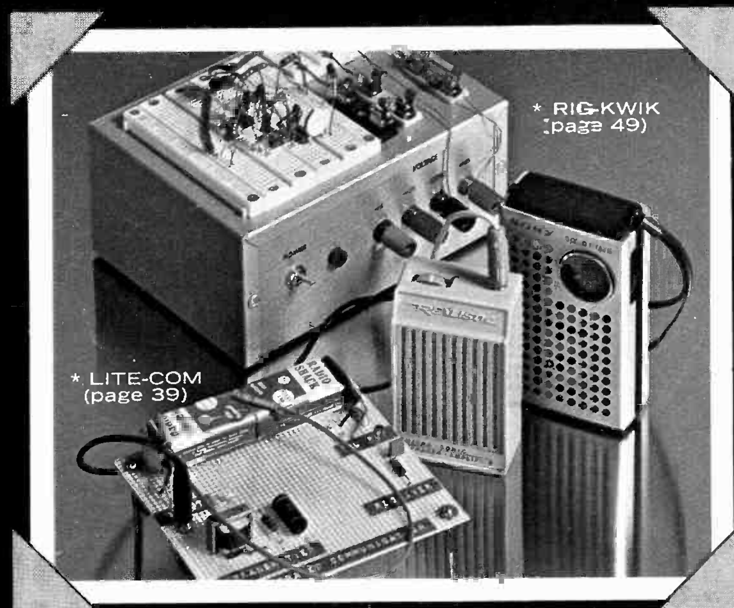
ELECTRONICS HOBBYIST

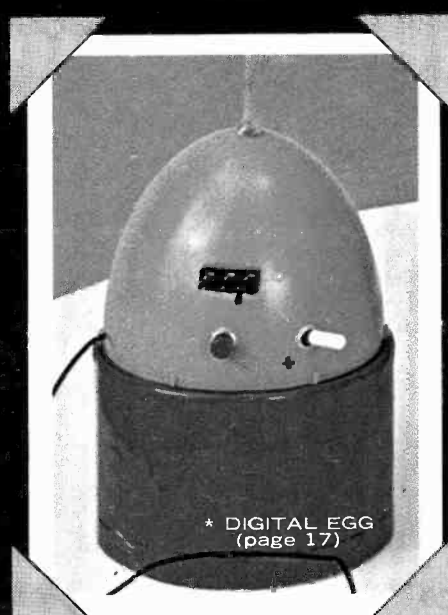
FALL-WINTER 1976 $1.35 02396

By the Editors of ELEMENTARY ELECTRONICS

Photo clips of FUN PROJECTS YOU CAN BUILD

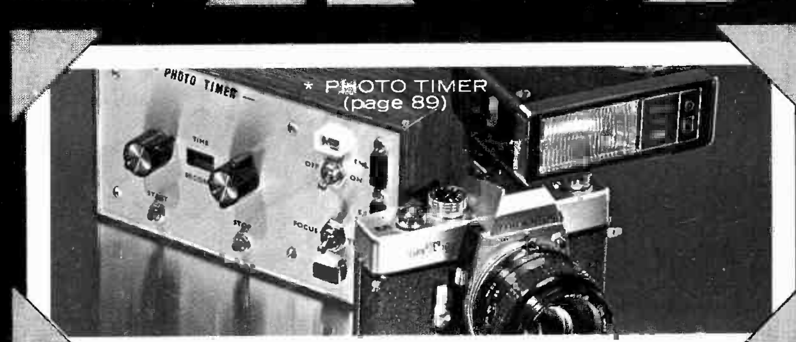
- Digital voltmeter assembled inside a plastic egg
- CB power supply brings your mobile rig indoors
- Convert pocket calculator to an elapsed time indicator
- Foot pedal that adds the whaa-whaa sound
- Powered breadboard for rapid IC circuit mockup and testing
- Audio light-beam transmission through fiber optics
- Darkroom printing meter that takes the guesswork out
- Go/No-Go Op Amp tester that turns sweepings into gold
- Multi-Band SW antenna is the cheapest one yet
- Fool-proof photo timer does the switching for you
- Gadget that spots defective AC outlets that can kill





How to get started in CB RADIO

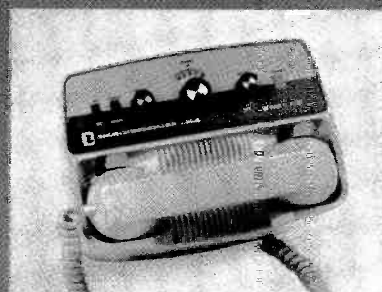
Inside dope, smart buys, and installation tips from a beginner who learned fast.



HIT THE ROAD WITH THE AUTOMATIC CB. JOHNSON.

"This year, lots of folks are takin' to the road for trips and adventures of all kinds. They're getting more fun out of every mile with the automatic CB from Johnson. And y'all know it's right handy if you're in a heap of trouble, too."

That's right, Sheriff. Johnson's built-in, automatic controls make operation easier and safer, performance better. Exclusive voice tailored audio circuitry automatically drops off signals outside voice frequencies to give you great reception.



Our automatic noise limiter keeps reception clean and built-in gain control prevents blasting and fading.

Johnson's unique electronic speech compression automatically selects and compresses voice frequencies to produce uniform, high-level modulation, maximum range. All automatically.

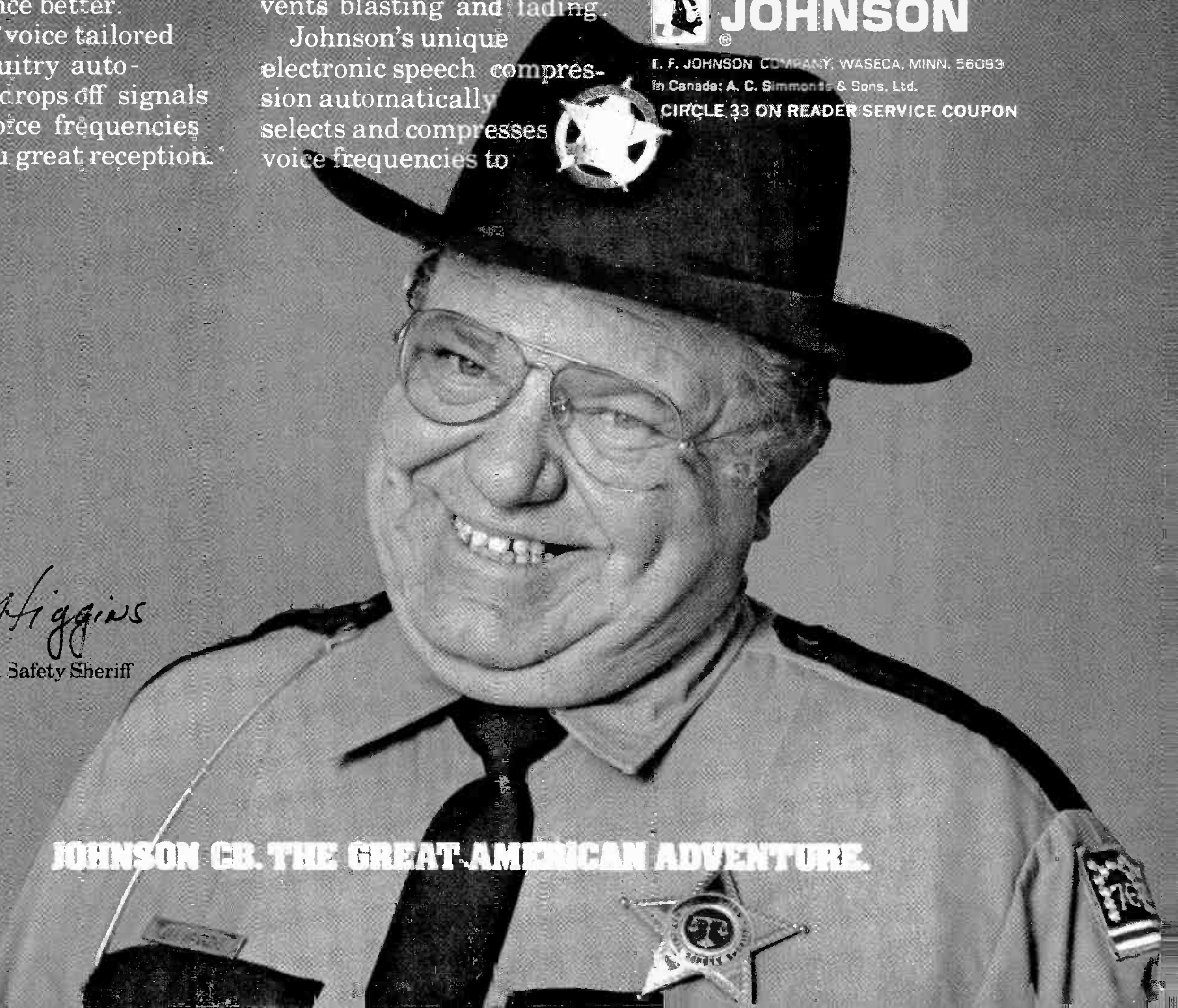
When you hit the road, go with Johnson CB. We back every Johnson with a full year parts and labor warranty and walk-in service at more than 850 locations. See a Johnson CB dealer and take off on *the great American adventure.*

JOHNSON®

E. F. JOHNSON COMPANY, WASECA, MINN. 56093
In Canada: A. C. Simmonds & Sons, Ltd.

CIRCLE 33 ON READER SERVICE COUPON

Joe Higgins
National Safety Sheriff



JOHNSON CB. THE GREAT AMERICAN ADVENTURE.

THE STAFF

MPA

MEMBER IHF INSTITUTE OF HIGH FIDELITY

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ELECTRONICS HOBBYIST

PROJECTS

FALL—WINTER 1976

SNAPPY PROJECTS

COLUMNS

★ Cover Features

BUILD 20 RADIO
and Electronics Circuits

Reg. U.S. Pat. Off.

PROGRESSIVE HOME RADIO-T.V. COURSE

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
- ★ EXCELLENT BACKGROUND FOR TV
- ★ SCHOOL INQUIRIES INVITED
- ★ Sold In 79 Countries

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 and switches, etc.

In addition, you receive Printed Circuit materials, including Printed Circuit chassis, special tube sockets, hardware and instructions. You also receive a useful 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

J. Stataitis, of 25 Poplar Pl., Waterbury, Conn., writes: "I have repaired several sets for my friends, and made money. The "Edu-Kit" paid for itself. I was ready to spend $240 for a Course, but I found your ad and sent for your Kit."

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."

