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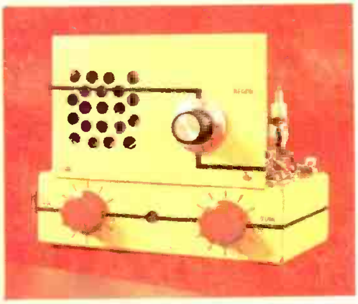
ELECTRONICS HOBBYIST

SPRING-SUMMER 1975 $1.35

Elementary Electronics Handbook

PROJECTS ANYBODY CAN BUILD



REMARKABLE experimenter's electronically-tuned **BCB REGEN RECEIVER.** Same "veractor" tuning system used in top-line TV and FM receivers. Adapted here for investigation into solid-state tuning.

VALUABLE test meter keeps your car rolling along. Add economy to cars, trucks, motorhomes. Set engine "dwell," check engine rpm with **DWELL/TACH.** An IC project makes wiring a snap and holds down costs.

SURPRISING low price when you build your own **DARKROOM COLOR ANALYZER.** Features just like the more expensive commercial units. For use with today's simple, low-cost home photography color print techniques.

COLOSSAL versatility in our **UNIVERSAL POWER TIMER.** All-semiconductor unit uses no relays. Has automatic touch-to-start, versatile timing modes. Many uses including kitchen, darkroom, and workbench.

SENSATIONAL savings—recycle unmarked, used, and surplus diodes with this **DIGITAL DIODE TESTER.** Tells which lead is anode, which is cathode by flashing "A" or "C" in display window. Bonus! Works with transistors too!

EXCELLENT for your car's electrical system. In-circuit **EXPANDED SCALE VOLTMETER** monitors your car, truck, boat, camper, or any 12-volt battery/generator system for electrical faults.

LATEST innovation in marking time. Exciting IC circuit ticks electronic time. **IC METRONOME**—the fourth step in the evolution of the original tick-tock wooden box.

A DAVIS PUBLICATION

ELECTRONICS HOBBYIST

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PROJECTS

SPRING/SUMMER 1975

QUICK AND EASY PROJECTS

PLUS—CHECK THESE OUT!

SPRING/SUMMER 1975

ELECTRONICS HOBBYIST

Dedicated to America's Electronics Hobbyists

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NEW PRODUCTS

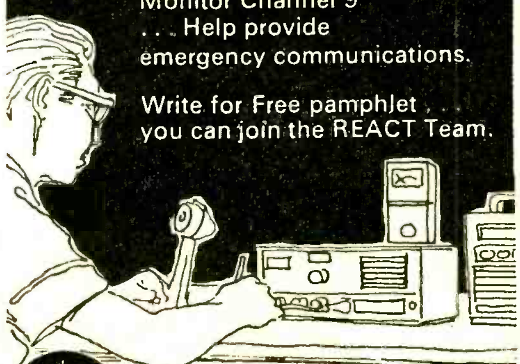
Home Security Kit

Total "do-it-yourself" burglar and fire protection in one complete kit is promised with the Audiotex Home Security Kit introduced by GC Electronics. The kit, Cat. No. 30-9025, features the popular Electro-Sentry alarm and all accessories needed for quick, easy security system installation—reed switches, fire sensors, hook-up wire, emergency button, and copy of the informative "Security And You" book. The popular Electro-Sentry is a completely self-contained, solid-state alarm with built-in 100-db horn and electronic timer. When triggered, the horn sounds until silenced by a special key, while the electronic timer allows you 20 seconds to enter or exit without triggering the alarm. Sells for $79.95. In its Audiotex Security line, GC Electronics offers a variety of burglar/fire alarms and accessories for home, business, auto and self-protection. Get your catalog by writing to GC Electronics, Division of Hydrometals, Inc., 400 South Wyman, Rockford, IL 61101.

Circle No. **34** on Reader Service Page **11** or **112**

Hands-Free Telephone

Imagine being able to have a conversation on the telephone with both hands free. Saxton Products, Inc. has created a low-priced, all transistorized telephone amplifier for the home, permitting a homemaker to care for her infant, prepare dinner, dress, even relax in the tub, with both hands free, and still chat on the phone. Dial or receive phone calls normally and simply place the telephone hand set onto the Saxton unit's amplifier cradle. A pressure-activated switch on the device automatically turns on the amplifier. When through, simply remove the hand set and the amplifier automatically shuts off. When it's operating, the Saxton Hands Free Telephone Amplifier boosts the sound level of an in-coming call so the caller's voice can be heard throughout the room. At the same time, the other party's out-



NEW PRODUCTS

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going voice is picked up and transmitted to the caller, eliminating the need to hold and speak directly into the phone's mouthpiece. It's a battery-operated unit and there is no installation or wiring. A houseful of friends can have a conversation with the person on the other end of the line. $17.45 including shipping costs from Saxton Products, Inc., Congers, NY 10920.

Low Cost Metal Detector

The Edmund Earth Challenger 1 metal detector can be the source of both pleasure and profit for beginners as well as serious treasure hunters. This fully transistorized, beat-frequency-oscillator unit can actually locate a twenty-five cent piece at eighteen inches. Its extreme sensitivity derives from a powerful 6-transistor oscillator-amplifier circuit. Collectors of old artifacts will find it handy for discovering relics on old battlefields, at forts and campsites. Lightweight (just 2 lbs.), but rugged, both pole and electronics housing are made of aluminum. The 6-inch waterproof search coil (Faraday shielded to eliminate outside interference) is high quality ABS plastic. The unit operates on a 9-VDC transistor battery (alkaline cell included) with a long (approximately 50 hours) life. The powerful speaker alerts you when approaching metal, and the whole perfectly balanced detector features simple 1-knob on-off tune control. It is available by mail (Stock No. 80,222 . . . $39.95 postpaid) exclusively from Edmund Scientific Co., 380 Edscorp Bldg., Barrington, NJ 08007.

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Electronic Siren

A small, yet powerful electronic siren, ideal for use with burglar or intrusion devices in home or auto, is offered by Audiotex Division, GC Electronics. The siren, Cat. No. 30-9130, features 12V-0.9A DC operation and is weather and corrosion resistant. It possesses a sound output of 105 db/10 ft. and comes complete with mounting bracket for easy mounting in any position. Only $44.95. As well as a wide variety of security accessories, GC Electronics offers a complete line of burglar/fire alarms under its Audiotex label for home, business, auto and self protection. For catalog, write to GC Electronics, Division of Hydrometals, Inc., 400 South Wyman, Rockford, IL 61101.

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Sound Odyssey

When Altec Corporation, Sound Products Division, tells the buying public that "truth comes in all sizes" to promote its mini-monitors, it does it with a 12-inch LP titled, "Odyssey." According to Altec officials, the album is a hit, having sold over 100,000 copies. Produced by A&M Records exclusively for Altec, "Odyssey" explores nine perspectives in contemporary music. Almost a "rock garden" of music, "Odyssey" is seeded with blues, jazz, country and classical music. The depth of music

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ranges from Quincy Jones' "Summer in the City" to Rick Wakeman's "Catherine Howard," which fuses rock with classical piano. "Odyssey" is available through participating Altec dealers, or by sending $1.25 to Altec, 1515 S. Manchester Avenue, Anaheim, CA 92803.

Foot Power

A convenient new solid-state foot-operated speed control, the Dremel Model 217, provides simple control of Dremel Moto-Tools in industrial, arts, crafts and hobby applications. It also can be used with other power tools and appliances, permitting variation in working speeds to suit the materials and providing greater freedom in handling tools and workpieces. The unit is equipped with a return spring that moves the treadle to its lowest speed position whenever foot pressure is released; where it is desirable to be able to hold a treadle position with the foot off the control, the return spring can be quickly and easily removed and then later restored for normal operation. The control is designed to handle loads of up to 5 amperes when controlling motors, and of up to 600 watts when controlling lights, glue guns, or similar de-

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ELEMENTARY ELECTRONICS MAGAZINE TO EXPAND SIZE!

Yes! Starting next issue, look for your favorite hobby electronics magazine in our new giant-size format with pages a full 49% larger. **Elementary Electronics** will be easier than ever to use. Your favorite features will be printed bigger and better. Our columnists will be here with more new information for SWLers, CBers, Antique Radio Collectors and Hobbyists. And you'll get more out of our better photographs—especially project photos—because there will be more to see.

Sure, we'll keep our same great format. There will be interesting science and electronics subjects, CB radio tests and information (even CBer's construction projects), our no-pain Basic Course for beginners, hi-fi things, and simple and advanced projects with a difference that bring hobby electronics to beginner and engineer alike.

Look for our new digital timepiece—rock-bottom cost, time and date display, 24-hour alarm, stand-by battery power, simple wiring, snooze alarm and more in **e/e's** easy-to-build construction format. Now even better with our new great size.

Look for other project firsts in our first big issue, like a super-efficient audio amp using new Class "D" digital techniques and low-cost ICs, and a goof proof project for CBers that puts SW time broadcasts or local action band channels on a transceiver *without* modifying it.

All this and more to come in every big issue starting with the March/April '75 **Elementary Electronics. Watch for it! On sale February 13th.** ■

LITERATURE LIBRARY

101. Kit builder? Like weird products? *EICO's* 1975 catalog takes care of both breeds of buyers at prices you will like.

102. *International Crystal* has a free catalog for experimenters (crystals, PC boards, transistor RF mixers & amps, and other comm. products).

103. See brochures on *Regency's* 1975 line-up of CB transceivers & scanner receivers (for police, fire, weather, & other public service/emergency broadcasts).

104. *Dynascan's* new B&K catalog features test equipment for industrial labs, schools, and TV servicing.

105. Before you build from scratch, check the *Fair Radio Sales* latest catalog for surplus gear.

106. Get *Antenna Specialists'* cat. of latest CB and VHF/UHF innovations: base & mobile antennas, test equipment (wattmeters, etc.), accessories.

107. Want a deluxe CB base station? Then get the specs on *Tram's* super CB rigs.

108. Compact is the word for *Xcelite's* 9 different sets of midget screwdrivers and nutdrivers with "piggyback" handle to increase length and torque. A handy show case serves as a bench stand also.

109. *Bomar* claims to have C/B crystal for every transceiver . . . for every channel. The catalog gives list of crystal to set interchangeability.

110. A *Turner* amplified mike helps get the most from a CB rig. This free brochure describes line of base & mobile station models.

111. *Midland's* line of base & mobile CB equipment, marine transceivers & accessories, and scanner receivers are illustrated in a new full-color 16-page brochure.

112. The *EDI (Electronic Distributors, Inc.)* catalog is updated 5 times a year. It has an index of manufacturers literally from A to Z (ADC to Xcelite). Whether you want to spend 29 cents for a pilot-light socket or $699.95 for a stereo AM/FM receiver, you'll find it here.

113. Get all the facts on *Progressive Edu-Kits* Home Radio Course. Build 20 radios and electronic circuits; parts, tools, and instructions included.

114. From *Olson* get their new, bargain-packed 36-page, full-color tabloid (a new issue every 2 months). It contains their latest electronics parts, supplies, and hi-fi components. Pick up a copy at Olson stores coast-to-coast or send for a free copy today.

115. *Trigger Electronics* has a complete catalog of equipment for those in electronics. Included are kits, parts, ham gear, CB, hi fi and recording equipment.

116. Get the HUSTLER brochure illustrating their complete line of CB and monitor radio antennas.

117. *Teaberry's* new 6-page folder presents their 6 models of CB transceivers (base and mobile): 1 transceiver for marine-use, and 2 scanner models (the innovative "Crime Fighter" receiver and a pocket-size scanner).

119. Besides *Browning's* colorful leaflet on their Golden Eagle Mark III base station, their packet includes other surprises. The LTD is pictured in actual size on a card for you to test on your car's dash. Specifications are given for both the SST and LTD.

120. *Edmund Scientific's* new catalog contains over 4000 products that embrace many sciences and fields.

121. *Cornell Electronics'* "Imperial Thrift Tag Sale" Catalog features TV and radio tubes. You can also find almost anything in electronics.

122. *Radio Shack's* 1975 catalog colorfully illustrates their complete range of kit and wired products for electronics enthusiasts—CB, ham, SWL, hi-fi, experimenter kits, batteries, tools, tubes, wire, cable, etc.

123. It's just off the press—*Lafayette's* all-new 1975 illustrated catalog packed with CB, hi-fi components, test equipment, tools, ham rigs, and more.

124. *Mosley Electronics* reports that by popular demand the Model A-311 3-element CB beam antenna is being reintroduced. Send for the brochure.

125. RCA Experimenter's Kits for hobbyists, hams, technicians and students are the answer for successful and enjoyable projects.

126. *B&F Enterprises* has an interesting catalog you'd enjoy scanning. There are geiger counters, logic cards, kits, lenses, etc.

127. There are *Avanti* antennas (mobile & base) for CB and scanner receivers, fully described and illustrated in a new 16-page full-color catalog.

128. A new free catalog is available from *McGee Radio*. It contains electronic product bargains.

129. Semiconductor Supermart is a new 1975 catalog listing project builders' parts, popular CB gear, and test equipment. It features semiconductors—all from *Circuit Specialists*.

130. *Heath's* new 1975 full-color catalog is a shopper's dream—chockful of gadgets everyone would want to build and own.

Electronics Hobbyist
Box 886
Ansonia Station
New York, N.Y. 10023

Please arrange to have this literature whose numbers I have circled at right sent to me as soon as possible. I am enclosing 50¢ to cover handling. (No stamps, please). Allow 4 to 6 weeks for delivery.

☐ **Indicate total number of booklets requested.**

Sorry, only 10 circled items maximum.

S/S75

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51 ☐ Enter my subscription for 9 issues at $3.97 and bill me.

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Not Valid After July 21, 1975

NEW PRODUCTS

vices; a replaceable 5-amp fuse protects the solid state circuitry against overloads. List price is $21.95. For further information contact Dept. PREE, Dremel Manufacturing, Racine, WI 54301.

Printed Circuit Kit

Everything needed to make quality printed circuit boards is contained in the Professional Printed Circuit Kit offered by GC Electronics. The kit, Cat. No. 22-297, contains drafting aids, tray set, etch resist sensitizer, etch resist lacquer, developing solution, etching solution, stripping solution, layout film (2 sheets, 8½-in. x 11-in.), contact frames, and two copper clad boards (3 x 5 x 1/16-in.; 4 x 6 x 1/16-in.). The Professional Printed Circuit Kit is ideal for students with back-to-school projects, as well as for the serious hobbyist or technician. GC Electronics offers a complete line of printed circuit materials including copper clad boards, chemicals, tools, and drafting aids. Sells for around $40.00. More facts can be had from GC Electronics, Division of Hydrometals, Inc., 400 South Wyman, Rockford, IL 61101.

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The Reader Service Pages offer coupons to our readers so that they may easily contact manufacturers and distributors of products of interest. Use this free service and get loads of information by mail—free! ■

Use Coupon on Left!

131. E. F Johnson's new full-color catalog for CB transceivers and accessories is now available. Send for a free copy. They also have a free brochure on their line of scanner receivers.

132. If you want courses in assembling your own TV kits, *National Schools* has 10 from which to choose. There is a plan for GIs.

133. Get the new free catalog from *Howard W. Sams*. It describes 100's of books for hobbyists and technicians—books on projects, basic electronics and related subjects.

134. *Sprague Products* has L.E.D. readouts for those who want to build electronic clocks, calculators, etc. Parts lists and helpful schematics are included.

135. The latest edition of *Tab Books'* catalog has an extensive listing of TV, radio and general servicing manuals.

136. *Leader's* catalog features "Instruments to Believe In." They have a complete line for industry, education and service, featuring oscilloscopes/vectorscopes, many generators, accessories, etc.

137. *Pace Communications* has a packet of information for you. The "Citizens two-way radio" answers all the questions from how to operate one to how much they will cost to operate. A booklet on Pace's scan/monitors to keep you informed is included.

138. *Pearce-Simpson* has a booklet, "Citizens Band Radios & Scanners," which pictures and describes the various models in this line. A section on CB antennas is included.

139. For the latest information on CB transceivers by *Courier*, send for their literature.

140. Featured in *Siltronix's* brochure are single sideband/AM citizen band transceivers, pictured and described with extra features and specifications listed. VFO sliders for monitoring are pictured as well as export models of linear amplifiers.

141. *Lee Electronics Labs* has an inexpensive circuit analyzer, which is featured in this catalog.

142. Available from *Royce Electronics* is a 28-page, full-color catalog for CBers base, mobile and handheld transceivers; accessories; and test instruments).

143. A set of Abraxas/4 speakers contains a rugged 12-inch long-throw woofer with a 22-oz. Alnico magnet, a 5-inch sealed-back rubber-damped midrange, and two 3-inch dome tweeters from *Designers Audio Products*.

144. For a packetful of material, send for *SBE's* material on UHF and VHF scanners, CB mobile transceivers, walkie-talkies, slow-scan TV systems, marine-radios, two-way radios, and accessories.

145. For CB'ers from *Hy-Gain Electronic* Corp. there is a 50-page, 4-color catalog (base, mobile and marine transceivers, antennas, and accessories). Colorful literature illustrating two models of monitor-scanners is also available.

146. *Robyn International* has 4-color "spec" sheets for each model of their CB (base and mobile) transceivers and monitor-scanner lines.

147. *Telex's* 4-page, 2-color folder illustrates their new line of boom microphone head-sets for CB'ers and hams, as well as their line of communications headphones.

148. *Surveyor Manuf.* Corp. offers you two catalogs in 4-color. One features their Electronics 2000/Surveyor CB, pictured with descriptions and specifications. Their Monitor/Scanner, Surveyor Model 4H 4U, is featured in the second catalog.

149. *Cush Craft* has a catalog on Citizens Band Antennas for every purpose. The Ringo base antenna is featured, as is the new Superfire 8-element horizontal/vertical power beam.

150. For TV or communications towers, aluminum spells rugged strength. An 8-page brochure from *ASCOM* details 30 models to fit every need for CB, ham, commercial 2-way radio, or home/institutional installations.

151. For a complete audio accessory line-TV, tape, phono and radio for home and auto, send for *Audiotex* catalog FR 73-A.

152. Send for the new, free descriptive bulletin from *Finney Co.* It features the Finco line of VOM multitesters (and accessories) for electronics hobbyists and service technicians.

153. A full-color brochure on *Tennelec's* scanners is available. They have portables, 3 bands—12 channels and 3 bands—16 channels. Outstanding features and specifications of the tri-bands are listed.

Ask Hank, He Knows

He Wants to Practice

Enclosed you will find a schematic of an electrical stimulator used in acupuncture which I took to a radio parts store for the parts listed. They supplied all the parts listed except the wire coils, and they said the coils would have to be hand wound. What am I to do?

—M.G., Jacksonville, FL

I'm not publishing the schematic because I don't want to lose any readers. As for your patients, Doc, don't build the gadget and you won't lose any, either.

Needs Lots of Work

Hank, what is the best kind of home study course to take? I know very little about electronics and want to go all the way.

—T.T., Newton Falls, OH

The best course to take is the one you will complete. Too many youngsters begin home study courses and quit after a few lessons when they discover self education takes work, dedication to their goal, continuous effort, and drive. Get started and stick to it. You'll thank me in 15 years—you said all the way!

To Be Young Again

I am just 12 years old, and interested in electronics. I'm thinking of buying a "Science Fair P-Box" shortwave radio kit. Could you tell me if it's any good?

—K.K., Winnipeg, Canada

First, OM, let me say welcome to shortwave listening and electronics. Since you are a smite young, the kit you mentioned is great. As you gain age, experience will demand bigger and better products. Get started today, and welcome to the club.

Needs More Speed

My turntable turns too slowly, and records sound awful. I've checked the capstan drive and idler wheel and they show no signs of wear. What could be wrong?

—G.M., Austin, TX

A clean-up job with some alcohol will do it. It seems your turntable, or is it a changer, has an idler wheel whose rubber has gone hard. Wash it in alcohol until all the black smudge comes off. Also, apply the spirits to the inside of the turntable rim and drive shaft you call a capstan. When dry, assemble turntable and enjoy it. If the rubber is too far gone, you may need a replacement.

His Opinion

Hank, I think the five-tube AC/DC radio is far superior to anything in the cheapie transistor radios. What's your opinion?

—T.K., Baton Rouge, LA

Yes it is, if you are an oldtimer who fixes his own. I don't believe there is a table-top tube radio I can't fix, but I've had lots of problems with solid-state jobs, especially when they are inexpensive. However, my next door buddy, a TV repairman, grew up with transistors and thinks I'm nuts. I believe he could convert his pocket calculator into a digital-tuned FM pocket radio in an afternoon if he wanted to. So you see, it's what you know and your life style that forms opinions, not rock-hard knowledge.

Save the Paper Work

Hank, I threw away the literature that came with my multi-element TV color antenna and now I have no idea what the impedance is. Can you help?

—G.C., Rome, NY

TV antennas are designed for 300-ohm twin-lead cable. Why not for 75-ohm coax I'll never know. As for the color antenna—since when can they tell the difference between color and black-and-white transmissions? Only your color TV set can do that.

Don't Ask

I've got a question for you Hank that I believe you can't answer because you have to be an antique radio buff to know the answer. Who can help me?

—R.S., Menands, NY

I dab in antique radio, but you are right. I'm not a buff. So why not direct your question to Jim Fred, our Antique Radio columnist for Elementary Electronics. If he doesn't know the answer, there are very few, if any, who do. You can write to Jim in care of this magazine. Also, see his column in e/e.

Wrong End

I installed a VU meter on my FM receiver and some of the local FM stations are overmodulating their signals. Should I report them to the FCC?

—F.J., Waco, TX

Save your stamps! A transmitter's clipping should be measured at the transmitter, and not at your receiver. All you are measuring is volume, and your ears can do the job better.

What Channel?

I saw nude forms and naked women's bodies on TV late at night. Why does the FCC allow this?

—H.D., Bronx, NY

We may have seen the same program on breast cancer. I believe the FCC allows this because it will save the lives and health of many women. I'm not the kind of guy that goes to X-rated pictures, but this program, and others like it, are A-OK with me.

ELECTRONICS HOBBYIST

READER SERVICE PAGE

• The Editor of ELECTRONICS HOBBYIST offers readers an easy way to get additional information about products and services advertised in this issue. Also, if you would like more information about any new product mentioned in our new products column, it's yours for the asking. Just follow the instructions below and the material you requested will be sent to you promptly and at no cost.

S/S 1975 — Void after June 21, 1975

ELECTRONICS HOBBYIST
Box 886, Ansonia Station, New York, N.Y. 10023

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City__________ State______ Zip Code______

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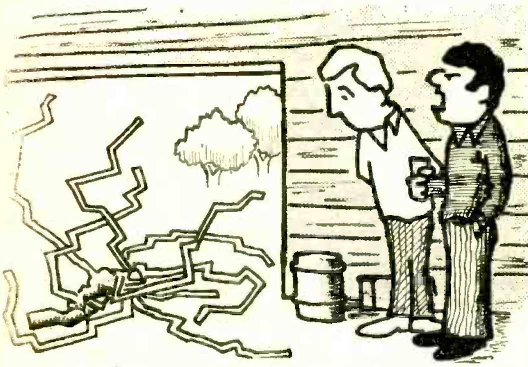
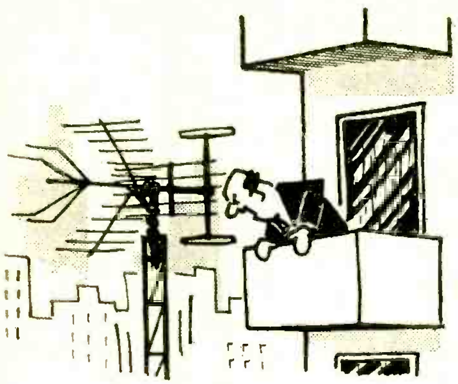
Address__________
City__________ State______ Zip Code______

ANTENNA ELEMENTS

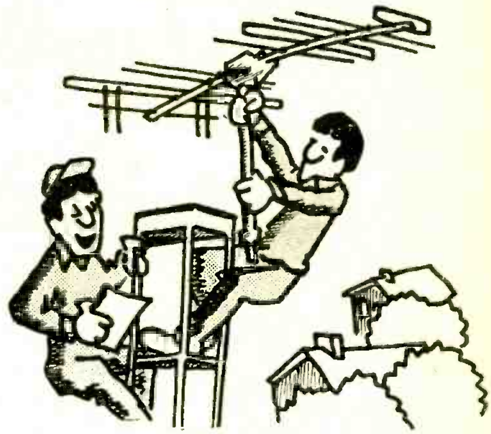
by Jack Schmidt



"It was a special 'Sig-Grabber' until Helene backed into the driveway."

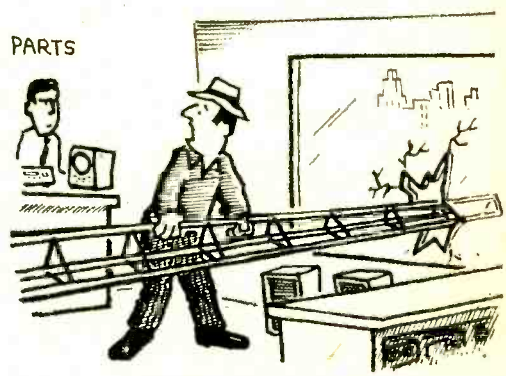


"... just a minute ..."



"Heres the problem. The mast diameter is measured in inches, and the tower hole is in centimeters."

"Ah ... yes?"



"Oops, sorry ..."

WARNING! DANGEROUS GAS PRESENT

BUILD OUR MOBILE GAS ALARM

by C. R. Lewart

Now—our mobile gas alarm means safety on the road; it stands silently by—sniffing with an electronic nose for dangerous combustible gases. When just a small concentration accumulates around its solid-state nostrils . . . *WHAMMO!* The area is shattered. Not by a tragic explosion, but by a loud sceaming alarm that keeps on sounding until *you* turn it off!

Best of all, this alarm can be conveniently powered by electrical systems found in cars, campers, trucks, travel trailers, motorhomes, houseboats, speedboats, electric-start outboard boats, airplanes, all-terrain vehicles, even your electric-start lawn mower—virtually everywhere 12 volt DC power is available. (Turn Page)

MOBILE GAS ALARM

Although we don't always like to think of it, there is a danger associated with deoxidizing (combustible) gas such as propane-fired camper stoves, gasoline fumes in the bilge of a boat, exhaust fumes released by everything from diesel trucks to lawn mowers. There's even the possibility of flame-out and gas leakage with a plumber's soldering torch.

All these situations and many more can mean danger if gas is allowed to accumulate in confined areas. Though the special semiconductor gas sensor used in this project has been the basis for kits and construction

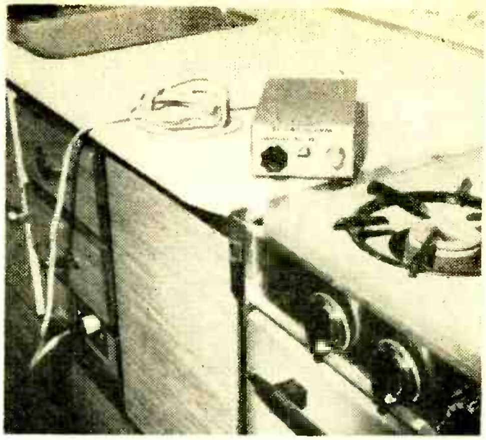
Author's model for portable use. A remote location for both the semiconductor "nose" and Sonalert alarm is an option to consider.

articles in magazines in the past, none, to our knowledge, made such efficient use of the power required to operate its sensor. OK. No problem when you're powered by your local electric company. It's when your power system is based on a storage battery that even ½-watt* becomes important.

But with this project e/e efficiently snips the AC power cord and moves the solid-state gas sensor anywhere 12-volt DC power is available.

You can have this modern gas sensor for use away from power lines that draws hardly more than one tenth of an amp at 12 volts—an average power of 1.2 watts. We've used the handy 555-type timer to *power-pulse* the detector at the 12-volt level, so the

*With a series dropping resistor lowering 12 volts to the required 1.2, you can waste 9 times the power actually used by the gas detector element. This is pure power waste you can't afford when operating from battery power—even high power auto batteries. Multiply that power loss by the number of hours the unit is in operation (say, overnight) on a camping trip, and you come up with a hefty amount of wasted watt-hours.



Typical temporary installation in a pick-up camper. Recreational vehicles often have an electrical outlet supplying 12 volt power.

average power is similar to that provided by 1.2 volts DC.

How Does It Work? Three basic parts of the circuit are a power-saving filament voltage supply for the sensor, the gas sensor device itself, and the alarm tripping circuit. Let us look at them one at a time.

• The power supply for the gas sensor consists of pulse-generating integrated circuit IC1 and a PNP power transistor Q1. The integrated circuit sends periodic pulses which turn the power transistor on and off and thus gate the battery power. This approach saves approximately 80 percent of the battery power as compared to the conventional voltage dropping resistor or power transistor with heat sink methods. Zener diode D1 assures a constant filament supply for the sensor independent of changes in the battery voltage.

• The gas sensor element (Fig. 1) is composed of bulk semiconductor material

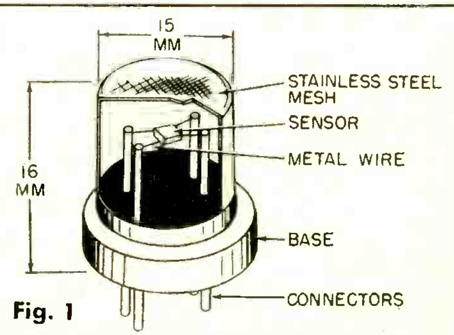


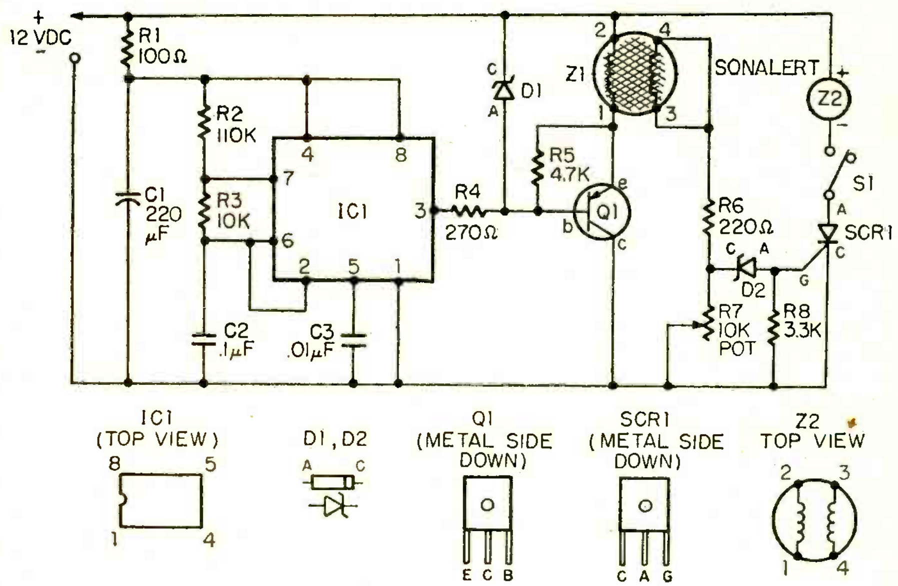
Fig. 1

This unit is electrically symmetrical. Either element can serve as the input or the output of this rugged detector.

(mainly tin oxide) heated by a thin filament coil. The semiconductor material lowers its resistance when exposed to a variety of deoxidizing gases. The sensor reacts to hydrogen, carbon monoxide, propane, and organic solvent vapors in the alcohol, ketone, and benzol families. For example, the sensor can easily detect concentrations of only 100 ppm of carbon monoxide. The sensor restores itself to high resistance a few minutes after the gas source has been removed, and it has a life span of several years.

• The alarm tripping circuit turns the buzzer on when the sensor resistance decreases so that the voltage at the gate of the SCR exceeds a value preset by R7, the sensitivity adjustment potentiometer. Once the SCR is triggered, the buzzer starts to operate. Then, switch S1 must be used to reset the SCR to stop the buzzer. Zener diode D2 prevents the circuit from sounding an alarm if a transient appears on the 12-volt power supply line.

Operation. The gas sensor element has a fair amount of thermal inertia as shown in Fig. 2. Therefore, after connecting the instrument to a 12-volt car or boat battery, wait for four to five minutes with S1 in *off* position and R7 at minimum (counterclockwise) resistance. After the time has elapsed, turn S1 on and start turning the sensitivity adjustment slowly clockwise. When the alarm sounds, switch S1 off, turn R7 slightly back, then switch S1 on again. To obtain maximum sensitivity you can

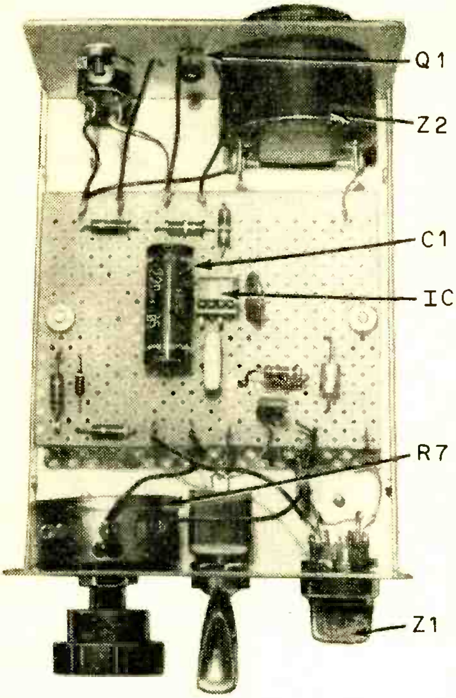


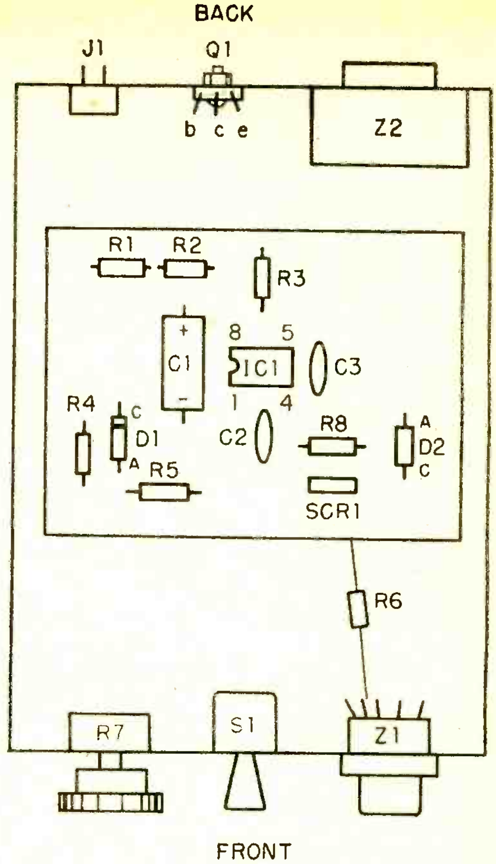
PARTS LIST FOR GAS ALARM

C1—220 uF electrolytic capacitor, 35 to 50 VDC
C2—0.1 uF capacitor, 25 VDC or better
C3—0.01 uF capacitor, 25 VDC or better
D1—Zener diode, 9-volt, ½-watt
D2—Zener diode, 4-volt, ½-watt
IC1—Integrated circuit, 555-type timer
Q1—Transistor, HEP-700 or Radio Shack 276-2026
R1—100-ohm, ½-watt resistor
R2—110,000-ohm, ½-watt resistor
R3—10,000-ohm, ½-watt resistor
R4—270-ohm, ½-watt resistor
R5—4700-ohm, ½-watt resistor
R6—220-ohm, ½-watt resistor
R7—10,000-ohm potentiometer, linear taper (*SENSITIVITY*)
R8—3300-ohm, ½-watt resistor
S1—Switch, spst, any style pushbutton or toggle you select (*ALARM RESET*)
SCR1—Silicon controlled rectifier, Radio Shack 276-1079, or General Electric C106.
Z1—Semiconductor gas detector model 105 (Available from Southwest Technical Products Co., 219 West Rhapsody, San Antonio, TX 78216 for $6.25 postpaid)
Z2—Sonalert model SC628 or equiv.

Misc.—Wire, solder, perf board, push-in clips, cabinet approx. 3-in. high by 4-in. wide by 6-in. deep, IC socket, knob, 7-pin miniature tube socket for Z1, polarized socket for 12-volt input power (Calectro F3-170 shown), automotive-type cigar lighter accessory plug and cord for 12-volt input power, etc.

MOBILE GAS ALARM





You can follow this layout exactly making point-to-point wiring connections underneath the perf board and to push-in clips. Take extra care to insure that correct polarity is applied.

repeat the adjustment after a half hour.

When the buzzer sounds, the only way to turn it off is with S1 (not with the sensitivity adjustment). Check the circuit by rubbing a drop of gasoline or alcohol on your fingers near the sensor. The alarm should then sound. It then takes the sensor four to five minutes to restore itself to the same sensitivity.

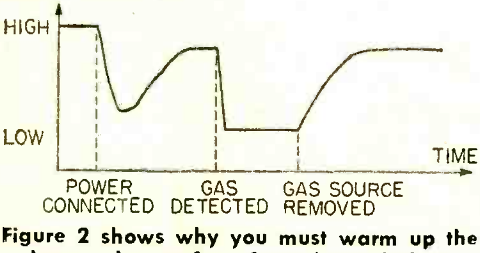
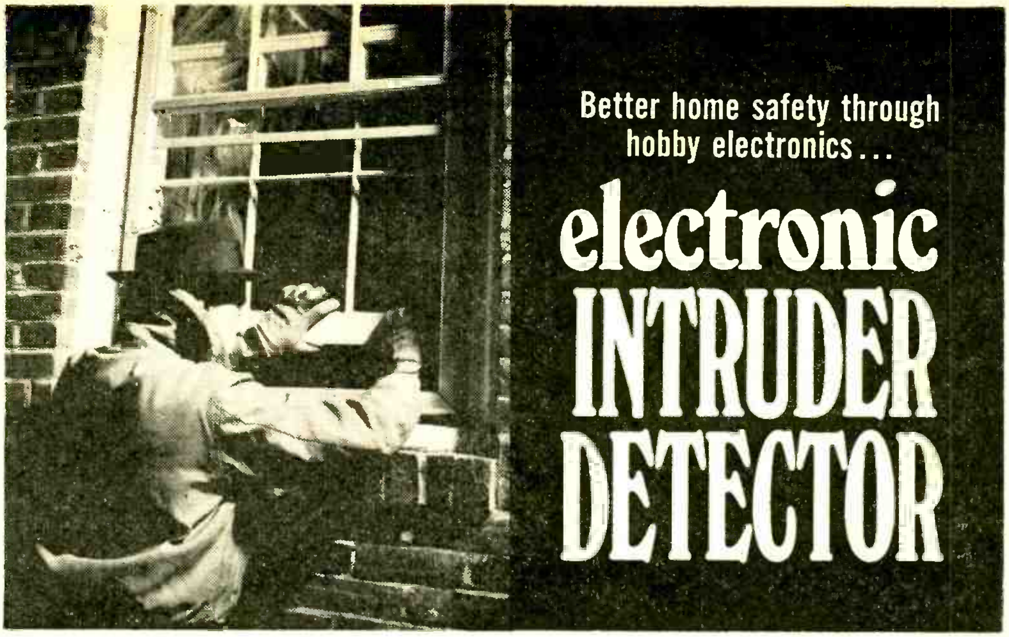


Figure 2 shows why you must warm up the heater element for a few minutes before making a sensitivity adjustment final.

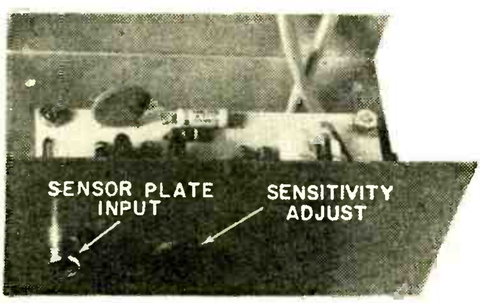
Construction. The project is straightforward. Follow the layout shown. All the components fit on a 3- by 4-in. perf board. A 6- by 3- by 2-in. cabinet will house the entire project. Mounting the gas sensor is easy, it fits into a 7-pin miniature tube socket. Pins 1 & 2 are interchangeable, as are pins 3 & 4. Though we mounted the sensor in the same cabinet as the rest of the circuit, you may want to install it at some remote location in your boat or trailer and connect it via a 3-wire, No. 18 stranded cable to the alarm box. Use the cabinet as a heat sink for transistor Q1; it does not have to be insulated since the collector on the metallic transistor tab is at ground potential. You can pick the 12-volt supply from the cigarette lighter or by making a separate connection to your battery. Use a socket for the integrated circuit to avoid overheating the pins when soldering. ■



Easy to build proximity sensor adds to existing burglar alarm!

by Charles Rakes

IF YOUR PRESENT burglar alarm system is lacking in a variety of input sensors, because the expense of the better motion and capacity activated sensors is above your budget, then consider building our ID proximity sensor. The ID proximity sensor will operate with *any* alarm system that uses a *normally closed sensor* circuit (99% do). An important feature of our proximity circuit helps to make it quite simple for you to build—no coil of any type is required in the oscillator detector circuit. I doubt that you will find one like it anywhere. Also, this sensor will work hand-in-hand with the alarms as presented in the March-April 1972 issue of ELEMENTARY ELECTRONICS.



The two wires you see at the rear are for 12 VDC power to operate the unit and a two wire cable from the normally open relay.

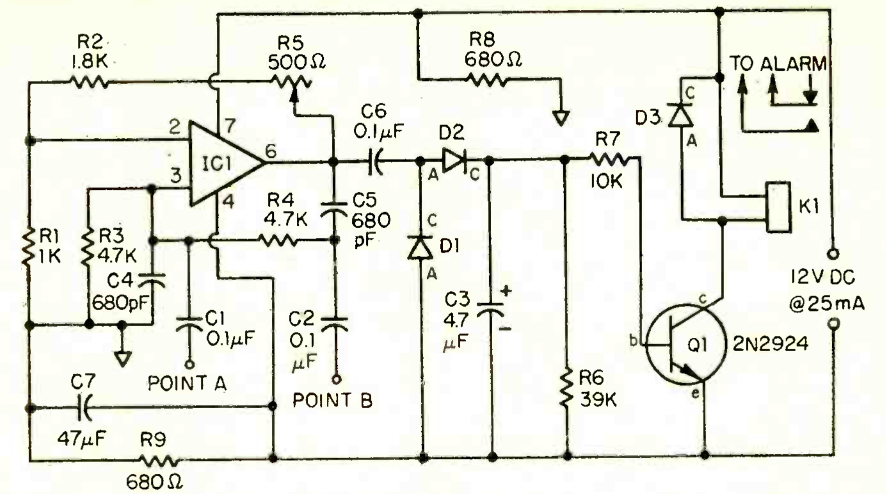
What Can It Do? With the ID sensor you can protect almost any metal object that can be isolated from earth ground—file cabinets, safes, window screens, door knobs, metal plates located under rugs, metal cookie jars! It can even be used to test your reflexes.

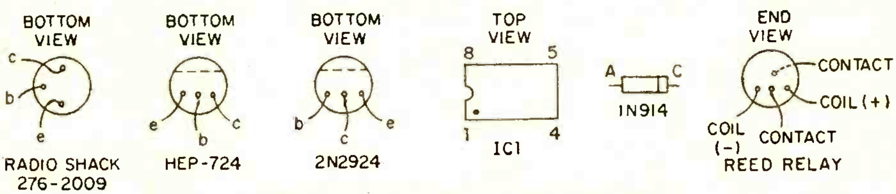
Here's what makes it tick. A single IC is connected in an RC high frequency oscillator circuit that is operating near the cut-off frequency of the device. Potentiometer R5 sets the feedback level just within the point needed to sustain oscillation. The RF signal produced at the output of the IC (pin 6) is fed to D1 and D2 which supply a forward bias current to the base of Q1 to keep the relay energized. With a metal object connected to the input of the sensor, and when an object is moved in close proximity to this metal object the capacitance to ground is increased which unbalances the capacitance between C4 and C5. This causes the oscillator to stop and the relay drops out (opens).

