CIRCUITS

101 ELECTRONIC PROJECTS

by the EDITORS of ELEMENTARY ELECTRONICS

1979 EDITION $1.95 CC 02272

PIN-UP PROJECTS FOR AN EVENING'S PUT-TOGETHER

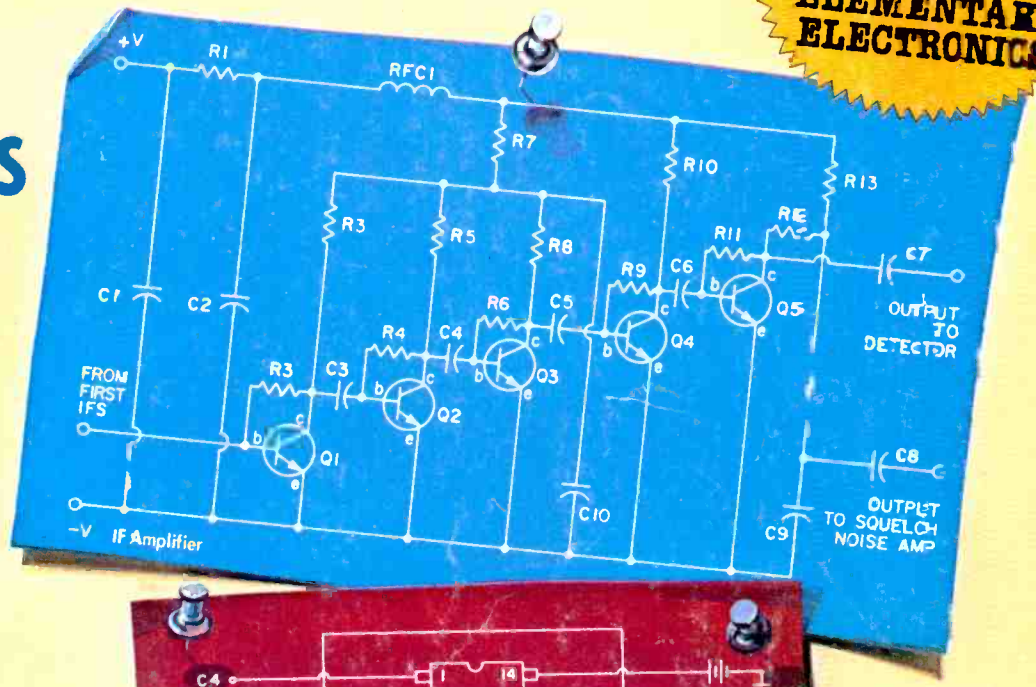
Sound-Sync Flash
CB Scope Monitor
Speaker-Mic
Pro Burglar Alarm
PhotoFlood Dimmer
Rocker's Mike Booster

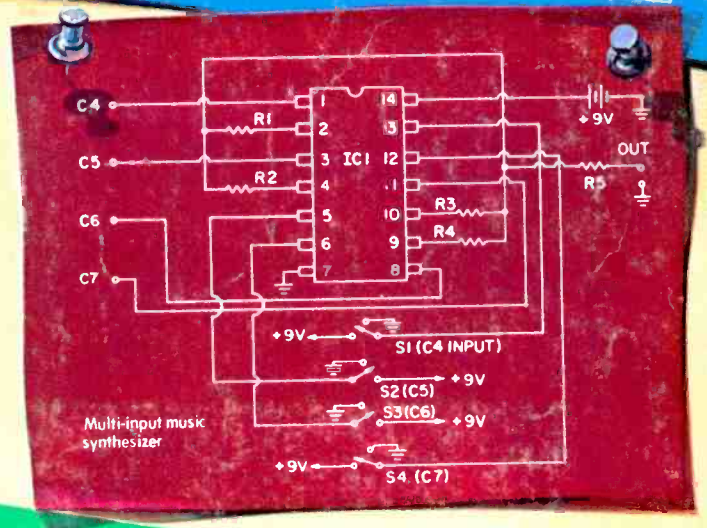
40 FABULOUS IC FEATURES

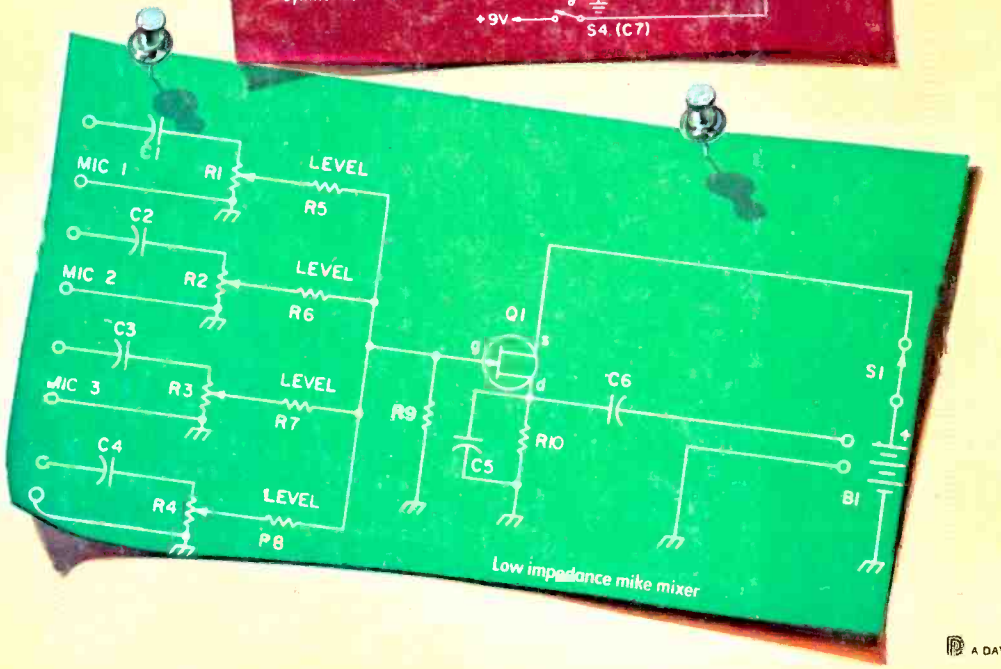
Porta-Amp
Ultimate Talk Power
Groove Booster
SCA Adaptor
Two-Tone Siren
SWL's Super Calibrator

PLUS— SUPER PROJECTS

Cyclops, the musical sentry
Friendly Flasher, to brighten your home
BCB Booster, soups up any receiver







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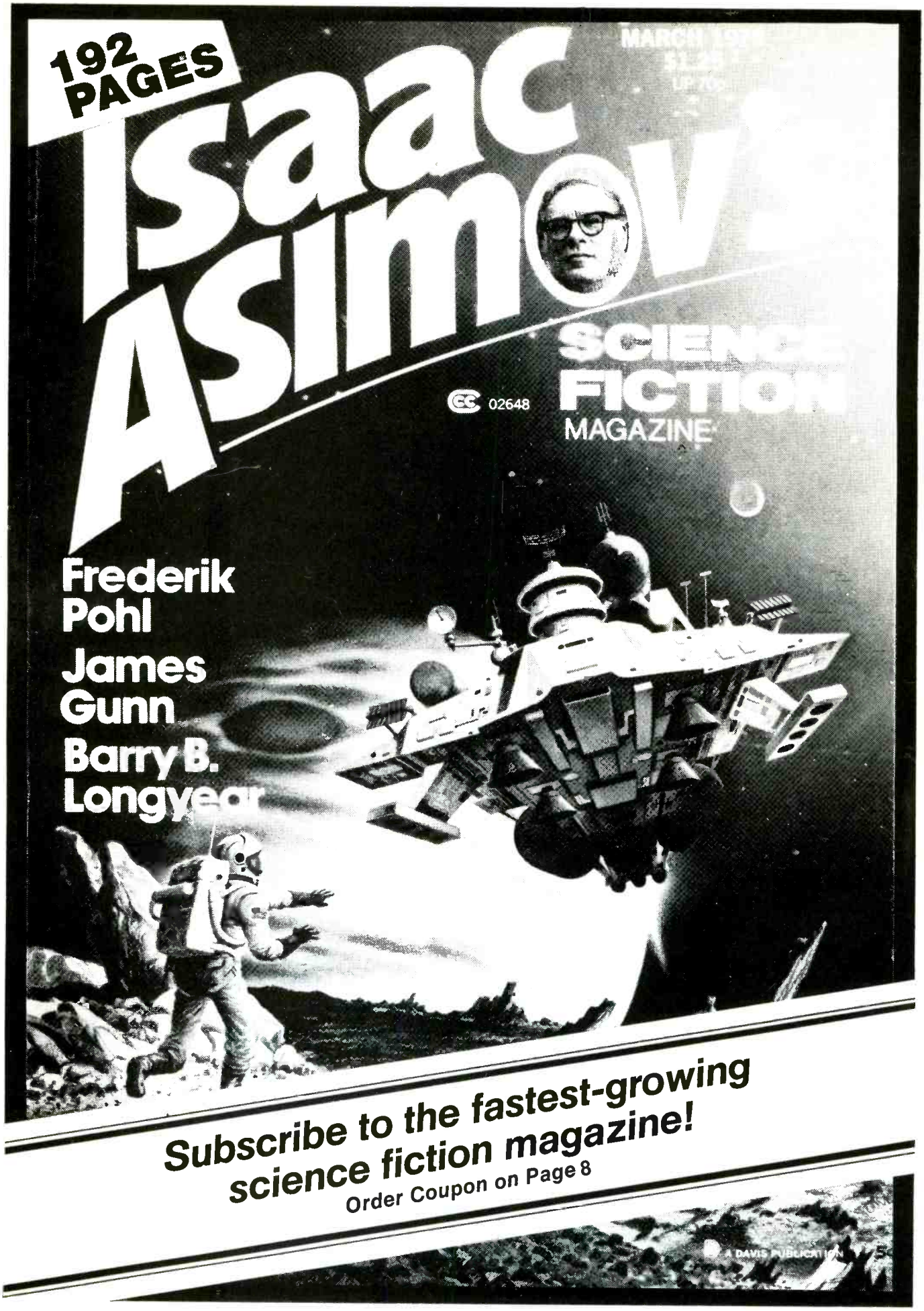
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Everybody's making money selling microcomputers. Somebody's going to make money servicing them.

New NRI Home Study Course Shows You How to Make Money Servicing, Repairing, and Programming Personal and Small Business Computers

Seems like every time you turn around, somebody comes along with a new computer for home or business use. And they're being gobbled up to handle things like payrolls, billing, inventory, and other jobs for businesses of every size...to perform household functions like budgeting, environmental systems control, indexing recipes, even playing games.

Growing Demand for Computer Technicians... Learn in Your Spare Time

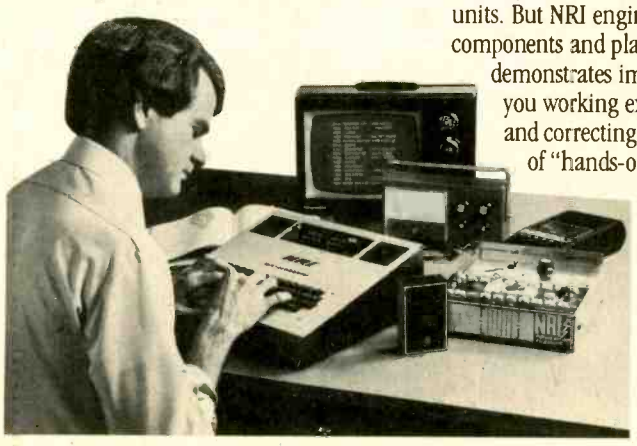
Even before the microprocessor burst upon the scene, the U.S. Department of Labor forecast over a 100% increase in job openings for the decade through 1985. Most of them *new* jobs created by the expanding world of the computer. NRI can train you at home to service both microcomputers and their big brothers. Train you at your convenience, with clearly written "bite-size" lessons that you do evenings or weekends without quitting your present job.

No Experience Needed

You don't need prior training in electronics or computers to take this exciting new course. NRI starts you with the basics, gives you a firm foundation to build on. And your personal counselor is always available, ready to help whenever you have questions.

Assemble Your Own Microcomputer

NRI training also includes plenty of practical experience. You perform meaningful experiments building and studying circuits on the NRI Discovery Lab.® Then you build your own test instruments like a transistorized volt-ohm meter, CMOS digital frequency counter... equipment you learn on, use later in your work.



And you build your own microcomputer, the only one designed for learning. It looks and operates like the finest of its kind, actually does more than many commercial units. But NRI engineers have designed components and planned assembly so it demonstrates important principles, gives you working experience in detecting and correcting problems. It's the kind of "hands-on" training you need to repair and service units now on the market.

Rush Card for Free Catalog... No Salesman Will Call

Send the postage-paid card today for our 100-page, full-color catalog. It describes NRI's new Microcomputer Technology Course in detail, shows all equipment, kits, and lesson plans. And it also tells about other NRI courses...Complete Communications with 2-meter transceiver...TV/Audio/Video Systems Servicing with training on the only designed-for-learning 25" diagonal color TV with state-of-the-art computer programming. With more than a million students since 1914, NRI knows how to give you the most in home training for new opportunity. If card has been removed, write to:

NRI McGraw-Hill

NRI Schools
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101 ELECTRONIC PROJECTS

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TRIED AND TRUE CONSTRUCTION PROJECTS

REGULAR DEPARTMENTS AND FEATURES

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New Products

Portable PA

A portable voice reinforcement (public address) system, the Perma Power Voice Carrier Model S-230), provides the volume you want, combined with portability in a single carrying case. It offers

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a six-speaker sound column, 35-watt solid state amplifier, and professional dynamic cardioid microphone, for excellent audio penetration. An adjustable microphone stand is included. The model S-702 amplifier is powered by ten D-size flashlight batteries. A 120 VAC adapter for the amplifier is available if desired. The Perma Power Voice Carrier Model S-230 is available through electronic distributors, school supply houses, and audio-visual dealers. The price is $349.50. Literature is available on request from Perma Power Electronics, 5615 W. Howard Ave., Chicago, IL 60648.

Digital Security Lock

Comp-U-Lock, a new keyless locking system by ESP Systems Development, is an electronically operated security system offering 10,000 possible digital combinations that can be changed in a matter of minutes. The electric latch part of the system fits most standard door jambs, and is easily installed with common hand tools. Comp-U-Lock also comes in a surface mount model that allows easy installation on door and wall surfaces.

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When the correct combination is punched into the key board, the latch will remain open for up to three seconds and then automatically re-lock. To change the combination, the inner control unit cover is removed and the new four-digit combination is set using thumb-wheel switches. The unit operates on a 117 VAC-to-12 VDC power supply, with a backup battery. Power is used only to open the electric striker. A major advantage to Comp-U-Lock is that there are no keys to lose. In addition, a readily accessible exit button opens the door from the inside for quick emergency exit. The Comp-U-Lock system automatically locks as the door closes, preventing unlocked doors as a result of absent-mindedness. It sells for $129.95. For further information, write to Comp-U-Lock, ESP Systems Development, Inc., 28189 Kehrig Dr., Mt. Clemens, MI 48045.

Film Groove Cleaner

Empire Scientific's "Disco Film," is an unique new method for cleaning phonograph records that removes dirt and

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grime from record grooves by applying a film-forming solution to the record, which peels off when dry. This cleaning technique eliminates the clicks and pops caused by imbedded dirt and noticeably improves the sound quality of a record. The Disco Film, a water-soluble solution that is harmless to vinyl, is sponged over the record surface with a built-in applicator. When dry, a flexible film is formed which is easily peeled off with Scotch tape. One container of Disco Film will clean up to 70 vinyl LP record sides. The product is not for use on shellac records. It sells for $29.95. Get more comp'ete information directly from Empire Scientific Corp., 1055 Stewart Avenue, Garden City, NY 11530.

Exerciser for Digital Circuits

Troubleshooting digital logic circuits can become a game of beat-the-clock if the system is left running at full speed. A much smarter method of troubleshooting involves the substitution of an external signal for the system clock oscil-

New Products

lator, a job performed easily and well by the inexpensive ($129.95) DM-4 Design Mate Generator from Continental Specialties Corporation. Nearly every pulse

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parameter is variable over a wide range. The pulse repetition frequency is continuously variable from 0.5-Hertz to 5-MHz in seven over-lapping vernier-tuned decade ranges. Duty cycle, pulse width and pulse spacing are variable over a 10,000,000:1 range, from 100 nanoseconds "on" and 1 second "off," to 1 second "on" and 100 nanoseconds "off." Pulse output is variable from 0.1-volts to 10-volts. Complete specifications are available from CSC's comprehensive catalog, available from CSC dealers or from CSC by writing to: Continental Specialties Corporation at 70 Fulton Terrace, New Haven, CT 06509.

Two Bench/Portable DMMs

Fluke has incorporated a highly reliable custom CMOS chip into two new bench/portables designated Models 8010A and 8012A. Both multimeters have large, crisp, LCD readouts, and incorporate a hybrid thick-film true RMS converter with 50 kHz response for AC measurements. A conductance function measures leakage to 10,000 megohms, plus transistor beta measurements and other unusual trouble-shooting capabilities. An optional probe allows the user to touch a test

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point and freeze the reading until it can be observed or recorded. Both the 8010A and 8012A are heavily protected against abusive input signals. The instruments reject 6000-volt transients which occur in bench service, and also protect the user and the electronics against potentials of up to 600 VDC (440 VRMS) applied to the current terminals. The instruments are identical except that the 8012A substitutes 2 and 20 ohm resistance ranges for the standard high-current (10A) ranges. The 8012A can effectively measure resistance from 1 milliohm to 10,000 megohms. Prices are $239 for the 8010A and $299 for the 8012A, with rechargeable battery versions an additional $40. For further data on the 8010A or 8012A, write to the John Fluke Mfg. Co., Inc. at P.O. Box 43210, Mountlake Terrace, WA 98043.

CB Marine Antenna

The "Bassin' Man" CB marine antenna is a fully-tunable high-performance 40-channel Citizens Band antenna from U.S. Fiberglass. This 3-foot-long fiberglass antenna is for use on small boats. Because it requires no ground plane, it can be installed on virtually any surface, at any

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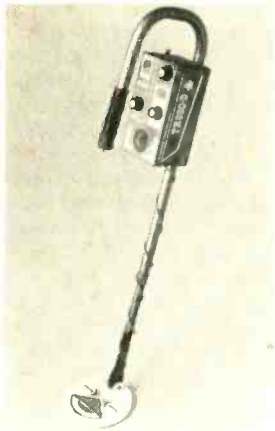
angle. The fully-adjustable nylon ratchet mount can be adjusted to a variety of "locked-in" positions. It also allows for fast lay-down when the boat is being docked, stored or trailered—or when it might interfere with other options. The "Bassin' Man" can be tuned without tools to achieve the lowest possible standing wave ratio (SWR) for efficient matching to any CB radio. Sold complete with nylon ratchet mount, 7-foot white coax cable, PL-259 connector, and all necessary stainless steel hardware for $39.95. For information on the complete line of marine antennas, write to U.S. Fiberglass, Division of Gladding Corporation, 5101 N.W. 36th Avenue, Miami, Florida 33142.

Discriminating Metal Detector

Edmund Scientific's new metal detector utilizes inductively balanced transmit/receive to provide stability and sensitivity. Although designed as an all-purpose instrument, it is an ideal detector for the serious coin shooter, because it allows the operator to control the amount of unwanted "junk" to be rejected. The unwanted targets are ignored because it yields no audio tone as the coil passes

over them. Designed for simplicity of operation, and containing new, improved circuitry, it can be retuned instantly by



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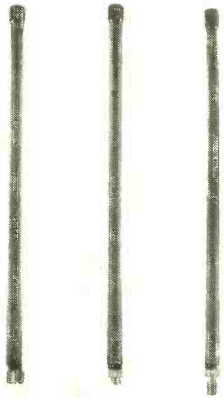
simply touching a button on the handle. Other features include an on/off volume control, normal and discriminate search modes, discriminate level adjustor, earphone jack, telescoping search rod, adjustable search coil, and a new power-saver system that allows the unit to run on just three 9-volt batteries. A two-position toggle switch is used to select the desired target characteristics. In the normal position, the detector will respond to non-ferrous metals such as gold, copper, silver, aluminum, coins and jewelry. The metal detector weighs only five pounds, and can be ordered by mail (stock no. 80,286) for $119.95 postpaid from Edmund Scientific Co., 7782 Edscorp Bldg., Barrington, NJ 08007. Add $1.00 for handling. Edmund's catalog can be obtained free for the asking, by writing to the same address.

Replacement Rubber Duckies

Antenna Specialists new P5-Series of highly efficient and flexible replacement antennas are designed for G.E., Repco, Motorola, and Sonar handheld 30-to-50-



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MHz transceivers. The antennas are designed for instant replacement of broken or defective telescopics, or to reduce potential injury hazard. Only 10-inches high, the antennas feature a ferrite slug-tuned loading coil and helical spring, encased in resilient, heat shrink tubing for long life and flexibility. The new antennas supplement Antenna Specialtists' extensive line of "rubber duckie" types for virtually all UHF and VHF handheld equipment. Suggested user price is $19.00. For further information contact, The Antenna Specialists Co., 12435 Euclid Avenue, Cleveland, OH 44106.

Dust Buster

Robins Industries has introduced a piezo-electric ionic static neutralizer, the Rob-O-Stat. The heart of the Robins Rob-O-Stat is a piezo-electric ceramic element. The stressing of the element by squeezing the trigger, generates and emits a stream of positive and negative ions, which neutralize the dust-attracting static

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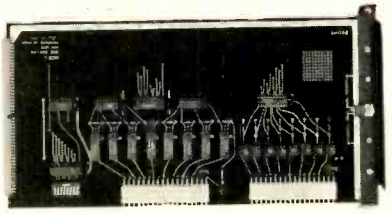
charges on the disc. Use of the Rob-O-Stat ionic static neutralizer is extremely simple—the gun-shaped neutralizer is

New Products

held a few inches away from, and pointed at the record. The trigger is depressed, creating a controlled ionic charge for a few seconds. The Rob-O-Stat sells for $22.95. For further information, contact Robins Industries Corp., 75 Austin Blvd., Commack, NY 11725.

Opto-Isolator/Relay Control Board

Although a computer can perform interesting operations and programs, its usefulness in controlling real world devices



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—like motors, burglar alarms, display lights, audio signal lines, and the like—is severely limited. The Opto-Isolator/Relay Control Board made by Mullen, can control low current devices directly, or heavy duty power relays or triacs. Additionally, 8 opto-isolators accept an 8-bit word from the outside world and send it to the computer for handshaking or further control purposes. Computer enthusiasts will find these boards valuable in plugging I/O gaps that prevent the computer from interacting with other devices. Model railroads, ham radio, music synthesizer, and hi-fi switching applications can now be brought directly under computer control. Features include: Compatibility with the S-100 buss, and built-in test circuit for verification of proper operation upon completion. Sells for $98.00. Send orders, inquiries, and comments to Mullen Computer Products, P.O. Box 6214, Hayward, CA 94545.

Heavy-Duty Rotator

The Beam Master antenna rotor was designed specifically for CB beam antennas with up to 5 square feet of wind loading area and large TV antenna arrays. It features a heavy-duty steel gear system; strong, weather-protected housing with snap-lock cover for easy installation; and a contemporary, low-profile rotor control unit. The Beam Master can withstand 8,400-in. lbs. of vertical force. It has a bulit-in thrust bearing that can handle loads up to 250 lbs. The mast support can accommodate masting from 1- to 2-in. outside diameters. The manufacturer says that Beam Master's rotor control unit combines smoother, quiet action with pinpoint positioning, and uses synchronized motors for on-target accuracy in the desired direction. The console has a modern, easy-to-read faceplate and compact, low-profile design. It comes with a strip guide for easy installation, plus, terminal barriers, a strain-relief, and furniture-protecting base pads. Beam Master is available in 115 volt AC (Model 9515) at a retail price of $89.95. For more information contact, Channel Master, Ellenville, NY 12428.

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Two Metal Detectors

Edmund Scientific is offering a new and greatly improved metal detector for just $39.95. Fully transistorized, it is 30% more sensitive than comparable models in its price range. Ideal for the beginner who is concerned with quality, it packs the power demanded by the professional. Called the Edmund TR Earth Challenger, it offers all of the sensitivity and depth of the transmitter/receiver circuit and has the capability to locate a penny down to six inches. Lightweight (2 lb., 6 oz.) and perfectly balanced, the new TR Earth Challenger's pole is constructed of rugged aluminum with a blue finish. Other features include an electronic housing and a six-inch search coil completely waterproofed in molded ABS plastic. It also comes with a 9 V transistor battery which will last about 50 hours. A deluxe version of the TR Earth Challenger is also available for $59.95. It comes with a telescopic shaft adjustable to 44-in. and is of all metal construction—yet it weighs just 2 lb., 6 oz. Another outstanding feature is a 10-turn metal/mineral tuner. Both of these fine-quality metal detectors can be ordered by mail—TR Earth Challenger (stock no. 80,262) $39.95 Ppd.; Deluxe Earth Challenger (stock no. 80,251) $59.95 Ppd. from Edmund Scientific, 7782 Edscorp Bldg., Barrington, NJ 08007.

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BUILD 20 RADIO AND ELECTRONICS CIRCUITS

PROGRESSIVE HOME RADIO-T.V. COURSE

Reg. U.S. Pat. Off.

Training Electronics Technicians Since 1946

Now Includes

- ★ 12 RECEIVERS
- ★ 3 TRANSMITTERS
- ★ SQ. WAVE GENERATOR
- ★ SIGNAL TRACER
- ★ AMPLIFIER
- ★ SIGNAL INJECTOR
- ★ CODE OSCILLATOR

- ★ No Knowledge of Radio Necessary
- ★ No Additional Parts or Tools Needed
- ★ Solid State Circuits
- ★ Vacuum Tube Circuits

YOU DON'T HAVE TO SPEND HUNDREDS OF DOLLARS FOR A RADIO COURSE

The "Edu-Kit" offers you an outstanding PRACTICAL HOME RADIO COURSE at a rock-bottom price. Our Kit is designed to train Radio & Electronics Technicians, making use of the most modern methods of home training. You will learn radio theory, construction practice and servicing. THIS IS A COMPLETE RADIO COURSE IN EVERY DETAIL.

You will learn how to build radios, using regular schematics; how to wire and solder in a professional manner; how to service radios. You will work with the standard type of punched metal chassis as well as the latest development of Printed Circuit chassis.

You will learn the basic principles of radio. You will construct, study and work with RF and AF amplifiers and oscillators, detectors, rectifiers, test equipment. You will learn and practice code, using the Progressive Code Oscillator. You will learn and practice trouble-shooting, using the Progressive Signal Tracer, Progressive Signal Injector, Progressive Dynamic Radio & Electronics Tester, Square Wave Generator and the accompanying instructional material.

You will receive training for the Novice, Technician and General Classes of F.C.C. Radio Amateur Licenses. You will build Receiver, Transmitter, Square Wave Generator, Code Oscillator, Signal Tracer and Signal Injector circuits, and learn how to operate them. You will receive an excellent background for television, Hi-Fi and Electronics.

Absolutely no previous knowledge of radio or science is required. The "Edu-Kit" is the product of many years of teaching and engineering experience. The "Edu-Kit" will provide you with a basic education in Electronics and Radio, worth many times the low price you pay. The Signal Tracer alone is worth more than the price of the kit.

THE KIT FOR EVERYONE

You do not need the slightest background in radio or science. Whether you are interested in Radio & Electronics because you want an interesting hobby, a well paying business or a job with a future, you will find the "Edu-Kit" a worth-while investment.

Many thousands of individuals of all ages and backgrounds have successfully used the "Edu-Kit" in more than 79 countries of the world. The "Edu-Kit" has been carefully designed, step by step, so that you cannot make a mistake. The "Edu-Kit" allows you to teach yourself at your own rate. No instructor is necessary.

PROGRESSIVE TEACHING METHOD

The Progressive Radio "Edu-Kit" is the foremost educational radio kit in the world, and is universally accepted as the standard in the field of electronics training. The "Edu-Kit" uses the modern educational principle of "Learn by Doing." Therefore you construct, learn schematics, study theory, practice trouble shooting—all in a closely integrated program designed to provide an easily-learned, thorough and interesting background in radio.

You begin by examining the various radio parts of the "Edu-Kit." You then learn the function, theory and wiring of these parts. Then you build a simple radio. With this first set you will enjoy listening to regular broadcast stations, learn theory, practice testing and trouble-shooting. Then you build a more advanced radio, learn more advanced theory and techniques. Gradually, in a progressive manner, and at your own rate, you will find yourself constructing more advanced multi-tube radio circuits, and doing work like a professional Radio Technician.

Included in the "Edu-Kit" course are Receiver, Transmitter, Code Oscillator, Signal Tracer, Square Wave Generator and Signal Injector Circuits. These are not unprofessional "breadboard" experiments, but genuine radio circuits, constructed by means of professional wiring and soldering on metal chassis, plus the new method of radio construction known as "Printed Circuitry." These circuits operate on your regular AC or DC house current.

THE "EDU-KIT" IS COMPLETE

You will receive all parts and instructions necessary to build twenty different radio and electronics circuits, each guaranteed to operate. Our Kits contain tubes, tube sockets, variable, electrolytic, mica, ceramic and paper dielectric condensers, resistors, tie strips, hardware, tubing, punched metal chassis, Instruction Manuals, hook-up wire, solder, selenium rectifiers, coils, volume controls, switches, solid state devices, etc.

In addition, you receive Printed Circuit materials, including Printed Circuit chassis, special tube sockets, hardware and instructions. You also receive a usefui set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio and Electronics Tester. The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator, in addition to F.C.C. Radio Amateur License training. You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector, a High Fidelity Guide and a Quiz Book. You receive Membership in Radio-TV Club, Free Consultation Service, Certificate of Merit and Discount Privileges. You receive all parts, tools, instructions, etc. Everything is yours to keep.

FREE EXTRAS

- **SET OF TOOLS**
- SOLDERING IRON
- ELECTRONICS TESTER
- PLIERS-CUTTERS
- VALUABLE DISCOUNT CARD
- CERTIFICATE OF MERIT
- TESTER INSTRUCTION MANUAL
- HIGH FIDELITY GUIDE • QUIZZES
- TELEVISION BOOK • RADIO TROUBLE-SHOOTING BOOK
- MEMBERSHIP IN RADIO-TV CLUB: CONSULTATION SERVICE • FCC AMATEUR LICENSE TRAINING
- PRINTED CIRCUITRY

SERVICING LESSONS

You will learn trouble-shooting and servicing in a progressive manner. You will practice repairs on the sets that you construct. You will learn symptoms and causes of trouble in home, portable and car radios. You will learn how to use the professional Signal Tracer, the unique Signal Injector and the dynamic Radio & Electronics Tester. While you are learning in this practical way, you will be able to do many a repair job for your friends and neighbors, and charge fees which will far exceed the price of the "Edu-Kit." Our Consultation Service will help you with any technical problems you may have.

FROM OUR MAIL BAG

Ben Valerio, P. O. Box 21, Magna, Utah: "The Edu-Kits are wonderful. Here I am sending you the questions and also the answers for them. I have been in Radio for the last seven years, but like to work with Radio Kits, and like to build Radio Testing Equipment. I enjoyed every minute I worked with the different kits; the Signal Tracer works fine. Also like to let you know that I feel proud of becoming a member of your Radio-TV Club."

Robert L. Shuff, 1534 Monroe Ave., Huntington, W. Va.: "Thought I would drop you a few lines to say that I received my Edu-Kit, and was really amazed that such a bargain can be had at such a low price. I have already started repairing radios and phonographs. My friends were really surprised to see me get into the swing of it so quickly. The Trouble-shooting Tester that comes with the Kit is really swell, and finds the trouble, if there is any to be found."

SOLID STATE

Today an electronics technician or hobbyist requires a knowledge of solid state, as well as vacuum tube circuitry. The "Edu-Kit" course teaches both. You will build vacuum tube, 100% solid state and combination ("hybrid") circuits.

PRINTED CIRCUITRY

At no increase in price, the "Edu-Kit" now includes Printed Circuitry. You build a Printed Circuit Signal Injector, a unique servicing instrument that can detect many Radio and TV troubles. This revolutionary new technique of radio construction is now becoming popular in commercial radio and TV sets.

A Printed Circuit is a special insulated chassis on which has been deposited a conducting material which takes the place of wiring. The various parts are merely plugged in and soldered to terminals.

Printed Circuitry is the basis of modern Automation Electronics. A knowledge of this subject is a necessity today for anyone interested in Electronics.

Progressive "Edu-Kits" Inc., 1189 Broadway, Dept. 511 FC Hewlett, N.Y. 11557

Please rush me free literature describing the Progressive Radio-TV Course with Edu-Kits. No Salesman will call.

NAME .....

ADDRESS .....

CITY & STATE ..... ZIP .....

PROGRESSIVE "EDU-KITS" INC.

1189 Broadway, Dept. 511 FC Hewlett, N.Y. 11557

CIRCLE 8 ON READER SERVICE COUPON

New Products

LED-Readout Frequency Counter

The Continental MAX-100 provides effortless, accurate frequency readings from 20 Hz to a guaranteed 100 MHz for audio, ultrasonic, RF (AM and FM), video and digital applications. A clip-lead or other input cable, or a mini-whip antenna is simply plugged in, and the

CIRCLE 43 ON READER SERVICE COUPON

unit turned on. MAX-100 Automaticaliy gives direct frequency readings on its big, bright 8-digit, 0.6-in. LED display. Read-out is updated once a second, and overflow signals (above 100 MHz) are automatically indicated by flashing the most significant (left-hand) display digit. Since it can operate on six AA cells (alkaline or rechargeable NiCad), 110 or 220 VAC (with charger/eliminator), 12 VDC (with mobile charger/eliminator) or any 7.2-10 VDC supply, it can be used virtually anywhere—in lab or field. And when battery supply is low (below 6.6 VDC), MAX-100 automatically signals by flashing all display digits simultaneously, which also prolongs remaining battery life. Heart of the new MAX-100 is a 3.579545 MHz crystal-controlled time-base with 3 ppm accuracy and high temperature stability, which insures precise readings. Sells for $139.95. For more information, contact Continental Specialties Corporation, 44 Kendall Street, New Haven, CT 06509.

For West Coast

Now you can install an electronic seismic device that registers unusual vibrations in buildings, above the normal mo-

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tion caused by weather and traffic, to give an early warning signal of an earthquake. The Seismolert sends out a shrill constant alarm when building vibrations register displacements of 1/100 of an inch. Often earthquakes begin with small foreshocks and there are many seconds and even minutes available to seek safety before the large shocks register. The system is made of totally solid-state American-made components and works without AC line voltages, using only low-voltage DC current with UL approved adapter. The patented device uses 25 cents of electricity per month and the Seismolert also has a battery system that will take over instantaneously in case of power failure. The system can be wired to include additional alarms and to cut off gas and electricity when the alarm sounds. For the seismic hobbyist there are models which record the intensity number and draw charts of the shock waves. The unit is portable and can be moved to any location. It comes complete and ready for installation, which takes less than five minutes and requires no special tools. Price is $89.95 for the Model #SML-2E. Models with utility regulation and charts are available for prices up to $199.95. For more information, write to Seismotronics Corp., 7001 Dublin Blvd., Dublin, CA 94566.

Digital Bathroom Scale

Heath Company has a new digital bathroom scale for the weight watcher. The GD-1186, called "Digi-Scale," has a large LED electronic digital readout that is visible from as far away as ten feet. The

CIRCLE 1 ON READER SERVICE COUPON

new scale is far more precise than most conventional scales since no springs, weights or pins are employed. Solid-state circuitry and a strain-gauge transducer element such as that used in electronic laboratory-quality scales insures excellent precision. The "Digi-Scale" weighs to 300 pounds, and reads out in 2/10ths of a pound increments. A zeroing feature permits adjustment for weighing small items. Extra cable supplied with the kit allows the readout to be mounted at eye level on a wall or any handy surface. The GD-1186 operates on six conventional "C" cells (not included). It is housed in a handsome cast-aluminum platform with burl-grained vinyl insert. For more information about the "Digi-Scale," which is mail order priced at $99.95 kit form and $139.95 assembled, write for a free catalog to Heath Company, Dept. 350-390, Benton Harbor, MI 49022.

Turn Burglars Off

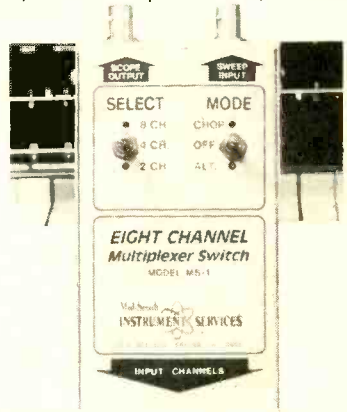
One of the simplest, most effective devices to keep burglars away has been introduced by Mountain West Alarm Co. of Phoenix, Arizona. The Guardian Switch turns lights, radios, tape recorders, etc. "on" and "off" to make your home or business appear to be occupied when you are away. Simply connect P10 switch to lamp, radio or whatever appliance to be used. Select the time pattern desired (3 available), plug into wall outlet and the Guardian is set. Darkness automatically triggers activity according to the duration and pattern selected. Can also remain in an inoperative state dur-

CIRCLE 45 ON READER SERVICE COUPON

ing daylight hours. Unit priced at $21.95. Excellent protection for a minimum cost. For more information, contact Mountain West Alarm Supply Co., Box 10780, Phoenix, AZ 85064.

Scope Multiplexer

The MS-1 Multiplexer Switch is an inexpensive, compact adaptor for converting any conventional, single channel oscilloscope into a multichannel logic analyzer for troubleshooting all types of digital logic circuits. The adaptor features two, four or eight channels of displayed data which is switch selectable and it operates in either chop or alternate sweep modes. The design features CMOS ICs for low power consumption, typically less than 6 mA total. With the MS-1, up to eight data lines may be sampled simultaneously while displaying the digital logic levels and timing relationships on a conventional scope. Each input channel is multiplexed through an analog switching device, so that waveforms as well as logic levels are preserved. In addition, the CMOS circuitry is completely compatible with logic families where the power supply voltages range from +3.5 volts to +15 volts (RTL, DTL, TTL, MOS, CMOS, and Microprocessors). The MS-1



CIRCLE 57 ON READER SERVICE COUPON

in kit form sells for $59.95. Additional information may be obtained by contacting Mid-South Instrument Services, Inc., P.O. Box 1252, Gretna, LA 70053 or call (504) 393-0450.

(Continued on page 117)

Ask Hank, He Knows!

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
101 ELECTRONIC PROJECTS
380 Lexington Avenue
New York, NY 10017

Saves Power

What is the difference between a 74L500 IC and 7400 IC?

—T. T., Cando, ND

In the Radio Shack catalog, the difference is only 14 cents. The L's in the type number indicate that the device is a low-power Schottky device that's easy on the battery supply. Otherwise, both units are identical for most hobbyist applications. I use the Schottky devices because most of my projects end up battery driven.

Too Old

What devices can be made of old TV sets? For example, can the amplifiers be used for a hi-fi set or a P.A. system? There's gotta be uses for those component circuits.

—A. W., Danville, CA

The trouble with old TV sets is the parts have been "baked" too long. I classify parts from old TV sets as junk. I'd throw the old TV out and find a different source for parts and circuits.

Forward & Reverse

What is forward current and reverse current in diode specs?

—L. N., Sunnyvale, CA

First let me define conventional current flow as that mythical flow of electronic current from the positive DC source to a negative DC source. Shades of ol' Ben Franklin! Now, the diode symbol of an arrow striking a cathode has meaning because the arrow points in the direction of ol' Ben's conventional current flow (just the opposite of electron flow). Forward current (If) is the amount of conventional current flowing from the *anode* to *cathode* for a given forward voltage imposed on the diode. In this instance, the anode is positive and the cathode is negative. We should expect the diode's internal resistance to be very low. Reverse current (Ir) is the amount of conventional current flowing from the cathode to the anode when a given reverse voltage is imposed on the diode. That's to say that the cathode of the diode is positive with respect to the diode's anode. Now the only problem remaining is identifying the anode and cathode leads on a diode. Easy—the banded end, a strip of black or red color usually, denotes the cathode side of the terminal.

Hot Up There

I need a remote thermometer to monitor the attic heat during the summer. This way, I'll know when to turn on and off my attic fan. Got any ideas?

—M. M., Globe, AZ

What you need is a thermostatically controlled switch in the attic to turn on the attic fan whenever the temperature is 105°F (who knows from Celcius). Nutone makes one which is placed in line with the power to the fan and at a hot point in the attic. Attic temperatures above 105°F turn the fan on until the temperature goes below 105°. Then the fan is turned off to save power. Nutone also makes a cutoff device in the event there is a fire. The device prevents forced air draft should the temperature exceed 190°F or thereabout. Both devices should be installed. Get all the details from your local Nutone dealer, electrical supplier, or write to Nutone at Madison and Red Bank Roads, Cincinnati, OH 45227 and ask for their attic fan catalog.

I See the IC

Where can I buy a 4543 CMOS chip?

—L. M., West Point, NE

Just happens I have a Radio Shack catalog on my desk, and it lists the 4543 at $1.89. Many other parts outlets, maybe not in West Point, Nebraska, now carry a large experimenter line of IC's. If you can't buy it locally, pick up a copy of ELEMENTARY ELECTRONICS and look at the ads in the back. Lots of good buys, and more IC's listed than are carried in most outlets.

Here Comes the Bride

Where can I get a car horn to play the Wedding March? I'm getting married and I want to surprise my wife-to-be.

—J. L., Bowie, MD

Unless you play a cassette tape into a loudspeaker, you'll have to settle for an expensive four-trumpet musical air horn system that sells for under $90. Order horn assembly No. 723-4 and tune No. 167. Either call Kolin Industries, Inc. for catalog at 1-800-327-2777 (in Florida call 800-432-2766) or write to Box 357EE, Bronxville, NY 10708.

Lend A Hand

If you can, please help out your fellow readers. Thanks in advance.

Δ Ray-Tel TWR-3 CB transceiver, Schematic diagram and specs needed; David B. Barbour, Rt. 1, Box 86, Willow Springs, NC 27592.

Δ Spartan, Model 110, RCA Radiola 18, Philco 60 and Philco 505, needs service information; Bruce A. McCoy, 1514 2nd St., LaPorte, IN 46350.

Δ Supreme Model 581 Signal Generator and Frequency Modulator, need all service literature and shop manual; Gene J. Taylor, Box 316, Long Pine, NE 69217. ■

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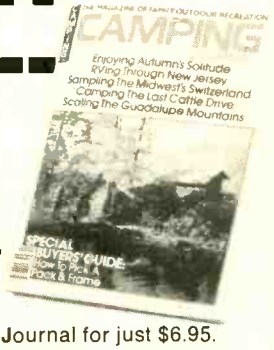

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101 Electronic Projects '79

An introduction to the fascinating world of electronics with a multitude of fun, quick, and easy-to-build projects, for the home, car, and office.

IN THIS ERA of non-ending inflation, we believe it is most important that a construction project serve as more than an evening's diversion, and not merely to be assembled, played with, and finally discarded. Surely the time, effort, and cost that go into any construction project can just as easily result in a device that can be used to enhance your daily living, just as it might be used to increase the enjoyment you get from a hobby or interest.

We believe a construction project should provide the same features and performance you might attain from commercial equipment, but at a substantially lower price than what you might pay in a hardware, discount, or electronics specialty store. For example, a professional quality burglar alarm control unit may cost between $30 to $50. In actual fact, you can assemble essentially the same device for well under $10, using components as reliable, or more so, than the commercial version. Another example: Let's assume you're into table-top or macro photography, or even portraiture. If you've priced studio floodlight controllers, then you're prepared to spend maybe $100 or more for full-range (full *off* to full *on*) control of just three lights. You can build almost the same three-light controller in a metal cabinet for about $25. In fact, the cabinet will probably be the most expensive component.

Just these two items should give you some idea of the wide range of projects you're going to find in this year's issue of 101 ELECTRONIC PROJECTS. And if you check the cost of building the projects, you'll find that most of them will cost under $15 even at today's inflated component prices. Some projects can be built for well under $10.

Bottom-line Prices. We have used the lowest cost generally available components. For example, a project might call for a 50-volt disc capacitor in a 6-volt battery operated circuit. While this appears strange at first glance, we specify the 50-volt capacitor because it is usually available at a much lower cost than the low voltage caps; it is also usually a lot easier to find 50-volt discs than the low voltage versions. Another example is our choice of resistors. Unless instructed otherwise, use ½-watt 10% because they are the least expensive. Sure, if you want to build a 10-watt amplifier in a pill box use ¼, ⅛, or 1/10 watt resistors, otherwise, take the least expensive way out. But if, however, the instructions or parts list call for a 5% resistor, don't try to get away with a ten-percenter; the project probably won't work right.

The electronics dealers who advertise regularly in the back of ELEMENTARY ELECTRONICS and other leading electronic hobby magazines are good sources for parts. So are your local electronic and radio parts stores. In many cases, you can get parts from your own "junkbox" after stripping them off old, broken equipment. Chances are a local TV repair shop can give you a junker to start you on your way.

As much as is possible, we have tried to avoid the use of industrial or specialty solid-state devices. With few exceptions, all the transistors are "general replacements" or types for which a general replacement is available. A good place to locate a specific solid-state device, not its "general replacement," is from the components and parts dealers that advertise in electronic hobbyist magazines such as ELEMENTARY ELECTRONICS.

Integrated circuits might be slightly more difficult to obtain because there aren't as many direct or equivalent dealers. As a general rule, try to use the exact IC specified, but if you can't locate it from a "back pages" components dealer, use a substitute from the Radio Shack, Motorola HEP, or Sylvania line. While there are several other "general replacement" lines available on a regional and national basis, we know the components specified have a replacement under one of the three major brands.

As a general rule, the projects can be assembled in any form, shape, or manner. You can even assemble many of them so the parts just hang from a

101

string, and they will still work. However, there are some instances where a special or particular type of assembly is absolutely required if the project is to work. For example, if we specify a "heat sink," you will probably blow a transistor or IC if you don't use one. If we call for a metal cabinet, use one; the hum pickup without one will probably make the project useless.

On the other hand, don't go overboard and make every project a "gold plated special." Using components of a higher grade, tolerance, and price than we specify, will add nothing to final performance. It will just make everything unnecessarily expensive.

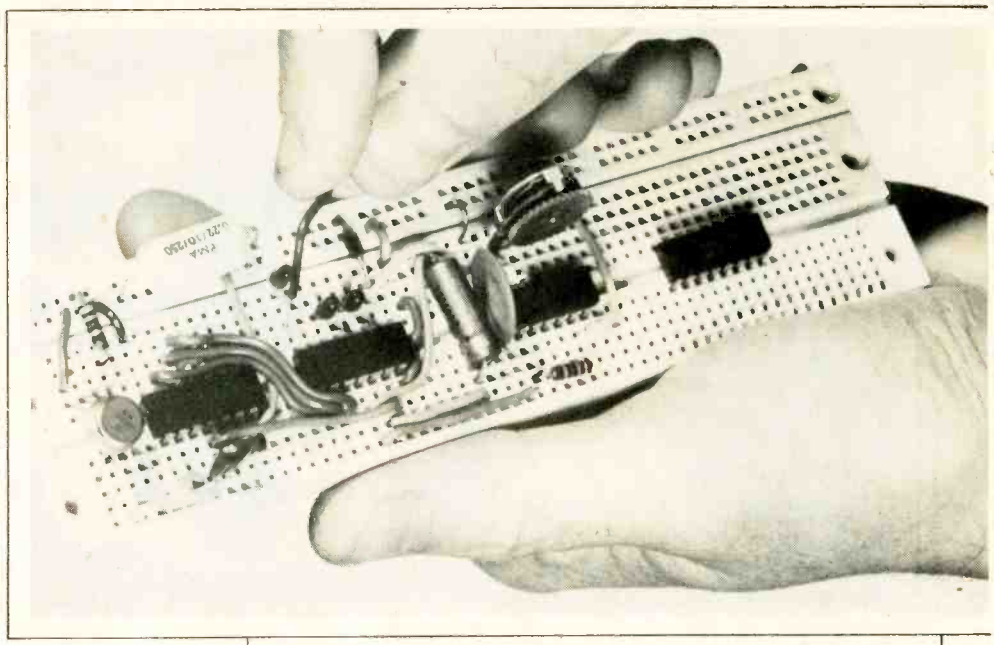
Bear in mind that the projects are designed to deliver the performance we claim; don't expect more. For example, if we say an IC amplifier delivers 1-watt output don't try for more power by using a higher battery voltage; you're certain to blow the IC. If we say a photoflood controlled can handle a 500-watt #2 lamp, don't try to control two #2 lamps; all you will do is destroy the solid-state device the instant you turn the power switch *on*.

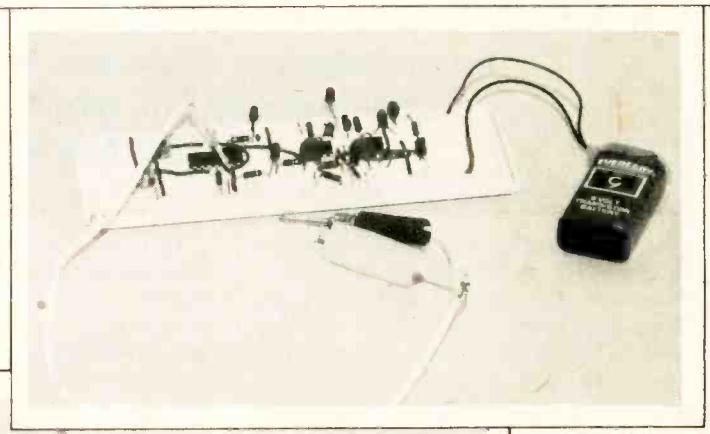
Finally, do not overlook the fact that many projects are designed to be both a complete device *and a building block;* that is, it can be used with one or more projects to create a device that actually doesn't exist in this book. As a general rule of thumb, it is safe to experiment by using battery-powered projects as building blocks, but do not try to interconnect line powered (120-VAC) and batery powered projects.

This doesn't mean that you're completely free from trouble, it just reduces the chance of an accident. But, there are still a few procedures to follow to avoid trouble.

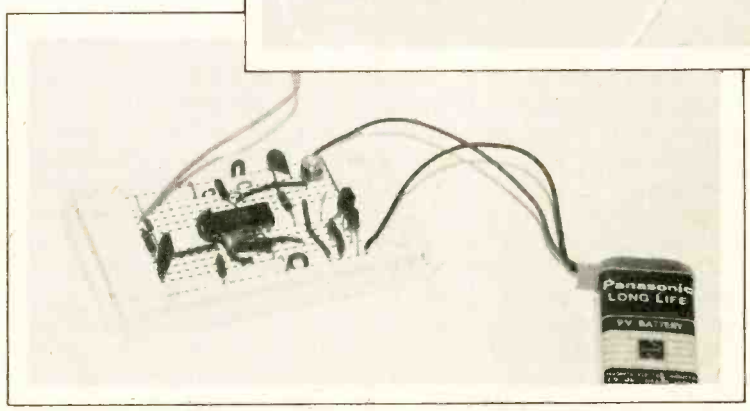
For one, always check across the power leads with an Ohmmeter before you connect power. If it reads less than 20-30 Ohms, you're going to be drawing too much current. That can drain your battery, blow your car's fuse, burn out your stereo's output or mess up the phone company lines all around you, depending on the project.

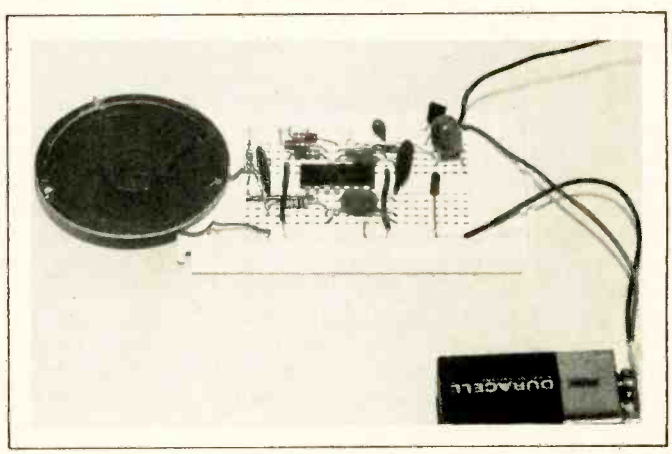
Don't attach anything to the phone lines unless and until you're very sure it won't disturb service. Make sure your parts can withstand a several-hundred-volt de-icing surge, and never leave anything attached for more than a few minutes. ■





As you can see, the compact size of solderless breadboards makes putting together any of the 101 projects a breeze. Spacing of the holes matches up with IC pins, so sockets are unnecessary.





Power for your projects is carried on the outer edges of the breadboard, thereby isolating the rest of the circuitry from the kind of goof which used to damage semiconductors with regularity. No power can get to a component unless you deliberately make it so.

101 ELECTRONICS PROJECTS

1 Slide Show Stopper

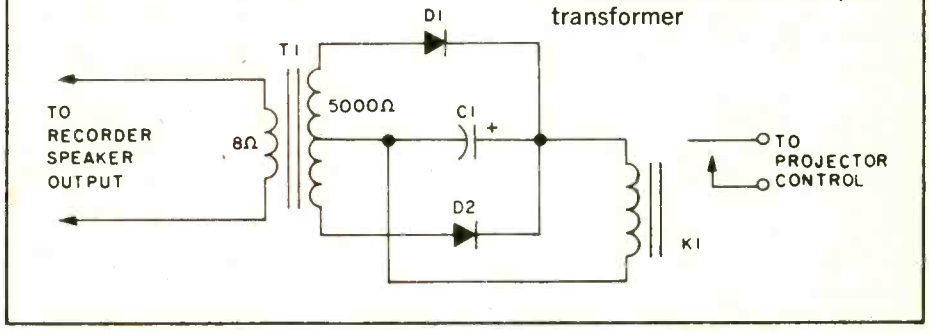
☐ Soundless slide shows are dull, dull, dull! But a stereo recorder can automate the whole show so slides change automatically in step with the commentary.

Record your commentary on the left track. At the instant you want slides to change, record a one-second noise or tone burst on the right track. Connect the programmer between the recorder's right speaker output and the projector's remote control cable. Make a test run to determine the right-track volume setting to make noise or tone bursts activate relay K1. No fancy tone generators needed here. Just give a hearty Bronx cheer into the mike of the left channel only!

Then start the tape from the beginning. The audience will hear your commentary or spectacular music-and-sound reproduction through a speaker connected to the recorder's left channel, while the signal on the right channel automatically changes the slides.

PARTS LIST FOR SLIDE SHOW STOPPER

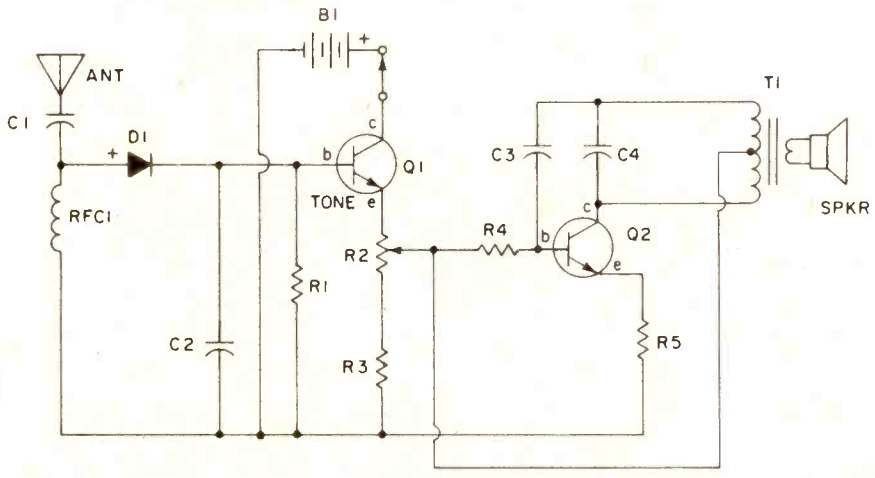
C1—25-uF, 50-VDC electrolytic capacitor
D1, D2—1-A/400-PIV silicon rectifier, Motorola 1N4004
K1—2500-ohm coil plate-type relay
T1—5000-ohm CT audio output transformer



2 Sidetone Oscillator

☐ CW (continuous wave, the form of modulation involving a simple turning on and off of the RF carrier) is the simplest way for a beginning ham to transmit to his fellow hams. And the famous Morse Code is how he gets his message across. But Morse is a lot easier to send if you can hear what you're sending. This circuit lets you do just that.

A short length of wire near the transmitter picks up RF as it's transmitted and acts as the antenna for our circuit. This RF is detected by D1, smoothed by C2, and used to turn Q1 on and off, following the transmitted signal exactly. Q1 switches the positive supply through R2 to beep oscillator Q2 through the center tap of T1. The values shown produce a pleasant, easily distinguishable tone.



PARTS LIST FOR SIDETONE OSCILLATOR

B1—9VDC battery
C1—50-pf capacitor
C2—470-pf capacitor
C3, C4—.01-uF capacitor
D1—Diode, 1N914
Q1, Q2—NPN transistor, 2N2222 or equiv.
R1—470,000-ohm resistor, ½-watt
R2—5000-ohm potentiometer
R3—4700-ohm resistor, ½-watt
R4—100,000-ohm resistor, ½-watt
R5—100-ohm resistor, ½-watt
RFC1—2.5-mH choke
T1—1000; 8-ohm transformer, centertapped
SPKR—8-ohm speaker

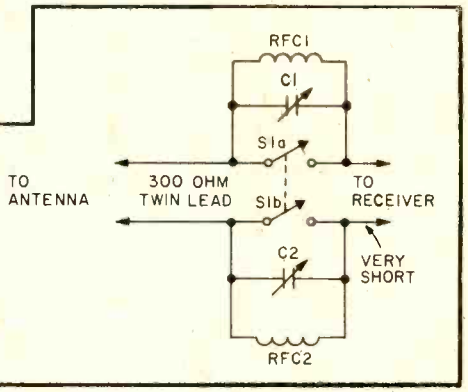
3 FM Overload Filter

☐ A simple filter is all it takes to remove a strong, local FM signal that is blocking or cross modulating other FM stations. The filter connects in series with the FM antenna's downlead. Just be sure to use the shortest possible length between the filter's output and the receiver.

The filter *must* be assembled in a metal cabinet with ¼-in. access holes so you can adjust the trimmer tuning capacitors. The metal cabinet is grounded to the receiver's chassis. Switch S1 by-passes the filter for normal operation. If your antenna's downlead is coaxial cable, only one filter is installed—in series with the center (hot) conductor. To adjust, tune in the offending station and use an insulated alignment screwdriver to adjust trimmer capacitors C1 and C2 for *minimum* signal strength.

PARTS LIST FOR FM OVERLOAD FILTER

C1, C2—40-pF trimmer capacitor
RFC1, RFC2—0.22-uH RF choke, any type
S1—Dpst slide switch
Misc—300-ohm twinlead, metal cabinet

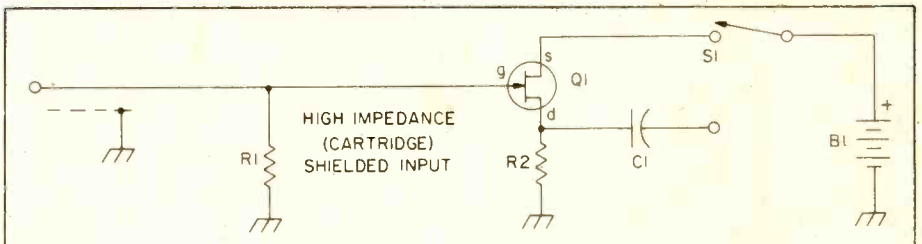


4 Ceramic Cartridge Preamplifier

☐ Here's the answer to how to marry that old ceramic cartridge phonograph with the amplifier that isn't quite hot enough to be able to accept it. It's a common enough problem, found by a lot of people when they attempt to upgrade a system. Here's the solution.

The circuit is really acting as an impedance converter, converting a high impedance input, such as a ceramic cartridge, into a low impedance. Choose an input resistor (R1) to match the impedance of your phono cartridge; the circuit's output impedance will be very close to the value of R2.

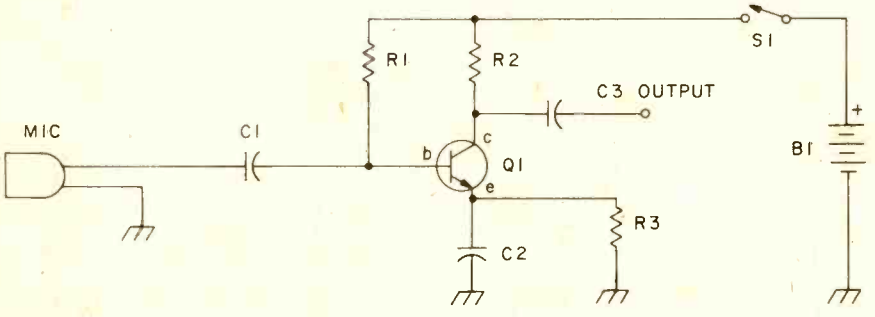
This same circuit, of course, can be put to other uses involving magnetic tape heads or piezoelectric transducers (used in ultrasonics), for example, or other high impedance sources. If installed inside the amplifier, B1 and S1 may not be necessary.



PARTS LIST FOR CERAMIC CARTRIDGE PREAMP

B1—6-15 VDC battery
C1—5-15-uF capacitor
Q1—N-channel JFET (Junction Field Effect Transistor) (2N5458 or equiv.)
R1—1-10 Megohm resistor, ½-watt
R2—820-150-ohm resistor (see text), ½-watt
S1—SPST switch

5 Dynamic Mike Amplifier



PARTS LIST FOR DYNAMIC MIKE AMP

B1—6-15 VDC battery
C1—5-25-uF capacitor
C2—50-250-uF capacitor
C3—2-15-uF capacitor
Q1—NPN transistor (2N2222, 2N-3904 or equiv.)
R1—33,000-68,000-ohm resistor, ½-watt
R2—2700-5600-ohm resistor, ½-watt
R3—82-150-ohm resistor, ½-watt
MIC—Low impedance microphone, 8-600-ohms

☐ This simple one-transistor preamp will get a little more signal out of even a tired old microphone. And the circuit is small enough to build right into a microphone, if you want to. If you use this circuit at the microphone, it will let you use a longer run of cable to the input of your cassette recorder, for example, or whatever you're using. The added amplification of this circuit should more than offset the additional line losses.

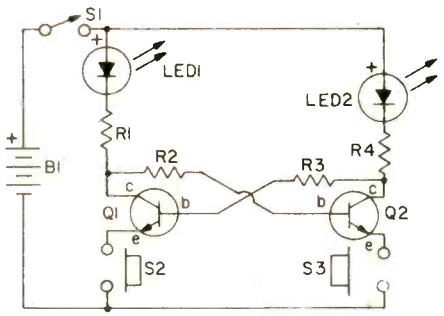
If your microphone includes a push-to-talk switch, you might want to investigate making it do double duty as a power switch as well. In most cases, this will be easier if you include S1 in the negative battery connection rather than the positive, as shown here.

6 Quick Draw Game #1

☐ Okay, podner, the fust one to push the button lights the light on his side, and blocks the other light from turning on.

You can yell "draw" by closing S1. But instead of a switch, you can find a trickier way of closing the contacts.

Try rolling a steel ball bearing down a channel with the contacts on the bottom. When the ball completes the circuit, go for your trigger buttons. Or you can just leave S1 closed. Once both "triggers" (S2 and S3) are released, this game is automatically set to be played again.



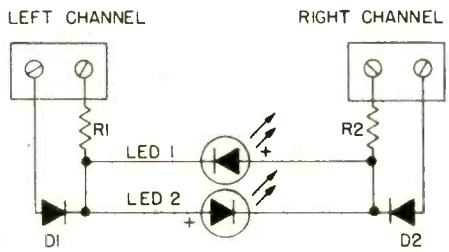
PARTS LIST FOR QUICK DRAW GAME #1

B1—6-15 VDC battery
LED1, LED2—Light emitting diodes
Q1, Q2—NPN transistors (2N2222 or similar)
R1, R4—150-390-ohms resistors, ½-watt
R2, R3—22,000-56,000-ohm resistors, ½-watt
S1—SPST switch (see text)
S2, S3—Normally open momentary, or micro, switches

7 Nulling Stereo Balance Checker

☐ Ever get frustrated trying to guess where the center of your stereo's balance control really was? A few components and a few minutes of time can take the guesswork out of it.

Set your stereo on MONO, put something on and you're ready. Now adjust the balance control from side to side. You'll see first one LED light, then the other. When you get near the transition point, go slowly. At some point, both LEDs will be off. This is the center balance position. This circuit may also be adapted to finding zero beat for hams and SWLs. Omit D1 and D2 and connect the leads of R1 and R2 across the receiver's speaker terminals. At zero beat, both LEDs will be dark.



