BUDGET SAVES BUCKS

BUDGET Electronics

by the Editors of Science & Electronics

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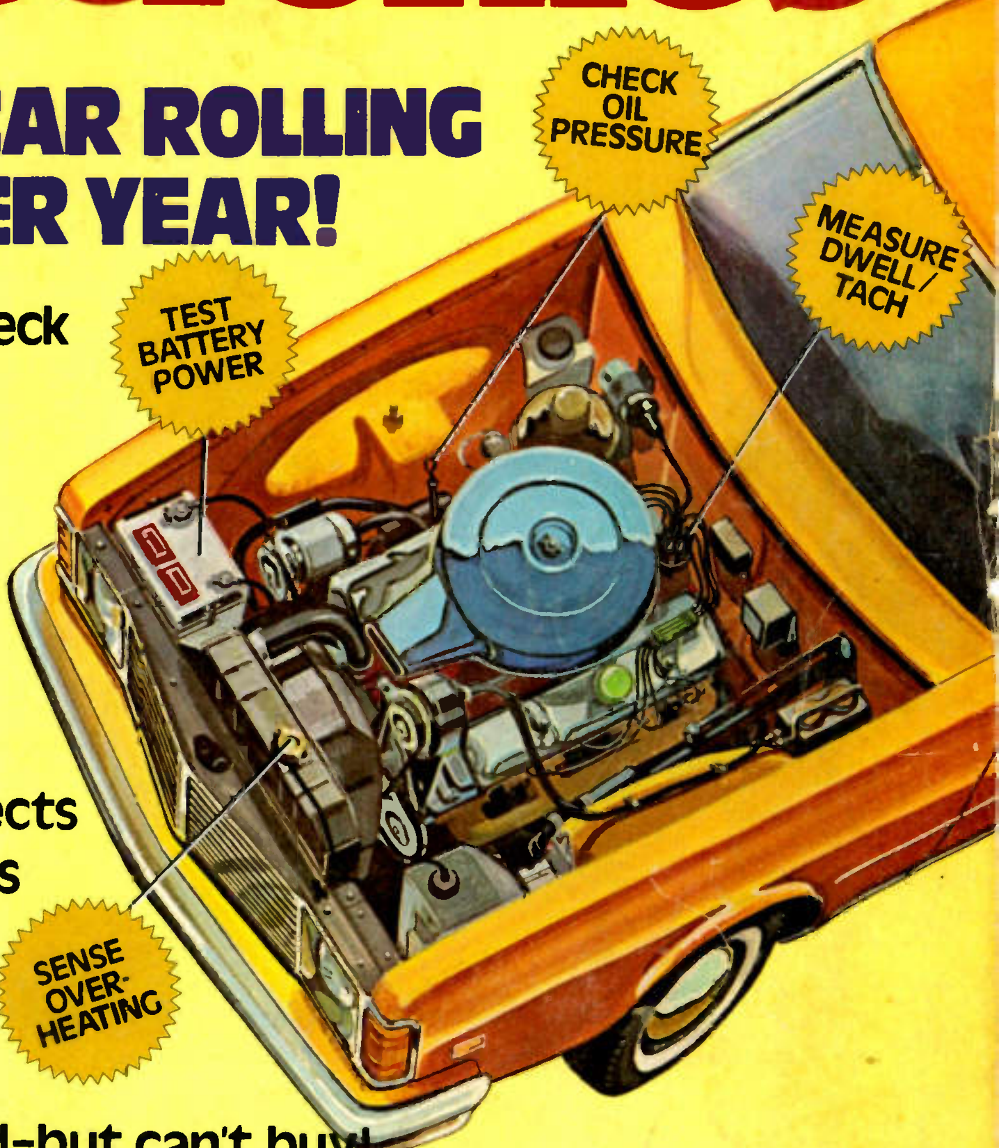

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ITEM NO.
WK-7

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- MOS-1416 14-16 CMOS SAFE INSERTER
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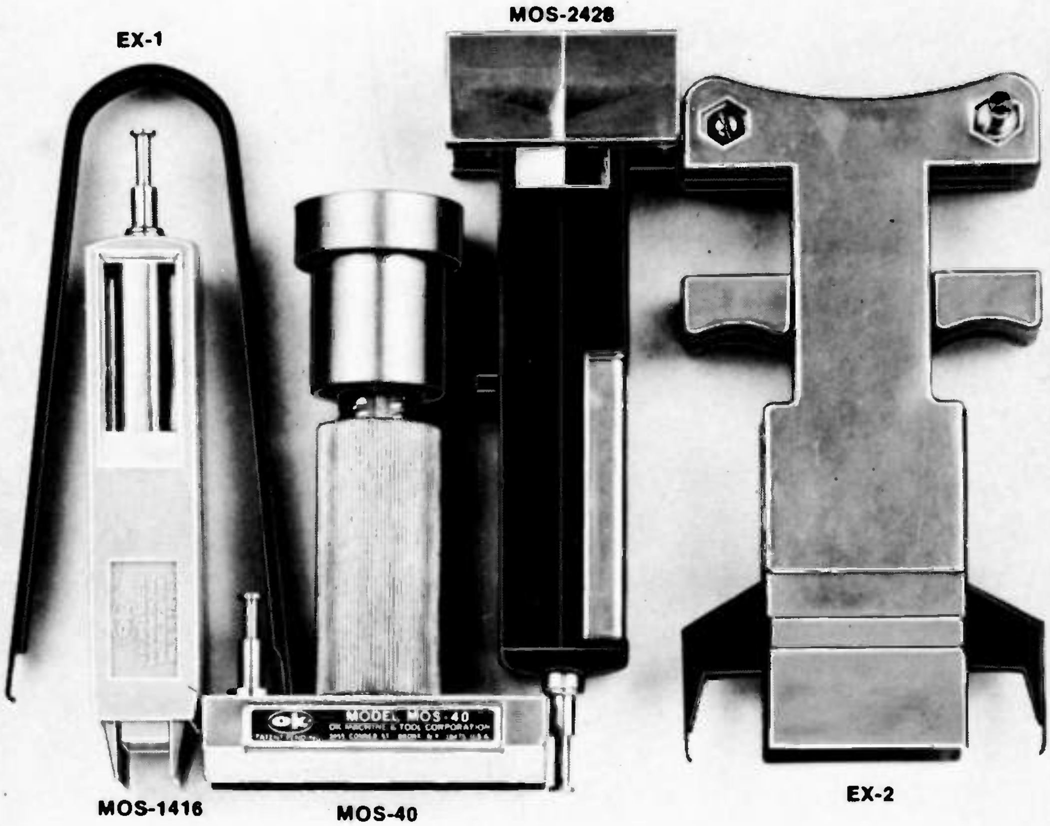

WK-7	COMPLETE IC INSERTER/EXTRACTOR KIT	$29.95

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MOS-1416	14-16 PIN MOS CMOS SAFE INSERTER	$ 7.95
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CIRCLE 8 ON READER SERVICE COUPON

BUDGET Electronics

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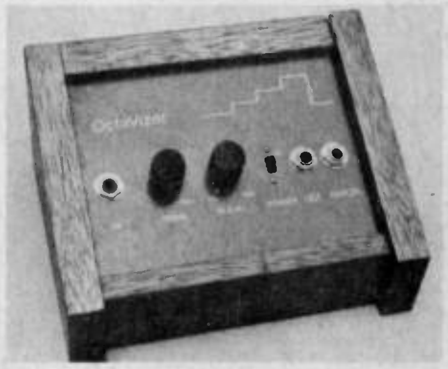
1981 EDITION

AUTOMOTIVE CONSTRUCTION FEATURES

Keep your car running year-after-year by monitoring major systems while you drive. Build these instruments and save.

FAMILY FUN AND GAMES PROJECTS

Put together these original projects which can't be bought in a store and give your whole family hours of fun.

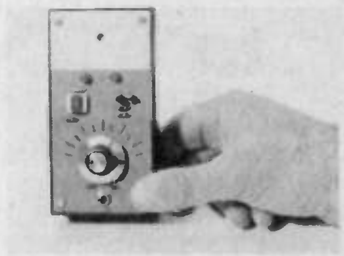


BUDGET PRACTICAL TIPS

Become a smart consumer and learn some tricks of the trade as well as make simple repairs of pesky problems.

DARKROOM ELECTRONIC MAGIC

Become a professional darkroom wizard with these easy-to-build accessories. You'll get quality prints every time.



LOW COST HOME & SHOP PROJECTS

This collection of projects will help keep your house safer, cooler and more entertaining. Easy on your pocket too!

REGULAR DEPARTMENTS

ISSN: 0364-9067

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New Products

Capacitance Meter

A portable autoranging digital capacitance meter, Model 830, automatically selects the correct range (of ten ranges) when an unknown capacitor is measured. This 3½ digit instrument resolves lowest range values to 0.1 pF and is basically accurate to 0.2%. Ten ranges cover from 1 pF to 199.9 mF. Capacitance values are displayed on a large LCD display. The first package of surplus capa-

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citors sized by the 830 will illustrate the dollar saver it really is! The auotranging capability of the 830 is ideal for quick sorting and measurement of unmarked capacitors or verification that a capacitor is within tolerance. If capacitors to be sorted are limited to a narrow value range, the RANGE HOLD capability can "freeze" the 830 in one range. Virtually any type of capacitor can be measured, from miniature discs to pole-mounted power types. Even the small amounts of capacitance encountered in cables or switches can be measured. The B&K-Precision model 830 comes wtih detailed manual. Optional accessories include the BP-28 rechargeable battery pack, BC-28 charger and LC-28 carrying case. The 830 is now available for immediate delivery at local B&K-Precision distributors at a price of $199.00. For addtional information, contact B&K-Precision, Sales Department, 6460 W. Cortland Street, Chicago, IL 60635.

Starve a Crook

Budget conscious hobbyists, car owners and home owners should investigate the new vehicle security system from Radio Shack. It is designed to alert you to attempted theft or tampering by means of a remote pocket-size receiver. The Archer Mobile Alert consists of a "coded" radio transmitter, pocket receiver with belt clip, and two electronic sensors. Additional, optional switches or sensors may be added to the system for even greater protection. The transmitter is mounted under the dash and connected to your car radio or CB antenna. When triggered, a coded signal "beeps" your pocket receiver. Range is said to be up to one-half mile, depending on terrain, conditions and type of antenna beng used. In addition to cars, trucks, vans, campers, RVs,

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boats and airplanes, the system can be adapted for use in monitoring specific building openings, gates, wall safes, store rooms, and even drawers, cabinets, luggage and brief cases. With the addition of a pushbutton switch, it can also be used for one-way paging. The transmitter operates from 12 VDC, negative ground. The pocket receiver uses two AA batteries. An FCC CB license is required. Priced at $99.95. The Archer Mobile Alert Vehicle Security System, complete with cables, hardware and instructions, is available from participating Radio Shack stores and dealers, nationwide.

Driving Computer Saves Bucks

Zemco, Inc., originators of the CompuCruise and ZT driving computers, have introduced a lower-priced version of their "automotive brain." With a suggested retail price of less than $120, this new model provides users with 28 computerized functions. (The 8-function computer available on Cadillac's Seville lists for $875.) The simplified button arrangement makes this computer very easy to use. It is easily-installable by most do-it-yourselfers or any automotive service outlet. And, it is operable on all cars, trucks, vans, and RVs, except those with diesel or fuel-injected engines. At the touch of the appropriate button, Zemco's driving computer instantly displays current or average MPG, fuel used and distance

traveled since fill-up, and fuel remaining and distance to go until empty. This fuel usage information can show drivers how to improve their driving efficiency, thus reducing fuel use and costs. Zemco's driving computer is a speedometer, displaying current and average MPH. The unit is also a quartz crystal clock, and will show both current and elapsed time. Zemco's new driving computer is available at major chain stores, discount stores, and automotive supply outlets.

Home Calculator

Panasonic's electronic calculator model JE-1801P is a 10-digit display/printing unit that weighs approximately 22 ounces—it's briefcase portable. Ideal for home desk, this AC/battery operated model prints clearly on standard 2¼ inch adding machine paper at the speed of two lines-per-second. The JE-1801 offers manual or automatic paper feed and a print/non-print option. This Panasonic electronic calculator includes a choice of 5/4 round-off or round-down system at the flip of a switch and a non-add feature for printing reference numerals or date. Other features include: input buffer and and two-key roll-over which help prevent overload during rapid key operation; decimal selection that has fully floating, 0-2-3 and add mode; constant calculation; three-digit punctuation; item counter; percent and memory functions.

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Panasonic model JE-1801 operates on four "AA" size batteries (not included) and AC adaptor is included. It has a suggested retail price of $89.95 for budget conscious consumers. Available wherever Panasonic products are sold. For more information, write to Panasonic, One Panasonic Way, Secaucus, NJ 07094.

Budget Organ Kit

Heath Company offers a new kit for aspiring musicians in the family. The TO-2130 is a budget, kit-form version of the Thomas Model 1130, Thomas' most popular organ. Features of the new organ include Color-Glo keys, color-coordinated music, single-finger chords and more. An "ex-

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pression pedal" adds color and dimension. Five rhythm settings add percussion. And the TO-2130 will also allow you to play any of ten different musical voices. Five "Solo Voices"—flute, trombone, trumpet, oboe and violin—can be registered separately or in combination for different musical effects. Four "Accompaniment Voices"—melodia, horn, diapason and string—provide harmonic background. And a "Fancy Voice" module combines with the "Solo Voices" to produce special instrumental effects. An "Orchestral Presence" module adds strings and tremulants. Fully assembled and tested circuit boards greatly simplify kit assembly. The cabinet comes completely assembled, with a matching padded bench included. For more information on the TO-2130 organ, mail order priced at $999.95, write for catalog, to Heath Co., Dept. 570-370, Benton Harbor, MI 49022.

4-Band 6-Channel in a Pocket

Electra's new model four-band, six-channel Bearcat Four-Six ThinScan pocket scanner is capable of receiving both VHF-AM and UHF-FM channels. ThinScan radios measure just 2¾-in. wide by 1-in. thick. Small enough to slip easily into a shirt pocket, the little unit can receive any mix of six channels on four bands (high and

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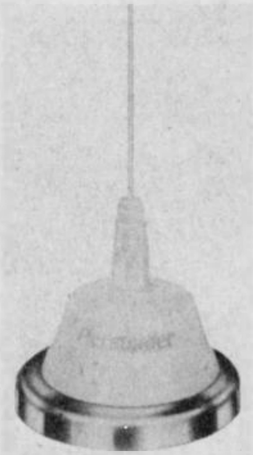
low VHF, UHF and UHF "T" Public Service Bands). It scans the six crystal-controlled frequencies at the rate of fifteen channels per second and has built-in scan delay. Each channel has a lockout control to bypass those channel(s) not of current interest. A SCAN/MANUAL function switch lets the user select and hold any of the six channels manually, LED indicators

New Products

show the channel being scanned. Additional features are: easy to operate recessed controls, anodized aluminum front panel and flexible "rubber ducky" antenna (an interchangeable wire antenna is also supplied). The suggested user price for the new Bearcat pocket scanner is $179.95. Complete information on the unit is available from Electra Company, P.O. Box 29243, Cumberland, IN 46229.

Budget Magnet

A new Super Magnet Mount accessory for the Persuader CB antenna, with 300 per cent greater holding power than the original magnet mount, is now available from Antenna Incorporated. Designed for easy field installation, the Super Magnet Mount (Model 10819), a heavy-duty, 4-in. diameter ceramic magnet, takes about two minutes to install. According to the manufacturer, the customer



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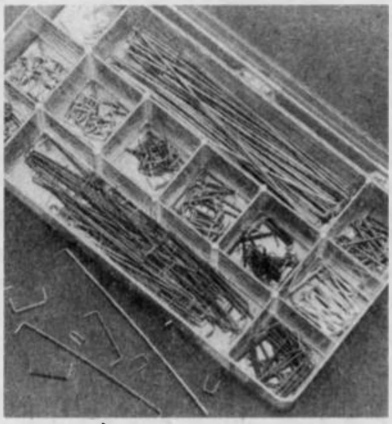
simply removes a portion of the vinyl pad on the bottom of the cup, takes out the screw holding the old magnet, places the new magnet over the existing magnet and screws in the longer screw provided. The whip should be cut ¼-in to ½-in. to compensate for the greater overall length. The new magnet, which is visible from the bottom of the cup as a bright chrome rim, complements the Persuader cup colors and gives the antenna an aura of ruggedness and power. In addition to improving the antenna's adherence to the vehicle, the Super Magnet also improves capacitive coupling to the ground plane for performance characteristics that are said to be superior to the Persuader antenna's current high performance standards. The Super Magnet Mount, which can be used on all coil-in-cup antennas, is also available from Antenna Incorporated dealers at the suggested price of $12.50. For further information on the Super Magnet Mount, the Persuader CB antenna, and other Antenna Incorporated personal communication and land mobile products, contact Antenna Incorporated, 26301 Richmond Road, Cleveland, OH 44146.

Wire Kit for Breadboards

Global Specialties Corporation, manufacturer of solderless breadboards, has added to the utility of these products with the introduction of Model WK-1 Wire Jumper Kit, a fully prepared assortment of insulated solid hookup wire in



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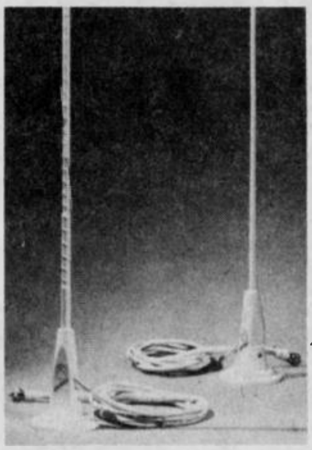
fourteen discrete, color-coded lengths. While ordinary hookup wire can be and usually is used for terminal-to-terminal connections in preparing a circuit on a solderless breadboard, it is nevertheless necessary to cut, strip and bend the leads. This task is accomplished for the breadboard user with the WK-1. AWG #22 solid hookup wire is precut, prestripped, and the ends bent 90 degrees to 14 lengths and sorted into compartments in a hinged-lid plastic case. Suggested U.S. resale price of this assortment is $10.00. For additional information write to GSC at 70 Fulton Terrace, P.O. Box 1942, New Haven, CT 06509.

CB Afloat

Antler has announced two marine antennas requiring no ground plane for use on fiberglass, wood, plastic or metal boats and recreational vehicles. The Sea King is a new 9-ft. fiberglass whip ($39.95) that provides maximum range and



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performance. The Sea Sprite is a loaded fiberglass stick type ($31.95) that adds the convenience of a short 39-in. height with high performance characteristics. Both of the Antler marine models feature a molded, hinged base that locks in an upright position for transmission and folds 180 degrees for out-of-the-way storage when the radio is not being used. Both models include a factory, pre-wired coax assembly sealed into the base for moisture protection. The development of the no-ground plane antenna opens the pleasure boating field to the world of CB safety, fun and convenience. For information, address Antler Antennas, P.O. Box 40526, Fort Worth, TX 76140.

Gas Saver

Heath's new portable digital engine analyzer, the CM-1550, handles several tune-up measurements, including dwell for 4 through 8-cylinder engines, RPM to 10,000 in two ranges, DC voltage to 200-volts in two ranges, resistance to 2-megohms in three ranges, and direct current to 20 Amperes. With the optional CMA-1550-1 Shunt Accessory, the CM-1550 will also measure starting current and battery charging/discharging current, up to 400 Amperes. The CM-1550's liquid crystal display shows all measurements. Power is supplied by a 9-volt battery (not included). The inductive pick-up for the RPM readings is attached to any spark plug wire. The CM-1550 can be assembled in two or three evenings, with just one circuit board

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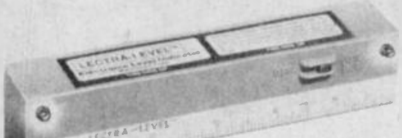
to wire. It is mail order priced at $94.95, while the optional CMA-1550-1 400-Amp Shunt Accessory sells for $14.95, mail order. For more information on the CM-1550 Engine Analyzer, send for a free catalog to Heath Company, Dept. 350-180, Benton Harbor, MI 49022, or pick up your copy at the nearest Heath Electronic Center.

LED Level

Here's a totally new kind of level indicator—unique because it operates electronically. The flick of a switch activates two LEDs when the surface is level—only the light on the high side is lit when it is not. Called the Lectra-Level, this



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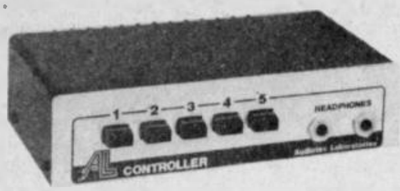
battery-operated tool is accurate to professional standards. The Lectra-Level is ideal for the weekend handyman. Suggested retail price is $13.95. For additional information, write to Martronics, Corp., 8700 Waukegan Road, Morton Grove, IL 60053.

5-way Speaker Switch

The Controller, a new stereo selector switch designed by Audiotex Laboratories Division of GC Electronics, allows hookup and independent control of up to five pairs of stereo speakers. Any one pair or up to all five pairs may be played at the same time! In addition, the Controller incorporates two stereo headphone jacks for private listening. The unit features built-in circuitry for amplifier protection, regardless of the number of speakers employed. The internal protection load may be switched out of circuit if desired when the speaker load is no less than 4-ohms. It's rated at 50-watts con-



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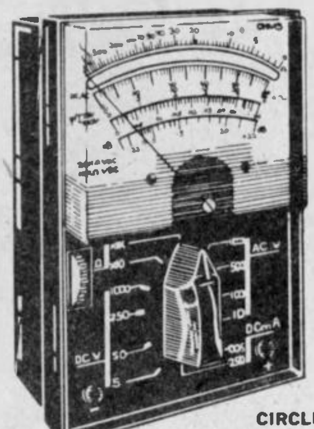
tinuous per channel. Suggested retail price of the Controller (30-8710) is $49.50, and it's available at electronics and audio dealers nationwide. Get all the facts directly from GC Electronics, 400 So. Wyman St., Rockford, IL 61101.

Handy Multimeter

Olson's 20,000 ohms/volt Multitester Model TE-424 fits conveniently in a tool case or is handy size for bench use. Easy-view



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meter has color coded scales for greater accuracy with pop-out stand to keep meter upright when in use. Operating ranges are AC/DC volts from 0-10-250 and 1000; DC current 0-250 ma; Resistance 0-1,000,000 ohms. Unit includes battery and test leads. Available at $12.98 from Olson Electronics, Akron, Ohio 44327.

Glass Mounted AM/FM Antenna

A new, glass-mounted AM/FM antenna gives greater range and crystal clear sound to mobile audio systems. Called the AFM-1,

(Continued on page 7)

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

Hank Scott, Workshop Editor
BUDGET ELECTRONICS
380 Lexington Avenue
New York, NY 10017

Saving Watts

The great job you did on attic ventilation can be helped a great deal by better fan control and the kind that is right up your alley. I used two thermistors in a bridge circuit tripping an SCR. One thermistor is outside in the shade. The other is in the attic. The outside thermistor continually biases, or resets, the attic thermistor so that its setting, where the SCR is tripped, is always about 5 degrees above the outdoor temperature. This is perfect from a heat gain point of view. It keeps the house heat pick-up from the attic to the bare practical minimum. My SCR sometimes short cycles on shut down, I have to work on this.

—G.K.M., Kettering, OH

Good to hear you're keeping down the watts and saving bucks. To prevent short cycling, I suggest you use a lockout feature that prevents the fan from coming on for a few minutes. Use a 555 IC with a variable time control. I believe a 5-degree temperature differential is too small. A well insulated attic could stand 20 to 30°F easily before the fan comes on.

Mike Tip

Hank, can you give me some tips on recording a vocalist.

—J.N., Walnut Creek, CA

Here are some simple rules for recording a soloist: The mike should generally be positioned 8-in. to 12-in. from the face and slightly to the side (to avoid "popping Ps"). If the recording is being done outside, a windscreen is a must. Recording a medium to large size vocal group represents more of a problem. A little "juggling" of the performers might be in order. The best idea is to position the strongest voices a little farther away so they won't overpower the weaker voices. In general, the best position for the mikes is slightly above head level. Choice of mike is most important. Dollars count when buying a mike; so if you plan to do some serious recording, get a good one!

Red Means Stop

Hank, I am building a low-light indicating system for my camera. I am planning to install an LED in the eyepiece which will shine directly and brightly into the user's eye, when the light level is too low to take pictures. Would the LED hurt the eye in any way?

—A.I., Nashua, NH

No way! But, don't make it too direct or too bright because you may cause a temporary blindspot on the retina of the eye. This would prevent you from focusing or viewing the next photo for several minutes.

Has Lots of Diagrams

I always notice that people constantly have trouble finding schematics, manuals, etc., and I thought I should write. My company has a large library of technical material, which includes the complete sets of the Rider manuals, the Bantam books, countless manufacturer's manuals, historic Sams' material, and the like. None is for sale, but we can run off copies and sell them at a small reasonable price. I know that you must be bothered by a large number of people with this problem, and we know you are anxious to rid yourself of this as soon as possible. Just tell them of our company and we can take care of them.

—Michael Catalanotti, Pres.
Novelty City Electronics
12 Woodberry
Sudbury, MA 01776

Thanks a lot, Michael!

R/C Does It!

I am interested in making a radio controlled shutter release device for my 35-mm camera. Do you know where I could find plans for such a device? I would like something with about a 300 ft. range, to be used for wildlife photography.

—B.N., Midland, TX

Visit any R/C model airplane hobby shop and you'll come away with some very good tips and products, too. Remember, the battery operated automatic rewind cameras make a lot of noise. The click and whine may scare away the birds.

Good Application

Hank, I'd like to know if the Digital Voltmeter project in the 1980 March-April issue of ELEMENTARY ELECTRONICS can be used in a variable (5-16 VDC) power supply.

—C.A., Las Vegas, NV

You bet. In fact, that's what your car's battery supply is when it's not charged properly.

Island SWLer

SWLs in Hawaii are scarce because there aren't any clubs of sort over here. I'd like to hear from some SWLs in Hawaii and get to know them so I can trade experiences with them and to know that I'm not alone. I am 13 years old and I have been a SWL since 1979. I logged about 40 countries, and received QSLs from Radio Australia, Radio Canada International, Far East Network, Radio South Africa, and N.H.K. Japan.

—Eugene Park,
2253 Kanealii Ave.,
Honolulu, Hawaii 96813

I sure hope you tie up with some active SWLers because sharing experiences is the best way to gain knowledge in your hobby.

Look Alikes

What's the difference between the 7400 and 7401 integrated circuits? Both consist of quad 2-input NAND gates.

—L.Y., Honolulu, HI

No difference until you look at the terminal diagram. One gate on the 7400 has inputs on 1 and 2, and output at 3. Whereas, the 7401's corresponding gate has its inputs on 2 and 3 and output at 1. The big difference to the fussy builder is printed circuit layout. Select the unit that provides the simplest foil layout. Solderless board builders don't really care—use either chip.

Pack O'Programs

I've got a TRS-80 and it works fine. Where can I get some programs that I can work on to make them better, to better learn TRS-BASIC? No, I don't want tapes or discs.

—J.N., Irving, TX

Pick up a copy of Tab Book's "1001 Things To Do With Your Personal Computer." It's a real fun book, full of programs you can use directly, or modify to your needs. Write to Tab Books at Blue Ridge Summit, PA 17214. It sells for $7.95 and is a hot buy!

Tops to LASCR

I'm trying to locate a LASCR by Radio Shack: part number 276-1095. I plan on using the LASCR for an auto strobe-slave flash. I have exhausted all cross-reference sources.

—E.R., Aberdeen, SD

You're out of luck. Radio Shack dropped this hot item because they can't be supplied anymore. I know of no replacement. Looks like the demise of an electronics part.

Moog Good

I've listened to many synthesizers, but the Moog is the best with its fat sound. How do they do it?

Moog circuits are about the same as others, but their filters, protected by patents, are excellent. That's the difference.

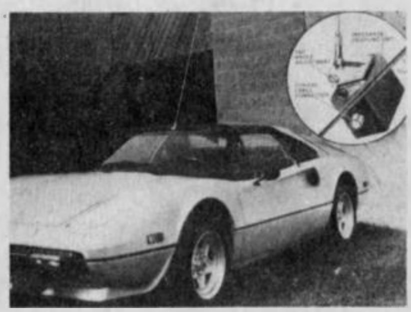
First Transistor Radio

I received a note from a reader who has a Regency pocket transistor radio, circa 1954, which is claimed to be the first

(Continued on page 103)

New Products

this antenna has three unique features. First, it's a 3 dB gain-type antenna which greatly exceeds the performance of window wire or fender mounted and retractable antennas. The AFM-1 helps to eliminate poor reception caused by signal blocking which occurs in mountainous or rolling terrain, as well as in urban areas where large buildings interfere with FM radio signals. The AFM-1 showed up to a 30 dB increase over an imbedded, window-type antenna. The second main feature of the AFM-1 is the Ritter noise control circuitry contained in the black pick-up box. This advanced feature enables the AFM-1 to reduce noise and static before it ever



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gets to your mobile radio. Last, the AFM-1 can be mounted quickly and easily on a glass windshield or window without drilling holes in the vehicle, and it sells for $34.95. For more information on the AFM-1 contact: Avanti Research & Development, Inc., Audio Division, 340 Stewart Avenue, Addison, IL 60101.

AM/FM/CB Disguise Antenna

A new 3-way antenna system by The Antenna Specialists Company disguises the fact that a CB radio is in the vehicle, helping to prevent theft. The antenna looks like a standard auto antenna and has no visible coil to show that it works on CB. It simply mounts in place of the standard AM/FM cowl mount antenna. Special hidden couplers permit it to give excellent performance on CB as well as AM and FM broadcast reception. Called the model M-266, the antenna includes a solid-state preamplier to significantly boost FM signal reception. By providing up to 15 dB of signal boost, it helps

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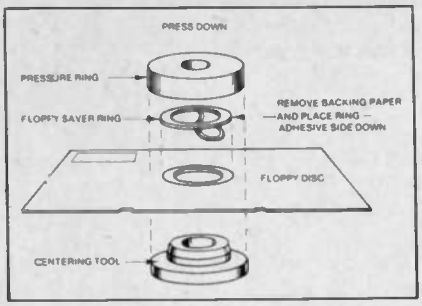
prevent noisy reception from distant FM stations and also reduces the "picket fencing" caused by rapidly changing signal strengths during highway driving. The suggested retail price of the new model M-266 antenna system is $49.95. Complete details are available from A/S antenna suppliers or by writing directly to The Antenna Specialists Company, 12435 Euclid Ave., Cleveland, OH 44106.

Ring a Floppy

The Floppy Saver is a reinforcing ring designed to lengthen the life of mini-disks by preventing damage to the center hole by the clamping hub and rotating spindle. Such damage can cause loss of the data and the disk. Floppy Saver is made of 7-mil (.007) my-



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lar with paper-protected super adhesive backing. The rings are punched on a special steel die with a tolerance not exceeding 0.0005-inches. The Floppy Saver is easily installed with the special tool provided and in many cases can resurrect damaged mini-disks. Price is $14.95 for a kit with 25 rings and tool. Contact your computer store or Tri-Star Corporation, P.O. Box 1727, Grand Junction, CO 81502. ■

BOOKMARK

Keeping Cool. It is amazing how an electromechanical-fluid system can seem so complex to us. So much so, that we cannot analyze what is wrong with it when it fails. *You and Your Air Conditioner* by Louis J. Mangro, Jr., is a practical guide to air conditioning repair. The layman will find easy-to-follow, step-by-step explanations of what must be done and how to do it. This service manual is for the use of the average air conditioner owner who would like to save money by avoiding expensive service calls .The author tells the reader how to troubleshoot and then shows how to replace defective parts and perform other maintenance on both central and window-

Repairing your air conditioner the easy way.

Soft cover
54 pages
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CIRCLE 60 ON READER SERVICE COUPON

unit air conditioners. Photographs and schematic drawings make it possible for the less experienced do-it-yourselfers to work safely and confidently from the directions in this manual. Published by Dorrance & Company, 35 Cricket Terrace, Ardmore, PA 19003.

Audio Builder's Guide. Now, with the over 100 projects contained in *The ABC Book of Hi-Fi/Audio Projects* by George Leon, anyone can boost the capability and performance of any hi-fi/audio system—or build a complete system from scratch if preferred. Each project is accompanied by a complete schematic wiring diagram and a detailed parts list. Many have PC board layouts ready for photo pickup. In this learn-as-you-build volume, the reader will find out how to design his own circuits, how to create new audio power supplies, how to

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build amplifiers, how to use timer circuits, how to make mockups of chassis layouts and control panel designs, how to construct enclosures, how to make mixer circuits, how to make printed circuit boards, how to build preamplifiers, how to modify and futurize his system in hundreds of ways. And one doesn't have to be an electronics whiz kid either—even a beginner can follow these simplified instructions and explanations—and then customize to his heart's content! Published by Tab Books, Blue Ridge Summit, PA 17214.

For Project Builders. *A Beginner's Guide to Making Electronic Gadgets* by R. H. Warring is a new project-by-project self-training course in modern electronic circuits and devices. It has a thorough introduction to the fundamentals, lots of easy-reading build-it instructions, and plenty of detailed circuit diagrams! The book explores every modern circuit type and device, and then shows how to use the information learned to create more complicated and sophisticated circuits. Step-by-step instructions, backed up by circuit diagrams containing parts values, show how to build a wide range of devices using all the latest semiconductors and miniature components like transistors, resistors, FETs, capacitors, etc. You can build circuits like audio oscillators, transistor radio boosters, DC ampli-

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fiers, stroboscopes, tuned amplifiers, band stop filters, RF and IF amplifiers, Hartley oscillators, telephone amplifiers, light-operated oscillators and output stages. Published by Tab Books, Blue Ridge Summit, PA 17214.

For Skyhook Dreamers. Hams, mobile operators, CBers, or SWLs, here's one manual that's a made-to-order guide to designing, building, installing, selecting, buying, and customizing any HF/VHF antenna wanted—from basic dipoles to stacks of beam antenna arrays! It features step-by-step instructions, lots of definitive schematics, plenty of shop-around info, and easy-to-follow reviews of antenna basics. It's the *Home-Brew HF/VHF Antenna Handbook*, by Bill Hood. It starts out at square one, with accurate coverage of essential antenna principles, elementary formulas, and basic antenna configurations, materials and ground systems. It's all solid antenna-building info, data that helps create intelligent designs that can reach out and grab the DX the reader wants. And to simplify antenna work, this comprehensive volume gives a fast-and-easy lesson in building and buying the accessory gear needed to design and maintain any anten-

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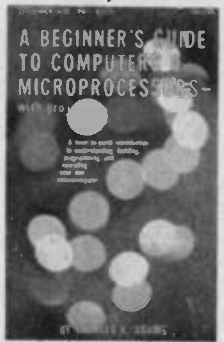
na system. Precise directions and detailed schematics teach how to construct dummy antennas, SWR meters, impedance bridges, field-strength meters, dip wavemeters, reflectometer circuits, traps, L and Pi-networks, filters, coupler circuits for any matching situation, and more. Published by Tab Books, Blue Ridge Summit, PA 17214.

Get Started With This One. You will have to look around for a long time before finding a better introduction to computers and microprocessors than *A Beginner's Guide to Computers and Micropricessors—with Projects*, by C. K. Adams. This manual is packed with information needed to understand, assemble, program, and troubleshoot a practical small computer system. It's a comprehensive guide that leads step-by-step from basic theory to computer customizing. Theory programming techniques, hardware, circuitry, applications—author Adams covers every aspect of the subject from every relevant angle, and he does it



An excellent, hands-on intro to home computers.

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CIRCLE 61 ON READER SERVICE COUPON

without getting too technical, without assuming the reader is a computer expert. To reinforce what is learned, he provides two chapters of ready-to-build projects centered around a simple, 8-bit 8080A microprocessor. All the elements to make a microcomputer project a success are there, from a 512-byte EPROM, to a 16-button data-entry keyboard. At reasonable cost, from readily available off-the-shelf parts, one can put together a small working computer system—and program and de-bug it! Published by Tab Books, Blue Ridge Summit, PA 17214. *(Continued on page 12)*

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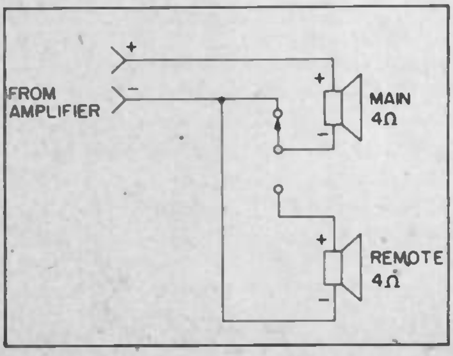
BUDGET TIP— Matching Remote Speakers

At one time, some of the very best high fidelity speakers had a 4-ohm impedance rating. Many of these speakers are still in service, as they offer performance that would cost several hundred dollars to replace with modern speaker systems. Unfortunately, if you presently own a solid-state amplifier, it's difficult to use the 4-ohm speakers in main-and-remote combination because the usual parallel speaker connection will result in a 2-ohm load, and many solid-state amps will virtually self-destruct if the speaker load is less than 4 ohms. Fact is, some solid-state amps cannot handle loads less than 8-ohms.

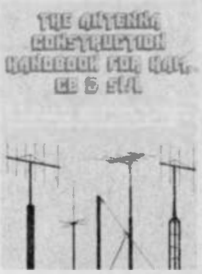
If you face this problem, simply use this series-switching arrangement: Instead of halving the load when the main and remote speakers are *on*, it actually doubles the load impedance, allowing the amp to run safely. (Note: This works for both 4 and 8 ohm speakers, so you can use the arrangement even if your amp is rated for an 8 ohm minimum load impedance.)

When switch S1 is "up," only the main speaker is *on*. When S1 is "down," the main and remote speakers are connected in series so that the effective impedance is equal to the sum of each speaker impedance. If the speakers are to be used in the same room, they should be "polarized" in-phase, as shown by the "+" and "–" symbols in the schematic. Generally, a speaker will have a color dot to indicate the positive terminal. If there is no dot, or any other marking, and the speakers are the same type, simply assume that they are wired identically and assign a "positive" designation to either terminal; for example, the *right hand* terminal on each speaker can be marked "positive." ■



BOOKMARK

Skybook Bible. Now it's all in one place—*The Antenna Construction Handbook for Ham, CB & SWL*, by Rufus P. Turner. The antenna is our interface with space—the last component at a transmitting station and the first at a receiving location. It consequently is a strategic device, and if it does not function efficiently, the finest transmitter or receiver is wasted. Designing and building one's own performance-boosting, super-efficient and super-practical antennas from scratch—that's what this book is all about. It shows how to construct any antenna for any purpose, for any kind of installation. Every conceivable type of antenna system—transmitting and receiving, fixed and mobile, emergency and makeshift antennas—is examined in careful detail in language the beginner can easily understand. Published by Tab Books, Blue Ridge Summitt, PA 17214.



Shows how to build a better signal "trap."

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Z-80 Brain Waves. The Zilog Model Z-80 represents a microprocessor that is extremely sophisticated and attractive to many computer users. Now you can pick inside the Z-80's brain by reading *Z-80 Microcomputer Handbook* by William Barden, Jr. Organized into three sections, the first section concentrates on hardware; the second on software; and the third on microcomputers built around the Z-80. This handbook will provide the current user and the prospective user with essential infomation on the technology of the Z-80 Published by Howard W. Sams & Co., Inc., 4300 West 62nd St., Indianapolis, IN 46206.

A handy guide to the Zilog microcomputer.

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304 pages
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CIRCLE 62 ON READER SERVICE COUPON

Solid on Solid-State. A new and updated edition of *Understanding Solid-State Electronics* published by the Texas Instruments Learing Center Library. This third edition covers today's semiconductor technologies and products, and reviews earlier electronic devices and integrated circuits to provide any person with a basic understanding of solid-state electronics. Written in plain, non-technical language, *Understanding Solid-State Electronics* is a self-teaching textbook complete with quizzes and glossaries. New additions include comprehensive discussions on MOS and large-scale integrated circuits; how an MOS transistor works, how it compares to a bipolar transistor and how MOS transistors have made microprocessors and microcomputers possible. New details are also provided on linear integrated circuits. *Understanding Solid-State Electronics* explains how diodes, transistors, thyristors and integrated circuits are made, how they work, and how they are used in systems. Other topics covered are: what electricity does in systems; how circuits make decisions and how semiconductors relate to systems. The books may be ordered from Texas Instruments Incorporated, P.O. Box 3640, M.S. 84, Dallas, Texas, 75285.

A comprehensive course for beginners.

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270 pages
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CIRCLE 63 ON READER SERVICE COUPON

Tuning In. Thanks to author Oliver P. Ferrel, the *Fourth Edition of Confidential Frequency List* identifies over 6000 stations operating betwen 4000 and 25,590 kHz in what is broadly termed the "Utility" stations. This compilation in a new convenient format is a "hot dog" text for SWLs who specialized in tuning in Military, Coast Guard, Maritime, Aeronautical Mobile, Fixed, VOLMET Time, RCMP, etc. stations. The authenticity of the text springs from the author's lifetime experience. Perry, as his friends call him, wrote numerous articles on FM and VHF propagation in the late 1930's. After service in WWII, Perry served as chief editor of CQ, Stereo Review and Popular Electronics. He has published original research papers on meteoric unization and sporadic-E cloud movements. The ***Confidential Frequency List*** is published by Gilfer Associates, Inc., P.O. Box 239, 52 Park Avenue, Park Ridge, NJ 07656. ■

Firsthand "Utility" station news.

Soft cover
104 pages
$6.95

CIRCLE 64 ON READER SERVICE COUPON

"Buy one speaker and get the other one free!" "Buy this stereo receiver for one penny!" "Buy this complete stereo system and we'll pay you to take it away!" You've undoubtedly heard hundreds of claims like these, but have you ever wondered how the audio dealer can honor these offers and still stay in business? Have you ever marvelled at those marketing miracles or did you just write a check, load up your car with the advertised goods, and hustle home as quickly as you relinquished your money?

The high fidelity industry is unique. With the exception of a neighborhood tag sale, or a Barcelona open-air produce market, no other business offers the consumer such apparent bargains.

Was your purchase the result of an intelligent decision, or was it merely an impulse brought on by a "last chance" deal that would be offered weeks later at the same store? Although you may be equipped with a thorough knowledge of technical information, specification details, and product familiarity, you may wind up dumping your carload of bargains into the nearest refuse receptacle.

By being aware of a few facts concerning the battle strategies employed by those involved in stereo price warfare, you, the consumer, can avoid the pitfalls that are camouflaged by that lucrative "deal."

History. Prior to 1975, it is unlikely that you would have seen such outrageous advertising claims as you do today. A fossil called "Fair Trade" hovered over the heads of dealers, preventing them from discounting the manufacturer's list price of an item. Thirty-six of the fifty states were bound by the Fair Trade Law. Some dealers were even taken to court for violating it. The law had been instituted some thirty-five years earlier in order to encourage the growth and well-being of post WW II business. Since a turntable at store "A" was the same price as the identical machine in store "B," the consumer's choice was based upon personality, service, and salesmanship. Price competition did not exist.

In 1975, the government decided that repeal of the Fair Trade Law would benefit the consumer. The original intent of the law had long since been realized by the dealer and now should be revised or dissolved to ensure better prices for the buyer. By the beginning of 1976, all participating

FOR YOU I'VE GOT THIS DEAL...

states had repealed the law. Prices dropped. The consumer bought, and bought, and bought. As a result, the audio industry blossomed from a 1.7 billion dollar business in 1975 to an awesome 4 billion dollar enterprise in 1978.

With the former protected profit margins now gone, how does the dealer survive? Was the repeal of the law an actual benefit to the consumer? The staggering growth figures of the audio industry indicate that the consumer has aided the growth. How could you be getting such a great deal and still enable the industry to flourish? Be aware.

"Black Box!" The most notorious method of maintaining a respectable profit margin in the hi-fi industry is the sale of "black box" or "house brand" speakers. These inflated list, low dealer cost items are designed to offset the declining profits realized in receivers, amplifiers, and other electronic components. A "black box" may bear a list price that quadruples the dealer's cost. Thus, a dealer may offer a "sale" that allows him to sell one speaker at regular retail price and give the matching counterpart away free of charge. He can still maintain a healthy 100% profit.

Some of these speakers can be recognized by a series of letters that indicate their "brand." These letters are often the initials of the selling firm. Joe's Bargain Stereo sells JBS speakers. But be aware that many highly reputable hi-fi companies, such as JBL, JVC, KLH and BIC, use their initials on their products. It is this confusion factor that enable dealers to claim high prices for house brands. It seems so obvious when put into print, but many consumers are confounded, or just don't make the association at the point of purchase. The best way to unmask these great pretenders is to familiarize yourself with the names mentioned in **Hi-Fi/Stereo Buyers' Guide** and other quality hi-fi magazines, since the only units mentioned are from recognized manufacturers. If it isn't mentioned, it ought to arouse your curiosity or encourage further research.

Black box", speakers are not fundamentally poor sound reproducers. In fact, some are rather good. They are conceived with a marketing idea in mind rather than the pursuit of sonic excellence. They are often the brainchildren of company executives who supervise the construction of boxes, shipping cartons, and wooden crates. The executives of these companies, observing the potential in the expanding audio industry, direct the construction of boxes, arrange for the provision of raw components from various driver manufacturers, and merchandise the finished product as their own "high fidelity" loudspeaker. Have you ever wondered how you could have purchased that impressive looking six-way tower for the same price as your friend's modest two-way bookshelf speaker? You paid only for the raw materials. The extensive cost of research and development required to manufacture a first-rate piece of audio equipment did not have to be figured into the price. If you think that you got a great deal on the monoliths that dwarf your friend's cufflink containers, try to sell those hulks in five years. Their resale is difficult, and the lifetime warranty that was offered with them at the time of the sale is now void because the manufacturer has changed its name and now only markets funeral caskets.

Try buying one of those high quality receivers for one cent *without* the purchase of the advertised set of speakers. Can you still take advantage of the one penny receiver ad? No. you can't.

Cartridge Deals. Massive profits for the dealer are also concealed within the tiniest stereo component, the phono cartridge. A cartridge listing for as much as sixty dollars may cost the dealer as little as eight bucks. There are many reasons for this seemingly unfair profit enjoyed by the dealer.

Many consumers don't realize that the cost of a cartirdge is *not* included in the cost of a turntable. Therefore, the cartridge manufacturer accommodates the dealer by providing him with a virtual give-away item. If the consumer *is* aware of this separate component, it enables the dealer to offer an apparent substantial discount on the turntable/cartridge combination.

Unfortunately, recognition of these inflated list phono cartridges does not come as easily as the identification of "black box" speakers. Most or all of these items bear familiar brand names. The intricate technology required to manufacture these micro-reproducers eliminates the mass-merchandising furniture or food chains from participating. The cartridge manufacturers recognize the necessity of maintaining the dealer's profit in order to assure their own existence.

Beware of that fifty dollar cartridge that is "thrown in" with the deal on your stereo system. You can benefit by paying a mere ten to twenty dollars additional investment and get a true hi-fi, rather than promotional, phono cartridge.

There are three types of phono cartridges. The first is the promotional freebee that is included with the purchase of any turntable. The second, though it may bear the same "list" price as the former, offers exceptional performance for a small additional cost. The third type are about the same mark-up as other audiophile equipment and should be considered separtely when purchasing a hi-fi system. These are for the avid hi-fi hobbyist. If you are a neophyte in the stereo jungle, avoid the first category. If you are a sound fanatic, go for the third. Phono cartridges in the middle category represent excellent overall consumer value.

Consult reviews in consumer maga-

zines to see if your cartridge has been reviewed. If it hasn't, you may be looking for that proverbial "needle in a haystack." Unless you are familiar with the product, confront the dealer. If you let him know that you are aware of the cartridge marketing facts, he will most likely lead you in the right direction.

Component Hoopla. Electronic components, amps, receivers and tuners, pose a different problem for the consumer. These can be selected on a more objective basis than speakers or phono cartridges. Power, distortion, sensitivity, and selectivity claims are carefully monitored by the Federal Trade Commission. The printed specifications of these components are solid, proven facts. Speakers and phono cartridges, on the other hand, possess those qualities which cannot be written down in black and white. "Uncolored," "open," "sweet," "smooth," and "silky" are intangible, subjective descriptions used to identify a speaker or cartridge. This sonic variation barely exists among receivers. The difference in performance is clearly spelled out in black and white.

What product line should you pursue? Which is the best? The fact is that they are just about all good. You may have to base your decision on features, cosmetics (Although this is an unpopular reason for choosing a component, remember, *you* have to look at it day after day. The salesperson doesn't.), circuit protection, or the feel of the controls. Suddenly an objective decision becomes subjective.

Subjectivity is not an undesirable attitude to maintain when evaluating a stereo system. In fact, an equal balance between subjectivity and objectivity will yield the most satisfaction for your money. Here are a few hints that may help you to realize this satisfaction:

Avoid amp/receiver lines, that are *consistently* "blown out" by dealers. Although the product may be good, *its* value and *your* investment are constantly declining. The low prices are not necessarily an indication of inferior quality, but rather, an indication of the manufacturer's marketing philosophy.

Know Your Dealer. Be cautious of the dealer who says that he does not carry a certain product line because "they all blew up," "they're quality has gone downhill since 1972 B.C.," or "the specs are overrated." The first reason is a lie, (today's electronic components are extremely reliable), (FTC preconditioning tests are rigidly observed since the 1974 court ruling). An audio dealer can't carry every line that is available just as a Ford dealer can't sell a Chevy product. Be wary of the salesperson who tries to sell by berating the product that does not grace his shelves. Listen to the dealer who sells his product on its own merits.

True Value. The best values in the hi-fi market can be found in end-of-year close-outs, demonstration units, and trade-ins.

A manufacturer does not discontinue a particular item due to problems. Models change at the rate of one a year and are no different than the changes in the auto industry. Don't worry about obsolescence. If you buy a 1980 Chrysler in 1980, it will inevitably be superceded by a 1981 model later in the year. The changes are primarily cosmetic, even though the manufacturer may introduce the new version as the embodiment of some major technical breakthrough. Actually, the manufacturer is anxious to get rid of his overstock of "old" models and offers a tremendous savings to the dealer. The dealer is anxious to clear his inventory for the advent of the new, "breakthrough" models and passes an *actual* value onto you.

Many consumers avoid the purchase of demonstration units. *You* shouldn't. Because of rapid model changes, a component rarely remains on the shelf for more than six months. In that six month period, the component receives as much use as an individual would give it in a two week period. Keep in mind that the demo unit you are looking at is only one of many on the dealer's shelves. It is not used exclusively as it would be in your home. Another positive benefit is that you know it works.

Trade-in components represent the "tied-up" profit of the audio dealer. The dealer generally wants to cover his cost when a new component is sold, and wants to turn the trade-in unit as quickly as possible. You pay only for the mark-up that the dealer is trying to retrieve, rather than a price that includes warranty service, advertising costs, and operating overhead. If you choose to buy a trade-in component, make sure that you ask for a warranty of at least thirty days. Most likely, the dealer will agree to this since trade-in gear is generally checked out before his original deal was made. If he refuses, stay clear.

Finally, observe the treatment that you get at various dealerships. The dealer who spends time with you before you have made your final decision is likely to spend the same time if you should have a problem after the purchase. The dealer who points to the price of an item and then shovels it out the door is likely to do the same thing with you if you should encounter any difficulty with the product.

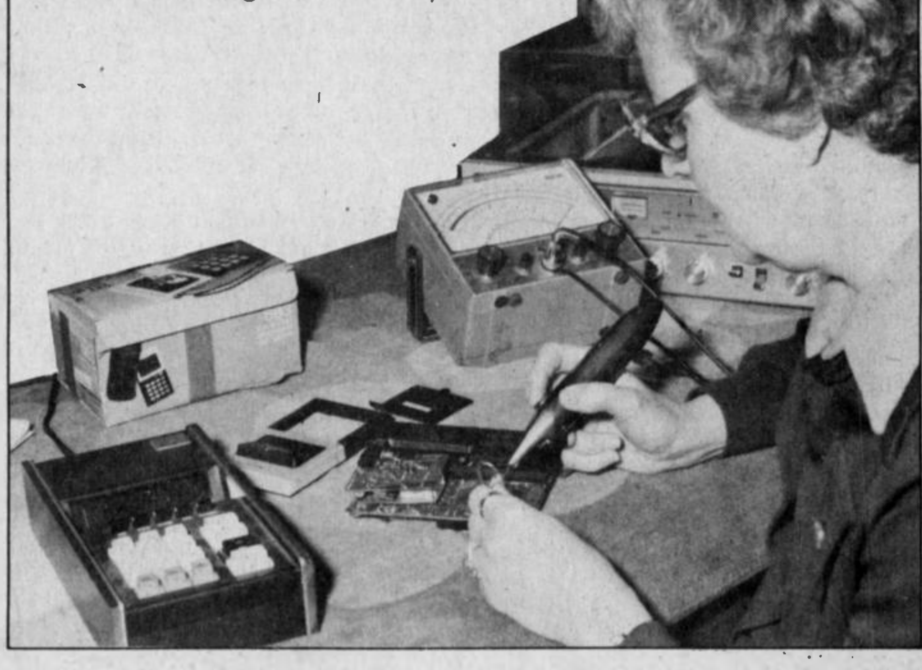
The audio salesperson is, like yourself, a hobbyist and a consumer. He has had the advantage of massive exposure to products that you might not be aware of. He knows . . . or should know all the technical details. Approach him with friendly skepticism, but not outright cynicism. He can become either your ally on the battlefield of stereo warfare or else a ruthless foe. Don't be an antagonist. That can only serve to thwart your potential "good deal." The arrogant question. "What's *my* price?," may not elicit an immediate response, but may manifest itself later in the form of slower service, or reluctant advice. Cooperate.

Rising costs and inflation have created a consumer who is more vigilant than ever. This is a time when you should be thinking about "what you are getting for your money" rather than "how much money you are saving." ■

Simple Calculator Repairs

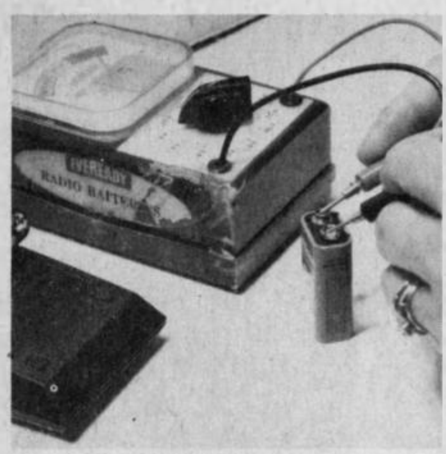
Don't throw that old calculator away!

Save time and money by troubleshooting calculators yourself



CHECKING OUT A MALFUNCTIONING pocket calculator is much easier than tackling a portable radio. There are fewer parts and they are not all squeezed together. Most problems found with the small calculator are quite simple and can be done quickly.

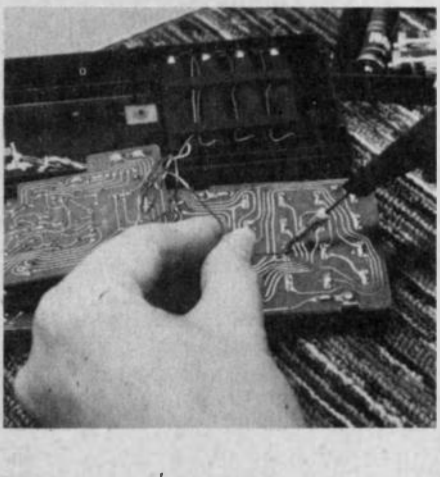
Most calculators are warranteed for 90 days. If the calculator breaks down in the warranty period, check the small warranty slip found in the original box, provided you didn't throw it away. A defective calculator may be returned prepaid to the manufacturer's service department. But, when the calculator breaks down after the warranty runs out, you may be able to put it back into operation with a few simple checks. Also, if you picked the pocket calculator up second-hand at a bargain table, you may find the minimum factory repair charge is more than you paid for it.



A simple battery tester like the one shown is a useful basic tool for checking and repairing small battery-operated calculators.

Checking the Batteries. Check for defective batteries since most pocket calculators are operated from only two power sources. You will find very tiny batteries in those thin type calculators. Be very careful when removing them, and always observe the correct polarity. Most battery polarity terminals are marked right on the plastic case. The calculator will not function if the batteries are put in backwards. In fact, you may damage some internal components by reversing battery cells. The suspected battery may be tested in a battery tester or with a VOM. If their quality is suspicious, replace them.

Since the small calculator pulls very little current, the batteries may last to the end of their shelf life. In other words, these small batteries should be replaced every year or so to prevent connection or component damage. When used constantly, they may need replacement three or four times a year. It's best to choose a battery that won't leak after a long period of time. You may find two or more small batteries in the pocket calculator.



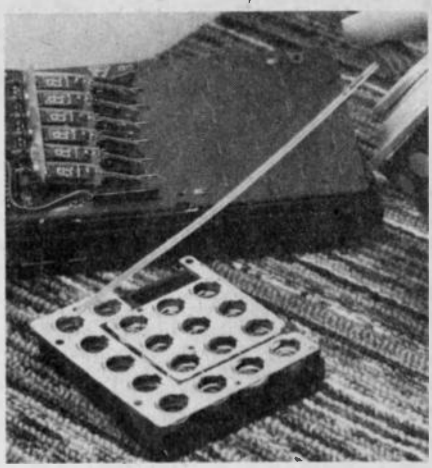
Great care must be used when working on a delicate PC board. Note the fine-tipped soldering iron, perfect for these spots.

Cracked PC Board. You may find a cracked PC board after careless handling or after an accident. When the calculator is accidently dropped or knocked around, check for broken wiring connections or a cracked PC board. In one particular instance, a pocket calculator was accidently dropped upon the cement floor of a garage and the cover accidently run over by a car. The only damage incurred was a broken corner of the calculator case and PC board.

Simply use small, solid hookup wire and join the broken foil ends. In very small pocket calculators, the PC foil is very thin and closely spaced. Scrape the PC foil with a pocket knife to bare any insulated areas (some PC boards are sprayed with a clear plastic liquid) then join the broken area with a piece of bare hookup wire. Be very careful not to overlap the soldered connection onto any adjacent PC foils. If the PC foil is really thin, select one strand of copper wire from stranded hookup cable and use it to join the broken areas back together.

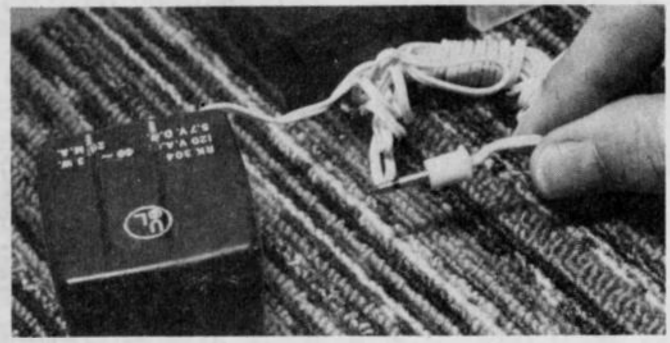
Defective Switch. If the calculator will not light up after new batteries are installed, suspect a defective On/Off switch. Wiggle the switch back and forth while checking for the numbers to come on. A dirty On/Off switch may produce erratic operation. Try spraying tuner or contact cleaner down into the slide switch area. You may be surprised to find that the lights come on and you can now add or subtract once again after this.