Putting It Together. The sensor may be constructed in any metal or plastic cabinet, but if the PC board is used, a cabinet 2½- x 4¼- x 2-in. is necessary to make the project neat.

If a PC board isn't used, try to follow the general layout of the PC board to

Intruder Detector





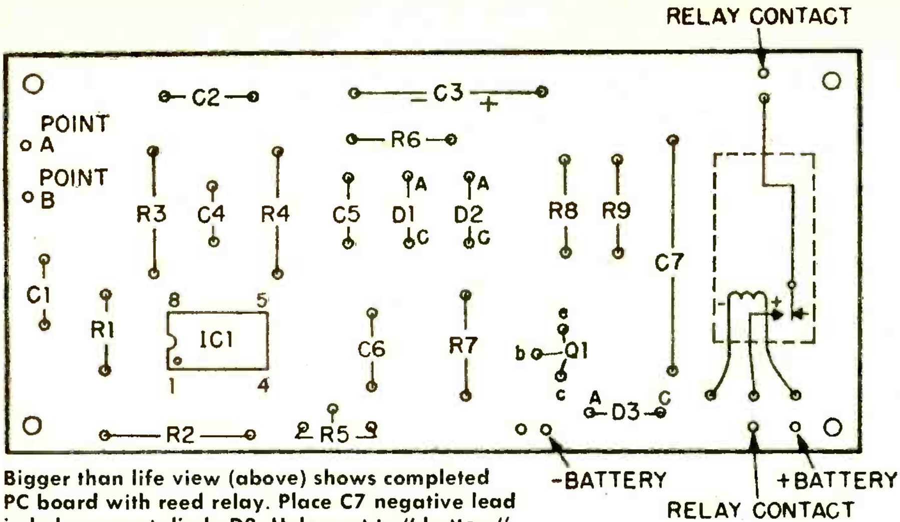
PARTS LIST FOR A PROXIMITY SENSOR

C1, C2, C6—0.1 uF capacitor, 16 VDC or better
C3—4.7 uF electrolytic capacitor, 16 VDC or better
C4, C5—680 pF disc capacitor, Sprague 5GA-T68, Mallory GP-368, Allied 710-1068, etc.
C7—47 uF electrolytic capacitor, 16 VDC
D1 to **D3**—1N914 silicon diode
IC1—741-type integrated circuit, any convenient type for point-to-point wiring, 8-pin mini-dip package for PC board use Radio Shack 276-007 or equiv.
K1—Relay, low current 12 VDC coil, Electronic Applications Co. 1A12AH fits PC board (reed-type relay) Radio Shack 275-003 for point-to-point wiring
Q1—2N2924 transistor, HEP-724
R1—1000-ohm, ½-watt resistor
R2—1800-ohm, ½-watt resistor
R3, R4—4700-ohm, ½-watt resistor
R5—500-ohm potentiometer, PC-type
R6—39,000-ohm, ½-watt resistor
R7—10,000-ohm, ½-watt resistor
R8, R9—680-ohm, ½-watt resistor
Misc.—Wire, solder, 3½- x 4½- x 2½-in. high case, phono jack, hardware, etc.

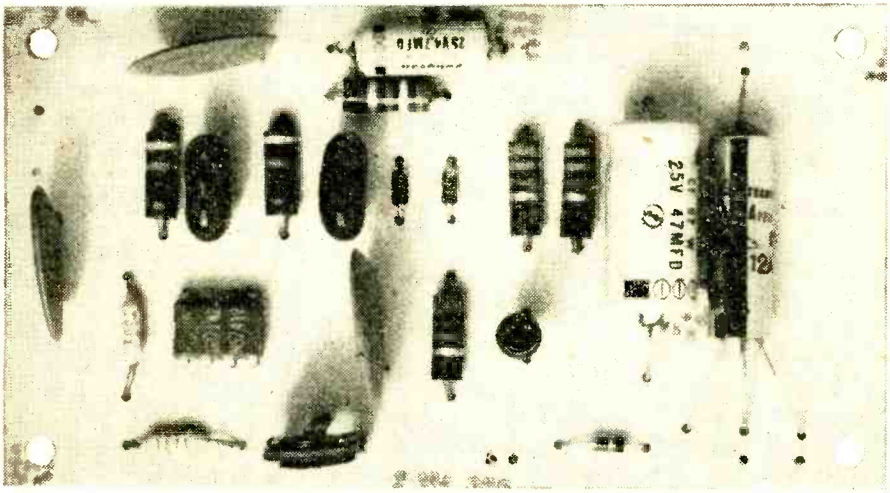
An etched and drilled printed circuit board for this project plus reed relay K1 are available for $8.90 postpaid from Krystal Kits, P.O. Box 445, Bentonville, AR 72712; printed circuit board available separately at $4.45, postpaid. Postal money orders will speed delivery. Otherwise allow 6-8 weeks for delivery. Canadians add $2.00 for additional postage.

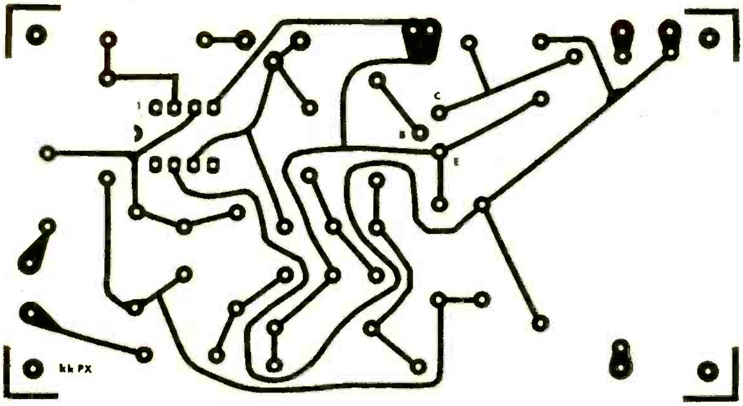
avoid any circuit operating problems. If the PC board approach is used, follow the component layout diagram to mount all parts on the board, then solder all parts in place. Take extra care when installing the semiconductors—be sure that each lead is in the proper location *before* soldering. A ¼-in. hole should be drilled in the cabinet to allow adjustment of the sensitivity pot R5. A phono jack is mounted in the front of the case and connects to the sensor input lead. The power input leads and relay wires run through the back of the cabinet.

Putting It To Use. A choice of inputs are available; input A is suited for small metal objects while input B is to be used for large objects. The selected input is wired to the phono jack mounted on the front of the cabinet. Circuit common (that's the negative battery lead) must be connected to a good earth ground such as a water pipe or the ground wire in a three wire electrical system if the sensor is to operate properly. The



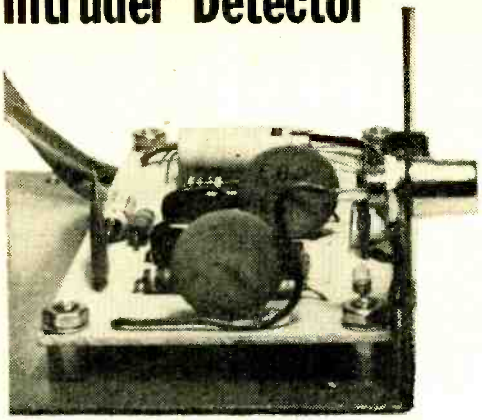
Bigger than life view (above) shows completed PC board with reed relay. Place C7 negative lead in hole nearest diode D3. Hole next to "-battery" is circuit common; connect to ground. See text. The minus side of battery (left) connects to Q1 (e).



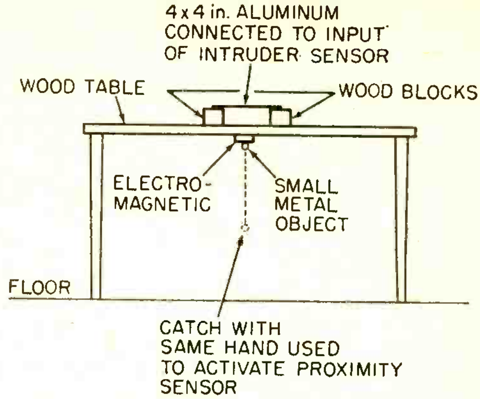


Flip the PC board (shown above) and the copper wiring pattern looks like the drawing at left. In fact, it's an exact size duplicate for those builders inclined to make their own.

Intruder Detector



Mount PC or perf (whichever you use) board with spacers and prevent shorts with case.



Game with small electromagnet, steel ball, and aluminum plate challenges your reaction.

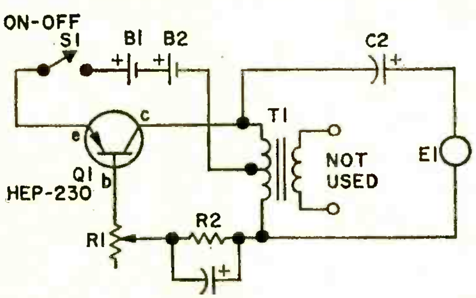
metal object to be protected snould *not* be put on a grounded surface, but on 2-in. wood blocks (or plastic, or foam, etc.) to lift it above ground level. Locate the sensor as much as three feet from the object.

Connect a ohmmeter to the output of the relay contacts and rotate the pot (R5) in a direction that causes the relay to close. This is the most sensitive adjustment. Or, if you wish, the adjustment can be made so the object must be touched to trip the relay. Just adjust R5 according to your needs.

The relay contacts can be connected in series with most "closed circuit" burglar alarm systems.

Just For Fun. You can connect a small electric magnet in series with a power source and the relay contacts. Locate the magnet (see drawing) on a wood surface and secure it with tape. Select a small iron or steel object small enough to be "trapped" by the magnet's magnetic field. Place a 4- x 4-in. piece of thin aluminum about 4-in. above the magnet and connect it to the input of the sensor. Adjust the sensitivity to release the small metal object when your hand is located 2-inches above the piece of aluminum. The object of this game of skill is to catch the metal object with the same hand before it reaches the floor. Have fun! ■

Angler's Bite Booster



Click-click might not sound like much to you but to a fish it's the dinner bell. That's the lure of this electronic circuit. Shove the whole works in a watertight container, lower it over the side, and wait for the fish to hit the hooks.

For proper operation T1 must be subminiature type about half as large as your thumb. E1 must be a crystal headphone.

PARTS LIST FOR ANGLER'S BITE BOOSTER

- **B1, B2—1.5-V AAA battery**
- **C1, C2—47-uF, 12-VDC electrolytic capacitor (Calectro A1-108)**
- **E1—Crystal earphone (Calectro Q4-213)**
- **Q1—Motorola HEP-230 or Calectro K4-520 pnp transistor**
- **R1—5000-ohm pot (Calectro B1-673)**
- **R2—27,000-ohm, 1/4-watt resistor**
- **S1—Spst switch, part of R1**
- **T1—Subminiature transistor output transformer: 500-ohm center tapped primary to 8-ohm secondary (Calectro D1-712)**

This Plain Jane occasional table conceals...

SOUND FORCE--

a 3-way speaker system with downward facing woofer!

by Herman F. Johnson

REMEMBER that old saying once in common use, "Children should be seen but not heard!" A loudspeaker should be the direct opposite, it should be heard but not seen. A speaker system need not look like one of the "common box" variety, either. This one *is* a box system, but it was designed to fit into a popular piece of furniture—the small occasional table known as a "parsons table." By employing one of these tables to house a speaker system, the enclosure can be made of unfinished material; wood joints and jointing screws are hidden from view, and for convenience in assembly, the screws are driven from the outside, into the enclosure.

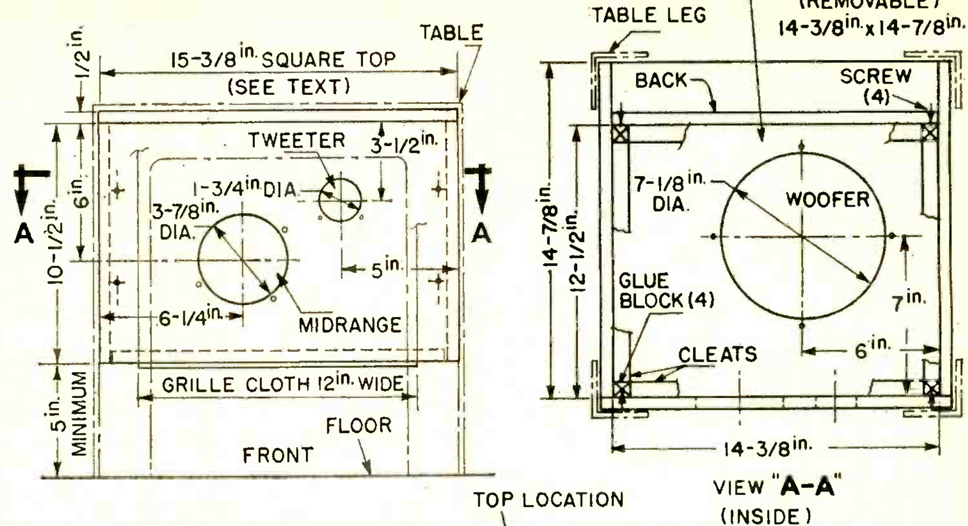
This is a high performance 3-way system that employs speaker components available at Radio Shack. The enclosure is designed to provide outstanding bass performance from a small system. The bass output is enhanced by locating an 8-inch high compliance woofer facing downward toward the floor. A 5-inch midrange driver and a super tweeter face forward to provide the all important midrange and high frequencies. The woofer is rolled off at 500 Hz. The tweeter picks up the highs from 3300 Hz and up. Of course, the midrange unit operates from 500 Hz to 3300 Hz. This frequency division is supplied by a 3-way crossover network that contains sound level controls for the treble and highs. The power handling capacity is rated at 60 watts.

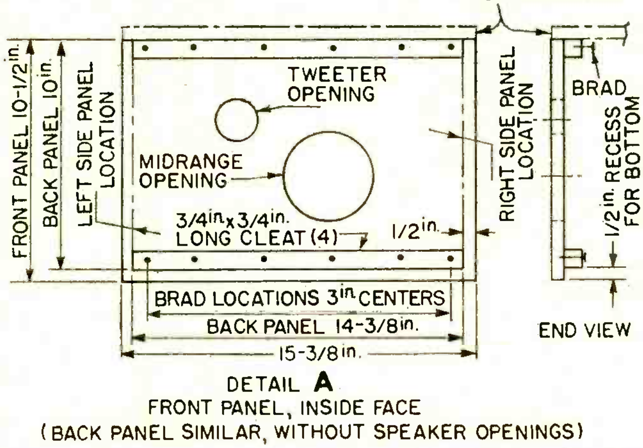
Construction. Before you purchase the speakers, locate a 16-in. cube-shaped occassional table. They are made of high gloss plastic in black, yellow, red and gray colors. Take a good look at the construction of the table before you decide upon the color. The table legs must be right angle shaped, not square, and it should be of one-piece construction rather than the kind with removable legs. These tables are usually found in stores that feature unfinished furniture.

When you have obtained the table that suits your decor, check the inside dimensions between adjacent legs at the under side of the top. This dimension should be 15½-inches in both directions. The dimension 15⅜-in. at the top of the drawing labeled front Elevation allows for 1/16 of an inch at all sides of the top panel for grille cloth covering of the front and both sides of the enclosure. If the dimensions are less than 15½-in. between legs, the square dimensions of the top panel should be reduced accordingly. The dimensions of the top determines the overall dimensions of the other panels.

View "A-A" in the drawing (top removed) indicates the location of all the panels, supporting cleats and glue blocks. Details "A" and "B" locate the cleats. Round dots indicate the location of brads that secure each cleat and glue block to a panel. Details "C" and "D" provide the

SOUND FORCE





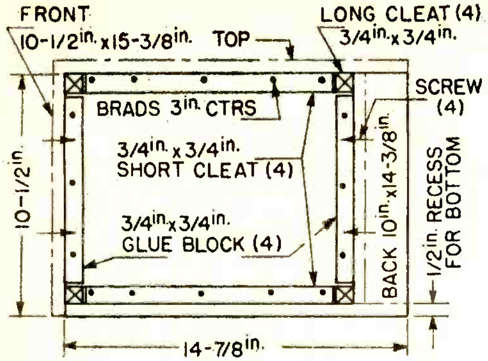
A look at the front and rear (top and bottom, left) of the forward-facing speaker panel. Inside view A-A (above) is a drawing of what you would see if you could look down from the top into the speaker enclosure. The bottom panel which supports the downward-facing woofer is held to the four cleats with screws which are positioned as shown in detail "D" at right.

locations of screw holes (round dots) in the top and bottom panels.

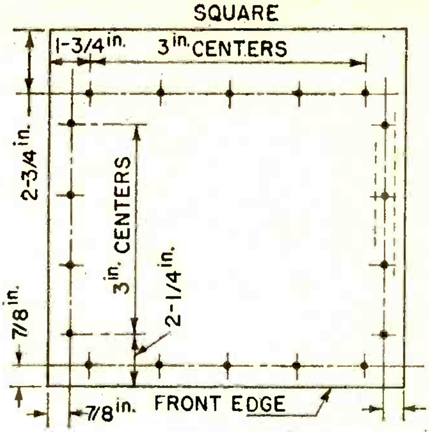
Construction Sequence. You will need a half sheet (48 x 48-in.) of plain particle board, ½-inch thick. Half a sheet is more than enough to build one enclosure, but it is not enough for a stereo pair. When the panels have been cut to size as indicated in the drawings, lay out the center locations for the speakers as shown in the front elevation view and in view "A-A". Carefully cut the midrange and woofer openings with a sabre saw. The 1¾-in. diameter opening for the tweeter is best cut by a hole saw chucked into an electric drill.

Ten feet of ¾-in. square pine is required for cleats and glue blocks. See the Bill of Material for the lengths. The glue blocks are the vertical corner reinforcements, all others are labeled cleats. Pencil-outline the location of each cleat and glue block on one side of each front, back and side panel. Start on the back panel where two long cleats are aligned along the panel edges as indicated in Detail "A". These lines serve as guides when glue is applied. One inch brads secure each cleat and glue block to the panels. Counter sink the brads about ⅛-in. below the surface. The use of cleats assists in the assembly and insures construction of an air tight enclosure (air tightness is a basic requirement to obtain good bass performance).

Next, lay out the screw hole centerlines on the top and bottom panels as shown in Details "C" and "D". Center punch each screw location and drill 1/16-in. holes as indicated. Then, assemble the front, sides,

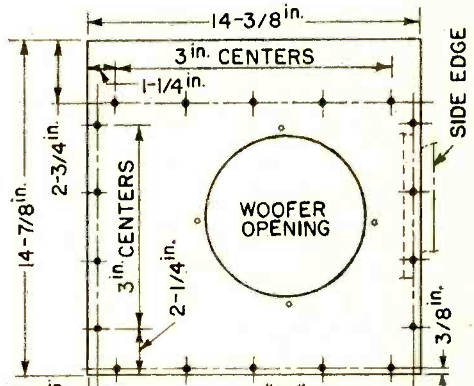


DETAIL "B"
LEFT SIDE PANEL, INSIDE FACE
(RIGHT SIDE PANEL SIMILAR)



DETAIL "C"
(TOP PANEL)

To complete your "box within a box" you will require panels for the left and right sides as detailed on B above; you will also require the top piece shown in detail C. This can be planed or filed as necessary to fit the inside characteristics of your table. Remember, the back panel is similar to the front panel (detail A) but without the speaker openings.



DETAIL "D"
(BOTTOM PANEL)

and back panel in the position shown in view "A-A" and align the top panel. You are now ready to mark screw locations into the top side of the cleats with the 1/16-in. drill. At this point you should examine the screw locations to see if any screw is likely to hit a brad when it is driven. If a screw location appears to be too close to a brad, it is best to drill another hole 1/4 or 1/2-in. away from the brad. When you are satisfied that all screws will clear, reassemble the same panels, down side up, and repeat this process for the bottom panel. When you are satisfied that all screw holes are in the clear, re-drill all of the holes 9/64-in. diameter and countersink for No. 6 screws. It is to be noted that four (4) screw holes are required in the front and back panels for screwing into the glue blocks. All of the panel edges should be given a coating of resin sealer to prevent flake off.

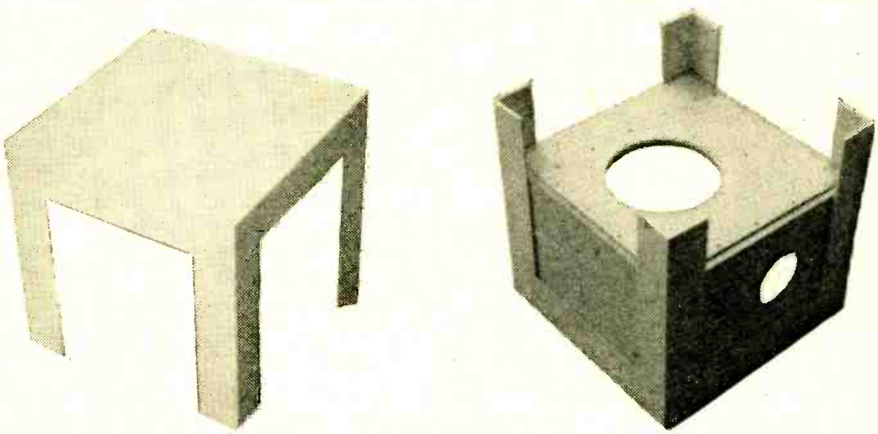
You are now ready for the final assembly—except for the preparation of screw holes to mount the speakers; this data follows under speaker component installation, below. Coat all mating surfaces with white glue between the panel and the cleats; then, screw the top down firmly. Do the same for jointing the front and back panels to the glue blocks you have installed on the sides.

Speaker Component Installation. All of the speakers are mounted to the inside face of the panels. However, the diameters indicated in the drawings will allow the two cone drivers to be "backed in" to their respective openings on the inside faces of the panels, so each driver will be centered in the opening. In this position, center punch all four (4) mounting holes from the frame of each unit. Remove the speakers and drive ½-in. No. 8 sheet metal screws into the panels about ¼-inch deep. Then, remove the screws and scrape off the displaced wood around each screw hole. This proceedure will prevent damage to the cone of a speaker should a screw driver slip when driving a screw. The woofer and the tweeter should be mounted with screws. The hole locations you have marked for the midrange unit should be drilled 11/64-in. or 3/16-in. in diameter for 8-32 machine screws.

The back of the midrange cone must be isolated in the enclosure from the woofer. This is readily accomplished by bolting a plastic cover over the back side of the midrange driver. A dessert bowl was used by the author. Any bowl that is quite stiff and has a flanged edge all around will do the job nicely. There is no need for a gasket. The edge of the bowl can be clamped to the smooth back surface of the speaker's frame by the mounting bolts.

The recessed space behind the back panel is convenient for mounting the crossover network. Draw a horizontal pencil line on the back panel at 4¼-in. from the bottom edge and center mark the location for two ½-in. No. 6 pan head sheet metal screws 4⅞-in. apart. Drive these screws in about half way. Slotted openings are provided on the back of the network for hanging it on two screws. The network is a self contained unit. Hence, three sets of connecting wires must be brought through holes in the back panel for connections between each speaker and a 12-screw terminal strip on the network. Drill holes through the back panel at 1½-in. from the bottom edge for a snug fit to the hookup wires. Follow the instructions attached to the network for connection to the speakers with jumper wires between designated terminals to engage the installed tweeter and midrange level controls that are located on the front of the network.

Cut the speaker hookup wire (zip cord is fine) in about 24-in. lengths. Solder one of these to the woofer terminal lugs, one to the midrange lugs (through a snug fit hole in the side of the plastic cover), and the third to the pull-type binding posts located on the tweeter. Red dot terminals on the speakers should be connected to their respective plus (+) terminals on the network (2, 8, and 10). Unmarked terminal lugs should be connected to the negative (common) terminals on the network (1 and 6). Since two wires must be connected to terminal 6 in a 3-way system, it is a good idea to use spade connectors. The input terminals are located adjacent to terminals No. 1 and 2. The input terminal adjacent to terminal No. 2 is the plus (+) terminal.



Check the Bill of Materials appearing on the last page of this article. Of course, you must have one set of materials for each speaker you wish to build. You should always use "zip" cord for speaker connections on moderate and high power installations; never that thin stuff sometimes sold on spools as "speaker hook-up wire." Use it for connecting intercoms, if you must, but stick to the #18 for hi-fi.

Sound Damping. A minimum amount of damping material is recommended to be installed inside the enclosure to absorb reflections from the inside surfaces, back to the woofer. Cut two pieces of one-inch thick fiberglas to fit over the cleats and glue blocks at the back and on one side. And, cut a third piece to fit over the cleats at the top. Staple or thumb tack the damping material to the cleats.

Your enclosure is now complete except for the final installation of the bottom panel containing the woofer. Install four (4) lengths of ⅜-in. by ¼-in. self stick foam weather strip tape on the face of the bottom cleats along the inside edge of each cleat to insure air tightness under the bottom panel. Then, screw it down in place.

Grille cloth provides an attractive method of covering the exposed unfinished front and side panels. It is sold by most electronic parts stores by the foot from rolls 32 or 36-in. in width. Three 12-in. inch wide strips about 14-in. long will cover the front and both sides when centered so that the edges are between the panels and the table legs as indicated in the front elevation view. Pick out a soft, cloth like, grille material that will take a smooth right angle bend. Coat the edges with rubber cement, about ½-in. wide, with a paint brush to prevent fraying. Staple or tack an end edge of the material to the bottom edge of the front panel (a paper stapler will do the job if held firmly), then draw it up over the edge of the top panel and staple it to the top. Repeat this process for covering both side panels. It is also a good idea to cover the woofer should a pet crawl under and damage the cone. Staple an 8½-in. square piece of grille cloth to the bottom panel.

Before inserting the enclosure into the table, examine the inside skirt edges of the table below the top. If these edges are a sharp right angle, round them over with a file to avoid abrasion of the grille.

With the table in an upside down position, lower the enclosure down between the legs. Then drill two holes 9/64-in. diameter through the table legs and into both side panels in a low position about 11-in. below the top of the table and at about 1¼-in. from the outside right angle corner of each leg. Drive ¾-in. No.6 round head, plated, wood screws in until the table leg is drawn snug to the enclosure. These four screws are all that is required.

Operation. As stated earlier, the bass response is rebust. If the lows are too strong for your ears, cut back on your bass control at your receiver. It is of considerable advantage to have variable output for both the midrange driver and the tweeter. The midrange control should be advanced more than half way and the tweeter control to about one-quarter turn for most listening rooms. ■

Bill of Material for Sound Force

Quantity	Name	Size	Material
1	top panel	15⅗-in. sq.	½-in. particle board
1	bottom panel	14⅜-in. x 14⅞-in.	
2	side panel	14⅜-in. x 14⅞-in.	½-in. particle board
1	front panel	10½-in. x 15⅜-in.	½-in. particle board
1	back panel	10-in. x 14⅜-in.	½-in. particle board
4	long cleats	¾-in. sq. x 14⅜-in.	pine
4	short cleats	¾-in. sq. x 11-in.	pine
4	glue blocks	¾-in. sq. x 8-in.	pine
44	flat head wood screws	1-in. No. 6	—
4	machine screws	1¼-in.	—
7	sheet metal screws	½-No. 8	—
60	wire brads	1-in.	—
1	occasional table	16-in. x 16-in. x 16-in.	plastic
1	woofer	8-in. (Radio Shack 40-1341)	—
1	mid-range	5-in. (Radio Shack 40-1292)	—
1	tweeter	1¾-in. (Radio Shack 14-1274)	—
1	network	3-way (Radio Shack 40-1339)	—

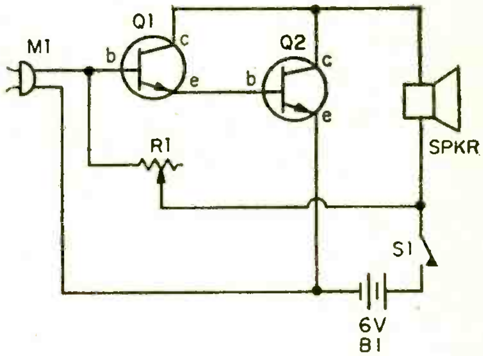
Misc.—Grill cloth, rubber cement, glue, speaker cord, connectors, 4-sq. ft. of 1-in. fiberglass, etc. (Author used Sycro "Parsons Table" from Sycro division, Dart Industries, Inc., Syracuse, NY 13201)

BUILD IT FAST...

Get out your tools, clean up a soldering iron and try your hand at one or both of these quick projects now!

BIG VOICE

☐ Build this loud hailer into a small cabinet and you'll be able to outshout nearly everyone at the next free-for-all. The microphone should be mounted or held behind the front facing speaker to reduce the possibility of feedback. The speaker must be rated no higher than 8-ohms, though best results are obtained with speakers in the 3.2 to 4-ohm range. Adjust potentiometer R1 for minimum distortion coincident with maximum volume while speaking into the microphone.



PARTS LIST FOR BIG VOICE

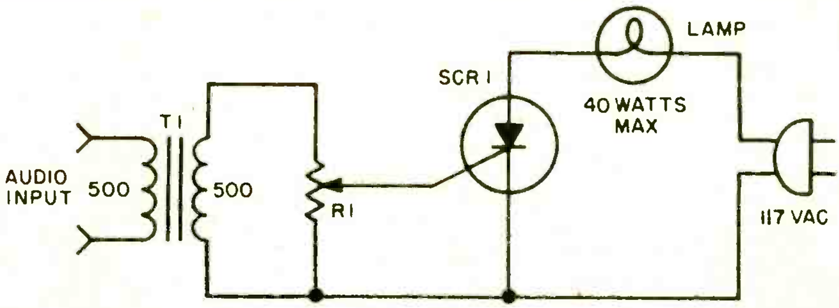
- B1—6VDC lantern battery
- M1—Carbon microphone (telephone type)
- Q1, Q2—NPN transistors, (RCA 2N1486 or equiv.)
- R1—5000 ohm potentiometer, any taper
- SPKR—3.2 or 4-ohm speaker
- S1—spst toggle or slide switch

BASIC COLOR ORGAN

☐ This simple color organ is certain to keep your party from becoming a drag. Connected to your hi-fi amplifier's speaker output (across the speaker terminals) it will throb in time to the music. Paint the bulb red or deep blue and your party room will take on the atmosphere of a rock club. Transformer T1 can be any matching transistor type in the range of 500/500 to 2500/2500 ohms. Note that none of the connections from SCR1 or its components are connected to ground. For safety's sake, you must keep the 117 volt line voltage from the amplifier connections; that's the reason for T1. To adjust, set potentiometer R1 "off" and adjust the amplifier volume control for a normal listening level. Then adjust R1 until lamp I1 starts to throb in step with the beat.

PARTS LIST FOR BASIC COLOR ORGAN

- I1—117V lamp, not to exceed 40 watts
- R1—Potentiometer, 500 to 5000 ohms
- SCR1—Silicon Controlled Rectifier (HEP-R1221 or equiv.)
- T1—Transistor output transformer, see text



Stop Wasting Energy! BUILD TIME TALLY

With electric power at top price, you will want to conserve it more than ever!

by Thomas R. Fox

Something's been hanging in there too long drawing current all the time, and it's costing you a bundle! What is it? Who knows? But *you* can find out with this simple electromechanical counter driven by a single integrated circuit and connected to the "on" switch of an electrical device, or appliance, or any electric-start engine.

By combining an up-to-the-minute integrated circuit with the old reliable electromechanical counter, you can make an ultra-simple and inexpensive elapsed time meter. The 555-type timer used here is a very handy IC because it is amazingly stable and accurate; its timing isn't significantly affected even if the supply voltage varies widely.

The circuit, centering around the 555 timer, emits half-a-second negative pulses once every 60 seconds. This short, power-stingy pulse triggers the electromechanical counter whose memory requires no power whatever. The 555 output is sufficient to drive the counter directly, which simplifies things quite a bit.

Put It Together. Since the entire project minus power supply has fewer than ten parts, construction is a snap. If the meter is to be used in outdoor equipment, one of the first things to be done is to find a protected spot in the equipment to mount the circuit.

If the meter is to be used indoors to count the minutes a TV is on a month, for instance, a case should be used to mount the counter. An IC socket can be used for the 555 or connections can be soldered directly to its leads if proper precautions against overheating are taken. *Use a 20-ohm, ½-watt resistor in series with one lead of counter Z1 if the meter is to be built into outdoor equipment that uses a 12-volt battery.* With 6-volt systems or with one of the AC power supplies, eliminate the series resistor.

Connect a 6 or 12-volt battery used in the machine or, if it is to be built for indoor use, use four "D" cells in series or a 6-volt lantern battery to calibrate the meter. With R1 set near its mid-point, the counter should advance one step every 55-60 seconds. Adjust R1 so that the counter clicks exactly every 60 seconds (decreasing the resistance of R1 decreases the time).

For Outdoor Engine Use. Since it is the most common, your machine probably has a negative ground electrical system (negative battery terminal connected to chassis). However, make sure by either examining the electrical wiring diagram or by using a voltmeter.

In negative ground systems, connect a wire to a terminal on the key switch (not to a terminal that is connected directly to the battery) to point "A" on the schematic.

TIME TALLY

Connect a wire from point "B" to the negative terminal of the battery or to any convenient ground. If the timer runs even with the switch off, you've connected point "A" directly to the battery, bypassing the switch. Try another terminal on the key switch (a voltmeter comes in handy when tracing circuitry). Before making the final installation, make sure the Time Tally works only when the key switch is *on*.

With positive ground systems, connect point "B" to a terminal on the key switch and point "A" to a ground. The counter itself can be mounted in any location where the numbers can be read. It is not necessary to mount it in the front panel.

Since the Time Tally records minutes, not hours, the "hours" usually referred to in the owner's manual should first be converted to minutes by multiplying the hours by 60. For instance, a 25 hour maintenance schedule should be changed to a 25X60=1500 minute schedule. It is most convenient to make the change right in the manual. It is also helpful to record the last minute you serviced the engine.

For Indoor Appliance Use. Use the Time Tally to find out which appliances are gobbling up those expensive kilowatt-hours. Use the following formula to find the exact costs of those "suspected" appliances.

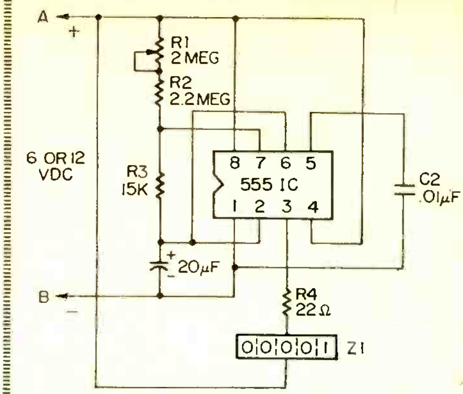
$/MONTH=(MINUTES USED/60,000) (APPLIANCE WATTAGE) (RATE IN $/KWH)

The electric rate is now usually in the vicinity of $.05 a kWh.

There are two ways of connecting the Time Tally to the appliance being timed. The simplest, in theory at least, is to connect a 6 or 12-volt power supply directly to the appliance on-off switch as shown in Fig. 1. However, because the switch is often in a tight corner, this approach is sometimes difficult. Another approach, which makes the Time Tally even more versatile, is shown in Fig. 2. With this set-up, one merely plugs the appliance into the Time Tally plug. The appliance switch is left *on* so that the appliance can only be turned on or off by using the Time Tally switch.

Other Uses. The Time Tally can be used in an auto to, say, time the length of driving time for a trip. Here the Time Tally should be connected as described in the outdoor engine use section.

The indoor version of the Time Tally, if used with the power supply shown in Fig. 2, can be used as a digital cooking timer. Just flick the switch the minute an egg goes into boiling water or a TV dinner goes in the oven, and watch for the recommended minute to show up. ■



PARTS LIST FOR TIME TALLY

C1—20 uF Tantalum capacitor, 20 VDC or better
Note. Common electrolytic capacitors may be used with some loss of timing accuracy.
C2—0.01 uF capacitor, any type, 12 VDC
IC1—555-type timer
R1—2 Megohm potentiometer, linear taper
R2—2.2 Megohm, ½-watt resistor
R3—15,000-ohm, ½-watt resistor
R4—22-ohm, ½-watt resistor
Z1—Electromechanical counter, 6-VDC, 5-digit, surplus type

Note. Author used ITT type CE50BN5014U. These units are available for $4.95 each plus postage for 10 oz. from BA, 3199 Mercer, Kansas City, Mo 64111.

Fig. 1

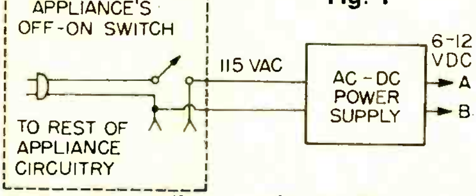
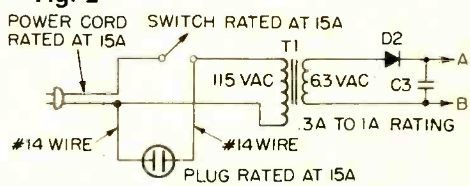


Fig. 2



Putting Time Tally to work. Use Fig. 1 set-up with permanent installations; Fig. 2 shows AC-DC supply. Diode D2 is rated at 1 amp., capacitor C3 is 10 uF at 15 VDC or better.

Electro-chemical action tests your car battery!

BATTERY MONITOR & CELL CONDITION TESTER

Are you one of the many who are servicing their own cars? 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 good 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.

by Charles Green

Wet Cell Tester

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.

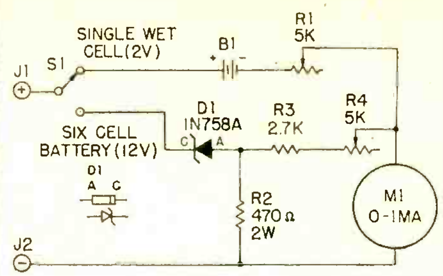
The best way to start construction is to cut out the M1 mounting hole in the panel and install the meter in approximately the position shown in the panel photo. Then locate and mount S1, and J1 and J2. Cut a section of perf board to size, and drill two holes to fit the M1 terminal screws to mount the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

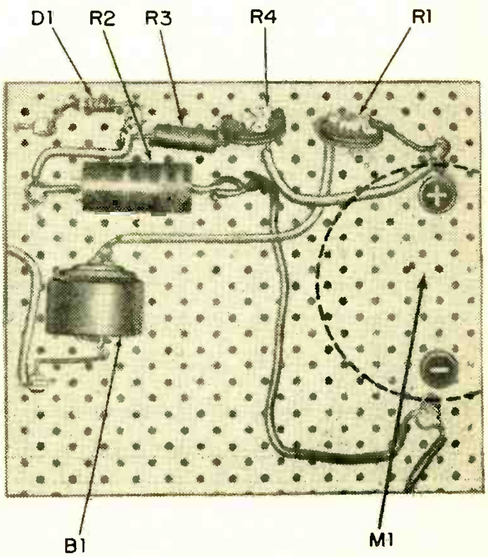
Begin construction by selecting a pair of mechanical pencils with black and red plastic bodies for your test leads. Carefully



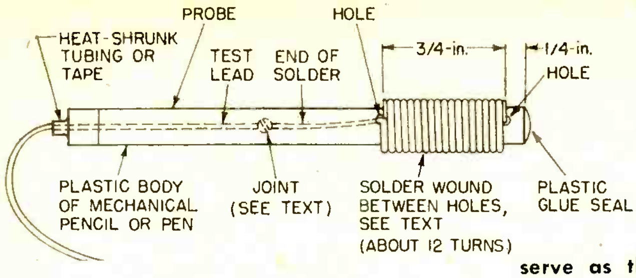
PARTS LIST FOR BATTERY MONITOR & CELL CONDITION TESTER

- **B1**—1.4-volt mercury cell, Eveready E640
- **D1**—10-volt, ½-watt zener diode (1N758A or HEP ZO220 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.



Perf board showing all 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. Two volts 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.

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.

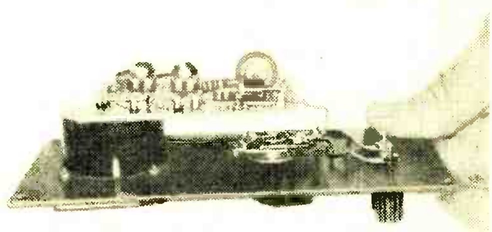
Drill two holes spaced ¾-in. apart approximately ¼-in. from the end of each pencil body, and wrap wire solder between the holes as shown. Insert the ends of the wire solder into the holes to hold the turns in place. The end of the wire solder in the hole toward the other end of the pencil body (the former 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 prodes. 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

(Continued on page 109)



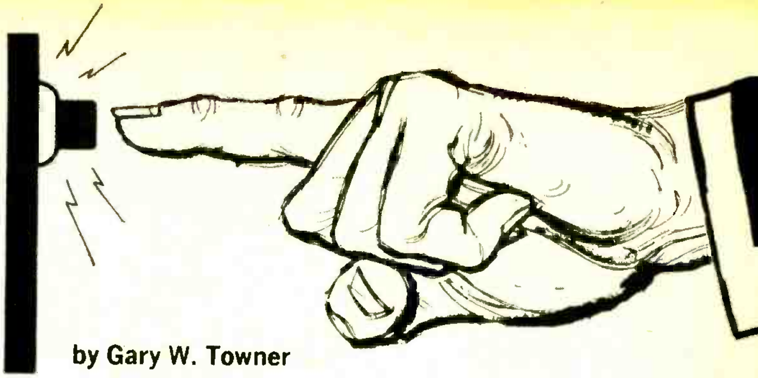
Inside the meter. Mount perf board to meter using screws in meter terminals. Solder to battery B1 terminals directly or use a clip.

Where do the pros get their training?

Almost half of the successful TV servicemen have home study training and with them, it's NRI 2 to 1.
It's a fact! Among men actually making their living repairing TV and audio equipment, more have taken training from NRI than any other home study school. More than twice as many!

FUN PROJECT

Pushie Button



by Gary W. Towner

☐ ***To play this dueling game*** two players sit opposite each other with the box in between. To start the game, the on-off-reset switch is closed and each player puts his hands in his lap. At the count of three each player hits his button. The first one to do so is the winner of the round as indicated by the lamp opposite his button. After each round, S3 must be turned *off*, then *on* to reset the lamps.

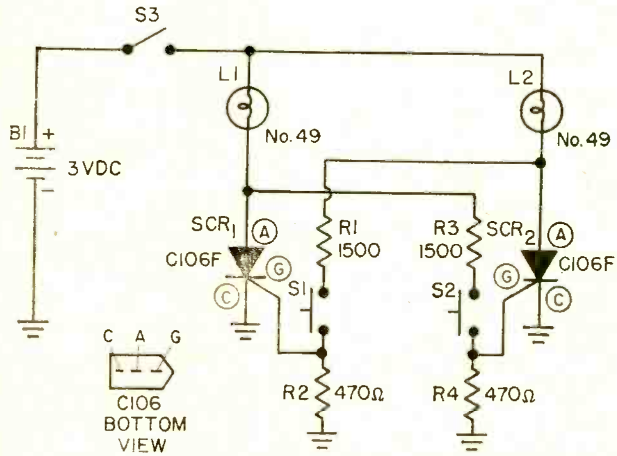
How It Works. Refer to the schematic diagram: each of the two lamps is returned to the negative of the battery through a silicon controlled rectifier (SCR). Such rectifiers are special in that a positive voltage between gate to cathode must exist before current can flow from the anode to the cathode. One other feature of the SCR is that once anode-to-cathode current flows it continues to flow no matter what is done to the gate voltage.

Suppose S2 is pressed. Current will flow through L1, R3, and R4. While this current is far too low to light L1, it is sufficient to develop a voltage drop across R4. With SCR-2 turned *on* in this way, L2 will light.