PARTS LIST FOR NULLING STEREO BALANCE CHECKER

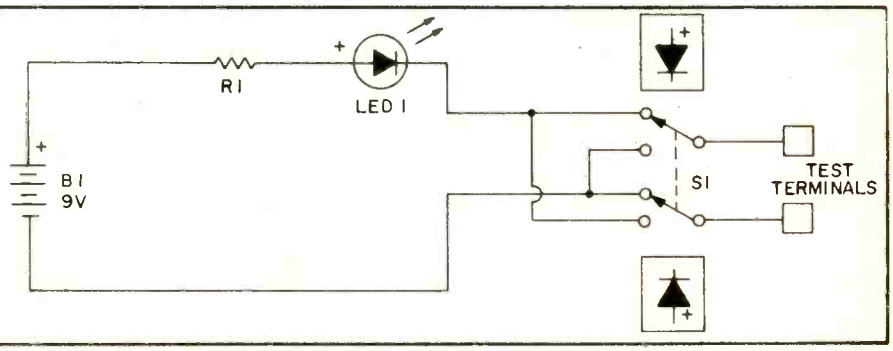
D1, D2—Diode, 1N914 or equiv.
LED1, LED2—Light emitting diode
R1, R2—1000-ohm resistor, ½-watt

8 Quick Diode Checker

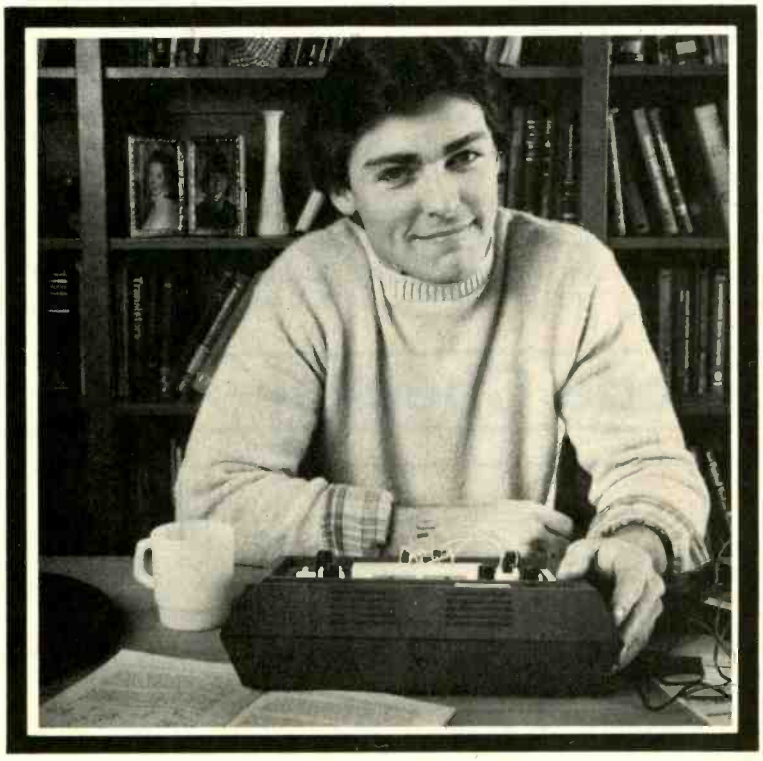
PARTS LIST FOR QUICK DIODE CHECKER

B1—9VDC battery
LED1—Light emitting diode
R1—470-ohm resistor, ½-watt
S1—DPDT switch

(Continued on page 22)



CIE has a terrific idea for a few people who know what they want.



If you want success in electronics . . . if you want the skills people are glad to pay for . . . find out about CIE training. It's a terrific idea that can get you on your way to success in electronics troubleshooting.

Let's face it, learning valuable new skills isn't something you just breeze through. Especially in a modern technological field like electronics troubleshooting. You've got to really *want* success if you're going to build your skills properly.

But, oh boy, the rewards when you do! In today's world, the ones who really *know* electronics troubleshooting find that people . . . even industries . . . look for their help.

What about you? How much do you want the thrill of success . . . of being in demand? Enough to roll up your sleeves and work for it?

Why it pays to build troubleshooting skills.

Suppose the automated production controls on an assembly line break down. Imagine how much money the manufacturer can lose when help doesn't come *fast!* And it takes a skilled electronics troubleshooter to move in . . . locate the problem . . . solve it . . . and get the lines moving again.

Or take a TV station. Breakdowns are costly in broadcasting where time is money. Viewers won't sit forever waiting for sound or the picture to come back. Before they change channels, the station needs to get back on the air again – with the help of a skilled troubleshooter.

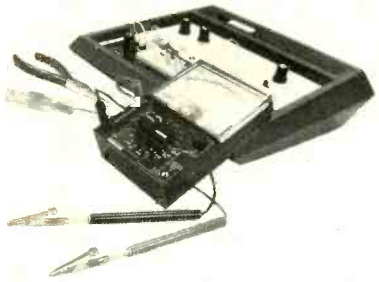
No question about it. Building new skills in electronics troubleshooting is an investment in your future. It's well worth the effort.

Why you should get CIE to help you do it.

Troubleshooting starts with *ideas* . . . principles. CIE's Auto-Programmed® Lessons help you get the idea – at your own most comfortable pace. Step by step at home, you explore each principle – each theory – until you understand it thoroughly and completely. Then you start to use it.

How CIE helps you turn ideas into reality.

If you're a beginner, you start with CIE's Personal Training Laboratory. You actually perform over 200 experiments to help you grasp the basics. Plus you use a 3-in-1 Precision Multimeter to get your first taste of the testing, checking, analyzing steps you take in troubleshooting!



How 3 practical steps help you build troubleshooting skills.

You'll take your first practical step in professional troubleshooting when you build your own 5MHz triggered-sweep, solid-state oscilloscope.

As a trained troubleshooter, you'll use your oscilloscope the way a doctor uses his X-ray machine. As a student, you learn how to "read" waveform patterns on a big, 8cm. x 10 cm. screen . . . how to "lock them in" for closer study . . . how to understand and interpret what they tell you.

Your second practical, skill-building step begins when you get your Zenith 19-inch diagonal, solid-state color TV – featuring nine removable modules! Now's your chance to apply the new skills you learned with your oscilloscope!

With CIE's guidance, you perform actual service operations – the kind you'd handle on the job as a trained troubleshooter! Using the TV, you learn to trace signal flow . . . detect and locate malfunctions . . . restore perfect operating standards . . . just as you would with any sophisticated electronics equipment.

Finally, step three rounds out your experience as you work with a completely solid-state color bar generator – actually a TV signal transmitter that produces ten different display patterns on your TV screen!

You study a gated color bar rainbow . . . crosshatch lines . . . dot patterns. You explore digital logic circuits . . . observe the action of a crystal-controlled oscillator!

This practical, "hands on" training takes concentration and effort. But it's enjoyable and rewarding. And it's a great way to prepare for a troubleshooting career!

Why it's important to get your FCC License.

For some troubleshooting jobs, you *must* have your FCC License. For others, employers often consider it a mark in your favor. It's government-certified proof of specific knowledge and skills!

Almost 4 out of 5 CIE graduates who take the exam get their Licenses. More than half of CIE's courses can prepare you for it . . . and the broadest range of career opportunities!

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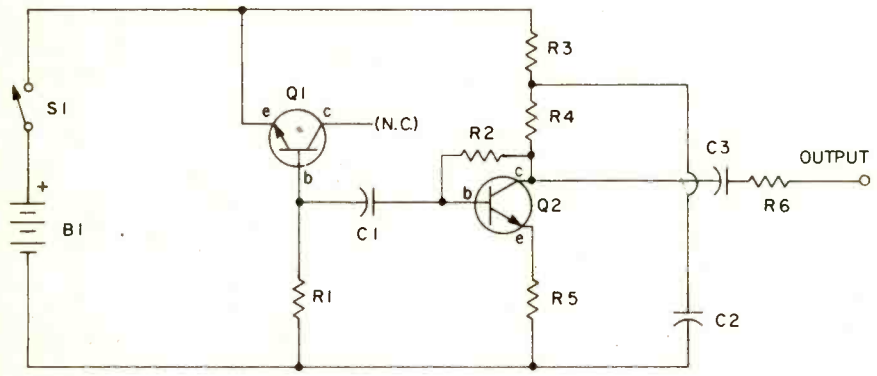
(Continued from page 17)

☐ This not only tells you whether or not a diode is good, it checks the polarity for you.

The diode under test completes the circuit through B1, R1 and the LED when inserted in the proper polarity. Switch S1 reverses the polarity of the diode under test. A good diode will light the LED only in one switch position. An open diode will not light it in either position. A shorted diode will light it in both positions. To use the circuit as a polarity indicator, connect the diode to the test terminals. The diagrams above refer to the polarity of the diode when the LED lights in the switch positions.

9 Noise Generator



PARTS LIST FOR NOISE GENERATOR

B1—9 VDC battery
C1—.05-uF capacitor
C2—220-uF capacitor
C3—.005-uF capacitor
R1—1-Megohm resistor, ½-watt
R2—1.8-Megohm resistor, ½-watt
R3, R5—150-ohm resistor, ½-watt
R4—120,000-ohm resistor, ½-watt
R6—56,000-ohm resistor, ½-watt
Q1, Q2—NPN transistor, 2N3904 or equiv.
S1—SPST switch

☐ Audio buffs often refer to their systems as having color or temperature. One that is rich in low end response is said to be warm and red; a bright high end on a system means it's cool and blue.

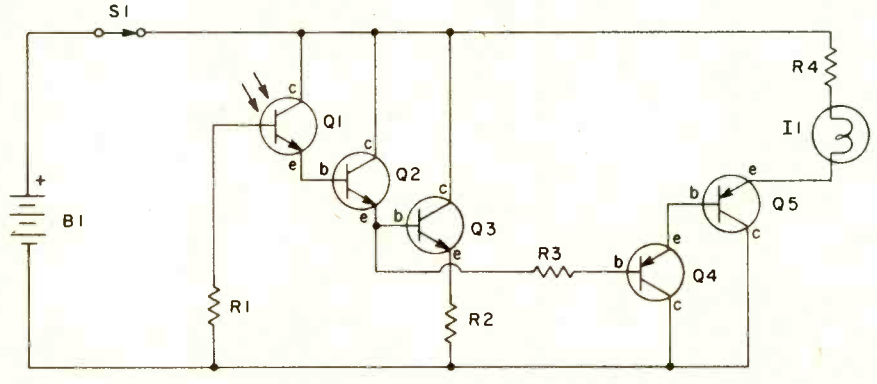
The mixture of all these characteristic colors is white, and white noise generators produce a whooshing shound that is randomly distributed throughout the spectrum. Likewise, pink noise generators are just a bit warmer. This simple noise generator is one we might call off-white. It takes advantage of the junction noise generated in a reverse-biased semiconductor junction (here, a base-to-emitter junction in NPN transistor Q1).

The noise generated by current through Q1 is amplified by Q2 and made available at the output. For a simple demonstration of tonal coloring, patch this noise into your sound system and see how manipulating your tone controls alters the nature of the noise your hear.

10 Nifty Night Light

☐ It's automatic! Let the face of Q1 get dark, and I1 turns on. Phototransistor Q1 turns on buffer switch Q2-Q3, which activates Darlington switch pair Q4 and Q5 to turn on I1. I1 is current limited by R4 to deliver long life and reduce the circuit's overall current drain.

Don't make the mistake a brilliant engineering school made years ago. They installed a sophisticated system based on a circuit much like this. It was designed to turn their area lights on at dusk, off at sunrise, and had delays built in to keep the lamps from flickering when a cloud, for example, temporarily blocked the sun. The mistake came when they placed the circuit at the bottom of the light poles.



PARTS LIST FOR NIFTY NIGHT LIGHT

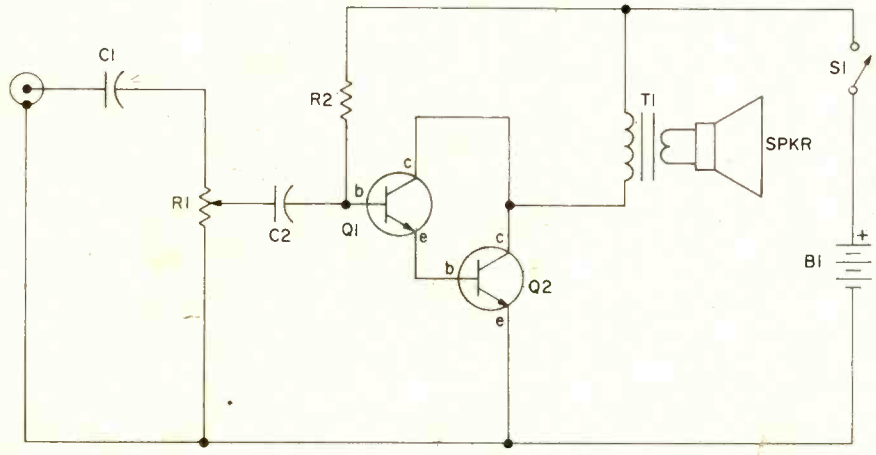
B1—9 VDC battery
I1—Bulb, #47-type
Q1—Photoelectric transistor, FPT-100 or equiv.
Q2, Q3—NPN transistor, 2N3904 or equiv.
Q4, Q5—PNP transistor, 2N3906 or equiv.
R1—10-Megohm resistor, ½-watt
R2—1000-ohm resistor, ½-watt
R3—100,00-ohm resistor, ½-watt
R4—27-ohm resistor, ½-watt
S1—SPST switch

The first night, the lights came on fine, but after a delay the circuit mistook them for sunlight and turned them off again. Which started the whole process over and had the campus blinking all night.

11 Penny Pincher's Utility Amplifier

☐ Here's high gain with just a handful of parts for a zillion audio applications. Q1 and Q2 are Darlington connected to deliver a lot of gain and make this a really hot circuit. Transformer T1 reduces the loading on the transistors to help assure a strong, clean output. This amplifier has many test bench applications, from signal tracing to loudness boosting to checking out new sound effects.

Add it to an inexpensive record or tape player for a quick and easy checkout. Or tie a high output crystal mike to the input and use it as an electronic stethoscope.



PARTS LIST FOR PENNY PINCHER'S UTILITY AMPLIFIER

B1—9VDC battery
C1, C2—.1-uF capacitor
Q1—PNP transistor, 2N3904 or equiv.
Q2—PNP transistor, 2N2222 or equiv.
R1 — 1-Megohm potentiometer, audio taper
R2—1.8-Megohm resistor, ½-watt
S1—SPST switch
SPKR—8-ohm speaker
T1—500:8-ohm transformer
J1—RCA phono jack (or any two-conductor jack)

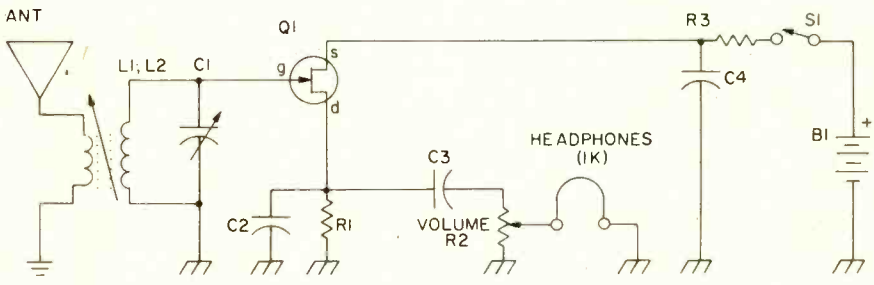
12 High Performance Transistor Radio

☐ Here's a neat way to update your crystal set, assuming you can still find it. Or use these few inexpensive parts to build from scratch. Instead of using a cat's whisker or a diode, this radio uses the very sensitive junction of a junction FET as its detector. This makes it a very "hot," very sensitive high impedance detector. Then the JFET does double duty by converting the high input impedance to a lower output impedance—low enough and with enough drive to power a set of high impedance headphones or a high impedance earphone (about 1K or so).

The antenna coil is one of those simple loopsticks you've seen at the parts stores. (Or you might want to wind your own on an oatmeal box). The broadcast variable capacitor is one of the tuning capacitors taken from an old, defunct radio. You can use any long wire for the antenna, but if you string it outdoors, be sure to use a lightning arrestor. You can also clip an alligator clip to your bedspring, a windowscreen, or the metal part of a telephone.

PARTS LIST FOR HIGH PERFORMANCE TRANSISTOR RADIO

B1—6-15 VDC battery
C1—Approx. 356-pF broadcast-type variable capacitor
C2—300-600-pF capacitor
C3—.05-.5-uF capacitor
C4—.22-1.0-uF capacitor
L1/L2—Ferrite loopstick, or ferrite-bar BCB antenna coil
Q1—N-channel JFET (Junction Field Effect Transistor) (2N-5458, MPF102 or equiv.)

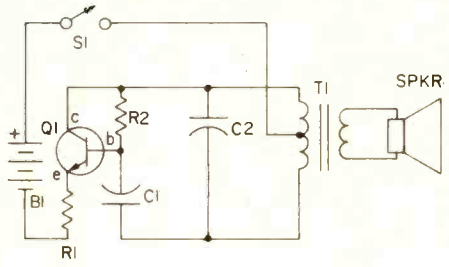


R1—18,000-47,000-ohm resistor, ½-watt
R2—20,000-100,00-ohm potentiometer
R3—4700-10,000-ohm resistor, ½-watt

13 Weirdly Wailing Oscillator

☐ Once you hear the nifty sound effect this tiny circuit puts out, you'll be dreaming up places to use it. The combination of C1 and C2 causes this oscillator to work at two widely separated frequencies at once. One, determined mostly by C2, determines the basic tone the oscillator will produce. The other, determined mostly by C1, governs the number of times per second the basic tone will be interrupted.

The output sounds very much like a pumping whistle—it's a sound effect associated with toy ray guns, tv and the movies. If you wish to build this as a toy, try using a momentary switch or microswitch for S1.



PARTS LIST FOR WEIRDLY WAILING OSCILLATOR

B1—6-15 VDC
C1—100-500-uF capacitor
C2—.1-.5-uF capacitor
Q1—NPN transistor (2N2222, 2N-3904 or equiv.)
R1—15-27-ohm resistor, ½-watt
R2—8200-15,000-ohm resistor, ½-watt
S1—SPST switch (see text)
T1—250-1000-ohm primary, center tapped; 4-16-ohm secondary

14 Wide Range Voltage Pilot

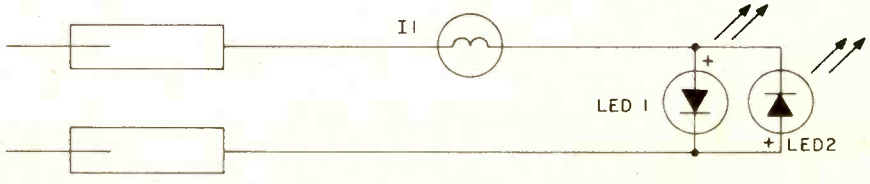
☐ Believe it or not, this simple tester will verify voltages between 2 and 120 Volts, AC or DC—and tell you which!

It's easy to understand if you can think of the filament of a small night-light bulb as being a wirewound resistor. It provides the current limiting that LED 1 and LED 2 need to operate safely. And, of course, when the voltage at the probe tips is high enough, I1 lights as well.

You can choose different colors for LED 1 and LED 2 and the probe tips for very quick polarity indications in the case of DC voltages. And seeing both LEDs glow is quick confirmation of an AC voltage.

PARTS LIST FOR WIDE RANGE VOLTAGE PILOT

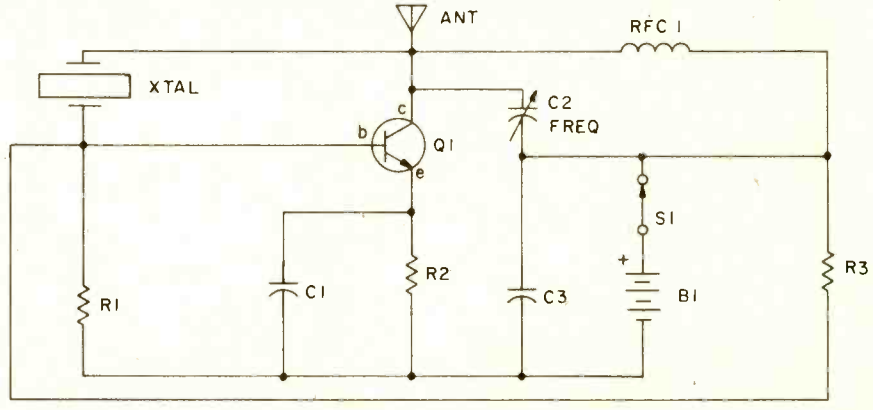
I1—Bulb, 7½ watts at 120-volts
LED1, LED2—Light emitting diode



15 Fox Hunt Transmitter

PARTS LIST FOR FOX HUNT TRANSMITTER

B1—9 VDC battery
C1, C3—.001-uF capacitor
C2—260-pF variable capacitor
Q1—NPN transistor, 2N2222 or equiv.
R1—10,000-ohm resistor, ½-watt
R2—470-ohm resistor, ½-watt
R3—47,000-ohm resistor, ½-watt
RFC1—2.5 mH radio frequency choke
S1—SPST switch
XTAL—crystal cut for the 49 MHz band



☐ Ever been to a radio foxhunt? Everyone brings a portable radio and a very directional antenna and tries to find where a small transmitter has been hidden. First one to find it wins. And here's just the transmitter to bring this old ham radio game to the rest of us. Transistor Q1 acts as a crystal oscillator in the new 49 MHz walkie-talkie band. The output of this oscillator is very low, and no license is required if you keep your antenna down to just a few inches in length.

Trimmer capacitor C2 lets you tweak the frequency of this transmitter right into the middle of the channel. Use a walkie talkie and listen for carrier; when you hear it best, you're on frequency. This same circuit can be used as a wireless mike. Connect a carbon microphone, like an old telephone handset mike, in series with R2 and ground.

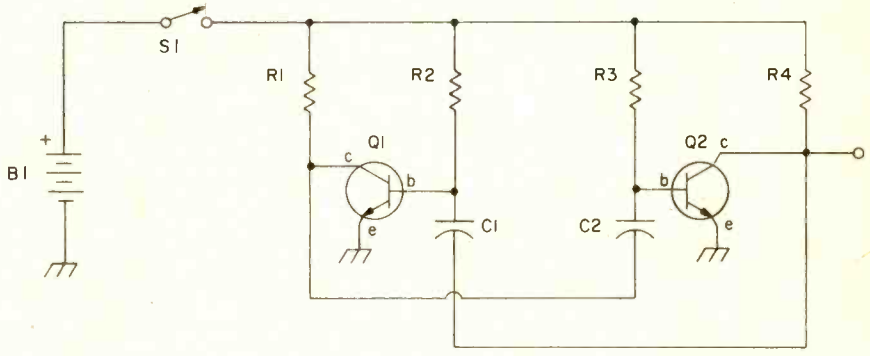
16 Multivibrator Tone Hummer

☐ This multivibrator produces an audio tone rich in harmonics. If you were to look at the output on an oscilloscope, you would see it is a square wave. Because it is so rich in harmonics, you can use this circuit as a signal injector for tracing signals in audio, if (intermediate frequency), and even some rf stages. Just how high the harmonics will go depends on the particular transistors you choose, the voltage you operate them at, and the specific values of the other components.

You can also use this circuit to provide very fast clock pulses to logic circuits, with pulse width in the fraction-of-a-millisecond range, if you like. Remember, the higher in pitch the tone that you hear, the shorter each pulse width. You can also use this as a signal injector or signal source in setting up stereo or intercom systems.

PARTS LIST FOR MULTIVIBRATOR TONE HUMMER

B1—6-15 VDC
C1, C2—.05-.5-uF capacitors
R1, R4—2200-4700-ohm resistors, ½-watt
R2, R3—4700-100,000-ohm resistors, ½-watt
S1—SPST switch
Q1, Q2—NPN transistor (2N2222, 2N3904 or equiv.)



17 High Impedance Mike Amplifier

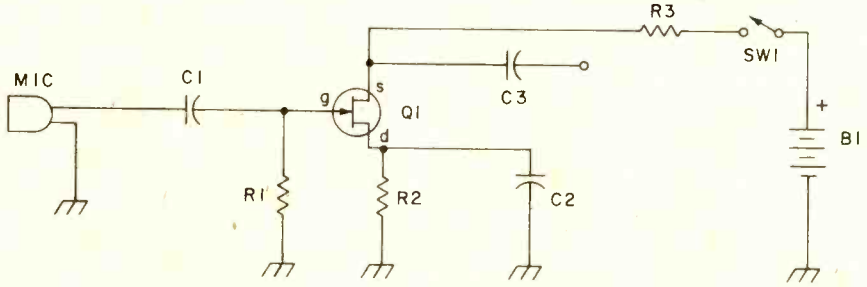
☐ This high-to-low impedance converter will let you use a high impedance crystal, ceramic or dynamic microphone with conventional (around 5K) microphone inputs. It will also let you use a high impedance mike over a longer run of cable with less danger of introducing hum.

Q1 is a general purpose N-channel JFET, like the Siliconix 2N5458, Motorola MPF102 or similar. Choose R1 to match the impedance of your microphone.

If you choose to mount this circuit in or near the microphone case (where it will do the most good), and the microphone is a push-to-talk type, investigate using the PTT switch in place of S1. This may work better if S1 is placed in the negative battery lead rather than the positive (as shown).

PARTS LIST FOR HIGH IMPEDANCE MIKE AMPLIFIER

B1—6-15 VDC battery
C1, C3—.001-.01-uF capacitors
C2—25-100-uF
Q1—N-channel JFET (Junction Field Effect Transistor) (2N5458 or similar)
R1—1-10 Megohm resistor, ½-watt
R2—1800-330-ohm resistor, ½-watt
R3—4700-10,000-ohm resistor, ½-watt
S1—SPST switch (see text)



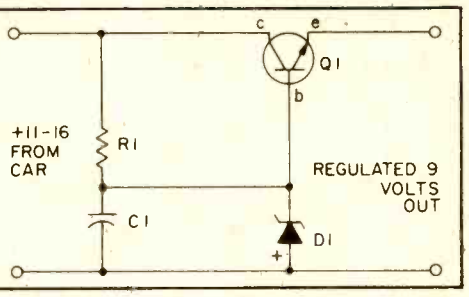
18 Cigar Lighter Power

☐ When you want to run your radio or some other low-power 9 volt device in your car, here's a way you can do it and save on batteries. This is a simple shunt regulator using a 2N2222 and 9.1 Volt Zener. With a 2N2222, you can power devices requiring as much as 800 ma; to drive devices requiring more current, use a 2N3055. With either device, unless the equipment you are driving is very low power, use a heat sink.

There are two easy ways to determine how much current your transistor radio or whatever draws (more to the point, whether or not the amount of current it draws will necessitate heat sinking). One is to connect your VOM in series between one of the battery posts and its associated clip connector. You will want to check the *maximum* amount of current drawn. Another way is to connect this circuit for only a few seconds and touch Q1 with your finger. If it gets too hot to hold your finger on, use a heat sink. You may want to use a heat sink in any case. You may also want to include a small fuse (try ½ amp).

PARTS LIST FOR CIGAR LIGHTER POWER

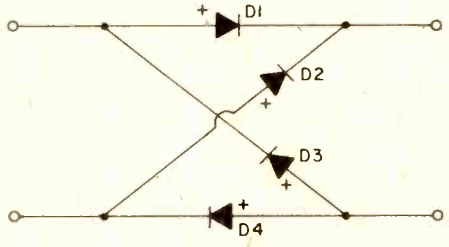
C1—100-uF capacitor
D1—Zener diode, 9.1 V at ¼-watt
Q1—NPN transistor, 2N2222 or equiv.
R1—560-ohm resistor, ½-watt



19 Wrong Way Battery Protector

☐ Want to ruin an expensive piece of solid state equipment? Just hook the battery or supply up backwards. But by adding these four diodes to your equipment, you can say goodbye to backwards forever. This diode arrangement is one you may recognize as a full wave bridge. In power supplies, it's used to rectify both halves of the AC waveform.

Here, it makes sure that no matter which way you connect the battery, the positive and negative supply terminals in your equipment get the right polarity voltage. Remember, since the forward bias of two diodes are introduced, your equipment will be getting about a volt less than your battery is delivering. And remember, choose your diodes so they're rated for all the current your circuit will draw.

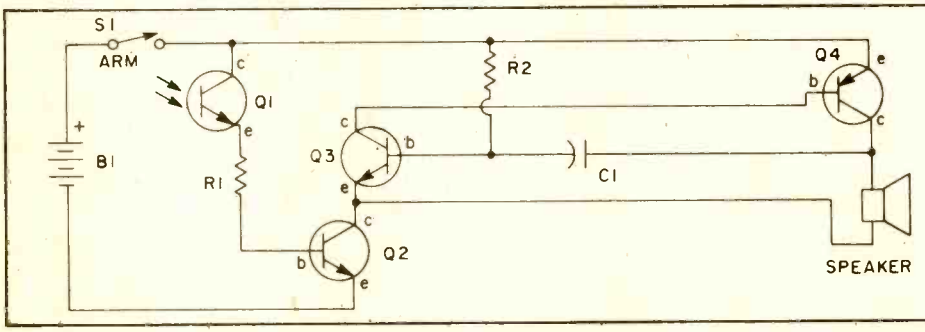


PARTS LIST FOR WRONG-WAY BATTERY PROTECTOR

D1, D2, D3, D4—Diode, 1N914 or equiv.

20 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

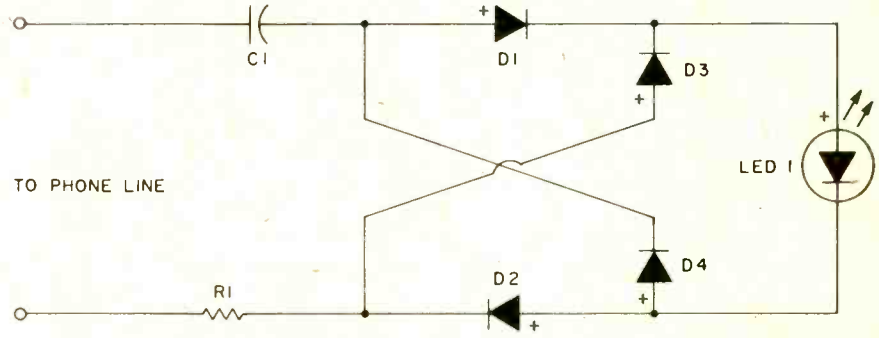
21 LED Telephone Ring Indicator

☐ Know what makes your phone ring? A 20 Hertz AC signal at anywhere from 60 to 120 Volts, depending on your phone company. That same bell-ringing signal can be used to light an LED with the circuit shown here, without significantly loading the telephone line. C1 provides DC isolation to help foolproof this project. The .1 value shown works, but you may want to increase it to .5 microfarads. Use a mylar capacitor (like the Sprague "Orange Drop" series) rated at 250-450 working volts or more.

Why so high? The telephone company keeps its lines clear of ice and trouble by daily sweeping a pulse of high voltage throughout the system. Too low a working voltage could mean trouble for them, and that is absolutely the last thing you want to cause. We might even suggest connecting to the telephone lines only temporarily to verify circuit operation. This will help avoid accidents and trouble. D1 through D4 act as a full wave bridge to deliver the AC ringing voltage as DC to LED1. R1 limits the current through the circuit.

PARTS LIST FOR LED TELEPHONE RING INDICATOR

C1—.1-uF capacitor
D1, D2, D3, D4—Diode, 1N914 or equiv.
LED1—Light emitting diode
R1—82,000-ohm resistor, ½-watt



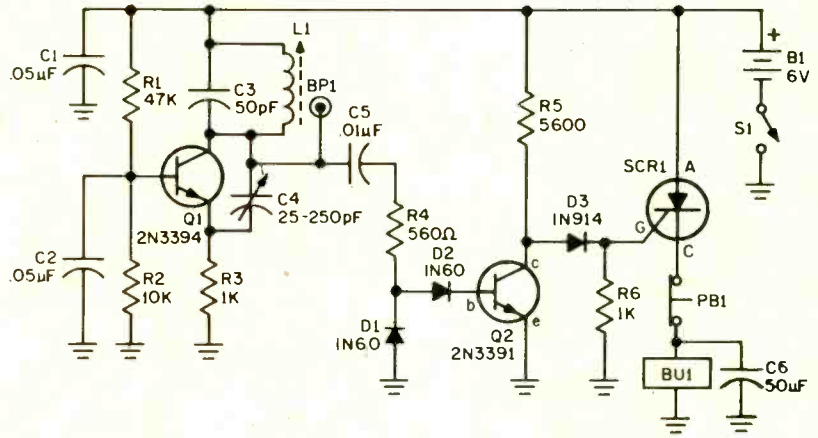
22 Doorknob Security Alarm

☐ Here's security for the traveler. Just connect this alarm to the doorknob of your motel room and a loud buzzer will sound if anyone touches the doorknob.

Transistor circuit Q1 is an oscillator with a connection through binding post BP1 to the doorknob. As long as Q1 oscillates, its rectified output is applied to Q2 which holds the SCR1 gate almost at ground poten-

PARTS LIST FOR DOORKNOB SECURITY ALARM

B1—6-volt battery, Burgess Z4 or equiv.
BP1—Binding post
BU1—6-volt buzzer
C1, C2—0.05-uF disc capacitor, 25 VDC or better
C3—47-pF silver mica capacitor (Allied Electronics 782-0860)
C4—300-pF trimmer capacitor
C5—0.05-uF, 25 VDC capacitor
C6—50-uF electrolytic capacitor, 25 VDC or better
D1, D2—Diode, 1N60
D3—Diode, 1N914



L1—15-uH adjustable RF coil (Miller 4205, or equiv.)
PB1—Pushbutton switch (reset)
Q1—2N3394
Q2—2N3391
R1—47,000-ohm, ½-watt resistor
R2—10,000-ohm, ½-watt resistor
R3, R6—1000-ohm, ½-watt resistor
R4—560-ohm, ½-watt resistor
R5—5600-ohm, ½-watt resistor
S1—Switch, spst (on-off)
SCR1—800-mA/30-V silicon controlled rectifier, HEP R1001

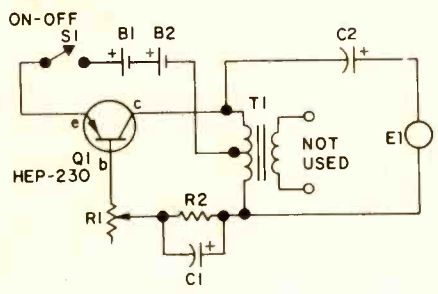
tial. When someone touches the doorknob, hand capacitance "kills" the oscillator, thereby removing that cutoff (holding) bias from the SCR1 gate; the SCR conducts and sounds alarm buzzer BU1. The alarm can only be turned off by opening reset switch PB1.

The alarm should be assembled in a small metal cabinet with insulated binding post BP1 at the top. A small wire loop attached to BP1 secures the alarm to the doorknob—the alarm actually hangs on the knob. To adjust, carefully set C4 in small increments until touching your finger to BP1 causes the buzzer to sound. If C4 is overadjusted, hand capacitance will not "kill" the oscillator. Best operation is obtained if the door is made of wood.

23 Angler's Bite Booster

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

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



PARTS LIST FOR ANGLER'S BITE BOOSTER

B1, B2—1.5-V AAA battery
C1, C2—50-uF, 12-VDC electrolytic capacitor
E1—Crystal earphone
Q1—Motorola HEP-230 pnp transistor
R1—5000-ohm pot
R2—27,000-ohm, ¼-watt resistor
S1—Spst switch, part of R1
T1—Subminiature transistor output transformer; 500-ohm center tapped primary to 8-ohm secondary

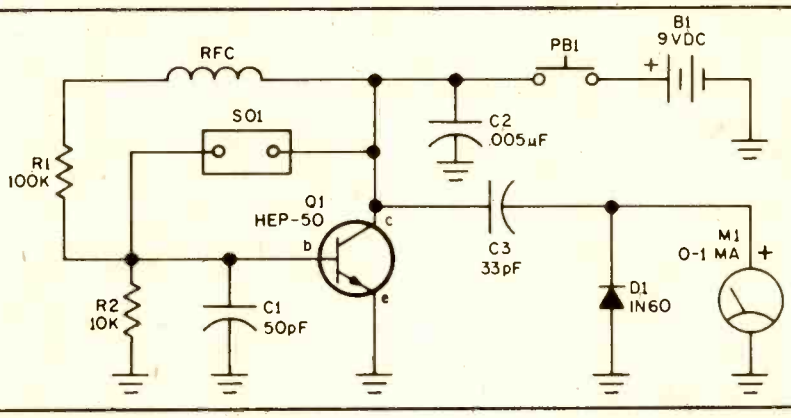
24 Crystal Checker

☐ A fast way to see if the crystal from your transmitter or receiver is properly "active" is to compare its output against that of a known good crystal. This crystal checker will handle both fundamental and overtone type crystals. Socket SO1 should match the pins on your crystals. If you use more than one type of crystal, install two (or more) sockets in parallel. The unit can be assembled in any type of cabinet.

To test a crystal's activity, first plug in a known good crystal, depress push button switch PB1 and note the meter reading. Then install the questionable crystal, press PB1 and note its meter reading; if it's good its output should approximate that of the reference crystal. Take care that you don't compare apples with oranges; the reference crystal should be the exact same type as the crystal to be tested. If good crystals drive the meter off scale, install a 1000-ohm, ½-watt, 10 percent resistor in series with meter M1.

PARTS LIST FOR CRYSTAL ACTIVITY CHECKER

B1—9-volt transistor radio battery
C1—50-pF disc capacitor, 100 VDC or better
C2—0.005-uF disc capacitor, 25 VDC or better
C3—33-pF disc or mica capacitor, 100 VDC or better
D1—Diode, 1N60
M1—Meter, 0-1 mA DC
PB1—Normally open push button switch
Q1—NPN transistor, HEP-50 (Radio Shack 276-2009)
R1—100,000-ohm, ½-watt resistor
R2—10,000-ohm, ½-watt resistor
RFC—2.5-mH RF choke
SO1—Socket to match crystals, see text



25 Add-A-Tweeter

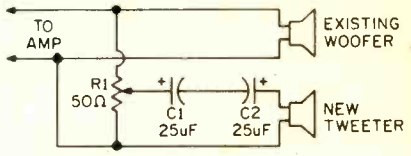
☐ Any single-voice coil speaker is hard pressed to handle both low and high frequencies simultaneously—and it's the highs that suffer most. A much cleaner sound can usually be obtained from speakers 6 inches or larger if the highs are pumped through a tweeter. It can be any small speaker rated 4 to 6 ohms of approx-

imately 2 to 3 inches in diameter.

The back-to-back capacitors, C1 and C2, permit only the highs from about 1500 Hz up to pass into the tweeter. By keeping the lows out of the tweeter, the highs come out cleaner, and there's no chance of the greater low frequency power "blowing" the tweeter. Potentiometer R1 is used to match the tweeter's output level to that of the woofer—because small speakers are generally much more efficient than large speakers. If you eliminate R1, the highs will literally scream in your ears.

PARTS LIST FOR ADD-A-TWEETER

C1, C2—22-uF electrolytic capacitor, 50 VDC
R1—50-ohm wirebound potentiometer, 1 or 2 watts.
Misc.—Cone type tweeters are suitable for use with this circuit.



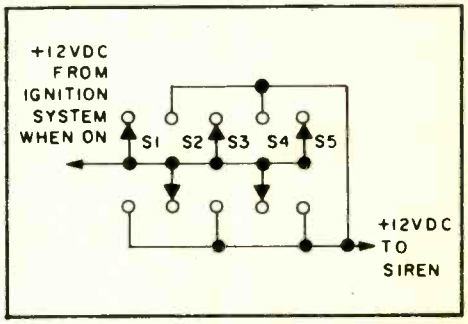
26 Auto Ignition Maze

☐ Install a combination lock on your car's dashboard and a thief would have a better chance playing Russian roulette.

Switches S1 through S5 are spdt rather than spst only to keep all external switch markings the same.

Tracing the circuit will show that only if switches S2 and S4 are down is the siren disabled. The siren sounds if any other switch is down or if S2 or S4 is up when the ignition is turned on. A simple wiring change lets you set any combination.

The switches can be "sporty" auto accessory switches sold individually or in switch banks such as G.C. 35-916. Provide labels such as "Carburetor Heater," "Window Washer," etc. and no one will know the car is wired for "sound."



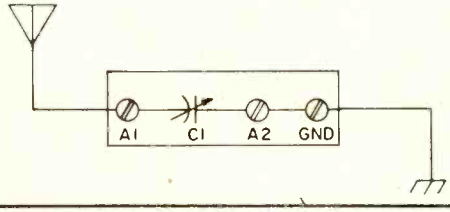
27 Add An Antenna Trimmer

☐ One part? That's all, but it can make a big difference in your shortwave listening. The American Radio Relay League's *ARRL Handbook*, the ham operator's "bible," can help you understand the complex nature of radio waves and how this circuit (is one part a circuit?) helps your antenna match your receiver at any given frequency.

But for right now, all you need to know is that when you add this trimmer (or connect it to these leads through coax, but only a very short length), you can adjust it to make your receiver really hot wherever it's tuned. It works by helping your receiver take advantage of all the signal your antenna can pick up. Try it and see.

PARTS LIST FOR ADD AN ANTENNA TRIMMER

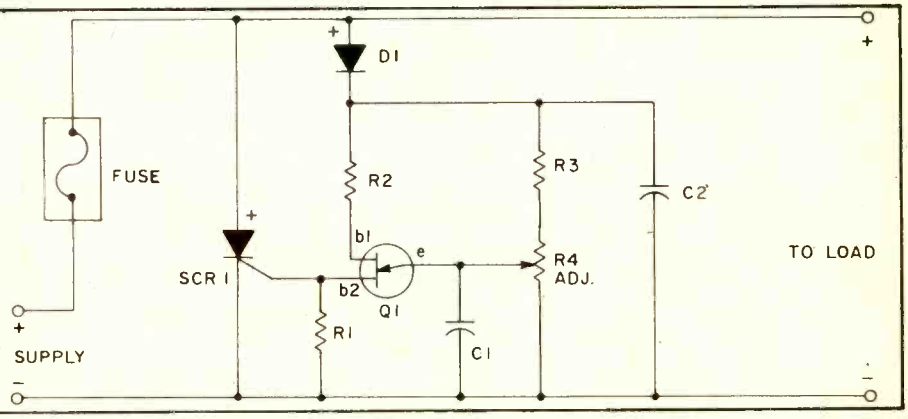
C1—60-pf trimmer



28 Adjustable Crowbar

PARTS LIST FOR ADJUSTABLE CROWBAR

C1—.02-uF capacitor
C2—2.2-uF capacitor
D1—Diode, 1N914 or equiv.
R1—47-ohm resistor, ½-watt
R2—330-ohm resistor, ½-watt
R3—3300-ohm resistor, ½-watt
R4—10,000-ohm trimmer potentiometer
Q1—UJT (Unijunction Transistor), 2N2646 or equiv.
SCR1—See text

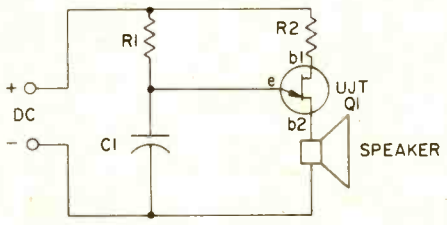


☐ This crowbar circuit takes advantage of the electrically well-defined switching point of UJT (unijunction transistor) Q1. Q1's actual trip point voltage is set by trimmer R4. The Q1 circuit is isolated from the load by D1. When Q1 conducts, it triggers SCR1, shorting the supply and blowing the fuse. Choose SCR1 to handle more than the rated fuse current at the maximum supply voltage.

To test for your trip point (when setting it, for example), disconnect the LOAD. Substitute a lamp of the proper voltage (the supply voltage or a little more) for the fuse. Set the voltage at the supply voltage terminals for the trip point you desire, then adjust R4 until the test lamp just lights.

29 Voltage Controlled Oscillator

☐ Unijunction transistors are very interesting. They love to be used in oscillators, and it doesn't take too many parts or very much coaxing to get their sawtooth outputs going. This little squealer will tell you how much voltage it's connected to. The higher the voltage, the lower frequency output you'll hear. 5 or 6 Volts should start its high squeal going; 25 or 30 volts and it'll be ticking like a metronome. You can take advantage of this voltage to frequency conversion and use this circuit as an audible voltmeter. Or, with a resistor across the input, it can be an audible current meter.



PARTS LIST FOR VOLTAGE CONTROLLED OSCILLATOR

C1—.5-2.2-uF capacitor
R1—10,000-47,000-ohm resistor, ½-watt
R2—82-150-ohm resistor, ½-watt
Q1—unijunction transistor (2N-2646 or equiv.)
SPKR—8-40-ohms

For a slightly stranger effect, connect a large value capacitor (say 50-100 uF with a voltage rating larger than the voltages you intend to apply). You'll hear a swooping effect. Many different components can be placed across the input for different effects when voltage is applied. Experiment and have fun.

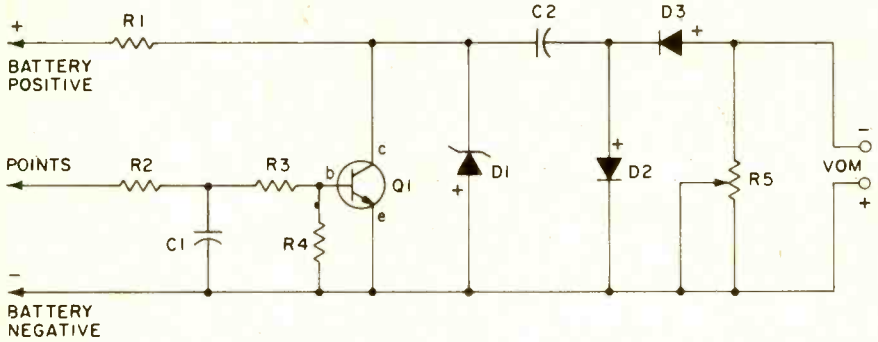
30 Make Your Vom A Tachometer

☐ Most of us don't need dashboard tachometers to drive by. But a tachometer can be invaluable as a tune-up aid. And it's a lot handier to have under the hood when you need it there than behind the wheel where you can't see it.

But is a tach worth the investment? With this arrangement, there isn't enough investment to worry about.

Pulses from the distributor points are amplified by Q1, limited by D1, coupled by C2, rectified by D2 and D3, and impressed as a voltage across R5. You could use R5 to calibrate this circuit to one of your VOM's voltage ranges, but that often isn't necessary. Much of the time, we are looking more for *changes* in engine speed than for a *specific* engine speed. If you do need to know specific speeds, of course, you can always borrow a known-good tach and calibrate with R5.

This same circuit can also be applied as a frequency to voltage converter for many other purposes.



PARTS LIST FOR VOM INTO TACHOMETER

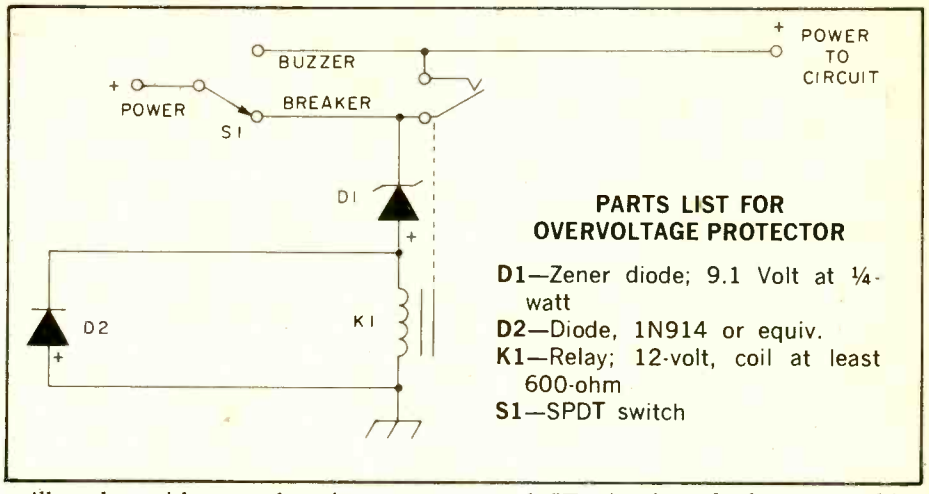
C1—2.2-uF capacitor
C2—.47-uF capacitor
D1—Zener Diode, 9.1V at ¼-watt
D2, D3—Diodes, 1N914 or equiv.
Q1—NPN transistor, 2N3904 or equiv.
R1—390-ohm resistor, ½-watt
R2, R3—220-ohm resistor
R4—1800-ohm resistor, ½-watt
R5—1000-ohm potentiometer

31 Overvoltage Protector

☐ Too high a voltage can damage any number of electronic components. Many other components can withstand high voltages, but only for a limited time. This circuit provides either protection against too much voltage in much the same way a circuit breaker protects against too much current, or a warning that an

overvoltage condition is occurring.

In the *Breaker* position, power is applied to the protected circuit only so long as relay K1 is not energized. K1 *will* energize whenever the input voltage exceeds the Zener voltage of diode D1, because above its zener voltage, a reverse-biased Zener diode like this one will conduct. In the *Buzzer* position, power remains applied to the circuit through the relay itself. When an overvoltage is present, the relay pulls in, disconnecting itself, which allows it to release and re-establish connection, which causes it to pull in and break connection and so on—exactly the action of a buzzer. And that's exactly the sound the relay will make—with enough noise generated to carry the buzz into the audio and IF circuits of almost anything connected or nearby.



PARTS LIST FOR OVERVOLTAGE PROTECTOR

D1—Zener diode; 9.1 Volt at ¼-watt
D2—Diode, 1N914 or equiv.
K1—Relay; 12-volt, coil at least 600-ohm
S1—SPDT switch

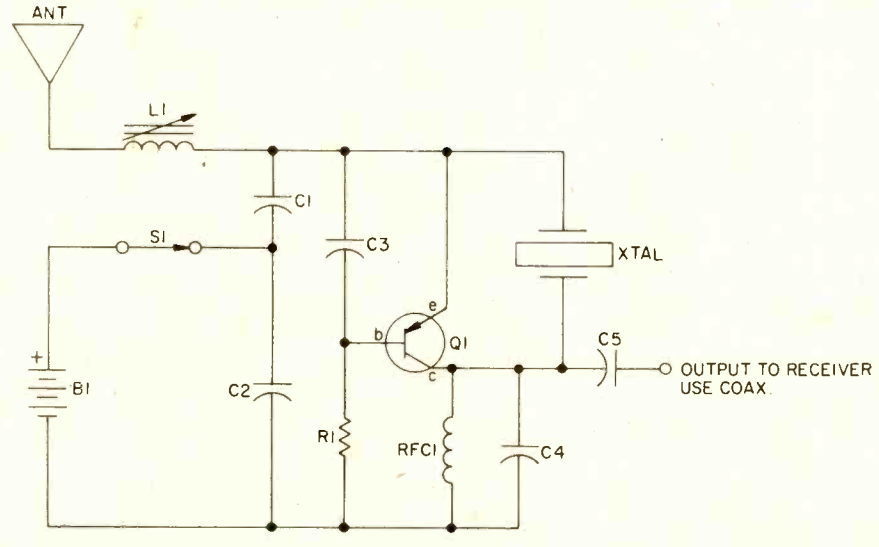
32 SWL's Low Band Converter

☐ Ever listened in on the long waves, from 25-500 kHz? It's easy with this simple converter. It'll put those long waves between 3.5 and 4.0 MHz on your SWL receiver.

Q1 acts as a 3.5 MHz crystal oscillator, mixing the crystal frequency with the long wave input from the antenna and forwarding the mix to your receiver.

L1 is a standard broadcast loopstick antenna coil. The crystal is available from many companies by mail order, or is likely to be at a ham radio store near you. You could also use a 3.58 MHz TV color crystal.

Adjust the slug of L1 for your best signal after tuning to a strong station.



PARTS LIST FOR SWL'S LOW BAND CONVERTER

B1—9VDC battery
C1, C4—470-pf capacitor
C2—.1-uF capacitor
C3—.001-uF capacitor
C5—50-pf capacitor
L1—Loopstick coil
Q1—PNP transistor, 2N3906 or equiv.
R1—470,000-ohm resistor, ½-watt
RFC—2.5 mH choke
S1—SPST switch
XTAL—3.5 MHz crystal

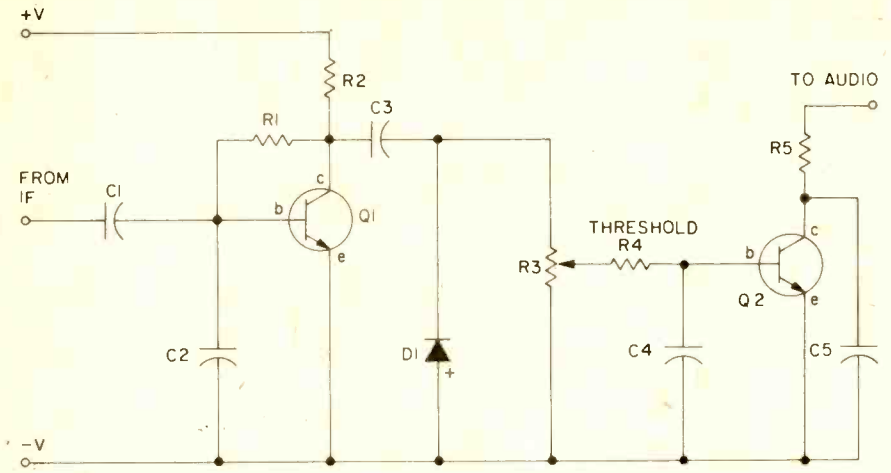
33 Transistor Squelch

☐ Here's a simple squelch circuit you can add on to most radios and it's as versatile as any.

Transistor Q1 acts as a noise amplifier, operating on signals from the receiver IF. The noise signal is amplified, then detected by D1. The resultant voltage appears across R3, which acts as a voltage divider at the input of switch Q2. When enough signal-derived voltage reaches Q2's base, it turns on, switching off the receiver audio output.

This audio squelching can be accomplished simply by connecting the input terminal of the receiver's audio stage to the R5 connection. This is a noise-operated squelch best suited for use with FM communications systems. On FM, signals tend to quiet the ever-present noise, and FM IFs are designed with noise outputs.

For use with AM systems, use the IF or detector signal output as the squelch input. Locate the -V connection of your receiver's first audio amplifier, break it, and connect it to the top of R5. Then increasing signal will enable receiver audio, and that's what squelches are supposed to do.



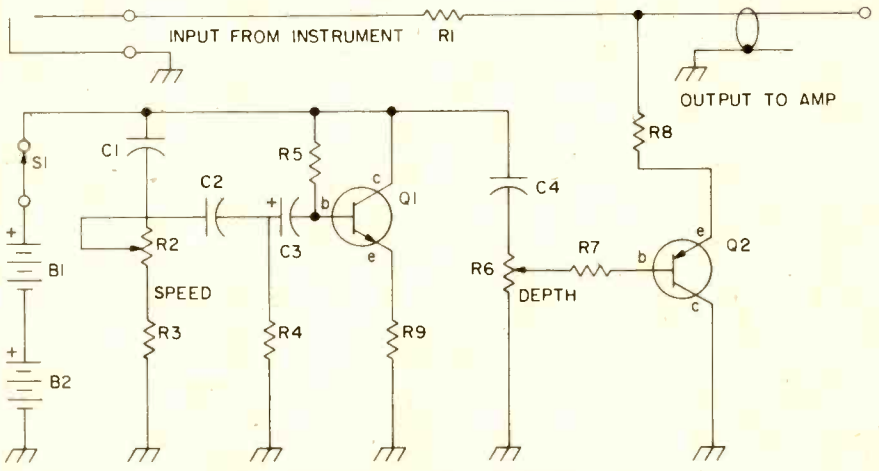
PARTS LIST FOR TRANSISTOR SQUELCH

C1, C3—.1-uF capacitor
C2—.01-uF capacitor
C4—33-uF capacitor
C5—47-uF capacitor
D1—Diode, 1N914 or equiv.
Q1, Q2—NPN transistor, 2N3904 or equiv.
R1—180,000-ohm resistor, ½-watt
R2, R3—10,000-ohm resistor, ½-watt
R4—680-ohm potentiometer
R5—330-ohm resistor, ½-watt

34 Super Vibrato

☐ This professional-sounding circuit adds vibrato to almost any electronic musical instrument. Now you can play all the vibrato effects the big, Top 40 groups have been using on their albums and singles for years. Q1, R2-5, and C1-3 form a phase shift oscillator. Speed control R2 varies its output frequency, which is coupled through C4, R6 and R7 to Q2. Q2 and R8 then amplitude modulate the signal in the line between the instrument and the amplifier. The amount of modulation applied is varied by Depth control R6.

You may also want to try this circuit out between a mike and your tape recorder to experiment with strange vocal effects. If driven hard enough, it can even make you sound as if you're talking under water. If the range of R6 doesn't permit this, try either adding a third battery or reducing the value of R8. You may decide to make S1 a momentary or push-push foot pedal switch and build this entire circuit into the foot pedal housing.



PARTS LIST FOR SUPER VIBRATO

B1, B2—9VDC battery
C1—.5-uF capacitor
C2—2.3-uF capacitor
C3—5-uF, 25VDC electrolytic capacitor
C4—.05-uF capacitor
Q1 — NPN transistor, 2N2222, 2N3904, or equiv.
Q2—PNP transistor, 2N3906 or equiv.
R1, R8—100,000-ohm resistor, ½-watt
R2—10,000-ohm potentiometer
R3—2700-ohm resistor, ½-watt
R4—3300-ohm resistor, ½-watt
R5—560,000-ohm resistor, ½-watt
R6—500,000-ohm potentiometer
R7—470-ohm resistor, ½-watt
R9—4700-ohm resistor, ½-watt
S1—SPST switch

35 Stereo Beat Filter

☐ Many early stereo tuners, and quite a number of modern budget priced stereo tuners, have considerable output at 19 kHz and 38 kHz from the stereo pilot system. While these frequencies aren't heard, they can raise havoc if they leak through to a Dolby noise reduction encoder, or if the frequencies beat with a tape recorder's bias frequency or its harmonics. Normally, Dolby-equipped units have a 19 kHz filter specifically to avoid the problem of pilot leakage from the tuner, but often the pilot interference is so high it still gets through.

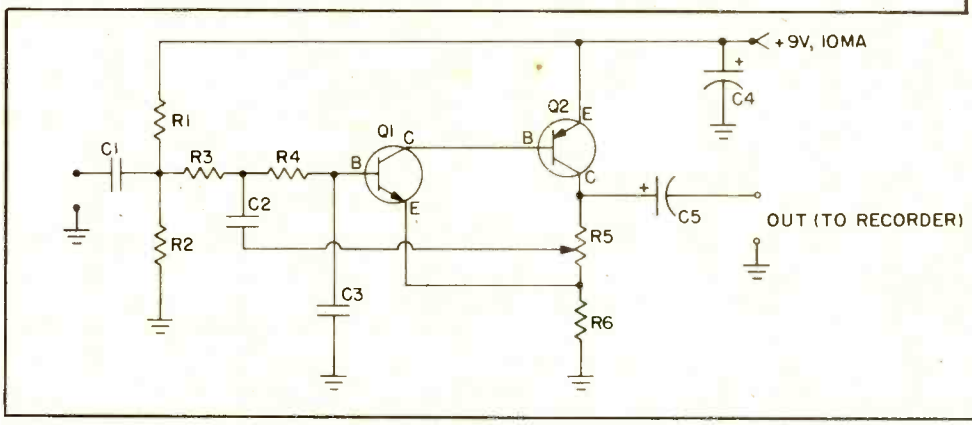
This filter, which can be powered by an ordinary transistor radio type battery, is connected to the output of the FM stereo tuner, and provides approximately 12 to 15 dB additional

attenuation at 19 kHz and about 25 dB attenuation at 38 kHz. It has virtually no effect on the frequency response below 15 kHz, the upper limit of frequencies broadcast by FM stations.

The only really critical components are C1, C2 and R4, and no substitutions should be made.

A signal generator is required for alignment. Feed in a 1 kHz signal and note the output voltage. Then change the generator to 10 kHz and adjust R5 so the output level at 10 kHz is the same as for 1 kHz. You might have to check the measurements several times to get R5 set correctly. When properly adjusted there will be perhaps 1 dB loss at 15 kHz.

The input signal should be in the range of 0.1 to 1 volt—typical level from a tuner's tape output jack.



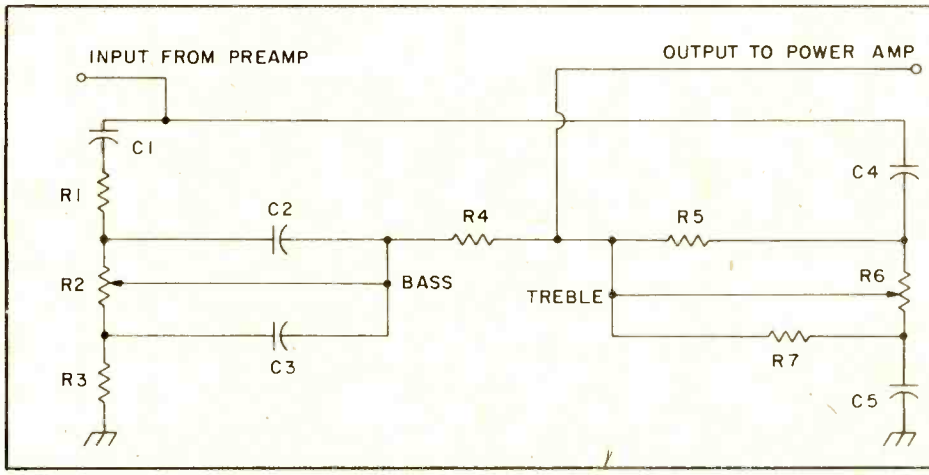
PARTS LIST FOR STEREO BEAT FILTER

Resistors ½-watt, 10%, unless otherwise specified
R1—470,000-ohms
R2—220,000-ohms
R3—33,000-ohms
R4—33,000-ohms, 5%
R5—5,000-ohm linear taper potentiometer
R6—3,300-ohms
Capacitors rated 10-VDC or higher
C1—0.047-uF
C2, C3—220-pF, 2% silver mica or equiv.
C4—25-uF
C5—1-uF
Q1—Transistor, Radio Shack 276-2009
Q2—Transistor, Radio Shack 276-2021

36 Tone Control Network

☐ Since there are no active devices in this circuit, like transistors or ICs, it can provide no amplification on its own to offset the very lossy characteristics of these networks. Fortunately, most audio systems have more than enough oomph to accommodate this network loss.

Once you have learned, by experimenting with the effects of various component values, just how you can alter the characteristics of these networks, you may want to construct your own graphic equalizer. Just include more stages similar to the two basic types of filters you see here: R1, R2, R3, R4, C1, C2 and C3 form one of the filters, the rest of the components the other. Just remember, the more stages of passive filtering you add, the more loss you introduce into your system. For that reason, most commercial graphic equalizers include built-in amplifiers. And, of course, you will have to duplicate your filter(s) for each channel if you're working in four or more tracks.



PARTS LIST FOR TONE CONTROL NETWORK

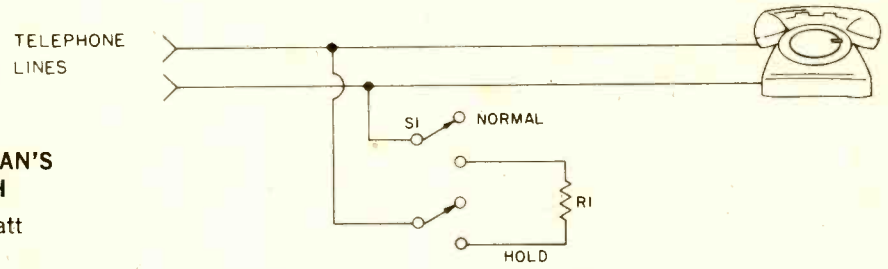
C1, C5—.068-.2-uF capacitors
C2—.033-.068-uF capacitor
C3—.33-.68-uF capacitor
C4—.005-.02-uF capacitor
R1, R4, R5—1500-ohm resistors, ½-watt
R2, R6—50,000-200,000-ohm potentiometer, logarithmic or audio taper
R3, R7—820-1500-ohm resistors, ½-watt

37 Poor Man's Hold Switch

☐ This is just one step more sophisticated than holding your hand over the telephone mouthpiece. We all find occasions when we would like to discuss something with the people in the room without sharing it with the party on the phone. This circuit provides dc continuity for the phone line to keep from losing a call when

you hang the phone up. There is some danger, though, of putting the phone on "terminal hold," if you forget. Because as long as you are switched to hold, it's just like leaving a phone off the hook: no one can call in, you can't call out.

Only two of the lines that reach your telephone are really part of the phone line, and these are most often the red and green wires that are in the cable between your phone and the wall. Other wires in the cable may carry power for lighting your phone, or may carry nothing. Check carefully. Also understand that if you make a connection to the phone line that inhibits the phone company's ability to provide service, they have the right to disconnect you for as long as they like. This is a proven, simple circuit that should cause no difficulty. But be careful.



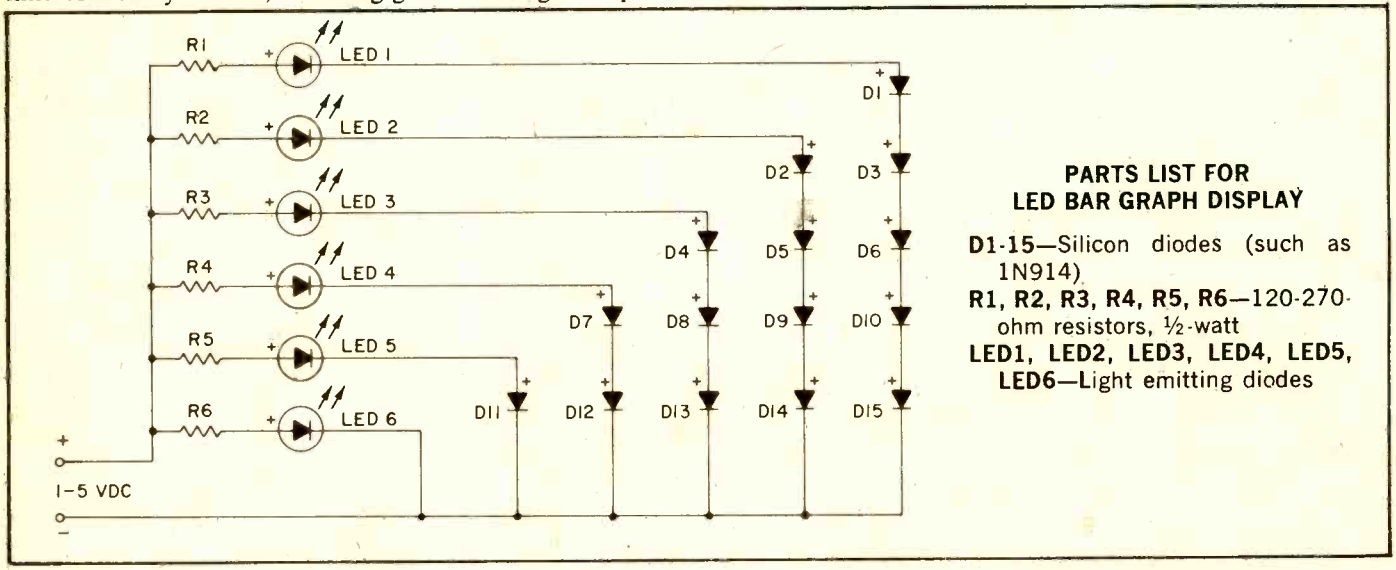
PARTS LIST FOR POOR MAN'S PHONE HOLD SWITCH

R1—650-ohm resistor, ½-watt
S1—DPDT switch

38 LED Bar Graph Display

☐ This circuit takes advantage of the forward voltage drop exhibited by silicon diodes. Each leg of the circuit shows a light emitting diode in series with a current limiting resistor and a different number of diode voltage drops, from 0 to 5. You may use any kind of diode you wish, including germanium, silicon, even expensive hot carrier types (although they won't exhibit quite as much drop, they're very expensive, and too large a current could burn them out).