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. 519EN 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. 519EN Hewlett, N.Y. 11557

CIRCLE 8 ON READER SERVICE COUPON

New Products

Made to Move

The next time you move out in your RV, or hit the Interstate for a distant sales call, plan to take along Pioneer Electronics new Centrex RK-114 Portable Cassette Recorder with AM/FM. It happens to be the top-of-the-line of four units introduced by Pioneer Electronics. The RK-114 features battery and AC power supply capabilities, built-in automatic recording level control, automatic shutoff at tape end, built-in condenser microphone, AC bias and erase, and electric motor speed governor to virtually eliminate wow and flutter. Pushbutton control of tape modes (record, play, fast forward, rewind, pause and stop/eject) is among the features. The RK-114 has external mike/radio mixing, continuously

CIRCLE 72 ON READER SERVICE COUPON

variable speaker monitor control, automatic or manual record level control, plus sleep to music and record level/battery condition/tuning meter. Also features built-in AFC on FM, illuminated slide rule radio dial, 3-digit tape counter and stereo headphone jack for undisturbed private listening pleasure. Jacks also provided for remote mike, external speaker, auxiliary sound source, 6V car battery used with optional power converter, and AC power input. There are separate controls for volume (speaker monitor), tone, tuning and recording level. Sells for $99.95. Get all the data on the RK-114 and other quality Centrex audio products from Pioneer Electronics, 1555 E. Del Amo Blvd., Carson, CA 90746.

Portable Frequency Monitor

A frequency counter has now been added to the Non-Linear Systems line of miniature, battery powered test instruments. The FM-7 frequency meter is small enough to take anywhere, only 1.9-in. high by 2.7-in. wide by 4-in. deep. It will monitor frequencies from 10 Hz to 60 MHz and display the frequency to seven digits using 0.25-in. high LEDs. Input sensitivity is 30 millivolts RMS from 50 Hz to 30 MHz, 100 millivolts RMS from 10 Hz to 60 MHz with a 1 megohm input impedance. It has an input signal overload capability of up to 250 volts RMS at 500 kHz. The gate time is 1 second, giving a resolution of 1 Hz below 10 MHz and 10 Hz from 10 MHz

CIRCLE 61 ON READER SERVICE COUPON

to 60 MHz. The accuracy is ±1 digit. There is only a ±10 ppm change over a temperature range of 0 to 40 degrees C. The meter operates on self-contained type AA NiCad rechargeable batteries. The batteries and a charger unit are furnished with the frequency monitor. Options include a panel-mount flange, a tilt stand, and a leather case which can be carried on a belt or around the neck. The FM-7 will retail for $195.00 and will soon be available from distributor stock. For more information, write to Non-Linear Systems, Inc., P.O. Box N, Del Mar, CA 92014.

Darkroom Exposure Meter.

PixTronics' new Model 200 Super Sensitive Electronic Darkroom Meter is used to determine the correct exposures of all black-and-white and color negatives for printing enlargements. The Model 200 is simple to utilize with any enlarger and its use eliminates the need for constantly making costly and time-consuming test strips. The unit works on 110 volts AC, measures 6¾ by 5¼ by 2¼ inches, weighs 2½ pounds, and is supplied with its own plug-in easel probe. The probe has two apertures (⁷⁄₃₂-in. and ³⁄₃₂-in.) taking care of all exposure requirements. The 4½-inch illuminated dial of the meter makes it easy to read the scales in the dark. The meter has three sensitivity ranges for reading photographic nega-

CIRCLE 67 ON READER SERVICE COUPON

tives of any density. It also has a Sensitivity Control for making the necessary reference reading of a test negative for quick-and-easy exposure determination of any new negative. The Sensitivity Control is also utilized in conjunction with the Easel probe to find the correct paper grades for black-and-white projection

CIRCLE 7 ON READER SERVICE COUPON

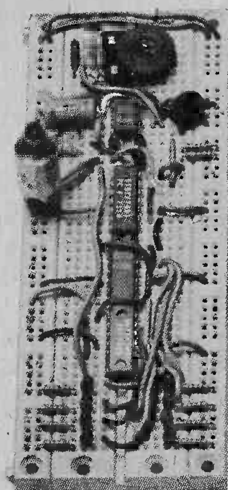
EVERY PROJECT ANOTHER REASON TO

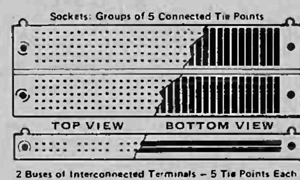
Whether you're a hobbyist or serious experimenter, CSC's line of precision digital/electronics design and testing equipment can take the manual labor out of your labors of love.

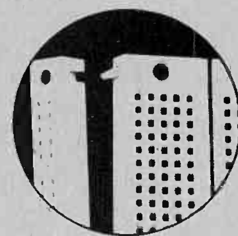
In fact, we can not only save you literally hundreds of hours a year, but *hundreds of dollars* as well. On parts, accessories and test equipment.

Want proof? Read on — you'll see why we're the fastest-growing company in the field!

QT Sockets and Bus Strips* — time-saving, money-saving solderless breadboarding — the CSC way





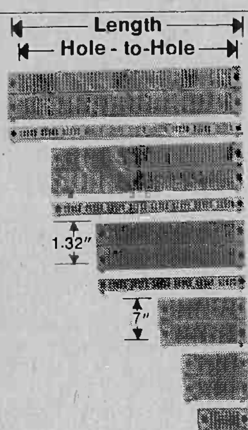


Our expandable, interlocking breadboarding system not only saves you hours of soldering, desoldering and resoldering, it also saves wear and tear on your components.

Resistors, capacitors, transistors, DIP's, LED's, micro-processors, etc., all connect with plug-in, plug-out ease. *Preassembled sockets with durable nickel-silver non-corrosive 5-point terminals* provide low-resistance interconnections you can arrange and rearrange at will. (And jumpers, where required, are short lengths of solid #22-30 AWG wire.)

Use QT Sockets and Bus Strips for designing, troubleshooting, interconnecting, patching and dozens of other applications. Our unique snap/lock mechanism joins units in seconds, so you can add-on or take-off at will.

Check the chart below for sizes and prices.
10 modestly-priced models to choose from — still at our original low prices.
All can be top or through-the-panel rear mounted.



	Length	Hole - to-Hole	Terminals	Unit Price $
QT-59S	6.5"	6.2"	118	12.50
QT-59B	6.5"	6.2"	20	2.50
QT-47S	5.3"	5.0"	94	10.00
QT-47B	5.3"	5.0"	16	2.25
QT-35S	4.1"	3.8"	70	8.50
QT-35B	4.1"	3.8"	12	2.00
QT-18S	2.4"	2.1"	36	4.75
QT-12S	1.8"	1.5"	24	3.75
QT-8S	1.4"	1.1"	16	3.25
QT-7S	1.3"	1.0"	14	3.00

*U.S. Pat. No. 235,554

All Prices Shown Are Manufacturer's Recommended List. Prices and Specifications Subject to Change Without Notice.

CONTINENTAL SPECIALTIES CORPORATION
44 KENDALL STREET/ BOX 1942
NEW HAVEN, CT 06509

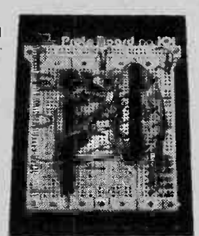
CIRCLE 12 ON READER SERVICE COUPON

IN THIS MAGAZINE IS READ THIS AD.

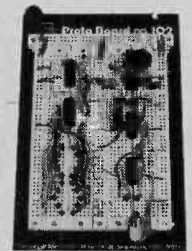
Build projects, test circuits, check components as fast as you can think... with CSC Proto-Board® Solderless Breadboards!

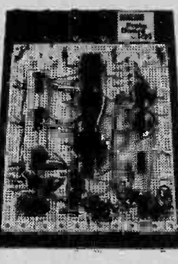
The right size for every circuit! The CSC Proto-Board system gives you the convenience and versatility of QT Bus Strips and Sockets *already mounted,* in use-tested configurations, on sturdy metal ground/baseplates** with non-marring feet. They're great for a wide variety of audio and digital projects, and you save money by using components over and over again.

PB-101—940 solderless tie points: ten 14-pin DIP capacity. Two QT-35S breadboarding sockets plus four QT-35B bus strips. Excellent for audio and smaller digital projects. Measures 4.5″ wide x 5.8″ long x 1.4″ high (114 x 147 x 35mm); weighs 9 oz. (.26 Kg). **Price: $29.95**

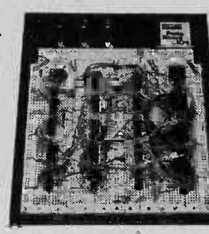


PB-102—1240 solderless tie points: twelve 14-pin DIP capacity. Two QT-47S breadboarding sockets, three QT-47B and one QT-35B bus strips. You'll want this one for intermediate digital needs, more complex audio projects among other things. Measures 4.5″ wide x 7″ long x 1.4″ high (114 x 178 x 35mm); weighs just 10 oz. (.31 Kg). **Price: $39.95**





PB-103—2250 solderless tie points: twenty-four 14-pin DIP capacity. Three QT-59S breadboarding sockets, four QT-59B and one QT-47B bus strips plus four 5-way binding posts. For all but the very largest circuits. Lets you build calculators, interfaces, complex switching circuits, etc. Measures 6″ wide x 9″ long x 1.4″ high (152 x 229 x 35mm); weighs 1.25 lb. (.57 Kg). **Price: $59.95**



PB-104—3060 solderless tie points: thirty-two 14-pin DIP capacity. Four QT-59S breadboarding sockets, seven QT-59B bus strips plus four 5-way binding posts. It's the largest breadboard we made for the largest projects you care to tackle—a CPU, encoder, complex display . . . just about anything. Measures 8″ wide x 9.8″ long x 1.4″ high (203 x 248 x 35mm); weighs 1.75 lb. (.79 Kg). **Price: $79.95**

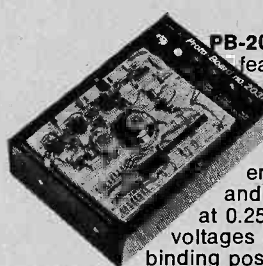
Save even more with Proto-Board Kits! Invest ten minutes of your time, using nothing more than a screwdriver and a pair of pliers, and you can have all the time-saving, money-saving features of CSC's Proto-Board system, for even less money! CSC Proto-Board Kits come with all hardware, non-marring feet and sturdy base-plate. And unlike other kits, *all sockets are pre-assembled,* eliminating tedious assembly and assuring long, trouble-free life.