If S1 is now pressed, very little current can flow through R1 and R2 because SCR-2 is turned *on* and represents, for all practical purposes, a short to ground. Therefore, not enough positive voltage can be developed between gate and cathode to turn on SCR-1. Of course, if S1 had been pressed first, L1 would be on and L2 off.

Construction Details. The wiring layout is not at all critical. You can use perf board or not, as you wish. Remember, the smaller the box, the more sporting the game. Dress up the metal front panel with self-adhesive shelf paper for good looks.

It's an exciting pushbutton gadget you can build for players of all ages. With a handful of parts and a few hours work anyone can construct this electronic game. By the way, the first player to achieve a ten-round win is the winner of the series and becomes eligible to participate in the annual Boardinghouse-Reach "grab-the-spuds" contest. ■



PARTS LIST FOR PUSHIE-BUTTON

- **B1**—3-volt battery (two D-cells in battery holder)
- **L1, L2**—Low power #49 lamps
- **R1, R3**—1500-ohm, ½-watt resistor
- **R2, R4**—470-ohm, ½-watt resistor
- **SCR1, SCR2**—Silicon controlled rectifier
- **S1, S2**—Normally open pushbutton switch
- **S3**—Spst slide switch
- **Misc.**—Utility box, lamp holders, wire, solder, etc.

NOW—
keen color quality at home with...
A Darkroom Color Analyzer

Today it's easy to make bright color prints at home with modern color chemistry and an electronic color analyzer!

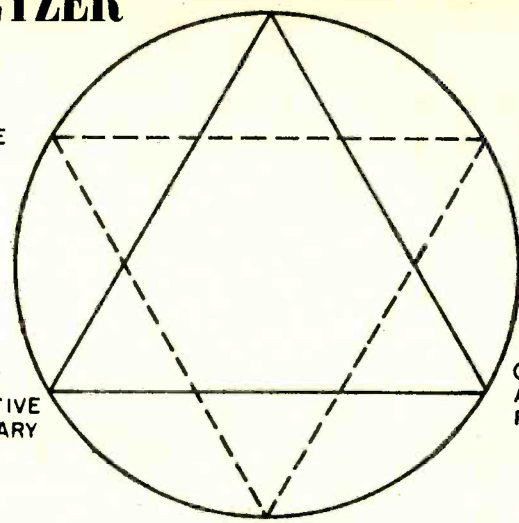
One of the shutterbug's most satisfying accomplishments is producing his own color prints. For years the time spent on and the cost of making color prints were discouraging, but with modern color chemistry, such as the Beseler system, you can turn out quality color prints *in less time than for black and white* (about 3 minutes), and the prints will be far superior to anything you're likely to get from a color lab.

One thing that takes the drudgery out of color work—besides the chemistry—is a color analyzer, a device that gives you the correct filter pack and exposure time at the very first crack. Most often, the very first print made with the analyzer will be *good*. At most, it will take perhaps 0.10 or 0.20 change of filtration for a *superb* print. This is a lot less expensive and time-consuming than making test print after test print. In fact, it's really the color analyzer that puts the fun into making your own color prints!

COLOR ANALYZERS ARE NOT CHEAP. A decent one

by Herb Friedman

COLOR ANALYZER



Any one of the primary colors on this circle is composed of its immediately adjacent colors in equal amounts. It is the balancing of additive primary colors of photographic light sources and subtractive-type color filters that provides control in color print photography.

costs well over $100, and a good one runs well over $200. But if you've got even a half-filled junk box you can make your own color analyzer for just the junk parts and perhaps $10 to $15 worth of new components.

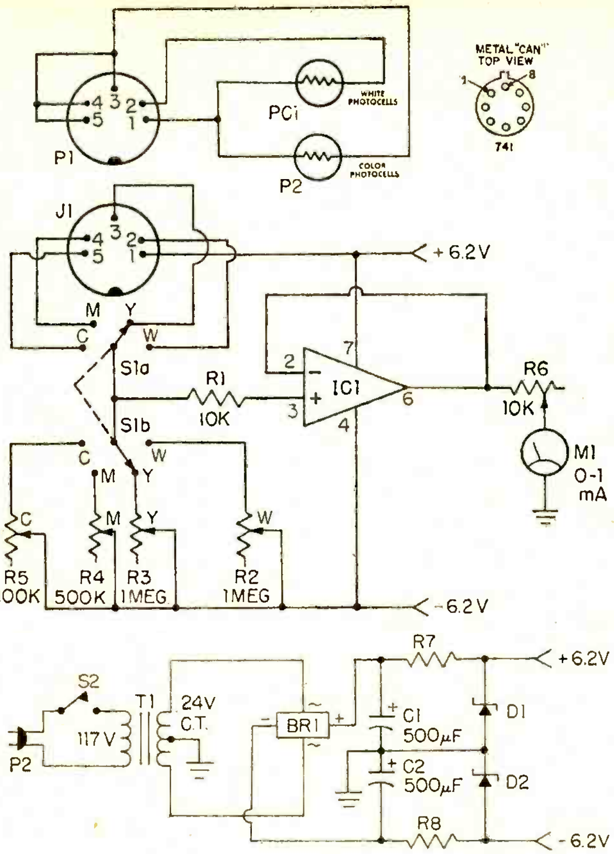
A color analyzer is basically a miniature computer. You make a "perfect" print the hard way—by trial and error—and then calibrate the analyzer to your filter pack and exposure time. As long as you use the same box of paper and similar negatives, all you need to do to make a good color print is focus the negative, adjust the filter pack and exposure so the analyzer reads "zero," and hit the enlarger's timer switch. Even if you switch to a completely different type of negative, the analyzer will put you well inside the ballpark, so your second print is a winner. (And even if the filtration is off, the exposure will probably be right on the nose.)

Construction. The color analyzer shown was specifically designed for the readers of this magazine—essentially an electronic hobbyist with an interest in photography. All components are readily available in local parts stores or as junk-box parts. Several protection devices have been designed into the circuit so accidental shorts won't produce a catastrophe. The printed circuit board template has foils for both incandescent and neon meter lamps, as well as extra terminals so you can use either a socket and plug or hard wiring for the color comparator and exposure sensor. In short, you can make a lot of changes to suit your individual needs.

The template for IC1 uses a half-minidip, Signetics V type package lead arrangement. However, you can also use an IC with a round (TO-5) configuration. If anything is wrong with the IC you can get the TO-5 out easily. The half-minidip removal might result in destruction of the PC board. We'll explain how to install the TO-5 IC on the PC board later.

You can either buy or make the printed circuit board (see parts list). Either way, the first step is to prepare the printed circuit board. If you do it yourself, make it any way you like, using free-hand or template resist. Nothing is critical, but be certain there are no copper shorts between the terminals for IC1. Use a number 56 bit for all holes. Then use a larger bit for transformer T1's mounting screws (#4 or #6 screws), a ¼-in. bit for resistor R6, and a number 30 to 40 bit for the line cord connections (any bit that will allow the linecord wires to pass through the board).

Assemble the power supply and check it out before any other components are installed. Install transformer T1 first. Any 24 volt or 25.2 volt center-tapped transformer that will fit on the board will be fine. Get



PARTS LIST FOR COLOR COMPUTER

BR1—Bridge rectifier, silicon, 50 PIV, 0.5 amp or higher
C1, C2—500 µF capacitor, 10 VDC or better
D1, D2—Zener diode, 6.2 volts, 1 watt
IC1—Type 741C operational amplifier, see text
J1—DIN type 5-pin socket (optional, see text)
M1—0 to 1 mA DC meter, see text
P1—DIN type 5-pin plug (optional, see text)
P1, P2—Photocell, Clairex CL5M5L, **do not substitute**
R1—10,000-ohms, ½-watt resistor
R2, R3—1-megohm potentiometer, see text
R4—500,000-ohm potentiometer, see text
R5—100,000-ohm potentiometer, see text
R6—10,000-ohm trimmer potentiometer (Mallory MTC-14L4 for exact fit on PC board; Radio Shack 271-218 or equiv. for point to point wiring)
R7, R8—820-ohm, ½-watt resistor
R9—100,000-ohm, ½-watt resistor
S1—Rotary switch, 2-pole, 4-position (Allied Electronics 747-2003; adjust stops for 4 positions)
S2—Switch, SPST
T1—Transformer, 117 volt primary to 24 or 26.6 volt secondary, see text (for point-to-point wiring)

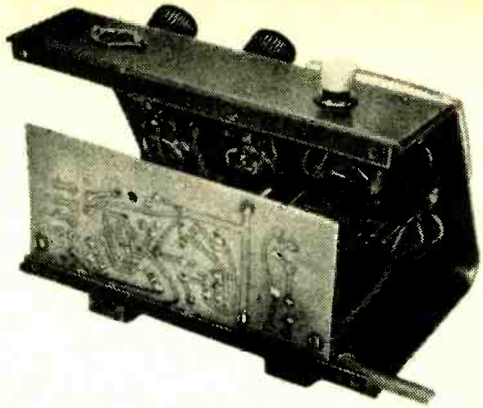
Note—you can also use two less expensive 12 volt transformers with secondary windings connected in series-aiding, if you have the space.

Capacitor Cx is a 20 pF disc capacitor that should be used only when a Type 531 OpAmp replaces the Type 741 OpAmp.

The printed circuit board for the Color Computer is available direct from Electronics Hobby Shop, Box 192, Brooklyn NY 11235 for only $5.45 (includes postage and handling). Canadian shipments add $2 extra. NY state residents must add sales tax. No foreign orders, please. Postal money orders will speed delivery. Otherwise allow 6-8 weeks for delivery.

If you cannot obtain the Clairex Type CL5ML5 photocell locally, write to the Electronics Hobby Shop at the above address, enclosing $3.00 for each photocell. Postage and handling are included. No Canadian or foreign orders. New York State residents add sales tax. Postal money order speeds delivery. Otherwise allow 6-8 weeks for delivery.

Misc.—Cabinet, pilot lamp for meter, 2-in. or 3-in. size Kodak Wratten filters #70, #98, and #99 (available from photo supply dealers), calibrated knobs, wire, solder, hardware, etc.



Rear view of author's color analyzer shows vertical mounting of electronic ckt board.

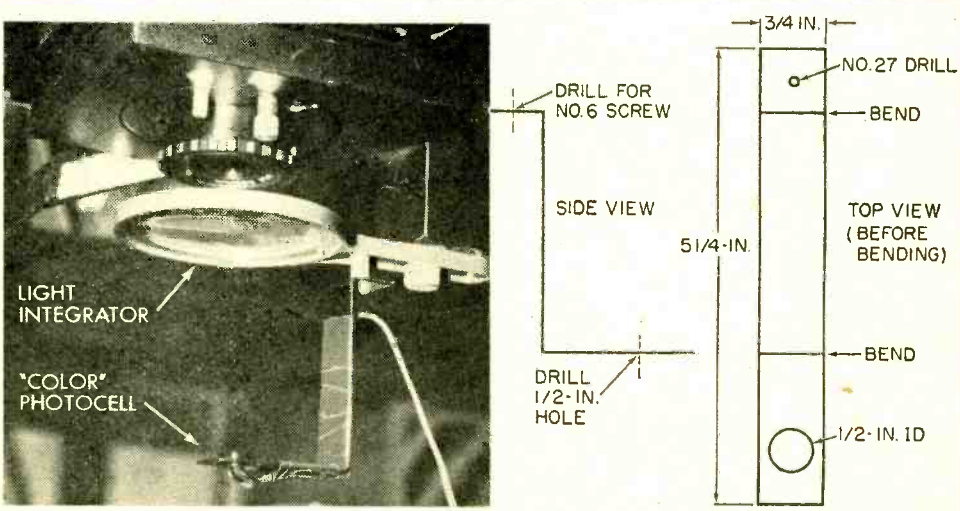
something small, like 100 milliamperes. A Wescom 81PK-100 is a perfect fit.

Bridge rectifier BR1 is the low cost "surplus" found in many distributors. This type has the positive and negative outputs at opposite ends of a diamond. The AC connections are the remaining opposite ends. Note that BR1 is installed in such a manner that its negative output is farthest from transformer T1 while the positive output is nearest to T1. Make certain your bridge rectifier has the same lead configuration: if it is different, modify the printed circuit template to conform to the rectifier you're using. Get it right the first time.

Finally, install C1 and C2, R7 and R8, and zener diodes D1 and D2. Take care so the capacitors and zener diodes are installed with the polarity correct. If the capacitors have their negative leads marked with an arrow or line, these markings face the *opposite edges* of the PC board (negative to the outside). The zener diodes are installed so that their cathodes (the banded ends) face each other towards the center of the board.

Initial PC Checkout. When the power supply is completed, temporarily connect a linecord. Connect the negative lead of a meter rated 10 volts DC or higher to the foil between T1's mounting screws (that's ground). Connect the meter's positive lead to the junction of R7 and D1, which is in the center of the board: the meter should indicate approximately+6.2 volts DC. Then connect the positive meter lead to the R8 and D2 junction, which is near the edge of the board. You should get approximately -6.2 volts DC. If the voltages are far apart in value, or if the polarity is wrong, make certain you find the mistake *before* installing IC1.

Disconnect the linecord and complete the PC assembly. If you use a 24 or 28 volt pilot lamp to illuminate the meter you connect to the holes adjacent to T1's secondary (24 V) leads. If you plan to use a neon illuminator, install a 100,000-ohm resistor



The color comparator photocell Z-bracket is installed under a light integrator. If your enlarger has a filter holder under the lens, attach the Z-bracket to the holder.

(R9) on the PC board and connect the lamp to the holes marked "neon." The lamp must have as little illumination as possible. Incandescent 24 or 28-volt lamps must be the miniature or "grain of wheat" type rated approximately 30 to 60 mA; the lamps come with attached leads. Do not use pilot lamps of the 100 to 500 mA variety. The excessive light will confuse the analyzer.

To install IC1 when it is the metal can TO5 type, fan out the number 1 to 4 leads and number 5 to 8 leads so they form two straight lines. Note that the lead opposite the tab on a TO5 package is #8. Insert the leads into the board leaving about ¼ inch between the IC and the board. The IC is correctly installed if the tab faces *away* from the transformer towards the nearest edge of the PC board. Solder IC1 and cut off the excess lead length.

The edge of the PC board nearest IC1 has four sets of paired foil terminals. These are provided as mounting terminals if you connect the photocell comparator and sensor without the use of a plug and jack. However, we strongly suggest the use of the specified DIN type connectors as they allow for easy repairs if the connecting wires break. (The connectors aren't *that* costly.

Potentiometers R2 through R5 can be linear or audio taper, though audio taper gives a slightly smoother adjustment—use whatever you have in stock.

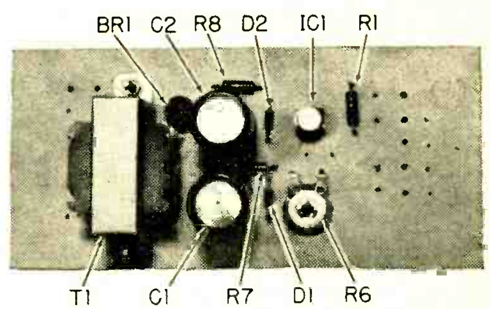
The analyzer shown is built in a Bud 7-inch AC-1613 Universal Sloping Cabinet. This is the least critical item and you can substitute whatever cabinet you prefer. Just be certain the cabinet will accommodate the type of meter you use.

Meter M1 should be O-1 mA with a zero-center scale. But these are expensive, so you can substitute any standard 1 mA meter you want. You will simply calibrate the instrument for zero-center.

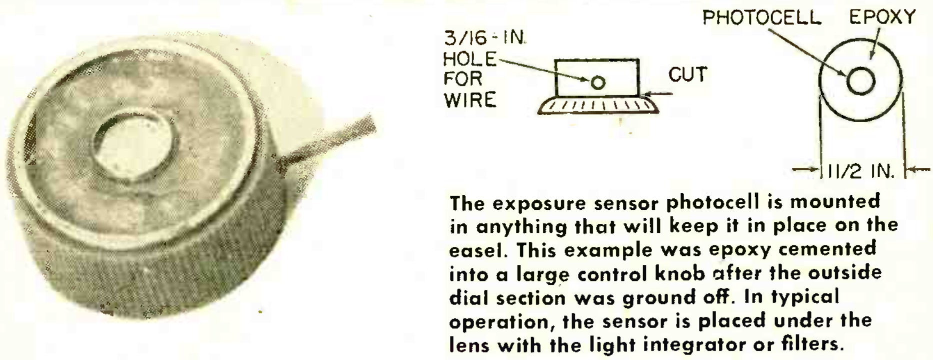
If you use a neon pilot lamp mount it directly above the meter and shield the forward brilliance with a piece of black tape; the lamp should radiate straight down onto the meter scale. If you use the meter in the parts list, remove the front cover by pulling it forward. Then remove the meter scale. As shown in the photographs, place a black dot approximately 3/16-inch wide at the center of the scale. If you want, you can also modify the meter for the incandescent lamp. Drill a ¼-inch hole in the lower right of the meter *from the rear*. Position the meter in the cabinet and mark the location of the meter hole on the panel. Remove the meter and drill a ⅜-inch hole in the panel. When the meter is installed you can pass a "grain of wheat" lamp through the panel into the meter. Reassemble the meter and complete assembly.

The Comparator. The photocells used for the comparator and exposure sensor, P1 and P2, must be Clairex type CL5M5L. Make no substitutions. From a piece of

(Continued on page 40)



This is the parts location when our PC board is used. To get a free template of the PC board, send a Self Addressed Stamped Envelope to: Davis Publications, Dept. T, 229 Park Ave. S., New York NY 10003

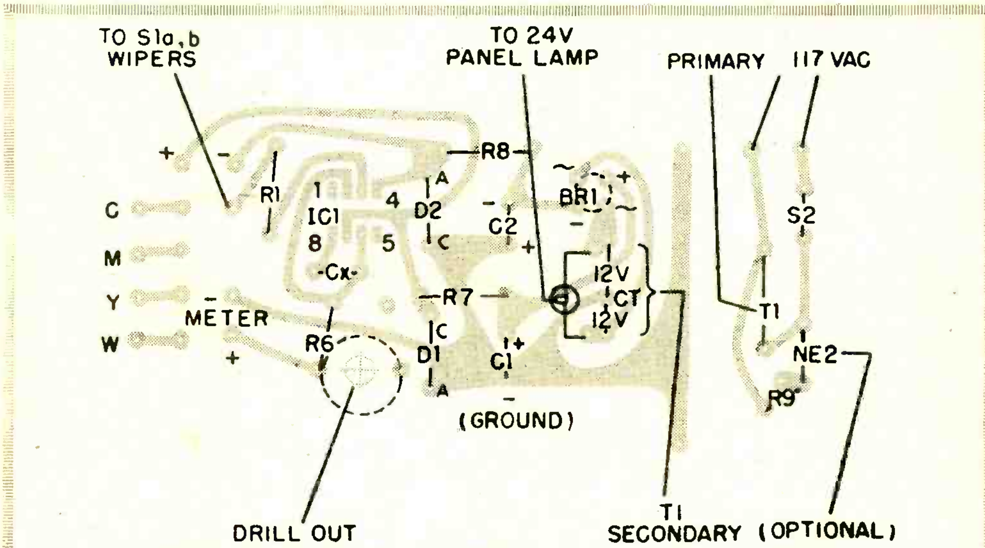


The exposure sensor photocell is mounted in anything that will keep it in place on the easel. This example was epoxy cemented into a large control knob after the outside dial section was ground off. In typical operation, the sensor is placed under the lens with the light integrator or filters.

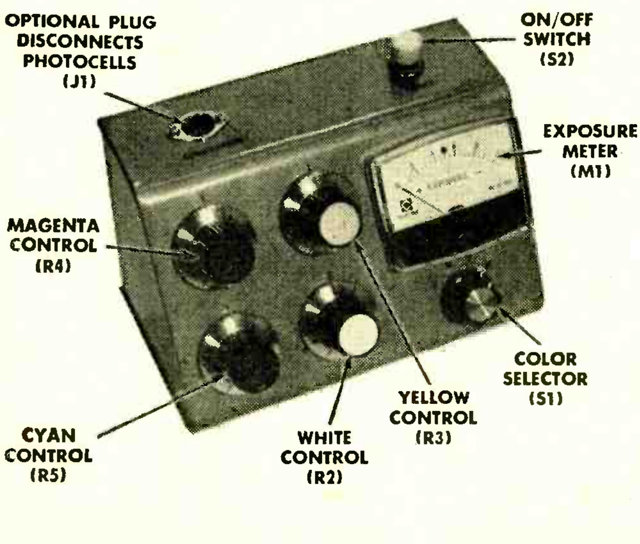
COLOR ANALYZER

scrap aluminum ¾ to 1-inch wide fashion a Z-bracket to the dimensions shown. Drill a ½-inch hole close to the end of the longer Z-leg. Fasten the other end of the Z-leg to your enlarger's under-lens filter holder. If your enlarger does not have a filter holder, or if it has a permanent swing-away red filter under the lens, mount a Paterson swing-away light integrator (available from local photo shops) under the lens. Fasten the short leg of the Z-bracket to the integrator—which has pre-drilled holes—in such a manner that the ½-inch hole is on the optical center of the lens. Then cement photocell P2 in the hole and attach the connecting wires; these can be extra-thin zip cord such as used for short-length speaker connections. (This whole bit reads a lot more complicated than it is. Use the photographs as a guide.)

Photocell P1, which measures the exposure light, can be mounted in anything heavy enough to hold it in place on the easel. The photographs show the photocell



There are few parts on the PC board and nothing is critical. Modify the board if you wish. Trimmer potentiometer R6 should be a flat mount, so it can be adjusted through a hole in the cabinet.



To avoid upsetting a control setting while groping for the on-off switch in the darkroom, mount switch S2 as far as possible from the controls.

epoxy-cemented in an oversize control knob.

When the complete analyzer is assembled, attach oversize calibrated knobs such as the Calectro E2-715 to R2 through R5. The knob calibrations are important so they should run out to the very edge of the knob skirt. If the calibrations don't run to the edge you won't be able to preset the controls with any reasonable degree of accuracy. Place a fine line or other indicator directly above each knob.

Checkout. Connect the photocells to the control unit and apply power. Don't worry if the meter pins at either end of the scale. Set switch S1 to the extreme clockwise position and adjust R2 through R5 until you find the control that changes the meter reading. Mark the switch and the control "C" for cyan. (We suggest you paint the cyan knob insert a blue-green. Also paint the other knobs the appropriate color.) Advance S1 one position clockwise, find the correct knob and label both "M" for magenta. Advance the switch another position clockwise, find the knob and label both "Y" for yellow. The last switch position and knob is labeled "W" for white (white light exposure). Make certain the C, M, and Y controls are reading P2, the color comparator mounted under the enlarger lens.

Set S1 to any position, turn on bright room lights, and adjust the associated color control until the meter pins, or approaches full scale deflection. Make certain the control is adjusted for the maximum meter reading. Adjust trimmer control R6 so the meter pointer just pins (don't be afraid to piN thE meTER). Depending on the amount of light the meter pointer will pin right (for bright light) and left (for dark or very low light). This is normal, there will be no damage to the circuit or the meter. (Note: If you use a zero-center meter the pointer will barely pin on both sides.)

Install the Z-bracket under the lens. If your enlarger uses a filter holder under the lens insert a diffusion screen or glass, or a Beseler Light Integrator or similar ground glass in the filter holder. You are now ready to make color prints.

It's modern chemistry and electronic control for . . .

Fine Color Prints from Your Own Darkroom

Look how todays techniques give home darkrooms exciting color print capability!

by Herb Friedman

THOUGH MOST PHOTO HOBBYISTS can turn out a superior black and white print using a minimum of equipment, few realize that it is even easier to turn out superior color prints by using modern color chemistry and an electronic color analyzer. The hobbyist can, in fact, generally produce color prints infinitely superior to what he can get from the local drugstore or camera shop.

Until recently, the average hobbyist could figure on spending an entire evening just making one quality color print. Typically, he first had to make a test strip for exposure, then a test print for color balance, then a final print, and possibly even a fourth print for optimum color. If he changed negatives, or the enlargement ratio, he had to repeat at least two steps, possibly more. Considering that each try could take from 10 to 20 minutes effort, you can see why the average photo hobbyist found it easier to drop off the film at the drugstore—even if the commercial prints weren't all that good.

But with modern techniques you can turn out a superior color print the first time, in less than three minutes from start to finish. Even if you change negatives, or the enlargement ratio, your first print will be a good print, greatness will be attained on the second print.

The first thing you need is a high speed chemistry, such as the two-step Beseler system which can produce a finished print in two minutes. The second item you need is an electronic color analyzer (for which you'll find plans in this issue). A color analyzer is simply a memory device that remembers all the conditions *you selected* to obtain the type of color print *you like best*.

Color Variables. Color materials such as the negative, printing paper, enlarger lamp, and even color correction filters vary in their sensitivity to light colors from batch to batch, roll to roll, and time to time. Even the enlarger's optical system can have a color cast. For this reason it is generally impossible to place a negative in your enlarger, expose the paper, and develop a good, let alone decent, color print.

One way we can correct for these variables is through an *additive* exposure, exposing the paper through blue, green, and red filters for differing lengths of time. Since blue, green, and red create all the colors in additive printing, any correction can be obtained by controlling the

COLOR ANALYZER

precise timing of each exposure. The additive system is a pain in the neck for the hobbyist, for the slightest desired change in color rendition or saturation (exposure) can involve changes in the exposure through all three filters.

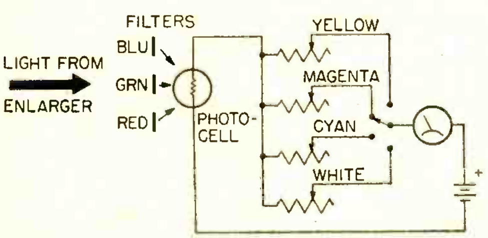
An easier to use and more favored printing system used by hobbyists is the *subtractive* exposure. A single filter pack made up of two of the filters known as YELLOW, MAGENTA, and CYAN makes all the color corrections at the same time. This filter pack is placed between the enlarger lamp and the negative; virtually all modern enlargers have a drawer in the lamphouse to accommodate a filter pack. A single exposure through the filter pack is all that's required to make a color print. Some of the more expensive enlargers have what is termed a "dichroic head" with variable filters as part of the light system; the exact value of filtration is simply dialed by the user. Again, all the color correction is provided at one time by the dichroic head so only a single exposure is needed.

More Info. A full and complete treatment of both types of color printing is contained in the Kodak publication *Printing Color Negatives;*

Provides a wealth of worthwhile info for photographers interested in the color print techniques available from Kodak or your photo dealer. Their publication No. E-66.

this book is a required reference for anyone who wants to make quality color prints. The book also gives the most convenient operating procedures for electronic color analyzers.

The subtractive printing procedure is particularly well adapted to use with a color analyzer, is the easiest method for the amateur, and is exceptionally fast-handling, so the illustrations to follow will refer to the subtractive system.



The basic color analyzer. Once controls are matched to a "standard" negative, you just select filters for a null on the meter for each individual color and white.

An electronic color analyzer basically consists of a photocell (vacuum tube photomultiplier or photoresistor) positioned under the lens, blue, green, and red filters mechanically positioned over the photocell (or positioned over the cell by hand) and a meter that indicates the amount of light falling on the cell. The meter is connected to the photocell through independent potentiometers as shown in the figure. Color analyzer readings will be accurate for most negatives and lighting situations as long as the same box of printing paper is used. The system needs to be recalibrated only when the printing paper is changed (so purchase boxes of at least 100 sheets to avoid extra work).

First step is to make a really fine print from a decent negative. You can do it the hard way, one print at a time, or use a Beseler Subtractive Calculator which puts you inside the ball park on the first try. When you have made a print with satisfactory flesh tones and color saturation don't disturb the enlarger or timer controls.

To Continue . . . Place the color analyzer's probe on the easel or swing it under the lens (if it is mounted on the enlarger). Install a light integrator—which is nothing more than a piece of ground glass or its equal—under the lens, between the lens and the analyzer's probe. The light integrator scrambles the picture into a diffused "white light" which contains all the color elements of your negatives and the filter pack. Place a blue filter (Kodak Wratten 98) on top of the light integrator. (Note that most hobbyist analyzers have a selector switch that also mechanically positions the correct filter over the photocell). Turn on the enlarger and adjust the analyzer's *yellow* control for a convenient reference meter reading. (Usually, center-scale or "null" is used as the reference reading, but any meter reading can be used as a null.)

Remove the blue filter, install a green filter (Kodak Wratten 99), switch the analyzer to MAGENTA and adjust the *magenta* control for a null meter reading. Remove the green filter, install a red filter (Kodak Wratten 70), switch the analyzer to CYAN and adjust the *cyan* control for a null meter reading (the color controls yellow, magenta and cyan refer to the color of the subtractive filters in the filter pack). Finally, remove all filters from under the lens, switch the analyzer to WHITE and adjust the *white* control (exposure control) for a null meter reading.

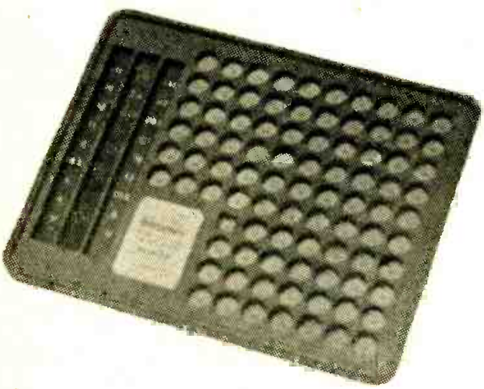
(The color analyzer in this project uses a separate photocell for the exposure. If you look at the easel you'll see a shadow cast by the Z-bracket holding the color comparator cell. Position the exposure cell on the easel so it is just off the edge of the shadow. If you prefer, you can place several thicknesses of opaque paper over the color comparator cell and use it for the white measurement, though we suggest you use the separate cell.)

When all the controls are adjusted you have programmed the color characteristics and exposure of your "reference" print into the analyzer, and you should note the control settings and exposure time for future use.

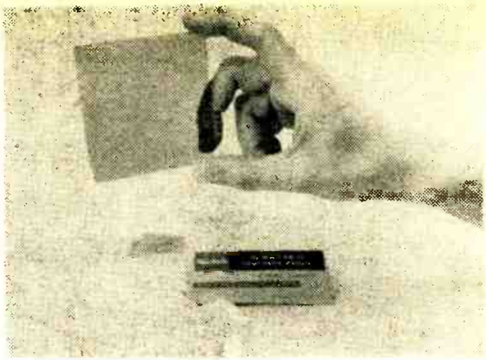
Down To Business. Now assume you want to make a print from another negative. First you set the degree of enlargement and focus, leaving the lens wide open. You place the analyzer's probe under the lens, install the light integrator and set the analyzer's switch to CYAN. Install the red filter on top of the light integrator and adjust the lens aperture until the meter indicates null. Switch the analyzer to MAGENTA, install the green-reading filter and note the meter reading. If it is not at null, add or remove magenta filters (from the filter pack) until the meter shows a null. Then switch the analyzer to YELLOW, install the blue-reading filter and modify the yellow filtration in the filter pack until the meter shows a null. Finally, set the analyzer to WHITE, remove all reading filters and adjust the lens aperture for a null indication.

Through the color analyzer you have now established a new filter pack and exposure time for the new negative. If the new negative uses similar lighting to the reference negative the print should be perfect. If the lighting was considerably different the print will be good—acceptable to most people, but requiring just a slight filter pack modification for a great print.

Swinging Filters. In the previous example the filter pack would wind up with magenta and yellow filters—which is what is generally needed. Some Kodacolor negatives, however, might require cyan filters plus magenta *or* yellow (but never all three). This information will have been programmed into the color analyzer, so you will have no difficulty if you make a slight modification in procedure. The first meter reading, the one where you adjust the lens's aperture, should be made for the



Modern color print chemistry techniques from Beseler include this subtractive color calculator to aid filter selection.



Kodak color printing filters. Typical filter designation CP20Y means *color filter* with a *.20 density;* the color is *yellow*.

filter you are *not* using in the filter pack. For example, if your basic filter pack has cyan and magenta, switch the analyzer to YELLOW, place the blue-reading filter in position on the light integrator, and close down the lens for a null indication. Then proceed with the other readings. If your reference negative did not require cyan in the filter pack, if it had yellow, magenta, or both, and you find a new negative just can't be pulled in for null meter readings with yellow and magenta filters, it indicates the new negative requires cyan filtration, so start with the assumption that yellow is not required. If you still can't null the meter, it means magenta should *not* be in the filter pack.

As we mentioned, a more thorough discussion and procedure for using a color analyzer is found in Kodak's *Printing Color Negatives.*

Most, but not all, commercial color analyzers use photomultiplier tubes which have no light memory, nor are they confused by infrared from the enlarger lamp. These units are, as you would expect, relatively expensive. Low cost models use photoresistors, such as used in the construction project found in this issue.

More Data. Photoresistors are infrared sensitive and they have a light memory, both of which can confuse the meter. The infrared is easily handled by installing a heat or infrared filter glass in your enlarger (it should be there to protect the negative anyway). The light memory is handled by using a consistent measurement procedure. The best way is to turn the enlarger off, install the reading filter and the light integrator, turn off the bright room lights, count to five, and then turn the enlarger *on.* Take the meter reading, or adjust the appropriate color control, slide the new reading filter in place before withdrawing the old one, switch the analyzer, and make the new meter reading. Repeat this for the third reading filter. You'll note that this procedure keeps bright white light from falling on the photocell between meter readings. If you want to change filters under room lights, make certain there are about five seconds of darkness between turning the room lights out and turning the enlarger on.

The whole bit might sound somewhat complicated, but after you've run through the procedure once or twice to get the hang of things it shouldn't take you more than a minute or so for a full color analysis of a new negative.

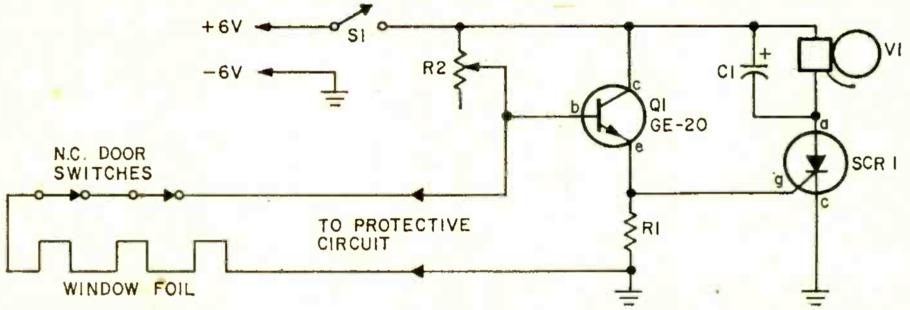
The Kodak Wratten filters needed are available from professional camera shops. For the construction project, color analyzer 2-in. or 3-in. Kodak Wratten filters Nos. 98 (blue), 99 (green), and 70 (red) are recommended. If you have difficulty obtaining these specific filters you can make the following substitutions, though the analyzer's precision will be slightly reduced: 47B (blue), 61 (green), and 92 (red).

The Pro Shop. We could not close without some words on commercially processed color prints such as you might order from a drugstore or camera shop. Commercial color labs have as high (if not higher) a remake rate than the amateur if *quality* color prints are desired. As a general rule, it takes two tries to get a decent color print, so the hobbyist with a color analyzer is way ahead of the game because he can turn out, at worst, two *good* prints for each three first tries. The average is even higher than this as the hobbyist gets skilled in the use of a color analyzer.

Commercial labs come close to a hobbyist's results only when they are equipped with a video analyzer such as the Kodak Video Color Negative Analyzer Model 1-K; and Kodak only claims a 75%+ first try acceptance rate for their analyzer. The video analyzer is a 5-in. x 5-in. TV display. The operator views the color negative as a positive color TV image, and adjusts the TV's controls for proper color balance and brightness (saturation). The control settings are translated to the printing equipment's filter adjustments so that the final print is similar to the image displayed on the TV.

The video analyzer is a fast and easy way to get good color prints on the first try, but since video analyzers cost in the thousands, the color analyzer is the best thing going for the hobbyist. ■

Foil-A-Burglar Alarm



This professional type burglar alarm can be used to protect windows or glass areas by using window foil that "breaks" a circuit as the glass is broken. It's an alarm that is triggered when the protective circuit is *opened*. All protective door and window circuits must be *normally closed* and series connected so that an opening of any protective device will trigger the alarm. Once the alarm is triggered it can be turned off only by opening master switch S1. The recommended power supply is an AC powered 6 VDC source or a lantern battery; standby current is about 100 *u*A. To adjust, connect a voltmeter (10 VDC range) across resistor R1, open the protective circuit and adjust potentiometer R2 so the meter indicates a voltage rising towards 1 volt. The alarm bell should ring before 1 volt is reached on the meter. If it does not, there is a wiring error. Finally, set R2 for the 1 volt meter reading, remove the meter and restore the protective circuit.

PARTS LIST FOR FOIL-A-BURGLAR ALARM

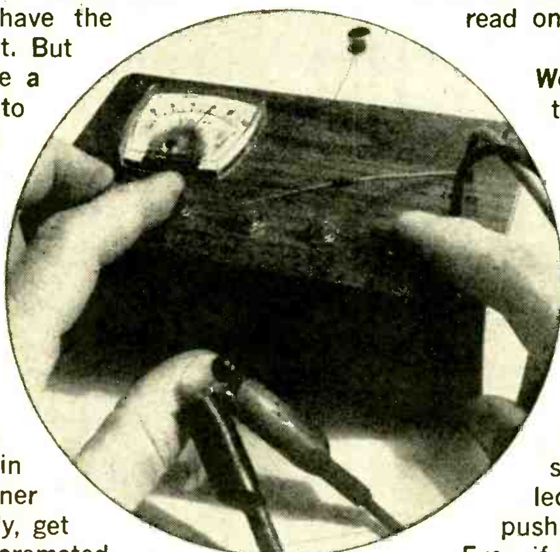
- C1—47 uF, 12 VDC electrolytic capacitor (Calectro A1-108 or equiv.)
- Q1—NPN transistor, GE-20 or equiv.
- R1—1000-ohm, ½ watt resistor
- R2—500,000-ohm, pot (Calectro B1-687)
- S1—SPST switch
- SCR1—Silicon controlled rectifier rated 12 PIV or higher (G.E. C106 series or equiv.)
- V1—6 VDC alarm bell (Audiotex 30-9100)

ZENER ZAPPER

Blasts a batch of constant current to any under-20-volt zener to check it out. Plus—this device spots cheap transistors that can substitute for expensive zeners.

by Charles Rakes

ONE OF THE MORE EXPENSIVE semiconductors, next in line to the transistor and diode in usage, is the *zener* diode. Zeners are semiconductor voltage regulators which are not difficult to test if you have the proper equipment. But if you don't have a tester designed to test zeners, then you must gather together a current meter, voltmeter, suitable power source, and a maze of clip leads.



If, while testing, you forget to add a current limiting resistor in series with the zener and power supply, get ready to bury the cremated zener and untangle the current meter's needle while controlling your good temper.

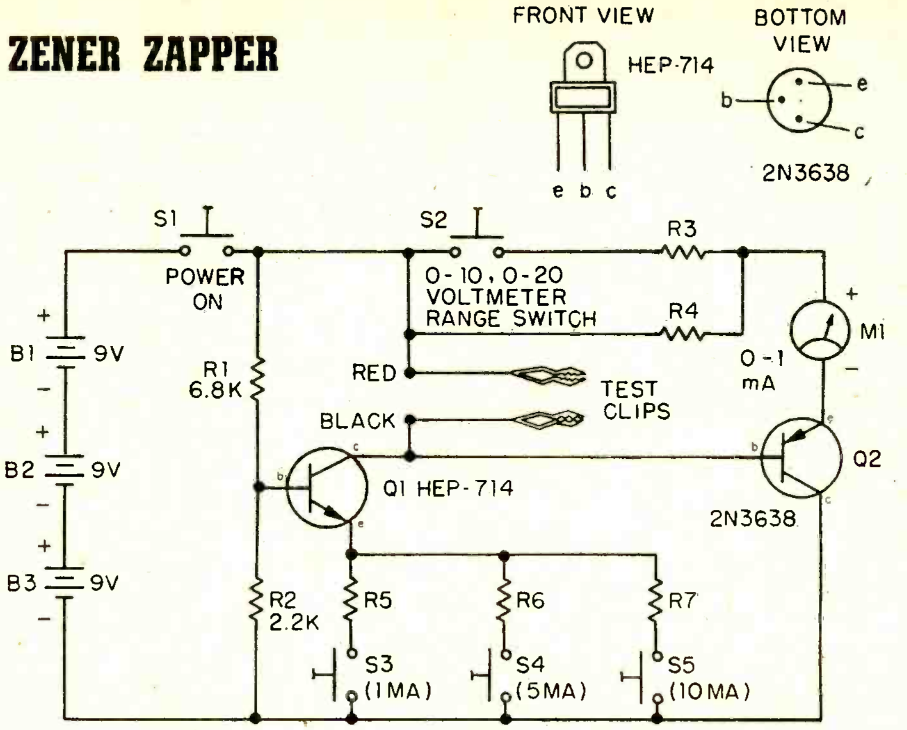
You can save those tears by spending less than ten bucks and a few hours time building this Zener Zapper. A little jewel like this will allow you to determine the zener voltage and knee characteristics, in seconds, of any zener diode with a zener voltage of less than twenty. The *Zapper* will allow you to turn the most common silicon transistor, that normally costs less than one-half that of most zener diodes, into one of the best zeners available at any cost.

Want to learn more? Then read on.

How The Zapper Works. Referring to the schematic diagram, Q1 is connected in a constant current circuit that supplies a constant current source to the test leads. The emitter of Q1 is connected to three current setting resistors that are selected by one of three push-button switches. Even if the test leads are shorted together the maximum current allowed to flow is limited to the value selected by the push-button switches. So no damage will occur to either the zener under test or to the Zapper.

Transistor Q2 is connected as an emitter follower to operate as a high impedance DC voltmeter that monitors the voltage developed across the test leads. S2 adds a special feature which

ZENER ZAPPER



PARTS LIST FOR THE ZAPPER

B1,B2,B3—9-volt transistor battery, 2U6 type
M1—0-1 mA meter
Q1—NPN transistor, 2N3725, HEP714
Q2—PNP transistor, 2N3638
R1—6800-ohm, ½-watt resistor
R2—2200-ohm, ½-watt resistor
R3 to **R7**—Selected 10% resistors (see text)
S1 to **S5**—Pushbutton switch, normally open
Misc.—6¼ x 3¾ x 2-in. case, battery holders, five-terminal terminal strip, red and black test leads, two test lead clips, battery clips, wire solder, etc.

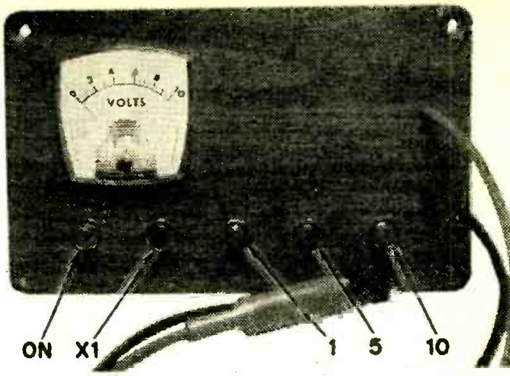
allows the meter range (20-volts) to be changed to a full scale voltage of ten.

Three 9-volt transistor radio batteries are used to supply the tester; under normal use they should last nearly their normal shelf life. Power switch S1 is a pushbutton (spring-return type) that must be operated with each test to conserve battery life and to insure that the *Zapper* isn't left on.

Building a Zapper. Our unit was constructed in a 6¼ x 3¾ x 2-in. plastic case with the meter, terminal strip, S1, S2, S3, S4, and S5 mounted to the front panel. The three batteries are kept in place in the back of the case with three metal holders.