Depending on the diodes you choose, each will exhibit a forward voltage drop between 0.3 and 0.7 volts. For consistency, stay with diodes of the same type, or at least the same family. Those twenty-for-a-dollar "computer" diodes will do just fine. To expand the range of this LED "meter," use two resistors as a voltage divider at the input. Connect one across the + and − terminals, the other from the + terminal to the voltage being measured. The LEDs will then be monitoring a range determined by the ratio of those resistors, as determined by this formula:



PARTS LIST FOR LED BAR GRAPH DISPLAY

D1-15—Silicon diodes (such as 1N914)
R1, R2, R3, R4, R5, R6—120-270-ohm resistors, ½-watt
LED1, LED2, LED3, LED4, LED5, LED6—Light emitting diodes

The voltage across the input equals the resistance across the output, divided by the sum of the resistances and multiplied by the voltage being measured. Or:

$$Ein = Em \times \frac{Rin}{Rsum}$$

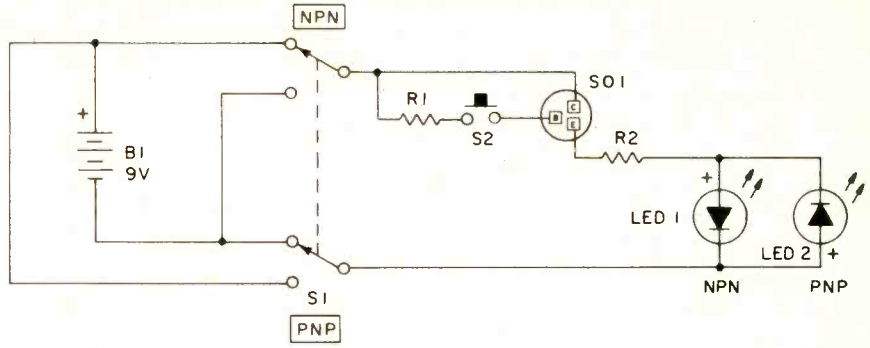
39 Transistor Checker

☐ It's pushbutton-easy to check transistors with this tiny marvel. Just plug the transistor in and push S2. If it's good and you set the PNP-NPN switch S1 properly, the appropriate LED will light.

Don't know the type? That's okay. Plug it in and try both S1 switch positions while you watch for the appropriate LED to light. You can even test diodes using the collector-emitter leads on the socket. The collector-emitter leads can also be used to check continuity.

PARTS LIST FOR TRANSISTOR CHECKER

B1—9 VDC battery
LED1, LED2—Light emitting diode
R1—1000-ohm resistor, ½-watt
R2—470-ohm resistor, ½-watt
S1—DPDT switch
S2—Momentary push button switch
SO1—Transistor socket



40 Flash Tester

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

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

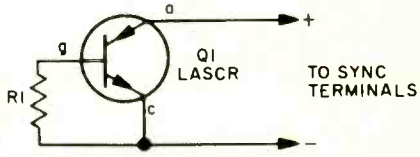
To operate, provide a 6-in. length of stiff wire for the anode and cathode connections and terminate the wires in a polarized power plug that matches the sync terminals on your electronic flashgun (strobelight). Make certain the anode lead connects to the *positive* sync terminal.

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

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

PARTS LIST FOR REMOTE FLASH TRIGGER

Q1—200-V light-activated silicon-controlled rectifier (LASCR)
R1—47,000-ohm, ½-watt resistor



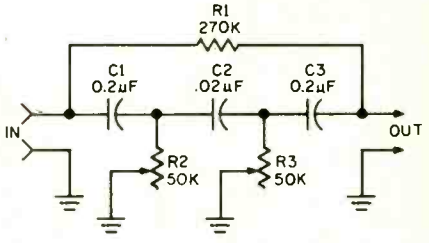
41 Record Restorer

☐ Old 78-rpm collector's-item records cut back in the early days when performers sang in front of a large horn usually have a peak in the mid-band that drives the sound into your mind like a fingernail scratched across a blackboard. The overall sound quality is easily tamed, and made more natural and modern, by attenuating the shrill peaks with a Record Restorer, a device that suppresses, by hi-fi standards, the mid-band frequencies.

The Record Restorer should be assembled in a metal cabinet to prevent hum pickup. Connect the output of your phonograph to the restorer input. Connect the output of the restorer to your tape recorder. Set potentiometer R2 to maximum resistance and adjust potentiometer R3 for the most pleasing sound. If R3's adjustment is too little, or too much as evidenced by a "hole" in the sound quality, trim the restorer with R2 until you get the optimum equalization.

PARTS LIST FOR RECORD RESTORER

C1, C3—0.25-uF mylar capacitor
C2—0.02-uF mylar capacitor
R1—270,000-ohm, ½-watt resistor
R2, R3—50,000-ohm potentiometer, linear taper

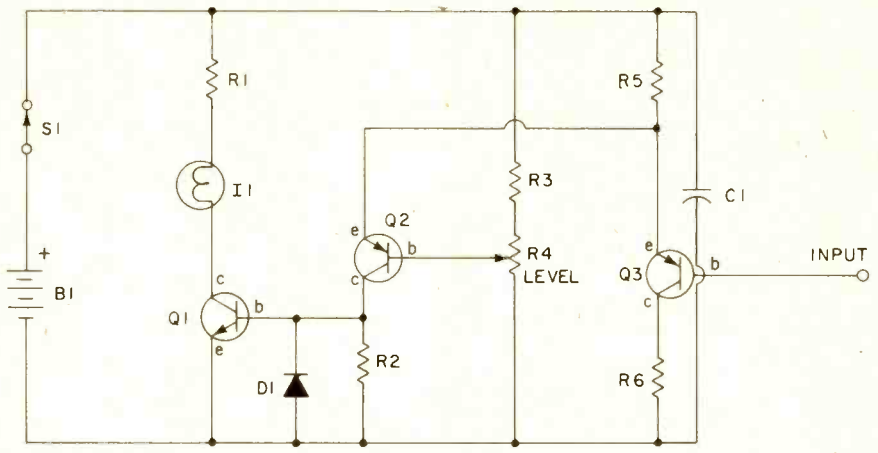


42 Level Detector

☐ There are times when voltages are allowed to vary widely in a given system, so long as they do not exceed some preset limit. This might happen in speed or temperature controls, for example, or even simple R-C timers.

This circuit is based upon a two-transistor comparator. An input voltage (which must not exceed B1 in either positive or negative value) at Q3 is compared to a preset divider R3-R4 at Q2. When the input volt-

age equals or exceeds the preset voltage, Q1 turns on, driving pilot lamp I1 on. Resistor R1 permits the use of a #47 type lamp with a standard 9 volt battery.



PARTS LIST FOR LEVEL DETECTOR

B1—9VDC battery
C1—.1-uF capacitor
D1—Diode, 1N914 or equiv.
I1—Bulb, #47-type
Q1—NPN transistor, 2N2222 or equiv.
Q2, Q3—PNP transistor, 2N3906 or equiv.
R1—27-ohm resistor, ½-watt
R2—5600-ohm resistor, ½-watt
R3—100,000-ohm resistor, ½-watt
R4—1-Megohm potentiometer
R5—3300-ohm resistor, ½-watt
R6—1000-ohm resistor, ½-watt
S1—SPST switch

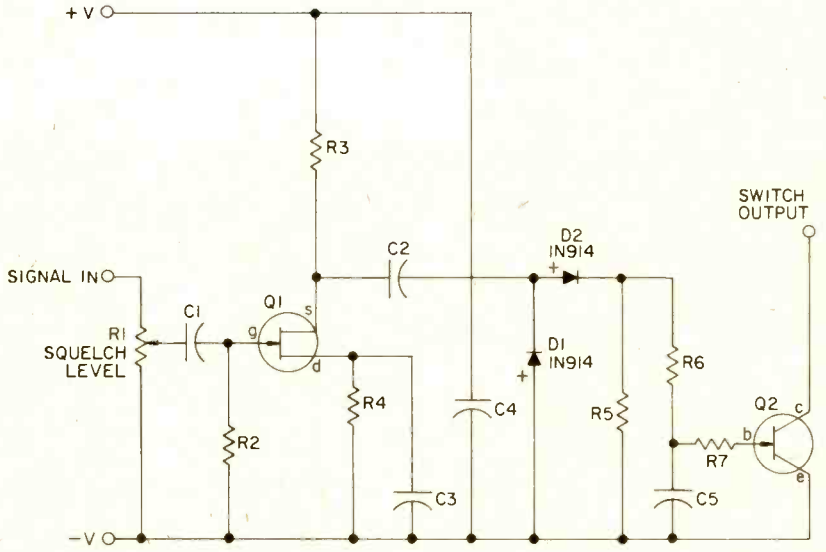
43 Sensitive Squelch

☐ The high sensitivity of this circuit is due to the use of a JFET at Q1. With R2 at just 47K, the high impedance input JFET is just loafing along. (If you need more sensitivity, try values up to 10 Megohms for R2). The signal input from a detector or other audio signal or noise source within your circuit is applied through voltage divider R1 and C1 to the gate of Q1. Q1 amplifies this signal and passes it through C2 to D1-D2, which convert it to a DC voltage. This is used to drive switch Q2 on, with a delayed turn-off provided by R7-C5. R6-C5 delay turn-on. These delays prevent picket-fencing.

FM squelches are noise operated, where the more noise there is, the less signal. So an FM squelch must *disable* with increasing input. In an FM system, Q2 would shunt the audio signal to ground at the first audio stage. An AM system would be designed to *enable* with increasing input. In an AM system, Q2 would be used.

PARTS LIST FOR SENSITIVE SQUELCH

C1—33-pF capacitor
C2—.05-uF capacitor
C3—4.7-uF capacitor
C4—10-uF capacitor
C5—.22-uF capacitor
D1, D2—Diode, 1N914 or equiv.
Q1—FET (Field Effect Transistor), 2N5458 or equiv.
Q2—NPN transistor, 2N2222 or equiv.
R1—100,000-ohm potentiometer
R2—47,000-ohm resistor, ½-watt
R3—12,000-ohm resistor, ½-watt
R4—3300-ohm resistor, ½-watt
R5—3.3-Megohm resistor, ½-watt
R6, R7—1000-ohm resistor, ½-watt



44 Idiot's Delight

☐ Sometimes the dashboard idiot lights aren't warning enough that something's gone awry. Bright sunlight, a burned-out lamp or simply a lack of attention can obviate Detroit's brilliant efforts. But this simple gizmo adds a buzz to their blink, plus a luxurious extra. R1, C1 and

(Continued on page 40)

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CIRCLE 1 ON READER SERVICE COUPON

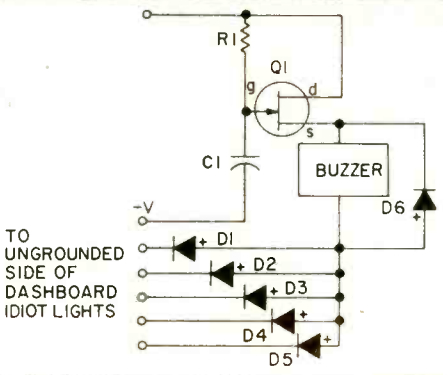
(Continued from page 36)

Q1 give you about 7 seconds when you first get into the car to get yourself going and let the idiot lights douse before the buzzer can sound.

D1-D5 can be added to or subtracted from to fit the number of dashboard dimwits on your car. You can use something other than a buzzer, if you wish, to help you keep from getting confused about your door being ajar, your key being in, or your lights being left on.

PARTS LIST FOR IDIOT'S DELIGHT

C1—15-uF capacitor
D1, D2, D3, D4, D5, D6—Diode, 1N914 or equiv.
Q1—FET (Field Effect Transistor), 2N5458 or equiv.
R1—470,000-ohm resistor, ½-watt



45 Two Transistor Radio

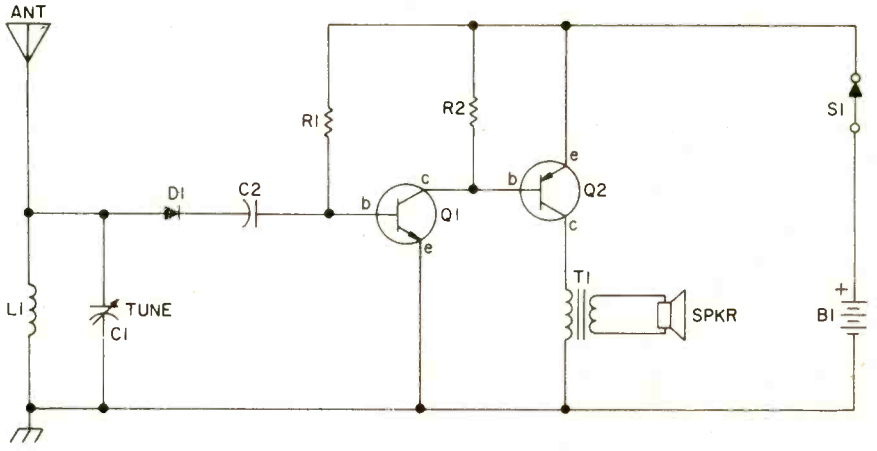
☐ Crystal sets are a lot of fun. Trouble is, their little earphones aren't. This is a nice little compromise, a loudspeaking crystal set.

L1 is a standard broadcast loopstick antenna, C1 a standard broadcast band variable capacitor. Chances are you can pull both parts from the carcass of an old radio. For an antenna, try attaching a length of wire with an alligator clip to any exposed metal part on a telephone, like the finger stop of a dial phone. You can also try window frames, bedsprings or bed frames.

(If you do construct any kind of outdoor antenna, keep far away from power and telephone lines and install a good lightning arrestor with a sound ground lead. It's also a good idea to ground the antenna when you're not using it, and not to use it in bad weather.) L1 and C1 form the tuned circuit that tunes the radio. Diode D1 acts as a detector. For better performance, substitute a germanium diode (such as a 1N34 or 1N60) or a hot carrier diode. Q1 and Q2 provide the amplification needed to drive the speaker.

PARTS LIST FOR TWO-TRANSISTOR RADIO

B1—9 VDC battery
C1—365-pF variable capacitor
C2—.1-uF capacitor
D1—Diode, 1N914 or equiv.
L1—Standard broadcast loopstick antenna
Q1—NPN transistor, 2N3904 or equiv.
Q2—PNP transistor, 2N3906 or equip.
R1—100,000-ohm resistor, ½-watt
R2—4700-ohm resistor, ½-watt
S1—SPST switch
T1—500:8-ohm matching transformer
SPKR—8-ohm speaker



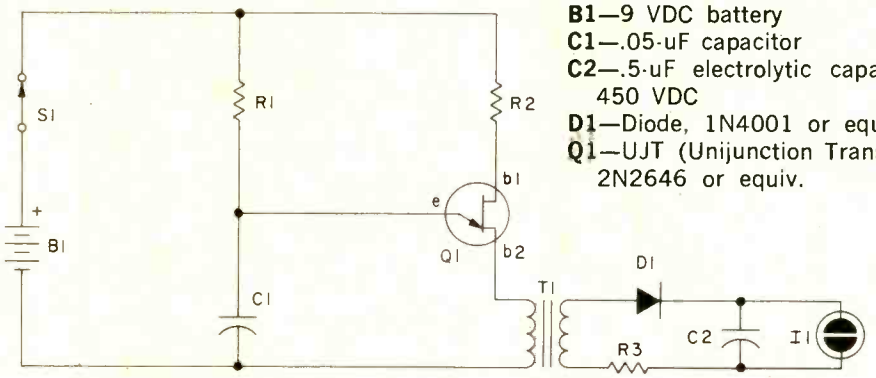
46 Blinking Neon Night Light

☐ UJT oscillator Q1 feeds a tone of about 2000 Hz to transistor transformer T1, which steps it up to a level where it can fire a neon lamp, I1. But the circuitry to the right of T1 does something a little more interesting. Diode D1 (which makes this circuit a true DC-to-DC converter) rectifies the AC signal and applies it to C2. Resistor R3 limits the rate at which C2 can charge. When C2 finally reaches a voltage high enough to allow I1 to light, I1 fires and discharges C2, starting the action over again.

Use a 200 PIV diode for D1 and a 250 Volt (or more) capacitor for C2, or just make sure both are rated for more voltage than appears across the secondary of T1. D1, C2, R3 and I1 form a circuit called a relaxation oscillator. Interestingly, that is exactly the kind of oscillator Q1 is. Both rely on some R-C combination charging a capacitor at a restricted rate, then discharging it at some determined time. Just as you can multiply the values of R1 and C1 to get a fix on the frequency of Q1 ($f=1/R1C1$, more or less), you can mul-

PARTS LIST FOR
BLINKING NEON NIGHT LIGHT

B1—9 VDC battery
C1—.05-uF capacitor
C2—.5-uF electrolytic capacitor, 450 VDC
D1—Diode, 1N4001 or equiv.
Q1—UJT (Unijunction Transistor), 2N2646 or equiv.
R1—10,000-ohm resistor, ½-watt
R2—100-ohm resistor
R3—470,000-ohm resistor, ½-watt
S1—SPST switch
T1—Transformer, 10,000-ohm primary and 100,000-ohm secondary



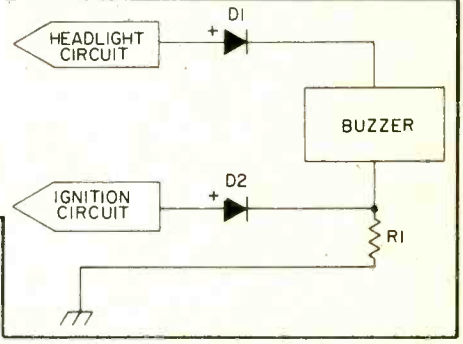
tiply R3 and C2 to determine that the NE-2 will blink about four times a second. You can also connect the circuit to the right of T1 to 110 Volt household power to see the same action.

47 Easy Headlight-On Warning

☐ Nobody has to tell you about the time and money you can get stuck going through if you forget and leave your headlights on when you leave your car. This circuit reminds you your lights are on the instant you turn your key off. The Detroit warning circuits wait until you open the door. You can connect to the voltages you need right at the fuseblock. Try the "radio" fuse for the ignition circuit, the "instrument" fuse connects you to the dashboard night lights, on whenever the headlights are on.

PARTS LIST FOR
EASY HEADLIGHT-ON WARNING

D1, D2—Diode, 1N914 or equiv.
R1—150-ohm resistor, ½-watt



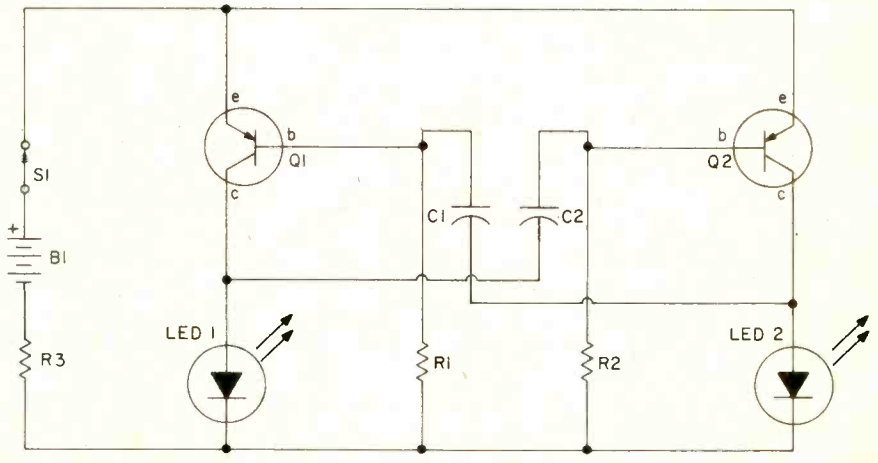
48 The Bamboozler

☐ Officially, this is a slow speed astable multivibrator with state-indicating photo-optic outputs. Unofficially, it's just a circuit to alternately flash two L.E.D.s. But you don't have to tell anybody that. Tell them it's counting Ekno Rays from the planet Nerd. Or it remotely controls your pacemaker. Or it can tell a person's innermost secrets. Or you'll think of something. R3 limits the current the whole circuit can draw. If you find the flashing too dim or unreliable, reduce the value of R3 to 150, 100 or 47 Ohms. If you could handle even dimmer blinks, increase R3 to a maximum of about 100 Ohms.

You could also use different color LEDs, add a magnetic reed switch in series with each capacitor, and hide a magnet between your fingers. Then, by careful positioning, you can control whether both flash, one stays on or both stay on.

PARTS LIST FOR
THE BAMBOOZLER

B1—9 VDC battery
C1, C2—10-uF capacitor
LED1, LED2—Light emitting diode
Q1, Q2—PNP transistor, 2N3906 or equiv.
R1, R2—47,000-ohm resistor, ½-watt
R3—220-ohm resistor, ½-watt
S1—SPST switch



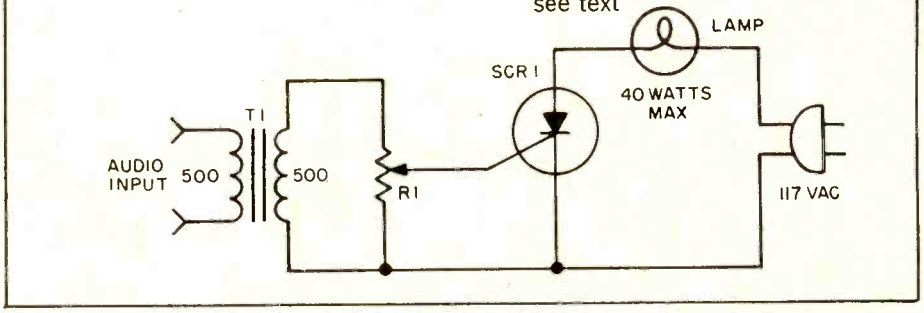
49 Basic Color Organ

☐ This simple color organ is certain to keep your party from becoming a drag. Connected to your hi-fi amplifier's speaker output (across the speaker terminals) it will throb in time to the music. Paint the bulb red or deep blue and your party room will take on the atmosphere of a rock club.

Transformer T1 can be any matching transistor type in the range of 500/500 to 2500/2500 ohms. Note that none of the connections from SCR1 or its components are connected to ground. For safety's sake, you must keep the 117-volt line voltage from the amplifier connections—that's the reason for T1. To adjust, set potentiometer R1 "off" and adjust the amplifier volume control for a normal listening level. Then adjust R1 until lamp I1 starts to throb in step with the beat.

PARTS LIST FOR BASIC COLOR ORGAN

I1—117V lamp, not to exceed 40 watts.
R1—Potentiometer, 500 to 5000 ohms
SCR1—Silicon Controlled Rectifier, HEP R1218
T1—Transistor output transformer, see text



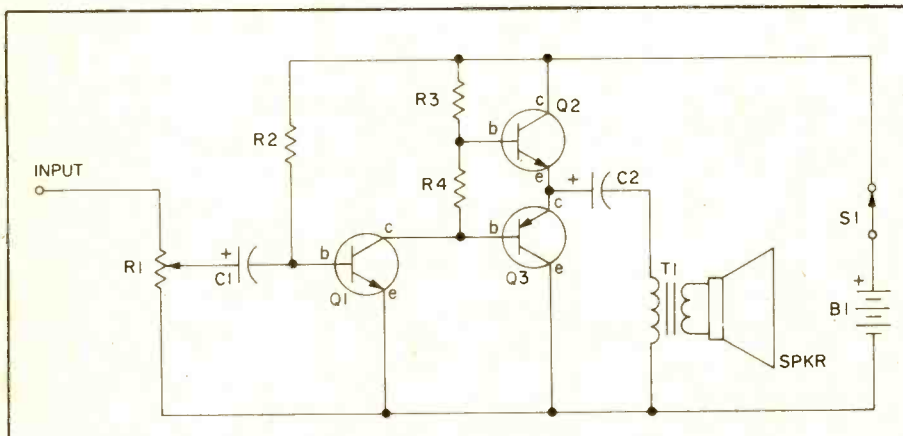
50 Audio Utility Amp

☐ This circuit may look familiar if you're in the habit of glancing at the schematics of your portable radios and recorders. This is a very popular way of getting a signal to a speaker. Transistor Q1 acts as a driver for complementary pair Q2 and Q3. Q2 and Q3 take turns conducting as they follow the input signal, so they can deliver a healthy signal through C2 to T1. T1 is suggested to reduce the loading that a low speaker impedance would cause if connected directly between C2 and ground; a higher impedance speaker or headphone could connect directly.

You can also use this circuit as a signal tracer to listen in on what's happening inside some of the other circuits on these pages. Just clip a lead between the minus leads of both projects and use one lead of a .01 microfarad capacitor in series with the input as a probe.

PARTS LIST FOR AUDIO UTILITY AMP

B1—9 VDC battery
C1—15-uF electrolytic capacitor, 15 VDC (or greater than needed)
C2—100-uF electrolytic capacitor, 15 VDC (or greater than needed)
Q1, Q2—NPN transistor, 2N3906 or equiv.
Q3—PNP transistor, 2N3906 or equiv.
R1—1-Megohm potentiometer
R2—270,000-ohm resistor, ½-watt
R3—1200-ohm resistor, ½-watt
R4—100-ohm resistor, ½-watt
S1—SPST switch
T1—500:8-ohm matching transformer
SPKR—8-ohm speaker



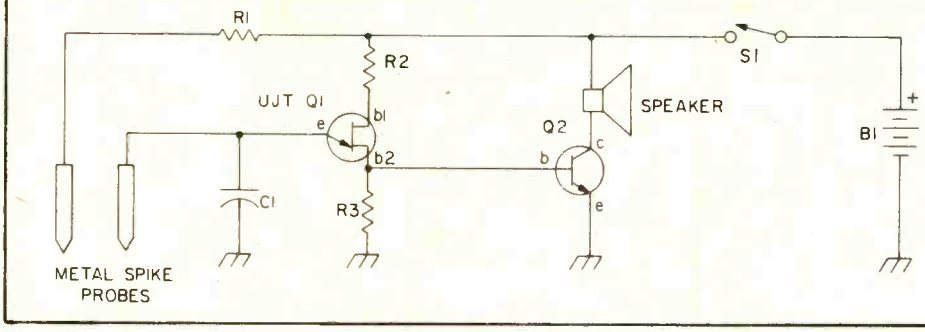
51 Plant Moisture Monitor

☐ Some people don't believe that plants can listen, talk, sing and play musical instruments. But you can prove, at least, that they sing out when you water them. This circuit lets you use the soil near your plants as a variable resistor that changes value as you add more water to it. Just stick the metal spikes into the soil, a few inches from each other. For best results, cut flat, skinny wedges out of thin copper or alumi-

num or out of printed circuit board stock. Depending on the soils resistance, the sound will vary from slow clicking noises to a high pitched shriek.

PARTS LIST FOR PLANT MOISTURE MINDER

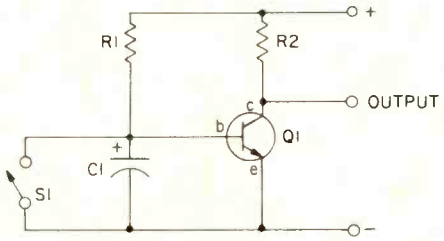
B1—6-18 VDC
C1—5-25 uF capacitor
R1—2200-5600-ohm resistor, ½-watt
R2—3300-5600-ohm resistor, ½-watt
R3—82-120-ohm resistor, ½-watt
Q1—Unijunction (UJT) transistor (2N2646 or equiv.)
Q2—NPN transistor (2N2222, 2N-3904 or equiv.)
S1—SPST switch
SPKR—4-32-ohm speaker



52 Switch Contact Debouncer

☐ Today's logic circuits are so quick that even the fast, tiny bouncing of switch contacts can be counted as separate switching events. This simple circuit adds a tiny delay to the switching to keep those bounces from reaching your logic. It gets its power right from the logic circuit you're using it with. Most logic requires switching between some input and ground. For those cases, use the circuit the way it's shown. It goes in the lead from the ungrounded side of the switch to the logic input (which is then connected to the Output shown).

Should your application require switching to the positive supply (assuming ground is negative above), simply swap the + and — leads and make Q1 a PNP transistor (2N3906, for example). Also, if the capacitor you're using for C1 is polarized, an electrolytic, for example, reverse its polarity as well.



PARTS LIST FOR SWITCH CONTACT DEBOUNCER

C1—.5-2.2-uF capacitor, electrolytic, (VDC greater than your power supply)
R1—10,000-56,000-ohm resistor, ½-watt
R2—270-1000-ohm resistor, ½-watt
S1—SPST (switch to be debounced)
Q1—NPN transistor (2N2222, 2N-3904 or equiv.

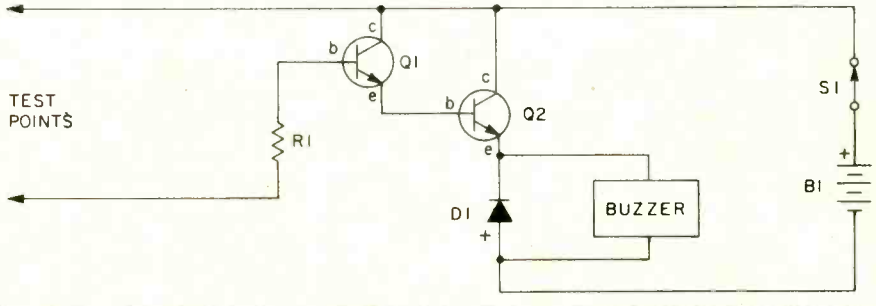
53 Quick Continuity Checker

☐ There are times when just knowing whether or not a complete circuit is present, whether a particular path is an open or a short, can provide the solution to a nasty troubleshooting chore. Here, the buzzer tells all. The use of two transistors in a Darlington configuration, as this circuit arrangement is called, provides more gain than could a single transistor.

As a result, this checker is sensitive enough to indicate continuity even when substantial resistance is present. Diode D1 protects the transistors from the potentially lethal (to transistors) inductive kickback of the buzzer. In much the same fashion as the single coil in a car's ignition can create a high voltage from a low one, the surges of current through the buzzer can destroy a transistor unless some protection is afforded. D1 shorts this inductive kickback out.

PARTS LIST FOR QUICK CONTINUITY CHECKER

B1—9VDC battery
D1—Diode, 1N914 or equiv.
Q1, Q2—NPN transistor, 2N2222 or equiv.
R1—1000-ohm resistor, ½-watt
S1—SPST switch



54 A Vom Thermometer

☐ Almost all electronic components change characteristics as temperatures change. In the case of silicon diodes, like the 1N914, the characteristic that changes is the amount of *forward voltage drop*.

Diodes aren't perfect conductors, you see, because they must take advantage of the bias (voltage) across a semiconductor junction (the place where the two different kinds of semiconductor material, *p* and *n*, meet) in order to operate.

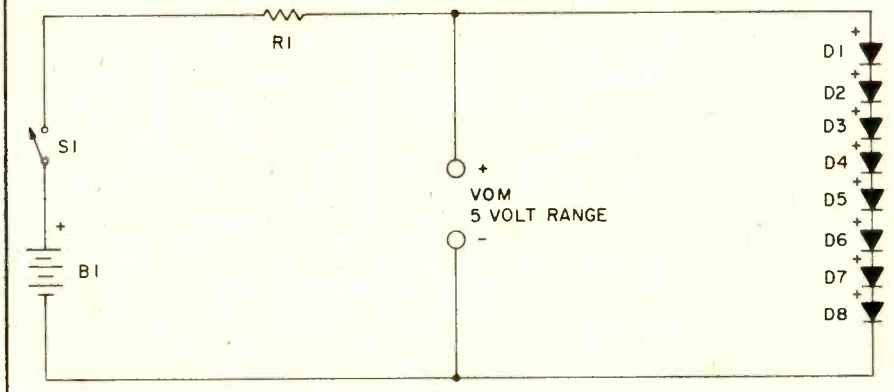
Almost every semiconductor device shows a junction voltage drop of about ½ Volt when forward biased, as the diodes here are. But the exact amount of that voltage drop changes with temperature.

So if you string eight diodes in series, like these, and measure the voltage across the string on the 5 Volt scale of your VOM, you'll see the voltage varying up and down around 4 Volts as you change the temperature the diodes are exposed to.

You could calibrate a separate meter to give you actual degree readings, but for many purposes, just knowing the temperature is changing is enough.

PARTS LIST FOR A VOM THERMOMETER

B1—9 VDC battery
D1, D2, D3, D4, D5, D6, D7, D8 —Diode, 1N914 or equiv.
R1—4700-ohm resistor, ½-watt
S1—SPST switch



55 Wet Basement Alarm

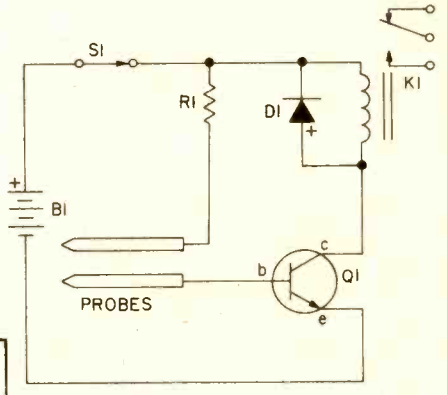
☐ For those of us with basements plagued by dampness, an early warning of wetness is our best, first line of defense. This tiny circuit monitors for wetness between its two metal probes. When it senses the wet, it pulls in relay K1.

Relay K1 can be connected to buzzers, bells, pumps, whatever your situation demands. Just make sure the relay contacts are rated for the load you wish to use.

Where actual liquids are to be sensed, the probes can be simple metal spikes driven into the most moisture-prone section of the basement floor. To monitor for dampness, etch or scrape a zigzag pattern through the middle of a blank copper-coated pc board and connect to each isolated area. Position the board along the floor or wall you wish to monitor.

PARTS LIST FOR WET BASEMENT ALARM

B1—12VDC battery
D1—Diode, 1N914 or equiv.
K1—SPDT relay, 12VDC
Q1—NPN transistor, 2N3904 or equiv.
R1—2700-ohm resistor, ½-watt
S1—SPST switch



56 Nine Volt Neon

☐ Wait a minute! Don't neon lamps need ninety volts to fire? Neon lamp I1 *gets* that kind of voltage—possibly more, depending on the state of your battery and the actual value of T1. Because T1 and Q1 act together to form a DC-to-AC converter.

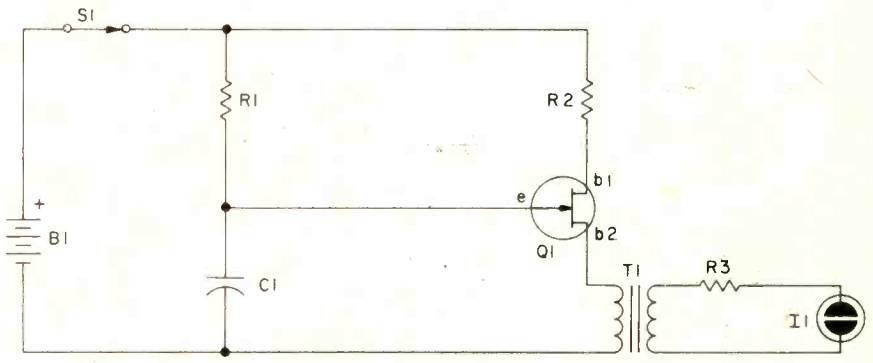
R1 and C1 set the frequency of UJT oscillator Q1 to about 1000 Hertz. Actually, any frequency near the middle of the audio range (300-5,000 Hz) would be okay, so feel free to take some liberties with R1 and C1's values. That's because those are the frequencies that are easiest to handle for T1, a transistor-type interstage transformer. You may find something suitable in one of your old junker radios or amplifier boards.

T1 acts as a step-up transformer, raising the input voltage to a level

where it can fire the NE-2. You may not need R3, but it limits the amount of current that I1 has to handle. For an interesting variation, use a large electrolytic capacitor between about 10 and 1000 microfarads for C1, or increase the value of R1 to 1-10 Megohms (this won't work with every UJT you try). This will cause the UJT oscillator to pulse at a rate somewhere between a few pulses a second and a pulse every few seconds. You'll know because I1 will flash with every pulse.

PARTS LIST FOR NINE VOLT NEON

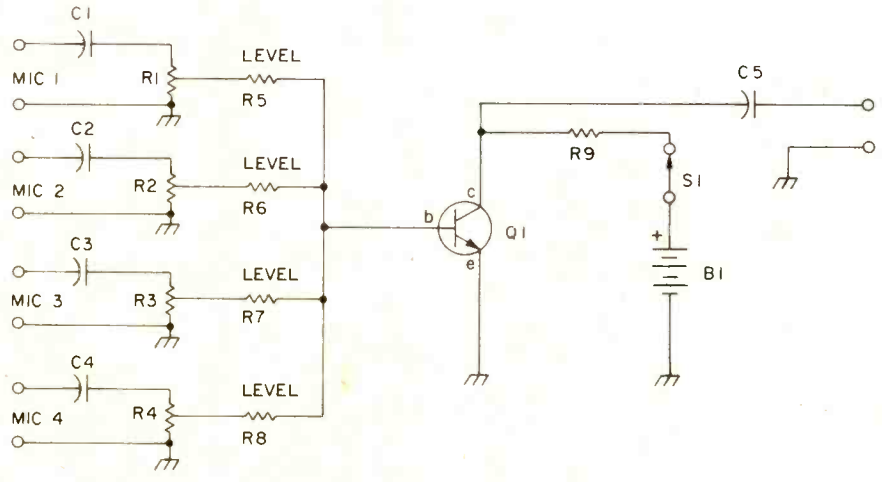
B1—9 VDC battery
C1—.1-uF capacitor
I1—Neon bulb, NE-2 type
Q1—UJT (Unijunction Transistor), 2N2646 or equiv.
R1—10,000-ohm resistor, ½-watt
R2—100-ohm resistor, ½-watt
R3—470,000-ohm resistor
S1—SPST switch
T1—Transformer, 10,000-ohm primary and 100,000-ohm secondary



57 Low Impedance Mike Mixer

☐ There's no reason to limit yourself to using just one mike at a time when you have this circuit to help you with your recording—or any other purpose. You can set up a small microphone mixing console. For pizzazz, you could use slide-style controls for R1-4; for miniaturization, you could use tiny trimmer resistors.

Each control adjusts the level of its associated microphone as they are mixed together. This gives you the versatility of making one mike louder or softer without upsetting the level of any of the others. Transistor Q1 provides a bit of amplification to compensate for losses in mixing, and to assure good level at the input.



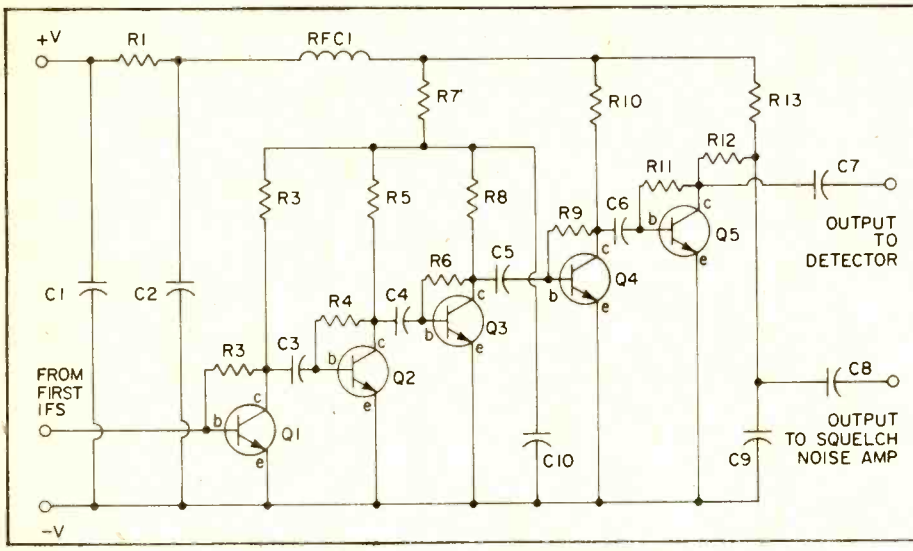
PARTS LIST FOR LOW IMPEDANCE MIKE MIXER

B1—9 VDC battery
C1, C2, C3, C4—.1-uF capacitor
C5—10-uF capacitor
Q1—PNP transistor, 2N3904 or equiv.
R1, R2, R3, R4—1-Megohm potentiometer, audio taper
R5, R6, R7, R8—100,000-ohm resistor, ½-watt
R9—15,000-ohm resistor, ½-watt
S1—SPST switch

58 IF Amplifier

☐ This IF module doesn't offer any selectivity, but it has a tubful of gain to offer, so it's perfect for following mechanical filters or other highly selective stages.

Q1 through Q5 act as individual gain stages, providing a great deal of overall gain for the system. R1, C1, C2 and RFC1 keep the supply line clearly filtered and by passed to avoid annoying parasitics and other bugaboos of high gain receivers. You can also use this circuit as a preamplifier for your test equipment. Oscilloscopes, counters and the like can become supersensitive to help you dig even the really weak signals out of the 455 kHz jungles.



PARTS LIST FOR IF AMPLIFIER

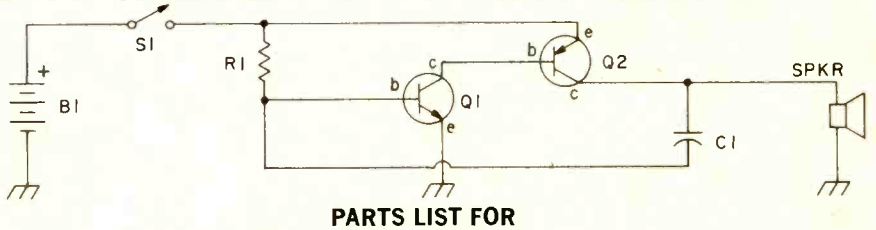
C1, C2, C7, C8, C9—.1-uF capacitor
C3, C4, C5, C6—.001-uF capacitor
C10—.01-uF capacitor
Q1, Q2, Q3, Q4, G5—NPN transistor, 2N3904 or equiv.
R1—47-ohm resistor, ½-watt
R2, R4, R6, R9, R11—180,000-ohm resistor, ½-watt
R3, R5, R8—27000
R3, R5, R8—27,000-ohm resistor. ½-watt
R7—680-ohm resistor, ½-watt
R10—10,000-ohm resistor, ½-watt
R12—6800-ohm resistor, ½-watt
R13—2200-ohm resistor, ½-watt
RFC1—2.5-mH choke

59 Simple Squealer

☐ Back when transistors were brand new and everybody wanted to see how they worked, one of the favorite circuits was very similar to this one. It put out an ear-piercing squeal. The only way anybody could put up with it was to use it with a telegraph key as a code practice oscillator, often in a very large room. The components you choose will have a great effect on the output of this circuit, and you can take it from a whine to a whisper, from a ticking to a squeal.

Just one precaution: it's possible that the components you use could allow too much current to pass through Q1 or Q2. So if the case of either transistor becomes too hot to touch, replace it with a transistor with a higher collector current rating, even a power transistor if you wish.

The editors can not be held responsible for the sanity of you or your neighbors after prolonged experimentation with this circuit.



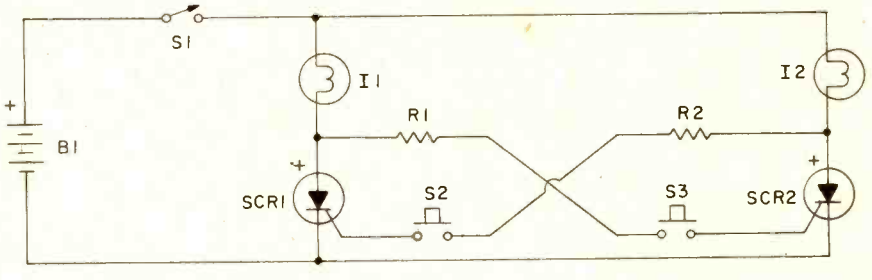
PARTS LIST FOR SIMPLE SQUEALER

B1—3-15 VDC battery
C1—.005-.05-uF
Q1—NPN silicon transistor (2N3904 or equiv.)
Q2—PNP transistor (2N3906 or equiv.)
R1—82,000-120,000-ohm resistor, ½-watt
S1—SPST switch or telegraph key
SPKR—4-16-ohm speaker

60 Quick Draw Game #2

PARTS LIST FOR QUICK DRAW GAME #2

B1—6-15 VDC battery
I1, I2—Pilot lights (see text)
R1, R2—1000-3900-ohm resistors
SCR1, SCR2—Silicon controlled rectifiers (see text)
S1—SPST switch
S2, S3—Normally open pushbutton, or micro, switch



☐ Here our Quick Draw Game goes Hollywood. The bright, incandescent pilot lights can be used with colorful jewels, and the SCRs give the game a "memory." Choose a lamp type for I1 and I2 that is compatible with the voltage you select for B1. And select an SCR type for SCR1 and SCR2 that is compatible with both the voltage of B1 (or greater) and the current requirements of I1 and I2 (or greater). S1 turns the game on. Then the first player to push his "trigger" switch will light his lamp and block his opponent. To reset, turn S1 off.

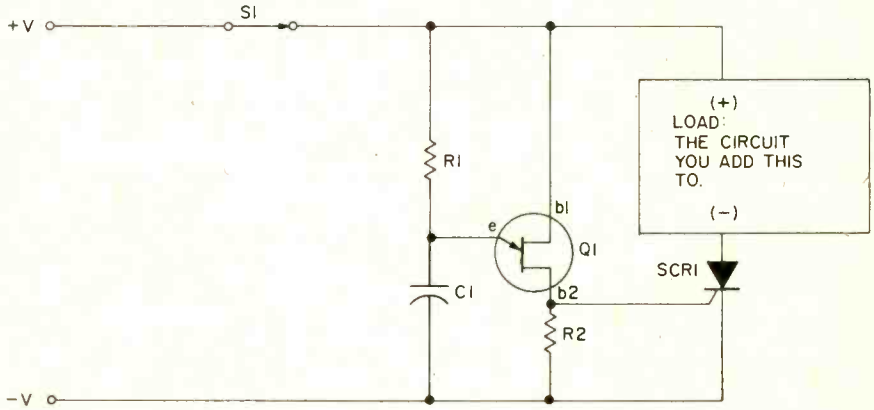
61 Turn-On Delay

☐ Turn the switch on and the circuit you're controlling (LOAD) won't turn on until 10 seconds later with this UJT delay. The SCR is the "switch" that eventually permits current to flow through the load. But the SCR won't turn on until the UJT timer circuit delivers a pulse to its gate. This happens after a time delay determined by the product.

Choose a value for SCR1 that can easily handle the maximum current the load will draw, plus a margin for safety, and the voltage of the power supply, plus a margin for safety. For a 9-12 Volt circuit drawing up to ½ amp or so, a 20 Volt 1 Amp SCR should do nicely. Since S1, when turned off, interrupts the flow of current through the SCR, turn-off for the load happens immediately.

PARTS LIST FOR TURN-ON DELAY

C1—220-uF capacitor
Q1—UJT (Unijunction Transistor), 2N2646 or equiv.
R1—47,000-ohm resistor, ½-watt
R2—22-ohm resistor, ½-watt
SCR1—See text
S1—SPST



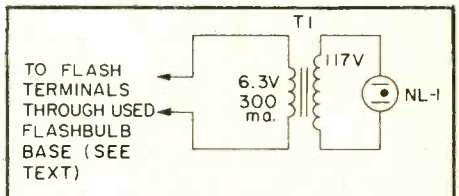
62 Remote Flash Trigger

☐ The way film and flashbulb prices are going these days, if your flash fails to fire you're stuck with almost half a buck in wasted polaroid film, and if you fire a flash to check the flashgun battery you've just burned up at least 25-cents worth of flash. But worse, if the flash fails to fire you might have missed the picture of a lifetime.

You can't check a flash battery with a voltmeter because the meter doesn't apply the heavy surge current needed by the flashbulb, and just about any fully dead battery that isn't leaking acid will check okay when tested without load.

This little flash tester you can probably build from junk-box parts will give you a quick load-check on flashgun batteries. T1 can be any 6.3-volt filament transformer rated from 300-mA up. NL-1 is just about any neon lamp of the NE-2 or NE-86 variety. Solder T1's terminals to those of a used flashbulb or flashcube.

To check the battery, just plug in the flash tester and trip the camera shutter (cover the lens if the camera has film). Lamp NL-1 will flash if the battery is okay (T1 requires a high inrush current, as does the flashbulb).



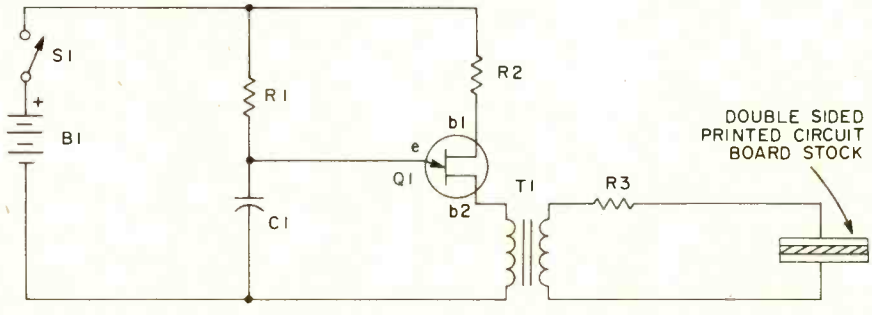
PARTS LIST FOR FLASH TESTER

T1—6.3-volt filament transformer
NL-1—Neon lamp, see text
Misc.—Used flashbulb base.

63 Gotcha Generator

PARTS LIST FOR GOTCHA GENERATOR

B1—9 VDC battery
C1—.1-uF capacitor
Q1—UJT (Unijunction transistor), 2N2646 or equiv.
R1—10,000-ohm resistor, ½-watt
R2—100-ohm resistor, ½-watt
R3—470,000-ohm resistor, ½-watt
S1—SPST switch
T1—Transformer, 10,000:100,000-ohm



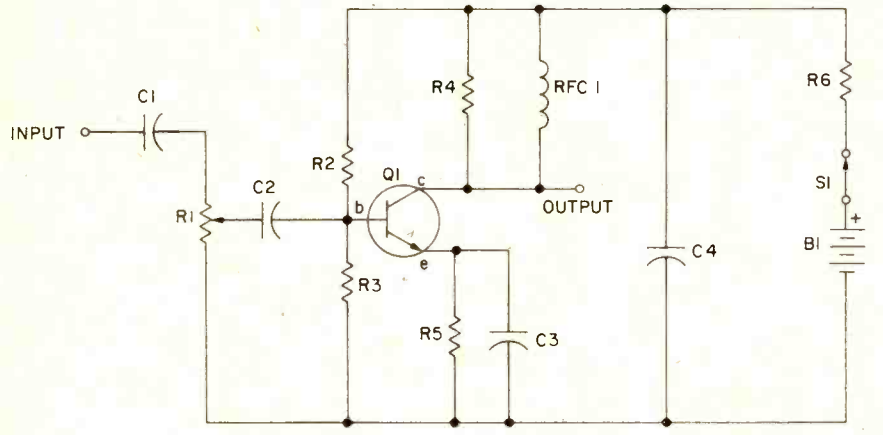
☐ Want to play a game of Hot Potato with a double sided printed circuit board stock? Just add this and you could be putting just under a hundred volts across it—but at only a few hundred microamps of current. (Change R3 to 10 Meg for just under 10 microamps of current). Transformers can be used to step up voltages, as you know. That's the way power transformers are designed. But power transformers have to be able to handle a great deal of current at only 60 Hertz, which requires a bulky package.

The AC supply for this transformer is generated by Unijunction transistor oscillator Q1. It only has to supply current in the milliamp range, and works at about 1000 Hertz, so we can use a small "transistor" interstage transformer for T1. A blank piece of copper coated double sided pc board stock is a good way to keep the stepped-up AC signal from shorting while close—one lead is attached to each face of the board. Bet a friend he can't hold it in his hand for a minute, then throw the switch.

64 Broadband Amplifier

☐ This simple one-transistor amplifier is capable of handily boosting signals from audio through high frequency RF.

The design is stable, well-bypassed, and a neat little performer. And its applications are endless. Connect it to a crystal checker, for example, add a short length of wire at the output for a flea-power marker signal source. Use it as a preamp to your frequency counter or oscilloscope with a short length of wire at the input to observe signals you couldn't see before. Hams can use it as a building block to simple QRP transceivers. SWLs can use it to pep up tired receivers. The circuit is fairly straightforward and trouble-free. You can help keep it trouble free by laying it out as the schematic.



PARTS LIST FOR BROADBAND AMPLIFIER

B1—9VDC battery
C1, C3, C4—.01-uF capacitor
C2—100-pf capacitor
Q1—NPN transistor, 2N2222 or equiv.
R1—10,000-ohm potentiometer
R2—100,000-ohm resistor, ½-watt
R3—10,000-ohm resistor, ½-watt
R4—4700-ohm resistor, ½-watt
R5—470-ohm resistor, ½-watt
R6—100-ohm resistor, ½-watt
RFC1—2.5-mH choke
S1—SPST switch

65 Photo Print Meter

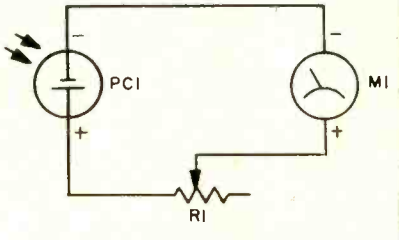
☐ Every print a good print! That's what you get with the photo print meter.

Meter M1 can be just about anything up to 0-1 DC mA. But if you prefer low light levels and long exposures, install a sensitive meter of 500 *u*A or less.

When light from the enlarger falls on the solar cell (PC1), a voltage is generated that is in proportion to the amount of light. Sensitivity control R1 allows the user to set the meter indication to a convenient value.

To use the meter, first make a good normal print in your normal manner from a No. 2 or No. 3 negative. Then, do not disturb the enlarger setting, but integrate the light by placing a diffusing disc or opal glass under the lens. Place the solar cell on the easel and adjust R1 for a convenient meter reading, say, full scale. The meter is now calibrated.

When using it, focus the enlarger, use the diffuser, and adjust the lens diaphragm until you get the reference meter reading. Then use the exposure time previously found for the calibration print. Suggested reading: Ilford Manual of Photography, obtainable from any photo store. Also, check Kodak publications available at the same place.



PARTS LIST FOR PHOTO PRINT METER

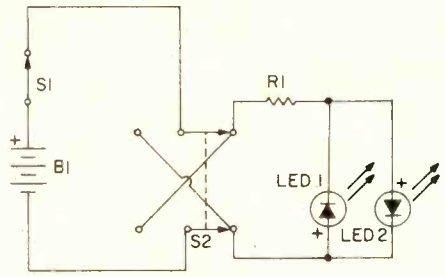
M1—100, 250, or 500-uA DC meter
PC1—Solar cell (Calectro J4-801)
R1—5000-ohm potentiometer linear taper

66 LED Simple Signaller

☐ Here's a tricky way to send three different codes down just two wires. You can signal LED1 only, LED2 only, or neither. It all depends on the polarity of the voltage to the right of S2, which S2 controls, and whether or not S1 is on.

You can also omit the two LEDs from the circuit and use it as a LED checker. Just connect the LED you want to check where LED1 and LED2 are shown. Then one or the other position of S2 will cause a good LED to light.

You can even add a fourth mode of operation by substituting a low voltage ac supply, like the plug-in small transformer variety. This will cause both LEDs to light. If you substitute a signal source for the battery, the relative brightness of the LEDs will give some indication of the duty cycle of the waveform.



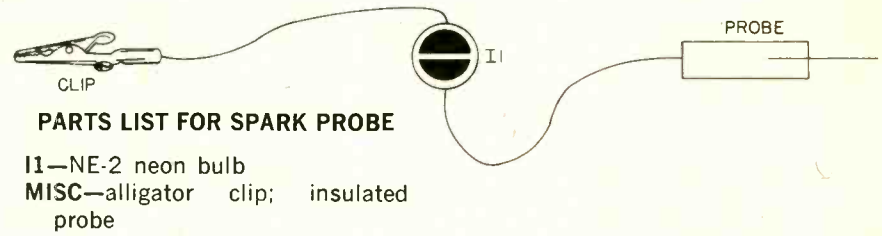
PARTS LIST FOR LED SIMPLE SIGNALER

B1—9VDC battery
LED1, LED2—Light emitting diodes
R1—470-ohm resistor, ½-watt
S1—SPST switch
S2—DPDT switch

67 Spark Probe

☐ Interested in a bright orange light you can turn on without batteries or a power supply? This gadget and your sweater on a dry winter's day can do it. Because the tiny currents and high voltage, static electricity can easily light this neon gas discharge lamp. So can the high voltage on the face of your TV's picture tube. The spark high voltage near your car's spark plug wires. The RF potential near a transmitter or antenna. And a lot more things you'll have fun finding.

In many cases, especially where direct contact and electronic sources of high voltage (such as power supplies and ignition circuits) can be *avoided,* you can attach the alligator clip to your watchband as you bring the probe near your sweater, your comb, or the face of your picture tube. For other applications, attach the clip to ground and make sure your probe is a very good insulator and thick enough to keep the high voltages from conducting through *you.*



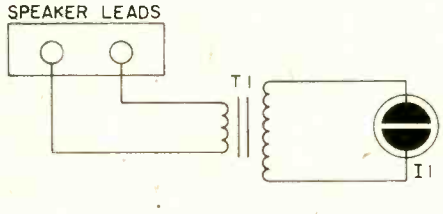
PARTS LIST FOR SPARK PROBE

I1—NE-2 neon bulb
MISC—alligator clip; insulated probe

68 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

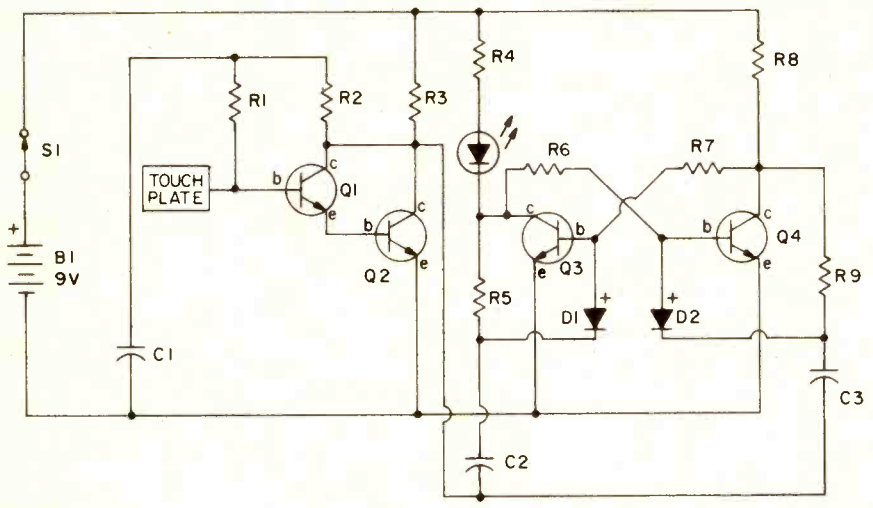
69 A Touchy Gamble

☐ Any bets on whether the LED winds up on or off when you take your finger off the touch plate? The odds are even with this little bandit.

Your body acts as an antenna, picking up power line hum and other stray signals and coupling them through your fingertip to the touch-plate and the input of high gain Darlington transistor pair Q1-Q2. Their output starts bistable multivibrator Q3-Q4 flip-flopping faster than the

eye can follow. Because it's symmetrical, the chances of stopping with Q3 on or off are equal.

When the multivibrating stops with Q3 on, it lights the LED. When Q3 is off, so is the LED. Now that you can let an LED call heads or tails for you, you can save your pennies for the gum machine.

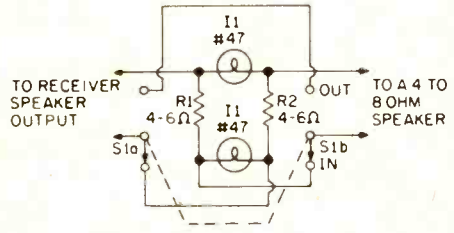


PARTS LIST FOR A TOUCHY GAMBLE

B1—9VDC
C1—2.2-uF capacitor
C2, C3—.01-uF capacitor
D1, D2—Diode, 1N914 or equiv.
LED1—Light emitting diode
Q1, Q2, Q3, Q4—NPN transistor, 2N3904 or equiv.
R1, R2—2.2-Megohm resistor, ½-watt
R3—10,000-ohm resistor, ½-watt
R4, R8—1000-ohm resistor, ½-watt
R5, R9—47,000-ohm resistor, ½-watt
R6, R7—22,000-ohm resistor, ½-watt
S1—SPST switch

70 SWL's Simple Squelch

☐ It's almost a universal rule that two-way radios have a squelch control, a device that mutes the background noise until a station is received. Even public service radios now include a squelch, so why put up with ear-jarring noise when listening on your SWL receiver. Just a couple of #47 pilot lamps scrounged from old tube radios and two resistors are all that's needed to squelch your SW receiver. And if you can't scrounge the lamps, they're available at just about every radio parts distributor and service shop. Switch S1 is needed only to bypass the squelch for very weak signals.



PARTS LIST FOR SWL'S SIMPLE SQUELCH

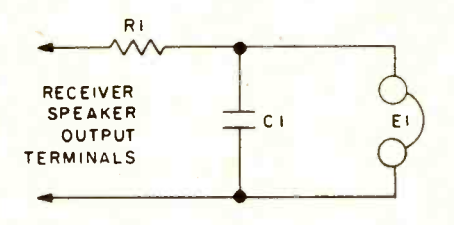
I1, I2—#47 pilot lamp
R1, R2—4 to 6-ohm resistor, 1-watt, 10 percent
S1—Dpdt switch

In many instances, the circuit will provide a basic attenuation of the noise background, not complete squelch. But it's a substantial squelch considering the low cost and ease of construction. Just about any enclosure, plastic or metal, can be used. The components can even lie on the table.

71 29¢ Mag. Phone Filter

☐ If you're tired of copying CW signals through the grind without a Q-multiplier on your receiver, the 29¢ Mag. Phone Filter is the next best answer. It's the cheapest route to greater selectivity.

Capacitor C1 plus the inductance of a magnetic headset form a parallel resonant circuit at approximately 1 kHz. All other signals are sharply attenuated so you hear mainly the signal you want. Resistor R1 isolates the resonant circuit to prevent a receiver's low output impedance from reducing the "Q" of the headset circuit.



PARTS LIST FOR 29¢ MAG. PHONE FILTER

C1—0.005-.05-uF capacitor (see text
E1—2000-ohm magnetic headset
R1—100,00-ohm, ½-watt resistor

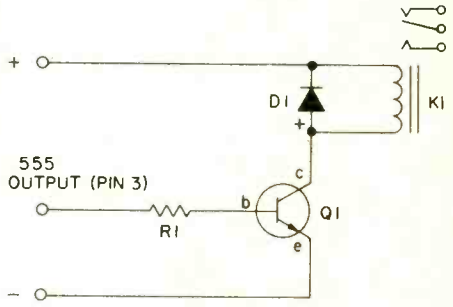
The exact value of C1 depends on the particular headset. Try different values in the range shown until the desired resonant frequency or peaking action is obtained.

72 555 Switch Hitter

☐ The "555" is a very versatile timer when you need a time delay or any kind of regular timed event. But if you try to draw more than 100 or 200 milliamps through it, you'll soon be drawing a blank and a new 555 from your parts drawer. With these simple additions, you can draw as many amps as your relay's contacts will carry. Q1 acts as a relay driver, triggered by the output of the 555 (pin 3) through a 1000 Ohm resistor (R1). Relay K1 can be driven from the 555's power supply (choose an appropriate coil voltage for K1) or from a separate positive power supply if the 555's supply can't handle the extra load. Q2 can handle up to 800 milliamps itself, so any relay coil that draws less than that (100 Ohms or so more than satisfies this) will work fine. Similarly, other loads can be substituted for K1-D1.

PARTS LIST FOR "555" SWITCH HITTER

D1—Diode, 1N914 or equiv.
Q1—NPN transistor, 2N222 or equiv.
R1—1000-ohm resistor, ½-watt
K1—Relay, (rated at least equal to system voltage)



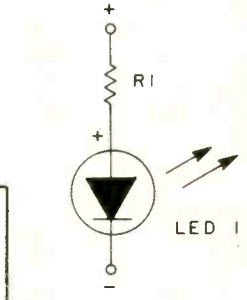
73 Let There Be Light

☐ Whether or not this makes sense for you depends on you. This is a pilot light that you can use with battery operated equipment. Connect it just after the power switch and it will be on whenever the equipment is on. Of course, this adds about 20 milliamp additional current drain to a circuit powered by a 9 Volt battery, and that could shorten your battery life.

But if you tend to forget that things are on—especially silent battery-operated things—the light could remind you and help save your battery. You will find other places in a circuit where adding these two parts can be useful or interesting. Go ahead and look.

PARTS LIST FOR LET THERE BE LIGHT

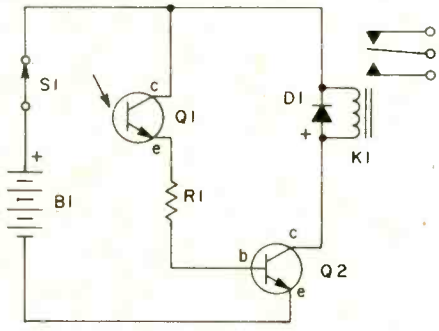
LED1—Light emitting diode
R1—470-ohm resistor, ½-watt



74 Flash Light Remote Control

☐ This is the kind of circuit that has always been called a TV commercial killer, but I happen to like TV commercials, so I put it to work doing other things. Whenever a beam from a flashlight hits Q1 (mounted in a short piece of plastic or cardboard tube to keep ambient light from affecting it), it conducts, pulling up the base of Q2. This turns Q2 on and pulls in the relay.