PB-6 Kit—630 solderless tie points: six 14-pin DIP capacity. Most economical way to take advantage of Proto-Board speed and convenience. One pre-assembled QT-47S breadboarding socket, two assembled QT-47B bus strips, four 5-way binding posts, metal ground/plane/base-plate, all required hardware. 10 minute assembly with pliers and screwdriver. Measures 6″ long x 4″ wide x 1.4″ high (152 x 102 x 34mm); weighs 7 oz. (.20 Kg). **Price: $15.95**

PB-100 Kit—760 solderless tie points: ten 14-pin DIP capacity. 21% larger capacity than PB-6 Kit. Comes with two pre-assembled QT-35S breadboarding sockets, one assembled QT-35B bus strip, two 5-way binding posts, pre-drilled and screened base-plate, non-marring feet and all required hardware. Fast 10 minute assembly. Measures 4.5″ wide x 6″ long x 1.4″ high (114 x 152 x 35mm). Weighs 7.5 oz. (.21 Kg). **Price: $19.95**

Now! Proto-Board convenience, plus regulated power! No need to hunt for a power supply when you're working with these CSC Proto-Board units. Built-in power supplies give you the DC power you need, with laboratory-precision regulation, plus low ripple and noise. Choose the PB-203 for digital circuits and other projects requiring 5V or less (with external components) or for maximum flexibility, the PB-203A, with 5VDC plus two independently-adjustable voltage sources.

PB-203—2250 solderless tie points: twenty-four 14-pin DIP capacity. *The Ultimate!!* All Proto-Board features *plus* short-proof, fused 5VDC, 1A regulated power supply with only 10mV ripple and noise at 0.5A; on-off toggle switch and pilot light. Three QT-59S breadboarding sockets plus four QT-59B and one QT-47B bus strips. Power supplied via two of the four 5-way binding posts. It all adds up to lots of capacity plus the proper DC voltage for most digital and many analog IC's. Measures 9.75″ long x 6.6″ wide x 3.25″ high (248 x 168 x 83mm). Weighs 5 lb. (2.27 Kg). For 117 VAC, 50/60 Hz (220 VAC, 50/60 Hz; also available at slightly higher cost). **Price: $75.00**



PB-203A—*The Ultimate . . . plus!!* All the features of the PB-203 including regulated 5VDC supply *plus* additional power supply flexibility (separate regulated +15VDC and −15VDC, 0.5A supplies, each with internally and independently adjustable output voltage; ripple and noise of + and −15V supplies, 10mV at 0.25A). Connections for 3 power supply voltages and ground available at four 5-way binding posts. Same size as PB-203; weighs 5.5 lb. (2.5 Kg). For 117 VAC, 50/60 Hz (220 VAC, 50/60 Hz; also available at slightly higher cost). **Price: $120.00**

TURN PAGE FOR MORE CSC PRODUCTS AND EASY ORDER FORM

**PB-100 has fibreglass-reinforced plastic baseplate.

8 MORE WAYS TO DO IN A LOT LESS TIME-FOR

CSC's Design-Mate™ Series. Laboratory precision at a hobbyist's price.

We knew what you were looking for when we created the Design-Mate Series. So we put the emphasis on laboratory precision and professional performance instead of needlessly expensive fancy cabinetry. Check it out! Check it all out!

DESIGN-MATE 1
BREADBOARD/CIRCUIT DESIGNER

Design-Mate 1 gives you everything you need for fast, easy solderless circuit design in a single compact package. QT speed and versatility for circuit design and modification as fast as you can push in (or pull out) a lead, using one QT-59S breadboarding socket and two QT-59B bus strips, mounted on the top panel. Adjustable, precision-regulated 5-15 VDC 600 mA short-circuit-proof fused supply, with less than 20 mV noise and ripple at rated output (9W max.). Built-in 0-15VDC meter lets you monitor voltages in circuit or supply. Top panel supply and meter connections are easily made via four 5-way binding posts; on-off and voltage adjustment controlled by potentiometer; bright LED indicates power. Measures 7.5″ wide x 6.5″ deep x 3.25″ max. high (191 x 165 x 83mm); weighs 3 lb. (1.4 Kg). For 117 VAC, 50/60 Hz (12W); also available for 220 VAC, 50/60 Hz at slightly higher cost. **Price: $54.95**

DESIGN-MATE 2
FUNCTION GENERATOR

Design-Mate 2 gives you a lot of signal generator for very little money. Advanced IC circuitry produces stable low-distortion sine waves (less than 2% THD), fast-rise-and-fall-time square waves (less than 0.5 microseconds across 600 ohms) and high-linearity triangle waves (better than 1% over range). Frequency is accurate—and repeatable—to 5% of dial setting, in 5 ranges: 1-10Hz, 10-100Hz, 100Hz-1KHz, 1-10KHz, 10-100KHz. Shortproof output is adjustable, 100mV-10V P-P for all waveforms, into open circuit. **Controls, switches, indicators and connectors:** toggle power switch with LED indicator; function selector switch; range switch; frequency selector dial (1-10 in 100 increments); amplitude control; twin 5-way binding posts. Measures 7.5″ wide x 6.5″ deep x 3.25″ high (191 x 165 x 83mm); weighs 2 lbs. (0.91 Kg). For 117 VAC, 50/60 Hz; also available for 220 VAC, 50/60 Hz at slightly higher cost. **Price: $69.95**

DESIGN-MATE 3
R/C BRIDGE

Design-Mate 3 is an indispensible tool for professionals and hobbyists alike. Makes precision resistance and capacitance measurements in seconds, with positive LED indication. Readings are accurate within 5% of the dial setting at any range—resistance: 10-100 ohms, 100-1K, 1K-10K, 10-100K, 100K-1 meg; Capacitance: 10-100pF, 100-1,000pF, .001-.01µF, .01-.1µF, .1-1µF. Simple 2-control operation: set range with switch, then turn Null Adjust dial until both LED are lit. **Switches, controls, indicators and connectors:** toggle power switch with LED indicator; range selector switch; Null Adjust dial (1-10 in 100 increments); LED null indicators; twin 5-way binding posts. Measures 7.5″ wide x 6.5″ deep x 3.25 max. high (191 x 165 x 83mm); weighs 2 lbs. (0.91 Kg). For 117 VAC, 50/60 Hz; also available for 220 VAC, 50/60 Hz, at slightly higher cost. **Price: $59.95**

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Design-Mate 4 is a multi-purpose, multi-mode pulse generator providing pulses from 0.5Hz-5MHz, rise and fall times less than 30 nsec and 10^7:1 duty cycle range, compatible with CMOS and TTL. It provides the precision, flexibility and versatility of a laboratory instrument, priced low enough for the workbench of every engineer, technician, student and hobbyist who works with digital circuitry. Its unique combination of performance and price makes it ideal for a wide variety of applications throughout the electronics industry. Design-Mate 4 may be used as a clock source, delayed pulse generator, synchronous clock source, manual system stepper, pulse stretcher, clock burst generator, in tandem with one or more DM-4's used to gate the output of one or more additional DM-4's. **Price: $124.95**

COMPLETE INSTRUCTIONS AND APPLICATION DATA PROVIDED!!

All Prices Shown Are Manufacturer's Recommended List. Prices and Specifications Subject to Change Without Notice.

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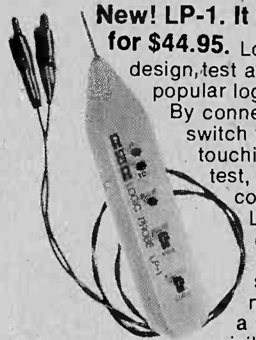
CSC's Digital testers save your sanity. And your money.



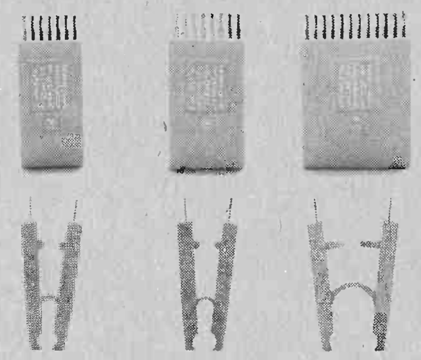
New! LP-1. It digs up a lot of information for $44.95. Logic Probe 1 is a compact, versatile design, test and trouble-shooting tool for all popular logic families and digital applications. By connecting the clip leads, setting a switch to the proper logic family and touching the probe to the node under test, you get an instant picture of circuit conditions.

LP-1 combines the functions of level detector, pulse detector, pulse stretcher and memory—makes one-shot, low-rep-rate, narrow pulses—nearly impossible to see, even with a fast scope—easily detectable and visible.

LM-1. It lets you check digital IC's faster than a scope, safer than a voltmeter, for a lot less than you might guess—only $74.95. Logic Monitor™ 1 speeds digital design and testing by accurately and automatically displaying static and dynamic logic states of DTL, TTL, HTL and CMOS DIP IC's. All in a compact, self-contained 16-pin circuit-powered unit. Use it to effortlessly trace signals through counters, shift registers, gating networks, flip-flops, decoders, etc. Clip it over any DIP IC up to 16 pins, and each contact connects to a single "bit" detector with high-intensity LED readout. Logic 1 (high voltage) turns LED on; Logic "0" (low voltage or open circuit) keeps LED off. A power-seeking gate network automatically locates supply leads and feeds them to the Logic Monitor's internal circuitry.

Proto-Clip™* IC Test Clips pay for themselves the very first time you use them.

Use Proto-Clip Connectors By Themselves...

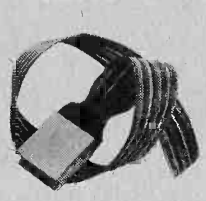


PC-14 (14-pin Proto-Clip) $4.50 each

PC-16 (16-pin Proto-Clip) $4.75 each

PC-24 (24-pin Proto-Clip) $8.50 each

Or With Pre-Wired Cables



The reason's as simple as the time you'll save testing, signal tracing or wiring in DIP's. Not to mention the cost of IC's ruined by accidental shorts. A Proto-Clip is the foolproof, short proof way to bring up leads from crowded circuit boards. Its patented, molded design and unique gripping teeth free hands for other work. Built to withstand tough day-to-day use, CSC clips are available with or without cable for 14- 16- and 24-pin DIP's starting at $4.50.

