if you want AM/FM stereo with 8-track or cassette tape you first have to find a car for which the manufacturer will provide the equipment (many won't sell tape players for their smaller, lower priced cars), and then figure $300 or more. Then you must hope he provides the right radio/tape combination. One of the major manufacturers supplies only radio/8-track; if you want cassette you're out of luck.

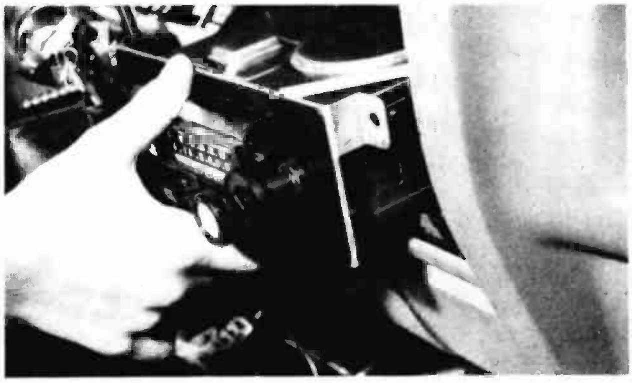
But if you're willing to spend three or four hours doing your own in-dash installation you can save quite a bundle over the new car prices, as well as having exactly the equipment you want.

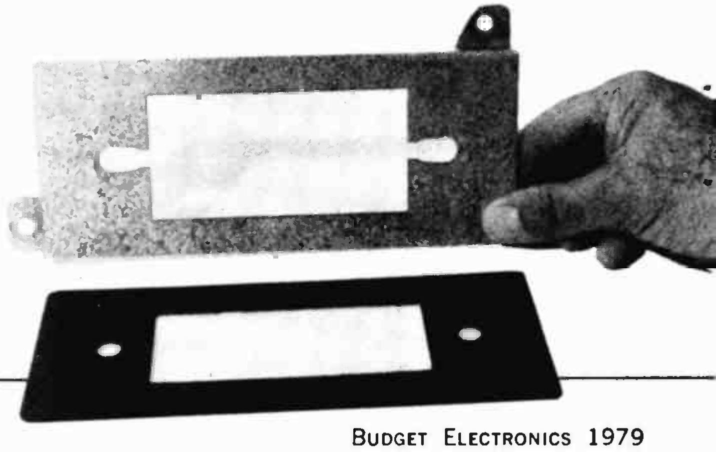
For example, figuring in good quality speakers worth about $12 each, and talking about the highest quality auto equipment, an AM radio will cost you about $40, an AM/FM radio installation will run around $60, AM/FM stereo will be about $90 (don't forget you need two speakers), an AM/FM Stereo/8-Track will cost about $120,



The "hot (+12 VDC) lead from the car's electrical system is usually red. At left you can see it and the ground lead which hook onto back of player. Lower left shows the unit sliding into place after removal of dashboard plate. Faceplate (lower right) fits over metal supporting plate (bracket). At right is shown separate ground wire which goes to chassis of car. Plastic dash hardware prevents many sets from being automatically grounded as they used to be in the good old days (when cars were all 6 volts DC).







PLAYER IN-DASH

you money two ways.

and an AM/FM Stereo/Cassette will run a little higher, about $140, again including two excellent quality loudspeakers.

Now any way you look at it, those are big savings, often more than enough so you can get a deluxe combination unit instead of an ordinary AM radio. But, you must do the installation yourself to get so much sound and so many features for so little money.

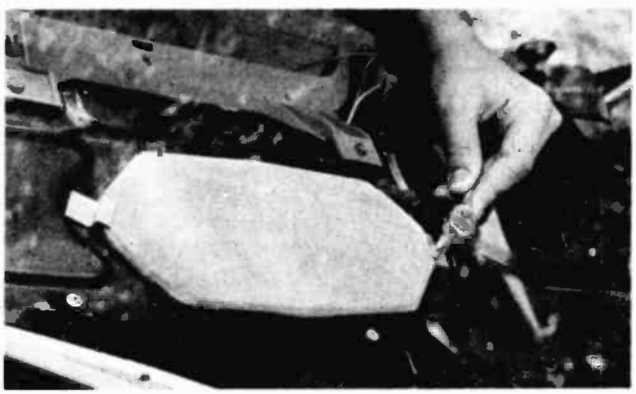
Easier Than It Looks. At first glance, substituting a tape or combination player for the existing car radio, or starting from scratch with all-new in-dash equipment, might appear formidable, and in the old days it was one hell of a job. Often, at the very least the glove box had to be removed, also part of the ductwork if your car had an air conditioner. But most manufacturers can no longer tie up their assembly line for a radio installation, nor can they make it extremely difficult for their dealer to do an after-sale installation, so you'll find many dashboards literally come apart for easy installation. You just have to locate the few, usually concealed, screws that hold everything together.

All American cars are pre-cut for radio. Either the dash is pre-punched for a *rear mount* radio, that is, the radio slides in from behind the dash, or there is a concealed cut-out that permits the radio to slide in from the front. A trim plate usually conceals either opening. If the car is designed for a behind-the-dash installation there is generally enough room so you can reach up and install a speaker behind the top of the dash. The radio simply slips into its cutout from the rear. Almost all radios and many tape players have a common size bezel so you have your choice of almost anything you want from at least two handfuls of brands—many you never heard of. Most of the better quality brands such as Audiovox and Automatic Electric have controls with adjustable shafts so you can match almost all radio cutout openings. And all of the better equipment comes with an extra trim plate, so your installation looks like a factory job when you're finished. The popular Radio Shack AM/FM Stereo/Cassette unit with *Fast Forward* and *Reverse* (almost unheard-of-features in combination units) has a universal mount and trimplate.

How To Front Mount. Front mounting takes a bit more trouble if you're starting from scratch because an adaptor plate is required. Also, no two front-installation cars or vans are alike, and your in-dash radio kit requires a lot of special bits and pieces so you can customize your particular installation.

The photographs show how easy it is to install an in-dash radio/tape player. Though a front mount installation is shown, many of the installation

Antenna installation is a snap if you have a Greenlee punch to make the single hole required for most aerials. At right is a standard antenna mounted on typical ball swivel. Lower right shows pre-cut speaker hole (6 x 9-inches) which is generally found (two of 'em) in rear deck. There's often one of these under decorative trim in the front also. Put a ladies stocking over speaker to keep dirt out. At right the set has been installed and the final trim is being replaced and secured. At left is typical oval car speaker.



procedures apply to rear mount equipment also.

Perhaps your most formidable problem will be the speaker. Many smaller cars make no provision for front stereo; the dash has a factory opening for only one (mono) speaker. There is often room for stereo speakers on the rear deck. But just because the dash has room for only one speaker is no reason you can't have a stereo radio or tape player. Just use one of the Radio Shack dual voice coil speakers. As shown in the photographs, these speakers have two independent voice coil connections. If you connect one set of terminals to the radio's right output, and the remaining terminals to the left output, you will hear the full mono equivalent of the stereo output. And you can still feed stereo to two rear speakers.

As you can see from the illustration, the speaker in this car mounts from the top of the dash after the dash cover is removed. To prevent small objects from settling into the speaker and rattling, slip a lady's *Ped* (about 55-cents) over the speaker(s) before installation. A section cut from an old pantyhose or stocking can also be used. Solder the connecting wires to the speaker terminals before mounting the speaker.

Antenna Installation. Next, install the antenna and route the wire all the way to the radio's location. Many cars have a pre-drilled fender hole for the antenna. Others you can cut with 1⅛-inch chassis punch (some antennas require other holes sizes). All standard AM and AM/FM antennas install from the top, and have some form of universal or 8-ball mount that allows the antenna to be vertical regardless of the slope of the fender. Most vehicles have a rubber grommet for the antenna cable somewhere behind the fender; just pierce the grommet with a knife and feed the cable through.

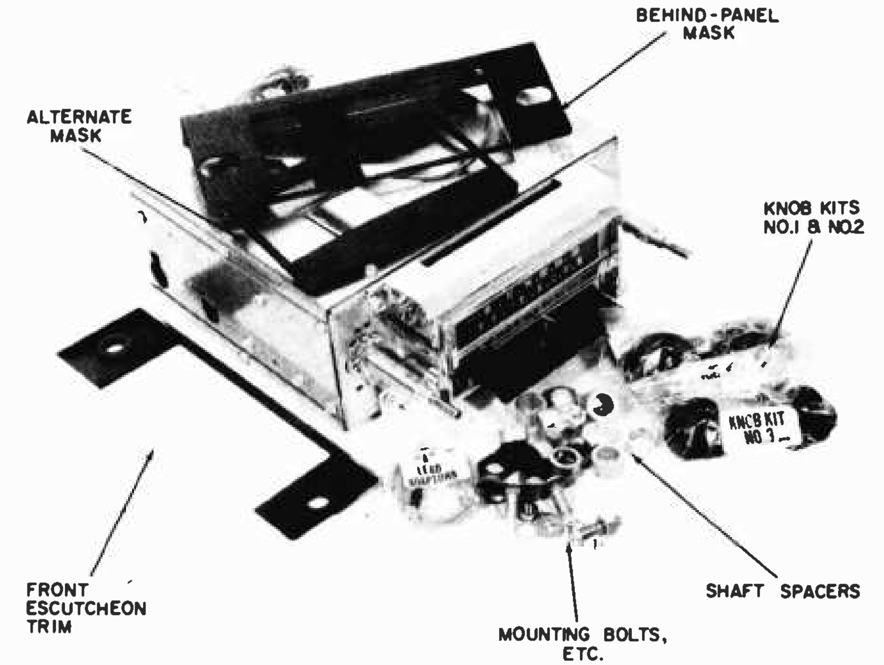
Okay, you have the speaker(s) and antenna in place, now you're ready for the radio/tape player. If your vehicle already has a radio simply remove it and install the new model. If it doesn't have a radio and it's a front mount you've found a gaping hole behind the trimplate. You need an adaptor kit.

In the adaptor kit you'll find a mounting plate, screws and if needed, a new trimplate. Secure the radio/player to the mounting plate, or the mounting and trim plates if that's the way they go into your car. If you have a better quality in-dash unit it comes with male and female connectors on all the connecting leads, and matching connectors are supplied for splicing into the speaker wires. Apply all the splice connectors first, then connect the wires all together. You'll find most cars are already prewired for a radio power connection, and the connector is floating behind the dash somewhere near the radio cutout. If your vehicle isn't pre-wired simply pick up the (12-volts positive) radio power terminal at the fuse block. (Audiovox in-dash units come with an assortment of connectors to match virtually any make or model.)

Because many cars now have plastic dashboards make certain you connect a well-grounded wire to one of the screws on the radio/player.

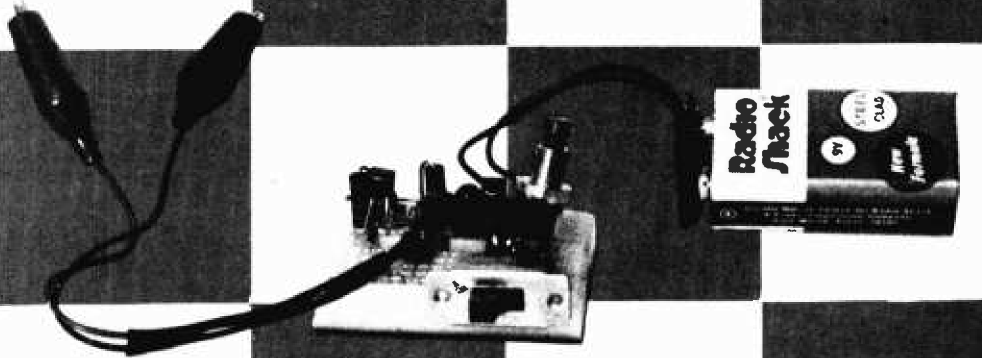
Plug in the antenna connector and then slide the unit into the cutout, taking care that no wires are crimped behind the radio. Secure the adaptor mounting plate with the supplied screws (never substitute adaptor screws) and then secure the ground wire under a dashboard screw you are certain connects to the metal vehicle body. (Use a meter to test for continuity to be sure.) Finally, apply the dash trim, or the radio's trimplate, and your installation is completed. If you have rear speakers install a front/rear fader in any convenient location so you can control the sound levels in the front and rear of the car independently.

Final Steps. If you've installed a radio your final step is to trim the antenna tuning for maximum AM sensitivity. On an AM-only radio the trimmer screw might be on the side, in which case you'll have to make the adjustment before the radio is installed in the cutout. On almost all AM/FM sets, and all radio/tape players, the trimmer is accessible from the front, usually behind one of the knobs, or inside the tape slot. To adjust the trimmer, tune in an AM station on the high end of the dial, preferably a very weak signal. If you cannot get any very weak signals try in the late evening hours. Adjust the trimmer screw for maximum signal strength—the loudest possible volume. That's the one and only adjustment as there is no adjustment for FM reception or tape. Many tape units have an accessible *azimuth* adjustment. Take care not to adjust this screw. Normally, there is a label warning the azimuth is a factory or service adjustment, but labels do fall off. If your home recorded cassettes and 8-tracks don't track properly check the auto player with a commercial pre-recorded tape. If the pre-recorded tape tracks properly the auto player is okay, it's your recording equipment that's out of alignment with the auto unit. If the pre-recorded tape doesn't track the player needs an azimuth adjustment—let a serviceman do the job under the unit's waranty. ■



If your radio/cassette player is mounted in-dash you can benefit in many ways for just a little effort. First of all, your insurance costs are lower for a permanent installation. Then, an in-dash player is just nicer appearing than under the dash.

BUILD CHECKERBOARD FOR QUICK TESTING



A handful of parts plugged into solderless breadboard make a tester for crystals, diodes, LEDs and lots more.

by Martin Weinstein

☐ I built a crystal tester several years ago and had an accident. Two of the connections were accidentally shorted together when I soldered the parts together. As a result, I soon discovered that my crystal tester was also good as a diode tester, a LED tester, a continuity tester, an electrolytic tester and more.

Now *that's* what I call a *happy accident!*

The whole circuit was built onto a scrap of printed circuit board and mounted in a small plastic box. I've used it for years, and it's come in handy dozens of times. Recently, while chatting with a couple of ELECTRONICS HOBBYIST editors it occurred to us that some of you might enjoy this handy little gadget. So I rebuilt it one evening on a small, inexpensive solderless breadboard. And now I can pass the secrets of this marvelous little *Checker Board* on to you.

What It Can Do. Checker Board started out as a crystal tester, with the desired action that a good crystal lights the LED and that a bad crystal won't. You can also use it to check out so many other components with just as simple an indication. These are some of the things you can test with your Checker Board: lamps, switches, diodes, LEDs, cables, capacitors, crystals, printed circuit traces, connectors and more. You can even use Checker Board to test itself!

How It Works, Part One. Transistor Q1 and the parts near it, R1, R2, C1, and C2, work together with the crystal you connect into the circuit as a simple crystal oscillator. Without a good crystal, the circuit will not oscillate. When it does oscillate, a signal appears at the emitter of Q1.

Capacitor C3 passes this signal to diodes D1 and D2, which are connected as a rectifier. They convert the signal (which is a high-frequency AC signal, at the frequency of the crystal) to a bumpy DC signal. C4 smoothes out most of the bumps. As result, the signal that leaves Q1 arrives at Q2 as a small DC voltage. Q2 then acts as a switch. When the DC voltage appears at its base, it completes the circuit from the battery and switch, through R3 and the LED, to ground. When this happens, the LED turns on.

With no signal coming out of Q1, no voltage appears at the base of Q2 so it doesn't turn on, and neither does the LED. R3 limits the current that can go through the LED to keep it from burning out and to help give it a very long life. It also lengthens Checker Board's battery's life.

And that's how Checker Board checks crystals.

How It Works, Part Two. Take a good look at R4. It acts as a kind of cheater, connecting the cathode end of the LED to the red clip. So, when there's no crystal in the circuit, R3, R4 and D3 are the only parts of the circuit actually connected to the clips, the switch and the battery. The equivalent circuit is shown nearby. As you can see, whatever you connect to the alligator clips then completes the circuit to light the LED. The purpose of R4, here, is to keep this mode of operation from interfering with Checker Board's performance as a crystal tester, since that's why we built it.

Building Checker Board. Use any construction technique you feel comfortable with. Nothing is very critical, and you can try lots of other values for any given component and still have a Checker Board that works.

The Checker Board you see here was built on a small solderless breadboard from AP Products. It's fully described in the Parts List. You can use any size wire from #20 to #28 to make the connections between terminals, and most components' leads plug right in.

You can help the switches, battery leads and alligator clip leads plug right in, too, if you use AP Headers. They're small contact posts embedded in a plastic strip at precise 1/10-inch intervals, so they can plug right into the breadboard. Just break off the number of posts you need from the rest of the strip, solder your connection to the short end and plug the long end into the breadboard.

I used small U-shaped pieces of bare wire plugged into several holes in a row to form a contact pad area, connected to each clip lead. This makes testing larger components as easy as touching

CHECKERBOARD

their leads to the bare wires.

You can use either a momentary switch, like a pushbutton, or any spst switch, or both for S1. It depends on whether you prefer on-off or push-to-test operation.

If you have trouble relating the schematic to the solderless breadboard, it should clear up quickly once you understand how the solderless breadboard is arranged.

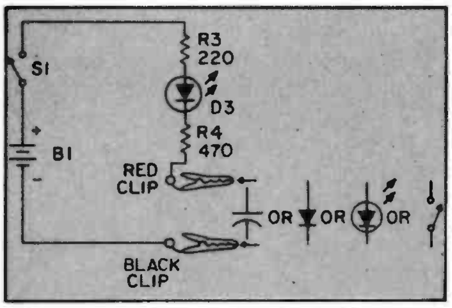
There are 17 rows of five holes each on each side of the center of the breadboard, a total of 34 rows in all. Underneath each row of five holes is a connecting spring clip. The clip holds onto whatever lead you push through the hole. And all the leads you've inserted in any one row (on each side of center, independently) are connected together.

In other words, there are 34 places where you can tie up to 5 leads together, 17 on each side of the center.

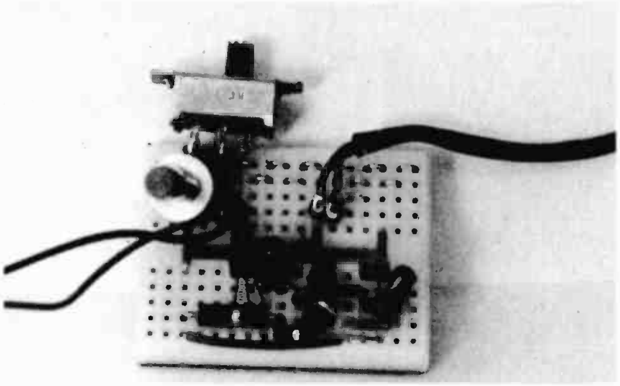
Once you know that, you can custom-design a circuit in just a few minutes, working directly from your idea onto one of these breadboards. Or you can translate a circuit like Checker Board into a solderless breadboard layout very, very quickly indeed. You can solder switches and cable leads to headers, like these from AP products, and plug them right into either solderless breadboards or female headers, the darker strips near the center of the photo. Headers come in rows of 36 contact posts, and either cut or can be broken to length. A single row of male headers, widely available, costs less than a dollar.

Using Checker Board. Follow the instructions below as you test each component. Generally, components can either be clipped-to with the alligator clips, plugged directly into the solder-

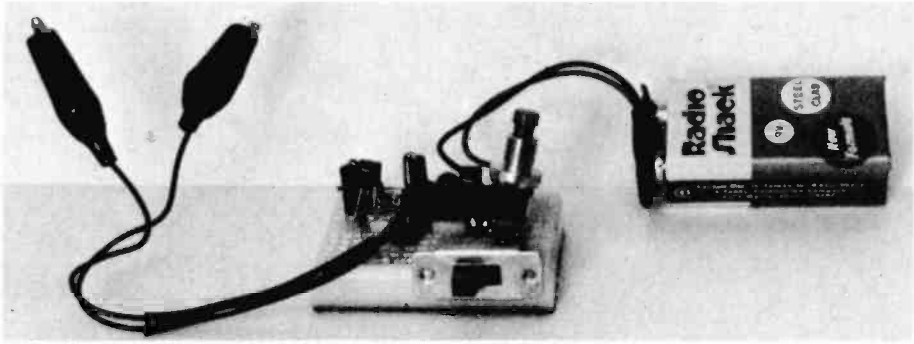
(Continued on page 114)



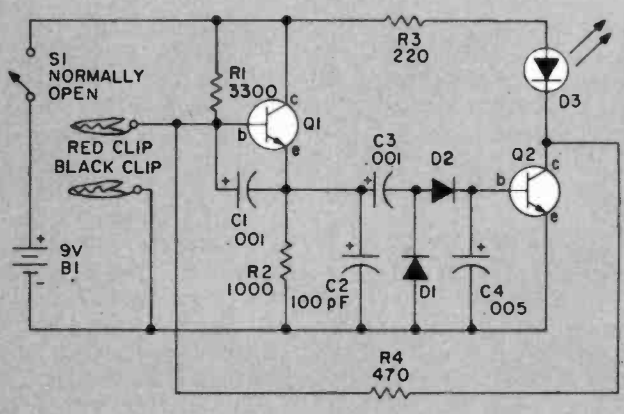
If you use Checkerboard circuit to test capacitors (electrolytics, tantalums, etc.) or diodes, LEDs, or switches, here's the actual working circuit, simplified from the complete Checkerboard circuit, which can check crystals.



Top view of Checkerboard tester assembled on solderless breadboard shows where the parts go if you use this method of assembly.



Prototype Checkerboard was built on AP Products' solderless breadboard for ease of construction and flexibility in layout. Perf board can also be used.



PARTS LIST FOR CHECKER BOARD

C1, 3—.001-uF capacitor
C2—100-pF capacitor
C4—.005-uF capacitor
D1, 2—1N914 or other general-purpose, rapid-response silicon diode
D3—LED (light-emitting diode)
Q1, 2—General-purpose, small-signal NPN transistor, 2N3904 or similar
R1—3300-ohm, ½-watt resistor
R2—1000-ohm, ½-watt resistor
R3—220-ohm, ½-watt resistor
R4—470-ohm, ½-watt resistor
S1—SPST toggle switch, or normally-open pushbutton. Use either, or both in parallel, as desired.
Misc.—Solderless breadboard (AP Products, Inc. distribution strip part number 923273-for AP dealer see end of Parts List); headers (AP Products), alligator clips with pastic covers, 9-V battery connector, 9-VDC transistor radio battery, hookup wire, solder, etc.
For name of dealer nearest you who carries AP Products telephone 800-321-9668 toll free.

The 470 ohm resistor (R4) is included to keep the continuity tester from interfering with the crystal checker. In the crystal tester mode, the crystal being tested plus C1, R1, R2 and Q1 act as a simple oscillator circuit. If the crystal is good a signal will appear at the emitter of Q1 and be rectified by D1 and D2 into a bumpy DC that will turn on Q2. If the crystal is bad nothing will get past Q1 and, therefore, there will be nothing to turn on Q2 and light LED 1.

"Bad SCR" LEDIT Said It

Here's a device to check those cheap, surplus bargains.

by David R. Corbin

☐ Everyone loves a bargain, and bargain bags of semiconductors often yield great buys in the form of perfectly good, but unmarked and untested diodes, transistors, and silicon-controlled rectifiers (SCRs). The trouble is, how do you go about identifying the leads and testing these semiconductors?

A simple, one-evening project using light-emitting diodes (LED) both as indicators and as functional circuit parts in the testing process can now be built for less than five dollars. This LED-indicating tester (LEDIT) will check out diodes and SCRs, and to some will even identify leads of and test many transistors for opens and shorts.

While transistors are actually quite easy to check on a standard ohmmeter, using the lower voltage, middle-range scales to prevent excessive voltage or current through the transistor, an SCR is a bit more difficult. As shown in the drawing, an SCR contains the equivalent of two transistors connected in a closed feedback loop. One lead is the *anode*, the other the *cathode*. A third lead is called the *gate*.

How SCRs Work. Whenever the gate is brought close enough to the voltage on the anode to cause a specified minimum current to flow in through the cathode and out of the gate, the SCR will suddenly turn *On* and exhibit a "short," similar to the action of a conducting diode, provided current is permitted to flow in the cathode-to-anode circuit. It will stay in this mode even if the positive voltage is removed from the gate. Only by reducing the anode current below a specified minimum level can the SCR be turned *Off* again.

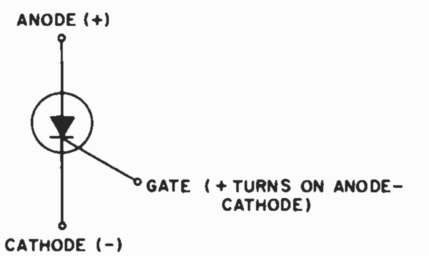
The problem with trying to check most common, small-size SCRs with an ohmmeter is that the minimum gate current and minimum holding current are naturally provided by the ohmmeter. All but the cathode-to-gate path may check "open," making it impossible to identify the leads on an unmarked SCR. What LEDIT does is to provide a quick and low-cost way of putting a safe current through the SCR gate and anode circuits, while providing enough current to turn on and latch virtually all small SCRs found in grab-bag assortments.

By placing an adjustable resistance and a current meter in series with the anode and gate, you could obtain the specified current levels, but for most quick testing of SCRs (open, shorted, or perhaps not even an SCR after all) LEDIT will provide all the information needed.

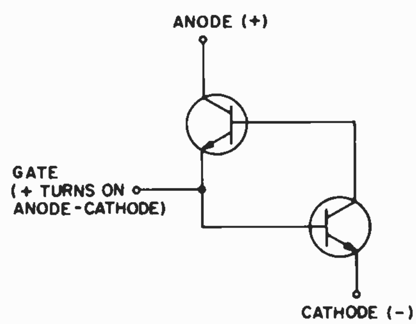
Checking SCRs. There are five ways to misconnect an SCR to the three posts, and one correct way. None of the incorrect ways will damage a good SCR among the vast majority of those around today. The correct connection, when identified, provides for short tests between gate and cathode, cathode and anode, and anode to gate. It also provides for open tests between cathode and anode, and cathode to gate, and turn-on/turn-off functions.

Here's How It Works. Light emitting diodes D2 and D3 have a current rating of about 10 milliamps, with between 1.5 and 1.8 volts across them. This is normally enough current to turn on any common SCR connected to terminals J2, J3 and J4, and to keep the SCR conducting after the gate voltage is removed. With the SCR turned on, current will flow through D3 in the anode circuit until the current is interrupted. Then the SCR will turn off again, and power can be reapplied to the circuit without illuminating D2 or D3.