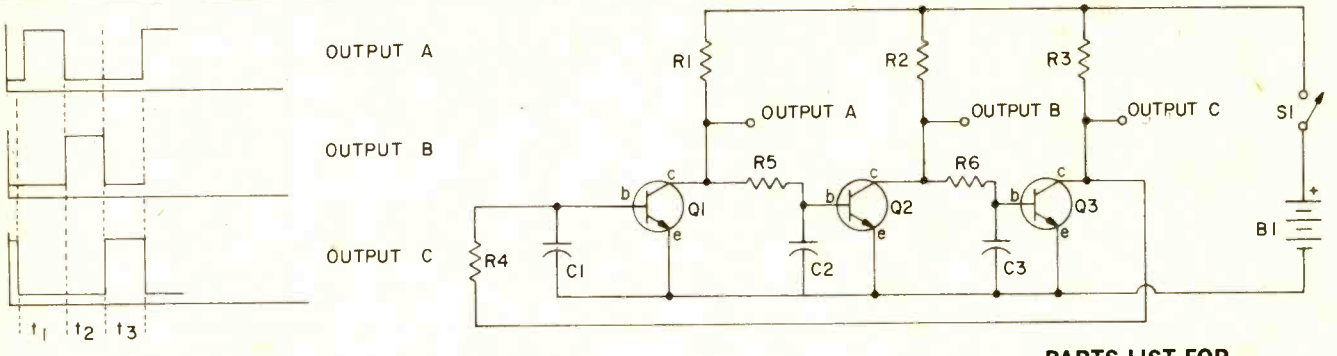
The relay can be hooked to any number of things. You can use it to start and stop a cassette machine, buzz someone into your apartment building, or answer a speakerphone. If you use it to turn on a lamp and let Q1 "see" the lamp, the lamp will stay on until you pass something over the lens of Q1 to shut the light out. Or attach a noisemaker or radio and let it point out your window for an electronic cock's crow that sounds when the sun comes up.



PARTS LIST FOR FLASHLIGHT REMOTE CONTROL

B1—12 VDC battery
D1—Diode, 1N914 or equiv.
Q1—Phototransistor, FPT100 or equiv.
Q2—NPN Transistor, 2N2222 or equiv.
K1—Relay, 12 VDC
R1—2200-ohm resistor, ½-watt
S1—SPST switch

75 Square Wave Generator



$t_1 = t_2 = t_3$ WHEN R1 = R2 = R3
C1 = C2 = C3 AND R4 = R5 = R6

☐ Here is a versatile square wave generator capable of surprising performance. It can deliver clock or switching pulses, act as a signal source, and more. And because the outputs take turns switching, it can be used as a simple sequence generator or as a multiple-phase clock.

The component values indicated will support a range of output frequencies from a few pulses per second up into the high audio range. And this square wave ouput is rich in harmonics. If you use a 5-volt power supply, this circuit can trigger TTL logic directly.

PARTS LIST FOR SQUARE WAVE GENERATOR

B1—6-15 VDC battery
C1, C2, C3—.5-uF capacitor
Q1, Q2, Q3—NPN general purpose transistor (2N2222, 2N3904 or equiv.)
R1, R2, R3—500-2700-ohm resistors, ½-watt
R4, R5, R6—10,000-47,000-ohm resistor, ½-watt
S1—SPST switch

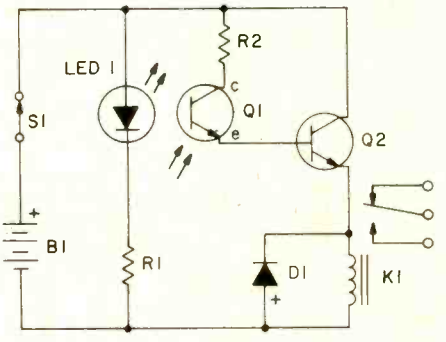
76 Photoelectric Tattletale

☐ How would you like to know whether or not the postal person brought you any post? Or how about a circuit to start something going whenever you put a card in a slot? That's what this little photorelay is all about. Whenever the phototransistor sees the LED, it pulls up the base of relay driver Q2 and pulls in the relay. Stick something between the LED and Q1 and the relay releases. D1 shunts out the relay's inductive kickback.

If you point the LED and Q1 in the same direction, they will act together as a reflective sensor. Then if anything comes close enough to bounce the light from the LED back into Q1 (assuming both are kept in the dark—any light will trigger Q1), the relay will pull in. The circuit can also be used without R1 and LED1 as a light- or no-light-operated alarm.

PARTS LIST FOR PHOTOELECTRIC SOMETHING'S THERE TATTLETALE

B1—12VDC battery
D1—Diode, 1N914 or equiv.
K1—SPDT relay, 12VDC
LED1—Light emitting diode
Q1—Phototransistor, FPT100 or equiv.
Q2—NPN transistor, 2N2222 or equiv.
R1—150-ohm resistor, ½-watt
R2—2700-ohm resistor, ½-watt
S1—SPST switch



77 Current Tattletale

☐ Ever have to check a line to see whether or not any current was flowing within it, and which way? Here's an easy answer. Any current flow here will build up a voltage in R1. If the voltage in R1 is more than about 2 volts, one or the other (or both, if AC) of the LEDs will light.

Different systems may require different values for R1. Use Ohm's Law to calculate R1. For example, if we wanted to know whether or not a car's taillight bulb had burned out, we could connect this circuit in series with the lamp's supply lead. Assume the particular lamp requires typically ½ Amp to light. We then need to know what value for R1 will provide

a 2 Volt drop.

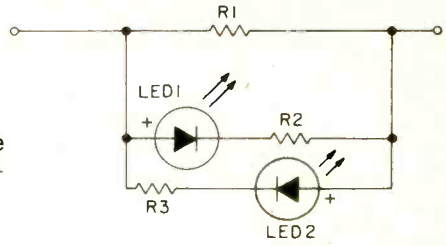
Using Ohm's Law, E=I×R, or R=E/I=2÷½=4 Ohms (you would want to use a 4 or 5 Watt resistor to comfortably handle this 1 Watt power dissipation).

In a 100 Volt B+ supply drawing 100 ma, R=E/I=2/.100=20 Ohms.

The circuit drawn above is sensitive enough to detect a few milliamperes of current flow.

PARTS LIST FOR CURRENT TATTLETALE

LED1, LED2—Light emitting diode
R1, R2, R3—470-ohm resistor, ½-watt

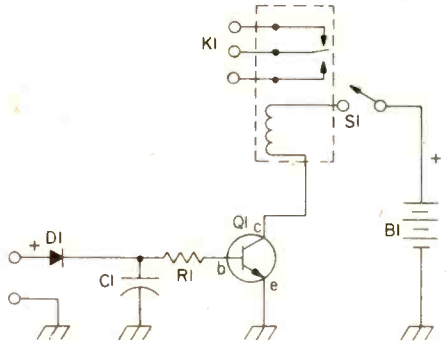


78 Signal Operated Switch

☐ If a VOX is a voice operated switch, is this signal operated switch a SOX?

You can take a signal, like the earphone jack output from a radio or tape player, and use it to trigger the relay operation. If used with an FM wireless mike, an FM radio and a cassette recorder, for example, this circuit could start the recorder whenever the FM radio receives the wireless mike signal. D1-R1-C1 form an R-C delay network that delays the turn-off of the relay until some time (the number of seconds of delay is roughly the number of ohms of R1 times the number of microfarads of C1 divided by a million) after the signal stops.

The signal charges C1 through D1, which keeps it from discharging back through the signal source. C1 then holds the base of Q1 high until it discharges enough through R1 and the base-emitter circuit of Q1 to reach a turn-off point. Q1 completes the circuit for K1's coil, and you can do whatever you want with the contacts (turn on a light, start a motor, honk a horn, fire up a computer, light up your TV).



PARTS LIST FOR SIGNAL OPERATED SWITCH

B1—6-1 VDC
C1—2.2-150-uF capacitor
D1—Silicon diode (1N914 or equiv.)
K1—Small, sensitive relay (reed relays are ideal); voltage compatible with B1; coil impedance greater than B1 voltage by Q1 collector current rating
Q1—NPN switching transistor; collector current rating greater than relay current (2N2222 handles 800 mA and most small relays)
R1—4700-470,000-ohm resistor, ½-watt

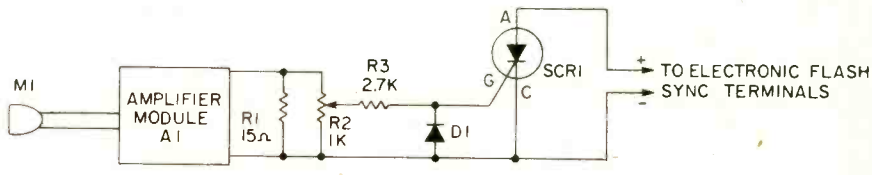
79 Sound-Sync Flash

☐ Those spectacular "peak-of-action" photos taken at the precise instant when a hammer breaks a glass, a pin pricks a balloon, or when a bullet leave a gun, are easily made if you use this sound-sync device to trigger your electronic flash. First, you darken the room lights. Then you open the camera's shutter. You are now ready to cause the action to occur, such as pricking a balloon with a pin. The sound of the "explosion" is picked up by microphone M1 (placed nearby), which causes the sound to activate SCR1, which instantly fires the electronic flash. As soon as the flash fires, you close the camera's shutter.

Miniature amplifier module A1 must have an output transformer. Do not substitute a module with an OTL (output transformerless) speaker output.

PARTS LIST FOR SOUND-SYNC FLASH

A1—1-watt amplifier module with transformer-coupled output (Calectro J4-590)
D1—50-PIV or higher silicon rectifier, type 1N4002, 1N4003, etc.
M1—microphone element, see text
R1—15-ohm, 1-watt resistor
R2—1,000-ohm potentiometer, see text
R3—2700-ohm, ½-watt resistor
SCR1—silicon controlled rectifier (Calectro J4-1730 or equivalent)

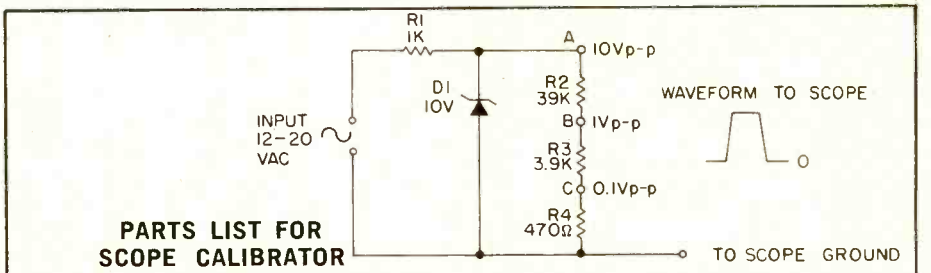


Use the 16-ohm speaker tap for the output connection. R1 simply terminates the amplifier. R2 is the sensitivity control for the flash. Set R2 for the minimum sensitivity that will trip the flash when the action occurs. Don't use so much sensitivity that ambient room noise will be "sensed" as the flash-trigger sound. M1 can be virtually any microphone or microphone replacement element. Use the least expensive model you can get. Sensitivity control R2 can be any potentiometer rated at 1000-ohms or higher. Use whatever you have available.

80 Scope Calibrator

☐ One thing which all lab-grade scopes have, and which is usually missing from general purpose scopes, is a vertical input calibrator. Inexpensive scopes usually have a variable vertical input attenuator with some form of stepped 10X multiplier, but because of the variable control, most experimenters have no idea what the graticule calibrations represent in terms of voltage at any given moment.

With this easy-to-build circuit, you can instantly calibrate your scope, because you will have a positive peak-to-peak reference of 10, 1, and 0.1-volts. Using ordinary 5% tolerance resistors will give you more than adequate accuracy. If price is no object, you can use 1% resistors, but they won't afford much of an advantage.



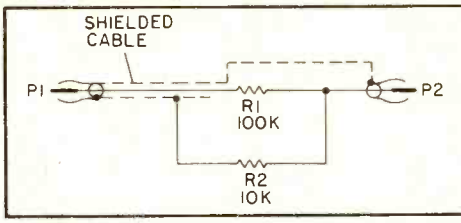
PARTS LIST FOR SCOPE CALIBRATOR

D1—10-volt, 0.25 to 1-watt Zener diode
R1—1,000-ohm, ½-watt resistor
R2—39,000-ohm, ½-watt resistor, 5% tolerance
R3—3900-ohm, ½-watt resistor, 5% tolerance
R4—470-ohm, ½-watt resistor, 5% tolerance

To calibrate your scope, simply adjust the variable attentuator for a convenient reference. For example, if you connect the vertical input to point A (10V peak-to-peak) and adjust the variable attenuator so the "square waveform" fills one vertical division, the scope is calibrated for *10-volts-per-division*. (Get the idea?) The input to the calibrator can be any AC transformer, of virtually any current rating, with a secondary rating of 12 to 20 volts RMS.

81 Computer Recording Attenuator

☐ Most personal computers use a low-cost cassette recorder as the data storage medium, the data generally being stored on tape as alternating audio frequencies. There is no standard output level for personal computer data signal levels, and the computers rely on the recorder's automatic record level control to prevent tape overload and saturation. The auto-level control generally works well. Unfortunately, the signal level from many computers is often sufficiently high to overload the recorder's input before the level control gets a chance to work, and thus the storage of data becomes intermittent, or even impossible.



PARTS LIST FOR COMPUTER RECORDING ATTENUATOR

P1, P2—plugs to match existing equipment
R1—100,000-ohm, ¼-watt resistor
R2—10,000-ohm, ¼-watt resistor

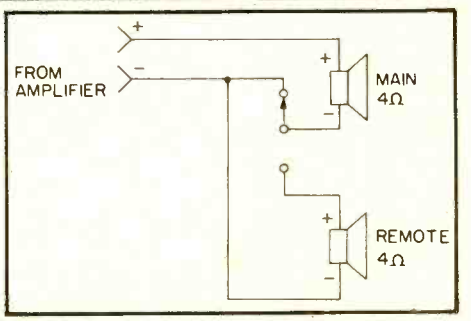
If you have trouble recording your programs, try installing this attenuator cable between the computer's "output to recorder" and the recorder's *auxillary* or *high-level* input. The 10:1 voltage ratio of the cable represents a 20 dB signal attenuation, usually just the right value to prevent overload of the recorder.

Resistors R1 and R2 should be installed directly behind plug PL2. Shielded audio cable must be used between PL1 and PL2. Plugs PL1 and PL2 should match your existing computer and recorder jacks.

82 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.)

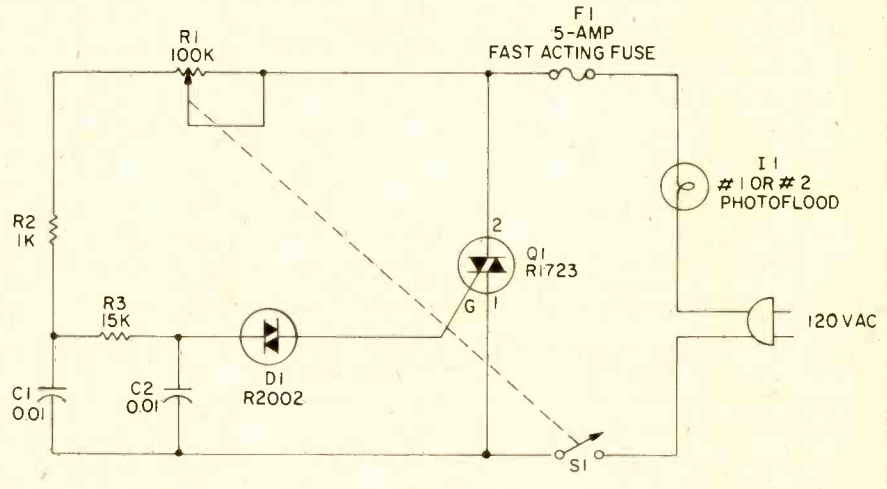
When switch S1 is "up," only the main speaker is *on*. When S1 is "down," the main and remote speakers are connected in series so that the effective impedance is equal to the sum of each speaker impedance. If the speakers are to be used in the same room, they should be "polarized" in-phase, as shown 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 designated "positive".

83 Photoflood Dimmer

☐ Professional quality photographic lighting requires complete control of the studio lights, and that's just what you'll get with the pro-type, full-range 500-watt dimmer. Each one can handle one 500-watt #2, or two 100-watt #1 photoflood lamps, and the lighting range can be adjusted from full off to full on.

Triac Q1 must be mounted to a large heat sink, preferably the metal cabinet used to house this dimmer. Make certain you insulate Q1 from the cabinet.

Fuse F1 *must* be used, otherwise, the surge current that occurs when 500-watt photofloods burn out will instantly destroy Q1. F1 must be a fast-acting fuse such as the type 8AG. The slower fuses such as the 3AG and the slo-blo offer no protection. Switch S1 is part of intensity adjustment R1, and R1 should be wired so it represents maximum resistance just before S1 switches off. (While S1 cannot normally handle a 500 watt load, in this circuit, it switches when the lamp is off and has no trouble handling any size photoflood.)

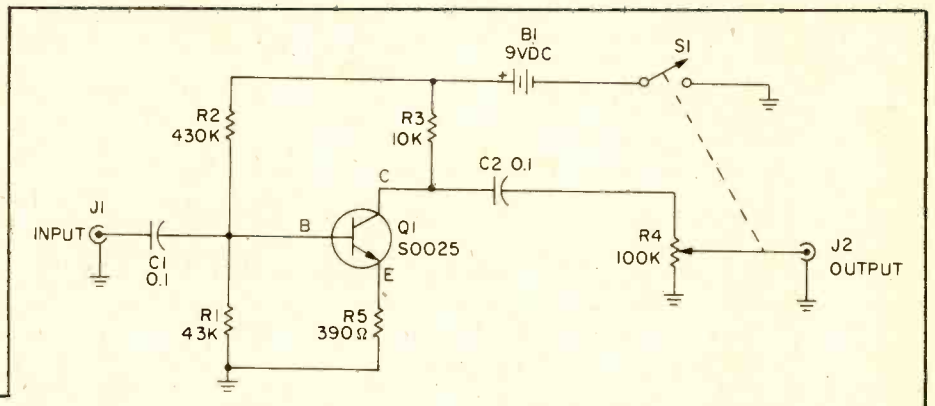


PARTS LIST FOR PHOTOFLOOD DIMMER

C1, C2—0.01-uF, 50-VDC ceramic disc capacitor
D1—HEP-R2002 bi-directional trigger diode
F1—8AG 5-Amp fast-acting fuse
Q1—HEP-R1723 Triac
R1—100,000-ohm, linear taper potentiometer w/SPST switch
R2—1,000-ohm, ½-watt resistor
R3—15,000-ohm, ½-watt resistor
S1—SPST switch, part of R1

84 Rocker's Mike Booster

☐ Between the lead and rhythm guitars, and the organ or synthesizer, the lead vocalist's mike often gets buried under the instruments if they all use a common amplifier. One way to get the vocalist up and out front is to give the mike some extra sock with a preamp. This one, specifically designed to handle most of the impedances commonly used by rock-group mikes, will give enough extra gain to project the singer's voice out to the last row of the balcony! Build it any way you wish, just as long as it's inside a metal cabinet.



PARTS LIST FOR ROCKER'S MIKE BOOSTER

B1—9-volt transistor radio battery, see text
C1, C2—0.1-uF, 10-VDC mylar capacitor
J1, J2—jacks to match existing cables
Q1—HEP-S0025 NPN transisto
R1—43,000-ohm, ½-watt resistor
R2—430,000-ohm, ½-watt resistor
R3—10,000-ohm, ½-watt resistor
R4—100,000-ohm, audio taper potentiometer w/SPST switch
S1—SPST switch, part of R4

85 CB Scope Monitor

☐ Any scope, from the least to most expensive, with provisions for direct connections to the vertical CRT plates, can be used for direct observation of the modulated RF waveform of a CB transmitter; not just the modulation itself, but the actual RF output at 27 MHz.

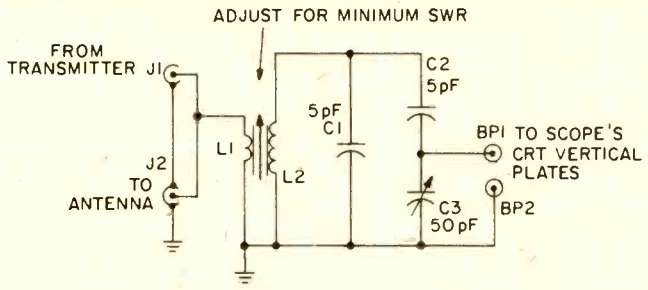
Taking virtually no energy from the CB rig's output signal, this scope monitor adaptor continuously samples the RF fed to the antenna system, providing a *real-time* monitor of what's being received on the other end of the two-way communications circuit.

The adaptor must be assembled in a metal cabinet. J1 and J2 are UHF coaxial jacks spaced as close together as possible.

L2 is wound first, in the center of a ⅜-inch, slug-tuned coil form. Then L1 is wound adjacent to the "ground" end of L2. Install the L1/L2 assembly so the tuning slug protrudes through the cabinet.

To use the adaptor, set your scope for direct vertical plate connection, and connect the plate jacks to binding posts BP1 and BP2. Connect an SWR meter between your CB transmitter and the adaptor, and then connect the adaptor to the transmission line. Key the transmitter and adjust L1/L2 for minimum SWR. (It should read as low as without the adaptor.) Adjust C3 for the desired trace size on the CRT. There is some C3/coil interaction, so it will probably be necessary to readjust L1/L2 for minimum SWR each time you adjust C3.

(Note: The adaptor must connect to a scope's vertical plate connection(s). The 27 MHZ RF usually can't pass through a scope's vertical amplifier unless it happens to be a lab-grade RF scope.)



PARTS LIST FOR CB SCOPE MONITOR

BP1, BP2—insulated 5-way binding post
C1, C2—5-pF silver mica capacitor
C3—5-pF trimmer capacitor
J1, J2—PL-259 UHF coaxial jacks
L1—3 turns of #22 solid, plastic-insulated wire, see text
L2—4 turns of #18 enameled wire, see text
Misc.—⅜-inch RF slug-tuned coil form (Miller #4400-2)

86 Pencell NiCad Charger

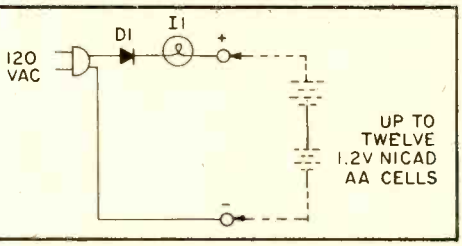
☐ Packaged in a fancy plastic box, with clips to handle up to four rechargeable batteries, this simple circuit sells for upwards of $10 in many automotive and hardware stores. In actual fact, it can cost less than $1 for the components, and will handle up to twelve AA (pencell) size NiCads such as used in CB walkie-talkies. The circuit automatically limits the charging current to a proper value, so you can even recharge just one NiCad at a time, if you must.

The best way to handle the NiCads is to use battery holders such as those sold in many electronic parts stores. You can get holders that accommodate up to six cells each, and a couple of alligator clip jumpers will allow you to configure the terminals to handle less than six cells per holder. Alternatively, you can build a holder from a strip of wood with metal, spring-loaded end terminals.

The lamp maintains the charging current at approximately 20-mA, and AA (pencell) Nicads should be charged for about 16-hours.

PARTS LIST FOR PENCELL NiCad CHARGER

D1—silicon rectifier rated at 200 PIV @ 0.5-Amps
I1—type S-6 6-watt candelabra lamp



87 Budget Lamp Dimmer

☐ Using almost all "junk box" parts, or those easily found at local parts distributors, this budget-priced lamp dimmer can be assembled directly inside a lamp socket, lamp base, or electrical outlet box (replacing a wall switch).

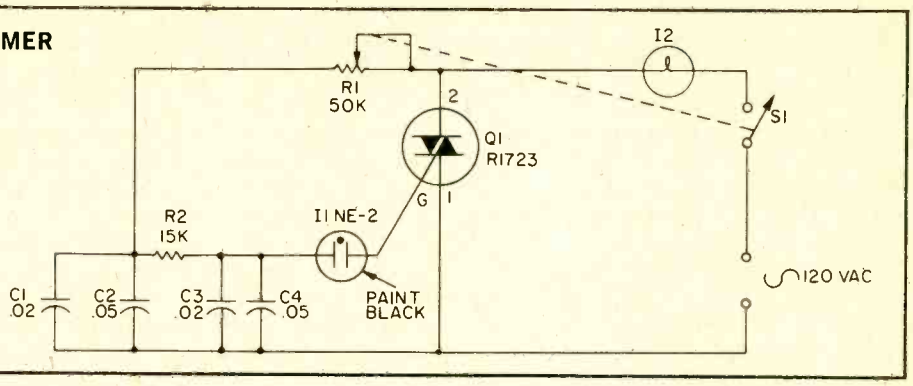
Triac Q1 can handle up to 75-watts without a heat sink. Over 75 watts, sink Q1 to the metal enclosure, or a small heat sink insulated from the socket (if you build the dimmer into a socket). If you mount Q1 on the enclosure, make certain none of the Triac's leads "short" to the enclosure. Use silicon heat sink grease between Q1 and the sink.

I1 is an ordinary NE-2 neon lamp. If it will somehow be exposed to light, paint the lamp black, or some other opaque color. (I1's "trigger" voltage threshold is affected by light.)

Because the neon lamp has a firing threshold above zero volts, the lamp cannot be turned fully off with the control. Rather, switch S1 snaps the lamp on to a very subdued brilliance which can be faded up to almost maximum lamp brilliance. Make certain R1 is wired so it is a maximum resistance just before S1 switches from on to off.

PARTS LIST FOR BUDGET LAMP DIMMER

C1, C3—0.02-uF, 50-VDC ceramic disc capacitor
C2, C4—0.05-uF, 50-VDC ceramic disc capacitor
I1—NE-2 neon lamp
I2—75-watt or smaller standard lighting fixture
Q1—HEP-R1723 Triac
R1—50,000-ohm, linear taper potentiometer
R2—15,000-ohm, ½-watt resistor



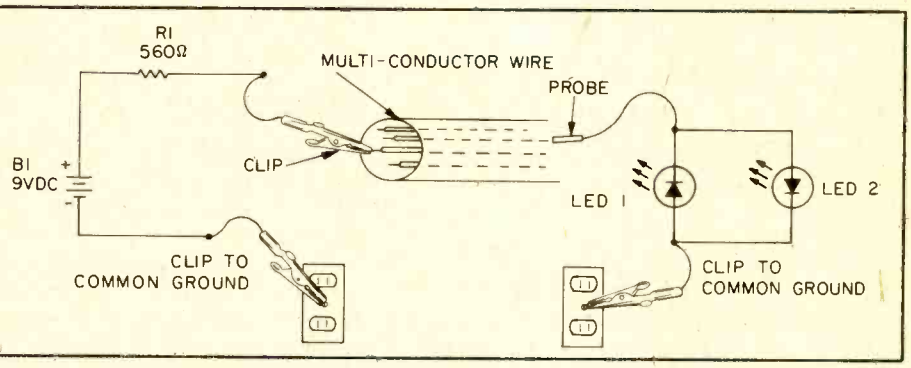
88 Wire Tracer

☐ Problem! You've just snaked a multi-wire computer and/or intercom cable through two floors, five bends, and two "pull" boxes, and you have the creepy feeling that one of the wires broke in the process. Then, you discover upon trimming away the outer jacket, that all of the wires are the same color. What to do? Simple, just check 'em all with this simple wire tracer. Clip one end of the LED1/LED2 circuit to the same ground source and touch the other end to each wire. When you find the wire being tested, one of the two LEDs will light.

It doesn't matter which LED lights. We use two only to prevent confusion in the event a polarity gets reversed. This way, one LED is certain to light. The LEDs can be any "general purpose" type available. Battery B1 is a 9-volt transistor radio-type.

PARTS LIST FOR WIRE TRACER

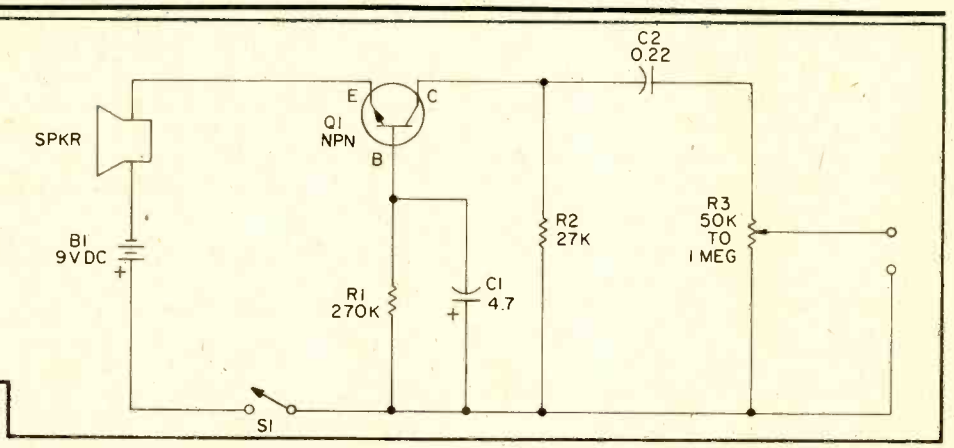
B1—9-volt transistor radio battery
LED1, LED2—general purpose LED, 0.02 mA
R1—560-ohm, ¼-watt resistor
Misc.—3 alligator clips, 1 test probe



89 Speaker-MIC

PARTS LIST FOR SPEAKER-MIC

B1—9-volt transistor radio battery
C1—4.7-uF, 10-VDC electrolytic capacitor
C2—0.22-uF, 10-VDC mylar capacitor
Q1—general purpose NPN transistor, see text
R1—270,000-ohm, ½-watt resistor
R2—27,000-ohm, ½-watt resistor
R3—audio taper potentiometer, see text
S1—SPST switch



☐ A "junk box" speaker and a general purpose transistor, plus a few other "general purpose" components are all that are required for a high-output microphone substitute. While not hi-fi quality by any stretch of the imagination, the Speaker-Mic handles voice frequency signals very well.

Transistor Q1 can be just about any general-purpose NPN wtih a Beta of about 50 to 150. The speaker can be anything you have lying around of virtually any impedance rating in the range of 3.2 to 42-ohms. If the entire circuit, including battery, is assembled in a small metal enclosure, you'll end up with a hand-sized "amplified microphone."

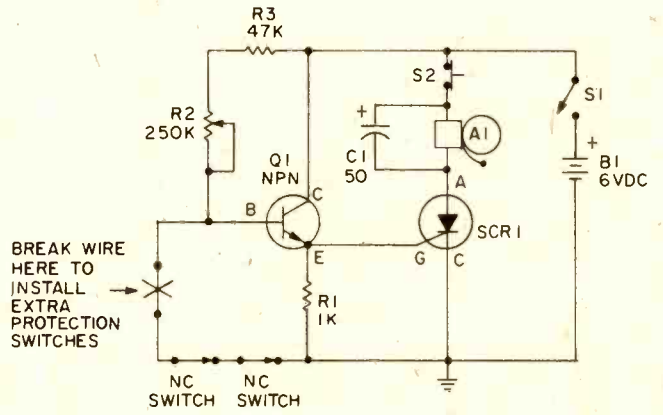
The volume level is adjusted with potentiometer R3, which can be any audio taper unit from 50,000-ohms to 1-megohm. You can substitute a linear taper potentiometer if you have one lying around, but you'll find the adjustment range is scrunched together on one end of the shaft's rotation.

90 Pro Burglar Alarm

☐ Almost without exception, professional burglar alarms are the so-called "supervised" type, meaning a closed circuit loop in which current, no matter how low a value, always flows so that cutting any of the wiring causes the alarm to sound. Early closed circuit alarms were entirely relay operated, and a high resistance which developed anywhere in the circuit usually caused the alarm to false-trip, which always seemed to happen in the wee hours of the morning. Solid-state supervised circuits, such as this Pro Burglar Alarm, are relatively insensitive to the high resistance developed in contacts through normal aging.

The switches shown as "N.C. (normally closed) Switch" can be any normally closed or continuous device, such as window foil. Battery B1 is a 6-volt lantern battery which will give service for almost as long as its shelf-life because the continuous current drain is only about 100 μA. Once the alarm is tripped, it can be turned off only by opening master power switch S1, or "bell stop" PB1, a normally-closed pushbutton switch. (Both switches should be concealed.)

To adjust: Open the protective circuit. While measuring the voltage across R1, advance R2 so the meter reading rises from zero towards 1-volt. At less than 1-volt, the alarm bell should trip. It it doesn't, you have made an assembly error. Finally, adjust R2 for a 1-volt reading, disconnect the meter and restore the protective circuit.



PARTS LIST FOR PRO BURGLAR ALARM

A1—6-VDC alarm bell or siren
B1—6-volt lantern battery
C1—50-uF, 6-VDC electrolytic capacitor
Q1—2N2222A NPN transistor or equivalent
R1—1,000-ohm, ½-watt resistor
R2—250,000-ohm linear taper potentiometer
R3—47,000-ohm, ½-watt resistor
SCR1—GEMR-5 silicon controlled rectifier
S1—SPST switch
S2—normally-closed SPST pushbutton switch

91 Balanced Input Mike Preamp

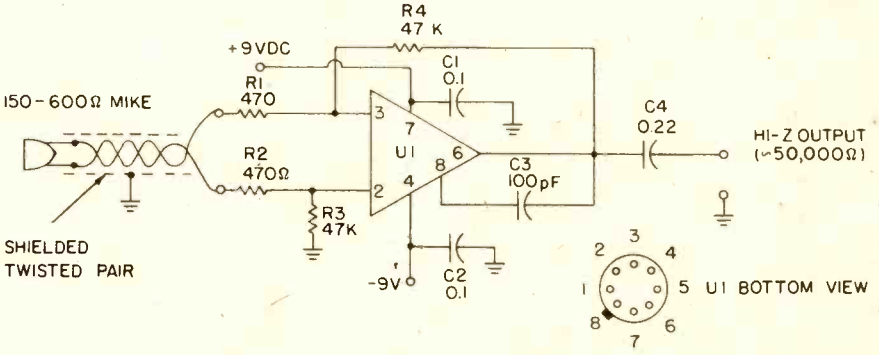
☐ Once the length of a "single ended" (one shielded wire) microphone cable exceeds 25-feet, it becomes highly susceptible to hum and noise pickup. One way the pros get around the problem is by using low-impedance *balanced-output* microphones. The Low-Z mike is less susceptible to noise pickup to start with, and what noises picked up by the line are picked up equally in both wires, so they cancel if the mike feeds a balanced input amplifier.

About the easiest way to get a balanced input is to use an operational amplifier as a preamp, because the op amp starts out with a *differential* (balanced) input. Virtually any op amp can be used, although the Signetics SE/NE-531 is a good choice because it's very stable. In addition to providing a balanced, noise-cancelling input, this circuit delivers a nominal 40 dB gain.

Aside from using a metal enclosure, there is no special assembly precaution, other than installing C1 and C2 as close as possible to the IC terminals. The 531 is available in both the "round" package shown and in a DIP. Either packaging type can be used. Any microphone with a balanced output up to 1000 ohms can be used, though the more common impedances of 150 to 600 ohms will produce optimum fidelity.

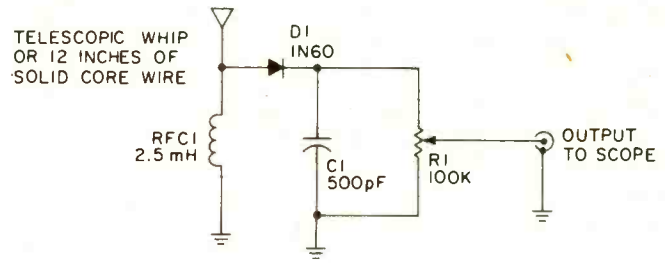
PARTS LIST FOR BALANCED MIKE PRE-AMP

C1, C2—0.1-uF, 15-VDC mylar capacitor
C3—100-pF, 500-VDC ceramic disc capacitor
C4—0.22-uF, 15-VDC mylar capacitor
R1, R2—470-ohm, ½-watt resistor, 5% tolerance
R3, R4—47,000-ohm, ½-watt resistor, 5% tolerance
U1—Signetics NE or SE-531 op amp



92 AM/CB Modulation Monitor

☐ Virtually any oscilloscope, even a rock-bottom-priced "experimenter" model, can be converted into an AM modulation monitor with these few parts found in most experimenters' junk boxes. Placed near any AM amateur or CB transmitter, it provides an exact replica of the modulation to the scope's vertical input. Simply adjust R2 and the scope's vertical sensitivity control for the desired CRT trace height. If you couple sine-waveform tone into the mike through a small amplifier and speaker, it will instantly tell you if that report of "distorted talk power" is really you, or a problem at the receiving station. Best results will be attained if the circuit is built in a metal enclosure with the antenna connected through a "tip" or "banana" jack. Operating range is 1.5 to 30 MHz.



PARTS LIST FOR AM/CB MODULATION MONITOR

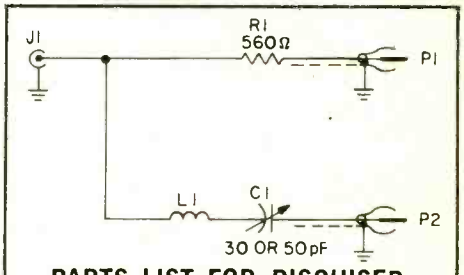
C1—500-pF, 50-VDC ceramic disc capacitor
D1—1N60 germanium diode
R1—100,000-ohm, audio or linear taper potentiometer
RFC1—2.5-milliHenries RF choke

93 Disguised CB Antenna Matcher

☐ If you're tired of your CB antenna acting like a beacon to every creep and hoodlum in your neighborhood (or wherever you travel) simply install a disguised CB cowl mount antenna in place of your car's existing auto antenna, and then use this matcher to connect the antenna to both your auto radio and CB, without need for any switching system between the two radios. The matcher automatically connects the antenna to the proper radio.

When transmitting on CB, the C1/L1 series-tuned circuit passes the RF to the antenna, while R1 keeps the RF out of the radio. When receiving broadcast stations, the C1/L1 combination represents a high impedance, keeping the signals out of the CB where they would be "shorted" by the receiver's "front end." The broadcast signals pass through R1 to the auto radio.

Build the matcher in a metal enclosure. Jack J1 and plugs PL1 and PL2 should match your existing equipment. The matcher must be adjusted to your antenna system for maximum CB performance. Connect an SWR meter between the CB rig and the matcher (PL2), adjust C1 for minimum SWR.



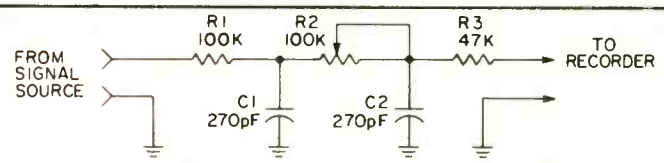
PARTS LIST FOR DISGUISED CB ANTENNA MATCHER

C1—30-pF or 50-pF trimmer capacitor
L1—RF choke (Ohmite Z-144 or equivalent)
R1—560-ohm, 1.2-watt resistor

94 Scratch Filter

☐ Next time you're dubbing some "oldies but goodies" to tape, there's no need to put up with the scratches and noise that have accumulated over a good number of years of usage. Just pass the signals from the records through this scratch filter, and you'll get rid of much of the noise without too much loss of music frequencies.

The filter connects between the signal source, such as a record player or an amplifier's tape output, and the line input of a tape recorder. It's cut-off frequency is slightly higher than 5000 Hz, with attenuation increasing as the frequency goes up. Potentiometer R2 permits you to vary the "corner" frequency slightly to attain more or less high frequency attenuation as required by the individual record. (Or, you can just set the control to the approximate center and forget about it.) For proper operation, the input impedance of the recorder should not be less than 40,000



PARTS LIST FOR SCRATCH FILTER

C1, C2—260-pF silver mica capacitor, 5% or better tolerance
R1—100,000-ohm, ½-watt resistor
R2—100,000-ohm, linear taper potentiometer
R3—47,000-ohm, ½-watt resistor

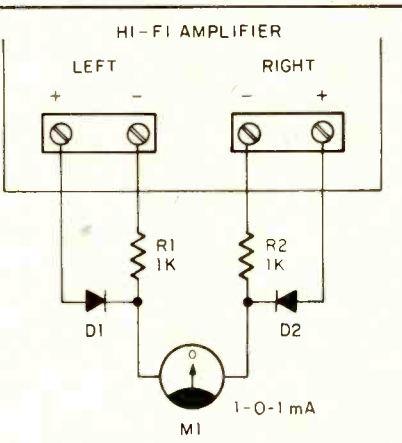
ohms—a common minimum value for most recorders. Do not eliminate R3 in an attempt to increase the output level of the filter, because it provides part of the filter's output impedance matching in conjunction with the recorder's input impedance. A metal enclosure is suggested, with RCA-type phono jack connectors.

95 Stereo Balance Meter

☐ One sure way to be certain your sound system is in perfect electrical balance is to use a power amplifier stereo balance meter to substitute for guesswork.

Meter M1 can be a zero-center DC milliammeter rated 1-0-1 mA or less. Alternately, you could use a standard meter but the pointer might be driven off-scale to the left while making adjustments, though the meter won't be damaged—it will just be an inconvenience.

Play any stereo disc or tape and then set the amplifier to *mono*. Adjust the left and right channel balance until meter M1 indicates zero; meaning the left and right output level are identical—that's balance.



PARTS LIST FOR STEREO BALANCE METER

D1, D2—Silicon rectifier rated 100 PIV at any low current
M1—Zero-center DC mA meter (see text)
R1, R2—1000-ohm, ½-watt resistor, 5% or 1%

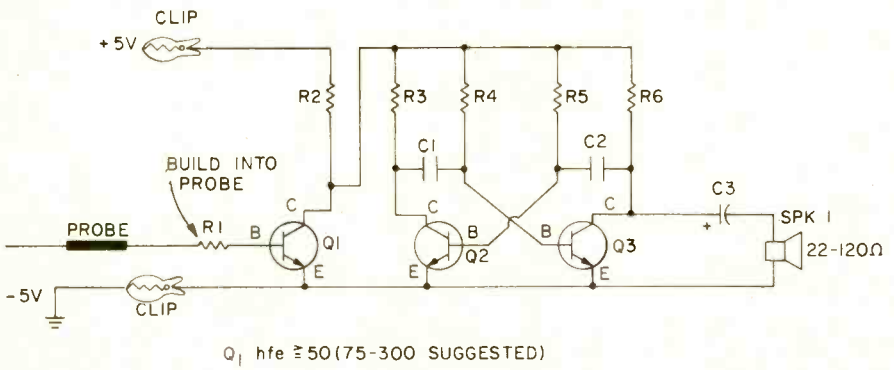
96 Audible Logic Probe

☐ One problem when servicing modern IC circuits is that everything is packed in so tight, and IC terminals are so close together, if your test probe slips a fraction of an inch (or centimeter) it's ZAP!, another component bites the dust; and trouble is, solid state breakdowns usually take out a whole string of components.

Logic probes used to trace digital circuits often lead the list in devices that ZAP ICs because you've got to keep one eye on the probe indicator lamp and the other eye on the tip of the test probe. But all that's a thing of the past with this Audible Logic Probe because you can keep both eyes and your full attention on the tip of the test probe, and a tone indicates a logic low.

Normally, Q1 is cut off (no base input), and there is a small, insignificant voltage drop across R2 so multivibrator Q2-Q3 receives operating voltage and produces an output in the speaker of approximately 700 Hz (at low but comfortable volume). When the probe is touched to a logic low (0) Q1 is still cut off so sound output indicates a low. When the probe is touched to a logic high (1) Q1 is driven to saturation and the full supply voltage is dropped across R2, so the multivibrator and its output is cut off, indicating a logic high.

Alligator or crocodile clips are used to connect to the TTL equipment's + and – 5-volt terminals. Resistor R1 should be built directly into the test probe to provide good isolation between the TTL equipment and your test lead circuit. Speaker SPK-1 should be rated 20 to 120 ohms—the higher the impedance the greater the volume. 20-, 32- or 45-ohm intercom speakers available on the surplus market are good choices.



PARTS LIST FOR AUDIBLE LOGIC PROBE

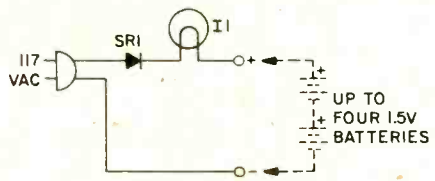
Resistors ½- or ¼-watt, 10%
R1—27,000-ohms
R2—1,000-ohms
R3—10,000-ohms
R4, R5—100,000-ohms
R6—3,300-ohms
Capacitors rated 10-VDC or higher
C1, C2—0.10-uF ceramic disc
C3—1 to 2.7-uF
Q1, Q2, Q3—NPN transistor, Radio Shack 276-2009
SPK-1—See text
Misc.—Clips

97 Dry-Cell Charger

☐ This circuit in a fancy commercial package will cost you about $5. Build a lamp bulb charger yourself and 50¢ may just about do it.

The lamp maintains constant charging of approximately 20 mA through one to four 1.5-volt batteries. But you can go as high as 22.5 volts for either batteries in series or a single battery.

Give small penlight batteries about 10 hours charge, the C and D cells about 20 hours. Yes, you can recharge NICads stamped with a charge rate of approximately 20 to 25 mA.



PARTS LIST FOR DRY-CELL BATTERY CHARGER

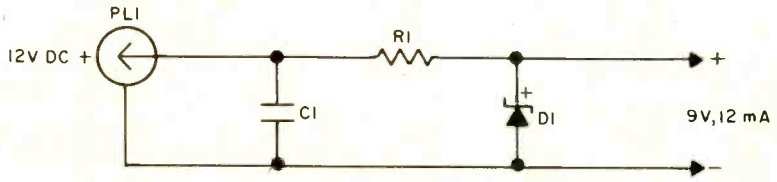
I1—No. S-6, 6-watt candelabra lamp
SR1—400-PIV, 1A silicon rectifier (Lafayette Radio Electronics 32R08824 or equiv.)

98 12 to 9 for Transistors

☐ When your auto radio poops out, this regulated voltage adapter keeps you in music from a transistor portable until you're ready to climb under the dash to get at the trouble and fix it.

Power is taken from the 12-volt auto battery through a cigar lighter plug. The zener diode can be anything with an approximate rating of 9 volts. For example, you can use a 9.1-volt unit (common in Zener kits), or even one rated at 8.6 volts. Make certain the Zener is correctly installed; the end marked with a band is the cathode.

The adapter is rated for a current of 12 mA maximum. A good rule of thumb is that a radio powered by a Burgess type 2U6 battery can safely operate on the adapter.



PARTS LIST FOR 12 TO 9 FOR TRANSISTORS

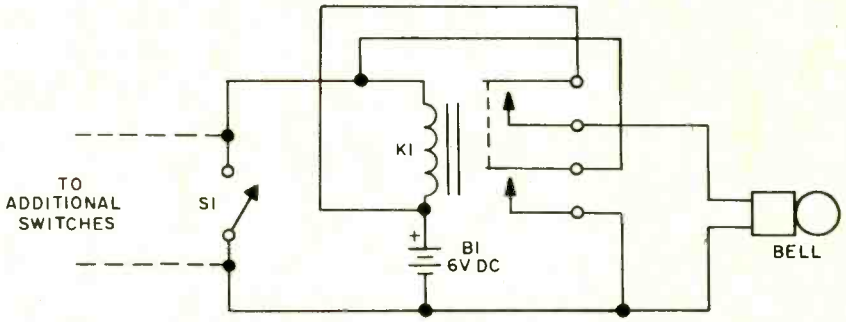
C1—0.05-uF, 400-VDC capacitor
D1—1-watt, 9.1-V Zener diode—HEP-104 (Radio Shack 276-562)
PL1—Cigarette lighter plug (Calectro N4-029)
R1—150-ohm, ½-watt resistor

99 Latching Burglar Alarm

☐ Open a fancy commercial burglar alarm and all you'll find inside is this ordinary relay latching circuit.

The input terminals are connected to parallel-wired normally open (N.O.) magnetic switches, or wire-type security switches stretched across a window that *close* a bell contact circuit when the wire is pushed or pulled.

When a security switch closes the series battery circuit, relay K1 pulls in. One set of contacts closes the alarm bell circuit, while the second set "latches" the battery circuit. Even if the security switches are opened, the alarm remains on. To disable the alarm, or for reset, install a concealed switch in series with one battery lead.



PARTS LIST FOR LATCHING BURGLAR ALARM

B1—6-V lantern battery
BELL—6-VDC alarm bell
K1—6-VDC dpst relay
S1—Spst n.o. switch

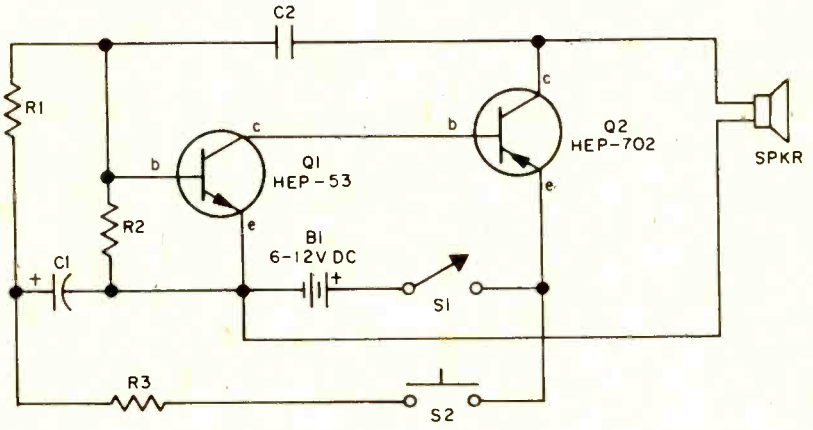
100 Yelp Oscillator

☐ A real screamer! Use a public-address type amplifier and horn under the hood of your car and you'll punch a hole in the tightest traffic jam. (Be certain, of course, that you hold a position that entitles you to a siren.)

Build this yelper in a small box and hold the PA mike 2-3 inches from the 8-ohm speaker. Press push-button switch S2 and the siren starts up, shifting to a higher frequency. Release it and the tone slides down until you press S2. Tone quality is adjusted by changing C2. If the siren pulsates before S1 is pressed, Q1 is too "leaky."

PARTS LIST FOR YELP OSCILLATOR

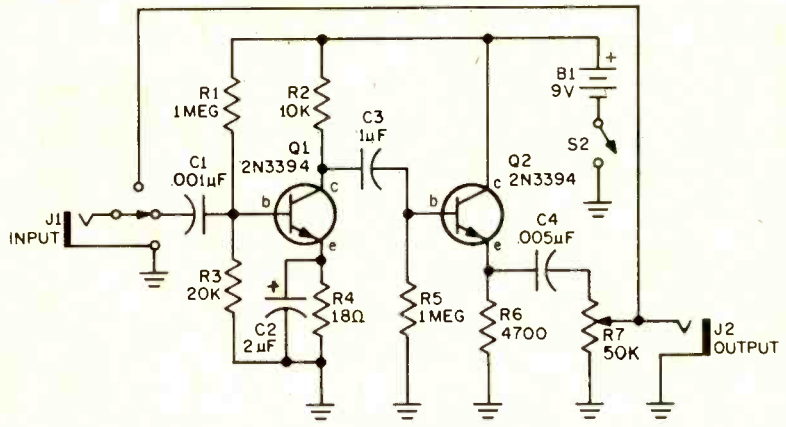
B1—6-V or 12-V battery
C1—30-uF, 15-VDC electrolytic capacitor
C2—0.02-uF, 75-VDC capacitor
Q1—Motorola HEP-53 npn transistor (Radio Shack 276-2009)
Q2—Motorola HEP-702 pnp transistor
R1, R2—56,000-ohm, ½-watt resistor
R3—27,000-ohm, ½-watt resistor
S1—Spst switch
S2—N.O. pushbutton switch (Calectro E2-142)
SPKR—8-ohm speaker or PA horn (Calectro S2-245/6 or equiv.)



101 Twang-A-Matic

☐ It seems no one cares for the sound of a plain, unadorned guitar. First they added fuzz, then big-boom bass, next it was reverberation and screaming highs. Now the in sound is *twang*, a guitar sound that more or less approximates a banjo or mandolin. A Twang-A-Matic produces these unusual sounds from an ordinary electric guitar by cutting the bass, severely distorting the midband and highs, and then amplifying the distortion. It might read "bad" to you, but it sure sounds good!

You can assemble the Twang-A-Matic in any type of cabinet. Switch S1 cuts the effect in and out while switch S2 turns the unit on and off. Output control R7 should be set so the Twang-A-Matic has the same volume level as the straight guitar feedthrough. Various degrees of twang are obtained by varying the output so the guitar picks up with the level controls built into the guitar. ■



PARTS LIST FOR TWANG-A-MATIC

B1—9-volt battery (Eveready 246 or equiv.)
C1—0.001-uF disc capacitor 25 VDC or better
C2—2-uF electrolytic capacitor, 15 VDC or better
C3—1-uF electrolytic capacitor, 15 VDC or better
C4—0.005-uF disc capacitor, 15 VDC or better
J1, J2—Phone jack
Q1, Q2—NPN transistor, 2N3394
R1, R5—1 megohm, ½-watt resistor
R2—10,000, ½-watt resistor
R3—20,000-ohm, ½-watt resistor, 5 percent
R4—18-ohm, ½-watt resistor
R6—4700-ohm, ½-watt resistor
R7—50,000-ohm potentiometer
S1—Switch, spdt (twang in-out)
S2—Switch, spst (on-off)

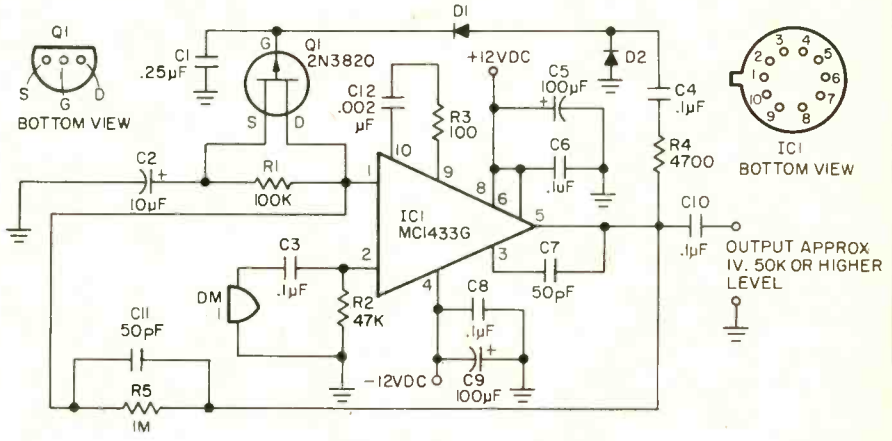
40 INTEGRATED CIRCUIT PROJECTS

1 Ultimate Talk Power

☐ Operating directly from microphone level and providing a nominal 1V output, this compressor delivers 20 dB of compression (essentially distortion-free limiting) and will give ultimate talk-power to P.A. systems and ham or CB transmitters. Fact is, some sideband transmitters might not be able to handle the almost continuous "peak power" output of our compressor!

The only restriction on its use is that the microphone, DM1, must be the dynamic type: any impedance from 50 to 50,000 ohms will work. If DM1 can be permanently connected to the circuit, components R2 and C3 can be eliminated. But they must be used if there is any possibility DM1 will be disconnected. No substitution can be made for transistor Q1.

Capacitors C6 and C8 must be installed directly at the IC terminals for instability suppression. Capacitors C5 and C9 can be installed anywhere that's convenient. A bi-polar 12V supply (well filtered) is required. Power can be provided by batteries (for total hum-free operation) because the current requirement is approximately 15 mA. Any gain controls must come after the output at C10.

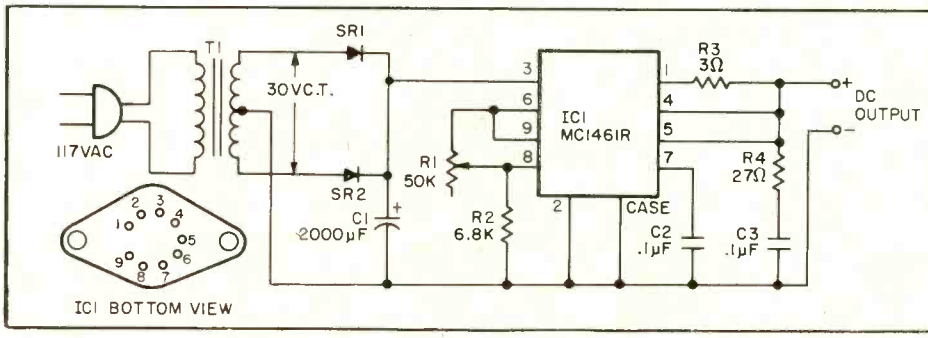


PARTS LIST FOR ULTIMATE TALK-POWER

C1—0.25-uF, 10 VDC capacitor
C2—10-uF, 10 VDC capacitor
C3, C4, C6, C8, C10—0.1-uF, 75 VDC capacitor
C5, C9—100-uF, 15 VDC capacitor
C7, C11—50-pF, 75 VDC disc capacitor
C12—0.002-uF, 25 VDC capacitor
IC1—Motorola MC-1433G
R1—100,000-ohms, ½-watt resistor
R2—47,000-ohms, ½-watt resistor
R3—100-ohms, ½-watt resistor
R4—4,700-ohms, ½-watt resistor
R5—1 megohm, ½-watt resistor
DM1—Dynamic microphone (see text)
D1, D2—Germanium diode, 1N60 or equiv.
Q1—FET transistor, type 2N3820 (Texas Instruments)

2 Protect-A-Volt

☐ A simple turn of a knob sets Protect-a-Volt's output voltage anywhere in the 3 to 20-volt range—and with full short circuit protection! Should there be a wiring error in the powered project, this supply automatically



PARTS LIST FOR PROTECT-A-VOLT

C1—2000-uF, 25 VDC capacitor (see text)
C2, C3—0.1-uF, 75 VDC disc or Mylar capacitor
IC1—Motorola MC-1461R
R1—50,000-ohms pot
R2—6,800-ohms, ½-watt resistor
R3—3-ohms, ½-watt resistor
R4—27-ohms, ½-watt resistor
SR1, SR2—Silicon rectifier, 50 PIV, 1A
T1—Power transformer; 117 VAC primary, 30 VC.T.: 200 mA secondary (see text)

shuts down the output voltage until the overload is removed. The maximum output current (short circuit protection) has been established by resistor R3's value to 200 mA. Power transformer T1's rating should not exceed 200 mA as extra current capacity could not be handled by the integrated circuit.

To make this project easy to build, and to sharply reduce total cost, it was necessary to eliminate a fully off, or zero output, setting for Voltage Adjust control R1. The minimum output voltage is 3V. The maximum voltage from T1's secondary must be 30V rms if the secondary is center-tapped; 15V rms if there is no center-tap and a bridge-rectifier is substituted for silicon rectifiers SR1 and SR2. Capacitor C1's voltage rating must be 25 volts minimum. Do not eliminate high-frequency-compensation network components R4/C3.

3 Hi-Level 4-Channel Mixer

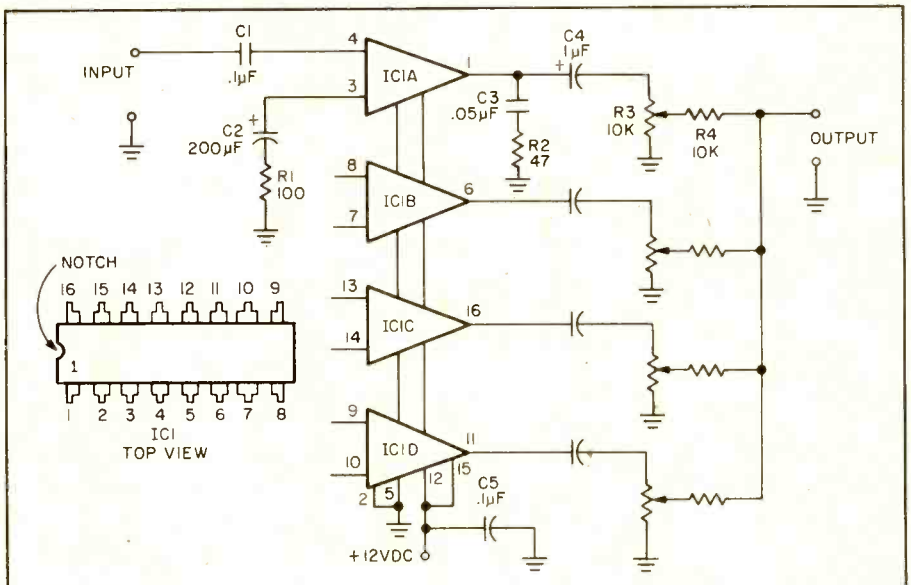
☐ Best signal to noise ratio in a microphone mixer is always obtained if amplification is provided ahead of the loss in the mixer network. You can easily put this idea to work with our mixer—a full-fidelity, professional-grade microphone mixer that contains four independent amplifiers within the integrated circuit.

For simplification, our schematic shows only the connections for one of the four amplifiers; the others are identical to the first.

Note that the power supply is a single-ended 12 VDC (negative grounded); it must be well filtered, or, use a battery supply. The current requirements are approximately 30 mA total. The power supply is internally connected to the amplifiers.

To prevent high frequency oscillation, components C3, R2 and C5 must be installed directly at the IC's terminals.

Any 50 to 50,000 ohm dynamic microphone can be used. However, crystal and ceramic mikes won't work with Pro-Mix; the medium impedance IC's medium input impedance will excessively load down a high impedance mike, resulting in sharp, low-frequency attenuation.



PARTS LIST FOR HI-LEVEL MIXER

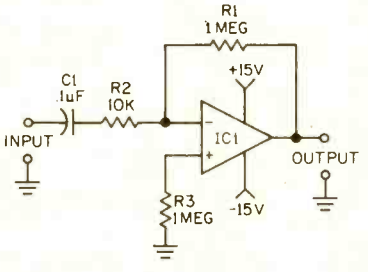
C1—0.1-uF, 3 VDC capacitor
C2—200-uF, 3 VDC capacitor
C3—0.05-uF, 75 VDC disc capacitor
C4—1-uF, 15 VDC capacitor
C5—0.1-uF, 15 VDC capacitor
IC1—RCA CA 3052
R1—100-ohms, ½-watt resistor
R2—47-ohms, ½-watt resistor
R3—Potentiometer, 10,000-ohms audio taper
R4—10,000-ohms, ½-watt resistor

4 The Basic Amplifier

☐ This general purpose amplifier features a power gain of 100 (20dB) and can be used as a preamplifier for a microphone, receiver, signal tracer, etc. The IC is internally compensated, providing stable performance with a flat frequency response to about 10 kHz with a gradual roll-off to 20 kHz. The overall gain can be reduced to 10 by increasing the value of R2 to 100,000-ohms. IC1 is available in several different packages; use the one most convenient for your particular component layout. R3 connects to the non-inverting (+) input of the IC, R1 between the output and the inverting (−) input. No pin connections are given because the IC is available in many different configurations.

PARTS LIST FOR THE BASIC AMPLIFIER

C1—0.1-uF Mylar capacitor, 25 VDC
IC1—Type 741 operational amplifier
R1, R3—1 megohm, ½-watt resistor
R2—10,000-ohm, ½-watt resistor, (see text)



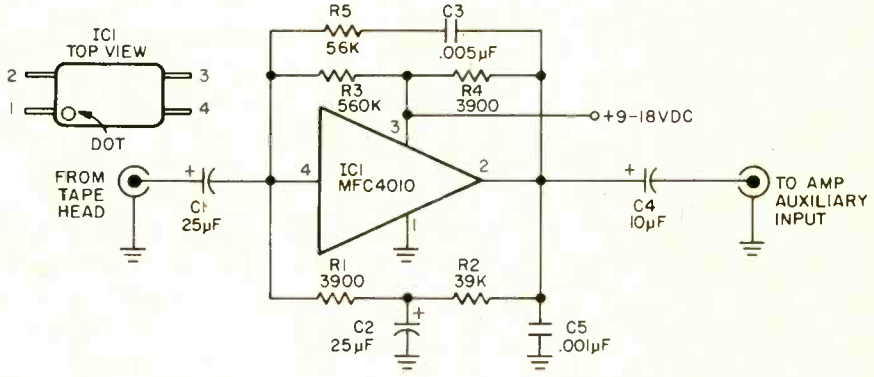
5 Bargain Tape Preamplifier

☐ From time to time you'll find bargains at dealers selling tape and cassette deck mechanisms at rock bottom prices—often less than $20! Complete with heads, these decks need only the electronics to get them working. The preamp provides both the amplification and equalization. You can feed its output directly into an amplifier's auxiliary input. Overall frequency response is suitable for cassettes and 3¾ IPS reel-to-reel tapes. Since the actual required equalization is determined partially by the playback head characteristics, it might be necessary to modify or "tailor" the equalization; this is done by small changes in the value of capacitor C3 and resistor R5.

If assembled on a small printed circuit board, the preamp can be tucked under the tape mechanism's base plate. The power supply can be anything from 9 to 18 volts at approximately 3 mA. Transistor type radio batteries will do; if batteries are used they must be bypassed with a 25-uF capacitor.

PARTS LIST FOR BARGAIN TAPE PREAMP

C1, C2—25-uF, 6 VDC capacitor
C3—0.005-uF capacitor
C4—10-uF, 20 VDC capacitor
C5—0.001-uF capacitor
IC1—Motorola MFC-4010
R1, R4—3,900 ohms, ½-watt resistor
R2—39,000-ohms, ½-watt resistor
R3—560,000-ohms, ½-watt resistor
R5—56,000-ohms, ½-watt resistor

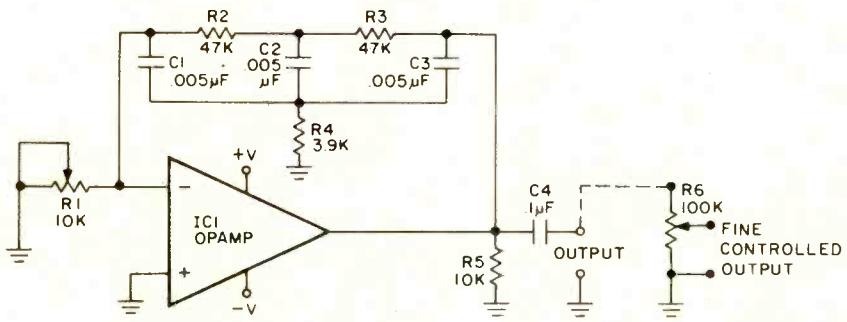


6 Notch Filter Oscillator

☐ Every experimenter's spare parts box has the necessary components for our Notch Filter 1 kHz Oscillator. It's suitable for testing audio equipment, signal tracing or tape recorder bias adjustments. Integrated circuit IC1 can be just about any operational amplifier sold through "surplus dealers." The 1 kHz "notch filter" from the amplifier output to the inverting or negative (−) input determines the output frequency. Notch Filter Oscillator's non-inverting or positive (+) input is grounded.