*U.S. Pat. No. 3,914,007

	Cable length inches	Price Single clip	Price Dual clip
PC-14-	12	7.50	14.50
PC-14-	18	7.75	14.75
PC-14-	24	8.00	15.00
PC-14-	30	8.25	15.25
PC-14-	36	8.50	15.50
PC-16-	12	8.25	15.75
PC-16-	18	8.50	16.00
PC-16-	24	8.75	16.25
PC-16-	30	9.00	16.50
PC-16-	36	9.25	16.75
PC-24-	12	12.00	25.00
PC-24-	18	12.25	25.25
PC-24-	24	12.50	25.50
PC-24-	30	12.75	25.75
PC-24-	36	13.00	26.00

NOTE: S=single clip (on one end of cable); D=dual clips (on both ends of cable). When ordering Proto-Clip units with cable, include Part No., cable length and Single (S) or Dual (D)—for example: PC-16-24-D is 24" cable with a PC-16 at both ends.

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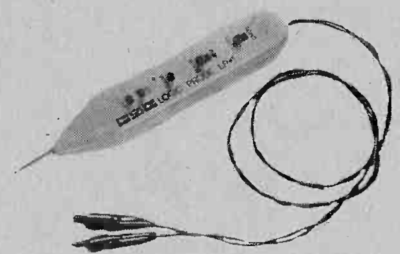
CIRCLE 13 ON READER SERVICE COUPON

New Products

printing. The Model 200 sells for $87.50. Two accessory probes, priced at $10.50 each, are also available. A special density probe and a simple pin-hole light box provide a practical, inexpensive, and accurate way to read directly the density of any negative. A regular probe, cylindrical in shape, ⅝-inch diam. by 2 inches along with 3-foot cable, is available for ground glass photography and many other applications. For more information, please write to PixTronics, Dept. NREE, 681 East 46th Street, Brooklyn, New York 11203, or Circle No.67 on the Reader Service Coupon.

Logic Probe

Continental Specialties now offers its Model LP-1 Multi-Family Logic Probe—a low-cost, pocket-sized, multi-function test instrument for digital applications. In a single housing not much bigger than a fountain pen, the LP-1 combines the functions of a pulse detector, pulse stretcher, and memory circuit, allowing hobbyists to get an instant picture of static and dynamic circuit conditions with most popular logic families. The Logic Probe's low price is $44.95. LP-1's ability to detect pulses as short as 50



CIRCLE 65 ON READER SERVICE COUPON

nanoseconds, coupled with its stretching and latching ability, means that one-shot, low-rep-rate, narrow pulses—nearly impossible to see, even with a fast scope—are now easily detectable and visible. LP-1 is housed in a rugged molded plastic case with built-in strain-relieved power cables and reverse-polarity/overvoltage protection. For further information, contact Continental Specialties Corporation, 44 Kendall Street, Box 1942, New Haven, CT 06509.

Stereo Entertainment Center

Now you can install a Stereo Entertainment Center in your pleasure boat, van, RV, or camper. The unit is an overhead "custom" housing designed to hold any J.I.L. in-dash model and two speakers, while providing easy access to front panel controls for driver and passenger.

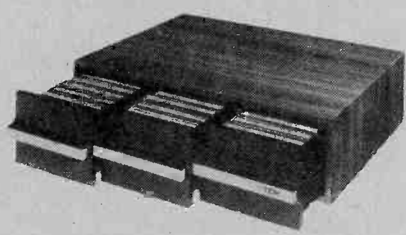
CIRCLE 73 ON READER SERVICE COUPON

The Stereo Entertainment Center's handsome, sculptured black grain casing incorporates a pair of air-suspended speakers.

Overall dimensions are 24 inches long by 5¼ inches deep by 9 inches wide. Price is $39.95. For complete information on the Stereo Entertainment Center, write Dept. P, J.I.L., 737 West Artesia Blvd., Compton, CA 90220.

Tape Drawers

A handsome woodgrain finish storage case for cassettes is being offered by TDK. The new case, called the CP-36, holds 36 cassettes in three drawers, each of which has an individual handle. The woodgrain finish makes the storage esthetically compatible with hi-fi components. The CP-36 has been designed so that a cassette deck can be placed



CIRCLE 66 ON READER SERVICE COUPON

directly on top of it to save shelf space. Suggested retail price is $33.95. For information on this product and for TDK tapes, write to TDK Electronics Corp., 755 Eastgate Blvd., Garden City, NY 11530.

Spot Tip

A Tweezer-Lite is just what its name implies—a pair of tweezers with a new dimension: a spotlight. It's an indispensable item for every shop or tool box, and a must for hobbyists, craftsmen, technicians, artists, and do-it-yourselfers whose jobs demand perfection. Tweezer-Lite is all metal, the finely balanced

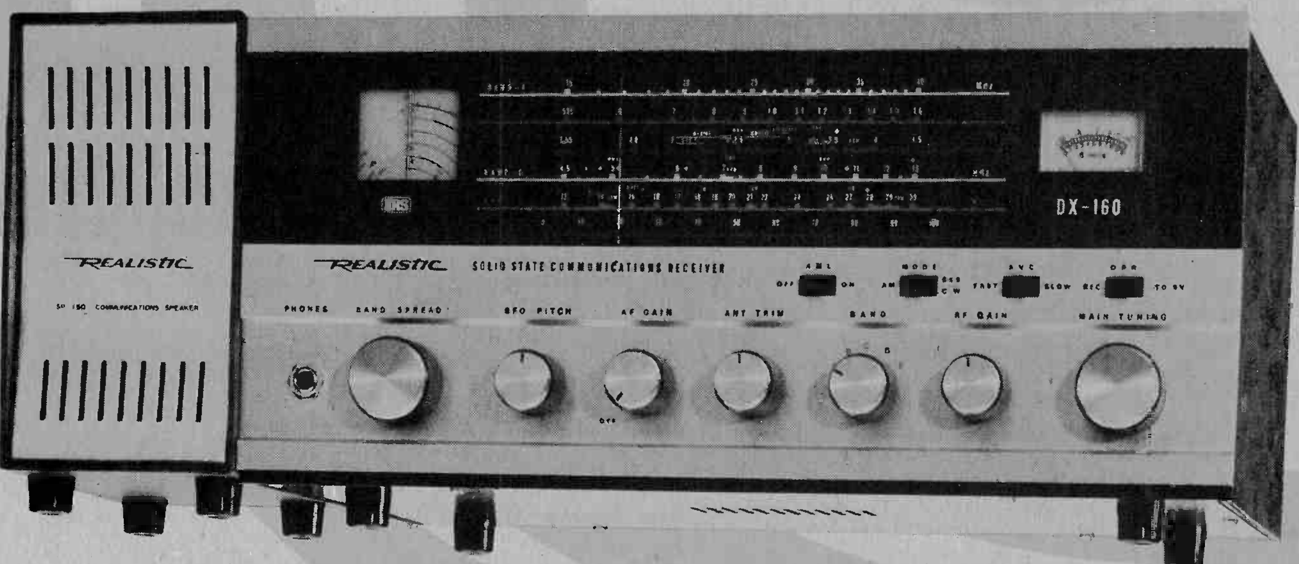
CIRCLE 75 ON READER SERVICE COUPON

barrell fits comfortably in the hand, sculptured blades are coined from the stainless steel. Precision tips are designed to grip the most infinitesimal objects. They are available in three styles: the Cosmetic has a beveled edge, the Universal a square edge, and the Professional is ground to a fine point. Price for a Tweezer-Lite is $9.95. For further information, write to Tweezer-Lite, 5911 Towne Avenue, #5 E, Los Angeles, CA 90003.

Rugged VOM

A new 30,000 ohm/volt VOM has been introduced by the VIZ. The WV-518B volt-ohm-milliammeter is the first of several new products to be announced since VIZ acquired the RCA test instrument line. The VOM measures AC and DC voltages from 0 to 1000V with ± 3% full-scale accuracy. It has four resistance ranges and five DC current ranges up to 5A. All switch-selectable ranges are fuse-

When the world talks, you can listen...



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Full-feature design for HAM/SWL CB/SSB/AM listening 159[95]

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The modern world is a "global village" when you own the versatile DX-160. Five bands covering 130 kHz to 30 MHz let you monitor all types of transmissions from all over the world. Pick up all the CB channels, both AM and SSB. Hear native music, news, even clandestine shortwave stations from places like Djakarta, Addis Ababa, and Barbados. Learn "first hand" of disasters and coups around the globe — minutes after they occur. Tune in longwave aviation/marine weather reports and special civil defense disaster frequencies. Receive WWV time signals and radio propagation forecasts. And you'll be surprised at the DX-power you get on the standard AM broadcast band. The DX-160 gives you eleven controls and switches; you can really "pull out" those distant stations. Main tuning control plus precision bandspread tuning calibrated for the Amateur bands. A product detector and BFO assure superior SSB and code reception. Controls for audio and RF gain, BFO pitch and antenna trim. Switches for automatic noise limiting, AM-to-CW/SSB, fast or slow automatic volume control, and standby for use with a transmitter. FET's in all critical stages for maximum sensitivity and selectivity and crystal-filter IF stages for reduced noise. Illuminated S-meter. Headphone jack. And the matching speaker is included. U.L. listed. The DX-160 — what a way to travel! Ask for 20-152.

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...ew Products

protected against burnout; a separate jack provides access to the 5A AC or DC current range. Recessed front panel jacks and flush-fitting test cable banana plugs assure a tight connection with no exposed metal to create a safety hazard. The rugged double ball-bearing detent switch with double action wiper ensures

CIRCLE 59 ON READER SERVICE COUPON

long life and high reliability. The WV-518B VOM sells for only $39.95. Additional information can be obtained from Robert Liska, VIZ Test Instruments Group, 335 E. Price St., Philadelphia, PA 19144.

Budget All-Band Scanner

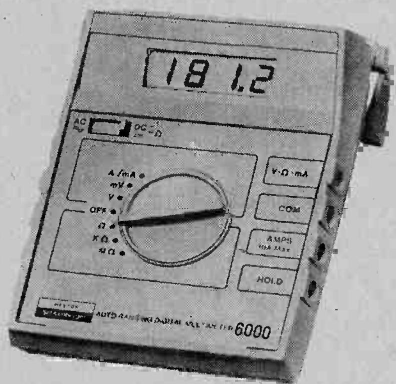
A real low price winner, the Regency ACT-C4 H/L/U is the first scanner to offer 3 band performance for under $100.00. Regency's new unit can cover as many, and in some cases more bands, as current units selling for $159 and up.