When the switch appears broken or doesn't make contact, check for poor switch continuity. Remove the back cover to get at the switch. Notice if all wires connecting to the switch are soldered in place. Now measure the resistance across the switch terminals. Make sure the batteries are disconnected. You should have a dead short across the switch contacts with the switch in the "On" position. If not, pull the switch out and disconnect all wires. Now, repeat the continuity test. Try to clean the switch contacts before ordering a replacement. In some small units, you may have to replace the whole keyboard, since the On/Off switch is sealed inside of it.



Spraying with one of the silicone cleaning and lubricating aerosols in very often a cure for problems with switch contacts.

Bad AC Adapter Jack. When the calculator will function on batteries and not with the AC power supply, suspect a defective power supply or adapter jack. If you had been using the calculator from the power line when it went dead, substitute batteries to determine if the calculator is at fault. You can measure the DC voltage at the output of the AC adapter jack with a VOM.



The most common fault with AC adapter jacks is defective contacts. If spraying with tuner cleaner doesn't help, you may have to replace either the jack or the plug that goes into it. Both of these repairs are easy to do.

If the DC operating voltage is present from the AC adapter, check for a defective female jack. A lot of these female jacks are very tiny and may be easily damaged. Generally, they are the self-shorting type, so when the AC adapter plug is out of the calculator, the batteries are switched into the circuit. First try to clean the jack contacts with tuner or contact spray. Move the male plug in and out to help clean the contacts. The broken or defective jack may often be replaced with a small earphone type jack found at Radio Shack or other Radio-TV outlet stores.

It takes only a very small amount of corrosion to prevent juice from getting to the calculator's circuitry. A light going over with alcohol very often does the trick.

Corroded Battery Terminals. When batteries are left unused for a long period of time, they begin to leak and corrode around the battery terminals. Try to keep fresh batteries in the calculator to prevent corroded terminals. Replacement with leak-proof and long life batteries helps, but after a long time they too may leak all over the battery case, corroding it.

Clean the battery terminals with alcohol or cleaning fluid. If the contacts are very corroded, scrape them with a pocket knife. Try using a small strip of sandpaper on the battery terminals. If the contacts are partially eaten away, you may have to make new metal contact strips. Select a piece of springy brass or copper material for this purpose and solder it on.

A shot of tuner cleaner or contact lube is usually all it takes to free sticking buttons, unless they are broken or have been heated to the point where they have fused.

Sticky Buttons. After a few years of operation, several of the most used buttons may not want to press downward, or they may want to just stay down. In fact, you would swear someone is pulling down on these small buttons. When plastic buttons work against plastic or metal areas, they have a tendency to stick and become sluggish.

You can cure this problem quickly by spraying contact lube or tuner cleaner down around the buton area. A drop or two of light oil will work as well. Work the button up and down until it is free. You might as well clean up all the buttons while you're at it. Wipe off all excess oil or cleaner with a soft cloth. Sticky buttons are a nuisance when trying to figure your income tax, adding today's enormous grocery bills or balancing checkbooks.

Calculator Repairs

Broken Terminal Wires. After carrying the calculator to school through the rush hour, and dropping the unit several times, you may find a broken terminal wire or two. If the calculator will not function after battery clean-up and replacement, suspect a broken connecting wire. Check the wires going to the battery terminals. Also, check to see if the On/Off switch wires are still connected to the terminals.

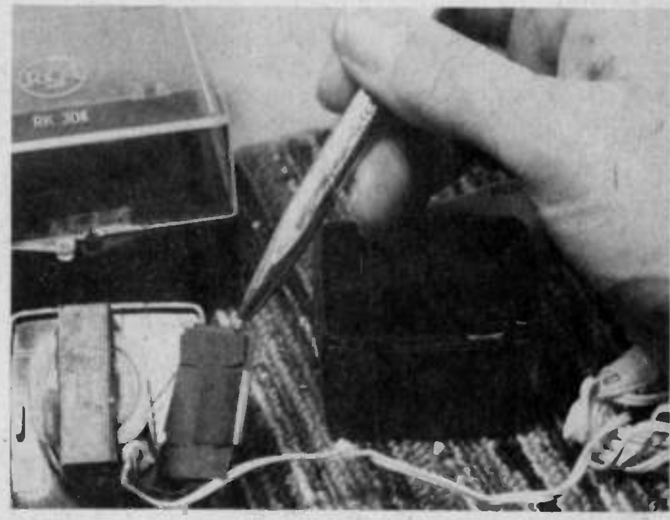
Sometimes you may find a broken conncting wire from the pushbutton assembly to the main PC board. You may find a broken terminal connection from the LED display unit to the PC board. Generally, the display unit is tilted at an angle to shield the display from overhead light. Use a very low-power soldering iron when making soldering connections on these delicate calculator boards.

A voltmeter is vital for checking out the electrical continuity, finding shorts and tracing through the circuitry. Pocket calculators very often show signs of abuse.

Defective Power Adapter. The battery eliminator or power converter plugs directly into the AC power outlet with the male plug inserted into the calculator socket. These small AC adapters or gadgets can save you money in the long run. Since leak-proof batteries are quite expensive, you may want to use the AC adapter instead. Check the enclosed literature, and you may find the operating voltage of your calculator. For instance, if the calculator uses three 1.5-volt batteries, the 4.5-VDC voltage adapter plug is used. If the calculator uses four 1.5-volt batteries, use the 6-VDC adapter plug. You may want to select a universal AC adapter with four different voltage sources.

If your battery eliminator or AC adapter is suspected of failure, measure the DC voltage at the male plug. No voltage at this point may be caused by a broken male plug, a broken cable or a dead power pack. Determine if the cord may be broken right at the male plug, or where it enters the AC adapter's case or housing.

It is possible to avoid replacing a defective AC power adapter by making a few simple repairs to the unit. Always measure the DC voltage at the male plug end to determine if the fault lies with the power adapter.



If one wire is broken at the male plug, cut off the cable about one inch up from the plug end. Always unplug the AC adapter while repairing it. Now scrape back the insulation and measure the DC voltage. If voltage is present, locate another male plug. Generally, these male plugs are of the molded type and cannot be used again. You may select a headphone-type plug the same size and install it. Be very careful to obtain the correct DC polariy at the male end to operate the small calculator without damaging it.

A Cracked Case. Rough handling or dropping the calculator may damage or break the plastic case. If the calculator ends up in a dozen little pieces, the plastic case may not be repairable. Some of the cases are made of tough plastic or impact material, and these may wind up with only a crack or two.

You can put the small calculator back into operation by repairing the cabinet with epoxy cement. Simply mix up the epoxy evenly upon a piece of cardboard. Then stick the broken pieces together, and apply a thin coat inside the container and on the outside. A broken corner may be repaired with a layer of thin cardboard held with masking tape on the inside. Then, apply a coat of epoxy over the broken area. Several layers of masking tape will hold the liquid epoxy in line until it sets up overnight. Sand down the rough corners with sandpaper or a coarse file. If the repair is too unsightly, spray paint the area, or the entire cover.

This list of troubleshooting hints should help you cure most of the common pocket calculator problems. And, especially these days, we can all use the savings in repair or replacement costs on these handy devices. ■

Simple cracks or breaks in the plastic of the calculator's housing can be repaired with epoxy cement. After applying epoxy, spray paint the case in its original color.

DARKROOM PRINT PERFECTOR

End the guesswork in print developing and save . . . Paper Time Money

A GOOD PRINT EVERY TIME is what you get using a printing meter. Whether every negative has a different density, or you continuously change magnification ratios, there'll be no need to waste paper or time making test strips or exposure guides. Just focus, slip the printing meter on the easel, close down the lens until two LED lamps on the meter turn *on*, place printing paper in the easel, and hit the timer's start switch. What you get after development will be prints that at the very least will be good, sometimes great. (*Great* prints are often made by dodging, using the basic time of a *good* print.)

If you're into color printing the printing meter can be used for the white-light exposure. After you've determined the correct color pack and time using the usual matrix guide, you can rack the magnification up and down without going through a complete series of matrix tests. Simply use the printing meter as you would for black and white printing—as we'll show you at the end of this article.

What you save in printing paper in one or two evenings' work will just about pay for this printing meter. What you save in time is immeasurable. You should be able to knock out 36 wallet-size exposures in less than one hour.

As for print quality, all the pictures used to illustrate this project were made with the meter, and they are all the very first try. Using a stabilization processor, from start to finish the prints were made in less than thirty minutes.

Picking Your Parts. Since the purpose of a printing meter is to save considerable money on supplies as well as time, we have carried the premise through to construction of the printing meter, which should cost between $7 and $15 depending on what components you have around the shop.

The entire meter is assembled on a printed circuit board, or solid phenolic board using point-to-point wiring, though the printed circuit construction is recommended. The board then becomes both the top of the meter's cabinet and the photocell "target," thereby saving the cost of a fancy cabinet, PC board mounting hardware, and a separate "target" assembly. Fact is, the few

To prevent a shock hazard caused by the pins sticking up on the top side of the printed circuit board, R1's terminals are tack-soldered to the pads on the etched side of the board. A strong physical connection is assured by through-the-board mounting of R1's shaft.

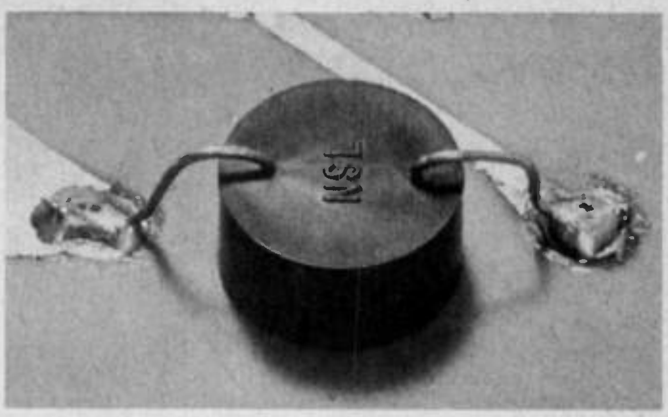
components sticking out on top of the board make the device a "conversation piece" for visitors to your darkroom.

Other than the photocell, which must be the exact unit specified in the parts list because it's selected for light sensitivity, value, and rate of change, and the size of the "target hole" under which the photocell is mounted, nothing is critical. Feel free to substitute if it will save a few dollars. For example, Q1 and Q2 can be any NPN silicon transistor of the 2N3394 type with a gain of 50 to 150. Even general replacement types from Radio Shack can be used. Similarly, the LEDs can be any type capable of handling at least 20 mA. Just don't use the sub-mini models because they are too small to easily see. The unit shown uses Radio Shack LEDs with Fresnel lenses because the lens makes them extra bright in the dark, and also keeps the light from falling on the photocell. The so-called *diffused* LEDs are even easier to see, but they are not always in stock at Radio Shack stores. Resistors are ¼-watt size, 10% tolerance.

U1 is any type of half-minidip, (8 pins) 741 operational amplifier. A socket is suggested for the IC because you can get a defective IC, and you will literally destroy the PC board trying to get it off the board if you don't use a socket. This is the only place it's worthwhile to spend a few cents extra building the printing meter.

Switch S1 can be any miniature type DPST. Many of you might prefer a momentary contact type which stays on only as long as the handle, or button, is held down. Don't worry about leaving the meter on and running down the batteries; one of the LEDs is always on if S1 is on, so it's unlikely you'll pack up for the night with the meter left on.

Potentiometer R1, which serves as the sensitivity control, has a *linear taper;* it's value is 100K, 250K, or 500K depending on how you use the meter.



After drilling a 3/16-inch hole in the PC board, center R6 in the hole, and tack-solder the leads to the solder pads in the same manner in which you attached R1.

Generally, a good rule of thumb is: "A print looks good if there is some black in it." This is standard metering practice. You make the exposure for maximum black somewhere in the print, which is produced by maximum exposure illumination coming through a negative area of minimum density. If you prefer this method, R1 is 100k.

If you prefer to balance "flesh tones" (greyscale), taking the exposure off, say, a person's forehead—much as you would when making portraits—a 250k value for R1 will be somewhat easier to handle. This is also the correct value if you "integrate" the exposing light for a "neutral grey value" by placing a diffuser under the lens when using the printing meter; the same as you do when making the matrix test exposure for color printing.

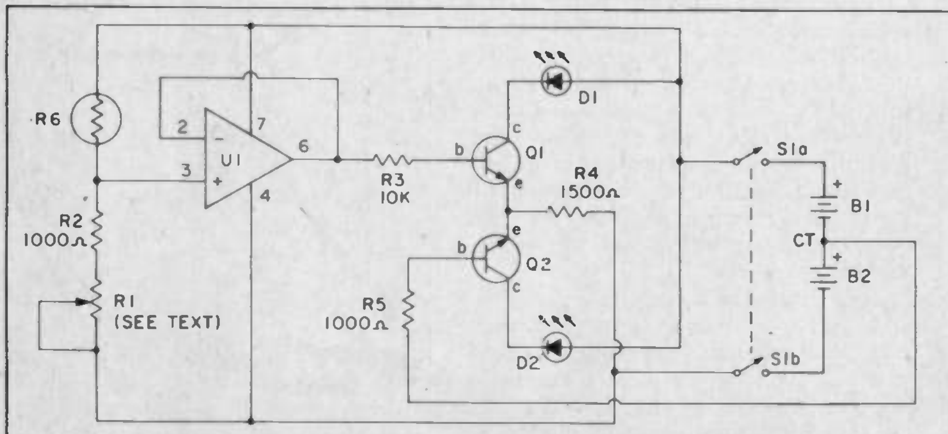
If you prefer "grey area" exposure metering, but have to deal with heavily overexposed or overdeveloped negatives, a 500K value for R1 is required. Increasing the value of R1 makes its calibration adjustment more delicate. Normally, 250K is a good "universal" value. The 500K value, however, lets you make a measurement that is often not even possible with rather expensive commercial printing meters.

Construction Notes. The "target hole" is precisely 3/16-inch. This is very critical. If you don't own the correct size drill, get one. Do not "approximate" its size. Photocell R6 is installed directly behind the hole.

No wires, such as those from the photocell, stick up through the PC board. They are soldered, as shown in the photographs, to PC foil "solder pads." These include the leads from R6, R1, S1, and the batteries.

Use battery terminals—don't solder wires directly to the batteries. Connect a red wire from one set of battery terminals to the black wire from the other battery terminal set, twist them together and tack solder them to the solder pad labled CT (for center-tap). The remaining red wire gets soldered to the "+" solder pad; the remaining black wire gets soldered to the "–" pad.

Final Checkout. Transistors come with an *ECB* or *EBC* lead arrangement; make certain you twist the transistors, if necessary, so the *B* and *C* (base and collector) leads aren't interchanged. Next, make certain that the IC's pin #1, the one indicated with an indent molded into its case, is near R1, not R6.



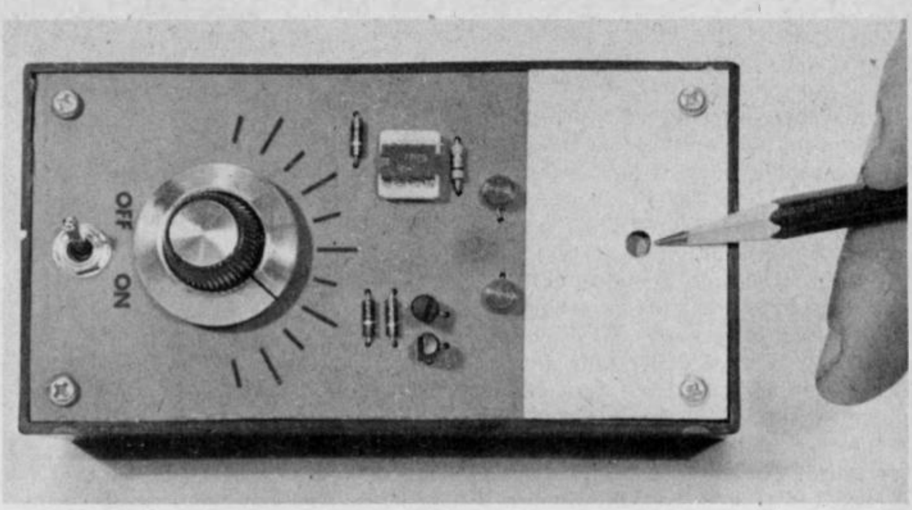
PARTS LIST FOR DARKROOM PRINT TIMER

B1, B2—9-volt transistor radio battery
D1, D2—red LED with diffusing lens, rated 20 mA
Q1, Q2—2N3394 NPN transistor or equivalent
R1—100K, 250K, or 500K linear-taper potentiometer (see text)
R2, R5—1,000-ohm, ¼-watt resistor
R3—10,000-ohm, ¼-watt resistor
R4—1,500-ohm, ¼-watt resistor
R6—type 4921 photoresistive cell—Do not substitute.
S1—DPST miniature toggle switch
U1—741 op amp (8-pin mini DIP)
MISC—cabinet, knob, PC board, IC socket, solder, battery clips, adhesive label, etc.

Note: The photoresistive cell is available for $4.00, and the PC board is available for $5.00 from Custom Components, Box 153, Malverne, NY 11565. Add $2.00 per order for postage, handling and insurance. Residents of New York must add 7% sales tax. Canadian orders must include an additional $2.00 for shipping. No foreign orders, please.

PRINT PERFECTOR

Install the batteries and turn S1 on. One or both LEDs will light. If neither light, either the LED polarity is reversed, or the Q1 and Q2 *B* and *C* leads are reversed. If all checks are okay, install a white target area cut from a piece of adhesive label (available at stationery stores). Punch a 3/16 or ¼-inch hole in the target, center it carefully over the 3/16-inch target hole, and then press the target down on the top of the PC board. Install a knob on R1's shaft, and install the PC board as the cover for a 5-1/16 by 2-5/8 by 1-5/8 inch Radio Shack Experimenter Box (#270-233).



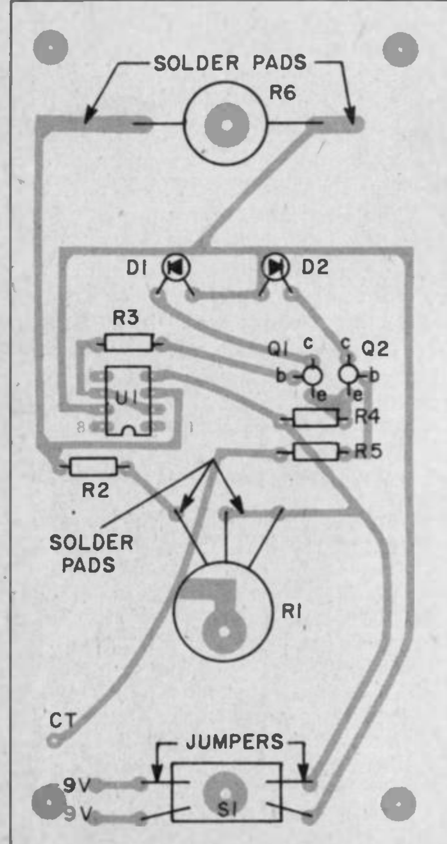
To make the front panel anti-glare mask, make a 3/16-inch hole in a piece of stiff oaktag apply cement to one side, center over the hole and press into position.

Using the Meter. First, calibrate the meter. Make a good print from a good negative using an exposure time of approximately 20-seconds. When you're satisfied with the print, do not touch the enlarger controls. Slip the printing meter on the easel and center the target hole under "maximum black" for the print, which is some point that has the brightest light coming from the enlarger. Then adjust potentiometer R1 slowly until both LEDs are at equal brilliance. In normal operation, one LED will be lit, then both light as R1 is adjusted, then the original LED will go out as R1 is rotated past the calibration point. Proper calibration is when both are at equal brilliance. Don't worry if they aren't precisely equal. The difference from the left LED switching on, to equal brilliance, to the right LED switching on is less than ¼ f-stop. (The printing meter is very fast.)

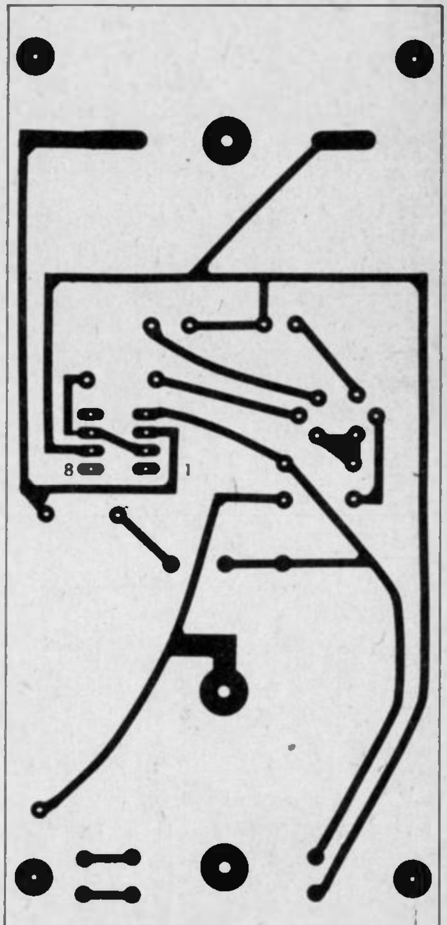
Once the meter is calibrated for your particular preference in print characteristics it's ready for use. Place the negative you want to print in the enlarger, rack for the desired size, and focus with the diaphragm wide open. Then pick the area of maximum light transmission, which will be black in the final print, place the meter's target hole in the brightest area and adjust the lens diaphragm until both LEDs turn on. The enlarger is now ready to expose, using your standard exposure time (20-seconds is recommended).

If you want a skin tone as the reference, simply make your initial meter calibration using a skin area, generally the forehead, as the reference light source. If you want an integrated calibration make the initial calibration with a diffuser under the lens, and make all subsequent adjustments through a diffuser. (Make certain you take the diffuser out of the way before you make the exposure.)

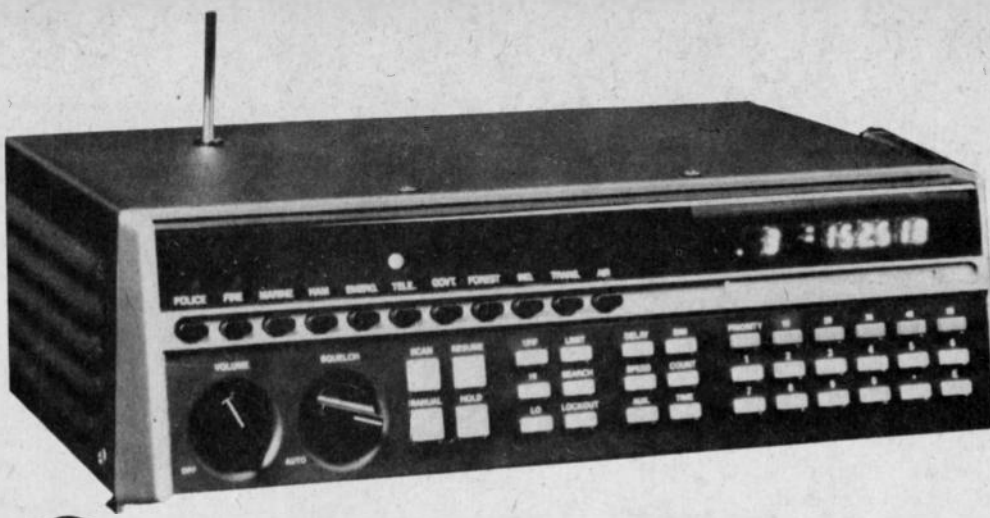
As a general rule of thumb, if you're making 4x5s or larger, or anything other than a portrait, exposing for some speck of black in the print is the best bet. For portraits, a meter reading off the skin is usually preferred—a portrait might not have any black in it to begin with. If you're grinding out what appear to be endless wallet-size "family" prints, an integrated, or "average grey" calibration will give you the easiest, and fastest way to grind out a stack of snapshots. For color print white-light exposure measurements, use the integrated method, using the diffuser that came with your color print kit. ■



You'll note that parts layout diagram is viewed from foil side. This is done to aid in orienting the R1 and R6 connections.



This is a full-scale template for PC board. The points marked "solder pads" on parts layout need no holes etched or drilled.



Scanner Antennas

Get the most out of your scanner at home or on the road

NEXT TO YOUR RECEIVER, an antenna is the most important component in an effective monitoring/scanner station. The finest receiver in the world is worthless without signals to hear. After all, those signals must be captured by the antenna.

Inside or Outside? Your scanner receiver probably came equipped with a short plug-in antenna, useful for metropolitan reception. Many scanner manufacturers recommend the use of that antenna only in order to prevent overpowering signals from causing a variety of problems in reception. Strong signal overload is a serious shortcoming with most scanning receivers.

But when signals are weak, or when the reception of distant stations is the goal, or if mobile operation is chosen, that short plug-in antenna won't help.

Fortunately, a number of reputable firms manufacture antennas directed exclusively toward VHF/UHF scanner users. There is a wide array of choices available, custom-engineered to your own requirements. For the sake of convenience, we will classify these products into two main groups: base station (outside, normally rooftop) and mobile.

The choice of an antenna, whether mobile or base station, will depend largely on two considerations: Is performance required on several bands—VHF-low (30-50 MHz), VHF-high (144-174 MHz), and UHF (50-512 MHz)? Are optimum reception and rugged construction important enough to justify premium cost? Once these two questions are answered, the rest is simple enough to figure out.

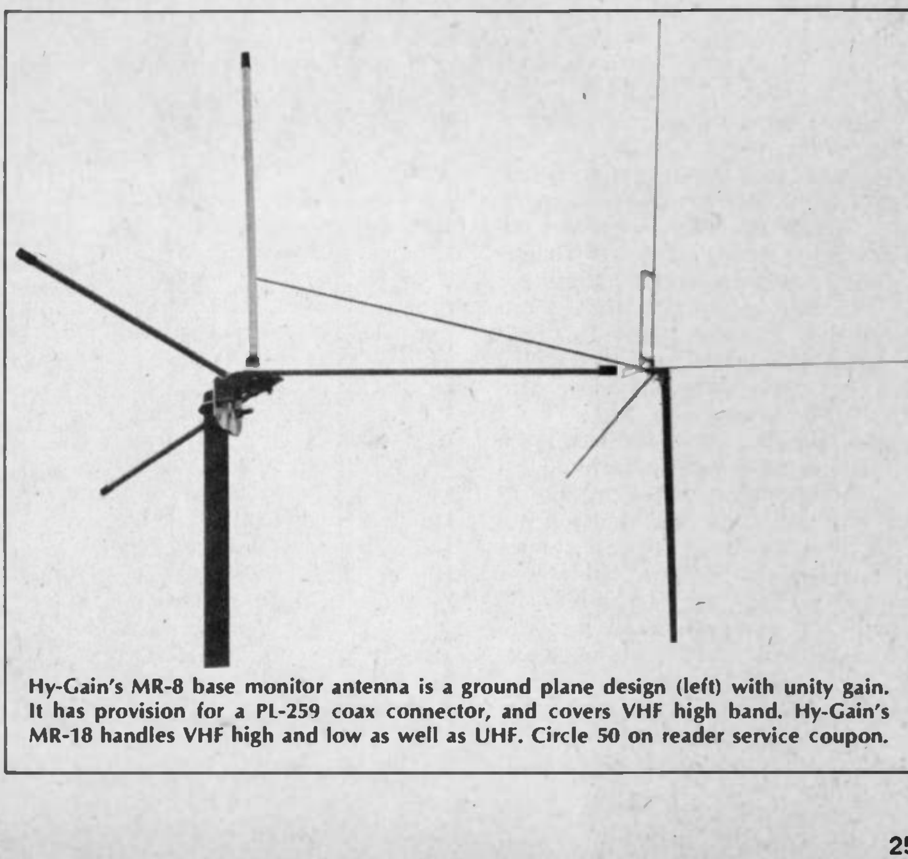
Base Station Antennas. For top performance, there is no substitute for a good outside antenna. It should be mounted as high as possible. Keep it free and clear of nearby obstructions like trees, wiring, or metallic objects. Generally speaking, the higher the antenna, the more will you be able to hear distant stations.

Most outside antennas are designed for rooftop mounting. They are omnidirectional, so you don't have to worry about "pointing" them in installation.

Commercial Antennas. Although it is certainly possible for the inveterate tinkerer to fabricate his own antenna, many manufacturers offer a variety of economical choices backed up by years of professional design experience. Why tamper with success?

When many hobbyists think of parts and equipment stores, they think of *Radio Shack* because there is hardly a town without one. To be sure, this super store chain has quite a selection of base antennas for scanners (as well as mobile antennas, which we will discuss shortly). A recent entry is their 20-014 all-band base antenna for $29.95. A VHF-high/UHF ground plane is also available (20-176; $10.95).

Antenna Specialists is one of the largest manufacturers in the business. A brand new catalog carries a number of scanner antennas, among which the MON-31 ($36.50) & MON-8 ($34.50) are particularly worth mentioning.



Hy-Gain's MR-8 base monitor antenna is a ground plane design (left) with unity gain. It has provision for a PL-259 coax connector, and covers VHF high band. Hy-Gain's MR-18 handles VHF high and low as well as UHF. Circle 50 on reader service coupon.

Scanner Antennas

Both are dual-band, ground-planes.

A close contender in the race for widest product line is *Hy-Gain*, now a division of *Telex*. Their MR-8 (VHF-high/low), MR-3 (VHF-high), and MR-4 (low band) antennas are directed toward the serious scanner buff.

Finco offers a model SMA-1 VHF-high/low/UHF antenna for only $14.20! This model is available with handy accessory kits one of which is a window mount (SMA1-WK, $35.10) for applications where a conspicuous roof installation can't be used.

Antenna Incorporated has been releasing new models at an incredible rate. Several of their new products are directed toward the scanner listener. The model 60501 covers VHF-low, high, and UHF bands—for only $21.09.

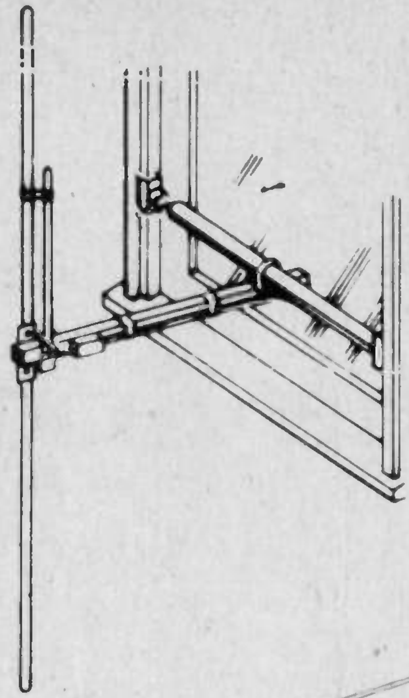
Probably no antenna ever designed has the wide frequency capability of the venerable "discone"—a 10:1 frequency range is typical! At this writing, and for many years, only one company has offered a VHF/UHF discone: *Hustler*. Their DCX is designed for general purpose use in the 40-700 MHz range. For those experimenters who want to hear things both inside and outside of the normal scanner tuning ranges, the Hustler DCX is a good bet ($19.95).

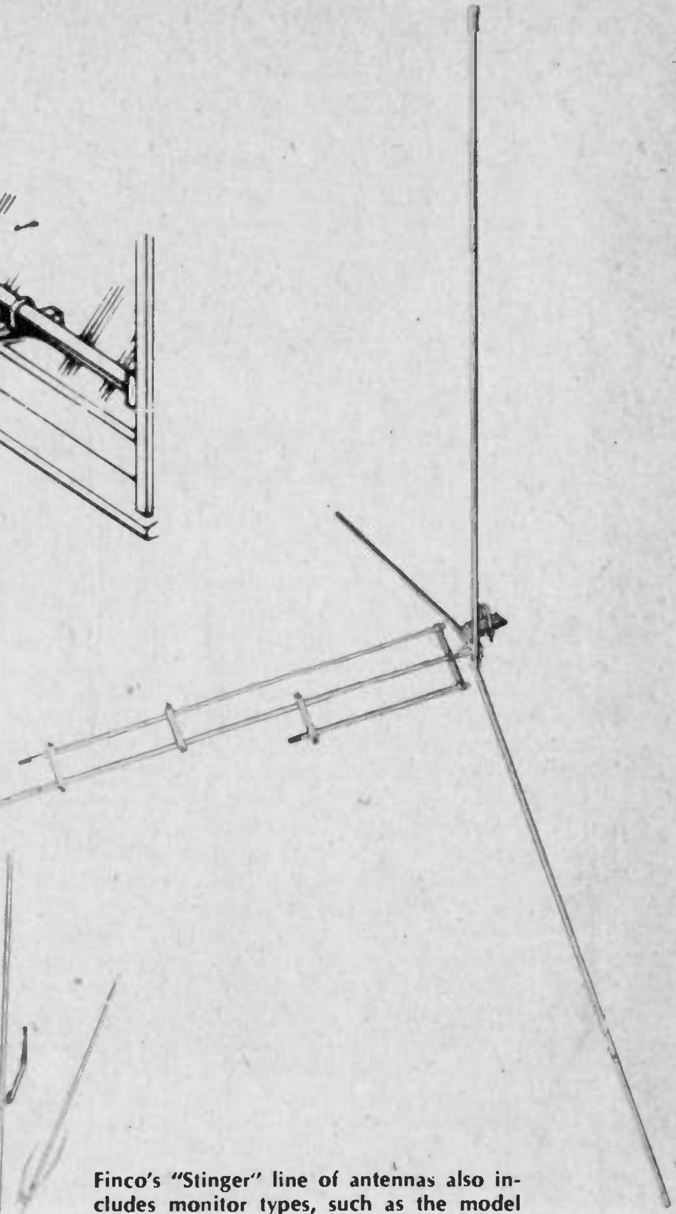
Avanti has become a living legend in CB antennas, and now they are offering a unique base station scanner antenna: The AV-801 "Astro-Scan." It's a big one—over ten-feet in length with its low-band elements! It offers better gain than most simple ground plane designs.

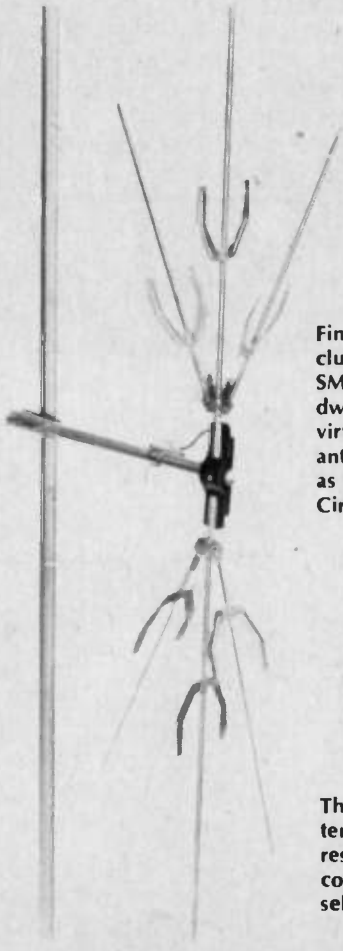
One of the weirdest looking base antennas we've seen for a long time comes from *Channel Master*. If you want to draw comments, try the all-band "Monitenna" (model 5094). It features a dipole cluster, arranged to resonate automatically at their proper design frequencies. *Channel Master* has built an excellent reputation with its fine line of TV antennas; their Monitenna continues that tradition.

Mounting the Antenna. Erecting an outside monitor antenna is no more difficult than installing a TV antenna. In fact, it is easier. Standoff insulators are not needed for the coax cable down lead, and monitor antennas are always lightweight. They are not directional, so it is unnecessary to point them toward a specified location. A single section pipe mast is satisfactory for roof mounting. An inexpensive chimney mounting kit provides rigid support.

If it is necessary for the antenna to



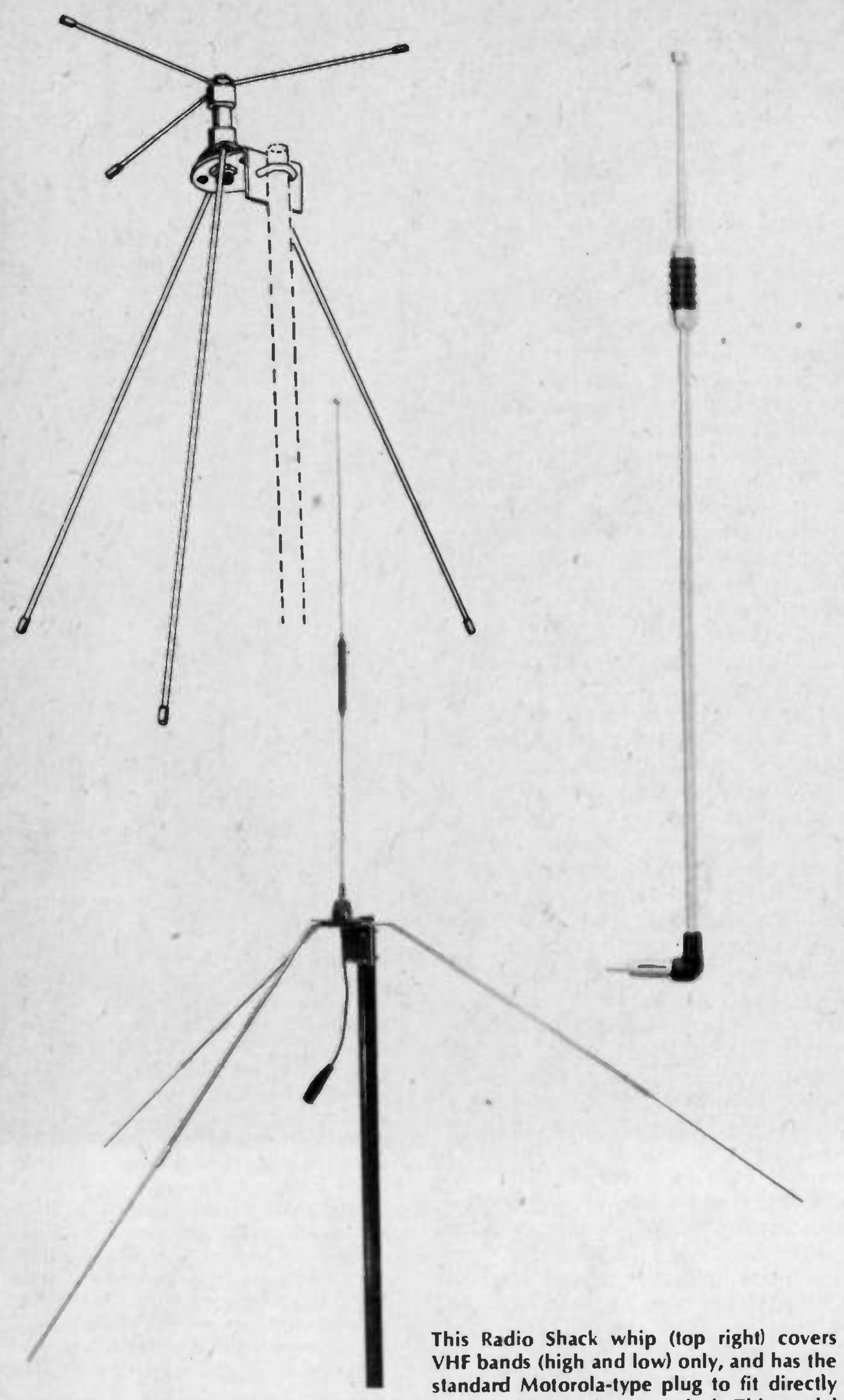




Finco's "Stinger" line of antennas also includes monitor types, such as the model SMA-1WK (top). It's ideal for apartment dwellers. Adjustable window mount will fit virtually any type of window frame, and the antenna itself will cover VHF high and low as well as UHF. It sells for $35.10 complete. Circle 53 on the reader service coupon.

Another all-band antenna is Radio Shack's model 20-014 (top center). Ground plane design works in conjunction with the three differently-tuned vertical elements. Circle number 32 on the reader service coupon.

The eye-catching design of Channel Master's model 5094 "Monitenna" (left) is the result of a set of three tuned dipoles which combine to provide all-band coverage. It sells for $25.25. Circle 52 for more info.



Hustler's model DCX discone antenna (top left) is an excellent, wide-range utility unit for continuous coverage from 40 to 700 MHz with no retuning necessary. Circle number 49 on the reader service coupon.

This Radio Shack whip (top right) covers VHF bands (high and low) only, and has the standard Motorola-type plug to fit directly into any scanners' antenna jack. This model 20-161 retails for $9.95. Circle number 32.

Antenna Specialists' MONR-31 (center) is an all-band ground plane with a center-loaded vertical whip. The built-in connector accepts a Motorola-type plug. It sells for $36.50. Circle 39 for more information.

be free-standing, many TV retail outlets sell push-up masts. Most important, the antenna must be high enough to be free of surrounding obstructions.

Coax. Use a good grade of coaxial cable for the downlead, especially if runs are in excess of fifty feet. This is doubly important if UHF reception is a primary consideration!

Before you buy cable, peel back a half inch or so of the vinyl jacket to have a look at the braided shielding. If you can easily see the dielectric (insulation beneath the shielded braid, and covering the center conductor), reject the cable. VHF/UHF coaxial cable *must* be well shielded for acceptable performance and noise rejection.

Another hint is the composition of the dielectric insulation itself. If is is styrofoam-white in color, it is probably low-loss, and especially desirable for scanner use. Most name-brand cable conspicuously labelled "low-loss" is of this type. Typical is the coax used in the cable TV industry. Often, substantial lengths of this excellent cable are discarded by cable TV installers, and hobbyists should not be hesitant to approach these sources for an adequate length for scanner-to-antenna lead-in. Don't splice! Use one length. If damage should ever require splicing coaxial cable, use only proper connectors designed for in-line cable splicing.

Small diameter RG-58 and RG-59 coax are useful on VHF for runs of less than 100-feet, especially if they are of the foam-dielectric type. On UHF, and for runs of 100-feet or more, use only large-diameter feedline such as RG-8 or RG-9. Cable TV coax is RG-6, and may require special adaptors for cable attachment, but the performance and low cost are worth the minor inconveniences involved.

Connectors. Years ago, manufacturers of automotive radios standardized on a plug-in antenna connector known as the "Motorola" type. All scanner manufacturers utilize that Motorola connector exclusively. Adaptors are available to interface with other fittings.

Mobile Antennas. Before installing a scanner in your car, check with your local police department. Some states and municipalities have laws and ordinances prohibiting the mobile operation of a receiver capable of intercepting police calls. Although these laws are being contested throughout the country, it is better to be safe than sorry.

Where Should I Mount It? In choosing the location for the installation of a mobile antenna, there are several considerations. First, the antenna should be mounted as high as possible; the center of the vehicle roof is ideal. Trunk lip

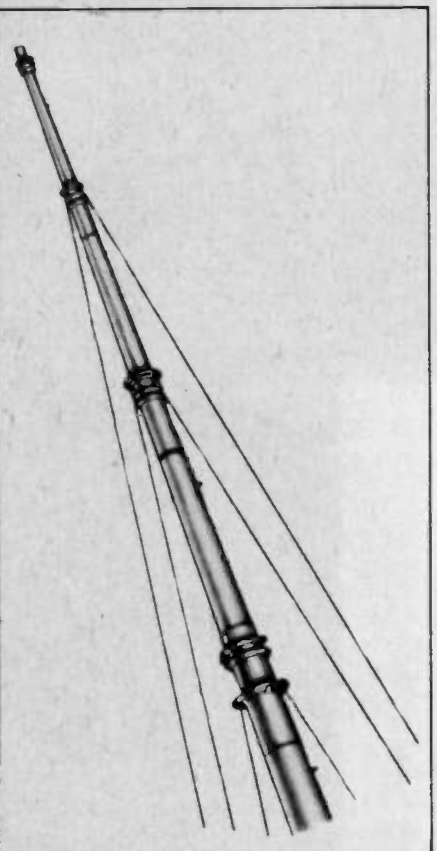
Scanner Antennas

and fender cowl mounting are next, and bumper mounting is last—and least!

The higher the antenna is, the more omnidirectional (non-directional) will be your reception. Directivity in a mobile antenna is not desirable; signal strength will fluctuate every time you change direction. Front cowl mounting exposes the antenna to a potential source of ignition interference, and mounting too low shields the antenna from arriving radio waves.

Mobile antennas are available in four basic mounting styles: magnetic, gutter clip, trunk lip, and permanent. In general, magnetic and permanent provide the most satisfactory reception. Gutter clip mounting tends to be quite directional. Trunk lip mounting is somewhat less directional, but not as good as in the center of the roof.

Because of the short length involved, the choice of coaxial cable is not important. Coax is nearly always supplied by the manufacturer in any case.



Radio Shack telescoping mast intended for a television antenna can serve as an ideal support for a scanner antenna. The coaxial cable can be run down either the inside or outside. Circle number 32.

How About Cost? In a mobile installation, the vehicle body acts as one component of the antenna system. Because radial elements are not necessary, one might expect that the average cost of mobile antennas is less than that of base station antennas. This is not the case. The special mobile mounting hardware is expensive to manufacture, and total antenna costs are about the same as those of comparable base station antenna installations.

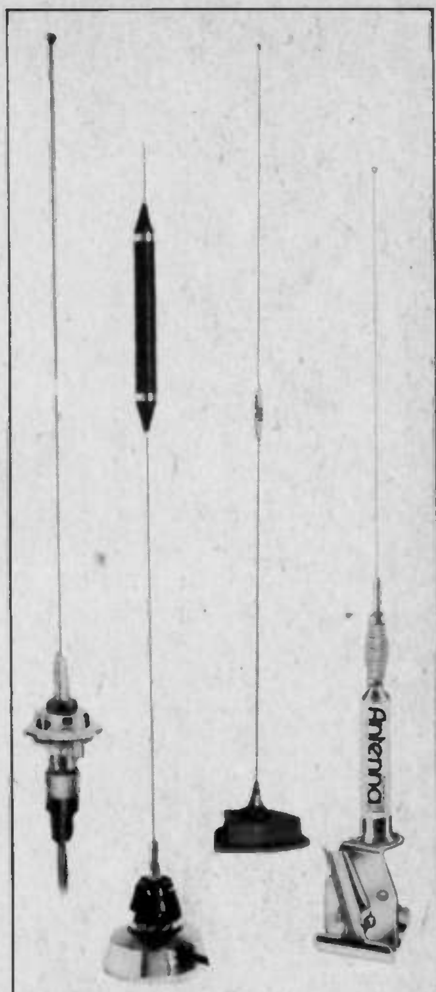
Considerations in choosing the proper mobile antenna are similar to those in selecting a base station antenna. Are all three frequency ranges important? Does your budget allow for the highest quality of manufacture, or is economy a major consideration?

Original Antennae. There is a temptation to use the AM (or AM/FM) automotive antenna already on the car for monitor reception. For close range, strong-signal applications, this is O.K. Several manufacturers produce special signal splitters to allow for such combinations; thus, the AM/FM car radio is not defeated. In fact, it may be used simultaneously with the scanner.

Remember, however, that original equipment automotive antennas are mass-produced with a cost factor in mind. Often, the coax cable is of low quality. The serious scanner listener should use a separate monitor antenna designed for that purpose. Remember, if you want first class reception, go first class with your antenna selection.

What Are The Choices? Not surprisingly, base station antenna manufacturers are also mobile antenna manufacturers. After the questions of frequency range and quality are resolved, there remains the task of choosing a manufacturer. Perhaps we can help. Since nearly all modern programmable scanners have three bands—VHF low, VHF high, and UHF—we will confine our sampling to those mobile antennas.

Avanti's AV-808 "Scan Fazer" is a convenient trunk-lip mount unit for $31.95. If you have a standard threaded base available, you can save three dollars by ordering the antenna element separately as the AV-804. *Antenna Specialists* has quite an assortment of mobile antennas. While a single band unit is only $19.95, all-band mobile antennas range from $21.95 to $28.95 depending upon the choice of mount. *Hustler* also offers their basic all-band antenna in a wide variety of mounts for mobile applications. Both trunk-lip and gutter-clip mounting configurations are available from *Antenna Incorporated* ($23.67 and $26.66). A series of *Hy-Gain* "MR" mobile antenna products provides something for everybody.



It probably will come as no surprise to you that the same people who manufacture quality base station scanner antennas also make mobile antennas as well. At left, Antenna Incorporated's disguise antenna (this one is for Chrysler cars) is just the thing for folks who don't like to advertise their mobile equipment. Circle number 34. Next, Antenna Specialists' MON-51 top-loaded magnet mount leaves no holes. Ideal for roof mounting. Circle number 39 on reader service card. Hustler's MOT center-loaded antenna covers all bands and uses a trunk-lip mounting. Circle number 49. At the far right, Antenna Incorporated's model 60003 has a convenient rain gutter clip mount for fast installation and removal. Circle number 34 on the reader service card for more information.

Conclusion. As we pointed out, the choices of antennas for the scanner listener are many. It was not our intention to list all the products available from these and other fine manufacturers. But hopefully, this sampling will help provide some insight into scanner antenna considerations and applications. Scanner listening is fascinating. And with a little planning, it will provide hours of intriguing listening. ■

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CIRCLE 4 ON READER SERVICE COUPON

BACKPACK AMP

Take your electronic instrument anywhere with this low cost portable amplifier

MUSICIANS WHO PLAY acoustic instruments, such as trumpet, saxophone, or violin, for that matter, have never experienced the problem of the electronic musician on an outing where he or she is separated from an electrical source for an amplifier (assuming that one had even managed the task of bringing one along). It's admittedly pretty hard to entertain your friends with an electric piano which lacks electricity. What then, is the answer to this dilemna?

It's quite simple, actually—build a Backpack Amp. Designed to operate from "C" or "D" cells, or two or three small lantern batteries, the all-in-one-IC Backpack Amp will directly drive a speaker from the output of virtually any electronic instrument without need for additional amplification. Install the Backpack Amp in a small cabinet along with a 6 or 8-inch speaker and you can take your electric guitar, or whatever, with you on holidays.

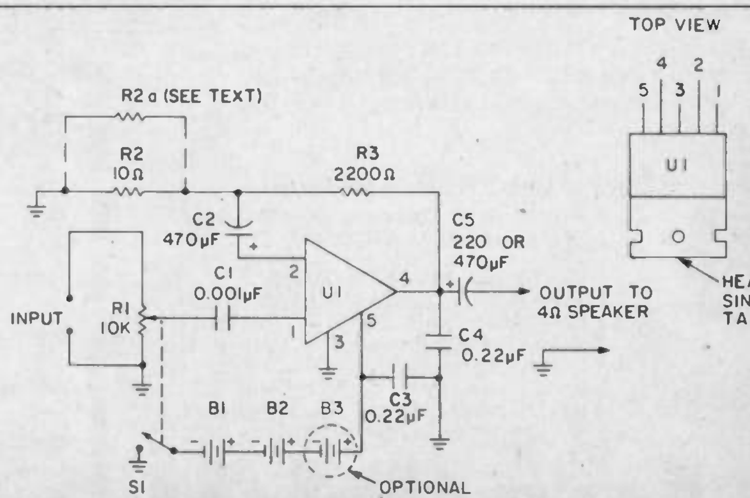
The Circuit. The Backpack Amp is assembled on a printed circuit board measuring 2¾ by 3⅝-inches. All active components which make up the preamplifier and power amplifier are contained in a single LM383T integrated circuit, which is available from Radio Shack. The resistor and capacitor values are considerably different than those given in the IC's data sheet (which is usually supplied with the IC). If you want the lowest distortion level from your electronic instruments use our values.

With a 12 to 18-volt power supply, the Backpack Amp will deliver from 1 to 3-watts into a 4-ohm load. Most replacement-type speakers are 4-ohms, and a 6 or 8-inch speaker is suggested. If all you have around, or can get, are 8-ohm speakers, we suggest you use two, parallel-wired 6-inch, 8-ohm speakers. (The amp will work with one 8-ohm speaker, but 1-watt is about the maximum low-distortion output even with an 18-volt power supply.)

The value used for capacitor C1 is 0.001-μF only if the amp will be used with an electric guitar. It compensates for the relatively higher low frequency output of an electric guitar pickup and prevents low frequency overload of the loudspeaker. If the Backpack Amp will be used with a synthesizer, you will probably be happier with the sound quality if C1 is 0.01-μF. If you use a 0.01-μF unit and find the low frequencies are overloading the speaker, sim-

PARTS LIST FOR BACKPACK AMP

- B1, B2, (optional B3)—6-volt lantern battery (see text)
- Note: Capacitor voltage rating must be equal to power supply voltage rating.
- C1—0.001-uF mylar capacitor (see text)
- C2—470-uF electrolytic capacitor
- C3, C4—0.22-uF mylar capacitor
- C5—220-uF or 470-uF electrolytic capacitor
- R1—100,000-ohm audio taper potentiometer with SPST switch attached (S1)
- R2—10-ohm, ½-watt 5% resistor
- R3—2200-ohm, ½-watt 5% resistor
- S1—SPST switch (part of R1)
- SPKR—see text
- U1—LM383T audio amplifier integrated circuit
- Misc.—Cabinet, screws, grille cloth, wire, solder, printed circuit etching materials, suitable input jack and matching plug, etc.



ply replace C1 with a 0.001-μF unit.

The correct value for R2 is usually 10-ohms. If you find your instrument's output is on the low side, and you have all gain controls wide open and still can't overdrive the amp, then tack-solder another 10-ohm resistor (shown as R2a in the schematic) across R2. If you need even more gain, R2 can be lowered to 2.2-ohms, but keep in mind that a 2.2-ohm resistor isn't the easiest of things to locate in this day and age.

Construction. Using any method you prefer, make the PC board using the supplied template. Note carefully the large copper foil area; it is part of U1's heat-sink and must not be eliminated. Don't substitute a thin foil strip as a *ground* connection. The foil rectangle in the middle of the PC board provides the anti-hum grounding for potentiometer (volume control) R1's shaft and frame. Again, don't substitute a thin foil strip because it might not contact R1's case when the potentiometer is installed. Depending on the particular style of potentiometer used, drill the proper size mounting hole where indicated by the dot in the foil rectangle.

Double-check the polarity of C2 and C5 before soldering. In particular, make certain C2's *positive* terminal goes to IC pin # 2. (It might not look correct but it really is.)

The IC must be mounted with a heat sink. From scrap aluminum, cut a section about ⅞ by 1¼-inch. Using the long dimension, bend a ⅝-inch tab. Drill a hole in the tab for a #4 bolt as close as possible to the "L" section (so as much metal as possible will be under the IC when the IC is positioned over the hole; but double-check that the tab does not touch any of the IC leads.)

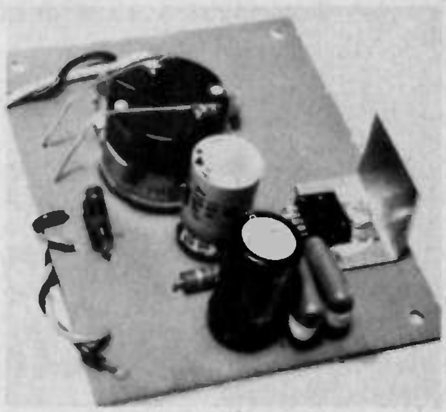
Using long-nose pliers, bend U1's leads to correspond with the holes in the PC board. To avoid shorts, the leads are offset: Nos. 1, 3 and 5 are close to the IC body; Nos. 2 and 4 are bent about ½-inch away from the body.

Place a drop of silicon heat sink grease on the underside of IC's mounting tab, position the IC on the sink, and then secure the IC and sink to the PC board with a #4 bolt, lockwasher, and nut. Place the lockwasher between the nut and the heat-sink foil on the PC board, and tighten securely.

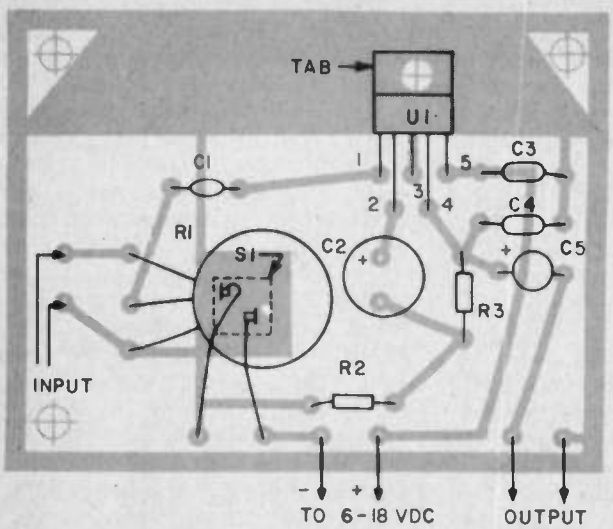
Installation. The Backpack Amp can be installed in any cabinet you prefer. (Note that it has a three-hole mounting.) If you can possibly locate a *potentiometer bushing extender*, which appears and then disappears in the marketplace from time to time, you can mount the amp with a single nut around the volume control's shaft.

While the power supply can be made up out of flashlight batteries, two or three series-connected small 6-volt lantern batteries make the most convenient and reliable portable power source.

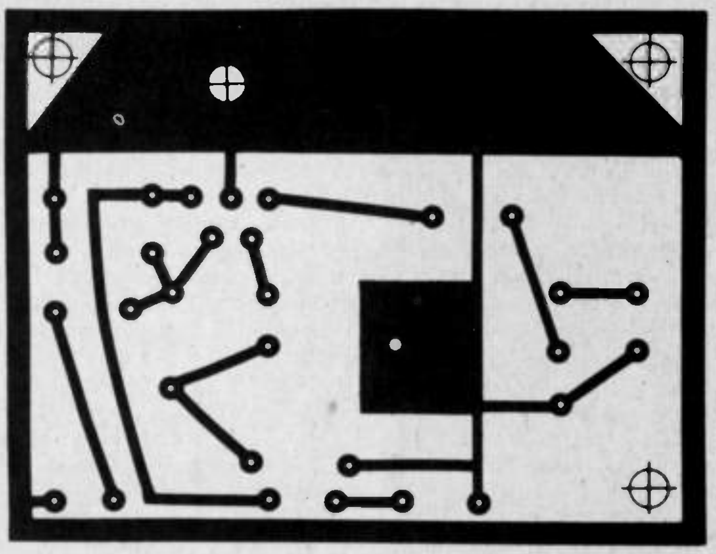
When it's all done, you and your ARP can head for the hills and commune with Mother Nature to your heart's content. ■



The completed PC board, showing U1 mounted with it's homebrew heatsinks.



The component placement guide above shows the SPST switch mounted on the back of volume control R1 (dotted line box). External switch can be substituted for R1/S1.



The full-scale printed circuit template has two areas of solid foil which must be duplicated on your board. The large area at top helps heatsink U1, the other grounds R1 to minimize humming.

Electronic Equipment and your Auto Insurance—A Closer Look

Are you sure that your gear is really insured?

ARE YOU CERTAIN that the electronic equipment that you have in your automobile is insured? Have you called your insurance agent lately and asked? If you haven't, you could be in for a surprise! Far too many CB, ham, eight-track or cassette stereo users, and now owners of "on-board computers," have no idea if their units are insured or not.

Too many of us assume that the "comprehensive" coverage of our insurance policy will automatically cover these items. Chances are, that NONE of the equipment is covered!

Some "old timers" scoff at this statement, but things have changed, fellas, and CB radios might be the cause for these changes. Let's look at this new problem piece by piece.

The Special Policy. As the two meter and CB boom swept our country, so did thefts of this type of equipment. This high theft rate forced the insurance companies to make a move on their own. So, along came the special radio policies. This "special" policy is really an extra policy that is attached to your present automobile comprehensive coverage. Therein lies the nub of a lot of misunderstandings. A point to remember is that if your automobile's comprehensive coverage calls for a fifty or one hundred dollar deductible, then the same deductible applies to the special radio attachment policy, too.