Since the component layout isn't critical and since nearly any wiring scheme will do, you can build the *Zapper* in about any enclosure that you choose, but if you want to duplicate our unit just follow the general layout shown. Only a single bit of advice is necessary in the construction, and that is to take extra care in drilling the holes in the plastic case. Calibrating the *Zapper* requires a well stocked resistor junk box or a resistance decade box. With only resistors R1 and R2 connected, as shown in the schematic, connect a resistance decade box between the emitter of Q1 and battery negative. Connect a 0 to 10 mA meter to the test clips, press the power switch S1, and adjust the resistance to produce a current of 1 mA. This resistance value should be near 6000 ohms and may be made up of one or more 10 percent resistors. This is the resistor value used for R5. Select resistors R6 for a 5 mA reading and R7 for a 10 mA meter reading in the same manner. Resistor R6 will be near 1000 ohms in value and R7 approximately 500 ohms.

Operation is simple: just connect the zener diode, push and hold the on button and one or more of the numbered buttons, which represent current in mA. The zener voltage is shown on the meter on a 0 to 20 volt scale. If the meter reads half scale or less, push the X1 button; the meter will change to ten volts full scale. See text for more detail.



To calibrate the voltmeter circuit, parallel-connect a 25,000-ohm pot and an external voltmeter, capable of reading 20 volts, to the test clips. Connect a resistance decade box for R4.

Press switches S1 and S3 and adjust the 25,000-ohm variable resistor until the external meter indicates 20 volts, then adjust the decade box until the Zapper meter reads full scale (20 V). Resistor R4 should be close to 20,000 ohms in value and may be made up of one or more 10 percent resistors. The value of R3 is the same as R4.

Make The Most Of Zapper. Select a zener to be tested and connect the cathode to the positive (red) test lead and the anode to the negative (black) test lead. Press S1 and S3 and read the zener voltage on M1. If the reading is under 10 volts. press S2 and change the meter range to 10-volts full scale. If, while changing from S3 to S4 or S5, the meter reading changes appreciably, this indicates that the zener's knee is sloppy and would not make a very good reference zener.

Some zeners require more than 1 mA to produce a good knee characteristic and should be checked at 5 and 10 mA for this test. If a greater current is desired, more than one push-switch may be operated at one time. With all three pressed, the test current will be about 16 mA.

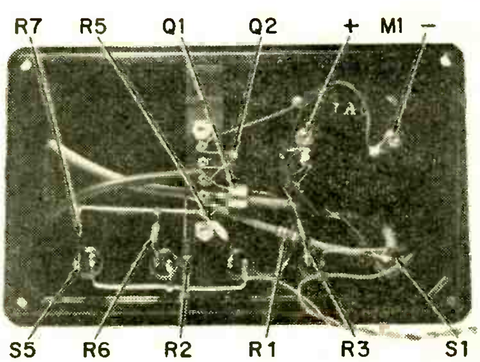
Transistors can be used as zeners. Almost all silicon transistors can be used as zener diodes. The base emitter junction is reverse biased to produce the zener action. Most will produce a zener voltage of between 5 and 15 volts. Connect the positive (red) lead to the base and the negative (black) lead to the emitter of a PNP transistor for testing, and reverse the leads of an NPN transistor.

After testing many different types of silicon transistors for their zener characteristics, we found that more often than not the transistor produced a zener with a knee characteristic as good or better than most zener diodes.

Turn the bargain zeners and transistors into the bargains they should be by building your very own zener zapper. ■

Something About Zener Diodes

What makes a silicon diode zener? Apply a difference of potential (a voltage) and a diode will either conduct (forward bias condition) or conduct very little or not at all (reverse bias condition). But if you exceed a certain magnitude of reverse bias, the diode will "avalanche" and conduct heavily—much as it does in its "forward bias" condition. There is, however, one interesting difference. It will avalanche only down to a certain level called the zener voltage. Manufacturers' tricks make diodes "zener" to a desired level. What was a rather poor diode with a low reverse bias specification became a highly stable voltage reference: that is, the zener voltage remains relatively consistant despite any changes in the voltage applied through a limiting resistor.



Since the circuit is quite simple, it can be built around a five-lug terminal strip.

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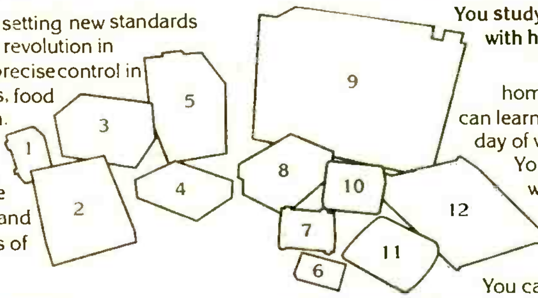

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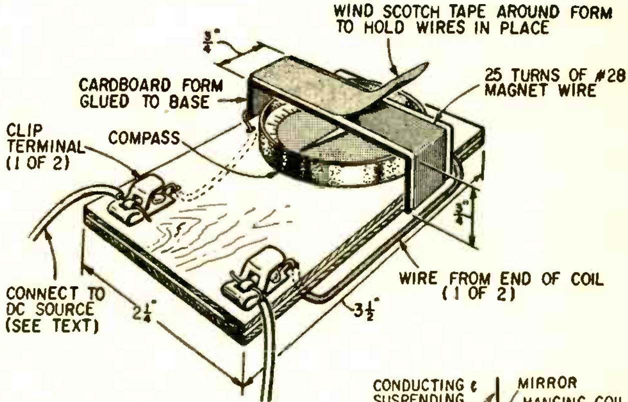
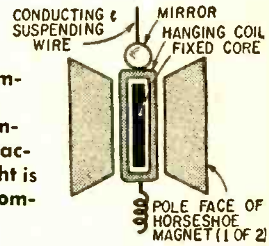
COMPASS GALVANOMETER

by T. A. BLANCHARD

Many electrical measuring instruments today are based on the design of the d'Arsonval *String Galvanometer,* but substitute a needle-suspended coil riding on jeweled bearings for the hanging coil employed in the original precise lab instrument.

The galvanometer is not often used to measure quantity of current flowing in a circuit, but rather to indicate the polarity and presence of small currents by comparison to null methods. The compass galvanometer (made from the illustration at right) can be used with a Wheatstone bridge to indicate null points.





Easy to build, the compass galvanometer (above) can be assembled in an hour at practically no cost. At right is hanging coil galvanometer used in labs.

The d'Arsonval instrument suspends a small coil between the pole faces of a permanent *horseshoe* magnet. When a current flows through the coil it becomes an electromagnet and its *like* poles repel the *like* poles of the horseshoe magnet, thus causing the coil to turn on the connecting wire. The strength of the current through the coil determines the extent of the coil's rotation.

A small pointer attached to the moving coil registers on a curved dial, or a tiny mirror is attached to the galvanometer string. A beam of light is aimed at the mirror, bouncing the beam off to a wall screen or chart to give great magnification of tiny current changes in a darkened room.

Making A Simple Galvanometer. A small amount of insulated magnet wire, any Boy Scout pocket compass and a 2¼ x 3½-in. scrap of plywood is what you need to make the compass galvanometer. Cut a strip of cardboard ¾-in. wide and 3¾-in. long. Score the cardboard ¾ in. from each end, with a dull knife blade and crease so the cardboard form resembles a C or bridge shape. Now glue the cardboard to the edges of the wood base. Do not use tacks!

Bind the cardboard with a rubber band until glue or cement dries. Wind 25 turns of #28 magnet wire around the cardboard. Heavier wire and fewer turns will work, too, with a slight drop-off in sensitivity.

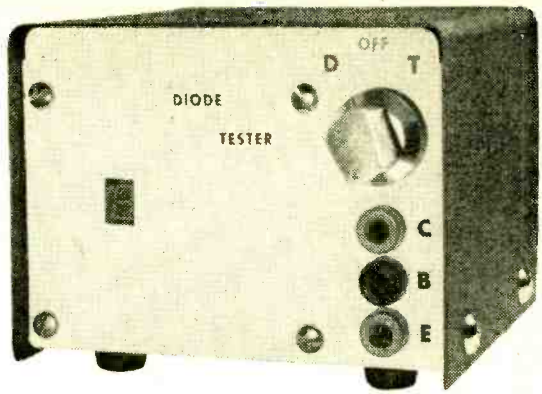
Scotch tape is wound around the finished coil to keep the wire turns in place. Connect the ends of the coil to screw terminals or clips. Slip the compass under the coil in a position where its needle comes under the coil and parallel to the coil turns.

Connect the galvanometer in series with a flashlight battery and bulb, a buzzer or a toy motor, etc. When the circuit is closed, the compass needle will be drawn so that it is at right angles to the coil. A slow swing of the needle indicates the circuit is drawing little current. A rapid swing denotes an increase in current flow.

To show how sensitive this simple galvanometer is, connect what appears to be a dead flashlight cell across the terminals, immediately breaking the circuit. The compass needle will spin at a merry clip, indicating there is still some life in the "dead" cell. ■

stamp out semiconductor bugs with our...

ELECTRONIC DDT



This Digital Diode Tester spots NPN and PNP transistors, too!

by Charles Rakes

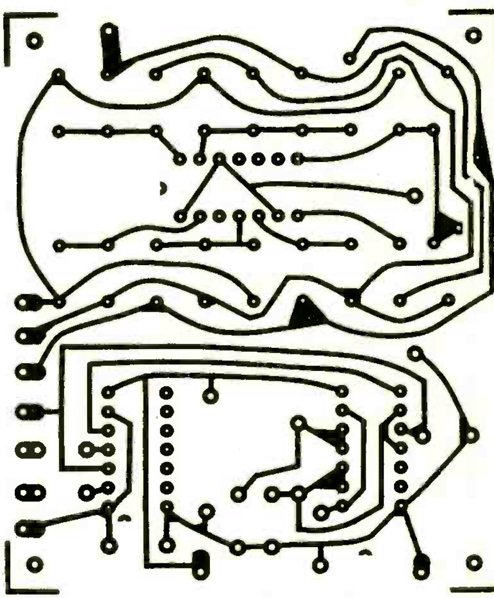
☐ JUST HOW MANY bullet diodes, miniature glass diodes, epoxy encapsulated diodes, unmarked diodes, gunn diodes, 10-for-a-buck diodes, unbanded diodes and stripped-from-equipment diodes have you run into? If you wanted to use any of these don't-know or not-sure-what-they-are diode types, you've had to drag out the ohmmeter for a front-to-back resistance check. Nothing wrong with that, of course. But here's an easy-to-build and inexpensive digital IC gadget that blinks an **A** or **C** in a little window to tell you if the end of the diode you've selected is the *anode* or the *cathode*.

And if that's not enough for you, plug in an unknown transistor and the same window will come up with an **N** or a **P**—you guessed it—to tell you what type you have: NPN or PNP! If you try to fool this gadget with an open transistor, it pops up an **A** (for throw it away?) in the window for as long as you keep it there. (If an open diode is tested, the readout doesn't budge from its normal 8. A shorted diode blanks the display window for as long as the diode is connected.)

So, if you have ever wished for a simple gadget that would indicate the type of transistor, either PNP or NPN, if it has gain, and what lead of a diode is connected to the test terminal, wish no more, for this DDT will test almost every type of transistor made including germanium, silicon, low, medium, and high power devices. As we said, if the transistor under test is good, the readout will indicate a **P** for PNP transistor, and an **N** for a NPN transistor. The readout will indicate an **A** for an open transistor, and will distinguish for a shorted transistor.

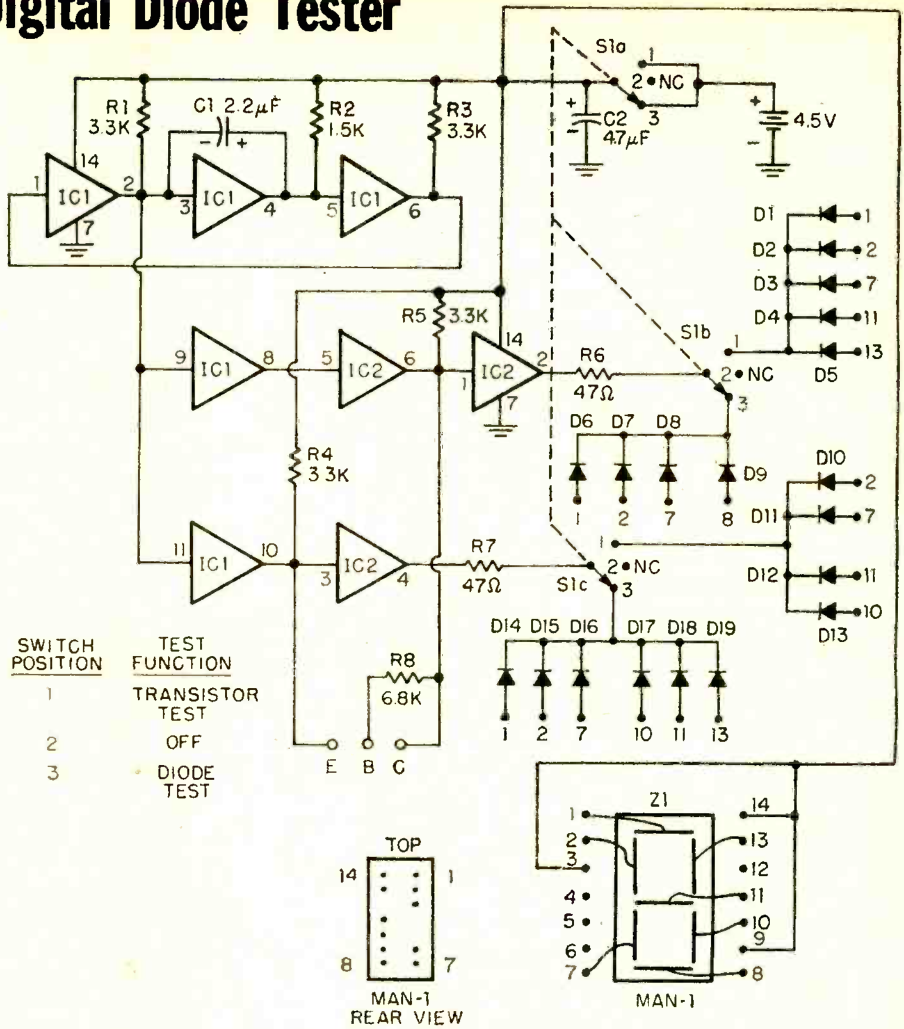
You can turn your white elephant collection of goodies into useable items by spending less than $20.00 and about four hours building an all-digital diode tester of your own. We believe you will agree that this tester is the most valuable transistor and diode tester available for twice the money.

How The Circuit Operates. One-half of



This actual-size printed circuit board is available pre-etched and pre-drilled. See the parts list for source and order info.

Digital Diode Tester



PARTS LIST FOR AN ALL-DIGITAL DIODE TESTER

B1—4.5-volt battery (three AA cells in series)
C1—2.2 µF tantalum dip-coated capacitor, 6 VDC or better (Sprague 196D225X0025HA1 or equivalent will fit circuit board. Use any convenient size for point-to-point wiring.)
C2—4.7 or 5 µF electrolytic capacitor, 6 VDC to 50 VDC
D1 to **D19**—Silicon diode, 1N914 or equiv. (Radio Shack 276-612 for a package of 10 untested diodes. Check F/B ratio with ohmmeter before using.)
IC1, IC2—TTL hex inverter, open collector, type 7405
R1, R3 to **R5**—3300-ohm, ½-watt resistor
R2—1500-ohm, ½-watt resistor
R6, R7—47-ohm, ½-watt resistor
R8—6800-ohm, ½-watt resistor
S1—Rotary switch, 3-pole 3-position, non-shorting
Z1—Readout, 7-segment LED type (Opcoa SLA-1, Monsanto MAN-1 or equiv.)
Misc.—Cabinet 4¼-in. x 3⅛-in. x 4-in deep, hardware, 14-pin IC sockets, battery holder, knob, banana plugs, banana jacks, wire, solder, etc.

An etched and drilled printed circuit board for this project is available for $4.00 postpaid from Krystal Kits, 2202 S.E. 14th Street, Bentonville, AK 72712. Canadian orders, add $2.00 extra. No foreign orders, please. Speedy service offered when postal money order accompanies order. Otherwise, allow 6 to 8 weeks for delivery. Also, the entire kit of parts that fit on the printed circuit board and the board itself are available for only $19.95 postpaid.

IC-1 operates as a ring oscillator. The output of the oscillator drives two sets of inverter stages.

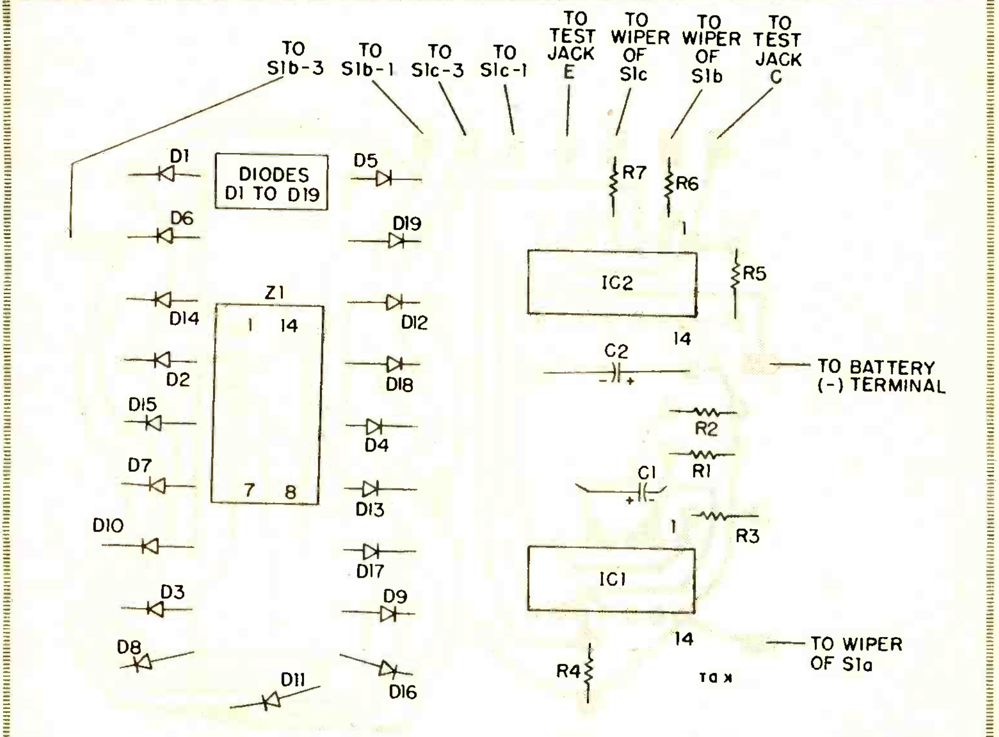
A test terminal marked C is driven through two inverter stages, while the E terminal is driven with only one inverter. This makes the voltage present at terminal C always opposite to the voltage at the E test terminal. When a diode is connected (with the anode at the C test terminal) the output of the inverter, IC2 pin 4, is *low* pulling the six segments to battery negative. These six segments form the letter **A** for anode. The same is true when the cathode of the diode is connected to test terminal C, but the output of another inverter, IC2 pin 2, goes *low* making the letter **C** appear. At the same time the other inverter that produced letter **A** goes *high* turning off the seegments relating to that letter only.

Transistors are checked in a similar way when S1 is in the transistor test position, but the base is included by biasing it from the collector test terminal through current limiting resistor R8. This allows the NPN transistor to conduct only when its collector is positive, and a PNP transistor when the collector is negative. The inverters are connected to the proper diodes (through S1) to cause the letter **P** to light on the readout for a PNP transistor, and the letter **N** for NPN transistors. The tester is powered by three 1½-volt penlight cells.

Building Your Own. The circuit is a simple one and can be constructed on perfboard or printed circuit board; the choice is yours because the layout isn't critical and the circuit will work in most any configuration.

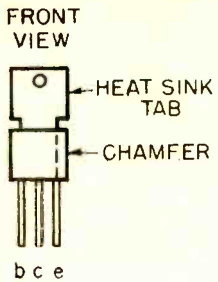
If a printed circuit board is used and the author's model copied, a metal or plastic cabinet about 4¼ x 3⅛ x 4-in. in size should do fine for an enclosure for the tester. If the kit of parts is used, just follow the layout of the author's model, and be very careful when soldering the semiconductors in place (if you are not using IC sockets) to avoid heat damage.

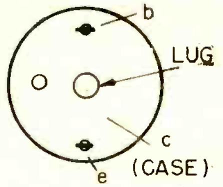
A printed circuit or perfboard is mounted to the front of the cabinet with a rectangle hole cut out on the LED readout (use a nibbler tool). This hole can be cut out and filed to a neat window for the readout. The

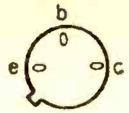


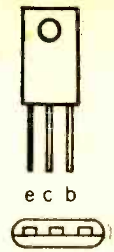
This is the component (top) of your printed circuit board with an X-ray view of the copper pattern. In addition to components illustrated above, be sure to supply battery power to the LED readout by including a jumper wire between the two empty pads shown.

Digital Diode Tester

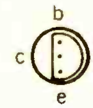


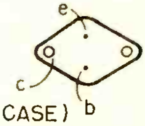






To be sure you have the correct transistor leads connected to your tester, here are some of the more common transistor base pin configurations. Get more base diagram data from the Motorola HEP Cross-Reference and Archer Transistor Substitution Guide.





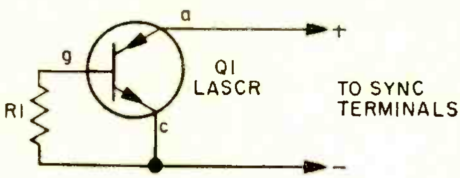
three penlight batteries are located near the back of the bottom of the cabinet. The selector switch may be mounted in any convenient location.

Initial Checkout. With the batteries in place, switch the selector switch to the "D" position (diode test) and connect a good diode to the C and E test terminals.

The readout should present the letter **A** or **C** to correspond to the lead that is connected to the C test terminal. If the test leads are shorted together, the readout should go dark, and with the leads open the readout should display an eight.

The only precaution to take when testing transistors is to be certain that it is connected to the proper test leads or the test results will be misleading. A group of the most common transistor base diagrams is shown. If the transistor to be tested falls into one of categories, no difficulty will be had in determining the type of transistor and its condition. Put those nameless functions to work for you now! ■

Remote Flash Trigger



Even if you spend $18 or $20 for a super-duper professional remote flash tripper, you'll get little more than this two-component circuit. Price is important if the results are equal.

Transistor Q1 is a light-activated silicon-controlled rectifier (LASCR). The gate is tripped by light entering a small lens built into the top cap.

To operate, provide a 6-in. length of stiff wire for the anode and cathode connections and terminate the wires in a polarized power plug that matches the sync terminals on your electronic flashgun (strobelight). Make certain the anode lead connects to the *positive* sync terminal.

When using the device, bend the connecting wires so the LASCR lens faces the main flash. This will fire the remote unit.

No reset switch is needed. Voltage at the flash's sync terminals falls below the LASCR's holding voltage when the flash is fired, thereby turning off the LASCR. ■

PARTS LIST FOR REMOTE FLASH TRIGGER

Q1—300-V light-activated silicon-controlled rectifier (LASCR)
R1—47,000-ohm, ½-watt resistor

BUILD THIS VERSATILE SOLID-STATE DARKROOM/KITCHEN TIMER . . .

UNIVERSAL POWER TIMER

Switch up to 300 watts to a photo enlarger or use a built in buzzer to time a 3-minute egg!

by C. R. Lewart

THE PROJECT described here should result in an extremely versatile darkroom timer with features not available even in commercial units. The timer can be used to turn on your enlarger for a specified number of seconds; it can also be used as a kitchen timer to sound a buzzer after a specified time has elapsed. The timer has a number of convenience features, such as cycle interrupt (*RESET*), manual override (*MAN/AUTO*), optional buzzer (*BUZZER ON*), touch setting (*START*) and selection of three timing ranges. These features should make this simple-to-build inexpensive timer a welcome addition to your dark room.

Here now are the main features of the timer in more detail. The solid-state design without relays does away with contact arcing problems. When the timer is set for a specified time period, the time-set control does not have to be returned to zero for subsequent use as is the case with some mechanical timers. Thus, the timing cycle is exactly reproducible!

The touch of a ring on your finger (a push button is optional) will start the timer. This method of operation prevents any shaking of the enlarger. The timing cycle can be set in the following three ranges which are the most convenient for photographic work: 0 - 15 seconds (normal enlarger timing), 0 - 150 seconds (special enlarger timing), 0 - 20 minutes (developer and fixer timing).

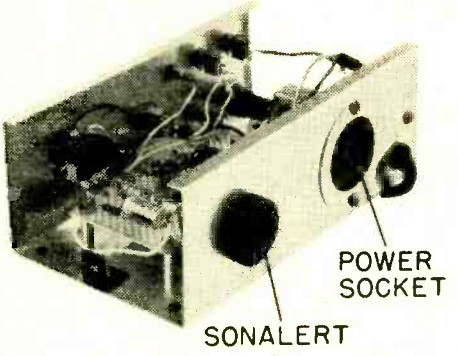
One mode of the operation of the timer is to have the enlarger light on *during* the timer cycle. Another mode of operation, se-

Universal Power Timer

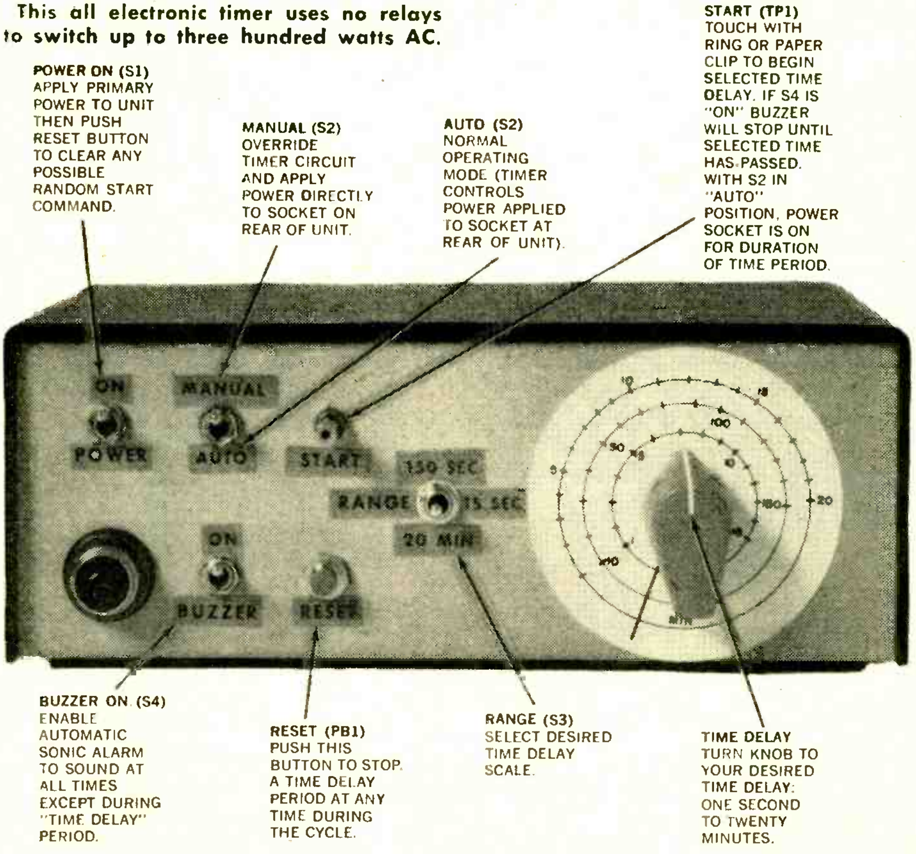
lected at the flip of a switch, is to energize a built-in buzzer *after* a specified time period has elapsed at the end of the timing cycle.

The timing cycle can be interrupted and reset to zero with a push-button switch. A separate switch (*Manual/auto*) connects ac power directly to the enlarger outlet thus bypassing the timer while you focus and plan your burning and dodging.

How Does It Work? The brain of the timer is a recently developed integrated circuit. This circuit consists of 23 transistors and over a dozen resistors and diodes. The timing cycle is determined by the external resistor R2 and the capacitors C2 through C4, where the timing cycle in seconds equals approximately the value of the resistor in megohms times the value of the capacitor in microfarads, times 1.5. The output of the integrated circuit (Pin 3) is normally low (at the ground potential); it is high (at the positive battery potential) during the timing cycle. The low current buzzer is operated directly from this output to battery plus. The same output also operates a light coupler to ground potential. The coupler consists of a low voltage, low current lamp and a photo cell in one envelope. When the output of the IC is high, the lamp



This all electronic timer uses no relays to switch up to three hundred watts AC.

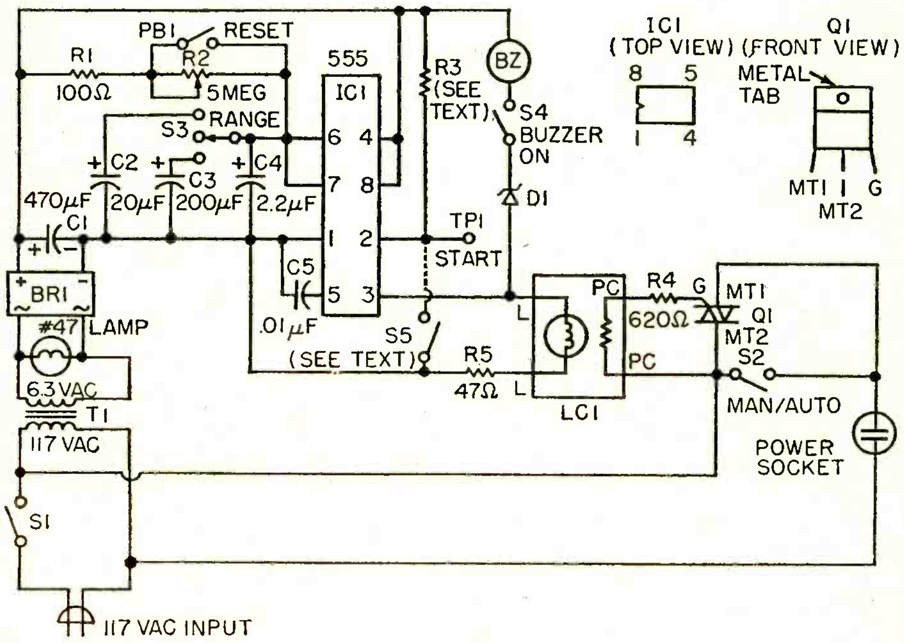


lights, the photocell lowers its resistance, and the Triac conducts the ac power to the enlarger outlet.

Transformer T1 with the diode bridge BR1 and capacitor C1 provide the dc voltage for the integrated circuit. The switches S1 through S4 select the timing range and the various options. Switch S5 can be added in place of touch-to-start if you wish.

Construction. The unit as constructed by the author fits comfortably in a 8-in. x 3-in. x 5-in. cabinet. If you select the touch option for starting the timer, make sure the case is grounded and that you use three-conductor cable for the ac connection. (the green "neutral" wire is connected to the chassis.) The touch button consists of a metal jack insulated from the cabinet. Body pickup should be sufficient to start the timing cycle. If you plan to use two-wire ac plugs and cables, use the pushbutton option for starting the timing cycle.

Electronic components fit on a 3-in. x 4-in. piece of perf board. We recommend using a socket for the IC. The Triac can handle a 300 watt lamp without a heat sink.



PARTS LIST FOR UNIVERSAL POWER TIMER

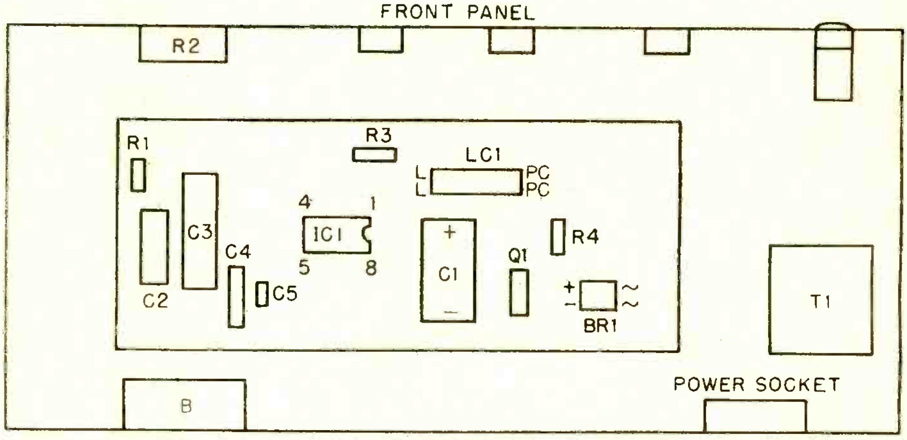
BR1—Bridge rectifier, ½-amp or better
BZ—Buzzer, low current sonalert, Mallory type SC628
C1—470 or 500 uF, capacitor, electrolytic, 16 to 55 VDC
C2—20 or 22 uF, capacitor, electrolytic, 10 to 50 VDC
C3—200 or 220 uF, capacitor, electrolytic, 10 to 50 VDC
C4—2 to 2.2 uF, capacitor electrolytic, 10 to 50 VDC
C5—0.01 uF, capacitor, 50 VDC or better
D1—Zener diode, 3 to 4 volts, ½-watt
IC1—Integrated circuit timer, Signetics 555 type
L1—Pilot light for 6.3 VAC such as Radio Shack 272-318 with No. 47 bulb.
LC1—Light coupler, Sigma 301T1-6B1 (available from Allied Radio, their number 917-1417)
PB1—Pushbutton, normally open
Q1—Triac, GE SC141 type, 200-volt, 8-amp
R1—100-ohm, ½-watt resistor
R2—5-megohm potentiometer, linear taper
R3—33,000 to 470,000-ohm, ½-watt resistor, see text
R4—680-ohm, ½-watt resistors
R5—47-ohm, ½-watt resistor
S1, S2, S4—Switches, SPST
S3—Switch, center-off SPDT
T1—Power transformer, 117 to 6.3 VAC, 250 mA or better
Misc.—Knobs, cabinet, single flush-mounted grounded outlet, wire, solder, etc.

Universal Power Timer

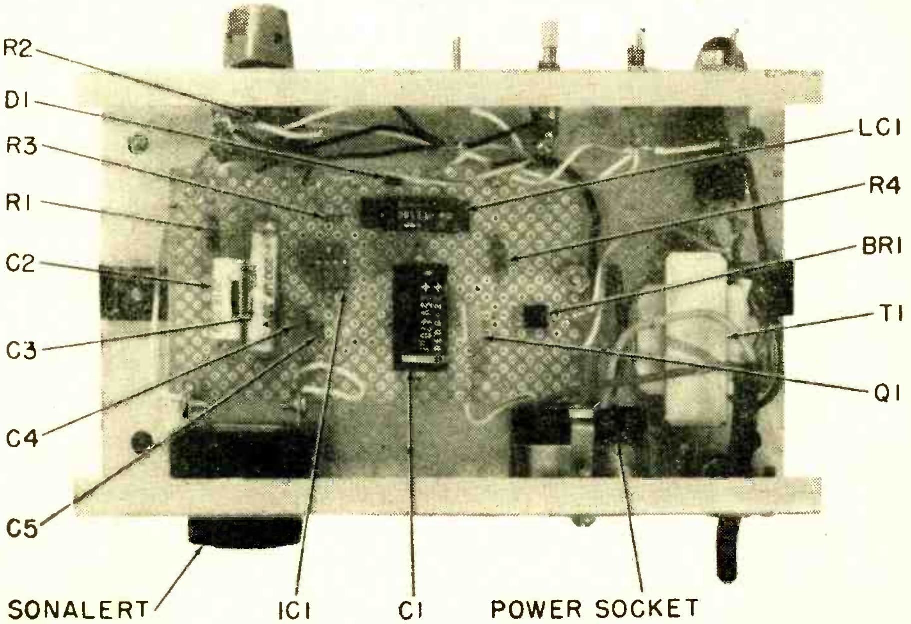
If you plan to use a larger lamp, use a heat sink. Make a dial out of a piece of white cardboard with three concentric circles for the three timer ranges.

Calibration. Calibrate the three timer ranges separately. Use a stopwatch or a watch with a second hand. Make marks on the dial with a pencil to indicate minutes and seconds.

If you use the touch option to start the timer, choose the value of R3 between 33K and 470K. A larger resistor will make the starting button more sensitive to the touch, however, if the sensitivity is too high, the timer may start unexpectedly when there is a "spike" on the ac line. We found the value of 47K best (this value should also be used for the push-button option). The "touch" sensitivity is then such that the starter will not operate if your finger is dry, but if you wet your finger, or even better, if you touch the button with a metal object (coin, key chain, ring, etc.) the timer will start reliably. ■



Component layout of the author's timer is shown in drawing and photograph. Place front panel switches according to photo on the second page of this article.



Hang an...
EXPANDED SCALE VOLTMETER From Your Dash

by Martin W. Bajor

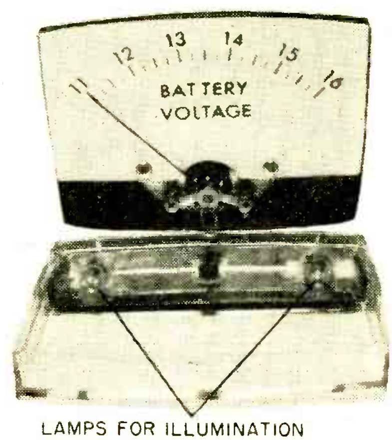
PROFESSIONAL DRIVERS in big over-the-road rigs depend on an ammeter *and* a voltmeter to gauge electrical operating conditions in their vehicles. How about you?

With this zener-regulated expanded scale voltmeter you can forget the idiot light and measure operational voltage fluctuations that can tell the real story.

Sure, an ammeter can be installed. After all, that's what most vehicular electrical gauges measure, if one is there at all, so why not install what manufacturers do?

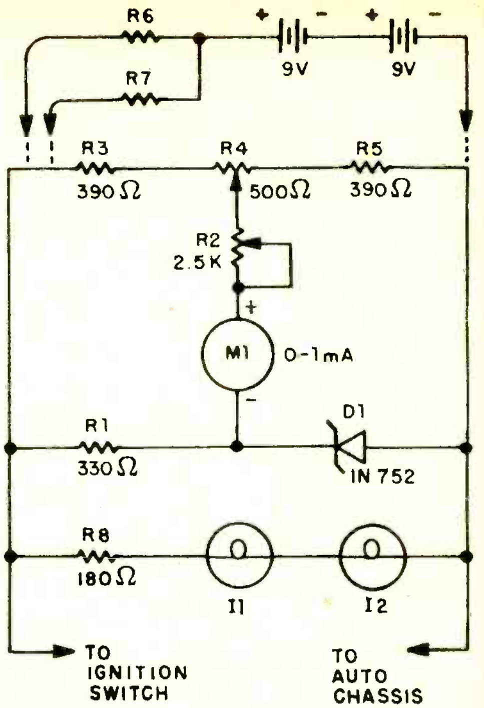
Why? Because you don't have the problem of installing a meter in series with the primary power cable as with an ammeter. Just a simple tap to the ignition switch or even to an accessory power cable such as the radio or heater line will do for a voltmeter. And for a plus in performance, you have a new sensitivity to electrical system operation—battery, alternator, voltage regulator and more—that only an expanded scale voltmeter can conveniently provide.

What Expanded Scale? An expanded scale meter is one on which the lowest reading is not zero volts but the lowest voltage of interest to the user. A conventional voltmeter has a scale reading from zero to a specified maximum voltage. On a typical meter with a full scale reading of 15 volts it would be difficult to read the difference of a few tenths of a volt that can be significant in the automotive electrical system. The range for this meter was chosen to be 11 to 16 volts. This covers the levels in which we are most interested.



Drill two small holes for lamp wire, then cement, glue, or use selastic to secure a pair of series-connected 6-volt mini lamps.

Expanded Scale



PARTS LIST FOR AN EXPANDED SCALE VOLTMETER

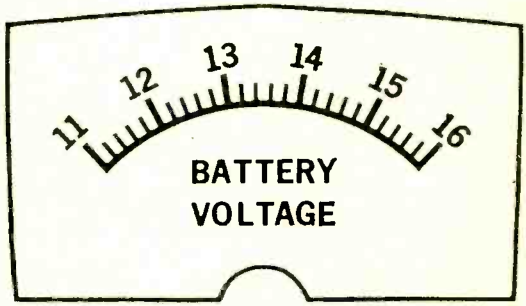
D1—Zener diode, 5.6 volts, ½-watt, 1N752 (Motorola HEP-Z0212 or equiv.)
I1, I2—Miniature lamps, 6 VDC, 25 mA
M1—Meter, 0 to 1 mA movement
R1—330-ohm, ½-watt resistor
R2—2500-ohm potentiometer, PC-type
R3, R5—390-ohm, ½-watt resistor, 5%
R4—500-ohm potentiometer, PC-type,
R6—820-ohm, ½-watt resistor, 5%
R7—160-ohm, ½-watt resistors, 5%
R8—180-ohm, ½-watt resistor

Misc.—Case (3 x 3¼ x 2-in. deep), perf board, push-in clips, 2U6-type 9-volt batteries (for calibration, see text), wire, solder, hardware, etc.

Look at the schematic. The negative terminal of the meter is connected to the junction of R1 and the zener diode, D1. Voltage at this point remains constant at 5.6 volts when the voltage across the circuit varies from 11 to 16. The positive meter terminal is connected through variable resistor R2 to the wiper of potentiometer R4. Network R3, R4, and R5 make up a voltage divider that is adjusted so 11 volts applied by the vehicle results in no current flow through R2 and the meter. Variable resistor R2 is set, when 16 volts is applied to the circuit, for a full scale meter deflection.

Building It. To insure accuracy only 5% tolerance (gold band) resistors should be used for R3, R5, and the calibrating resistors R6 and R7. If you can not obtain a 160-ohm resistor, two values totaling 160 may be connected in series—150 and 10 or 120 and 39. Be certain that the zener diode is installed in the proper direction. If a type other than the one in the parts list is substituted, the end with the band must go to the junction of the meter and R1. It must be a 500 milliwatt (½ watt) rating. A higher power rating will not properly regulate the voltage in this circuit. Provisions to conveniently disconnect the R3 end of the voltage divider for calibration should be made.

The meter face must be modified for meaningful readings. If you use the meter called for in the parts list cut out and cement in the pattern provided. Carefully pry the faceplate off the meter. The meter face can be removed by taking out the two screws; slide it out taking extreme care not to damage the pointer. If you use a different meter you can remove the unwanted numbers on the dial by gently rubbing them with a pencil eraser taking care only to erase the black lettering and not the white paint underneath. New numbers can be put on with dry transfer letters available from



Copy or cut out this exact-size meter face.

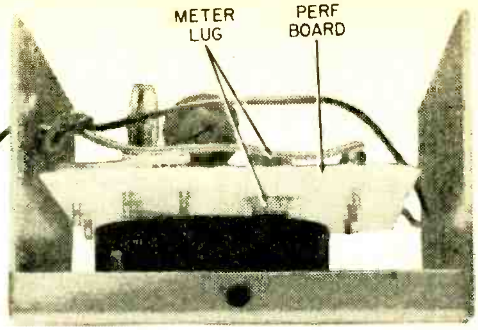
art supply stores or electronic distributors.

If your installation requires lights, miniature bulbs can be built in behind the meter faceplate. While the faceplate is removed carefully drill a 3/32-in. hole about 1/4-in. in from each bottom corner. Drill two matching holes in the chassis so the wires can go through to the circuit board. Cement the bulbs in place with silicone adhesive. Connect the bulbs in series as shown in the schematic. The 180 ohm resistor is to drop the voltage slightly so lamp life is extended.