As the schematic shows, voltage is supplied through J1, or from a 9-volt battery if you prefer. A 9-volt DC transistor radio or tape player AC sup-



Silicon-controlled rectifier (SCR) is really a diode which conducts only when a third element, the gate, lets it. Circuit between anode (+) and cathode (—) is normally open, until the voltage on the gate approaches the anode. When that happens electrons flow from cathode to anode almost as though the diode were a "short."



Equivalent circuit of an SCR looks like this—two NPN transistors connected. Gate is same as base of lower. It can turn On the lower transistor, which turns On the base of the upper.

LEDIT Said

ly is a very convenient way to power small projects like LEDIT which have very low current requirements. More importantly, if LEDIT is used only occasionally a battery may tend to run down, leak, and become a nuisance when left on the shelf too long. One 9-volt DC supply can power any number of projects simply by plugging it in, if you use an external supply jack as shown here.

A negative 9 volt potential is applied through diode D1 to the rest of the circuit as a precaution against applying reverse power. Resistor R1 is a 1000-ohm cathode-to-gate resistor which shunts the flow of current rushing into the internal capacitance of the anode-to-gate junction whenever voltage is first put across an SCR under test. If it were not for R1, the SCR would turn on every time it was connected, even without a gate signal voltage, an effect called *dv/dt* and meaning "change in voltage with a change in time." The rapidly-applied anode voltage causes a small current to flow which charges the junction capacitance, and it flows through the cathode-to-gate circuit unless shunted by R1. Since cathode-to-gate current is what normally turns on an SCR, there is nothing very mysterious about this dv/dt effect.

More on LEDIT's Action. Two pushbutton switches control the gate and anode currents of the SCR under test. Switch S1 is in series with R2 and D2 and is normally open. This is the gate signal voltage. Since "ground" is positive in this design, pressing S1 lets cathode-to-gate voltage flow through D2 and R2. R2 limits the current to a safe value for both the SCR and D2.

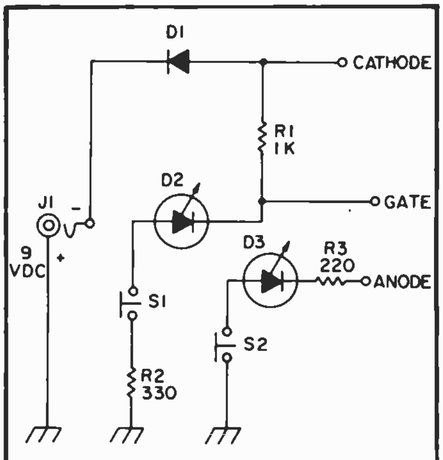
If the gate is either normal or shorted, D2 will emit red light. But only if the gate is normal will D3, the anode current indicator, come on with a clear light. Letting up on S1 should let D2 go out and leave D3 on. If it does not, then the SCR either cannot remain on with a 10 mA anode current (which is not too likely, but possible) or it is defective.

Pushing normally-closed switch S2 interrupts the anode current. The clear light will go out. When that switch is released, the light should not come on again. If it does, there is likely a problem with the SCR, or possibly R1 is not small enough for that particular device. This is not very likely since 1000 ohms is getting near the minimum value used with most SCRs.

If S1 is pressed and D2 (red) does not light, then the gate is open. Actually, D2 will light very weakly through the 1000-ohm shunting resistor even without an SCR in the tester, but it is easy to tell the difference between a good light-up and this weak glow.

Put It Together. None of LEDIT part values are critical, and any convenient "next-size" part can be used with reasonable results. Resistors R2 and R3 are necessary to limit the current to D2 and D3 (LED indicators), and shouldn't be much smaller than indicated in value. If anything, use slightly larger values. The gate turn-on current is rather stiff for small devices so don't hold them "on" with the turn-on button any longer than necessary. I've tested innumerable smal devices and none were damaged by LEDIT but when dealing with unknown parts, it's

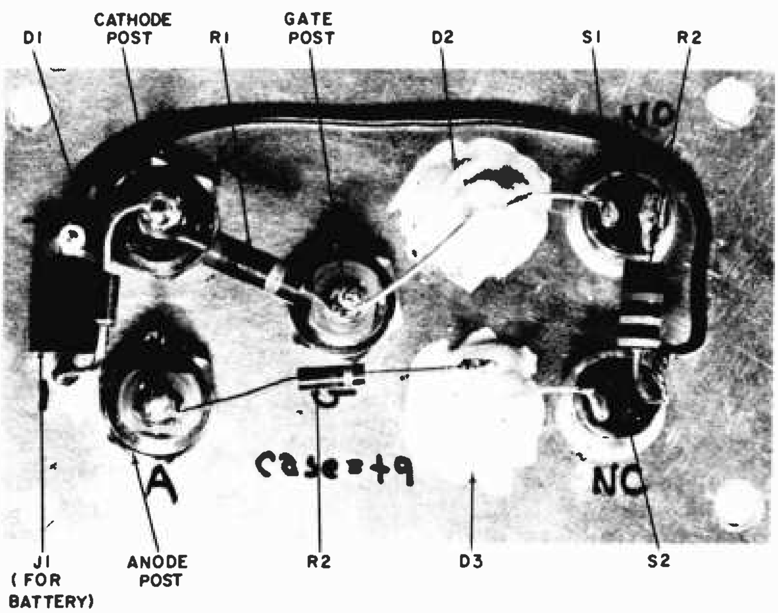
(Continued on page 120)



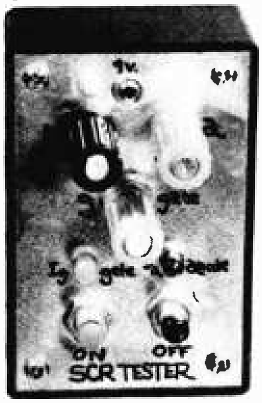
PARTS LIST FOR LEDIT SCR TESTER

D1—1000-PIV, 2.5-A rectifier, HEP R0170
D2—Red LED
D3—Clear LED
R1—1000-ohm, ½-watt resistor
R2—330-ohm, ½-watt resistor
R3—220-ohm, ½-watt resistor
S1—SPST normally-open pushbutton switch
S2—SPST normally-closed pushbutton switch
Misc.—Cabinet 4-in. x 2½-in. x 2½-in., approx., jack for battery connection (any convenient type), 5-way binding posts.

The circuit used in LEDIT is extremely simple and should take little time to assemble. The parts, with the possible exception of the two LEDs, will probably be in your junk box. Mount the panel on an old plastic box—perhaps from a broken midget volt/ohm meter that's seen better days or been canibalized for its meter. The resistors can be 10 percent, but no smaller than indicated.



Here we have a view of LEDIT's interior, specifically the reverse side of the front panel. No PC board is necessary or recommended, just follow the author's design of direct point-to-point wiring for neat and easy assembly.



Author's LEDIT is finished and ready to test unknown SCRs as well as units which have their leads identified. The LEDIT is an easy project for a weekend builder. Find out the truth about those SCRs and diodes!

Las Vegas LED

Win a bundle of fun with this electronic casino game!

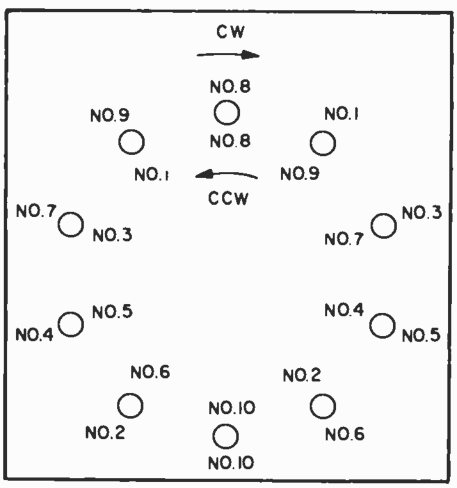
by Walter Sikonwitz

PEOPLE HAVE ALWAYS BEEN fascinated by games of chance, as diversions and obsessions. Inveterate gambler or not, chances are you'll really like *Las Vegas LED,* our version of that old favorite, Roulette. Here's more good news—you won't have to drop a bundle to cash in on the fun.

Las Vegas LED's spinning wheel of fate is a revolving dot of light, provided by a ring of ten LEDs. A glance at the photographs will show you that play is governed by three controls: *Accelerate, brake,* and *decay*. You start by pressing the *accelerate* button, which causes a red dot of light to revolve at an ever-increasing rate until a terminal velocity is reached. If you release *accelerate,* the spinning light will gradually coast to a standstill. The rate of deceleration is determined by the *decay* control. Pressing *brake* while the light is coasting causes a more rapid, but not instantaneous, halt to the spinning.

At least two games are possible, with this control format. Using a little imagination, you can probably devise more. The first possibility is similar to standard Roulette. A player presses *accelerate*, then releases it, and hopes that the number he has predicted beforehand will be the one at which the light ultimately comes to rest. Alternatively, the player starts the light into motion; then, upon the release of *accelerate,* he tries to stop the light on a number designated by his opponent, using only one pulse of the *brake* switch for this purpose. This second variation is quite a frustrating game; particularly so if various decay times are used. Decay times from about 1.5 to 15 seconds can be selected via the *decay* potentiometer.

How It Works. Before discussing construction, let's delve into the theory behind our Roulette game. We start with a very simple voltage-controlled oscillator. We then devise some means for converting the oscillation of our VCO into the apparent revolution of a spot of light (this might seem hard, but we'll see how simple it is later); the velocity of the light will be directly proportional to the VCO's frequency. The VCO's frequency, however, is proportional to the control voltage applied to it. We can produce acceleration of the revolving light if we cause the VCO's control voltage to gradually rise while the *accelerate* button is depressed. Conversely, deceleration of the light is synonymous with a gradual reduction in control voltage. How do we produce a control voltage that behaves in such a manner? We can charge and discharge a capacitor through resistors, and use the voltage across the capacitor as our control voltage.



Mount the LEDs in one of the two orders shown here, which one depending on whether you wish your wheel to "rotate" clock-wise (cw) or counter-clockwise (ccw).

Take a look at the schematic diagram. The voltage across capacitor C3 is our control voltage, and you can see how pressing S2, the *accelerate* button, charges the capacitor through R13. Once S2 is released, charge accumulated on C3 drains away through R13, R11, and *decay* control R12. Setting R12 to its maximum resistance produces the slowest rate of capacitor discharge; hence, as we'll see later, the revolving light will take a maximum amount of time to come to rest.

Brake switch S3 also discharges C3, this time through R14. Since the resistance of R14 is set to a relatively small value, the rate of discharge is quite rapid, and produces a quick cut in the speed of the light. It is the voltage on C3 that is to be our control voltage. Transistor Q11, functioning here as an emitter follower, reads C3's voltage; and because the emitter follower configuration is used, Q11 will not significantly contribute to the discharge of capacitor C3. At Q11's emitter we now have a voltage proportional to that on C3, which is used to drive our VCO.

Unijunction transistor Q13, along with R16, R17, R18, R19, and C4, comprise a relaxation oscillator, the frequency of which is proportional to the input voltage present on the left-hand end of R16. We don't have the nice, linear, voltage-to-frequency conversion of fancier VCOs, but what we have serves our purpose well enough. The output signal of our VCO appears across R19, and is a series of short-duration spikes with an amplitude of a volt or two. Such a signal won't be acceptable to the circuitry that follows, so we first feed it to transistor Q12, set up so that only a small input signal saturates it fully. The resultant output signal, available at Q12's collector, is a well-defined series of negative-going pulses, approximately 9 volts in amplitude.

Now we convert the variable-frequency pulses from Q12 into the ap-

Las Vegas LED

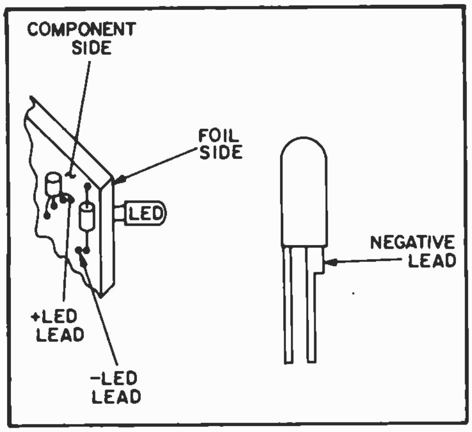
parent revolution of a dot of light by using an integrated circuit known as a decade counter. One essential characteristic of such an IC is that it has ten outputs, and at any given instant of time, nine of these outputs will be at a low potential, while the tenth will be high. The second important feature of the decade counter is that whenever its input, (pin #14 in this case), senses a specific change in potential (high-to-low in this case), the lone high signal advances serially along the outputs. Specifically, successive input pulses to IC1 will cause the high signal to advance from output #1 all the way to output #10, and then back to output #1 again. You might logically assume output #1 to be available at pin #1, and so on; however, this is not the case. We won't discuss the actual location of the individual outputs, because this information is available on the data sheet that accompanies this IC.

From the schematic, we see how Q12's output feeds IC1's input, pin 14. The outputs of IC1 (pins 1 through 7, plus pins 9, 10, and 11) connect to ten LEDs through buffer transistors Q1 through Q10. These buffers are emitter followers; they're necessary because the IC alone cannot supply sufficient current to illuminate an LED. Whenever a particular output is high, its associated driver transistor will supply current to a LED, and light it.

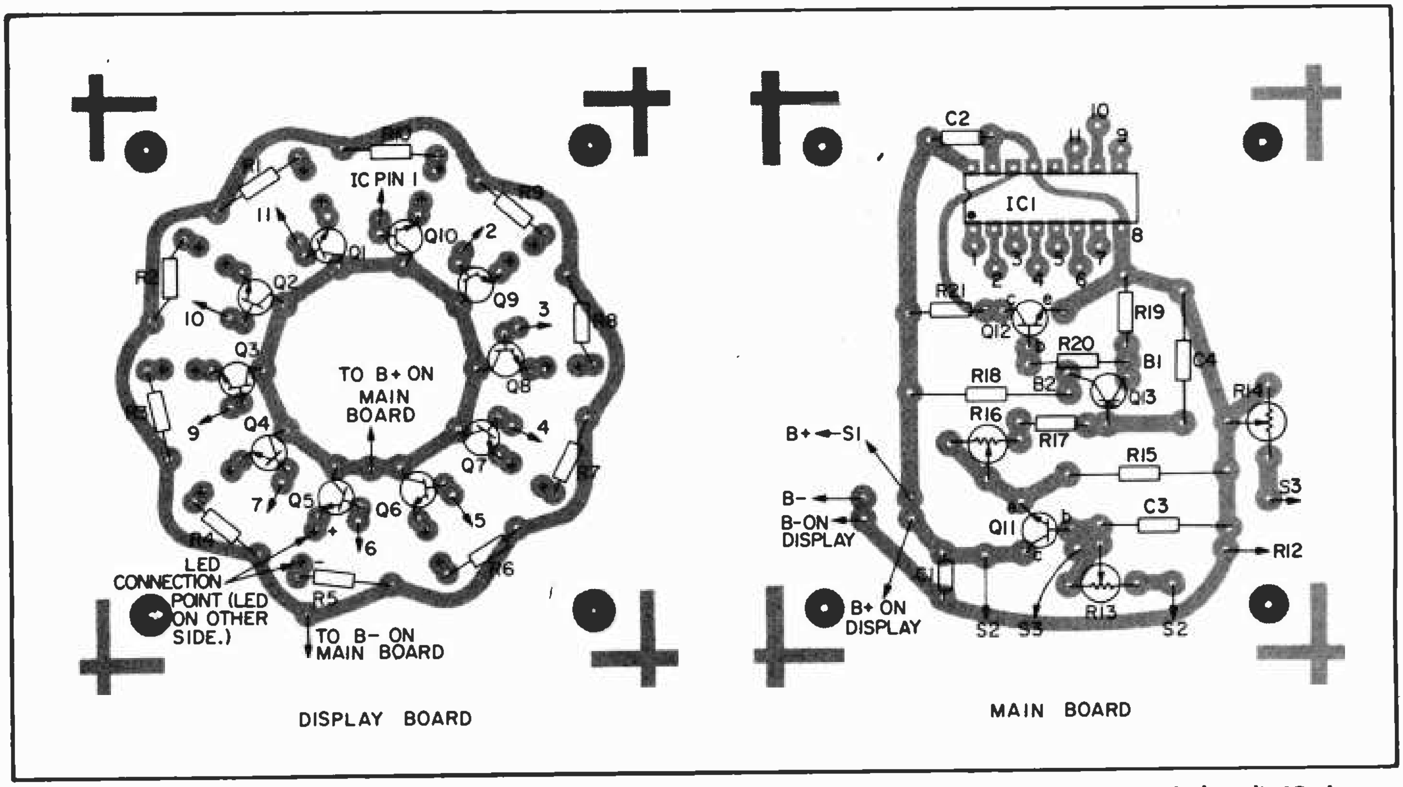
We arrange these LED's in a circle so that as we progress in a clockwise direction, starting at the LED associated with output #1, we encounter, *in proper consecutive order,* those LEDs associated with output #2 through output #10. When we feed an input signal to our IC, we see the LEDs fire sequentially so that a spot of light appears to be revolving in a counterclockwise direction. One full revolution of the light requires ten input pulses, and the rate of revolution is in direct proportion to the input frequency.

Let's review what we have: 1) the frequency of our VCO is controlled by the gradual charge and discharge of a capacitor; 2) the variable-frequency signal from the VCO feeds a decade counter, which drives ten LEDs; and 3) proper LED arrangement results in the apparent revolution of a single dot of light, with a velocity proportional to the frequency of the VCO. That's all there is to it.

Wiring. Since nothing about the circuit is critical, you may build it any way you wish. Perfboard construction is good. Alternatively, you might want to copy the PC layouts provided; the choice is up to you. A good place to begin constructio1 is by drilling your cabinet to accept the ten LEDs. With a compass, lay out a small circle on a sheet of paper. If you intend copying the PC layout provided, the circle's radius should be exactly .9 inch. With a protractor centered at the circle's center, divide the circle into arcs at 36-degree intervals. Trim away any excess paper, leaving just the circle and a small border around it. Position the circle conveniently on your cabinet, and tape it down. With a fine, sharp awl make



LEDs are to be wired to the foil side, with their leads left long enough that their heads poke through the front cabinet (see text). Observe polarity; the negative leads of the LEDs are notched, as shown, and should be connected as both the pictorials and the schematic indicate.



The component sides of the main and display boards are shown in this pictorial view. Make certain that the main board's IC pins are all interconnected properly to the solder-points on the display board, as labeled. Connect, for example, IC pin 1 to Q10. Don't forget about R11 which is not shown and is wired point-to-point between R12 and S2.

slight indentations in the cabinet at the points where the circle is subdivided into arcs. Remove the circle, and at each indentation drill holes through which the LEDs can protrude.

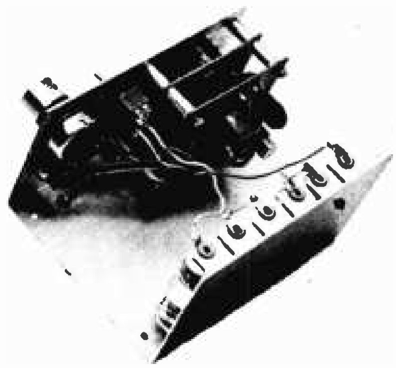
The drawing given shows the order of mounting of LEDs for both clockwise and counterclockwise revolution. The PC layout supplied for the display board provides counterclockwise revolution of the light.

The majority of the components mount on two circuit boards—either the main board or the display board. Even if you decide not to use a PC board, the PC layout provided for the display board may be helpful to you. Note that the arrangement is particularly simple, even though a good many parts are involved, because a radially symmetric pattern is employed instead of the usual rectilinear layout.

When installing components on the display board, follow the dimensional details in the accompanying drawings. Note that Q1 through Q10, and R1 through R10 mount on the component side of the board. LED1 through LED10 mount on the opposite foil side, with leads of such a length that the tops of the LEDs extend beyond the spacers and through the cabinet's panel. The semiconductors that mount on the display board are not especially fragile, but as is the case with all solid-state devices, excess heat can be damaging. Solder all connections quickly, using a 25-watt iron and fine, rosin-core solder. Twelve wires will run between the display board and the main board; ground, +, and the ten counter output leads.

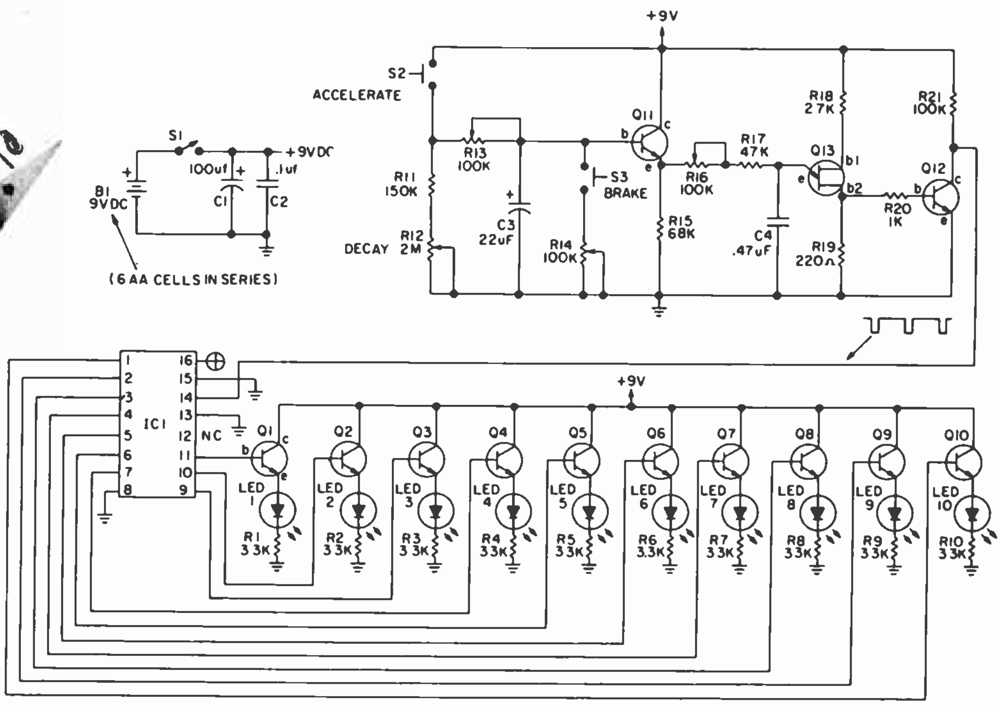
The main board contains the rest of the components. Note that if the PC patterns supplied are copied, the main board may be stacked right behind the display board. This makes for a very dense packing arrangement, but if you have ample space, the boards may be mounted in any manner you like. R11 does not appear on either circuit board; instead, it is wired point-to-point between R12 and S2. Be sure to use a 16-pin socket for IC1. This IC is a CMOS unit, and should be inserted into its socket only after all soldering is finished. If, in checking out your unit, you should find an error that requires re-wiring, remove IC1 before applying a soldering iron to the board.

In assembling the circuit, pay atten-



Inside view of Vegas LED showing stacking of PC boards.

Completed Vegas shown fully assembled, and installed in case.



PARTS LIST FOR LAS VEGAS LED

- **B1**—Six AA (penlight cells) 1.5 VDC
- **C1**—100-uF, 16-VDC capacitor
- **C2**—.1-uF capacitor
- **C3**—22-uF, 16-VDC tantalum capacitor
- **C4**—.47-uF, capacitor
- **IC1**—Decade Counter/Divider CD4017
- **LED1-LED10**—Light Emitting Diodes
- **Q1-Q12**—2N3904 transistors
- **Q13**—Unijunction transistor
- **R1-R10**—3300-ohm resistor
- **R11**—150,000-ohm resistor
- **R12**—2-Megohm potentiometer
- **R13, R14, R16**—100,000-ohm trimmer
- **R15**—68,000-ohm resistor
- **R17**—47,000-ohm resistor
- **R18**—2700-ohm resistor
- **R19**—220-ohm resistor
- **R20**—1000-ohm resistor
- **R21**—100,000-ohm resistor
- **S1**—SPST toggle switch
- **S2, S3**—SPST pushbutton switches, normally open
- **Misc.**—Battery clips, IC socket, aluminum spacers, wire, solder, hardware, etc.

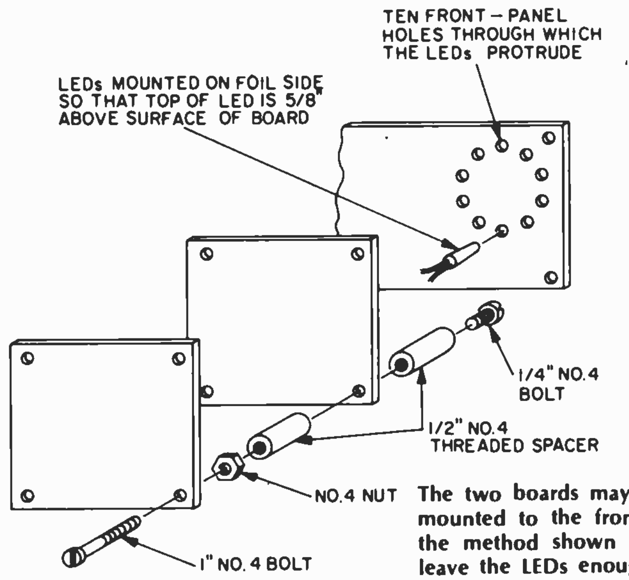
You might not be able to afford a trip to Vegas; but Las Vegas LED will bring the glittering, gambling glamor of that city right into your own home town. When you assemble the circuit, just pay strict attention to the orientation of C3 and C1. It also pays to doublecheck the positions of all ICs and transistors; you'd be surprised how often a simple positioning error can lead to hours of fruitless trouble-shooting. The boards may be mounted in any way you like within the cabinet, but remember to leave room for the batteries to fit into later on. Finally, make absolutely sure you have positioned the LEDs properly depending on whether you want clockwise or counter-clockwise rotation of your "wheel." Follow the diagram on the first page very exactly. Once it's all together just get your bet down and start Las Vegas LED spinning around.

Las Vegas LED

tion to the orientation of C3 and C1. Likewise, make sure the transistors and IC are correctly positioned. The LEDs must also be properly oriented. The leads of all these devices are identified on the packages in which they are sold. Because of the circuit's low power consumption, six 1.5-volt penlite cells in series will power it for a long, long time. A single 9-volt transistor battery could also be used.

Because this is not a finicky circuit, the operating controls and circuit boards can be mounted in any convenient way inside your cabinet, but be certain to allow sufficient room to accommodate the batteries. When you've completed cutting and drilling the cabinet, finish off the front panel with press-on decals. As shown in the photographs, LED1 through LED10 should be identified with numerals applied in a random order.

Final Calibration. After assembly is complete, only a few simple adjustments are necessary to put the circuit into operation. Turn R12 so that its resistance is at a minimum. Set R13, R14, and R16 to the midpoints of their ranges of rotation. Apply power, and depress the *accelerate* button. Within several seconds you should see a spinning dot of light. Adjust R16 for the desired maximum velocity. Too high a maximum speed blurs the image and spoils the effect, whereas a slow-poke display is equally undesirable.