The power supply is bi-polar; use any voltage up to ±15 VDC. While resistor R5 is not needed in many instances, its use insures your Notch Filter Oscillator project's success. Potentiometer R1 sets the output level; its maximum value will approach the total power supply voltage. If fine output control is desired, add potentiometer R6.

When your Notch Filter Oscillator is connected to a DC circuit, connect a DC blocking capacitor in series with R6's wiper arm. If the oscillator is to drive circuits of less than 10K ohm impedance, substitute a 1-uF nonpolarized capacitor for C4, rated to the power supply's voltage.



PARTS LIST FOR NOTCH FILTER OSCILLATOR

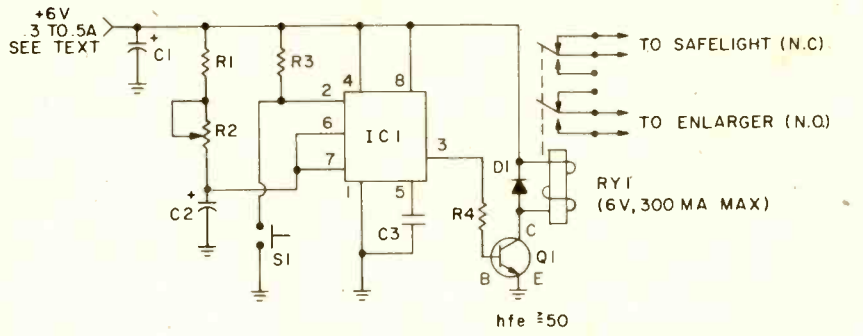
C1, C2, C3—0.005-uF, 75 VDC capacitor
C4—0.1-uF (see text) capacitor
IC1—741-type operational amplifier
R1—10,000 ohms pot
R2, R3—47,000-ohms, ½-watt resistor
R4—3,900-ohms, ½-watt resistor
R5—10,000-ohms, ½-watt resistor (see text)
R6—Potentiometer, 100,000-ohms, audio taper (see text)

7 Photo Timer

☐ You can spend $50 to $125 for a photo-enlarger timer but chances are you're not going to get more than a fancy version of this easy-to-build circuit. If you use a DPDT relay, as shown, your safelights can be wired to turn on when the enlarger turns off and vice versa.

If R2 is 1-megohm the timer's range is about 1 to 110 seconds. If R2 is 1.5-megohms the timer's range is approximately 1 to 165 seconds. The precise range will be determined primarily by C2's accuracy, so use a reasonably good quality capacitor for C2, but don't get a precision or MIL-spec part; it's not necessary.

If you use a low current relay for RY1, say less than 100-mA at 6-VDC, you can eliminate Q1 and connect the relay directly from IC terminal 3 to ground. If you use a heavy-duty relay, as high as 300-mA at 6-volts, use Q1. The power input should be 6-volts (doesn't have to be regulated) at 300-mA, or 500-mA for a heavy-duty relay. We suggest any popular-brand low cost relay, such as P&B, Magnacraft or Calectro.



PARTS LIST FOR PHOTO TIMER

Resistors ½ watt, 10%, unless otherwise specified.
R1—10,000-ohms
R2—1.0- or 1.5-megohm linear taper potentiometer (see text)
R3—22,000-ohms
R4—560-ohms
Capacitors rated 6-VDC or higher
C1—100-uF electrolytic
C2—100-uF electrolytic (see text)
C3—0.01-uF capacitor
IC1—Integrated circuit timer type 555 (any package)
Q1—NPN transistor, Radio Shack 276-2030 or equiv.
D1—Silicon rectifier, 1N4003, equiv. or higher PIV rating.
RY1—6-VDC relay, see text
S1—N.O. push-button or momentary contact switch.

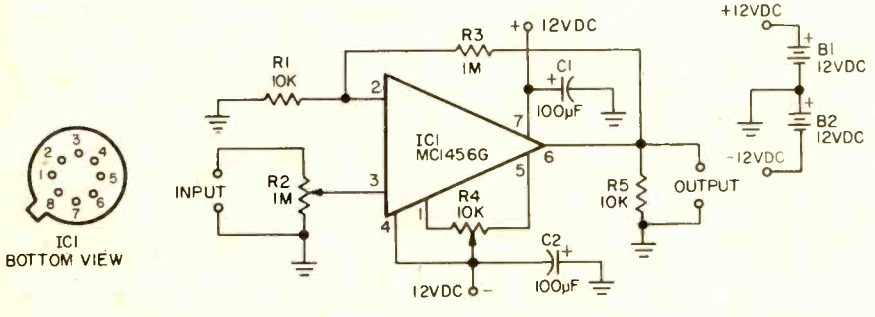
Potentiometer R2 should be linear taper. After the timer is assembled attach a large pointer knob to R1's shaft, and using an electric clock with a sweep second hand as a reference, calibrate timing control R2.

If the unit is assembled in a metal cabinet use a three-wire linecord to ground the cabinet. If you use an all plastic cabinet with no exposed metal hardware that can be touched you can use a two-wire linecord.

8 100X Instrument Amplifier

☐ When voltages drop too low to be indicated on your scope or VTVM, just connect our 100X Instrument Amplifier ahead of your test gear and you get full-screen or full-scale readings. With an input impedance of 1 megohm, and a flat frequency response from DC to 20 kHz and beyond, the 100X Instrument Amplifier provides a gain of exactly 100 when potentiometer R2's wiper is at the top (full gain).

Connected ahead of a VTVM, the 100X Instrument Amplifier will convert, for example, a 10 mV DC level into 1V. Here's a value that can be read on your VTVM! Similarly, if connected ahead of a scope's vertical input, the amp boosts a signal that will just cause a wiggle on the CRT to almost a full screen trace. The maximum input signal level for undistorted output is 100 mV peak-to-peak. Naturally, higher input signals



PARTS LIST FOR 100X INSTRUMENT AMPLIFIER

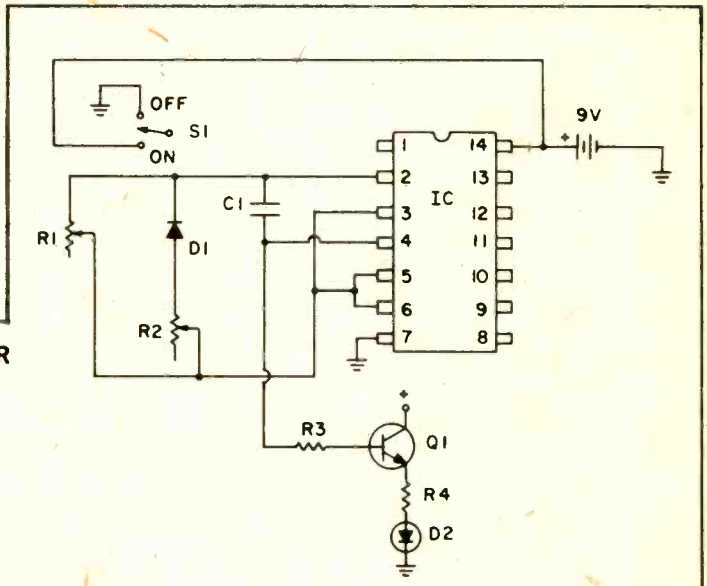
B1, B2—Battery, 12V
C1, C2—100-uF, 15 VDC capacitor
IC1—Motorola MC-1456G
R1—10,000-ohms, ½-watt, 5% resistor
R2—Potentiometer, 1 megohm
R3—1 megohm, ½-watt, 5% resistor
R4—Potentiometer, 10,000-ohms linear taper
R5—10,000-ohms, ½-watt resistor

can be used because of the attenuation provided by sensitivity control R2.

After you've completed the 100X Instrument Amplifier, connect a VTVM across the output, adjust R4 for a zero DC meter reading. From time to time check the DC output; if it has drifted off zero, simply readjust R4. It might happen that changing R2's setting over a wide range might cause the output to drift off zero; if so, simply readjust R4. If you are primarily concerned with AC measurements, the output DC zero drift is unimportant, and a 0.1-uF capacitor can be connected between the 100X and your VTVM or scope.

9 Basic CMOS NAND Oscillator

☐ Closing S1 causes this CMOS NAND oscillator to flash the LED. The "ON" time is controlled by R1 and the "OFF" time is controlled by R2. This oscillator can sit for months with S1 open because, being CMOS, it draws very little power. It is a basic oscillator useful for driving buzzers, computer clocks, counters, various alarm circuits, windshield wipers and uncountable other applications. The output from pin 4 can drive small loads, even small relays, directly, or you can drive a transistor or SCR to handle bigger loads.

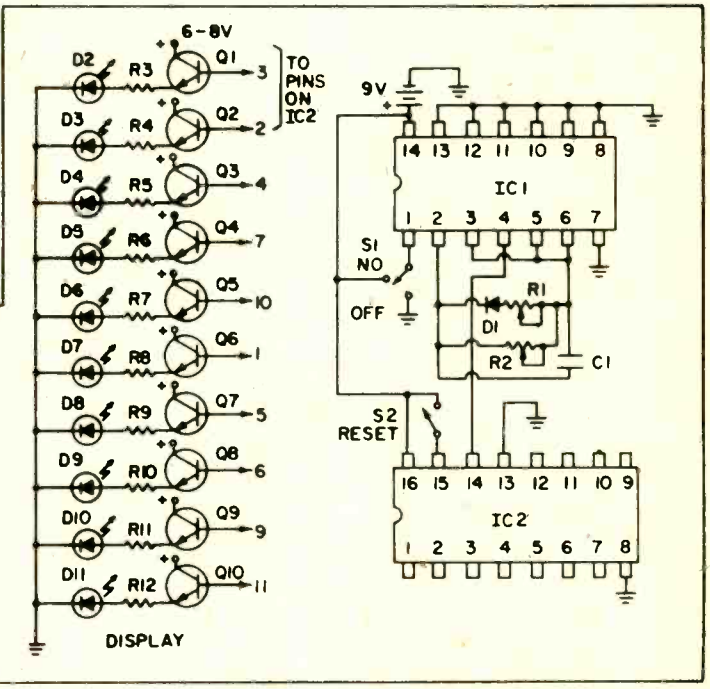


PARTS LIST FOR BASIC CMOS NAND OSCILLATOR

C1—0.1-uF ceramic capacitor, 15 VDC
D1—1N4001 diode
D2—small LED
IC1—4011 quad NAND gate
Q1—2N4401 transistor
R1—10,000,000-ohm linear-taper potentiometer
R2—100,000-ohm linear-taper potentiometer
R3—1,000-ohm, ½-watt resistor
R4—10,000-ohm ½-watt resistor
S1—SPDT slide switch

10 Rippling Wave

☐ The rippling effect on the ten LEDs is a beautiful and interesting sight, especially if they are mounted atop a nice wooden case and placed in the living room. A nice conversation piece. The speed of the ripple is controllable via R1 and R2, where a smaller R1 and R2 makes the ripple go faster. The "on" of each LED overlaps perfectly with no momentary "off," so the ripple travels very smothly.



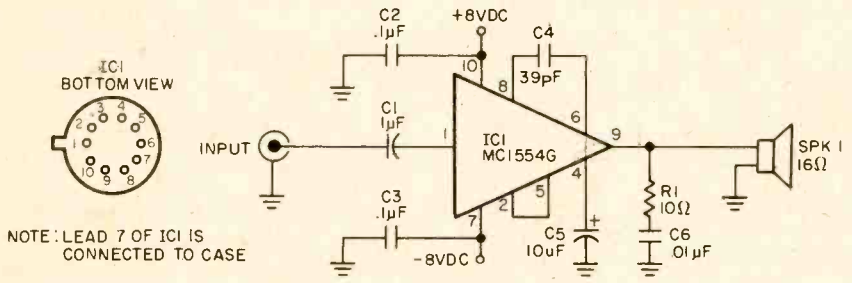
PARTS LIST FOR RIPPLING WAVE

C1—0.01-uF ceramic capacitor, 15 VDC
D1—1N4401 diode
D2 through D11—small LED
IC1—4011 quad NAND gate
IC2—4017 decade counter
Q1—Q10—2N4401
R1—10,000,000-ohm linear-taper potentiometer
R2—500,000-ohm linear-taper potentiometer
R3 through R12—1,000-ohm, ½-watt resistor
S1—SPDT slide switch
S2—SPST momentary-contact pushbutton switch

11 Bi-Polar Power Amplifier

☐ It is incovenient when working with IC preamplifiers requiring bi-polar power sources to convert to a single-ended power source for the power amplifier. Our Bi-Polar Amp, however, can be driven from a bi-polar power supply. One of the benefits enjoyed by Bi-Polar Amp is that a large, expensive output coupling capacitor isn't needed. Since the device responds well into the high frequency range, capacitors C2 and C3 must be placed directly at the IC terminals to prevent high frequency oscillation. While capacitor C1 can be an electrolytic type, a non-polarized 1 uF is suggested.

The amplifier's input impedance is 10,000 ohms, a suitable value for solid-state projects. Voltage gain is 36. If less overall gain is required (say, 10X), disconnect pins 2 and 4 and connect pin 5 to ground through capacitor C5.



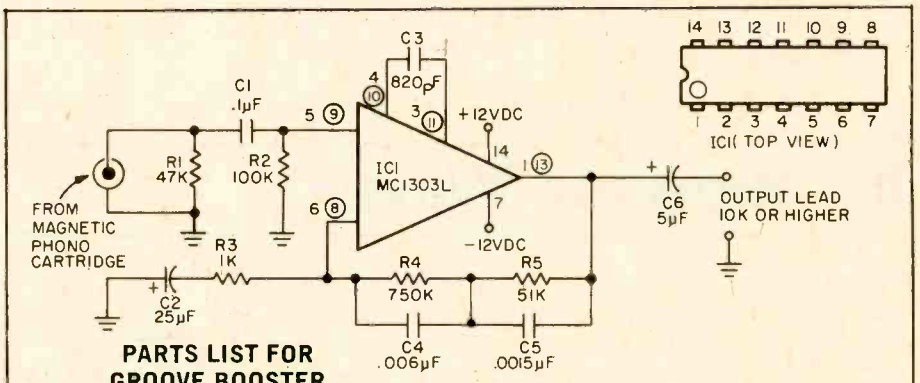
PARTS LIST FOR BI-POLAR POWER AMP

C1—1-uF, voltage rating at least equal to peak input voltage from preceding stage, capacitor
C2, C3—0.1-uF, 10 VDC capacitor
C4—39-pF, 100 VDC disc capacitor
C5—10-uF, 10 VDC capacitor
C6—0.01-uF, 25 VDC capacitor
IC1—Motorola MC-1554G
R1—10-ohms, ½-watt resistor
SPK1—16-ohm speaker

12 Groove Booster

☐ Using a dual operational amplifier IC, the Groove Booster will provide a fully equalized 1 V rms output from standard phono magnetic pickups. The terminal numbers which are circled on the schematic are the connections for one of the two independent stereo amplifiers on the single IC chip.

The uncircled numbers are the terminals for the stereo second IC. Power supply terminals #14 and #7 are common to both stereo amplifiers. Note that the power supply is ±12 volts to ground. Two 6-volt batteries in series can be used for each side of the power supply. If batteries are used, connect 25-uF capacitors from pins 7 and 14 to ground—and get their polarity correct.



PARTS LIST FOR GROOVE BOOSTER

C1—0.1-uF, 3 VDC capacitor
C2—25-uF, 3 VDC capacitor
C3—820-pF, 500V VDC disc capacitor
C4—0.006-uF, 100V VDC disc capacitor
C5—0.0015-uF, 100V VDC disc capacitor
C6—5-uF, 25 VDC capacitor
IC1—Motorola MC1303L
R1—47,000-ohms, ½-watt resistor
R2—100,000-ohms, ½-watt resistor
R3—1,000-ohms, ½-watt resistor
R4—750,000-ohms, ½-watt resistor
R5—51,000-ohms, ½-watt resistor

13 One-or-Two-Way Reflex Tester

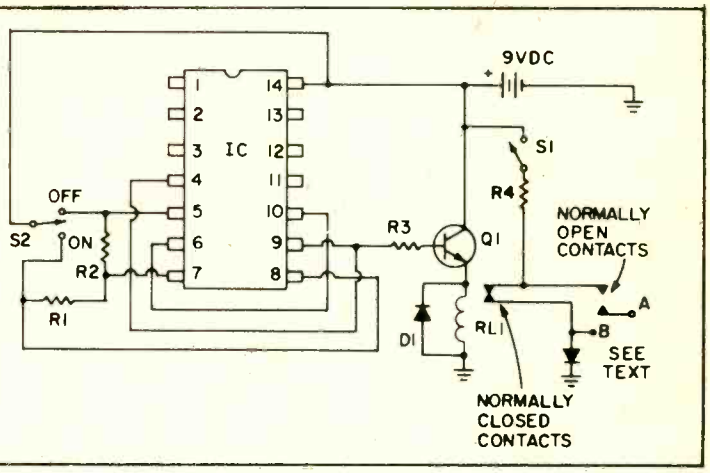
☐ Two people are required to play this circuit: one, the "tester," and the other, the "testee" (sic). By building two of these circuits (as discussed below), one "referee" can test two players against each another. In the "tester-testee" version, the tester operates S1 out of sight of the testee. This causes D1 to light, which the testee must extinguish as fast as possible by operating S2. The flip-flop circuit of the CD4001 assures that testee begins with his switch in the full "off" position, not somewhere in the middle, as D1 will not extinguish unless this condition is met. Also, the relay assures that there is enough of a time delay to see how long D1 is on and compare, visu-

ally, that "on" time with that of a competitor. S2 is then opened and closed to restart the game.

In the dual-circuit (competitive) version, two identical circuits are built and S1 becomes a DPST switch. The two circuits are interconnected by using a second set of normally open contacts on the relay. Point "A" of one competitor's circuit is connected to point "B" on the other's. When this is done, the winning competitor not only extinguishes his own LED, but "locks" the other competitor's "ON." So the slow one gets the "glow."

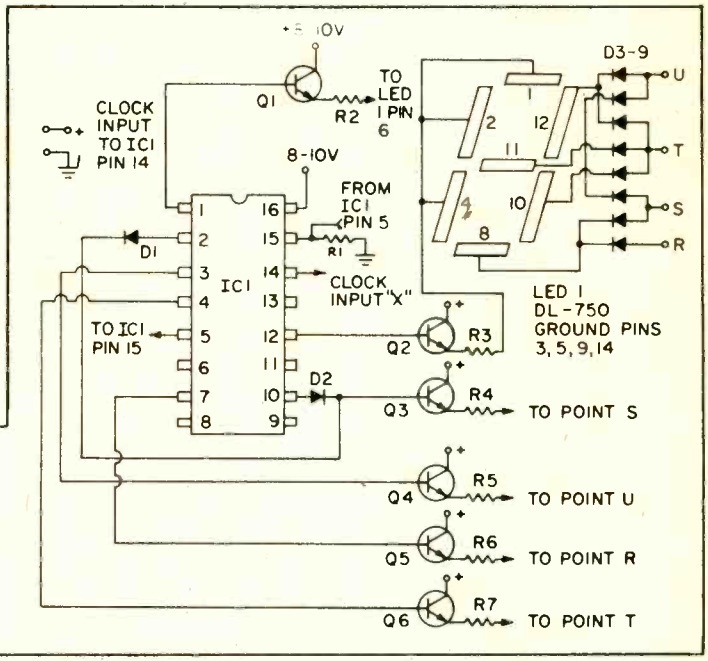
PARTS LIST FOR REFLEX TESTER

D1—1N4001 diode
D2—small LED
IC1—4001 quad NOR gate
Q1—2N4401 transistor
R1, R2—870,000-ohm, ½-watt resistor
R3—2,000-ohm, ½-watt resistor
R4—510-ohm, ½-watt resistor
RL1—relay w/9 VDC coil; one set normally open contacts, and one set normally closed contacts
S1—SPST toggle switch
S2—SPDT toggle switch



14 Spelling It All Out

☐ The title, we must hasten to admit, is a slight misnomer. The seven-segment digital display finds it difficult to handle letters such as K, M, and Z, for example. But the following demonstration proves it's far from illiterate. Part of the trick here is to make use of letters sharing common display segments, in this case A, E, and F. Through the use of steering diodes, each step of the 4017 counter spells out the letters P-E-A-C-E. (the period being the decimal point). The next step resets the counter. Note that the common segments are powered up only during the 0-4 steps, when the "divide-by-ten" or "carry" output, pin 15, is high. Other words, up to nine letters in length may be programmed with suitable diode matrices.



PARTS LIST FOR SPELLING IT ALL OUT

D1 through D9—1N4148 diode
IC1—4017 decade counter
LED1—DL-750 7-segment display
Q1 through Q6—2N4401 transistor
R1—2,200-ohm, ½-watt resistor
R2, R6—680-ohm, ½-watt resistor
R3, R4, R5, R7—330-ohm, ½-watt resistor

15 Lie Detector

☐ When a person is under mental stress one of the physiological changes includes a lowering of the body's skin resistance, and one of the characteristics measured by the modern lie detector is skin resistance.

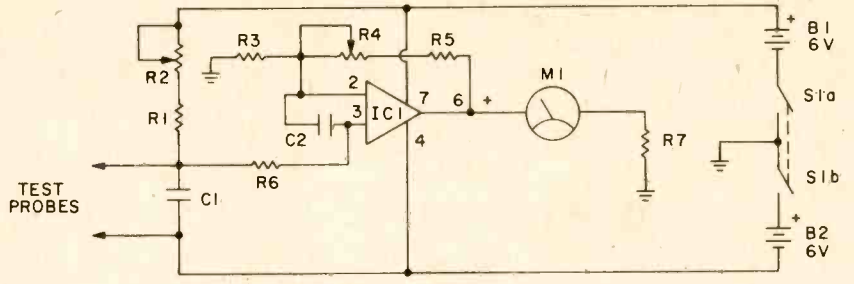
Our "lie detector" works the same way: it measures the body's skin resistance. In typical use you would connect one test probe, actually a length of non-insulated wire taped to the skin, to each hand, arm, or wrist, adjust control R2 for a meter null (zero meter reading), and then ask your questions. If a question causes the subject mental stress you will usually see this stress indicated by an increase in the meter reading.

Potentiometer R4 serves as a sensitivity control. To avoid pinning the meter start with R4 at about the mid position: increasing the resistance increases the gain, while decreasing the resistance reduces the gain and the meter reading.

If you want to avoid taping the probes to your subject you can use

the inexpensive, less-than-$1-a-pair bicycle clips available in most department and sporting goods stores. Solder the test probe wires to the clips and then bend the clips so they hold onto the hand or arm gently but firmly. Wiping the area under the clips with alcohol will improve overall sensitivity.

If long test probes are used, say in excess of 3-feet, shielded wire is suggested, with the shield for each test probe wire connected to the chassis ground—the junction between switches S1a and S1b. You can also use two-wire shielded cable (two wires in one shield) and fan the wires out a foot or so from under the probe end.



PARTS LIST FOR LIE DETECTOR

Resistors ½- or ¼-watt, 10%, unless otherwise specified
R1, R5—10,000-ohms
R2, R4—1-megohm potentiometer
R3, R6—1,000-ohms
R7—560-ohms
C1, C2—0.01-uF, 25 VDC or higher
IC1—Operational amplifier, type 741
S1—Switch, DPST
B1, B2—6 volt battery, Burgess Z4 or equiv.
M1—Meter, 0-1 mA DC

16 CB Mobile-to-Base Power Supply

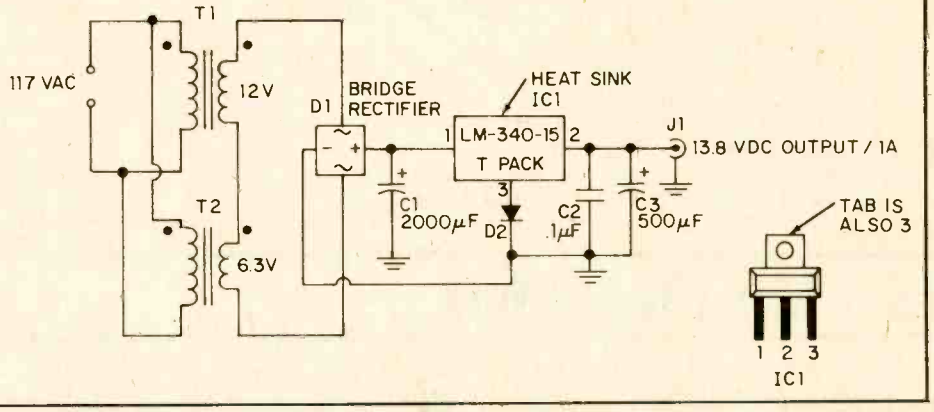
☐ CB mobile transceivers and 3 to 5-watt CB handie-talkies are easily converted to base station operation with this 13.8 volt regulated power unit. Transformers T1 and T2 should be rated 2 amperes. When T1 and T2's secondaries are connected, test the transformer(s) output voltage with an AC voltmeter. If the meter indicates approximately 6.3 volts, reverse the connections of *either* transformer's *primary or secondary,* but *not both.* The meter will then read about 18 VAC. Complete the rest of this project only after you are certain the output voltage from the transformer(s) is about 18 VAC.

IC1 must be heat sinked to the cabinet. Note that IC1's tab is a "hot" terminal; make certain it is insulated from the cabinet with a power transistor insulator or a mica washer. Coat both sides of the insulator (washer) with silicon heat sink grease. And make certain the mounting screw is insulated from the cabinet; use fiber shoulder washers under the screw.

Connect rectifier D2 exactly where shown in the circuit. D2 should be rated at least 50 PIV at 3 amperes. Bridge rectifier D1 is rated 50 PIV at 6 amperes. Do not substitute a 3 ampere bridge rectifier for D1 unless you heat sink it to the chassis. (Heat sinking for D1 is suggested for both the 3 and 6 ampere types.)

PARTS LIST FOR CB MOBILE-TO-BASE POWER UNIT

C1—2000-uF, 25-VDC electrolytic capacitor
C2—0.1-uF Mylar capacitor
C3—500-uF, 25-VDC electrolytic capacitor
D1—Bridge rectifier, see text
D2—Silicon rectifier, 50 PIV, 3 amperes
IC1—Voltage regulator, LM-340-15 (T-package)
T1—12-volt, 2-ampere filament transformer
T2—6.3-volt, 2-ampere filament transformer



17 Tape Head Preamplifier

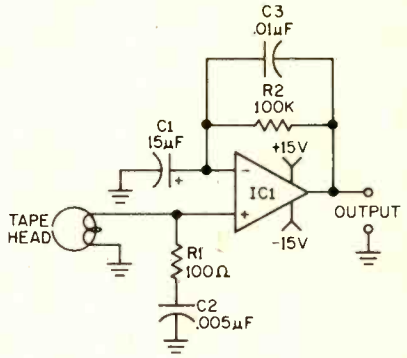
☐ Is it worth about $20 to have another tape or cassette player? From time to time surplus dealers offer complete tape or cassette mechanisms —everything ready-to-go except for the electronics, and at rock-bottom prices of $10, $15 or $20. All the mechanism needs is this equalized tape head preamplifier. Though the

power supply is rated at ±15 VDC, almost optimum results will be obtained with supply voltages as low as ±7 VDC. Two ordinary 9-volt transistor radio batteries will power the preamp for many hours.

The op amp, ICI, is internally compensated and no special wiring practices are needed; the preamp can be built in just about any enclosure, though the connecting wire from the tape head should be shielded. R1 connects to the non-inverting (+) input of the IC, R2 between the output and the inverting (−) input.

PARTS LIST FOR TAPE HEAD PREAMP

C1—22-uF electrolytic capacitor, 25 VDC or better (Calectro A1-128)
C2—0.005-uF disc capacitor, 25 VDC or better
C3—0.01-uF disc capacitor, 25 VDC or better
IC1—Type 741 op amp
R1—100-ohms, ½-watt resistor
R2—100,000-ohms, ½-watt resistor



18 Electric Butler Intercom

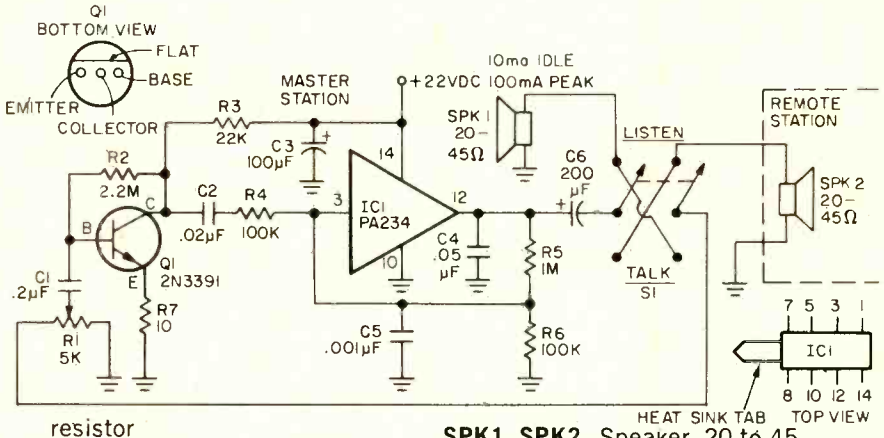
☐ Using a miniature 1 watt IC power amplifier, our Electric Butler provides very high sensitivity and a loud, clean output. Wiring and layout is not critical as long as capacitors C4 and C5 are installed directly at IC1's terminals. Capacitor C6 can be as low as 100 uF if you want to cut costs and are willing to give up a little bass response. While S1 can be a standard DPDT switch, a spring-return type will keep the Master station always monitoring the Remote.

The speakers can be any "intercom type" rated from 20 to 45 ohms. Though miniature 16 ohm speakers can be used, they do not have the power handling capacity of the "intercom" speaker. If there appears to be some high frequency instability, use a shielded wire between S1 and R1; make a single-shield ground at R1.

If an AC power supply is used, it must be rated for at least 100 mA drain. If a battery supply is used, figure the 10 mA idling current; the batteries will be able to deliver the 100 mA maximum output peak current. Solder a 1 inch square tin heat sink to IC1's tab during construction.

PARTS LIST FOR ELECTRIC BUTLER INTERCOM

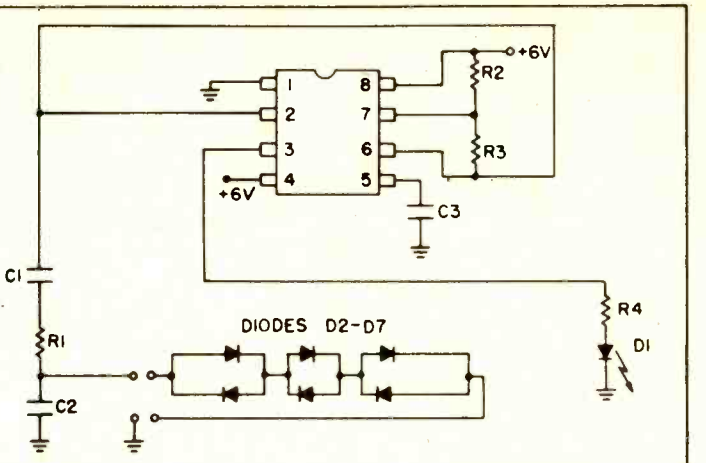
C1—0.2-uF, 3 VDC capacitor
C2—0.02-uF, 3 VDC capacitor
C3—100-uF, 25 VDC capacitor
C4—0.05-uF, 75 VDC capacitor
C5—0.001-uF, 10 VDC capacitor
C6—200-uF, 25 VDC capacitor (see text)
IC1—General Electric PA-234
Q1—NPN transistor 2N3391 (HEP 726)
R1—Potentiometer, 5,000-ohms, audio taper resistor
R2—2.2 megohms, ½-watt resistor
R3—22,000-ohms, ½-watt resistor
R4, R6—100,000-ohms, ½-watt resistor
R5—1 megohm, ½-watt resistor
R7—10-ohms, ½-watt resistor
SPK1, SPK2—Speaker, 20 to 45 ohms, (see text)
S1—Switch, DPDT (see text)



19 Tempera-Tone

☐ Another application of the 555 timer teams it up with the temperature sensitivity of common germanium diodes, like the 1N270. The 555 is configured as an oscillator operating in an area of from 700 to 1500 Hz. The tuning capacitor, instead of returning to ground, goes through R1 and a string of three or four 1N270 diode pairs connected back-to-back as a temperature probe. This probe may be positioned some distance away from the circuit to monitor a device or environment where the temperature, or its change, is of concern. An increase in temperature causes the frequency to decrease, while a temperature fall increases the frequency. The audio output may be monitored via the "Micro-Mini PA" amplifier circuit in this book. Larger values of C1

will cause temperature variations to be detected by varying the flashing rate of the LED, which shows that the system is in operation.

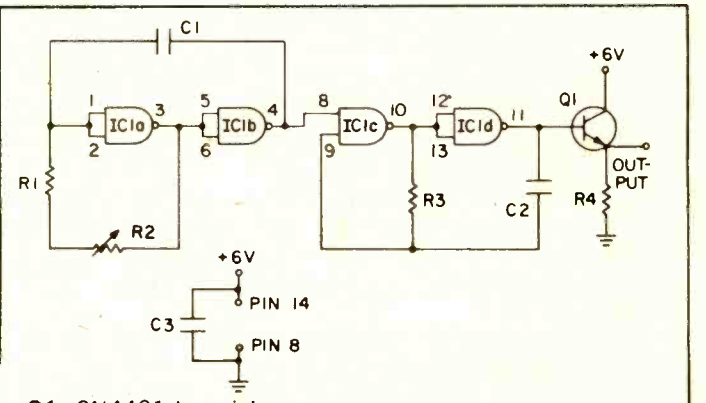


PARTS LIST FOR TEMPERA-TONE

C1–0.01-uF ceramic capacitor, 50 VDC (see text)
C2, C3–0.01-uF ceramic capacitor, 50 VDC
D1–small LED
D2 through D7–1N270 diode
IC1–555 timer
R1–22,000-ohm, ½-watt resistor
R2– R3–100,000-ohm, ½-watt resistor
R4–560-ohm, ½-watt resistor

20 Digital Modulator

☐ When a high-frequency oscillator is gated by a much lower frequency, modulation is accomplished. The following circuit provides a 1 MHz oscillator modulated or gated by a variable frequency in the audio range. A transistor-buffer is used for the output. The resulting signal can be employed for a variety of AM radio testing and each signal may be individually be taken off, increasing the versatility of this little circuit. *Note*: Do not use an antenna longer than 3 ft., or RF emission may exceed allowable FCC standards and cause illegal RF interference.



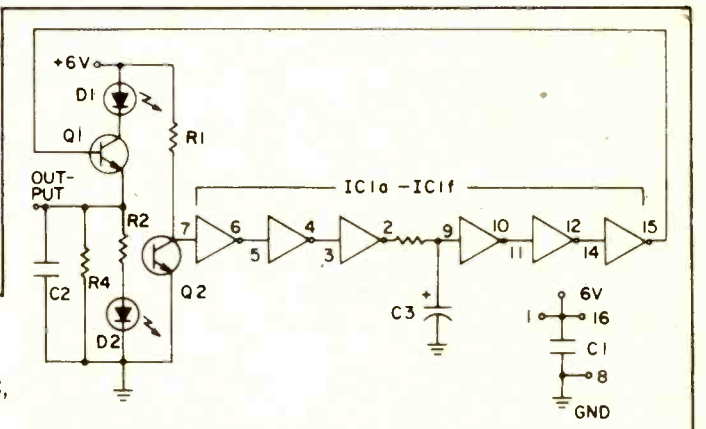
PARTS LIST FOR DIGITAL MODULATOR

C1–0.01-uF ceramic capacitor, 15 VDC
C2–100-pF mica capacitor, 15 VDC
C3–0.1-uF to 0.22-uF ceramic capacitor, 15 VDC
IC1–4011A quad NAND gate
Q1–2N4401 transistor
R1–10,000-ohm, ½-watt resistor
R2–100,000-ohm, ½-watt resistor
R3–2,200-ohm, ½-watt resistor
R4–150-ohm, ½-watt resistor

21 The LED Connection

☐ Opto-isolators are popular for coupling two remote or incompatible signal inputs and outputs. Using the FPT-100 photo-transistor and a suitable LED, an opto-isolator may be simulated. A medium-sized or large LED, red or clear, is brought into proximity with the photo-surface of the transistor. A rubber grommet can be used to both tightly hold the two units and prevent external light from affecting the transistor.

For demonstration purposes, an oscillator is shown. It



PARTS LIST FOR THE LED CONNECTION

C1, C2–0.1-uF ceramic capacitor, 15 VDC
C3–0.001-uF to 0.1-uF ceramic capacitor, 15 VDC, depending upon desired frequency.
D1–small LED
D2–large LED
Q1–2N4401 transistor
Q2–FPT100 phototransistor
IC1–4069 hex inverter
R1, R3–100,000-ohm, ½-watt resistor
R2–100-ohm, ½-watt resistor
R4–1,000-ohm, ½-watt resistor

employs the LED-phototransistor coupler, with a 4009A or 4049 hex-inverter IC and an NPN transistor as an emitter-follower driver. Frequency is determined by C3.

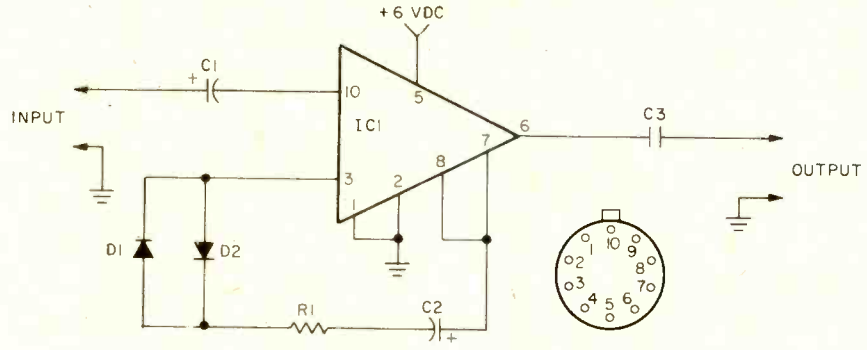
Since the coupler effectively conceals the operation of the main LED, a secondary LED in the collector of the driver transistor gives visual indication of oscillation.

22 Comm-Press Log Amplifier

☐ A log amplifier is a device that takes a large change in input signal and converts it to a small change in output. Hook one into a communications system and both low and loud sounds come out at almost the same level giving you a lot more talk power; it sounds just like the hard-sell commercials on TV. The input level should be about 0.1 volt peak for an output voltage of about 1 volt peak.

Since this is a high frequency device, lead dress and good power supply bypassing at the power supply terminals are required. Keep the ground leads short. If a microphone preamplifier is used before the log amplifier, connect a volume control before the log amp's input.

Some experimentation will be needed for optimum P.A. operation. Because of the much higher average voice power, a P.A. system using a log amp compressor might appear to be more sensitive to acoustic feedback (howling). Actually, you will have much more voice output before the howling starts.



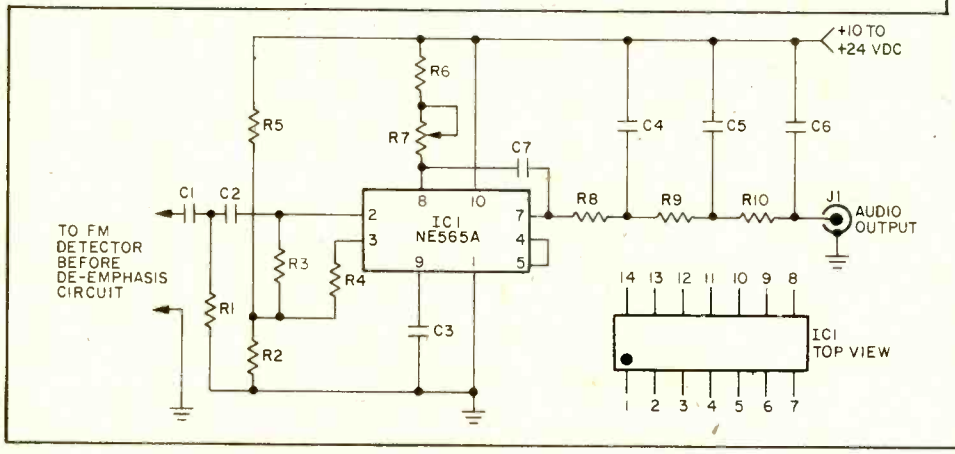
PARTS LIST FOR THE COMM-PRESS LOG AMP

C1—1-uF, 6 VDC electrolytic capacitor
C2—10-uF, 6 VDC electrolytic capacitor
C3—0.1-uF, 75 VDC Mylar capacitor
D1, D2—Diode, Silicon, 1N914
IC1—Signetics SE501
R1—510-ohm, ½-watt resistor

23 SCA Adaptor

☐ This simple but very effective SCA Adaptor can be assembled on a section of perfboard about 2-in. x 3-in. in size. All components should be firmly soldered to push-in terminals. The input *must* connect to the FM receiver's detector output before the de-emphasis network. The SCA output at J1 can be connected to any relatively high-gain amplifier—the output level is about equal to that of a crystal microphone.

The FM receiver must be tuned to a station you know has SCA programming. Then adjust potentiometer R7 for a clean SCA audio output. Potentiometer R7's adjustment is not critical—the subcarrier is pulled in when R7's adjustment is near the correct setting. A metal cabinet is suggested. If desired, a *pre* de-emphasis output jack can be installed on the FM receiver or tuner so that the normal (after de-emphasis) output can feed the hi-fi system independent of the SCA output.

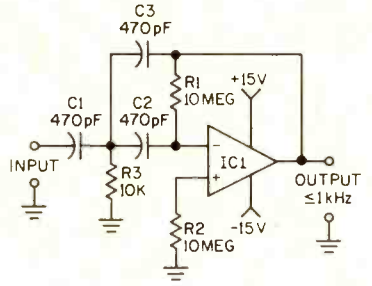


PARTS LIST FOR THE SCA ADAPTOR

C1, C2—510-pF, 500 VDC ceramic disc capacitor
C3, C7—0.001-uF, 75 V Mylar capacitor
C4, C6—0.018-uF, 500 VDC ceramic disc or Mylar capacitor
C5—0.047-uF, 75 VDC Mylar capacitor
IC1—Signetics NE565A
J1—Phono jack
R1, R2, R3, R4—4700-ohm, ½-watt resistor
R5—10,000-ohm, ½-watt resistor
R6—1800-ohm, ½-watt resistor
R7—5000-ohm potentiometer
R8, R9, R10—1000-ohm, ½-watt resistor

24 Versatile Hi-Pass Filter

☐ A high pass filter is a handy device to have around. Depending on the corner (turnover) frequency you select it can serve as a hum filter, distortion meter or highly-selective audio equalizer. The values of C1, C2, C3 and R1 provide a corner frequency of 1000 Hz. The IC has internal compensation so special wiring techniques are unnecssary. No pin connections are given because the 741 IC is available in many different pin configurations. Check the manufacturer's specs for the particular IC used. R2 connects to the non-inverting (+) input of the IC, R1 between the output and the inverting (−) input.



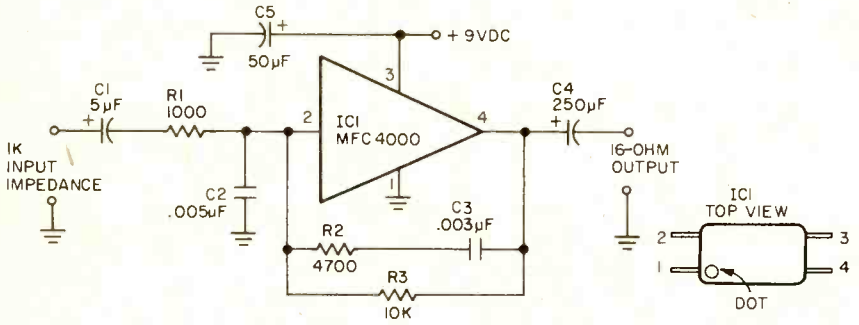
PARTS LIST FOR VERSATILE HI-PASS FILTER

C1, C2, C3—470-pF, disc capacitor, 50 VDC or better
IC1—741-type operational amplifier
R1, R2—10 megohms, ½-watt resistor
R3—10,000-ohms, ½-watt resistor

25 Cigar-Size Amplifier

☐ Using an IC no larger than a fly, Cigar-Size Amplifier delivers almost 250 mW into a 16-ohm speaker. A 50 mV input signal coming from a source whose output impedance is 1000 ohms or lower is required for maximum output. The power supply can be a 9 volt type 2U6 battery; the idling current is no higher than 6 mA. Best way to keep things small is to use a printed circuit board assembly or a mini-mount as shown.

Cigar-size amplifier can serve as a general utility amplifier for checking out low-level audio projects, or it can serve as a monitoring amplifier for tape and cassette decks.

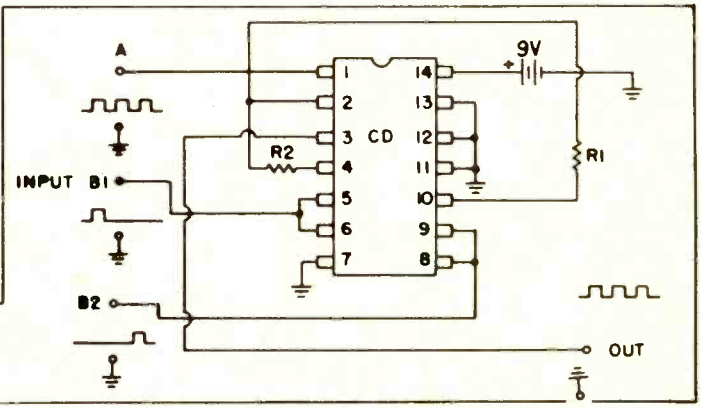


PARTS LIST FOR CIGAR-SIZE AMPLIFIER

C1—5-uF, 10 VDC capacitor
C2—0.005-uF, 10 VDC capacitor
C3—0.003-uF, 10 VDC capacitor
C4—250-uF, 10 VDC capacitor
C5—50-uF, 10 VDC capacitor
IC1—Motorola MFC 4000
R1—1,000-ohms, ½-watt resistor
R2—4,700-ohms, ½-watt resistor
R3—10,000-ohms, ½-watt resistor

26 Pulse Pulser

☐ This simple circuit allows a lot of experimenting, especially if you try combining it with the "Pulse Stopper" circuit. Here, we have a case where the pulse stream coming in at A will not make it through to the output unless either B1 or B2 has an input pulse signal. If A is connected to a CMOS oscillator circuit, and B1 or B2 are connected to a Morse Code keyer, you can practice code with someone on B1 and someone on B2. The output will drive an amplifier like the "Micro-Mini PA" project.

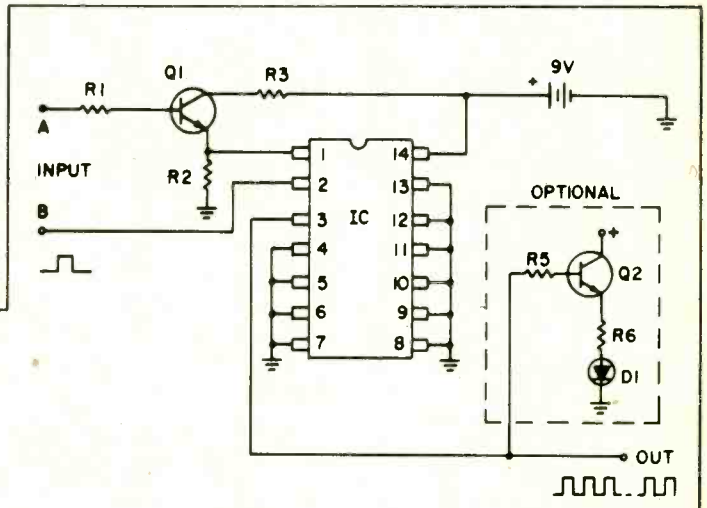


PARTS LIST FOR PULSE PULSER

IC1—4001 quad NOR gate
R1, R2—1,000-ohm, ½-watt resistor

27 Low Level Pulse Stopper

☐ The object of this simple circuit is to show how you can take a low-level (around ¼ volt to 1 volt) stream of input pulses and take a chunk right out of it without disturbing the rest of the pulse stream. The pulses come in at point A, actually between A and ground. The size of the chunk you want to take out is controlled by the width of the positive pulse you put in at point B. The output will be your desired pulse stream, and an optional LED circuit can be added for indication. The unused pins of the IC should be grounded.

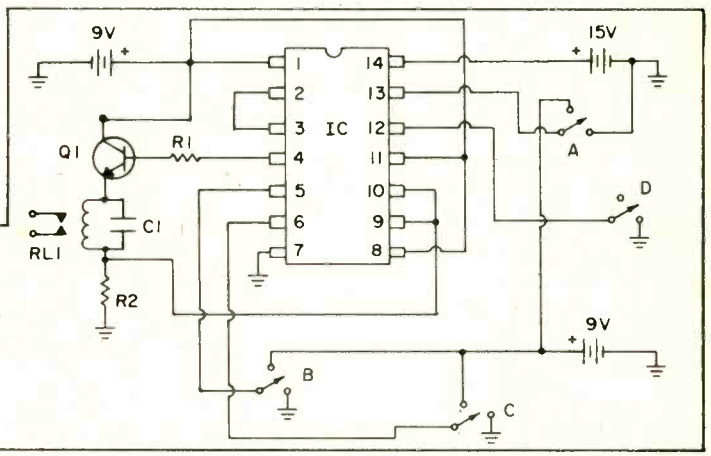


PARTS LIST FOR LOW-LEVEL STOPPER

D1—small LED
IC1—4001 quad NOR gate
Q1, Q2—2N4401 transistor
R1—33,000-ohm, ½-watt resistor
R2, R3—4,700-ohm, ½-watt resistor
R4—10,000-ohm, ½-watt resistor
R5—1,000-ohm, ½-watt resistor

28 Electronic Combination Lock

☐ The CD4016 contains four electronic switches that can be operated with control current. The relay in this circuit will operate only if A and B switches are on (switched to the +9V side) and if C and D are off. You can experiment with different connections to make your own combination, or substitute rotary switches with additional contacts.

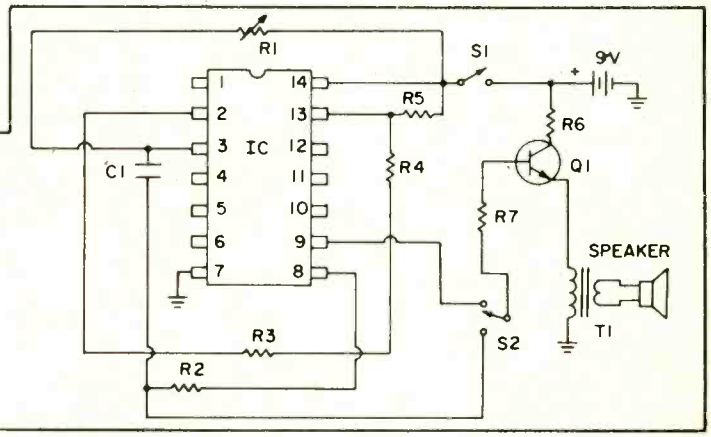


PARTS LIST FOR ELECTRONIC COMBINATION LOCK

C1—0.1-uF ceramic capacitor, 15 VDC
IC1—4016 quad bilateral switch
Q1—2N4401 transistor
R1—10,000-ohm, ½-watt resistor
R2—100-ohm, ½-watt resistor
RL1—any relay w/9 VDC coil to suit application
SWITCHES (A, B, C, D)—SPDT slide type

29 Two-Tone Siren

☐ This circuit lets you generate an up-and-down siren sound by varying R1, and lets you change the type of sound by flipping S2. The output from pin 4 is a sawtooth waveform which causes one type of sound by



PARTS LIST FOR TWO-TONE SIREN

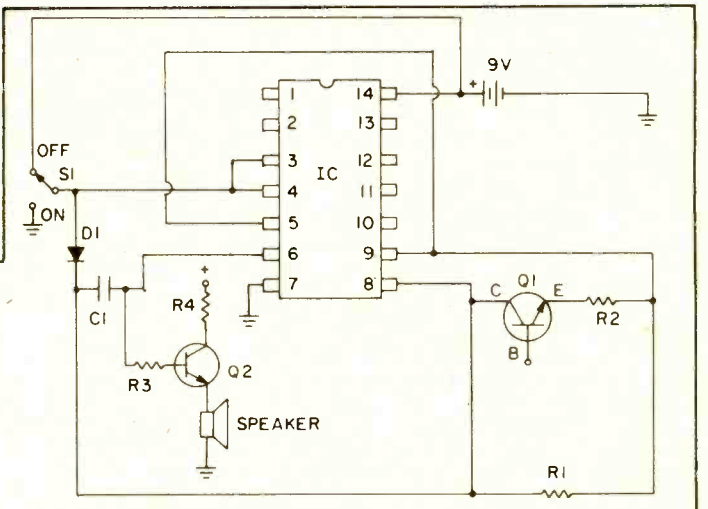
C1—0.01-uF ceramic capacitor, 15 VDC
IC1—3900 quad op amp
Q1—2N4401 transistor
R1—1,000,000-ohm linear-taper potentiometer
R2—100,000-ohm, ½-watt resistor
R3—510,000-ohm, ½-watt resistor
R4—120,000-ohm, ½-watt resistor
R5—1,200,000-ohm, ½-watt resistor
R6—1,000-ohm, ½-watt resistor

R7–2,000-ohm, ½-watt resistor
S1–SPST toggle switch
S2–SPDT slide switch
T1–audio output transformer 500-ohm primary/8-ohm secondary

flipping S2. The output from pin 4 is a sawtooth waveform which causes one type of sound through the speaker. The other type of sound, sharper and higher than the first, comes from the square wave output of pin 9. Flipping between the two types of sounds while varying R1 produces the sound of a French Police car siren.

30 Haunted House

☐ An eerie sound comes from a small box in a dark room. As your friends shine a light toward the sound, it whines with a higher pitch, but falls again as they drop the light and run. The output at A can also be run into your hi-fi system to cause a very loud witch's squeal. The principle is a NOR-gate oscillator with a pitch controllable via the light-sensitive transistor Q1. Changing R1 to a higher value will give a lower-pitched wail.



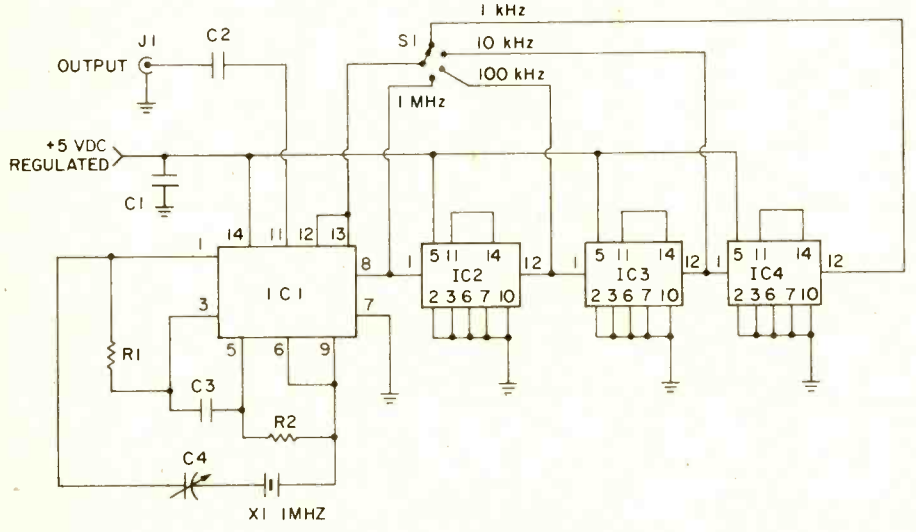
PARTS LIST FOR HAUNTED HOUSE

C1–0.01-uF ceramic capacitor, 15 VDC
D1–1N4001 diode
IC1–4000 dual NOR gate w/inverter
Q1–FPT100 phototransistor
Q2–2N4401
R1–30,000-ohm, ½-watt resistor
R2–1,000,000-ohm, ½-watt resistor
R3–2,000-ohm, ½-watt resistor
R4–500-ohm, ½-watt resistor
S1–SPDT toggle switch

31 SWL's Super Calibrator

☐ Providing WWV referenced outputs at 1 MHz, 100 kHz, 10 kHz and 1 kHz, this super calibrator looks quite difficult to assemble, but if you lay it out for a printed circuit board you'll find it's one of the easiest projects to build and get working because there's very little that can go wrong if the ICs and the crystal are okay.

IC1 serves as both the oscillator and buffer amplifier. Another buffer amplifier is used for the output amplifier (terminals 11, 12 and 13), IC1's output at pin 8 is a buffered 1 MHz. ICs 2, 3 and 4 are *divide by 10 frequency dividers* providing outputs of 100 kHz, 10 kHz and 1 kHz. Since all outputs are square waveform, all output signals are rich in harmonics and so can be used to calibrate receiver dials to well above 60 MHz for the 1 MHz output and to at least 30 MHz for the 100 KHz and 10 kHz



PARTS LIST FOR SWL'S SUPER CALIBRATOR

R1, R2–220-ohms, ½-watt, 10%, resistor
C1, C2, C3–0.01-uF, 10-VDC or higher, capacitor
C4–5-50-pF trimmer capacitor
X1–1-MHz crystal, Calectro J4-1900 or equiv.
IC1–Integrated circuit type SN7400
IC2, IC3, IC4–Integrated circuit type SN7490
S1–SP4T switch
J1–Output jack (phono type suggested)

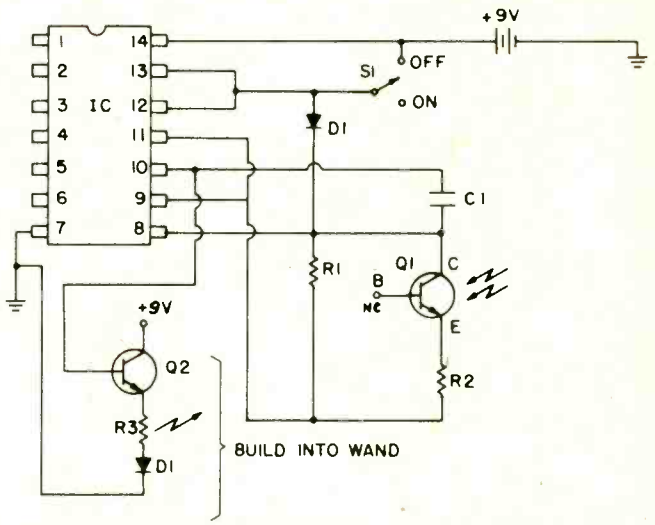
outputs. The 1 kHz harmonics can range up to 30 MHz depending on your receiver's sensitivity. The calibrator's output at jack J1 can be connected directly to the receiver's antenna input terminals without affecting the calibrator's output frequency.

The unit is set to zero-beat with WWV with trimmer capacitor C4. It can be assembled in any type of cabinet, but a PC board is specifically recommended for circuit stability.

Power must come from a 5-volt regulated source and we recommend the LM340 5-volt three-terminal regulator for this project. Make certain capacitor C1 is installed as close as possible to IC1 pin 14.

32 Magic Blinker

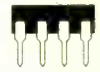
☐ Imagine a small black box that you place on a table in front of your friends. Connected to the box with a thin wire is a wand with a small red light (LED) on the end. The light flashes about twice a second, but at your command, it flashes faster and faster. You hand it to your friends, but they cannot do it. The secret? In the box is a small hole with photo transistor Q1 showing through. As D1 gets closer to Q1, it flashes faster and faster but it will take your friends a long while to catch on. It's especially effective when all the room lights are out. Have fun.



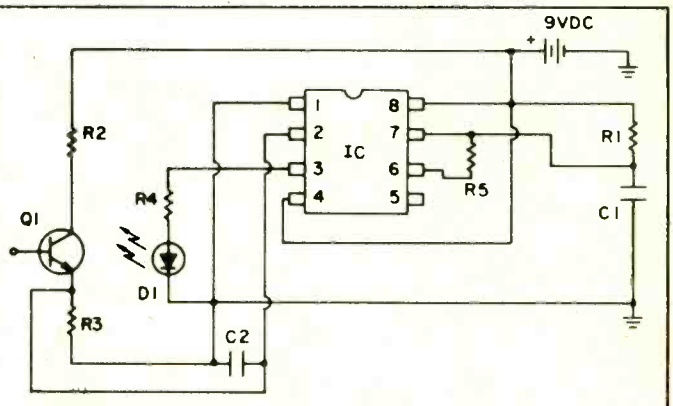
PARTS LIST FOR MAGIC BLINKER

C1–0.01-uF ceramic capacitor, 15 VDC
D1–small LED
D2–1N4001 diode
IC1–4000 dual NOR gate w/inverter
Q1–FPT100 phototransistor
Q2–2N4401 transistor
R1–5,000,000-ohm, ½-watt resistor
R2–1,000,000-ohm, ½-watt resistor
R3–680-ohm, ½-watt resistor

33 Optical Confusion



☐ "As anyone can plainly see, the LED (D1) flashes rather rapidly," you say to an unsuspecting guest. "But in fact, the flashes are an optical illusion. Just hold this white paper in front of the LED and look at the light through the paper. You will see that in fact the LED is not flashing, at least not until you remove the paper." Your guest will be the victim of optical confusion. The trick lies in the fact that the LED flashes only as long as its light shines on Q1. Put the paper between D1 and Q1 and the LED shines continuously.

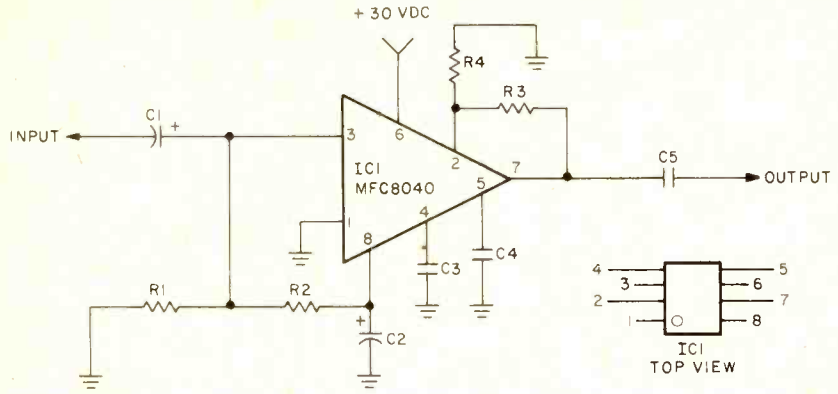


PARTS LIST FOR OPTICAL CONFUSION

C1–0.01-uF ceramic capacitor, 15 VDC
C2–0.1-uF ceramic capacitor, 15 VDC
D1–large LED
IC1–555 timer
Q1–FPT100 phototransistor
R1–10,000,000-ohm, ½-watt resistor
R2, R3–1,000,000-ohm, ½-watt resistor
R4–220-ohm, ½-watt resistor
R5–2,000,000-ohm, ½-watt resistor

34 No-Noise Mike Preamplifier

☐ Packing a walloping 60 dB gain with a 7 volt output, this mike preamp nevertheless is almost dead quiet. The input impedance is about 75,000-ohms; output impedance about 100-ohms. Actual maximum output voltage depends upon the load resistance, ranging from 7 volts output into a 10,000-ohm load to 4 volts output into a 1000-ohm load. Parts layout is not critical and any type of assembly can be used. The power supply current is approximately 8 mA, with a maximum of 12 mA.

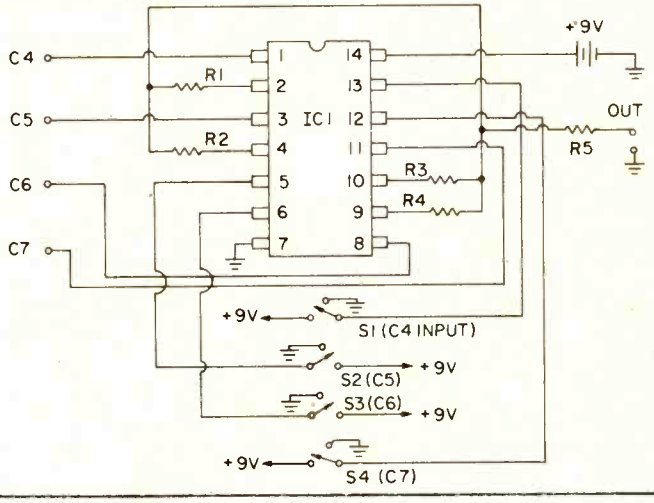


PARTS LIST FOR THE NO-NOISE MIKE PREAMP

C1—2-uF, 12 VDC electrolytic capacitor
C2—100-uF, 12 VDC electrolytic capacitor
C3—0.047-uF Mylar capacitor
C4, C5—0.1-uF Mylar capacitor
IC1—Motorola MFC 8040
R1—75,000-ohm, ½-watt resistor
R2—270,000-ohm, ½-watt resistor
R3—110,000-ohm, ½-watt resistor
R4—100-ohm, ½-watt resistor

35 Multi-Input Music Synthesizer

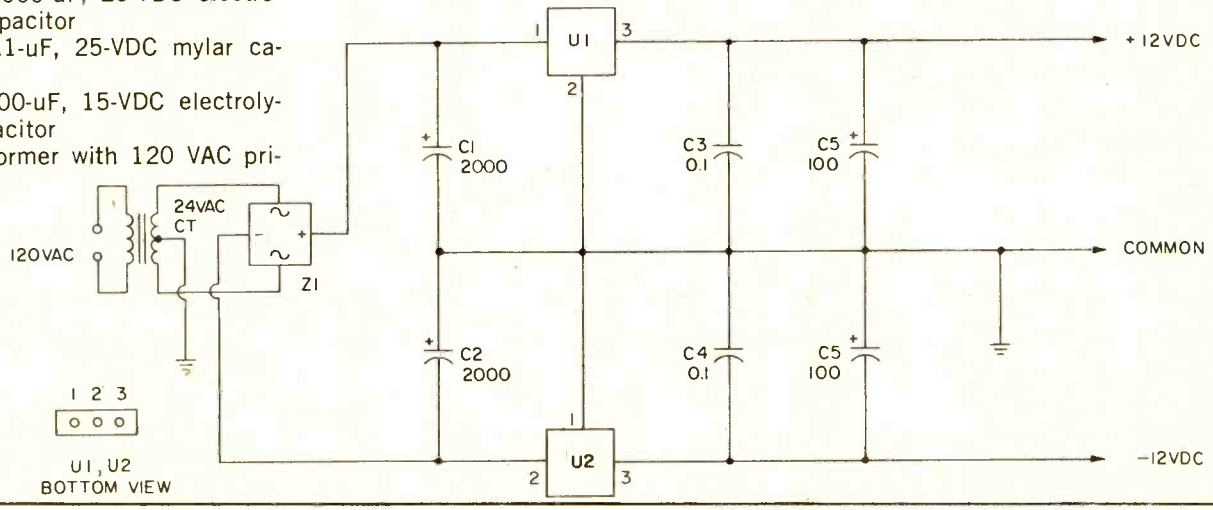
PARTS LIST FOR MULTI-INPUT MUSIC SYNTHESIZER
IC1—4016 quad bilateral switch
R1 through R5—1,000-ohm, ½-watt resistor
S1 through S4—SPDT slide switch



☐ The inputs to this synthesizer can be from any musical instruments. C4 can be from an electric guitar, C5 from an electronic organ, etc. Or the inputs can be from the outputs of the "Octave Music Maker" project. The voltage should not exceed 9 volts at these inputs. The output will be a combination of the inputs, where you control the combining via the switches. The switch marked "S1" will put the C4 input through to the output when it is switched to the down position.