The cost of this "special" radio policy will vary from company to company and is based on the *retail* value of the insured equipment. This rate seems to vary from eight to eighteen dollars and up per year. Another factor that usually comes to the surface only after you have filed a claim, is the *depreciation factor*. Again, this will vary among different insurance companies, but a rule of thumb seems to have been standardized: The figures the companies use for depreciation, usually run at one percent per month after the initial year. This means that if your CB or ham rig was stolen after two years of use, it would have depreciated twenty-four percent.

What's it Worth? With this material in mind, let's look at a couple of examples of just how this would work. John Doe purchased a new single sideband CB radio for $250.00. A year and a half later, his unit is stolen. His comprehensive coverage on his automobile contains a $100.00 deductible. He has also purchased the requisite "special" CB radio policy as an attachment (rider). This rider costs him $10.00 per year. This is how his claim might possibly be computed:

Original purchase price	$250.00
His deductible is	$100.00
1½ years depreciation	$ 45.00
Premiums paid	$ 15.00
Total Reimbursed	$ 90.00

Once again, this will vary with different companies. Also, in this example, we have deducted $15 for premiums paid in. John D. would actually receive a check for $105.00, but try replacing your rig for that! By the same token, how about the CB'er that owns a $39.95 discount special? We're sure you've already seen the light. He gets zilch!

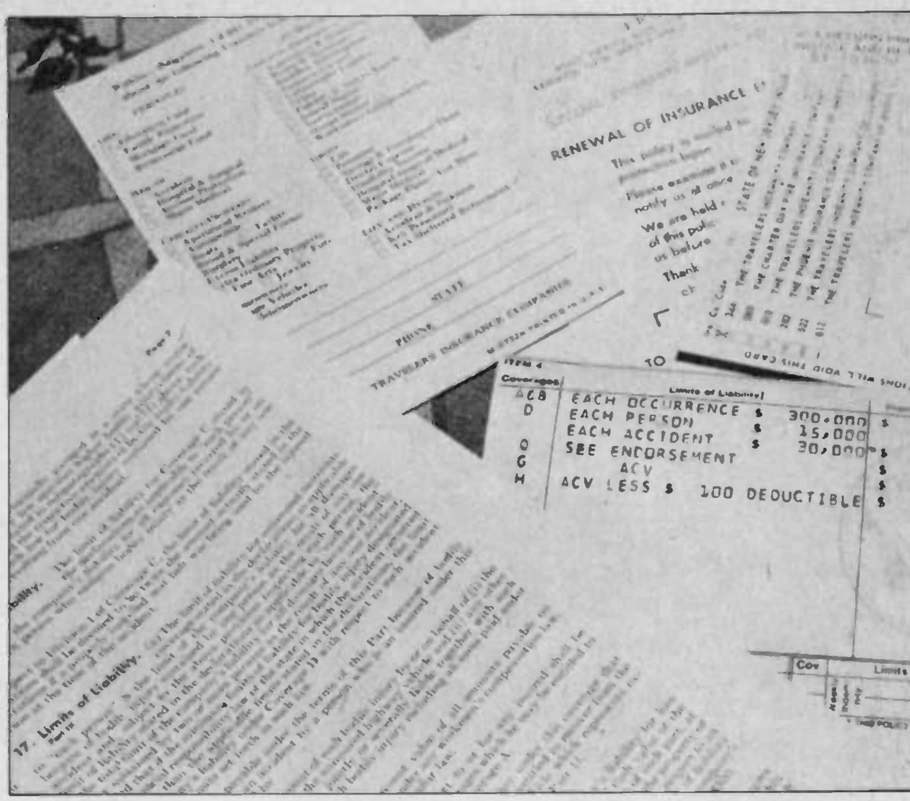
In interviewing insurance agents, we found that about fifty per cent of the insuring companies will replace your stolen unit rather than mailing you a check. This appears the better of the two deals. But it carries what may be an unfair advantage for the insurance companies that follow this practice.

In our previous example of the $250.00 SSB unit, if the company replaces this unit with something comparable, you feel ahead of the game, right? Well, maybe! The insurance company often purchases the replacement from a distributor at, or somewhere near the distributor's cost. In our example, let's say the cost is $150.00. The point here is, why should your "special" CB radio policy have a premium figured from the retail price of $250.00? In reality, the premium should have been figured at the distributor's (or replacement) cost!

Now, with so many of us increasing our deductibles to keep our ever-increasing premiums down, these "special" policies are even more useless. In conversations with practicing insurance agents, it was found that they too feel that these special attachment policies are just not worth the money one must pay for them. The only exception would be the radio enthusiast that has several hundred to thousands of dollars worth of equipment in his mobile.

In defense of the insurance agents, it should be pointed out that they, by selling you this "special attachment policy," do so only to protect themselves from you. If you were to have your radio stolen and called your agent for reimbursement, only to find that your rig isn't covered at all, you would certainly be upset and the agent could lose you as a valued customer. Also, the agent makes only one or two bucks by writing this "special" policy rider, but no more than that. It's easy to see that the agent isn't pushing the policy to make money, but rather to insure his or her integrity as a competent agent.

Cassette and Eight-Track Players. These tape players are generally covered under much the same conditions as the aforementioned radios. We can add in vehicle telephone systems here, too. Of course, while the costs of stereo players and telephone systems are as far apart as one can get, they still provide us with the insight as to what is worth paying an extra premium for, and what is not.



Don't wait until after you've been ripped off to check your policy's coverage. The best source of information (unless you can decipher your policy's legalese) is your agent.

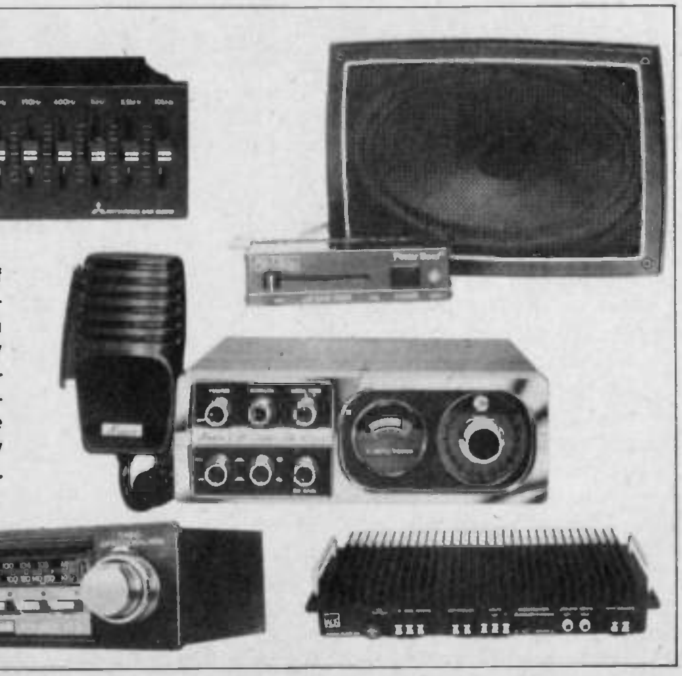
A very elaborate stereo system could have cost you many hundreds of dollars and, of course, merit special insurance. However, what about the $49.95 eight-track and two inexpensive speakers? Don't waste your time and money. Mobile telephones, on the other hand, are very expensive items and should be insured against theft. They can run into the thousands of dollars and most certainly will require your agent's advice on insuring them. A good rule to follow is that almost all sound reproducing equipment will require the special attachment policy or it is not insured!

The exceptions to this rule are the CBs, stereo players, etc. that are *factory-installed* in your car. Your comprehensive auto insurance will cover these units as they are "an integral part of the assembled vehicle."

This brings us to the "onboard computer." This calculator-styled unit is appearing in more and more cars as its use becomes known. The onboard computer can tell you everything from the time of day to how many miles you'll be able to travel on the gas remaining in your car's gas tank. Until recently, these units were found only in the luxury cars and were considered "an integral part of the automobile." But now, many companies offer them as "add-on" devices for almost any car.

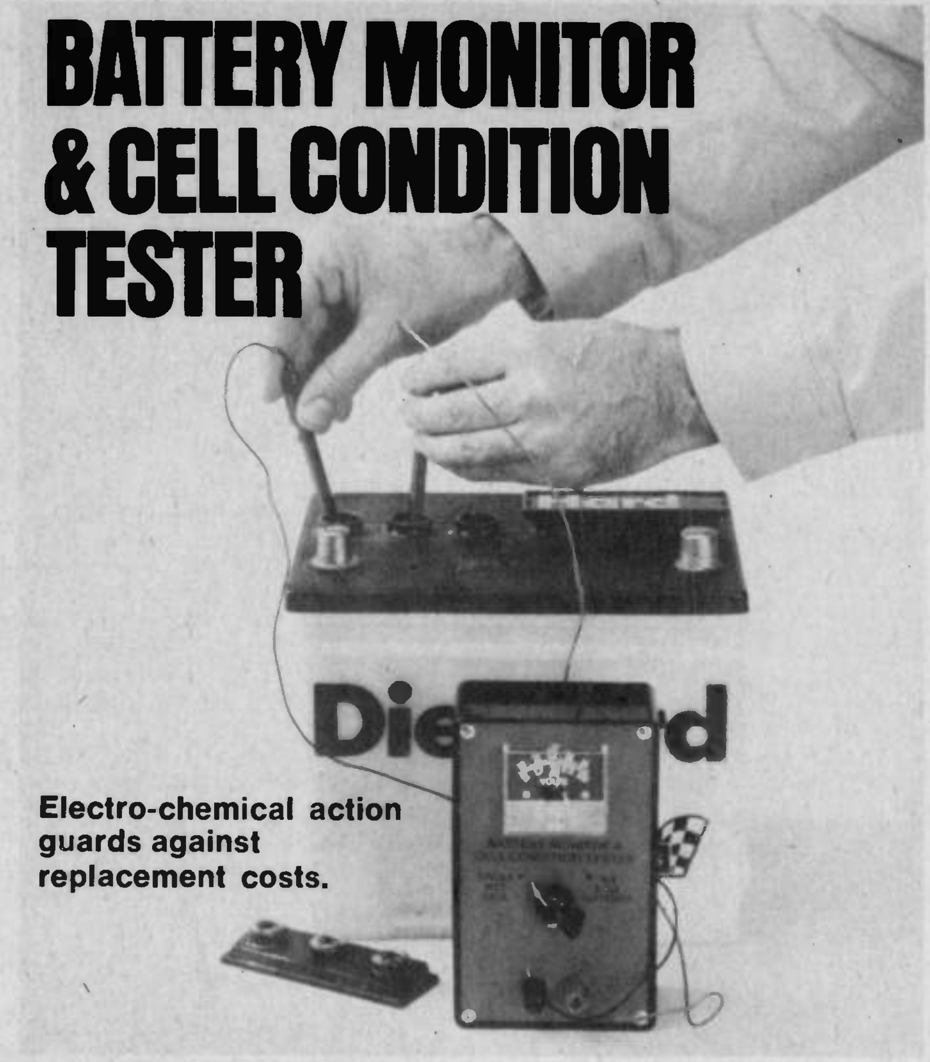
As of this writing, the majority of companies do not list these computers on their "extra insurance needed" lists. The agents interviewed warned that because they were slowly becoming a popular "add-on," the companies would surely soon insist on special insurance for them, too.

Conclusion. The only safe answer to this insurance dilemma is to contact your agent. Have him explain the deductibles and depreciation variables that are contained in your particular automobile insurance policy. With what is (and what isn't) covered changing almost daily, your agent is the only one that can give you the true figures. Don't wait until you have a claim to file, check it out and add it all up! You may be surprised at what you may learn. And what you learn may just save you some trouble and, more importantly, a lot of money. ■

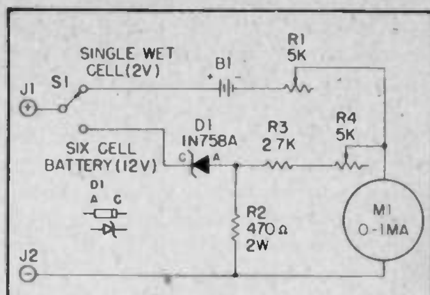


Question: Which of the car-fi and communications gear seen here would normally be covered by a standard automobile insurance policy? See the text for what may be a surprise answer.

BATTERY MONITOR & CELL CONDITION TESTER



Electro-chemical action guards against replacement costs.



PARTS LIST FOR BATTERY MONITOR & CELL CONDITION TESTER

B1—1.4-volt mercury cell, Eveready E640
D1—10-volt, ½-watt zener diode (1N758A or Archer 276-562 or equiv.)
J1, J2—binding posts; red, black
M1—1-mA DC meter
R1, R4—5,000-ohm miniature potentiometer
R2—470-ohm, 2-watt resistor
R3—2,700-ohm, ½-watt resistor
S1—spdt rotary or toggle switch
Misc.—plastic chassis box and panel 6 x 3½ x 1⅞-in. (approx.), perf board, push-in clips, plastic mechanical pencils and solder for test probes (see text), wire, etc.

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

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

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

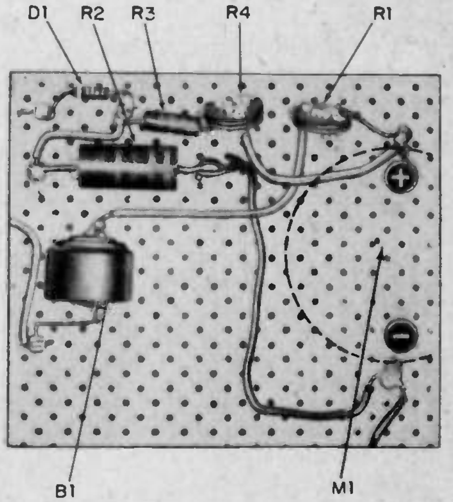
When S1 is set to the "six cell battery" position, zener diode D1 operates similarly to battery B1 in the other position. Since D1 is a 10-volt zener diode, a test voltage higher than 10 volts is required to allow M1 to indicate voltage.

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

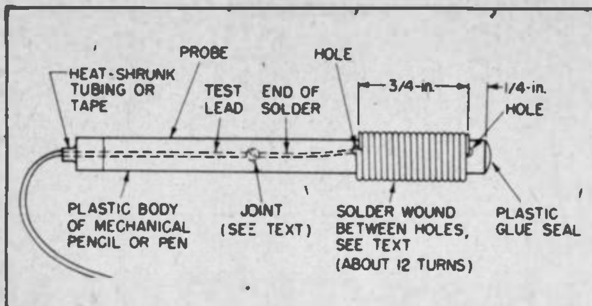
Construction. The Tester is built in a 6 x 3½ x ⅞-in. plastic box with a plastic panel. The box dimensions are not critical, and any convenient size can be used. To minimize possible electrical short circuit hazards, do not use a metal box. Most of the components, are installed with push-in clips on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

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

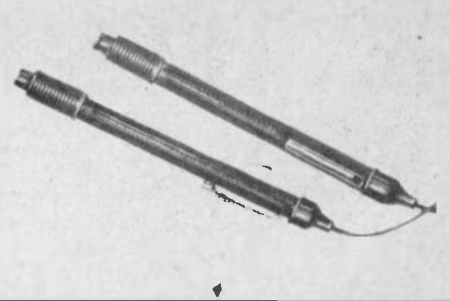
Mount the board components with push-in clips at the approximate locations shown in the board photo. Use short leads for best mechanical rigidity, and wire as shown in the schematic. Make sure that D1 and B1 are connected with the proper polarities as



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



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



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

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

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

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

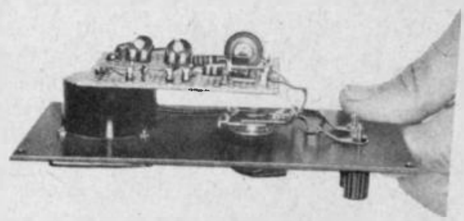
Drill two holes spaced ¾-in. apart approximately ¼-in. from the end of each pencil body, and wrap wire solder between the holes as shown. Insert the ends of the wire solder into the holes to hold the turns in place. The end of the wire solder in the hole toward the other end of the pencil body (the former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

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

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

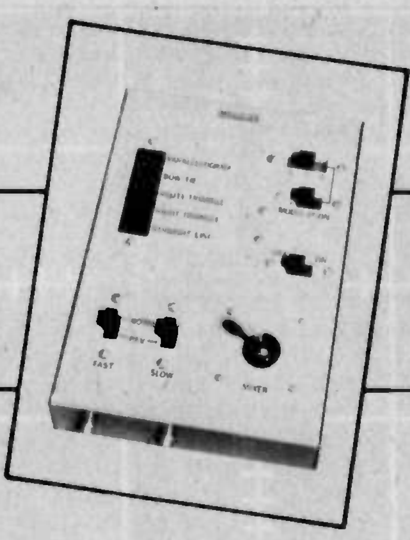
Operation. Automobile storage batteries consist of a number of 2-volt cells connected in series—three cells for a 6-volt battery and six cells for a 12-volt battery. As shown in the drawing, the tester probes are inserted into the electrolytic filler holes of a pair of *adjacent* (series-connected) cells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

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



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

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



Save big dollars and help your scope make 3-D figures

IMAGICIAN

HOW WOULD YOU LIKE TO be able to generate beautiful geometric line drawings electronically? And what if these figures could be made to look 3-dimensional, with forms that expand, rotate, and flow under the command of a joystick? Sounds expensive and complicated, doesn't it? If you've seen some of the graphics produced by hobby-type digital computers, you're probably skeptical and rightfully so. Small digital computers generate simplistic graphics with a chunky appearance. Generating smooth lines and complex figures with a digital computer requires much more memory than most computer hobbyists can afford.

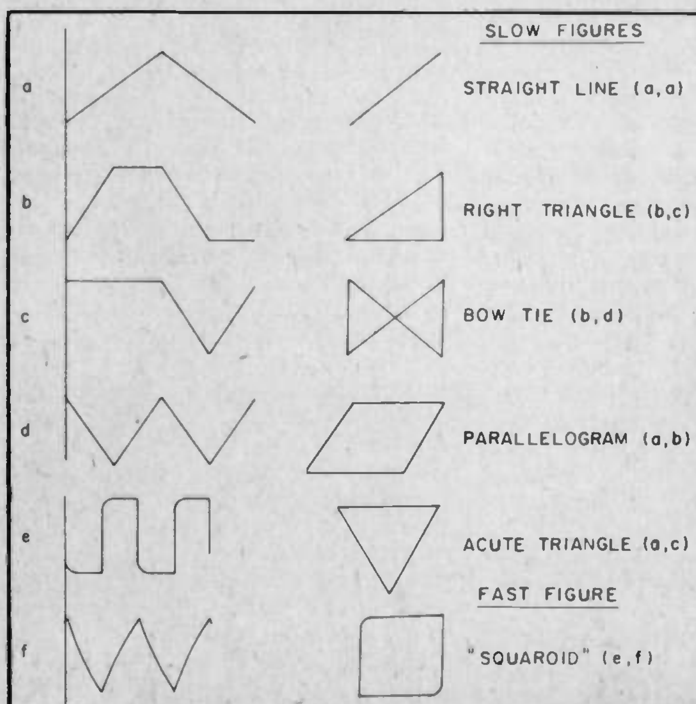
But if a few ideas are borrowed from the *analog* computer, a device rarely mentioned anymore, it's possible to generate dazzling graphics with simple, inexpensive circuitry. That's the principle of the Imagician, a simple, two-IC project that transforms your oscilloscope's screen into a window on a magic land of animated geometric figures.

The Lissajous Figure. Before delving into the workings of the Imagician's circuit, let's talk about Lissajous figures. If you own a scope, no doubt you are familiar with them. A Lissajous figure is a closed curve that results when two harmonically related signals are applied to a scope—one signal to the vertical input, the other to the horizontal input. The most familiar figure occurs when a sine wave is applied to one input, and a phase-shifted sine of the same magnitude and frequency is fed to the other input. On the scope's screen there appears either an elliptical or circular trace, depending upon the phase relationship between the two signals. With non-sinusoidal waveforms driving the X and Y inputs, other geometrical displays can be created.

Let's examine the various waveforms synthesized within the Imagician (Figure 2). From just these six signals, thousands of fascinating displays can be produced. Waveforms *a*, *b* and *c* all oscillate at 60 Hz; signal *a* is a triangle wave, *b* is a symmetrically clipped triangle, and *c* is trapezoidal. Signal *d* is another triangular waveform, but with a frequency of 120 Hz. For reasons that will be apparent later, let's call figures *a* thru *d* "slow" figures.

It stands to reason that there must be some fast signals, too. Waveforms *e* and *f* are the fast ones, with a frequency equal to 3840 Hz (64 times faster than 60 Hz). Signal *e* might be called a "soft-shouldered square wave," while *f* just begs to be called a "shark-fin wave."

What are the simplest Lissajous figures that can be generated by selected pairs of the above six waveforms? Figure 3 shows these fundamental figures along with the X and Y components necessary for their generation. It is assumed that the X and Y components are of equal magnitude; if such is not the case, the shapes will be distorted to new forms. Note that these fundamental Lissajous figures are segregated into slow and fast classes. The slow figures have slow waveforms (*a* through *d*) as components, while the fast figure has fast components (*e* and *f*). The slow figures include familiar geometric shapes: a straight line, a right triangle, a parallelogram, an acute triangle and the perhaps not-so-



This chart depicts the basic waveforms (lettered a thru f at left) generated by Imagician's oscillator. The slow and fast waveforms are created by pairing two of the basic waveforms together (b, d for the bow tie, etc.). The table of switch positions on the last page of the article shows which positions are used for selection of figures.

familiar bow tie. Were it not for a slight slope to the sides and a pair of rounded corners, the fast figure would almost appear to be a square. In recognition of the similarity, let's call the fast figure a "squaroid."

New complex Lissajous figures, some of which will appear to be 3-dimensional, can be synthesized by adding together one of the slow figures and the squaroid. This is accomplished by summing the X- and Y-component waveforms of the two figures independently. Furthermore, it's not necessary to mix signals in a one-to-one ratio. Different mixing ratios yield new and fascinating displays in a manner that's often hard to predict. As a final touch, the components of the fast figure (squaroid) can be amplitude-modulated. The type of modulation used here was specifically chosen to enhance the illusion of perspective in those displays that appear 3-dimensional.

The Circuit. Let's consider the Imagician's circuit in detail. Two batteries, B1 and B2, provide +9V and –9V supply potentials for the circuit when power switch S1 is closed. Diodes D1 and D2 protect the ICs from incorrect battery installation and also drop the supply potential slightly, which is desirable here. Capacitors C1 through C4 provide supply bypassing.

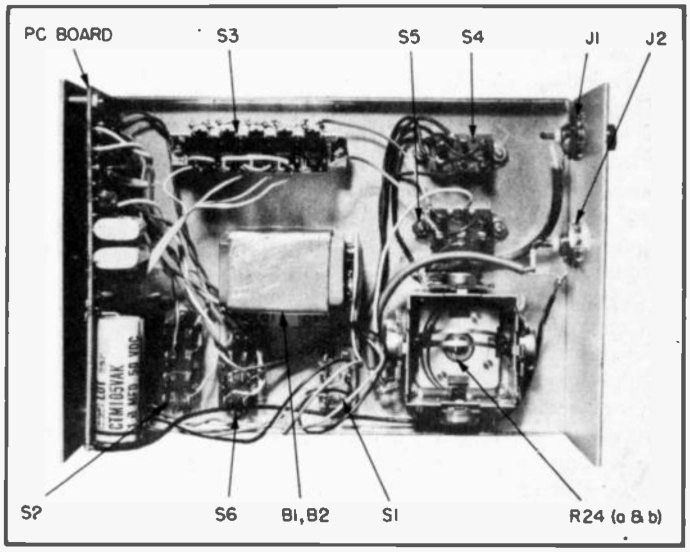
Q1, a programmable unijunction transistor (PUT), works together with R1, R2, R3 and C5 to form an oscillator that feeds pulses to the clock input (pin 1) of U1, a 4024B seven-stage binary frequency divider. U1 divides the input frequency by 2, seven times in succession to yield seven harmonically related square-wave outputs. We need harmonics in order to generate Lissajous patterns, but square waveforms do not yield interesting displays. Consequently, the greater portion of the Imagician's circuitry is devoted to the shaping of square waveforms into other more useful signals.

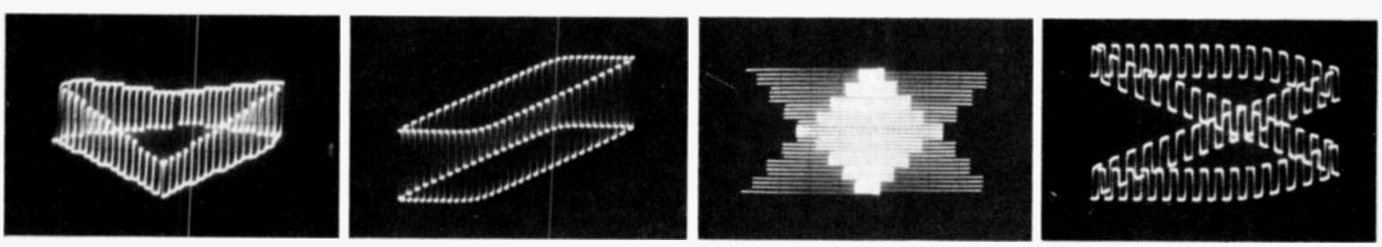
At pin 3 of U1, we find the lowest-frequency square wave (60 Hz), while pin 4 supplies the second harmonic (120 Hz). R15 and C6 integrate the 60 Hz signal to a triangular waveform (*a*). Diodes D3 and D4 together with integrating network R16/C7 produce the symmetrically-clipped 60 Hz triangle (*b*). Driven by both the 60 and 120 Hz signals, the D5/D6/R17/R18/C8 network yields a 60 Hz trapezoid (*c*). Finally, the last slow waveform, triangle wave *d*, is generated when R19 and C9 integrate the 120 Hz square-wave signal.

Fast waveforms *e* and *f* are formed with the aid of shaping networks R22/C10 and R23/C11, respectively. When S6 is flipped to the left, as indicated in the schematic, amplitude-modulated currents at 3840 Hz are fed to the shaping networks just discussed. As a result, waveforms *e* and *f* are also amplitude-modulated. The manner in which modulation is obtained here requires further explanation: U2, a 4070B quad EXCLUSIVE-OR gate, taps harmonically related signals from frequency divider U1. The gates within U2 are connected so as to yield a sort of digital multiplier when the various outputs are summed together (by R5/R9 and R10/R14). Switch S2 controls the shape of the modulation envelope, with three choices available. If S6 should now be flipped to the right, an unmodulated 3840 Hz square-wave current will be fed to each R/C shaping network. Consequently, signals *e* and *f* will be of constant amplitude.

The rest of the circuitry serves only to combine signals *a* through *f* in various ways. Switch S3 selects pairs of X and Y components for the 5 slow Lissajous figures. These signal pairs are routed to the vertical (R24a) and horizontal (R24b) mixers via reversing switch S4. (When a Lissajous figure's X and Y components are interchanged, it flips to a new orientation on the screen.) Switch S5 performs the same function as S4, but it operates on the components of the fast figure instead. Addition of the X components of the slow and fast figures occurs in the horizontal mixer; the vertical mixer sums their Y components. R24a and R24b are part of a joystick assembly; north-south movement of the stick controls R24a, while east-west motion affects R24b. Thus, a single control manipulates two pots independently of one another. If desired for reasons of economy, however, two separate potentiometers could be used for R24a and R24b. Jacks J1 and J2 send the mixer output signals to the appropriate high-impedance (1 Megohm) scope inputs.

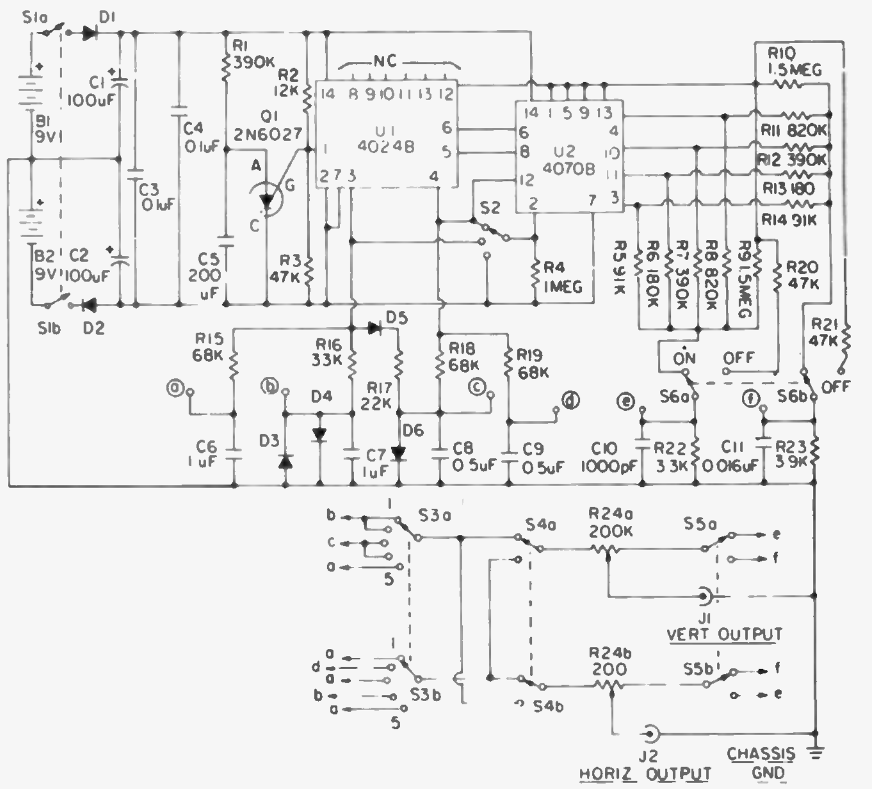
This underside view of the chassis shows the positions of the panel switches and joystick control. As usual, this should only serve as an example of how you can go about building your own model. There are no critical component placements in Imagician.





Here are a few examples of the designs which can be produced by mixing of the basic waveforms. What we can't show are the moving figures and the shifts which are possible. From left to right are: acute triangles, parallelograms, inverted acute triangles, and a double bow tie formed in a dot pattern instead of solid lines. With experimentation, you can come up with many more.

IMAGICIAN



Construction. Printed-circuit construction of the Imagician is recommended, and complete details of the board can be found in Figures 4 and 5. For the sake of shielding, an aluminum cabinet should be used to house the circuit. Furthermore, the chassis should be connected to system ground at some point. Connections between the Imagician and your oscilloscope should be effected by means of relatively short, (18-inches or less) shielded cables.

As usual, solder joints should be made with a small, 25-watt iron and resin-core solder. Sockets are required for the two CMOS ICs, which should be installed only after all soldering is finished. Be certain that U1 and U2 both have the "B" suffix—devices with an "A" suffix will not work in this circuit.

Capacitor C5 must be a polystyrene (or mica) unit to ensure that your oscillator's frequency is close to that of the prototype. Be careful with those devices requiring proper orientation—electrolytic capacitors C1 and C2, Q1, the ICs, and the diodes. Although S3 is shown schematically as a rotary switch, it's obvious from the photos that a pushbutton unit was used in the prototype. You can use whatever is most convenient.

Current consumption is on the order of 1-milliampere, so batteries will last a long time. Be sure that both batteries are fresh—if they are not, lop-sided displays will result.

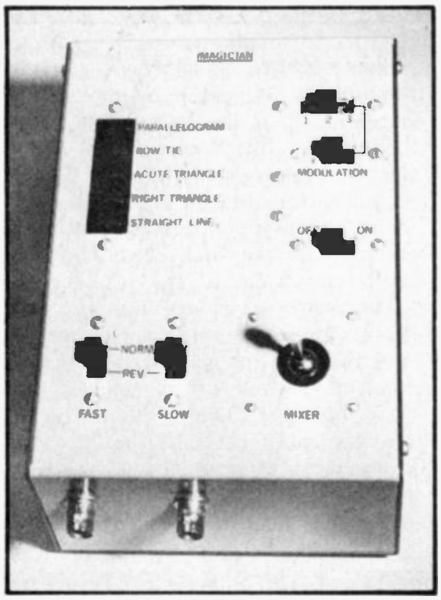
When wiring the joystick, you'll find that it comes equipped with four pots. Use any two pots on adjacent sides of the square support assembly. The potentiometers on opposite sides are ganged together and cannot be adjusted independently.

Checkout and Operation. After construction is complete, the circuit should be given a thorough workout to make sure that everything is in order. Begin by turning on your scope and allowing 15 minutes warm-up time. If the grati-

PARTS LIST FOR IMAGICIAN

B1, B2—9-volt transistor battery
C1, C2—100-uF, 16-VDC electrolytic capacitor
C3, C4—0.1-uF ceramic disc capacitor, 100-VDC
C5—200-pf polystyrene capacitor 100-VDC
C6, C7—1.0-uF mylar capacitor, non-polarized
C8, C9—0.5-uF mylar capacitor 100-VDC
C10—1000-pf polystyrene capacitor 100-VDC
C11—0.016-uF mylar capacitor 100-VDC
D1 thru D6—1N914 diode
J1, J2—BNC jack
Q1—programmable unijunction transistor—2N6027, 2N6028 (Note: 2N6028 Available from SOLID STATE SALES, BOX 74A, Somerville, MA 02143.)
R1, R7, R12—390 K, ½-watt resistor, 5%
R2—12 K, ½-watt resistor, 5%
R3, R20, R21—47 K, ½-watt resistor, 5%
R4—1 Megohm, ½-watt resistor, 5%
R5, R14—91 K, ½-watt resistor, 5%
R6, R13—180 K, ½-watt resistor, 5%
R8, R11—820 K, ½-watt resistor, 5%
R9, R10—1.5 Megohm, ½-watt resistor, 5%
R15, R18, R19—68 K, ½-watt resistor, 5%
R16—33 K, ½-watt resistor, 5%
R17—22 K, ½-watt resistor, 5%
R22—3300-ohm, ½-watt resistor, 5%
R23—3900-ohm, ½-watt resistor, 5%
R24a, b — two, linear-taper 200K-ohm pots mounted in a joystick assembly (Herbach & Rademan #TM21K167; address is 401 E. Erie Ave., Philadelphia, PA 19134)
S1—DPST slide switch
S2—SP3T rotary or slide switch
S3—DP5T rotary or pushbutton switch
S4, S5, S6—DPDT slide switch
U1—4024B binary ripple counter
U2—4070B quad EXCLUSIVE-OR gate
Misc: aluminum cabinet, IC sockets.

Note: An etched and drilled printed circuit board for the Imagician is available from *LECTRO-GRAPHIX* P.O. Box 537, Auburn, NY 13021, for $5.90 postpaid to U.S. and Canadian residents. Foreign and overseas orders should include an additional $1.50 for postage and handling, and should remit the cost in the form of a money order or other drafts payable in U.S. currency. Allow 2 to 3 weeks for delivery. NY residents add 7% sales tax.

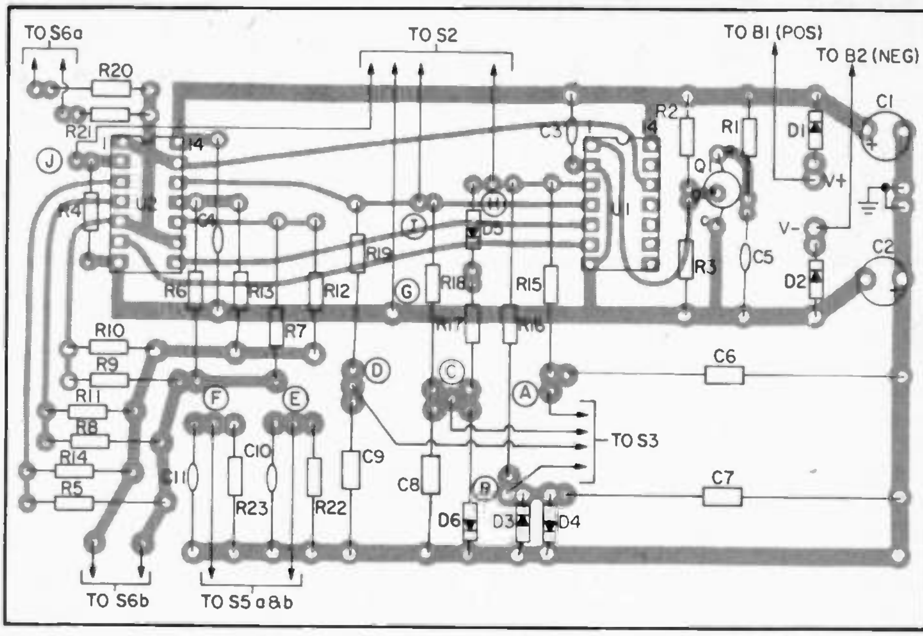


This front panel closeup shows the relative positions of all the controls, and the dry transfer lettering we utilized to achieve a more professional appearance for the prototype. We positioned the input and output coaxial jacks at the bottom front rather than at the top, so as to minimize the effects of body capacitance when one's hand is brought into proximity of the input and output cables. This feature also allows much more freedom of access to the controls as opposed to top mounting of the jacks.

cule on your scope is removable, as on the older Heath and B&K models, it might be a good idea to take it off; the gridwork of lines serves no useful purpose in this application, but it may distract attention from the display. If the graticule cannot be removed, just turn the GRATICULE ILLUMINATION control completely off.

Both the X and Y inputs should have an impedance of about 1-Megohm. This almost universally is the case, but check your scope's specifications to be sure—especially if a very old model is being used. With the horizontal and vertical inputs grounded, center the dot on your screen. Signals from both channels of the Imagician have peak-to-peak amplitudes of 1.2-volts; set your vertical and horizontal gain controls so that a 1.2-volt signal would roughly span the screen.

On the Imagician, turn MODULATION switch S6 to OFF, and set SLOW-FIGURE SELECTOR S3 to its PARALLELOGRAM position. Connect the outputs of the Imagician to the appropriate scope inputs with short shielded cables. After turning on the power with S1, you should see an image of some sort on your screen. The display will probably be faint, so rotate your scope's INTENSITY control to maximum. (However, when centering the dot as described above, you should use only *minimal* intensity to avoid burning the scope's screen.) Now, readjust the scope's vertical and horizontal gain controls so that the image just fills the screen. Finally, adjust the ASTIGMATISM and FOCUS controls, if your scope has them, for an image that is sharp and clear at all points on the screen.



This is the component location guide used with the printed circuit board. Just about all of the components used in Imagician, with the exception of the switches, jacks and R24, are mounted directly on the board. Use IC sockets and be sure to orient them properly. Take special note of the takeoff points that lead away to the switches.

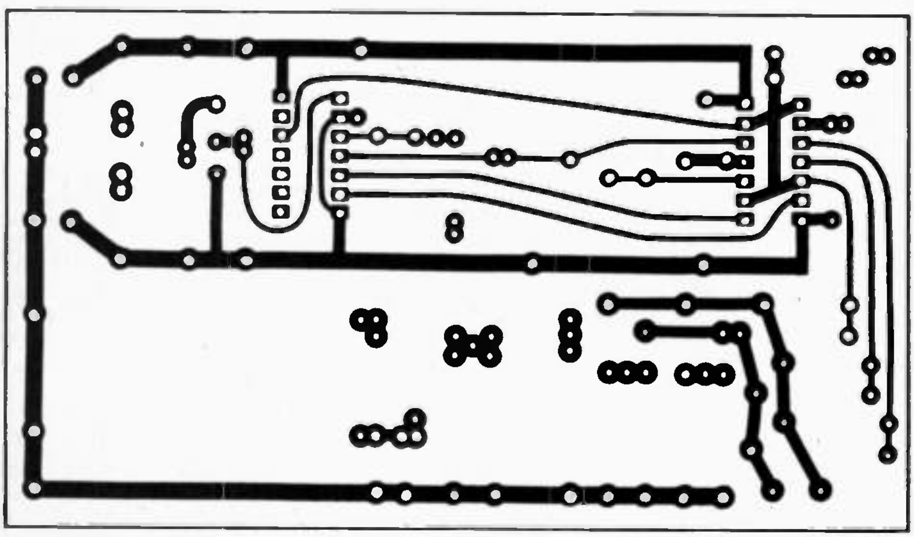
S1—Power
S2—Modulation Selector
S3—Slow-Figure Selector:
1 = parallelogram
2 = bow tie
3 = acute triangle
4 = right triangle
5 = straight line
S4—Slow-Figure Reversing Switch
S5—Fast-Figure Reversing Switch
S6—Modulation ON/OFF
R24a, b—Mixer

This table shows which switches perform what functions and, for S3, what figures are generated in each switch position.

Bend your Imagician's joystick until you reach the position where a simple parallelogram fills the screen. Next, flip S3 to its four other positions so that the rest of the slow figures may be observed. After viewing them all, return to the parallelogram. Use the joystick now to create new images. Note that this is a "high-powered" control—a seemingly slight adjustment can lend a whole new character to the display. With practice, you'll learn to make images dance and change form at will through skillful manipulation of the stick.

Still using the parallelogram, adjust the joystick until the resultant display has a 3-dimensional character. Turn on the modulation via S6, and check out the various effects produced by MODULATION SELECTOR S2. Manipulate the joystick, too, in order to get different views.

Conclusion. By now, you should be somewhat familiar with the controls on the Imagician. You can proceed to create 3-D patterns based on the remaining four slow figures. Also, check out the effects of the reversing switches, S4 and S5; the effects of S5 are subtle and depend upon the setting of the joystick, so watch closely. If you wish, it's possible to capture some of your prize creations on film with the aid of a Polaroid scope camera, which you might be able to borrow from a school science department. With a little imagination in the photodeveloping process, you may become the first electronic Picasso! ■



This is the etching guide for the PC board, shown in exact scale. If a project of this magnitude is beyond your abilities, you can obtain a ready-made circuit board from LECTROGRAPHIX. Their address and ordering information is shown beneath the parts list.

Long Delay Timer

Inexpensive basic timer measures delays of microseconds or months

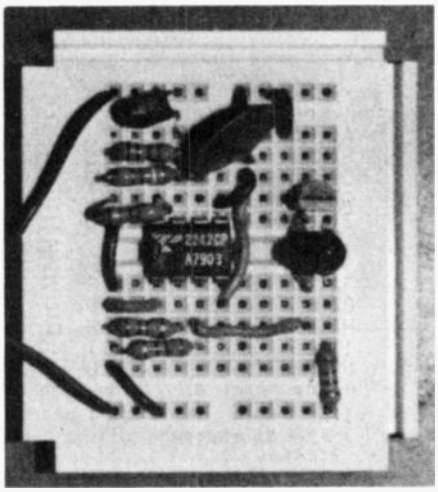
BY NOW, MOST ELECTRONICS hobbyists are quite familiar with timers, such as the 555. Projects built with these chips can serve a multitude of purposes, ranging from sirens to triggers for digital counters. However, in straight timing applications, the relatively high frequency at which these chips operate dictates the necessity for a lot of additional circuitry in the construction of long-range timer circuits.

This limitation has been solved with the introduction of the EXAR XR-2242 timer, which allows the user to set delays ranging from microseconds to (with the use of another 2242) virtually a year. So if you want to build a once-a-year alarm clock to nab Punxatawney Phil on Groundhog Day, or whether you need a repeating clock to trigger a light display every few seconds, try our Long Delay Timer.

Heart of the Matter. The Exar XR-2242 integrated circuit is a long-delay timer and very low frequency oscillator.

The functional plan of the 8-pin chip is shown in Fig. 1. It consists of a time base oscillator, the output of which is supplied to an 8-bit counter. There is a total count of 128. A control circuit is included to initiate and reset the time delay activity.

A simplified schematic of the timer IC, Fig. 2, shows the time-base circuit at the left. The external resistor and capacitor are connected among pins 1, 7 and 8. The time pulse generated



by the time-base oscillator has a period equal to 1RC. The output of the time-base oscillator is applied to a counter chain that provides a total count of 128. Therefore the delay time at the output is equal to 128RC.

$$Td = 128To = 128RC$$

This output is made available at pin 3. An output is also derived from the input counter and is in the form of a square wave with a period of 2RC. This output is derived at pin 2.

The recommended range of operation for the time constant circuit is between 1000-ohms and 10-megohms for the resistance R1 and between 0.01 and 1000-μF for capacitor C1.

The control logic provides a trigger input at pin 6. A positive edge initiates the delay interval. After the delay interval is initiated, it will continue for a time period of 128RC.

Circuit Function. A positive pulse applied to the trigger input, pin 6, will start the time-base oscillator. At the moment it is triggered, it generates a very short duration negative pulse. Capacitor C1 charges through resistor R1 forming a ramp voltage with a period equal to the RC product (time constant). At the conclusion of the charging period (ramp), a second sharp negative pulse is generated. This train of negative pulses at pin 8 is applied to the input of the counter chain. The trigger time-base output and output of the first binary counter are shown in Fig. 3. The output of the last counter is shown, but not in the same scale.

The output swings negative to logic 0 when the positive trigger pulse is applied. The output remains negative for a time interval equal to 128RC. After this interval of time, the output again returns to the logic 1 position and awaits the arrival of a trigger pulse at pin 6. Any trigger pulses that arrive during the time delay period (T) do not influence the operation of the circuit. However, the arrival of the first trigger after the delay period initiates a new time-delay interval. If the time-delay interval is to be stopped or reset it can be done by applying a positive pulse trigger to pin 5. This will reset the circuit, making it ready for the arrival of the very next trigger at pin 6.

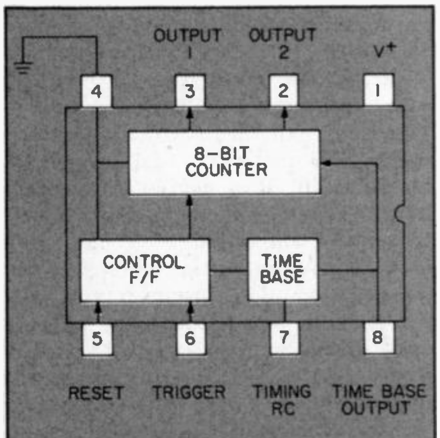
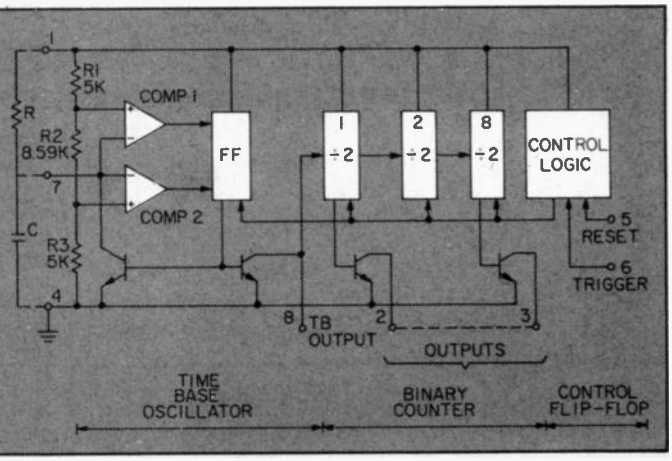


Fig. 1. This is a block diagram of the EXAR XR-2242, the heart of the timer.

Fig. 2. This function diagram of the workings of the XR-2242 indicates just what's taking place inside. The three major segments of the chip are detailed in the text, but a quick glance at this diagram when experimenting or troubleshooting will help to save you time.



Operating Modes. The external circuit can be arranged for three basic modes of operation. These are: monostable, astable trigger and reset operation, or astable free-running self-triggered operation. In monostable operation, the timer awaits the arrival of a trigger pulse. When it does arrive, the circuit will go through one time-delay operation and stop. It will remain inoperable until the next trigger arrives.

In triggered astable operation, the arrival of the external trigger will start the circuit in operation. However, at the conclusion of the first delay interval, it will recycle itself and continue operation in this manner even though there is no arriving trigger pulse. The free-running circuit provides continuous operation. The circuit self-triggers as soon as power is supplied and there is no necessity for re-applying a pulse.

Experimental Circuit. The circuit of Fig. 4 shows the connection arrangement for using the timer for either monostable or triggered bistable operation. The time period equals the product of resistor R1 and capacitor C1:

$$Td = 39K \times 2 \times 10^{-6} = 0.078\text{-seconds}$$

This delay is multiplied by the counter chain to a value of:

$$Td = 128To = 128 \times 0.078 = 9.984\text{-seconds}$$

Thus the delay time at the output should be approximately 10-seconds. The actual delay time depends very much on the true values of resistor R1 and capacitor C1. If you wish to adjust the circuit for some precise time interval, use a fixed resistor and a potentiometer for resistor R1 as shown in the optional circuit of Fig. 4. This arrangement permits you to adjust the time-base oscillator frequency precisely to obtain an exact 10-second delay interval. A stop-watch can be used to make the potentiometer adjustment.

Testing and Operation. Close switch S3 for monostable operation. Open switches S1 and S2. Connect the LED indicator circuit to the output and apply power. The LED indicator should light indicating that the output is high (logic 1). *Momentarily* close switch S1. Since S1 connects to the supply voltage, this is the same as applying a positive trigger. At the mo-

(Continued on page 103)

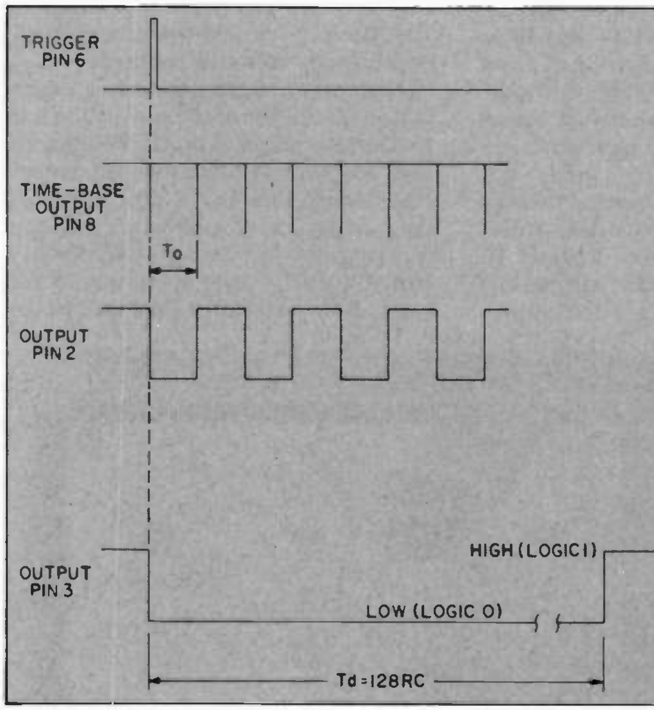


Fig. 3. This diagram depicts the output waveforms of the trigger, time base and of the first binary counter (pin 2). The second binary counter's output (at pin 3) is also shown for reference, but not in the same time scale as the other three. It's own scale is shown beneath it (Td=128RC).

Figure 4

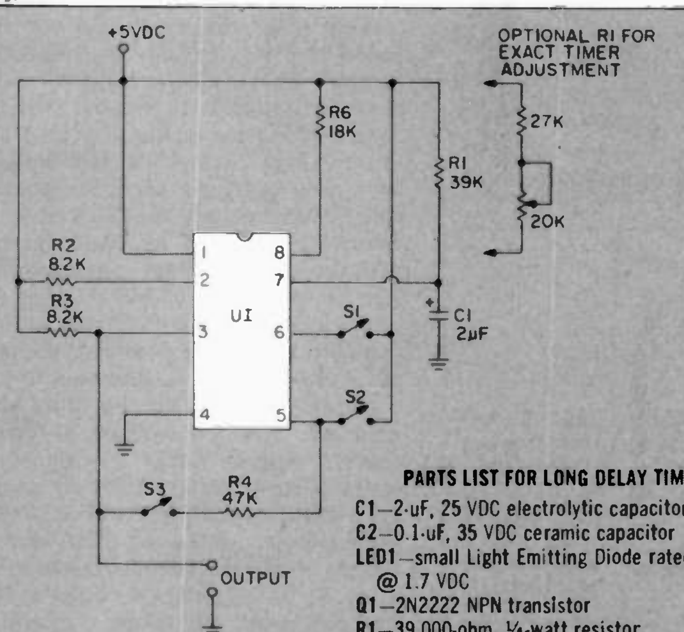
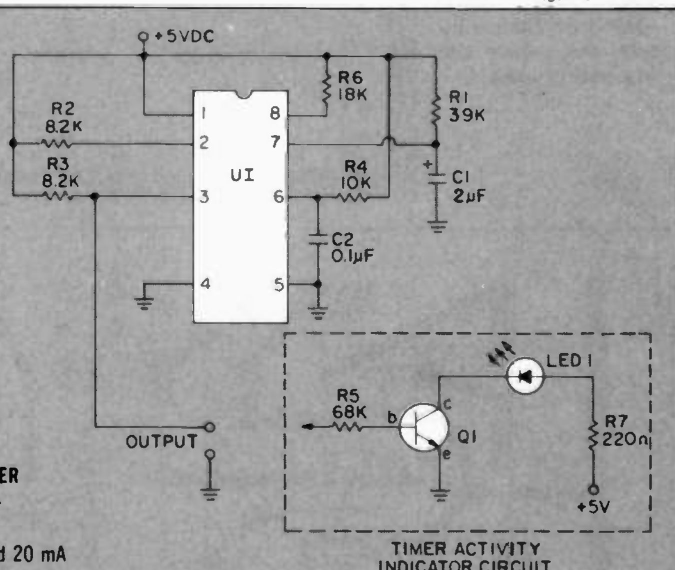


Figure 5



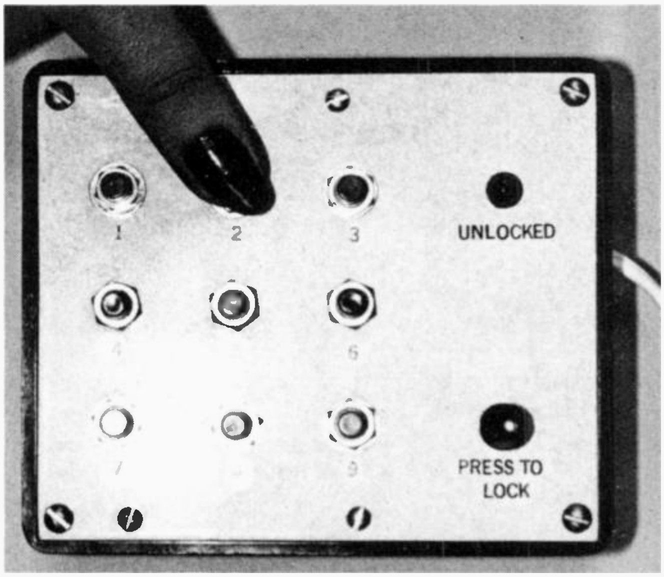
PARTS LIST FOR LONG DELAY TIMER

C1—2-uF, 25 VDC electrolytic capacitor
C2—0.1-uF, 35 VDC ceramic capacitor
LED1—small Light Emitting Diode rated 20 mA @ 1.7 VDC
Q1—2N2222 NPN transistor
R1—39,000-ohm, ¼-watt resistor
R1 (optional)—27,000-ohm, ¼-watt resistor, plus 20,000-ohm, linear taper potentiometer
R2, R3—8,200-ohm, ¼-watt resistor
R4—10,000-ohm, ¼-watt resistor
R5—68,000-ohm, ¼-watt resistor
R6—18,000-ohm, ¼-watt resistor
R7—220-ohm, ¼-watt resistor
S1, S2, S3—SPST toggle switch
U1—EXAR XR-2242 timer integrated circuit

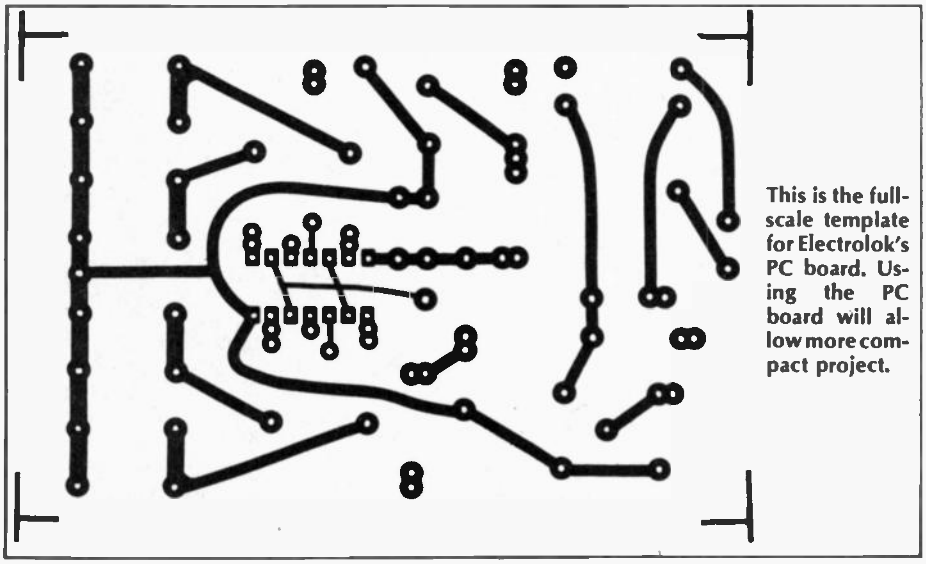
ELECTROLOK

HAVE YOU EVER stopped to consider just how many locks there are in the average house? Take a census in your own home: the number will probably surprise you. Most of the locks you find—in fact, probably all of them—will be mechanical. While such devices are fine for the majority of household applications, sometimes what you really need is an *electronic* lock. For example, suppose you have a favorite piece of electronic equipment; something that's expensive and delicate. To make sure that no one else can meddle with it—whether it be a photographic enlarger, an amateur transceiver, a stereo system or a computer—you need to prevent the power from being turned on. Although you might lock things up mechanically, an electronic lock is the easier, more effective solution.

Features. Presented here is a simple, inexpensive, electronic combination lock that's really tough to crack. To open the lock and turn on the protected apparatus, you must enter a 5-digit numerical code by means of pushbutton switches. If you enter the wrong code, the system will disable itself for about 15 seconds, during which time the lock cannot be opened even if the correct combination is entered. Furthermore, the code must be entered quickly; if someone dawdles more than a second or so between entries, the lock won't open, even with the right code. All these features add up to a system that is both convenient (no key) and difficult to beat.



Electrolok may be assembled in any convenient cabinet, or combined with an easily available surplus telephone-type touch-pad to give a real finished look. Make sure that the touch-pad you get has discrete-wired switches. Other types (matrix) might not be compatible with Electrolok's wiring arrangement.



This is the full-scale template for Electrolok's PC board. Using the PC board will allow more compact project.

Circuit Function. Let's see how the lock works by taking a look at the schematic diagram. A half-wave-rectifier system consisting of T1, D1, and C1, supplies power to the lock. Resistor R1 and zener diode D2 do not regulate the supply voltage. Instead, they just clip any voltage spikes generated on the power line, thus protecting U1. You'll note that there is no power switch on the primary (117 VAC) side of T1. That's because standby power consumption is so minute, that a power switch was deemed unnecessary. (However, you might wish to include one. In that case, the primary power switch would have to be turned on before the 5-digit combination could be entered.)

Capacitor C3 is charged up by supply current flowing through resistor R2. Let's assume that enough time has elapsed after the application of AC power for C3 to have become fully charged. In that case, a logic "1" input is seen by pins 2, 5, 9 and 12 of the four AND gates comprising U1. The result is that each AND gate behaves as a very-high-gain amplifier. Specifically, if the voltage presented to the one remaining input of any gate exceeds half the supply voltage (approximately), the gate's output will be high (at supply potential). With inputs of less than half the supply potential, the output remains low (grounded).