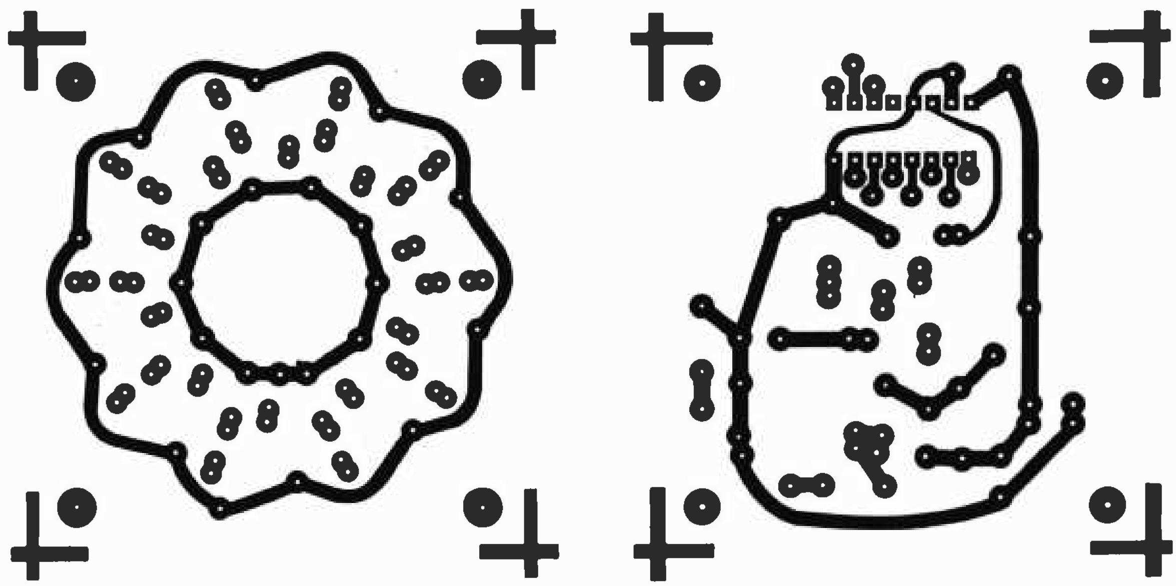


The two boards may be easily and neatly mounted to the front panel by following the method shown here. Make sure you leave the LEDs enough lead, and that you mount them to the foil side of the display board.

Release the *accelerate* button, and the velocity of the light will diminish rapidly. Press *accelerate* again, and then release it, repeating the cycle several times, and at the same time adjust R13 to get an acceleration response that you like. In general, the best position for R13 will be somewhere in the middle of its range of rotation.

Turn R12 so that its resistance (and the decay time) is a maximum. Press the *accelerate* button until the display reaches maximum velocity, then release it, and press *brake*. Note the rate at which the display is slowed down. Adjust R14 while alternately pressing *accelerate* and *brake* until you obtain a rate of deceleration that you like. A very rapid braking action is undesirable; the brake should diminish the velocity, not halt motion instantaneously.

The game may be used as already described in the opening paragraphs. However, just as dice can be found as constituent parts of many other games, so too can Las Vegas LED be adapted to games of your design. ■



Las Vegas LED uses two compact PC boards to keep its "wheel" spinning. The display board, on the left, takes advantage of a repetitious circuit to achieve a neat, clean symmetry of design. The main board, on the right, is also simple to etch and wire. Use these two full-size patterns as templates for your own Las Vegas LED.

RF from your Calculator

Your pocket calculator can save you sums, when you use it as an RF signal generator.

by Bob Baxter

☐ The virtues of portable electronic calculators are by now so well-known and their prices have dropped so low that the units are found almost everywhere. Many presently-available machines–especially those employing LED displays–can be used as quick troubleshooting aids in addition to performing their usual day-to-day calculating chores. Whenever you need a fast, convenient, and portable amplitude-modulated RF source for equipment checkout, your calculator can often fill the bill.

Here's why. Just about all battery-powered calculators emit strong, wideband RF signals which extend well up into the tens of megahertz. These signals are generated primarily as side-effects by the operation of two components of the calculator: the power supply's DC-to-DC converter and the multiplexed LED digital readout.

Not every calculator has a DC-to-DC converter. But those operating from two or three penlight or nicad cells usually do, using it to step the low battery voltage up to a higher level more suitable for operating the MOS ICs which do the arithmetic. The converter produces a harmonic-rich square-wave output at a fundamental frequency typically between 20 kHz and 100 kHz–but the harmonics extend well up into the megahertz region.

Even if your calculator is one of those without a DC-to-DC converter, it's still almost certain to use a multiplex system to drive the output digital display. Multiplexing means that each selected segment of the digital readout is rapidly turned on and off many times each second rather than staying on continuously. When this switching is done rapidly enough, the readout appears to stay on all the time because of the relatively slow response time of the human eye. Readout devices are multiplexed for two reasons. First, multiplexing drastically reduces the power required to operate the readout at any given *apparent* brightness level because the readout is actually on and drawing current for only a small percentage of the time. As a consequence, batteries last much longer. Secondly, multiplexing permits a great reduction in the total number of IC's needed to actuate the calculator's readout display with an attending cost reduction at the time of purchase.

With a standard calculator's seven-segment LED readout and anywhere from 8 to 12 display digits, the multiplexing frequency is typically around 100 kHz. When currents of 20 mA or so are abruptly switched on and off through the LED display segments, significant amounts of RF energy at multiples of the multiplexing frequency are generated. These harmonics may extend well into the tens of megahertz. In fact, this harmonic radiation is one of the main reasons there are so few AM clock radios with LED time displays on the market today. The standard AM broadcast band is almost totally obliterated if the receiver's RF sections are within a foot or so of the multiplexed readout display unless extensive shielding is employed. Fortunately, there are two more practical and less expensive solutions than shielding. The first is the addition of resistance-capacitance networks to slow the rise and fall times of the multiplex waveform–and consequently filter out most of the higher-order harmonics. The second method is to drive each display digit directly and not use multiplexing at all. This second technique is much more practical in a clock radio than in a calculator for two reasons. First, clock radio displays normally have considerably fewer digits than most calculators; hence, the circuit problem isn't nearly so complex. And secondly, with a clock operated from the AC power line, the problem of rapidly discharging the batteries unless the output is multiplexed is eliminated. National Semiconductor Corporation has recently introduced a clock chip with direct drive of all readout segments to eliminate RF interference. It was designed with clock radio applications in mind.

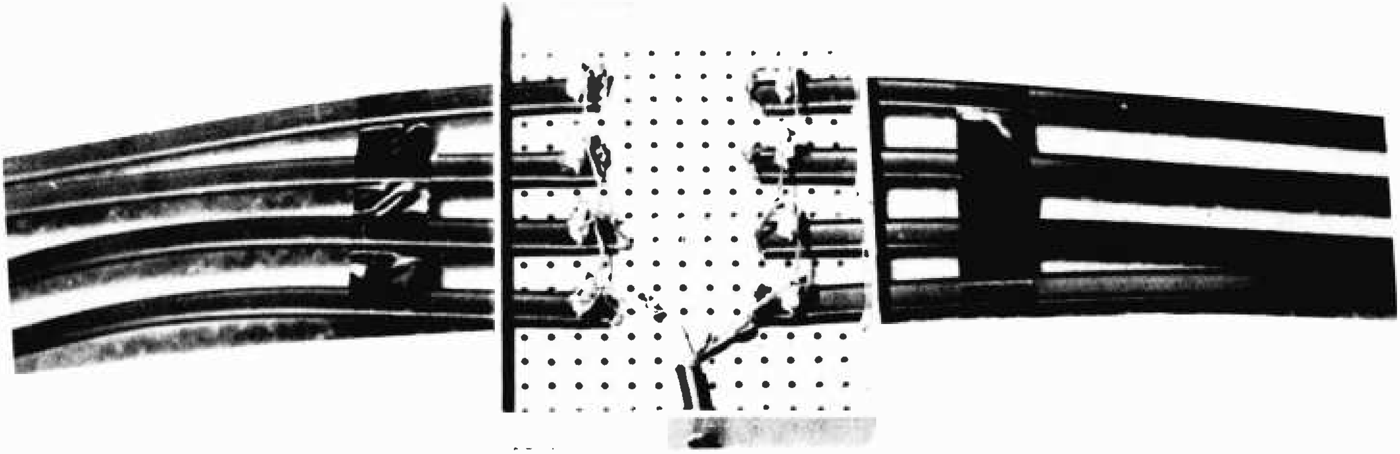
One of the many uses for your calculator other than calculating. Here it is being used to check a windshield antenna.

But now back to your calculator, which almost certainly is multiplexed and unfiltered and produces a rich harmonic output. Turn it on and slowly bring it near a standard AM radio which is tuned either to a weak station or between stations. You should hear a mixture of buzzes and tones as the calculator is brought within several inches of the radio or its antenna. These tones probably will shift in frequency if you key different numbers into the display.

Now that you've verified that your calculator is a portable, wideband, RF source, what can you use it for? Well, a number of applications are obvious. Anytime you need a quick check to see if the RF and IF stages of an AM receiver are working, your calculator can provide a test signal. Probably its handiest use, though, is in continuity testing antennas and connecting cables. Auto antennas and their accompanying cables and connectors are easily tested for opens and shorts by bringing the calculator near the antenna while monitoring the radio output. Perhaps the ultimate example of this technique you can perform in your automobile. Place a calculator near the windshield antenna of a late model General Motors car. In cases of poor or non-existent reception, one or both of the two thin antenna wires imbedded inside the glass may be broken. By carefully tracing the path of each individual wire, a break or faulty connection can be located when the radio's output changes abruptly.

And one final thought. Those of you with LED digital watches might experiment with them. The power is much lower, and the metal watch case provides a lot of shielding, but there just might be enough RF coming from the display to be useful. ■

Mini-Cost Multiband Antenna



Easy-to-build, inexpensive SWL skyhook covers 8 bands!

by Dan Ramsey

NEARLY EVERYBODY knows that dollar-for-inflated-dollar your best SWL investment is a good antenna system. But, you ask, what is a really "good" antenna? It's one that's easy to construct, inexpensive to build and will pull in stations on all of your favorite bands equally well without a complicated switching system. And that's a good description of our Mini-Priced Multi-Band antenna system.

For less than $20 you can construct this simple-to-build and easier-to-operate antenna on even the smallest of lots. With an overall length of less than 80 feet, this home-made DX chaser will bring in each of the seven major international shortwave bands *plus* CB for fun when nothing else is cooking. A couple of hours on a Saturday afternoon will put it up and you'll soon wonder how you ever eavesdropped the ether without it.

Technically our Mini-Priced Mutli-Band is a resonant dipole antenna with eight different-length half-wave legs and low-loss coax leadin to match. But what makes the system unique is that the antenna needs only 180 feet of popular 300 ohm TV twinlead (lead-in) wire available everywhere. Other easy-to-get parts include a perf-board box to house the center taps, a few solderless terminals to hold things together and 25 to 50 feet of RG-59/U coaxial cable to bring the signal down to your receiver. It's about the simplest, most practical and least costly SWL antenna a hobbyist can build.

Antenna Theory. The resonant-dipole antenna has won universal acceptance, literally, as SWLers the world over rely on its simplicity and sensitivity It's easy to understand why.

A half-wavelength dipole (cut to half the *electrical* length of the incoming shortwave, then tapped in the center) offers the advantage of receiving one group of frequencies, or a band, stronger than others striking your antenna at the same time. It is frequency-sensitive. As opposed to the popular longwire, which is a "general" antenna, the dipole is a *specialized* antenna. It specializes by resonating—being most efficient in receiving a particular band, for which it was designed. It is frequency-selective. And because it is physically little more than a longwire antenna tapped in the center rather than on the end, the dipole is nearly as easy to construct.

However, the dipole does have certain disadvantages. The problem is that, though a dipole is usually most sensitive to whatever signal range you have cut it to receive, its frequency range is rather narrow, and it is much less efficient on outside frequencies than the general-coverage longwire antenna.

You can turn this fact to your advantage by setting up a resonant half-wave dipole for *each* of your favorite bands. This will insure that you can listen to any one of these bands with top sensitivity while attenuating signals from outside the band so they don't interfere with your listening pleasure. The bands you'll probably choose are the seven international shortwave bands (49, 41, 31, 25, 19, 16 and 13 meters) plus something just for fun, like eavesdropping on the CBers (11 meters).

So what we've designed is an eight-band resonant half-wave dipole antenna. And it's engineered for low cost, selectivity, sensitivity, and efficiency. Now that we've designed our "perfect" antenna, in theory, how can we make it actually fly?

Simple! By using various lengths of 300 ohm TV twinlead wire we can have four parallel sets of double wires that will resonate in the middle of each of the eight bands we've chosen. Why twinlead? It's easy to obtain for one thing. Nearly every town has at least a TV repair shop where you can usually buy twinlead in 50 and 100 foot rolls or cut to specific lengths for about 4 to 9 cents a foot. Also, it offers two insulated antenna wires in one weatherproof package.

When buying your twinlead, you won't want the best, the shielded type, because that would defeat your purpose of getting the signal to the enclosed wire with the least amount of loss. And you won't want a low-grade type either, because of the brittleness of the wire and insulation. About the best wire for a shortwave antenna is 7-strand number 20 or 22 wire. And the better-grade foam-insulated TV twinlead is made up of 7x22 copper wire. Perfect! It's highly-conductive, weatherproof, self-supporting and inexpensive.

Let's go back to resonance. Engineers have come up with a simple formula that will help you decide what length you will want to cut each of your antennas to in order to make them *resonant* (most sensitive to one frequency

Basic parts for your Mini-Priced Multi-Band are two rolls of 300 ohm TV twinlead, about 50 feet of coax cable, perf-board box, electrical tape and solderless spring terminals. The two short pieces of rigid wire are used for making the common connections at center of the antenna array.

range) half-wave dipoles. The formula is:

$$\frac{468}{\mathrm{F\,(MHz)}} = \tfrac{1}{2} \text{ wavelength.}$$

which means: one-half a wavelength is equal (electrically) to the magic number of 468 divided by the frequency you desire (measured in Megahertz). The answer is in feet. Example: for the 49-meter band (5.95 to 6.2 MHz), use the approximate center frequency (6.075 MHz) in the above formula and you will come up with 77 feet. That's the length of wire you'll need to make your antenna resonant, or most sensitive, to that frequency band. It's a simple process to choose the lengths you'll need for each of the eight shortwave bands we've decided on. (See our *Resonant Antenna Table*)

Construction. Putting the whole thing together is easy. The 49- and 41-meter band wires will be mated in one twinlead, the 31 and 25 meter bands go in another, 19 and 16 share a twinlead, and 13 and 11 meters take the final length.

Steps: Cut each twinlead to the longer of the two resonant lengths (Cut the 49-41 meter twinlead to 77 feet.). Then figure the difference between the two resonant lengths (41 meters should be 65 feet long, so the difference is 12 feet. Divide the difference by two (answer—6 feet) because you are eventually going to cut the whole twinlead in the center to tap it and will want an equal amount of resonant antenna on each side of the center tap. Come in that distance (6 feet) from each end and snip the *bottom* wire of the twinlead at that point. Then go to the closer end, cut the *bottom* wire back, take a firm grip on it and zip it out through the side of the insulation to the point where it was snipped.

Do this with each of the four twinleads according to the lengths in the *Resonant Antenna Table*. Remember, if you have purchased your twinlead in two 100 foot rolls to cut the 77 foot and 21-ft. 8-in. lengths out of the same roll.

To make your antenna a dipole you must tap it in the center. This is done by first folding each twin-lead exactly in half and cutting it. With 178 feet of wire all over the floor, you should tape appropriate sections together and label them as they are cut to avoid later confusion. When you lay the antenna system out on the ground it should look like the spread wings of an eagle, tapered inward from top to bottom and with the center tap cuts all meeting in the middle. Now it's time to tie it all together.

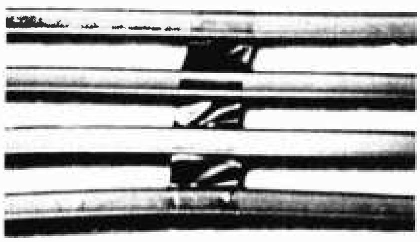
Here's where the other parts come in: the perf-board box, the solderless spring terminals, coax cable and the electrical tape.

First, open up the perf-board box and lay the gray or perforated section open end up. (You can use a hobby box and a perforated board also, but the Archer brand Experimenter's P-Box, distributed by Radio Shack, has a distinct advantage in that necessary holes can be cut in the gray portion of the box with a hot soldering iron.)

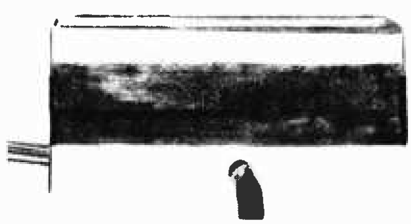
Next, cut four holes in each side of the box for the twinlead, and one at the bottom edge for the coax. Then bring the four half-sections of twinlead into each side of the box, strip all wires back about one inch, make a hole in the center of the insulation another ¼-in. back for the spring terminals and insert them into the insulation. Next, put the two loose wires from each twinlead into its respective terminal, push the terminal into the correct holes in the perf-board box and connect the terminals on each side with a common wire. Now you have all wires from one side of the box connected commonly, and all wires from the other side connected at another common point.

The next step is to bring the coax cable in from the bottom, connect the center wire to one common set of taps and the outer (shield) braid to the other set. You should spot solder the terminals when you've completed your work to assure a good electrical bond. Close the box and seal it with electrical tape. You're just about finished.

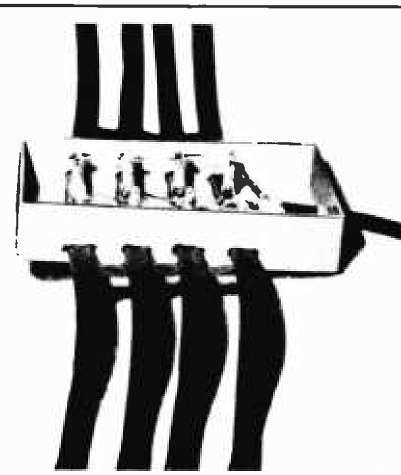
Stretch all of the twinleads out in parallel from the box. Every three feet or so, wrap electrical tape from the top to the bottom twinlead leaving about an



Short lengths of electrical tape help space out the twin-leads to keep them isolated and to support them in place properly.



After final assembly the perf-board box is closed and sealed with black plastic electrical tape. Coax cable leadin is shown exiting at center front.



Twin-leads enter box at side—coax exits at bottom. Spring terminals conduct signals, also serve to secure twin-leads.

inch between each one. This is done so the top twinleads will support the bottom ones. For further support, use a short cord to tie the top two ¼-wave legs together on the outside of the box. This will minimize stress on the top twinlead center connections when it is installed.

The next step is rigging up your antenna. You will need 80 feet of space, lengthwise. A strong nylon cord tied from each end (egg insulators not needed) and to a nearby support will do the trick. Make sure you raise the antenna to a height of at least 20 feet and away from obstacles that would attenuate the incoming signals. The higher it is, the better it will be. Carefully run your coax in to the shack, hook it up and stand back.

Signal Tracing. To see how your Mini-Priced Multi-Band works, let's follow an incoming signal. It hits your antenna along with a hundred others, but your dial is tuned to 9.690 MHz in the 31-meter band. Because signals follow the path of least resistance and because the lowest resistance is between your top wire on the second-from-the-top twinlead and your receiver, that particular signal is chosen. It runs towards the center of your dipole. At the same instant, the identical signal is coming in from the other half of your half-wave dipole and rushes towards the perf-box. They haven't met yet.

Even though you are using what's called *300 ohm* twinlead, the actual impedance (resistance of an AC circuit) of each dipole is about *70 ohms* as it is in every center-tapped half-wave dipole antenna. (The impedance would be about 300 ohms if the farthest ends of the twinlead were loaded or connected together, but they are not.) And so your 72-ohm coaxial cable is a near-perfect match. The signal again takes the path of least resistance, down the coax to your receiver.

Some inexpensive communications-*type* receivers have higher input impedance, but most better-quality communications receivers have an input impedance of about 75 ohms. Again, a very close match for your incoming signal and it rushes into your tubes and/or transistors to be amplified, rectified and certified "good SWLing." No loading coils or bandswitches necessary.

Hints. Remember that the dipole antenna, while able to detect signals from just about any direction, is most sensitive to signals coming in broadside (at right angles) to the antenna. So try, if you can, to run your antenna basically north and south if you want to receive most signals from the east and west.

Another plus for the dipole is its noise-cancelling characteristic. Each of the ¼-wave legs brings the signal to your receiver as a mirror of the other. One runs down the center wire of the coax and the other moves via the outside coax braid. When they meet in your receiver they mix and cancel much undesired amplitude-modulated impulse noise. Another good reason why the dipole is so popular.

Horizontal and vertical polarization? Don't worry about it! After skipping off the ionosphere a time or two, it doesn't make any difference whether the station sent the signal out with a horizontal or vertical antenna. It's flip-flopped through the atmosphere enough before it gets to you so the signal is virtually omni-polarized.

While you're installing your Mini-Priced Multi-Band, don't forget the value of an antenna lightning arrester. It may save your receiver from an overload of a few thousand volts. And it doesn't take lightning to make it a useful gadget. It will also discharge the static electricity that can bulid up on a wire during an electrical storm. It's great insurance!

Long-time SWLers know that one dollar in the antenna system is worth about ten dollars in the receiver. So this less-than-$20 project may just inflate your shack's value by almost $200. And that's a good investment in *any* economy! ■

RESONANT ANTENNA TABLE

BAND (meters)	FREQ. (MHz)	LENGTH (Ft.)	TRIM (ends)
49	5.95-6.2	77	none
41	7.1-7.3	65	6 ft.
31	9.5-9.775	48⅔	none
25	11.7-11.975	39⅔	4½ ft.
19	15.1-15.45	30⅔	none
16	17.7-17.9	26+2 in.	2¼ ft.
13	21.45-21.75	21⅔	none
11	26.965-27.225	17+6 in.	2 ft.

PARTS LIST FOR MINI-PRICED MULTI-BAND ANTENNA

178 ft. 300-ohm foam TV twinlead
25-50 ft., as needed for lead-in, RG-59U coaxial cable
Perfboard box or experimenter's P-box (Radio Shack 270-105 or equiv.)
Solderless spring terminals
Roll electrical plastic tape

You can't listen to all the world if you can't hear all the Bands. Hear all the action with a multi-band dipole antenna!

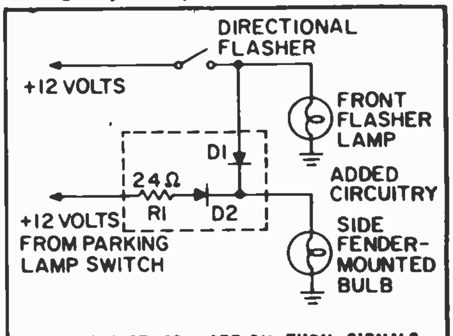
Turn Signals from Side Marker Lights

☐ Side clearance lights are the lamps usually mounted on the front and rear fenders. These lights can be made to provide additional driving safety by adapting them to flash *in unison* with the directional flashers if the auto does not now have rear flashers.

The circuit diagram shows how the present auto or pick-up electric wiring is modified so the side lights will also flash. A 24 ohm resistor is added in series with each side-clearance lamp bulb filament. This reduces the brilliance of the side bulb to about half of what it was originally. An epoxy diode is used to isolate the parking lamp filament from the flashing light circuit.

A separate wire lead is run from the side lamp to the directional flasher lamp on the same side of the auto. The side clearance lamp will then flash in unison with the front directional flasher lamp. A second diode is used to isolate the flasher filament from the parking light circuit so that it will not turn on when the parking light turns on.

Make good electrical connections by using instant auto electric connectors or soldering with a good soldering iron. Wrap all connections and components with a good amount of black plastic electrical tape so that they will withstand the weather. The side clearance lights will now flash not only with the directional signals but also when the emergency 4-way flasher is turned on. ■



PARTS LIST FOR ADD-ON TURN SIGNALS

D1, D2—Diode 1 amp, 50 PIV or better (Radio Shack 276-1135 or equiv.)
R1—24-ohms, 1-watt resistor (Radio Shack 271-1000 or equiv.)
Misc.—wire, electrical tape.

SUPER SCA SOOTHER

Get fancy restaurant music for down-home kitchen prices with your own FM tuner.

by Herb Friedman

YOU CAN LISTEN TO SCA BROADCASTS at far greater distances with this SCA (Subsidiary Communications Authorization) adapter for your FM receiver or tuner than with previous designs, even those costing many times more. The secret lies in a new integrated circuit now available at very low prices which decodes the ultrasonic frequency the SCA signal is on. This IC is a PLL (Phase-Locked Loop) which acts as the detector of the 67 kHz SCA carrier wave which the subsidiary signals are transmitted on.

Although most people are unaware of it, many FM stations transmit not just the two signals of a stereo program, but one, two, or even three other programs, usually music, which cannot be heard by the owners of normal FM tuners or receivers. These programs can be heard only if you have a special SCA receiver, or if you have an SCA adapter, similar to the one described in this article.

Our SCA Super-Soother is so-called because the most common use for SCA is to transmit Muzak-like background music into stores and factories. It uses two ICs which cost $6.00 (total, including postage) plus a handful of resistors and capacitors. Because of the advanced design made possible by the PLL IC, Super-Soother can grab SCA signals which ordinary SCA adapters would lose completely, or at best receive with lots of hash and/or distortion—and who needs that with soothing background music, music to lull you by . . . or whatever?

Using a two IC circuit in an amplifier / (PLL)-detector configuration Super-Soother will actually permit you to DX your FM-SCA programs. No longer will your SCA listening be restricted to local FM stations. You can now monitor *fringe reception* FM stations with SCA programming.

But before going further let's take a look at what SCA is all about. When a *Subsidiary Communications Authorization* is granted to an FM station by the FCC the station is permitted to transmit up to *three more programs* in addition to its regular program (called the main channel program) by a special method of modulation. A standard FM radio—either mono or stereo—cannot detect the SCA programs. The regular listening audience hears only the main channel programming. In fact, there is no way a listener with a standard FM radio can tell the station is transmitting an SCA program(s). Only listeners with FM radios equipped with an SCA adaptor can hear the SCA program.