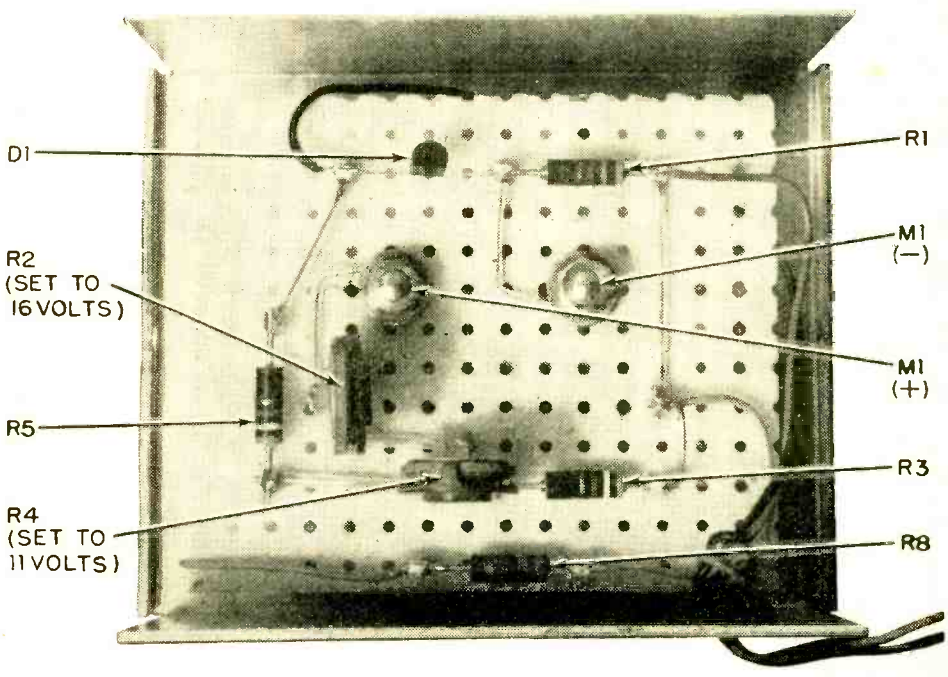
Calibration. If you have a variable power supply and an accurate voltmeter such as an automotive analyzer you may calibrate as follows. Apply 11 volts DC across the circuit and zero the meter with R4. Turn the supply to 16 volts and adjust the meter to full scale using R2. Repeat the procedure to be sure the settings are correct. Remember you must set R4 first then R2.

If you don't have a power supply use the following procedure. Disconnect the R3 end of the voltage divider. Connect R1 to the positive terminal of your car battery and the circuit ground to the negative terminal. Connect two 9-volt batteries in series with the negative end going to ground. Connect the positive end of this 18-volt battery through the 820-ohm resistor to the open end of R3. Adjust R4 to zero the meter; then connect the 18-volts through the 160-ohm resistor and set R2 to make the meter read full scale. Repeat to check settings. Using silicone adhesive or other suitable glue, cement the knobs of the potentiometers in place. Reconnect R3 to the circuit.

Installation And Use. Connect the positive lead of the meter circuit to a spare accessory terminal on the ignition switch. If this is not available, the lead to the radio will do. The ground lead goes to some con-



Pre-drill a pair of holes in the perf board; slip it over the meter lugs. The two nuts on each lug permit varying the mounting height.



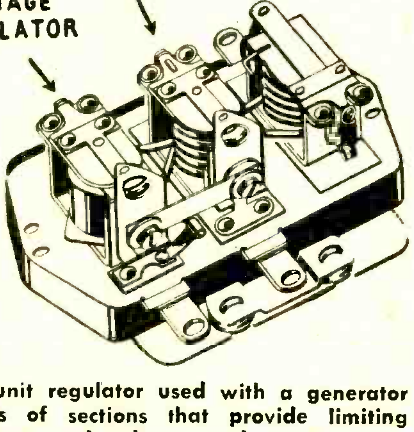
Very simple layout uses push-in clips for stable mounting of the few parts used.

venient chassis ground point; try under the head of a screw in the dash. When the key is turned to the accessory position (with none of the car's electrical equipment turned on) the meter will read the battery voltage. A fully charged battery will be above 12.5 volts. A reading of less than 11.5 volts (with no load) indicates a discharged battery.

Start the engine and run it for a few minutes at moderate to high idle. The meter reading under these conditions should be 13.5 to 14.4 volts for most cars. In colder temperatures the readings will be higher. A reading of over 15 volts indicates the regulator probably needs adjustment. Rapid fluctuations in the reading while driving could mean a loose alternator drive belt or an open stator winding or even an open diode.

A test of the battery's capacity can be performed as follows. Crank the engine with the starter for three seconds. If the engine starts turn it off immediately and turn the key to the accessory position. Turn the lights on low beam and watch the meter reading slowly drop. If, after one minute with the lights still on, the voltage drops below 11.7 the battery should be checked.

Vehicle Maintenance. Fan belt tension is critical with the alternator. Always make sure the belt is in good condition and adjusted to specification.



Three-unit regulator used with a generator consists of sections that provide limiting of current and voltage, and circuit cutout.

Following adjustment of the fan belt, turn your attention to the regulator. Make sure all connections at this unit are tight. Then check the battery terminals where high resistance could be causing the trouble. Remove the cables and clean the terminals and posts. Make sure the ground cable is clean and tight. Finally, check at the alternator for loose connections.

If trouble still persists, replace the brushes in the alternator since poor contact between brushes and slip rings is a major factor for a low charging rate. In some cars, the brushes can be removed from the alternator with the unit in the car. This is done by unscrewing the external cap screws to which the brushes are attached. In other cars, the unit must be removed from the car to reach the brushes, which can then be unscrewed.

If you still have poor alternator performance remove the alternator from the car and check the stator. Open windings cause an unsteady, low charging rate. If it is necessary to take the unit apart, remove it from the car and split it open, separating the stator from the rotor. Test the rectifiers first. This can be done with a commercial diode tester, although you can also use any continuity tester, such as an ohmmeter or a test lamp.

If a diode is defective, it must be replaced. This requires special tools and should be left to a professional shop.

If the meter indicates low charge rate at all speeds and you get a run-down battery, which indicates low voltage output, hook the negative voltmeter lead to the battery's negative post and the positive to the positive post. Connect a jumper wire from the ignition terminal to the field terminal on the regulator and then start the engine. The voltmeter should read about 14 to 15 volts for a 12-volt charging system. If not, the regulator is faulty. If you have a mechanical regulator, try adjusting the regulator points; if that does not increase the voltage output, you probably need a new regulator.

But if the regulator does check out, go to the alternator and tighten all connections. The trouble could also be a shorted rectifier, or grounded or open stator, so check them as well.

I'm sure that when trade-in time for your car comes one of the first things removed will be the voltmeter. ■

Tune This Radio with a Voltage Divider!

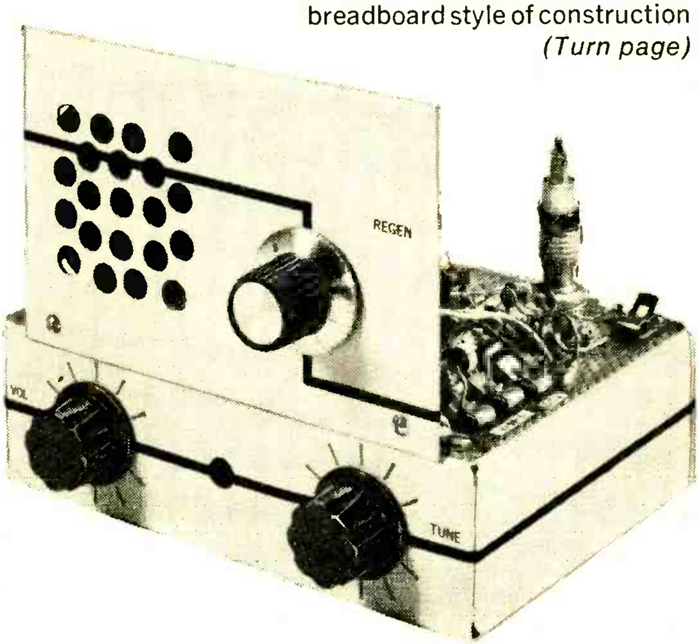
by Charles Green W6FFQ

TUNE IN with the new space-age solid-state components that have transformed receiver technology. The old reliable tuning capacitor that was used in the old tube receivers is still with us and is still almost as large in size. Attempts at size reduction, decreasing the air gap between plates or using a mica dielectric, still are not enough.

But in the last few years, a solid state equivalent to the tuning capacitor has been developed to the point of enough capacity to tune the broadcast band and will be put into use soon. This solid-state device is called the Varactor, and is a type of semi-conductor diode.

You can experiment with varactors with our simplified broadcast band receiver. The old reliable regenerative detector circuit is used for simplicity, and is brought up to date with a field effect transistor (FET) used as the detector. An audio amplifier module is included that drives a small speaker mounted on the front panel. The receiver is built using an rf breadboard style of construction

(Turn page)



VARI-CAP TUNING

for some very easy experimentation on a 7-in. x 5-in. x 2-in. metal chassis. Information is given for the use of selected silicon diodes as varactors in addition to commercial varactors.

About The Circuit. RF signals from the antenna are connected via J1 to the primary winding of coil L1 which, in turn, is tuned by the varicap diode with tuning control R4. Signals from the tuned circuit are detected and amplified by a FET version of the grid-leak—the *gate-leak* detector Q1. Some of the rf energy from the source circuit of Q1 is fed back from the tickler winding, detected, and re-amplified. When there is too much feedback, the gate-leak detector circuit of Q1 will oscillate. The amount of feedback is therefore controlled by the *Regen* control R2 and adjusted to just below the point of oscillation for maximum sensitivity and selectivity of BC band signals.

The detected signals from Q1 are coupled via T1 to volume control R6 and the amplifier module. Further amplification of the signals is performed by the module and the signals are heard on the 8-ohm speaker.

What's a Varactor? The varactor diode is a semiconductor junction diode that behaves like a capacitor when reverse voltage bias is applied. The capacitance is formed by the space charge or depletion region around the internal P-N junction of the diode, and the amount of capacity is changed by varying the reverse voltage bias. This type of diode is also known as a voltage-variable capacitance diode or as a vari-cap.

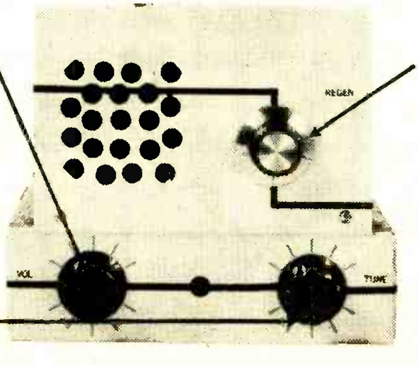
The basic semiconductor junction diode is formed of a material such as silicon that has two portions of the material *doped* in manufacturing by adding controlled amounts of chemicals. The doped portions have opposite electrical characteristics; "P" type with an excess of positive electrical charges (or hole) and "N" type with an excess of negative electrical charges (electrons). As shown in the drawing, the boundary between the two types is called a P-N junction, and there is a depletion layer (or region) that is also called the space charge region. This region is in an area along both sides of the P-N junction.

This space charge region is an area that acts as an electrical insulator (electrons will not normally flow across it) when no external bias voltage is applied, and therefore bars the passage of an electric current through the P-N junction. When an external voltage bias is applied the space charge region will narrow and disappear. This will permit the diode to conduct (electrons will flow across the P-N junction). As shown in the drawing of a diode being used as a rectifier; the space charge region will vary from very narrow (and disappearing) to very wide, when the alternating voltage changes polarity and gives the diode a reverse bias.

Solid Tuning. As also shown in the drawing, a diode has an internal capacity between the P and N type materials with the non-conducting space charge region acting as the capacitor dielectric. When the diode has a low reverse bias voltage, the space charge region is narrow, and the capacity effect is the same as if the plates of a tuning capacitor are close together—high capacity. If the diode has a high value of reverse bias voltage, the space charge region is wide, and the effect is as if the plates of a tuning capacitor were moved apart—low capacity. The actual capacity depends upon the physical and electrical

Start Here. Back off volume to a low level until station is tuned and regeneration is properly adjusted.

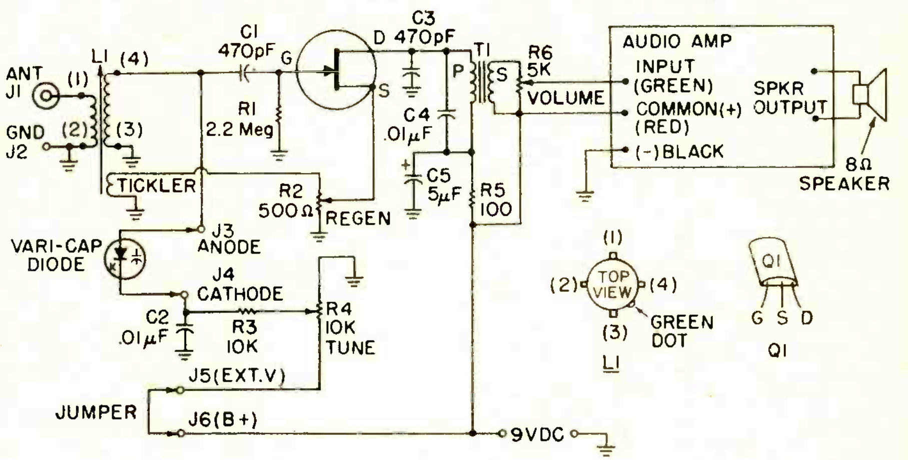
Then. Rotate tuning control until a whistle is heard indicating the presence of a broadcasting station. Rock control back and forth to tune radio to center of channel as indicated by the loudest whistle.

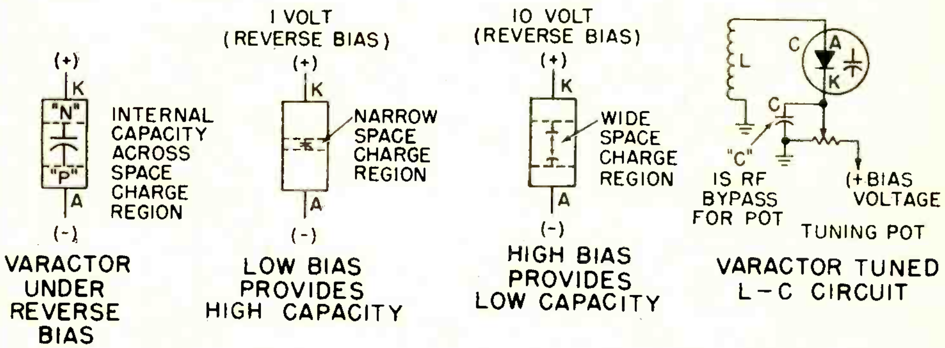


Finally. Back off the regeneration control until the whistle just disappears. This control should be adjusted as near to the point of oscillation (audio whistle) as possible. Increase volume control as required. If the unit again breaks into oscillation, back off the regeneration control to a stable setting.

characterists of the particular diode, and commercial varactors are specially manufactured and selected semiconductor diodes.

When a varactor diode is connected into a tuned circuit as shown in the diagram, the capacity of the diode can be varied by a tuning potentiometer which changes the value of the reverse bias voltage of the diode. When the bias voltage is high, the tuned circuit is at the highest frequency of operation, and when the voltage is low, the frequency is low. Capacitance "C" is an rf bypass capacitor for the tuning potentiometer.





PARTS LIST FOR VOLTAGE-TUNED RADIO

AA1—Audio amplifier, 100 mW, 4 to 8-ohm output
C1, C3—470 pF disc capacitor, 12 VDC or better
C2, C4—.01 uF disc capacitor, 12 VDC or better
C5—5 uF electrolytic capacitor, 12 VDC or better
J1—Phone jack or binding post for antenna terminal
J2 to J6—Fahnestock clips for binding posts
L1—BC Band antenna coil with three-turn tickler winding; see text (Miller A-5495-A)
Q1—FET, HEP-802 (Motorola)
R1—2.2-megohm, ½-watt resistor
R2—500-ohm potentiometer, linear taper
R3 10,000-ohm, ½-watt resistor
R4—10,000-ohm potentiometer, linear taper
R5—100-ohm, ½-watt resistor
R6—5,000-ohm potentiometer, audio taper
T1—Transformer, 10,000-ohm primary, 2,000-ohm secondary

Misc. 8-ohm speaker, 7-in. x 5-in. x 2-in. chassis, 5-in. x 7-in perfboard, push-in clips, 4-in. x 7-in. front panel (metal or copper-backed phenolic), knobs, Vari-cap diodes (see text), 9-volt battery or 9VDC power supply, hookup wire, solder, etc.

VARI-CAP TUNING

When a varactor is used in a tuned circuit, the amount of the change in capacitance of the semiconductor diode with the applied reverse bias voltage becomes important. In a tuned circuit (LC) the frequency ratio varies directly as the square root of the capacitance ratio. A varactor must therefore have a capacitance ratio of 4 to 1 if the tuned circuit is to be tuned over a range of 2 to 1.

Simple Building Hints. The receiver is built breadboard style with the components mounted on a perf-board. Even though the receiver operates on the BC band, wiring of the Q1 regenerative detector circuit may be critical. For best results, follow our photos for parts placement.

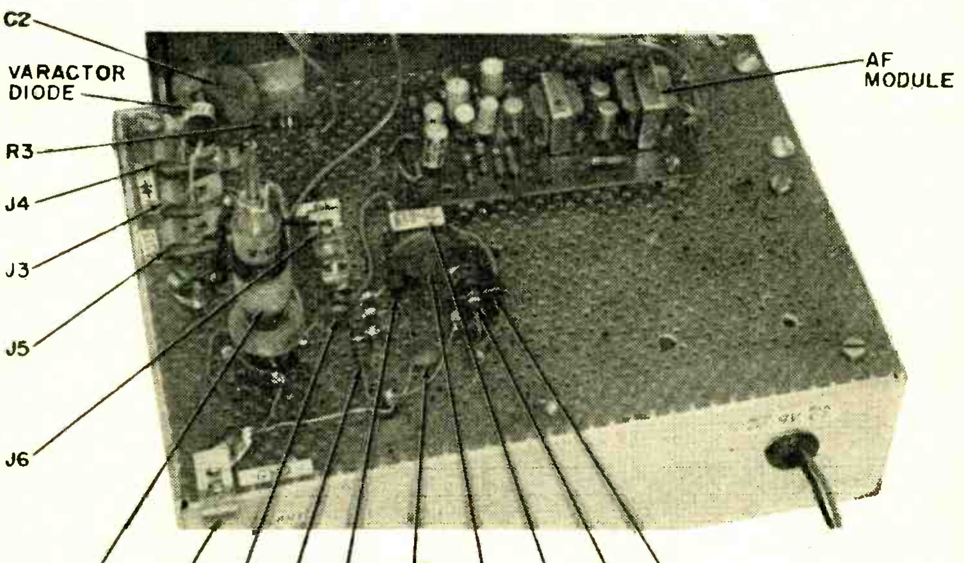
Start construction by cutting out the top of a 5 x 7 x 2-in. aluminum chassis to a ½-in. rim all around. Slot and bend up two 1½-in. tabs at each end of the front rim of the chassis and drill mounting holes for the front panel. Our front panel is a 4 x 7-in. copper-backed phenolic section of the type used for printed circuits, but any size metal panel can be used as well. Cut a perf board section to size to fit the top of the chassis and install it with sheet metal screws to the rim of the chassis.

Coil L1 is mounted on the perf board by soldering the terminals to push-in clips. Remove the 10 pF ceramic capacitor supplied with the coil before mounting, and make sure that the coil is positioned for the shortest connections (as shown in the schematic). Q1 is also mounted with push-in clips soldered to the leads and positioned close to L1. T1 is installed on the board with push-in clips soldered to the transformer mounting tabs.

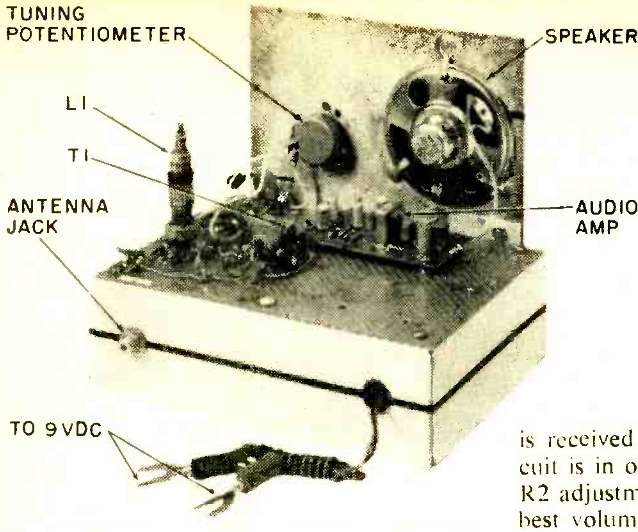
Install the remainder of the parts on the perf board and chassis, then wire them as shown in the schematic. Wind three turns of hookup wire around the top end of the L1 secondary winding for the tickler and twist the leads together to hold them in place on the coil.

The amplifier module is mounted on the perf board with machine screws and ¼-in. spacers. Make sure that you connect the common (+) red wire to B+ as shown in the schematic. Clip off the unused red wires that normally are connected to a switch. (See the schematic supplied with the module for details.) The amplifier module black (−) wire should be centered to B− (common ground).

Check The Tickler. Connect a good outside antenna to J1 and a ground connection to J2. Connect the red wire (B+) to the (+) terminal of a 9-volt battery or dc power supply, and connect the black (B−)



If you place your components in approximately the same location as the author, you will have an excellent chance for success with your project. Note "tickler" at top of L1.



To this simple circuit tuning in stations means varying a reverse bias voltage to the varactor diode which increases capacitance in proportion to the decrease in reverse bias. Varactors are solid-state variable capacitors that can take the place of the usual mechanical variety.

receiver wire to the (—) terminal. Connect a 100 pF capacitor to J3 and J4 (in place of a varactor), and adjust the tuning slug on L1 until you hear a received signal in the speaker. Adjust R6 for a convenient audio volume, and then adjust R2 until the signal is received as a whistle (the Q1 regen circuit is in oscillation). Then back off on the R2 adjustment until the signal is received at best volume and selectivity. It may also be necessary to readjust the L1 tuning slug. If the signal can not be received as a whistle, reverse the connections to the tickler winding.

You can connect a 365 pF variable tuning capacitor in place of the 100 pF capaci-

TUNING THE 50 STATES ON MEDIUM WAVE

Because the BCB band is so crowded with stations, logging all 50 states is tougher than it used to be. But, with patience and luck, you can do it. Here are your best bets.

State	Call	Freq. (kHz)	State	Call	Freq. (kHz)
Alabama	WYDE	850	Montana	KXLF	1370
Alaska	KFQD	750	Nebraska	KFAB	1110
Arizona	KTAR	620	Nevada	KOH	630
Arkansas	KAAY	1090	New Hampshire	WKNE	1290
California	KFBK	1530	New Jersey	WPAT	930
Colorado	KOA	850	New Mexico	KOB	770
Connecticut	WTIC	1080	New York	WABC	770
Delaware	WDOV	1410	North Carolina	WBT	1110
Florida	WQAM	560	North Dakota	KFYR	550
Georgia	WSB	750	Ohio	WLW	700
Hawaii	KORL	650	Oklahoma	KOMA	1520
Idaho	KGEM	1140	Oregon	KEX	1190
Illinois	WLS	890	Pennsylvania	KDKA	1020
Indiana	WOWO	1190	Rhode Island	WPRO	630
Iowa	WHO	1040	South Carolina	WCSC	1390
Kansas	WREN	1250	South Dakota	WNAX	570
Kentucky	WHAS	840	Tennessee	WSM	650
Louisiana	WWL	870	Texas	WOAI	1200
Maine	WCSH	970	Utah	KSL	1160
Maryland	WBAL	1090	Vermont	WHWB	1000
Massachusetts	WBZ	1030	Virginia	WRVA	1140
Michigan	WJR	760	Washington	KGA	1510
Minnesota	WCCO	830	West Virginia	WWVA	1170
Mississippi	WOKJ	1550	Wisconsin	WKOW	1070
Missouri	KMOK	1120	Wyoming	KWYO	1410

VARI-CAP TUNING

tor for easier signal tuning or to allow reception of signals at the lower end of the band for this test. This test will show that the basic receiver circuits are operational. At the conclusion of the test, remove the capacitor from J3 and J4, and then connect a short jumper wire between J5 and J6. This jumper is necessary to provide a B+ connection to the R4 tuning control.

Selecting Your Varicap Diode. The receiver can be used with either commercial varactors or selected ones from your stock of surplus or used semiconductor diodes. Some transistors will also operate as varactors. The commercial varactors may not be easily available to the experimenter, as they may have to be specially ordered from local parts houses that handle industrial electronic components.

The following are some varactors that can be used with this receiver: Motorola—MV1401 ("EPICAP") 550 pF at 1-volt bias, 10:1 ratio; Motorola MV1405 250 pF at 2-volt bias, 10:1 tuning ratio; HEP R2505 100 pF at 4-volt bias, 3:1 ratio; and Radio Shack; 276-676 (5 varactor diodes kit) 10 to 50 pF. There are many more types by different manufacturers, but at this time not much information is available for the experimenter. Unfortunately, most of the commercial varactors do not have enough capacity to tune over the complete BC band; they are more suitable for short wave and UHF operation. But industry is still in the process of developing varactors for use in home radios (as well as TV sets) and more varactors should be available for experimentation.

You can also experiment with ordinary silicon rectifiers used as varactors with this receiver. Since the properties of a diode that go to make a good varactor are not necessarily that of a good rectifier, it is necessary to test the diodes for varactor operation. Also varactor qualities may vary a lot. Even when one of a particular type or manufacture is found to have varactor operation, other diodes of the same type may not work at all. It may be considered to be a sort of treasure hunt to find varactors among your surplus and used diodes.

Best way to test diodes for varactor operation is to connect them to the receiver—the diode anode to J3 and the cathode to J4. Then. tune R4 and see if signals can be received over the BC band for a rough check.

It was found that a GF-X4 rectifier diode worked ok, and several of the Radio Shack 276-599 kit of untested diodes operated as varactors. Disconnect the connection between J6 and J5 and try operating the varactors with the external dc power supply (+) terminal connected to J5, and the (−) terminal to J2 for a greater capacity tuning ratio range. Try various higher voltages within the maximum voltage rating of the diode.

Try experimenting with transistors as varactors. Connect them as follows: *emitter* of an NPN type to J4, *base* to J3; or *collector* to J4 and *base* to J3. Connect the *base* of a PNP type to J4, *collector* to J3; or *base* to J4 and *emitter* to J3. ■

AM CLEAR CHANNELS FOR NORTH AMERICA

540 Clear (Canada)	780 Clear	1010 Clear (Canada, Cuba)	1170 Clear
640 Clear	800 Clear (Mexico)	1020 Clear	1180 Clear
650 Clear	810 Clear	1030 Clear	1190 Clear (U.S., Mexico)
660 Clear	820 Clear	1040 Clear	1200 Clear
670 Clear	830 Clear	1050 Clear	1210 Clear
680 Clear	840 Clear	1060 Clear (U.S., Mexico)	1220 Clear (Mexico)
690 Clear	850 Clear	1070 Clear (U.S., Canada)	1500 Clear
700 Clear	860 Clear (Canada)	1080 Clear	1510 Clear
710 Clear	870 Clear	1090 Clear (U.S., Mexico)	1520 Clear
720 Clear	880 Clear	1100 Clear	1530 Clear
730 Clear (Mexico)	890 Clear	1110 Clear	1540 Clear (Bahamas)
740 Clear (Mexico)	900 Clear (Mexico)	1120 Clear	1550 Clear
750 Clear	940 Clear (Mexico, Canada)	1130 Clear (U.S., Canada)	1560 Clear (Cuba)
760 Clear	990 Clear (Canada)	1140 Clear (U.S., Mexico)	1570 Clear (Mexico)
770 Clear	1000 Clear (U.S., Mexico)	1160 Clear	1580 Clear (Canada)

Stretch more miles from your gas supply . . .

BUILD A PROFESSIONAL DWELL/TACH

Plus tune-up tips by C. R. Lewart

With gasoline prices going up, and with the growing concern about air pollution caused by automobile exhaust, a well tuned car becomes a must. One of the essential tools for a tune-up is a dwell/tachometer that helps you adjust your engine to its optimum specs. What we describe here is a dwell/tach based on a newly-developed integrated circuit. It's easy and inexpensive to build, but with the IC it will also be more precise and easier to handle than most currently available commercial units. You may either put the unit in a portable case, as we have done, for use as a diagnostic tool, or you may mount it permanently on the dashboard.

The main advantages of the circuit are readings basically independent of the battery voltage, temperature, and the shape of the voltage at the points.

How Does It Work? First let's consider the shape of the voltage at the distributor points. When the points open there is a sharp spike of 100 to 300 volts followed by damped oscillation settling at the battery voltage as shown in the illustration. When the contacts close, ground is applied to the bottom of the ignition coil, and voltage across the points drops to zero as current flows in the ignition coil primary.

In the integrated circuit there is a temperature-compensated monostable pulse generator section, an amplifier-limiter section, and a voltage regulator section.

For the tachometer mode, the input circuit (R1, R2, R3, D1 and C1) assures that only the initial high-voltage spike caused by the opening points triggers the pulse generator. The generator produces a single rectangular pulse whose amplitude is determined by the IC parameters, and whose pulse width is determined by R4, R5, and C2. The pulses are amplified and fed into a one-milliampere meter which reads the average current. The higher the RPM, the more pulses, and the higher the meter reading.

In the dwell meter mode we bypass the pulse-generator section of the IC and apply the signal directly to the amplifier-limiter section. The meter reading then corresponds directly to the percentage of time the points

DWELL/TACH

are closed.

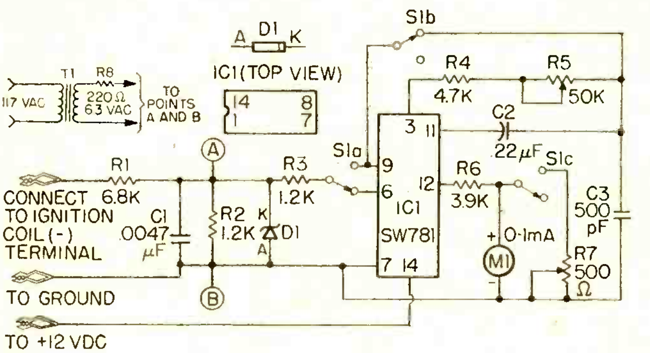
Calibration. The easiest way to initially adjust your unit is to connect it to a 12-volt battery and use a small 6.3-volt filament transformer to supply 60 pulses per second from the power line. *A 60-Hz line frequency corresponds to the following meter reading in rpm.* Set meter to the proper reading with calibration control R5. A 4-cylinder engine scale would read *1800 rpm* with the 60-Hz input, a 6-cylinder engine would read *1200 rpm*, and an 8-cylinder engine, *900 rpm*.

If, for example, you decide on a 2000-rpm full scale for a 6-cylinder engine (equivalent to 3000 rpm for a "4-banger" and 1500 for a V-8), set calibration control R5 for a 0.6 mA reading. The calibration reference for a 6-cylinder engine in rpm (1200) divided by the full scale in rpm (2000) times the full scale meter reading (1 mA) equals the calibration point meter reading in current (0.6 mA). Once calibrated, the rpm value is determined by multiplying the meter reading and the full scale. In this example the full scale is 2000 rpm, so a meter reading of, say, 0.4 mA would mean an engine rpm of 800. Once R5 is set it should not require recalibration unless accidently moved. If you prefer several ranges on a tachometer, or if you would like to use the same scale for 6- and 8-cylinder engines, switch-select a second pot of the same value as R5. Use one switch setting to calibrate for 6-cylinder engines, then throw the switch and use the second pot to calibrate for 8-cylinder engines.

It might be a good idea to tape a small mA-to-rpm conversion chart to the back of your meter. Compute rpm values for major meter divisions to give yourself a quick conversion capability, particularly if you choose a full scale of other than 1000 rpm. If you select a 1000-rpm full scale for V-8 engines, the meter will read directly in rpm. Just ignore the decimal point. For example, .55 would be 550 rpm.

With the values of components shown, you can adjust R5 for a full scale reading for a 6-cylinder engine between approximately 1200 and 6000 rpm.

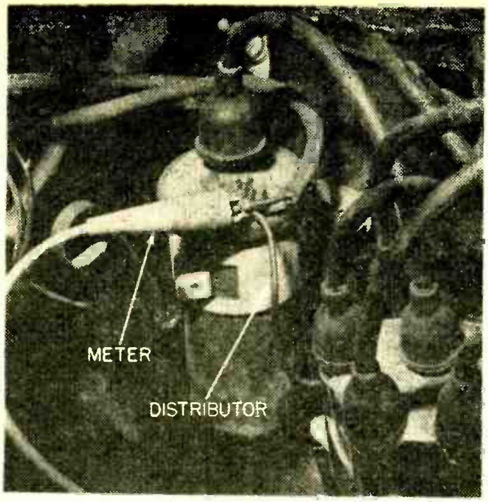
A dwell meter adjustment is done with R7. When the input (points) lead is disconnected, the meter should read full scale. Due to excellent voltage regulation in the IC, this potentiometer should not need adjustment after your initial setting. Full scale automatically corresponds to a 45-degree angle for an 8-cylinder engine, 60 degrees



PARTS LIST FOR DWELL/TACH

C1—0.005-uF capacitor
C2—0.22-uF capacitor
C3—470 pF-capacitor
D1—Zener diode, 9-volt, ½-watt
IC1—SW781 (available directly from the manufacturer, Stewart Warner Corp., 730 E. Evelyn Ave., Sunnyvale CA 94086, for $5.25 postpaid)
M1—0-1 mA meter
R1—6200-ohm, 1-watt resistor (you can use two 12,000-ohm, ½-watt resistors in parallel)
R2, R3—1200-ohm, ½-watt resistor
R4—4700-ohm, ½-watt resistor
R5—50,000-ohm potentiometer
R6—3900-ohm, ½-watt resistor
R7—500-ohm potentiometer
R8—220-ohm, ½-watt resistor
S1—3PDT switch, 3 sections used
T1—Transformer, 117 VAC to 6.3 VAC

Misc.—Perf board, clip leads, wire, solder, metal cabinet (5¼x3x6-in.), etc.



Clip "meter" wire from dwell/tach to ignition coil minus terminal. Look for "distributor" wire. It runs from the (—) terminal to the base of your distributor.

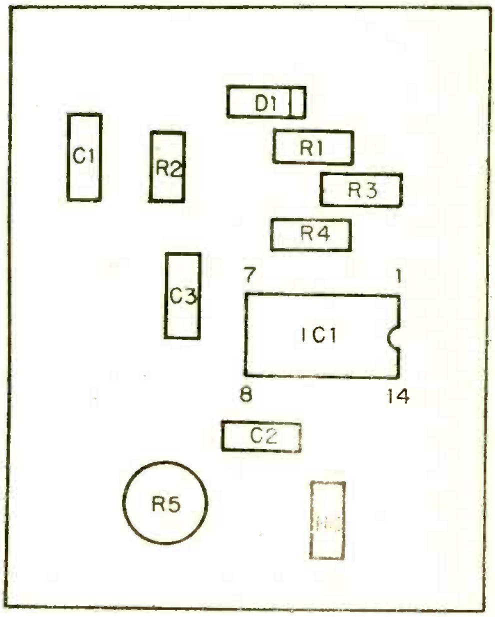
for a 6-cylinder, and 90 degrees for a 4.

Operation. Connect plus and minus power input leads to your 12 volt car battery. Switch S1 to the dwell function and adjust if necessary for a full scale meter reading, then connect the third lead to the points (thin wire going from coil minus to the distributor housing). Now you are ready to take measurements.

Auto Ignition Info. Let's define some of the points about ignition points. A term used very widely is distributor contact dwell. Degrees of distributor dwell are the degrees of rotation during which the breaker, or contact points, remain closed. This is commonly referred to as dwell angle or cam angle. Correct distributor contact dwell is essential for good ignition performance and point life. Distributor contact dwell in effect is the amount of time that the points remain closed; during this interval of time, magnetic energy builds up in the ignition coil which, when the points open, generates the high voltage pulse that *arcs* across the spark plug electrode. Generally a longer dwell period (larger dwell angle) is more advantageous for high speed operations.

Replacing ignition points is a simple matter of unscrewing the point retaining plate and screwing down the new one. This is just the beginning of a good tune-up. To check dwell reading you should have a dwell meter. Like most, ours is combined with a tachometer. With the engine running and the dwell meter/tachometer connected you should observe the dwell meter reading. If the dwell reading is within specifications for the engine then you can assume you have the correct gap, and that point contacts are in satisfactory condition. If the dwell reading is not within specifications, the point gap may be incorrect, the cam worn, the rubbing block worn or the moveable contact arm may be distorted.

Mini Lube Job. Distributor lubrication is something which is usually overdone. If the distributor has an oiler on the outside of the distributor base add three or four drops of SAE10W motor oil to the oiler. If there is a felt wick under the rotor at the top of the distributor cam, use three to six drops of SAE 10W oil. All grease should be wiped from the distributor cam and rubbing block. It's very important that the ignition points be free of grease or oil.



Use perfboard construction and lay out circuit components as shown. Components R7, S1, and M1 are located on front panel.

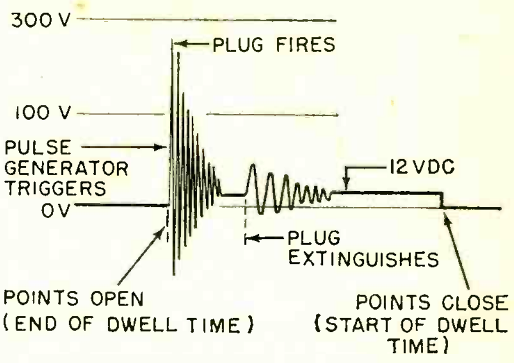
Many ignition systems use dual breaker points. These dual breaker point systems are designed for long life and good high speed performance. They are handled in the same way as single ignition points with the following exceptions: One set of contacts should be blocked open with a clean insulator. A match book section makes a good clean insulator for this. Adjust the opposite set of points to specifications using a dwell meter. Loosen the stationary contact block screw just enough so that the stationary contact can be moved with a light touch otherwise it will be difficult to set the contacts accurately. When the one set of contacts has been adjusted for the correct clearance, tighten the stationary contact lock screw. Block the adjusted set of contacts with an insulator and adjust the other set of contacts in the same manner as the first set. Remove the insulator and recheck the tightness of the stationary contact lock screw. If the contacts have been properly adjusted the dwell should be as specified for both contact sets. Again you must make sure that the gap and the dwell specifications are met for both sets of points.

Don't Overlook The Carb. A list of malfunctions caused by a sick carburetor reads like a "Who's Who of Auto Ailments." It includes hard starting, flooding, delayed acceleration, poor gas mileage, stalling, rough running, fouled spark plugs, and the gas leaks at the carburetor.

Not all of these problems, however, result only from an ailing carburetor. For this reason you should make sure spark plugs, ignition parts, compression, and timing are all in good condition before beginning carburetor service. In short, make sure your engine is correctly tuned, because your carb depends on proper operation of the rest of the engine.

All types of carbs—no matter how many barrels—have only one throttle adjusting screw. Two- and four-barrel units, however, have two idle adjustment screws—one for each idle system.

Warm the engine to operating temperature and have the choke valve completely open when adjusting. Start the engine and let it idle. If it stalls, turn the throttle screw in until the engine is running steady without any foot pressure on the accelerator.

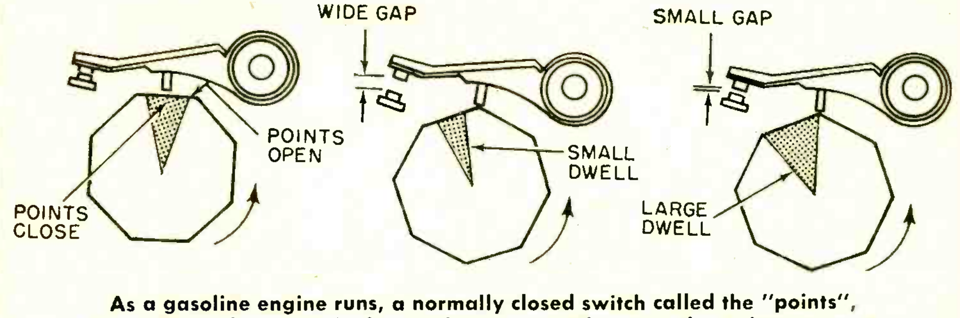


A pulse generator in your dwell/tach is designed to trigger just once each time the points open and a plug fires. Often, erratic behavior in some non-electronic tachometers is due to this complex wave.

The idle mixture should be adjusted to give a smooth idle. Missing is a sign of too lean an idle mixture while rolling or loping indicates too rich a mixture. Turning the screw in leans the mixture. It may be necessary to readjust the idle speed and mixture after the air cleaner is installed.

(Note: late model smog-controlled cars usually have a plastic limiter that restricts the movement of the mixture screw. An acceptable mixture adjustment should be possible within its limits.)

Turn the idle adjusting screw in slowly



As a gasoline engine runs, a normally closed switch called the "points", is constantly being pushed open by a cam. Whenever the points open, a high voltage is generated by the ignition coil to "fire" a spark plug. Dwell shows how many degrees the cam turns before it opens the points. Cam shown is for 8 cylinder car. Six cylinder motor has hexagon cam.

until the engine is about to stall. At this point, turn it out about a half-turn. If the engine seems to race, turn the throttle adjusting screw out slowly until the speed comes down.

Tune-up helped this overdrive equipped '68 Rambler increase mileage from 21 to over 25 mpg at todays 50-mph speeds. They laughed when I ordered overdrive back in 1968. Now one tank gives us a 375-mile driving range!

Service Your Plugs. Be extremely careful how you apply the socket wrench over the spark plug insulators. While they can resist the sledge-hammer blows under extreme temperatures and load that take place inside the cylinder each time they fire, they can be cracked by carelessly banging them with a wrench either taking them out or putting them in.

After removing your spark plugs, you have three things you can do: put them right back in the engine, have them cleaned and regapped and reinstalled, or replace them with new spark plugs.

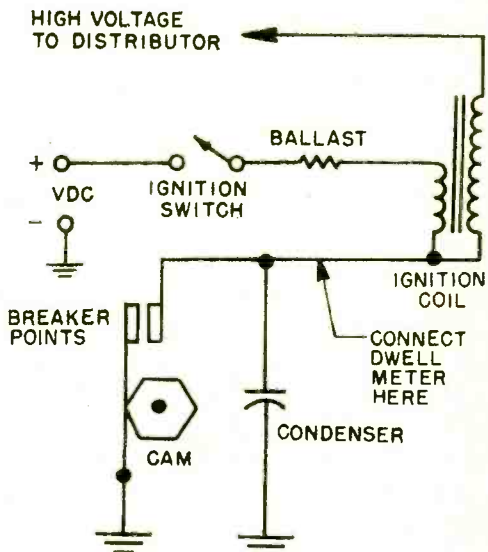
In the first case, you may merely want to examine the general condition of the plugs or check to see if the heat range is correct for the particular engine. Choice number two would be normal if spark plugs have only been used for around 5,000 miles and show normal wear. Clean and regap after 5,000 miles of use. Choice three would normally apply to spark plugs that have 10,000 miles of use or more on them.

Assuming that no particular complications exist, soak the spark plugs in a good parts cleaner for a few minutes to remove any oily deposits that exist.

To remove carbon deposits, use a small knife or any other small tool which will fit up inside the plug along the insulator. Be careful not to chip the ceramic and avoid the use of a wire wheel, which will completely ruin the plug.

Hard carbon formations are often impossible to remove. As you examine the plugs, you may notice such a condition, or possibly a burned condition of the electrodes. In such a case, it's advisable to install a new set of spark plugs as you'll need them soon anyway.

If the condition of the spark plugs is satisfactory after cleaning, open the gap. File the electrode sparking surface with an ignition point file before opening up the gap. You will get better firing from clean, flat surfaces, so this is an important part of spark plug servicing. Finally, adjust the gap to the manufacturer's specifications (Check the owners manual).