In this lock circuit, the four AND gates are arranged to form a sort of "bucket brigade"—only it's not water that's being transferred, it's an electrical charge instead. When S1 is pressed momentarily, capacitor C4 charges rapidly to supply potential through R5. Once S1 is released, C4 begins to discharge through R6, taking a second or so to discharge half way. Since AND gate A's input (pin 1) reads the voltage on C4 through R5, we know that the gate's output (pin 3) is going to be high for about a second, which is

This electronic combination lock keeps your equipment safe

the time it takes C4 to discharge half way. Therefore, if we press S2 before the one-second interval has elapsed, it is possible to charge capacitor C5 to supply potential. (If we dawdle more than a second, however, gate A's output will have dropped to ground potential, and no charging of C5 will be possible.)

Assuming that C5 has been charged, it is obvious that gate B's output (pin 4) will remain high for the second or so that it takes R8 to discharge C5 half way. Therefore, we can now charge C6 by pressing S3 before another second goes by. Applying the same reasoning, it should then be possible to charge C7 if S4 is pressed quickly enough. Finally, pressing S5 within a second of S4 will send a current from U1-D's output (pin 11) through R13 into the gate terminal of the SCR (Q1). This causes Q1 to latch in a conducting state, thereby allowing current to flow through relay K1 and light-emitting diode LED1. Once actuated, the relay's contacts close and supply power to whatever device you wish to control. The lighting of LED1 alerts you to the fact that the circuit is unlocked.

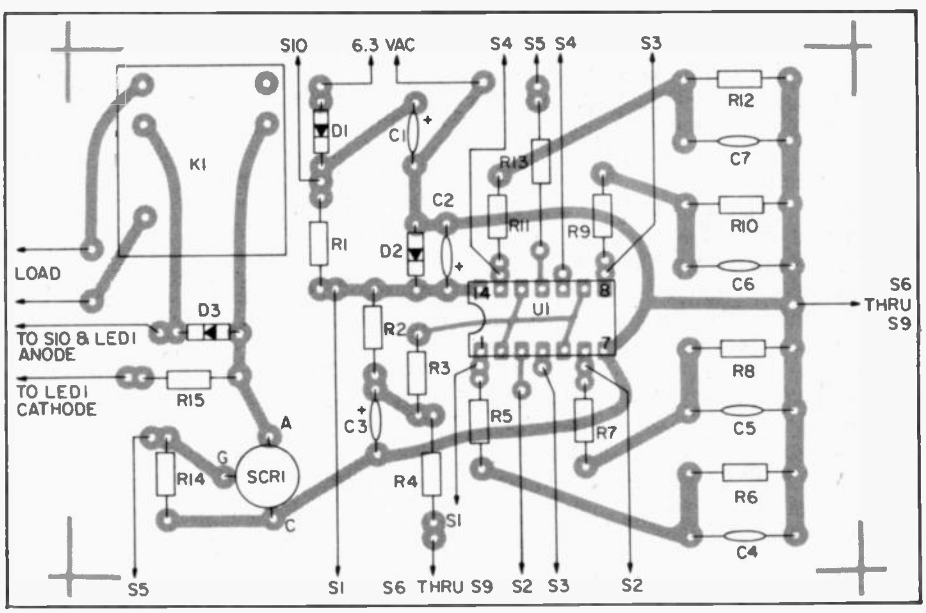
To lock the circuit once more, it's necessary to momentarily interrupt the flow of anode current through the SCR. This can be done by pressing S10. Once the anode current has been interrupted, Q1 will not conduct until the proper code has once again been entered.

From the schematic, you can see that besides the five pushbuttons required to open the lock, there are four extra dummy switches; S6 through S9. These serve the purpose of foiling any attempt to pick the lock. Whenever one of the four dummy switches is pressed, C3 gets discharged quickly through R4. While C3 is recharging through R2 to a potential greater than half the supply voltage—an interval of 15 to 20 seconds on the average—the bucket brigade remains disabled and all AND-gate outputs are locked at ground potential. Therefore, any code, even the correct one, entered while C3 is insufficiently charged, will have no effect. Once a would-be lock picker touches a dummy switch, it is very probable that he will press another dummy before C3 has been sufficiently recharged. This means that the bucket brigade remains inoperative for 15 seconds more. Consequently, the chances of cracking the code by punching in numbers at random are exceedingly slim.

Numbers may be assigned to S1 through S9 at will. Therefore, should someone break the code (an unlikely but still possible occurrance), you can easily change the combination by rewiring some of the switches.

Although the pushbuttons used in the prototype were small discrete units, you might wish to employ a calculator-type keyboard instead. If you do, make sure that the board you choose has individually accessible switch contacts. Some keyboards have switches wired in a matrix arrangement, which would be useless here.

Select a relay that can handle the maximum expected current drawn by the equipment you intend to control. The device used in the prototype is rated for an RMS current of one amp @ 117 VAC. For heavier loads, use the Circuit Specialists #D1-966, which can



Here's a top view of the PC board showing the component locations. All parts except F1, switches, LED 1, and power transformer mount here. We recommend use of an IC socket.

ELECTROLOK

handle three times as much current. When using the latter relay, however, be sure to modify the circuit board, which was designed specifically to accommodate the pin arrangement of the prototype's Radio Shack device.

Construction. Construction of the lock should be simple; either perfboard or a printed circuit will do. For those who choose PC construction, suitable templates are featured elsewhere in this article.

Use a low-heat (25-watt or less) iron and resin-core solder for all the electrical connections. It is recommended that you *not* solder U1 directly into the circuit. Instead, use an IC socket, and install the integrated circuit into the socket only after all soldering and construction are completed. This will minimize the chances of accidentally damaging your IC.

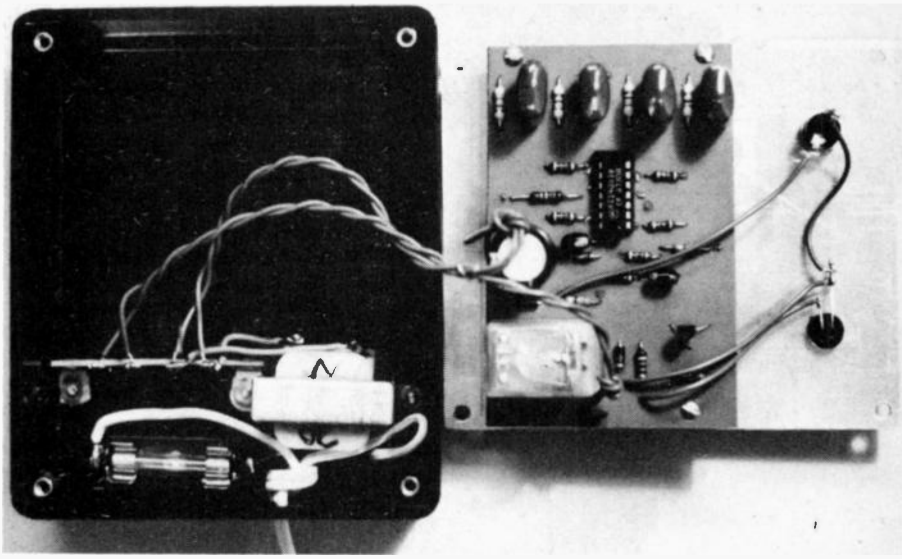
Be certain to observe proper polarities with all the diodes, Q1, U1, and all the capacitors.

Almost any small cabinet can be used to house the lock circuit. In the prototype, a 2 by 5 by 4-inch plastic cabinet was used, but if you lack experience in small-scale construction, you may be more comfortable with a larger box.

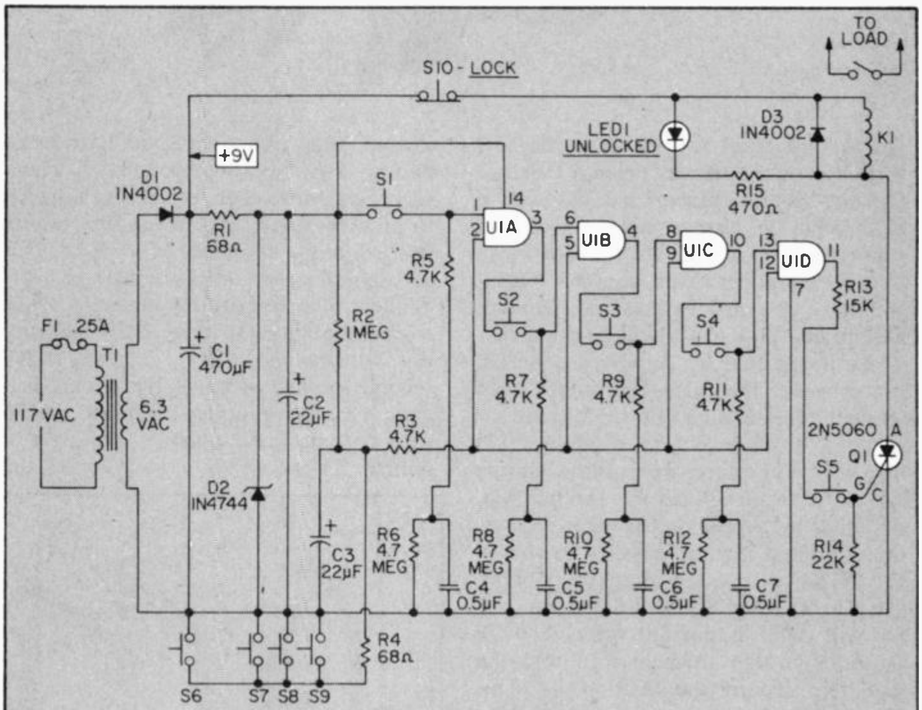
Operation. When construction is complete, you're ready to check out your work. In these initial stages of testing, do *not* connect any load to relay K1. Plug the circuit into the AC line, and wait one minute. This is more than enough time for C3 to charge up completely. Now, quickly punch in the correct combination (according to the way you've wired up the pushbuttons). After the entry of the last digit, LED1 should light up, and K1 should emit a faint "click" as it pulls in.

Once you have successfully unlocked the device, press switch S10. The circuit should return to its locked state, and LED1 should cease to glow. Next, hit one of the dummy switches, followed by the correct combination. Your circuit should be unaffected by the code and remain locked.

Final Touches. When proper operation of the lock has been verified, you can proceed to wire K1's contacts into the load circuit. In addition to the applications already suggested, you might consider using the lock to control an electronic garage-door opener or burglar-alarm system. In fact, there are so many ways to use the circuit, that you may wish to build several units—each with a different combination. ■



The prototype Electrolok with the cover removed, shows the placement of the PC board and off-board components. No power switch is used, as idle current is very low in the operating mode. You can add an SPST switch in series with a transformer primary lead.



PARTS LIST FOR ELECTROLOK

- **C1**—470-uF electrolytic capacitor, 35-VDC
- **C2, C3**—22-uF tantalum capacitor, 25-VDC
- **C4 to C7**—0.5-uF mylar capacitor, 25-VDC
- **D1, D3**—1N4002 diode
- **D2**—1N4744 zener diode
- **F1**—0.25-amp fuse (3AG type)
- **K1**—relay with 6-VDC, 500-ohm coil (Radio Shack #275-004 or Circuit Specialists #D1-966—see text)
- **LED1**—small LED rated 20-mA @ 1.75-VDC
- **R1, R4**—68-ohm, ½-watt resistor, 10%
- **R2**—1-megohm, ½-watt resistor, 10%
- **R3, R5, R7, R9, R11**—4,700-ohm, ½-watt resistor, 10%
- **R6, R8, R10, R12**—4.7-megohm, ½-watt resistor, 10%
- **R13**—15,000-ohm, ½-watt resistor, 10%
- **R14**—22,000-ohm, ½-watt resistor, 10%
- **R15**—470-ohm, ½-watt resistor, 10%
- **SCR1**—2N5060 silicon-controlled rectifier
- **S1 to S9**—SPST normally open pushbutton switch
- **S10**—SPST normally closed pushbutton switch
- **T1**—power transformer; primary rated 117-VAC, secondary rated 6.3-VAC @ 100-mA
- **U1**—Motorola MC14081B quad AND gate
- **MISC.**—suitable enclosure, line cord, IC socket, hookup wire, solder, etc.

(Note: U1 is available from Circuit Specialists, Box 3047, Scottsdale, AZ 85257.)

Build a budget DWELL/TACHOMETER

Saves money on tune-ups!

OUTSIDE OF A GOOD SET of wrenches, the most commonly called for automotive tool is the dwell/tachometer. When tuning up an engine, there's no substitute for the kind of accuracy a dwell/tach can bring to your engine adjustments. A commercial version of this apparatus might run as high as $25.00. With some judicious parts buying, you should be able to do the job for roughly half of that figure. In addition, our dwell/tachometer gives you an additional feature not found on any but the most expensive commercial units: a DC voltmeter, which is highly useful in checking a car's electrical system and, in particular, the ignition.

Most of the parts used in the construction of this instrument will probably be found in the electronics hobbyist junk box. The meter is a common 1 mA DC movement. If desired, other meter movements may be used by simply changing circuit values to accommodate a more or less sensitive meter.

Construction. Most of the circuitry of the instrument is built on a printed circuit board, which mounts all components except the front panel switches and meter. The PC board is mounted to the rear of the meter by means of the two meter studs. This type of construction allows the entire circuit of the instrument to be contained in one module, and allows ease of assembly and service if ever necessary. The components layout as seen from the parts side of the board is shown in Fig. 1, and the printed circuit layout as seen from the copper side of the board is shown full size in Fig. 2. If you are going to use a physically different meter than that specified in the parts list, be sure to take into account the center-to-center stud distance when laying out the printed circuit board.

Fig. 3 is an illustration of a meter scale which can be used for the instrument. This scale has two ranges; 0 to 1500 RPM, and 0 to 60 degrees dwell. To change the 0 to 1 milli-

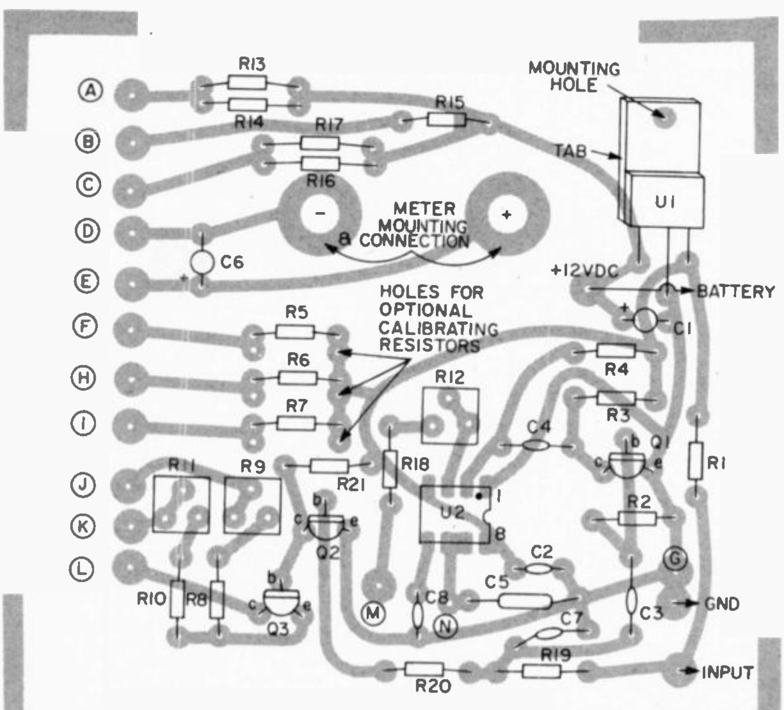
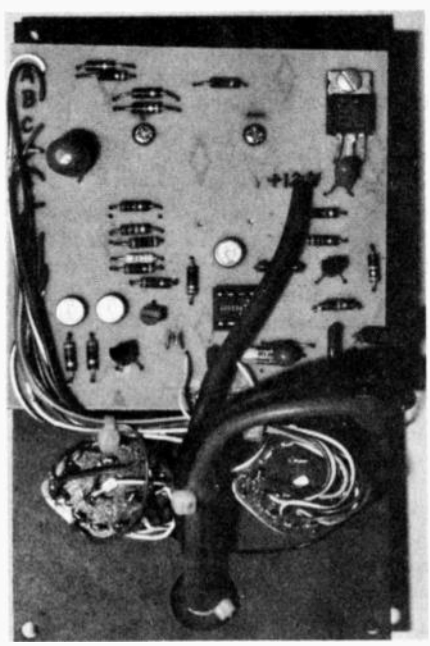


Fig. 1. The component layout diagram will guide you in assembly of board. Take care not to cover holes for calibrating resistors near R5, R6 and R7.



Compare this photo with the component layout guide at left for reference during assembly. In author's prototype, some calibrating resistors have been added. Don't be discouraged if your model needs them.

DWELL/TACH

ampere scale on the meter, remove the plastic front of the meter and carefully remove the two small screws which hold the scale in place. You can then paste the scale of Fig. 3 over the back side of the meter scale and put it into place over the meter movement. Be careful not to disturb the meter needle during this operation, since it is very fragile. Fig. 4 can be used as a front panel label which provides the FUNCTION and CYLINDER lettering.

The instrument is connected to the automobile ignition system with three wires, as shown in Fig. 6. Be sure to use different colors to help prevent misconnections when the instrument is placed in use. Rubber covered test lead wire is ideal for the purpose, and comes in several colors besides red and black. Alligator clips and boots can be placed on the ends of the wires for the connections to the automobile.

Connections between the printed circuit board and front panel switches are indicated on the schematic diagram and printed circuit layout by a group of 14 letters, A through N. Three additional wires are used for the three operating leads of the instrument. These connections are clearly marked on the parts location guide diagram.

After the unit is completely wired, double check to make sure that the transistors, integrated circuits, and electrolytic capacitors are mounted to the printed circuit board in the correct direction. These components are polarized and will be damaged if they are placed into the circuit improperly.

The Circuit. In order to best understand the operation of the dwell/tachometer circuit, it is necessary for the reader to be familiar with the voltage waveform appearing at the primary terminal of the ignition coil. This is shown in Fig. 5. The basic voltage waveform is a rectangular pulse with a considerable amount of ringing on the rising edge of the pulse. This ringing is caused by the sudden cut-off of current in the ignition coil, and results in the high voltage generation which fires the spark plugs. The duty cycle of the rectangular pulse is determined by the dwell angle of the ignition points (or solid state circuit in electronic systems), and must fall within specified limits for

The dwell meter section of the instrument is composed of Q2, Q3, and associated components. Q3 is connected as a constant current generator with eight-volts impressed upon the base and

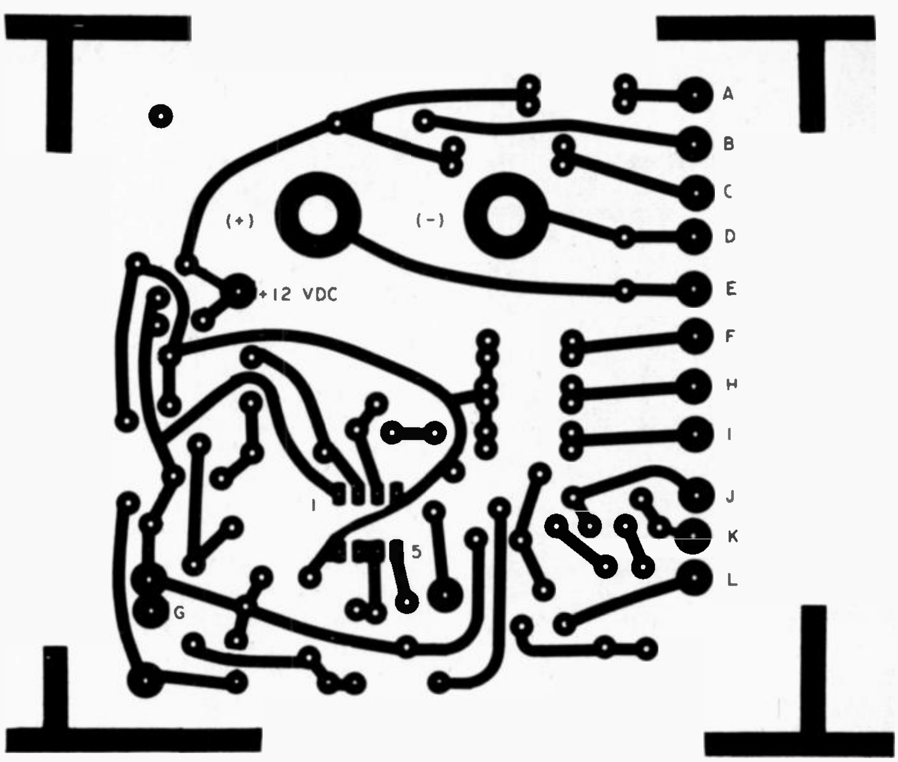


Fig. 2. This is the full-scale etching guide for the Dwell/Tachometer's printed circuit. DO NOT etch the board until you know the center-to-center distance of the studs.

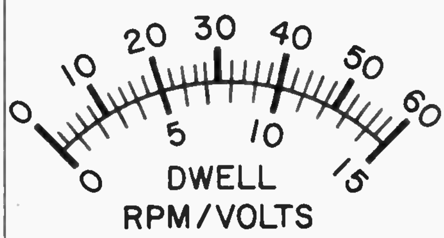
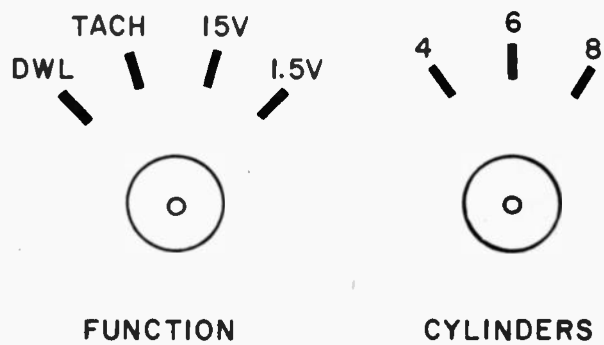


Fig. 3. This is a full-scale template for use on the meter face. It is designed to be used with the GC Electronics movement described in the parts list, but will likely fit other meter faces just as well.

Fig. 4. Function template, also full-scale, can be used on the cabinet front to illustrate the switch positions. If your configuration differs from ours, a good method of illustrating the front panel is to use transfer lettering stencils.



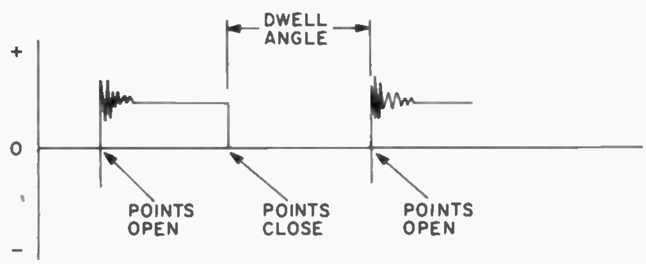
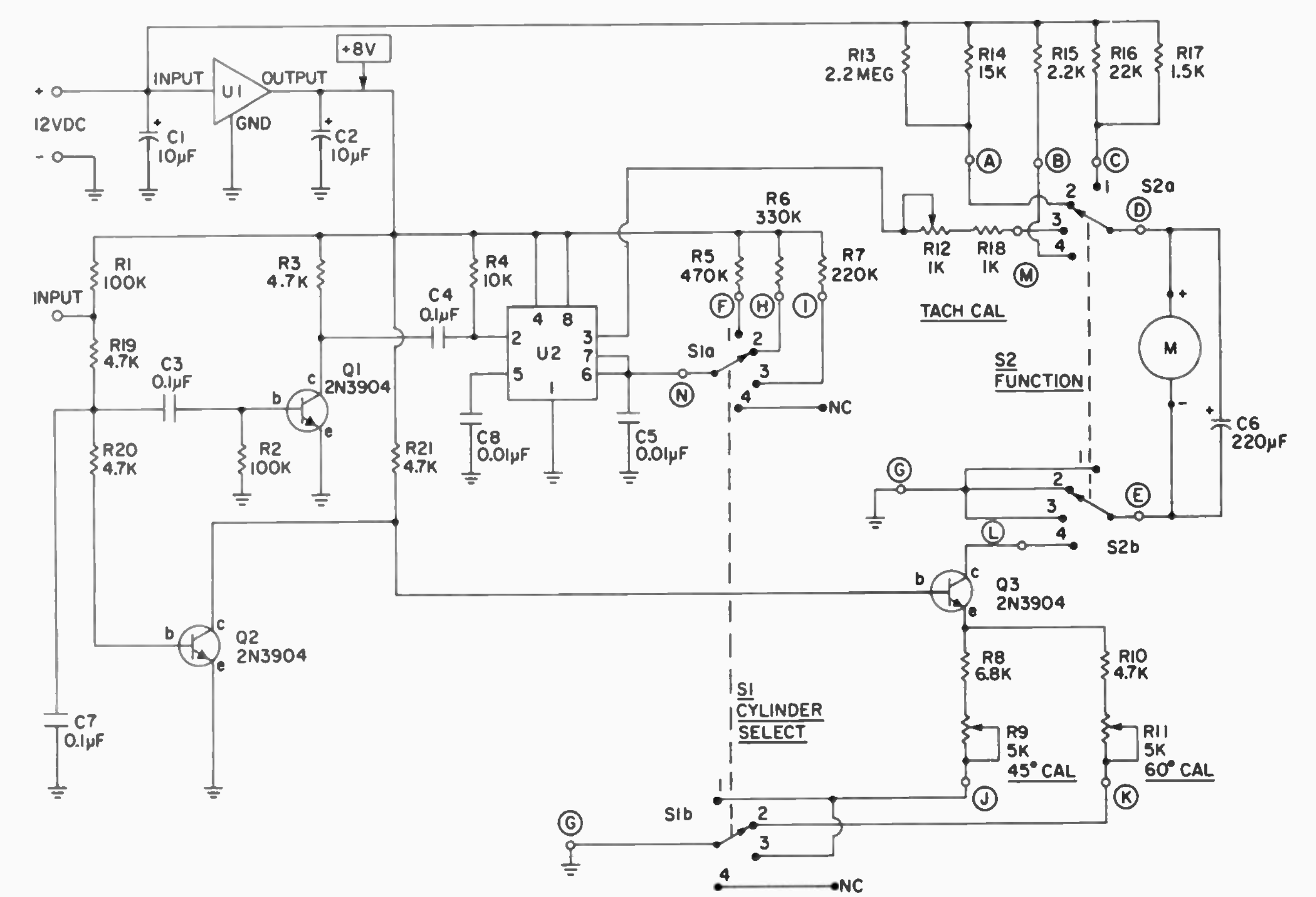


Fig. 5. A waveform diagram of the voltage across the ignition points illustrates exactly what happens during operation, and what it is that you're measuring when you use the instrument.

the meter placed in the collector circuit by the FUNCTION switch. The value of resistance placed in the emitter of Q3 determines the collector current of the transistor, and is adjusted so that the meter reads the full dwell angle (45 or 60 degress) when the sensing lead of the instrument is shorted to ground. Q2 acts as a switch which controls the base of Q3, and causes Q3 to either be on or off, depending upon the state of the ignition points. When the points close, Q2 is cut off and Q3 passes its calibrated constant current through the meter. When the points open, Q2 is forward biased and saturated by the voltage appearing across the points. This cuts off Q3 and the meter current is zero. Since this action takes place much faster than the meter needle can follow, the meter reading is the average of the two conditions, and is the actual dwell angle measurement.

The tachometer section of the instrument makes use of the fact that the meter of spark plug firings per second is directly related to the RPM of the engine. Q1 is used as a buffer transistor between the ignition system and the trigger input of a 555 timer IC which is connected as a one-shot multivibrator. Each time the ignition circuit produces a positive-gain pulse, U2 generates an 8-volt pulse of 2500 to 5000-microseconds duration, depending upon the number of cylinders of the engine under test. The output of U2 is fed to the meter through a calibrating potentiometer. C6 acts as a filter to smooth out the pulses to nearly pure DC, and provides a steady meter reading which is engine RPM.

The voltmeter section of the unit consists of R13, R14, R16 and R17. These components are used as multiplier resistors so that full scale meter current is generated when either 15



PARTS LIST FOR DWELL/TACH

C1, C2—10-uF, 25-VDC electrolytic capacitor
C3, C4, C7—0.1-uF, 25-VDC ceramic capacitor
C5—0.01-uF, 25-VDC tubular capacitor
C6—220-uF, 6-VDC tantalum capacitor
C8—0.01-uF, 50-VDC disc capacitor
Q1, Q2, Q3—2N3904 NPN silicon transistor (or equivalent)
R1, R2—100K, ¼-watt resistor, 10% (all resistors 10% tolerance unless otherwise noted.)
R3, R10, R19, R20, R21—4.7K, ¼-watt resistor
R4—10,000-ohm, ¼ watt resistor
R5—470,000-ohm, ¼-watt resistor
R6—330,000-ohm, ¼-watt resistor
R7—220,000-ohm, ¼-watt resistor
R8—6,800-ohm, ¼-watt resistor
R9, R11—5,000-ohm linear taper potentiometer (PC mount)
R12—1,000-ohm linear taper potentiometer (PC mount)
R13—2,200,000-ohm, ¼-watt resistor
R14—15,000-ohm, ¼-watt resistor
R15—2,200-ohm, ¼-watt resistor
R16—22,000-ohm, ¼-watt resistor
R17—1,500-ohm, ¼-watt resistor
R18—1,000-ohm, ¼-watt resistor
S1, S2—2-pole, 4-position rotary switch, GC Electronics #E2-166, or equivalent
U1—LM340T-8, 8-volt regulator integrated circuit
U2—555 timer integrated circuit
Misc.—0 to 1 mA DC ammeter movement, GC Electronics #D1-912, or equivalent, cabinet, solder, alligator clips, knobs, etc.

A pre-drilled and labeled printed circuit board, as well as a complete parts kit for the Dwell/Tachometer, is available for $26.00 postpaid from: Niccum Electronics, Box 271B, Stroud, OK 74079. Please, no C.O.D.s or foreign orders. Allow 3-4 weeks for delivery.

Here the Dwell/Tach's voltmeter function is being utilized to test a battery. If you look closely, you'll see that the meter is reading a nominal 12-volts.

or 1.5-volts is fed to the power leads of the instrument. The function switch of the unit connects the proper resistors into the circuit as necessary for a full scale voltmeter reading of either 15 or 1.5-volts.

U1 is a fixed, 8-volt regulator IC which provides the power to operate the dwell and tachometer sections of the unit. Since the circuit derives its power from the battery and alternator of the automobile under test, the 8-volt regulator ensures that the calibrated accuracy of the instrument is retained regardless of varying voltages being generated by different charging systems.

Checkout and Calibration. To check and calibrate the unit, you will need a variable DC power source of 0 to 15-volts, an accurate DC voltmeter, and an audio oscillator which can deliver at least 15-volts RMS output. A Hewlett/Packard 200CD or equivalent is ideal.

Set the FUNCTION switch to 15-volts and connect the positive and negative leads of the instrument to the power supply. Connect the voltmeter across the output of the supply. Raise the voltage of the supply from zero to 15-volts while watching the instrument, which should agree with the DC voltmeter. If necessary, you can change the value of R14 to provide an accurate indication of 15-volts. Reduce the output of the supply to 1.5-volts and set the function switch to 1.5-volts. If necessary, the value of R17 can be changed to provide an accurate indication of 1.5-volts.

The next check to be made is upon the dwell meter circuit. Set the FUNCTION switch to DWELL, and the power supply to 14-volts. Connect the sensing lead of the instrument to the negative side of the power supply. This should result in some positive meter reading. Set the CYLINDER switch to 8, and adjust R9 for a meter reading of 45 degrees on the 0 to 60 dwell scale. Set the CYLINDER switch to 6 and adjust R11 for a meter reading of 60 degrees. Check the meter reading with the CYLINDER switch set to 4. It should read 45 degrees. (This reading will be doubled during operation of the instrument, and is actually 90 degrees for 4 cylinder engines). Remove the sensing lead from the negative side of the power supply. The meter should read zero for all settings of the CYLINDER switch. This completes the dwell calibration.

To calibrate the tachometer section of the unit, connect the instrument, power supply, and audio oscillator as shown in Fig. 6. Set the power supply to 14-volts output, and the audio oscillator to 30 Hertz at 15-volts output or more. Set the FUNCTION switch of the instrument to TACH and the CYLINDER switch to 8. Adjust R12 for a meter reading of 450 on the 0 to 1500 scale of the meter. Check the reading of the meter with the cylinder switch set to 6 and 4. These readings should be 600 and 900 respectively. If necessary, you can parallel R5, R6 or R7 with resistors as required to attain proper calibration for all positions of the CYLINDER switch. The printed circuit layout has additional pads and holes for any extra resistors that may be necessary.

Operation. The Dwell/Tach is connected to the automobile system as shown in Fig. 7. Note that cars with factory installed electronic ignition systems will have a special terminal for the connection of the sensing lead of the instrument. Refer to the service manual for your car, or ask your dealer where this terminal is located. Once the instrument is connected to the automobile, the function switch can be set to DWELL, TACH, or 15-volts as necessary. Keep in mind that when measuring dwell on 4 cylinder engines, you must double the meter reading. Be very careful not to switch the function to the 1.5-volt scale unless you have first checked the voltage of the circuit under test with the 15-volt scale to be sure that the voltage is less than 1.5 volts. This will avoid possible damage to your meter. ■

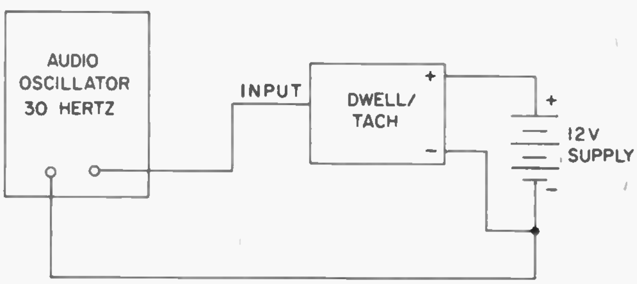


Fig. 6. This is the wiring setup utilized for final calibration. A well-regulated 12-volt power supply is a necessity here. Alternatively, you can use the car's battery if it is fully charged.

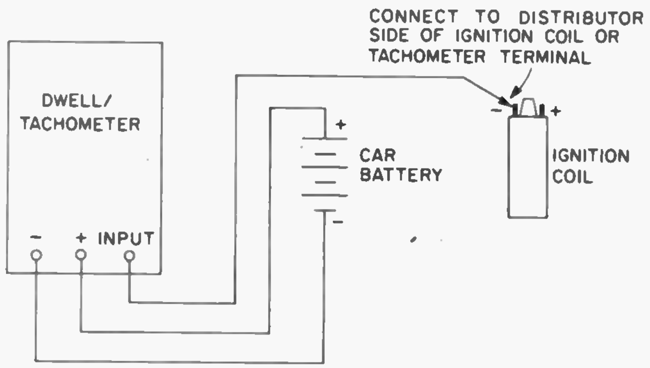
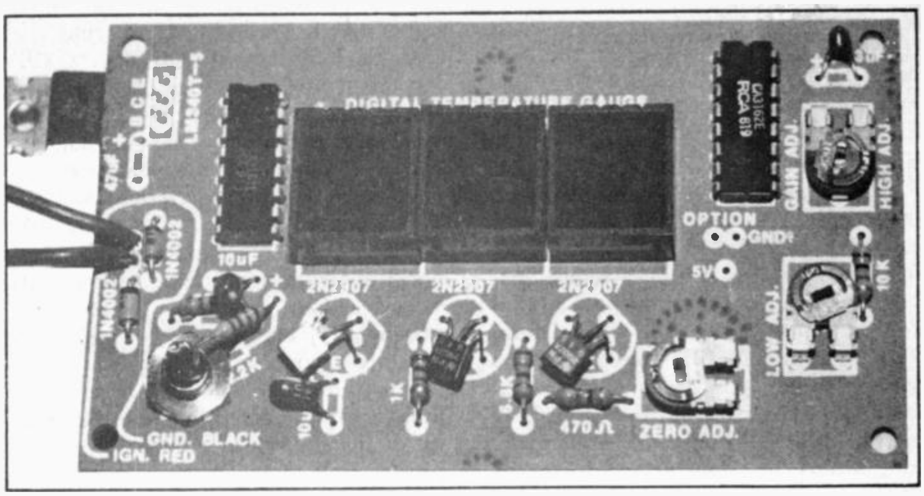


Fig. 7. This is a schematic representation of the manner in which Dwell/Tachometer is connected to car's ignition system. No other connections needed to use all of meter's functions.



Dashboard Digital Temperature Gauge

Budget's accurate gauge can help the car's engine and its owner keep their cool

NO MATTER WHAT TIME OF YEAR it may be, from the arctic blasts of a Buffalo winter to the swelter of St. Louis in August, you've probably had the unfortunate experience of having your car's engine overheat. Whether it's due to a malfunctioning water pump, a broken fan belt, frozen coolant, or a leaky radiator hose, the bottom line is that it's one All-American pain in the neck when it happens. Regular and thorough automotive maintenance will prevent this most of the time. However, when the unexpected happens, a temperature gauge can forewarn you of impending disaster—and possible engine damage, *before* the engine overheats.

It's unfortunate that most car manufacturers do not see fit to offer gauge packages (except at outrageous optional prices) on their vehicles. The few that do, offer mostly uncalibrated units which are no more helpful than a dummy light—they tell you only that you're *in* trouble, not that you're *about* to be. The following is our answer to this dilemma.

Features. This relatively simple and inexpensive temperature gauge offers three-place digital readout of Farenheit temperatures in the car's engine from a low of 0° to a high of about 250° (well above where your engine is likely to start melting). About the only type of engine with which this gauge may not work would be the small, 4-cylinder diesels now found in Volkswagens and some other imports. These engines normally operate at higher temperatures than gasoline engines, and may have an effective heat range outside the limits of this gauge. Check with your dealer or manufacturer for the nominal operating temperatures of your car's engine just to make sure.

Use of our gauge will not interfere with factory-installed gauges or dummy lights, and we suggest that they be retained as a back-up system. In addition, our gauge is easy on energy, with a maximum current consumption of 160 mA or less.

Circuit Operation. Spike protection (spikes result from turning inductive devices on and off) for the LM340T-5 (U1) is provided by capacitor C1 and diodes D1 and D2. Transients ("noise") on the 5-volt line are suppressed by capacitor C2 and the LM340T-5.

A positive potential between pins 11 (+) and 10 (−) of U2 is converted by the CA3162E into a BCD (binary coded decimal) output which reflects that difference. The CA3161E is the control element that actuates the 7-segment display. For an example of a typical cycle of switching action, assume that the display is displaying "2." This is the 1's place or least significant digit. The instant pin 5 activates the PNP switching transistor of the least significant digit, the BCD for "2" is generated in the CA3162E. The BCD code leaves pins 2, 1, 15, and 16, and enters pins 7, 1, 2, and 6 of the CA3161E decoder driver (U3). The CA3161E then takes that BCD code and activates (lights) those segments of the 7-segment display forming a "2." In reality, an optical illusion is being created for the eye. At any given time, only one display (digit) is actually on. Because of the brain's image retention of the eye's sensing capacity, all displays appear to be on simultaneously. The same cyclic sequence occurs with the two remaining displays.

As a final note on operations, we should touch on the matter of cyclic conversions or comparisons made each second (note the point marked OPTION on the schematic). With the OPTION point left disconnected, the comparison (or display update rate) is set at 4 Hz. We feel that this is probably the most pleasing to the eye and the least distracting. With the OPTION point grounded, the comparison rate goes up to 96 Hz. The result of this is that the display will appear to be unstable as the numbers fluctuate at the more rapid rate. As a result, and depending upon where in the line of the driver's vision the gauge is mounted, it may tend to be a distraction. This is the common bugaboo with all digital gauges, especially tachometers and speedometers, which can undergo rapid changes in readout as data input from the engine changes. Experiment yourself, but you'll probably agree that the 4 Hz rate is decidedly the most attractive of the two choices.

Sensing Probe Operation. The response to temperature change of a silicon diode is linear as it reflects a rise or fall. As the temperature rises across the diode's PN junction, the forward voltage developed across it drops. This would make it seem that diodes could be interchanged with no effect on readings. Unfortunately, such is not the case. While the rise and fall responses to temperature changes are for all practical purposes uniformly linear, the *base starting points are not*. Because of this, *calibration must be repeated* if the sensing probe diode is replaced.

Note that resistors R1 and R2 form a voltage divider network that has a one-volt (approximate) drop across R2. The one-volt is dropped across R3 and R7 in series with the temperature-sensing diode (the probe). The latter two resistors limit the current to the temperature-sensing diode. The forward voltage drop that is developed across the temperature-sensing diode is now applied to the negative input terminal, pin 10 of U2. As the temperature rises, the forward voltage drops linearly. The inversion resulting from the rise or fall is compensated for by applying the forward voltage to the negative input,

Temperature Gauge

which is pin 10 of U2.

Let's illustrate the action described in the preceding paragraph. Assume for each degree of Fahrenheit change there is a corresponding 1.0 mV change. Assume, also, that at 32°F, there is a 0.55-volt or 550 mV forward voltage drop. The CA3162E (U2) "looks" at the positive input (pin 11) and the negative input (pin 10), and then generates a BCD code reflecting that difference, transmitting this to the display by means of the CA3161E (U3). If the positive input, pin 11, is 32 mV greater than the negative input, pin 10, or reads a total of 582 mV, then the CA3162E will "see" a difference of 32 mV and the 7-segment displays will display "O32." As the temperature increases, the difference becomes wider. At 212° F, the voltage at the negative input would be 370 mV. Therefore, the voltage difference between pin 11 (positive) and pin 10 (negative) would be 212 (582 mV −370 mV = 212° F). Since the tolerances of diodes tend to vary somewhat, we have only stated an approximate maximum reading range for our temperature gauge. The temperature at which your gauge will cease to function linearly will be determined by the quality of the individual diode used in the construction of the probe.

Assembly. After etching your PC board, (or receiving one from Digital World) check the finished product for foil bridges and other imperfections which might create difficulty during assembly and calibration. Leaving installation of U2 and U3 for later, install all other components on the board, following the component placement guide. Be sure to observe polarity with respect to diodes, electrolytic and tantalum capacitors and the LED displays. Make sure that when J1 is installed, the outer shell is given a good ground by soldering it to the large foil area on the board.

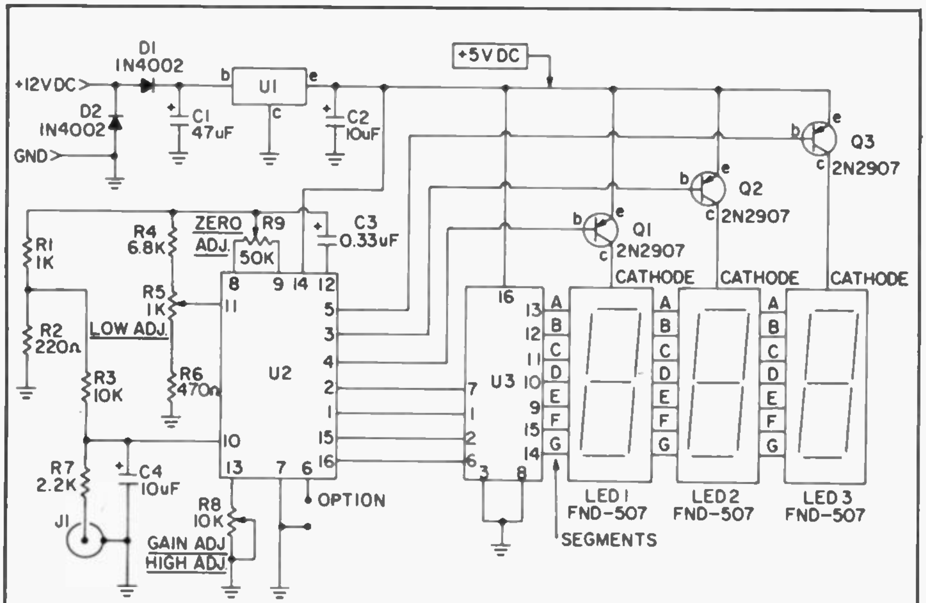
We strongly suggest that you make use of IC sockets when installing U2 and U3. These two chips are highly sensitive to static electrical damage caused by handling without insulated tweezers. In addition, stray AC from the tip of your soldering iron (not to mention excessive heat) can also cause irreparable damage to the chips.

With all components installed, make a final check of the board against the component layout diagram as a precaution. If the final check is positive, proceed to wire in the 2 leads for the 12-volt power source. The unit is now ready for calibration.

Probe Assembly. As mentioned earlier, the probe itself is simply a 1N4002 diode which is wired across one end of a length of RG58A/U coaxial cable. Check the diagram to obtain proper diode polarity and for details on its construction. Be certain that you have a length of cable that is sufficient to pass through the firewall and reach the point at which you are planning to install the gauge. You should avoid having to splice the coax at any point to add length. Moisture entering under the outer insulator of the coax will cause rapid deterioration and result in inaccurate or erratic temperature readings from the gauge.

Obtain a new intake manifold bolt (or stud) from your automotive dealer or parts supply house. Placing the bolt carefully in a bench vise (take care not to damage the threads), drill a 5/16-inch diameter hole down the center of the bolt, stopping 1/8-inch from the bottom. Solder the diode's anode to the center conductor, and the cathode to the braided shield (see diagram). Now, mix the epoxy that will be used to anchor the probe in the hole. Use of a slow-setting type will allow you more time in setting the depth of the probe.

Now attach one terminal of an ohmmeter to both the shield and the center conductor of the coax at the free (gauge) end. Ground the other ohmmeter terminal to the bolt. You will use the ohmmeter to make certain that the soldered diode connections do not contact the sides of the bolt hole, creating an unwanted short.



PARTS LIST FOR DIGITAL TEMPERATURE GAUGE

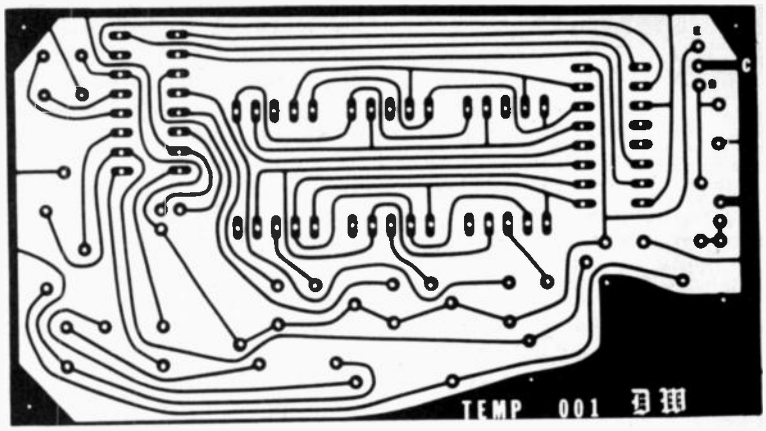
C1—47-μF, 25-VDC electrolytic capacitor
C2, C4—10-μF, 16-VDC tantalum capacitor
C3—0.33-μF, 35-VDC tantalum capacitor
D1, D2, D3—1N4002 diode
J1—RCA-type phono jack
LED1, 2, 3—FND-507 7-segment, common cathode display
P1—RCA-type phono plug
Q1, Q2, Q3—2N2097 PNP transistor
Note: All resistors rated ¼-watt, 5% tolerance unless noted otherwise.
R1—1,000-ohms
R2—220-ohms
R3—10,000-ohms
R4—6,800-ohms
R5—1,000-ohm trimmer potentiometer
R6—470-ohms
R7—2,200-ohms (see note below)
R8—10,000-ohm trimmer potentiometer
R9—50,000-ohm trimmer potentiometer
U1—LM340T-5 voltage regulator integrated circuit
U2—CA3162E dual slope/dual speed BCD encoder
U3—CA3161E BCD decoder/display driver
Misc.—5 to 10-foot length of RG58A/U coaxial cable, epoxy glue, red plexiglass stock, solder, spacers, hookup wire, replacement intake manifold bolt for probe assembly (obtainable from your new car dealer), etc.
Note: During the calibration procedure, it may be impossible to calibrate for the high end unless the value of R7 is lowered to 1,500-ohms, or even 1,000-ohms. Select the highest value of resistance for R7 that allows full scale calibration (212° F).

A pre-etched, drilled and labeled PC board for the Digital Temperature Gauge ($6.00) and a complete parts kit, including PC board ($28.50), but not including plexiglass screen, is available from: Digital World, Inc., P.O. Box 5508, Augusta, GA 30906. Allow 4-6 weeks for delivery. No C.O.D.s or foreign orders please.

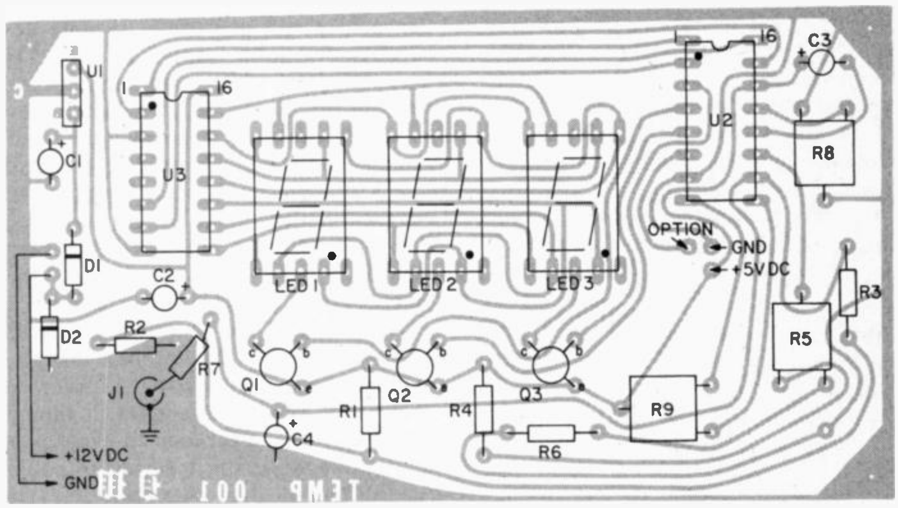
Fill the hole halfway with the epoxy mixture. Some of this will be forced out as the probe is inserted, but it can be wiped away easily. Force the probe all the way in until it stops. At this point, the ohmmeter should be showing a completed circuit. Gently begin withdrawing the probe until the ohmmeter shows that the circuit is broken. Secure the coax in this position until the epoxy sets, continuing to check to see that there is no reading on the ohmmeter. Let the assembly dry for at least 24-hours before checking once again to see that the probe is not in contact with the bolt. If the process is successful, you may now proceed with the installation of the probe on the manifold.

If, due to the design of your car's manifold (or a reluctance on your part to remove a manifold bolt) you do not wish to follow the recommended installation procedure, we can suggest an alternative. Simply secure the probe to the side of the engine block with the epoxy. Prepare the area first with a thorough cleansing before applying the epoxy. Apply a coat of epoxy sufficient to coat the metal entirely within the intended installation area. Allow this to set until very tacky. Next, observing the same anti-short procedures as described above, embed the diode in the semi-hard epoxy, and cover with more epoxy to completely enclose the probe and coax end in it.

While this method is obviously the easier of the two, you will experience some loss of sensitivity and accuracy (we estimate somewhere between 5 and 10%, depending upon how close you can get the diode to the engine wall without creating electrical contact). Whether you accept the trade-off between accuracy and ease of installation is up to you, and should be determined primarily by your degree of mechanical expertise. If you doubt your ability to remove, modify and re-install the manifold bolt, have someone else do it for you, or else use the external attachment.

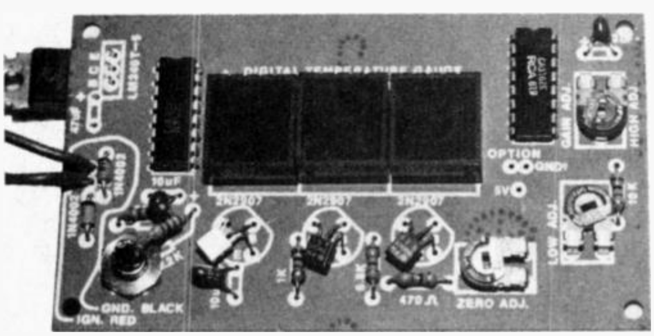


Here is the full-scale etching template for the printed circuit board. See the parts list for ordering information on a ready-to-go board if you don't etch your own.

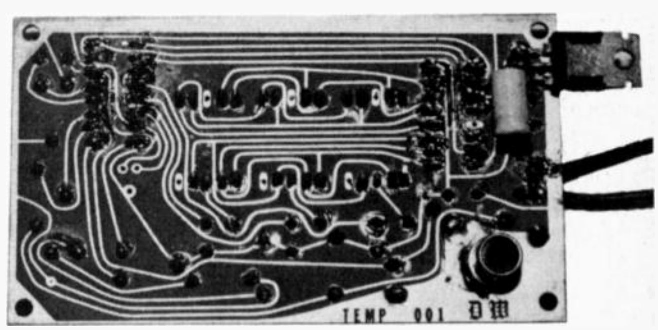


Follow this component layout guide when assembling the PC board. Note that in this diagram, U1 is installed on top of the board. Depending upon your space requirements, it can go on top or bottom, but be careful not to reverse the pin connections.

Troubleshooting. As an initial check prior to calibration, apply a DC voltage of between 10 and 16-volts (preferably 13.8-VDC) to the power input of the gauge, after having connected the probe to the gauge via J1. You should obtain some reading on the displays, and all three should be lit. If this is not the case, and all displays are unlit, check the connections to the power source, and check to see that R9's, wiper is centered. Furthermore, check to see that all components have been installed properly on the board



This photo shows the completed board ready for installation in a car. Jack J1 may be reversed for flush mounting on the dash.



The foil side of the completed board shows U1 mounted from the underside. If pins are reversed, U2 and U3 will be ruined.

Temperature Gauge

with respect to polarity, especially D1 and D2. Improper orientation here will prevent power from reaching the rest of the circuit. If these steps fail to alleviate the problem, make a physical inspection of the printed circuit board for foil or solder bridges that might be creating shorts. Before removing any solder bridges in and around the ICs, remove the ICs from their sockets to avoid heat and AC current damage.

Calibration. Assuming that all bugs have been removed from the circuitry by means of the troubleshooting section (or by virtue of your expertise having obviated the need for troubleshooting in the first place), apply power to the circuit and begin the calibration procedures. At this point, we should note that the accuracy of your gauge will be determined by the degree of calibration exactness that you apply here. Take your time.

To zero the gauge (as you would with a mechanical meter movement), temporarily ground pins 10 and 11 of U2 to circuit ground, and adjust the wiper of R9 very slowly until all displays read zero. Disconnect the temporary ground on U2. Center the wiper of R8, and place the probe in ice water for a full five minutes (to compensate for thermal inertia). At the end of five minutes, slowly adjust R5 until the display is reading "032."

Next, immerse the probe in boiling water for five minutes, and at the end of this time, adjust R8 for a reading of "212." Of course, this adjustment is made on the basis of the sea level boiling point of water. Check the boiling point for your locality's altitude, and adjust R8 accordingly. Repeat the low and high end adjustments at least once more to compensate for any interaction among the two adjustments. Again, patience here will pay off in a more accurately operating instrument.

Installation. Select an appropriate position for the gauge, and install it by whatever convenient means suits your car and the position you have selected. Use a red plexiglass screen across the opening in the cutout for the displays. Red, althought it probably doesn't seem logical at first thought, will offer the highest contrast display background.

Next, install the modified manifold bolt (containing the probe) on the cylinder head. Obviously, in order to protect the coax at this point, it should be coiled into a tight loop to avoid putting undue stress on it during rotation. After the bolt has been properly retorqued, route the coax directly away from the engine towards the fender. This will avoid close contact with hot engine parts and high-voltage ignition leads, either of whose presence in close proximity to the coax could cause deleterious effects.

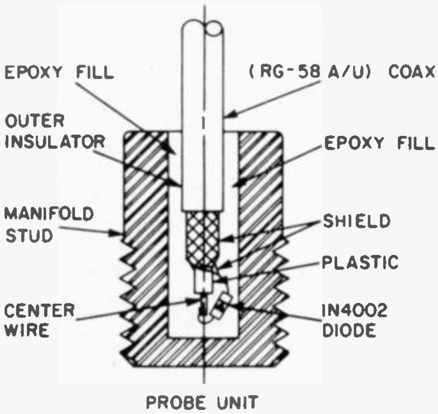
Locate a point in the firewall where accessory wires are passed through grommets to the passenger compartment, and feed the coax through at this point. Should you be unable to locate or utilize existing holes, locate a point on the firewall clear of obstacles both in the engine compartment and passenger compartment (behind the dash) and drill a ⅜-inch hole through. After passing the coax through the hole, apply silicone cement to the area to provide a weatherproof seal. Water has a nasty habit of travelling along lines, through holes, and onto irreplaceable carpets and ruining them if sufficient precautions are not taken.

Trim any excess coax so that it runs to the gauge in as direct a manner as possible from the firewall, and install P1. Plug P1 into jack J1, and connect the power leads (preferably to the horn fuse for V+, and to a good chassis point for ground).

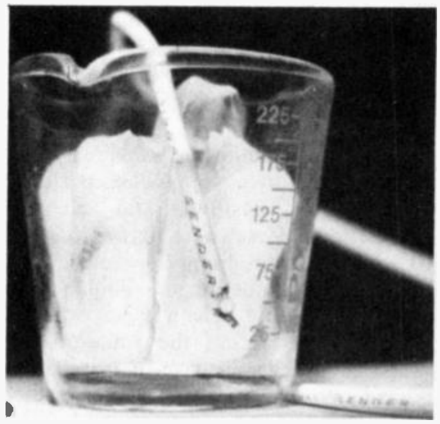
Conclusion. Some of you are no doubt questioning the wisdom of center-drilling so fragile a component as a manifold bolt, especially on older cars, where the original bolts may be either rust or heat-seized. If, when removing the original bolt to replace it with the probe-carrying bolt, you should happen to break the bolt off, do not become alarmed. This happens commonly during carburetor and gasket overhaul and replacement at car dealers and service stations. They are capable of drilling the remaining piece of the bolt out for you quite easily, leaving you free to install the new bolt.

We have selected this method of probe installation to insure the most accurate readings allowable. Other methods, such as insertion of the probe in the coolant itself, would tend to violate the pressure integrity of the car's systems, leaving open the possibility of leakage and fluid loss at a later time. Additionally, encasing the probe in the necessary waterproofing material would result in an unacceptable loss of sensitivity. ■

Here's a closeup of the probe assembly. Anode is soldered to the coax center wire.



This is a cutaway of the probe assembly mounted in the manifold stud.



Use a setup like this for the low end calibration of the temperature gauge. See text.

Allow 5 minutes in boiling water to compensate for thermal inertia in the diode.

Understanding Antique Radio Problems

GET THE OLD SPEAKERS INTO SHAPE

Many of the letters I receive are from readers seeking information about how to replace the electro-dynamic speakers in their old 1928 to 1942 radios. An electro-dynamic speaker is one that has a field coil to supply a magnetic field whereas a PM (Permanent Magnet) speaker has a permanent magnet to supply the magnetic field. Since electro-dynamic speakers are no longer made there are two basic ways to get that old radio to play again.