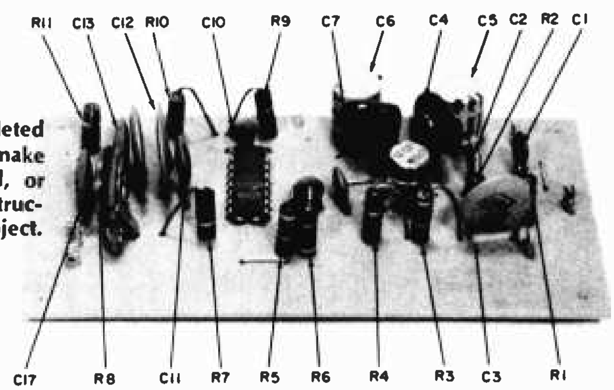
If you would like to tune in to these "phantom broadcasts" you can do so with Super-Soother SCA Adapter. It's super because its extra-high sensitivity permits reception of SCA programs that other low cost SCA adaptors can't detect.

What You Can Hear. For many years SCA has been used to transmit educational programs and weather reports to specialized audiences; it has been used for reading to the blind, and even for broadcasting some school tests. The most common use of SCA, however, is the transmission of background music—the type heard in restaurants and shopping centers—and ethnic music. For example, in the New York City area there are FM stations with SCA programs of the music of China, Greece, Ireland, and many others.

Best of all, this pleasant, interesting music is rarely, if ever, interrupted by an endless barrage of commercials or the patter of an announcer in love with his or her own voice.

How It Works. SCA programming is transmitted by a 67 kHz FM subcarrier (or sometimes 65 kHz impressed on the main FM carrier). When a station broadcasting SCA is received

Here's the way the completed board looks. You can make your own circuit board, or order it. Perf board construction won't do in this project.



SOOTHER

by a standard FM radio or tuner the SCA subcarrier is simply wiped out in the radio's detector and the listener has no idea it exists.

To receive SCA the regular FM detector output must be fed into a 67 kHz detector before the 67 kHz subcarrier is eliminated by the standard FM detector's de-emphasis network.

Until recently it took a lot of expensive hardware to receive SCA programs: a very sensitive receiver and a rock-steady detector. (A good receiver is needed because the SCA subcarrier is usually only 10% of the total FM signal.) Though many low-cost SCA adaptors have been available in projects, or in wired form, most had a tendency to burp, gargle or distort on weak SCA levels.

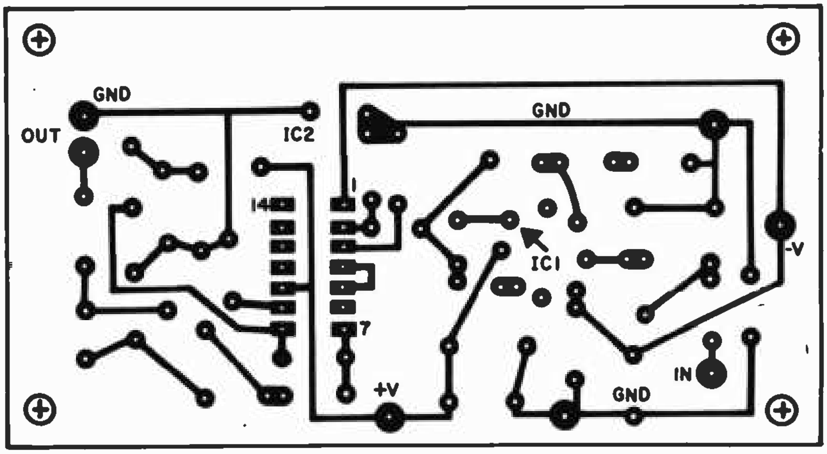
While the radio astronomy crowd had a great weak-signal detector known as the *phase-locked loop* or PLL, it was also true that the astronomical-use PLL was astronomical in price. Thanks to modern solid-state techniques, however, the Signetics Corp. has come up with a PLL specifically intended for SCA detection that's priced well under $5.

Available in both the standard 8-pin round and the 14-pin DIP IC packages the Signetics SE/NE565 requires virtually no external hardware for SCA detection. Most important, since the PLL automatically locks onto the incoming SCA subcarrier frequency the SE/NE565 will demodulate subcarriers of either 67 or 65 kHz without need for individual adjustment.

Combination Gets Results. Unfortunately, the phase-locked SCA detector requires at least 80 mV input from the FM detector for good reception, and this usually means that only one or two very strong, or local SCA stations can be received. To make our Super-Soother the best there is we have combined the PLL with a high gain operational amplifier. The result is the Super-Soother which can receive SCA programs even using a cheapie FM radio and an indoor (rabbit-ears) antenna.

Another plus feature of Super-Soother is that no large filter coils are needed to suppress the main channel program. Even SCA programs on stereo stations are received cleanly, with no trace of *stereo hash*. And because large coils aren't need the entire adaptor can be assembled on a 2¼-in. x 4¼-in. printed circuit board which you can purchase, or make, as you wish.

Because the gain of the adaptor is unusually high it must be assembled on the circuit board exactly as described to insure stability. You can't build this project on perfboard.



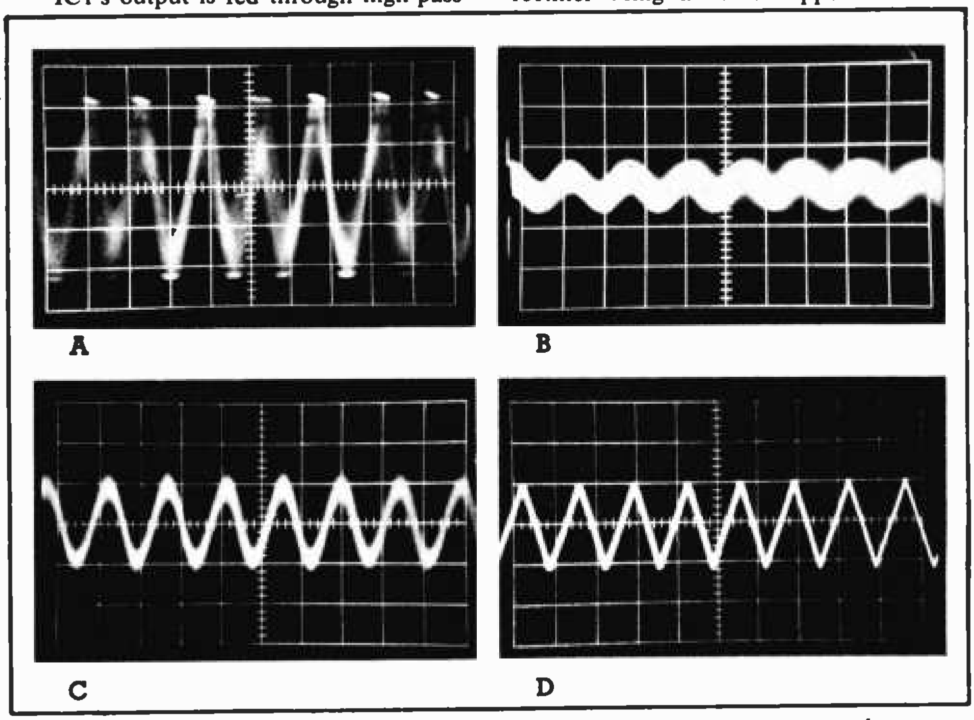
Exact-size printed circuit board layout is shown here. Transfer the image to copper clad board using carbon paper. This is the bottom (copper) side.

How The Circuit Works. The signal from your FM tuner's detector, before de-emphasis, is applied to operational amplifier IC1 through a high-pass filter consisting of C2, R1 and R2. The filter's effective frequency is 60 kHz, which removes just about all of the main-channel information. The frequency response of the amplifier is tailored by the feedback loop through R3 and C3 to further suppress main-channel information.

IC1's output is fed through high-pass filter C9 and R5 to IC2, the PLL detector. IC2's output is passed through a low-pass filter consisting of C12, C13, C14, R9, R10 and R11 which provides SCA de-emphasis and noise suppression. The output level at C15 is about 50 to 100 mV depending on the particular signal, and can then be fed to your hi-fi amplifier.

Since SCA audio response is limited to a maximum of 7 kHz just about any amplifier can be used.

Note that Super-Soother requires a bipolar power supply in the range of ±6 to ±9 VDC. The supply can be either batteries or a power-line bridge rectifier using a center-tapped 12-volt



Oscilloscope patterns will pinpoint any possible difficulty. You can use a general purpose scope since the signals are under 100 kHz. With "triggered" scopes, set the time base to u sec/cm. Photos B and C are input and output of IC1, the 67 kHz amplifier. If signal is clipped as in A, main channel program may break through—see text for curves. Normal IC2 pin 9 waveform is shown in the waveform of D. Vertical sensitivity B, 20mmV/cm; C, IV/cm.

filament transformer as shown on the schematic. Since the SCA adaptor requires only about 10 mA of current any small power transformer can be used.

Assembly. If you cannot make your own circuit board, you can purchase a drilled and plated board. See the parts list for information.

If you make your own board use a #56 bit to drill the holes for the push-in connecting terminals and trimmer potentiometer R8. Drill the corner mounting holes to clear a #4 screw. Drill the component holes with a #58, #59, or #60 bit.

Install IC1 and IC2 before any other components. Note that the IC1 lead opposite the case tab is #8. Insert the leads—beginning with #8 and push IC1 within 1/4 to 3/8-inch of the board. Solder the leads and cut off the excess.

If this is your first IC project it would be wise to use IC sockets.

Hold the board so you are looking at the top, with IC1 to your left. Hold IC2 so the notch is away from you and insert IC2's leads into the matching holes. *Doublecheck the notch before soldering.*

Install trimmer potentiometer R8 and solder. Then install the three wire jumpers, and finally, the remaining components, taking extreme care the polarity of capacitors C5 and C6 is correct. Note that C5 has the positive lead connected to ground.

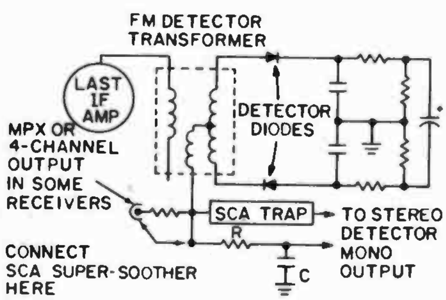
While capacitors C12 and C14 are indicated as 0.02 uF they aren't the easiest to obtain in miniature size. You can substitute two parallel-wired 0.01 uF capacitors.

The three oscillosqpe traces show what you can expect to get if you are tuned to an SCA station. Photo B is the input, IC1 pin 2; note the presence of a 67 kHz carrier. Photo C is IC1 pin 6; note the very strong 67 kHz carrier. Photo D is IC2 pin 9, the phase lock detector's voltage controlled oscillator triangular wave output.

If you don't get photo B, the trouble is the connection between the tuner and the adaptor. If you get photo B but not photo C, the trouble is in the IC1 circuit. If you get photo C but not photo D, the trouble is in IC2.

If you don't get photos C and D, there is most likely a major fault in the assembly; we have specifically designed the adaptor so one defective IC cannot disable another IC.

Setup And Checkout. Either a bipolar battery power source or an AC supply can be used. Since there is no difference (in this case) in performance between a ±6 and ±9 VDC supply use whatever you have available. For long-term battery life Burgess Z4 6-volt batteries are suggested. However regular 9-V transistor batteries will work fine. *(Continued on page 116)*



The Super-Soother (or any other SCA adaptor) is connected after the FM detector, but before the deemphasis network, as here.

PARTS LIST FOR SUPER-SOOTHER

C1, 9—470-pF capacitor
C2—47 or 50-pF capacitor
C3—.005-uF capacitor
C4, 7—.1-uF capacitor
C5, 6—100-uF, 16-VDC or better electrolytic capacitor
C8—7 or 10-pF capacitor
C10, 11—.001-uF capacitor
C12, 14—.02-uF capacitor
C13, 17—.05-uF capacitor
IC1—op amp integrated circuit Signetics NE 531T (available from supplier listed below)
IC2—phase-locked-loop SCA detector integrated circuit Signetics NE 565A (available from supplier listed below)
R1, 5, 6—4700-ohm, 1/2-watt resistor
R2, 4—47,000-ohm, 1/2-watt resistor
R3—470-ohm, 1/2-watt resistor
R7—1800-ohm, 1/2-watt resistor
R8—5000-ohm potentiometer, circuit-board mounting
R9, 10, 11—1000-ohm, 1/2-watt resistor
S1—SPST switch
Misc.—Cabinet 6-in. x 4-in. x 2 3/8-in. or larger, two batteries 9-VDC or 6-VDC unless power supply is used, battery connecting clips, phone jacks, wire, solder, etc.

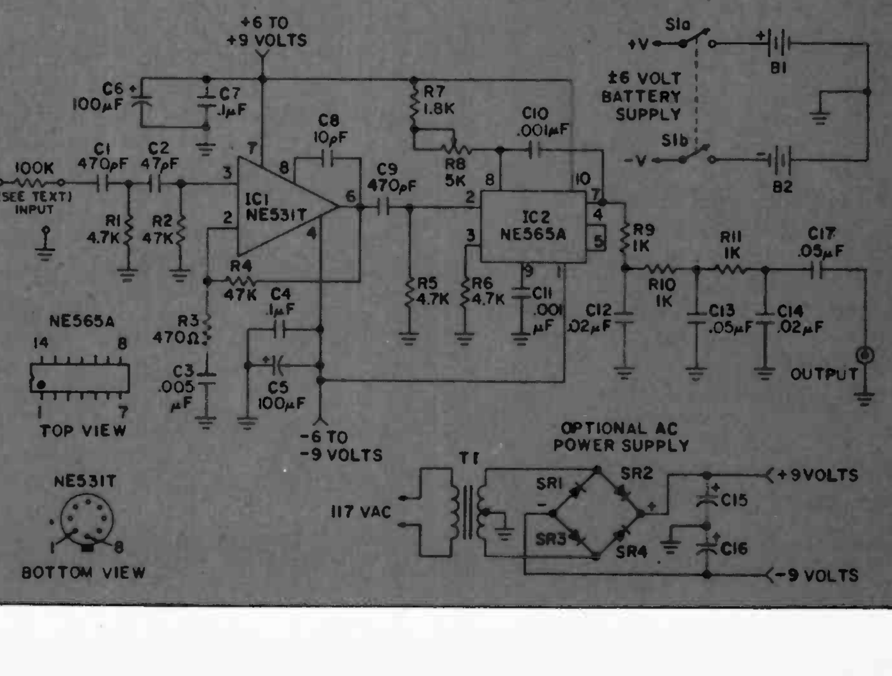
An etched drilled, printed circuit board for the Super-Soother SCA Adapter is available from Electronic Hobby Shop, Box 192, Brooklyn, NY 11235 for $6.95. US orders add $2.00 for postage and handling; Canadian orders add $3.50. No foreign orders, please. Postal money orders will speed delivery; otherwise allow 6-8 weeks for delivery. NY state residents must add sales tax.

The two ICs for this project are available from Circuit Specialists Co., Box 3047, Scottsdale, Ariz. 85257 for $6.00 which includes shipping and postage. Prices subject to change.

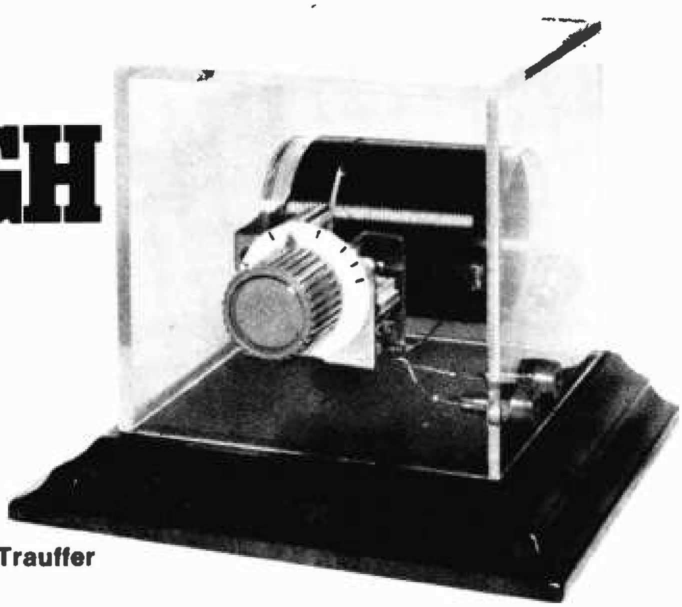
PARTS LIST FOR POWER SUPPLY FOR SUPER-SOOTHER

C15, 16—2000 or 2200-uF, 20 VDC or better electrolytic capacitors
SR1-4—Bridge rectifier, or separate diode rectifiers—anything over about 15 mA will do
T1—Small 12.6-VAC filament transformer

Blasting, raucous commercials can ruin an otherwise blissful evening of enjoying the FM broadcast band. Let Super-Soother calm the savage commercial. With this new adapter you'll be able to pick up even the weaker SCA (Subsidiary Communications Authorization) stations. These SCA stations transmit background music to such clients as stores and restaurants and, with a little ingenuity, right into your own living room as well. This particular adapter features extra-high sensitivity to receive, soothingly clear, SCA broadcast that many other adapters can't detect. Forget about commercials—get fast, fast, fast relief with Super Soother.



Build the SEE-THROUGH CRYSTAL RADIO RECEIVER



by Art Trauffer

☐ Have you ever wanted to recreate those old days of listening to AM radio on a crystal set and headphones? No tubes, no batteries, no hum, no nothing but pure clean sound drifting out of the ether into your headset? If you have the yen to get a crystal set which has the advantage of using a crystal diode instead of the old unreliable cats-whisker and galena crystal, this radio is the one for you to build. In addition to being about as good a power-supplyless AM receiver as you can make, it's also a pleasure to look at.

It closely resembles the beautiful glass-enclosed radio receivers that were custom-built by manufacturers for display in radio exhibitions in the 1920's. Manufacturers of radio receiver kits mounted and wired their kits in glass cabinets so the visitors could see the "works" from all angles instead of lifting the lid to look inside. Those glass cabinet radios are now rare collectors items.

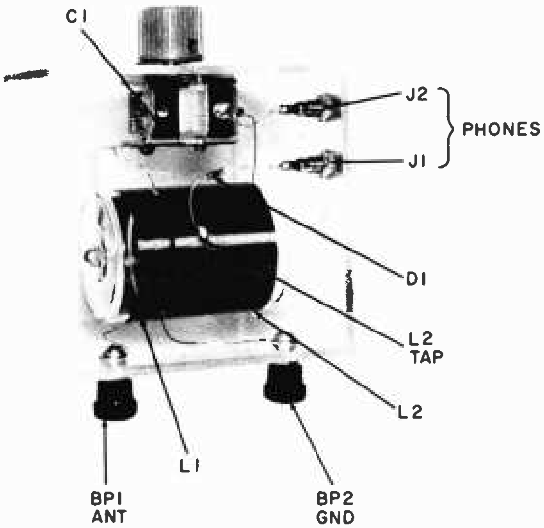
This crystal radio also saves you the work and expense of making a wood cabinet, and it is low-loss for radio frequencies because the cabinet and coil form are made of styrene plastic which is a good dielectric material. The cabinet is simply a clear plastic 4-in. square photo display cube, and the coil form is a clear plastic pill container about 2-in. in diameter.

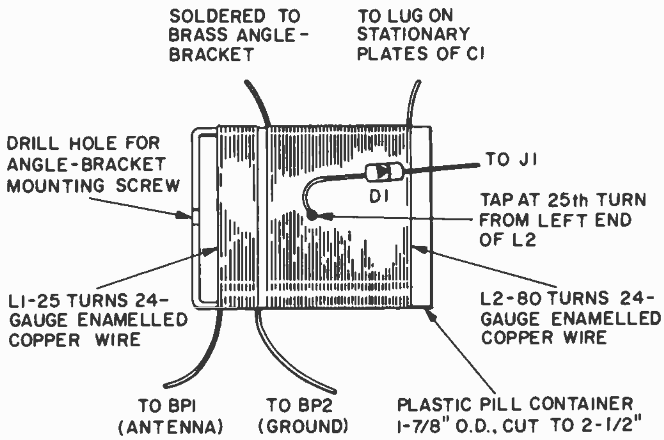
Circuit Description. The simple schematic diagram shows a time-tested hookup which is still widely used, but it's improved here by connecting one side of the crystal diode to a tap on the secondary, L2. This greatly increases the receiver's selectivity and helps you separate the powerful local stations.

Making the Coil. To make coils L1 and L2 the four ends of the coils are anchored in small holes drilled through the wall of the plastic container and spotted with Duco cement. You can also make small holes by pushing a hot sewing needle through the plastic. To make the tap on the coil, simply twist a small loop in the coil and spot it with Duco cement. Scrape the enamel insulation off the loop, and solder to it.

Build Your Own or Ours. The plastic cube makes a very attractive enclosure, as you can see in the photographs. However, the parts layout isn't at all critical, and you can breadboard this radio any way you want, so long as it's wired correctly. If you want to have a beautiful-looking radio you can show off you'll follow the model I made which is shown in the photographs.

Mounting The Parts. The photograph shows how the parts mount inside the plastic box. The coil form is mounted to the rear of variable capacitor C1 by means of a brass angle-bracket. Use lockwashers wherever needed to hold the screws, binding posts, and phone tip jacks securely to the plastic material.



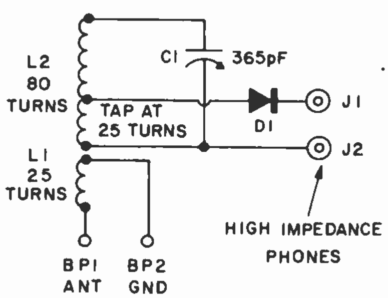


Apart from getting hold of the parts, construction of the See-Through Crystal Set should take you less than two hours in all. You can use any kind of box you want, but the lucite box shown will make it into a real showpiece.

When assembling and wiring this receiver be careful not to scratch the plastic, and keep the soldering iron well away from the plastic. If you use rosin core solder, protect the plastic by covering it with pieces of paper taped in place to keep the rosin from splattering on the plastic.

The completed crystal radio is mounted on a fancy walnut base purchased from a woodworking shop. The plastic box is secured to the wood base by spotting the four corners of the bottom of the box with Duco cement. The dial for the pointer knob is simply a small disc of white double-weight paper held to the plastic box with a spot of Duco cement. Make pencil marks at the places where your local stations come in.

Use of a pair of sensitive high-impedance magnetic or crystal earphones, a good connection to a cold water pipe, and a long outdoor antenna (for best results, put up a long single-wire, random-length antenna.) With a simple crystal set it becomes particularly important that the antenna-ground system be the best possible. Remember, unlike its bigger cousin, the superheterodyne, the crystal set does not have rf amplifiers and other circuitry to help it pull in all those signals floating around out there in the ether. ■



PARTS LIST FOR CRYSTAL RADIO

BP1, 2—Binding posts for antenna and ground connections; may be any convenient type

C1—365-pF variable tuning capacitor, single-gang.

D1—Small-signal, general purpose diode, similar to 1N34.

J1, 2—Jacks for headphones (dependent on phone(s) selected.

Misc.—Headphone(s), high impedance. May be crystal or magnetic, or small earphone as supplied with transistor radios and portable tape machines; plastic photo display cube, approx. 4-in. each dimension; plastic pill container, 1 7/8-in. diameter, for use as coil form; 1/4-lb. 24-gauge enamelled copper magnet wire (Radio Shack 278-004 or equiv.); brass mounting strip, assorted screws, nuts and lockwashers.

SAVE YOUR VOLTMETER

And neaten up your bench area too, with these coiled leads.

☐ To be truly useful your bench voltohmeter usually comes equipped with two pretty long test leads—up to three or so feet. But most of the time you're using that black and red pair of leads to measure some resistance or voltages right under your nose, and only a few inches or so from the meter.

What can you do about those long messy leads which tend to tangle and curl around things, including the meter itself? How can you keep from constantly trying to untangle the leads, with the attendant danger of pulling the meter off the bench onto the floor?

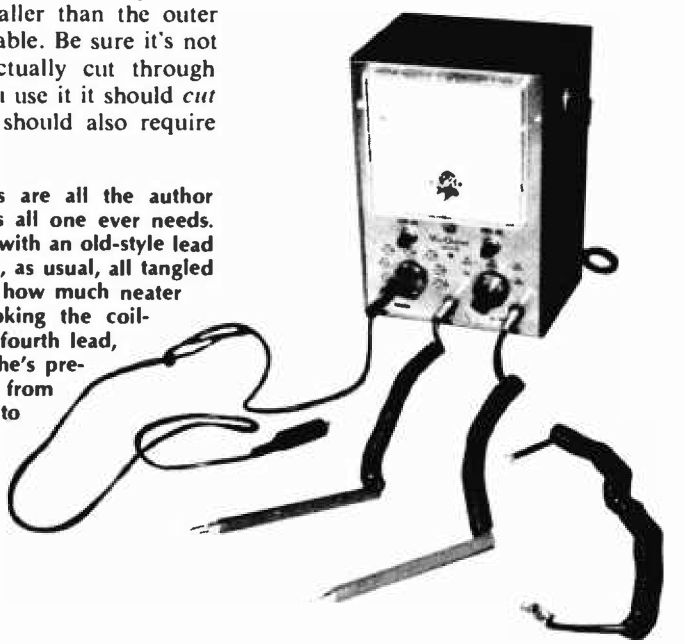
Make Coil-Cord Leads. Here's a good answer to this problem, sent in by Harry Miller of Sarasota, Florida. Substitute a coil-cord lead pair, made for flashgun-and-camera use, for the separate cables which came with your test meter. You'll have to remove the camera and/or flashgun fitting from the ends of the coiled cable first. Then cut off the short plug-in tips which go into the meter jacks. Finally, cut the two red and black cables about eight inches below the ends of the test probes.

Now comes the only tricky part of this job. You have to strip the black plastic outer covering of the coiled cable away from the two inner wires. I tried several ways to do this, and the best one is as follows. Use a pair of adjustable wire strippers, and set the size of the stripping hole, very carefully, just a bit smaller than the outer size of the plastic cable. Be sure it's not small enough to actually cut through the cable. When you use it it should *cut into* the cable, but should also require you to exert considerable force to tear the final bit of plastic off.