CIRCLE 48 ON READER SERVICE COUPON

Scanners retailing for $139 or less have, in the past, only offered one or two band performance. The new ACT-C4 H/L/U is beautiful, yet the rugged molded ABS cabinet features an exclusive top sliding panel for convenient programming and crystal access. Each of the unit's four channels is controlled by the channel lock-out feature. Continuous broadcasts, such as the NOAA weather service, or digital data exchange periods on the exciting mobile telephone frequencies can be automatically bypassed with the channel lock-out switch. Priced at $99.95. For all the facts, write to Regency Electronics, Inc., 7707 Records St., Indianapolis, IN 46226.

Autoranging Portable DMM

Weston Instruments has just announced the introduction of the Model 6000 Autoranging Portable Digital Multimeter at the low price of $195. The Model 6000 is a field grade multimeter with the performance characteristics of a bench type instrument. Automatic ranging is provided for the five standard measurement functions: AC volts, DC volts, AC amps, DC amps and resistance. Twenty-six different ranges cover voltage measurements from 200 mV to 1 kV, current measurements from 2 mA to 10 amps, and resistance from 200 Ohms to 20 megohms. A special "Hold" input jack provides a convenient memory retention capability for remote measurements. Automatic zero and automatic

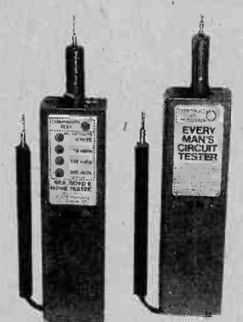


CIRCLE 54 ON READER SERVICE COUPON

polarity are built-in. The overall size of the Model 6000 is 7 × 5.75 × 2.25-in. and the unit weighs less than two pounds. A combination carry handle/display cover/tilt stand makes the meter convenient and practical for either field, bench, or lab use. For further info, write to Weston Instruments Inc., 614 Frelinghuysen Avenue, Newark, NJ 07114.

Meterless Testers

Instant answers are what you get when you make electrical tests with these new Meterless Testers just introduced by E/B/A Marketing. No complex faces to stare at, no puzzling over which scale to use, no squinting at the reading. Instead of meters these new testers use bright red LEDs to instantly signal all answers to your tests. Designed espe-



CIRCLE 58 ON READER SERVICE COUPON

cially for the do-it-yourselfer for use around the home, cars, boats, RVs, snowmobiles, motorcycles, trailers, etc., you can choose from two models of these new meterless testers. The "Sea, Road, & Home Tester," priced at $22.95, uses five LEDs. Four are used on the combination AC and DC Voltage tests of 6, 12, 110, and 220 volts, nominal. The fifth LED is used as an indicator for the Continuity test. The tester will also show Polarity of DC voltages and the "hot" side of AC power lines. The four voltage test levels were chosen as those most often encountered in normal do-it-yourself repair and installation projects. The 6- and 12-volt tests help in working on cars, RVs, boats, cycles, etc., with the capability of measuring not only DC battery voltages, but also the AC output of alternators. The 110 and 220 volt tests are of most use around the home. The "Everyman's Circuit Tester," priced at $11.95 assembled and $8.95 as a kit, uses a single LED in a "universal" circuit which indicates continuity, voltage presence (any potential from 4 volts to 600 volts, AC or DC), and polarity. A two-position switch selects the tests. An ordinary 9-volt transistor radio battery (not supplied) gives the testers "go-anywhere" portability. The probes will reach test points as far as 50 inches apart. The red (positive) probe is an integral part of the tester case to make readings even more convenient with the LED readouts being right in your hand at the test point. These new meterless testers are available in the U.S. by mail order from E/B/A Marketing, Box 727, St. Joseph, MI 49085.

Fail-Safe CB Base Station

A compact 23-channel Citizens Band AM transceiver by SBE has automatic "fail-safe" circuitry which switches the unit from normal 117 VAC to battery operation in event of a power failure. The Trinidad II is less than ten inches wide, five inches high, and nine inches deep. It can be instantly switched from base station operation to virtually any mobile

CIRCLE 64 ON READER SERVICE COUPON

application. The unit offers synthesized frequency control of all 23 CB channels in both transmit and receive modes. In addition to squelch, volume, and channel selection controls, the Trinidad II also provides the user with a Paging-Public Address function. The unit is supplied with a dynamic microphone with coil cord and four-conductor plug. The Trinidad II sells for $214.95. For further information, write SBE, Dept. P, 220 Airport Blvd., Watsonville, CA 95076. ■

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
ELECTRONICS HOBBYIST
229 Park Avenue South
New York, NY 10003

Receiver Feature

What is an RF gain control on a CB transceiver? Is it a real advantage?

—S. N., Wrightwood, CA

You can put an RF gain control to good use in CB operation. Most sets don't have them. They operate as if the missing control was set to maximum RF gain. That's good when the band is not crowded and all signals are weak. However, if you are working a local with plenty of signal, turn down the RF gain control (if your set has one) and it will reduce the background noise and weak signals. I know of two remote chain stores that stay in touch with beam antennas and reduced gain. Only their signals get through except for the moments when some mobile rides between the antennas. This is rare and the store's communications are as reliable as the telephone.

FM vs AM on Two-Way

Hank, what is the advantage of FM 2-way communications over AM like we have on CB?

—J. W., Scottsdale, AZ

FM can be said to have superior signal-noise ratio, lower usable signal level, received signal does not deteriorate gradually with distance between receiver and transmitter, carrier power does not depend on audio power, and interference with weaker signals on the same frequency does not exist. FM is the way to go if you need 100 percent reliability without interference.

Gets the Lead Out

What would happen if a lead acid battery was shorted out by a heavy bus bar that could not melt? My buddy says nothing, but I don't think so. What do you think?

—R. K., New Hyde Park, NY

The lead acid cell, like any other battery, will tend to overheat and maybe self-destruct. Excessive heating in a lead-acid battery causes sulfation, plate buckling and electrolyte boil off. The net result will be an interior short in one of the cells. If the battery survives, its overall capacity to deliver its rated ampere-hours will be greatly reduced.

Calculators Count

Hank, why should I learn how to do log problems using tables and longhand as required in my school when the pocket calculator my dad bought me does it all in seconds? Please don't mention my name, the school's principal reads Elementary Electronics.

—X. X., Some City, MN

Okay, X. X., as you say! The solving of log problems is not as important as understanding that logs are really numbers that are expressed by exponents of 10. When you multiply two numbers, you add their exponents. Once you know all the ins and outs of exponents and logs, use your calculator. Me, I still use the old fashioned slide rule on difficult problems. It takes longer, and gives me time to think. Once I know exactly what I am doing, the calculator is the greatest.

Sheets Stop Eddies

Why do they use laminated iron sheets to make up the iron core of a transformer in power supplies?

—T. S., Oklahoma City, OK

The use of metal laminations greatly reduces eddy current losses. These eddy currents in the iron core of a transformer serve no useful purpose and expend energy in the form of heat. Just touch the iron core of a power transformer after it has been in use and you'll feel the heat. Imagine the heat loss multiplied several times when a single iron bar is used in place of laminations. The heat could burn the insulation and melt the copper wire.

Thought in Harness

Is co-phasing two antennas that important, or is one antenna really enough?

—K. D., So. Fallsburgh, NY

If you are using two antennas on one vehicle, yes. If you are using one antenna, and would like to know if two are better, yes. But, let me say that two antennas do not give you twice the signal one would offer. Two antennas give an improved omnidirectional radiation pattern over a single antenna. Of course, we are talking about mobile antennas mounted on one of the worst ground planes in the world—your car. The harness of cables interconnecting the antennas and the CB set do two things of importance. One, the harness provides the correct cable lengths so that the antennas will be in step with each other, and two, the harness provides impedance matching for minimum SWR and maximum power transfer. This is co-phasing and it may be important to you.

Woe is Who

I am the president of our high school radio club. Our club (sorry to say) is going downhill because of the rapid expansion of CB radio. We need people to join our club but more and more people are going to CB radio. What is going to happen to amateur radio?

—B. M., Northampton, MA

Don't worry about amateur radio. Amateurs are like the Marines—they're looking for a few good men! CBers who decide chit-chatting 20 miles or so is kid stuff will work for their ham ticket to pull in a rare 6 to 9 thousand mile distant piece of DX. The amateur's day is coming!

Class A CB Rates an F

What is UHF-CB? A local oil company has a set-up and won't tell me anything.

—G. W., Reidsville, NC

UHF-CB is actually Class A CB. You can read about it in Part 95 of the CB Rules and Regulations. Class A CB is expensive and has difficult licensing conditions. If you want to hobby on UHF, go ham. If you want UHF for business, go business band.

Kids Go CB

Do you have to be 18 or older to operate a CB? I'm 15 years old now, do I have to wait three years?

—G. R., Marietta, OH

You cannot apply for a CB license until you are 18 years old, but your father or other member of your family can apply for a license. Once obtained, anyone in your household can operate CB.

Sunk

I have a Lafayette Micro-66 CB rig and I live in a canyon and can't get my signal out. What do you suggest?

—B. H., Goleta, CA

Start a landfill project. Or maybe a 60-foot tower would help.

Lend a Hand Department

▲ Our readers ask for information and materials that you may be able to offer. So, lend a hand boys, and Hank thanks you in advance.

▲ R. W. Wick, Rt. 3, Box 4, Stoughton, WI 53589 would like operational manuals for the R-77/ARC-3 and T5015/ARC-502.

▲ VW alternator noise is killing CB reception for D. W. Leibfried, 107 Clayton Rd., Hatboro, PA 19040. If you solved the problem in your VW without yanking the motor, let our friend know.

▲ Tell Carl Diffeur how to kill RF interference from his Toyota Corona fuel pump. Write to him at 1113 Duke of Gloucester, Colonial Heights, VA 23834.

▲ H. W. Kattelmann of 163 Via Los Altos, Redondo Beach, CA 90277 needs the schematic diagram and service data on the Sargent Rayment SR51-B tuner and SR88 amplifier. He has a distortion problem.

(Continued on page 93)

No bunny brought this egg...
It's DIGITAL EGG a digi-voltmeter

This little treasure egg, popular with the fair sex, measures volts from −100 to +100 in one-tenth volt steps—uses CMOS ICs and a mini-LED digital display.

by Norm Myers

☐ There are so many test instruments with digital readout available for the experimenter and technician to use today that it seems old-fashioned to use the familiar kind, the ones which have standard meter-scale faces. The old-fashioned needle movement may never completely disappear, but the digital meter has so many good things to offer, that it is fast overtaking the older kind. For the hobbyist and the circuit designer, the digital meter is not only desirable, but also a real asset. Digital meters give precise and quick, easy-to-see readings that the needle-movement can't offer. This has caused a bunch of manufacturers to jump on the bandwagon and offer a variety of assembled digital meters and kits. Most units on the market are the bench-top type, and the hand-held type has hit the market hard in recent months. These units, however, are priced around $150, although some kits are available for as low as $80. For the hobbyist needing a digital voltmeter (DVM) at a low cost there seemed to be no answer—*until now.*

Born From M'Lady's Legs. The Digital Egg is not a toy. The egg shape was conceived from the packaging used to enclose L'eggs brand panty hose. The electronics part of the Digital Egg DVM is easy to build, easy to use, accurate and inexpensive. Further, it is professionally designed so that it has features you would not expect to find in such a simple unit. In short, our Digital Egg DVM is a hard-boiled competitor that is hard to beat.