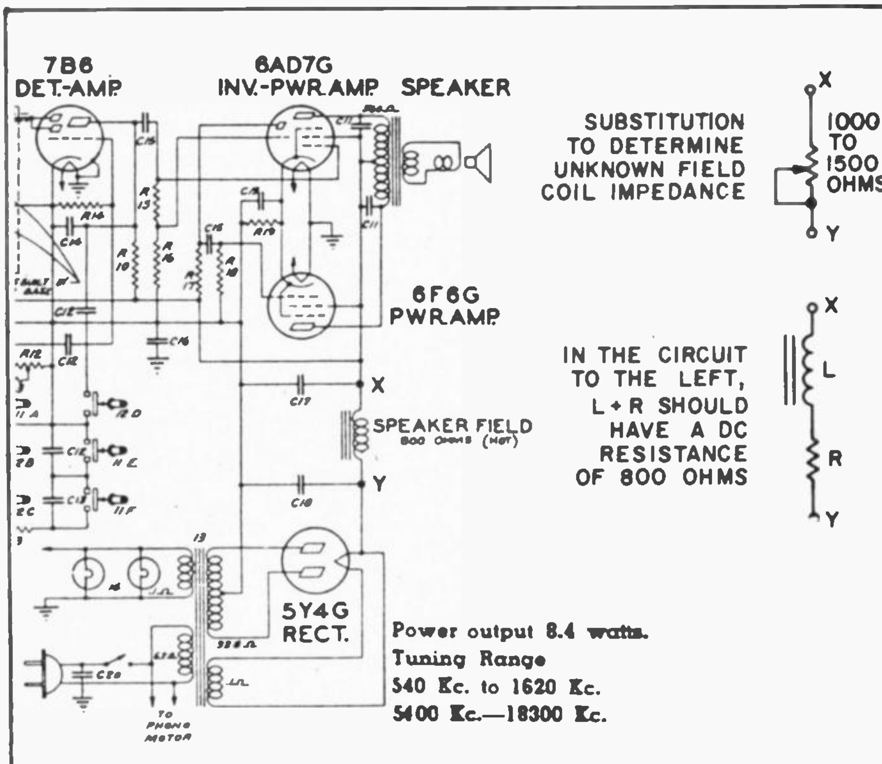
1. Have the original speaker repaired, i.e., replace the cone or have a new field coil installed.
2. Replace the old speaker with a new modern permanent magnet type.

To enable you to make an intelligent choice, I will present a detailed account on how to replace the original speaker. Having the original rebuilt means sending it off to a mail order repair shop. But first, let's review the loudspeaker, story and refresh your memory on the different types of speakers usually found with antique radios.

Early Speakers. First of all, there are two basic types of speakers found in radios made between 1920 and 1950. The first radios only used headphones, sometimes called earphones. Headphones limited the number of persons that could listen to a radio at one time. They were reasonably sensitive, worked with crystal radio sets, or with 1-tube battery-operated radios. The basic design of an earphone consisted of two coils of fine wire, with laminated cores inside the coils, surrounded by a horseshoe-shaped magnet. Suspended a few thousandths of an inch above the coils was a very thin, soft iron diaphgram that vibrated in unison with the received audio frequencies. The diaphgram produced sound waves.

Quite soon, someone mounted the earphone on a horn and the sound was then loud enough for the whole family to enjoy. Soon manufacturers were making larger headphone units to be mounted on larger horns. Distortion was a problem with the limited power handling ability. The next step was to build a cone type speaker, and the center-pin driven reproducer. The above types all fall into the category of Magnetic Speakers. Meanwhile out in California, Magnavox began to build a horn-type dynamic loud speaker. This speaker produced more power and better tone. Since the battery sets of that time used a 6-volt storage battery for the tube filaments, the speaker field also operated on 6-volts. The biggest drawback to the dynamic horn speaker was its size. The consumer was asking for radio that was self-contained with speaker and set all hidden inside a wooden cabinet. The dynamic cone speaker was introduced about the same time that AC operated radios became popular.

Dynamic Speakers. As you can see from the illustration, the dynamic speaker had a paper cone with a voice coil cemented to its center. The voice coil was a cylinder of paper from ½ to 2-inches in diameter, depending on the power handling design of the speaker. One or more layers of insulated mag-



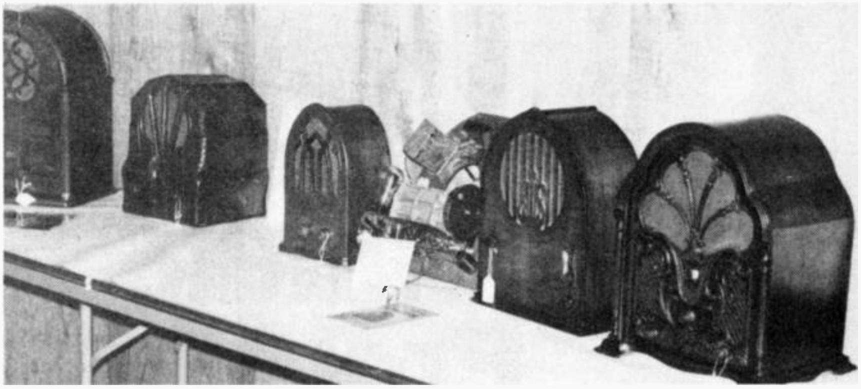
When you want to substitute a modern speaker for an old one that had a speaker field coil, you need to replace the lost impedance in the circuit. Unlike this schematic of a Zenith Model 7S681/2 many old-time schematics don't always include the value of the coil. Determine this with the top circuit and replace it with the bottom one.

net wire was wound on the voice coil and ultimately connected through an impedance matching transformer to the audio output stage of the radio receiver. Centered inside the voice coil was a soft iron pole piece which in turn was surrounded by a field coil wound with thousands of turns (except in car radio speakers) which when connected into the radio high-voltage circuit produced a magnetic force in the pole piece. This speaker was called an electro-dynamic speaker. The illustrations show the various types of speakers we discussed plus a typical radio circuit diagram using an electromagnetic dynamic speaker. It took a lot of electrical power to magnetize the pole piece, so when more efficient permanent magnets were developed most manufacturers began to make PM dynamic speakers.

The EM dynamic speakers used in auto radios, at this time, had only 4 or 6-ohms resistance, and it took 1 to 1.5 amperes to excite the field. If you remember the automobiles that had 6-volt ignition systems you will also remember that they were never too good in winter.

When the PM speaker was introduced, auto radio manufacturers were the first to use them. Later they were used in portables and house radios. Alnico V was the magnet used most successfully in speakers. Generally speaking, a larger magnet will permit the speaker to handle more power. Thus a small 4-inch speaker may have a half-ounce magnet while an 18-inch speaker may have a 2- to 3-pound magnet. Replacing a PM speaker is no problem since replacements are readily available at all radio parts stores.

Replacing an EM or field coil speaker is another problem. To start with, the field coil had a certain amount of inductance and therefore it acted as a filter choke in the "B" power supply circuit. The resistance of the field coil was also the resistance that determined the "B" supply voltage supplied to the tubes in the radio. So when replacing an EM speaker with a PM we have a couple of important factors to consider. The first factor is physical size. Whenever possible, always use the largest PM speaker that will fit the allotted space. The larger speaker will reproduce bass notes more efficiently than a small speaker. If you use a smaller than original size speaker, you will have to make an adapter board with the proper size hole for your new speaker and make it large enough to cover the old hole. Without going into acoustic theory, I would advise you to never leave an opening around the speaker cone. To produce the same amplitude and frequency tone range as the radio did when new, you should try to return the set to its original baffle condition.



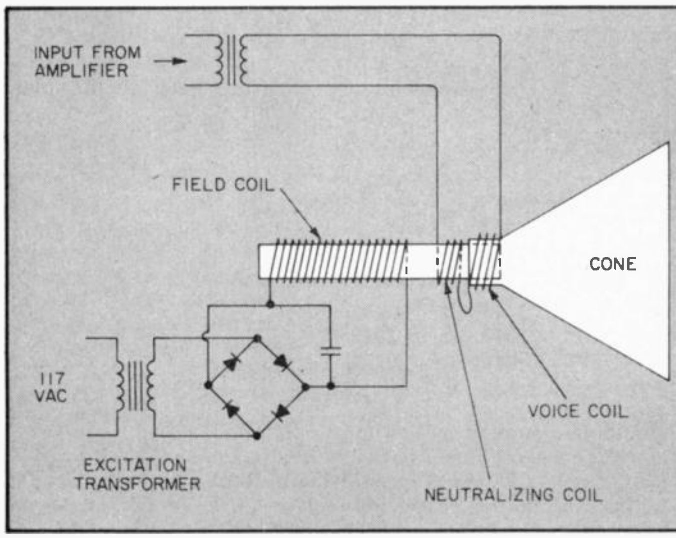
When you repair old speakers try to use as authentic a grill cloth as is possible. Note the fine restoration work on these cathedral radios displayed at an Illinois exhibition.

Choke. The second factor is to introduce some inductance into the power supply circuit in place of that lost by removing the speaker field winding. If you are replacing the speaker in a console radio, you may have room to leave the field coil connected and place the coil in an out of the way spot. Mount the new speaker in the proper place and use the old output transformer with the new speaker. If there isn't room, as in a table model radio, then you can use a small inductor and resistor to get the correct impedance.

The rectifier tube changes the 60 cycle AC voltage into 120 cycle pulsating DC. The filter capacitors and inductance (speaker field or choke coil) work together to smooth out the pulsations so the net result is hum-free DC. Since the inductance of a speaker field coil varies according to the number of turns of wire in the winding it is difficult to place a value on every speaker field. I have found that a 1.5 to 2 Henry choke will usually suffice. If you salvage parts from old TV sets, you will find a filter choke that will work fine. The choke should be capable of carrying 150 to 200 milliamperes of current.

Since the choke will usually have less resistance than the field did, you must add resistance in series with the choke coil. The total resistance of the choke and resistor in series must equal the speaker field resistance. If this isn't done all the "B" voltages will be too high. Higher than original "B" voltages can lead to blown out capacitors, overloaded resistors, and tubes being operated beyond their ratings. For example, if the speaker field measures 750-ohms and your choke coil measures 150-ohms, you will need a 500-ohm resistor in series with the choke coil. Use a 25-watt, 500-ohm wire-wound power resistor. If the resistance value had turned out to be a non-standard value you could have used an adjustable, wire-wound resistor.

If, after you replace the EM speaker in the manner we just described, the hum level in the speaker is higher than normal, then you will have to put



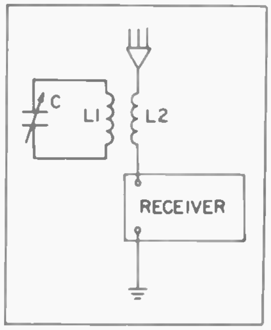
This schematic representation of a dynamic loudspeaker shows how the parts relate to each other. The field coil energizes the core (now permanent magnets are used) so that it is a steady field magnet. The fluctuating magnetic field on the voice coil moves the cone over the core.

additional filtering in the set. Try a 20 μF., 450-volt DC capacitor connected between the junction point of the choke coil and resistor, and "B–." There will be special cases in which the speaker field will have a tapped winding. Use what you have learned and use two resistors if necessary. Remember to connect one of the choke leads to the same point the field coil connected to, i.e., the rectifier filament or cathode.

Find the Value. There will be isolated cases where the speaker field coil is burned out and no value is listed on the schematic drawing or you have no schematic. In this case, use a power rheostat of 1000 to 1500-ohms at 100 watts and connect it in place of the field coil. Adjust the rheostat until the voltage readings on the audio output tube plates are normal, and then connect a choke-resistor combination in the circuit. If you don't have a schematic that shows the proper tube voltages use the data in a tube manual.

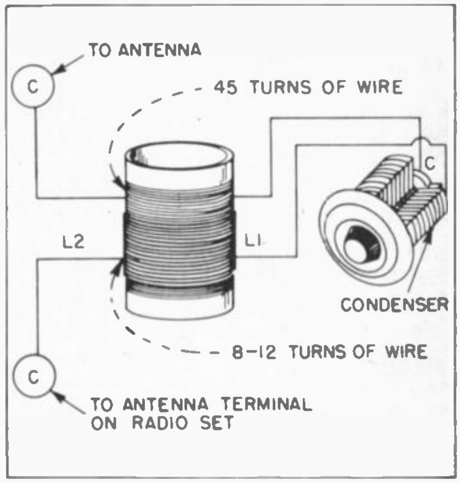
Cure Interference. We have often been asked what can be done to eliminate interference from strong local stations. This is especially a problem with the older, less selective battery powered receiving sets.

A wave trap can be built quite inexpensively that will reduce interference from strong local broadcasting stations. This simple wave trap can be constructed by connecting a variable capacitor and a coil of wire in parallel. The drawing shows one version that was used in the 1920's. The coil consists of a 4-inch diameter non-metallic tube, either cardboard or plastic, with two windings on it. Winding L-1 has 45 turns close wound, that is wound without any space between the wire,



This diagram shows connections for the wave trap. For really serious interference, try two traps in series.

of number 28 enameled wire. Over the center of the 45-turn coil wrap several layers of waxed or gummed paper. Now wind in the same direction coil L-2, consisting of 10 turns of number 22 enameled wire. Connect the winding L-2 in series with the antenna and the antenna binding post of your receiver. Connect winding L-1 in parallel with a variable capacitor of 500-picofarads capacity (.0005-mfd.).



Cure the interference problems common to older, less sensitive receivers with this simple wave trap.

To use this wave trap, the first step is to tune in the interferring station to the loudest signal on your radio receiver. Now tune the wave trap until the signal is at its weakest. You might have to retune the set and wave trap several times to get rid of the offending signal. It must be remembered that the trap will absorb energy on only one frequency at a time. If you have more than one interfering station, you may want to try using two wave traps. ■

TROUBLE SHOOTING AUTOMATIC VOLUME CONTROLS

□ Those of you who restore the early AC-operated radios know the aggravation of signal fade on your favorite stations. Imagine how it was when the set was new and there weren't many local stations and those that were on the air were usually running only 50-watts. Reliable daytime radio reception was limited to a 25-mile radius from the transmitter. At night, because radio waves travel much farther than they do during the day, there was considerable interference between stations, and fading became a real problem. After a few minutes of listening to a strong local station, it might fade out to be replaced by a weaker, more distant one.

It wasn't until the introduction of the multi-element tubes that reception could be counted upon on a reliable basis no matter what time of day the listener wanted to use his or her radio.

Grids and Tetrodes. When screen grid tubes were introduced, i.e. 24 and 35/51, they were referred to as tetrodes because there were four active elements. There were five base pins plus a top cap connector on AC-operated filament tubes and four base pins and a top cap on battery-operated filament tubes. The tetrode had an additional grid inserted between the control grid and the plate. A DC voltage, which was less than the plate voltage, accelerated the flow of electrons from the filament or cathode to the plate. The result was that the tetrode had a much higher amplification factor than the triode. This tube was used as an RF (radio frequency) amplifier and as an IF (intermediate frequency) amplifier. Another advantage was that a tetrode did not need to be neutralized when used as an RF or IF amplifier.

The next step was to insert another grid called a "suppressor grid' between the screen grid and the plate. This grid was usually grounded or connected to a highly negative voltage. In AC-operated tubes, the suppressor grid was brought out to a separate pin resulting in a six-pin base with a top cap connector. In battery-operated tubes, the grid was internally connected to the center of the filament. In tetrode tube operation, electrons were often dislodged from the plate as it was bombarded with electrons from the filament. These secondary electrons would collect on the positively-charged screen grid and increase its current flow and reduce the amplification of the tube. Putting the negatively-charged suppressor grid next to the plate deflected the secondary electrons back to the plate and thus increased the plate current and reduced the screen grid current. This tube was called a pentode.

The development of the remote cutoff tube, usually called a variable-mu tube, allowed for the design of radio sets with automatic volume control. By merely varying the control grid bias, the amplification factor of the tube could be varied, and it could be used to prevent fading of signals.

Diode Rectifier. At the same time the variable-mu tube was developed, there arose a need for a diode rectifier that could be built into the same glass envelope with a triode or a tetrode. The diode (two elements) is essential because it is one of the few simpie tube structures which produces a direct current proportional to the carrier wave of a signal. The diode plates, being very small, were usually built into the same envelope with a triode, becoming the 55, 75, or 85 types. There were some diode-only tubes such as the 6H6 and the 6AL5. The duo-diode-triode tube was usually used as a detector and source of AVC voltage with variable-mu tube types.

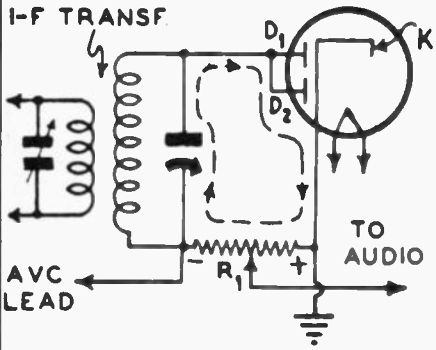


Fig. 1. This is a duo-diode arrangement with D1 and D2 paralleled. The arrows show the current flow in operation.

If you will refer to fig. 1, we will discuss the operation of the duo-diode-triode tube. The two diode plates, D1 and D2, are tied together and to one lead of the last IF transformer secondary. The signal voltage is rectified (because no current can flow when the diode plates are negative) and flows through R1. This resistor will be positive (as far as the signal is concerned) at its grounded end. A wire from the negative end then connects to the control grid return leads of the AVC-controlled tubes. Since rectification takes place in this diode circuit, the audio portion of the signal also appears across the resistor. The arm of the potentiometer connects to the grid of the triode section of the same tube and controls the volume of the radio receiver.

Some engineers prefer to keep rectification separate from AVC action, as shown in fig 2. This may be done by connecting D1 and D2 together through a small capacitor as shown. The rectified current due to D1 goes to the audio amplifier, and that due to D2 to the AVC lead. Each diode plate has its own load resistor across which the rectified voltage appears.

AVC System. Figure 3 shows a typical AVC system. Diode D2 rectifies the signal, a small portion of which is taken from D1 through capacitor Cc. This rectified current produces a voltage across resistor R4. Now the voltage across R4 is of a pulsating type and therefore contains an average DC value and an alternating value; the alternating value is composed of the RF carrier and the audio signal. For the purposes of AVC, all the alternating components must be eliminated; only DC is wanted. It is the purpose of capacitors C1, C2, and C3 and resistors R1, R2, and R3 to filter out this alternating component and leave only pure DC.

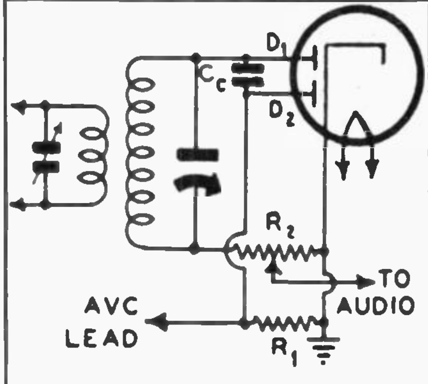


Fig. 2. This AVC arrangement has the 2 diodes acting separately. Diode D2 has the control function for the AVC line.

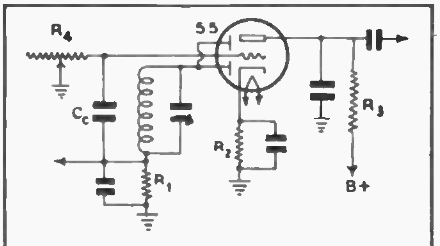


Fig. 3. A simplified AVC system using a duo-diode triode tube. Grid bias is controlled by DC across resistor R4.

In the simplified circuit of fig. 4, the action of the AVC voltage is easier to understand. The voltage across R4 is applied to C3 through R3. These resistors have high values, typically a half to one megohm, so that with a given strength carrier, the voltage across C3 is constant regardless of the audio variations. The grid bias of any tube is the bias voltage measured from grid to cathode. If a stronger signal is tuned in the DC voltage across R4 rises, increasing the total bias applied to the tubes which reduces the amplification of the tube. Conversely, if the signal drops in strength the total bias applied to the tube decreases which increases the amplification of the tube.

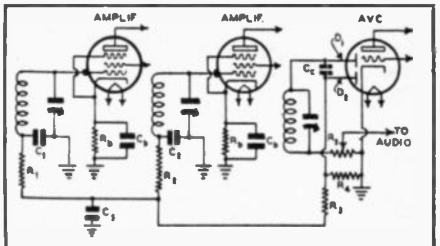
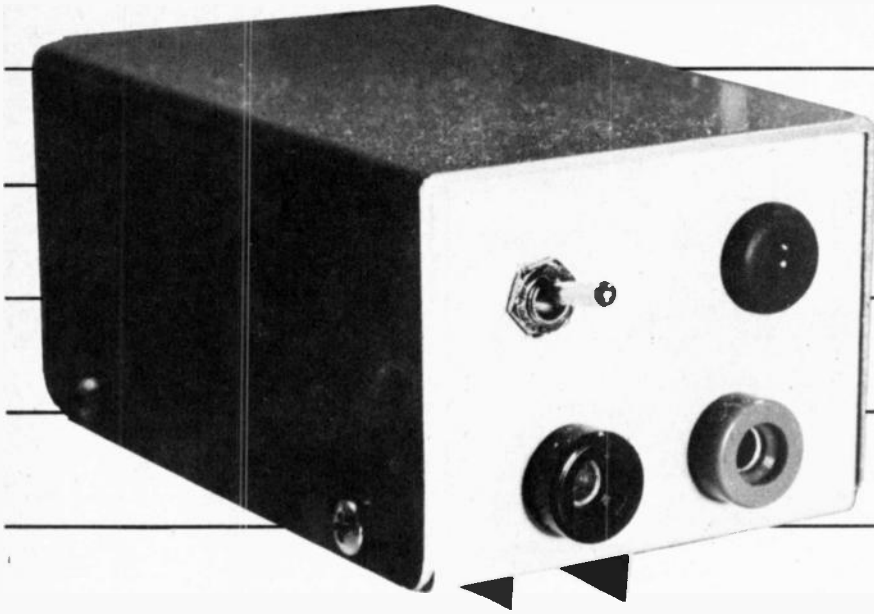


Fig. 4. This a complete, typical AVC system. A network consisting of R1, R2 R3/C1, C2, C3 filters out the AC.

Troubleshooting Tips. In a well-designed radio receiver where the AVC voltage can be applied to several stages, the audio level will stay quite constant regardless of signal fading. When troubleshooting AVC circuits, the capacitors in the older sets will usually be found to be leaky or have high resistance readings. These capacitors should be replaced. It is also a good idea to measure the resistors and if their resistance varies more than 20% from the original value, replace them too. Leaky capacitors will cause low volume, poor sensitivity, and often will result in squeals and howls coming from the speaker. Learning to trouble-shoot AVC circuits isn't difficult. You must have a VTVM or FET voltmeter, with 10-megohms or more input impedance, to measure AVC voltages. Apply your voltmeter to ground and to the junction of resistor R3 and R4 (see fig. 3 or 4). When you tune in a radio station, the voltage reading should rise and fall as you tune the station out. A local station should give a much higher reading than a faraway station. If this voltage reading doesn't increase and decrease as you tune the station in and out, you have a problem in the AVC circuit. ■

HANDY U.S. METRIC CONVERSION TABLE ***(Use a calculator for larger multipliers)***

VOLUME To Convert	Multiply by	WEIGHT To Convert	Multiply by
Pints (liquid) to liters	0.47316	Ounces to grams	28.3495
Pints (dry) to liters	0.5506	Ounces to kilograms	0.02835
Quarts (liquid) to liters	0.9463	Ounces to milligrams	28,349
Quarts (dry) liters	1.1012	Ounces to micrograms	28,349,527
Gallons (liquid) to liters	3.7853	Grains to milligrams	64.798
Gallons (dry) to liters	4.0476	Pounds to grams	453.59



BUILD A SIMPLE VOLTMETER AND SCOPE CALIBRATOR

Make your test instruments precision measuring devices without breaking the bank

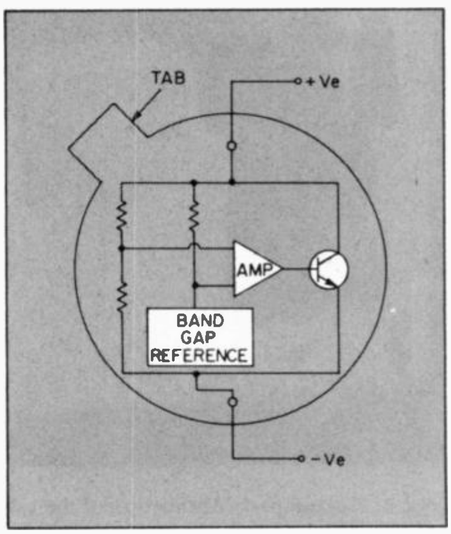
PRECISION VOLTAGE MEASUREMENTS require a calibrated source against which to compare the readings of the voltmeter or oscilloscope. In really high-class measurements, where absolute accuracy is needed, laboratories will use something like a Weston cell and a precision potentiometer. But to the hobbyist, such instruments are both too costly and, in most cases, more accurate than is necessary. In the past, the hobbyist had to be content with zener diode calibrators. Unfortunately, these diodes are not the best and tend to drift. But today, a new breed of regulator is available. Several manufacturers are now offering regulator/reference source ICs using *band gap* zener diodes, and internal amplifiers. These ICs give the hobbyist a low-cost method for building a reference voltage source.

Calculate Your Needs. The circuit in Fig. 1 is sufficient to operate as a hobbyist-grade voltage calibrator. Only a power supply (in this case a battery), a resistor, the regulator IC, and a means for turning it on and off are required.

The value of the series resistor depends upon the reference current selected and the power supply voltage. The reference current may be set at any point in the range of 2 to 120 milliamperes, provided that the overall power dissipation is kept to less than 300 milliwatts. In practice, however, one is advised to select a value in the 2 to 5 mA range. In the example of Fig. 1 we have selected 8.75 mA for a very special, high level, technical reason—we had a 4.2-volt battery and a 200-ohm resistor in the junkbox at the time.

The series resistor's value is computed as:

$$Rl = \frac{Eb - Eo}{Ir}$$



Here is an internal schematic of the band gap zener diode, which serves as the heart of the calibrator. Use the tab on the case as the reference point for making circuit connections. No heatsink is required here.

Where:
Eb is the battery voltage
Eo is the output voltage (1.26 or 2.45-volts)
Ir is the reference current
Rl is the resistance in series with the IC

Example:
In the circuit of Fig. 1, we used a 4.2-volt mercury battery, and selected a reference current of 8.75 mA. Find the value of the resistor needed for *Rl*. A ZN458 (2.45 volts) is used.

$$Rl = \frac{(4.2-2.45)\ volts}{(0.00875)\ Amp}$$

$$Rl = \frac{(1.75)}{(0.00875)} = 200\text{-}ohms$$

The resistor used should be a low temperature coefficient type. We used a wirewound precision resistor for *Rl*, and selected it because it was in the junkbox. Contrary to the example above, we actually selected the reference current based on the resistors on hand. An ordinary carbon composition resistor could be used, but the results are not guaranteed.

Construction. The construction of the calibrator is shown in Fig. 3. The largest part in the project is the battery, so a small LMB aluminum box was selected to house the calibrator. The electronic circuitry was built using the banana jacks as tie points; no wire

SCOPE CALIBRATOR

board is needed. The battery holder is ordinarily used with size "C" batteries, but the Mallory TR233 (4.2-volt mercury cell) fits nicely. The battery holder was fastened to bottom of the box using a small 4-40 machine screw. Small rubber feet can then be glued to the box to offset the "bump" created by the screw head. If you want to avoid this, however, it should be easy to superglue the battery holder flush to the aluminum.

The ZN458 has a 100 *parts per million* (PPM) drift specification, the ZN458A is a 50 ppm device, while the ZN458B is a 30 PPM device. The voltage output is nominally 2.45-volts DC. (measured at 2 mA reference current), but may have an absolute value between 2.42 to 2.49-volts. With no additional circuitry, then, these devices will produce an accuracy of ±40 millivolts, or better. This voltage cannot easily be adjusted without external circuitry, but you can use any of the standard IC operational amplifier voltage regulator circuits to set the output voltage to a standard level. Fig. 2 shows a circuit that is usable for this purpose. The ZN458 is used to set the voltage at the noninverting input of the op amp. The output voltage can then be trimmed to the desired value by potentiometer *R3*. This circuit is an ordinary op amp noninverting follower, so the desired output voltage can be derived in the following equation:

$$Eo = Eb\left(\frac{R3 + R2}{R1} + 1\right)$$

The table shows values for *R2/R3* needed for output voltages of 5 and 10-volts. Note that the resistors used in this circuit must be low temperature coefficient precision (1%) resistors, or drift will result. It is even more important in this circuit, than in the circuit of Fig. 1. The trimmer potentiometer should be a ten-turn, precision type, so that very tight control over the adjustment of the output voltage is possible.

There is, however, a hitch in this variable output circuit. It is not inherently "calibrated" as is the case of Fig. 1. Although this circuit is capable of better accuracy, initially, it must be adjusted. You will have to find a very accurate voltmeter, or precision reference potentiometer to make the initial adjustment. After this adjustment, however, it should remain in calibration for a long time. ■

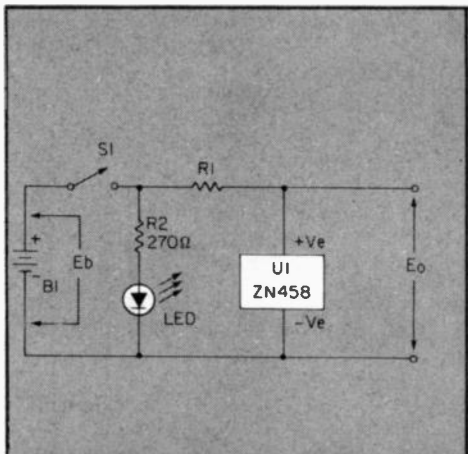


Fig. 1. This is a basic schematic used to demonstrate the calculations necessary to determine the value of the associated components used in the regulator circuit. Refer to the text for a full explanation.

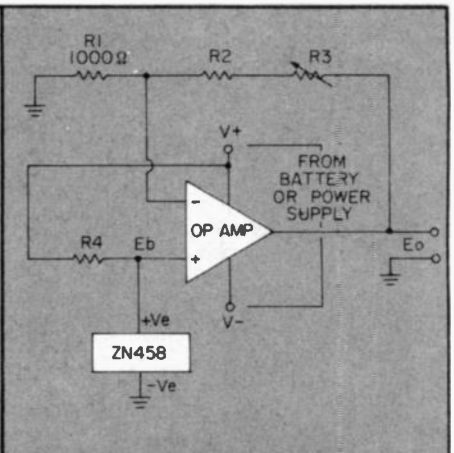


Fig. 2. This schematic depicts a variable regulated power supply, with the source being either a battery or a line-powered DC source. Refer to the table below and text, to determine your own parts needs.

TABLE 1—ZENER SELECTION

Type	Voltage	Drift
ZN423	1.26	–
ZN458	2.45	100 ppm
ZN458A	2.45	50 ppm
ZN458B	2.45	30 ppm

TABLE 2—R2/R3 SELECTION

Output Voltage	R2	R3
5	1000-ohms	100-ohms
10	2600-ohms	500-ohms

The four most popular low-voltage band gap zener diodes are listed above, with their respective drift figures. Obviously, the smaller the drift figure (in terms of parts per million) the more accurate the calibrator circuit will be. Use the highest tolerance parts available, in order to enhance the accuracy of the circuit. Refer to the text for an explanation of the significance of the values given for R2 and R3 in Table 2 above.

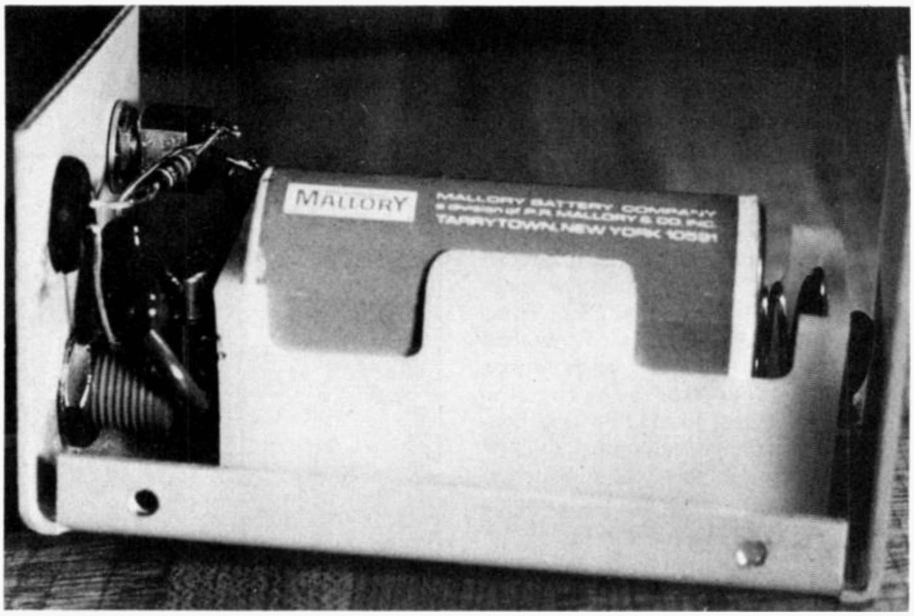


Fig. 3. The compact construction of the calibrator is seen here. We wired all components to the terminals of the banana jacks first, and then bolted in the battery holder to the bottom of the chassis to allow working room for assembly. You may choose to utilize either perfboard or even a printed circuit board for your model. This will allow you to mount it directly inside the cabinet of whatever test instrument you wish to calibrate. With this method you can always have a reliable source of instrument calibration with you, no matter where you might happen to be doing your repair or field operations.

OCTAVIZER

Add a third dimension to the sound of music

CONNECT ANY ELECTRIFIED or electronic musical instrument to OctaVizer and your instrument's single frequency output is expanded threefold. In addition to the single frequency input signal, square waves at fifty-percent of the frequency and one at twenty-five-percent of the frequency are available at OctaVizer's output. All three signals can be mixed in any proportion desired, using the *blend* and *prime* controls. The composite output signal can be used immediately, or further processed using filters or other such devices.

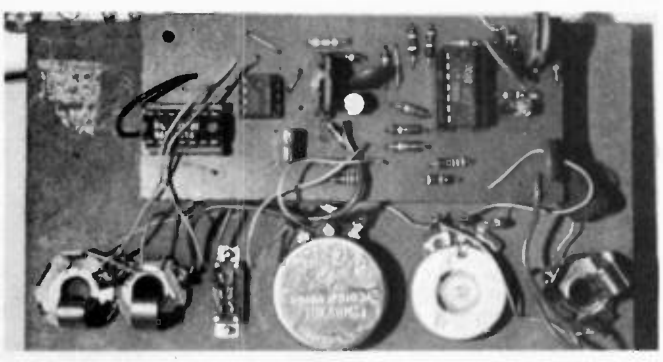
The *blend* control adjusts the relative magnitude of the two square wave signals, while the *prime* control adjusts the amount of input signal which is fed through to the output. The footswitch-operated cancel function disables the square wave outputs when activated.

OctaVizer uses readily available linear and CMOS digital integrated circuits, is powered by a single 9-volt battery, and can be built for less than $15.00.

How It Works. As shown in the schematic diagram, the input signal is AC coupled through C1 and C6 to a low-pass filter and a level control (R23) respectively. R4 and C2 form the low pass filter with a −3 dB point of about 350 Hz, which filters higher order harmonics that might otherwise be detected in later stages and cause false triggering. The filtered signal is amplified in IC1D along with the DC level set by R2. The output of IC1D is further processed in IC1A where it is squared up and clipped. The output of IC1A is AC coupled through C3 and added to the variable DC level set by R12 in the R11, R12, R13 voltage divider. This composite signal is used to trigger a monostable multivibrator (one shot) formed from IC2, R14, R15 and C4. If pin 4 of IC2 is held low by grounding J2, the output remains low regardless of the input. If J2 is not grounded, pin 4 of IC2 is held high by R16 and the pin 3 output is a pulse train of the same frequency as the input signal. This pulse train is used to clock two divide-by-2 flip-flops (IC3B and IC3A) which produce square waves at one-half and one-quarter the frequency of the input pulse train. The two flip-flop outputs are attenuated in the two variable voltage dividers formed by R17, R18 and R19. With R19 set at midrange, two equal voltage dividers are formed which attenuate the 9-volt square wave outputs to about 95-millivolts each (a level similar to that of the input signal). As the wiper is moved toward one side, that divider's signal level is decreased while the other's is increased. Therefore, *blend* control R19 can select either signal alone, or any ratio of the two. The level of the input signal provided to IC1B is selected by the *prime* control (R23). This signal, along with the output of the two voltage dividers, is added in unity gain summer IC1B. Since the output of IC1B has a DC component, it is coupled by C5 to output jack J3.

Construction. OctaVizer can be constructed using any standard technique. Standard CMOS handling precautions should be observed when handling IC3. IC sockets may be used if desired. Assemble all components onto the board, being sure to observe polarity for the ICs, D1, and C5. Note that C6 is not mounted on the PC board, but is wired directly between J1 and R23. Interconnect the completed PC board with all jacks and controls. Any suitable case may be used to house the project.

Alignment. If the input to OctaVizer was always a pure, mono-frequency signal, no alignment would be necessary. However, many electrified musical instruments' outputs are generated by a non-linear electromagnetic device (such as a magnetic pickup) and, as such, contain non-sinusoidal and/or harmonically related components. These



As you can see from this almost full-scale photograph, the circuit board is rather compact. It would be a relatively easy matter to build it into an existing pre-amp. Any suitable case can be used to house this board, but a "woodgrain" type will match the instrument's finish.

OCTAVIZER

components can be detected and cause false triggering. The alignment procedure outlined below will minimize the effects of these components while maximizing the overall response of the unit.

Begin by setting the wiper of R2 to ground, and the wipers of R12 and R15 to midposition. Connect the input device you will be using, and patch the output to an amplifier. Turn the unit on and rotate the wiper of R12 towards ground until you hear oscillation begin. Now turn the wiper of R12 slightly past the point where the oscillations stop (If a VOM is handy, set the voltage on the wiper to about 3¼-volts). Set R23 (*prime*) to minimum and R19 (*blend*) to high. As you play the instrument, rotate the wiper of R2 until an output is obtained. If the output is not half the frequency of the input (as determined aurally), back off R12 very slightly. You will notice that when the proper frequency output is obtained, its duration may be short. To increase the duration, adjust R2 slightly in the direction that produces oscillation. Next, play the highest note you will intend to play. The output will either be correct, very static sounding, or much lower in frequency than anticipated. If the output is correct, no adjustment is required. If the output is static sounding or lower than anticipated, rotate R15 until the proper output is obtained.

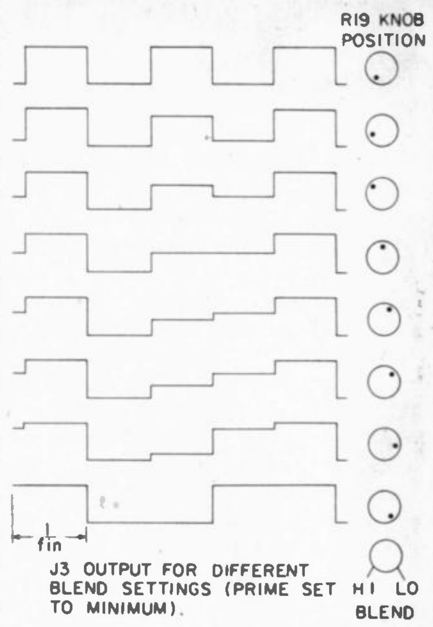
The final step is a fine adjustment which will maximize how long the signal lasts while minimizing false triggering. This adjustment consists of alternately adjusting R12 and R2 until you are satisfied you have obtained maximum duration and minimum (if any) false triggering.

Use. OctaVizer can be used over a 3-octave range. As with any new device, it is best to experiment with all controls to determine the effects that can be obtained. A standard guitar can be used with OctaVizer to create a raspy bass guitar effect by setting *blend* to "Hi" and *prime* to "Min." An interesting effect is created with *blend* to midvalue and *prime* set so both output components are of equal loudness. By striking the strings forcefully, you can create high amplitude harmonics that will false trigger the unit and raise the square wave outputs in frequency by an octave. Thus, by varying your striking force, you can play in different octaves.

When viewed on an oscilloscope, the output signal changes shape as shown in the diagram when the *blend* control is rotated. As you can see, at midsetting of the *blend* control, a step approximation to a ramp wave is generated. This signal can be fitted to produce a realistic reed-type sound.

A standard foot switch can be used for the *cancel control*. If not available, one can be made using a push on-push off SPST switch and a length of audio cable.

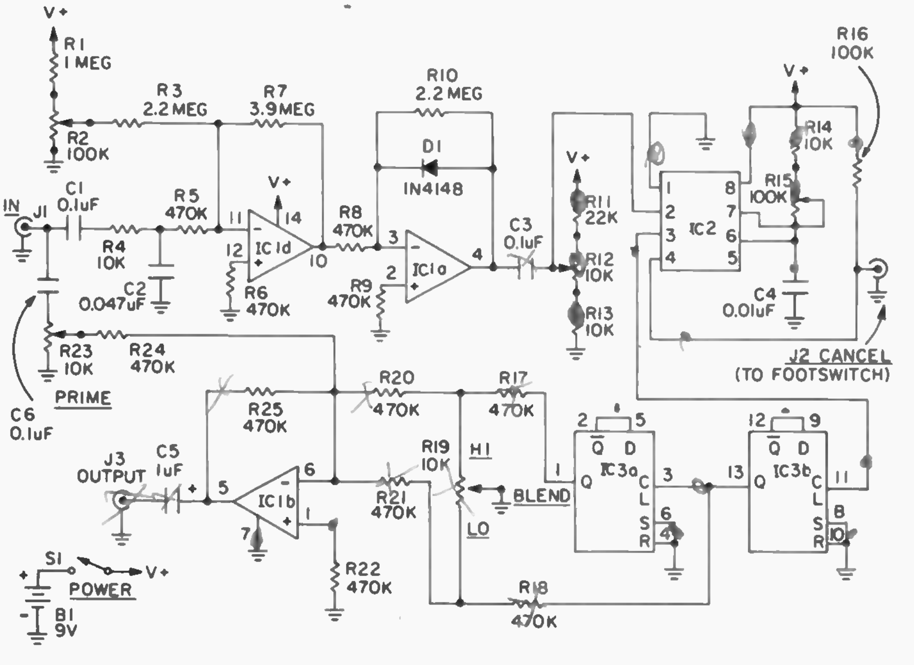
As you familiarize yourself with this new tool, you will find it an interesting and useful special effects device. ■



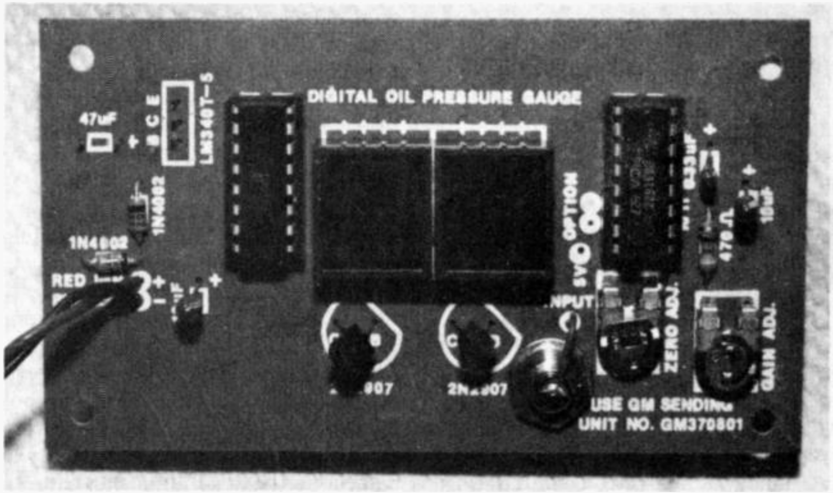
Here is the chart of the various waveform configurations made possible by varying settings on the "blend" and "prime" controls. Although designed for use through a three-octave range, if used with an electric guitar, false harmonics can be generated by forceful strumming, thus raising the outputs by one full octave automatically.

PARTS LIST FOR OCTAVIZER

B1—9-volt transistor battery
C1, C3, C6—0.1-µF, 25-VDC disc capacitor
C2—0.047-µF, 25-VDC disc capacitor
C4—0.01-µF, 25-VDC disc capacitor
C5—1.0-µF, 16-VDC electrolytic capacitor
D1—1N4148 diode
IC1—LM3900 quad op amp
IC2—555 timer
IC3—CD4013 dual flip-flop
J1, J2, J3—standard 2-conductor phone jack
R1—1,000,000-ohm, ¼-watt resistor
R2, R15—100,000-ohm, ¼-watt vertical-mount trimmer potentiometer
R3, R10—2,200,000-ohm, ¼-watt resistor
R4, R13, R14—10,000-ohm, ¼-watt resistor
R5, R6, R8, R9, R17, R18, R20, R21, R22, R24, R25—470,000-ohm, ¼-watt resistor
R7—3,900,000-ohm, ¼-watt resistor
R11—22,000-ohm, ¼-watt resistor
R12—10,000-ohm, ¼-watt vertical-mount trimmer potentiometer
R19, R23—10,000-ohm, ¼-watt linear-taper potentiometer
S1—SPST slide switch
Misc.—cabinet, hookup wire, knobs, etc.



Note: A complete parts kit is available from: BNB Kits, 72 Cooper Ave., West Long Branch, NJ 07764, for $20.95. The PC board alone is $7.00 from BNB also.



Dashboard Digital Oil Pressure Gauge

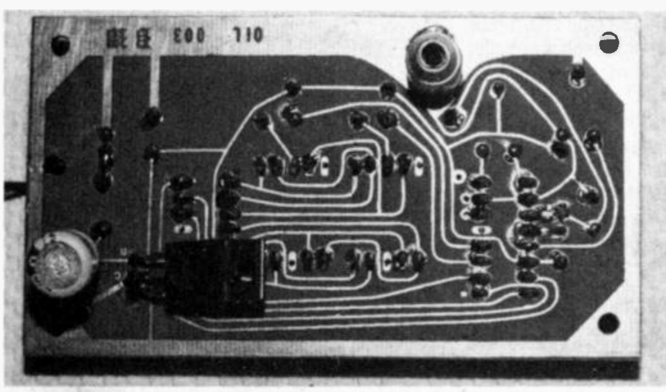
An essential instrument to help prolong engine life

THERE ARE TWO MAIN CAUSES of "blown" engines, and they both relate to the subject of oil. Either there's not enough to sufficiently lubricate the engine, or it is circulating under too low a pressure to reach all of the areas it is supposed to. In any event, if either condition persists too long, you're likely to be looking for a new mill in very short order, something which can run you anywhere from $300 to $1,000, not to mention the cost of labor involved.

For a few dollars, and with some basic attention to the markings on your dipstick, you can build a highly accurate oil pressure gauge and with it, establish good maintenance habits which can prolong the life of your car or boat engine for thousands of extra miles. Why should you add a gauge if your car already has a dummy light? A dummy light will only signal you when oil pressure has *already* dropped to a dangerously low level. At this point, it's usually too late, and the pistons will seize against the cylinder walls, causing the car to stop as if hit head on by a truck. A gauge, on the other hand, allows you to establish the normal operating pressures for your car, and can take note of the fluctuations caused by worn oil pump gears, jammed oil pump pressure relief pistons, leaking seals and gaskets, and can even tell you, by indicating an increase in pressure, when it's time to change your oil filter. In some cars, a gradual drop in oil pressure can indicate low oil levels, although the only *positive* method for determining the amount of oil left in the oil pan is by checking the dipstick itself.

One of the best features of this gauge is that it is installed so as not to eliminate the function of the dummy light system. In effect, the dummy light serves as a fail-safe against the possibility of gauge or sender malfunction.

The Circuit. Regular readers of this magazine will no doubt recognize the basic design of the oil pressure gauge from those of the voltmeter and temperature gauges. The same three versatile ICs are used again here.



A view of the foil side of the PC board for our Digital Oil Pressure Gauge. Note the clean layout. If you mount the regulator chip on the foil side, carefully bend it parallel to the board, making sure that nothing shorts out.

The ignition input (+12 VDC line) should be connected to some point on the car's electrical system that is active only when the ignition switch is on, and the motor is running. At all other times, the ignition line should be off. The most desirable connection would be the same fuse terminal that the horn or windshield wiper is connected to.

Note the point marked OPTION on the schematic. With pin 6 of the CA3162E disconnected, there are four conversions or comparisons made each second. Tying pin 6 to the 5-volt line will result in 96 conversions or comparisons per second. The 96 Hz rate moves with excessive rapidity, is not appealing to the eye, and usually results in the least significant digit appearing to be blurred. Of the two rates, the 4 Hz is by far the more pleasing to the eye, is easier for the eye to focus on quickly, and is the recommended rate. These rates could vary slightly because of capacitor variance from stated values.

The multiplexing digit driver pins (pins 3 and 4) on the CA3162E switch the two transistors that drive their respective 7-segment displays. The CA3162E determines which display is to be on, and sends the BCD (Binary Coded Decimal) information to the display that is on. The BCD information is converted into a 7-segment output by the CA3161E. This, in turn, causes those segments to be lit that correspond to that BCD number.

Note that across pins 8 and 9 of U2 there is a 50K (R2) potentiometer connected. Pin 12 of U2 has a 0.33-μF tantalum integrating capacitor (C4). These components (in conjunction with the CA3162E) generate the necessary waveform for that IC to perform the conversion. The operation of the 50K potentiometer (ZERO ADJUST) will be covered in the calibration procedure.

Sending Unit Operation. The maximum voltage differential that can be read by the CA3162E is 999 mV. With this in mind, examine the circuit configuration. The sending unit specified must be used because of its ¼-inch pipe thread and its electrical characteristics. With the application of pressure, the sending unit's resistance change is virtually linear. At 40 PSI (pounds per

Oil Gauge

square inch), the resistance is approximately 40-ohms.

Let's now consider what happens when voltage is applied to the sending unit and the digital oil pressure reading which results. By applying a small current through the 470-ohm resistor to the sending unit, the resulting voltage is almost linear in relation to pressure. At 40 PSI there are approximately 400 mV developed across the sending unit. The voltage enters pins 11 and 10 of U2 by means of the coax cable coming from the sending unit to the display board. There the 400 mV is converted to a BCD equivalent. The BCD information enters the CA3161E (U3), a current-limiting, decoder/driver IC. This causes the 7-segment display to display 40 pounds of pressure. An Ohm's Law calculation will show that the voltage is actually slightly less than 400 mV. This requires compensation, which is corrected (or compensated for) by using the GAIN ADJUST.

Assembly. After etching your PC board, (or receiving one from Digital World) check the finished product for foil bridges and other imperfections which might create difficulty during assembly and calibration. Leaving installation of U2 and U3 for later, install all other components on the board, following the component placement guide. Be sure to observe polarity with respect to diodes and capacitors.

We strongly suggest that you make use of IC sockets when installing U2 and U3. These two chips are highly sensitive to static electrical damage caused by handling without insulated tweezers. In addition, stray AC from the tip of your soldering iron (not to mention excessive heat) can also cause irreparable damage to the chips.

With all components installed, make a final check of the board against the component layout diagram as a precaution. If the final check is positive, proceed to wire in the 2 leads for the 12-volt power source. The unit is now ready for calibration.

Calibration. The degree of accuracy ultimately attainable with the gauge will be determined to a great extent by how carefully you adhere to procedures.

Begin the calibration by applying 13.8 VDC to the voltage input lines. While the LM340-T (U1) is a darned good regulator, seeing as how you'll be powering the gauge from 13.8 VDC during operation, why not try to duplicate operating conditions during calibration? At this point, you should get some sort of reading on the LED displays. If not, skip ahead to the Troubleshooting section to clear up the difficulty.

Assuming all is well, momentarily ground pins 10 and 11 of U2 to circuit ground, and adjust R2 until the LEDs read "00." Avoid rapid movement of the wiper on R2, as the range is very short, and you may pass the desired point before realizing it. Remove the ground on pins 10 and 11.

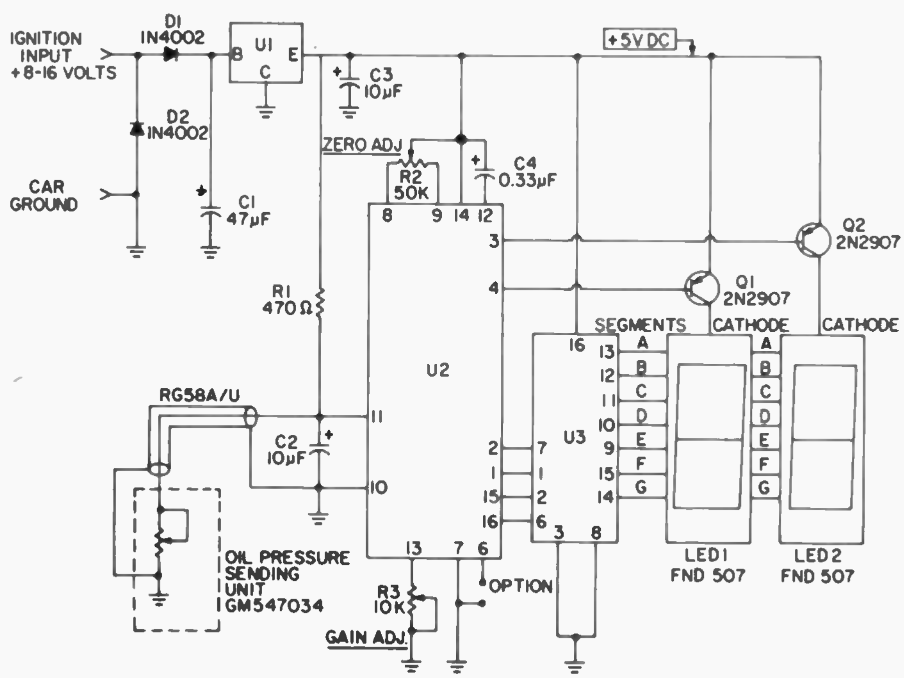
Momentarily disconnect the sending unit's coax plug from the board and insert a 47-ohm resistor across J1. Slowly adjust R3 until the displays read "47." This completes the calibration procedure, and the unit is now ready.

Troubleshooting. If, as mentioned above, the displays do not light when power is applied, recheck to see that you have not created any solder bridges which may be shorting out some components. Check to make sure that all diode polarities are correct, and that the input power line polarity is also correct. Additionally, check to make sure that the wiper of R2 is centered. If the displays light only dimly, check to make sure that Q1 and Q2 have been installed correctly.

Some GM sending units may generate electrical noise during their operation, which may result in rapidly fluctuating readings. If this is the case, you may either replace the unit with another one, or try replacing C2 with a 100-uF, 16-VDC electrolytic capacitor. This may filter out the undesired noise.

Mounting The Unit. Determine where the gauge will be installed and how it will be mounted; i.e., glued, bolted, or clamped. This will, of course, vary from car to car.

The plexiglass panel should be cut and fitted to the circuit board (then re-



PARTS LIST FOR DIGITAL OIL PRESURE GAUGE

C1—47-uF, 25-VDC electrolytic capacitor
C2, C3—10-uF, 16-VDC tantalum capacitor
C4—0.33-uF, 35-VDC tantalum capacitor
D1, D2—1N4002 diode
LED1, LED2—FND-507 7-segment, common cathode display
Q1, Q2—2N2907 PNP transistor
R1—470-ohm, ¼-watt resistor, 5%
R2—50,000-ohm linear-taper potentiometer
R3—10,000-ohm linear-taper potentiometer
U1—LM340T-5 voltage regulator integrated circuit
U2—CA3162E analog-to-digital converter integrated circuit
U3—CA3161 BCD decoder/driver integrated circuit
J1—RCA-type phono jack
P1—RCA-type phono plug
Misc.—Genera! Motors oil pressure sending unit #547034 (fits 1966-79 Chevy, Buick, Olds), ¼-inch brass pipe tee fititng (available at most auto supply/speed equipment distributors), 1 to 2-inch length of ¼-inch diameter extender pipe, teflon plumber's tape (for sealing pipe threads), 10 to 15-feet RG58A/U coaxial cable, IC sockets, spacers, red plexiglass contrast panel, hookup wire, solder, etc.

A complete parts kit for the Digital Oil Pressure Gauge is available from Digital World, P.O. Box 5508, Augusta, GA 30906. Price is $28.50 for the kit (less GM sending unit, coaxial cable, plexiglass or brass fittings). All shipments prepaid in the U.S. and Canada.

moved) before the board is assembled.

A plexiglass panel with a metal rim may be purchased from Radio Shack for several dollars. Ask to see the die-cast bezels. We have no information at this time on the availability of multiple display bezels. The single unit bezels look "pro" and are relatively easy to fit, requiring little or no modification.

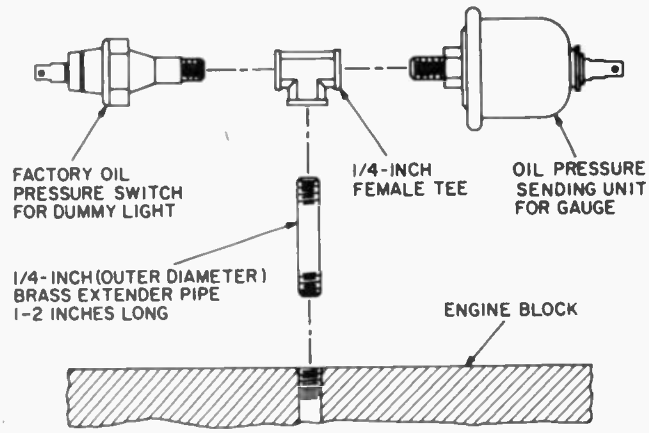
You may wish to use a larger piece of plexiglass for a multiple display panel, attaching several units to it. This requires detailed planning in layout, care in cutting the total panel, and patience in the drilling of the holes for the four retaining bolts (for each gauge) to be mounted behind it.

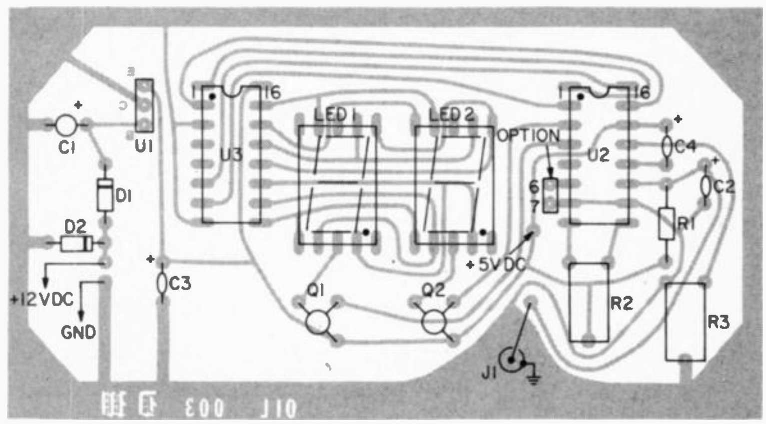
Another idea is to place the LEDs (for a series of gauges) on a "perf-board" behind the single panel, putting the units elsewhere, out of sight but easily accessible for repairs. However, this requires extensive wire hookups between the circuit boards of the several units and the corresponding display LEDs. Such a project is not recommended for the hobbyist just starting to work with digital units.