This is a typical non-electronic ignition system used for nearly all auto and truck engines since Henry Ford dropped buzzer ignition for his Model A. Additional part of ignition switch usually shorts out the ballast for more spark during starting.

Making sure you have the right spark plugs installed and that they are in good condition is vital to good ignition system performance. But it's only part of the story. Other parts of the system must be working properly if the plugs are to do their job. Wiring, distributor components, and coil condition all affect the production of a healthy spark. ■

BUILD IT FAST...
SIMPLEX INTRUDER DETECTOR

Foil burglars for under five bucks!

by Herb Friedman

For less than $5—using parts readily available from Radio Shack stores—you can literally throw together an effective intruder alarm suitable for use around the house or as a portable alarm for use in hotels and motels.

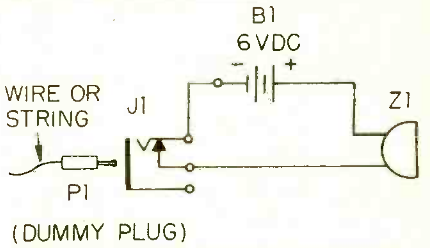
How it works is best explained by following the schematic. The alarm itself consists of an extra-loud buzzer, battery B1, and normally-closed jack J1. Note that this is a series circuit that is normally closed so that the horn would sound (when it goes on) until you turn it off. These three items are housed in a small cabinet that is mounted adjacent to a door or window.

Plug P1 is a dummy plug to which a short wire or string is attached. When PL1 is inserted into jack J1, the series circuit is opened and the horn is turned off. The free end of the wire from P1 is affixed to the door or window (with a thumbtack). When an intruder attempts to force entry by opening the door or window, the wire pulls out of the jack, whose normally-closed contacts spring together, thereby completing the series circuit and sounding the horn.

Plenty of Sock! The buzzer-horn specified in the parts list is marked for 1.5 to 3-volt operation. Dependable, loud operation is secured only with a 6-volt power supply, so do not substitute a 1.5-volt battery for the 6-volt battery specified in the parts list.

Jack J1 must be the miniature type specified in the parts list. Do not substitute a standard "phone" jack as it will not allow the plug to be conveniently pulled out. If you have an old transistor radio lying in the junk-box, simply salvage the headphone output jack.

When connecting the pull-wire to P1 take extreme care that you do not short-circuit the two plug connections as this will cause the alarm to sound continuously. Plug P1 is only a dummy used to open jack J1; it is not used as a connection.



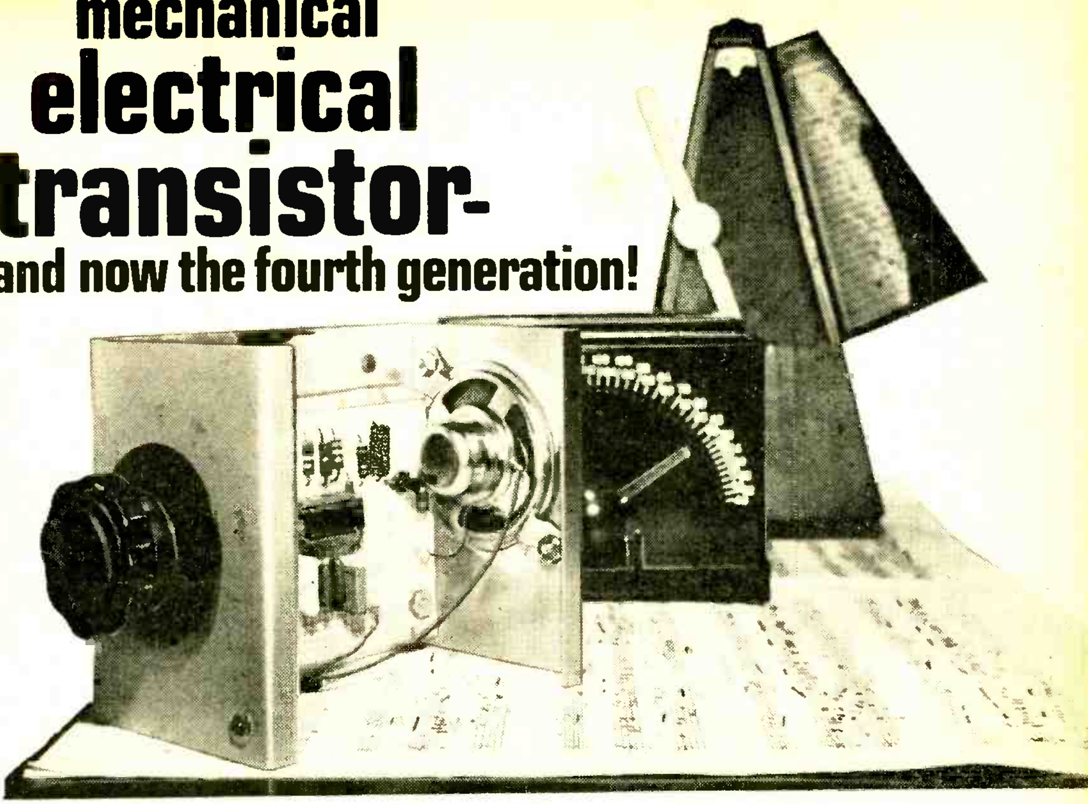
PARTS LIST FOR SIMPLEX DETECTOR

- **B1**—6-volt battery, Burgess Z4, RCA VS 068 or equiv.
- **J1**—normally closed mini-jack (Radio Shack 274-292 or equiv.)
- **P1**—plug to match J1 (see text)
- **Z1**—1.5 to 3-volt buzzer, Radio Shack 273-004
- **Misc.**—2 x 4 x 2¼-in. utility case (Radio Shack 270-231 used by author), "D" cell battery holder (Radio Shack 270-1438 or equiv.), wire, solder, etc.

The alarm can be secured adjacent to a door or window by a small screw passed through the back of the cabinet, or you can install a hanger bracket on top of the cabinet so the alarm can be slipped on and off a nail.

Since there is no standby current, the battery will last its shelf life. It's best to put a date sticker on the battery and replace it every year. To avoid soldering directly to the battery terminals the use of a "D" cell battery holder is suggested. As shown in the photographs, the specified 6-volt battery is a perfect fit for a "D" cell holder. ■

mechanical electrical transistor- and now the fourth generation!



IC METRONOME

It's stable, portable, economical and is the only *simple* metronome we found that keeps its beat for wide voltage and temperature changes.

by C. R. Lewart

WHAT, ANOTHER METRONOME PROJECT? They've been around for years, you say. Why another one then? Well, as far as we're concerned, currently popular versions of the electronic metronome—a unijunction relaxation circuit—simply aren't in the picture anymore.

With this project, you can have a metronome that will run on a single 9-volt transistor radio battery for *thirty* to *fifty* hours and keep the beat accurate throughout the useful battery life, even under wide temperature variations.

Unijunction transistors are extremely dependent upon supply voltage. So either you power the unit with 117 VAC (which means it's tied to a not-always-convenient outlet), or you regulate the battery voltage—a practice that is expensive both in parts and battery power. You either suffer a change in tempo in step with battery aging, or tie yourself to a power socket.

In addition to battery voltage and temperature independence, the sound this metronome makes is a dry *snap* or *click* much like the mechanical variety. The sound of the click does not change as you vary the beat frequency, and the dial is not squeezed at either end. An optional light-emitting diode (LED) flashes with each click to give a visual beat indication.

When we went to press the 556 IC was new, so you may not be able to obtain it through the regular hobby channels. You can, however, use two individual 555-type IC timers which are much easier to find.

IC Metronome

The only disadvantage to using two 555 ICs compared to a single 556 is a slightly higher battery drain with its associated, slightly lower, battery life. Check the table for equivalent pin connections if you use the two 555s.

Why It's Better. The first IC, a 555-type timer, is connected as an astable multivibrator, which is something like an automatic switch that turns itself on-off-on-off.

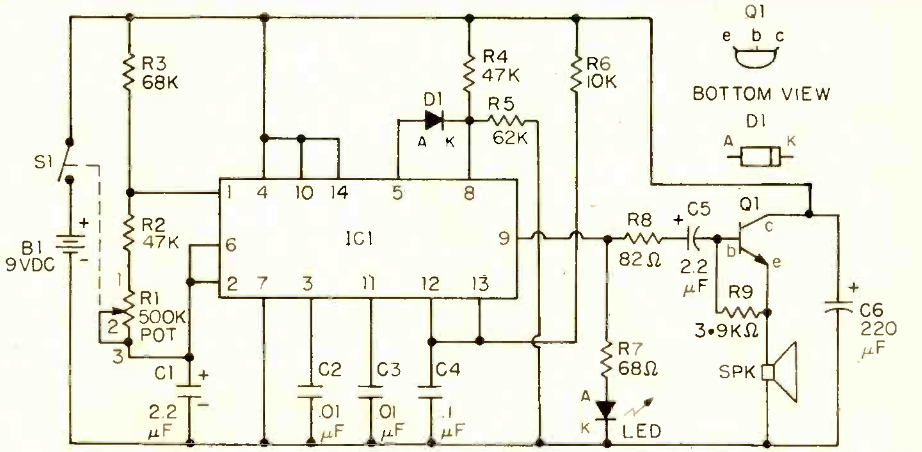
This generates the basic metronome beat frequency, which is determined by C1, R1, R2, and R3. Variable resistor R1 determines the time necessary to charge capacitor C1 to approximately two-thirds the battery voltage. By specifying R1 with an audio taper, you have a fairly uniform beat frequency scale without crowding at the high end.

Each on-off cycle of the first IC triggers the second IC (an identical 555-type unit) for a short, fixed on-off cycle. It is the output of the second IC that produces the waveform ultimately used to drive the speaker. This "click" stage lights the LED and, with additional amplification by transistor Q1, drives the speaker.

A critical component in the circuit is C1, which determines the beat frequency. A ceramic or mylar capacitor would be best here. Though an electrolytic will also work, it will make you lose some of the inherent voltage and temperature accuracy of the circuit.

Construction. Install the components on a 2½-in. x 3-in. piece of perf board, following the layout shown. Then mount the perf board on spacers in a 3 x 4 x 5-in. cabinet. Make a bracket for the 9-volt battery. Cut a hole in the cabinet wall for the speaker, and cover the hole with a piece of speaker cloth or perf board. Mount the speaker with small brackets or attach it with epoxy glue.

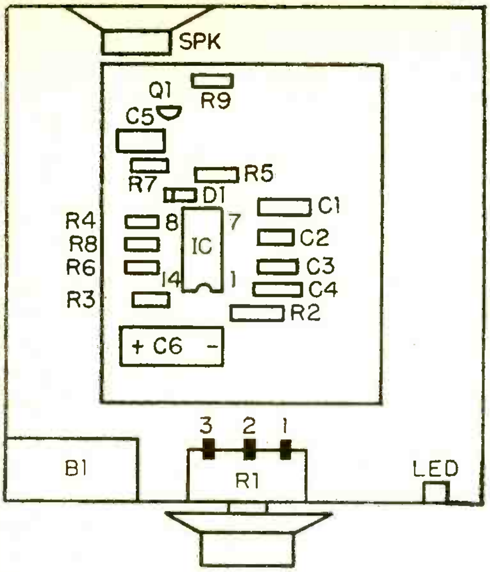
When you're ready to calibrate, use press type or cut out a round piece of white cardboard to make the dial. Mark the beats-per-minute by counting them for sixty sec-



PARTS LIST FOR AN IC METRONOME

B1—9-volt transistor radio battery
C1—2.2 uF capacitor, ceramic or mylar, (Centralab UK225 or equiv.)
C2, C3—0.01 uF capacitor
C4—0.1 uF capacitor
C5—2.2 uF electrolytic capacitor
C6—220 uF electrolytic capacitor
D1—Silicone diode, 1-amp, 50 PIV or better
IC1—Dual IC timer, Signetics or Raytheon type 556
Note: You can use two 555-type IC timers in place of the 556, see text.
LED—Light emitting diode, 20 mA
Q1—npn transistor, Motorola HEP735
R1—500,000-ohm potentiometer, audio taper w/SPST switch
R2, R4—47,000-ohm, ½-watt resistor
R3—68,000-ohm, ½-watt resistor
R5—62,000-ohm, ½-watt resistor
R6—10,000-ohm, ½-watt resistor
R7—68-ohm, ½-watt resistor
R8—82-ohm, ½-watt resistor
R9—3900-ohm, ½-watt resistor
SPK—Small 3.2 to 8-ohm speakers; salvage from discarded transistor radio

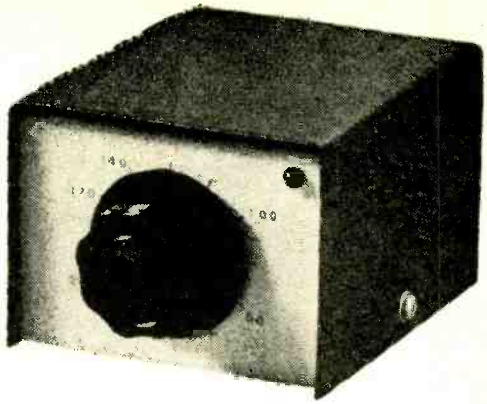
Misc.—Wire, solder, 3 x 4 x 5-in. cabinet, perfboard, knob, etc.



Tempo-set potentiometer R1 drawn in birds eye view above, shows solder lugs facing up. It can be wired as indicated on the schematic so clockwise rotation will decrease tempo, or by moving the lug no. 2 connection from 3 to 1, for increasing tempo.

IC	PIN EQUIVALENTS													
556	1	2	3	4	5	6	7	8	9	10	11	12	13	14
555 (NO.1)	7	6	5	4	3	2	1							8
555 (NO.2)							1	2	3	4	5	6	7	8

The layout shown above is for the single IC version. If you use two 555s, convert from the 556 numbers with the chart above.



A musical tool for budding Beethovens.

onds at various settings of R1, or compare with a well-calibrated mechanical metronome. The range should be between approximately 40 and 210 beats-per-minute. If you would like a different range, change C1 to affect low beat frequencies and R2 for high frequencies. To change the sound of the metronome you may want to vary R6. You may also want to write the musical terms for various beat frequency ranges on the dial. They are:

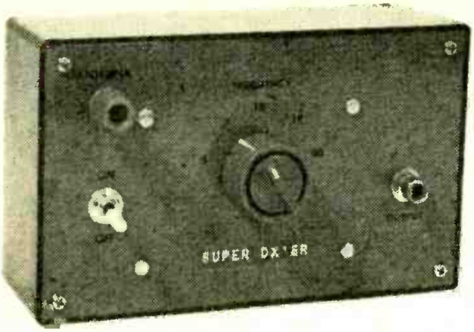
Tempo	Beats/Minute
Presto	208—182
Allegro	182—154
Andante	154—124
Adagio	124—98
Larghetto	98—69
Largo	69—44

Perhaps that tall pyramid-like box which all music teachers once carried in their music case will become a thing of the past following the introduction of electronic metronomes. The old box is up against some stiff competition. ■

☐ Mechanical vs. electronic is not the first controversy surrounding the metronome (originally called the *chronometer*). There is a long-standing duel among musical historians that surrounds the name of the inventor. The actual date of the invention is thought to be around 1815. This is determined by the fact that Beethoven republished eight of his Symphonies in 1817; all were marked with metronome time. In fact, the Eighth Symphony has a series of staccata sixteenth notes in the allegretta movement that are thought to represent the tick of the metronome. Some historians believe it was Beethoven's feeling that no accomplished musician required the use of a metronome; apparently, any orchestra that could properly play the Eighth, was accomplished. It is believed that Beethoven learned of the metronome from his friend Johann Maelzel. However, in some musical records it appears that the actual inventor was one Dietrich Winkel. Whichever of these two gentlemen was actually responsible for the metronome may never be determined, but we're sure he would be pleased with the electronic advancements made to improve his tick-tock wooden pacesetters.

a DX central project

SUPER DXER



Our outboard rig makes QSL waves—
adds 20 dB minimum gain
to any shortwave receiver

CAN YOU REMEMBER back to the early days of TV—back to the mid and late 1940's—when the Jones' who had the only TV in the neighborhood would strain to clean-up a snowy, flickering picture by adjusting a "booster" that sat on the top of their 12-in. phosphor cyclops?

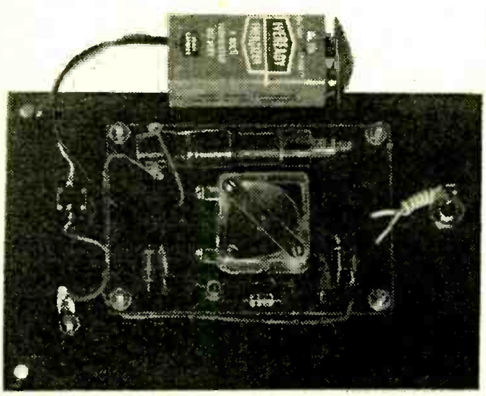
Well, more often than not, those outboard boxes, with their 6J6's in push-pull tuneable circuits, didn't amount to the proverbial hill-of-beans! Those World War II vintage tubes were not well suited to the new-fangled wide-band requirements of TV. But later on as the technology advanced, and more powerful transmitters were built, good, solid pictures became the rule.

Unlike old TV boosters, today a good booster for short wave receivers, a preselector, can be designed with all the advantages of the latest solid-state devices—and, to boot, can be simple and very easy to build. It's the easiest way to turn any receiver into an even hotter signal sniffer. You use a booster (a very high gain RF amplifier) between the antenna and the receiver antenna terminals. A good one will also provide sharp image rejection by adding a relatively hi-Q circuit to the receiver input. Image signals (that often take the pleasure out of receivers with low frequency single-conversion IF amplifiers by jamming desired signals) vanish as if by magic when passed through a hi-Q booster or preselector. In short, a top quality super booster such as the SUPER DXER, will add another dimension of performance to any shortwave receiver.

What It Can Do. The SUPER DXER provides from 20 to 40 dB of signal boost—the exact amount is determined by the particular input characteristics of your receiver. Figuring on 6 dB per S-unit, that's an increase of better than 3 to 6 S-units. In plain terms, the SUPER DXER will bring in stations where all your receiver will pick up running barefoot is its own noise.

The SUPER DXER's input is a diode protected FET (field effect transistor); the protection diodes are built into the FET so that excessively strong input signals, and even static discharges, will not destroy Q1. Since the FET input impedance is many thousands of megohms, there is virtually no loading of the L1/C1 tuning circuit; its "Q" remains high and provides a very high degree of image-signal attenuation.

The SUPER DXER output circuit is a low impedance emitter follower, and it will match, with a reasonable degree of performance, just about any receiver input impedance. As long as your receiver has two



Add an extra 20+ dB gain to your shortwave receiver. Simple kit-of-parts is available. You supply just the outer case and a knob. Note: Wrap J1 ground wire as shown above.

antenna terminals, one "hot" and one ground, you can use the SUPER DXER.

Optimum performance will be obtained if your receiver is equipped with an antenna trimmer. Just as the antenna trimmer peaks the receiver for use with any type of antenna, so too does it add something extra when matching the SUPER DXER.

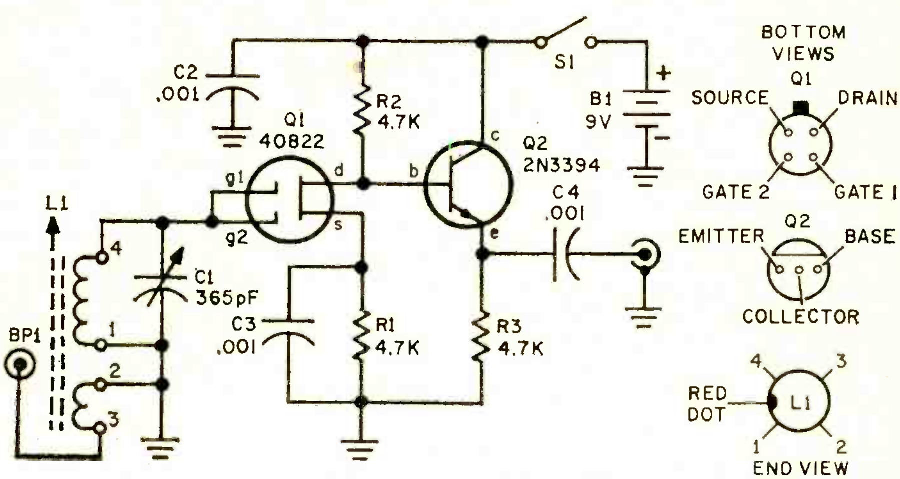
Set Bandpass. The SUPER DXER has a tuning range of slightly more than 3-to-1 between 5 and 21 MHz. That means if the low end is set to 5 MHz, the upper limit will be slightly higher than 15 MHz (3 times 5). If the lower limit is set at 7 MHz, the upper frequency limit will be slightly higher than 21 MHz. Since the slug in tuning coil L1 is adjustable, you can select any operating range between 5 and 21 MHz.

SUPER DXER, though a very high gain device, is absolutely stable if built exactly as shown and described. There will be no spurious oscillations or response. It is possible that changes in the component layout or construction will result in self-oscillation at certain frequencies: hence, make no modifications or substitutions unless you are qualified.

Getting Started. Your first step is to prepare the printed circuit board. Using steel wool and a strong household cleanser such as Ajax or Comet, thoroughly scrub the copper surface of a 2¼-in. x 3¼-in. copper-clad board. Any type will do—epoxy or fiberglass; the type of board is unimportant. Rinse the board under running water and dry thoroughly.

Cover the copper with a piece of carbon paper—carbon side against the copper—and place under the full-scale template we have provided. Secure the PC board in position with masking tape. Using a sharp pointed tool such as an ice pick, indent the copper foil at each component mounting hole by pressing the point of the tool through the template and carbon paper. Next, using a ball point pen and firm pressure, trace the foil outlines on the template.

After all foil outlines have been traced, remove the PC board from under the template and, using a resist pen, fill in all the desired copper foil areas with resist. Make certain you place a dot of resist over the indents at each of the corner mounting holes. Pour about one inch of etchant into a small container and float the PC board—



PARTS LIST FOR SUPER DXER

B1—9-volt battery (Eveready 216 or equal) and connector
BP1—Insulated binding post
C1—365 pF tuning capacitor, subminiature
C2, C3, C4—0.001 uF ceramic disc, 25 VDC or better
J1—RCA type phono jack
L1—5-20 MHz antenna coil, Custom Components SW-520
Q1—MOSFET, RCA 40822
Q2—NPN transistor, 2N3394
R1, R2, R3—4700-ohms, ½-watt resistor
S1—Switch, SPST (power on-off)

A kit of all the above components including the printed circuit board is available from the Electronic Hobby Shop, Box 192, Brooklyn, N.Y. 11235. Price of $22.50 includes postage. New York State residents must add sales tax. No foreign orders. Allow 6-8 weeks for delivery. Postal Money Order speeds delivery.

SUPER DX'ER

copper foil down—on top of the etchant. Every five minutes or so gently rock the container to agitate the etchant. After 15 or twenty minutes check the PC board to see if all the undesired copper has been removed. When every trace of the undesired copper is gone, rinse the board under running water, and then remove the resist with steel wool or a resist "stripper."

Continue. Drill out all the mounting holes marked by an indent with a No. 57, 58 or 59 bit—this includes the corner mounting and C1 mounting holes. Then drill the corner mounting holes for a #6 screw, and use a 5/16-in. bit for the C1 mounting hole.

Install tuning capacitor C1 first. Tuning capacitor C1 should be the type provided in the kit of parts. It has a plastic dust cover and a long shaft. Do not use the type supplied with a short shaft to which a tuning dial for the broadcast band can be attached. Remove the mounting nut and ground washer from C1's shaft. Then make certain the shaft's retaining nut is tight. It is usually supplied loose. Discard the ground washer and secure C1 to the PC board with the mounting nut. Then install tuning coil L1. Make note of two things about L1. The terminal end of L1 has a large *red* dot (ignore any other marks). L1 must be positioned so the red dot faces the bottom edge of the PC board—the edge closest to the coil. Also note that the lug connected to the top of the fine-wire primary is adjacent to the bottom of the heavy-wire secondary. When the red dot is facing the edge of the PC board, both these lugs are against the board. Solder the lugs to the matching holes in the PC board. Use the shortest possible length of wire to connect the remaining primary (fine-wire) terminal to the antenna input printed foil. Connect the remaining L1 terminal (heavy wire) to its matching hole with solid, insulated wire—form a right angle bend in the wire so it doesn't touch L1. Now mount the remaining components.

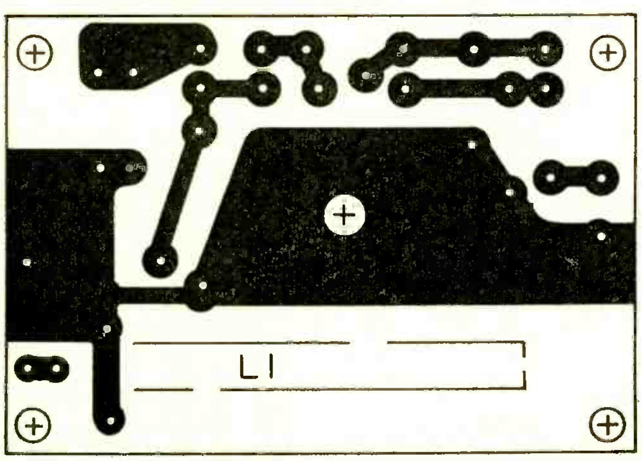
Orienting Q. Note that Q1 is positioned properly when the small tab on the case faces the nearest edge of the PC board. Also note that the round edge of Q2 faces the nearest edge of the PC board. The flat edge of Q2's case should face C1.

Because the printed copper foil faces the front panel when the assembly is mounted in the case, and is therefore inaccessible for soldering, the connecting wires to front panel components should be installed at this time. Solder 6-in. solid, insulated wires to the antenna, output and output ground, and + 9V foils. Solder the negative (usually black) wire from the battery connector to the ground foil.

The SUPER DXER is mounted in a standard plastic or Bakelite case approximately 6 3/8-in. x 3 3/16-in. x 1 7/8-in. The front panel must be aluminum. If the cabinet is not supplied with an aluminum panel, obtain an optional or accessory metal panel. Do not use a plastic panel.

(Continued on page 82)

A kit of all the DXer's components including the printed circuit board is available from the Electronic Hobby Shop, Box 192, Brooklyn, N.Y. 11235. Price of $22.50 includes postage. New York State residents must add sales tax. No foreign orders. Postal Money Order speeds delivery to your doorstep.



Exact PC board size. Transfer image to copper clad board using carbon paper. This is the bottom (copper) side of your board. Mount it to the front panel with 1/4-in. spacers between board and panel at each mounting screw. Secure the battery to the back of the cabinet with tape.

SUPER DX'ER

(Continued from page 80)

Drill a 3/8-in. hole in the center of the front panel. Position the PC assembly over the hole with C1's shaft fully inserted through the hole, and mark the locations for the four PC board mounting screws. Drill the panel and temporarily secure the PC board to the panel. Then locate the positions for power switch S1, antenna input binding post BP1 and output jack J1. Make certain J1 is as close to the PC board output terminals as is possible—within 1½-in.

Remove the PC board and drill the holes for the panel components. Power switch S1 can be any inexpensive SPST type such as a slide switch. Install the panel compon-

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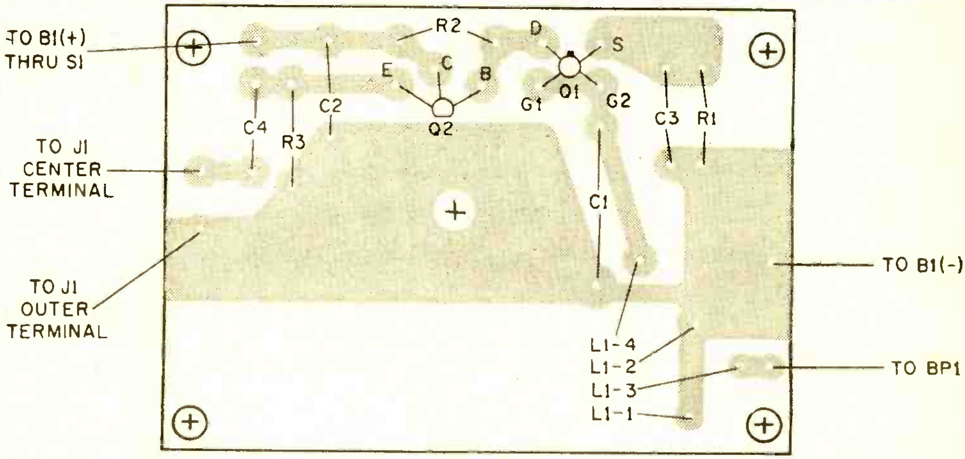
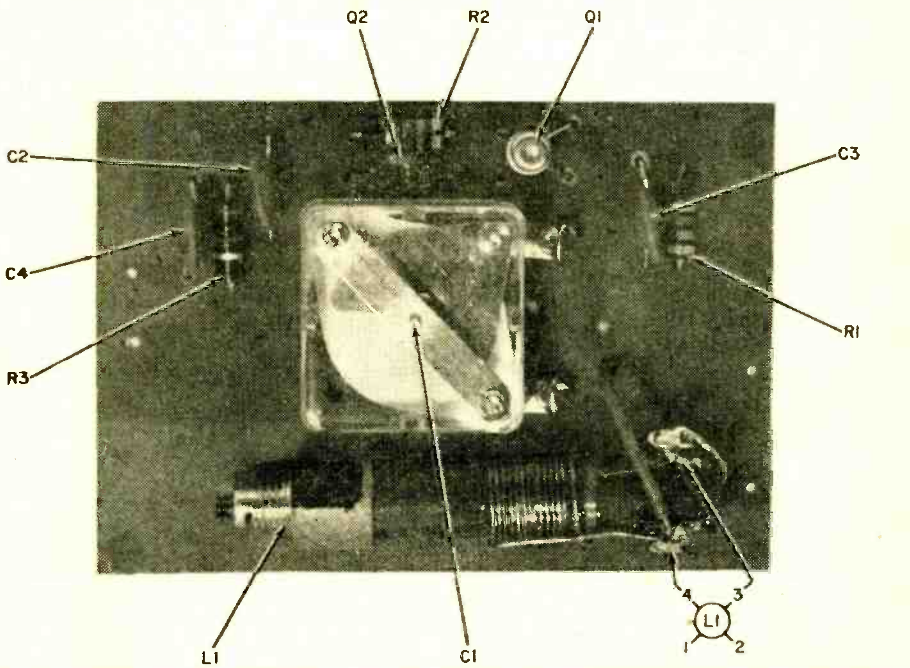
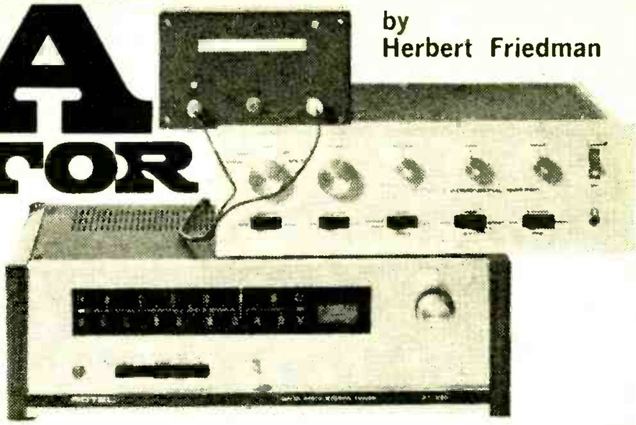


For exact part placement on PC board, see diagram above. View is from component (top) side of your Super DXer board. Layout below shows a completed Super DXer. Pins 3 and 4 of the dual winding coil L1 are shown in an end view for clarity.



SUPER SCA ADAPTOR



by
Herbert Friedman

Hot Enough For DXing

You can build a Super SCA detector that's powerful enough for DXing! It's a two-IC circuit in an *amplifier* and *phase locked loop* detector configuration. And it's superior to many other PLL detector circuits because it has an IC amplifier to boost and *lift* the relatively weak 67 kHz subcarrier signal from the FM signal. That makes it a must for fringe areas.

But let's go back to what SCA is. When a Subsidiary Communication Authorization (known as SCA) is granted to an FM station by the FCC, that station is permitted to transmit a second program *in addition* to its regular program by a special method of modulation. A standard FM radio, even a stereo radio, cannot detect these special broadcasts. The regular listening audience hears only the standard mono or stereo programming. In fact, there is no way of even telling whether or not a station engages in SCA programming. That is, not without a special SCA adaptor that you can build!

If you think you'd like to tune to these hidden broadcasts, we've provided this special project. Special because its high sensitivity permits reception of SCA signals that other low cost adaptors miss.

What You Can Hear. For some time now, SCA has been used to transmit educational programs and continuous weather reports to specialized audiences; however, it is *primarily* used for background music—the type heard in restaurants and shopping centers. For example, in the New York City area there are FM stations with SCA programming in light popular music, while others specialize in music of India and Greece. Best of all, this pleasant, interesting music is never interrupted by an endless barrage of commercials or the patter of an announcer in love with his own voice.

How it's done. SCA programming is transmitted by a 67 kHz FM sub-carrier that is impressed on the main FM carrier. When a station broadcasting SCA is received by a standard FM tuner, the SCA sub-carrier is simply wiped out—the listener has no idea it exists. To receive SCA, the FM tuner's output is usually passed through a filter that wipes out everything except the SCA sub-carrier and it's modulation. When the sub-carrier is demodulated, the output is only the SCA program; to the SCA listener, the standard programming doesn't exist.

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 carrier is only 10% of the total FM signal.) Though many low cost SCA

Adaptor above is teamed with Rotel RT-620 AM/FM tuner and Dynaco SCA-80Q amplifier

SUPER SCA ADAPTOR

adaptors have been available in project or wired form, most had a tendency to burp, gargle or distort on the very weak signal level of the SCA.

While the radio-astronomy crowd had a great weak-signal detector known as the phase locked loop, it was also true that the astronomical phase lock detector was astronomical in price. But thanks to modern solid-state techniques, the Signetics Corporation has come up with a phase locked loop detector specifically intended for SCA detection that is priced well under ten dollars.

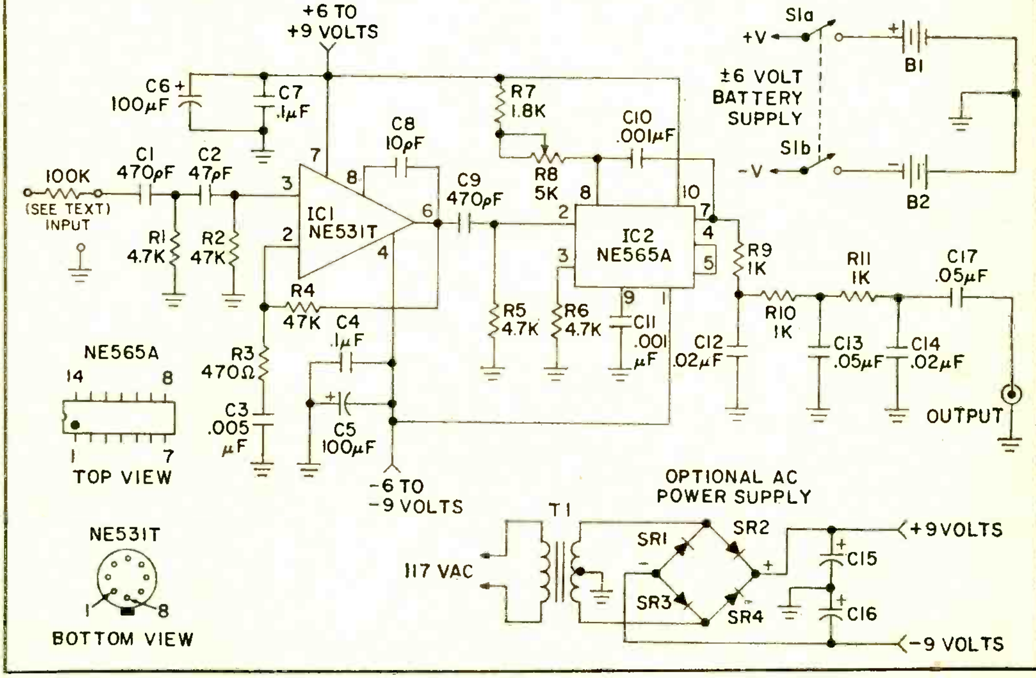
Available in the standard 8 pin round and 14 pin DIP IC packages, the Signetics SE/NE565 requires virtually no external hardware for SCA detection. Most important, since the phase lock detector automatically locks on the incoming SCA carrier frequency, the Signetics SE/NE565 will demodulate SCA subcarriers of either 65 kHz or 67kHz without adjustment; whichever subcarrier frequency the broadcasting station uses will be received equally

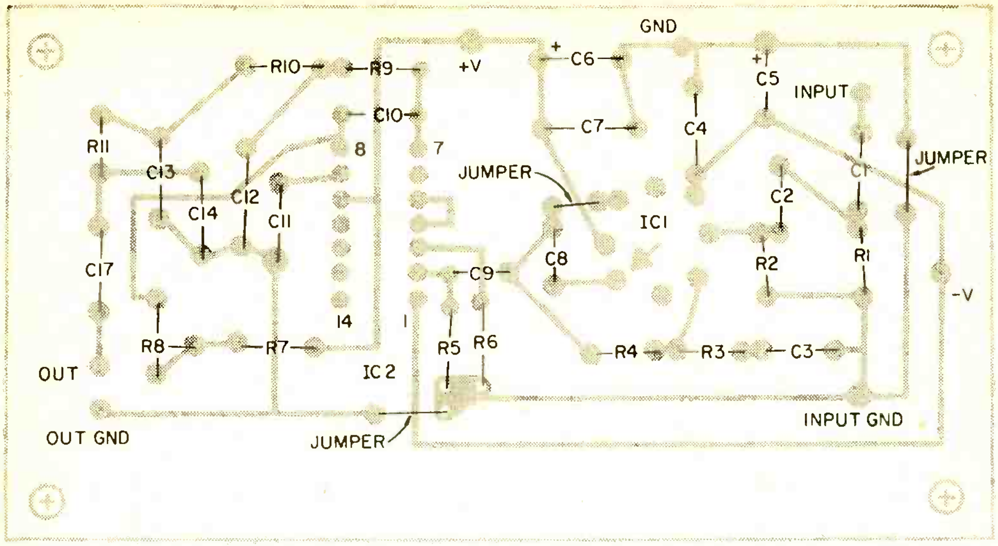
PARTS LIST FOR SUPER SCA ADAPTOR

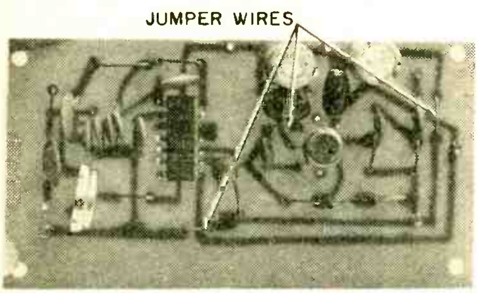
B1,B2—6-volt battery, RCA VS068 or equiv.
C1,C9—470 pF disc capacitor, 15 VDC or better
C2—47 or 50 pF disc capacitor, 15 VDC or better
C3—0.005 uF disc capacitor, 15 VDC or better
C4,C7—0.1 uF disc or Mylar capacitor, 15 VDC
C5,C6—100 uF electrolytic, 15 VDC or better
C8—7 or 10 pF disc capacitor, 15 VDC or better
C10,C11—0.001 uF disc or Mylar, 15 VDC
C12,C14—0.02 uF disc, 15 VDC or better (see text)
C13,C17—0.05 uF disc or Mylar, 15 VDC or better
C15,C16—2000 uF electrolytic capacitor, 15 VDC or better
IC1—Integrated circuit amplifier, NE531T (Signetics). Write to Circuit Specialists Co., Box 3047, Scottsdale AZ 85257 for IC prices.
IC2—Integrated circuit PLL, NE565A (Signetics)
R1,R5,R6—4700-ohms, ¼-watt resistor, 5%
R2,R4—47,000-ohms, ¼-watt resistor, 5%
R3—470-ohm, ¼-watt resistor, 5%
R7—1800-ohm, ¼-watt resistor, 5%
R8—5000-ohm potentiometer, PC board mounting
R9,R10,R11—1000-ohms, ¼-watt resistor, 5%
SR1 to SR4—Silicon diodes, HEP-154 or equal
S1—Toggle or slide switch, SPDT
T1—Small filament transformer, 12.6 volt center tapped

Misc.—6 x 3½ x 2-in. case, printed circuit material, etchant, RCA phono jacks, push-in clips, hardware, wire, solder, etc.

The printed circuit board for the Super SCA project is available direct from Electronics Hobby Shop, Box 192, Brooklyn NY 11235 for only $6.50 (includes postage and handling). New York state residents must add sales tax. No foreign orders, please. Postal money orders will speed delivery of Super SCA PC board. Otherwise allow 6-8 weeks for delivery.







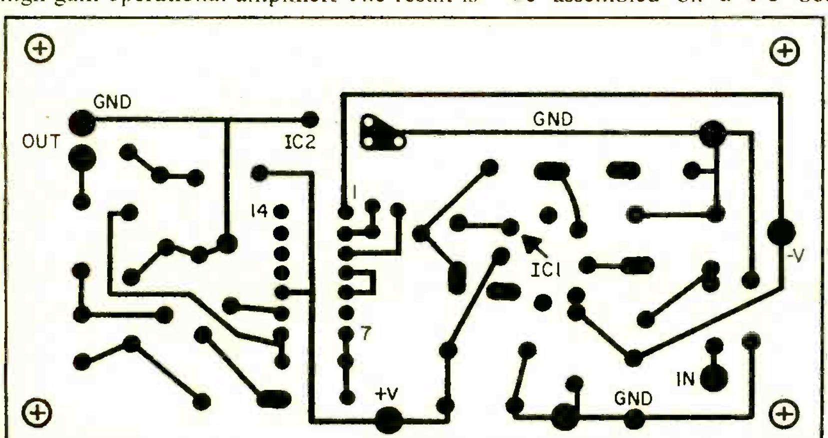
Strong backlighting, left, shows printed circuit wiring through a completed circuit board. Layout above and photo on next page show where to place components.

well with this unit.

Combination Gets Results. Unfortunately, the phase lock detector requires at least 80 mV for good reception, and this means that usually only one or two stronger or local SCA stations can be received. To make our SCA adaptor the best there is, we have combined the phase lock detector with a high gain operational amplifier. The result is a Super SCA Adaptor that can receive SCA programs on a real cheap FM tuner and an indoor rabbit-ear antenna.

Another plus feature for our Super SCA Adaptor is that no large filter coils are needed to suppress the main channel program. Even SCA programming on stereo stations is received cleanly and with no trace of stereo hash. And because large, bulky coils are not needed, the entire adaptor can be assembled on a 2 ¼-in. x 4 ¼-in. printed circuit board for which we provide the template.

Because our adaptor gain is high, it must be assembled on a PC board exactly as



Exact PC board size. Transfer image to copper clad board using carbon paper. This is the bottom (copper) side of your board.

described to insure complete stability.

Some Tech Talk. The signal from your FM tuner's detector before de-emphasis is applied to operational amplifier IC1 through a high pass filter consisting of C1, C2, R1 and R2. The filter's rollover frequency is 60 kHz, which removes a substantial part of the main channel information. Frequency response of the amplifier is tailored by the feedback loop through R3 and C3 to further supress main channel information. IC1's output is fed through high pass filter C9 and R5 to IC2, the phase lock loop detector. IC2's output is passed through a low pass filter consisting of C12, C13, C14, R9, R10 and R11 which provides de-emphasis and noise supression. The output level at C15 is about 50 to 100 mV, depending on the signal, and can be fed to your hi-fi or utility amplifier.