Features. Pick Digital Egg up, press the button, touch its antenna-like probe to a voltage point in the circuit and the common lead to ground. Then read the voltage from the three-digit LED display. No need to worry about loading down your breadboard circuit, because the input impedance of Digital Egg is over 1 megohm. If the polarity at the probe is negative, the LED display will read "88.8." This tells you to flip the polarity switch to get the proper negative reading. The Digital Egg goes from 00.0 (zero) to 99.9 DC volts in 0.1 volt steps. And there is no scale switch to fuss with! The 0-to-99.9 DC volt range is all on one scale. The accuracy of your readings will be about 2 percent (typical), which is better than most needle-movement meters. And this accuracy does not fade away as the supply battery voltage drops; it holds on to the last drop of juice.

How it works. Resistors R2 and R3 provide a voltage divider so that any voltage across the input clip and probe at S2 is divided by approximately 100. When a 50 volt Input is read, for example, the voltage applied to the input of the analog-to-digital converter in the Digital Egg is only 0.50 volts. By painting (or inking) the decimal point at

DIGITAL EGG

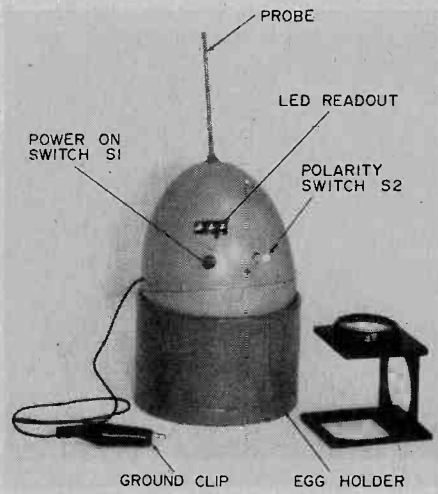
the proper place (see schematic) on the LED display, the output will read 50.0, which is *eggs-actly* right.

In the upper half of the schematic diagram is an operational amplifier (½ IC1) set up for unity gain, thereby providing high input impedance and the low output impedance required to drive input pins 1 and 2 of the analog-to-digital (A/D) chip, IC2. Resistor R1 and diode D1 simply work with the other operational amplifier in IC1. This op amp is arranged as an inverter so when the input voltage is opposite to the polarity required by IC2, pin 8 of IC4 is driven positive and the display is made to read "88.8." When this reading occurs during use, it tells you to flip switch S2 to reverse the polarity of the input.

Now let's see how the A/D conversion chips work. Chips IC2 and IC3 actually do the conversion while IC4 changes the binary-coded-decimal (BCD) output of IC3 to a seven-segment code to drive the LED display, LD1. These three ICs are state-of-the-art units fabricated in COSMOS form. COSMOS is an acronym for *complementary-symmetry metal-oxide semiconductor*. RCA calls their units COS/MOS, Motorola calls theirs McMOS, and the shorter term generally used by everyone is CMOS. The advantage of CMOS devices is that they consume very little power, typically a microwatt or less. This low power requirement is one reason battery B1 of the Digital Egg will last so long. CMOS also offers a high level of on-chip complexity that generally exceeds that of DTL or TTL devices. Consider, for example, that whole calculators and clocks are placed on single CMOS chips, and in this project we see an entire A/D converter on two chips. The A/D conversion in IC2 and IC3 is accomplished by what's called *dual slope* conversion. The term *dual slope* comes from the way the ICs first charge up, and then discharge capacitor C1 in order to determine the magnitude of the input voltage.

Here's how it works. It is basically easy to understand. First, there is a clock inside IC3 which puts out pulses to IC2 at a rate determined by C2. The analog input voltage to pins 1 and 2 of IC2 causes integrating capacitor C1 to charge up, but only for a fixed number of clock pulses, which in this circuit is about 1000. This means that higher input voltages will put more current into C1 after 1000 pulses than will lower voltages. In fact, halving the input voltage means halving the charge. Now all that is needed is to determine in some digital way how much charge is on the capacitor, and that charge will tell what the input voltage is.

The amount of charge is determined by chip IC2 which automatically applies reference voltage (Vr) of opposite polarity across C1, at which point IC3 begins counting the number of clock pulses that pass before the capacitor is fully discharged. If, for example, C1 is fully discharged after 1000 pulses, then V1 (the voltage across pins 1 and 2 of IC2) must be equal to the reference voltage, Vr. In other words, if the



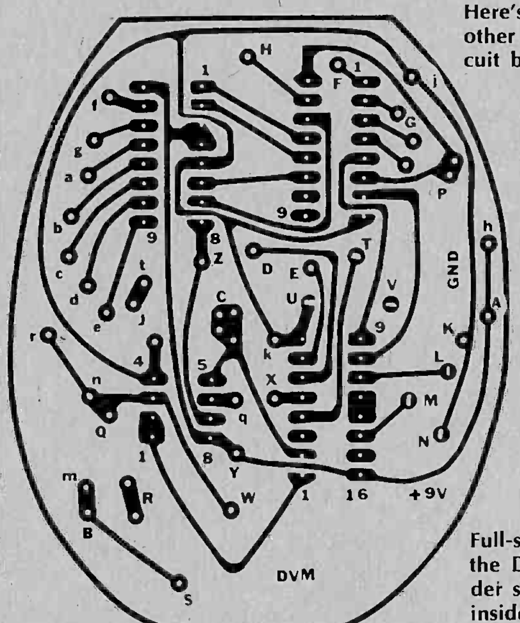
Digital egg sits in its holder (from Leggs package) when not in use. Power switch S1 is momentary-on, with spring to save battery when DVM egg is not in use.

charge put on C1 by V1 after 1000 pulses is completely removed by Vr after 1000 pulses, then V1 and Vr must be equal. If only 500 pulses are needed to discharge C1, then V1 must be 500/1000, or one-half, of Vr. The general equation that applies here is

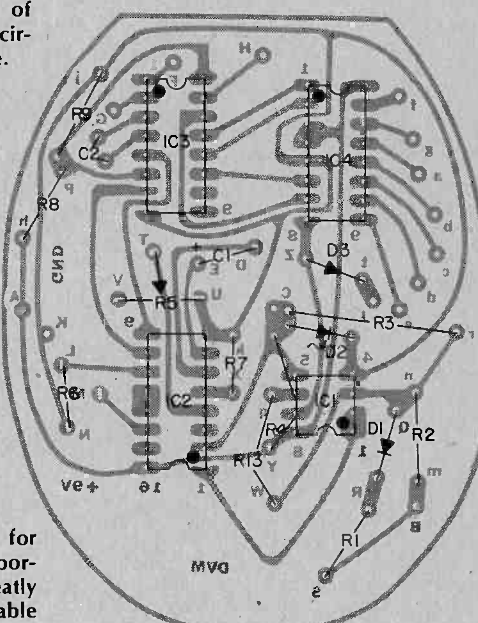
$$V1 = \frac{K}{1000} \times Vr,$$

where K equals the *number of pulses required to discharge C1*.

Reference voltage. The reference voltage, Vr, is supplied by IC2 and made adjustable by R6, which is the full-scale adjustment for Digital Egg. After adjusting pot R6 for your particular ICs and components, Vr will be



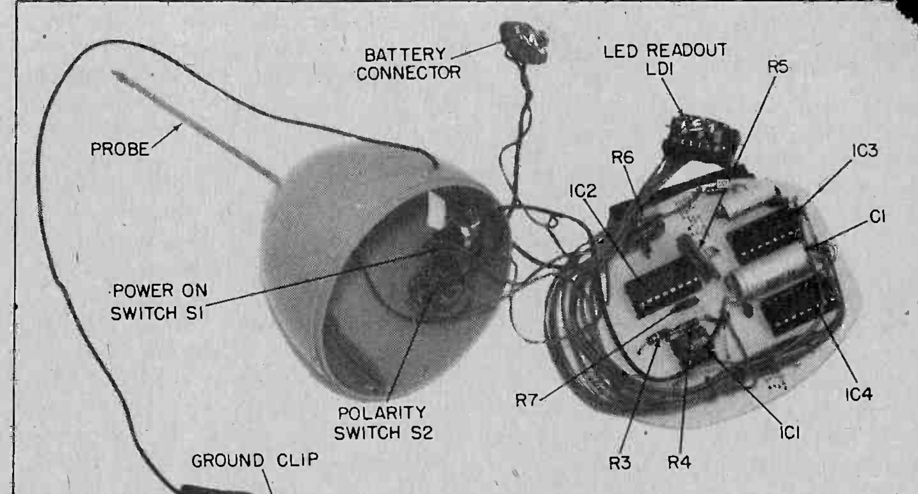
Here's where the four ICs and handful of other small parts go on the printed circuit board—seen from components side.



Full-size printed circuit board layout for the Digital Egg voltmeter has outside border shaped so you can trim it to fit neatly inside Leggs case. Etched board is available from supplier at address in Parts List.

about 1 volt. Therefore, for a 15-volt input between clip and probe there will be a 15/100, or 0.15, volt input to pins 1 and 2 of IC2 (V1, 2 = 0.15). The above equation shows that there will be 150 pulses required to discharge C1 in this example. Chip IC3 will count these 150 pulses and translate that through IC4 to light "150" on the LED display (LD1). By having the decimal point permanently marked between digits 2 and 3 the output will read 15.0, as desired. There is also a zero adjust, R5, which prevents a zero input voltage from generating clock pulses and causing "00.0" to appear on the display.

You may be wondering how IC4 lights all three LED digits at once. Well, it doesn't—it lights them one at a time, but so fast that you "see" all three lit at once. The three leads out of pins 1, 2, and 15 of IC3 tell the LED display which digit to light, while the leads out of IC4 determine just which segments will be lit. This is the same multiplexing scheme used in most pocket calculators. It saves lots of wiring, cost, and battery power.