The Coax Connector. What length should the coax cable be? A simple way is to use a piece of string to measure sufficient coax length. A coax piece too short must be spliced and could be of questionable operational efficiency. Measure distance from the sending unit, routing it about the motor to points where it may be easily and firmly secured and which are well away from the hot manifold and the vicinity of the spark plug wires. Cut a sufficient length of RG58A/U cable (coax) to go from the sending unit to the display board dash location. It is wise to allow at least an extra 18-inches, permitting possible relocation, should a second location be selected later.

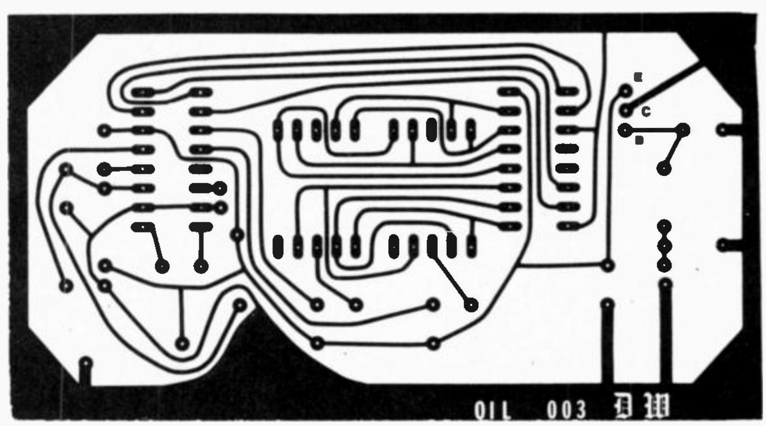
Solder the center conductor wire to the terminal of the sending unit, and the shield to the case of the sending unit. Do not rely on the car chassis ground to complete the path of current flow for the sending unit. The properly installed shield acts as the ground. The coax cable should be further secured and protected by being heavily taped to the sending unit. Failure to do this could result in the cable being broken at the connections because of car vibrations and/or turbulent winds under the car at higher speeds. At the dashboard end of the coax, the center connector is soldered on to the middle pin of P1, and the shield is soldered to the outer skirt. The plug is then ready to be inserted into the female jack on the back of the circuit board. Again, thread and secure the coax away from the hotter parts of the motor and the ignition system wiring.

A drawing of the sending apparatus. This system insures that both the gauge which we're installing and the original oil warning light will keep operating. Thus, there are two warning devices, backing up each other, thereby bringing about real auto safety.





Parts layout for the Digital Oil Pressure gauge. There are relatively few components to worry about, those that there are, are relatively well-spaced. VCR's on other side.



Here's the printed circuit board for the Digital Oil Pressure Gauge, foil side up. This is exactly the way the board you make for the unit should look. Watch for solder bridges!

The Dual System. Examine the dual system connection diagram. To use the dual system, a brass "tee" adaptor is required. Use a ¼-inch, 3-input female adaptor, which should be available at your local plumbing supplier. Purchase, also, a 1-inch or 2-inch piece of standard ¼-inch brass pipe (long enough for the sending unit to clear the engine block and other components). Next, screw the pipe extender into the center of the "tee" adaptor. Now, screw the other end of the extender pipe into the engine block where the factory switch was installed. The two remaining arms of the tee are used to atach the factory warning light switch on one end and the GM sending unit on the other. On foreign cars using the metric standards, it may be necessary to use an adaptor for the ¼-inch extender pipe, or to secure a blank brass pipe and

(Continued on page 104)

HIGH-AMP METERS

Keep up with current events by expanding your meter's amp-ability

WITH THE RISING COST of test equipment it is advantageous to be able to perform several operations with one meter. For instance a DC milliammeter can be converted to read higher values of current by adding a shunt to bypass the bulk of the current around the delicate meter. By following a few simple steps a milliammeter can be converted to read 10 to 20 amps or more. The first step is to determine the internal resistance of the meter. From this you can calculate the shunt resistance needed and the type of material to be used.

To find the internal resistance of the meter, construct the test circuit illustrated here. The 4700 ohm resistor is used to limit current and serves no other purpose. Start with the power supply set to zero volts, leaving S2 open and S1 closed. Slowly increase the current flow by varying R3 until the meter needle moves to full-scale deflection. Without touching the setting of R3, close S2 and adjust R2 until the meter reads half of full scale. According to Ohm's Law the resistance of the meter and of R2 are now equal. Open switch S2 and measure the resistance across R2. This value will be equal to the internal resistance of the meter.

Shunt. Precise shunt resistance is important for accurate current readings and must be chosen carefully. With the shunt connected across the meter, most of the current is diverted past the meter. This is the theory behind a small meter being able to read high currents. The shunt can be a wire, steel or copper bar, or almost any material that will offer the proper resistance. To determine the needed shunt resistance we will consider an example. If we want a 0 to 10 milliammeter to be able to read full-scale for a current of 10 amps. Therefore 10 mA will flow through the meter when 9.990 Amps are diverted through the shunt. If the meter resistance was 100 ohms, using Ohm's Law the voltage across this parallel circuit is found by using the following equation:

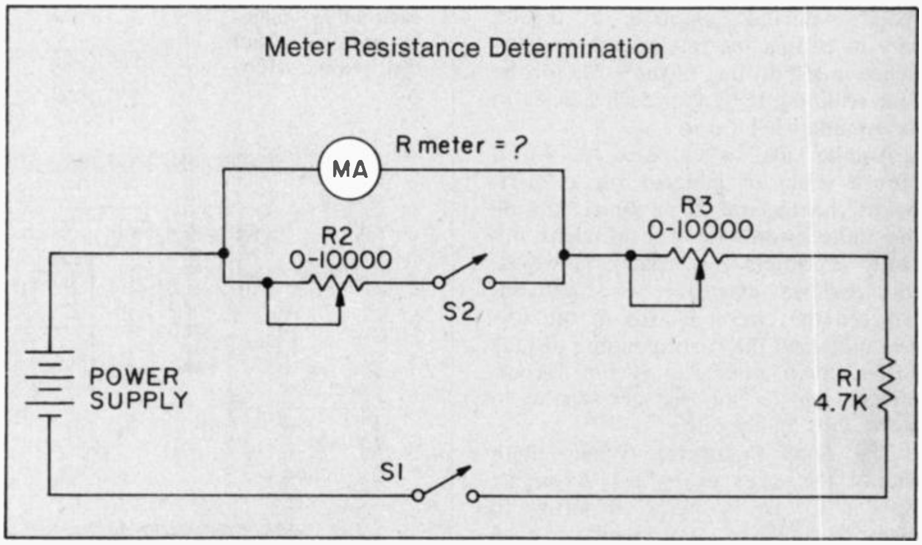
E = (Current) X (Resistance)
= (0.01 amps) X (100 ohms)
= 1 volt

Using the calculated voltage and solving Ohm's Law for resistance the proper shunt can be found. This derivation is shown below:

$$\text{Resistance} = \frac{\text{Voltage}}{\text{Current}} = \frac{1\ \text{Volt}}{9.990\ \text{Amps}} = .1001\ \text{Ohms}$$

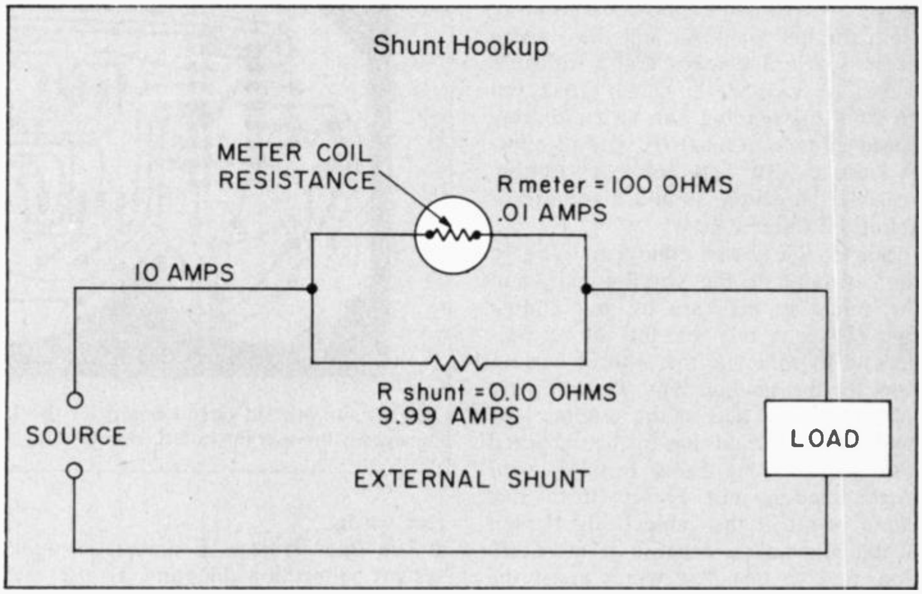
In this case the milliammeter would be capable of giving a readout directly in amperes.

By following these few simple steps you will greatly expand the versatility of your test equipment. It will increase your ability to handle a greater variety of test and trouble shooting situations. ■



To determine the internal resistance of a meter construct a circuit like the one illustrated above. If you don't have the parts in your junk box then check an electronics surplus outlet.

A shunt resistor bypasses the bulk of the current around the meter while allowing a regulated amount to pass through the meter's coil and give an accurate reading. A shunt can be a resistor or a measured length of wire. Make sure it will handle the current.



DIGI DICE

An electronic dice game with infinite possibilities

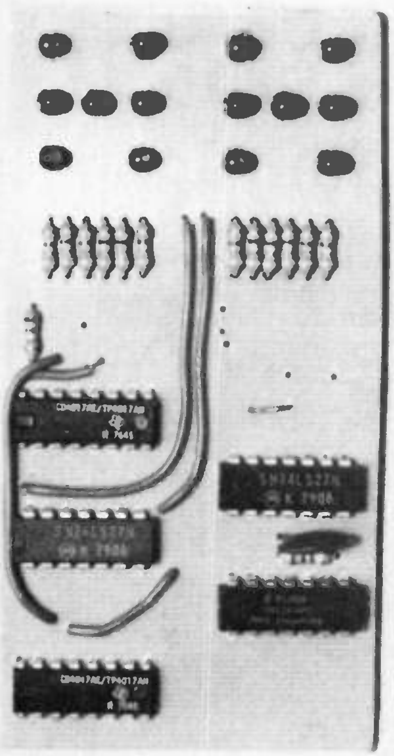
HERE IS A PROJECT for those of you tired of rolling old fashioned mechanical dice. *Digi Dice* can be used anywhere normal dice are used, and has been designed to be cheap, portable, and fun. And, since it is an electronic device, it is probably more random than any regular dice with their inherent mechanical imperfections. Construction time will vary, of course, but we built our dice in an afternoon and by evening were "rolling" in a game of craps. Total cost should run about $12 to $15, depending on how much spare junk you have lying about and where you buy the needed parts.

The Circuit. Refering to the block diagram, you can see that *Digi Dice* is composed of three main blocks. Block A, the oscillator, is made of two 74LS inverters connected as an oscillator, using a resistor and capacitor to regulate the frequency. The output of this oscillator is sent to block B, the counter. This consists of two CD 4017 decimal decoded counters, each wired to reset at a count of six, such that its sequence is 0, 1, 2, 3, 4, 5, 0, 1, etc. The first IC (U1) gets its input directly from the block A oscillator, while the second (U2) receives its pulses every time its partner resets itself to zero. Obviously, the second 4017 only counts one sixth as fast as the first.

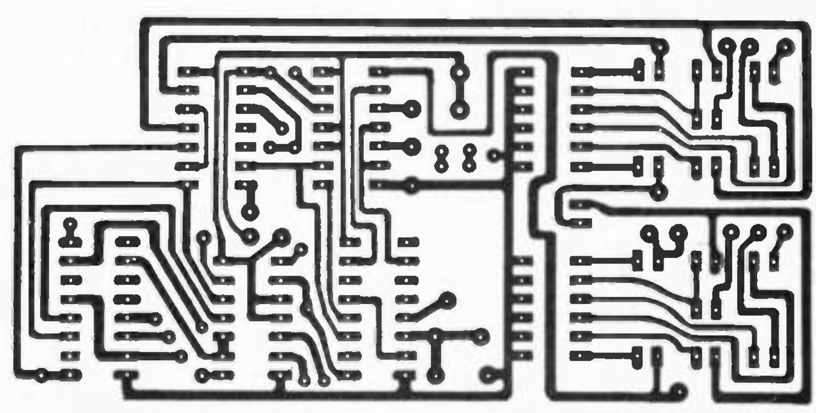
The net result of all this is a two-place base six (modulo six) counter. If we now interrupt the count at some point, each 4017 will contain a value of 0 through 5. If then, and this is the heart of the circuit, we run the counters so fast that we don't know where they are when we halt them, we have devised two independent and "random" six counters. But that is exactly what mechanical dice are, so now all that must be done is to display our results in some suitable way.

Block C, decoding and driving, does this by interpreting the values present in the CD 4017s and displaying them using red LEDs arranged to give the appearance of a pair of dice.

Now, look at the schematic diagram for a more complete idea of how the circuit operates. Switch S1 is power on-off. S2 is a normally closed momentary-contact pushbutton which inhibits



This front view of the PC board shows the arrangement of ICs and the LEDs that read out the score. "Snake eyes" lights up first.



This is the exact size of the PC board for Digi Dice, shown here with foil side up. If you do not care to etch the board yourself, order a pre-etched and labeled Niccum kit.

DIGI DICE

counting in both U1 and U2 by holding pin 14 at ground. Opening (pushing) S2 allows R14 to pull pin 14 to a high level, thereby allowing the counters to run. When this happens, the decoder/drivers will be displaying the contents of the U1 and U2 using the LEDs, but so quickly that the eye cannot follow. Releasing the pushbutton switch (closing S2) will freeze the count in each 4017, which can now be seen displayed by the LEDs.

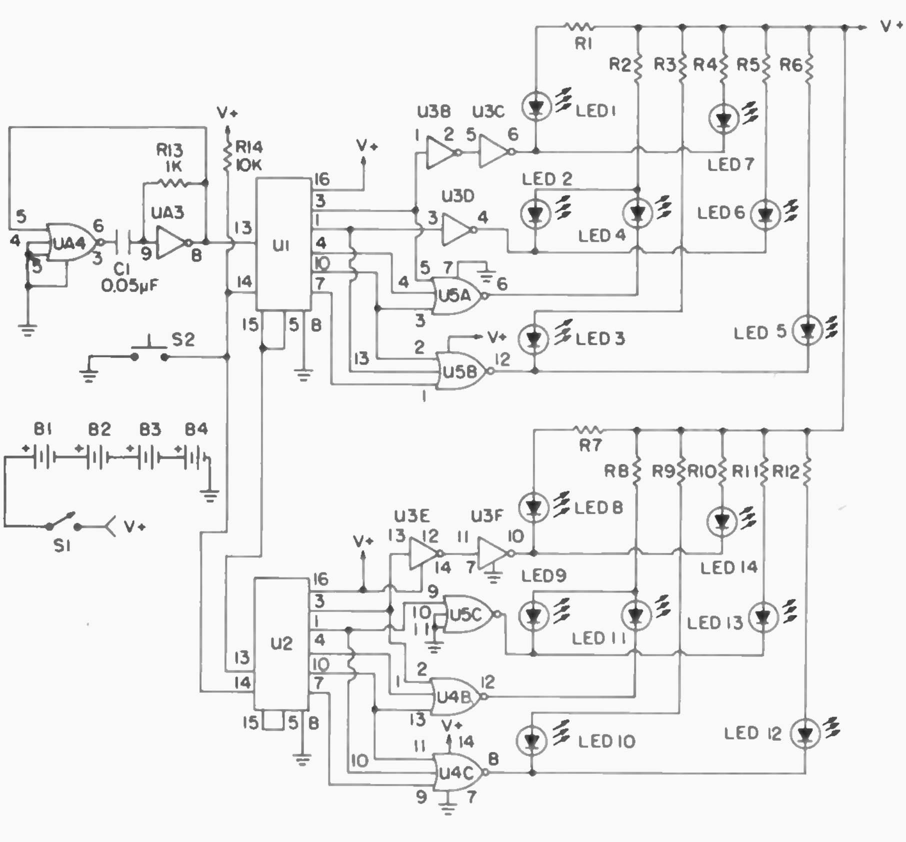
Construction. A full size PC board layout is shown for your use. As the pattern is very tight, we recommend that only advanced hobbyists attempt a reproduction. Wire wrapping is a bit more tedious and time consuming, but easier to correct. Anyway, if you do choose the PC route, carefully check for breaks and shorts in the foil with an ohmmeter, since they are easy to miss by visual inspection.

Follow the parts layout guide when assembling the PC board, and be sure you have the correct orientation of the chips; a small notch is preesnt at pin #1 of each chip. Also, don't arrange the LEDs backwards. The anode lead (+), which is usually longer than the cathode lead is always nearest to the ICs on the board. Reversing this won't hurt the LED but it won't light either.

The entire project fits neatly into a 2¼-inch by 2¼-inch by 4¹⁄₁₆-inch plastic box available in art supply stores. We ran four wires out of the main box to a smaller matching unit in which we mounted switches S1 and S2. Ribbon cable is perfect for this. The battery and circuit board are stabilized by styrofoam strips and blocks cut to the necessary shapes and either glued or press-fit into the large box. When the time comes to change batteries, the holder is easily unclipped and slid out of the case. Incidently, any 5-volt to 6-volt source can be used in place of the dry cells. The absolute maximum voltage the 74LS chips will tolerate is 7 VDC, so be careful.

Operation. Closing switch S1 activates the circuit. Don't be surprised if an unusual combination of lights appears when the unit is first turned on. Now press pushbutton switch S2. All of the LEDs will illuminate, some more brightly than others. Releasing the pushbutton will force *Digi Dice* to display two random values. Repeat the sequence for further play.

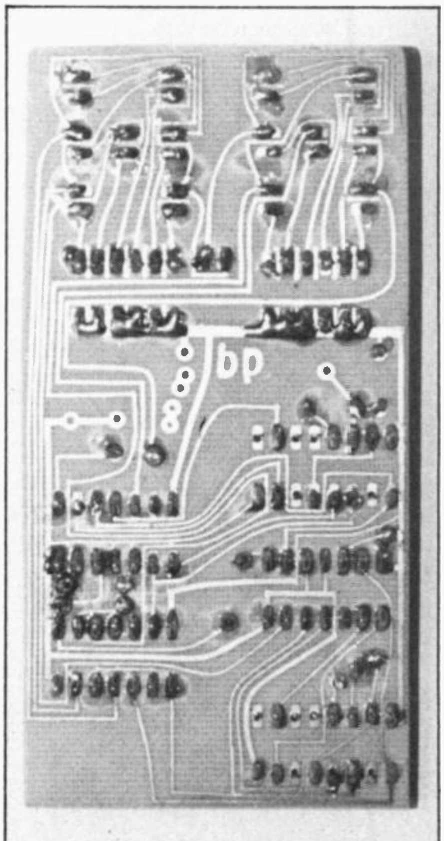
To test the theory of randomness, we "rolled" Digi Dice one hundred times. A summary of the results is shown. Although the tabulation was not checked using statistical analysis, you can see



PARTS LIST FOR DIGI DICE

B1 thru B4—1.5 VDC battery
C1—0.05-uF, 50 VDC ceramic disc capacitor
LED1 thru LED 14—light emitting diode rated 20 mA @ 1.7 VDC
R1 thru R12—470-ohm, ¼-watt resistor, 10%
R13—1,000-ohm, ¼-watt resistor, 10%
R14—10,000-ohm, ¼-watt resistor, 10%
S1—SPST subminiature slide switch
S2—SPST normally closed pushbutton switch
U1, U2—CD4017 decade counter integrated circuit
U3—74LS04 hex inverter integrated circuit
U4, U5—74LS27 three section, triple input NOR gate integrated circuit
Misc.—battery holder/clip, suitable enclosure, IC sockets, hookup wire, solder etc.

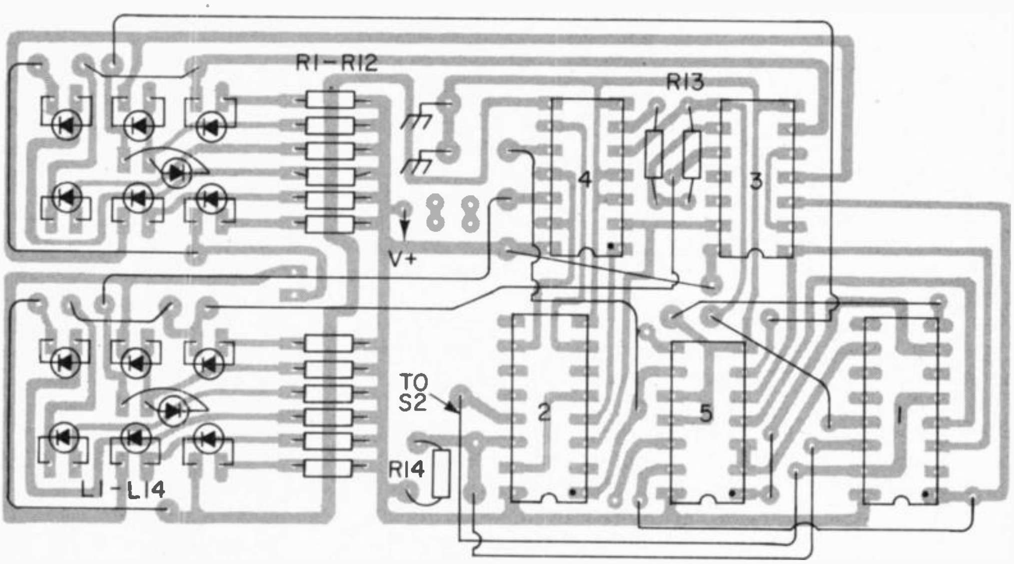
A complete parts kit including PC board and all components is available from Niccum Electronics, Rte. 3, Box 271B, Stroud, OK 74079. Price for the complete kit is $24.50; a pre-etched and labeled PC board only is $5.50. No CODs, please.



The foil side of the completed PC board is a gem of neat solder connections. The unit fits into a variety of handy plastic cases.

that the theoretical 16⅔ frequency for each level is closely approached—the small variations are just random fluctuations in this relatively few number of trials. *Digi Dice* draws about 20 to 60 mA from the supply, depending on how many LEDs are lit. Alkaline cells are best for long life, but regular carbon-zinc batteries will provide several hours of "rolling." Be sure to try this circuit in a game of backgammon. It runs much more quickly and a third person can get into the game as a dice roller.

Conclusion. We'll add the usual caution at this point about getting involved with "money" games. While *Digi Dice* has been designed to be as "random" as is possible for a project of this nature, we certainly do not wish to become referees in arguments between you and your friends (or your victims). *Digi Dice* is intended for entertainment only, and any other use of this project (either with a modified circuit or not), especially for gambling, is done against our strongest recommendation. If you're all that hot to *really* gamble, the Chamber of Commerce of Atlantic City would no doubt like you to visit the town's casinos instead! ■

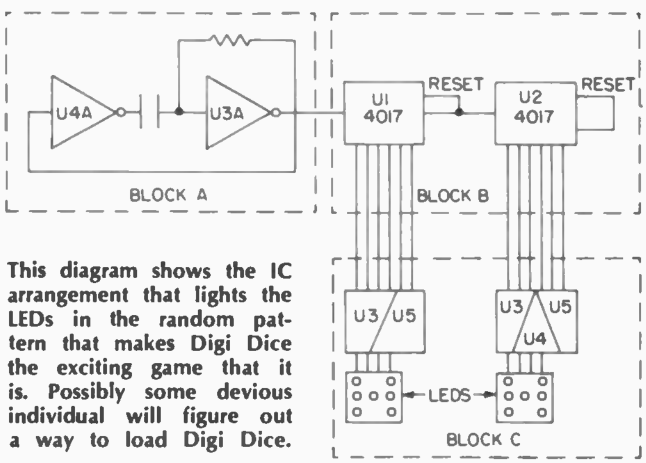


The parts overlay diagram shows the placement of components on the PC board. As in all projects using a number of delicate ICs care must be taken with the pins and with the use of soldering irons too near to the chips. Digi Dice is a project to gladden a gambler.

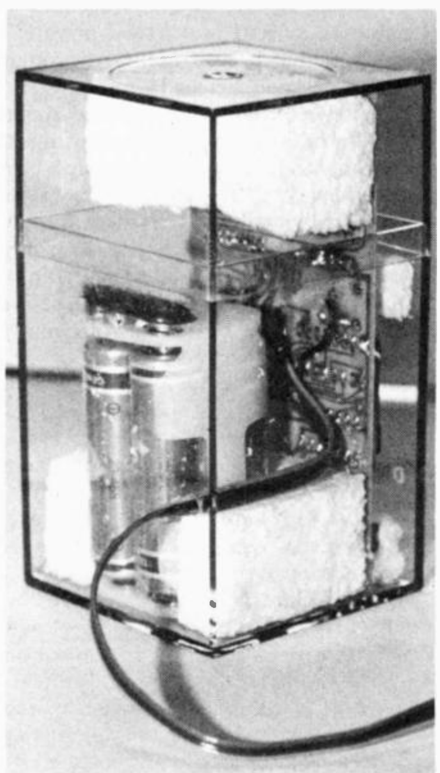
STATISTICAL BREAKDOWN OF 100 ROLLS

Face Value	Die #1/100 Rolls	Die #2/100 Rolls
1	18	16
2	14	18
3	18	14
4	15	17
5	18	16
6	17	19
Total	100	100

This chart shows how truly random Digi Dice is, much more so than old-fashioned "bones." While it may be possible, we know of no way to rig Digi Dice.



This diagram shows the IC arrangement that lights the LEDs in the random pattern that makes Digi Dice the exciting game that it is. Possibly some devious individual will figure out a way to load Digi Dice.



The battery pack holding the four 1.5 volt cells that power Digi Dice fits neatly into one of the common rectangular plastic boxes which can be found in a variety of shops. Styrofoam or a similar material can be used to take up room in the box, since the PC board and battery pack aren't likely to fill the entire box.

Getting the most from your Video Recorder

A versatile, low cost distribution system for VCR and home TV

WHILE THE POLITICIANS have given us two chickens in every pot, and many of us have two or more TVs in the home, we have not yet reached the stage where the average TV viewer has more than one video cassette recorder. So what do we do when Junior wants to watch last evening's Star Trek off the tape, while Sis wants to view tonight's Mork & Mindy?

The solution to your programming problems is an antenna/recorder distribution system: your own private TV network that brings the tape or antenna signal to every set in the house.

While you could go out and spend a bundle on an amplified master antenna system, for a very modest cost you can install a TV distribution system specifically tailored to meet most of your home's viewing needs. You might not get every possible combination of antenna and recorder programs at every set at the same time. but you won't be spending a hundred dollars or more for the system either.

Here are several popular and convenient TV signal distribution systems that do not require extra booster amplifiers, so long as your picture isn't already filled with "snow" from excessively weak signals. All three are possible because of a device called the hybrid splitter/coupler, which we will cover before getting into the actual wiring of a TV network for your home.

The Splitter/Coupler. A splitter, or coupler, is generally a device that can take one signal source input and split it into two or more outputs, so that more than one TV receiving device–receivers and/or video recorders–can be connected to the same antenna. You normally cannot simply connect two or more receivers or recorders across the same antenna wire. Under most conditions it won't work, unless all are tuned to the same station, and even then the connection can produce severe "ghosts." Basically, the splitter/coupler isolates each device from all the others, so that the input tuning of one TV tuner does not affect the others. For example, if two TVs are connected across the same antenna lead-in, and one is tuned to a VHF channel while the other is tuned to UHF, the UHF set will usually short circuit the VHF signal. This does not occur when the TVs are isolated by a splitter/coupler.

The problem is, the inexpensive splitter/couplers isolate each output through resistors, which produce considerable loss of original antenna signal. If your received signal is moderate to weak, by the time it comes out of the splitter/coupler it might not be sufficiently strong to overcome the inherent noise of the TV set itself, which is reproduced on the screen as "snow."

Minimum signal loss is produced by a special type of splitter/coupler called a *hybrid/splitter/combiner*. This is a two-way device which uses coils rather than resistors. A hybrid splitter/combiner can take one input and split to two or more outputs, or it can be reversed, and mix several inputs into one output. You can series-connect several hybrid splitter/combiners before their loss equals one resistive splitter. For our purposes, all references to a *splitter* mean specifically the hybrid type. Not all manufacturers spell it out clearly, so a general rule of thumb is: if it doesn't say *hybrid*, but it does say *splitter/combiner*, it is the low-loss hybrid coil type. In the easiest TV/recorder distribution system, the antenna connects directly to the VCR (video cassette recorder) and the output of the VCR connects to a 2, 3 or 4-output splitter. All VCRs have an antenna switch that provides either the antenna or tape playback signal at the VCR output. When the switch is set for the antenna, the splitter is fed broadcast signals, and all the TVs can tune any TV station. When the switch is set to VCR, the tape playback is fed to the splitter, and then on to all the TVs.

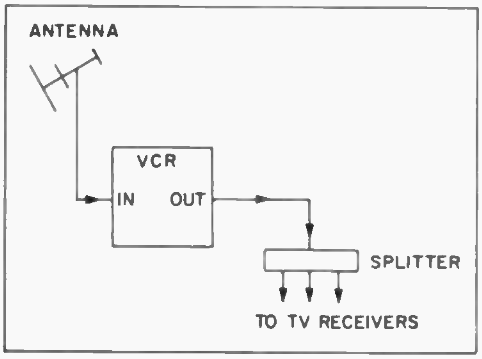
All current VCRs have separate UHF antenna connections. Actually, the UHF signals get through the VCR's own built-in splitter, so you can receive UHF on the TVs by using a VHF/UHF splitter directly at each TV.

Adding a DPDT switch to the circuit gives considerably more flexibility in signal distribution. The antenna signal can be fed to one, or more TVs, while the VCR feeds the remaining TVs. Remember, the VCR output signal can come from the antenna or the tape. When the switch is flipped, the TV gets the VCR, and the "remote" TVs get the antenna signal through the splitter.

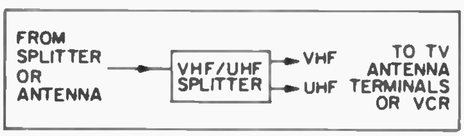
Putting It All Together. A distribution system is generally wired with 75-ohm RG-59/U coaxial cable, although some stores sell a more expensive, supposedly low loss coax similar to RG-59/U. RG-59/U will work just fine unless you're out in the boondocks, where reception is best described as "deep fringe." The standard TV coax connector is the solderless F-59, available from stores selling closed-circuit TV equipment. This is the same connector used for VCR outputs. The F-59 usually cannot be used for the low loss coax whose diameter is somewhat larger than RG-59/U. This requires the F-56 connector, which looks very similar to the F-59. Make certain you get the correct one. The F-56 connector can be used for either cable; but the F-59 can only be used with RG-59/U and similar sized coax.

The connectors are held to the coax with a separate or integral crimp ring. These are very easy to apply if you know how to do it, and have the right tool. If you have never installed an "F" connector, make certain someone at the store tells you which type you have and how to install them.

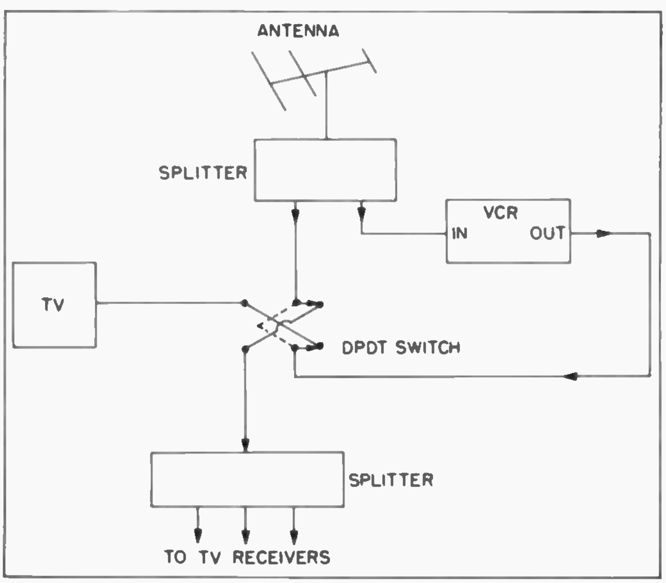
Prepare for expansion now. If you presently have only two TVs, consider if you will eventually get a third or fourth. If so, install a three or four-way splitter. You can always use extra outputs for the FM tuner if you don't like to see empty sockets.



Shown here in its simplest form, this VCR system carries signal from the antenna, to the VCR itself, and then to the various TVs.



This close-up diagram shows the heart of a video distribution system for the home.



This is a diagram of a fancy home VCR system. It feeds up to four separate sets, and can be switched to provide live TV, or "canned" video programming. Without getting into elaborate and expensive equipment like metal towers or cable TV grade hook-ups this system will give a great deal of satisfaction for a reasonable pricetag.

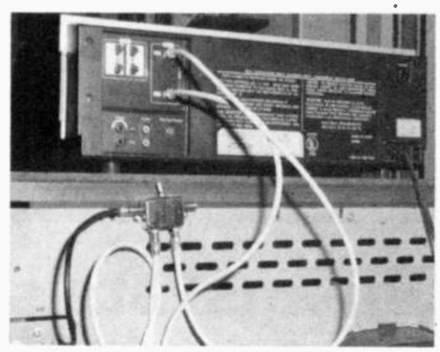
To avoid a rat's nest of wires in the living room or den, it's best to install the splitter somewhere in the basement or attic, and branch wiring out to each set. The basement is generally better than the attic, since you don't have to worry about falling through a ceiling. If you live in an apartment, a closet is the best location for the splitter.

Normally, unused splitter outputs cause no problems. But if the TV picture looks smeared, or if there are "ghosts" you didn't have before, install 75-ohm terminations on the unused outlets. These are made by simply putting a 75-ohm, 1/2-watt carbon resistor inside an "F" connector and soldering one end to the connector shell (ground) The free resistor lead is passed through the connector; leave 1/8-inch beyond the front of the connector as the center conductor pin.

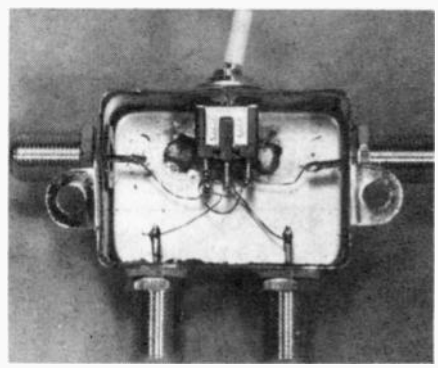
If you plan on using an antenna/VCR transfer switch, it's easier and sometimes cheaper to modify a Radio Shack Archer 4-way hybrid splitter than to purchase a batch of connectors and install them in an aluminum box.

To modify the Radio Shack splitter, first remove the back, which is held in place with a soft mastic ahesive. Using a sharp shop knife, cut through the mastic and then pop the cover off with a screwdriver. If the cover gets bent, it's easily straightened with a hammer. Unsolder the coils and remove the top connector (just remove the mounting nut and the connector drops out). Install a Radio Shack DPDT mini-switch in place of the top connector and, using very fine wire (#26 is perfect), wire the switch to the remaining connectors to make a DPDT "reversing" circuit. Cement the cover in place (use rubber or contact adhesive) and the coaxial switch is completed. Generally, the best mounting location for the transfer switch in on the back of the TV on which the VCR is located. Place it out of sight, but high enough so it's easily reached.

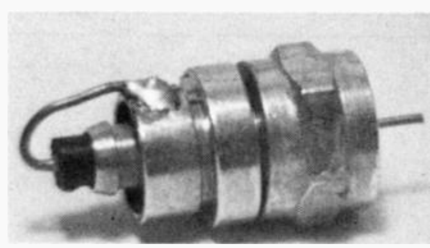
Impedance Matching. If your TV antenna download is 75 ohms, and some or all of your TVs have 75-ohm VHF antenna inputs, you've got it made. Just connect everything together. If the antenna and/or TVs are 300 ohms, you'll have to use 75-ohm matching transformers (available from Radio Shack and others) if you want the sharpest possible picture. Mismatching generally



The DPDT switched splitter is attached to the main TV set. Note the wiring layout.



Line splitters are easily modified to take a switch. This switching ability is vital.



If you get "ghosts" from unused splitter outputs, make up terminations from F-type connectors and ½-watt carbon resistors.

Video Recorder

produces a slight "ghosting" that appears as a loss in sharpness.

The 75/300-ohm matching transformers have an "F" connector on one end and short piece of 300-ohm twin-lead on the other. (Warning: Some transformers made in the Orient have an oddball coax connector and screw terminals for the 300-ohm output. Avoid them like the plague.) Install one matching transformer between the 300-ohm antenna downlead (inside the house, where it's protected) and one at each TV that doesn't have a 75-ohm VHF tuner input. If you're trying to keep costs to an absolute minimum, use the matching transformer between the antenna downlead and the coax.

If you move the TVs from room to room make life easy by using plug-in coax connections from the TVs. Terminate the leads from the splitter(s) with a Motorola-type socket installed on a plastic plate and box.

Shop Around First. The cost of parts for a TV distribution system can vary by as much as 40%. Shop around before you purchase *any* electronic components. We have seen the same hybrid splitter selling for $4.95 and $9.95. We have also purchased 100 feet of white RG-59/U for $10 and 100-feet for $14.95. Similarly, a blank plastic "TV outlet cover" which we drilled for the Motorola socket cost us $1.98. We then purchased a sturdier "electric outlet" plastic cover for 69¢ in an electrical supply house.

Final Checkout. First, make certain you can make a VCR recording from the antenna system. If not, you have a wrong connection to the splitter or switch. Then, feed the tape playback through your system and check that the rooms which should have the tape have it, and that the rooms with antenna feed actually have a signal from the antenna. If not, doublecheck the switch connections, if you have used a switch in the system.

When the switching is working as you intended, check the picture quality. It should be razor sharp. If not, or if some outlets are sharp while others are not quite as sharp, try terminating unused splitter outputs. Make certain you're using 75/300-ohm matching transformers where required.

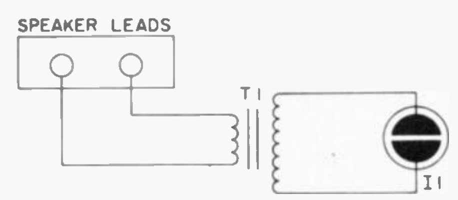
If you thought things out well before you started, you should have a system that handles most, if not all, of your family's TV viewing needs. ■

BUDGET TIPS FOR FUN AND SECURITY

Cheapskate's Light Show

☐ Here's one for small spenders. It takes the sounds that just about anything will turn out, through speaker terminals, headphone jacks or almost any audio output, and turns them into a bright, pulsating orange glow on an inexpensive neon lamp.

Transformer T1 can be almost any interstage transformer. The primary



PARTS LIST FOR CHEAPSKATE'S LIGHT SHOW

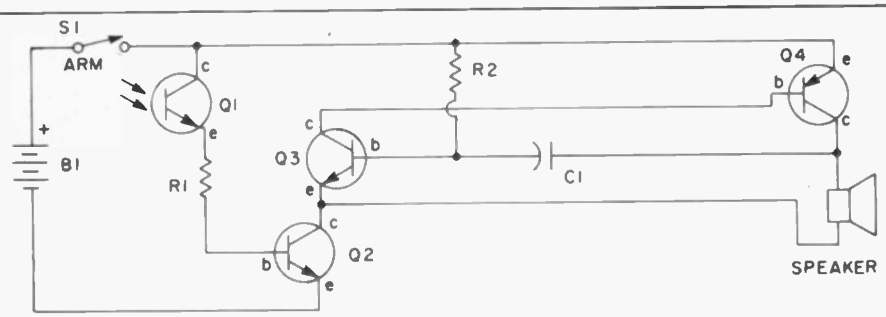
I1—NE-2 neon bulb
T1—1000:10,000-ohm transformer

Attache Alarm

☐ Who knows what evils lurk, ready to pilfer the Twinkies out of your attache case when you're not looking? This squealer does. Because when you arm the alarm by turning on S1, the lightest touch will set it off. More accurately, the touch of light. Light striking Q1 turns on transistor switch Q2, which energizes oscillator Q3-Q4. And that blows the whistle.

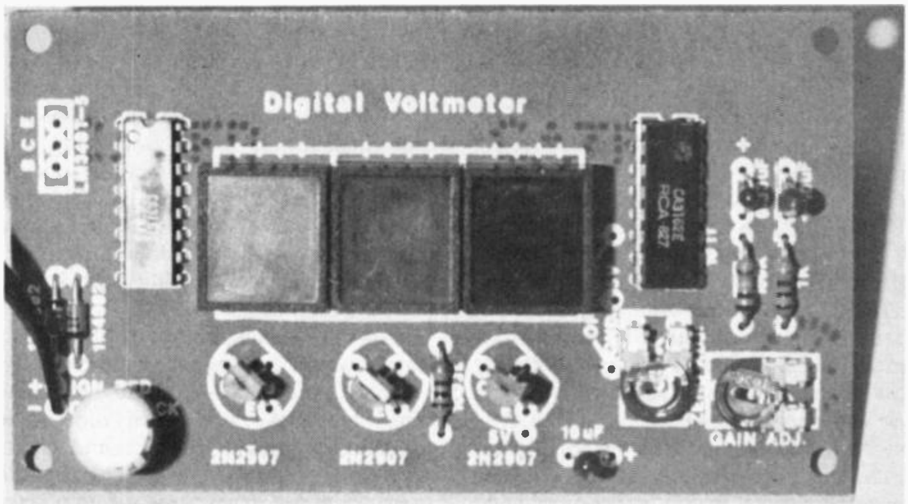
PARTS LIST FOR ATTACHE ALARM

B1—9 VDC battery
C1—.01-uF capacitor
Q1—Photoelectric transistor, FPT 100 or equiv.
Q2—NPN transistor, 2N2222 or equiv.
Q3—NPN transistor, 2N3904 or equiv.
Q4—PNP transistor, 2N3906 or equiv.
R1—2200-ohm resistor, ½-watt
R2—100,00-ohm resistor, ½-watt
S1—SPST switch
SPKR—8-ohm speaker



Dashboard Digital Voltmeter

Keep an electronic eye on the voltage level of your vehicle's electrical system and save on expensive repair bills later



YOU'RE MAKING TIME down the interstate at three in the morning, and all of a sudden you become aware that the lights on the dash seem kind of dim, and that the headlights don't seem to be reaching out as far ahead to warn you of darkened semis parked on the shoulder. Are your eyes just playing tricks on you, or is there something the matter with your car's electrical system? A quick glance down at the three glowing LED numerals on the dash gives you the instant answer. Either you pull into a rest area and grab a few hours of shuteye, or you pull into a service area and have the battery, alternator and voltage regulator given a good scrutinizing by the mechanic.

In either case, your car's digital voltmeter has given you the information sought about the state of the electrical system, and maybe saved you either a headache, a smashup, or a king-sized repair and towing bill. Maybe all three.

Recent advances in the design and availability of industrial integrated circuits have opened up many doors to the electronics hobbyists. Analog-to-digital devices have become more complex internally, thus making the portions of the circuitry which have to be assembled by the hobbyist that much more simple. The Dashboard Digital Voltmeter takes advantage of these advances, utilizing three ICs and a small handful of discrete components to give you an instrument capable of better than ± 1% accuracy in reading the voltage level delivered by your car's (or boat's) electrical system.

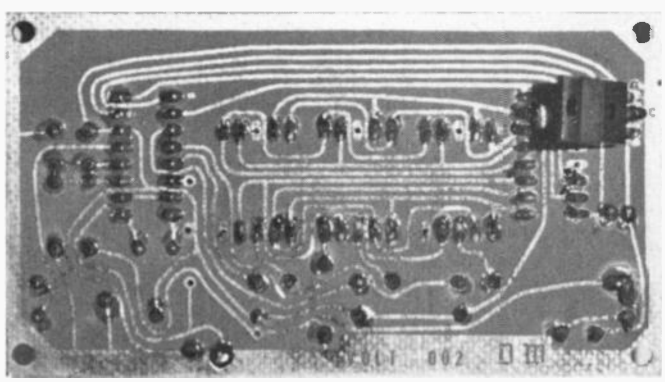
Two New ICs. The system is built about three ICs: the LM340T-5 (a 5-volt regulator now available for several years); a CA3162E; a CA3161E; and a support combination of diodes, resistors, and capacitors. It is the CA3161E and CA3162E that now open the door to new horizons in possible applications not only because of their unique capabilities, but also because they reduce substantially the numbers and types of formerly required support components. The heart of this system is the CA-3162E, a dual-slope, dual-speed, A/D converter industrial chip. Its almost equally important companion, the CA-3161E, is a BCD, 7-segment, decoder/driver chip. It is also unique in that it has a current-limiting feature. This eliminates the necessity of resistors in series with the 7-segment displays that were required in earlier designs.

The above feature not only reduces circuit board space requirements, but reduces the probability of component failure. Power required to operate this voltmeter is minimal (160 mA or less), a result of the multiplexing feature of the CA3162E. With that as a background, let's consider some of the more important operations of this simple, but very accurate digital instrument.

Circuit Function. Analog voltage from 000 mV to 999 mV can be applied between pins 11 (+) and 10 (−) of the CA3162E (U2). That IC converts the voltage into a Binary Coded Decimal (BCD) equivalent. The BCD leaves pins 2, 1, 15, and 16 (the group represents the 1's, 2's, 4's, and 8's) and enters pins 7, 1, 2, and 6 respectively of the CA3161E (U3). The latter IC takes the BCD code, converts the output, then uses it (in conjunction with the 7-segment display) to generate (form) the number that correlates to the BCD input of the CA3161E. The multiplexing driver pins 5, 3, and 4 (5 being the least significant and 4 the most significant) turn on that display by means of the PNP switching transistors. Concurrently, the CA3162E is providing the BCD information to the CA3161E driver/decoder.

As indicated earlier, the system includes a combination of diodes and capacitors. These are required to control or minimize the voltage spikes (positive and negative) that result from turning inductive devices on and off; e.g. windshield wiper, air conditioner, and electric windows, etc.

The maximum input differential between pins 11 and 10 of CA3162E is 999 mV. A resistor network (R1, R2) is used to attenuate the applied 13.8-volts to 138 mV. An Ohm's Law cal-



This view of the assembled PC board shows the voltage regulator, (U1) mounted on the underside of the PC board. This was done in order to accommodate a flush-mount installation in a smaller car. Let your space needs dictate placement of this component.

Digital Voltmeter

culation would give a result of 136.6 mV. The gain-adjust potentiometer compensates for the slight drop. The FND 507s display this as 13.8-volts.

Note the point marked OPTION on the schematic. With Pin 6 of the CA-3162E grounded or disconnected, there are four conversions or comparisons made each second. Tying pin 6 to the 5-volt line will result in 96 conversions or comparisons per second. The 96/second rate moves with excessive rapidity, is not appealing to the eye, and usually results in the least significant digit appearing to be blurred. Of the two rates, the 4/second conversion (4 Hz) is by far the more pleasing to the eye, is easier for the eye to focus on quickly, and is the recommended rate. These rates could vary slightly because of capacitor difference and manufacturer variance from stated values.

Assembling the Voltmeter. The unit may be assembled quickly and relatively easily using a predrilled and etched circuit board. If a Digital World circuit board is being used, the four corner holes will have been drilled. If a blank board is being used, drill the corner holes *before* starting to "stuff" the board. It is easy at this point to scribe the plexiglass panel and mark the corner holes on it for later drilling and perfect alignment. Additionally, examine the recess or place where the completed unit will be mounted. Determine how it will be secured (bolted, clamped, or glued), doing any additional drilling that may be required.

Get the workbench ready for soldering. Use a low wattage, electrically-isolated, fine-tipped soldering tool and fine solder. A blunt-nosed tool could damage or destroy the ICs and create foil bridges between pins. This is both expensive and frustrating. If you have had limited experience in soldering in small areas, it may be wise to practice on something else before you start.

Now, locate all resistors and potentiometers on the circuit board placement diagram and install them in their respective holes. Next, do the same for all capacitors, observing polarity. Install the CA3161E and CA3162E. *Caution!* When inserting the ICs, be careful *not* to fold the pins under or bend them in any way.

IC *orientation* is critical. Be sure these chips (CA3162E and CA3161E) are aligned as shown on the diagram. Note the notch mark on the chips and the corresponding notch mark on the schematic, or the "1" on pin 1 on top of the plastic case. All manufacturers use one or both of these base reference directional indicators.

If you have doubts about your soldering ability or the type of solder tool you have (grounded or not grounded), place two 16-pin sockets in the chip holes. The ICs may then be placed (not soldered) in the sockets. Next, insert the three LEDs, noting the notch marks on the LEDs and the notch marks indicated on the diagram. For the final action on this side of the board, insert both diodes in their respective holes (observing cathode markings).

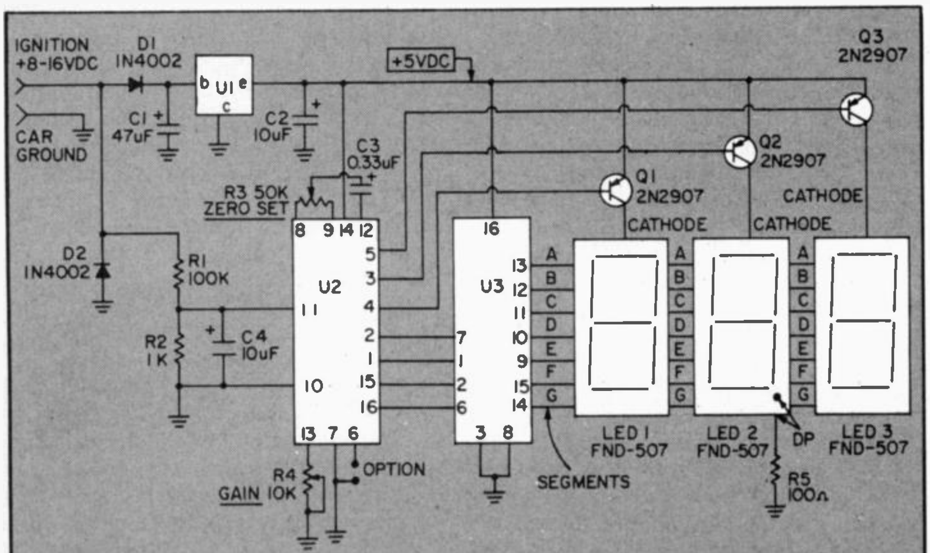
Reverse the circuit board and install the LM340T-5 regulator. *Caution!* This must be correctly placed or it will destroy your unit when power is applied. The *metal side* of the regulator must be facing the FND 507 pins. Recheck it to make sure.

Now, turn the board over again. Use a red wire for the ignition line and a black wire for the chassis ground. Determine the lengths required (usually three-feet is sufficient). Solder the red wire to the point marked IGNITION on the diagram and the black wire to the GROUND.

Calibration Procedure. Correct calibration determines the accuracy of your voltmeter. Follow these steps carefully and sequentially. Apply a *known* voltage source (above 10 and below 16-volts) to the IGNITION point. We recommend a 13.8-volt source. Next, for zero adjustment, ground pins 11 and 10 to the circuit board ground momentarily. Using a small screwdriver, slowly rotate the wiper arm on R3 until there is a reading of 000. Remove the ground from pins 10 and 11. Set the *gain control* (R4) by rotating the wiper arm until the displays are displaying the same voltage as is being applied.

Installation. One final action is necessary before your unit is ready to be mounted in the dash location of your choice. Secure the black wire to the metal chassis ground and the red wire to any accessory line that is active only when the motor is running. Secure and mount the voltmeter in the location of your choice.

A colored plexiglass facing (cover) is required and we recommend red for most display contrast. A location which is not usually exposed to the sunlight will make the displays easier to read during the brighter periods of the day. If the unit is going into an existing recess, the present glass cover may be



PARTS LIST FOR DIGITAL VOLTMETER

C1—47-uF electrolytic capacitor, 25 VDC
C2, C4—10-uF tantalum electrolytic capacitor, 16 VDC
C3—0.33-uF tantalum capacitor, 35 VDC
D1, D2—1N4002 diode
F1—1-amp fuse
LED1, 2, 3—FND-507 7-segment LED display
Q1, 2, 3—2N2907 PNP transistor
R1—100,000-ohm, ¼-watt resistor, 5%
R2—1,000-ohm, ¼-watt resistor, 5%
R3—50,000-ohm PC trimmer potentiometer
R4—10,000-ohm PC trimmer potentiometer
R5—100-ohm, ¼-watt resistor, 5%
U1—LM340T-5 5-volt voltage regulator
U2—CA3162E Analog-to-Digital converter
U3—CA3161E BCD display driver

Misc.—solder, hookup wire, red plexiglass (for display filter), IC sockets, transistor sockets, suitable enclosure, etc.

Note: An etched and drilled circuit board for the Digital Voltmeter is available for $6.50 (postpaid in U.S. and Canada), and a complete parts kit, including PC board but not including plexiglass, is available for $27.50 from: Digital World, P.O. Box 5508, Augusta, GA 30906. Please allow 4 to 6 weeks for delivery. No C.O.D.s or foreign orders, please.

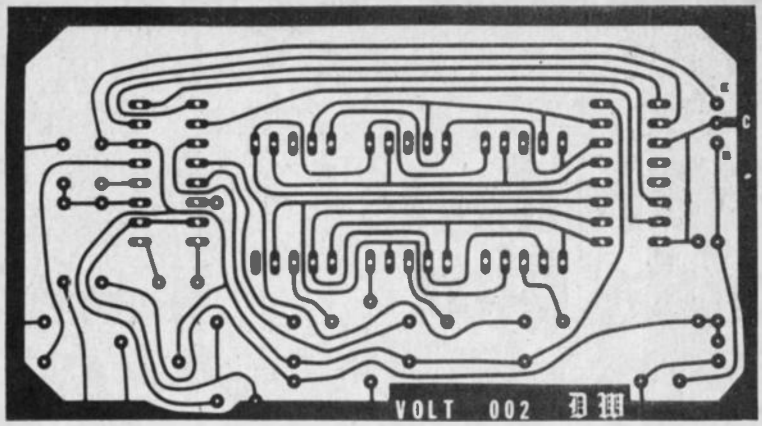
used as a template for the plexiglass cover dimensions. One-eighth or 1/16-inch thickness plexiglass works well and is relatively easy to cut using a roofer's shingle cutter knife. Place two clamps on a straight line along the template edge, then cut one side at a time. Scribe it deeply with a dozen or more strokes, then break off the excess with a pliers. When drilling screw holes, use a small starter bit first, then the larger bit. This should prevent the larger bit from wandering across the plexiglass.

The plexiglass must be "spaced" away from the board by approximately 5/8-inch, using either spacers or the bolt/nut method. The latter method is to insert a bolt through the plexiglass corner hole and put a nut on the reverse side. Put a second nut on the bolt, allowing a 1/2-inch inside space between the two nuts. Do this on all corners. Next, insert the bolts into the board corner holes and put on the final nuts. We recommend securing all four corners, rather than just two.

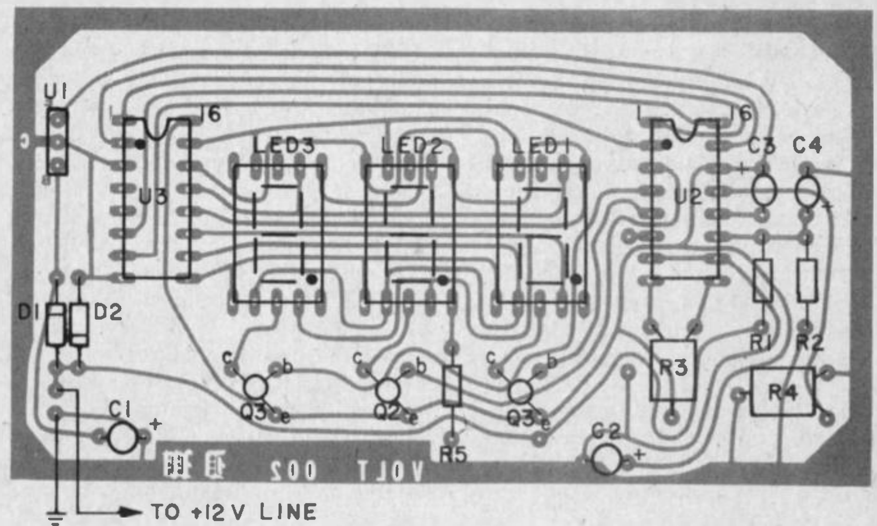
Troubleshooting. If the unit does not light up for the calibration procedure, first check that the wiper of R3 is centered. If it still does not light up, recheck your work. Carefully inspect for possible solder bridges and loose connections, If a solder bridge is discovered, remove it carefully. It is easy to destroy a chip during the removal process. If it still fails to light up, start a systematic test check to isolate possible faulty component(s).

If the unit does not function after installation, recheck for a good electrical connection on the line that supplies power from the car. Did you break or loosen the solder connections of the source wires during installation? If so, this will require removal and resoldering, plus a bit more care during installation the second time.

One Final Note. Some ICs, and quite possibly the ones used in this project, generate high frequency harmonics which might find their way into your car's radio. Try holding your LED readout pocket calculator next to the radio antenna with the radio tuned to a blank spot on the AM dial to see what we mean. If you experience any interference from the voltmeter circuit, try rerouting the antenna coax away from the voltmeter itself. A metal case around the voltmeter's PC board will also aid in the reduction of RFI. We suggest that you avoid using the radio's power lead as the voltage source for your voltmeter. The power lead to the horn (or horn relay) or the hot lead of the windshield wiper switch (find it at the fuse box) is probably the best place to attach the voltmeter. ■



This full-scale etching guide for the voltmeter's PC board is one of the trickiest we've offered. Unless you know your stuff, we suggest you use a Digital World board.



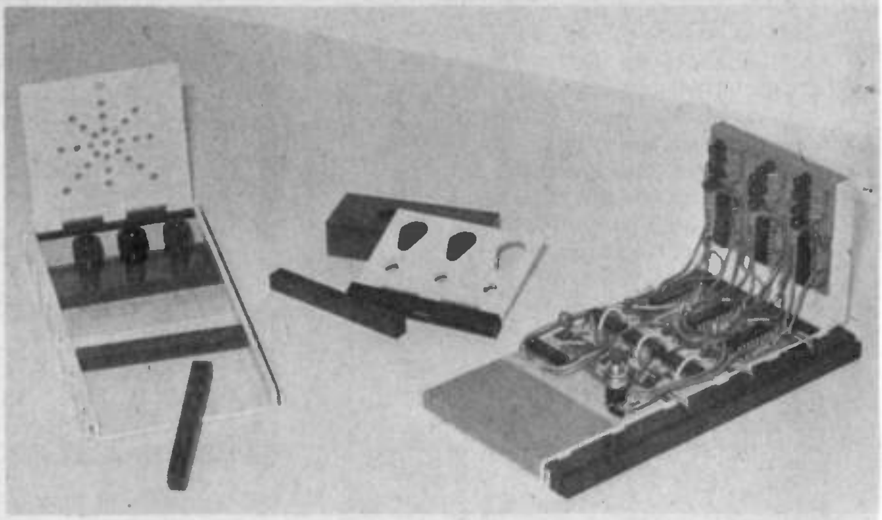
The component placement diagram for the PC board shows all IC and capacitor polarities. Take special care to observe them during assembly phases of project.

Even the best voltmeter in the world won't help you keep your car running if you don't take care of your battery. Check water level often and add only pure, distilled water.