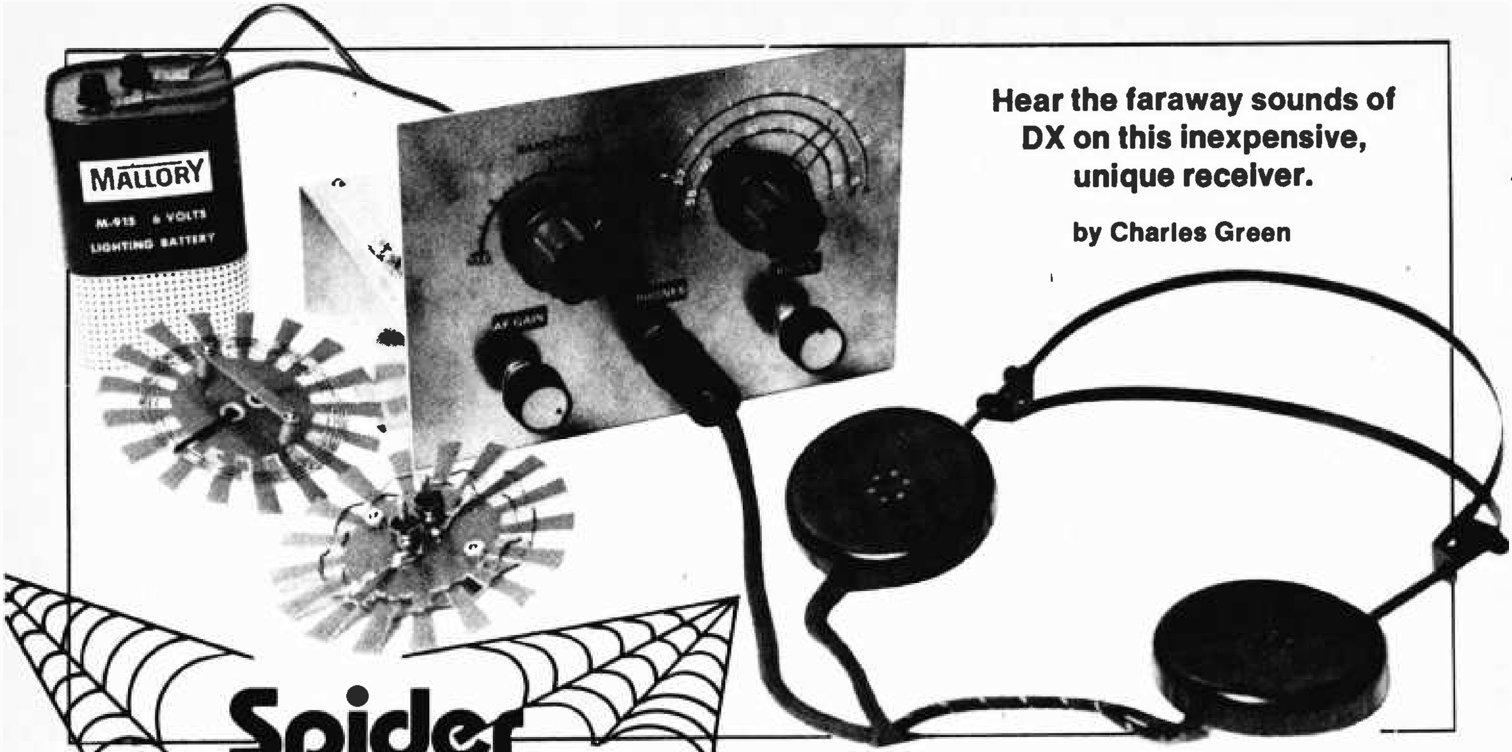
Wire These Connections. After stripping about two inches of the outer covering back from the inner wires, solder the black inner wire to the black cable (8-inches) coming from the black test probe. Similarly connect the white inner wire to the red cable coming from the red test probe. Wrap both joints carefully and securely with black plastic tape. Now tape them both together and double them over against the main cable to keep the strain away from the small inner wires.

Make the connections at the meter end of the cable similarly. You'll find you can unscrew the red and black plastic bodies of the plugs from the metal ends. Unsolder the short pieces (red and black leads) remaining and replace them with the white and black inner wires of the new cable. Tape for security. Finally, secure your meter with heavy masking tape or by other means so it won't jump off the bench when you extend the coiled cord to read something 2½ to three feet from the meter. That's it.

The Deluxe Version. If you want to do a really deluxe job, use two separate camera-to-flashgun coil-cords. Parallel the inner wires of each pair. It'll cost more, and take up a bit more space, but they'll last a lot longer. ■



Two coil-cord leads are all the author made because that's all one ever needs. Here they're shown with an old-style lead on the left, which is, as usual, all tangled and twisted. Notice how much neater and professional-looking the coil-cord leads are. The fourth lead, at the right, is one he's preparing to convert from photographic use to the new function of voltmeter lead.



Hear the faraway sounds of DX on this inexpensive, unique receiver.

by Charles Green

Spider Web Receiver

IN THE OLD DAYS OF RADIO, back when grandpa was building his first one tube radio, the spiderweb coil was the "cat's pajamas." This type of tuning coil was very popular with the home-constructors, and with good reason; the spiderweb coil is a high Q type, wound with interleaved turns for minimum residual capacity. Many of the old timers made long distance reception commonplace with this type of tuning coil in their radios.

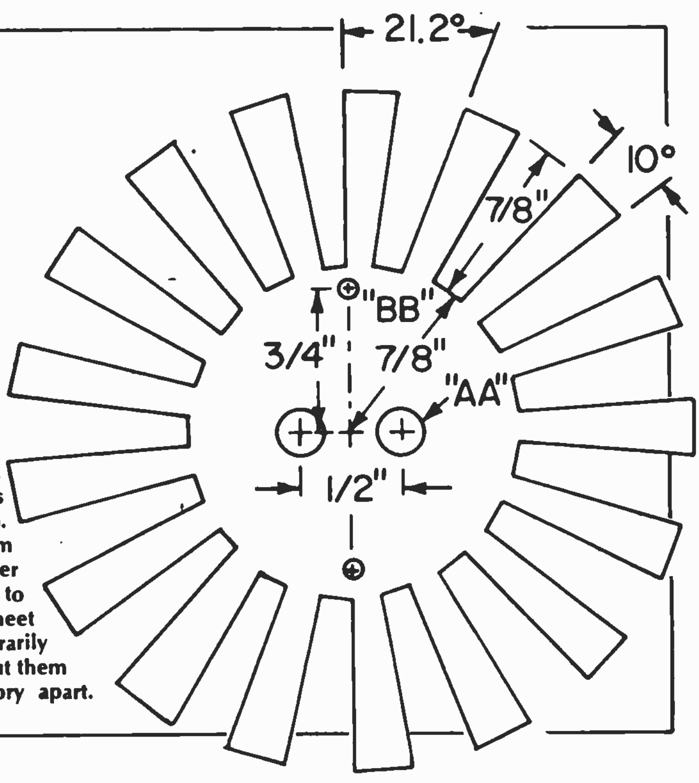
The spiderweb coil is a type of coil in which the wire is wound on a flat form so that the radius of successive turns increases from the center outward. You can experiment with this type of coil by building our receiver model which combines the old spiderweb coil with present day solid state circuitry. The receiver covers from 550 kHz to 14 MHz, with three plug-in spiderweb coils in a FET regenerative-detector circuit. A stage of audio is included with a pnp transistor directly coupled for good headphone volume.

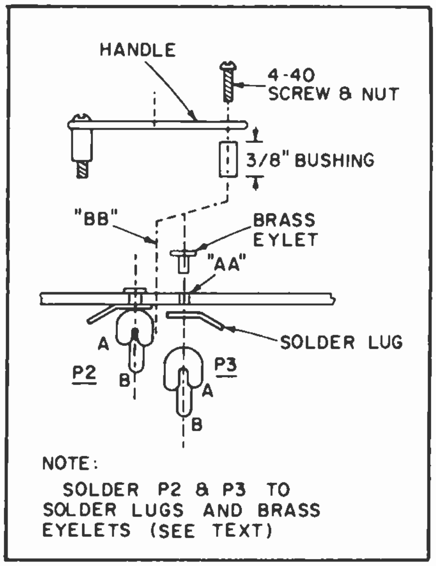
The Spiderweb Coil Receiver Circuit. Signals from the antenna are coupled through J1 and C1 to L1 and the tuning capacitor C3. The bandspread capacitor C2 is used to fine-tune crowded SW bands and the resultant signals are fed via C4 to the gate-leak R2 and the gate of FET Q1. The RF signals are detected and amplified by Q1 and a portion of the RF is fed back into L1 from the source circuit of Q1. This feedback RF is detected and further amplified by Q1. The regen control R1 varies the amount of RF feed-back to L1.

The detected audio signals in the drain circuit of Q1 are coupled through T1 to the AF Gain control R5 and to the audio amplifier circuit of Q2. The amplified signals are direct-coupled via the collector circuit of the pnp transistor Q2 through J4 to external high impedance phones. DC power for the circuits is supplied by an external 6 volt battery. Bias current for the Q2 base circuit is supplied by the R6-R7 divider circuit, and R8-C7 acts as the interstage decoupling network to minimize audio feedback between the stages via the DC power bus.

Three plug in coils are used for L1, each one covering a different band of

The best material for the coil is the plastic used for making printed circuit boards (approx. 1/16-in. thick). There are 17 vanes, each about 7/8 inches long and about 1/4-in. wide. Trace this diagram with thin tissue paper then glue the paper to three pieces of plastic sheet that have been temporarily glued together. Then cut them with a jig saw and pry apart.





Solder the phono plugs to each spiderweb by using small brass eyelets as rivets. A handle will simplify plugging-in.

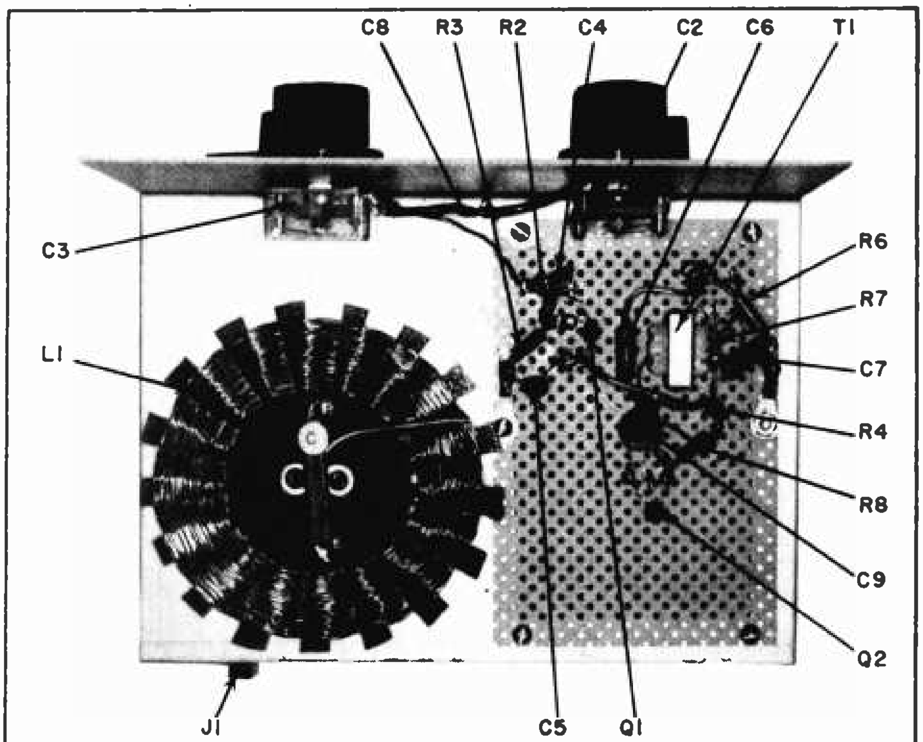
frequencies. L1 A tunes from 7 MHz to 14 MHz, L1 B tunes from 1.7 MHz to 5 MHz, and L1 C tunes from .55 MHz to 1.6 MHz.

Spiderweb Coil Construction. Look at the drawing of the spiderweb coil form. There are seventeen "vanes," ⅞-inch long and approximately ¼-inch wide, positioned around the perimeter of a 1½-inch disc. A good quality plastic should be used for the coil form; the coil forms shown in the receiver model photo are made from the type of plastic sheet used for printed circuit boards (approx. 1/16-inch thick).

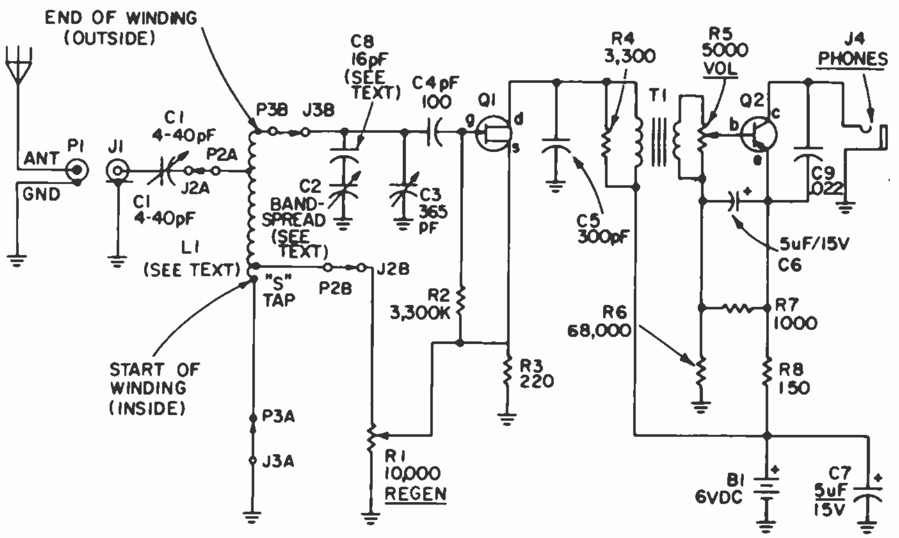
The easiest way to start construction of the coil forms, is to trace the outline of the spiderweb coil form drawing and temporarily cement the tracing onto a sheet of plastic. Then cut out the coil form with a hack saw. If desired, three sheets of plastic can be temporarily cemented together with rubber cement and the coil forms for all three bands can be cut out at the same time. After cutting out the forms, carefully pry apart the spiderweb coils.

Brass eyelets (available at notions counters in department stores) are soldered to lugs and P2-P3 as shown in the drawing. Carefully drill holes to fit the eyelets, positioned ½-inch apart, for each of the three spiderweb coil forms, and mount the phono plugs (P2-P3).

Refer to the Spiderweb Coil Winding Table and wind the coils with the turns indicated for each band. Start winding on the inside of each coil form and wind to the outside of the form. Allow enough wire at each end of the coil to solder to P3A-B as shown in the schematic. After winding the coil make the



This layout shows how best to locate the spiderweb coil to leave room for the perfboard. Note capacitor C8 which is used to help achieve the desired bandspread.



PARTS LIST FOR SPIDERWEB RECEIVER

C1—4 to 40 pF midget mica trimmer (ARCO 422 or equiv.)
C2—Bandspread capacitor (modified C3, see text)
C3—365 pF subminiature variable capacitor (Radio Shack 272-1341)
C4—100 pF capacitor
C5—300 pF capacitor
C6, C7—5uF/15 VDC Miniature electrolytic capacitor
C8—16 pF capacitor (see text)
C9—.022 uF capacitor
J1, J2, J3—Phone jacks
J4—Phone jack
L1—See Coil Table and text
P1, P2, P3—Phono plugs (see text)
Q1—FET (NPN), Motorola HEP-F0015, or equiv.)
Q2—Transistor (PNP), Motorola HEP-57 or HEP-S0019 (or equiv.)
R1—10,000 ohms linear taper potentiometer
R2—3,300,000-ohm resistor, ¼-watt
R3—220-ohm resistor, ¼-watt
R4—3,300-ohm resistor, ¼-watt
R5—5,000-ohm audio tape potentiometer
R6—68,000-ohm resistor, ¼-watt
R7—10,000-ohm resistor, ¼-watt
R8—150-ohm resistor, ¼-watt
T1—Audio transformer; PRI: 10,000-ohms, SEC: 2,000-ohm (Calectro D1-722 or equiv.)
Misc: 5 by 7 by 2-in. aluminum chassis, 5 by 7-in. copper clad board (for front panel), sheet plastic for L1 form (see text), knobs. 3 by 4½-in. perf board, two lug solder strip (to mount C1) 6 brass eyelets.

taps as indicated in the table; carefully scrape the enamel off the wire for a good soldered connection to the tap leads to P2A-B.

Receiver Construction. Most of the receiver components are mounted on a 3- by 4½-inch perf board section installed on a cut-out portion of a 5-by 7- by 2-inch aluminum chassis. As shown in the photos, the perf board is installed on one half of the top of the chassis to leave enough room for the plug-in spiderweb coils. The tuning capacitor C3 and the bandspread capacitor C2 are mounted on a 5- by 7-inch section of copper-clad printed circuit board used as the front panel. A similar section of sheet aluminum would also be suitable for the front panel. The panel is held by the mounting nuts of the regen control R1, audio gain (volume) control R5, and the phone jack J4 that are mounted in holes drilled through the front of the chassis and the lower half of the panel.

Begin construction of the receiver by cutting the perf board section to size and then temporarily positioning it upon the top of the chassis. Lightly draw the outline of the board on the top of the chassis, then remove the board and layout the chassis cut-out within the board outline. The cut-out section on the model shown is approximately 2½ by 4-inches. Drill holes near the inside corners of the cut-out section and use the holes to start a hack saw or jewelers saw. After the chassis section is cut-out, drill six mounting holes for the perf board edges. Install the perf board on the chassis with small machine screws and nuts.

Locate and install the board components with perf board clips. Do not install Q1 at this time to minimize any possible damage to the FET; solder Q1 into the circuit when all of the other components have been connected. Temporarily place an alligator clip across the source and gate leads (shorting them together) while soldering the FET in place. Cut the leads of all of the components to allow short, direct connections and to prevent any of the leads from accidently coming in contact. Make sure that you remove the alligator clip from the FET after soldering. For best results follow the component layout of the model shown in the photo. T1 is mounted by drilling holes in the perf board to fit the mounting tabs and then bending them over for a snug fit under the board. Position the three ground lugs on three of the board

SPIDERWEB COIL WINDING TABLE

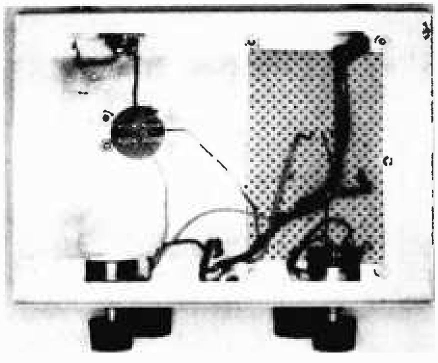
	WIRE SIZE	TOTAL TURNS	ANT TAP (P2A)	"S" TAP (P2B)
BAND A 7 MHz to 14 MHz	#18 Enam.	4	½-Turn from end	1-turn from start
BAND B 1.7 MHz to 5 MHz	#24 Enam.	17	1½-turns from end	2-turns from start
BAND C .55 MHz to 1.6 MHz.	#28 Enam.	52	10-turns from end	1-turn from start

mounting screws, as shown in the photo.

Cut holes in the center of the remaining portion of the chassis top to fit J2 and J3. Space the two jacks to fit the plugs P2 and P3 mounted on the plug-in spiderweb coils. A dual jack was used on the model shown in the photo. But, it may be easier to use separate jacks for easier spacing in the front and rear of the chassis to fit the components to be installed; R1, R5 and J4 on the front and J1, C1 and the rubber grommet for the DC power leads on the rear chassis. C1 is mounted on a two lug terminal strip with a small access hole drilled in the chassis to allow adjustment.

Bandspread Capacitor Construction. The bandspread capacitor C2 is a modified tuning capacitor that originally had a 365-mmf capacity. The model in the photo utilizes a Radio Shack miniature type with plastic dielectric. In this particular make of capacitor, the stator blades are made from thin sheet metal and are fastened with only one screw and nut. Carefully remove the end nut (after removing the plastic outer cover) and pry out the stator blades one by one with small pliers until only one blade is left. Replace the nut and tighten it. Check with an ohmeter to see if the blade is shorted to the rotor blade assembly. If so, remove the nut and readjust the stator blade. The rotor blades should be able to rotate freely as the shaft is turned.

Front Panel. Mount the panel on to the front of the chassis by drilling the appropriate holes and securing it with the mounting nuts of the panel controls. After the panel is mounted with the copper clad surface facing outward, locate and drill the holes for C2 and C3. Install the two variable capacitors and then connect them to the circuit board with short leads. C8 is mounted between the stator of C2 and the stator of C3. The exact value of C8 is best determined by experiment after the receiver is operational for the desired bandspread. A good starting value is 16



This bottom view of the receiver shows the jacks for the spiderweb and how they are hooked up to the antenna. Note how the perfboard is secured to the chassis.

mmf (as on the model shown in the photo).

Completing Construction. Complete the construction of the receiver by wiring the underchassis components. Make sure that the leads to J2 and J3 are as short and direct as possible; position these leads up and away from the chassis bottom. Connect the DC power leads to the circuit and mark them with the proper polarity. Or, a red lead can be used for positive and a black lead for negative polarity. Make a knot in the power leads before putting them through the rubber grommet on the rear of the chassis.

Install knobs on the shafts of the front panel controls. If necessary, cut the shafts of the controls for a uniform appearance. Cement a 1-in. length of Number 18 wire on the rear of the C3 knob. Or, a shaped section of clear plastic with a black line drawn down the center can also be used for a pointer.

Dial Calibration. The front panel dials are marked with rub-on lettering positioned on three concentric India-ink lines for the C3 dial, and one inked line for C2. Begin dial calibration by plugging in the "C" Band (Broadcast Band) coil and connecting earphones and a six

(Continued on page 119)

CHANNEL CHANGER Soups Up Your Scanner

Add the versatility and excitement of extra frequencies to your Public Service Band monitoring.

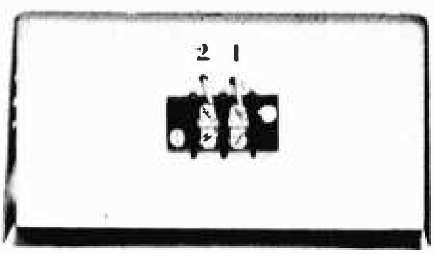
by Louis A. Smith II

☐ With today's increasing crime rate, and the increasing need for security, many police departments are expanding the number of frequencies on which they transmit information. In most scanners you can only fit either eight or ten different frequencies, and the task of changing crystals when the ones you have installed are temporarily out of use, is bothersome, especially in a mobile unit!

Of course, instead of changing crystals you could always buy one of the sixteen-channel synthesized units, and pay in excess of $300! Or you could solve the problem of changing crystals by building and installing the "Channel-Changer." It's small and easily installs on either a mobile or base scanner, and requires no external power source. It provides you with capability of changing crystals at the flip of a switch. For this project I used a Realistic Patrolman PRO-14, but the principle can be easily adapted to work with most major crystal-controlled scanning monitors.

What it Does. The Channel-Changer is a low-cost switching device which performs the task of changing crystals in a scanner. It does this by using a 12-position, single pole, rotary switch to change from one crystal to another. This gives a maximum of 12 possible frequencies for one crystal position in the scanner. The only limitation is that all crystals in the Channel-Changer must be in the same frequency band, i.e., *all* frequencies installed in the device must be either in the 30-50 MHz (VHF low), 150-174 MHz (VHF high) or 450-512 MHz (UHF) range. Do not install several crystals from one of these bands and several from another band in the Channel-Changer at the same time, as this may damage the crystal, the scanner, or both. This rule of thumb only applies to the crystals installed in the Channel-Changer itself; the other nine crystal sockets in the scanner may be used with crystals in any frequency band.

Construction. All components are mounted in a metal utility cabinet using the base of the box as the chassis.



This back view of the Changer shows the barrier terminal strip and its two interconnection points to connect to the scanner.

First mount S1, the crystal-selector switch, on the front panel of the case. Exact placement isn't critical, but it should be mounted near the center of the panel.

Next comes the crystal holder. For this purpose I utilized a 22-pin edge card connector. The edge card connector is excellent for this purpose because firm contact with the crystals is essential. Before mounting the connector on the chassis, some wiring must be done. Connect the first twelve terminals on one side of the connector together, using #20 gauge wire. After this wiring has been completed, the connector may be mounted in the center of the chassis base, parallel with the front and back panels. It should be mounted on one-inch aluminum spacers, with the side with the terminals connected facing the back panel of the case.

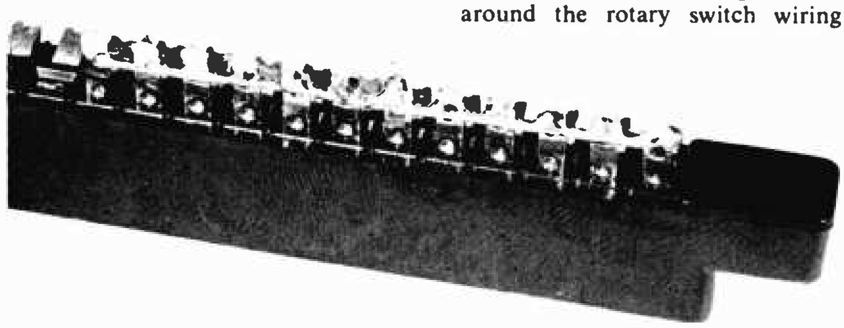
Lastly, mount the 2-terminal barrier strip on the outer side of the back panel, near the center. Drill two ⅛-inch holes in the back panel, one above each terminal.

Now attach some type of indicator knob on the shaft of S1. I used a communication knob. The shaft of S1 will have to be shortened to accommodate such a knob.

Wiring the Changer. When the components are mounted, it is time to finish the construction by wiring the project.

The first step in wiring is to connect a wire from the common (innermost) terminal on S1 to terminal 1 on the barrier strip.

Next S1 must be wired to the edge card connector (crystal holder). When looking at S1 from a rear view, choose one of the 12 outside terminals which is approximately at the 6 o'clock position. Connect a wire from this terminal on S1 to the first terminal on the edge card connector, (that is, the terminal facing the leftmost of the twelve which were previously wired together.) This will be the connection for crystal socket #1 in Channel-Changer. Continue around the rotary switch wiring the



Wire the first twelve terminals of an edge-card connector together, as shown above. Some of the terminals opposite those wired are bent down for greater clarity.

CHANGER

next terminal on S1 to the next terminal on the connector, going from left to right on the connector, and clockwise around S1. Continue wiring in this manner until all twelve positions on S1 have been wired to the corresponding twelve terminals of the crystal holder.

The final connection to be made in wiring is to connect a wire from one of the twelve terminals on the connector which were wired together, to terminal 2 on the barrier strip. Consult the schematic diagram.

Interfacing with the Scanner. After the wiring is finished, install up to twelve crystals in the twelve wired positions in the edge card connector. The position furthest to the left will be position #1, the next, position #2, and so on. Although Channel-Changer has the capability to hold 12 crystals, it may be used to switch any number from 2 through 12. Now the Changer is ready to be attached to the PRO-14.

First, remove the crystal compartment cover, located on top of the scanner. Choose the channel to which you want to connect the device and remove a crystal, if one is already present in the socket. Next, move the "Band Select Switch" for that channel to the specific band in which all the crystals in the Channel-Changer are. If the channel you selected is channel 1 through 5, connect a wire (#20 gauge) from terminal 1 on the barrier strip to the *lower* pin in the socket. If the selected channel is 6 through 10, connect a wire from terminal 1 on the barrier strip to the *upper* pin in the crystal socket. Instead of inserting a plain wire into the crystal socket, it is better to use some type of metallic terminal. The pins on these terminals are .042 inches in diameter, so I recommend pinching them slightly with long-nosed pliers to fit in the crystal sockets which are made to accommodate the pins on a crystal which are approximately .038 inches in diameter. (See schematic diagram for definition of upper and lower pins in the socket.)