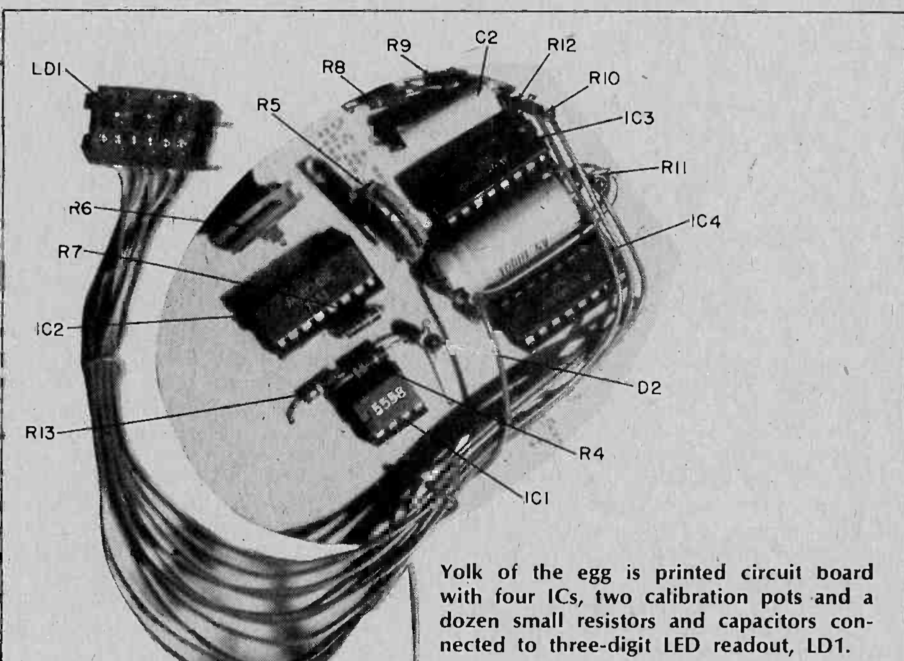


DVM egg, just before being put back together again! Lower half of the Leggs case is not shown in this photo.

Construction. While the egg shell is not necessary in this project, it provides a good inexpensive case for a hand probe. The plastic egg can be obtained by buying a pair of nylon stockings in most any grocery store. The printed-circuit board provides the easiest construction because most of the wiring is already done. Also, without this circuit board, it is difficult to get everything inside the egg shell because the wiring might be too bulky. The printed-circuit board can be cut and filed to exactly fit your egg shell (or any other holder).

The author had a lot of fun placing the DVM inside a plastic egg shell. However, you may not find it so easy, or enjoyable. The DVM circuit can be spread out on a larger printed-circuit board and placed in a standard plastic box. How it's done is up to you.

An important point in constructing this (and other CMOS projects) is to take care in handling the ICs. The gate-insulation oxide can be destroyed by static electricity. It helps to be sure you are not carrying static charge before you handle the ICs (reach over and grab a water pipe) and to be careful not to handle the units by their pins. Also, avoid placing the ICs on plastic material unless it is the conductive (black) plastic in which they are usually packaged. It's also important to be sure the power to any unit which uses CMOS devices is turned off before inserting or removing the ICs. Generally no problems arise in handling these CMOS devices, but it is best to be careful.



Yolk of the egg is printed circuit board with four ICs, two calibration pots and a dozen small resistors and capacitors connected to three-digit LED readout, LD1.

With or without the printed circuit board, construction begins by mounting sockets for the ICs. Low-profile sockets, such as Radio Shack 276-1998 (16 pin) and 276-1995 (8 pin for IC1) help save space. A low-profile socket can also be used to hold the LED display. The display has 12 pins, so Radio Shack type 276-1998 can be used to hold it. To plug in the display, first cut the leads just a bit in order to form a point on each. That way the leads will slip easily into the socket. Remember that the ICs must never be placed into the sockets until construction is complete. Again, the battery should be disconnected while the ICs are being inserted in place.

The zero-adjust potentiometer (R5) and the full scale-adjust potentiometer (R6) can be mounted after the sockets are in place. Position them to be accessible for adjustment. In connecting diodes D1, D2, and D3, be certain to place the cathode and anode in accordance with the schematics, and to use heat sinks on the leads (needle-nose pliers will do) to protect the CMOS devices while soldering. Remember, too, it is best in all construction using printed circuit boards or sensitive components like diodes and small resistors,

DIGITAL EGG

to use a soldering iron with only a 25- or 30-watt heating element.

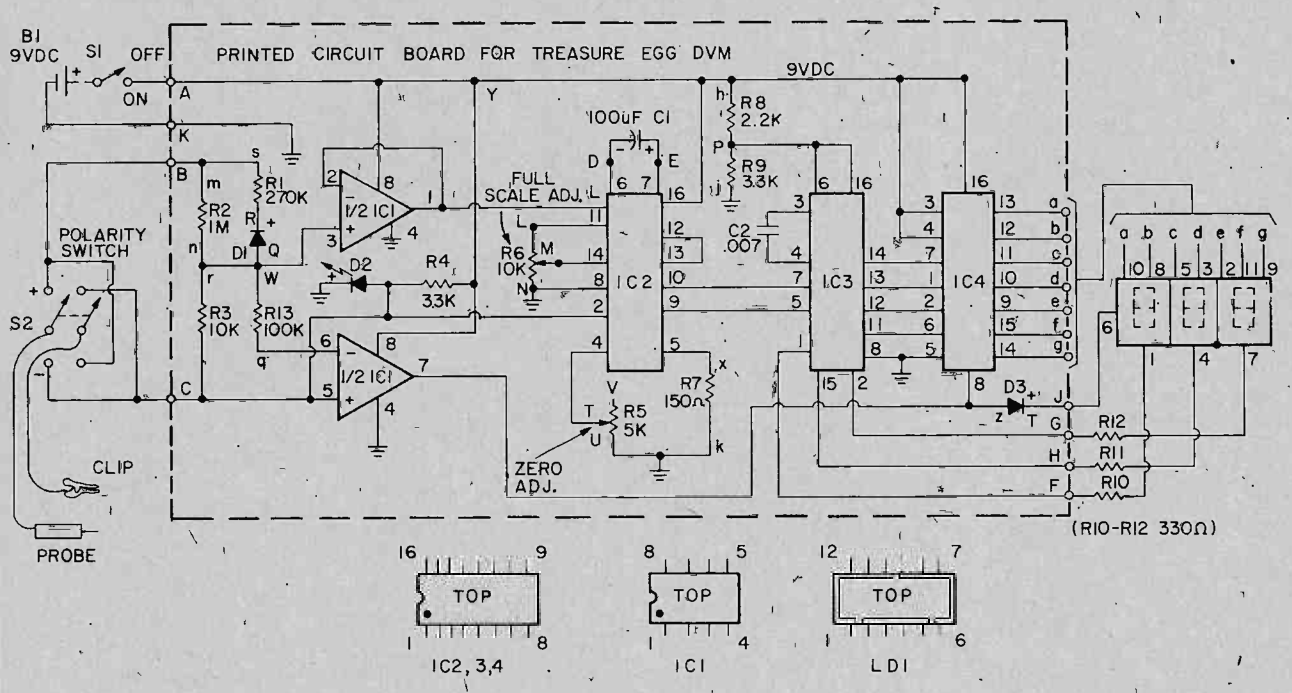
The slot in the egg shell for the LED display (LD1) can be cut with a hobby knife. Heating the knife makes the job go faster, but requires lots more care. The edges of the slot can be filed smooth. The switches can be mounted through the egg shell by drilling holes through the plastic. When you are ready to place the battery inside the egg, wrap it with tape first so that the metal sides of the battery do not accidentally short-circuit some points on your circuit board. Also, by taping a large piece of foam rubber to the battery it can be made to fit snugly in the egg shell. The wire probe coming out the top of the egg is number 14 solid wire covered with insulation.

Printed Circuit Board. If you purchase the printed circuit board from the supplier in the Parts List you will find that the actual board is rectangular. To make the board into the required egg shape you can trim the board, which is a specially-selected glass epoxy, with a pair of scissors. Trim as close as possible to the outside of the oval foil which shows the outline of the egg shape. After making the cutout with scissors, smooth the edges with medium or fine grade sandpaper to exactly the outside of the foil. When you've shaped the board exactly so it fits neatly into the egg you may leave the oval foil, or remove it, as you wish.

The board is shipped with a 3/64-inch drill which is just right for drilling most of the holes for mounting the components.

Some Changes. The author designed a printed circuit board layout which is illustrated in the photographs. The editors, as they usually do, saw fit to make some changes. For example, the au-

(Continued on page 94)