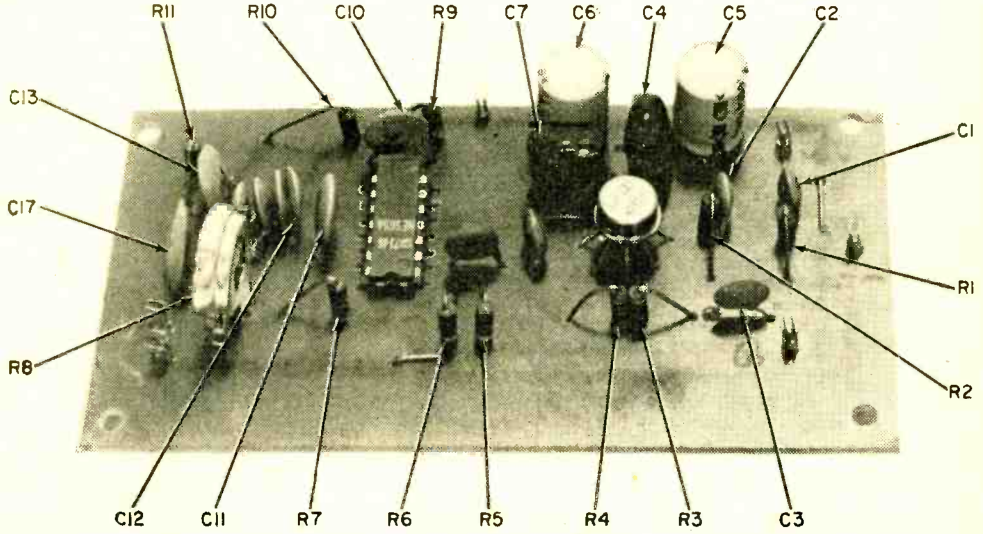
Since SCA frequency response is limited to 7 kHz, just about any amplifier can be used.

Note that the adaptor requires a bi-polar power supply in the range of ±6 to ±9 volts. The power supply can be either batteries or a power line bridge rectifier using a center-tapped 12 volt filament transformer as shown on the schematic. Since the adaptor requires only about 10 mA of current, any small transformer can be used.

How to Etch a Circuit. Your first step is to prepare the PC board. Since the board must be precise, we suggest you work directly from the supplied template rather than through an intermediate tracing. Cut a section of any type copper clad board to 2 ¼-in. x 4 ¼-in., clean the copper surface with a strong household cleanser such as Ajax or Comet and place a piece of carbon paper, carbon side towards the copper, on the board. Tape the board under the template and, using a sharply pointed tool such as a scribe, indent the copper foil at each component mounting hole by pressing the point of the tool through the template into the foil. (Each indent will serve to mark the hole's location when the board is drilled.) Using a ball point pen and firm pressure, trace the outline of the foil areas.

Continue. . . Remove the board from under the template, discard the carbon paper and, using a resist pen such as the Kepro RMP-700, available from Allied Radio, fill in the foil areas with resist. Note that some of the IC1 and IC2 pins are not used, though they must pass through the board. Place a drop of resist over the indents so you'll know where to drill after the unwanted copper is etched away. Similarly, mark the indents at the corner mounting hole locations. Make certain you mark IC1 terminal number 8; you can use a drop of resist.

Immerse the PC board under at least ¼-in. of etchant for about 45 minutes and then inspect the board. If all the unwanted



Completed circuit board. Resistor R8 easily adjusts frequency of PLL to 67 kHz.

copper has not been etched away, re-immerse the board in five minute intervals until all the copper not protected by resist has been removed. Then rinse the board under running water and remove the resist by scrubbing briskly with a steel wool pad such as Brillo.

Using a #56 drill bit, drill the holes for the connecting terminals (push-in terminals) and trimmer potentiometer R8. Drill the corner mounting holes to clear a #4 or #6 screw and drill the remaining component holes with a #58, #59 or #60 bit.

You Can Buy the Board. You don't have to make a printed circuit board for the Super SCA—you can buy one. The Electronics Hobby Shop is offering the PC board completely etched ready for drilling and assembly. This beats trying to copy the author's board layout exactly, and the mess and expense of etching copper.

Mount the Components. Install IC1 and IC2 before any other components. Note that the IC1 lead opposite the case tab is number 8. Insert the leads (begin with number 8) and push IC1 toward the board until there is about 3/8-in. between IC1 and the board. Solder the wires and cut off the excess.

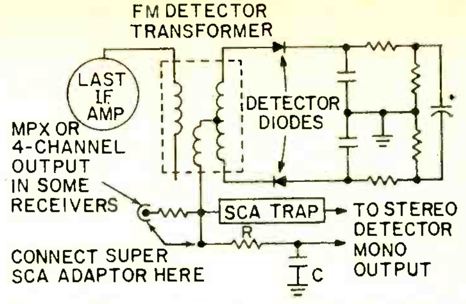
Hold the PC board so you are looking at the top with IC1 to the left. Hold IC2 so the notch is away from you and insert IC2's leads into the matching holes. *Doublecheck the notch before soldering.* It is correct if the distance from the notch to the edge of the PC board is greater than that of the unnotched end to the opposite edge of the PC board. If all is okay, solder IC2.

Install trimmer potentiometer R8 and solder. Make certain you use sufficient soldering heat to flow solder to R8's terminals.

Then install the three wire jumpers and, finally, the remaining components taking extreme care that 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 are not the easiest to obtain in miniature size. You can substitute two parrallel-connected 0.01 uF capacitors. Simply twist their leads together and insert them into the matching holes. Do not tin the twisted leads prior to soldering as they will not fit into the holes if tinned.

Set-up and Checkout. Either a bi-polar battery power source or a standard bi-polar power supply can be used. Since there is



Always connect SCA adaptor before de-emphasis network R, C as shown above. Most tuners, receivers do have an MPX jack for a home SCA, or 4-channel use.

essentially no difference in performance between a ±6 V and ± 9 V power supply, use whatever you have available. For long-term battery life we suggest Burgess type Z4 6 volt batteries (or their equivalent).

The Super SCA adaptor connects to your mono FM tuner or receiver detector *before* the de-emphasis. If you connect after the de-emphasis network, you will find the 67 kHz subcarrier has been filtered from the signal, so you will get nothing but noise from the adaptor. The figure shows a typical FM detector output, the de-emphasis network and the correct connecting point for the adaptor. Since it is possible the adaptor might load down the detector for normal FM reception, we suggest a switch be installed, so the adaptor can be removed from the circuit for normal FM listening.

The adaptor is most conveniently connected through a phono jack installed in the tuner's rear apron, though you can use a direct wire connection.

Note that if you have one of the older mono FM tuners with an "MPX output" you already have the correct connection as the MPX output is the non de-emphasized detector output. Similarly, if you have a modern FM Stereo tuner with a "4-channel decoder" or a "quadrasound decoder" output you also have the correct connection; they are also non de-emphasized detector outputs.

Connect the tuner's detector output to the adaptor with the shortest possible length of shielded cable or ordinary zip cord, or install the adaptor directly in the receiver if there is sufficient room. Connect the adaptor's output to any high gain amplifier; for example, the microphone input of your hi-fi amplifier, or a utility amplifier is fine, or maybe an old tape recorder. *(See page 88)*

R8 Locks Loop. Tune in a station you know is transmitting an SCA program (a call to your local station should get you the info.) and adjust trimmer potentiometer R8 for best sound quality. Normally, the reception will be almost completely garbled, then fade into a clean signal as R8 is adjusted, then fade into garbling again as R8 is further adjusted. Set R8's wiper so it is approximately midway between the two points of garbled sound. Usually, the best sound will occupy a broad part of the R8 adjustment range, so don't try to be too fussy.

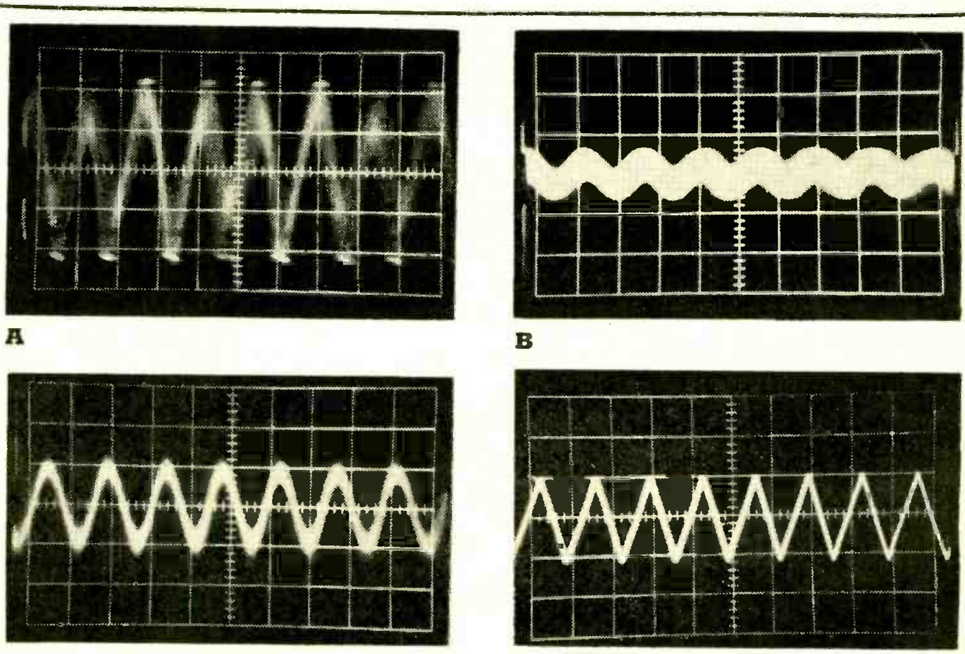
If you don't know which station(s) are transmitting SCA, set R8 to the mid position and tune every station very carefully and slowly. When you hear anything that sounds like distorted music, try adjusting R8; if it is real SCA, it will turn *clean* as R8 is adjusted. Some stereo stations might cause sound bursts that you think are SCA. If adjusting R8 doesn't bring in a clean signal, it's not SCA. Note that once R8 is adjusted there is no stereo hash interference on SCA signals. Hash will only be heard from non SCA signals.

Problems? The high sensitivity of this system may require desensitizing procedures: in the event you cannot receive *any* SCA stations, you either have none in your area or you have made a construction error. If the non-SCA program from the tuned-in station is heard breaking through the SCA programming, follow the suggestions in our troubleshooting box. If your adaptor doesn't work at all, beg, borrow or steal an oscilloscope and check input and output waveforms as shown in the scope photos. Just be sure to return the scope so we don't get in trouble with John Law for inciting a felony!

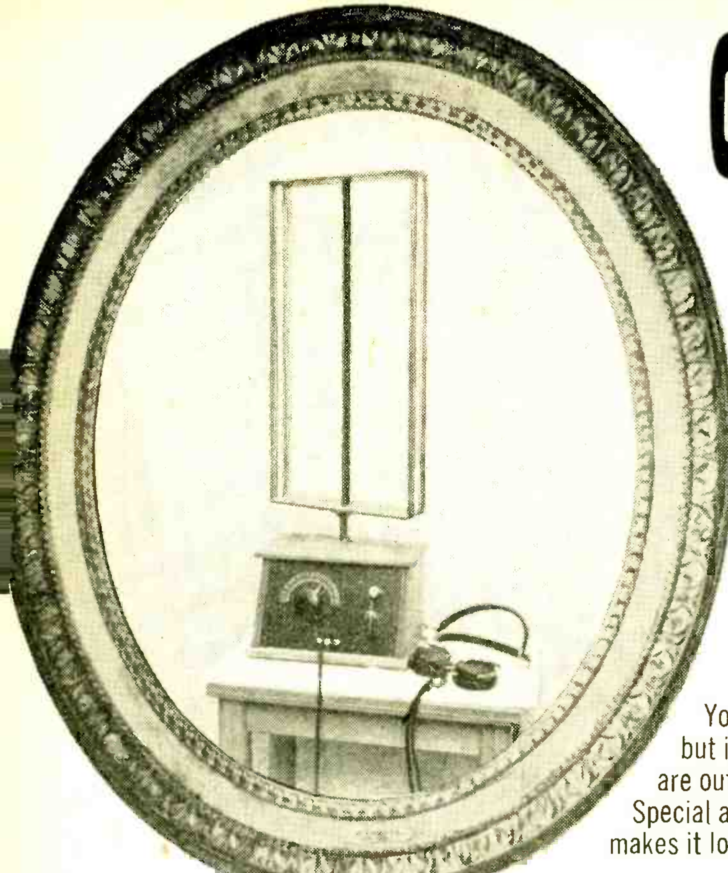
What's Your Beef? Here are some hints to help you steer clear of trouble—straight toward your musical enjoyment and SCA DXing!

☞ *If your problem is a weak signal re-*

(Continued on page 109)



Oscilloscope patterns quickly locate 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 10 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 cures. Normal IC2 pin 9 waveform at D. Vert. sens: B, 20mV/cm; C, 1V/cm.



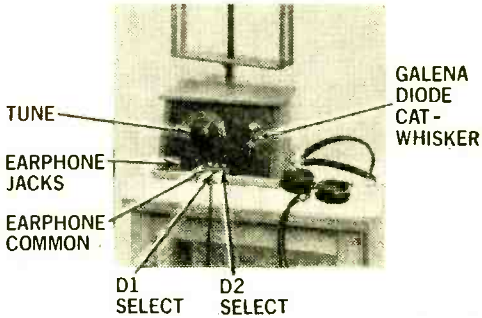
OLD-TIME FLAVOR CRYSTAL RADIO

You build this radio with new parts, but its circuit and operation are out of the past. Special attention to cabinetry makes it look the part, too!

by Art Trauffer

HERE'S a crystal radio that needs neither a long wire antenna, nor a wire to the water pipe for a ground. A large coil of wire on top of the radio doubles as both a tuning coil and an antenna. This radio is quite selective because the loop antenna is center-tapped and directional—you can aim the loop at the desired station, thus reducing interference from some of the other stations. This radio looks as though it was made in the early 1920s and is quite a conversation piece; and, it will fit nicely in your home or your school museum. As for performance, I have no trouble separating the six Council Bluffs and Omaha stations. Using a sensitive crystal and a pair of sensitive high-impedance earphones, I can even hear station KMA, Shenandoah, about 45 airline miles from my home—not bad for a crystal radio having no conventional antenna and ground!

Remember the Loop? Simply stated, when the loop lies in the *same* plane as the incoming signal wave, that is, pointing toward the radio station, maximum induction takes place in the loop. The current induced by the electrical field in the side of the loop pointing toward the station is *ahead* of the current induced on the opposite side of the loop; thus, a current will flow around the loop as a result of the two induced signals.



This showpiece project actually works! Tune in to the AM broadcast band in an authentic twenties style. Two diodes make tuning easy.

Crystal Radio

When the plane of the loop is at *right angles* to the station, all points of the loop will be reached by the wave at the same instant, so the induced voltages on both sides of the loop will be equal but opposite in direction and therefore will neutralize, or cancel out.

The loop has less static pickup than a long wire antenna, and there is no lightning worry. The loop is highly directional, and thus more selective, and it lets you tune out interfering stations located at right angles to the desired station, even when both stations are on the same wavelength or nearly so.

Who Invented the Loop? No one man can be given credit for inventing the loop antenna. Here's how it happened. Many early "wireless" experimenters noticed that they could faintly hear signals from near-by wireless stations even with the antenna and ground disconnected, and that the signals were loudest when the tuning coil in the receiver was positioned so that the turns of wire in the coil were in the direction of the station. So they figured that the coil itself was picking up RF energy from the station, and if they made the coil larger in diameter, the pickup would be increased. Thus the coil would act as both an antenna and a tuning coil. It wasn't practical to wind coils on large tubular coil forms, so they built large wood frames to wind their coils. So that's how the loop antenna came to be!

Bill of Materials for Crystal Radio

Material for Cabinet

Top—9¾-in. x 5¼-in. x ½-in. walnut, mahogany, or oak.

Bottom—9¾-in. x 7¼-in. x ½-in. hardwood.

Sides—½-in. hardwood about 4⅞-in. high x 4⅞-in. at top sloping to 7-in. at bottom. 2-pieces required.

Back—8-in. x 4⅞-in. x ½-in. hardwood.

Front—8-in. x 5¼-in. x ⅛-in. black non-metallic panel (Plexiglas, Formica, hard rubber, Bakelite, or composition board covered with black contact paper.)

Strips—12-in. length of ½-in. hardwood.

Misc.—Nails, screws, wood glue, sandpaper, wood stain, etc.

Material for Loop

One 22-in. length of ½-in. diameter wood dowel for loop upright

One 3-conductor ¼-in. stereo phone plug (Radio Shack 274-139 or equiv.)

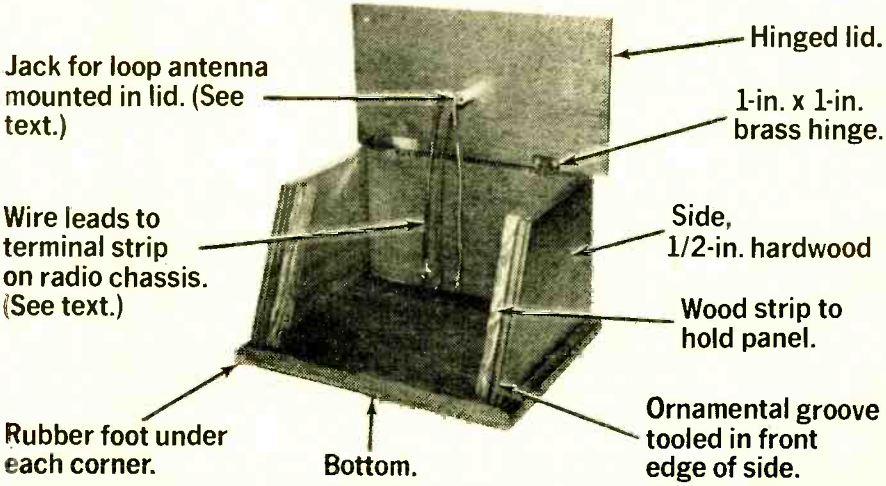
One 3-conductor ¼-in. stereo phone jack (Radio Shack 274-141 or equiv.)

Two pieces 9 ½-in. x 2¾-in. x ¼-in. hardwood to match cabinet wood, if possible, for loop cross-pieces.

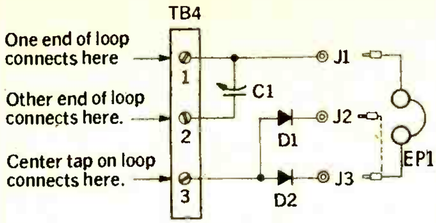
One 5-in. x ½-in. x 1/16-in. brass strap for making U-bracket.

Misc.—Hook-up wire, solder, wire for loop antenna (Author used about 100-feet of AC-DC Radio Antenna Wire made by White Electric Cable Co., Haverstraw, NY, or he also suggests Belden 8014 Indoor Antenna Wire.)

Constructional Details. A photo gives details for the wood cabinet which features a hinged lid and a slant front, like many cabinets in the early days. I used ½-in. mahogany, and after the pieces were cut to size



You who know an auger from a brace-and-bit can duplicate the fine hand-crafted workmanship shown in the author's model. This matching of woodworking and electronics gives you a "period piece" suitable for home display.



PARTS LIST FOR OLD-TIME CRYSTAL RADIO

C1—365 uF variable capacitor

D1—Germanium diode, 1N34

D2—Detector diode, galena-and-cat-wisker-type and stand. (Modern Radio Labs type K/D 9-14 stand and 9-1 crystal: Modern Radio Labs, 1477-G, Garden Grove, CA, 92642)

EP1—2000-ohm earphones

J1, J2, J3—Standard phone-tip jack (Radio Shack 274-724 or equiv.)

TB1—Terminal strip with 3 screw-type terminals

Misc.—Wire, solder, lugs, hardware, dial scale and tuning knob (Black fluted tuning knob used by author is Burstein-Applebee 12A34. Author can supply a photo reproduction of an old-time, 0-180 dial scale used in this project for 75¢ and a self addressed stamped envelope; one scale to a customer, please. Send to Art Trauffer, 120 Fourth Street, Council Bluffs, IA, 51501.)

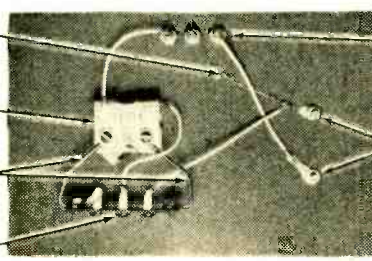
they were sanded smooth and put together using wood screws and small nails and Sears Hide Glue. I used walnut satin, but you may prefer dark mahogany stain.

Photographs give most details for the simple receiver; all parts are mounted right on the panel. The black non-metallic panel (like the early days) can be ⅛-in. Plexiglas, Formica, hard rubber, or Bakelite. If you have trouble getting any of the above, use ⅛-in. composition board and cover the front side with black contact paper.

If your variable capacitor (C1) has no mounting hole on the front side of the frame, you will have to drill and thread a hole for a 6-32 x ¼-in. flat-head screw, or simply glue the capacitor to the back of the panel using a good all-purpose cement.

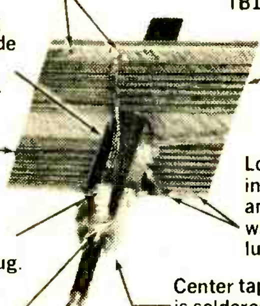
As stated in the materials list, you can get your galena-and-cat-whisker crystal detector stand from MRL in Garden Grove, California, and also a steel galena crystal. Black fluted tuning knobs are still available and these look much like the knobs of the old days. Make a metal pointer and cement it to the underside of the knob, as shown. The curved metal panel-mounted dial scale, calibrated 0 to 180, is no longer being made, so I made photo reproductions printed on double-weight paper which can be cut out with a pair of scissors and cemented onto the panel. If you want a scale check the parts list for more information.

Note that three phone tip jacks are provided on the panel. When you get tired of hunting for a sensitive spot on the crystal you simply plug one of the phone cord tips



Above—The schematic diagram at the top of the page is so simple you can't go wrong unless you really try! Photo of wiring on back of front panel is above. Fixed detector diode D1 eliminates hunting for that "sensitive" spot on the galena crystal, but sensitivity with fixed diodes is usually lower.

Below— Phone plug serves as both a swivel-point and three circuit electrical connector.



Crystal Radio

in the germanium diode jack. The germanium diode is the only modern feature used in this old-time radio.

Making Your Loop. Photos give most details for making the plug-in type loop antenna. Note in the illustrations that one end of the loop wire goes to the frame of the 3-conductor stereo plug, which goes to the frame of the 3-conductor stereo jack, which goes to the frame of the variable capacitor (C1). The other end of the loop wire goes to one of the other lugs on the phone plug, and the center tap on the loop goes to the remaining lug on the phone plug. It is then an easy matter to get your leads right, going from the phone jack to the three-terminal strip by experiment.

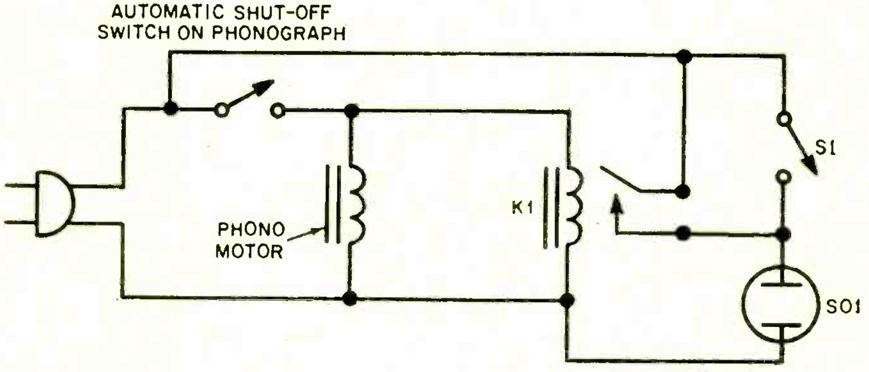
The wood frame of the loop can be stained to match the cabinet, or you might like to paint the wood dowel upright black to match the black radio panel as I did.

For winding the loop antenna I used *AC-DC Radio Antenna Wire* made by White Electric Cable Company, Haverstraw, N.Y. This is a flexible (13 strand) wire having a beautiful brown woven insulation and looks much like the loop antenna wire used in the early days. If you cannot obtain this, try Belden 8014 Indoor Antenna Wire which is very similar (see materials list).

For best results from this radio use the most sensitive germanium diode and galena crystal, and the best high-impedance magnetic earphones you can get. ■

Automatic Hi-Fi Shutoff

It happens to just about everyone. One minute you're listening to the hi-fi, the next you're called away to answer the doorbell or a phone call. You forget all about the music, the record plays through, the automatic turntable shuts off—but the amplifier stays on until you happen to pass by and notice the glow from the pilot lamps. Yet, this simple circuit, which you can throw together in less than an hour, will automatically turn off the amplifier when the turntable shuts off. The relay coil voltage is taken from across the phono motor; when the turntable motor is on, relay K1 closes and applies power to AC socket SO1; when the turntable shuts off, removing voltage from the motor, K1 opens, disconnecting power from the outlet. Because the turntable automatic shutoff switch might not be able to carry the amplifier load, the AC power for SO1 is taken off before the automatic shutoff switch. Switch S1 bypasses the relay contacts and applies power to the socket even when the turntable is off. ■



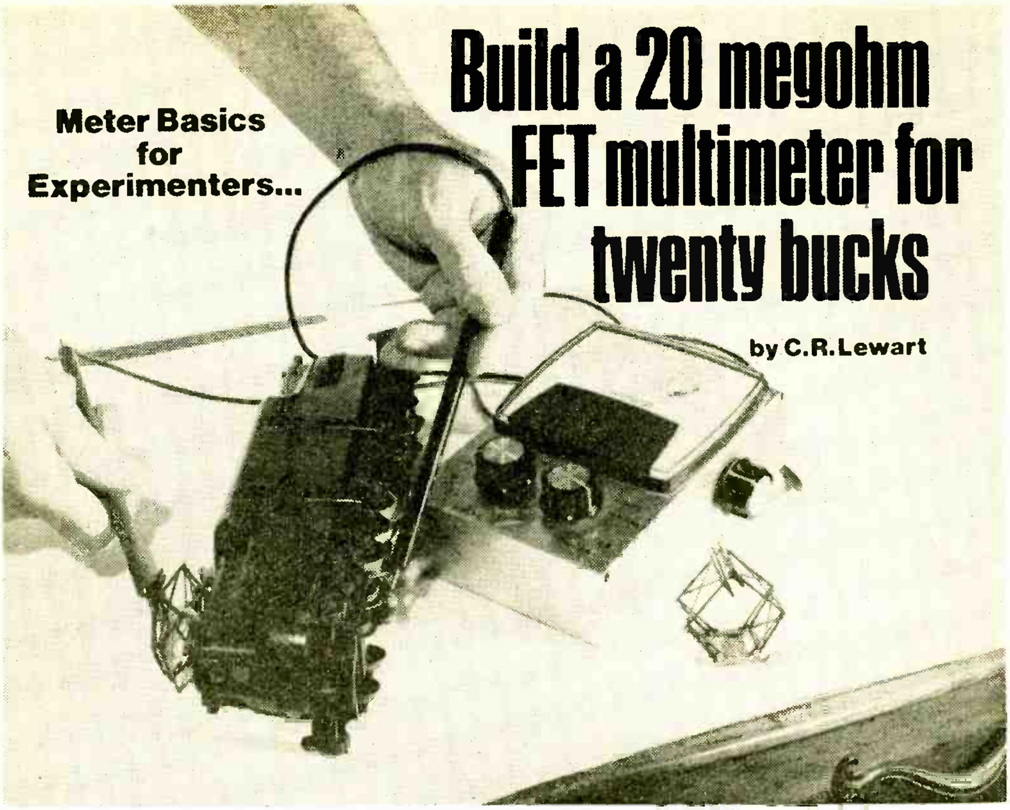
PARTS LIST FOR AUTOMATIC HI-FI SHUTOFF

K1—117 VAC relay with contacts rated at least 5 amperes at 117 VAC (Calectro D1-980 or equiv.)
S1—Switch, SPST (shutoff bypass)
SO1—AC socket (Calectro F3-100)

Meter Basics for Experimenters...

Build a 20 megohm FET multimeter for twenty bucks

by C.R.Lewart



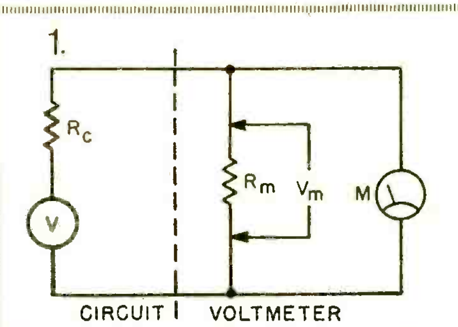
Discover valuable multimeter theory while you build this useful shop tool!

☐ THIS PROJECT IS A MODERN VERSION OF the VTVM of yesteryear—a battery operated field effect transistor volt-ohm meter with a very high (20 megohm) input resistance on all ranges. The cost of this project should be around $20—about what you can spend on a run-of-the-mill volt-ohm meter. Accuracy of this experimenter's meter may not be as great, however, since costs have been kept low by specifying 5 and 10 percent resistors.

A meter like the one shown can be built with features such as high input resistance on all ranges, polarity reversal switch, protection against meter over-voltage on all ranges, long battery life, and 1 percent resistors in the range divider for greater accuracy. Plus, this meter has been designed for up to ten voltage and four resistance ranges, but it can be built with fewer ranges and only one function (voltage or resistance measurements) if you wish.

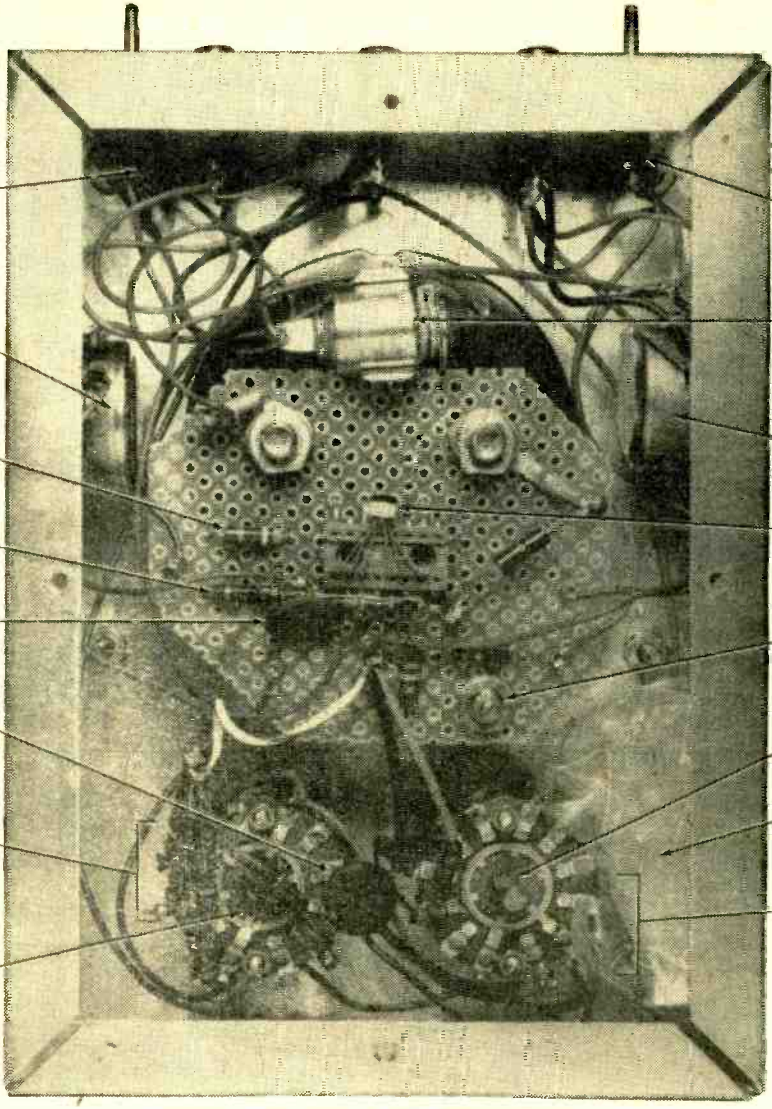
What Is Meter Resistance? No matter what circuit you are measuring, figure 1 describes what you are doing.

There is a voltage (V) which you are trying to determine. The resistance (RC) of the circuit can be anything from a few tenths of an ohm (a fresh battery) to several megohms (the grid circuit of a tube). RM is the resistance of the voltmeter. What you are actually measuring is VM which can be very close or very far from V depending



This is what actually happens. Voltage "V" to be measured is divided across a series resistor set Rc and Rm. See text.

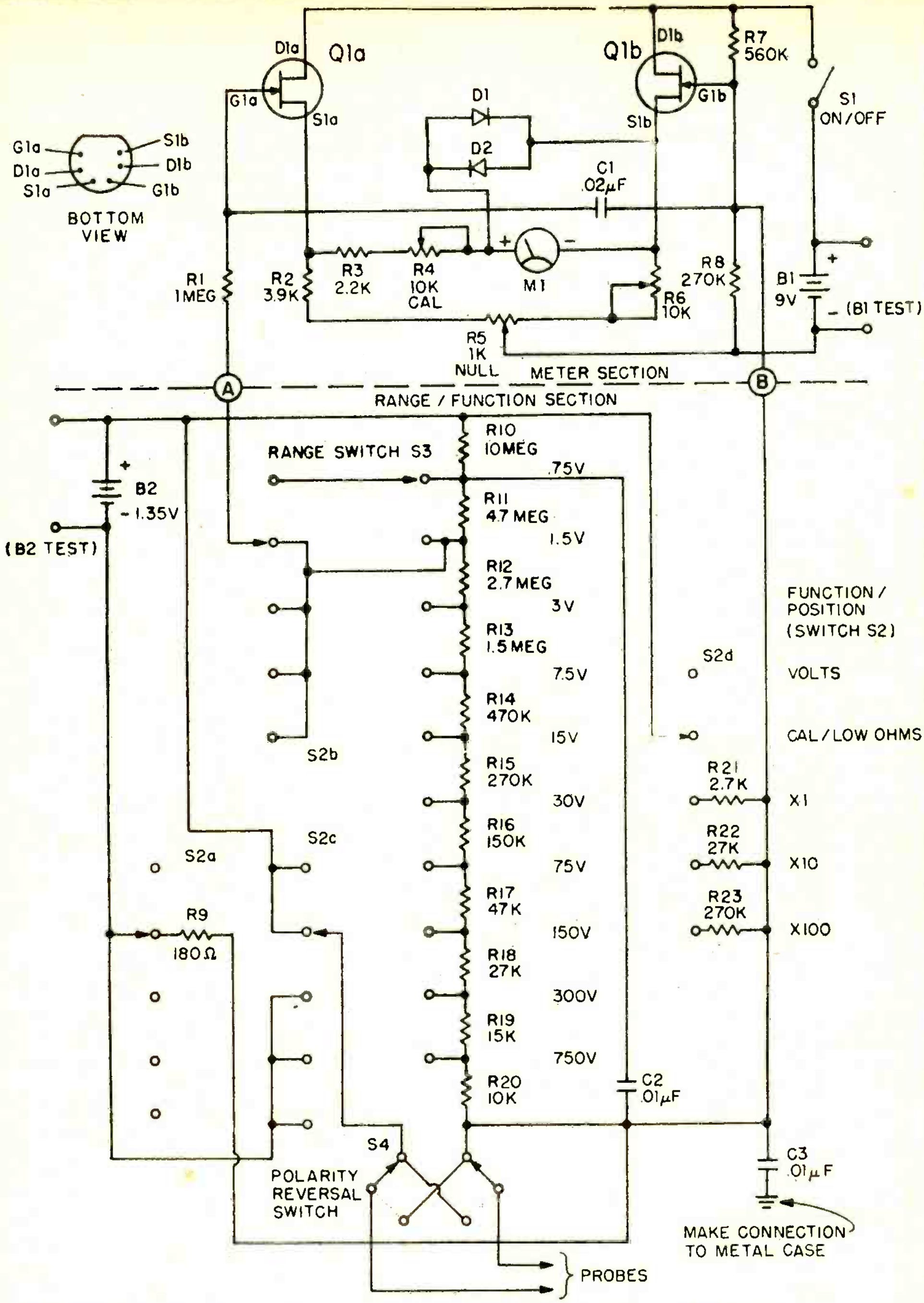
FET Multimeter



PARTS LIST FOR A FET MULTIMETER

B1—9-volt battery, 2U6-type (Radio Shack 23-464 or equiv.)
B2—Mercury cell, Mallory RM640 or equiv. (Radio Shack 23-1515)
C1—0.02 μF capacitor, 100 VDC or better (Radio Shack 272-1056 or equiv.)
C2, C3—0.01 μF capacitor, 600 VDC or better (Allied Electronics 926-6895 or equiv.)
D1, D2—Silicon diode, general purpose type such as 1N914 (Radio Shack 276-1101 or equiv.)
M1—50 to 100 μA full scale meter (see text)
Q1a, Q1b—Dual FET (Calectro K4-636)
R1—1 meg, ½-watt resistor (Radio Shack 271-000 or equiv)
R2—3900-ohm, ½-watt resistor
R3—2200-ohm, ½-watt resistor
R4, R6—10,000-ohm potentiometer, linear taper (Radio Shack 271-1715 or equiv.)
R5—1000-ohm potentiometer, linear taper
R7—560,000-ohm, ½-watt resistor
R8, R15, R23—270,000-ohm, ½-watt resistor
R9—180-ohm, ½-watt resistor
R10—10 meg, ½-watt resistor
R11—4.7 meg, ½-watt resistor

Note: **All ½-watt resistors can be Radio Shack 271-000 series; specify value when ordering under this number.**



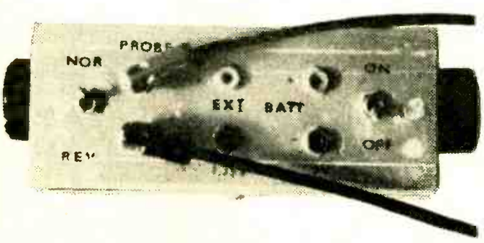
R12—2.7 meg, ½-watt resistor
R13—1.5 meg, ½-watt resistor
R14—470,000-ohm, ½-watt resistor
R16—150,000-ohm, ½-watt resistor
R17—47,000-ohm, ½-watt resistor
R18, R22—27,000-ohm, ½-watt resistor
R19—15,000-ohm, ½-watt resistor
R20—10,000-ohm, ½-watt resistor
R21—2700-ohm, ½-watt resistor
S1—Spst switch (Radio Shack 275-612 or equiv.)
S2—4-pole 6-position rotary switch (function) (Allied Electronics 747-2011 or equiv.)
S3—1-pole 11-position rotary switch (range) (Radio Shack 275-1385 or equiv.)
S4—Dpdt switch (Radio Shack 275-614 or equiv.)
Misc.—Probes, jacks, case, wire, solder, etc.

on R_M and R_C. Why? Because by using Ohm's Law we obtain the following mathematical relationship among the circuit "variables."

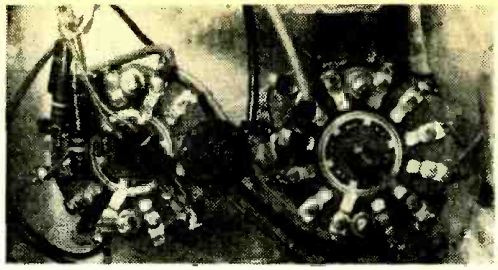
$$V_M = V \times \frac{R_M}{R_M + R_C}$$

If R_C is much smaller than R_M then V is very close to V_M (such as when measuring battery voltage). If, however, R_C has a similar value to R_M, the reading (V_M) will be way off from the true value of V. Therefore, to measure batteries, electric motors, appliances, and other low resistance devices, just about any kind of meter will do. However, for *electronic* measurements of circuits with high "internal" resistance (R_C) you need a meter with a *high* value of R_M to obtain meaningful readings.

You will notice by looking through the instrument catalogs that one of the advertised features of volt-meters with passive components is so-and-so many *ohms per volt.* Typical values are 1,000, 5,000, 10,000, 20,000, 50,000, and 100,000 ohms/volt. Where a 1,000 ohms/volt meter may sell for around $10, a 20,000 ohms/volt meter will cost around $20 and the 100,000 ohms/volt meter may cost $100 or more. What this ohms/volt number means is simply the resistance that occurs between the meter probes when a given voltage range is selected. For example, a 20,000 ohms/volt meter on the 1.5 volt full scale range has a resistance between probe terminals of 20,000 × 1.5 = 30,000 ohms. The same meter on the 50-volt range will have a resistance of 1,000,000 ohms (20,000 × 50). The resistance depends on the range selected and not, as is often assumed, on the actual measured voltage. If, for example, you measure 20 volts on the same 50-volt full scale range, you would still have a one megohm meter resistance.



Add pin jacks to externally check batteries used in meter. A flip of the normal-reverse switch flops test lead polarity in all modes.



Function switch S2 is on left; range switch S3 on right. Range resistors R10 to R20 can mount conveniently right on switch terminals.

Higher Cost. The reason that the price of a voltmeter increases with the ohms/volt value is the more precise and expensive meter movement required. A 1,000 ohms/volt meter deflects fully at 1 mA (one ampere divided by the ohms/volt value) but a 50,000 ohms/volt meter has to deflect fully at only 20 μA, a very small current indeed. To achieve full deflections at such small currents, the meter has to be a precise and expensive instrument with fine tolerances. A development in this field was the taut band meter in which, instead of bearings, the meter needle is suspended on a piece of flat spring wire, thus reducing mechanical resistance. Unfortunately, these meters are still quite expensive.

A Solution. To overcome the natural limitations of building passive meters with high input resistance, a meter with active components and amplification was developed. For many years this was the bulky vacuum tube voltmeter (VTVM). The resistance of such a voltmeter could be several megohms on all ranges because of the high input resistance of tubes used with the input divider. A disadvantage of the VTVM was the necessity for a power supply, either 110 volts AC with a rectifier or a large battery pack.

Development of transistors did not help much to redesign the VTVM because the transistor is basically a low resistance device. The picture changed with the development of field effect transistors (FETs). These devices, which control the flow of electrons by applying an electrostatic field, behave very much like vacuum tubes insofar as their high input resistance is concerned, but they operate at lower B+ voltages and require, of course, no filament voltage as tubes do. An FETVM can have the same features as a VTVM but can give many hours of operation from small portable batteries. The circuit described here gives a full 20 megohms of resistance on all ranges and it will operate for 40 to 50 hours on a 9-volt transistor-type battery.

Measurement Example. The high input resistance is particularly important for measuring low voltage transistor circuits. A typical collector resistance (R_C) may be of the order of 100,000-ohms. If you measure it with a 20,000 ohms/volt meter on the 6-volt scale (voltmeter resistance = 120,000 ohms) your reading will be off by about 45 percent (100,000 ohms in parallel with 120,000 ohms) and the working point of the transistor will be completely changed. With a 20-megohm auxiliary probe, however, a reading will remain within 0.5 percent (100,000 ohms in parallel with 20 megohms) of the actual value; that's as good or better than the accuracy of the average meter.

The volt-meter portion of the circuit is a balanced bridge consisting of two field effect transistors and associated resistors. Various voltage ranges are selected by the voltage divider consisting of resistors R10 through R20. You will notice that the meter resistance seen from the probes is 20 megohms (the sum of the values of resistors R10 through R20) independent of the range selected.

In the resistance mode, the meter measures voltages across the unknown resistor through the voltage divider consisting of the range resistors R9, and R21 through R23. Battery B1 supplies power for the FET circuit; battery B2 is for resistance measuring configuration and for circuit calibration. Diodes D1 and D2 protect the meter from overload; capacitor C1 stops stray RF fields from affecting the readings. Switch S4 reverses the polarity of the probes. It can be included in your meter if you wish.