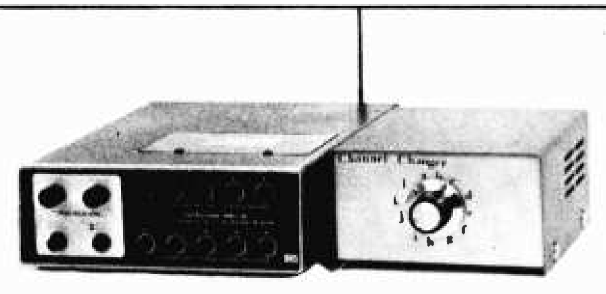
Next connect a wire to terminal 2 on the barrier strip and fasten the other end of this wire to the outside of the crystal compartment cover with electricians tape. Strip about ¼-inch of the plastic covering on this wire off the end which is attached to the compartment cover. These two wires running from terminals 1 & 2 on the barrier strip to the crystal compartment of the PRO-14 can be of any length, but it is best to keep them short to avoid possible interference with the FM broadcast band.

After these connections have been made in the compartment, the cover can be replaced. Be careful not to tighten the cover screws too much as this may cut the wire running from terminal 1 on the barrier strip to the inside of the scanner, and thus short out the connection.

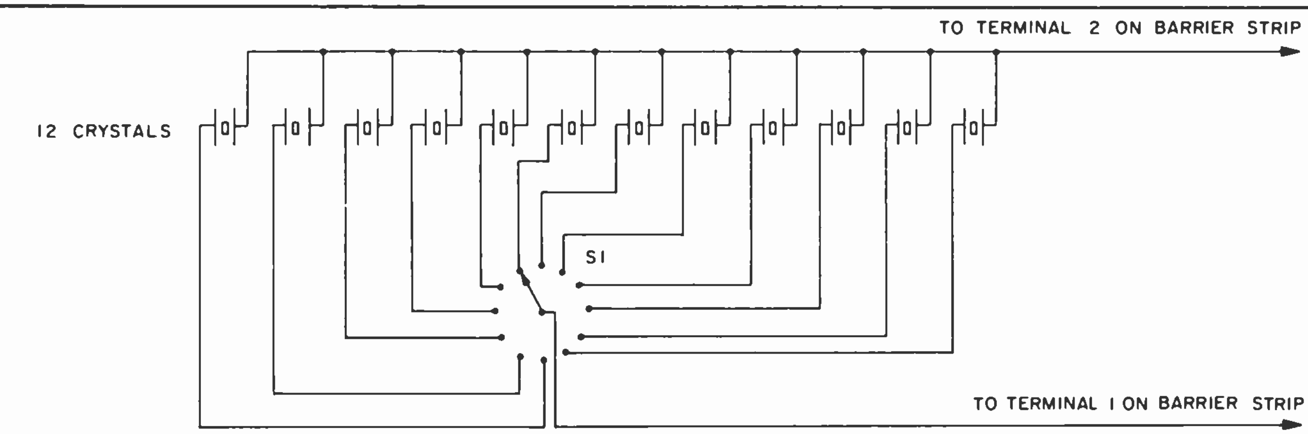
A few final construction hints: It is advisable to label the positions of S1 on the front panel, so that it can be easily seen which crystal is connected to the scanner at any given time. Labeling should be done before replacing the cover of the utility case, while looking at the back of S1 to see which crystal is connected when S1 is in any of its twelve positions. Dry-transfer lettering works well on the surface of the utility case.

Testing it Out. When construction is completed, Channel-Changer is ready to be tested out. Before turning power in the scanner on, check all wiring against the schematic diagram, and correct any errors.

With a National Weather Service crystal, (or any other continuous broadcasting crystal in your area, such as mobile telephone, etc.) installed in the changer, set S1 so that this continuous broadcasting crystal is connected in



Here's Channel Changer ready for action! With it, you can add twelve more channels of excitement to your scanner. It's both easy to build, fun to use.



This extremely simple circuit can be put together in an evening with a minimum of effort. Wire up the switch and terminals in sequence so that the wiring is neat and orderly, and mark the front panel carefully to align with the switch positions.

PARTS LIST FOR CHANNEL CHANGER

S1—Rotary switch, single-pole, 12-position, shorting

XTAL holder—Edge card connector, made to accommodate 22-pin card

Misc.—aluminum spacers, barrier terminal strip, 2 terminal, communications knob, crystals, see text for options, dry-transfer lettering, hook-up wire, gauge 20, metal utility cabinet, metalic terminals

RADIOTELEPHONE (RCC) FREQUENCIES

These VHF and UHF frequencies are used by mobile telephone systems across the country.

Receive	Transmit	Channel Designator
VHF "High" Band		
152.03	158.49	1
152.06	158.52	3
152.09	158.55	5
152.12	158.58	7
152.15	158.61	9
152.18	158.64	11
152.21	158.67	13
UHF Band		
454.025	459.025	21
454.050	459.050	22
454.075	459.075	23
454.100	459.100	24
454.125	459.125	25
454.150	459.150	26
454.175	459.175	27
454.200	459.200	28
454.225	459.225	29
454.250	459.250	30
454.275	459.275	31
454.300	459.300	32
454.325	459.325	33
454.350	459.350	34

Thanks to Channel Changer, you're going to have a lot of extra frequency requirements in your scanner. The radiotelephone bands can make for some real exciting listening. Here's the lowdown—our compliments.

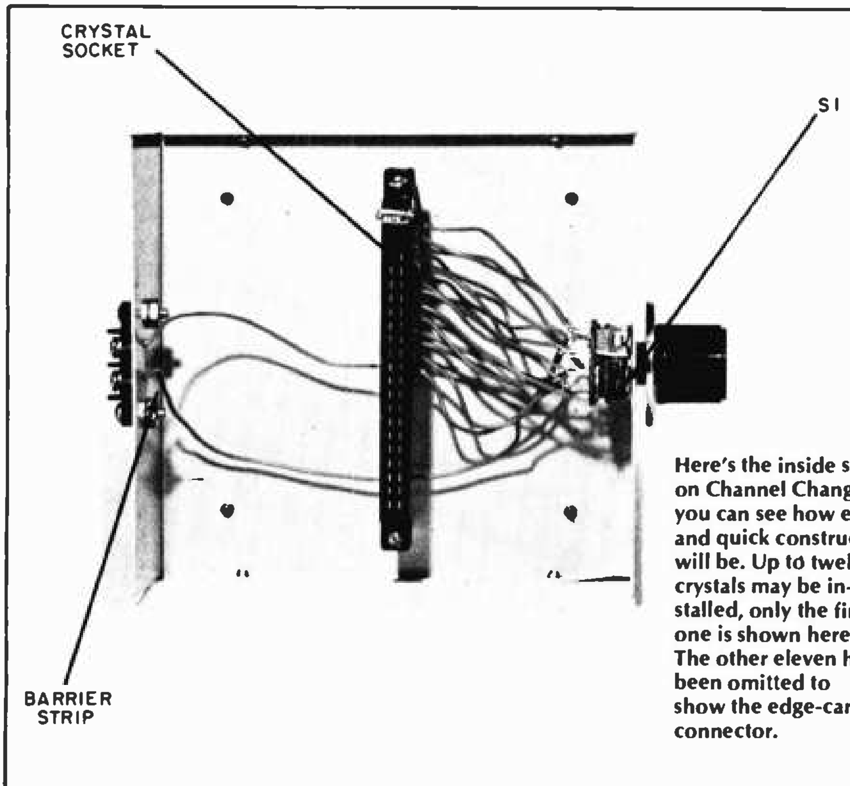
the circuit. Turn the scanner on, and manually stop the scanner on the channel to which the Changer is connected. The scanner should now be receiving the frequency of the continuous broadcasting crystal. If reception is poor, or doesn't exist at all, switch the connections at the terminals on the barrier strip. If this doesn't correct the problem, a bit more of the plastic covering should be removed from the wire which was taped to the crystal compartment cover. Also, make sure that the wire in the crystal socket is securely in place. This should improve reception.

Installing the Changer. Channel-Changer can be easily mounted in either a base or mobile installation. It should be kept in mind that the two leads extending from the terminals of the barrier strip should be kept as short as possible.

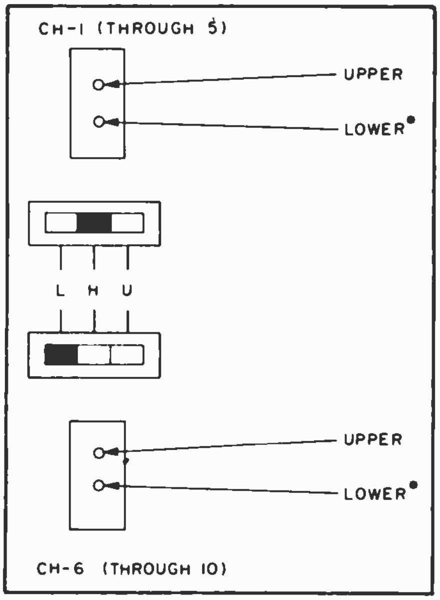
To install Channel-Changer on a base installation, it can be set either on top or beside the scanner after the wiring between the Changer and the Scanner has been completed.

If you want to install the Changer in a vehicle, it can easily be bolted under the dash board next to the scanner after all interconnections have been made.

Channel-Changer is very useful for scanner-owners who live in major metropolitan areas, or in areas in which police departments have several frequencies, but who primarily use one for general communications, and hold



Here's the inside story on Channel Changer, you can see how easy and quick construction will be. Up to twelve crystals may be installed, only the first one is shown here. The other eleven have been omitted to show the edge-card connector.



If you're interfacing Channel Changer on your scanner's channels 1 through 5 (inclusive) connect a wire from terminal one on the barrier strip to the lower pin in the socket. If to channels 6 through 10 (inclusive) then the wire goes from the terminal to the upper pin in the socket Make certain you don't do it backwards.

the others in reserve for special or emergency messages. It is also useful when installed on a mobile unit, for people who commute from one area to another, because the crystals of the police or fire departments of another locality could be installed in the Changer, and switched to only when you drive within receiving range.

Operation. After the PRO-14 scanner is turned on, set the control knob (S1) on the Changer to the desired crystal position. The scanner will scan 9 crystals installed in the scanner itself plus the one crystal in the desired position of the Changer. The PRO-14 will not scan all twelve crystals in the Changer at the same time, but only the one to which S1 is set. When a transmission is received on the selected crystal in the Changer, the channel indicator light on the PRO-14 will light corresponding to the channel in the scanner to which the Changer is connected.

As an example if the Channel-Changer is connected to channel 3 on the scanner, the indicator light for channel 3 will light when a transmission is received on the crystal selected in the Changer. The Changer can be cut out of the scanning circuit altogether by simply locking out the channel on the scanner to which it is connected.

Now that you've built the Channel-Changer, you've solved your crystal change problem! Happy PSB listening! ■

IT IS A LITTLE KNOWN FACT, but the simple act of using jumper cables to start (boost) a car with a dead battery can lead to severe personal injury. It's true!

A good Samaritan in California was helping his neighbor start his car by jumping the battery. The battery exploded and our hero got a face full of sulfuric acid for his trouble. A man in Pennsylvania noticed another charging his batteryincorrectly. When he attempted to rearrange the cables from the charger there was some sparking, and the battery exploded.

The reason for both of these accidents, and many others, is the fact that a battery being charged produces hydrogen gas, a very combustible and explosive element. The longer a battery is charged the greater the accumulation of hydrogen, and the greater the danger of a serious explosion. All that is required is a single spark as one connects either of the jumper cables to a battery post.

How does one avoid such an occurrence? Simple. Just follow the step-by-step procedure given below whenever you need to jump one battery to another.

10 steps to safe battery boosting

By Thomas R. Sear

1. Ensure that the ignition switches and all electric accessories, including the lights, are turned off in both cars.

2. Verify that both batteries are rated for the same voltage. Most automotive-type batteries are 12-volt models these days; but many older cars, as well as some of the smaller models, may have a 6-volt battery.

3. Remove the dustcaps from each cell of both batteries, and make certain that the electrolyte reaches the FULL-mark. If not, ordinary tap water can be used to top-off each cell if distilled water is not available. If the dead battery is to be recharged, the dustcaps should be left off to prevent any buildup of pressure due to the rapid release of hydrogen gas from the battery fluid.

4. Cover the battery openings to prevent any splashing acid from reaching your skin or clothing. Your handkerchief will suffice.

5. Attach only one jumper cable at a time. Connect one end of the *red* jumper cable to the positive terminal of the good battery first. This is the terminal marked with a +, a P, or POS. Then connect the other end to the positive terminal of the dead battery.

6. Connect one end of the *black* jumper cable to the negative terminal of the good battery. This is the terminal marked with a –, an N, or NEG. Then connect the other end to a point on the frame of the car with the dead battery at least 18 inches from the battery.

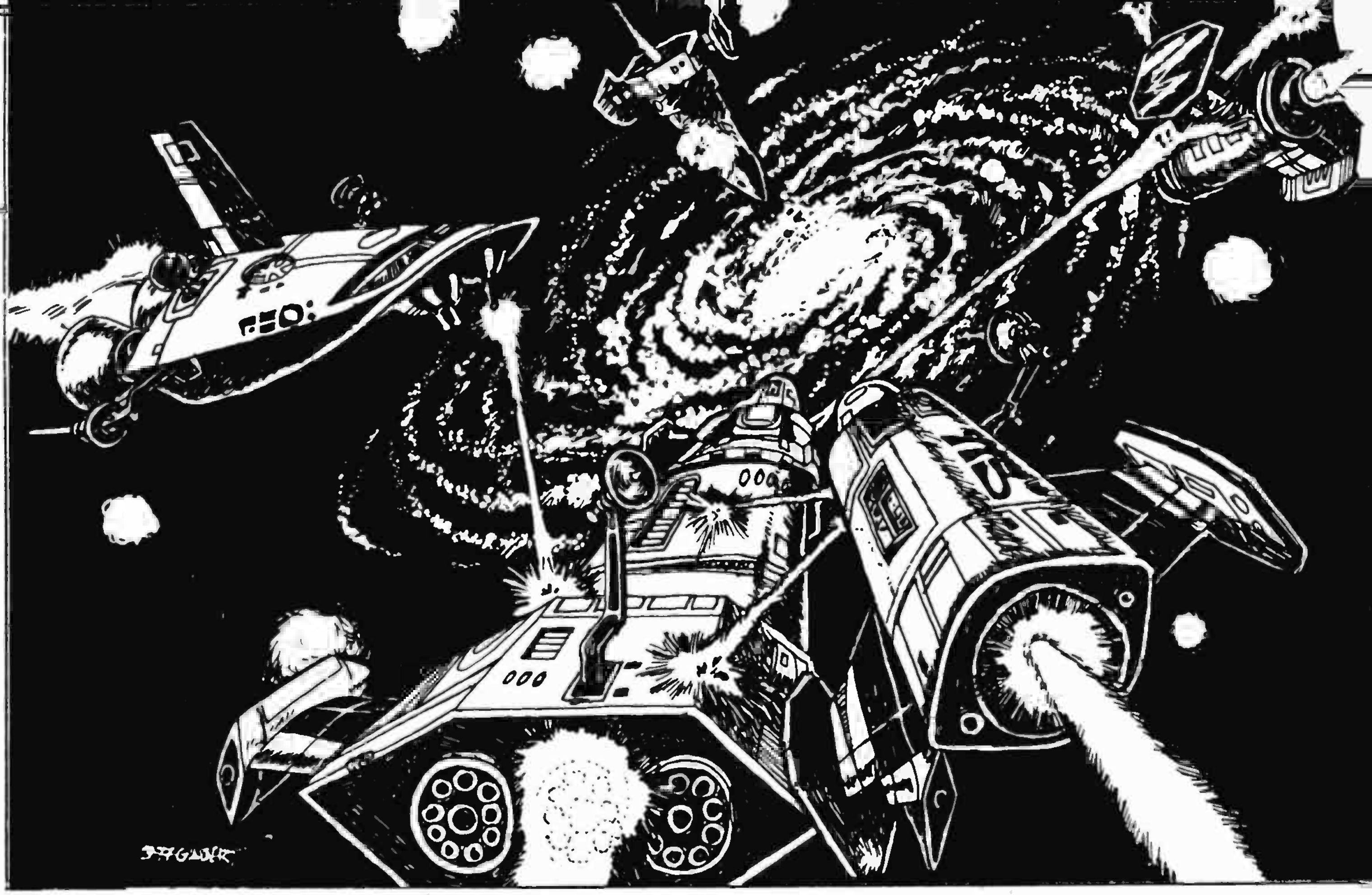
7. Start the engine of the car with the good battery. Allow the car to warm up for a few minutes, holding engine speed to a fast idle.

8. Start the engine of the car with the dead battery. If the engine starts, proceed to Step 9. If it doesn't, turn off the ignition and wait several minutes. Don't flood the engine with too much gasoline. If the battery is completely dead, wait about half an hour so the battery may be charged by the running car. Try to start the dead car again. Now, if successful, proceed to Step 9. If the car cannot be started, see a mechanic.

9. Disconnect the jumper cables by reversing the order in which they were connected. Keep the car with the bad battery running at a fast idle until it is warmed up. The chance of stalling is thus greatly reduced.

10. Replace the dustcaps on the dead battery.

Some final notes: It's always best to determine why the car didn't start in the first place and have the car adjusted or repaired. Repeated battery boosts are unwise and unsafe. Also, because of the hydrogen gas present when batteries are involved, *never* smoke a cigarette near a battery that is being charged. ■



SPACE: 1978

Run a farflung stellar Empire on pennies a day!

By Neil Shapiro WB2KQI

Look up past the treetops, further still, beyond the clouds and the familiar blue sky into the black velvet of Space. Height no longer has meaning, and the stars are sprinkled like a diamond cutter's dust and scattered to the farmost edges of Infinity. In the silence of that void, like technological phantoms, interstellar ships of competing galactic empires move at unimaginable speeds through uncharted dimensions. The ships fly on their missions of power and conquest, linking together the blue and habitable worlds which circle yellow stars, and often these ships clash terribly in that night, temporarily bringing light to an emptiness never lit before.

In a way, all of this is fantasy—but on the other hand, it seems quite real to the hundreds of people who play GALAXY II each month by mail. Once every turn a prospective Galactic Emperor must make hard and fast decisions on how to run his own segment of the galaxy. Everything, from building ships and naming their captains to founding colonies, fighting battles, collecting and disbursing taxes, and much more, is all figured into each turn. There are more than forty players in each game who send in monthly moves. The moves are then collated, followed through, and any player interactions decided, all by computer.

Of course, it's not just any computer which can handle the complexity of a game such as GALAXY II. The game is run on two System 370 model 168's from IBM. These are huge computers with over seven megabytes of real core storage. In fact, these computers use something termed "virtual storage" which, as the name implies, means that the available memory space is virtually unlimited depending on how the system is configured.

Does this mean that only computer programmers and high-level scientists are among those playing GALAXY II? Well, many of the players (all of whom hope to become a Galactic Emperor) come from backgrounds widely divorced from the sciences and research.

Brett Tondreau, GALAXY II's designer, states, "We're looking for overworked, highly educated people who are jaded with the cursory forms of entertainment currently so common in the TV and movie theatres. We need people who are conscious of what they like and have a very high respect for both their own creative energies and those of others."

So, if you're tired of watching *Star Trek* re-runs on the tube, here's your chance to set out on your own mission and go 'where no man has gone before.' All it takes is the creative energy to be able to envision what it would be like to run your own galactic empire, and the desire to give it a try. The rules are complex in their entirety, but each part of the whole can be readily enough comprehended with just a little effort. Once you know what you're doing, you would be hard put to swear that all those spaceships, planets and colonies *don't* exist. It is simply amazing how receiving personal reports of a mission accomplished from one of your favor-

SPACE:1978

ite starship captains tends to make you believe in everything that's going on.

Because of the wealth of detail involved in GALAXY II, there is really no such thing as a typical turn. There are, however, typical parts to most turns, operations which are done again and again but put together in varying ways for different goals.

For instance, let's say you're ready to launch a new spaceship. Your first act is to see that the planet launching that ship has enough Matter-Antimatter-Drive units (MADs) to contribute to a vessel of the size you plan on designing. If not, you'll have to decide how much of that planet's industrial capabilities to assign to producing those MADs, and then you'll have to begin juggling priorities. To make it easy, we will assume that the planet has already stockpiled 8 MADs, which is enough to fashion a Lance-Class vessel.

So, you have the eight MADs. Now, each MAD has to be contained within a hull unit (HU). You will then have to assign at least 8 HUs to the ship. Again, you have to decide to either build new HUs or to use any stockpiled.

Let's not forget the fact that the ship has to be crewed. You may want to also assign it a goodly number of colonists in "cold sleep," along with maybe one or two high-level passengers. All of these people breathe, and so you will have to assign a value of Life Support (LS) that will last at least as long as the mission you plan. To get those peopeople where you want to send them will require you to assign Power Support (PS).

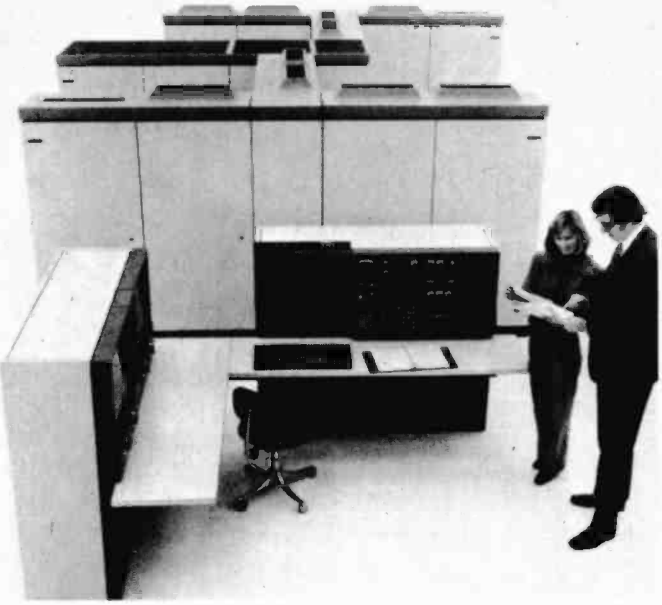
Unfortunately (though it's a lot of fun!), everyone "out there" isn't going to be friendly. It would be a good idea to assign that Lance-class ship a certain number of Beams (BEs) for offense and a goodly number of Shields (SHs) for defense. Combat will be decided using these variables along with how experienced your ship's captain is from previous battles or missions.

Further, you may want to assign each ship a number of Probes (PBs) so that it may gather intelligence for you. Of course, don't forget the Screens (SCs) which can shield that ship from an enemy's probe and mask its identity.

Figure on having only a small fleet in the beginning of the game. Sooner or later, once you figure out which stars hide your opponents' own degenerate races as opposed to your own race of superbeings, you'll have to build a bigger fleet to root the blighters out.

Be sure you don't forget your planetary development. This is one of the

(Continued on page 116)



GALAXY II is run on an IBM-370 model 168 like the one shown here. The computer offers seven megabytes of real core storage along with virtual storage systems which give an almost unlimited storage capability. The game makes use of the system's peripherals which are configured to include such things as: 32 disk drives, three banks of tape drives and IBM's fastest printer terminal. Right now, GALAXY II is using only 500K of memory so there is plenty of room for future Empires to expand and war into.