36 Regulated Bi-Polar Power Supply

PARTS LIST FOR BI-POLAR SUPPLY
C1, C2—2,000-uF, 25-VDC electrolytic capacitor
C3, C4—0.1-uF, 25-VDC mylar capacitor
C5, C6—100-uF, 15-VDC electrolytic capacitor
T1—transformer with 120 VAC primary/24 VAC center-tapped secondary @ 1.5-Amps
Z1—bridge rectifier, 50 PIV @ 1-Amp



☐ Although an unregulated bi-polar power supply will do for most experimenter operational amplifier projects, for utmost precision and reliability, a regulated supply should be used, particularly if your powerline (120 volts) isn't too "tight"; meaning the voltage can vary over a relatively broad range of values from moment to moment.

Short of a power failure, this supply will provide a rock-steady output over a wide range of powerline and load current variations.

Take careful note that IC1 and IC2 have different connections even though they appear to be the same. Check, and then recheck their identification numbers very carefully before installation. One is a positive regulator, the other a negative regulator. Both must be secured to a heat sink, or a metal cabinet, to attain the full rated 1-ampere output.

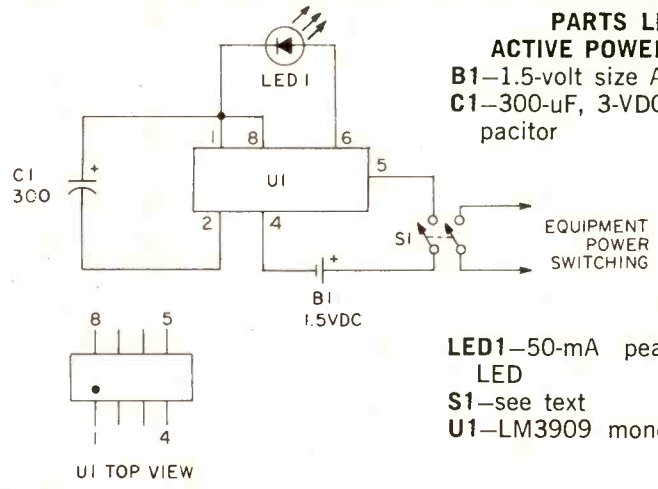
Transformer T1 should have at least a 1-Ampere rating, though it will run considerably cooler if it has a rating of 50% above maximum current load (1.5-Amp).

No special assembly precautions are necessary other than placing C3 and C4 as close as possible to the IC terminals.

37 Active Power Indicator

☐ One reason battery-powered devices rarely have lamps to indicate power *on* is because the lamps often consume more power than the device itself. This is particularly true of solid-state devices where current requirements might be well under 10-mA, or even 1-mA for CMOS ICs. Problem is, the mechanical "flags" often used to indicate power *on* usually go unnoticed.

There's still nothing like a lamp indicator, and that's where this project fits in. Using an ordinary penlight AA battery, this simple circuit will flash an LED once every second for at least six months if not turned off. Used intermittently to indicate when Power is on, the AA battery should last for its shelf life or one to two years. The circuit is turned into a power indicator by simply using a double pole switch to control both the indicator and the operating circuit, as shown in the schematic.

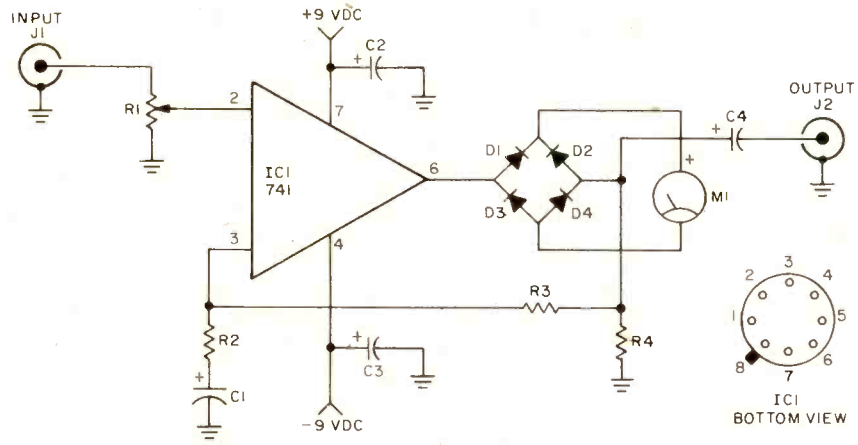


PARTS LIST FOR ACTIVE POWER INDICATOR

B1—1.5-volt size AA battery
C1—300-uF, 3-VDC electrolytic capacitor
LED1—50-mA peak current-rated LED
S1—see text
U1—LM3909 monolithic oscillator

LED1 can be any type as long as it's rated to handle at least 50-mA peak current. The circuit will work with LEDs of lower peak rating, but many of the "surplus" LEDs in the marketplace are so greatly undersize they will "blow out" on the first blink. Stick with a 50-mA LED.

38 Record Remote Amplifier



PARTS LIST FOR RECORD REMOTE AMPLIFIER

C1—220-uF, 12 VDC electrolytic capacitor
C2, C3—47-uF, 50 VDC electrolytic capacitor
C4—0.1-uF or 25-uF, 12 VDC capacitor (see text)
D1, D2, D3, D4—1N60
IC1—Type 741 operational amplifier
J1, J2—Shielded jacks
M1—VU meter with internal rectifier removed (Calectro D1-930 or equiv.)
R1—50,000-ohm audio taper potentiometer
R2—100-ohm, ½-watt resistor
R3—15,000-ohm, ½-watt resistor
R4—560-ohm, ½-watt resistor

☐ Here's a professional performance record remote amplifier suitable for the hobbyist, amateur recordist or professional broadcast engineer. The input is any microphone with an output impedance up to 50,000 ohms, or for professional use, the input can be at line level. Output is 500-ohms at line level with a bulit-in VU meter indicating output level. When the distance between the remote amplifier and its associated equipment is less than 25 feet the amplifier can be connected to any hi-fi type, high impedance input (10,000-ohms or higher).

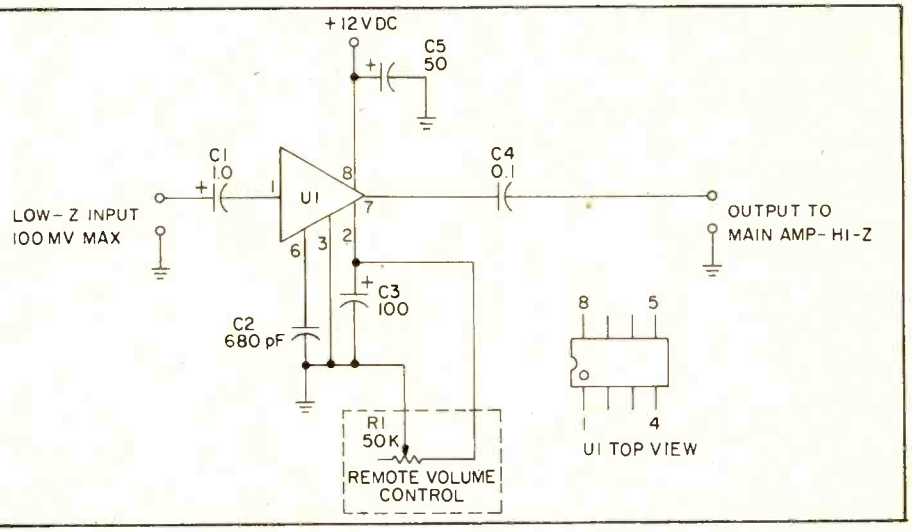
For long line or professional applications, connect a 500/500 line matching transformer to output jack J2. Capacitor C4 is 0.1 *u*F for all applications except when used with a line matching transformer. When a transformer is used C4 is 25 *u*F. Better results can be obtained with a line matching transformer if the transformer primary *replaces* R4 (eliminating C4).

M1 is a standard VU meter whose internal rectifier has been removed (open the case and unsolder the rectifier). Total current drain is less than 5 mA and the bi-polar power supply can consist of two transistor radio type 9-volt batteries.

39 Remote Control Amplifier

PARTS LIST FOR REMOTE CONTROL AMPLFIER

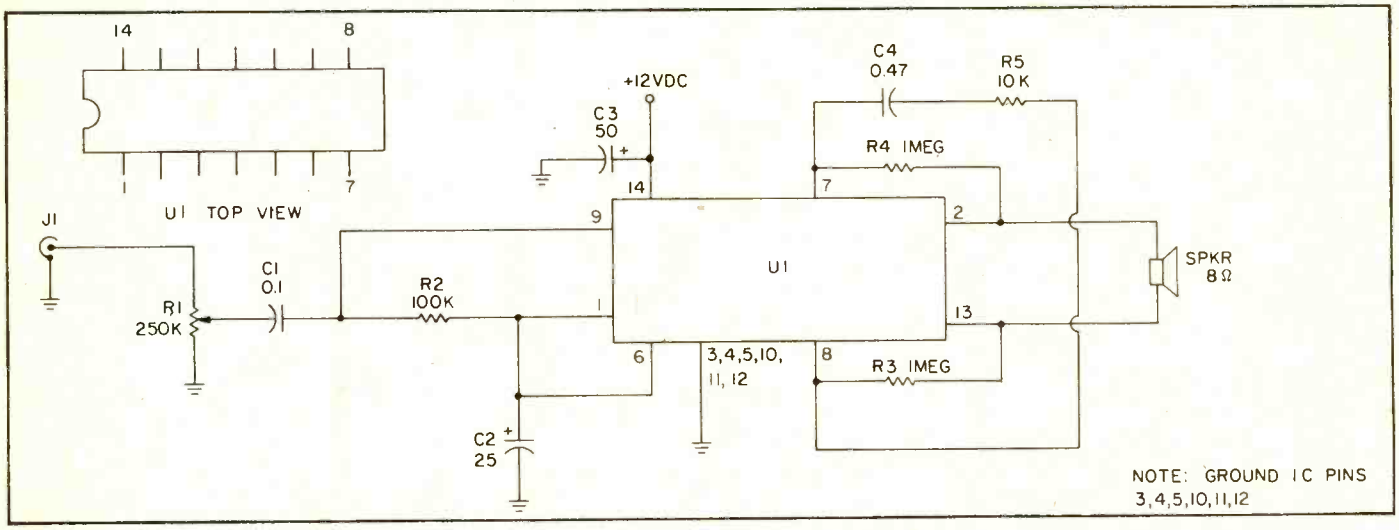
C1—1-uF, 12-VDC electrolytic capacitor
C2—680-pF, 50-VDC ceramic disc capacitor
C3—100-uF, 12-VDC electrolytic capacitor
C4—0.1-uF, 25-VDC mylar capacitor
C5—50-uF, 15-VDC electrolytic capacitor
R1—50,000-ohm, linear taper potentiometer
U1—HEP-C6009P electronic attenuator



☐ As a rule of thumb, the farther an amplifier's volume control is located from the amplifier itself, the greater the possibility of hum and noise pickup. But by using a special integrated circuit amplifier, noise pickup is eliminated.

This remote control amplifier is designed to handle microphone levels—maximum input is 100-mV—and the output is "line level."

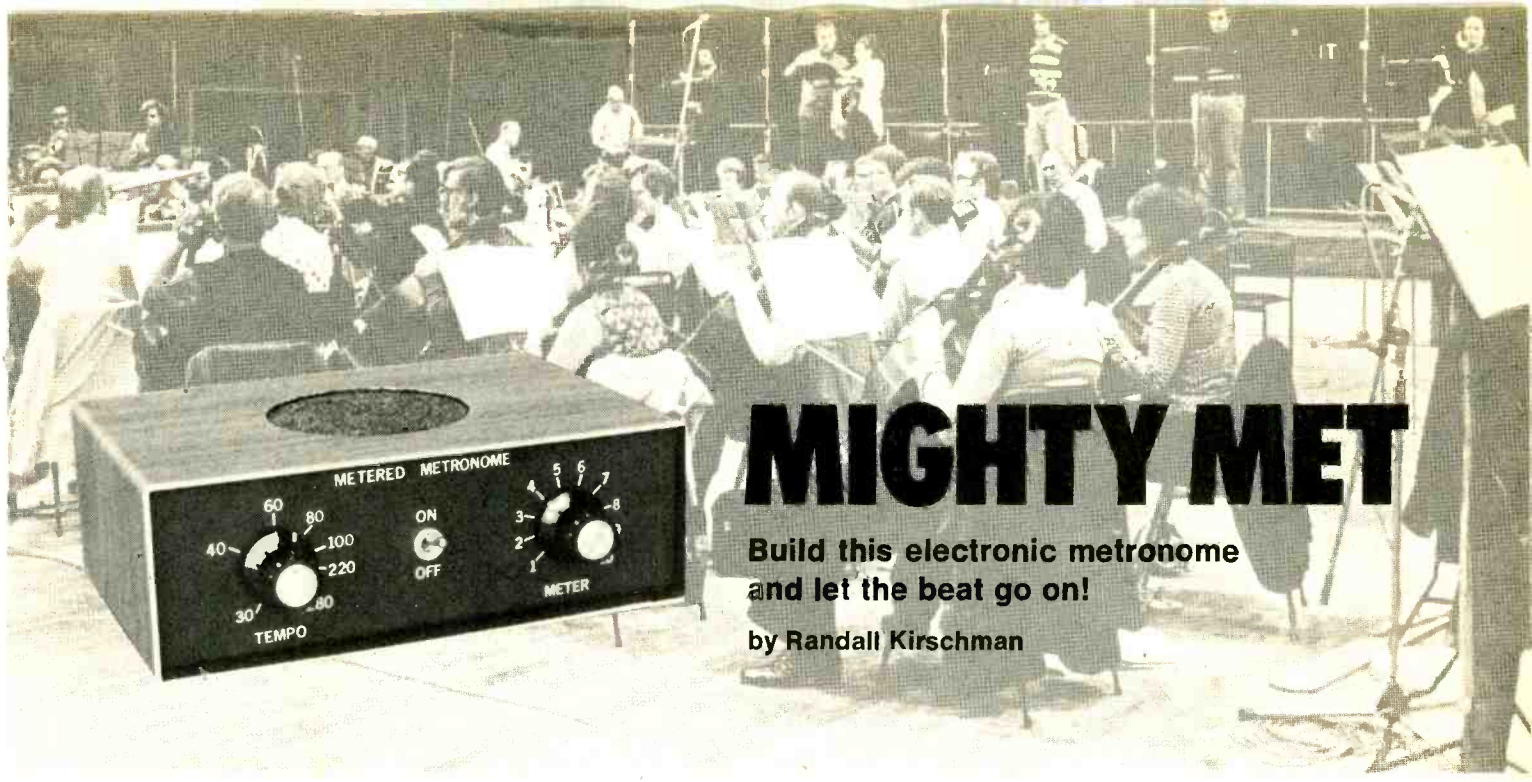
40 Porta-Amp



☐ Packing a whopping 4-watts output, this battery-powered amplifier will let you take along your electric guitar on picnics and outings. Power is supplied by two series-connected 6-volt lantern batteries, or you can plug it into your auto's cigar lighter socket.

If you play "laid back" music, you

(Continued on page 118)



MIGHTY MET

Build this electronic metronome and let the beat go on!

by Randall Kirschman

FROM THE TICK-TOCKING of a timepiece to the clickety-clickety-clacking of a musical tempo, here's a metronome for all reasons. It's a *Mighty Met*, and features an easy-to-build design that will help you tick away many happy hours.

Mighty Met not only provides steady beats like an ordinary metronome, but also keeps track of the downbeat in each measure. An ordinary metronome produces beats that are all the same, but Mighty Met allows one beat in a group, for example every fourth beat, to be made either louder or softer than the others. In order to match the meter of the music, a ten-position switch allows the user to emphasize (or de-emphasize) every beat, every second beat, every third beat, and so forth, up to every tenth beat. The "odd" beat can then be used to indicate the first beat or downbeat in each measure of music.

The unit can also serve as an audible darkroom timer. For this application, the tempo can be set to 60 (one beat per second) with every tenth or every fifth beat emphasized to help keep track of the count. Its advantages over other timers are that it can be used in complete darkness, and does not need to be watched or set.

Pulsing Right Along. The circuit is built around a 555 timer and three CMOS IC's. CMOS type IC's (also called COS/MOS) were used in the design because of their low power requirements and ability to operate from a wide range of supply voltages. These characteristics allow the circuit to be powered by a 9-volt transistor-radio battery. Battery drain is about 5 to 10 milliamps, comparable to that in a pocket transistor radio.

The 555 timer, IC1, and associated components R1, R2, R3, and C1 form an astable (free-running) multivibrator which generates a continuous series of pulses. The pulses appear at pin 3 of IC1, and are used to produce the basic metronome beats. Potentiometer R2 varies the pulse rate to adjust the tempo. The pulses also drive a divider comprising IC2 and IC3. A division factor of from 1 to 10 is selected by rotary switch S2. For example, if S2 is set to 4, then for every four input pulses from IC1, the divider will produce one output pulse. The output pulses from the divider, at pin 4 of IC3, are used to produce the downbeat. How the divider works is explained later.

The output pulses from the divider go to two places. First they go to IC4C where they are inverted. From the output of IC4C, pin 10, comes a series of negative-going pulses used for the downbeat. Second, they are combined logically with the basic beat pulses in IC4A. The result, at the output of IC4A, is a series of beat pulses with the downbeat missing. These pulses are inverted by IC4B so that they are negative-going also. Again, taking as an example S2 set to 4, the fourth beat would appear at the bottom of pot R7 (pin 10 of IC4C), while the other three beats would appear at the top of R7 (pin 11 of IC4B).

If the wiper of pot R7 were set to the midpoint, both sets of pulses would be fed equally to the output circuitry and Mighty Met's output would be a succession of equally loud clicks, like those from an ordinary metronome. Rotating the wiper of R7 toward the bottom end would accentuate the fourth pulse and decrease the other three pulses. Thus every fourth click would be louder. The greater the rotation, the greater the contrast. Conversely, rotating the pot in the opposite direction, toward the top, would decrease the fourth pulse and accentuate the three other pulses. Thus every fourth click would be softer. For metronome purposes, the fourth click serves as the first beat or downbeat of the measure of music.

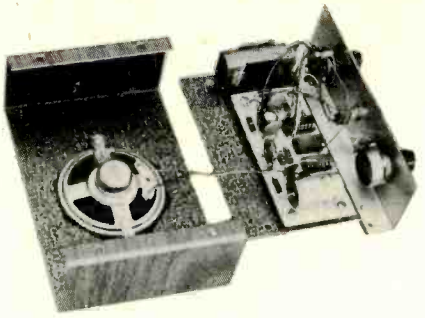
From the wiper of R7, the pulses are fed through R8 and are amplified by transistors Q1 and Q2, which are connected in what is known as a Darlington configuration. Between pulses, pins 10 and 11 of IC4 rest at the positive supply voltage. Thus no current flows, in the base of Q1, and it is cut off. Likewise, Q2 is also cut off. During a pulse, when either pin 10 or 11 of IC4 goes low, base current flows in Q1, turning it on. The resulting current through Q1 turns Q2 on, causing a momentary surge of current through the speaker, which is heard as a click. To provide sufficient current to pulse the speaker (about half an amp), a large electrolytic capacitor, C5, is connected to the output circuit. Capacitor C6 takes the sharp edges off the pulses to mellow the click a bit, and also eliminates any stray spikes from the fast switching of the IC's.

R4, R6, C2, C3, and C4 in the +9-volt supply line provide decoupling to isolate the various sections of the circuit and avoid unwanted interactions which could cause faulty switching. Having a 0.2 uF capacitor, C3, in parallel with the 100 uF capacitor, C4, may be puzzling. The reason is that although electrolytics do a good job of bypassing low frequencies, they generally have too

Mighty Met

high an impedance at high frequencies to be effective for bypassing high frequencies or very fast pulses. To take care of these another capacitor must be added, in this case a disc ceramic, C3. This scheme is used fairly frequently. The power switch, S1, is connected in such a way that switching the metronome off shorts the +9-volt line to ground and quickly drains C4 and C5 and stop the clicks immediately.

Divide and Conquer. The heart of the divider is IC2, a CD4017 decade counter/divider. This IC contains five flip-flops interconnected to form a counter which has ten possible states. The states are usually identified by the ten decimal digits 0, 1, 2, 3, . . . , 9. For each input pulse fed into the CD4017 at pin 14, it changes from whatever state it was in to the next state. When it reaches state 9, the next pulse causes it to change to state 0. So that the counter can be started from a known state there, is also a provision to reset it: a logical high (+V) applied to pin 15 sets the counter to the 0 state, regardless of the state it was in previously.



Here the speaker has been mounted to the top-side of the cabinet, though you may wish another arrangement entirely. If you choose, a slightly larger speaker can be used to increase Mighty Met's volume.

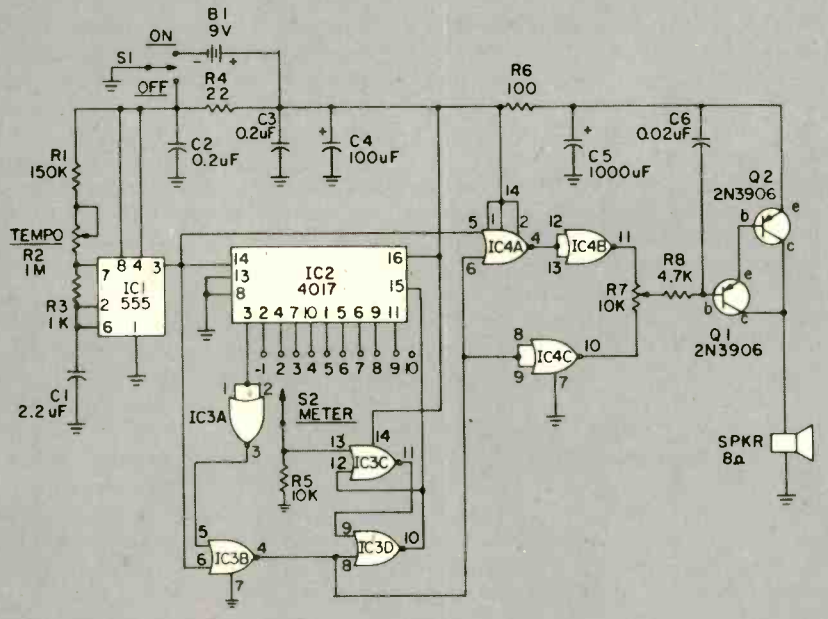
In the CD4017 the ten states are also decoded, which means that for each state there is a corresponding output pin which goes high when the counter is in that state. For state 0 (reset) pin 3 is high while all the other output pins are low; for state 1, pin 2 is high while all other output pins are low, and so on. Having this decoding function built in simplifies Mighty Met's construction.

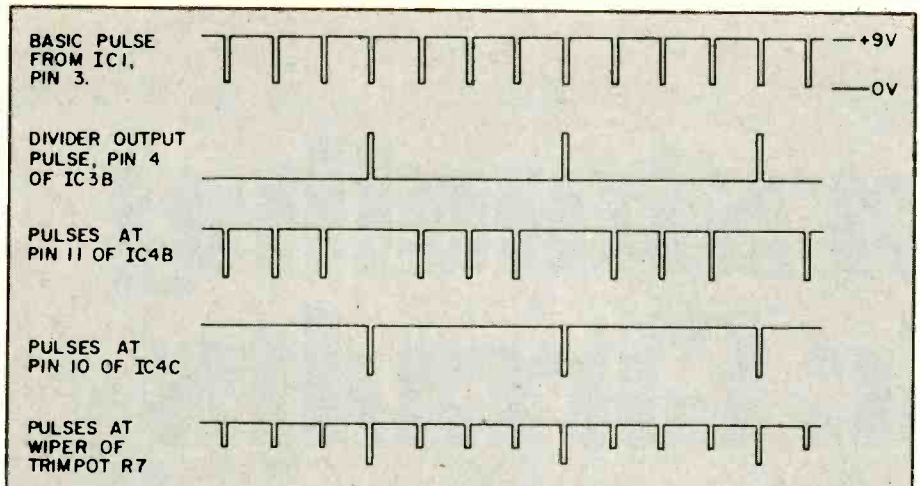
To understand how division is accomplished, suppose we choose a division factor of four. In this case the output pin for state 4 (pin 10) will be used to reset the counter. Assume the counter starts in state 0 (reset). As pulses are fed in, the first pulse advances it to state 1, the second pulse to state 2, the third to state 3, and the fourth to state 4. The output pin for state 4 is now high which causes the counter to reset, and the cycle will repeat indefinitely. For every four input pulses there will be one reset pulse, in other words the input pulse rate is divided by four, as required. To divide by any other factor from 1 to 9, the appropriate output pin is used to reset the counter (to divide by ten, this scheme is not necessary since the counter resets by itself every ten pulses). Besides IC2, the divider also includes S2 to select the division factor, and IC3 to carry out the resetting of IC2.

Theme and Variations. Mighty Met can be designed according to the desires of the builder. For the parts specified, the *tempo* range is about 30 to 280 beats per minute. The tempo is equal to the pulse rate of the multivibrator, which is determined by the time constant of R1 + R2 and C1 (the effect of

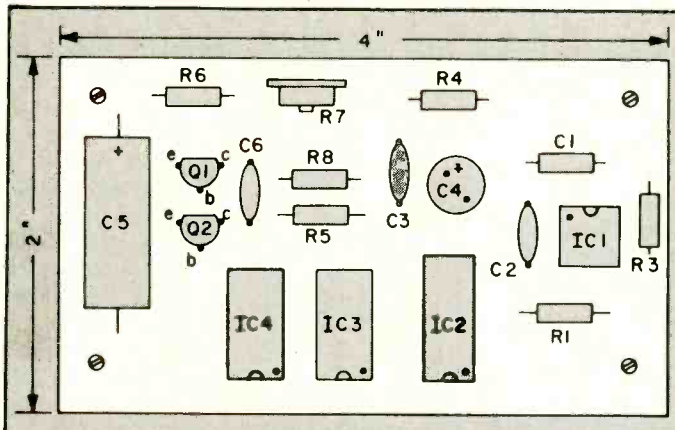
PARTS LIST FOR MIGHTY MET

R4—22-ohm resistor (Radio Shack 271-005, 271-1303 or equiv.)
R5—10,000-ohm resistor (Radio Shack 271-034, 271-1335 or equiv.)
R6—100-ohm resistor (Radio Shack 271-012 271-1311 or equiv.)
R7—10,000-ohm trimpot (CTS X201-R103, Radio Shack 271-218 or equiv.)
all resistors except R2 and RT are ¼ or ½ watt, 10%
R8—4,700-ohm resistor (Radio Shack 271-030, 271-1330 or equiv.)
S1—SPDT miniature toggle switch (Radio Shack 275-613 or equiv.)
S2—1-pole, 10 position, non-shorting rotary switch (Calectro E2-161 with one position unused, or equiv.)
Spkr—8-ohm speaker, size to suit (author used 2½-inch Radio Shack 40-2471 or equiv.)
Misc.—cabinet, battery holder and connector (Radio Shack 270-325 or equiv.), knobs (Radio Shack 274-415 or similar), perforated board (Radio Shack 276-1394 or similar), IC sockets—2 14-pin (Radio Shack 276-027, 276-1999 or equiv.), 1 16-pin (Radio Shack 276-030, 276-1998 or equiv.), speaker grille, wire, solder, etc.
B1—9 VDC transistor radio battery (Eveready 216, Radio Shack 23-464 or equiv.)
C1—2.2-uF electrolytic capacitor (Radio Shack 272-1407 or equiv.)
C2, C3—0.2-uF capacitor (Radio Shack 272-1070 or equiv.) (author used disc ceramic)
C4—100-uF electrolytic capacitor (Radio Shack 272-955 or equiv.)
C5—1000-uF electrolytic capacitor (Radio Shack 272-1008 or equiv.)
C6—.02-uF capacitor (Radio Shack 272-1066 or equiv.) (author used disc ceramic)
all capacitors are 10 VDC or greater
IC1—555 timer IC (Radio Shack 276-1723.)
IC2—CD4017 CMOS decade counter/divider IC (Radio Shack 276-2714 or equiv.)
IC3, 4—CD4001 CMOS quad two-input NOR gate IC (Radio Shack 276-2401 or equiv.)
Q1, 2—PNP general purpose transistor, 2N3906 or equal
R1—150,000-ohm resistor (Radio Shack 271-047, 271-1349 or equiv.)
R2—1-megohm, linear taper potentiometer (Radio Shack 271-211 or equiv.)
R3—1000-ohm resistor (Radio Shack 271-023, 271-1321 or equiv.)

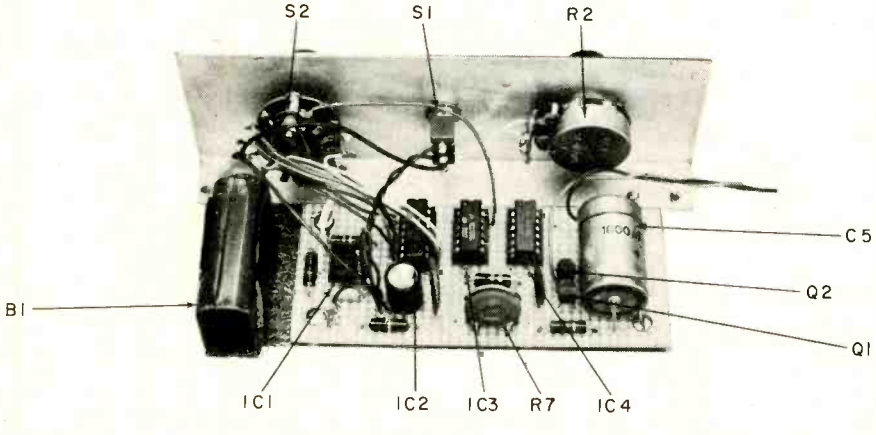




Mighty Met utilizes digital logic circuitry which, at first glance can seem a bit of a mystery. Diagrams such as this, along with a careful reading of the text, can serve as a good initiation. You'll soon understand just how it is that Mighty Met makes such a tuneful beat. This pictorial shows the "meter" control set at 4. The bottom waveform is the result when wiper of R7 is set toward the end connected to pin 10 of IC4C, emphasizing downbeat. Follow it through a few times in the text and refer back to this diagram as you read. Pretty fast, you'll unravel the Mystery of Mighty Met!



Mighty Met uses a perfboard construction, so it is important to follow this layout as given. Use sockets for the IC's and treat them as the text says to, they are very sensitive to any static charges. Wiring can be point-to-point beneath the board, or you can use flea clips. No matter how you build it, Mighty Met is one swell way to let the old beat go on!



As you can see, following the author's perfboard layout results in a very neat and professional appearance, a fine-looking Mighty Met. If you complete the construction with a nicely finished cabinet and press-on lettering you'll have a finished product that would be more than welcome (by the wife) in any room of the house.

R3 is negligible). A different range may be had by changing the values of R1, R2, or C1. R1 determines the upper tempo limit, while R2 determines the lower limit. Changing C1 will affect the overall tempo range. The sound quality of the clicks can be changed by increasing or decerasing the value of R3, which changes the width of the pulse from IC1. Do not make R3 less than 200 ohms, however.

To make Mighty Met louder, substitute a larger speaker for the one suggested. Since fidelity is not a concern in this application, an inexpensive speaker can be used. On the other hand, if the clicks are too loud, increase the value of R8.

If the unit is to be used as a darkroom timer, the *tempo* control, R2, can be a trimpot. Also the divider can be simplified. For example, if every fifth click is to be emphasized, then pin 13 of IC3 can be connected directly to pin 1 of IC2 and S2 and R5 can be eliminated. Similarly if every tenth click is to be emphasized, pin 13 of IC3 can be connected to ground, and S2 and R5 eliminated. Another possibility is to replace S2 with an SPST switch to select either every fifth or every tenth click, leaving R5 in.

On Composition. First, a word about precautions which should be observed when working with CMOS IC's, like those used in this project. CMOS IC's can be damaged by static electricity or other excessive voltage. Although this is true to some degree for all types of IC's, the CMOS type are particularly susceptible. They should be left in their protective packaging until they are needed and should not be handled unnecessarily. The use of sockets is highly recommended for the three CMOS IC's in Mighty Met. They should not be inserted until all wiring is completed, and should be inserted or removed only with power off. When inserting or removing a CMOS IC, first "ground" your body to the circuit by touching your free hand to the wiring or by a similar method. This helps to avoid a difference in potential or static charge between the IC and the socket.

Construction of the Metered Metronome is straight-forward. Most of the parts values are not critical. Use a linear-taper pot for R2, as specified, rather than an audio taper. An audio taper would result in excessive crowding of the scale at the upper end of the *tempo* range. In the prototype, most of the circuit was assembled on a piece of perforated board, about 2 x 4 inches. If you use this method, be sure to get a board with holes spaced 0.1 in. apart

(Continued on page 118)

Understanding Logic Circuits

by Gordon Sell

A simplified look at how logic circuits "think"

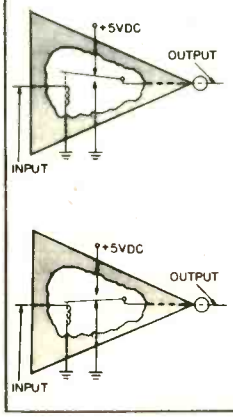
THE FIRST MISTAKE made by people trying to explain digital logic is their insistence on name dropping. They confuse a reasonably simple subject with technical terms such as CMOS, TTL, PMOS and so on and so on. There's plenty of time to learn about these later, but first we must learn what a digital logic circuit is.

A digital logic circuit is, for all intended purposes, a *solid state relay network*. After a statement like this there are probably a few engineers out there grinding their teeth and pulling out their hair, but this basic definition will help you more than any explanation of "electron movement through silicon substrates."

All digital logic circuits can be broken down into combinations of three basic *logic gates*. These gates receive information in the form of one or more inputs of a high- or a low-voltage level —usually +5 volts DC and 0 volts (ground potential). Depending on what type of gate it is, an appropriate voltage level appears at the output. The three basic gates are called NOT, AND and OR. Their operation can be simulated by using plain old-fashioned mechanical relays.

NOT Gates. Now we will see where the relays come into action. Look at the diagrams of the NOT gate. When there is no input voltage the relay is not energized and the relay contact connects the output to the high voltage level. In other words, a low input is inverted by a NOT gate. When a high voltage level is applied to the input the relay energizes and connects the output to ground potential. The gate has inverted the high input to a low output. No matter what the input is, it is NOT the output.

NOT Gates



This is the magnetic-relay equivalent of a logical NOT gate. When the input is too low to energize the magnet the relay contact is connected to the 5-volt DC power source. So, when the input is low the output is high. In the second diagram the input is high enough to energize the relay and the contact is grounded. When input is high, output is low.

The next two gates, the AND and OR gates, are a bit more complicated since they have two or more inputs. When you think of them try to think of the AND gate as a *series* gate and the OR gate as a *parallel* gate. This may not be clear yet but it will help you to keep things straight in the future.

AND Gates. In order for the output of an AND gate to be high all inputs must be high. If any of the inputs are low the output will be low. Look at the first of the AND gate diagrams. Both inputs are low and neither relay is energized. The relay contacts connect the output to ground and therefore the output is low.

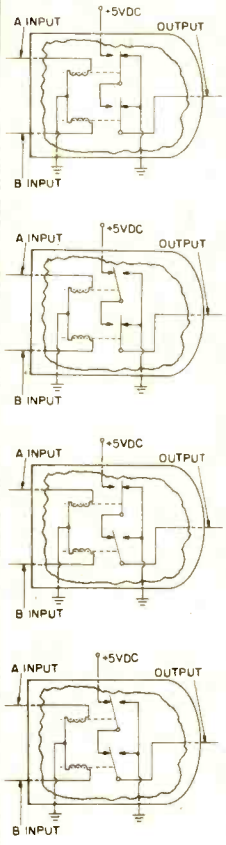
In the next two diagrams we try putting a high on one or the other inputs. In each situation the output is still connected to ground and the output is low.

When all of the inputs are high the relay contacts connect the output pin to 5 volts DC and the output of the gate is high. Any number of relays could be added in a similar manner and the output would be high only when all inputs were high, hence it is a series gate.

OR Gates. An OR gate is a parallel gate and its output is high if any of its inputs are high. In the first diagram all the inputs are low and none of the relays are energized. The contacts of the relays connect the output pin to ground and the output is low. In the next two diagrams one of the inputs is high while the other is low. Now the output is connected to 5 VDC and the output pin is high. A resistor has been added to each ground line to prevent an internal short circuit when one contact is on high while the other is low. In the last sketch both relay contacts are connecting the output to the high-voltage source, and the output is high. As with the AND gate, any number of relay circuits could be added in this parallel format. If any number of inputs are high then the output will be high.

Now we have learned how our three basic digital logic gates work. Of course, in an actual logic circuit the relays are

AND Gates



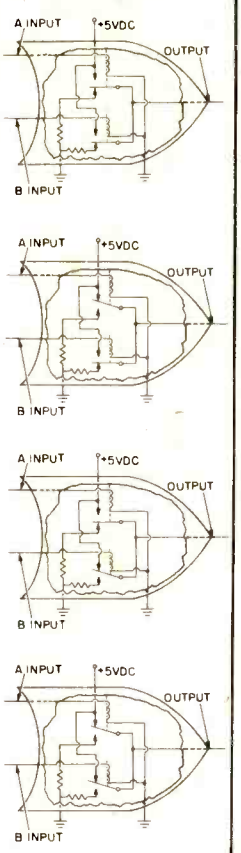
When both inputs to an AND gate are at a low level, as is shown in the first diagram, the relays are de-energized. Each set of contacts connects the output to ground.

In the second diagram input A is at a high voltage level (typically 5 volts DC) and the upper relay is energized, yet the output is still low.

Now, in the third diagram, we put a high on the B input. The lower relay is energized but the output pin is still grounded.

In the last diagram we see what happens when both input are high. The two relay contacts connect the output to 5 VDC. The output will be high only if both inputs are high.

OR Gates



In the relay-equivalent circuit of an OR gate we have added a couple of resistors to prevent an internal short circuit. Note that when both inputs are low both relay contacts connect the output to ground.

In the second OR gate diagram the upper relay is energized by a high voltage level at the A input. This connects the output to the 5 VDC contact of the relay

In the third diagram the B input is high while A is low. Again you can see by tracing out the current flow that the output will be high.

By now the last diagram should need little explanation. Both relays are energized and the output is connected to 5 VDC through both relay contacts.

replaced by integrated circuit transistors that switch the levels from high to low, but the inputs and outputs are the same.

Combinations. By now you are probably asking why this article has ignored all the other gates you've probably heard about—the NAND and NOR gates for example. The reason is that these and all other logic gates are combinations of the three basic gates. A NAND gate is really a NOT/AND gate since it is a combination of the two. In the diagram of the NAND gate you will see that it is an AND gate who's output is inverted by a NOT gate. For example: When any of the AND gate's inputs are low the output is low, but now the input of the NOT gate is low so its output is high. If all AND gate inputs are high then the input to the NOT gate is high and its output is low. Therefore the output of a NAND gate is high unless all inputs are high, and then the output would be low. The output of a NAND gate is always the opposite of an AND gate if the inputs are identical.

A NOR or NOT/OR gate works in much the same way except that its output is the opposite of an OR gate. A NOT gate is added to the output of the OR gate turning the lows to highs and the highs to lows. A NOR gate's output will be high when both inputs are low, and its output will be low when one, or both, are high.

Exclusive Gates. Two more important gates are the exclusive OR and exclusive NOR gates. The exclusive OR gate has a low output when the inputs are either all high or all low. If one input is high and the other low then the output is high. An exclusive NOR gate, as you might have guessed, has a high output if the two inputs are the same and a low output if they are not the same. An exclusive OR or NOR gate can only have two inputs.

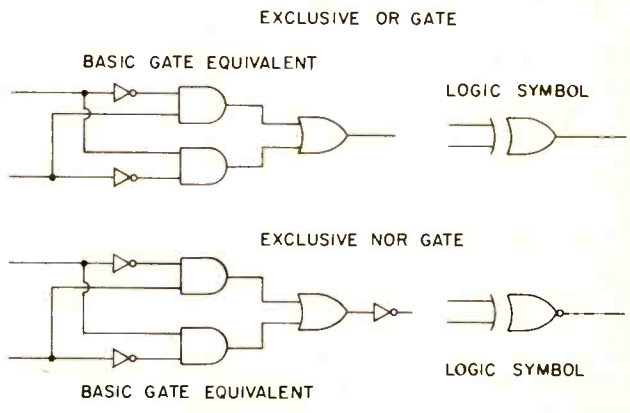
Making an exclusive OR gate is a little more tricky. It comprises two NOT gates, two AND gates and an OR gate. Study the diagram of this gate and see what happens. When both inputs are the same the two NOT gates cause each AND gate to receive a high and a low. They will, in turn, put a low on each input of the OR gate and its output will be low. Now, if we put different signals into the two inputs the NOT gates will criss-cross the signal levels so that one AND gate receives two lows and the other two highs. This will put a high on the OR gate's input and its output will also be high. To make this and exclusive NOR gate we just add a NOT gate to the final output.

Flip Flops. You now have a pretty-good understanding of how digital logic circuits work, but there is one more type of device that needs some explaining—the flip-flop. The best way to understand about flip flops is to think back to your childhood when you used to play a game called "Red Light—Green Light." One kid was "it" and the others could only sneak up on him when he turned his back and said "green light." If he said "red light," everyone had to freeze in whatever positions they were in before he turned around and stay that way until he gave another "green light." A flip flop works just like that. When the circuit gets the "red light" its output freezes at whatever level is on the input at that moment. An actual flip flop may have a few more frills but if you remember red light, green light you should have no problems with these handy devices.

To see how a flip flop works we have to put our collection of logic gates together in a more-complex fashion. There are actually two main sections in a flip flop, the gating network and the flip flop itself.

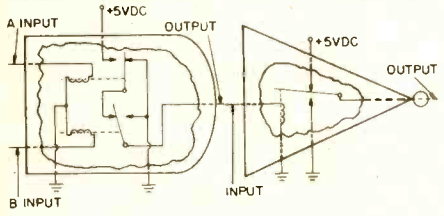
First, let's take a look at the gating network. There are two inputs—the data input and the latch (red light—green

Exclusive Gates are special combinations of logic gates. Use your knowledge of the three basic gates to see how the exclusive OR gate and exclusive NOR gate operates. First, see what happens when both inputs are low; then make A high and B low; then B high and A low; then try it with both A and B at a high level. See how the two gates are opposites.

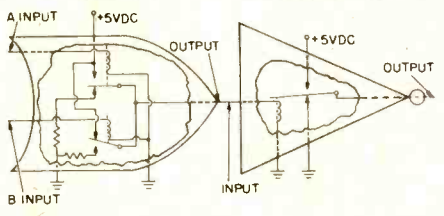


Digital Logic

light) input. Now, consider what happens under green-light conditions when the latch input is high. This input is connected to one input on each of 2, two-input AND gates. (Refer to the gating network diagrams). The data input is split into two lines, one goes straight into one AND gate and the other goes through a NOT gate to put the opposite signal on the other AND gate. These two inputs are referred to as D and $\overline{D}$ ("data bar" is how "$\overline{D}$" is said), D being the data and $\overline{D}$ being its opposite or compliment.

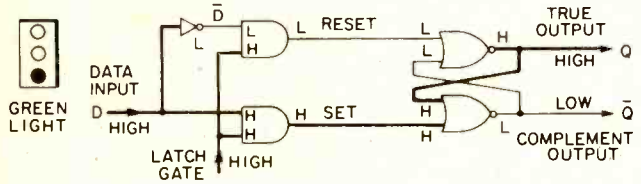


An AND gate in series with a NOT gate is a NAND gate. It is normally shown as an AND symbol with a circle to represent an inverted output. Trace out the current flow with different inputs.

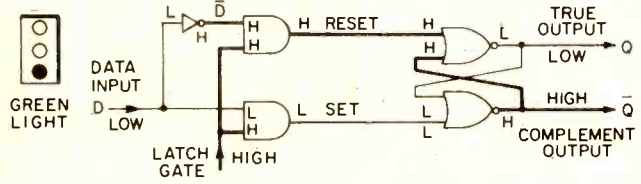


An NOR gate is an OR gate with its output inverted by a NOT gate. It is represented as an OR symbol with a small circle at the output. Again, trace out the circuit for all possible input combinations.

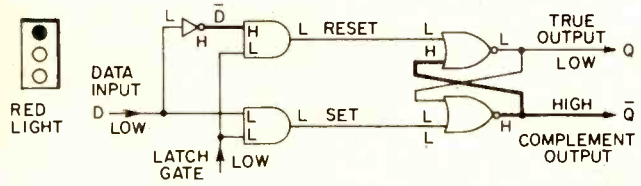
The heavy lines represent high voltage levels and the light lines represent low levels.



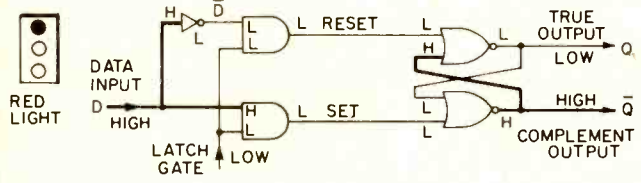
Under green - light (latch input high) conditions with a high data input, the set line is high and the reset low. The true output is high and it is fed back to reinforce the set line's data input.



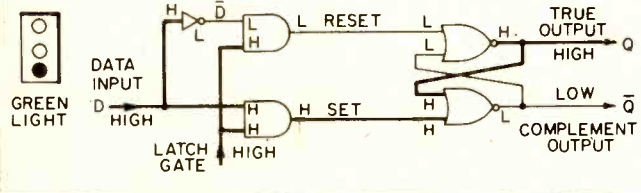
A low data input will toggle the set and reset lines to their opposite levels. Now the compliment output is high and it reinforces the reset line.



Changing the latch input to a low voltage level causes both AND gates to have a low output on set and reset. The compliment output, however, still keeps a high on the reset NOR gate and the true output is still low.



If the data input now toggles to a high value it will have no effect on either the true or the complimentary outputs. The flip flop is now latched tight.



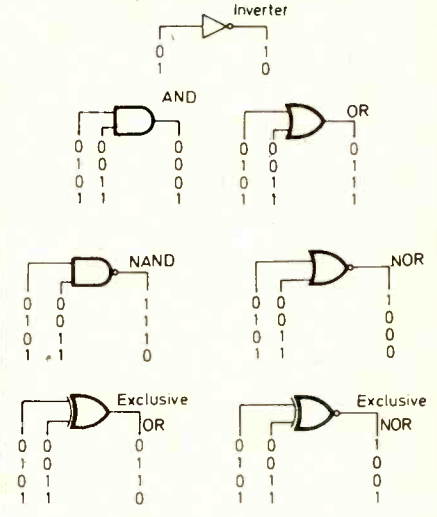
In this diagram we return the high voltage level to the latch input. The circuit is now free to toggle back and forth with the incoming signal.

The outputs of the AND gates are called set and reset. When D is high, set is high and reset is low. When D is low then reset will be high and set low. The levels on these two lines will toggle back and forth with the level of the input data.

The set and reset lines, known as S and R, feed into the two NOR gates that make up the flip flop section of the circuit. The second input of each NOR gate is fed by the output of the other NOR gate. As the levels on the S and R inputs change then so changes the output of the flip flop. Flip flop outputs are referred to as Q (the value equal to the true data input) and $\overline{Q}$ its compliment. Now, what happens when the light turns red?

Applying a low level to the latch input changes things around considerably. Both AND gates now have a low on one of their inputs. No matter what other signals they may receive, their outputs will both be low and therefore the R and S inputs to the flip flop will be low. If the flip flop is toggling back and forth, with the outputs alternately going high and low, when R and S both go low the toggling will stop. The outputs Q and $\overline{Q}$ will hold at the last value before the red light. If you study these diagrams for a few minutes then it will all become very clear.

Basic Logic Symbols



Above are all the elementary gates but this time we have used the common logic level indications of "0" for Low and "1" for High. This type of chart is called a truth table.

Once you have learned how all these different logical circuits operate you will be able to work out some more complicated arrangements, and perhaps even spend some time researching the differences between TTL, CMOS and all those other little digital details.

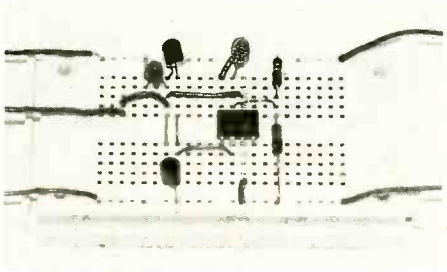
Building With ICs. While integrated circuits are basically composed of groups of transistors and other common electronic components, many of them require special handling techniques. Some types, especially CMOS, are susceptible to damage in the wierdest wavs.

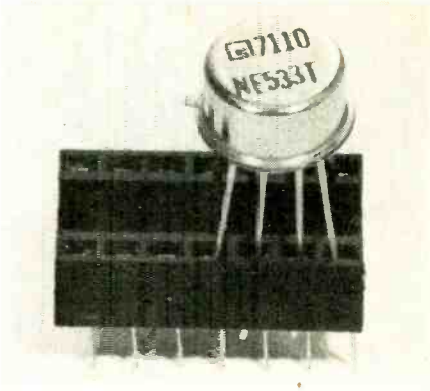
Even though almost all devices now are designed with resistor/diode protection circuits on the input leads, it is possible for the static electrical charge built up in your body to cause damage to parts of the IC. You'll never know it happened until it's too late, so it might be a good idea to invest in a pair of non-conductive tweezers, or a standard IC puller/installer made expressly for the purpose.

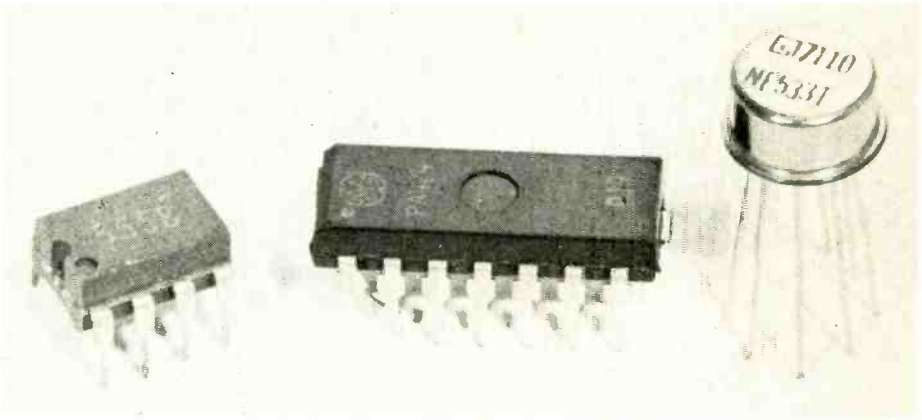
Soldering. If you solder the IC leads directly into the circuit, which we don't recommend, be sure to use a heat sink on the lead between the chip and the tip of soldering iron. Use a low power iron, and apply heat for the shortest period possible. A fried IC is no fun, and it doesn't even taste good. Always ground the tip of the iron before applying it to an IC. Stray AC in the tip can also damage a chip severely, and again, you'll never know until it's too late. Unless you're using commercially made breadboards, such as Continental Specialty Corp.'s "Experimentor"™ series, whose holes accommodate IC pin spacings to begin with, we suggest that you invest in sockets for the particular ICs which you're planning to use. Through the use of sockets, solder connections can be made without the danger of damage to the IC, and voltage and input signal tests can be performed without the IC being exposed to their hazards.

When debugging a circuit, or testing for signals and voltages prior to firing your project up for the first time, it is important that you remember to NEVER apply an input signal to a chip unless the circuit is powered up. Damage will certainly occur. Also, in those projects which require a separate input signal, such as a clock source, which is not an integrated part of the circuit you're building, it's a good idea to use a power switch which is capable of controlling the supply to both circuits. This will minimize the possibility of applying a signal to a non-powered chip, both in turning on the circuit and turning it off. If you find it inconvenient to utilize this method, you can literally tie a string around your finger to aid you, by tagging the signal source input line with a piece of brightly colored electrical tape, which hopefully will serve as a reminder. If you take care of your ICs, they will serve you very well. ■

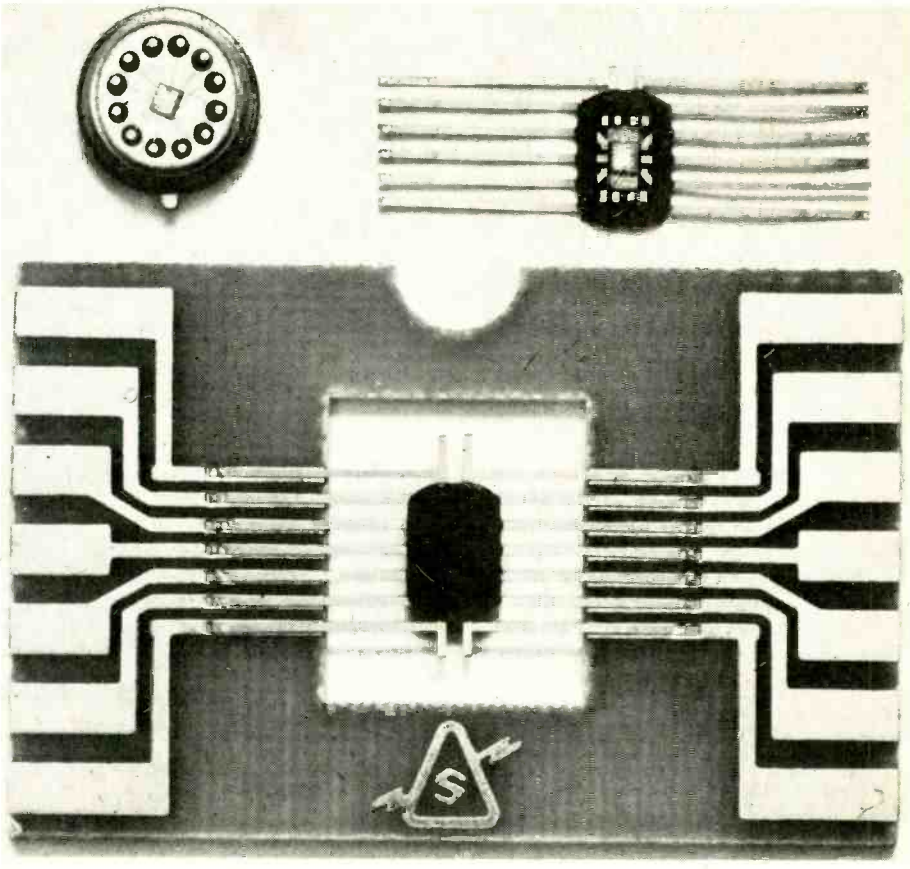
If you assemble your projects on breadboard, or as point-to-point, then use an IC socket. The best alternative is to use solderless breadboard, which holds an IC's pins.







The two types of intergrated circuit packages which you will encounter in building from 101 Electronic Projects are shown above. You only need one type of IC socket, however.



Shown here, several times magnified, are both an in-line IC package, and a radial type, with their innards exposed. ICs could be much smaller than they already are, if engineers didn't have to design using as parameters the elephantine proportions of the human hand.

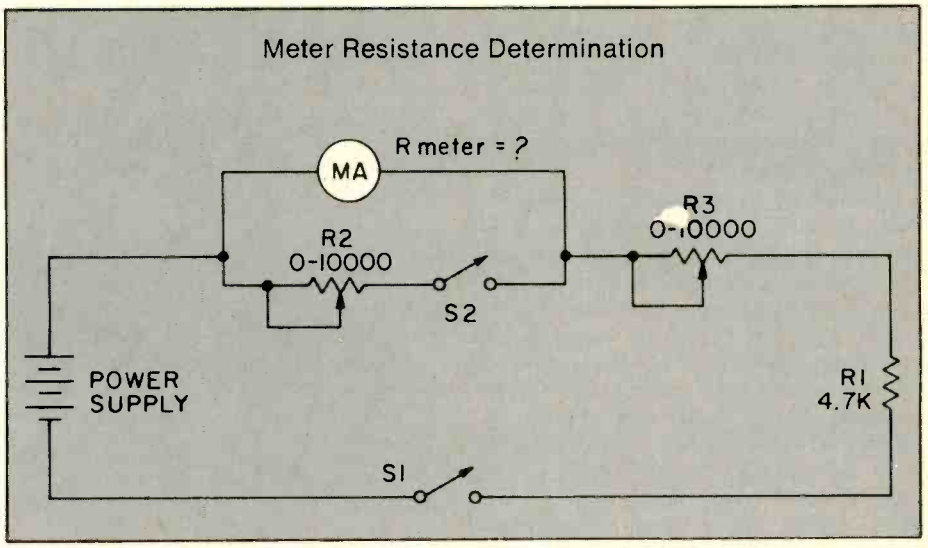
Keep up with current events by expanding your meter's amp-ability

HIGH-AMP METERS

by Jeff Jones

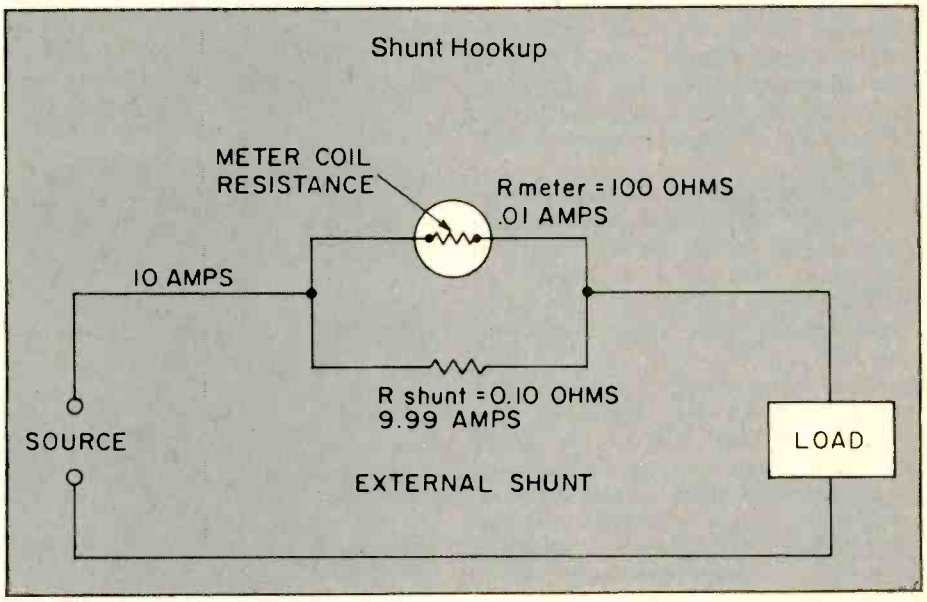
WITH THE RISING COST of test equipment it is advantageous to be able to perform several operations with one meter. For instance a DC milliammeter can be converted to read higher values of current by adding a shunt to bypass the bulk of the current around the delicate meter. By following a few simple 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.



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.



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. ■

CYCLOPS

Sleep for 1001 peaceful nights with this electronic genie standing faithful guard

by Anthony J. Caristi

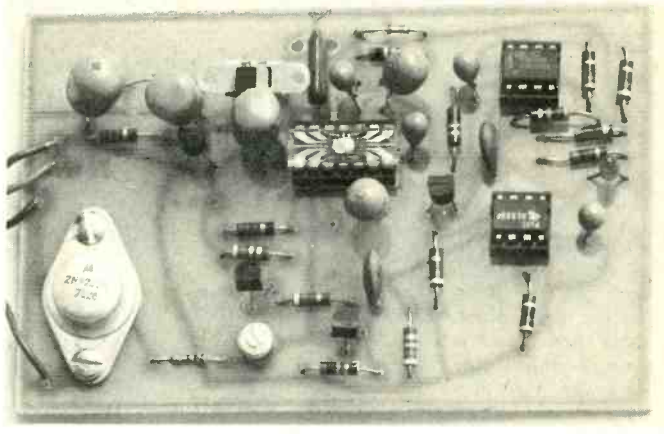
BUILD CYCLOPS. With his space age magic eye he will stand guard over your house or property and sound a musical alarm if an intrusion should occur. He does this without the use of any special light source by monitoring the ambient light intensity falling on his eye. Cyclops performs his guard duty with a very meager appetite for power, consuming only ½ watt while he is on duty. If an intrusion should occur, Cyclops responds by sounding an attention getting alarm, and automatically resets himself after a specified time delay selected by you.

You can also take advantage of Cyclops' unfailing eye by using him as an automatic doorbell. When someone approaches the door of your house and casts a shadow, the resulting change in light intensity falling upon Cyclops will cause him to sound a short and pleasant series of musical notes. You can extend his detection range by placing him in your driveway or garage to announce the arrival of an automobile at night, when he sees the headlights of a car.

Versatility. Cyclops is quite versatile and can be used for purposes other than an intrusion alarm or automatic doorbell. For example, you can construct an electronic rifle range by placing Cyclops' eye at the center of a bull's eye and shooting with a beam of light from a home-made ray gun. Each time the bull's eye is hit, a series of musical tones will sound. An electronic ray gun or rifle can be constructed by modifying a small flashlight which emits a narrow beam so that the light rays are concentrated. In order to produce a "shot," the circuit shown can be used. This will drive the light bulb from a charged capacitor and result in a pulse of light. Use a spring loaded SPDT switch.

Cyclops' built-in musical ability can be used as the basis for a "Close Encounters" sound generator accompanied by a flashing light, or you can even place Cyclops in your car and have an unique musical horn. This and all the other features of Cyclops can be performed by a single electronic assembly which can be constructed at low cost. Simple modifications of the circuit will permit you to use Cyclops for whatever purpose you desire.

About the Circuit. The eye and heart of Cyclops is a specialized integrated circuit which is the result of a marriage between a photodiode and a digital and linear circuit on a single chip. Such a device is called an Optolinear and is available to you from the source specified in the parts list for Cyclops. This is the 14-pin IC chip shown in the photograph of the Cyclops PC board.



The Optolinear IC chip is the eye of Cyclops. This nifty little package detects small changes in the ambient lighting conditions and triggers the alarm. You can use this handy device as a burglar alarm or as a household remote controller.

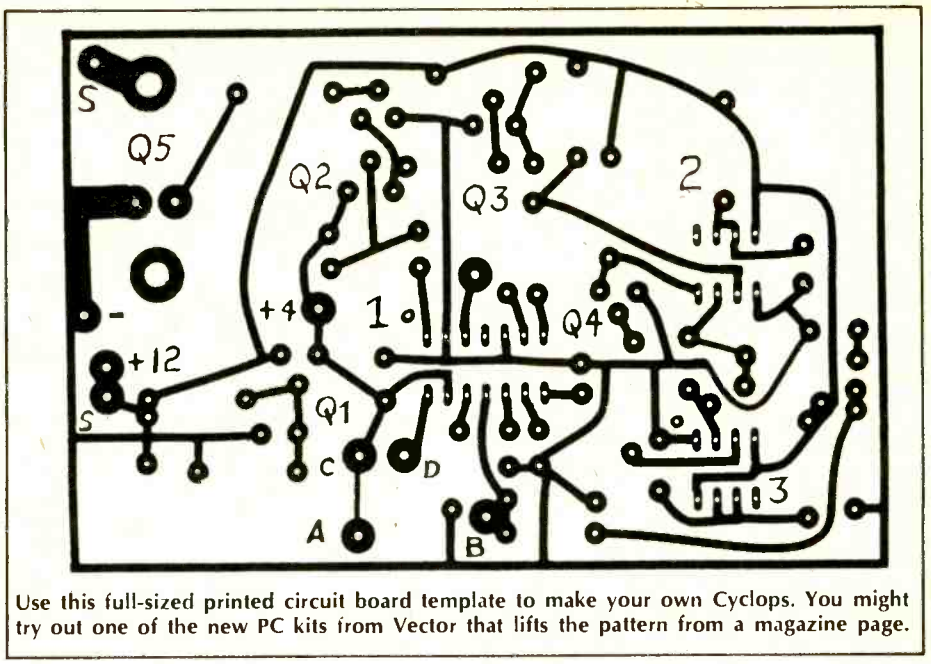
IC1 is an integrated circuit motion detector which monitors the ambient light intensity falling on the built-in photodiode. When a change in light intensity occurs, a circuit is triggered which produces a series of pulses of varying frequency in the audio range. A digital counter within the chip permits a specified number of pulses to be generated, and then resets the circuit back to a standby mode to await the next change in light intensity falling upon the photodiode. The series of audio pulses produced, when amplified and fed to a loudspeaker, is a simulation of the familiar whooping sound which is characteristic of some alarms. C4 determines the rate at which the circuit changes from one tone to the next, and can be changed to suit individual tastes. IC1 has an additional digital circuit which produces a second set of random musical tones which might be described as "Close Encounters" music. When the chip is in this mode of operation, it is also capable of flashing a 6 volt light bulb in time with the music.