Project Builder's Budget Tip

AP Products Hobby Blox

Prefitted color-coded building blocks make for easy perf-board project assembly



CIRCLE 70 ON READER SERVICE COUPON

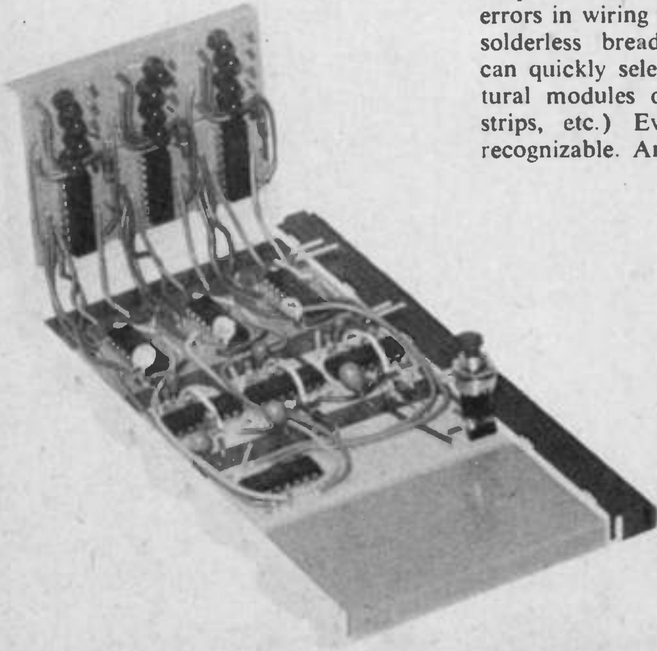
INFLATION BUSTING begins at home, and electronics hobbyists can help by saving cash on the price of their solderless breadboards. Until now, electronics hobbyists had to buy pro-type solderless breadboards and pay "professional" prices to build those projects. Hobbyists have long dreamed of a total breadboard system which would allow the user to customize the board to fit his projects while being both economical and flexible. Well, it looks like the hobbyists have what they want with help from A P Products. Recently, our technical editors had a sneak preview of their HOBBY-BLOX, a new modular circuit-building system designed and produced by A P Products.

At the core of the HOBBY-BLOX system are two starter packs; one for discrete component projects, the other for integrated circuit projects. Each system comes with a number of modules which fit into a tray and an accompanying project booklet that describes step-by-step how to build ten projects with the existing packaged parts. For a suggested retail price of under $7.00, the hobbyist has everything he needs in breadboards at his fingertips.

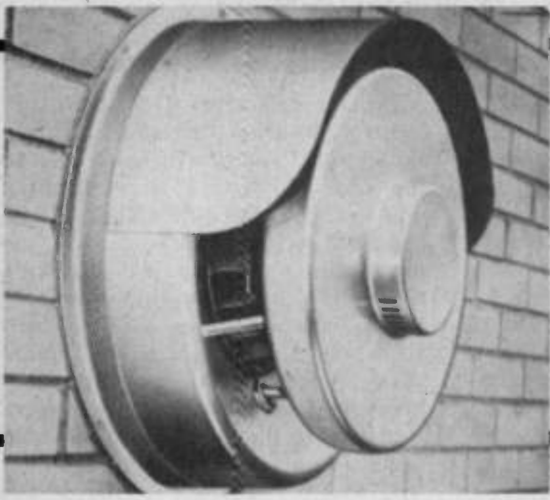
The Benefits! Every hobbyist (from beginner to more advanced) who gets his hands on the HOBBY-BLOX system will probably make his own list of benefits for this system. Just to give you an idea of the positive features you'll discover, the HOBBY-BLOX system is modular. It doesn't matter what pack you start with, all the modules are interchangeable. A color keyed system is very helpful to the hobbyist because each module is grouped in a different color as it relates to its function. This simplifies building and eliminates two errors in wiring common to uni-colored solderless breadboards. The hobbyist can quickly select the light gray structural modules or the yellow terminal strips, etc.) Every module is easily recognizable. Another feature which is a big plus to the new system is the benefit of being expandable by allowing the hobbyist to add modular parts to design new projects or expand on existing ones. The HOBBY-BLOX system includes 14 separate modules which can be purchased individually.

Two features, compatibility and affordability, are probably the most important to the hobbyists. This system is compatible with DIPs of all sizes and a wide variety of discrete components with wire lead diameters from diode size to ½-watt resistor size (.015" to .032" diameter). In terms of affordability, it would seem like A P Products has thought of everything, even down to the important aspect of costs. Here again, the hobbyist doesn't have to be a Rockefeller to enjoy his pastime. The HOBBY-BLOX system costs less than professional systems with individual modules available to choose only what the hobbyist needs.

The Way We See It! By offering a variety of modules, A P's HOBBY-BLOX system allows the electronics hobbyist to use his imagination to build and expand on a multitude of projects. Our editorial staff saw this concept in its developmental stages and even at that time, the system met the primary objectives of expandability and affordability. The idea of color coding and indexing as well as offering a modular system allows the hobbyist to progress and learn with each project completed. For the experienced hobbyist, here's a fast way to modify projects, and troubleshoot them when circuit design failures occur. To find out where you can buy HOBBY-BLOX system call this toll free number (800) 321-9668; or write A P Products, Inc., 1359 W. Jackson Street, Painesville, Ohio 44077. For more information, circle number 70 on the reader service coupon. ■



The Hobby Blox system gives the project building hobbyist an easy vehicles for assembling circuits to a professional level without having to resort to expensive and often complicated solderless breadboards.



Cut In a Wall Fan and Save Cool Cash

In this time of soaring prices and costs one of the best ways to save a buck is to install a wall fan. No, we're not kidding. Wall fans can give you a couple of extra years on a paint job, eliminate the need for an air conditioner or two, keep your basement shop supplied with fresh air to cut down on tool rust, exhaust chemical fumes from your darkroom or printed circuit board preparation area, and even get rid of stale household odors (though odors don't generally cost you money).

Still think we're joking? Okay, let's take a closer look at how a wall fan works for you. First the kitchen. Any family cooking introduces grease molecules into the air. Unless it's sucked out by a well-ducted range hood (not one of those recirculating filters) the grease spreads throughout the house, darkening wall and ceiling paint and wallpaper. Quite often the house that needs repainting every three or four years can get six years or more on a paint job (or wallpaper) if there's a good wall fan in the kitchen.

And when it comes to saving power, a good fan is king. Say you've got a good size air conditioner in the living room or den. But the kitchen and dining area steams from the oven when you cook. There's no need to invest in extra air conditioners—and the extra electric cost; just install a moderate size wall fan in the kitchen or dining area—about 600 to 650 cfm (cubic feet per minute). It will pull in just enough cool air to keep the kitchen and dining area comfortable. You won't need a sweater, but you won't be supporting the local electric company with extra—unneeded—air conditioners. You can pull off the same trick if you have a small bedroom or den opposite an air conditioned room. A small wall fan will generally pull in enough cool air to keep you comfortable without exhausting all the cold air in the next room. Just keep in mind that a wall fan takes a lot less electric power than an air conditioner, and a kilowatt saved pays for the next increase in gasoline and home heating oil.

Fig. 1. Pick a location for the grille-damper, and make certain it's between two wall studs. Using the duct as a template, scribe the outline on the wall and then use a razor to cut away the wallpaper.

Fig. 2. If the wall is sheetrock (drywall) score the outline with a knife, a narrow chisel, or an old screwdriver, then cut all the way through and punch out the circle.

Fig. 3. If the wall is plaster, scribe the outline and then chip out the plaster until the lath is exposed. The lath can be either strips of wood, wire mesh, or plasterboard—a sheetrock-type material with a pattern of large holes into which the plaster locks when dry.

Down in your shop a wall fan will expel damp moist air and suck in drier air from upstairs. It's not as efficient as a dehumidifier, but a dehumidifier is really a small air conditioner and costs almost as much to run. Not every basement is damp enough for a dehumidifier; often, a fan is all that's needed to keep rust off your tools. And don't overlook the fact that a fan will suck out the fumes from printed circuit chemicals, Krylon-type spray paints, and plastic solvents. The lungs you save might be your own.

"Fine," you say, "I'm ready for a wall fan." Unfortunately, a commercial installer will charge the cost of his next vacation to install any fan. And if your house has brick walls, he'll take his next *two* vacations on you. But the truth is a wall fan installation can be done by anyone familiar with tools, and you as an electronics hobbyist should be perfectly able to do a professional installation. After all, you have most of the tools, and what you don't have can be rented for well under $10 a day.

Before we show you how easy it is to install a wall fan, the first step is to get the right fan. Virtually every hardware and discount store sells wall fans; there are more models than politicians looking to raise your taxes. We suggest the type where the fan itself is outside the house (in a waterproof housing), so it sucks the air through a duct, rather than pushing it through. What's the difference? Almost maintenance-free ducts. When the fan is inside the house

Fig. 4. If you have made a measuring error and find a stud running past the hole, don't panic. The wall will stand even if you cut through one stud. Use a saber saw to trim the stud so the cuts correspond to the circular duct pattern.

Fig. 5. Remove any insulation between the inner and outer walls and then drill through the exact center of the outer wall. The hole will be the pilot when you're working on the outside. If the wall is masonry or brick use a carbide tipped bit. A standard bit is okay for a frame construction (wood siding).

Fig. 6. Before cutting the outer wall and mounting the fan unit, install all the necessary electrical wiring. While you can use a simple on-off switch, a multi-speed selector switch or variable speed control can be a great help when you want to move air slowly, in small quantities.

Fig. 10. If you have no one to help when mounting the fan assembly, cut down the overall weight by removing the motor and fan from the rain shield. Secure the shield to the wall and then install the motor and fan. Note the electric wires from inside the house coming up through the shield.

Fig. 11. Install the motor, making certain the BX cable armor runs all the way to the motor connection box to provide a solid electrical ground. If you're using Romex wire make certain you use the type with the ground wire, and double-check that the ground is secure at the motor.

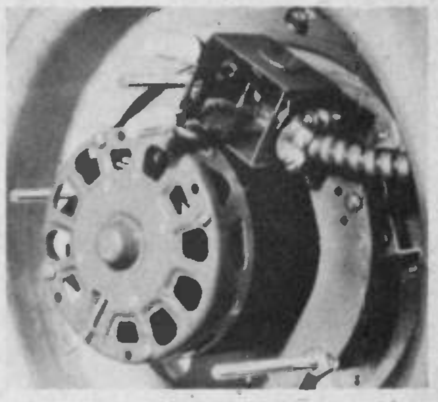


Fig. 12. Here is a close-up of the fan motor and electrical connections. BX cable comes from house wiring and connects to an electrical box mounted on the motor. Wire nuts cover the splices.

at the start of the duct to the outside, the fan pushes the air into the duct. The air pressure decreases along the duct and the grease drops off along the duct. Eventually, the duct will have a heavy grease layer that will have to be cleaned out.

When the fan is on the outside, at the end of the duct, the air velocity builds as it travels through the duct to the fan, and much more grease is discharged—less settles along the duct.

When the fan is mounted outside, the input to the duct has automatic damper doors that keep out the cold air in winter and bugs in summer. When the fan starts, air velocity (suction on the duct side) causes the doors to automatically open.

One of the best choices in fans from a budget and ease-of-installation viewpoint is the NuTone WF-1N for wall mounting, or its cousin the RF-1N roof fan. Both are rain-proof and are the same type as used at your local pizzeria—and you know what kind of exhaust problems a pizzeria has, or for that matter, any restaurant.

Both fans take a multi-speed control, standard 8-in. round ducts, automatic damper, and a mesh grease filter. To show how easy a wall fan installation can be, we've taken on the most difficult of all: a house with a brick wall. Just follow the steps shown in the photographs and you'll have as little trouble as our installer—an electronics hobbyist with little in the way of carpentry experience. ■

Fig. 7. While a saber saw can be used to cut through a frame outer wall, something a lot heavier is needed for brick. You can hack away at the brick with a cold chisel and sledge, but a few dollars spent to rent an electric hammer (with chisel bit) will let you bust out the wall in minutes. Note the screw sticking through the pilot hole, used to center the duct circle scribed with chalk.

Fig. 8. The final trim is done by hand with a cold chisel and small sledge. The sheet metal duct should just slide through the hole without bends or a force fit. Chip away small bits of brick until the duct can slide in and out easily.

Fig. 9. The damper assembly is generally long enough to pass through thin-walled buildings. If you need extra length, standard 8-in. flue pipe obtainable at local plumbing outlets can be cut to size.

Fig. 13. After the connection has been made, the box cover is screwed in place. Now check that the fan rotates freely and the housing is secured firmly to the wall. Some weatherproofing caulking is necessary. Less than one half a cartridge from a grease-gun squirter is needed.

Fig. 14. Finally, secure the motor's cover in place to complete the outside installation. Turn the power on and check that the fan rotates quietly without hitting any obstruction in the 8-inch duct. The neat appearance and low noise level of the fan will not be offensive to your neighbors.

Fig. 15. After the fan is checked out for operation and multi-speed control (if so equipped), install the automatic damper doors and grille on the inside. Be very careful not to bend or force the damper doors into the duct. Make certain the dampers swing open at all settings of the fan's multi-speed control. The wire screen should be removed periodically for cleaning. Don't wait too long; if you do, you'll be wasting valuable electricity.

Nutone offers an interesting fan catalog you can obtain by circling No. 68 on the Reader Service Coupon.

When you build a speaker system, you sometimes find that it's easier to get good sound than a professional-looking cabinet. Here is a speaker that can give you both at a low price; and it's so easy to build you will need only a few hand tools. The night table speaker has one obvious use: as a set of stereo extension speakers in a bedroom, but the two-way woofer/tweeter system performs well enough to serve anywhere you need a set of speakers.

Speaker Components. A two-way system is a good compromise between the inadequate frequency response of most single cone speakers and the expense of a three-way set of crossovers and drivers. This one requires only two crossover components—a capacitor that acts as a high pass filter for the tweeter and an L-pad that permits you to balance the output of the tweeter to that of the woofer in any acoustical environment or location.

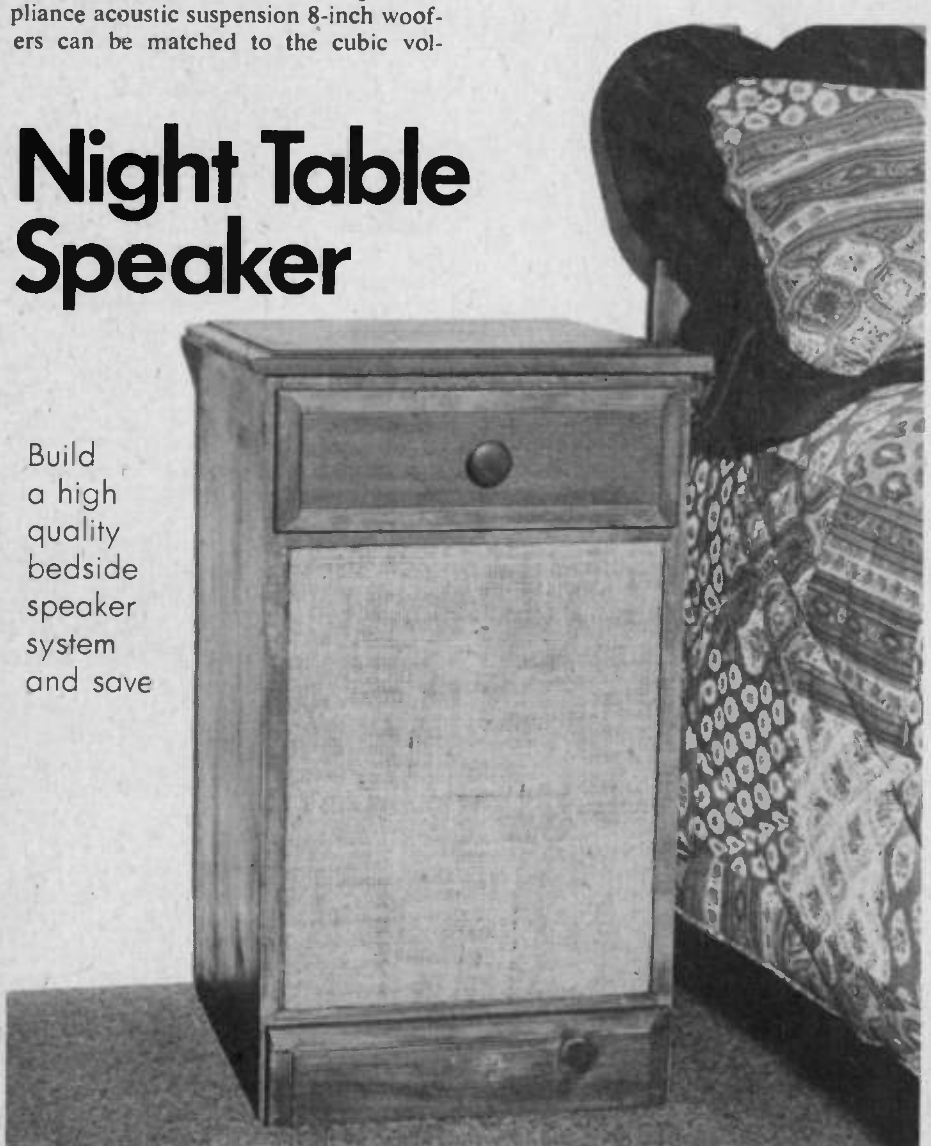
Fortunately, most current high-compliance acoustic suspension 8-inch woofers can be matched to the cubic volume of the enclosure described here for optimum bass performance. So if you already have some 8-inch woofers, there is a good chance that they will perform satisfactorily in nightstand cabinets. The speaker components list shows a choice of speakers, two systems that survived a test that included a number of other speakers.

For good performance at the lowest possible cost, the Varco woofer and CTS mid-tweeter are hard to beat. But if you want a system with deeper bass, somewhat smoother overall response and better high frequency dispersion, you should consider the Speakerlab kit. It is clearly the better system of the two, but at more than twice the price. To make the right choice you should consider the kind of use you'll make of the speakers as well as the size of your bank roll.

You may have to alter the diameter of the woofer hole slightly to fit the woofer you use. The plans show this as 7⅜-inch about right for the Varco woofer, but for most 8-inch woofers the diameter should be 7⅛-inch. If you use the smaller diameter and later want to enlarge it, you can round off the outer edge of the cutout with a rasp or a piece of coarse sandpaper. Just knock off the front edge and the woofer will fit into the hole.

Night Table Speaker

Build a high quality bedside speaker system and save

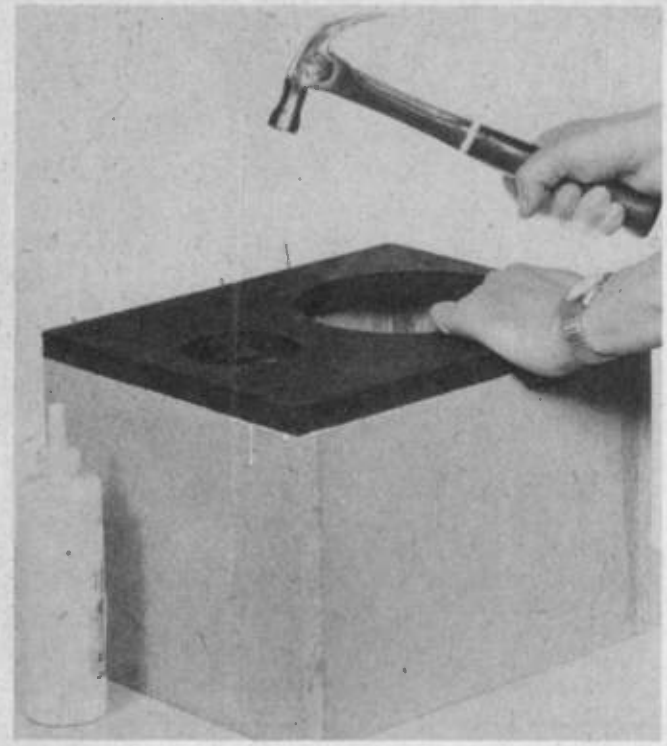


Putting It All Together. The speaker is built around, or into, a department store night table kit: Creative Furniture Kit #21114. This kit includes glue and nails with the pre-cut parts—everything you need except a hammer and screwdriver. For the inner speaker box you'll need some kind of saw to cut out the parts and a saber or keyhole saw to make the speaker holes.

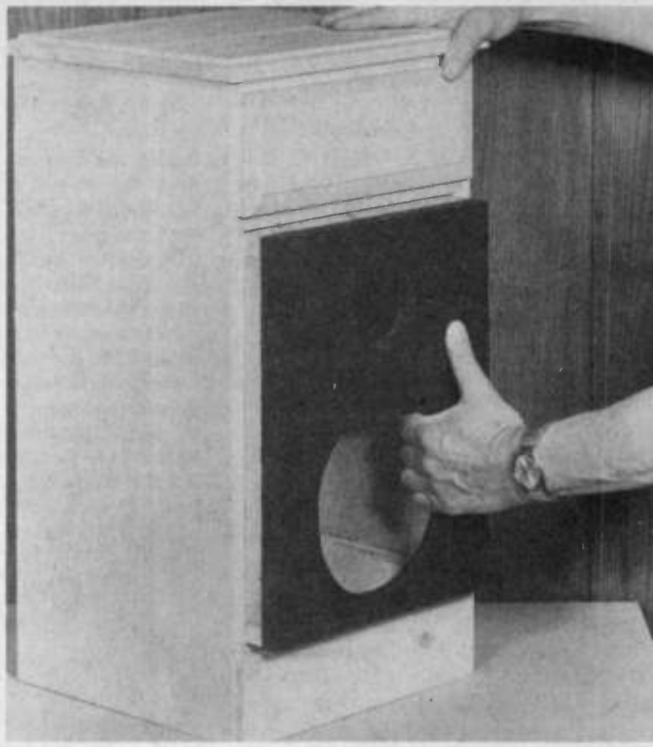
You can use another brand of night table kit if you adjust the inner box dimensions to make it fit the night table. The speaker enclosure shown here has an internal volume of about 0.7 cubic feet. You can reduce the volume to about 0.5 cubic feet if necessary, but then you should use more sound damping material in a smaller box than is specified here. In fact, you may find that you get better sound from a smaller box by loosely filling it with polyester sound damping material. Don't overstuff the box by compressing the material; put it in gently.

When you unpack the night table kit, it's a good idea to separate the three kinds of nails and two kinds of screws so you'll use the right ones at each step. The kit instruction sheet has one ambiguous drawing: the one showing how to nail together the frame parts. The ⅝-inch "berry box" nails should go through the parts at *right angles* to the tongues of the cleats. Someone at the store where I bought my kit had misinterpreted the drawing and put some nails through the frame in such a way that their heads showed from the outside of the finished cabinet of the display example. If you follow the printed instructions correctly, you will have no nail-heads that show. Remember that only finishing nails go through the exterior boards.

If possible, nail the frames together on a hard, flat surface to flatten any nail points that penetrate the rails. A smooth concrete floor is an ideal nailing support. When you assemble the cabinet, note that the top frame rests on the dadoed ends, its nails driven vertically through the frame members into the ends. Before you install the back panel you should cut a 3-inch by 4-inch rectangular opening in it to give access to the control board in the back of the inner box. Center this opening



The inner speaker enclosure box must be assembled carefully. Make certain that all edges are square and flush.



Properly assembled, the speaker box should fit inside the opening in the night table with no space at sides.

between the left and right edges of the back with the lower edge of the opening located about 6 inches from the bottom of the panel.

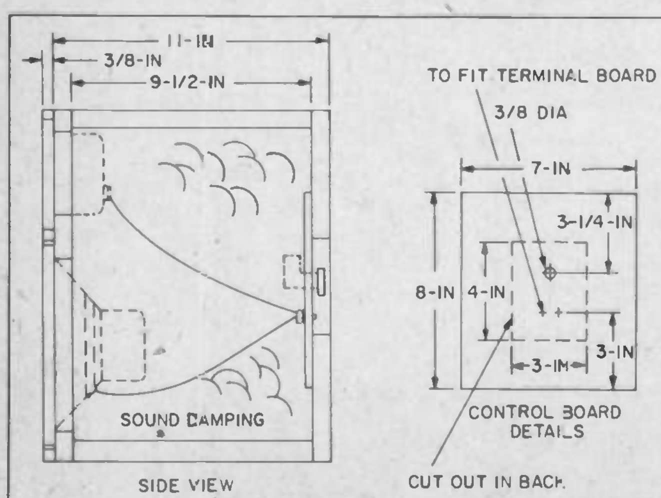
Inner Speaker Enclosure. For the speaker box you can substitute ¾-inch plywood for the particle board mentioned, but try to get pieces with no significant spaces between the layers. Cabinet shops often have left-over pieces of particle board or plywood that you can buy at reduced prices. They usually choose industrial grades of particle board with smaller particles and of denser construction than the cheaper grades.

Cut out the parts according to the plans and set them together to make sure that the inner box will fit into the cabinet. Even better, tape or lightly nail the box together and try the fit. Then take the pieces apart and paint the speaker board flat black.

To assemble the box, apply a liberal coating of glue to the joining surfaces and nail the top and bottom pieces to the sides with 4-penny finishing nails. Then glue and nail on the prepared speaker board. After the glue sets, caulk the inner joints with latex or silicone rubber caulking compound.

Prepare the control board on ¼-inch tempered hardboard according to the plan shown. Note that this step is unnecessary if you get the Speakerlab kit, which comes with its own control board and pre-wired crossover. Drill a ⅜-inch hole for the L-pad and two ¼-inch holes to match the position of the screws on the terminal board that you use. Install the L-pad with the hardware that came with it. Install the terminal board with glue and small screws or tacks. Connect a 12-uF non-polarized capacitor between the lug on one box terminal and pin #3 of the L-pad. Connect a wire from the other terminal to pin #1 of the L-pad. Then connect an 18-inch length of lamp cord to the box terminals for woofer leads and another 18-inch length to pins #1 and #2 of the L-pad for tweeter leads. Trace out the leads and mark the common leads with pieces of black tape, or check the lamp cord to see if one lead is coded by ribbing.

It's a good idea to check out the wiring before installing the terminal board. Turn off your amplifier and receiver before you connect or disconnect the speakers and turn the volume control all the way down. Connect the speakers to the proper leads, turn on the amplifier and listen to them at low volume. Turn up the volume just enough to see if the bass is coming from the woofer and the highs from the tweeter. Check to see if the L-pad controls the tweeter. If the wiring passes these tests, you can solder all the connections on the control board. Then glue and screw the board to the inside of the back, using silicone rubber glue.



This side view shows speaker box dimensions, placement of the speakers and sound damping material and control board specifications. The control board fits in the cut out in the back of the speaker enclosure box before the speakers are put in place and attached.

Table Speaker

If you can leave it for a half day without moving it, you can use silicone rubber glue alone. But don't forget to place it on the back so that the speaker terminals will be accessible.

Line the side walls with a two-inch layer of damping material. You can fasten the material to the walls with tacks or blobs of glue. Glue and nail the back on the box. Caulk the inner joints around the back, working through the woofer hole. Then cover the back with a layer of damping material, inserted through the woofer hole.

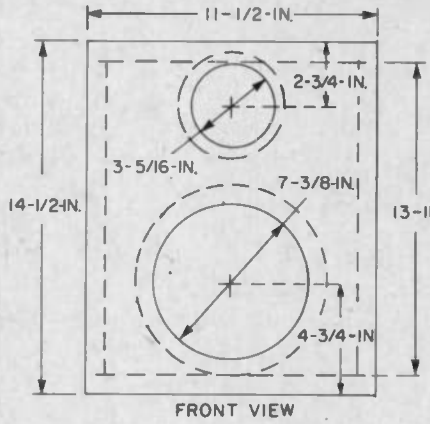
Bring the speaker leads out through the damping material and solder them to the proper speaker terminals. Run a bead of silicone rubber glue around the edge of the tweeter cut-out in the speaker board and set the tweeter in place. Follow the same procedure for the woofer. The silicone rubber automatically forms an air-tight gasket between the speakers and the board and holds them to the board. Don't use the speaker until the glue has set.

Check the woofer's polarity by connecting a flashlight battery to the exterior terminals and watching the woofer cone movement on contact and break. When the battery is connected so that the woofer cone moves forward on contact, mark the terminal connected to the positive pole of the battery with a red dot or a plus mark. Do this for each speaker system you build to make. phasing easier when you wire the speakers to your receiver.

Make up a grille frame by cutting a 4½-inch hole for the tweeter and an 8⅜-inch hole for the woofer in a piece of ⅜-inch plywood. Center the holes on the same points as the holes in the speaker board. Put the speaker box into the night table and check the fit of the grille frame. You may have to enlarge the woofer cutout to get the frame to go onto the box easily and still fit the space in the lower compartment of the night table. When it's right, paint the front of the frame flat black. Wrap some grille cloth around the frame and staple it to the rear surface.

Final Adjustments. Put the speakers in their permanent locations and connect them to your stereo system. Set the tone controls on your receiver to the flat position and turn the tweeter control down all the way. Then select a high quality program source and adjust the tweeter control up until the sound from the tweeter blends with that of the woofer. ■

Putting the final touches on the speaker cabinet. The grille cloth on the front gives the unit its decorative qualities. The Night Table Speaker is a handsome piece of furniture in its own right. If it's not sold in your local hardware or department store, order Kit #21114 from: Kerns RTF, Box 1187, 227 S.E. Byers, Pendleton, Oregon 97801.

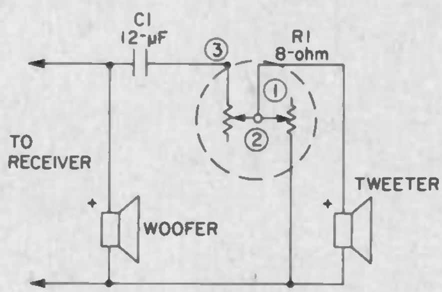


Front view of the speaker enclosure box, showing speaker placement and front panel dimensions. Hole diameters may vary slightly with speaker size.

PARTS LIST FOR SPEAKER BOX

Particle Board
2—11½-in. x 14½-in. x ¾-in Front and Back
2—9½- in. x 13-in. x ¾-in. Sides
2—9½-in. x 11½-in. x ¾-in. Top and Bottom
Plywood
1—11½-in. x 14½-in. x ⅜-in. Grille Frame
Tempered Masonite
1—7-in. x 8-in. x ¼-in. Control Panel

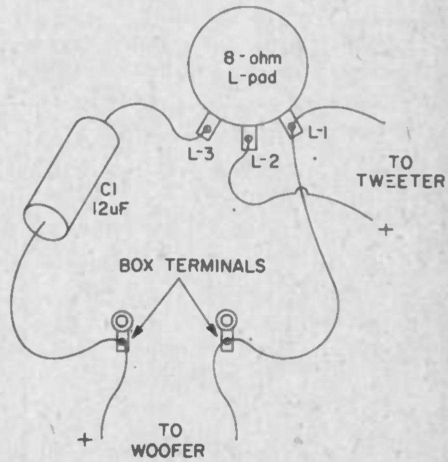
The speakers are housed in a Creative Furniture Kit #21114; this night table kit, or one very similar to it, is available at department or hardware stores in kit form, or assembled and unfinished.



Crossover diagram for woofer and tweeter balancing. These components are included in the Speakerlab kit.

PARTS LIST FOR SPEAKERS

8-inch woofer (Varco-8 or equivalent)
2 to 3½-inch tweeter (CTS or equivalent)
8-ohm L-pad level control
12-uF non-polarized electrolytic capacitor OR: Speakerlab SLS kit, which includes woofer, tweeter and crossover components in one kit. From Speakerlab, Dept. BER, 735 Northlake, Seattle, WA 98103 or an electronics supply house stocking Speakerlab.



Component connections for the do-it-yourself version of the crossover circuit. Pay close attention to speaker polarity when wiring this balancing unit.

Darkroom Color Analyzer

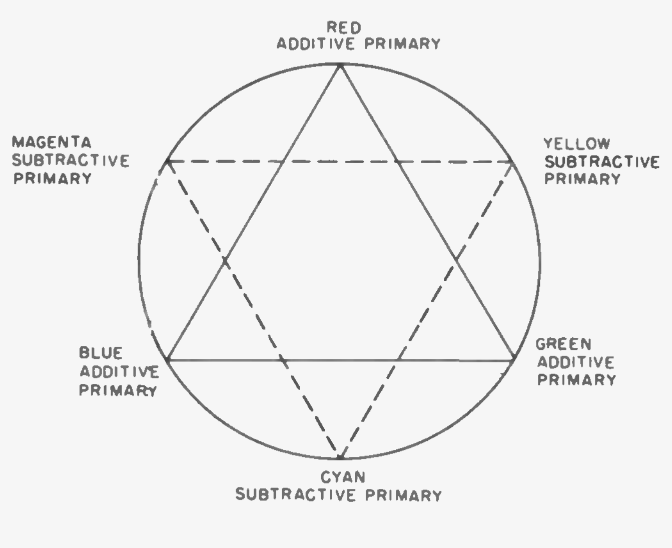
It's easy to make quality, bright color prints at home with modern color chemistry and this electronic color analyzer!

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 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



Any one of the primary colors on this circle is composed of its immediately adjacent colors in equal amounts. Each primary-color is also complementary to the color directly across the center of the circle. Complementary colors added together form neutral densities. It is the balancing of additive primary colors of photographic light sources and subtractive-type color filters that provides control in color print photography.

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 electronics 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.

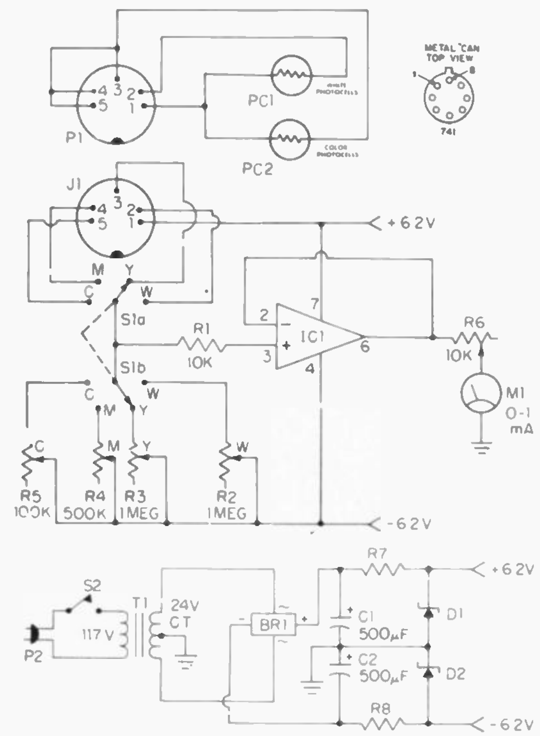
You can either buy or make the printed circuit board (see parts list). Either way, the first step is to prepare the printed circuit board. If you do it yourself, make it any way you like, using free-hand or template resist. Nothing is critical, but be certain there are no copper shorts between the terminals for IC1. Use a #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 #30 to 40 bit for the linecord 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 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 that 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



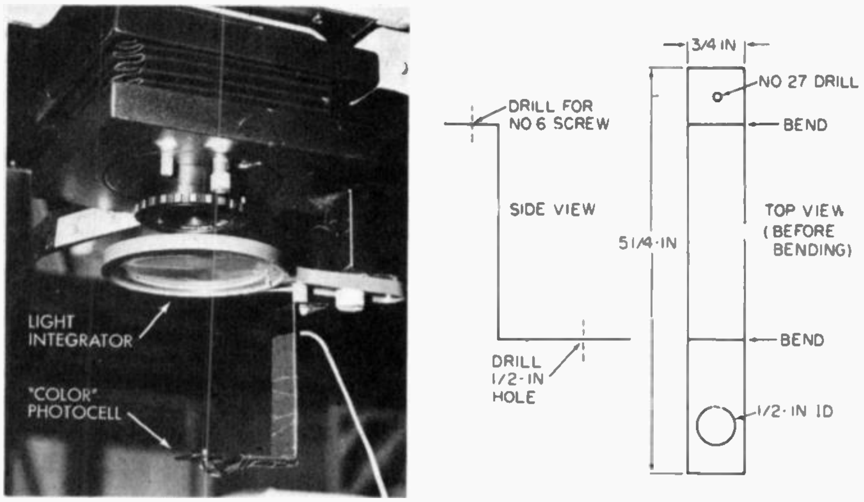
PARTS LIST FOR COLOR ANALYZER

- BR1—50-PIV, 0.5-amp or higher silicon bridge rectifier
- C1, C2—500-uF, 10-VDC or better electrolytic capacitor
- D1, D2—6.2-volt, 1-watt zener diode
- IC1—type 741C operational amplifier, see text
- J1—5-pin socket, DIN-type (optional, see text)
- M1—0 to 1-mA DC meter, see text
- P1—5-pin plug, DIN-type (optional, see text)
- PC1, PC2—Clairex CL5M5L photocell, **do not substitute**
- R1—10,000-ohm, 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)
- R7, R8—820-ohm, ½-watt resistor
- R9—100,000-ohm, ½-watt resistor
- S1—2-pole, 4-position rotary switch (Allied Electronics 747-2003; adjust stops for 4 positions)
- S2—spst switch
- T1—117-volt primary, 24 to 26.6-volt secondary transformer, 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.)

The printed circuit board for the Color Analyzer is available direct from Electronics Hobby Shop, Box 192, Brooklyn, NY 11235 for only $5.60. US orders add $2.00 for postage and handling; Canadian orders add $3.50. No foreign orders, please. Postal money orders will speed delivery; otherwise allow 6-8 weeks for delivery.

If you cannot obtain the Clairex Type CL5M5L photocell locally, write to Electronics Hobby Shop at the above address, enclosing $5.00 for each photocell. U.S. orders add $2.00 for postage and handling. Canadian order add $3.50. No foreign orders, please. New York State residents add sales tax. Postal money orders speed 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.



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.

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 (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 #1 to 4 leads and #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).

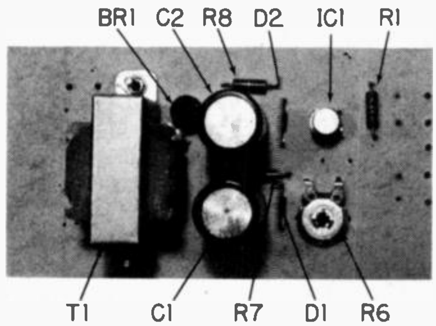
Potentiometers R2 through R5 can be linear or audio taper, though audio taper gives a slightly smoother adjustment; use whatever you have in stock.

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.

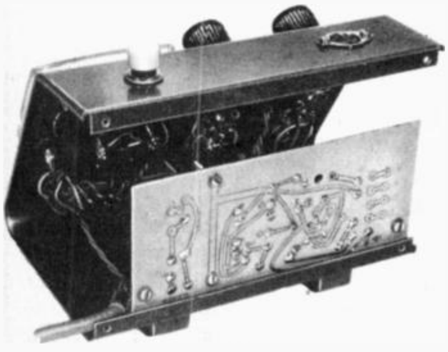
Meter M1 should be O-1 mA with a zero-center scale. But these are expensive, so you can substitute any standard 1-mA meter you want. You will simply calibrate the instrument for zero-center.

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.

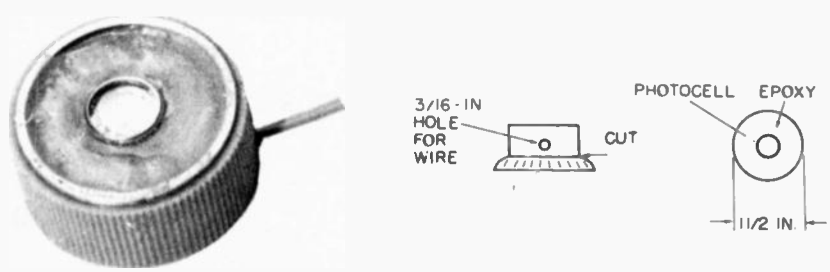
The Comparator. The photocells used for the comparator and exposure sensor, P1 and P2, must be Clairex type CL5M5L. Make no substitutions. From a piece of scrap aluminum ¾ to 1 inch wide, fashion a Z-bracket to the dimensions shown. Drill a ½-inch hole close to the end of the longer Z-leg. Fasten the other end of the Z-leg to your enlarger's under-lens filter holder. If your enlarger does not have a filter



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 BUDGET ELECTRONICS, Davis Publications, Color Analyzer, 380 Lexington Ave., New York, N.Y. 10017.



Rear view of author's color analyzer shows vertical mounting of the circuit board.



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

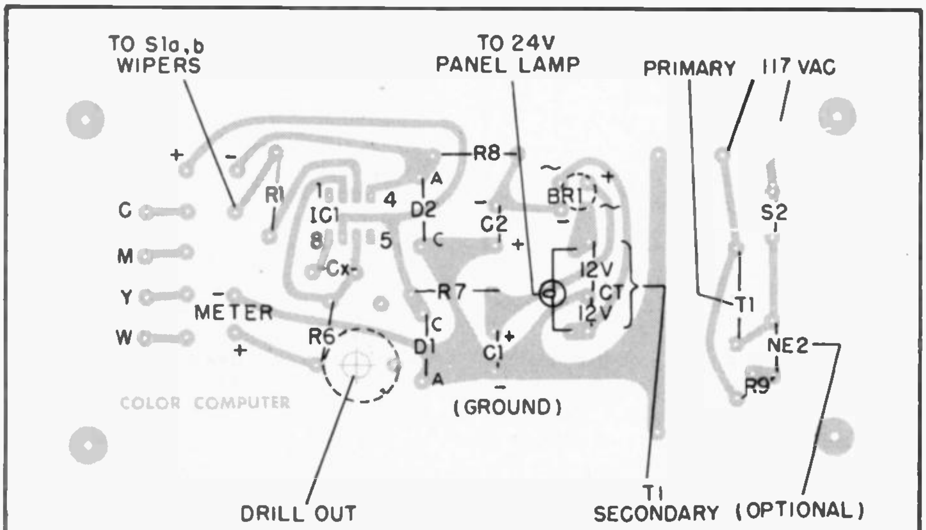
holder, or if it has a permanent swing-away red filter under the lens, mount a Paterson swing-away light integrator (available from local photo shops) under the lens. Fasten the short leg of the Z-bracket to the integrator—which has pre-drilled holes—so that the ½-inch hole is on the optical center of 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 epoxy-cemented in an oversize control knob.

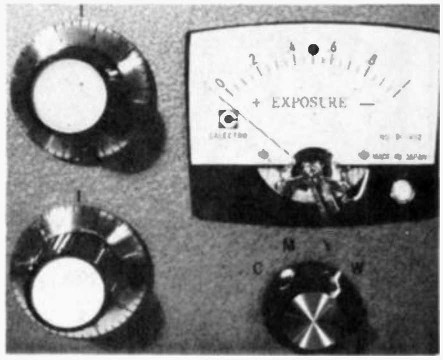
When the complete analyzer is assembled, attach oversize calibrated knobs such as the Calectro E2-715 to R2 through R5. The knob calibrations are important so they should run out to the very edge of the knob skirt. If the calibrations don't run to the edge you won't be able to preset the controls with 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, set all other controls to their mid-position, and turn on bright room lights. If the meter pins out or approaches full scale deflection, 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 and 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.)



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.



Close-up of meter face showing a small scale-illumination lamp in lower right corner. This lamp should not be operated at full voltage to avoid fogging the film.

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.

The first thing you need to make fine quality color prints 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 the electronic color analyzer for which we've already given you the plans.

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.

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.

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.

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

A printing system that's easier to use and more favored 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;* 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 for 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.

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).

The 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 No. 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.)

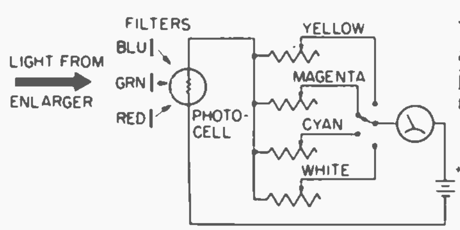
Remove the blue filter, install a green filter (Kodak Wratten No. 99), switch the analyzer to MAGENTA and adjust the *magenta* control for a null meter reading. Remove the green filter, install a red filter (Kodak Wratten No. 70), switch the analyzer to CYAN and adjust the *cyan* control for a null meter 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.)

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

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. Put the new negative in the enlarger. Then set the degree of enlargement and focus, leaving the lens wide open. 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

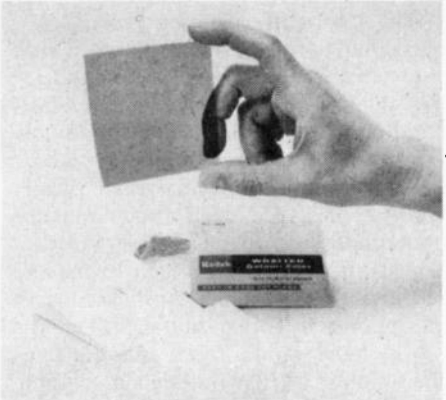


The basic color analyzer. Once controls are matched to a "standard" negative, just select filters for a null on the meter for each individual color and white.

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 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 lters 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 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



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

required. It 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.

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.*

Professional equipment used by color labs includes this Kodak Video Color Negative Analyzer. It uses a 5-in. color TV screen to assist an operator in selecting the correct filter.

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.

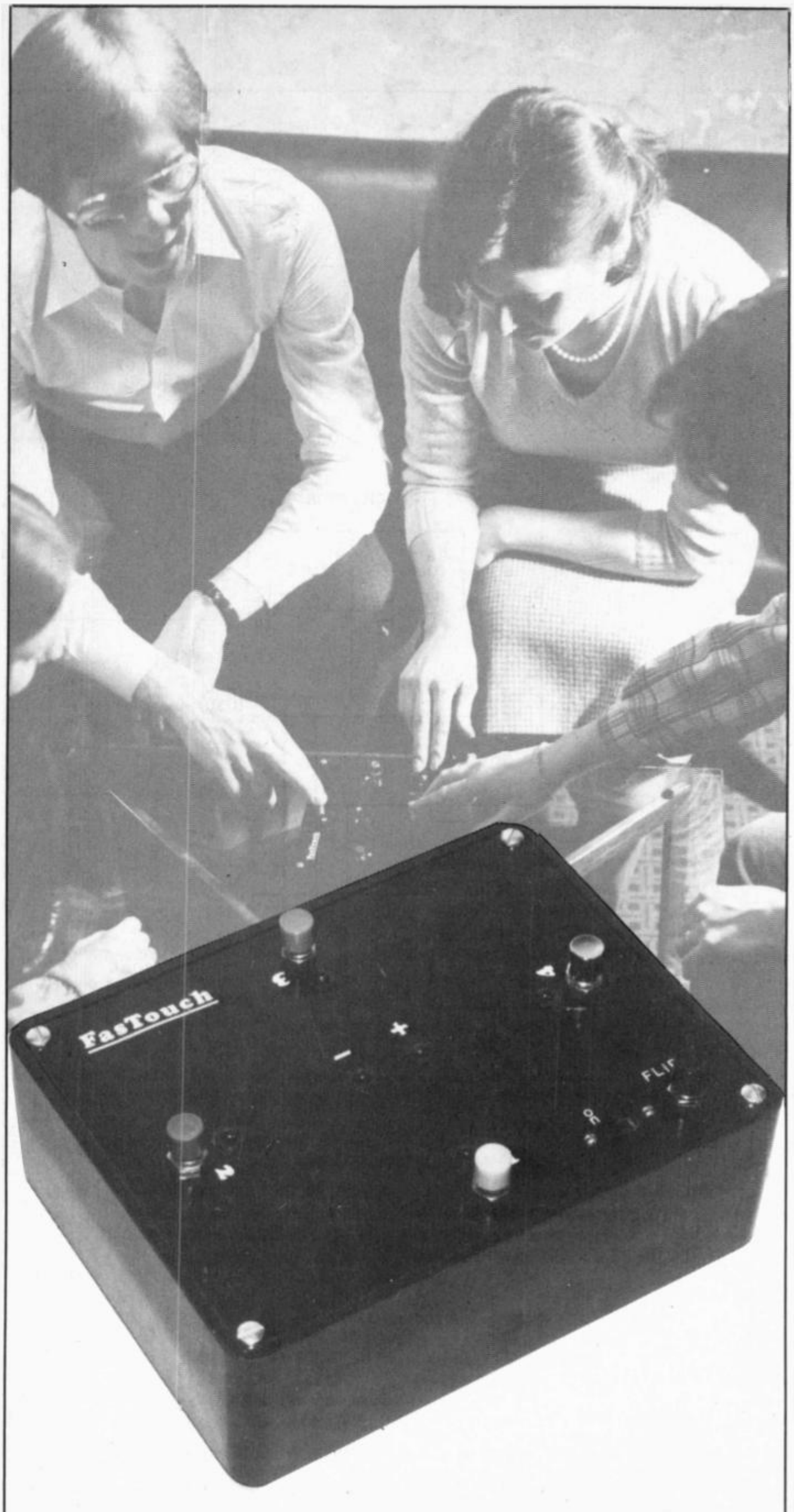
The whole bit might sound somewhat complicated, but after you've run through the procedure once or twice to get the hang of things it shouldn't take you more than a minute or so for a full color analysis of a new negative.

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, through 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. ■



BUILD FASTOUCH

An electronic party game that's fun for any occasion

ELECTRONIC GAMES ARE "in," and most of the major toymakers (most notably Mattel) now have their own electronics divisions, hoping to cash in on the latest party craze. Unfortunately, because the demand for these games has been so great, we really haven't seen any real price breaks on them, and the prices are starting to climb, even for the simplest of games.

If you've been itching to get one, but have resisted thus far because of inflated prices, then why not build *FasTouch*? Like its commercial counterparts, it's useable by up to 4 players, and it moves fast enough so that many can get their hands on it during the course of a party or rainy afternoon.

It's a game of reflex and recognition which allows mixes of players from any age group. Two flashing LEDs, actuated by a "FLIP" button, alternate on and off for a few seconds, with one eventually staying on continuously. If the one that stays on is the "+" LED, then the first player to hit his or her scoring button will light his or her scoring LED and receive 1 point. In addition, the other players' scoring LEDs will be locked out, keeping them from scoring. If the "–" LED lights, any players pressing their scoring buttons will cause their scoring LEDs to blink on and off, signifying loss of a point. You can set a winning score of any number, but to help the game move faster, 10 is usually the best compromise. Of course, that's based on our tests. As you can see in the picture above, our editorial staff subjected *FasTouch* to extensive tests, so intensive in fact, that we eventually had to hide the battery in order to get some work done around here. *FasTouch* can be addicting, so be warned!

Getting back to economics, we should mention that *FasTouch* uses readily available CMOS ICs, is powered by a single 9-volt battery, and can be built for under $20.00 with some judicious shopping around for parts, even if you purchase the pre-etched printed circuit.

The Circuit. Referring to the schematic, you can observe that closing S1 allows capacitor C1 to charge towards the V+ potential. Closing S2 ("FLIP") rapidly discharges C1, causing NAND gate U1A to go high, and gate U1B to go low. Opening S2 allows C1 to begin charging towards V+ in a time proportional to R1 times C1. As the voltage across C1 passes V+ ÷ 2, U1A is forced low, and U1B is forced high.

During the time that gate U1A is high, the two complimentary output signals from oscillator A can pass inverted through gates U2C and U2D. These square waves are transformed into pulses by the C3/R3 and C4/R4

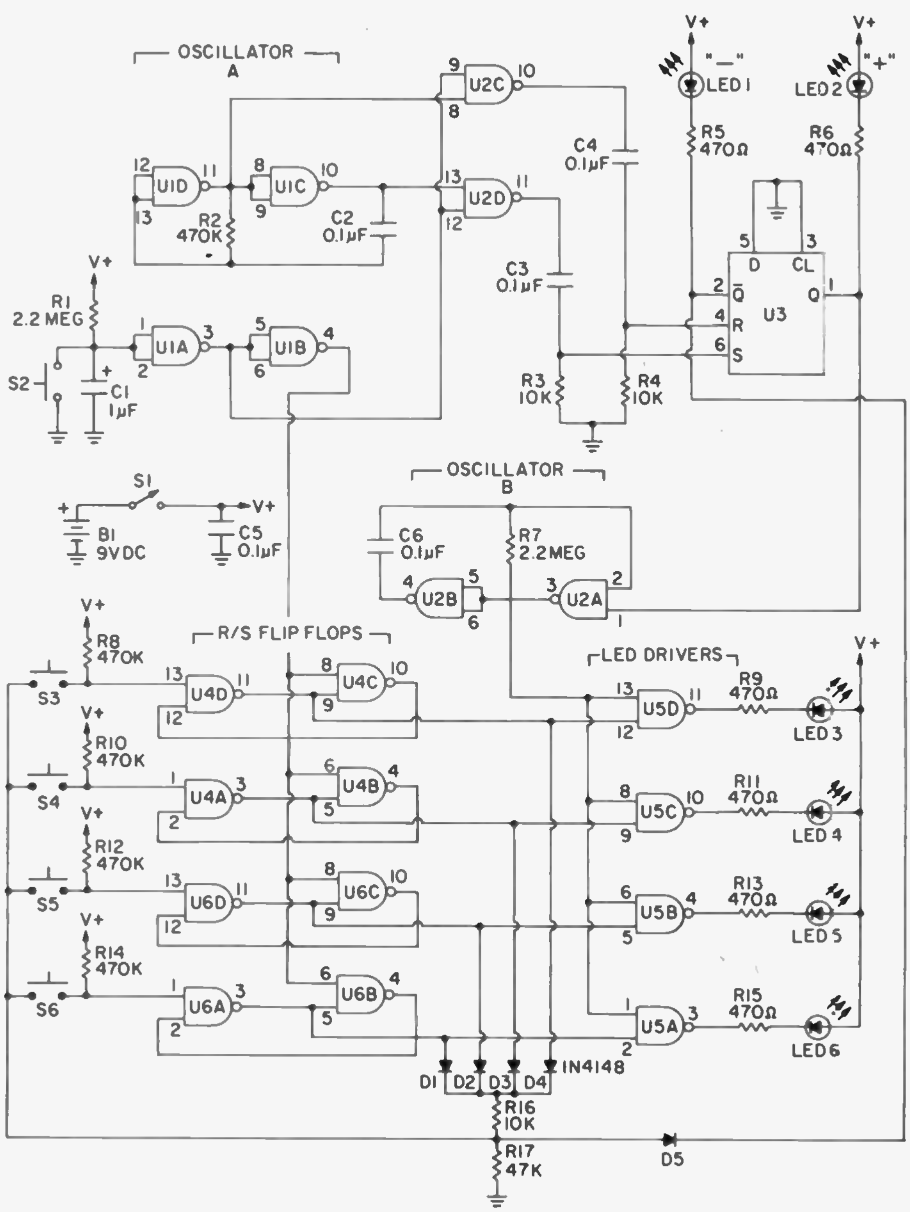
BUILD FASTOUCH

high pass filters which alternately set and reset flip-flop U3A. This is seen as a rapid blinking of LED1 ("+") and LED2 ("–"). At the end of the C1 timing interval, when gate U1A is forced low, the set and reset pulses stop and the LED on at that instant remains on. The LED which stays on is chosen by a random sequence, with the chances being essentially equal.

Two gates each are wired together to create the four R/S (Reset/Set) flip-flops–one for each player. Setting a flip-flop is accomplished by providing a low level to one gate by way of the scoring switches (S3 thru S6). Resetting the flip-flop requires a low level to the other gate (in this case, via the common line from gate U1B). During the time LED1 and LED2 are blinking, the low output from gate U1B resets all flip-flops, none of which can be set until the low reset level is removed. When the blinking stops, gate U1B goes high, and the first scoring switch closed sets that flip-flop. The one which is set will provide a high level to its LED driver (one of the gates U5A thru U5D). This high level is also transmitted through the discrete OR gate made up of D1 through D4, R16 and R17. When this happens, the common line for the scoring switches is at a high level, thereby disabling all of them.

The above sequence of events occurs, however, only when LED1 is energized, since the high output to LED2 (pin 2 of U3) reverse-biases D5. Conversely, when pin 2's output is low (energizing LED2), D5 is forward-biased and clamps the scoring switch common line low. Now, any number of flip-flops can be set without disabling the other player switches. Since LED2 is energized, this is the "–" condition where the player scoring LEDs (LED3 thru LED6) blink. This is a result of the output from oscillator B turning the LED drivers on and off at the oscillator rate. With LED1 energized (the "+" condition) the low output from U3 disables oscillator B, whose output to the common input line of the LED drivers is high. This accounts for the steady illumination of the player scoring LEDs during the "+" condition. Power is supplied through switch S1 by a single 9-volt battery. Capacitor C5 bypasses any transient signals on the power line to ground, preventing erratic operation.

Construction. Because of the use of CMOS devices, a PC board is recommended. Soldering should be accomplished with a low-wattage (35-watts or less) pencil-type iron, using thin core rosin solder. Apply only enough solder and heat to form a good joint. When inserting the CMOS ICs in their sockets, avoid handling them by their leads. Mount all components on the PC board as indicated in the diagram, being sure to observe polarity of C1, D1-D5 and



PARTS LIST FOR FASTOUCH

B1—9-VDC transistor battery
C1—1-uF, 10-VDC electrolytic capacitor (with radial leads)
C2, C3, C4, C5, C6—0.1-uF, 100-VDC ceramic disc capacitor
D1, D2, D3, D4, D5—1N4148 diode
LED1 thru 6—light emitting diode rated 20 mA @ 1.7-VDC (NSL5053 or equiv.)
R1, R7—2,200,000-ohm, ¼-watt resistor, 10%
R2, R8, R10, R12, R14—470,000-ohm, ¼-watt resistor, 10%
R3, R4, R16—10,000-ohm, ¼-watt resistor, 10%
R5, R6, R9, R11, R13, R15—470-ohm, ¼-watt resistor, 10%
R17—47,000-ohm, ¼-watt resistor, 10%
S1—SPST slide switch
S2 thru S6—normally-open SPST pushbutton switch
U1, U2, U4, U5, U6—CD4011 dual input quad NAND gate
U3—CD4013 dual D flip-flop

Misc.—battery clip, stranded hookup wire, suitable enclosure, solder, IC sockets, etc.

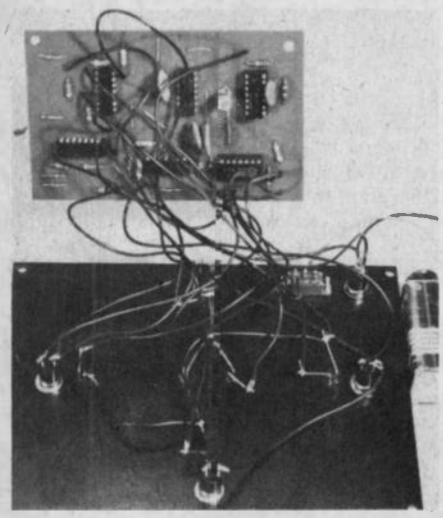
Note: A pre-etched and drilled printed circuit board for FasTouch is available for $8.95 from: BNB Kits, 72 Cooper Ave., West Long Branch, NJ 07764. U.S. orders include $1.00 (Canada $2.00 U.S.) for postage and handling, allow 3 to 6 weeks for delivery. Please, no C.O.D.s or overseas orders.

U1-U6. Form 6 jumpers from the clipped-off component leads and mount where indicated by a "J" in the component layout guide. Prepare 14 lengths of the stranded wire for wiring of the front panel. Mount these wires as indicated in the front panel wiring guide.