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WHAT FOLLOWS IS AN ACCOUNT OF THE ACTIONS ON THE PLANET AVALON   GALACTIC COORDINATES 14-14-3 IN THE POST FLIGHT PHASE
COLONY   LOCATION GOVERNOR   BEAMS SHIELDS   PROBES SCREENS    MADS   HULLS  ECONOMIC  MINERAL-II  INDUSTRIAL UNITS   CAPACITY
AVALON   14-14-3 GAWAIN         18      20       20      20       1       0  RESOURCES      466           2817           13.32
                EXPERIENCE                     DESIGNATION                   MINERAL-I MINERAL-III UNIVERSAL UNITS  EFFICIENCY
                         1                         AH                          522        293          -21988           3.97
```

Each month the GALAXY II computer tells you how your dreams of Empire are being made into reality—either that or how you're gradually being wiped from the map by your opponents. Here we see a typical report on a planet by the name of Avalon, which is governed by a gentleman named Gawain. The planet is in fairly good shape mineral-wise, and is just beginning to show signs of economic expansion. Obviously the treasury has been depleted, as shown by the -21988 Universal Unit figure. Hopefully, this money has been invested soundly and new factories (Industrial Units) have been planned as well as investing in the indexes of Capacity and Efficiency. If this plan of deficit financing succeeds then Gawain will wind up governor of a rip-roaring planet.

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SHIPS LOG OF THE VESSEL IGRAYNE   CLASS: MSH        FIRST FLIGHT PHASE

FLIGHT EXECUTED.  PRESENT LOCATION OF IGRAYNE  IS 14-14-2.
CAPTAIN BLAMOR   REPORTING A SUCCESSFUL FOUNDATION OF COLONY CORNWALL AT 14-14-2 WITH   30 INDUSTRIAL UNITS.
COLONY CORNWALL REPORTS SUCCESSFUL ADAPTATION.  INITIAL CONDITIONS INDICATE THE CAPACITY OF PLANET AS 0.33 . -CAPT. BLAMOR
WE HAVE TRANSFERRED          12 SCS TO THE COLONY CORNWALL
VESSEL   LOCATION  CAPTAIN   BEAMS SHIELDS  PROBES SCREENS    MADS   SECURITY     TRIBUTE  POWER SUPPORT  MINERAL CARGO  MINERAL-II
IGRAYNE   14-14-2  BLAMOR      20     20        0       0       6     (S)              0    25.1999                          0
                EXPERIENCE  PASSENGER & EXPERIENCE  CLASS  HULLS  DESIGNATION  INDUNITS  LIFE SUPPORT      MINERAL-I  MINERAL-III
                        20                        C   MSH      6      AH              0    79.9951                0           0

SOLAR SYSTEM REPORT AT 14-14 (RACE,DG,COND.,COLONY): (NO RACE  UH   UNNAMED ) (LOGRES   AH   CORNWALL) (LOGRES   AH   AVALON  )
AND  2 VESSELS (BY ORB,HULL,DG,C,BRACE): ORBIT 0: ORBIT 1: ORBIT 2: IGRAYNE  AH  MSH  LOGRES   ORBIT 3: YSOLDE   AH  MSL  LOGRES
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The computer also reports on each and every one of your starships; tells you where they've been, what they've seen and what actions they've taken. Here we see the log of the Igrayne, under the command of the noble Captain Blamor. The good Captain is able to report to his Leader that the colony of Cornwall was successfully founded and the colonists transported safely there. His ship is now empty of cargo (INDUNITS) as all the colonists have been dropped off. The Igrayne's armament, while not too very formidable, consists of a good selection of beams, shields, screens and MAD. The Igrayne under Blamor's command would be a tough nut to crack

Ring-A-Thing

Don't miss that money-making call, build Ring-A-Thing and hear them all!

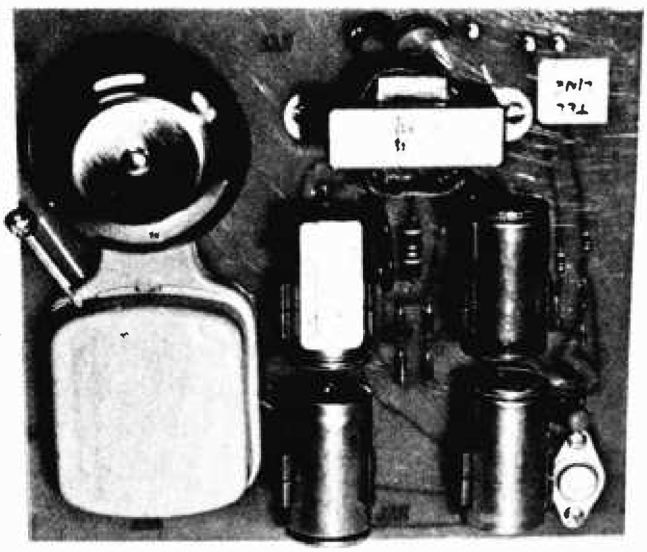
by Anthony Caristi

DID YOU EVER MISS an important telephone call because you were out of range of sound of the telephone bell? It doesn't have to happen again if you build and install this inexpensive remote telephone bell. It is battery operated and can be located anywhere inside or outside your home. Since it is self-powered it requires virtually no energy from the telephone line. The input impedance of the circuit, as seen by the telephone line, is almost 100,000 ohms and the input resistance is infinite. When connected across the telephone line it is undetectable and has no effect on telephone performance.

No Power Problems. The circuit derives its power from four rechargeable NiCad cells connected in series which provide 4.8 volts to drive an ordinary doorbell. Since the power demand on these cells occurs only when the telephone rings, the battery will operate the bell over 1000 times on one charge. This should last several months, depending upon how many calls you receive. A built-in battery charger is included in the circuit so that the cells may be conveniently charged from the AC power line at any time. Full recharge takes 14 hours, but the charger may be left in operation indefinitely, if desired, with no damage to the cells due to overcharge. This is possible since the charging circuit has been designed to deliver a limited current to the cells. The NiCad cells used in this circuit are size C, but other sizes may be used. This is possible since the charging circuit has been designed to deliver a limited current to the cells. The NiCad cells used in this circuit are size C, but other sizes may be used. This will be covered later in this article.

How It Works. When the telephone rings, a 20 Hertz AC voltage of about 220 volts peak to peak is impressed across the telephone line. The series circuit composed of R1, R2, R3, C1, and C2 is connected across the line to provide isolation and act as a voltage divider for Q1. C1 and C2 provide DC isolation, since the line normally has a DC voltage of about 48 volts across it when the telephone is not in use. Q1 responds to the 20 Hertz ringing signal by conducting current during each positive half cycle applied to its base. CR1 prevents Q1 from being reverse biased during the negative half of the ringing signal. The emitter current of Q1 is applied to the base of Q2 causing it to saturate and act as a switch. This applies full battery voltage to the bell, causing it to ring. The voltage applied to the bell is essentially a 20 Hertz square wave which produces a slightly different sound than that produced by pure DC. CR2 and C3 protects Q2 from any reverse voltage spikes produced by the collapsing magnetic field of the bell.

The battery charger circuit is composed of T1, a 4 diode bridge rectifier, and R5. T1 provides isolation from the AC power line while reducing the voltage to about 6 volts RMS. The ouput



This view is from the top of Ring-A-Thing, looking down on the PC board. There really aren't many components, so you'll see how neatly spaced they are. The board has to be large, because of the size of the bell, which is mounted on it at left.

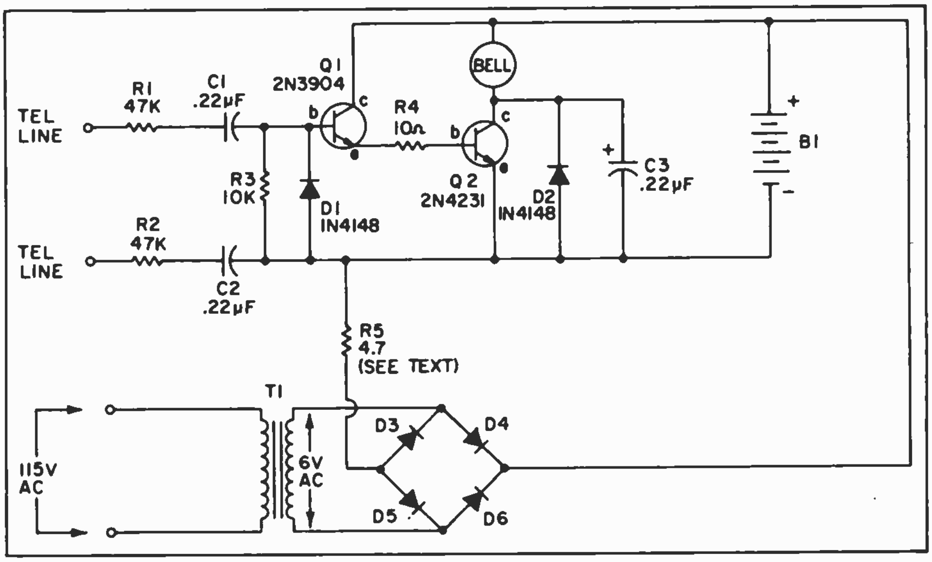
Ring-A-Thing

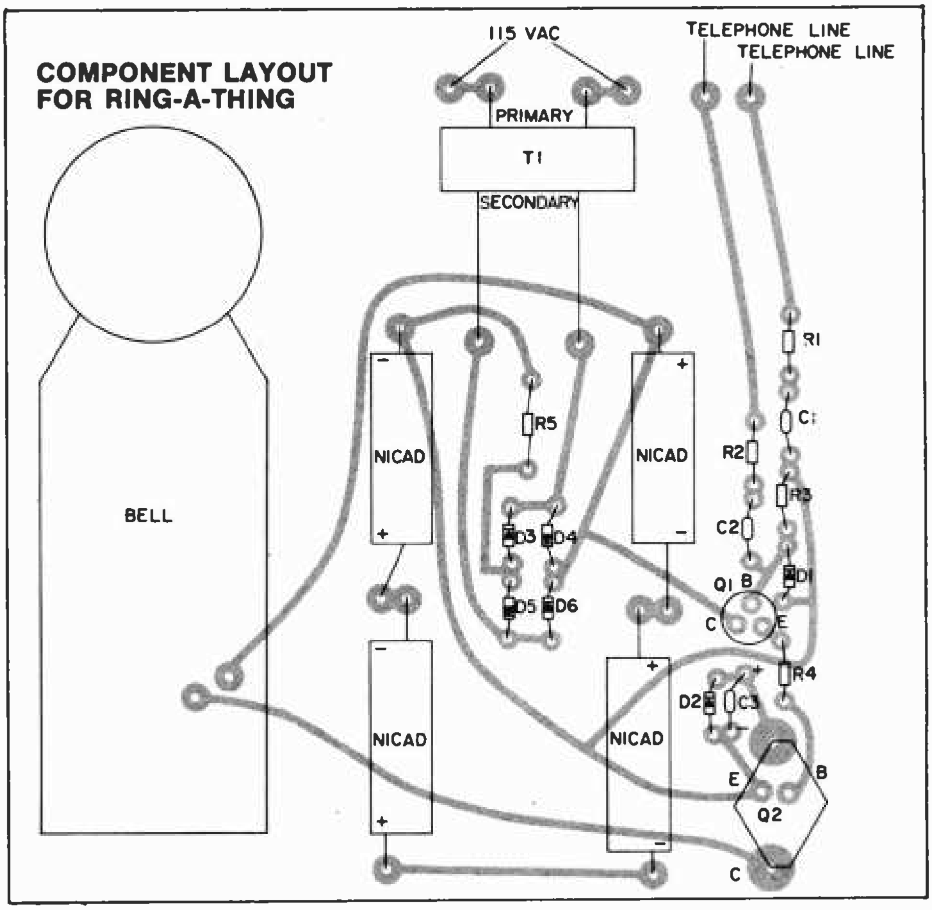
of the bridge rectifier, a pulsating DC of about 9 volts peak, is applied to the four cells through a current limiting resistor, R5. This type of circuit is recommended for NiCad cells, and provides essentially a constant charge current regardless of the state of charge of the battery or power line voltage. By limiting the current to not more than one tenth of the ampere hour rating of the cells, the charger may be operated for any length of time without damage to the battery due to overcharge. When the cells attain full charge, the gases produced within the cell are recombined chemically preserving electrolyte.

Construction. The entire circuit is built on a 6½-inch x 9½-inch printed circuit board. The foil layout is shown half size in figure one and the component layout is shown in figure two. The cells are securely mounted to the printed circuit board using steel clips. This method of assembly is recommended since it would not be good practice to rely on the connecting wires of the cells to hold them in place. If the cells you are using do not have solder tabs, the wires can be soldered directly to the positive and negative metal parts of the cell. In this case do not use excessive heat when soldering so that the cells do not become damaged. When mounting the cells be sure to follow the exact polarity as shown in figure two.

The printed circuit layout for the bell connections may be changed to accommodate the type of bell you are going to use. Be sure to locate the mounting holes for the bell before laying out the printed circuit to avoid a conflict between the copper foil and mounting screws. Do not solder R5 into the printed circuit until insrtucted to

(Continued on page 115)

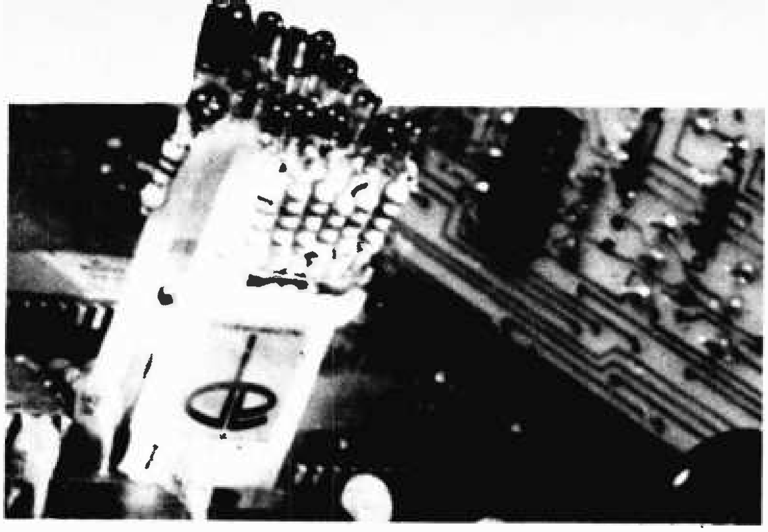




The component layout of Ring-A-Thing, with the foil side down. You'll see, if you look carefully, that the diagram has a few more components than the photograph of the unit has. That is because your editors added a few capacitors, etc.

PARTS LIST FOR RING-A-THING

B1—Size "C" NiCad cell
C1, 2—0.22uF, 250-volt tubular or ceramic capacitor
C3—22-uF, 16-volt tantalum capacitor
D1, 2—General purpose silicon diode
D2-6—0.5A, 100-volt or greater silicon diode
Q1—NPN silicon transistor, 2N3904
Q2—NPN Silicon power transistor, 5-A, 2N4321
R1, 2—47,000-ohm, ¼-watt, 10% resistor
R3—10,000-ohm, ¼-watt, 10% resistor
R4—10-ohm, ¼-watt, 10% resistor
R5—4.7-ohm, 1-watt, 10% resistor (Allied Electronics—address below—824-5049 or equiv., see text)
R6—2.2-megohm, ½-watt resistor, 5% tolerance
R7, R8—51,000-ohm, ½-watt resistor, 5% tolerance
R12—39,000-ohm, ½-watt resistor
R17—2.2-megohm, ½-watt resistor
C2—.01-uF capacitor, 5% tolerance
S2—SPDT pushbutton switch, momentary action
T1—6.3-volt, 1-A filament transformer
Misc.—Bell (Standard 6-volt doorbell), battery clips, wire, solder, etc.
Allied Electronics' address is 401 E. 8th St., For Worth, TX 76102.
To obtain a printed circuit board template free from ELEMENTARY ELECTRONICS that will speed up your construction of **Ring—A—Thing** send a stamped, self-addressed number 10 business envelope to The Editor, ELEMENTARY ELECTRONICS, 229 Park Ave. So., New York, NY 10003.



chip-clip

IC testing got you flipping? Don't give up, try Chip-Clipping!

by James Gupton

□The dual-inline-package (DIP) integrated circuit (IC) is not a really new electronics device; it's been around for more than ten years. While it was the microprocessor and mini-computer revolution that focused attention on this device, even those of us not involved in computers use ICs. For example, tape decks, radios, and television receivers now use them. Unfortunately, ICs are not infallible, and do on occasion breakdown. Due to the compact size of the IC, working space between devices is scant, to say the least. The need for an IC tester becomes apparent when one tries to follow a schematic diagram, manhandle two snake-like probes, and keep one eye on a meter and the other on an IC pin at the same time. That's where our deluxe *Chip-Clip* becomes a necessity.

Most frequently, repairmen come across digital ICs. In digital logic circuits there are only two input and output values (called states), low or high, corresponding to off or on. Most digital logic ICs use a voltage of +5 volts DC for the high state and 0 volts for the low state. We use the low or high voltage to turn off or on a light emitting diode (LED) and let a number of LEDs tell us what the present state is at every IC pin simultaneously. Chip-Clip will close on the small, tightly spaced IC pins without shorting adjacent pins. Equally important, it can be attached to an IC when there is only a quarter of an inch of space between circuit components.

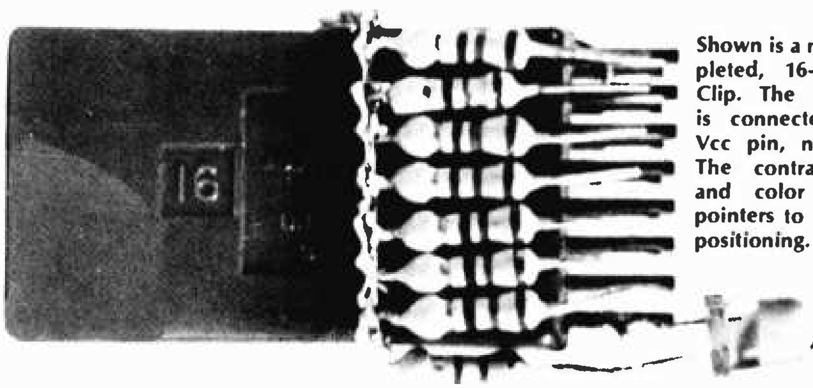
To further illustrate the utility of our Chip-Clip, lets take a look at two types of logic ICs. We have illustrated a 7420, quad input, positive, NAND gate. It actually contains two separate four-input NAND gates, one on each side of the DIP. In either circuit, the output voltage will be high if a low voltage appears on any of the four input pins. When all four input voltages are high, the output voltage goes low. Therefore, to find out why the output is high on either or both NAND outputs, there are eight close-quarter voltage measurements that you must make. Imagine how difficult it would be to keep your meter probe in the right spot without wandering and shorting between pins! We have also diagrammed the 7404 hex inverter logic IC. Here we have not two logic devices but six independent inverting circuits. In operation, if a high voltage appears on the input pin, the output drops to a low voltage. Should the input go low, the output goes high. By taking advantage of the high and low voltage states, we can observe the on or off condition of the LEDs and see the status of all six inverters simultaneously. Here, too, the Clip-Chip will prove an invaluable aid.

Building the Chip-Clip. The foundation of the Chip Clip is the standard 14 pin or 16 pin IC test clip available at any Radio Shack store or from any number of electronic mail order firms. To the IC test clip we add subminiature LEDs and a current limiting resistor between each logic test-clip pin and the IC ground pin. As mentioned previously, when low voltage is present on the IC pin, the LED does not light. When +5 volts appears on the logic input pin, the LED turns on. In addition, Chip-Clip has a different color LED on the Vcc connection (pin 14 or 16) to confirm the presence of Vcc voltage. The contrasting LED color prevents confusing Vcc indication with a logic indication.

The assembly drawing illustrates the necessary connections for the 14 pin Chip-Clip. If you are building a 16 pin unit, two additional LEDs and resistors are needed for the two extra test points. The IC ground changes to pin 8 and Vcc input changes to pin 16. The additional LEDs are connected to pins 7 and 15. No other changes are necessary.

The ground pin is connected to a common ground wire loop. It consists of two rectangular loops fashioned from 20 gauge solid wire. One of these loops is placed around each edge of the test clip one-half inch down from the top of the plastic. Four 0.028 holes are drilled to anchor the ground bus to the test clip. Since there is one ground bus loop on each half of the test clip, they must be connected together with a short piece of #20 flexible stranded wire to allow free movement of the test clip's sections and enable the test clip to clamp onto the IC DIP pins.

On the 14 pin test clips, six 150 ohm, quarter watt resistors are soldered to the ground bus loop on each side of the test clip and are positioned vertically. The body of the resistors should not stand above the top of Chip-Clip's frame and the resistor leads should be trimmed to the level of the metering pins. The



Shown is a nearly completed, 16-pin Chip-Clip. The green LED is connected to the Vcc pin, number 16. The contrasting size and color serve as pointers to the correct positioning.

chip-clip

resistor for the Vcc pin is positioned at the same level as the rest of the resistors but instead of being positioned on the side of the test clip, it is placed at the end of the clip next to the Vcc pin.

Finishing Touches Installing the LEDs is only a matter of soldering the cathode LED lead to a resistor and the anode lead to one of the test clip's metering pins. The cathode lead can be identified by its knotch or flat side. Remember, no LED goes to the test clip's pin 7 on a 14 pin Chip-Clip, or pin 8 on a 16 pin one. All oher test clip metering pins have a LED and resistor attached. It should be noted that the specified LEDs have a forward voltage rating of 1.6 volts d.c. and a maximum current rating of 20 mA. For voltages greater than 5 volts at Vcc, a new value of current limiting resistance must be used. (See accompanying box.)

Determining Limiting Resistance

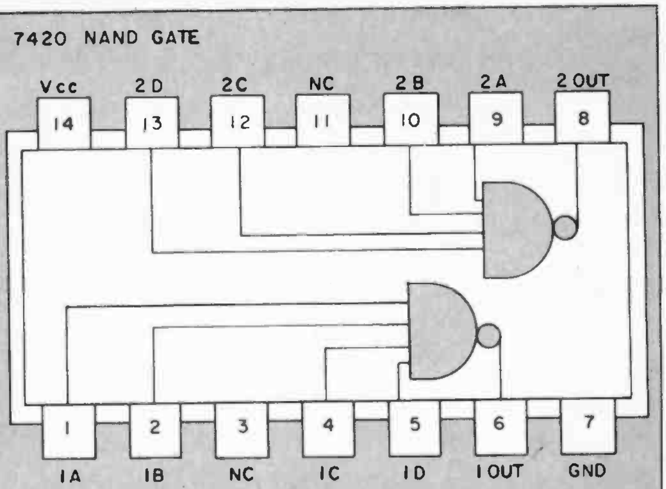
The simplest way to determine the value of current limiting resistance for any value Vcc is by the formula:

$$R = \frac{Vcc - 1.6}{.020}$$

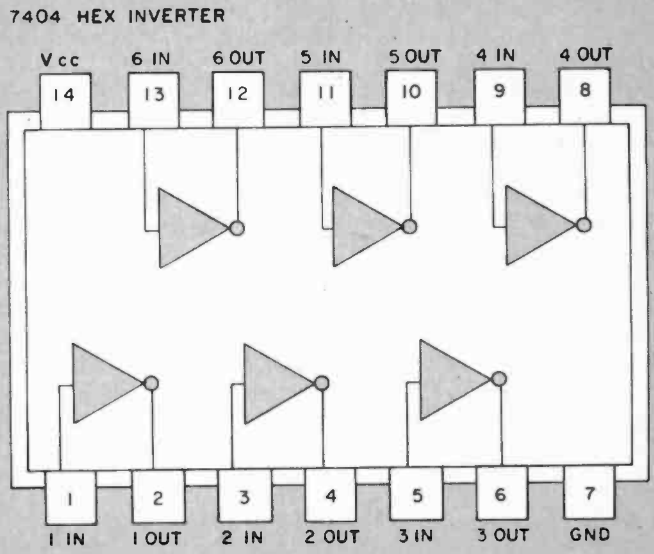
Vcc = voltage greater than + 5 volts.
1.6 = forward voltage of LED
.020 = maximum LED current
R = the new resistance

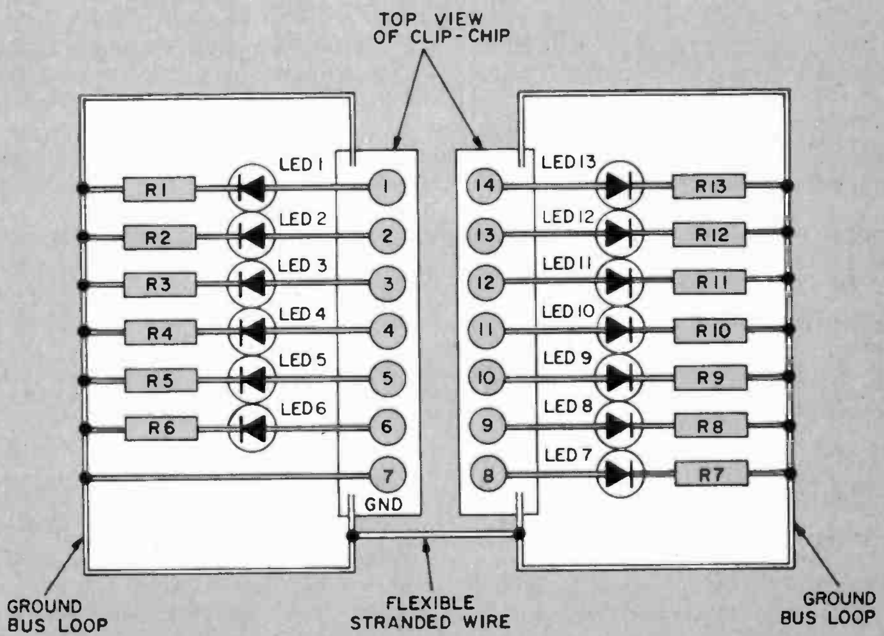
While almost any size LED can be used, the subminiature LED is recommended because of the limited space across the side of the IC test clip. In the author's model, a green emitting LED, jumbo size, was used to indicate the presence of Vcc voltages. The contrasting color prevents mistaking the lit LED as a logic function and serves as a pointer to the correct positioning of the test clip on the IC under test since the Vcc indicator is on pin 14 or 16.

Final Checkout. There are two things to be sure of. Be certain that the LEDs polarities are observed. Also, identify pins 1 and 14 on the 14 pin test clip or 1 and 16 on the 16 pin test clip and always be sure that these numbers always point towards the IC identifying notch, dot, or indenture on the top of the IC case. Final note, while these logic status test clips have been designed only for logic type ICs, it may be possible to employ them for other 14 or 16 pin ICs providing your schematic diagram confirms pins 7 or 8 as ground and pins 14 or 16 as Vcc. If in doubt, *don't use the Chip-Clip.* ■



A NAND unit's output is low only if all inputs are high. If any inputs are low, the output must be high. The 7420 is actually two separate NAND logic units housed in the same package and powered from the same source. An inverter's function is to convert a high signal into a low signal, or vice-versa. The 7404 Hex inverter contains six independent units. Like the 7420, the only interfaces are common packages and Vcc inputs.





Composite wiring-component placement drawing for 14 pin Chip-Clip. The LEDs are shown connected to the test clip's metering pins. They are attached to the current limiting resistors which are in turn all fastened to the ground bus loops. The ground bus loops must be firmly anchored to the test clip. Flexible wire connects both loops electrically making them into a common ground wire loop which is wired to pin 7.

Electronic Eccentricities...

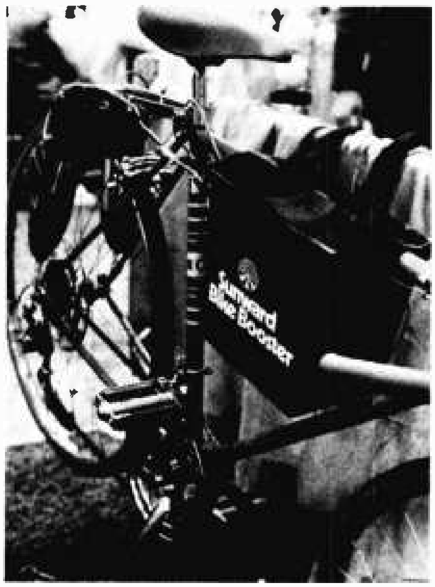
Voltswagon Bike

The "Voltswagen" is the answer for the bicyclist who wants to rest awhile without slowing down. The unit can either power a bicycle for a short length of time, or lend power assists in climbing steep hills.

A heavy-duty, 12-volt, U-1 size aircraft battery which weighs in at twenty pounds is fastened in a sling arrangement to the crossbar of the bike. Two motors attach to the axle of whichever wheel drives the bike, one motor on each side of the tire. Controls are accessibly mounted on the handlebars.

The battery-driven motor can move the bike along at speeds in the range of 15 to 20 miles per hour. One overnight charging provides an elecrtical reserve good for about thirty miles under most conditions. Besides full-power function, a touch to a special button provides the cyclist with a power-assist which continues until the button is released.

Price class of the Voltswagen is around $150 and it's manufactured by Sunward Corporation of Canoga Park, California. It may not be the greatest invention since the pedal-pusher, but it can take the exhaustion out of a hard day's cycling. ■



Here's a bike that's really ready to go. The "Voltswagen" battery rides in a sling on the crossbar and the two motors are visible on either side of the rear tire.

Recorded Boots

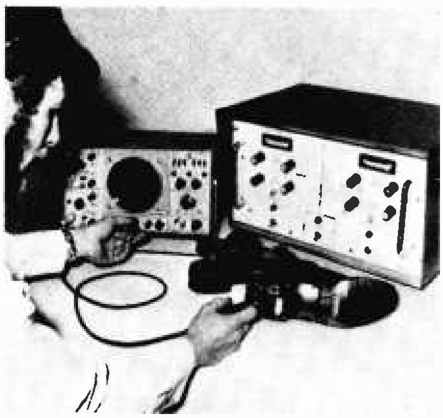
Patients who suffer from diseases of the hip-joint can now be better diagnosed and helped via electronics. Doctors can now have patients wear specially-designed shoes which determine elaborate data regarding the loads and stresses put on the various bones of the leg and foot. Such information can spell the difference between a successful course of treatment and a long, drawn-out and fruitless series of hospital visits and operations.

Shoes, with telemetry equipment in the soles, have become the newest diagnostic aids. The signals from the shoes are relayed to two separate display and recording units. From the data, a qualified podiatrist can determine all sorts of things relating to the patient's physical well-being.

Normal gait curves are, for instance, characterized by a series of double-peak curves with the nature of the curves varying according to the disability and the severity of it.

The sole of each shoe contains a pressure-sensitive capacitor consisting of metal filigree sheets between layers of spongy rubber. When the patient walks, the rubber is compressed and this alters the electrical capacitance. Currents are then amplified and inductively coupled to a pick-up wire, going from the heel to the measuring instruments.

The shoes are expected to be marketed for hospital use. ■



These specially-designed shoes, along with the instruments shown, can be instrumental in combating diseases of the hip-joint. Using variable capacitance effects, electrical impulses are telemetered to the displays where a doctor can interpret them.

Driverless Bus

If the idea of stepping foot into a driverless bus, and then having the vehicle tear madly off down the road to the next stop seems somewhat less than appealing—try to have a little more faith in modern day electronics. Such a scene is commonplace at England's Road Research Establishment.

The first step in the automatic bus-route is to lay a cable about four inches beneath the road surface the bus will travel along. A monitor which is slung beneath the bus' chassis will keep the vehicle electronically guided along the cable length.

The driverless bus is equipped with a form of "radar." If, during its travels, the vehicle is blocked by an unprogrammed hazard, the "radar" unit at the front of the bus senses this, puts on the brakes and will only release them once the route is clear again. The Harrison-Fraba Optical Detector unit emits an infra-red, modulated beam which, when interrupted by a blockage on the road ahead, reflects back to a photocell detector which activates the braking and gear-changing system. So, while not radar in the true meaning of the term, it functions in much the same way. The Optical Detector is sensitive from approximately 1.75 to 30 meters in front of the bus.

Right now the bus is only in use at the Road Laboratory, but eighty miles of cable have already been laid along a roadway in Berkshire. Soon all of Merrie England may be riding on automatic buses, and the rest of the world may not be far behind. ■

Passengers riding in this bus have a completely unobstructed view out the front windshield, there being no driver to get in the way. The driverless bus has been in operation for some time now at England's governmental testing labs and may soon be a familiar sight along many superhighways.

Checkerboard

(Continued from page 84)

less breadboard, or placed in contact with the bare wire groups. You can test as you go by using a slide, toggle or rocker switch at S1, or push-to-test with a momentary switch.

Checking Diodes. A properly operating diode will conduct in one direction only, and will not conduct when the leads are reversed. So you can check a diode with just two passes on Checker Board. If it lights the LED no matter which way it's connected, your diode has an internal short. If it won't light the LED no matter which way it's connected, its opened up. If it lights the LED only when connected, then you can identify the anode end (the triangular arrowhead on schematic representations) as being connected to the red alligator clip (at the junction of R1, C1 and the base of Q1). The cathode (bar) end is then connected to the black alligator clip (ground).

Checking LEDs. You can follow the instructions for checking diodes to check LEDs, but that's the hard way. The LED you test will light up, too, assuming it's good, when you test it on Checker Board. Make sure you get the polarity right. You can also trace 7-segment and multiple-digit LED displays to see which pin does what.

Checking Electrolytics. The thing that most often goes wrong with electrolytic capacitor's is that they short out. And that's the easiest thing to spot with Checker Board. Connect the + lead to the red alligator clip and the – lead to the black, or plug the electrolytic right into the solderless breadboard. This test will be more fun with the momentary switch. Push it and watch the LED. You should see a bright flash that decays into darkness. The bigger the electrolytic, the longer the flash lasts. A shorted electrolytic won't go out—an open one won't flash.

Checking Crystals. Connect the two crystal leads to the alligator clips. If the LED lights brightly, the crystal is good. If it lights dimly, the crystal is good but will not work in all kinds of oscillator circuits. If the LED does not light at all, it probably means the crystal is bad. But it *may* mean that the crystal is one of the few, obscure types that cannot make Q1 oscillate in the Checker Board circuit. Most crystals, if good, will light the LED brightly.