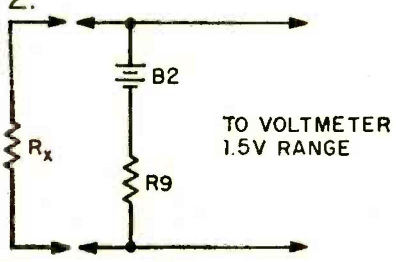
Parts Selection. The main ingredients of our design are a dual FET and a panel meter. The reason for selecting a dual FET rather than two individual ones is better matching of two FETs in a single package. The advantage of well-matched FETs is that when the meter is adjusted for one range it will not require readjusting when switching to another range. Concerning the panel meter, any 50-uA or 100-uA meter will do. However, the simplest way to have a meter with well-marked volt and ohm scales is to get a discarded meter from a 10,000 ohms/volt or 20,000 ohms/volt instrument. The resistors R9 and R21 through R23 correspond to half-scale resistance readings.

The reason for this becomes obvious by looking at figures 2 and 3. On the low resistance range, the circuit of figure 2 prevails where the voltage across the meter (V_M) is equal to the voltage of the battery times the ratio of R_X over R_X plus R9: $V_M = (V)\, R_X/(R_X + R9)$.

For a half-scale meter deflection ($V_M = V/2$), R9 must be equal to Rx. If, for example, you find or mark your meter with a center scale ohms value of 7500 (high ohms circuit of figure 3 is the basic circuit), you would select a 7500-ohm resistor for R21. Similarly, the remaining two scales (X10 and X100) would require 75,000 and 750,000-ohm resistors for R22 and R23 respectively. If you intend to use different ohm scales on this meter than those shown, use the corresponding half-scale resistor values.

Similarly, on the voltage scales the range resistors R10 through R20 can be changed if you want other voltage ranges. The sum of the resistors R10 through R20 should be approximately 20 megohms, and, for a particular range, the total resistance in *kil-*

2.



Switches on the main schematic are in the low ohms position. You can trace this basic low ohms circuit (Fig. 2) from resistor R9.

3.

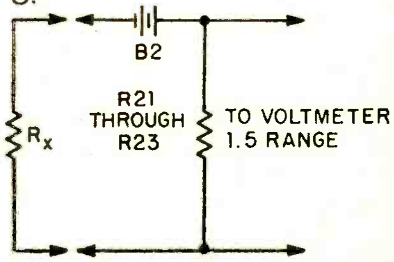


Figure 3 shows the most-used ohmmeter circuit where shorted test leads (Rx=0 ohms) deflect the meter to the zero ohms point.

FET Multimeter

ohms between a tap on the divider (R10 to R20) and ground should be equal to 7500 divided by the range in volts. For example, on our meter a 75-volt range would result in a resistance of 100,000 ohms which is approximately the total of R17 through R20. If you want to use, say, 1.5, 15, and 150 volt ranges, you would omit R14 through R20 and select R10 to R13 as follows:

$$R13 = \frac{7500}{150} = 50 \text{ (50 kilohms)}$$

$$R12 + R13 = \frac{7500}{15} = 500 \text{ (500 kilohms)}$$

Since R12 and R13 together equal 500,000 ohms, and since R13 is 50,000 ohms, then R12 must be 450,000 ohms.

$$R11 + R12 + R13 = \frac{7500}{1.5}$$
$$= 5000 \text{ (5 megohms)}$$

therefore, R11 must be 4.5 megohms and R10 must be the difference between the above and the 20 megohms total. Therefore R10 equals 15 megohms.

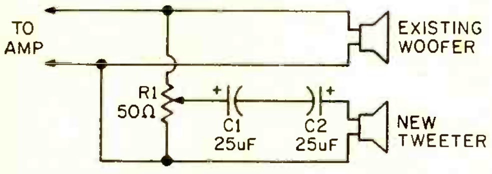
Operation. Set switch S2 to *cal low ohms* and turn the main power switch S1 *on*. Short the probes together and set the meter to zero with the *null* adjustment (R5). Open the probes and set the needle to the 1.35 volt mark on the meter with *cal* adjustment R4; repeat if necessary. Turn S2 to *volts*; you are now ready to measure voltages; select the range with S3.

To measure resistance, alternately short and open the probes on one of the resistance ranges and adjust the meter for zero ohms (leads shorted) and infinite resistance (leads open) with the two potentiometers. Adjustment on any resistance range should give satisfactory readings on other ranges. If you cannot calibrate the meter, check the batteries (with another voltmeter). The battery leads can be brought out to jacks for testing.

Initial Calibration. Set R4 (CAL) to max, R5 (NULL) to the center of its range, and the function switch to the VOLTS position. Then adjust R6 to indicate zero volts with the probes shorted together.

This article has provided you with some multimeter basics and an experimenter's example of a working FET voltmeter. You can simplify the design by making just a voltmeter, just an ohmmeter, or an abbreviated version of a volt-ohmmeter, if you wish. Use a simple basic meter 0 to 50μA and add your own scale, or find a surplus or used meter movement and design voltage ranges and "half-scale" ohmmeter ranges to match the printed scale. Any way you do it, an experimenter can get a feel for what's inside the widely used FET multimeter, and come up with a useful diagnostic tool to boot! ■

Add-A-Tweeter Today



Any single voice coil speaker is hard pressed to handle both low and high frequencies simultaneously—and it's the highs that suffer most. A much cleaner sound can usually be obtained from speakers 6 inches or larger if the highs are pumped through a tweeter. It can be any small speaker rated 4 to 6 ohms of approximately 2 to 3 inches in diameter. The back-to-back capacitors, C1 and C2, permit only the highs from about 1500 Hz up to pass into the tweeter. By keeping the lows out of the tweeter, the highs come out cleaner, and there's no chance of the greater low frequency power "blowing" the tweeter. Potentiometer R1 is used to match the tweeter's output level to that of the woofer—because small speakers are generally much more efficient than large speakers. If you eliminate R1, the highs will literally scream in your ears.

PARTS LIST FOR ADD-A-TWEETER

C1, C2—22-uF electrolytic capacitor, 50 VDC (Calectro A1-152)
R1—50-ohm wirebound potentiometer, 1 or 2 watts.
Misc. Cone type tweeters such as the Lafayette 99-01562 are suitable for use with this circuit.

Build this long range microphone and...

Bug Mother Nature

by F. J. Bauer

With a parabolic mike offering sonic and electronic amplification you're in tune with Helix Aspera to Yellow-bellied Sapsuckers!

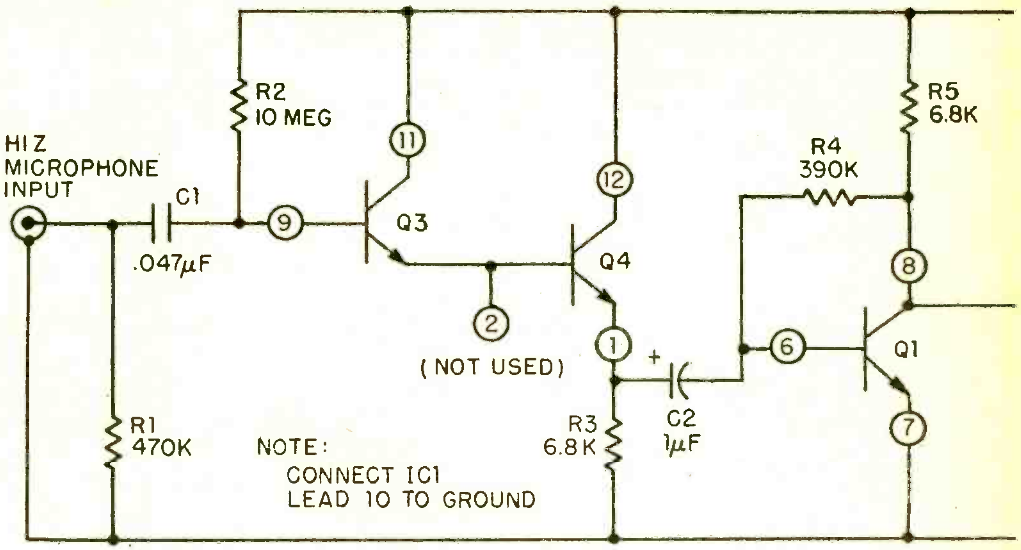
Englishman George Riley lives in Kent, works in London and goes home to an unusual hobby.

"It all started about a couple of years ago when I borrowed a friend's parabolic directional microphone dish. This type of equipment is hyper-sensitive and can be pinpointed to record a sound without external noise interference. I was using it to record the sound of crickets when I suddenly heard a strange 'slurping crunching' sound. This turned out to be a large snail making the most of some hard grass. From then on I was hooked," says George.

Experts such as zoologist Donald J. Borror have used the parabolic microphone technique to produce 33⅓ rpm records that sonically illustrate ornithology books and booklets.*

After stumbling over a couple of radar antenna dishes a few years ago, I finally decided to put one of them to work. Since I was no microwave expert, I decided to try an acoustic application. After all, I reasoned, a parabolic dish is a parabolic dish whether it is used for reflecting and focusing microwaves or sound waves. The result is the parabolic microphone described in this article.

Bug Mother Nature



PARTS LIST FOR A PARABOLIC MICROPHONE

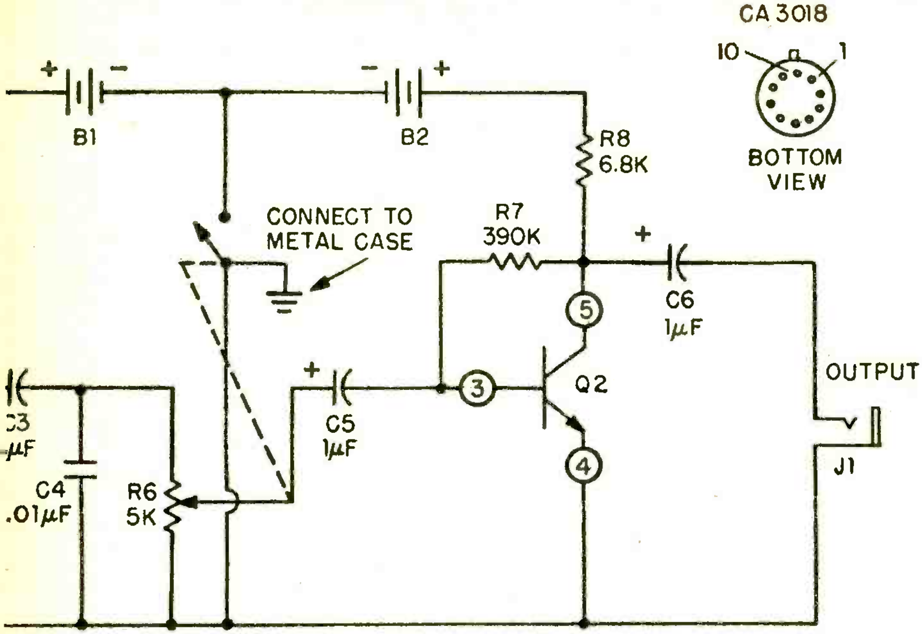
B1, B2—9-volt battery, 2U6-type
C1—0.047 μF disc or tubular capacitor
C2 C3, C5, C6—1 μF capacitor, electrolytic (observe polarity) or tubular, 35 volts or better
C4—0.01 μF capacitor, ceramic disc
IC1—3018 integrated circuit (RCA CA3018) Available from Circuit Specialists Co., Box 3047, Scottsdale, AZ 85257; $2.00 postpaid.
R1—470,000-ohm, ¼-watt resistor
R2—10-megohm, ½-watt resistor
R3, R5, R8—6800-ohm, ¼-watt resistor

If you want to go all out for added gain, look over the surplus dealers' list for an 18 inch or larger aluminum model. As nearly as I can tell with the test equipment available, the 18-inch reflector adds about 10 dB gain to the microphone.

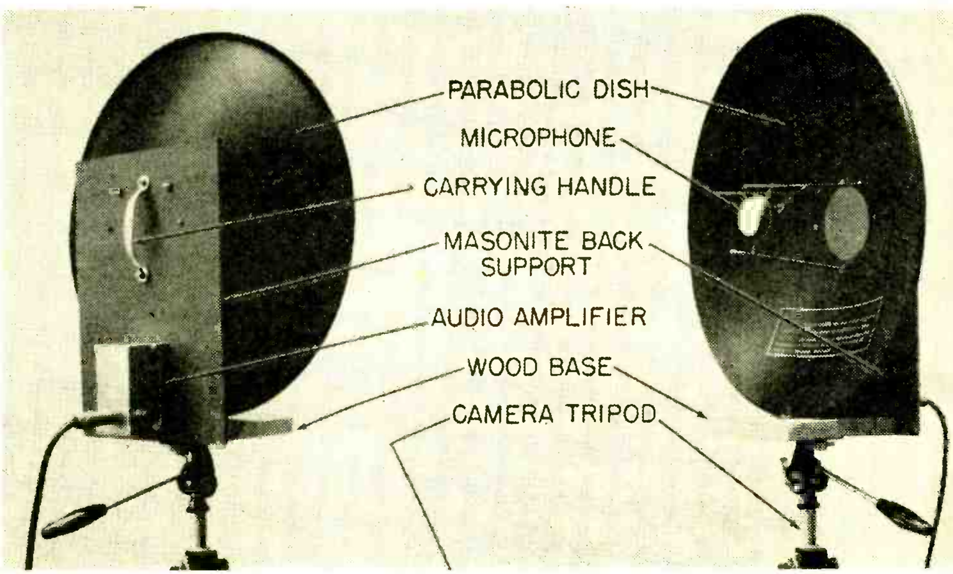
Construction. It's simple enough as reference to the photos will reveal. The mount for the dish is made of wood and masonite. The dish is held in place by three threaded rods which also serve as the microphone support. Almost any kind of rod material will do, as long as it is or can be threaded. I happened to have some odd pieces of 9-gauge aluminum clothesline which threaded easily with a 10-32 die. Make the rod length about 7½ inches to allow sufficient leeway

The other end of George Riley as he searches for optimum mike placement to record feeding snails. Cassette recorder also drives earphones for real-time monitoring.

Suspend the microphone you use from rubber bands that extend to the support rods. Or, a clamp wrapped in foam packing material holds Riley's microphone securely. ►



R4, R7—390,000-ohm, ¼-watt resistor
R6—5,000-ohm potentiometer, audio taper, with spst switch
Misc.—Aluminum case, x 4-in. perf board, plugs, jacks, hardware, push-in terminals, microphone (high impedance crystal, see text, or hand-held type such as Radio Shack 33-907) wire, solder, etc.
Note: The ETCO catalog lists a "government surplus" aluminum parabolic reflector on page 36. ETCO Electronics, 464 McGill Street, Montreal 125, Canada.

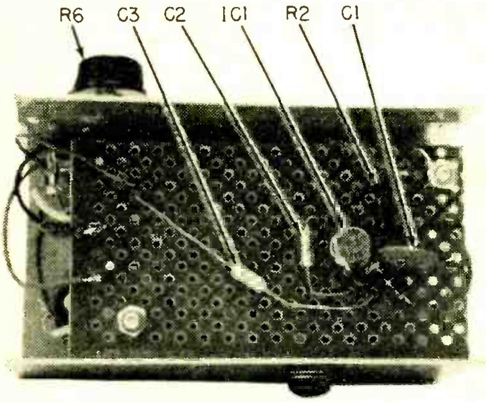


for adjusting the microphone for optimum focus. A small bracket or block may be added where the dish touches the wooden base to add rigidity, and a hole in the center of the base will make it convenient to mount the whole assembly on a camera tripod.

Any low priced ceramic or crystal microphone cartridge will work well with this reflector. The one shown in the photograph happens to be out of a pre-WW II hearing aid!

Mount the microphone cartridge on the rods with rubber bands. The exact method of attaching the rubber bands to the microphone cartridge is left to the ingenuity of the builder, since this will largely depend upon the physical configuration of the microphone.

Next route a 16-inch piece of shielded microphone cable from the microphone



Place components above and below the raised perf board. High impedance circuit makes it necessary to shield the amp in a metal box.

along one of the rods, through the dish (but inside the back plate), and terminate the cable in a phono plug. The cable should have sufficient slack so it may be easily plugged into the amplifier box. Also, be sure to allow sufficient lead slack at the microphone end of the cable so that the shock mount effect of the rubber bands is not nullified. This will complete the microphone reflector assembly, which should be set aside until the amplifier is built.

Electronics. The amplifier is a three stage affair using an RCA CA 3018 integrated circuit. Transistors Q3 and Q4 are used as a Darlington pair in an emitter-follower circuit in the first stage. This provides the necessary high input impedance required by the crystal microphone. The two following stages utilize Q1 and Q2 respectively as conventional common emitter amplifiers. The average gain per stage is about 38 dB.

Capacitor C4 across audio gain control R6 provides a 3 dB roll-off at 15 kHz, thus limiting amplifier frequency response to the desired audio range. In addition to limiting the frequency response, this capacitor also reduces the tendency of the amplifier to oscillate at higher frequencies, which could result in instability and low output. The 3 dB point at the low frequency end is about 70 Hz, sufficient for this application.

Two 9-volt transistor batteries are used to power the amplifier; not because of high current drain but, rather, to avoid common coupling between the output stage and earlier stages of the amplifier. An RC decoupling network could, of course, be used instead of two batteries, but it was found that oscillation would occur in spite of the decoupling network after the batteries had been in service for awhile. Two batteries absolutely guarantee against amplifier instability during the useful life of the batteries. The total current drain of the amplifier, by the way, is only 1.5 mA.

No trouble should be experienced with the amplifier if the original layout is followed. All amplifier components are mounted and wired on the perf board as shown. The volume control, capacitor C4, and the earphone jack are mounted on the part of the minibox that serves as a cover and battery holder. All connecting wires are soldered to push-in terminals on the perf board, and the perf board is mounted above the batteries with small bolts and spacers. After assembly, connect the microphone to the amplifier input with a short piece of cable.

Check Out. When testing the amplifier on the bench, either have the microphone connected to the input terminals or substitute a half-megohm resistor for the microphone input. If you have a hum problem it is probably caused by nearby AC wiring. (I had to turn off power to the workbench whenever I tested the amplifier out of its

*Common Bird Songs, the title of a booklet and record by Borror, is available from Dover Publications, 180 Varick Street. New York 10014 for $3.50 postpaid; order number 21829-5. It provides songs of sixty species such as the Robin, Cardinal, Bluejay, Bobolink, and Tufted Titmouse!

case.) Alternatively, you may find a place in the house that is hum free; make your tests there. With the amplifier completely enclosed in its case, there is absolutely no hum pickup problem.

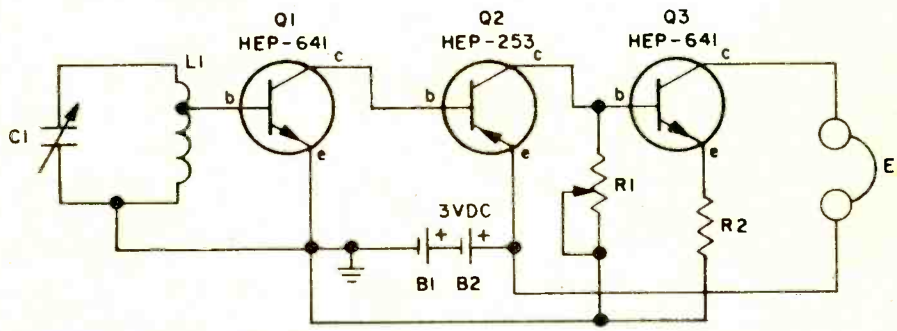
When you are satisfied that the amplifier is stable and working properly, solder the short microphone cable to the input terminals and mount the amplifier in its case. You are now ready to set up the microphone for maximum gain. To do this, you will need a code practice oscillator or other source of audio signal and an AC voltmeter with a ten-volt range connected to the amplifier output.

Set the equipment up in a clear area. Enable the CPA and adjust the audio gain so that the voltmeter reads two volts or less. Next move the microphone cartridge towards and away from the center of the dish to find the microphone position giving the greatest output. Do not let the voltmeter reading go above three volts because overloading the amplifier will make it difficult to find the point of maximum gain. After finding the best position for the microphone, secure the rubber bands on the support rods with dabs of cement.

The parabolic snooper may be used in several ways. As a portable field instrument, just plug in a set of 2000-ohm earphones and be on your way through the woods. The unit will also work as a combination microphone-preamplifier with any amplifier or tape recorder. However, if you are using a speaker for monitoring outside noises, be sure to have sufficient acoustic isolation between the microphone and speaker, such as closed doors and windows. If you don't, all the world will know by your feedback howl that you are listening. When using the unit with an audio power amplifier it is best to run the gain quite high on the amplifier and adjust the system gain as needed with the preamp gain control.

Now you're ready for a new world of close up sound. Get out there and bug those bugs. ■

DC Coupled BCB Radio



A shirt-pocket project, this direct-coupled radio uses transistor Q1 as a diode detector and first audio amplifier. Detection is across the base-emitter junction which operates as a diode. Normal base-emitter capacitance provides RF filtering. L1 can be a tapped (transistor type) ferrite antenna coil. Tuning capacitor C1 is a miniature *poly*-type variable.

Earphone E can be magnetic or crystal as long as its impedance is in the 2500- to 5000-ohm range.

Control R1 is adjusted for best earphone sound—or least distortion consistent with maximum volume.

During construction, carefully note that npn and pnp transistors are used. Don't intermix them since reverse polarity voltage can destroy a transistor.

Batteries B1 and B2 are the penlight (AAA) type—good for many hours of dependable service for the all-night listner.

PARTS LIST FOR DC COUPLED BCB RADIO

B1, B2—1.5-V battery
C1—365-pF variable capacitor (Calectro A1-227)
E1—2500-5000 ohm earphone (Calectro J4-825)
L1—Tapped ferrite antenna coil
Q1, Q3—Motorola HEP-641 npn transistor
Q2—Motorola HEP-253 pnp transistor
R1—5000-ohm potentiometer
R2—100-ohm, ½-watt resistor

Antiquing an Old Tube into Antiquity

by Art Traufer

Many antique radio collectors have one or more early battery radios in their collections which have bayonet shell-type sockets made for O1A type tubes. The O1A tubes require 5 volts on the filament and draw a hefty .25 amps each. Since these tubes were out of production many years ago and are becoming hard to find, it is desirable to use more modern tubes having lower filament voltages and less "A" battery drain. One such tube is the type 30 tube, which requires only 2 volts on the filament at only .060 amps!

Type 30 tubes have the same four pin arrangement as the old O1A tubes. However, the 30's base is smaller in diameter than the O1A's base and it also does not have the metal pin for use in bayonet sockets. The 30 tubes were made for use in "push-in" type sockets.

To use a 30 in an O1A bayonet socket it isn't necessary to make an adapter or to "re-tube" an O1A base with a 30 glass envelope. All you have to do is build up the diameter of the 30 base so that it fits the bayonet socket and then put small metal pins in the base.

How To Do It. Buy a 12″ length of Crown Line PCV-1120 1″ white plastic pipe at a plumbing supply house, or buy any other plastic pipe having an inside diameter the same (or slightly larger) than the diameter of the 30 tube base. Be sure the outside diameter is the same (or slightly smaller) than the opening in the O1A bayonet tube socket.

Saw off a 1″ piece from the plastic pipe, then file the tough sawed edges smooth and glue the 1″ piece on the base of the 30 tube. If the plastic fits a little too loose on the tube base simply wrap a turn or two of *Mystik* cloth tape around the tube base before you apply the glue. Let the glue harden.

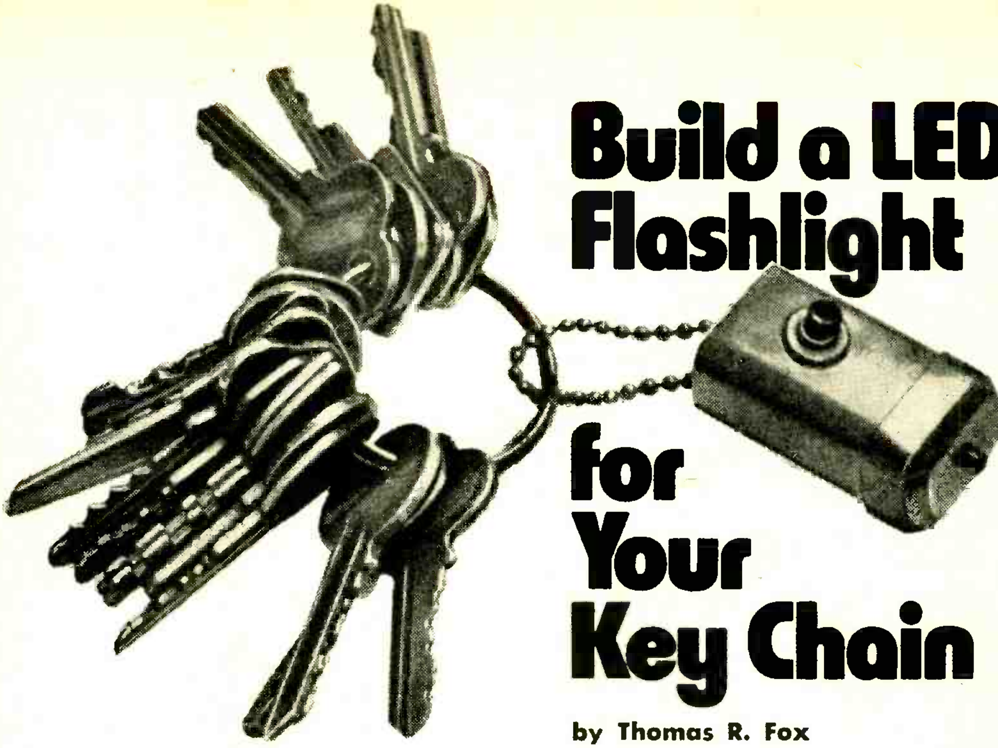
If the modified 30 base now fits a little too loose in the O1A bayonet socket wrap a turn or two of the cloth tape around the base.

To complete the job fasten a small metal pin in the base. To do this drill an undersize hole through the plastic and into the tube base and then twist in a machine screw

(Continued on page 108)

Shown from left to right are: type 30 vacuum tube unmodified, type 30 vacuum tube modified by a wider base and addition of a base bayonet pin, type OA1 vacuum tube grandfather used, and last, the bayonet socket that is the cause of the problem.

Fabricate an OA1 from a type 30 tube and keep your ancient rig on the air!



Build a LED Flashlight for Your Key Chain

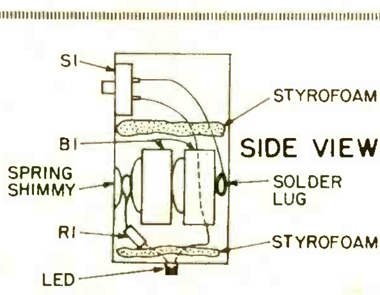
by Thomas R. Fox

A miniature flashlight, attached to a key chain, is an extremely useful device. The trouble is, most key chain flashlights use standard filament light bulbs, which are notorious current hogs and have rather short lifetimes. Because of its minute size, almost unlimited lifetime and very low current consumption, the LED (Light Emitting Diode) is, to date, the best device to use in such a flashlight.

The LED is a revolutionary new solid state lighting device that has no filament to heat up and burn out. Instead, it produces a 'cold light' like fireflies do. It is basically a forward-biased diode composed of gallium arsenide instead of the more usual silicon or germanium. Since it generates most of its light in a narrow bandwith, the LED is only a step away from being a LASER. Also, its nearly monochromatic properties, the color of the LED is quite unusual and many have a rubylike appearance. See light chart.

Many types of LED's are suitable for such a miniature flashlight. Motorola's MLED600 is a good choice to use in a miniature flashlight since it provides a high light output at a low voltage—1.55 volts is enough to turn it on.

The power supply B1, for the device is two 1.35-volt mercury button cells connected in series to give a total voltage of 2.7 volts. This voltage is then dropped to 2.3 volts by the addition of a 15-ohm resistor. With normal use, these mercury cells should

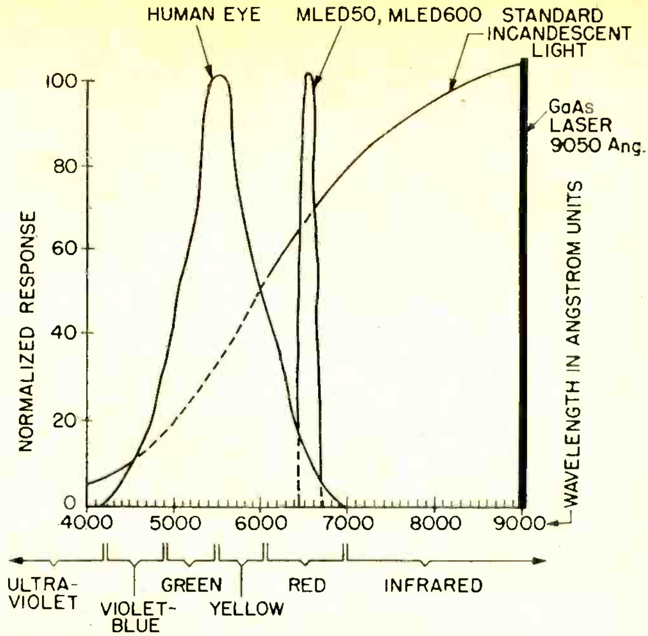


PARTS LIST FOR LED FLASHLIGHT

B1—1.35-VDC mercury button cell, 2 required (Mallory RM-635TR2, or any pair of cells thin enough to fit the plastic toothbrush tube you use)
LED—Motorola MLED600, HEP-P2000 or equiv.
R1—15-ohm, ½-watt resistor
S1—Subminiature, momentary-contact s.p.s.t. pushbutton switch (GC Electronics 34-002 or smaller)
Misc.—Toothbrush plastic container, solder lugs, wire, styrofoam, silver paint, etc.

LED Flashlight

The visible light spectrum shows the colors we see and the narrow band of light the LED generates.



last at least a year. Assuming 20 seconds of use a day, the batteries in the LED flashlight might last as long as their shelf life.

Building It. The case for the LED flashlight can be made from the plastic container in which a toothbrush comes. Either the heavy-weight plastic container or the flexible one can be used.

Cut this plastic container 1¼-in from the bottom and save the cover. You now have the case.

Follow the wiring diagram to complete construction. Styrofoam is used as an insulating material and the specified piece of sheet metal is used as a spring shimmy to get a good connection between the solder lugs and the batteries. Since you can't solder to the batteries directly, pressure contact is required.

Before fastening the cover, check out the flashlight to see if everything is working properly. If the LED lights when the switch is pressed, fine; if not, reverse the batteries or solder lugs. LED's, unlike common incandescent lights, are polarized. If it still doesn't work, check battery contacts, mercury cells, switch and LED in that order.

If everything works okay, finish construction by drilling a small hole in the cover. Put a small piece of styrofoam between the batteries and LED. From the inside of the cover, stick the LED through the hole you drilled. Fasten the cover (it might need to be cut down to size) to the case using small sheet metal screws (or even glue, since the batteries rarely need to be replaced). To appear professional, paint the plastic case with aluminum paint. For the final touch, drill two small holes in the bottom of the case and string a key chain through the holes.

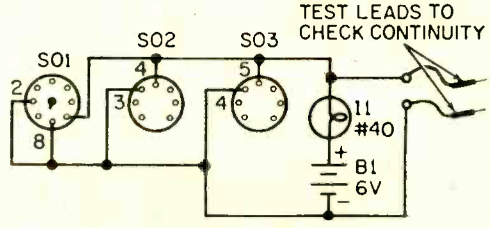
Total cost of this ultra-modern miniature flashlight can be as low as $3.50 including batteries, and it weighs less than 0.5 ounce. ■

Quicky Vacuum-Tube Filament and Continuity Checker

☐ Most tube failures are caused by open filaments, so you can save a lot of time when troubleshooting radios and TV sets by using this instant tube checker. Simply plug a tube into the matching socket; if the filament is okay, lamp I1 will light. If you have any odd-ball tubes that use sockets other than the standard three shown, simply build them into the checker. The continuity test leads allow you to check TV picture tubes. ■

PARTS LIST FOR TUBE CHECKER

B1—6-VDC lantern battery
I1—#40 pilot (Calectro E2-437 or equiv.)
SO1—8-pin octal socket
SO2—7-pin socket
SO3—9-pin socket



TAKES TWO TO COUPLE

by William R. Shippee

Gotta be! Just about every home has two TVs. Gotta be! But the number of homes with two set couplers falls way short of what would be considered a reasonable number. So let's equalize the situation a bit by offering our readers a simple, easy-to-build two-set coupler that everyone can build and use with delightful reception results. We call it the TSC—obviously from *T*wo-*S*et *C*oupler.

The TSC may be used to couple two TVs, two FM sets, or a TV and an FM set from a single antenna. Several of these couplers may be connected to a single antenna system for more than two receivers. Insertion loss is less than 2.5 dB and the set-to-set isolation is about 6 dB.

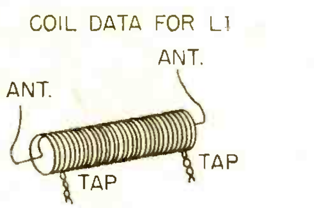
Start building the TSC by winding coil L1 as shown in the drawing and with the information given in the Coil Data. Close-wind (no space between turns) the No. 22 enamel wire, and use care when making the taps to assure a good connection, since the signal level is very low. Check the completed coil with an ohmmeter to make sure the taps are soldered properly. Check the coil visually to be certain that none of the turns are shorted! A shorted turn in coil L1 will make it practically useless.

Keep all leads as short in length as practical, make sure all connections are mechanically sound before soldering, and, if an enclosure is to be used, make it wood or plastic or some other non-metallic material. Coil L1 is designed to be non-resonant when operated in a twin-lead, 300-ohm antenna line, but there is some possibility that resonance may occur. This will either give much greater signal on one channel (frequency) or drop the signal level appreciably. To remedy this, simply install a resistor valued at approximately 300 ohms from one tap to the other. The author has constructed several TSCs and has run into this problem only once.

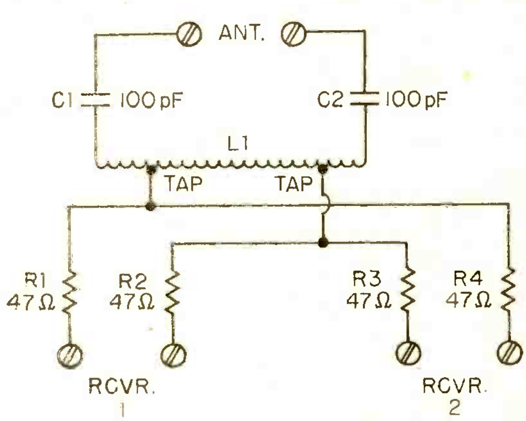
Best way to hook up the antenna is to solder directly to the coil ends. Alas, some people like screw posts, so spring for some brass screws (aluminum or nylon are also o.k.) to keep down magnetic fields near the coupler. Solder the leads from the TV antenna terminals directly to the TSC for the same reason.

Parts are easy to come by. No. 22 enameled wire is available in ¼-pound spools (Radio Shack 287-003). 47-ohm resistors (Radio Shack 271-1800 ¼-watt jobs are best) and 100 pF disc capacitors (Radio Shack 272-123) are available everywhere and are probably in your spare parts box right now. So get on with it, boy, for the TSC has got to be! ■

CONSTRUCTION DETAILS



Use Bakelite or wood form 5/16-in. diameter about 1-in. long. Use No. 22 enamel copper wire close-wound for 24 turns. Taps located at 3 and 21 turns.



Construction is simple provided you keep it simple! Avoid iron hardware—brass is best, but keep its use down. Install the coil and resistors in a plastic box and fill with "gunk" after wiring is complete. Resistors need be 10% tolerance only.

Antiquing an Old Tube

Continued from page 104

about $\frac{3}{32}$-in. in diameter letting the screw cut its own threads in the hole. Clip off the screw leaving about ⅛" projecting from the base and file the clipped end smooth.

> Caution: Do not drill too deep into the tube base or you might strike the glass inside the base and ruin the tube. Use a depth marker on the drill so you will not drill too deep.

Who Has It? Possible sources for type 30 tubes or other battery tubes having the same type bases as the 30s and having low filament voltages and low filament drain:

George Haymans, WA4NED, Box 468, Gainesville GA 30501. George has a good stock of new type 30 tubes at this writing. Write him for prices.

Barry Electronics, 512 Broadway, New York NY 10012

Cornell, 4213 University Ave., San Diego CA 92105

Steinmetz, 7519 Maplewood. Hammond IN 46324

Transelectronic, Inc., 1306 40th St., Brooklyn NY 11218

United Radio Co., 56 Ferry St., Newark NJ 07105

Zalytron, 469 Jericho Turnpike, Mineola NY 11501

A purist collector may say that you are cheating when you substitute a 30 for an 01A job. Maybe so, but your restored ancient receiver will be operative, and if you're lucky, you may uncover an 01A. ■

Super DX'er

Continued from page 82

ents and then the PC board. To prevent the copper foil on the underside of the PC board from shorting to the panel place a ⅜-in. plastic or metal spacer, or a stack of washers, between the PC board and the panel at each mounting screw. Connect the panel components to the appropriate wires extending from the PC board and the SUPER DXER is ready for alignment.

Alignment. Prepare a length of 50 or 52 ohm coaxial cable (such as RG-58) that will reach from the SUPER DXER's output jack to the receiver antenna input terminals. Solder a standard phono plug to one end. Take care that you do not use ordinary shielded cable such as used to interconnect hi-fi equipment: coaxial cable is a must.

Connect the coax between the SUPER DXER and your receiver. Rotate the C1 shaft fully counterclockwise and install a pointer knob so that the pointer extends to the left (9 o'clock position). Connect your antenna to binding post BP1. Then, set L1's slug so the *bottom* of the screwdriver slot is level with the very *top* of L1. This will provide a frequency range of approximately 5 to 15 MHz. If you back out the slug ¼-in., the frequency coverage will be from approximately 7 to 21 MHz. You can use any in-between slug adjustment.

Turn on the receiver and booster, and set the receiver tuning to 5 MHz, or whatever frequency you selected for the "bottom end." Adjust C1 for maximum received signal or noise and mark the panel accordingly. Repeat the procedure at approximately 7, 10, 14 and 15 (or 20) MHz. The panel markings are important because the SUPER DXER tuning is so sharp it must be preset to near the desired frequency or you'll receive nothing—neither signal nor noise. The panel markings complete the adjustments.

Pull 'em In. To prevent self-oscillation, you must keep the antenna wire as far as possible from the coaxial output cable. To receive a signal, set C1 to the approximate desired frequency and then tune-in the signal on the receiver. Finally, peak C1's adjustment for maximum signal strength as indicated on your receiver S-meter, or listen carefully for an increase in speaker volume. Keep in mind that, if the signal is sufficiently strong to begin with, the receiver AVC will "absorb" the SUPER DXER's boost, and the speaker volume will probably remain the same, though the S-meter reading will increase. SUPER DXER's boost will be most apparent on very weak signals, digging out those signals below the receiver's usual threshold sensitivity, making them perfectly readable.

Don't worry about strong signals overloading your SUPER DXER; it is virtually immune to overload even from excessively strong signals. However the booster's output can be so high as to overload the input of some budget receivers. If this occurs simply reduce the booster's output by detuning C1 just enough to drop the overall signal strength below the receiver's overload value. Happy DX'ing. ■

Super SCA Adaptor

Continued from page 88

sulting in high frequency noise. Change C12 and C14 to 0.05 uF.

☞ *If your problem is background breakthrough from the main program.*

This problem is caused by clipping (white lines on waveform A). 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 may get lost (well you can't win or hear em all!).

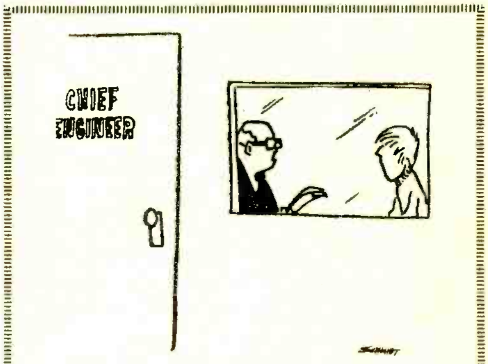
A second and simple corrective procedure is to put a 100,000-ohm resistor in series with the input from the FM radio. This effectively cuts down on the input signal to eliminate overload.

☞ *If your problem is an inoperative adaptor (even after you've checked components, made sure power supply polarity and receiver connection are correct), you must determine at what point in the circuit your signal is at fault or is lost.*

The three oscilloscope 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 a defective IC cannot disable another IC. ■



". . . and, Mr. Phanphool, what experience did you have after 'Heath-Kit'?"

Battery Monitor

Continued from page 31

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.

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. ■

CLASSIFIED Market Place

Classified Ads 75¢ per word, each insertion, minimum ad $15.00, payable in advance. For information on Classified ads—to be included in our next ELECTRONICS HOBBYIST—write to R. S. Wayner, Classified Ad Manager, 229 Park Ave. South, N. Y. 10003.

CLASSIFIED MARKET PLACE

(Continued from page 110)

MAGIC TRICKS, JOKER NOVELTIES & PUZZLES

WOW! Largest selection. Newest, best tricks, jokes. Giant 150 page catalog 25¢. Abracadabra-WC, Colonia, New Jersey 07067.

MAIL-ORDER OPPORTUNITIES

START "Your" mail-order dealership!! "Guaranteed Instructions"!! Cannot Lose! Want Wealth?? $3.98. Products, Box 1375, Mountain View, CA. 94042

MISCELLANEOUS

NEVER WON ANYTHING? Anyone can win Sweepstakes contests! Free details. Services, Box 644-SFA, Des Moines, Iowa 50303.

MIRACLE Beam Fits Any Key. Has Silver Cell, No Bulbs or Batteries to Replace. Guaranteed, $3.95. Crosby Specialty Sales Co., Box 181, Crosby, Texas 77432

MONEYMAKING OPPORTUNITIES

STUFF MAIL ENVELOPES!! $250.00 profit per thousand possible. Offer details: Stamped self-addressed envelope. Kings, B-37K-DVC15, Jamaica, NY 11422.

EXCELLENT income possible clipping newspaper articles. Act Now! Free details. Satisfaction Sales, Dept. B, Box 87, Ward Hill, Mass. 01830.

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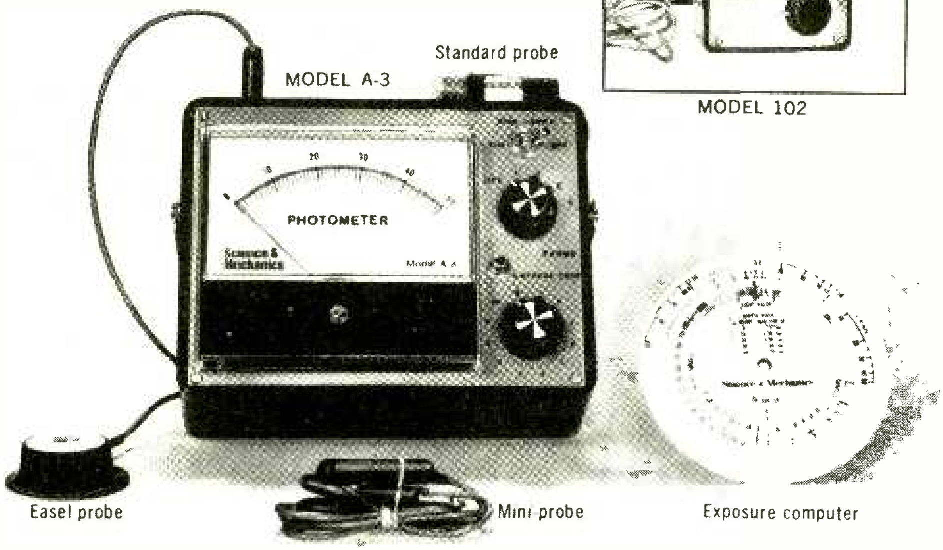

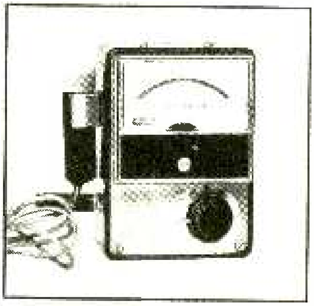

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