Control of the operation of IC1 is accomplished by feeding a positive voltage to either or both control input terminals, pins 11 and 14. When terminals C and D of the printed circuit are connected together and terminals A and B are open, the circuit is set to perform as an intrusion alarm. Opening the circuit between terminals C and D, and A and B, programs the circuit for "Close Encounters" music. Automatic control of terminals A and B of the circuit is provided by IC2 and IC3, and manual control of terminals C and D is provided by a single pole silde switch mounted directly on the printed circuit board.

CYCLOPS

Power to drive a loudspeaker is provided by Q2 and Q5 which amplify the low voltage output pulses of IC1 and deliver peak currents of up to 1 ampere into the speaker. When IC1 is in standby mode, the voltage at the output terminal, pin 1, is about 4 volts. This cuts off both Q2 and Q5 so that current in the loudspeaker is zero. When IC1 is activated, Q2 conducts current and provides base drive to Q5 through R3 which acts as a volume control. When the circuit is set for maximum volume, Q5 acts as a switching transistor, driving the loudspeaker with pulses of about 12 volts. The circuit will drive loudspeakers of any impedance. Greatest volume will be obtained with a 3.2 ohm speaker, since this will draw the highest load current from Q5. Peak power delivered to a 3.2 ohm speaker can be as high as 40 watts when the volume control is set to maximum. Average power will be much less than this since the circuit delivers pulses with a duty cycle of less than 50%.

Construction. Cyclops can be constucted on a single sided printed circuit board measuring 2⅞ by 4¼ inches. This includes all the necessary circuitry with the exception of the 12 volt power source. If an AC operated power supply is desired, it can be added to the circuit at the option of the builder. A typical power supply circuit is shown with the schematic on the next page.

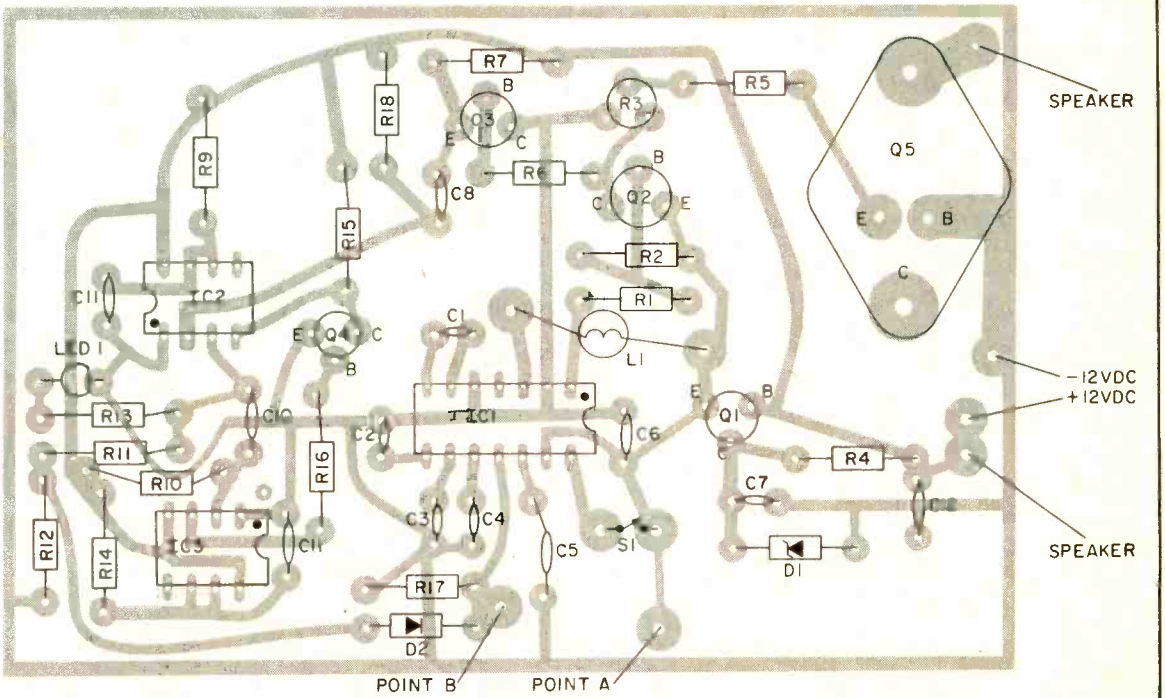


Use this full-sized printed circuit board template to make your own Cyclops. You might try out one of the new PC kits from Vector that lifts the pattern from a magazine page.

The printed circuit layout in this article is shown full size as seen from the copper side of the printed circuit board. The component layout is also shown. If possible, make photocopies of the printed circuit, component layout, and schematic diagram and work from these copies. This will avoid wear and tear on the originals which you will want to keep in good condition for future reference.

After etching the printed circuit, go over it with a magnifying glass to pick up any shorts or opens which may exist. This will help avoid problems when the circuit is first placed in operation. For a slight additional cost, it is strongly recommended that sockets be used for the integrated circuits. Their value in a printed circuit assembly cannot be overemphasized. The use of sockets give you the ability to troubleshoot the circuit, should a problem exist, in much less time than if the IC's were soldered in place. It is extremely difficult to remove a multi-pin IC which has been soldered into a printed circuit without destroying the IC or printed circuit. Do not mount the integrated

This parts location diagram will help you get everything in the right place. This view is of the component side with the parts facing up. The foil PC pattern is on the underside. Building this project is a snap even if you are a beginner.



circuits until instructed to do so in the checkout procedure.

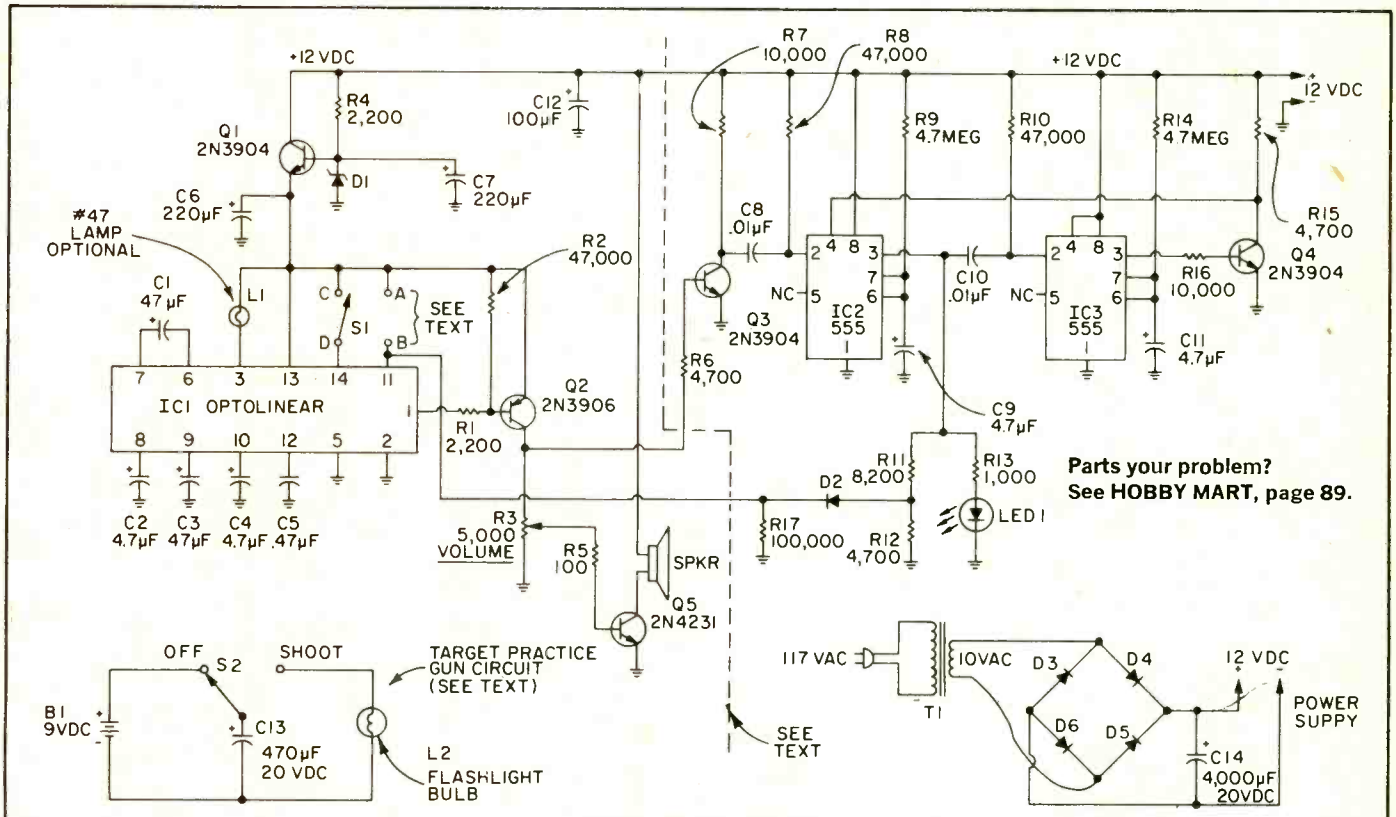
The component layout shows control switch S1 and volume control R3 mounted directly to the printed circuit board. You may want to mount the printed circuit board in a small cabinet with these components accessible from the outside. If you are going to use the lamp with the circuit, be sure to place it so that its light will not fall upon IC1. Should this happen, the additional feedback signal from the lamp may cause a circuit malfunction, although no damage will occur.

You will note that the power output transistor, Q5, is mounted to the printed circuit board with no heat sink. None is required since this transistor operates as a switch at high current levels, and therefore dissipates very little heat. Mount Q5 to the printed circuit board with two 4-40 screws and nuts. Make them tight but not overtight.

Checkout Procedure. The printed circuit assembly should be checked with power applied before installing any of the integrated circuits in place. This will avoid damaged components in the event of possible short circuits or miswiring. Apply 12 VDC power to the circuit using a battery or AC operated power supply, observing correct polarity. Measure the voltage at pin 13 of IC1 using the negative side of the DC power supply as the meter reference. This should be between +3.5 and +4.5 volts DC. If the voltage is not within this range, check zener diode D1 for a voltage drop of 4.2 to 5.2 volts. Check also that D1 is mounted

(Continued on page 120)

If Cyclops really appeals to you as a useful gadget, but you don't have the time or experience to put it together, then you might consider ordering Delta Electronics' Motion Detector. It uses the same IC as Cyclops. It sells for $24.50 in kit form or $69.50 fully assembled with NiCad batteries and charger. Delta's address is in the parts list of this article.



Parts your problem? See HOBBY MART, page 89.

PARTS LIST FOR CYCLOPS

B1—9-volt battery
C1, C3—47-uF electrolytic capacitor, 10 VDC
C2, C4—4.7-uF electrolytic capacitor, 10 VDC
C5—0.47-uF ceramic disc capacitor, 10 VDC
C6, C7—220-uF electrolytic capacitor, 20 VDC
C8, C10—0.01-uF ceramic capacitor, 10 VDC
C9, C11—4.7-uF electrolytic capacitor, 20 VDC
C12—100-uF electrolytic capacitor, 20 VDC
C13—470-uF electrolytic capacitor, 20 VDC
C14—4,000-uF electrolytic capacitor, 20 VDC
D1—1N5230 4.7 volt zener diode
D2—1N4148 silicon diode
D3, D4, D5, D6—1N2069 silicon diode
IC1—Optolinear IC (see text for explanation)
IC2—555 timer
IC3—555 timer
L1—#47 lamp
L2—flashlight bulb
LED1—light emitting diode
Q1, Q3, Q4—2N3904 NPN silicon transistor
Q2—2N3906 PNP silicon transistor
Q5—2N4231 NPN silicon transistor
R1, R4—2,200-ohm, ¼-watt resistor
R2, R8, R10—47,000-ohm, ¼-watt resistor
R3—5,000-ohm trimmer potentiometer (PC board mounting type)
R5—100-ohm, ¼-watt resistor
R6, R12, R15—4,700-ohm, ¼-watt resistor
R7, R16—10,000-ohm, ¼-watt resistor
R9, R14—4,700,00-ohm, ¼-watt resistor
R11—8,200-ohm, ¼-watt resistor
R13—1,000-ohm, ¼-watt resistor
R17—100,000-ohm, ¼-watt resistor
SPKR—3.2-ohm PM type speaker
S1—SPST miniature slide switch
S2—SPDT momentary-on switch
T1—10-volt, 1.2 amp transformer
Misc.—large plastic cabinet (8 in. by 4 in. by 4 in.) screws, spacers, wire, AC plug and zip cord, etc.

Note: IC1 is available from:
Delta Electronics
7 Oakland St.
P.O. Box 2
Amesbury, Mass. 01913
Catalog #1072W
Price: $8.95

BATTERY MONITOR & CELL CONDITION TESTER

by Charles Green

Electro-chemical action guards against replacement costs.

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.

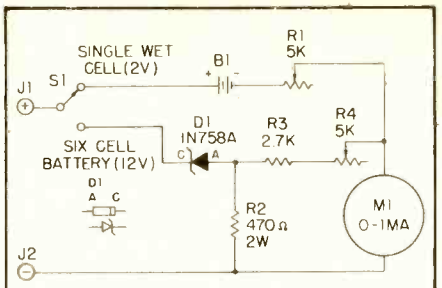
Tester Circuit. When S1 is set to the "single wet cell" position and voltage is at J1 and J2 (from the test leads), M1 will indicate only when the test voltage at J1 and J2 is higher in value than 1.4-volt battery B1. For example, if the test voltage is 1 volt (positive polarity at J1 and negative polarity 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

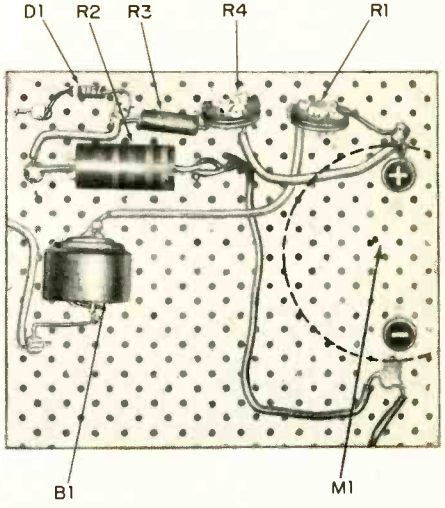


PARTS LIST FOR BATTERY MONITOR & CELL CONDITION TESTER

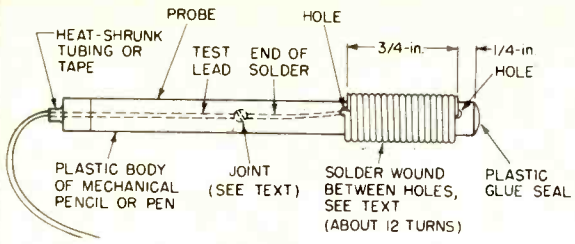
B1—1.4-volt mercury cell, Eveready E640
D1—10-volt, ½-watt zener diode (1N758A or HEP Z0220 or equiv.)
J1, J2—binding posts; red, black
M1—1-mA DC meter
R1, R4—5,000-ohm miniature potentiometer
R2—470-ohm, 2-watt resistor
R3—2,700-ohm, ½-watt resistor
S1—spdt rotary or toggle switch
Misc.—plastic chassis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

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.

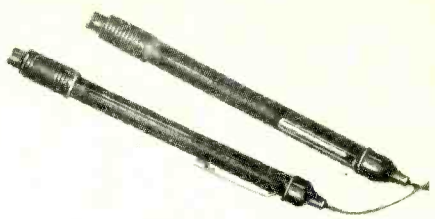
Mount the board components with push-in clips at the approximate locations shown in the board photo. Use short leads for best mechanical rigidity, and wire as shown in the schematic. Make sure that D1 and B1 are connected with the proper polarities as



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.

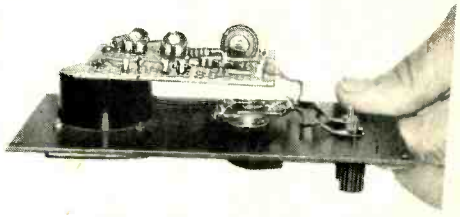
Drill two holes spaced ¾-in. apart approximately ¼-in. from the end of each pencil body, and wrap wire solder between the holes as shown. Insert the ends of the wire solder into the holes to hold the turns in place. The end of the wire solder in the hole toward the other end of the pencil body (the former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

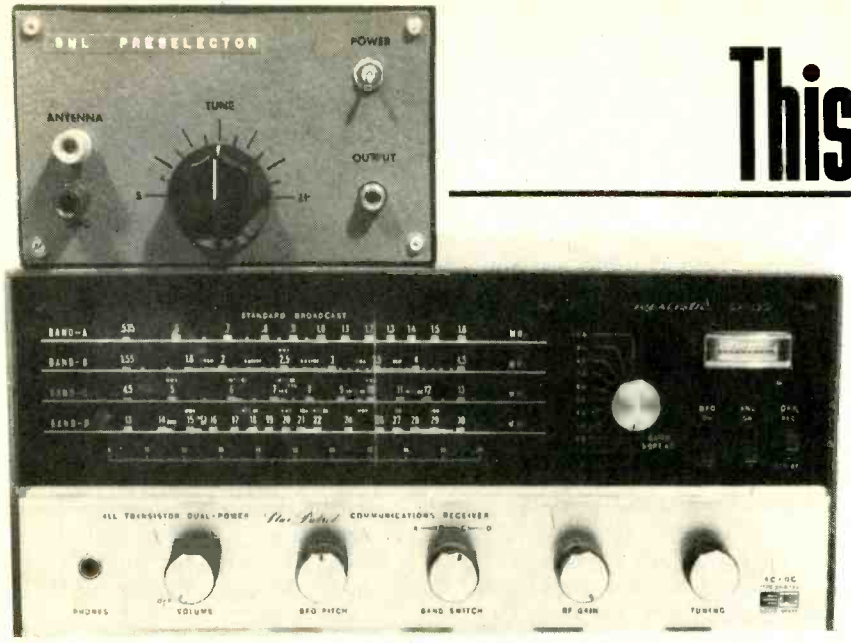
Operation. Automobile storage batteries consist of a number of 2-volt cells connected in series—three cells for a 6-volt battery and six cells for a 12-volt battery. As shown in the drawing, the tester probes are inserted into the electrolytic filler holes of a pair of *adjacent* (series-connected) cells 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. ■



This Piggyback SWL

Add 20 dB of valuable signal-grabbing power

by Herb Friedman W2ZLF

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

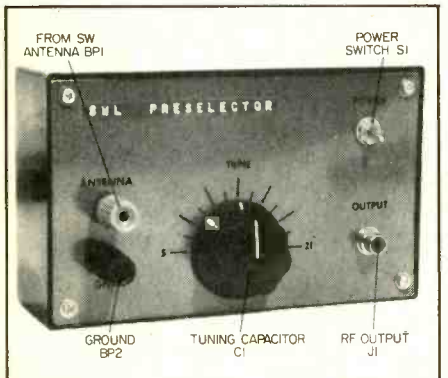
Unfortunately, preselectors have so much gain and sensitivity they had to be built like the Rock of Gibraltar in a cabinet almost as large as the rock itself in order to avoid self-oscillation. Many preselectors were as large as the boat anchors we used to call receivers, so like those old tube-type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

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

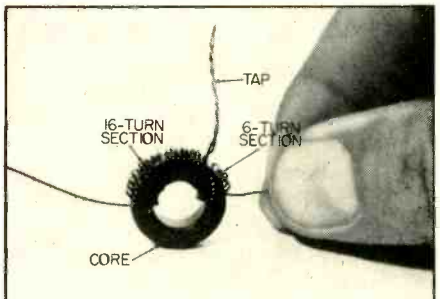
The Design. Input coil L1 is home-brewed on a toroid form. Since toroids have exceptionally high Q the input tuning is razor sharp—sharp enough to attenuate the image frequencies. In fact, if this unit is tuned to 10 MHz while the receiver is tuned to 20 MHz virtually no signal will pass through the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

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

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



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



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

Preselector Will Make You a Pro in One Evening

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

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

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

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

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

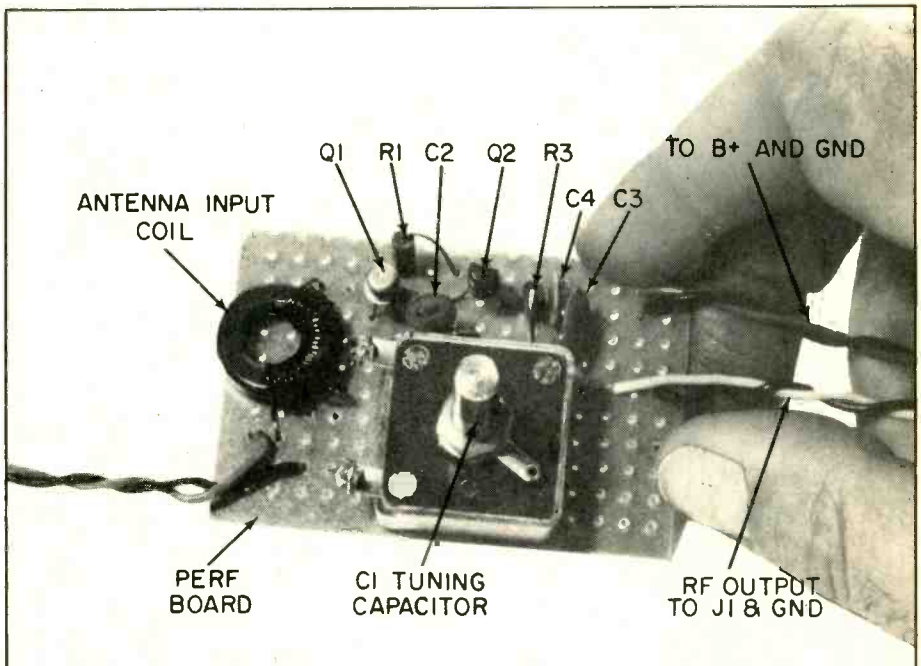
Mark off the approximate location of the tuning capacitor on the circuit board and then complete the board assembly, including the power, input and output wires. These can be about six inches long.

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

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

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

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



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

PIGGYBACK SWL PRESELECTOR

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

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

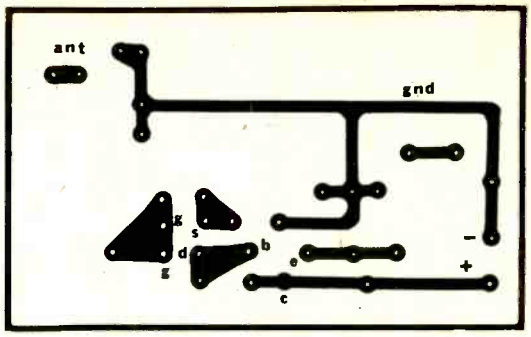
Final Connections. Use some kind of coaxial output connector for J1. Even a standard phono jack can be used. Use coaxial cable such as RG-58 or RG-59 between the preselector and receiver and keep it as short as possible.

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

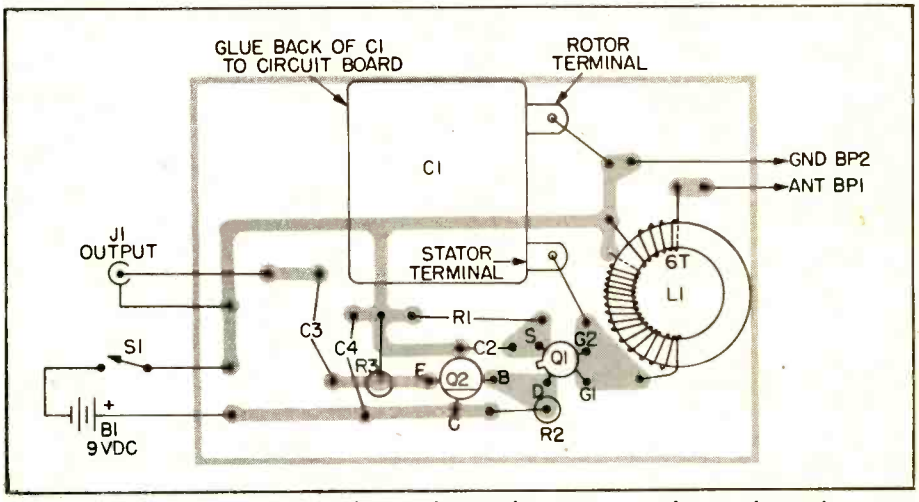
Calibrate! The tuning is so sharp the preselector must be tuned near the desired frequency or you might not hear anything at all in the receiver. Use whatever calibrations on the panel you find necessary to put the preselector tuning inside the ballpark.

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

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



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



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

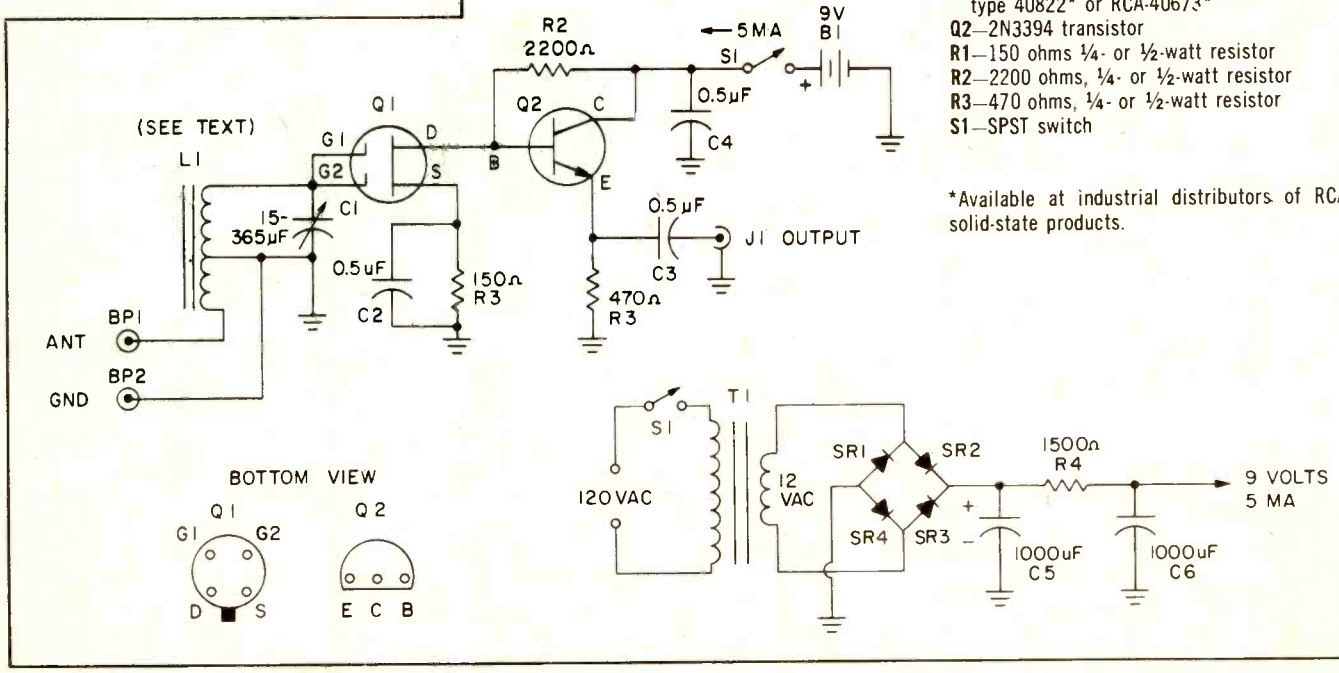
PARTS LIST FOR PRESELECTOR POWER SUPPLY

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

PARTS LIST FOR SWL PRESELECTOR

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

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



The Fine Art of Buying Electronic Parts

by Walter Sikonowiz

An inflation fighter's guide to buying components

ASK A GROUP of electronics enthusiasts what the single most difficult part of project building is, and more often than not the reply will be, "Buying the #$%&* parts." Such an attitude is not unwarranted because, try as you may, you will never find one distributor capable of supplying all the parts you need. Even so, there is no reason for the incredible amount of difficulty experienced by some people.

If you're planning to build a particular group of circuits from 101 Electronics Projects, you may do well to plan in advance, and only have to make one or two parts orders by mail, or the same number of trips to the local parts stores. Buying in larger groups can also cut costs, becaues some houses give discounts for purchases of the same part in excess of five pieces. Your savings can really add up if you exercise some prudence in shopping.

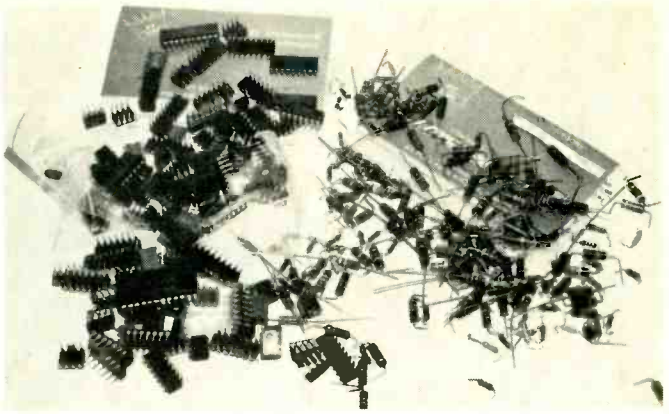
The Big Four. You start by collecting catalogs; the more the better. Ten will get you by, but twenty is not too large a figure. Begin with the Big 4: Burstein-Applebee (3199 Mercier St., Kansas City, Missouri, 64111), Radio Shack (everywhere), Allied (401 E. 8th St., Fort Worth, Texas, 76102), and Lafayette Electronics (PO Box 428, Syosset, New York, 11791). These are the general practitioners of electronics; they dispense a little of everything.

The Specialists. Once Ohm's Syndrome takes hold, however, and your sales resistance rises in the face of inflation (and limited selection), it's time to see a specialist. This might be any one of several firms selling certain products, such as integrated circuits, and little else. Because of specialization, these companies can afford to have very complete inventories of selected merchandise. Furthermore, although you might expect a specialist to slap you with a fat fee, in most cases just the opposite will happen; you'll save money.

Who are these specialists? They are the mail-order businesses that advertise in the back pages of ELEMENTARY ELECTRONICS (as well as other publications). Some of these companies restrict themselves to new merchandise, which they sell at very agreeable rates because of low overhead. Others sell only surplus, that is, unused components obtained from manufacturers willing to sacrifice some inventory for ready cash. A component's appearance on the surplus market can be caused by a multitude of economic factors which are unfortunate for the manufacturer, but a windfall for you, the buyer.

New or Surplus? How can you tell whether merchandise is brand new or unused surplus? In many instances, the catalog will tell you. If not, there is one sure indication: If the merchandise is being sold for a fraction of the retail price you would expect to pay, it's surplus. Three firms that deal exclusively in surplus are Delta Electronics (PO Box 2, 7 Oakland St., Amesbury, Massachusetts, 01913), B&F Enterprises (119 Foster St., Peabody, Massachusetts, 01960), and John Meshna

Parts



You can buy bulk components at next-to-nothing prices if you buy untested, surplus parts. Poly Paks is a popular bulk supplier and two of their packs are shown here. Most of the parts are useable.

Inc. (PO Box 62, E. Lynn, Massachusetts, 01904). Others, like Poly Paks (PO Box 942, South Lynnfield, Mass., 01940), or Herbach & Rademan (401 E. Erie Ave., Philadelphia, Penn., 19134), offer a mixture of surplus and brand new stock. Regardless of whether the merchandise is new or surplus, all firms offer some guarantee of satisfaction.

In order to get better acquainted with the various suppliers, let's survey the market item-by-item. In the following paragraphs, whenever a specific company is mentioned in connection with a component, it is only because that firm is particularly strong in a certain area. Some degree of overlapping does exist among all firms, however, so don't assume that any one supplier is being recommended to the exclusion of all others.

Integrated Circuits. Although human life is based on the chemistry of carbon, it is the chemistry of silicon that now forms the basis for our business and industry, thanks to the integrated circuit. Because of their tremendous importance, integrated circuits are sold by almost every electronics supplier, big or small. You'll find that the Big 4 have quite respectable IC inventories, but prices are relatively high, and selection is not complete. Jameco Electronics (1021 Howard St., San Carlos, Calif., 94070), and Ancrona Corp. (PO Box 2208, Culver City, Calif., 90230) feature perhaps the widest selections of ICs; linear, TTL, CMOS, DTL, ECL, LSI and so forth. Jade Computer Products also offers a good selection of ICs in their catalog.

Circuit Specialists (PO Box 3047, Scottsdale, Ariz., 85257) is a nice company to do business with, since they require no minimum-size order. In addition to a wide range of the standard ICs, Circuit Specialists carries special numbers from RCA, Motorola, and Mostek. Digi-Key (PO Box 677, Thief River Falls, Minn., 56701) also features a wide assortment, including some circuits difficult to find elsewhere. Last, but not least, there is Solid State Sales (PO Box 74A, Somerville, Mass., 02143). Although this company's selection may be a trifle smaller than some, its service is like the fabled "greased lightning."

Occasionally, you are going to receive a dud. When this happens, it's best not to go berserk. A calm request for a replacement is usually accommodated very quickly. After all, these companies want your continued business in the future. As a precautionary measure, you might consider ordering two of each IC. The chances of getting one dud are so small that the probability of receiving two duds simultaneously is infinitesimal. You can use the extra IC, if it is good, in a future project.

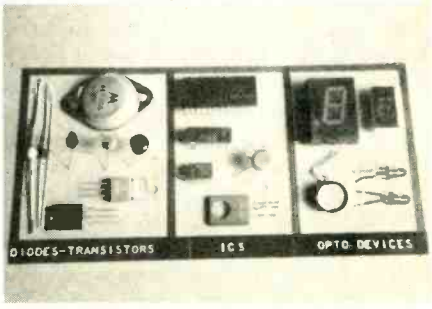
Occasionally, the inevitable happens, and you will find yourself with an inoperative circuit. If you have any reason to suspect the IC as the culprit, either from poor handling technique, or from having eliminated any other possible causes, a spare IC will cure many late-night headaches caused by projects that have no good reason *not* to work. Try the new IC before you burn the schematic!

Discrete Semiconductors. This category is an exceptionally broad one. Included are: bipolar transistors, FETs, SCRs, diodes, UJTs and so on. As in the case of ICs, almost everyone sells some discrete semiconductors, but few vendors stock each part number. Before giving up an elusive part, try either Hanifin Electronics (PO Box 188, Philadelphia, Penn., 19405), or the Ancrona Corp. These two firms have perhaps the most extensive listings of discretes.

Most suppliers offer special discounts to encourage volume buying of parts. This appeals directly to the squirrelish instincts of the electronics hobbyist, but be careful. Just like that greedy little tree-dweller, you will probably horde more than you can ever use. If you must stockpile parts, do it sensibly. Choose those discrete components that are most frequently used: 2N3906 PNPs, 2N3904 NPNs, 1N914 switching diodes, 1N4003 rectifiers and so forth. Avoid the high-wattage zener diodes now appearing in surplus. Today, integrated circuits have supplanted zeners as regulators at all but the lowest power levels.

Resistors. Buying from one of the larger retailers, you can expect to pay around 10 cents a piece for carbon-composition resistors. Compare that with the typical 4-cent selling price from the specialist firms, and the choice of a supplier is obvious. Resistors are one class of component that can be sensibly stockpiled. Buy half-watters with a 5% tolerance. They cost only a bit more than 10% resistors

Since a great many people have trouble remembering the color code, a useful aid to sorting surplus resistors is an old tie box with the color code marked inside the lid.



Try to build up a supply of transistors, diodes, ICs and electro-optical devices.

ADDRESSES OF PARTS SUPPLIERS:

Ace Electronics
5400 Mitchelldale
Houston, TX 77092

Active Electronics Sales Corp.
12 Merser Rd., Natick, MA 01701

ALdelco, 228 E. Babylon Tpk.
Merrick, N.Y. 11566

Allied Electronics, 401 E. 8th St.
Fort Worth, TX 76102

Ancrona Corp., P.O. Box 2208
Culver City, CA 90230

B&F Enterprises, 119 Foster St.
Peabody, MA 01960

Bullet Electronics, P.O. Box 1944
Dallas, TX 75219

Burstein-Applebee, 3199 Merceir St.
Kansas City, MO 64111

Chaney Electronics, P.O. Box 27038
Denver, CO 80227

Circuit Specialists, P.O. Box 3047
Scottsdale, AZ 85257

Delta Electronics, P.O. Box 2
7 Oakland St., Amesbury, MA 01913

Diamondback Electronics Co.
P.O. Box 194, Spring Valley, IL 61362

Digi-Key, P.O. Box 677
Theif River Falls, MN 56701

Digital Research Corp.
P.O. Box 401247B, Garland, TX 75010

Electronics Distributors, Inc.
4900 N. Elston
Chicago, IL 60630

ETCO Electronics, 521 Fifth Ave.
New York, NY 10017

Formula International, Inc.
12603 Crenshaw Blvd.
Hawthorne, CA 90250

Fuji-Svea, P.O. Box 3375
Torrance, CA 90510

Herbach and Rademan, 401 E. Erie Ave.
Philadelphia, PA 19134

HobbyWorld, 19355 Business
Center Dr., Northridge, CA 19324

Integrated Electronics
540 Weddell Dr., Sunnyvale, CA 94086

International Electronics Unlimited
Village Square P.O. Box 449
Carmel Valley, CA 93924

Jade Computer Products
5351 W. 144th St.
Lawndale, CA 90260

Jameco Electronics, 1021 Howard St.
San Carlos, CA 94070

John Meshna, Inc., P.O. Box 62
East Lynn, MA 01904

Lafayette Electronics, P.O. Box 428
Syosset, NY 11791

Mouser Electronics,
11511 Woodside Ave.
Lakeside, CA 92040

New Tone Electronics, P.O. Box 1738
Bloomfield, NJ 07003

Olson Electronics
260 S. Forge St.
Akron, OH 44327

Optoelectronics
5821 N.E. 14th Avenue
Fort Lauderdale, FL 33334

Poly Paks, P.O. Box 942
South Lynnfield, MA 01904

Quest, P.O. Box 4430
Santa Clara, CA 95054

Radio Hut
P.O. Box 401247
Dallas, TX 75238

Ramsey Electronics
Box 4072
Rochester, NY 14610

Radio Shack, Consult your local phone book

Signal Transformer Co.,
500 Bayview Ave.
Inwood, NY 11696

Solid State Sales, P.O. Box 74A
Somerville, MA 02143

Steven Products, P.O. Box 698
Melville, NY 11746

Surplus Electronics Corp.
7294 N.W. 54th St., Miami, FL 33166

and save you the trouble of stocking two tolerances.

All the circuits in 101 Electronics Projects can use resistors with a tolerance of 10%, unless specifically noted otherwise in the parts lists.

Power resistors, with ratings from 5 to 100 watts, are available from the surplus dealers at incredible prices. Buy a small assortment. Power supplies and audio amps often need dummy loads during checkout, and for such purposes these high-power resistors are ideal. If you do not have exactly the right resistance at hand, use serial and parallel combinations whose net resistance is the desired value.

Don't forget those high-class resistors, the metal-film precision units with tolerances of 1% or better. You can get these from the larger retailers, but at 60 cents to one dollar apiece (often with a ten-piece minimum order) who needs them? Actually, for certain ultrastable or low-noise circuits, precision resistors are mandatory. Active filters, accurate voltage dividers, and analog-computer circuits are but a few examples. When you really need precision resistors, Hanifin Electronics can supply them at about 15 cents each. But because Hanifin is an industrial supplier, do not send in a 75¢ order; fifteen dollars worth is a realistic minimum. Since Hanifin offers lots of goodies besides resistors, you should have no trouble putting together a good-sized order.

Capacitors. The best all-around capacitor that money can buy is the polystyrene type. It also happens to be one of the cheapest, a fortunate coincidence. Polystyrenes are available in the range from 5 pF to 0.5-uF, but above .01-uF, they begin to get bulky and expensive. Your best and most complete sources for these capacitors are Burstein-Applebee and Allied (addresses supplied previously). Standard tolerances are 5% (super for a capacitor), with 2.5% and 1% available at higher prices.

In the range from 0.01-uF to 1-uF, you are best off with mylar (polyester) capacitors. (Mylars are available outside this range, too.) Standard tolerances are 20% and 10%. A great many firms carry mylar capacitors.

Above 1-uF, most capacitors are aluminum electrolytics, which are polarized devices. One of their most important functions is filtering, particularly in AC power supplies. Tolerances tend to be relatively loose since applications rarely call for very precise electrolytic capacitors. Capacitances as high as 40,000-uF and beyond are available.

The aluminum electrolytic has a more sophisticated cousin, the tantalum capacitor, which is commonly available in capacitances as high as several hundred microfarads. Relative to the aluminum electrolytic, the tantalum features tighter tolerances (10% typically), lower leakage, and smaller size for equivalent capacitance. As a result, tantalums are preferred over aluminum electrolytics in timing applications. Both electrolytic types are stocked by many distributors.

Surplus capacitors are available, with perhaps the best source being Poly Paks (see above), at least in terms of variety. If you do buy surplus capacitors, play it safe and check each one on a capacitance meter. Ceramic bypass capacitors for digital logic are available very cheaply as surplus, and so too are mylars. On the other hand,

Parts

be very cautious when buying surplus aluminum electrolytic capacitors. They have a limited shelf life, and once they dry out, they are useless. Most dealers are scrupulous enough not to do this to you, but you can end up with a relic of the 1950's that looks more like an artillery shell than a capacitor. Choose carefully.

Potentiometers. New pots cost about the same no matter where you buy them. Imported units may sell for less, but cheap materials yield an inferior device, one that is often difficult to turn because of high-friction bearings. While imports are excellent for experimenting, it always pays in the long run to use top-quality pots in your projects.

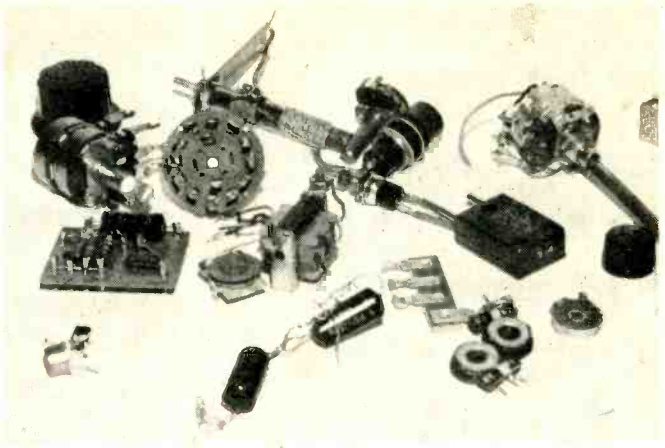
Surplus pots can save you a lot of money, but read the fine print closely. Pay attention to shaft length. Some units are intended for screwdriver adjustment and have short, slotted shafts which cannot accept a knob. In addition, watch out for strange tapers, such as "reverse logarithmic." Pots specified as having either "linear" or "audio" tapers are the ones most usually called for in projects.

You will find that only linear and audio taper potentiometers are called for in the circuits described in 101 Electronics Projects.

For some reason, wirewound pots seem to abound in surplus. These are fine for low-frequency work, often at high power. But wirewounds have poor resolution and should never be used in a circuit where very precise adjustments must be made. For the bulk of your experimenting, standard carbon-composition pots are your best choice.

Slide pots are a great convenience in audio work, especially if you are building a mixer or music synthesizer. Many outlets carry them, but most units have too short a path of travel (1¼ inches) to be really useful. Slide pots with twice the adjustment range are preferable, and they can be purchased at reasonable cost from Mouser Electronics (11511 Woodside Ave., Lakeside, Calif., 92040).

Relays. These may well share the fate of the dodo, thanks to fast and reliable solid-state switchers like triacs, SCRs and transistors. Industrial control systems that once bristled with relays and cam-actuated microswitches now rely on digital logic and thyristors. Even Ma Bell, at one time the patron saint of relay manufacturers, now uses electronic switching to route calls. The result of all this phasing-out is a surplus market chock full of relays at bargain prices.



The best way to build up your parts inventory is to salvage useable components from junked pieces of electronics gear. Transformers, switches, potentiometers, crystals and coils are always handy to have.

Despite the decline in its commercial popularity, the relay still possesses some admirable qualities, such as excellent driver/load isolation and minimal temperature sensitivity. Furthermore, it happens to be one of the easiest devices for the beginner to understand and use. All things considered, it makes sense to take advantage of the surplus bargains now, while they last.

Power Transformers. Here is another item carried by almost every supplier, but inventories are generally limited in scope. When your application demands just the right transformer, it pays to be able to order directly from the manufacturer. Signal Transformer Co. (500 Bayview Ave., Inwood, N.Y., 11696) offers a wide array of transformers, from tiny, PC-mount devices to mammoth, kilowatt isolation transformers. Other makers also offer diverse selections, but some may not encourage direct mail ordering.

Undoubtedly the most economical way of securing a transformer is through a surplus dealer like Delta. Many kinds of transformers end up as surplus, and with just a little luck you can find one to suit your purposes. Discounts greater than 75% off list are common, so the money you save may be substantial. This is especially true if you are planning to construct something big such as a high-powered audio amplifier. Transformers from some of the best amps ever to shake a loudspeaker end up as surplus, victims of design changes and competition.

PC Supplies. There is no surplus material worth mentioning in this category, so let's focus on new merchandise. The simplest PC methods involve placement of a pattern directly on copper-clad board. These are fine in the beginning, but for serious experimenters, photographic techniques are a must. Not only do photographic methods yield neater copper traces and a greater density of components on your board, they also allow any number of boards to be produced from a single piece of artwork.

Photographic PC processing can best be learned from one of the kits offered by various manufacturers. You do not need expensive equipment like a camera or enlarger. All necessary materials and instructions come in the kit. These PC kits may employ either negative or positive photographic processes, which differ from one another principally in the method used to prepare a board's artwork. Positive methods are perhaps easier for a beginner to visualize, but negative kits seem to be equally popular. Most suppliers carry at least one brand of PC kit, if not more. Choose one that fits your needs and budget. You'll find the professional-looking results to be well worth the extra effort.

Although only the tip of the iceberg has been exposed here, you should have a pretty good idea of how to find supplies by now. To obtain copies of the catalogs you want, write directly to the companies mentioned in the text. Note that our coverage has been by no means exhaustive. Undoubtedly other worthwhile catalogs are available, so hunt carefully through the back pages, too. Remember, all companies stock much more merchandise than they can economically include in a single magazine advertisement.

Now that you have a good idea on how to purchase the parts you'll need for 101 Electronics Projects, make a checklist of the projects which most appeal to your needs, and compile a master parts list. As you do this, you will see that we have attempted to use as many of the same parts values throughout the magazine as we possibly could have. This should not only make your shopping easier and less costly, but also help to round out your parts box with some of the most commonly called-for components. ■

SUPER BCB Booster

Make any broadcast receiver a DX star with this sharp-tuning preamp.

IMAGINE YOUR BROADCAST BAND RECEIVER jammed from end to end with a solid wall of signals! Flea's-whisper stations, that normally can't be heard with headphones, booming into your shack at S9. This is the kind of reception you'll get with the *Super BCB Booster*, a preamplifier specifically designed for BC DX'ers.

Whether you live in a concrete and steel tower, or out in the boondocks with enough space for a long-wire antenna, the *Super BCB Booster* will dig out stations you've never heard before because its average gain is almost 42 dB—7 S-units of extra sensitivity.

The booster can function as an electronic antenna with signals received only by loopstick antenna coil L1, or as a preamplifier, with a "longwire" antenna connected to binding post BP1.

How It Works. The signal voltage appearing across tuned circuit L1/C1 is fed to FET Q1, which provides approximately 20 dB gain on top of the L1/C1 resonant "gain." Q1's output feeds transistor Q2, an emitter-follower that provides a 10- to 15-dB power gain, and also a low impedance output for connection to the relatively low impedance input of a communications receiver.

Though intended for direct connection to a receiver's antenna input terminals, the *Super BCB Booster* can also be used with "loop antenna radios" by connecting the booster's output to a loopstick antenna (duplicate of L1) positioned near the radio. We'll show how both connections are used.

Powered by a 2U6 type 9-volt transistor radio battery the current drain is less than 2 mA and a standard battery will last at least three-months, even under heavy service. An activator or heavy duty battery can last a year or more. With such low power consumption there's no reason to build an external AC power supply for the *Super BCB Booster*.

Construction. Although the circuit appears simple, extreme care must be taken with the circuit board preparation since the high overall gain can cause instability if a single component, or printed circuit foil, is out of position. We suggest no attempt be made to use point-to-point wiring. Use a PC board that is an exact copy of the supplied template (any PC board material can be used). If you cannot make your own PC boards you can obtain a *plated board* (for easy soldering) from the source indicated in the parts list.

Avoid component substitutions; Q1 and Q2 should be the specified types. Though the booster might work with some "general replacement" transistors, it might not work with others. Worse yet, it might work only on very weak signals while distorting strong signals.

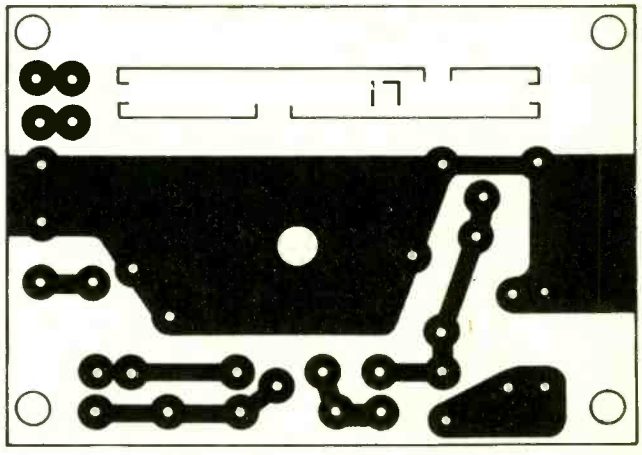
The specified components will provide distortion-free reception on signals as strong as 80,000 uV. It will deliver excellent performance with battery voltage falling as low as 6-volts.

The circuit board and a *very short* connection to output jack J1 are the only critical assemblies. You can make mechanical modifications as long as the general layout approximates the unit shown in the photographs.

We suggest that the unit be assembled in a plastic cabinet with an aluminum front panel, though a full plastic cabinet can be used because the PC board has a built-in hand-capacitance shield. Maximum stability, however, is attained through the use of a metal front panel because it reduces the possibility of feedback from booster's output to its input.

Drilling the PC Board. All of the component mounting holes except for tuning capacitor C1 can be made with a #58, #59, or #60 bit. Capacitor C1 requires a 5/16-inch hole. If you don't have a 5/16-inch bit use a 1/4-inch drill and enlarge the hole very carefully with a miniature round file. The corner holes, which are used for the mounting screws, should clear #4 or #6 screws—which ever you prefer to use.

The PC board is best assembled in the following manner: Install capacitor C1 first, then all the remaining components except Q1. Then push Q1's leads through the board and solder. Note that Q1 is supplied with a shorting-clip around all the leads. *This clip must be*



Make a PC board that is an exact duplicate of this Template. Do not try to use point-to-point wiring since the high gains could cause instability if any parts or strips of foil were out of position. If you have any problem making yours write to the address listed with the parts for a finished board.

Booster

left in position until assembly is completed and the booster is ready for operation. If the clip is removed a high static voltage from the tip of the soldering iron, or a voltage generated through normal handling, might destroy Q1. Place a paper or tape tag on or near Q1 to remind you to pull off the shorting clip before applying power.

Double-check that the tab sticking out from Q1's case faces the nearest edge of the PC board before soldering. The round side (opposite the flat) of Q2 should face the same edge of the PC board.

Note that L1's primary and secondary windings are independent though their *ground* connections are generally shorted together by a wire jumper on the PC board. If for some reason you prefer a separate antenna system ground, open the shorting wire and install a "ground binding post" on the panel.

After L1 is wired to the PC board it can be secured with a few dabs of silicon rubber adhesive such as Silastic or G.E.'s RTV.

Since stand-offs space the PC board away from the panel to prevent shorts between the foil(s) and the metal panel, it will be impossible to add wiring after the assembly is installed on the panel. Install the wires for the connections to BP1, J1, SW1 and the battery connector before mounting the PC board. Insulated #20 or #22 solid wire is suggested. Mount the PC board to the panel using a 1/4-inch spacer or stack of washers between the panel and PC board at each mounting screw.

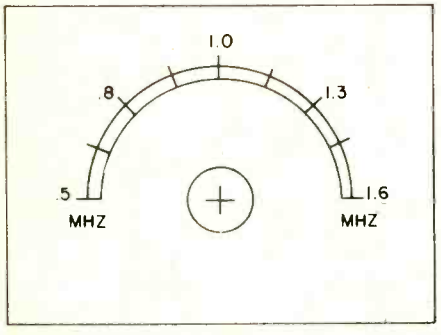
After all wiring to the panel components is completed adjust L1's slug so it protrudes between 1/4- to 1/2-inch from the top of the coil form—no further tuning is needed.

Make up a connecting lead from shielded or coaxial cable to go from output jack J1 to the receiver's antenna terminals. For least signal attenuation the lead length should not exceed 15-inches.

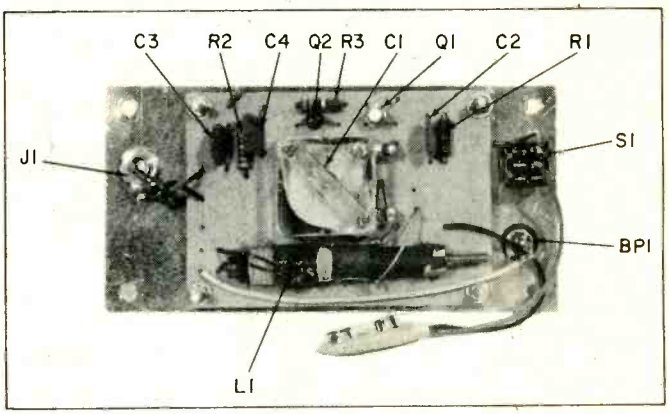
If the booster will be used with a transistor-type radio having a built-in loop antenna and no terminals, connect the free end of the output cable to a loopstick antenna coil the exact duplicate of L1. Remove the primary winding—the heavy outer winding of plastic insulated wire wrapped around the coil. Position this coil on the radio's case opposite the built-in loopstick antenna and tape the coil in place.

***Using The* Super BCB Booster.** Turn on both the receiver and booster and tune in the desired station or frequency. Then adjust tuning capacitor C1 for maximum signal strength or highest S-meter reading. As a general rule the

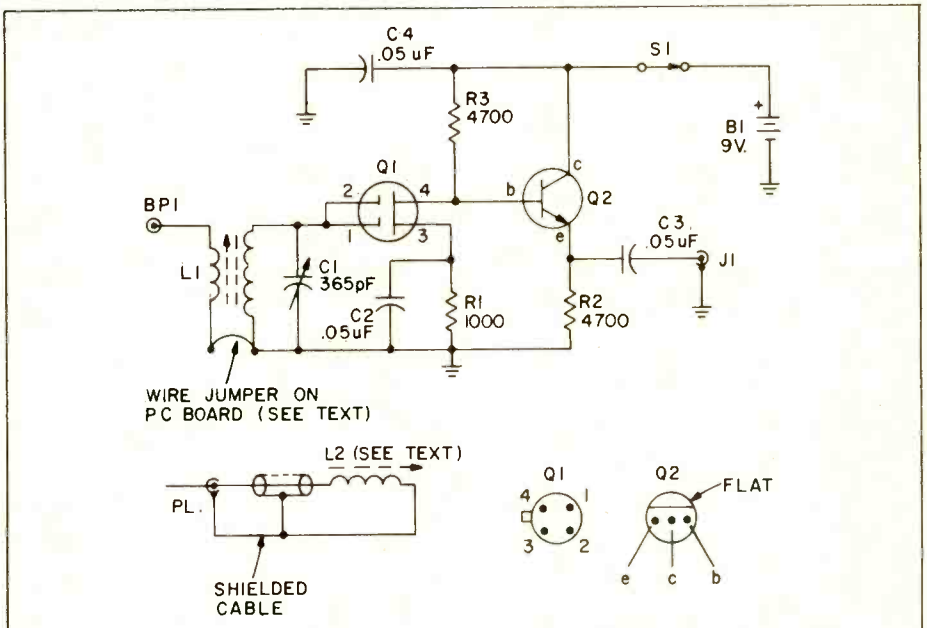
(Continued on page 118)



The tuning dial faceplate can be used as is; just cut it out and paste it down.



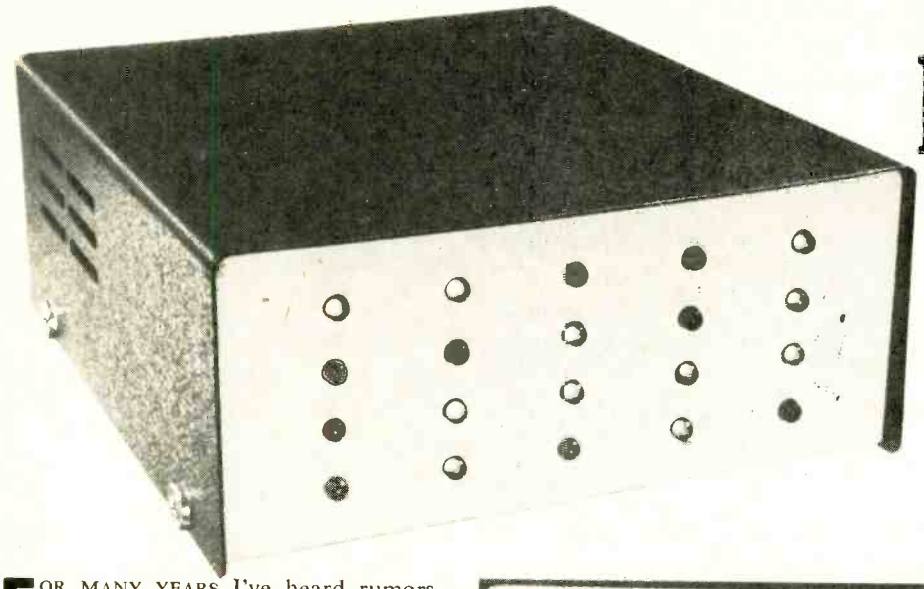
The complete assembly—showing the recommended locations for BP1, S1 and J1. Note that J1's ground lug is used; there are two connections to the PC board—one for the ground terminal and one for the jack's center conductor. Shielded cable isn't needed; just wrap the ground wire around the conductor a few times.



PARTS LIST FOR SUPER BCB BOOSTER

B1—9-volt battery (type 2U6 or equiv.)
BP1—Insulated 5-way binding post or equiv.
C1—365 pF miniature tuning capacitor (Polyvaricon type)
C2, C3, C4—0.05 uF disc capacitor rated 10 VDC or higher
J1—Phono jack
L1—Loopstick antenna (Radio Shack 270-1430 or equiv.)
L2—Same as L1 (Optional. See text.)
PL1—Phono plug (Optional for L2)
Q1—FET, RCA 40600
Q2—NPN transistor, 2N3394
R1—1000 ohms, ½-watt, 10% resistor
R2, R3—4700 ohms, ½-watt, 10% resistor
S1—SPST switch
Misc.—Cabinet, PC board, hardware, etc. A plated printed circuit board is available for $5 from the Electronic Hobby Shop. Box 192, Brooklyn, N.Y. 11235. U.S. orders add $2.00 for postage and handling: Canadian orders add $3.50. No foreign orders, please. New York State residents must add appropriate sales tax for your area. Postal money orders speed delivery; otherwise allow 6-8 weeks for delivery.

L1 is secured to the back of the PC board, after it has been wired, with a couple of drops of silicon rubber adhesive. The coil can serve as an "electronic antenna," and a "long wire antenna is needed only if you are after super-DX reception. To keep dust out of the tuning capacitor's plates—and thereby avoiding snaps, crackles and pops when tuning—we suggest a model that is supplied with a plastic cover.



Friendly Flasher

Solid state circuits make your livingroom look like a computer center.

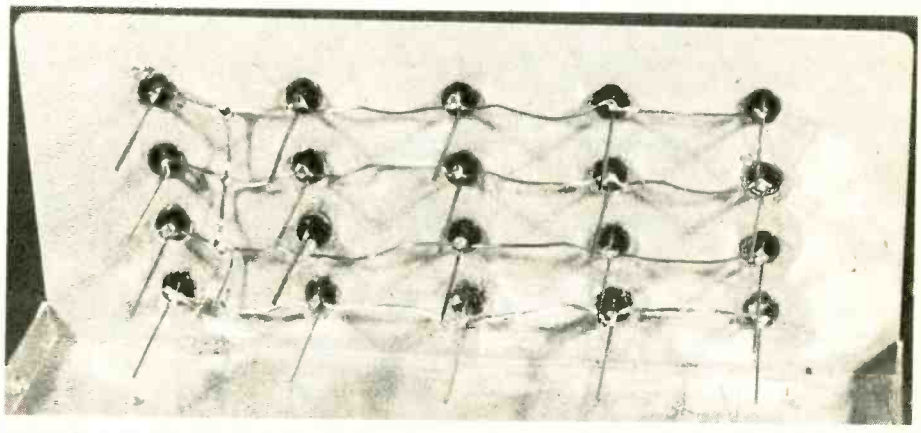
FOR MANY YEARS I've heard rumors that the banks of blinking lights seen on the front panels of many computers are just to impress the computer's owner. It must be admitted that the sight of several square feet of flashing lights acting under the control of unseen forces can exert a powerful pull on almost anyone. Certainly a display of this sort is much more fascinating than a painted metal panel even though they often convey the same amount of useful information.

The Old way. While it's fine for a businessman to have a large computer merrily blinking away, the average electronics enthusiast must find other, less expensive ways to have a decent set of flashing lights. One simple approach that has been used for many years is based on small neon-filled tubes.

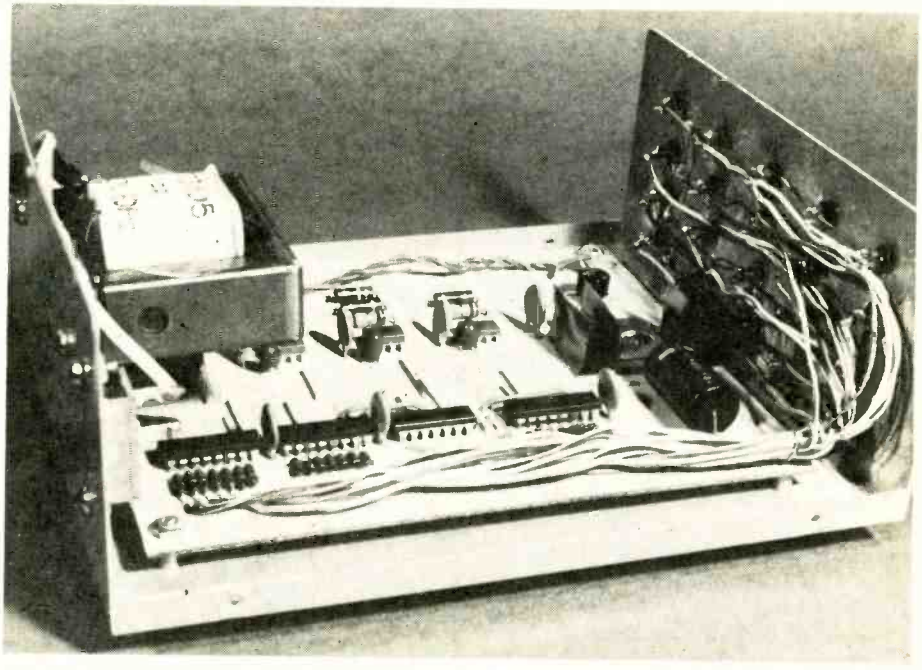
Experimenters take several of these circuits, hook them up in parallel and feed them off a ninety volt battery. Variations in values of the resistors and capacitors keep all the lights from coming on and going off at the same time and the total current drain is so low that battery life is measured in months of continuous use.

Over the years, I've built several versions of the neon tube Idiot Box. Recently, I decided to see if I couldn't design and build a modern, solid-state box of blinking lights. I had so much fun in the process that the things I learned from necessity were a real pleasure. The design I evolved is fairly simple but offers several instructive pointers, especially in the area of combining standard circuits in novel ways. And to keep things as simple as possible, I only used parts available from local electronics supply stores, which means anyone should be able to obtain them.

How it works. In order to get an over-



This view of the back of the flasher front panel shows how the LEDs are connected to the five-volt DC power source. On a more complex panel design it would be a good idea to use insulated wire. The design of your flasher is up to you.



An interior view of the completed flasher gives a good perspective of how the project is laid-out and how the wiring is routed to keep the chassis neat and professional looking. This project is a good one for those interested in learning more about digital integrated circuits, how they are interconnected and designed.