Checking Switches. With Checker Board connected to any pair of switch contacts, the LED will light whenever there is continuity between the contacts. When there is no continuity, it will not light. With this information, a sheet of paper and a pencil, you can methodically analyze when continuity occurs with each change of setting of an unknown switch. This can tell you what kind of a switch it is, And, of course, when you know what kind of a switch you have, Checker Board can tell you whether or not it's working properly.

Checking Continuity. A closed circuit will light the LED, an open circuit won't. (We're speaking of DC continuity here). With this in mind, you can check cables, connectors, printed circuit paths, relays, light bulbs and many other devices. As long as the testing-path resistance doesn't get too high (just how high is too high depends on your particular LED and what shape your battery is in), anything that needs to maintain continuity in order to work (or discontinuity, in case you're looking for shorts) can be checked on the Checker Board.

Checking Out Checker Board. Yes, Checker Board even checks itself out. Just clip the two alligator clips together. If everything is working, the LED will light. Light up! ■

Budget Bench

(Continued from page 43)

matched pairs for use in circuits where normal value variations would not be acceptable.

The bridge has a resistance range of 10 ohms to 10 megohms, an inductance range of 10uH to 10H, and a capacitance range of 10pF to 10uF.

AC Power Supply. All of these 5280 series Heathkit test instruments can be batery powered, which is a real convenience when you need a portable unit for testing auto electrical systems. But for truly convenient test-bench use; there's no denying the very real convenience of an AC power pack that eliminates the need of most batteries.

The Heathkit Model IPA-5280-1 AC Power Supply is specially designed to power all of the 5280 series equipment, *without the need to unplug one equipment to power another.* The unit has five separate output cords so that all test equipment can be plugged in simultaneously for instant action. The power pack operates from 110 or 220 VAC outlets without rewiring.

It features full wave rectification, capacitor filtering and dual integrated circuit regulators to insure correct voltage output of +9 and –9 VDC ±9%. The maximum output current is 100 milliamperes. ■

Lettering

(Continued from page 69)

with a brush-on spray coating. It's best to use products made for this specific purpose, which should be available from the same sources as the rub-on lettering. Ordinary lacquers, clear fingernail polish, etc., are likely to damage the lettering. Always make a test beforehand or you may end up with an ugly mess.

Here are some additional suggestions:

1) Read the instructions (if any) that accompany the lettering set.
2) If this is your first experience with rub-on lettering, practice on scrap material first to get the feel of it.
3) When applying the lettering, keep a backing sheet beneath the part of the carrier sheet that you are not using. This prevents unwanted letters from transferring and also keeps the lettering clean. Dirt or skin oils can interfere with adhesion.
4) To align rows of letters or words, tape a strip of paper to the panel about 1/16-inch below where the row will go.
5) A word made from individual letters can be centered by starting in the middle and working outward to both ends. ■

Alternator Tester

(Continued from page 31)

tive lead of the Alternator Tester is connected directly to the battery terminal of the alternator. The reason for this is that the ripple measurement depends upon the small, but finite, resistance between the alternator and battery. In order for the ripple test to be accurate, the alternator must be delivering a sizeable current. This is accomplished by slightly discharging the battery. Before starting the test shut the engine off and turn on the car headlights for about ten minutes. During this time you can connect the Alternator Tester to the car. Leave the headlights on while making the test. Start the engine and bring the RPM up to about 2000. Note the reading of the meter. An alternator in proper operating condition will have a ripple voltage somewhere between 0.2 and 0.5 volts peak-to-peak. Should one or more of the diodes be defective the ripple voltage will increase to 1 volt peak-to-peak, or more. If this is the case you will have to remove the alternator from the car to disassemble it and locate the defective diode. ■

Ring-A-Thing

(Continued from page 110)

do so in the test procedure outlined below. Q2 is mounted directly to the printed circuit board without a heat sink. None is required since the transistor operates as a switch, resulting in almost no power dissipation.

The method of connecting the telephone line and AC power cord to the printed circuit is left up to the builder. If the unit is to be used at a location not convenient to AC power you may want to use a small terminal strip or connector for the telephone line. This permits easy removal when battery charging is required.

Watch It, Buddy! It is recommended that the cells be handled in a discharged state. NiCad cells are capable of delivering very large short circuit currents (50 amperes or more) even when only partially charged. Once the cells are mounted and wired to the printed circuit any accidental short circuit between the cells or other components on the board may cause a very large current flow. Such currents can easily burn out printed circuit wiring.

Checking The Circuit. After the unit is assembled and wired it is recommended that the charger current be measured so that the proper value of R5 can be placed in the circuit. Since different 6.3-volt filament transformers can vary considerably in output voltage and internal impedance, the current delivered by the charger should be checked and adjusted if necessary. The best method of measuring charging current is to insert a 0-1 ampere DC meter in series with R5. An alternate method is to measure the resistance of R5, connect it into the circuit, and measure the DC voltage across it. Current can then be calculated by dividing the voltage measurement by the resistance.

The recommended charge current for the C cells specified in the parts list is 120 milliamperes. This will charge the battery in 14 hours, and there would be no danger of overcharge if the line power was connected for several days. If you prefer to leave the charger permanently connected to the AC power line the charge current should be reduced by a factor of three, to 40 milliamperes. This will keep the cells at 100% charge without any danger of cell damage. If NiCad cells of other capacities are used the charge current should be set up to one one tenth of the ampere hour rating of the cells, or to 1/30 the rating if the charger is to be operated permanently. For example, if size D cells with a 3.5 ampere hour rating were used, the charge current would be set to 350 milliamperes or 115 milliamperes. The value of R5 should be changed, if necessary, to provide the desired current. Note that it is not necessary to set the current to exactly one tenth of the rating of the cells. Less current can be used with the disadvantage being that it would take longer than 14 hours to fully charge the battery. Do not use a larger current than specified. To do so will damage the cells on overcharge.

Installing Ring-A-Thing. The unit is connected across the telephone line as shown in the schematic. The only exception to this will be for two party telephones. In this case the telephone ringing signal is impressed between one of the telephone lines and ground. (The other party's ringing signal is impressed across the other line and ground). You will have to experiment to determine which of the two lines has your ringing signal. If you inadvertantly connect the circuit to the wrong line, you will be answering the other party's calls! For the ground connection you may use any convenient ground point such as a BX ground.

Before installing the unit you should operate the charger at least 14 hours to fully charge the battery, unless you plan to leave the charger connected permanently to the power line. With a fully charged battery the unit will operate several months before a recharge is necessary. The power demand of the charger is about 2 watts, and will have little effect on your electric bill if left operating. In this case the unit would need no further attention, and you can forget it.

When You Start. You'll need a template to build Ring-A-Thing's printed circuit board. Take a look at the parts list under the schematic diagram to find out how to get it. ■

"Agnes! Come quick! I think I've picked up Australia on my new TV kit!"

"Well, at least you didn't blow up. Sometimes a great change comes over you when you run into problems!"

Getting Out

(Continued from page 16)

erally you are interested in being heard in only one horizontal direction at a time, why waste a lot of power in all the other horizontal, non-skyward directions, too? Why, indeed. So a beam more or less eliminates all wasted energy and radiates in one and only one direction at a time.

The only problem is that if someone is trying to talk to you from a directiion other than the one in which your beam is pointed, you may never even notice him. Therefore, a beam is seldom used all by itself. An omnidirectional antenna is usually used with the beam as a stand-by antenna. You listen for callers on the stand-by antenna and then point the beam at them to talk.

Power Mikes. And finally, there are power mikes. When a microphone is keyed, a carrier wave is sent out. It is a steady kind of radio wave, having the same amplitude always.

There are various ways to increase your modulation. You can hold the microphone very close to your lips and talk loudly into it, and this will give good modulation. Or you can buy a power mike and then not worry about where the mike is or how loudly you speak—the power mike will take care of it.

If you do want to buy a power mike, there are some things to remember. First, not all power mikes fit all radios. Second, it takes some skill to install a power mike. And third, if your radio has a mike gain knob on it, you already have a power mike.

Now, I don't want to offend you or make you feel unwelcome, but why dont you take your radio and get out?! ■

Space: 1978

(Continued from page 108)

most interesting features of GALAXY II, and is certainly a realistic simulation of economics. Depending on a planet's environment level, and level of development, it has what is termed Indexes of Efficiency and of Capacity. Simply put, the Index of Capacity governs how fast your population can grow and how quickly your planetary colonies can expand.

A player, who is considered his own race's leader, can invest in either of these indexes. This means you can decide, "Well, maybe I won't build that lovely fleet of Destroyer-class ships this turn. If I take the money and invest it in research (i.e. in my Index of Efficiency) then perhaps on the next turn I'll be able to build twice as many ships at only half the cost.

The interesting thing is, you can invest money (UUs—Universal Units) that you have or that you *don't* have. The latter method is known as deficit financing and is done by raising the income taxes of your colony to wartime levels. This is great, but does have certain drawbacks. For instance, after two turns of this, and if your investment has not shown a profit, your own colonists are likely to rebel against you. You can find yourself fighting not only a galactic war, but a few civil ones at the same time!

GALAXY II, which is play-by-mail with monthly turns, allows a person who is interested in computer gaming but who doesn't own a microcomputer to particpate in a computer-run simulation.

The cost per turn is based on how many orders a Leader sends to his galactic minions. An average turn should cost in the neighborhood of five to eight dollars, no more than a magazine subscription. Brett Tondreau has a special introductory package available for twenty-five cents to any interested parties who write to: Brett Tondreau, GALAXY II, 20121-5 Leadwell St., Canoga Park, California 91306. Further information may be had by circling No. 72 on the reader service card. ■

SCA Soother

(Continued from page 97)

Super-Soother connects to your radio or tuner between its FM detector and de-emphasis filter. If you connect after the de-emphasis filter you will find the 67 kHz subcarrier has been filtered from the Detectors output signal and you will get nothing but noise from the Super-Soother. The drawing shows a typical FM detector output, the de-emphasis network, and the correct connecting point for the adaptor. Since it is possible the Super-Soother will load down the detector for normal FM reception I suggest a switch be installed so it can be removed from the circuit when not being used for SCA listening.

Super-Soother is most conveniently connected through a phono jack installed on the rear apron of the tuner or radio.

If you have one of the older FM tuners with an *MPM* output you already have the correct connection because the MPX output *is* the *non-deemphasized* detector output. Similarly, if you have a modern FM tuner with an *FM detector, 4-channel, or FM Quadrasound* output jack you also have the correct connection as they are all FM detector outputs from *before* the de-emphasis network.

Connect the tuners detector output to the Super-Soother with the shortest possible length of shielded cable, or install it directly inside the tuner or receiver if there is sufficient room. Connect Super Soothers output to any high-gain amplifier such as the microphone input of a hi-fi or general-purpose amplifier.

Locking The Loop. Tune in a station you know (or believe) is transmitting an SCA program (a call to the station should get you the info) and adjust trimmer potentiometer R8 for best SCA sound quality. Normally, the reception will be almost completely garbled and then fade into a clean signal as R8 is adjusted. As R8 is adjusted further the sound will again garble. Set R8 so it is approximately midway between the two settings that produced garbled sound. Usually, the adjustment is quite broad so don't be too fussy.

If you don't know which stations are transmitting SCA set R8 to its mid-position and tune the station very carefully and very, very slowly. When you hear anything that sounds like distorted music try adjusting R8—if it'real SCA it will turn into clean sound as R8 is adjusted. Note that some stereo stations can cause sound bursts that appear to be SCA. If adjusting R8 doesn't clean up the bursts it's not SCA. Note that once R8 is properly adjusted there is no stereo hash interference with SCA signals; hash will only be heard from non-SCA signals.

Problems? The high sensitivity of this system may require that the overall gain be reduced. In the event you cannot receive *any* SCA stations you either have none in your area or you have made a construction error. Here are some hints to help.

1) If your problem is a weak signal resulting in high frequency noise try changing C12 and C14 to 0.05 uF.

2) If your problem is background breaking through from the main channel the problem is probably caused by adaptor overload (clipping). Simply change C1 and C9 to approximately 300 pF. This will attenuate the subcarrier and clean up the breakthrough on very strong signals, though very weak signals might get lost (you can't grab, or hear, them all). A second, simply corrective procedure is to install a 100k ohm resistor in series with the input from the radio or tuner's detector. This effectively cuts down the input signal and eliminates overload. ■

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335. The latest edition of the *TAB BOOKS* catalog describes over 450 books on CB, electronics, broadcasting, do-it-yourself, hobby, radio, TV, hi-fi, and CB and TV servicing.

338. "Break Break," a booklet which came into existence at the request of hundreds of CBers, contains real life stories of incidents taking place on America's highways and byways. Compiled by the *Shakespeare Company*, it is available on a first come, first serve basis.

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367. *Optoelectronics'* new catalog features their new Frequency Counter, a 6-digit clock calendar kit, mobile LED clock, biorhythm clock, digit conversion kit, and many others.

368. *Cherry Electrical Products* has a handbook describing their new "PRO" keyboard for personal computer, hobbyist and OEM users. Included are instructions on how to customize it on-the-spot, schematics, charts, and diagrams.

369. *Motorola Training Institute* offers a brochure on two new home-study courses: Four lessons cover semiconductors, designed for all technicians servicing electronic equipment; the 34-lesson professional FM two-way radio course is for those planning to service land-mobile equipment.

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Spiderweb

(Continued from page 102)

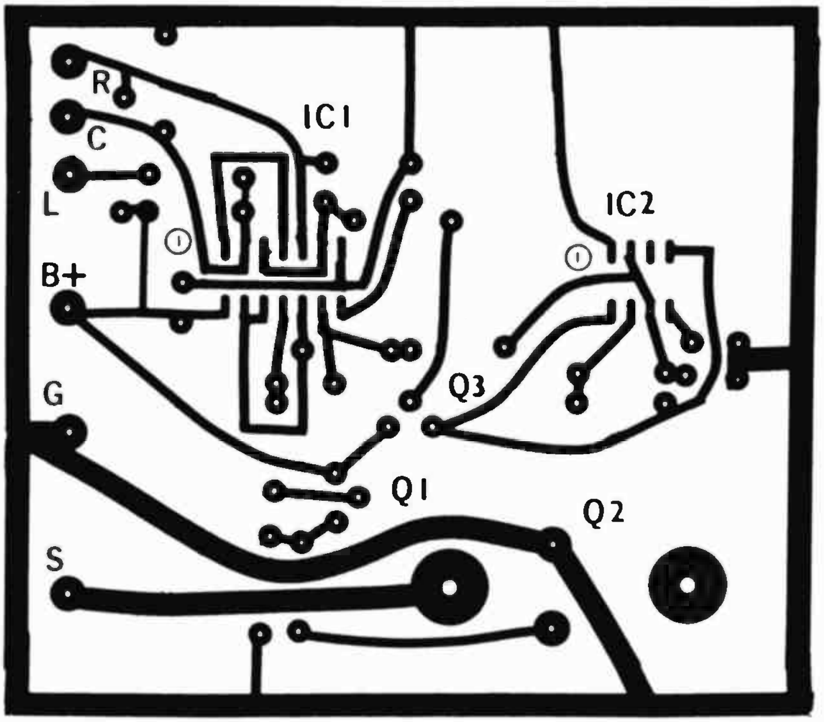
volt battrey to the receiver. Set the Bandspread capacitor C2 to minimize capacity and the Tuning Capacitor C3 to maximum capacity. Connect a signal generator to J1 and then calibrate the dial with the generator. Adjust the AF Gain R5 and R1 as necessary for a good received signal. Make sure that the signal generator output is kept low enough to prevent overloading of the receiver. Begin with a modulated signal generator frequency of 550 kHz and mark the receiver dial accordingly. Proceed up the dial to 1600 kHz and mark the scale at convenient points. Then replace the "C" with the "B plug-in coil and calibrate the scale from 1.7 to 5 MHz with the signal generator. Also, calibrate the "A' plug-in coil with a generator from 7 to 14 MHz. If a signal generator is not available, you can calibrate the bands with markings noted from received radio stations of known frequency. The Bandspread dial is not calibrated, but, a set of points can be marked over the range of C2 to aid in tuning the dial, or for logging purposes in the crowded SW bands.

Operation. For best results a good antenna and ground are required. Also high impedance earphones (2000 ohms or more) are needed. If a DC power supply is used in place of the 6 volt battery, make sure that the supply does not have any hum in the output as this will affect the receiver sensitivity. Tune C3 for a received station, while at the same time adjusting the Regen control R1 for a whistle. If the station is AM, back off R1 until the station is received clearly. If the received station is CV, adjust R1 for a convenient "beat note." Many strong side-band stations can also be received by experimentally tuning R1 and C2 for best reception. Adjust the AF Gain control for good earphone volume. Adjust C1 for best reception for each coil. The position of the "S" tap can be experimented with (moving up or down on L1) for best regeneration over the band. Also, try several FET's as Q1 for maximum sensitivity over the higher SW frequencies. ■

B/F Brain

(Continued from page 48)

When installing the alarm in an automobile you must add a key-operated power switch which is accessible from the outside of the car, or place the power switch in the trunk. Otherwise the circuit would be tripped as you open the door to leave the vehicle. ■



Here's the way the parts are located on the printed circuit board. No heat sink is needed for the big transistor. Use an IC socket for IC2.

Lone Ranger

(Continued from page 63)

and the case is covered. Solder the positive lead from the battery clip to one side of S1. To the other terminal of S1 solder the short lead from the circuit board. Finish off by mounting the cover and applying press-on decal labels as desired.

Calibrating Lone Ranger. Set the range selector to the low-light measurement position (the larger hole), then point the meter towards a bright light bulb and depress S1. One or more LEDS should light, depending upon the brightness of the source. If not, go back and check whether any components have been improperly oriented. When all is working well, only the calibration of the meter remains. Borrow a good light meter for this task. Choose a large, preferably blank wall and evenly illuminate it (avoid using fluorescent light sources, however). Adjust the light source and the distance until your reference meter indicates f/8 at ASA 125 and 1/30 sec. When you have obtained the correct reading on your reference meter, hold your Lone Ranger in the same spot and point it in exactly the same direction that the reference meter had been facing. Press S1 and adjust R2 so that LED4 (the one farthest) extinguishes. Now turn R2 back the other way until LED4 just comes back ON. The meter is now calibrated. To use the meter with different film and shutter speeds, consult the Table.

Film Speed ASA	Exposure Correction
400	+2
250	+1
125	0
65	−1

Shutter Time	Exposure Correction
250	1/8
125	1/15
30	1/30
15	1/60
−	1/125

ASA = 123
+ —go to higher f-stop
− —go to lower f-stop

Additional Circuit Uses. You may have noticed that the comparator circuit presented here has great potential. A thermistor might be submitted for photocell PC1 and the circuit becomes an electronic thermometer. Or mount a potentiometer so that its control shaft spins as another shaft rotates. The LED display would then indicate angular position, perhaps for an antenna rotor. The information here plus your own imagination should produce many new devices. ■

Midget Digit

(Continued from page 53)

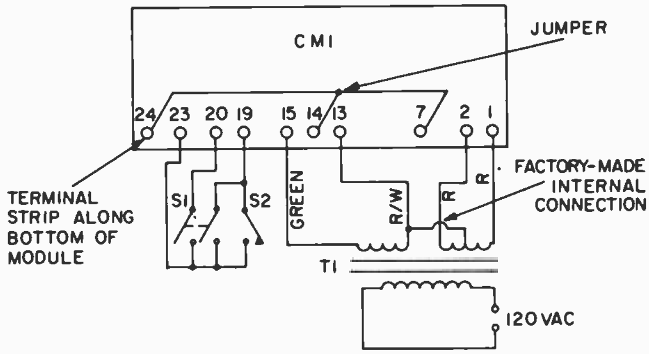
wires connect to terminals 1 and 2 (either way will do); the red wire with white tracer is the centertap for the red wires and connects to terminal 13; the green wire connects to terminal 15. Connect reset *switch* S1 and *hold* switch S2 as shown in the schematic. That's the whole construction.

Checkout Procedure. Apply power to Midget Digit (our model does not use a power switch). The display will be some random time that blinks on and off, incrementing seconds with each blink. If you don't get the incrementing effect you have made a wiring error or the module is defective.

Pressing the *reset* switch will stop the blink, the display will remain on and reset to zero, then start incrementing in one second intervals. Each time the reset switch is pressed the display should return to zero. If the *hold* switch is depressed (remaining depressed) the timer should hold. Releasing the switch should cause the timer count to resume without a reset to zero.

If you don't get the proper reset and hold functions you most likely have a wiring error rather than a defective module. In particular, check the wiring on *reset* switch S1. The two wires should be shorted only when the switch is closed. When the switch is open the wires from module terminals 19 and 20 should not be shorted.

A timer is a must for every photographer. Why pay five times as much for a commercial model when our Midget Digit is so easy to build and actually performs better in the bargain? ■



Parts List For Midget Digit

CM1—Twelve hour LED display digital electronic clock module
S1—DPDT spring-return or push-button switch (Allied 757-0730 or equiv.)
S2—SPST toggle switch
T1—Special transformer for clock module
Misc.—Cabinet (see text); thin, insulated hook-up wire (Allied 708-348N or equiv.); standard hook-up wire.

LEDit

(Continued from page 86)

better to be safe than sorry.

In thousands of parts tested I've never had a false indication except in the case of a few rare *dv/dt* turn-ons. When this happens, here's what to do. Just interrupt the power with S2 several times and see if the indicator D3 lights every time, or just part of the time. Part-time turn-on indicates a definite *dv/dt* situation. Full-time turn-on usually indicates a short. Thats all there is to it! ■

TERMINAL POST			BUTTON PRESSED			LED ON.			INDICATES
Anode	Cath.	Gate	None	On	Off	Red	Clear	None	
a	c	g	x					x	a-c not shorted
a	c	g		x		x			g-c short or a-c open
a	c	g	x				x		a-c short or possible dt/dv
a	c	g		x				x	g-c open
a	c	g		x		x	x		normal turn-on
a	c	g			x			x	normal turn-off
MISCONNECTIONS									
g	c	a	x				x		
g	c	a		x		x	x		
c	a	g	x					x	
c	a	g		x				x	
a	g	c	x					x	
a	g	c		x				x	
c	g	a	x					x	
c	g	a		x				x	
g	a	c	x					x	Clear LED may be on weak
g	a	c		x				x	Clear LED goes out
DIODES									
a	c		x				x		normal
a	c		x					x	open
c	a		x				x		shorted
c	a		x					x	normal

"*. . . and don't call me Mac!*"