Checkout. Check out the unit by snapping in a 9-volt battery and turning S1 on. LED1 and LED2 should blink for a few seconds and then cease, with either LED1 or LED2 remaining on. Press S2 ("FLIP") and note that this happens again. Press S2 a sufficient number of times to insure that both "+" and "–" outcomes occur. On a "+" outcome, press one scoring switch. Note that the corresponding LED lights (LED 3 for S3). Note that pressing any other scoring switch does not light any other scoring LED. Press S2 and note that the scoring LED goes out. On a "–" outcome, press all scoring switches and note that all scoring LEDs come on and blink. Press S2 and note that all scoring LEDs extinguish. This completes the assembly and checkout.

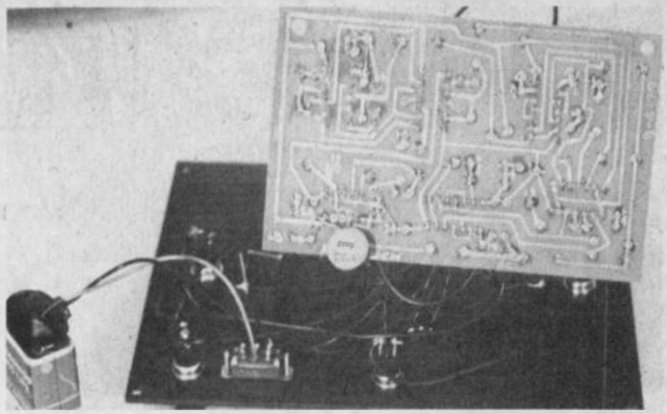
Playing It. Each player should position himself at his scoring switch. All players should be able to see the "+" and "–" LEDs easily. When all players are ready, one player presses the "FLIP" switch. As stated above, the object is to be the first player to press the scoring switch for a "+" outcome, and avoid pressing on a "–" outcome. There is only one technical rule–A player cannot press his scoring switch before the "+" and "–" LEDs stop blinking. If he does, his scoring LED will blink, indicating a "foul" and he should be penalized one point. No further scoring should be allowed for that round (i.e., when the "+" and "–"

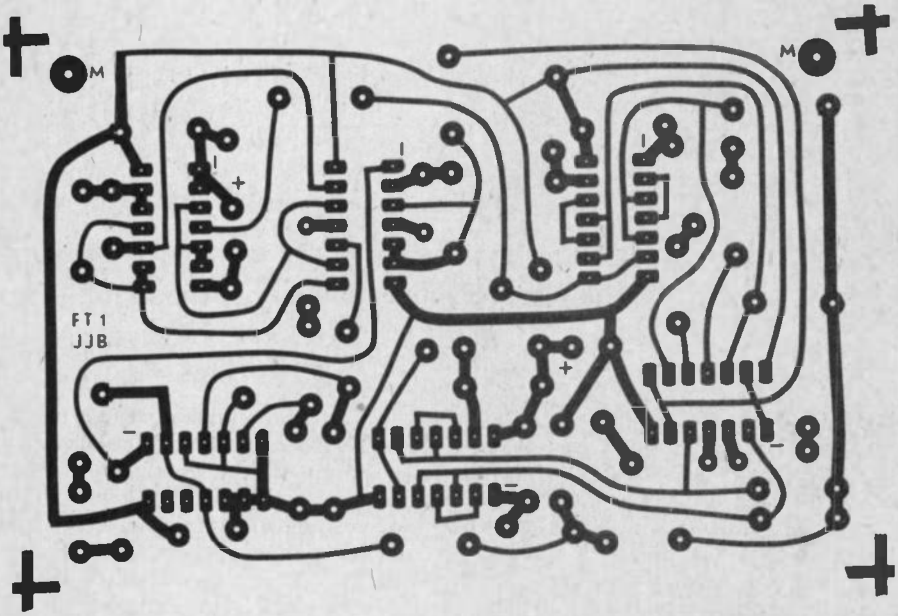
(Continued on page 104)



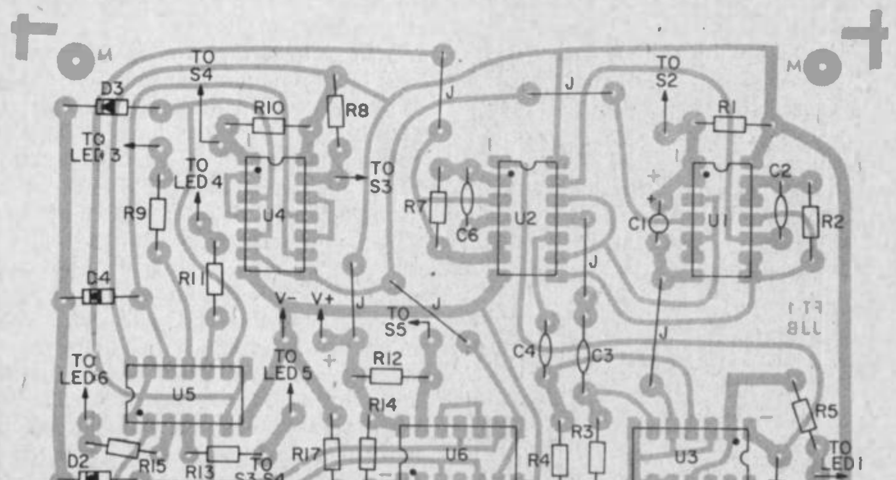
Board to panel connections and wiring of FasTouch. There's a lot of wiring, so be sure that you keep track of it all, and are careful.

Foil side photo of FasTouch. As you see, very few of the components are mounted on the foil side. The foil isn't too critical, but watch out for solder bridges.



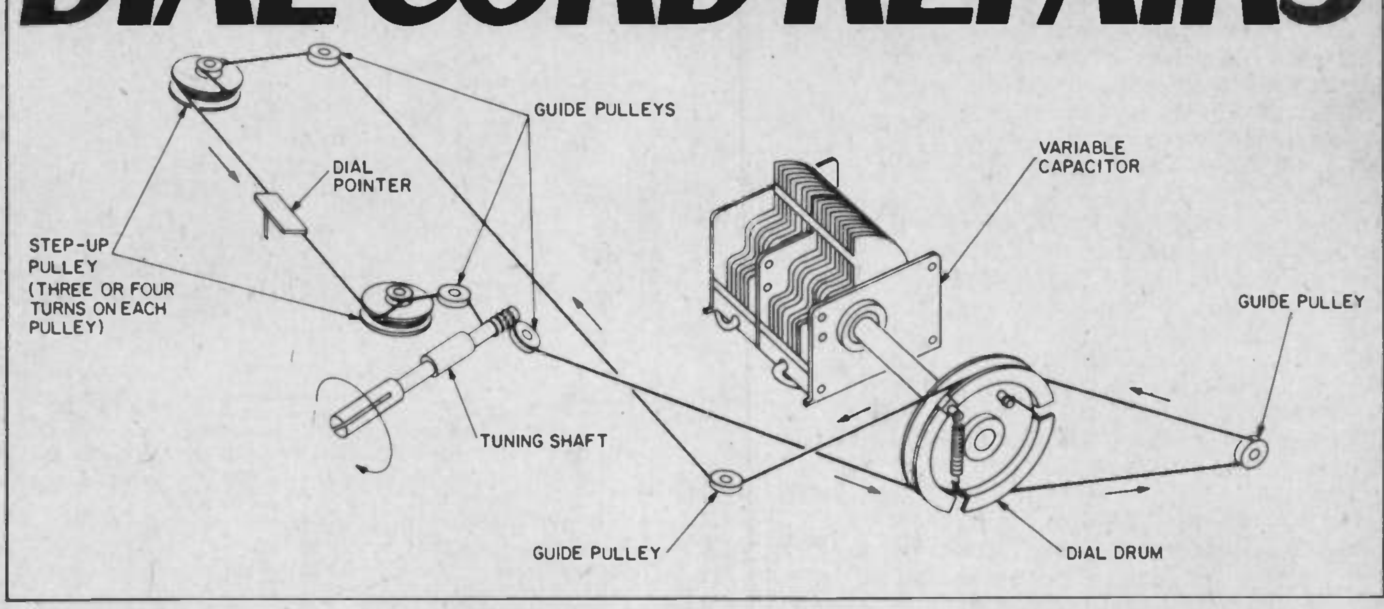


This is the parts location sketch for FasTouch. While FasTouch is not exactly an easy kit to build, there really aren't any stumbling blocks on the component layout side.



Printed circuit board for FasTouch. This is the exact size PC board that you'll need to build FasTouch. Remember, when doing PC boards, always use the foil side layout.

DIAL CORD REPAIRS



The old pro shows how to get those radio dials back in line

WHO EVER SAID THAT REPLACING a dial cord was quick and easy? Probably someone who has never had to do it. That simple little repair can quickly turn into a disaster, and if you want to avoid dial-cord disasters then read on. The photos and text should untangle just about any problem.

When you tune in a radio station the dial pointer should end up exactly at the right spot on the dial. To do this the dial pointer is linked to the variable tuning capacitor by a dial cord. When one moves 500 kHz so does the other. It's a simple, straightforward system but once in a while things go wrong.

Slip-Slide, Slipping Dial. Most dial cord slippage occurs at the tuning control knob and shaft (Fig. 1). If the dial cord sticks at one end and won't move or slides erratically across the dial assembly, suspect slippage at the tuning control shaft area. Either the dial cord has slipped off the tuning pulley, become stretched or is almost broken.

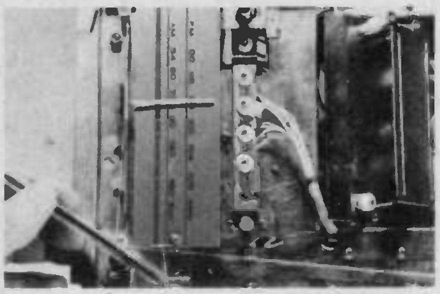


Fig. 1. The base of the tuning shaft is the best place to start looking for a source of slippage in the tuning dial cord assembly.

After removing the receiver chassis from the cabinet inspect the dial cord latch-up. Check the dial cord for broken or worn areas. Thumb the small dial spring for tightness and see if the cord is taut. Now turn the tuning shaft and notice where the cord is slipping or has stopped moving.

If the slippage occurs at the tuning shaft and the cord is only stretched, you may take up the slack by cutting off a turn or two on the dial spring. Replace the spring if necessary and rotate the tuning knob. This will snug up the dial cord. In case the dial cord is still slipping, check for at least three complete turns of cord around the tuning shaft. It's possible someone tried to rewind the dial cord and didn't put enough turns around the shaft. You can stop stubborn shaft slippage with liquid rosin (Fig. 2). In real difficult cases, apply a coat of phono dressing on the tuning shaft and let it dry. The cord may not slip again at this area but be real careful that you don't turn the dial assembly beyond either end or it's possible to snap the dial cord in two.

Repairing the Broken Dial Cord. Locating your favorite station with a broken dial cord is like trying to find a needle in a haystack. Sometimes the tuning capacitor will turn and then snag, but the dial pointer remains in one place. It's best to remove the radio from the cabinet and inspect it.

The dial cord can break almost anywhere (Fig. 3), but most dial cords wear out at the tuning shaft. The dial cord may also break or pull out at the plastic pulley. Sometimes the metal clips on the dial pointer will cut the cord when excessive pressure is applied. But, no matter where the dial cord breaks—replace it; don't waste your time trying to tie a knot.

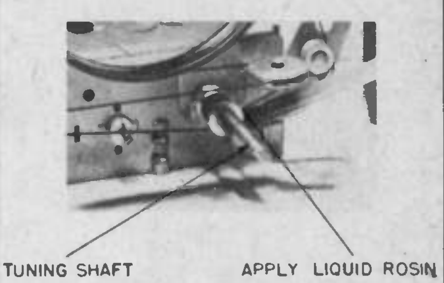


Fig. 2. An application of liquid rosin, usualy found in most TV repair supply shops will help to eradicate the dial cord slippage.

If a dial stringing guide is not handy, try to draw a schematic around and over the pulleys—just the way the dial cord is laying. Take a peek, you may have a dial stringing guide in your service literature. On large, deluxe dials,

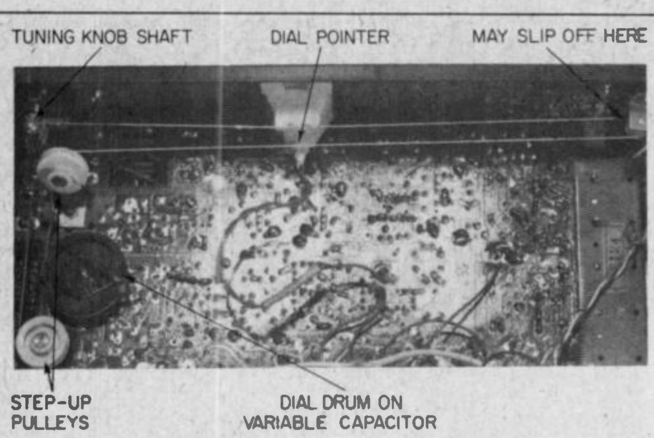


Fig. 3. No matter where the dial cord happens to part, don't waste time trying to tie a knot in the cord. Replace cord entirely with a new one.

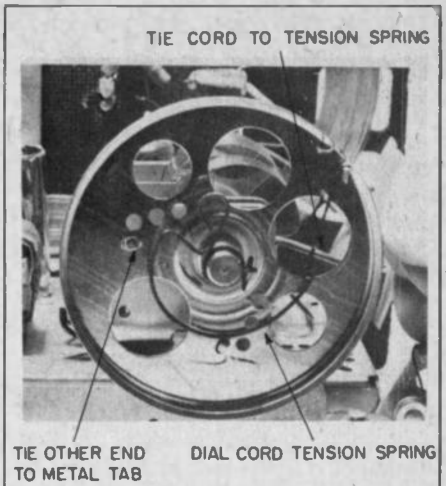


Fig. 5. Start the re-stringing by securing the cord to a tab or hole on the drum. End by securing the cord to the tension spring.

it's best to obtain a stringing guide before attempting the job.

Remember, when the tuning shaft is rotated the dial pointer must move in the same direction. If you start out wrong you may have to rewind the dial drum or reverse the dial procedure at the tuning shaft. Here (Fig. 4) is typical a dial stringing guide. Notice how the arrows and numbers indicate the method of restringing in the correct direction. Dial cord stringing is easy with these simple directions.

From Start to Finish. After a stringing dial guide or a drawing is made, select the correct size of dial cord. Most of the radio dial cords are either a medium or fine grade. They come in handy hanks or on spools. You may buy them at a radio supply store or local TV shop. Remove the broken dial cord pieces and lay them along side the new dial cord. Cut the dial cord about six inches longer than the two broken pieces. This will give you plenty of cord to complete the dial cord stringing procedure.

Start by tying a loop knot in the end of the cord and tying to a plastic hole or metal clip in the dial drum. Some technicians prefer to first tie the dial cord to the spring and keep it taut while stringing the whole dial assembly (Fig. 5). But I find it best to tie it to a solid point on the dial drum and then string the dial cord around the pulley guides.

On large dial drums, the dial cord may go half way around the drum before taking off to a guide pulley or tuning shaft. With a dial stringing guide, follow the numbers and proceed around the guide pulley, tuning shaft and dial drum assembly. If no direction arrows or numbers are shown on the dial schematic, start at the opposite end where the spring connects to the dial drum. Rotate the tuning capacitor to the end of rotation.

Make sure you have at least three turns around the tuning shaft area. If not, the dial cord may slip. Now finish going around the guide pulleys and at least half-way around the dial drum. If you have wound it correctly you should have about five inches of cord left. If not, double check the schematic.

Now, before tying the cord to the dial spring, hold it tight on the drum and slowly turn the drum and notice the direction of the cord movement. A small piece of masking tape placed upon the dial cord at the dial pointer area may help to show the correct direction. Remember the dial pointer will rotate in the same direction as the tuning shaft. Also, notice the dial pointer will go towards the higher dial number as the plates of the capacitor are unmeshed. When a station is found at 540 kHz the tuning capacitor plates are fully meshed.

With the dial cord moving in the right direction, all we have to do is stretch the dial spring and tie a knot or two. If the dial cord is not moving in the right direction, check the dial stringing guide to see if you started correctly at the dial drum and went around the tuning shaft in the right direction. Sometimes by reversing the direction at the tuning shaft you are back in business.

Now insert the end of the dial cord through the dial spring and pull it tight. Wrap about three turns inside the spring loop to prevent the spring from loosening up and tie a knot. Keep the cord and spring taut at all times. Check to see if the dial cord moves freely across the entire band. If so, tie another knot in the dial cord, at the spring loop, and place a dab of glue at both tied ends of the dial cord. Now install the dial pointer assembly.

Dial Pointer Assembly. Dial pointers

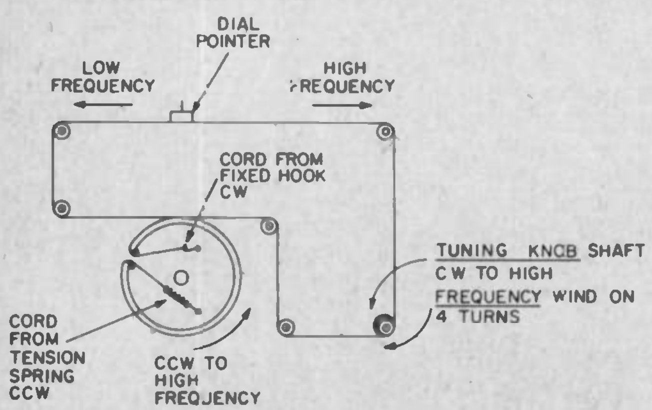


Fig. 4. This is a typical stringing guide. Of course, since almost every maker has its own layouts, this can only serve as a general guide.

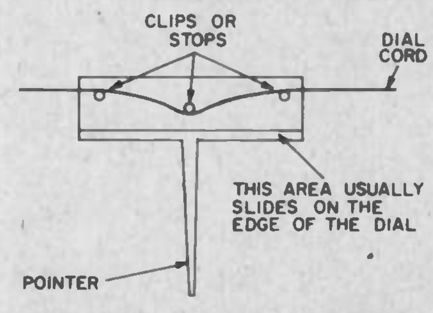


Fig. 6. A drop of plastic cement placed on the stops of the dial pointer will usually prevent the pointer from slipping around.

DIAL CORD

come in all sizes and shapes. Some plastic jobs just slip over the end of the dial shaft, while others connect to the dial cord and slide up and down the dial scale area. You may find the latter are either metal or plastic pointers. Generally, the dial cord is fastened at the back of the dial pointer with clips.

Clean the old grease and dirt from the top track of the dial pointer assembly with alcohol. Install the dial pointer after the dial cord stringing operation is completed. Pull or feed the dial cord around the metal or plastic stops. Then dab on a drop of cement to hold it in place (Fig. 6).

If the plastic dial pointer is broken you can repair it with epoxy cement. On long plastic pointers connect the two broken pieces with a stiff wire such as a single strand of guy cable. A small needle will also do the job by placing the wire or needle at the back of the plastic pointer and pressing it into the plastic pointer area with the tip of a soldering iron. Be careful not to apply a lot of heat or it's possible to damage the plastic pointer.

With long broken metal dial pointers, you can repair them with a stiff piece of number 14 copper wire. To straigthen the copper wire, roll it over the work bench under a short piece of 2-by-4. Now scrape off the metal pointer area, apply rosin grease and solder the new pointer to the dial assembly. Smooth down the soldered area with a rat-tail

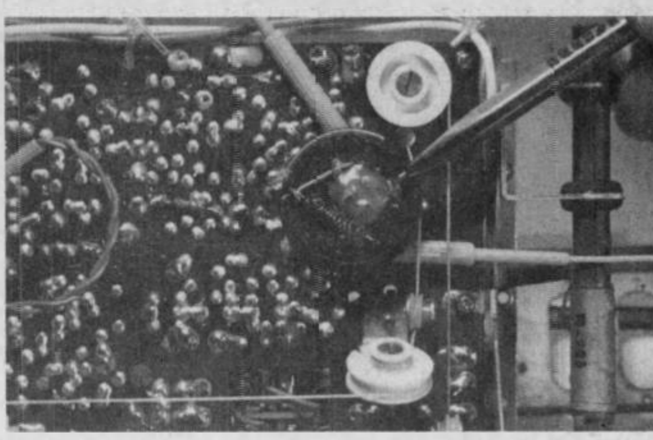


Fig. 8. You can repair a cracked drum without removing the cord by applying epoxy to the drum side facing you, and holding it as it becomes firmly set.

file and touch up the pointer with red enamel spray paint. You may also use a piece of red spaghetti over the new dial pointer.

In case the one or more clips or plastic stops on the back of the dial pointer assembly are broken off, apply a coat of epoxy cement over the dial cord and let set up overnight. Before fastening the dial pointer into position, tune in a local station and clip the dial pointer in place. For instance, if you have a local station at 1400 kHz and another at 540 kHz tune in either station and fasten the dial pointer at the spot. Now, tune to the other station and see if it's right on the nose. You may have to jockey the pointer back and forth a little before cementing into position.

Keeping the Cord on Track. Keep the dial cord on track with masking tape when working upon the dial drum or servicing a component underneath it (Fig. 7). Here in a GE model C4332C radio, the AM oscillator transistor was replaced and the dial drum had to be disconnected to get to the soldered connections. Always apply the tape over the mouth or entrance where the cord enters at the dial drum. The dial cord will remain taut and will not unwind or fly off the guide pulleys.

Take note of the large dial spring. Here a large flat and curved spring keeps the dial cord taut in the dial assembly. Generally, you will find round-coiled springs in most dial cord drums.

(Continued on page 104)

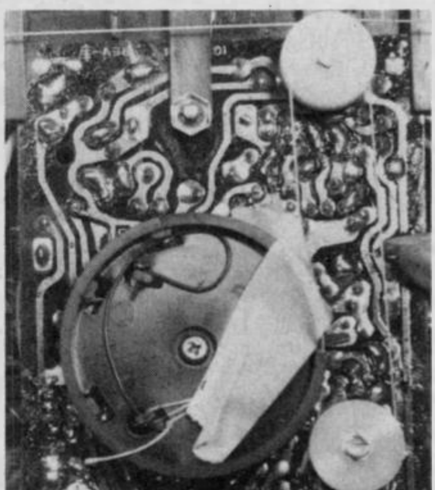
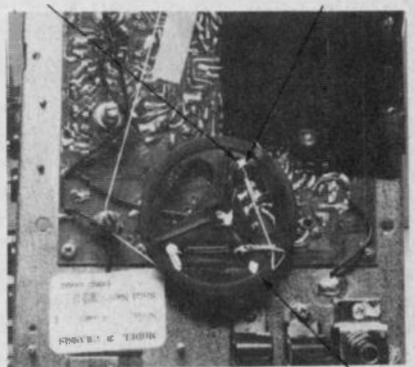


Fig. 7. If the dial drum must be moved during service, lock the cord onto the drum with tape to avoid unwinding the cord.

DRILL ANOTHER HOLE ABOVE

SOMETIMES DIAL CORD BREAKS OUT THE PLASTIC

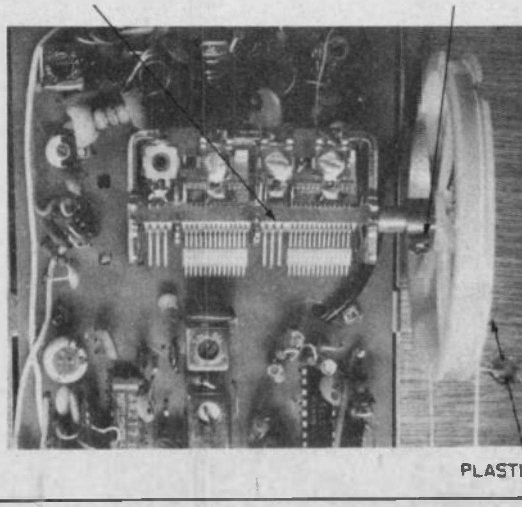


DIAL DRUM

Fig. 9. If the original hole in the drum is broken, simply drill annother hole as close as possible to the location of the original.

VARIABLE TUNING CAPACITOR

CHECK LOOSE SET SCREW



PLASTIC DRUM

Fig. 10. If the dial pointer seems to hang up at random spots on the dial, suspect a loose set screw on the tuning drum. If the screw continues to work loose, apply a drop of Loctite™ to hold it securely on.

RF from your Calculator

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

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

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

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

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

With a standard calculator's seven-segment LED readout and anywhere from 8 to 12 display digits, the multiplexing frequency is typically around 100 kHz. When currents of 20 mA or so are abruptly switched on and off through the LED display segments, significant amounts of RF energy at multiples of the multiplexing frequency are generated. These harmonics may extend well into the tens of megahertz. In fact, this harmonic radiation is one of the main reasons there are so few AM clock radios with LED time displays on the market today. The standard AM broadcast band is almost totally obliterated if the receiver's RF sections are within a foot or so of the multiplexed readout display unless extensive shielding is employed. Fortunately, there are two more practical and less expensive solutions than shielding. The first is the addition of resistance-capacitance networks to slow the rise and fall times of the multiplex waveform—and consequently filter out most of the higher-order harmonics. The second method is to drive each display digit directly and not use multiplexing at all. This second technique is much more practical in a clock radio than in a calculator for two reasons. First, clock radio displays normally have considerably fewer digits than most calculators; hence, the circuit problem isn't nearly so complex. And secondly, with a clock operated from the AC power line, the problem of rapidly discharging the batteries unless the output is multiplexed is eliminated. National Semiconductor Corporation has recently introduced a clock chip with direct drive of all readout segments to eliminate RF interference. It was designed with clock radio applications in mind.

One of the many uses for your calculator other than calculating. Here it is being used to check a windshield antenna.

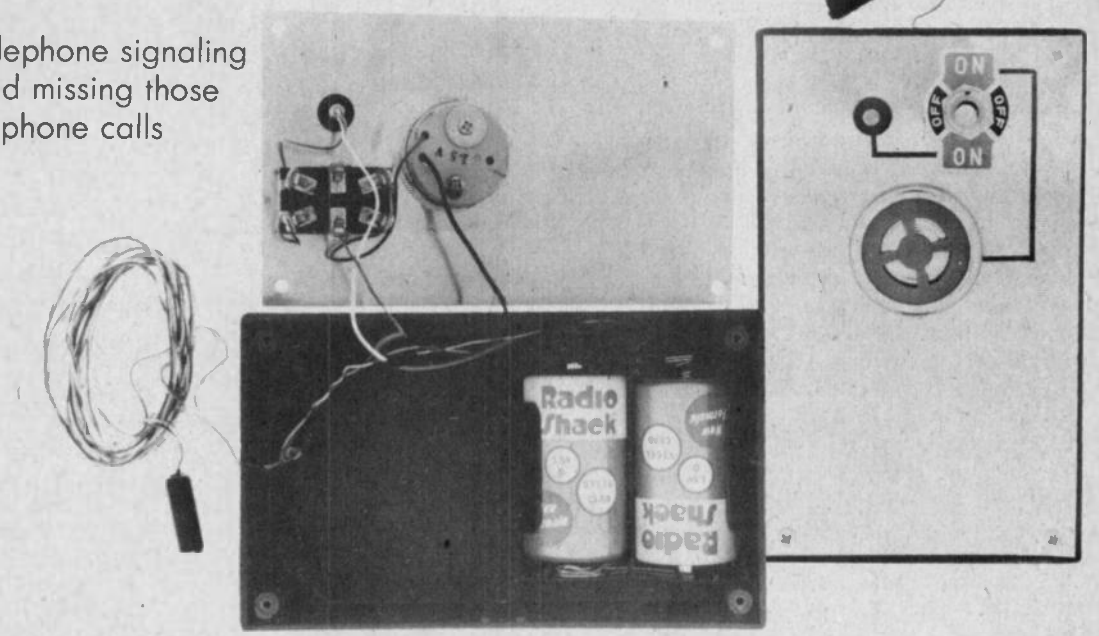
But now back to your calculator, which almost certainly is multiplexed and unfiltered and produces a rich harmonic output. Turn it on and slowly bring it near a standard AM radio which is tuned either to a weak station or between stations. You should hear a mixture of buzzes and tones as the calculator is brought within several inches of the radio or its antenna. These tones probably will shift in frequency if you key different numbers into the display.

Now that you've verified that your calculator is a portable, wideband, RF source, what can you use it for? Well, a number of applications are obvious. Anytime you need a quick check to see if the RF and IF stages of an AM receiver are working, your calculator can provide a test signal. Probably its handiest use, though, is in continuity testing antennas and connecting cables. Auto antennas and their accompanying cables and connectors are easily tested for opens and shorts by bringing the calculator near the antenna while monitoring the radio output. Perhaps the ultimate example of this technique you can perform in your automobile. Place a calculator near the windshield antenna of a late model General Motors car. In cases of poor or non-existent reception, one or both of the two thin antenna wires imbedded inside the glass may be broken. By carefully tracing the path of each individual wire, a break or faulty connection can be located when the radio's output changes abruptly.

And one final thought. Those of you with LED digital watches might experiment with them. The power is much lower, and the metal watch case provides a lot of shielding, but there just might be enough RF coming from the display to be useful. ■

SIMPLEX-A-THING

Remote telephone signaling helps avoid missing those important phone calls



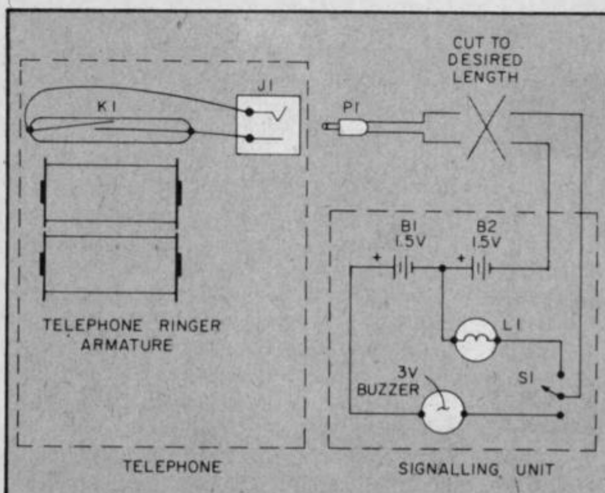
YOU WON'T MISS any more phone calls when out of hearing range of your telephone, if you add this simple remote signalling unit which alerts you to incoming calls by means of either a buzzer or blinker light. The unit is self powered for easy placement in any room in your home, or even outdoors where there are no AC outlets.

Now that you are permitted to own your own phone, you don't have to worry about the legality of add-on convenience devices, so long as you don't upset the phone company's circuits. This unit won't bother Ma Bell one bit because it is *not* electrically hard-wired to the telephone lines, and therefore cannot possibly cause voltage drops that could be detected at the phone company switching station. This gadget simply senses the normal ringing of the telephone with a magnetic reed switch placed near the telephone ringer armature. When the phone rings, the armature generates a strong electro-magnetic field, which trips the reed switch. The switch is triggered even if you turn the regular telephone bell off to provide completely silent signalling by means of a blinker light.

Construction. Solder a 14-inch-long insulated wire to each end of the reed switch and terminate these leads with a phone jack. Insulate the switch body before installation in the telephone, by means of a plastic sleeve or with electrical tape.

Open the telephone and remove the bell-clapper arm back to where it joins the armature-coil assembly.

Have someone call you on another dialer mechanism by gently lifting it off its mount. Find the ringer armature located just behind the dialer. You can recognize the armatur by following the telephone so that the regular bell rings. With the reed switch plugged into the signalling unit, and the selector switch thrown to the buzzer position, gradually move the reed switch close to the ringer armature. When the buzzer beeps in time with the telephone bell, the reed switch is correctly placed. If the buzzer sounds continuously, even when the phone stops ringing, back the reed switch off a little. In the telephone shown here, mounting was achieved easily by simply taping the reed switch to a large capacitor. ■



PARTS LIST FOR SIMPLEX-A-THING

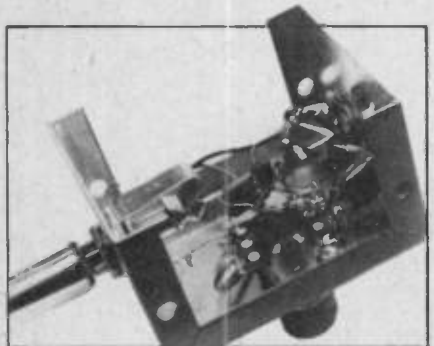
- **B1, B2**—1.5-volt "D"-cell battery
- **J1**—subminiature phone jack, 2-conductor
- **K1**—miniature reed switch, SPST
- **L1**—1.5-volt flashlight lamp
- **P1**—subminiature phone plug, 2-conductor
- **S1**—SPDT toggle switch
- **MISC:** suitable mounting cabinet, 3-volt buzzer or screamer module, length of 2-conductor wire for extension, hookup wire, solder, tape, etc.

BIG BOOST

This inline preamp puts more punch in your mike

WHEN THE VOCALIST can't make it over the bass player, or the lead guitar gets buried behind the rhythm section, or the audience can't tell the keyboard player is really tickling the ivories, that's the time you need a big boost in preamplification between the performers and the amplifiers. And that's just what you'll get from Big Boost, a self-contained mike/guitar/keyboard preamp you can plug directly into the amp, or into the mike or instrument itself.

Big Features. Though the Big Boost is a simple one-transistor project, it has several features specifically intended for rock or dance band use, or just for straight vocal amplification. First off, the Big Boost contains its own battery power supply, a standard 9-volt transistor radio battery operating at only 1 mA drain. Next, it is virtually overload immune; whether driven by a mike or the signal from an electric guitar pickup (about 0.1-volt) the output signal is not driven into clipping. As for gain, it's a whopping 25 dB, almost "ruler flat" from 100 Hz to about 20kHz. If you need extra bass for a keyboard, simply change C1 to 0.1-μf. Finally, the whole device is assembled in a palm-sized metal cabinet, and using a Switchcraft phone plug-to-phone plug adaptor, you can plug the Big Boost directly into an amplifier input. Or, because it's also unusually light, you can plug the preamp into the guitar or keyboard so the volume control is directly at the instrument.



Use the jacks and volume control leads to wire up your amp point-to-point. Parts layout is not critical with this project.

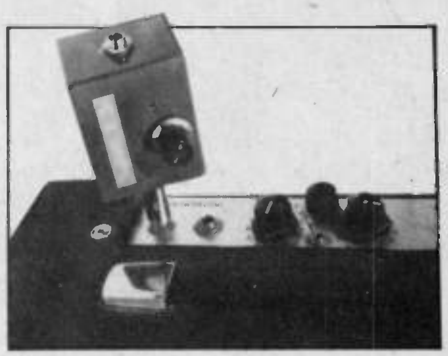
Assembly. The unit shown in the photographs was assembled inside of a 2¾ by 2⅛ by 1⅝-inch Mini-Box. Admittedly, it's a tight fit, but it can be done if input and output phone jacks J1 and J2 are installed ⅛-inch off-center on each end (make certain they are offset to the same side). This should leave just enough clearance for battery B1 on one side. Rotate J1 and J2, and bend their lugs if necessary, until you are certain the battery will fit with the Mini-Box's cover in place.

Potentiometer R5 is the volume control, and the miniature type specified in the parts list must be used if you want to get everything in a miniature cabinet. You must be certain R5 will not interfere with insertion of plugs into J1 and J2. It might appear that there's lots of room, but there really isn't. To avoid problems, it's best to insert a dummy plug into both J1 and J2 while marking R5's mounting spot.

R1 is supplied with a DPDT switch, S1a and S1b. Take note that some types have only two wire lugs for each switch section, the third connection being a rivet through which the builder sticks the component lead before soldering. Don't think something is wrong with the potentiometer because each switch section has only two lugs. Remember, the third connection for each switch is a solder-rivet.

No terminal strip is needed for assembly. All components are self-supported by simply twisting them together and soldering. If you keep the connecting leads as short as possible, the assembly will be sufficiently rigid to take the most rugged handling without shorts or "sound dropouts." It will all squeeze in nicely if the resistors used are ¼-watt units, and the capacitors are the miniature mylar printed circuit type (both leads from the same end) available from Radio Shack.

As with the mounting of R5, double-check that inserting a plug into J1 or J2 does not touch any wire or compon-



Use of the double male phone plug allows placement of the preamp at the amp's control head or right at mike stand.

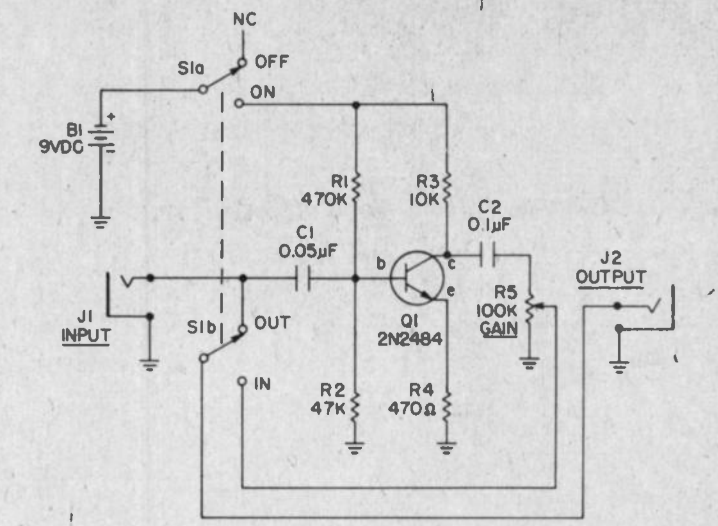
BIG BOOST

ent. Again, your best bet is to wire the project with dummy plugs installed.

Checkout. Install a battery, rotate R5's shaft until you hear the power switch click, and then check the voltage from Q1's collector to the cabinet. It should be about half the battery voltage (4 to 5-volts). If it's excessively high, around 8-9 volts, or excessively low, 1-2 volts, you have either made a wiring error or substituted an improper transistor for the specified Q1.

Connect a mike or an electric instrument's output to the Big Boost input and connect the preamp's output to your main amplifier's input. Advance R5 as you speak into the mike or play the instrument. The volume should increase as R5 is advanced. If it doesn't, you have wired S1a/S1b incorrectly. Note that when R5 is fully counterclockwise (off) the battery is disconnected and J1 is connected through S1a directly to J2. When R5 is advanced, closing S1, the battery is connected and S1a connects the preamp's output via R5's wiper to J2.

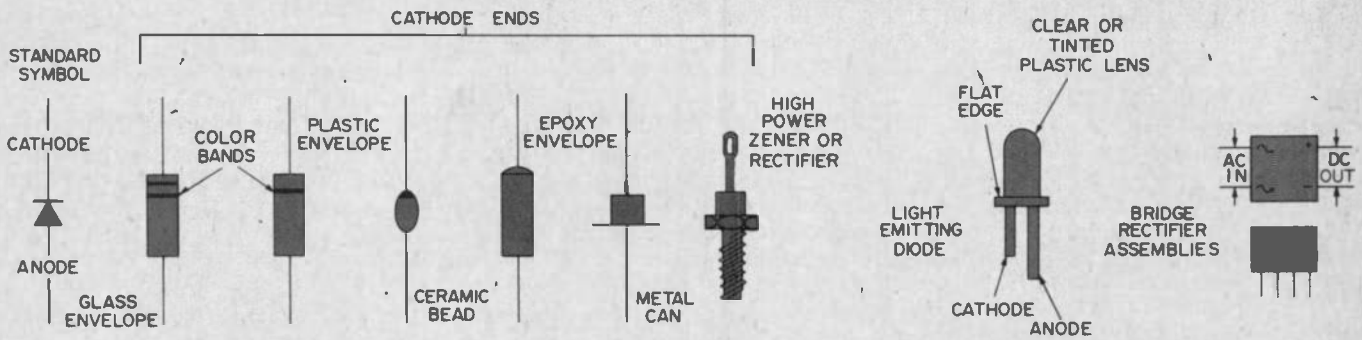
Plug to Plug. While you can use patch cords to connect the Big Bcost to your equipment, it's usually a lot more convenient and less of a hazard if the Big Boost is right at the amplifier input. Professional musicians do this by using a special *phone plug-to-phone plug* adaptor sold at music instrument shops. You can use the adaptor for either the input or output. If desired, you can plug the Big Boost directly into an electric guitar or keyboard output jack, and then use a regular patch cord to the amplifier's input. ■



PARTS LIST FOR BIG BOOST

B1—9-volt transistor battery
C1—0.05-uF, 15 VDC mylar capacitor (see text)
C2—0.1-uF, 15 VDC mylar capacitor
J1, J2—¼-inch standard phone jack
Q1—PN2484 NPN transistor
R1—470,000-ohm, ¼-watt resistor, 10%
R2—47,000-ohm, ¼-watt resistor, 10%
R3—10,000-ohm, ¼-watt resistor, 10%
R4—470-ohm, ¼-watt resistor, 10%
R5—100,000-ohm audio taper potentiometer with built-in DPDT switch (Radio Shack part #271-216 or equiv.)
S1—DPDT switch (part of R5)
Misc.—cabinet, wire, battery clip, knob, phone plug (female-to-male) adaptor, etc.

DIODE DIGEST



It may sound silly, but it seems that a lot of people still don't know which end of a diode is up. A letter we received recently from O.M.S. of Guilford, Connecticut illustrates this point. He writes:

"I have been trying for the last three months to purchase a power supply that I can use to power a walky-talky from house current. I've finally given up and decided to build my own. I have a transformer that converts 110 VAC to 12.6 VAC, some large filter capacitors salvaged from an old television, and some 'bargain bag' diodes I purchased from a discount store. The diodes are black, unmarked, and have one rounded end. Can I use them, or will I have to shell out for ones with known values?"

Of course, we couldn't be sure of just exactly what he had in hand, but from the description, and basing our guess on the chart, we were pretty sure that these were epoxy-encapsulated rectifiers, with probably about a 100 to 200-PIV rating. These would fill his needs if our guess was right. Although we haven't heard any more from that gentleman, we assume he didn't blow himself up. By tearing out the chart and pasting it up inside the cover of your spare parts box, you can have a handy reference guide for identifying the leads and types of whatever diodes happen to find their way into your hands. ■

LITERATURE LIBRARY

403. *PAIA Electronics* gives you "Advanced Electronics For The '80s and Beyond." Brochure features computerized music synthesizers.

402. *Technical Electronics* has descriptions galore of all kinds of electrical gadgets—transistors, computer power supplies, and logic probes—in its latest (6-80 B) mail order catalog.

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396. *Creative Computing's* first software catalog of various education and recreation simulation programs as well as sophisticated technical application packages is available now.

395. *OK Machine and Tool* explains the technology of wire-wrapping, complete with illustrations, in its catalog of industrial and hobby products. The 60-page book (80-36N) is available now.

394. *KEF Electronics Ltd.* is offering two speaker systems in kit form at a significant cost-savings. The Model 104aB and the Cantata can be easily assembled and may be auditioned before purchasing.

389. You can't buy a bargain unless you know about it! *Fair Radio Sales'* latest electronics surplus catalog is packed with government and commercial buys.

388. SWLs need *Gilfer's* Shortwave Mail Order Catalog for economy one-stop armchair shopping. From top-notch rigs to reporting pads, Gilfer supplies all your hobby needs.

327. *Avanti's* new brochure compares the quality difference between an Avanti Racer 27 base loaded mobile antenna and a typical imported base loaded antenna.

362. A new catalog crunched full of military, commercial and industrial surplus electronics for every hobbyist is offered by *B&F Industries*. 44 pages of bargains you've got to see!

384. *B&K-Precision* has issued BK-10, a condensed catalog describing their oscilloscopes, semi-conductor testers as well as test instruments for CB, radio and TV repair.

310. *Compumart Corp.*, formerly NCE, has been selling computers by mail since '71, and is offering a 10-day return policy on many items featured in their latest catalog.

322. *Radio Shack's* latest full color catalog, "The Expanding World of TRS-80," is out now, packed with up to the date information on this microcomputer. Specifications for the new Model II as well as the Model I are included.

386. If you're looking for books on computers, calculators, and games, then get *BITS, Inc.* catalog. It includes novel items.

335. The latest edition of the *TAB BOOKS* catalog describes over 450 books on CB, electronics, broadcasting, do-it-yourself, hobby, radio, TV, hi-fi, and CB and TV servicing.

338. "Break Break," a booklet which came into existence at the request of hundreds of CBers, contains real life stories of incidents taking place on America's highways and byways. Compiled by the *Shakespeare Company*, it is available on a first come, first serve basis.

345. For CBers from *Hy-Gain Electronics Corp.* there is a 50-page, 4-color catalog (base, mobile and marine transceivers, antennas, and accessories).

393. A brand new 60-page catalog listing *Simpson Electric Company's* complete line of stock analog and digital panel meters, meter relays, controllers and test instruments has just come out.

373. New 96-page "Electronic Things and Ideas Book" from ETCO has over 4000 gadgets and goodies, many not found in stores or elsewhere.

382. Buys by the dozens in *Long's Electronics* super "Ham Radio Buyer's Guide." Good reading if you're in the market for a complete station or spare fuses.

383. If you're a radio communicator, either ham, SWL, scanner buff or CBer, you'll want a copy of *Harrison Radio's* "Communications Catalog 1980." Just what the shack book shelf needs.

380. If your projects call for transistors and FETS, linear and digital ICs, or special solid-state parts, then look into *Adva Electronics'* mini-catalog for rock bottom prices.

301. Get into the swing of microcomputer and microprocessor technology with *CREI's* new Program 680. New 56 page catalog describes all programs of electronics advancement.

306. *Antenna Specialists* has a new 32-page CB and monitor antenna catalog, a new amateur antenna catalog, and a complete accessory catalog.

377. *John J. Meshna, Jr., Inc.* has a super-saver catalog out (SP-16) featuring walky talkies, police radar detectors, vacuum pump compressors and other fascinating products to choose from.

330. There are nearly 400 electronics kits in *Heath's* new catalog. Virtually every do-it-yourself interest is included—TV, radios, stereo and 4-channel, hi-fi, hobby computers, etc.

404. A great source for home or business is *Advanced Computer Products* latest catalog. Includes brand name computer hardware and software plus games, calculators and more.

390. *Whitehouse & Co.*, your "hard to find parts specialist," offers over a dozen parts and kits in their latest catalogue, featuring an entire section on gunnplexers for Amateur Radio buffs.

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

320. *Edmund Scientific's* catalog contains over 4500 products that embrace many sciences and fields.

328. If you are into audio, ham radio, project building, telephones, CB or any electronics hobby you'll want *McGee's* latest catalog of parts and gadgets.

333. 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.

354. A government FCC License can help you qualify for a career in electronics. Send for information from *Cleveland Institute of Electronics*.

355. New for CBers from *Anixter-Mark* is a colorful 4-page brochure detailing their line of base station and mobile antennas, including 8 models of the famous Mark Heliwhip.

391. A new software products catalog for the Apple II Computer has just been issued by *Charles Mann & Associates*. The booklet contains business accounting, accounts receivable, inventory, BASIC teaching and other special purpose business applications.

359. *Electronics Book Club* has literature on how to get up to 3 electronics books (retailing at $58.70) for only 99 cents each . . . plus a sample Club News package.

311. *Midland Communications'* line of base, mobile and hand-held CB equipment, marine transceivers, scanning monitors, plus a sampling of accessories are covered in a colorful 16-page brochure.

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Long Delay Timer

(Continued from page 43)

ment switch S1 is closed, the LED will be unlit indicating that the delay interval has been initiated. Output is low (logic 0). For the circuit of Fig. 4 it should remain unlit for approximately 10-seconds. After this interval the LED will again light and remain so until switch S1 is momentarily closed again.

Close switch S1 momentarily to initiate a new cycle. Then very quickly close S2 momentarily. Note that the LED will light immediately after the closing of switch S2. This activity is the same as applying a positive reset trigger pulse to pin 5.

Triggered astable operation is obtained by opening switch S3. Momentarily close switch S1 to initiate a delay interval. (The LED will be unlit.) After the delay interval, the output will switch to high and the LED will light. It will remain lit for approximately 10 seconds and then it will go out indicating the initiation of a new delay interval. This time, the new cycle was initiated even though switch S1 was not closed momentarily. This activity will repeat itself in an astable manner until the reset switch (S2) is momentarily closed during one of the time delay intervals. The circuit will not recycle itself again until the trigger switch S1 is again momentarily closed.

Free-Running Oscillator Operation. To operate the timer chip as a low-frequency oscillator, connect the circuit of Fig. 5. Note in this arrangement that pin 5 is grounded and that the trigger (pin 6) is connected permanently to the supply voltage through a resistor. This means that a fixed supply voltage is supplied to the trigger circuit which will insure self-triggering operation.

Rearrange the circuit for oscillator operation. Supply power to the circuit. Note that the LED will be lit for ten seconds and then off for ten seconds and so on. This indicates that a very low-frequency squarewave (one cycle each twenty seconds) is being generated at the output, the output swinging between high and low and back to high again during a single pulse period.

Connect the LED indicator to pin 2. The LED will flicker, indicating the much higher frequency square wave that is to be found in this initial stage of the counter chain. Return the LED indicator circuit to the pin 3 output.

If you wish, you can now experiment with other components for resistor R1 and capacitor C1. A 10-μF capacitor substituted for C1 will result in a delay of approximately 50-seconds. The LED will be off for 50-seconds and on for 50-seconds, etc. The use of a 1-megohm resistor and a 100-μF capacitor would result in a delay time in excess of 3 hours. A 3900-ohm resistor and a 2-μF capacitor would cut the delay time down to approximately 1-second.

You have learned how the XR-2242 operates as a long-delay timer and a very low-frequency oscillator. A more elaborate circuit could be added to the output, operating a mechanical or solid state relay, the activities of which could be regulated by the time-constant combination resistor R1 and capacitor C1. Other applications may come to mind for this versatile circuit as you continue to experiment. ■

Ask Hank, He Knows

(Continued from page 6)

of its kind. The unit is in mint condition mainly because it requires a difficult-to-find 22.5 VDC battery—which he claims put it out of contention. In our March/April 1980 issue of ELEMENTARY ELECTRONICS, we claimed the Regency unit to be the first, not the first with a 9 VDC battery. I wonder who came up with the first 9 VDC transistor battery radio to fit in a pocket?

Lend a Hand

The list is small this issue, but the need is always great! If you can assist, please do!

∆ Knight Star Romer Shortwave Receiver; needs owner's/operator's manual; Mike Carl, 2364 Douglas Ave., Yorkville, NY 13495.

∆ Edison Voicewriter, Model 87000; needs schematic diagram and any other information; David Boyd, Star Route Box 73A, Cave City, AR 72521.

∆ RME Sideband Selector, Model 4301; would like to purchase unit; Howard H. Halperin, 4122 W. Flower St., Phoenix, AZ 85019.

∆ Friden 5610 Computyper consisting of 2210 Flexowriter and 5601 Computyper Unit; need help from someone who knows the system, literature urgently needed; Robert Osman, 4601 Carlisle NE, Apt. E-4, Albuquerque, NM 87109.

∆ Lafayette HB-115A CB transceiver; needs schematic diagram, microphone and power cord; Tom Stan, P.O. Box 391, Amsterdam, OH 43903.

∆ Hallicrafters S-720 and SX-730; needs schematic diagrams and operators manuals to restore units; S. Sienicki, R.D. #1, Box 328C, Jamesboro, NJ 08831.

∆ Heathkit 03 oscilloscope, T-3; would appreciate any information and manuals; Stacey Brogden, 2430 Albert Way, Arcadia, CA 91006. ■

Dial Cords

(Continued from page 96)

Also, two large guide pulleys help keep the dial cord on track.

New Drums. Sometimes it's very difficult to obtain a dial drum replacement for certain models. You may be able to repair these plastic drums if they are not broken or damaged too badly. In this particular AM-FM-MPX model (Fig. 8) the plastic drum was broken around the hub area and would let the drum fall down towards the variable capacitor. You could only tune part of the radio band as the drum would jam against the printed circuit board wiring.

The plastic drum was repaired to its original position and held off the P.C. board by a couple of pencils while it dried. Now, level the plastic drum. Tighten down the screw and top washer. Mix up a dab of epoxy cement and apply over the drum shaft area. Let it set overnight.

When the dial cord will not move and the dial cord end is pulled clear out of the plastic hole, simply make another hole a little higher upon the drum (Fig. 9). Sometimes the cord will pull out a chunk of plastic from the drum area. You may repair it with epoxy cement.

Erratic Dialing. When the dial will only move in certain areas or stop at a different spot each time, suspect a loose set screw (Fig. 10). Sometimes these small screws will not bite into the tuning capacitor shaft.

Erratic dialing may be caused by slippage at the tuning shaft. First, tighten the dial spring and apply a coat of liquid rosin at the tuning shaft area.

You may encounter a dry or bent dial pointer assembly causing erratic dial operation. Notice if the pilot light wires are snagging on the PC wiring when the dial pointer assembly contains an enclosed dial bulb.

So, the next time you have a dial break or start slipping, sit down and do the work yourself. One thing for sure, you will soon find out if you have ten fingers—or ten thumbs. ■

Oil Pressure

(Continued from page 65)

have a machine shop thread an extender pipe to that car's metric specs. Stop the oil leaks before they occur by using a pipe cement or plumber's teflon tape when assembling the fittings. Exercise caution when tightening this fragile piping, especially when tightening it in the motor block. It is frustrating work to remove a sheared piece from the motor block hole.

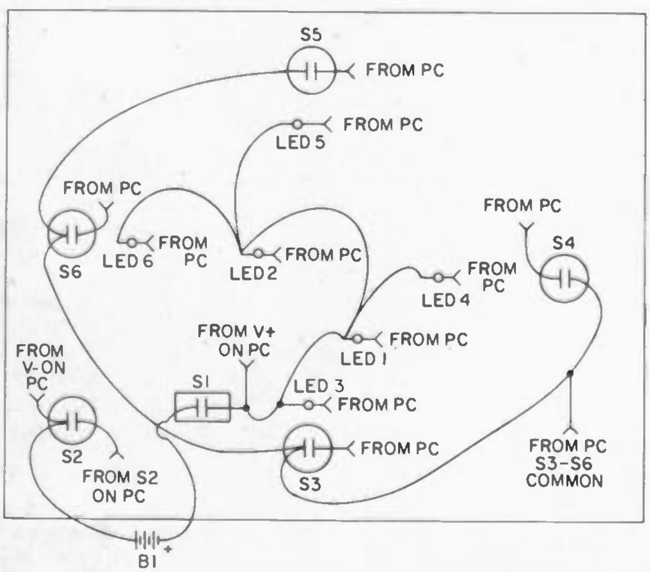
Conclusion. There you have it, a relatively easy (as promised) method of keeping watch on one of your car's most important systems. Combined with the digital voltmeter and temperature gauge, and those gauges coming up in later issues, this represents one of the most important weapons you can have in your arsenal in the fight against the ever-rising costs of automotive maintenance and repair. In addition, you will possess a set of instruments of far greater accuracy than those analog devices commonly available for aftermarket installation. This is one instance in which you could not possibly buy anything better than what you can put together on your workbench in a few hours' time. ■

Fastouch

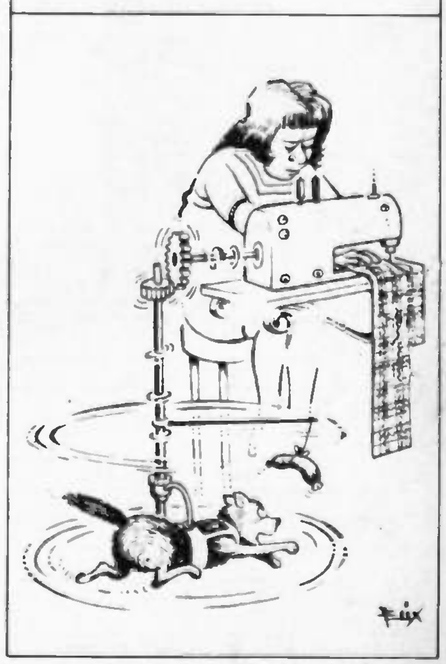
(Continued from page 93)

LEDs stop blinking). It is advisable to use pencil and paper or some other apparatus for scoring since, as the game progresses, scores will be constantly changing. *FasTouch* will not guarantee that you'll be the hit of the party, only that your parties will be a bit more lively when it's out on the coffee table.

If you have enjoyed building and playing *FasTouch*, why not drop us a line and tell us. ■



Outline of the PC board to panel connections of FasTouch. It's simple, so just follow this diagram, and go ahead! Lots of luck.



SEE PAGE 7 FOR EXTRA COUPON

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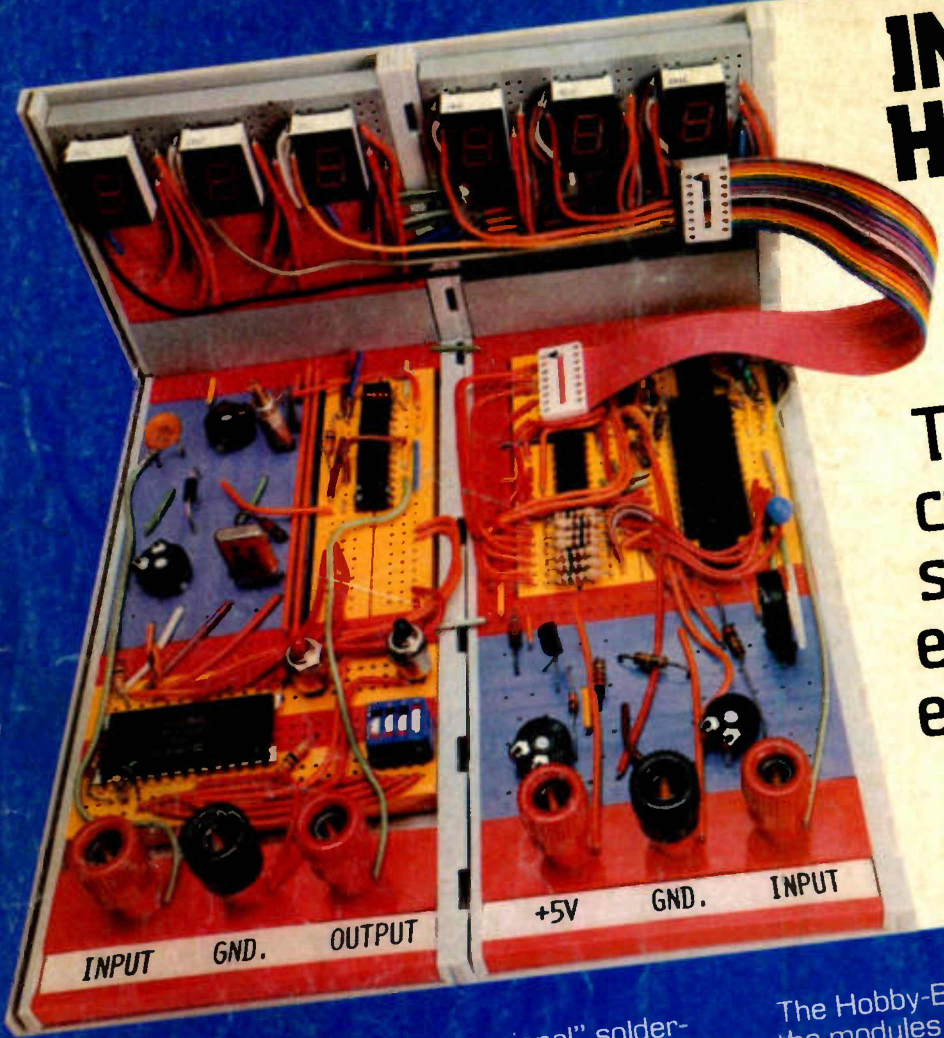

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