Flasher

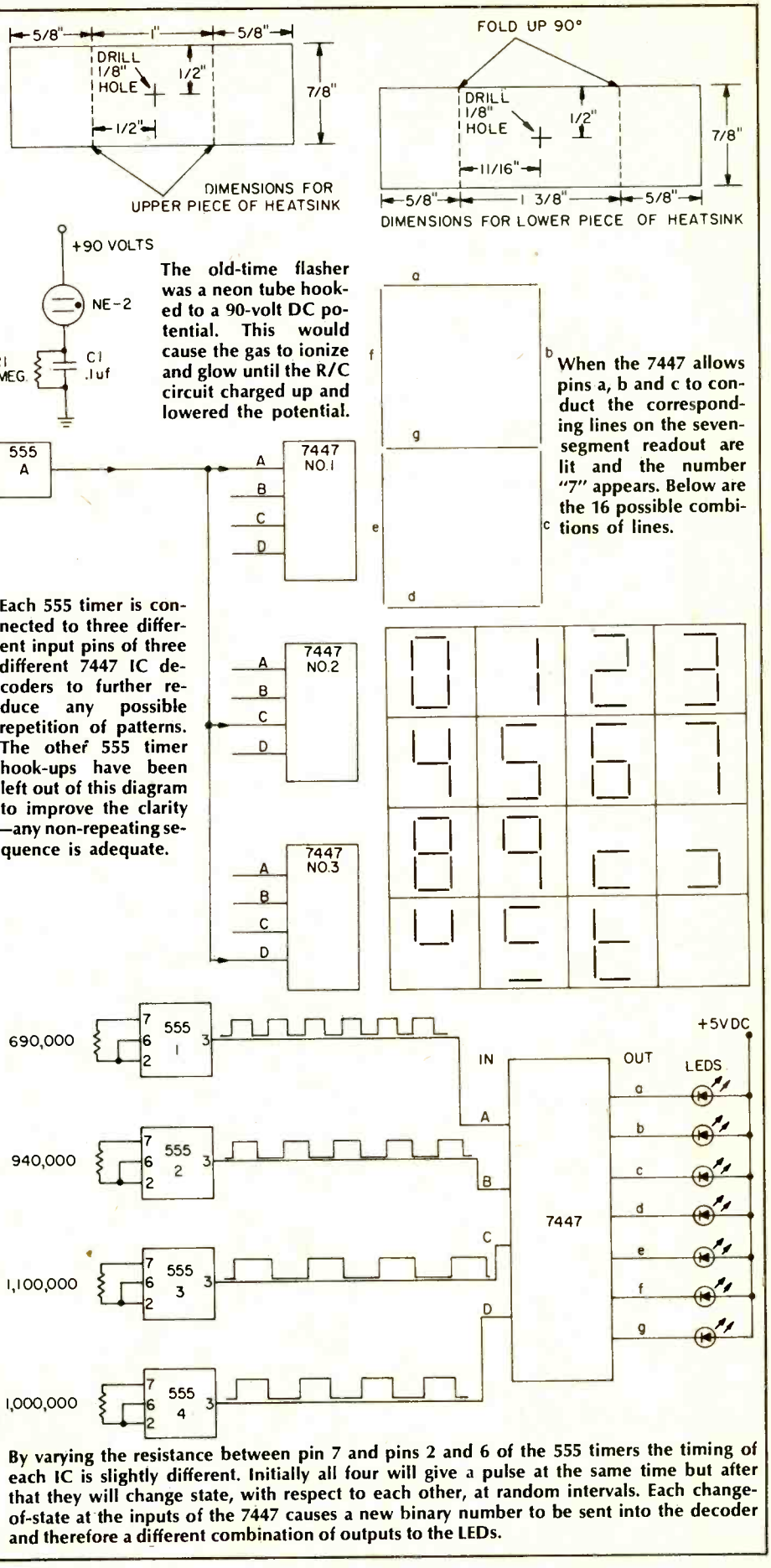
all idea of how the circuit works, we can begin by studying the inputs and outputs of a 7447 integrated circuit. This particular circuit is designed to decode Binary Coded Decimal inputs in order to turn on the correct outputs which are used to drive a seven segment readout. For now, it is enough to know that by applying one of the sixteen possible combinations of inputs to the chip, we get a unique combination of output lines turned on. We can replace the seven segment readout with seven individual light emitting diodes (LEDs). If we can devise a scheme to turn the inputs of a 7447 on and off at different times, we have a solid basis for a modern box of flashing lights.

This turns out to be relatively easy to accomplish. We can use a standard multivibrator circuit built around the 555 timer chip to provide repeating cycles of on and off signals. If we build four of these multivibrators and cause each one to have a different period of oscillation, we can then connect the output of each multivibrator to one of the input pins of the 7447 decoder/driver.

The output of each 555 multivibrator is connected to only one input of the 7447. Each time any of them changes from low to high or from high to low, the overall combination of inputs to the 7447 is changed and this in turn causes a new pattern of output lamps to turn on.

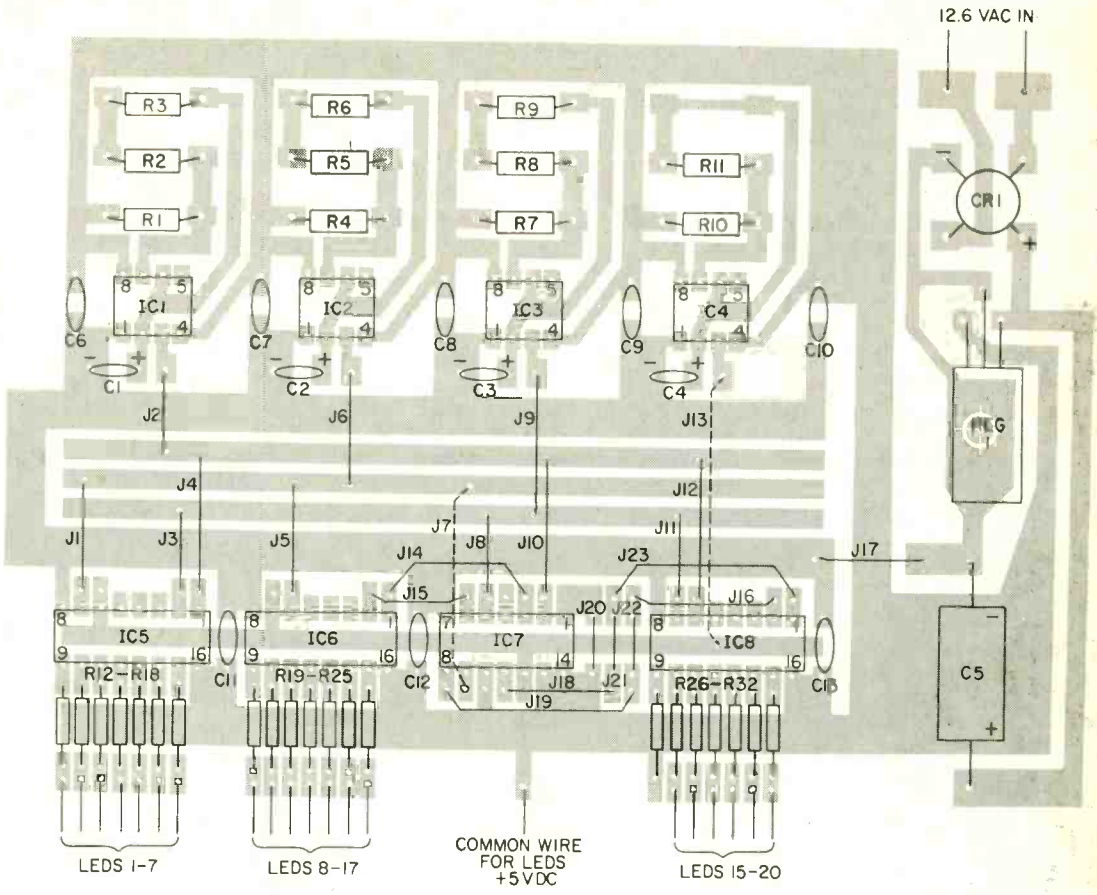
So far we have used a total of five integrated circuits to control seven lamps. This poor ratio of chips to lights can be greatly improved if we care to add more lights. It only takes one additional 7447 to handle each further group of seven lamps. We can share the outputs of the existing 555 multivibrators among the inputs of these additional 7447 decoder/drivers. By thoroughly scrambling the order in which we connect the multivibrators to the inputs of the new 7447s, we can keep the output pattern from each 7447 from being the same.

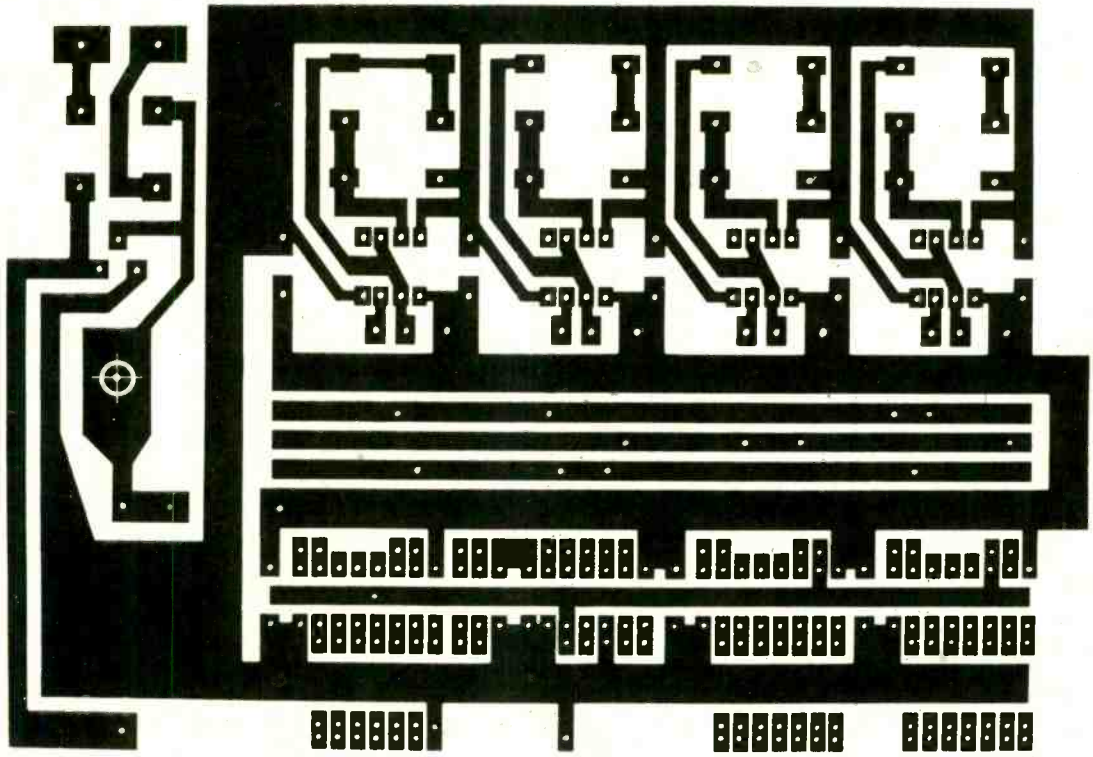
The next step in this progression is to simultaneously apply the output of one multivibrator to three different input lines of three separate 7447s. In this case, we are applying the same output to the A input of the first chip, the C input of the second and the D input of the third. Because of the way 7447s decode the various input lines, the same signal being applied to different inputs on each 7447 has a completely different effect on the output pattern from each of these chips. By similarly scrambling



By varying the resistance between pin 7 and pins 2 and 6 of the 555 timers the timing of each IC is slightly different. Initially all four will give a pulse at the same time but after that they will change state, with respect to each other, at random intervals. Each change-of-state at the inputs of the 7447 causes a new binary number to be sent into the decoder and therefore a different combination of outputs to the LEDs.

This is the parts location diagram for the friendly flasher. Note the author's liberal use of despiking capacitors (C6 through C13). If a 21st LED is desired, cut the foil pattern to separate the outside end of resistor R26 from the body of the circuit board. Then run a wire from the resistor connection to the LED then back the 5VDC common. Be careful to use insulated jumpers on the bottom side of the circuit board and where one jumper crosses another. Elsewhere in this article is a chart which explains what type of jumpers should go where. Use IC sockets for all the IC chips. This will simplify assembly, testing and, if needed, repair.





Here is a full-sized template of the circuit board pattern. A photo etching procedure would be ideal for such a complex circuit, or else one of the new kits that enable you to lift a pattern straight off a magazine page. What ever technique you use, be very careful that you don't get any bridges between sections of the board. Don't be put-off by the apparent complexity of this project—once you figure it out it is really quite simple and straightforward, especially after you have a completed printed circuit board. Making the printed circuit board is, after all, part of the fun of building any project.

Flasher

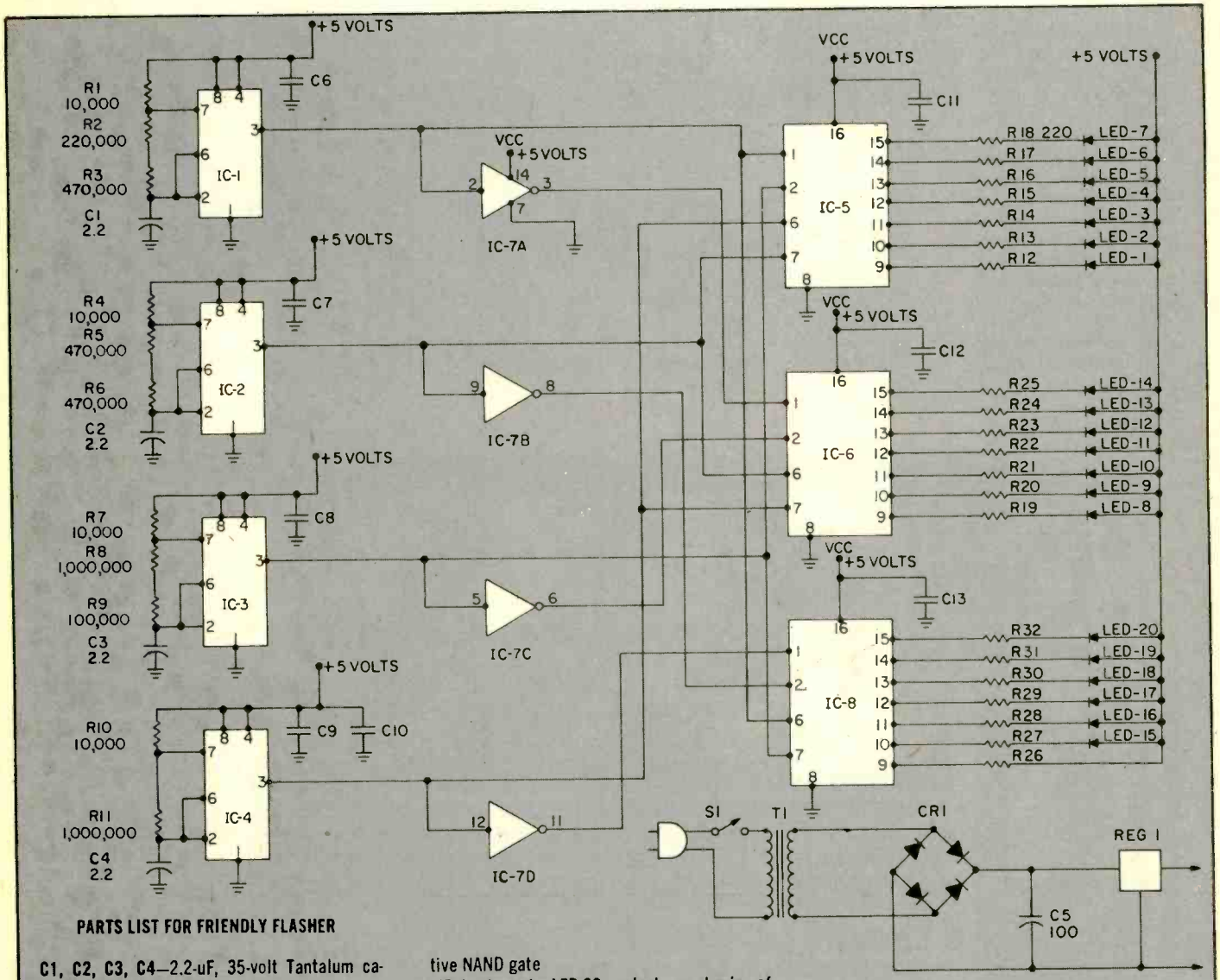
the outputs of the remaining multivibrators among the other inputs of the 7447s, we can obtain a well mixed final set of patterns.

The six-percent solution. As I mentioned earlier, the 7447 integrated circuit is normally used to decode Binary Coded Decimal inputs and then turn on the correct segments of a seven segment display. The individual segments of such a display combine to create sixteen possible output combinations. One of the combinations of inputs results in all seven outputs being turned off.

Any time all four of the 555 multivibrators happen to have their outputs high, all inputs of the 7447s will be high and this will cause all output lamps to be turned off. This occurs each time power is first applied to the circuit (the capacitors are charging) and roughly six percent of the time during normal operation.

I was so horrified when I first saw all the lamps turn off in my breadboard version of this circuit that I added an extra integrated circuit to correct this situation. In essence, I allowed the output of each 555 multivibrator to go directly to an input on two of the 7447s. Before I allowed this output to reach an input of the third 7447, I inverted it. This meant that anytime all the outputs of the 555s went high, some of the inputs of the 7447s would have lows (inverted highs). This would prevent all four inputs of any given 7447 from simultaneously going high.

While I could have used a 7404 Hex Inverter (six inverters on one chip), I chose the common 7400. By tying one of the two inputs of each gate to +5 volts, each gate acts as an inverter. The reason I selected this method of invert-



PARTS LIST FOR FRIENDLY FLASHER

C1, C2, C3, C4—2.2-uF, 35-volt Tantalum capacitor
C5—100-uF, 50-volt electrolytic capacitor
C6, C7, C8, C9, C10, C11, C12, C13—0.1-uF, 10-volt disc capacitor
CR-1—Full-wave bridge rectifier, 1.5-amp, 50-volts
IC-1, IC-2, IC-3, IC-4—555 Timer
IC-5, IC-6, IC-8—7447 BCD to seven segment decoder/driver
IC-7—7400 (A package) quadruple 2-input positive NAND gate
LED-1 through LED-20—select on basis of color, size and price
REG-1—Type 7800, 5-volt, 1-ampere regulator
R1, R4, R7, R10—10,000-ohm, ½-watt resistor
R2—220,000-ohm, ½-watt resistor
R3, R5, R6—470,000-ohm, ½-watt resistor
R8, R11—1-megohm, ½-watt-resistor
R9—100,000-ohm, ½-watt resistor
R12 through R32—220-ohm, ½-watt resistor
S-1—SPST slide switch
T1—Small 12.6-VAC filament transformer
Misc—Cabinet 6¼ in. by 2¾ in. by 7¼ in. assorted machine nuts and screws; wire caps; power cord; scrap metal for heatsink; grommet; circuit board standoffs and paint.

ing the multivibrator outputs lies in the fact that there are exactly four gates available on a 7400 chip. This allowed me to use one gate for each multivibrator output and not have any left over.

Power supply. The power supply shown is quite straightforward. An ordinary filament transformer changes the line voltage to 12.6VAC which is then rectified and filtered to 12.6VDC. I then used an inexpensive 5-volt regulator to produce a stable smooth 5VDC output. Avoid 6.3 VAC filament transformers since the regulator becomes unstable with an input of less than seven volts.

One of the nice features of the 5 volt regulator is the fact that it will automatically shut itself off if its temperature approaches dangerous levels. The higher the voltage we apply to the regulater, the more power it must dissipate in order to maintain a constant output. This wasted power can heat up the regulator and cause it to shut off.

One final comment and we will have covered the entire circuit. Based on personal experience, I added a small despiking capacitor between the +5 volt inputs and ground on each integrated circuit. While those who like to design for a minimum number of components will feel that this is a wasteful practice, I believe the cost of these capacitors is so low in relation to the amount of trouble they can prevent that I always include a generous number of them in any digital project I'm building.

FRIENDLY FLASHER JUMPERS

Jumper number	Type of wire	Location
1	Bare	Top
2	Bare	Top
3	Bare	Top
4	Bare	Top
5	Bare	Top
6	Bare	Top
7	Insulated	Bottom
8	Bare	Top
9	Bare	Top
10	Bare	Top
11	Bare	Top
12	Bare	Top
13	Insulated	Bottom
14	Insulated	Top
15	Insulated	Top
16	Insulated	Top
17	Bare	Top
18	Bare	Top
19	Insulated	Top
20	Bare	Top
21	Bare	Top
22	Bare	Top
23	Insulated	Top

Construction. Due to the relatively slow speed at which this circuit operates, almost any of the usual construction techniques can be used. The best place to begin construction is with the circuit board. The pattern shown can be used or you can devise your own. Either way, you should start by etching and drilling your board. Then, if you are using my pattern, solder the various jumpers in place. The component layout shows their placement. Once all jumpers are in place, carefully inspect the board for solder bridges. Install the bridge rectifier and 100 mfd filter capacitor in place. Take care to observe the polarity markings on the capacitor and to orient the rectifier correctly. The package the rectifier comes in shows how to identify the leads.

Next, install the 5 volt regulator and its heatsink. The two pieces of the heatsink are placed next to the board and the regulator on top of them. A small screw is then run through the regulator, heatsink and circuit board. When everything is properly aligned (regulator leads in their holes, heatsink not shorting out any leads), fasten everything in place with an appropriate nut. The heatsink can be fashioned from almost any kind of scrap metal.

Now is a good time to install all the resistors and capacitors. This will take care of most of the parts to be installed and at this stage, problems are easy to diagnose. The component layout shows where these parts go. I suggest that you insert and solder one part at a time rather than trying to do them in batches. Be especially careful with the current-limiting resistors along the bottom edge of the board. Watch for solder bridges and solder flowing into the other hole on the pads.

Testing the ICs. Now, taking care to align the pins correctly, insert IC-1 into its holes and solder in place. You may plug the line cord in and use your voltmeter to take a reading on pin 3, the output pin. The voltage here should swing between roughly zero and five volts, remaining at each point about one-half second. If this is the case, the entire circuit of the first multivibrator is working. If it isn't, make sure the IC is really a 555, check for solder bridges, measure the +5 voltage on pins 8 and 4 and recheck the orientation of the pins to make sure the IC isn't installed backwards. As a last resort, remove the chip and substitute another.

Once the first multivibrator is functioning correctly, remove the line plug from the wall and solder in the remaining 555s (IC-2, IC-3 and IC-4) one-at-a-time. After each is soldered in, apply power and verify its operation the same way you did for the first 555. When all the 555s are in place and working, you will have a functioning power supply and four good multivibrators.

You should now solder IC-5 in place. In order to test its operation, an LED can be used to probe each of the outputs. To do this, take an LED and gently spread its leads apart. Then use an ohmmeter to take forward and reverse readings across these leads in order to make sure that you have a good LED. (One reading should be much higher than the other.)

Next, cut about a foot of stranded hookup wire and solder one end to the pad used as a common return for the LEDs. This pad is located along the bottom edge about midway between the first and second groups of current limiting resistors. Then attach either lead of the LED to the other end of this wire. At this point, apply power to the board and briefly touch the free end of the LED to ground.

Should the LED light up when you touch it to ground, kill power to the board and lightly solder the lead attached to the hookup wire. If it failed to light up, reverse the leads of the LED at the stranded wire and again touch the free lead of the LED to ground. This time it should light and after killing power, you should solder the lead attached to the hookup wire.

What you have done is fashion a simple test probe that will light up whenever the free lead of the LED is applied to a point at ground potential. (The power supply must be on.) Since this simple probe has no means of limiting the current flowing through the LED, you can destroy the LED if you touch ground more than a brief instant. However, you can safely probe the output sides of the current limiting resistors already on the board and that is how you will test the outputs of the 7447 lamp drivers.

To proceed, apply power to the board and touch the free end of the LED to each output lead of the current limiting resistors located just below the first 7447 (IC-5). The output lead of these resistors is the one nearest to the bottom edge of the board. As you probe each lead, the LED should flash on and off in an irregular fashion. If everything appears fine at all these outputs, remove power from the circuit and solder in the second 7447 (IC-6). If something isn't working right, follow the general hints I suggested for correcting problems with the multivibrators.

Use the above check-out procedures for the second 7447 (IC-6) and then the third (IC-8). After you have in-

(Continued on page 120)

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 square-wave output at a fundamental frequency typically between 20 kHz and 100 kHz—but the harmonics extend well up into the megahertz region.

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

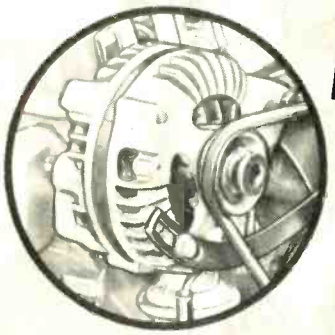
With a standard calculator's seven-segment LED readout and anywhere from 8 to 12 display digits, the multiplexing frequency is typically around 100 kHz. When currents of 20 mA or so are abruptly switched on and off through the LED display segments, significant amounts of RF energy at multiples of the multiplexing frequency are generated. These harmonics may extend well into the tens of megahertz. In fact, this harmonic radiation is one of the main reasons there are so few AM clock radios with LED time displays on the market today. The standard AM broadcast band is almost totally obliterated if the receiver's RF sections are within a foot or so of the multiplexed readout display unless extensive shielding is employed. Fortunately, there are two more practical and less expensive solutions than shielding. The first is the addition of resistance-capacitance networks to slow the rise and fall times of the multiplex waveform—and consequently filter out most of the higher-order harmonics. The second method is to drive each display digit directly and not use multiplexing at all. This second technique is much more practical in a clock radio than in a calculator for two reasons. First, clock radio displays normally have considerably fewer digits than most calculators; hence, the circuit problem isn't nearly so complex. And secondly, with a clock operated from the AC power line, the problem of rapidly discharging the batteries unless the output is multiplexed is eliminated. National Semiconductor Corporation has recently introduced a clock chip with direct drive of all readout segments to eliminate RF interference. It was designed with clock radio applications in mind.

One of the many uses for your calculator other than calculating. Here it is being used to check a windshield antenna.

But now back to your calculator, which almost certainly is multiplexed and unfiltered and produces a rich harmonic output. Turn it on and slowly bring it near a standard AM radio which is tuned either to a weak station or between stations. You should hear a mixture of buzzes and tones as the calculator is brought within several inches of the radio or its antenna. These tones probably will shift in frequency if you key different numbers into the display.

Now that you've verified that your calculator is a portable, wideband, RF source, what can you use it for? Well, a number of applications are obvious. Anytime you need a quick check to see if the RF and IF stages of an AM receiver are working, your calculator can provide a test signal. Probably its handiest use, though, is in continuity testing antennas and connecting cables. Auto antennas and their accompanying cables and connectors are easily tested for opens and shorts by bringing the calculator near the antenna while monitoring the radio output. Perhaps the ultimate example of this technique you can perform in your automobile. Place a calculator near the windshield antenna of a late model General Motors car. In cases of poor or non-existent reception, one or both of the two thin antenna wires imbedded inside the glass may be broken. By carefully tracing the path of each individual wire, a break or faulty connection can be located when the radio's output changes abruptly.

And one final thought. Those of you with LED digital watches might experiment with them. The power is much lower, and the metal watch case provides a lot of shielding, but there just might be enough RF coming from the display to be useful. ■



ALTERNATOR TESTER

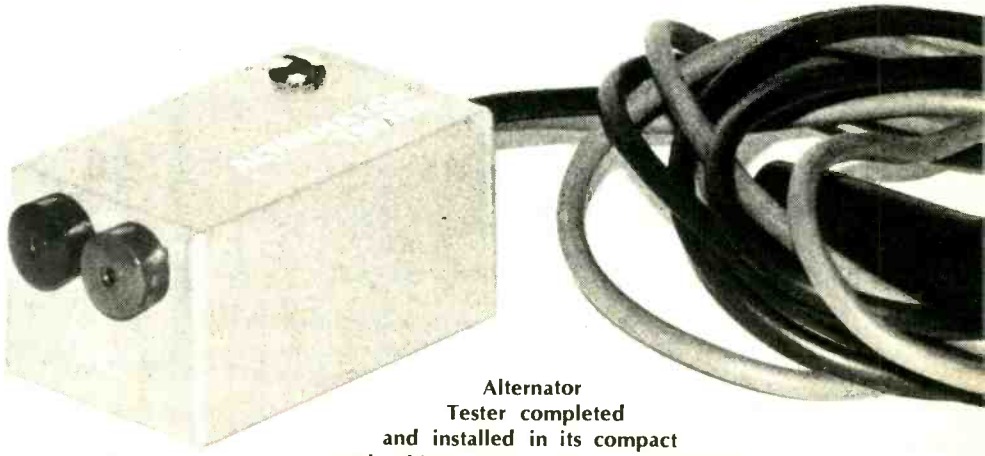
Your alternator may be building for a big breakdown without your knowing it. This simple circuit lets you check it out.

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

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

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

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



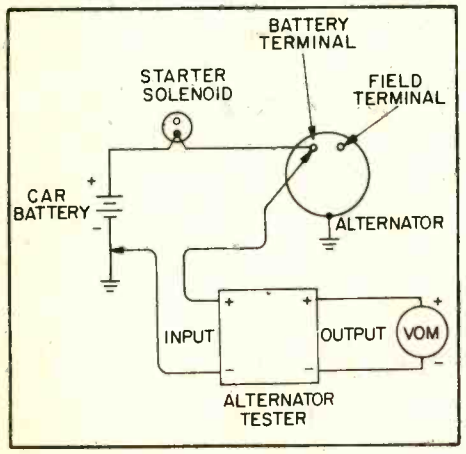
Alternator Tester completed and installed in its compact metal cabinet, shown with its test leads.

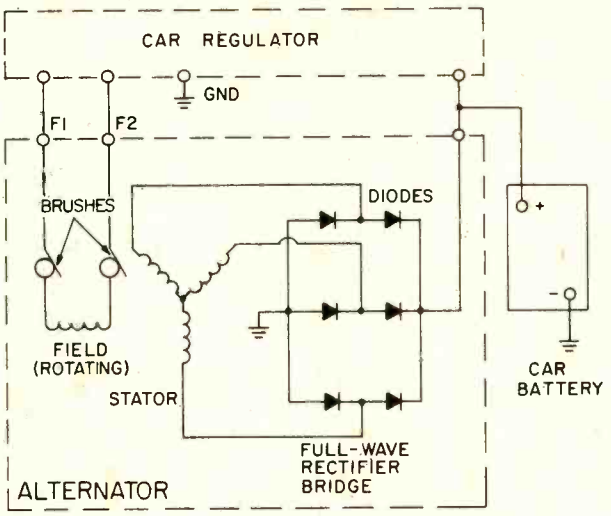
ALTERNATOR TESTER

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

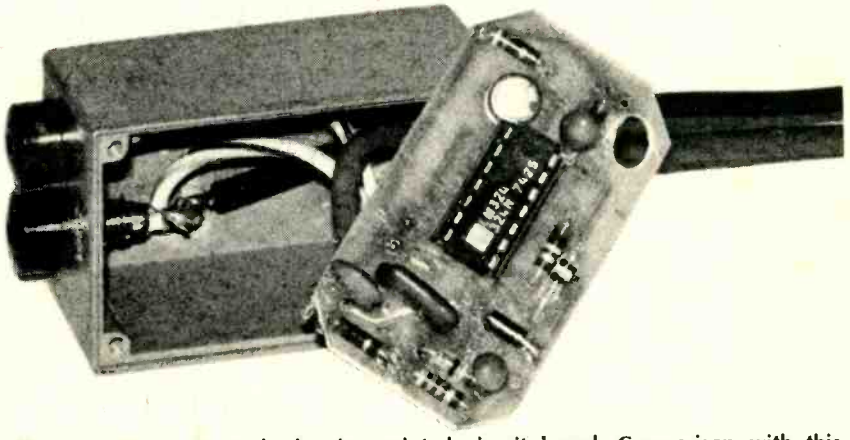
About the Circuit. The Alternator Tester is basically a peak detector circuit which responds to the peak-to-peak value of an AC voltage fed to its input terminal. Power to operate the circuit is derived from the output of the alternator on the same lead which feeds the ripple voltage to the input of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

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

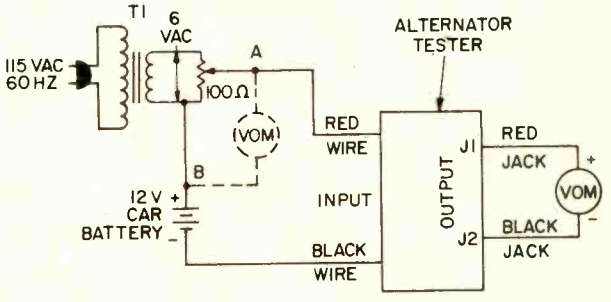




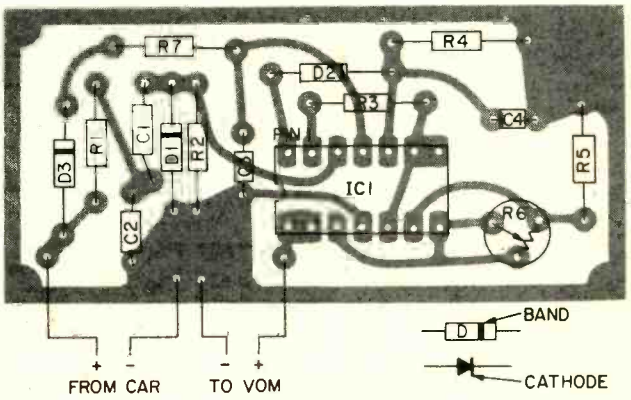
Typical automotive charging circuit. Latest model alternators have solid-state regulator circuit built into alternator frame.



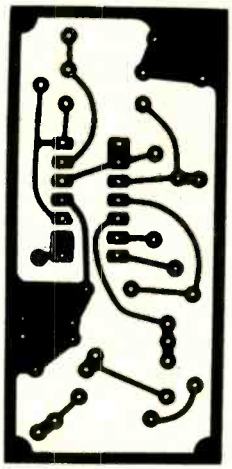
Alternator Tester opened, showing printed circuit board. Comparison with this early version of printed circuit board reveals improvements made by the editors.



Calibration of the Alternator Tester.



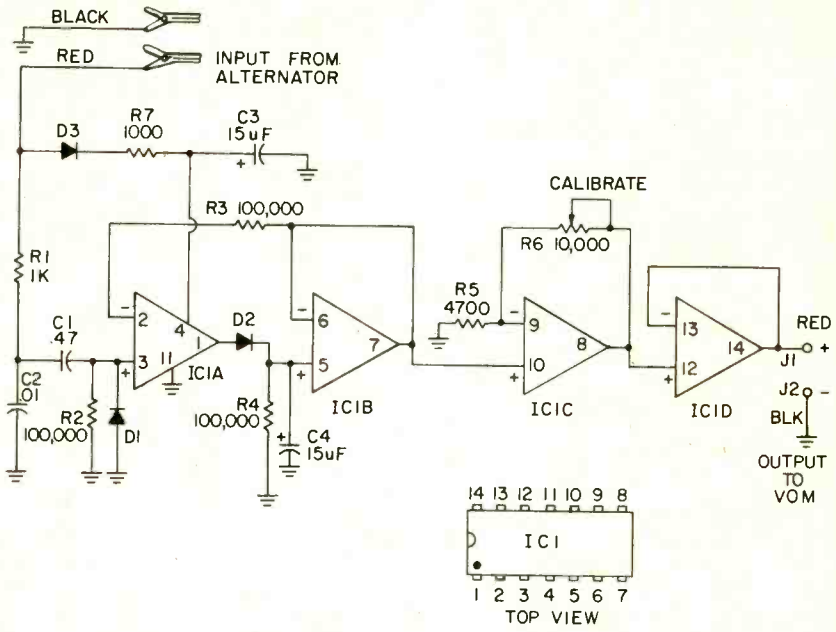
This shows the parts placement on the printed circuit board. Shown larger than actual size for clarity.



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

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

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



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

PARTS LIST FOR ALTERNATOR TESTER

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

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

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

(Continued on page 120)

Solderless Breadboarding

The neat, easy, quick way to go for the experimenter.

by Paul Kaufman

THERE ARE A LOT OF WAYS to put electronic circuits together, among them point-to-point wiring on a chassis with sockets and terminal strips, perf-boards and printed-circuit boards, to name the most familiar conventional methods, all of them depending heavily on soldering. But over the last few years, assembling and testing circuits on *solderless* breadboards has become increasingly popular. And little wonder, because this technique offers hobbyists and professionals alike a way to save considerable amounts of time, as well as saving sizeable amounts of money, since parts can be used and reused over and over again.

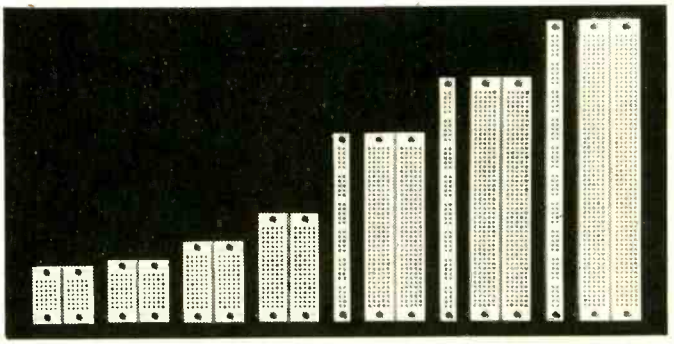
More Work in Less Time. To the electronics professional, engineering and technician time is a valuable resource, and it's really no different for electronics enthusiasts who spend late weekday hours or entire weekends experimenting with new circuits. But how, exactly, is the time spent? With solder in one hand and a soldering iron or gun in the other, which should really be no surprise, when you think about it, since even a simple amplifier can have well over a dozen connections. Add the fact that today's projects, with their 14-, 16-, 24- and 40-pin ICs, multiple LEDs, plus the usual assortment of transistors, capacitors, resistors, potentiometer, etc., are often considerably more sophisticated, and your newest labor of love can involve a lot of manual labor.

A Better Way. In their search for a better way to assemble circuits, a number of engineers and technicians came up with crude solderless breadboarding systems, using such ingredients as alligator clips, springs, fahnestock clips, perforated masonite, and the like. These were awkward and often unreliable, particularly when multiple connections were necessary at a given point in the circuit. Happily, like semiconductor technology, solderless breadboarding technology has come a long way since the early days. Precision and versatility have increased, while prices have decreased to the point that the many advantages of solderless breadboarding are now easily affordable by even the most budget-conscious electronics buff. Today, complete solderless breadboarding sockets carry manufacturer's recommended retail prices as low as $2.50.

With solderless breadboarding, connecting, disconnecting and reconnecting components and leads is nearly as fast and easy as plugging a conventional AC line cord into a wall socket. Just about the only preparation necessary is to strip the insulation from hookup wires, because no connectors are required. Leads from all types of components (ICs, transistors, resistors, capacitors, etc.) plug in directly, and interconnect just as easily.

We're getting ahead of ourselves. A better way to understand the way solderless breadboarding sockets function is to remember the old days before transistors, when electron tubes plugged into chassis to make things work. Manufacturers of breadboarding sockets have taken this basic idea and extended it. Instead of round sockets, holes are placed in a rectangular grid, spaced at regular intervals, corresponding to the spacing of standard components, such as ICs. And instead of terminating in soldering lugs, the lugs beneath these holes are interconnected in larger or smaller groups. Smaller groups (usually five or so), used to connect a few component leads together, are called "terminals." Larger groups, often of 25, 40 or more, which are used to connect large numbers of leads to a single point in the circuit (such as supply voltage, ground or common signal paths), are called "buses." By using these terminals and buses, circuits can be easily and quickly assembled *in as little as one-tenth the time of conventional wiring techniques.* Let's see why.

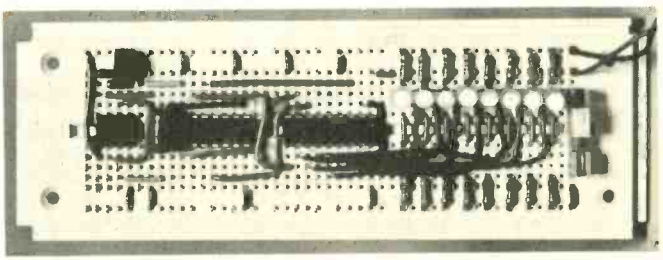
Figure 1.



Figures 1 and 2 illustrate typical solderless breadboarding sockets and bus strips used to build and test electronic circuits. As you can see from Figure 3, these can be combined together and "grown" to accommodate virtually any size circuit, using a variety of components.

Leads from all components, including DIP (dual-inline

Figure 2.



package) integrated circuits, are inserted directly into the sockets, and interconnections are accomplished with short lengths of #22-30 AWG solid hookup wire, stripped of insulation at either end. The result is a neat, compact layout that can be used for testing, or actually built into a housing or mounted on a baseplate and used as a completed project. Changes are no problem either. Changing a wire from one lead or another typically takes less than 10 seconds even if the socket is crowded with components.

Adding up the Advantages. By now, if you're like most experimenters who've been exposed to solderless breadboarding for the first time, you're probably already interested in trying this fun way to build circuits for yourself, just on the basis of the time you'll save. But speed isn't the only nice thing about solderless breadboarding. Here are some of the other major advantages.

You can translate circuits directly from schematic or pictorial diagrams directly to working circuits. There's almost never a need to come up with a separate wiring diagram or go through other intermediate steps. And if you're designing a circuit yourself, you can go from rough sketch right to assembled unit, to check your ideas in minutes. Once you're finished, you can easily translate the working circuit back into a schematic, too.

These are two of the most underrated factors in designing and building circuits. On a solderless breadboard, all components are right there in front of you, so it's hard to miswire a circuit. It's also easy to change component values or connections, especially if you're improving or otherwise modifying a circuit. Component values and parts designations are right there in front of you. And it's rare that you have to move any components to get at others.

Want to add a stage? Feed one circuit into another? Compare two different ways to do things, side-by-side? With modular solderless breadboarding, it's easy. Just keep adding sockets or bus strips as you need them!

Quality breadboarding sockets and bus strips have molded-in mounting holes that let you put them anywhere you need them; on a chassis, the surface of a cabinet or workbench. You name it! Be sure the sockets have insulated backing, to prevent shorting if you mount them on metal, or your circuits will be *short*-lived!

Utilize Your Junkbox. Even components with larger leads can be connected to solderless breadboards by using short lengths of hookup wire soldered to their terminals. And since the better solderless sockets are made of materials that withstand 100°C or more, you can even use heat-dissipating devices in close proximity to the sockets without fear of damage. You can even solder to components while they are still connected to the sockets. Note: consult manufacturers' specifications before you do, though.

For many experimenters, particularly those with tight budgets (and who hasn't one these days?), solderless breadboarding offers one more advantage that outweighs all the rest. Instead of giving components a lead-length "haircut" each time you use them, components are intact, so you can use them over and over again. And, because there's no soldering involved, there's no chance of accidentally overheating a delicate diode or expensive IC chip with an accidental touch of the soldering iron. Instead of shrinking your junkbox with each new project you build, your junkbox grows. So you can spend that hard-earned money on *new* components, and build a larger variety of new projects!

When, Where and How. Quality solderless breadboarding systems are compatible with a wide range of circuit types, including digital, and analog audio, all the way up to video and RF, if proper wiring practices are followed. Capacity between adjacent terminals should be less than 10 **pF**, which gives you the ability to work up to about 20 MHz, for most applications. Virtually any type of component can be used, though with components having very small diameter leads, stranded leads, or leads larger than .033-inch diameter, you should solder a small length of #22 hookup wire to them, using spaghetti or electrical tape where necessary, to prevent shorts.

Figure 3.

Wiring and Hookup Hints. While most of the points raised below are good basic wiring practices, it especially pays to keep them in mind when using solderless breadboards, because the speed and ease with which your circuits go together may tempt you to overlook some of them.

Leads in general should be as short as possible, particularly with high-frequency circuits. Keep component leads and jumpers as direct as possible, since excessive leads can add inductance or stray capacitance to circuits, sometimes producing unwanted oscillation. Neat lead layout, lead bending, etc., also makes components easier to insert, and helps you trace the circuit for later diagramming, debugging, etc.

To jump two or more tie-points, you'll need short lengths of wire. Almost any #22-30 solid hookup wire will do. Strip insulation a bit more than ⅜ inch from each end, to allow for insertion and bending, and be careful not to nick the wire when stripping it. When estimating jumper length, allow a total of a bit more than ¾ inch (for the ⅜ inch-plus of bare wire you'll need at each end), plus any extra wire required for bending, to make a neat layout. And don't throw those jumpers away! They can be re-used again and again, so store them on an unused portion of your socket, or in a plastic box.

When laying out circuits, allow several rows of tie-points between components, especially ICs. This will give you plenty of maneuvering room to add extra components, run wires, etc., as well as yielding a more open, neater layout.

One of the nice things about solderless breadboarding is that you can lay out a circuit just the way it's drawn on a schematic, with supply buses at the top, signal buses in the middle, and ground buses at the bottom. With high-frequency circuits, be sure those ground buses are handy, since you'll want to run bypass capacitors with short leads directly to them. And speaking of bypassing, remember that leads to and from the socket can sometimes pick up stray signals, so you might want to bypass power lines to ground right where they connect. ■

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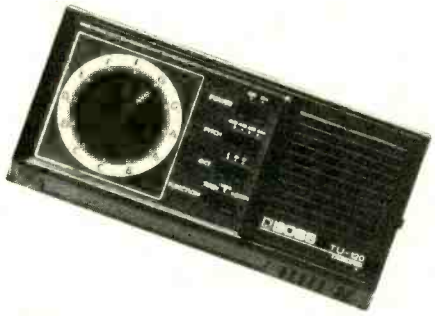
New Products (Continued from page 10)

Tone Tuner

RolandCorp US is introducing a unique stroboscopic 12-note tuner that features a highly accurate (±1 percent) and stable tuning fork oscillator. The TU-120 is being marketed under the Boss label, and carries a suggested retail price of $199.50. The tuner operates off self-contained batteries or from an AC line. AC adaptors for 117, 220, and 240 volts are optional. The TU-120 features function, octave, and pitch selectors, a 16-LED display, built-in microphone, calibrator, monitor, and output and input jacks. Electronic output instruments are plugged into the tuner, and sound from acoustic instruments is picked up by the microphone. The LED display clearly shows any tuning variance. The system tunes over a five-octave range. Tuning by ear can be accomplished over a three-octave range. For more information, simply write to RolandCorp US, 2401 Saybrook Ave., Los Angeles, CA 90040.



CIRCLE 41 ON READER SERVICE COUPON

Dual Trace

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

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Portable Digital Capacitance Meter

The B&K-Precision Model 820 portable digital capacitance meter is a compact instrument capable of measurement over the wide capacitance range of 0.1-pF to 1-Farad. The unit's accuracy greatly exceeds the tolerance of most capacitors. It features a bright, 4-digit LED display for easy reading on test benches. Because the accuracy of this unit greatly exceeds the tolerance requirements of most users, required values can be "hand selected." Matched capacitors can also be singled out for use in bridge circuits and other critical applications. Ten ranges cover from 0.1-pF to 1-Farad with resolution up to 0.1-pF. The B&K-Precision Model 820 comes with a 26-page detailed manual. Optional accessories include the BP-28 rechargeable battery pack, BC-28 charger, and LC-28 carrying case. The 820 is available at local B&K-Precision distributors for $130.00. For additional information, contact B&K-Precision, 6460 West Cortland Street, Chicago, IL 60635. ■

CIRCLE 39 ON READER SERVICE COUPON

Mighty Met

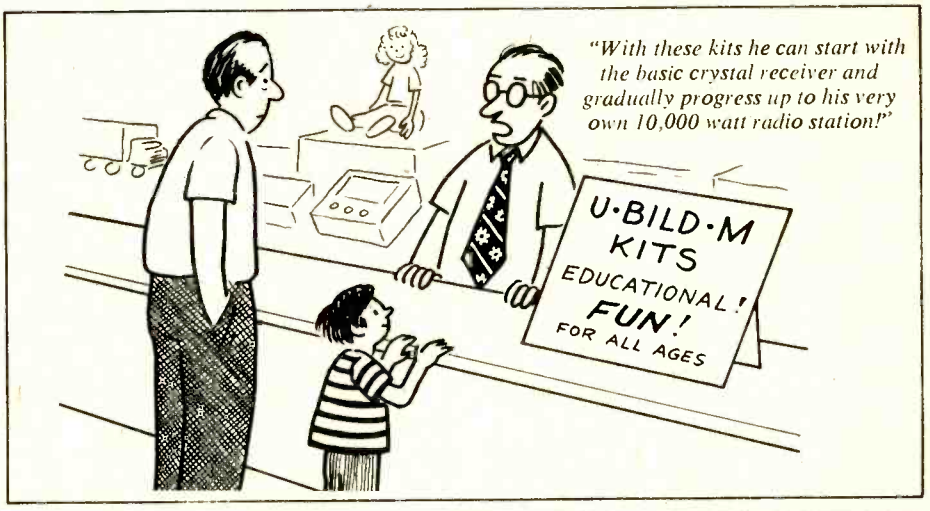
(Continued from page 85)

in a square pattern. Flea clips could be used to support the wiring, but it is just as easy and less expensive to run the component leads through the board and connect them on the underside with fine wire, like the type used for wire-wrapping. Double check the orientation of the IC's and transistors, and the polarity of the electrolytic capacitors and battery. The prototype was assembled in a 2 x 6 x 4-inch cabinet, but another size or type could be used. The circuit board was mounted to the bottom of the cabinet with four ¼-inch spacers. The speaker was mounted by means of two ground lugs soldered to its frame. For the sake of appearance, the two bolts holding the speaker and grille were epoxied to the inside of the cabinet.

Performance and Revision. After all wiring is complete, plug in the IC's, then connect the battery and adjust trimpot R7 to midrange. Turn the Mighty Met on and it should produce a continuous series of clicks whose rate can be varied by the *tempo* control. Adjust trimpot R7 for the desired difference in loudness between the initial beat and the other beats, and check the function of the *meter* switch. Finally, calibrate the *tempo* control, using a watch or clock that indicates seconds. For the faster tempos, set *meter* to 5 or 10 and count the initial beats. If there are problems, try to determine which part of the circuit is faulty: If there are no clicks, first check that there is about +9 volts between the +V supply line and ground. If not, check for a wiring error or short. Next check for pulses at pin 3 of IC1; an oscilloscope is preferable, but an audio amplifier can also be used. If there are no pulses, the problem is in the multivibrator circuit. If everything is operating up to this point, check pin 4 of IC3 for pulses to see if the divider is working, then check pins 10 and 11 of IC4, and finally the output circuit.

Marking Time. Use of Mighty Met is straightforward. A word of caution is in order, however. When a metronome of this type is used for practicing on an instrument, there may be a tendency for the player to accent the first note of each measure, even when it is not appropriate for the particular piece of music being played. This tendency is more likely if the initial metronome beat is louder than the others. The Metered Metronome was designed to allow the initial beat to be made softer than the others, by suitably adjusting trimpot R7, as a means of counteracting this tendency.

For darkroom use or other timing applications a natural concern is how much the timing changes as the battery voltage drops with use. Specifications for the 555 timer IC used in the circuit indicate only a fraction of a percent timing variation per volt; variation with temperature is also only a fraction of a percent over an ordinary range of temperatures. Tests of the prototype showed no significant change (less than one second in 5 minutes) for a battery voltage variation from 10 volts down to 7 volts. ■



"With these kits he can start with the basic crystal receiver and gradually progress up to his very own 10,000 watt radio station!"

Booster

(Continued from page 104)

direct signal pickup by L1 will be sufficient. If greater sensitvity is needed connect 6 to 15 feet of wire to BP1. If you connect a longwire antenna take note; the signal level out of the booster can be so high as to overload the receiver.

If there is a strong local station in your area it's possible that the signal strength will be boosted to a level that swamps the receiver when listening to a weak signal on the other end of the dial. If this happens simply detune the booster away from the strong signal's frequency until the interference is reduced or eliminated. While this might sacrifice some gain on the desired station, the loss will probably be slight.

It is possible for the booster's output to radiate back to its input (particularly when using a loopstick coupling coil). You'll know when this happens—the booster breaking into self-oscillation—if the receiver gets "blocked," or off-frequency signals get tuned in and *lost* as C1 is adjusted. If this problem occurs, position the booster as far as possible from the receiver and keep any external antenna, if used, away from the receiver and booster's output cable.

Under certain conditions the *Super BCB Booster* will provide an additional benefit which should not be construed as improper operation. Some inexpensive receivers are highly prone to "marine band" image interference when signals at the high end of the broadcast band are received. The booster, by providing tuned preselection, suppresses or eliminates these interference-causing image signals while providing amplification to broadcast signals. Don't assume the loss of image signal reception means reduced sensitivity. Actually, the desired signal will be getting full boost while the image interference is squashed. ■

Porta Amp

(Continued from page 82)

can get away without a heat sink. But if you go for hard-driving or acid rock, mount an "inline" heat sink on IC1—any type will do.

The complete amp, including the speaker, should be mounted in a wood cabinet which will also serve as the speaker baffle. A good quality 8-inch or 10-inch speaker is recommended.

While you can mount the batteries inside the cabinet, they might break loose in transit and cause more damage than the convenience is worth. ■

PARTS LIST FOR PORTA-AMP

C1—0.1-uF, 15-VDC mylar capacitor
C2—25-uF, 15-VDC electrolytic capacitor
C3—50-uF, 15-VDC capacitor
R1—250,000-ohm, audio taper potentiometer
R2—100,000-ohm, ½-watt resistor
R3, R4—1,000,000-ohm, ½-watt resistor
R5—10,000-ohm, ½-watt resistor
SPKR—8-ohm PM speaker
U1—LM377 dual audio amplifier

LITERATURE LIBRARY

322. *Radio Shack's* 1979 catalog colorfully illustrates their complete range of kit and wired products for electronics enthusiasts—CB, ham, SWL, hi-fi, experimenter kits, batteries, tools, tubes, wire, cable, etc.

323. *Lafayette Radio's* 1979 catalog offers almost everything in hi-fi, CB, ham and many electronic parts. A product index will help you find anything from auto equipment accessories to wire wrapping tools.

381. *Fordham Radio's* handy catalog covers test instruments, tools, parts, home and car audio products, scanners and lots more. Get your free copy today!

385. Amateur Radio buffs and beginners will want the latest *Ham Radio Communications Bookstore* catalog. It's packed with items you should be reading today!

373. 48-page "Electronic Things and Ideas Book" from ETCO has the gadgets and goodies not found in stores and 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 1979." Just what the shack book shelf needs.

372. Just what the experimenter needs can be found in *Olson's* bargain flyer—parts, assemblies, semiconductors, components, and more. Even more interesting are the prices.

379. There's everything in the area of musical synthesizers for drums, strings, other instruments and full orchestras, as well as audio gear, video display modules, and a computer in *PAIA Electronics'* catalog.

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.

384. *The B&K-Precision* test instruments are described in a new compact catalog all experimenters should have! Start stepping up your test bench capabilities.

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.

302. Big catalogs are coming back. *Burstein-Applebee* will send you theirs. It's a parts bonanza every experimenter would want to see. Latest catalog is over 200 pages.

303. *Graymark's* catalog reveals a host of products and kits every experimenter would like to have. Unusual binary clock is a winner. A *must* catalog for the beginner.

305. A new 4-page directional beam CB antenna brochure is available from *Shakespeare*. Gives complete specs and polarization radiation patterns for their new fiberglass directional antennas.

371. Your computer system needn't cost a fortune. *Southwest Technical Products* offers their 6800 computer complete at $395 with features that cost you extra with many other systems. Peripheral bargains are included here.

374. *Radatron's* Catalog 1006 lists many projects from a self-contained portable lab station for an electricity-electronics course to many texts, lab manuals, and applied activities.

306. *Antenna Specialists* has a new 32-page CB and monitor antenna catalog, a new amateur antenna catalog, and a complete accessory catalog.

307. *Atlas* calls their 210X and 215X the perfect amateur mobile rigs. Their 6-page, full-color detailed spec sheet tells all. Yours for the asking.

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.

308. Your guide to equipment for radio communication is an informative product booklet offered by *R. L. Drake Co.* Hams and SWLers alike should scan this 20-page shopper's guide.

310. New and used personal computer machines, and peripherals you never dreamed existed, or were available are in the *Newman Computer Exchange* catalog. Get yours today.

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 18-page brochure.

312. *E.D.I. (Electronic Distributors, Inc.)* carries everything from semi-conductors to transformer/relays to video cameras. In prices ranging from 19¢ to $500, products appear from over 125 electronic parts manufacturers. The catalog is updated 3 times a year.

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

314. Cover the Ham bands from 80 to 10-meters with one classy rig—*Swan Electronics'* 100-W 100 MX mobile transceiver. Get the details direct from *Swan*.

316. Get the *Hustler* brochure illustrating their complete line of CB and monitor radio antennas.

318. *GC Electronics* offers an "Electronic Chemical Handbook" for engineers and technicians. It is a "problem solver" with detailed descriptions, uses and applications of 160 chemicals compiled for electronic production and packaging. They are used for all types of electronic equipment.

320. *Edmund Scientific's* new catalog contains over 4500 products that embrace many sciences and fields.

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

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.

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. Hard to find parts fill each page, so get a copy of the catalog from *McGee* today!

329. *Semiconductor Supermart* is a new 1979 catalog listing project builders' parts, popular CB gear, and test equipment. It features semiconductors—all from *Circuit Specialists*.

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

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.

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). Colorful literature illustrating two models of monitor-scanners is also available.

354. A government FCC License can help you qualify for a career in electronics. Send for Information from *Cleveland Institute of Electronics*.

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Alternator Tester

(Continued from page 113)

tive lead of the Alternator Tester is connected directly to the battery terminal of the alternator. The reason for this is that the ripple measurement depends upon the small, but finite, resistance between the alternator and battery. In order for the ripple test to be accurate, the alternator must be delivering a sizeable current. This is accomplished by slightly discharging the battery. Before starting the test shut the engine off and turn on the car headlights for about ten minutes. During this time you can connect the Alternator Tester to the car. Leave the headlights on while making the test. Start the engine and bring the RPM up to about 2000. Note the reading of the meter. An alternator in proper operating condition will have a ripple voltage somewhere between 0.2 and 0.5 volts peak-to-peak. Should one or more of the diodes be defective the ripple voltage will increase to 1 volt peak-to-peak, or more. If this is the case you will have to remove the alternator from the car to disassemble it and locate the defective diode. ■

Friendly Flasher

(Continued from page 109)

stalled all three 7447s and verified correct operation at all twenty outputs, you are ready to install and test the 7400 (IC-7) which will be used as four inverters.

Make sure that power has been removed from the board and solder the 7400 (IC-7) in place. To test the 7400 for correct operation, apply power and use a DC voltmeter on pins 1, 4, 10, 13 and 14. Each of these pins should read a steady five volts. Next, check pins 2, 5, 9 and 12 for inputs swinging back and forth between high and low. Finally, check the output pins 3, 6, 8 and 11 to make sure that they also swing between high and low.

When you have met all these conditions, you may remove power. At this point, you have a working circuit board that you have thoroughly checked out. All that remains is to wire in the LEDs and assemble everything in a suitable enclosure.

The selection of an enclosure for this project is pretty much a matter of individual taste. You may wish to build your own or purchase one ready-made. Rather than give detailed instructions which may not apply to your particular choice, I want to pass along some general hints.

The area requiring the greatest attention to detail is the mounting of the LEDs. Make sure that all the holes are exactly lined-up; the slightest misalignment will make the project look sloppy. Paint the front panel before installing the LEDs and, when you do install them, use one of those super strong, super fast instant glues. Be sure to test the LEDs before installation. Finally, in a random fashion, solder the twenty output wires to the LEDs. Be sure to use a heat-sink each time you solder a wire to an LED.

Before applying power, recheck all LEDs with an ohmmeter and secure any loose wiring. Make a final visual check and then plug in the power cord. Now hit the switch and you should be rewarded with twenty flashing LEDs. Let everything cook for a couple of hours and then put the rest of the cabinet together. ■

Cyclops

(Continued from page 93)

so that the cathode side is connected to the base of Q1. Do not proceed further until the voltage at pin 13 of IC1 is within the range of +3.5 to 4.5 volts.

Measure the voltage at pins 2, 5, 6, 7, 8, 9, 10, and 12 of IC1. This voltage should be zero. Measure the voltage at pin 8 of IC2 and IC3. This voltage should be about +12 volts. Measure the voltage at pin 1 of IC2 and IC3. This voltage should be zero. This completes the voltage measurements. Correct any improper voltage readings before proceeding further.

Disconnect the power from the circuit. Very carefully insert the integrated circuits in their sockets, paying strict attention to the proper orientation for pin 1 as shown in the component layout. Pin 1 of the Optolinear IC is indicated by a red dot or "U"-shaped indentation molded into the top of the plastic case at one end. Do not confuse this with the circle molded at the opposite end. IC2 and IC3 have a small identification mark molded into the plastic case near pin one. Note that IC2 and IC3 are inserted into the printed circuit board in opposite directions. If it should be necessary to remove an IC from its socket, use an IC puller instead of trying to pry it from the socket. This will avoid bent pins and a damaged IC.

Be sure the speaker is properly connected to the circuit between the +12 volt bus and the collector of Q5. Set S1 to the ON or closed position. Adjust the volume control about halfway and apply 12 volts of power to the circuit, observing correct polarity. You should hear the whooping sound generated by the circuit, and the LED should light. The LED should remain lit for about 30 seconds, and when it goes out, the sound should continue for a few seconds more. Once the sound stops, you can wave your hand over IC1 and cause the sound to start again. This time the circuit will reset itself after a few seconds, since IC2 is being inhibited by the timed cycle of IC3. After another 30 seconds has passed, the cycle can be repeated.

To generate the "Close Encounters" music sound, throw S1 to the OFF or open position. When you apply power to the circuit, Cyclops will generate the whooping sound for 30 seconds, and then will switch to the "Close Encounters" music for another 30 seconds as IC2 and IC3 switch on and off. This sequence will repeat indefinitely. If you wish to generate only the "Close Encounters" sound, remove IC2 from the circuit. Cyclops will then automatically switch from the whooping sound to "Close Encounters" and will hold this mode of operation unless the photodiode detects a change in light intensity.

Applications. Cyclops can be used in many applications depending upon the connections between terminals A, B, C, and D of the circuit and whether or not the timing circuitry of IC2 and IC3 is included in the assembly.

For a short timing interval, such as would be needed for an automatic doorbell or light operated rifle range, the circuit shown on the right of the dotted line of the schematic can be deleted. S1 should be set to the ON or closed position and terminals A and B of the printed circuit board should be connected together. For these applications, as well as using Cyclops for a musical automobile horn, you may want to slow the whooping rate for a more pleasant sound. This can be easily accomplished by changing the value of C4 to 10 microfarads or more, as desired.

The circuit can be used as an inrusion alarm with a long timing interval by building the complete circuit as shown in the schematic. Set S1 to the ON or closed position and short terminals A and B of the printed circuit board together.

A combination whooping sound and "Close Encounters" music can be produced by building the entire circuit and setting S1 to the OFF or open position. Delete the timing circuit for continuous "Close Encounters" music. ■

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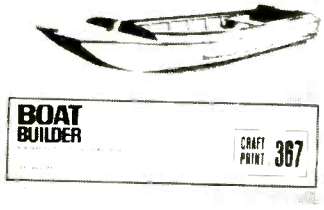
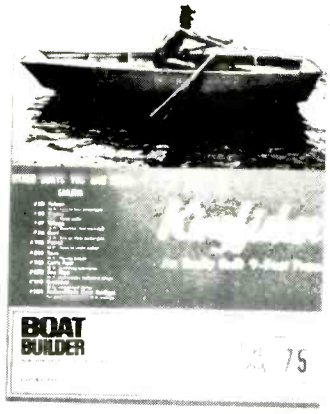
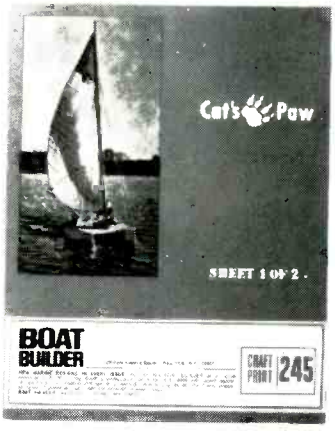


367. ROBIN is a versatile skiff that can be used for hunting or fishing, as a yacht club tender, or a work boat. It is rugged, yet its plywood construction makes it easy to build; no special jig or tools are needed. It can take a motor of 7-10 hp. L.O.A., 12′; beam, 5′1″. $5.00



75. KINGFISHER is a modern version of the Scandinavian pram developed hundreds of years ago. It rows easily, sails well, and propels nicely with a small outboard motor. Its 90 lb. weight and small size make it ideal to car-top; construction is plywood. L.O.A., 9′; beam, 4′. $5.00



245. CAT'S PAW catamaran provides a stable base for a lot of sail area to make for fast sailing. And she's easy to build because of her straight-sided hulls, flat sheer, and straight bow and stern. It's an ideal boat in which to learn sailing. L.O.A., 12′, beam, 6′2″; sail area, 85 sq. ft. $6.00

343. MINIMOST is an 8′ outboard sports hydro you can build in just 15 hours, and at a cost of less than $25 for materials. Its advanced underhull design makes speeds in the 30 mph range possible with a 10 hp motor. L.O.A., 8′. $5.00
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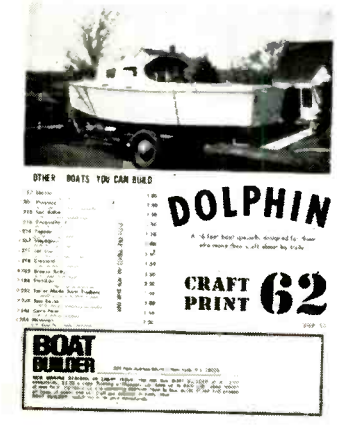

62. DOLPHIN is small and light enough to be transported anywhere by trailer, yet it will accommodate two persons for extended cruising or a party of four on day trips. Plywood is used throughout, and the hull is designed to get the most from modest power. L.O.A., 16′; beam, 5′9″. $5.00

356. TABU gets up on plane, just like an outboard, to provide speeds up to four times higher than those possible with a conventional hull of the same size. Hull is of plywood, covered with resin and Dynel cloth. L.O.A., 16′; beam, 4′8″; draft, centerboard down, 2′6″; sail area, 165 sq. ft. $5.00

371. JAMAICAN is a sailing surfboard of unique construction. Fiberglass and Dynel cloth are stretched and stapled in place over a wooden framework, then resin is applied. No special building jigs or forms are needed. Foamed-in-place polyurethane adds stiffness. L.O.A., 12′; beam, 3′. $5.00

36. CHUM is a speedy little runabout that can be built as a single cockpit or double cockpit model. Use a lightweight engine of no more than 100 hp for top performance. Construction is of marine plywood over hardwood frames. Decks are of mahogany-faced plywood. L.O.A., 15′6″ $5.00

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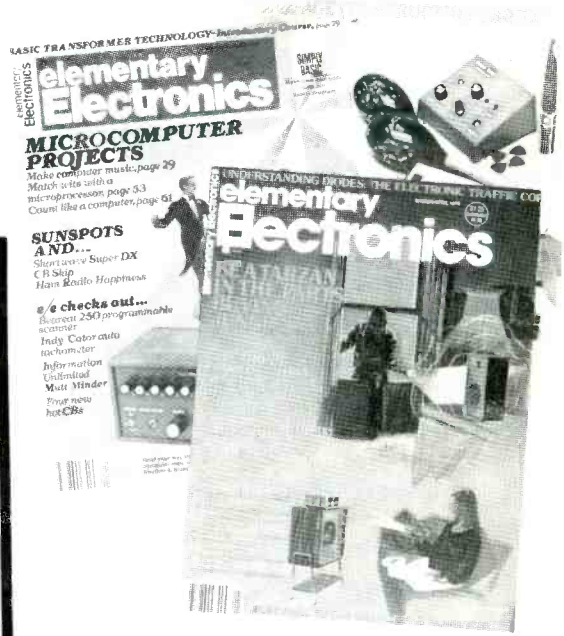

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