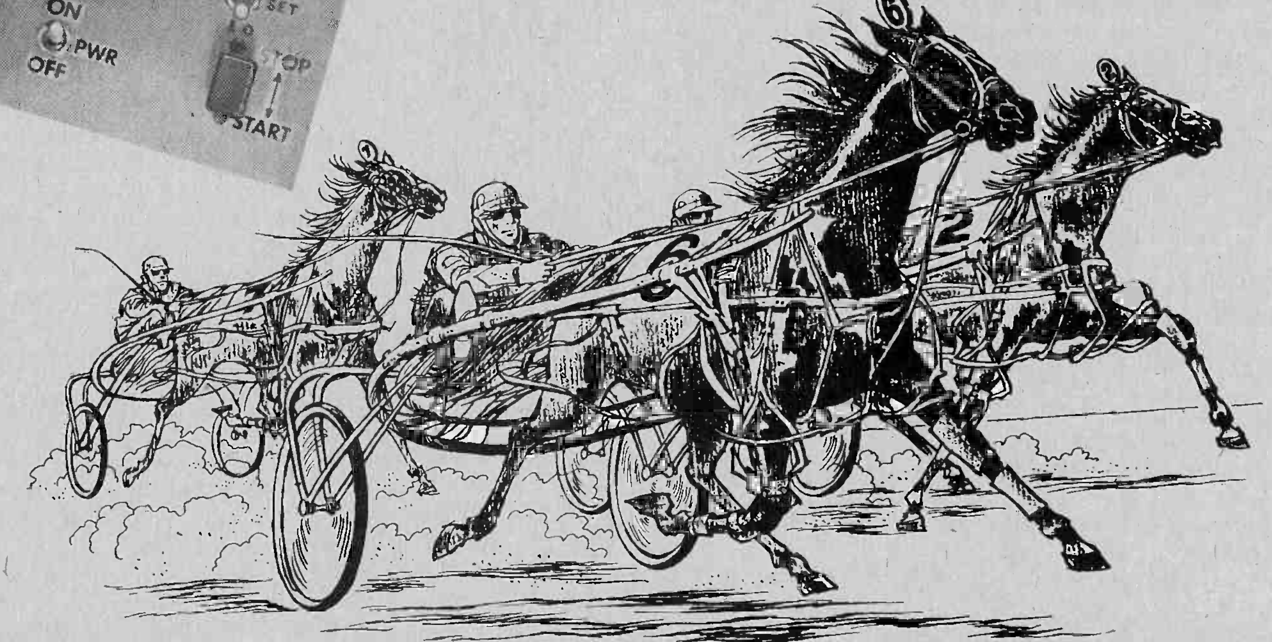
PARTS LIST FOR DIGITAL EGG

B1—9-VDC transistor battery
C1—100-uF, 5-VDC or more electrolytic capacitor
C2—0.007 uF, 50 VDC capacitor
D1, D3—1-A, 200-PIV diode rectifier
D2—LED, 1.5 to 2.5 forward volts at 20 mA
IC1—Dual 741 op amp
IC2—CMOS analog-to-digital converter IC (Motorola MC1405L)
IC3—CMOS analog-to-digital converter IC (Motorola MC14435VP)
IC4—CMOS binary-coded decimal driver IC for LEDs (Motorola MC14511CP)
LD1—3-digital readout display (Radio Shack 276-055)
R1—270,000-ohm ¼-watt resistor*
R2—1-megohm, ¼-watt resistor*
R3—10,000-ohm, ¼-watt resistor*
R4—3,300-ohm, ¼-watt resistor*
R5—5,000-ohm printed-circuit-board potentiometer
R6—10,000-ohm printed-circuit-board potentiometer
R7—150-ohm, ¼-watt resistor*
R8—2,200-ohm, ½-watt resistor
R9—3,300-ohm, ½-watt resistor
R10, R11, R12—330-ohm, ¼-watt resistor*
R13—100,000-ohm, ¼-watt resistor*
*Note: If space allows, you may substitute ½-watt resistors for ¼-watt resistors.
S1—SPST pushbutton switch, normal-off
S2—DPDT toggle switch
Misc.—Case made from Leggs hosiery package; printed circuit board kit; IC mounting sockets—three 16-pin, one 8-pin; #22 stranded wire; solder; cement; etc.

A kit of three CMOS Motorola integrated circuits, IC2, IC3, IC4 (MC1405L, MC14435VP, and MC14511CP), for the Digital Egg DVM may be ordered from Corvair Electronics, Inc., 150 Fifth Ave., N.Y. NY 10011. Send postal money order for $22.95 for Kit 101. It will be sent to you via postpaid, insured mail. N.Y. State residents add applicable local sales tax.

A printed circuit board for the Digital Egg voltmeter may be ordered from Techniques, Inc. 236 Jackson St., Englewood, N.J. 07631. It will be shipped via first class mail anywhere in the United States and Canada for $2.95. (N.J. residents add 5%). Included with the board is a 3/64-inch drill.

MARK TIME INDICATOR USES YOUR OWN CALCULATOR



Time seconds, minutes, hours, or what-have you--or count up or down to 9,999,999--with this inexpensive adaptor for common calculators.

by Robert Way

☐ BUILDING THIS MARK TIME INDICATOR is an easy way to get an event timer using a pocket calculator as the readout device. You can use any low-cost calculator (or a better one) that you happen to own with *Mark Time Indicator* (which we'll call *MTI* from here on). MTI drives the calculator to read minutes, seconds, or half-minutes/seconds, as well as many other intervals you can readily program it to indicate. Your calculator continues to work just as it did before, and is connected to MTI only by a small jack you install in the calculator. When not in use as part of MTI you disconnect the calculator by just pulling out the jack.

In addition to using MTI to clock off seconds or minutes it can be set to a predetermined number of seconds (or minutes) and subtract them one at a time or ½- sec. or ½-min.) until it gets down to zero. Further, it can even work with negative numbers, clocking as many as you want, starting at zero and going toward –9,999,999–one at a time! It can also add in increments of 2, 3, 5, or any other amount you choose, clocking away at any of the four time intervals you desire.

This means your MTI, if set to count minutes, one at a time, could count for 9,444 days, or 190 years—provided the batteries were replaced with an AC-powered supply. Since it's unlikely most readers will want to count such periods of time we've settled for internal batteries as the power source.

MTI's Advantages. A digital interval timer usually costs several dollars per digit to build, and involves assembling a time base, counters, latches, drivers, and the readout (display) device. But it's easy and inexpensive to build MTI if you have a pocket calculator such as the Radio Shack EC-220 which has the auto-constant feature (most calculators do). MTI finds many uses in the darkroom, at sporting events, for timing long distance calls, cooking eggs, or even guarding against sunburn at the beach. Some of the advantages and features of MTI are:

- It's portable, and battery-operated.
- It has a capacity that's very large: 9,999,999 seconds, or minutes.
- It counts either up or down.
- The time interval can be interupted and restarted, without going back to zero, plus other operating variations.
- You can choose any of four timing intervals via switches (many more, by internal adjustment).
- Accuracy is close to one percent.
- It's easy to build—only four ICs, six resistors, and two capacitors.

You have to make just one simple modification to the calculator, and that doesn't affect the normal operation of the calculator in any way.

Check Your Calculator. Before making the single modification you need to use your calculator as the readout for MTI, you should double-check that your calculator has the auto-constant feature (most do) which is necessary to let it work as part of your MTI.

To verify the calculator's counting operation, proceed as follows:

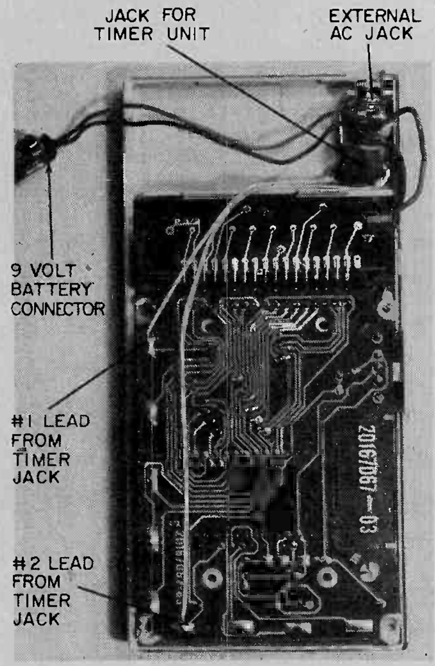
Press the + and 1 keys, and then press the = key several times. After the first time you should get an increase in the number displayed by one each time you press the = key. To read upward starting at zero, enter —, 1, +, 1, = to read 0. Now pressing = will count up by one, but it will start at 0.

To make the calculator count down, enter any number, then press the — and 1 keys. Now each time you press the = key, the calculator display will count down one digit at a time. All of the above steps take less time to perform than to describe, and after playing with your calculator for a few minutes you won't even have to think about the sequence. The timer circuits in the MTI electronically complete the = operation each second, half-second, minute or half-minute.

If the above steps all work out on your calculator you may be assured your calculator will work as the readout for MTI. Go ahead now with the simple modification to your calculator so it can display the time intervals as they are ticked off by MTI.

Calculator Modification. Modification requires merely adding a subminiature phone jack which is connected to two terminals of the circuit board inside the calculator. These are the terminals which connect to the = key on its keyboard.

If you have a Radio Shack EC-220 calculator you can follow these modification steps exactly. If you are adding the jack to some other calculator the steps may be slightly different but the result is the same—to put the terminals of the small phone jack in parallel with



Radio Shack EC-200 calculator, back removed, showing the two leads which are paralleled with = key going to small jack for MTI. Note that IC3 mounts on a smaller board (or DIP mount, with pins bent flat). Main board is Radio Shack's 276-151.

the terminals connecting to the = key of your calculator.

Slide off the battery cover, and remove and disconnect the battery. Unscrew the four Philips screws from the back and remove the back from the main body. Locate the rows of large solder tabs along the left and bottom edges of the circuit board (see photo). There are 5 of these tabs along the left edge, corresponding to the 5 horizontal rows of calculator keys, and 4 tabs along the bottom edge, corresponding to the 4 vertical rows of keys. Solder a 6½-in. length of insulated hookup wire to the left-hand tab along the bottom, and a 4-in. wire to the other top terminal. Be sure to connect these two wires as described, and as shown in the schematic diagram. If they are reversed you won't hurt anything, but MTI won't work. Similarly, if the two wires which go from the MTI to the tiny plug which mates with the jack in your calculator are reversed, it won't work. So be careful with the connections.

Finally, mount the jack to the top cover of the calculator, just beneath the AC power jack (as shown in the top right-hand corner of the photo) by drilling a 5/32-in. hole in the top cover and bolting it on with the nut provided with the jack. This is best done by temporarily dislodging the wires connected to the AC adapter jack, positioning the added jack beneath it to locate the hole to be drilled, and drilling from the circuit board side. Reconnect and replace the battery, and replace the back cover. Solder two 10-in. lengths of insulated wire to the subminiature phone plug, insert it in the jack, and turn on the calculator. Set up the calculator to count, as previously described, and touch the loose ends of the plug wires together; each time the wires make contact, the calculator display will increase by 1. This completes the calculator modification, and the calculator can be set aside until you complete your MTI.

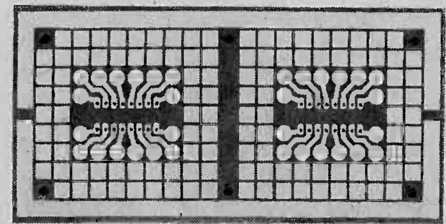
Other Calculators. If you're working with a calculator other than the one shown in our modification, determine which of the two leads from the = key is the more positive (or less negative). Be sure to connect the more positive one to the center connector of the subminiature phone plug.

How MTI Works. The timer circuit starts when capacitor C1 (or C2, depending on the position of switch S2) is discharged, and the output of IC1 (at pin 3) is low. At the beginning of a timing cycle (initiated by pressing S3), the output at pin 3 goes high, and C1 (or C2) starts to charge up toward the battery voltage (6 volts) through R1, R2, and R3 (or R4, R5, and R6). When the charge on C1 equals 2/3 of the battery voltage, pin 7 of IC1 goes to ground and the capacitor discharges through R2 & 3, or R5 & 6. At this instant the voltage at pin 3 goes low. When the charge on C1 has fallen to 1/3 of the battery voltage, the cycle repeats. Hence the timing cycle consists of C1 alternately charging and discharging between 1/3 and 2/3 of the battery voltage. However, at the very first cycle the capacitor is at ground potential and must rise from 0 volts to 2/3 of the battery voltage, while on succeeding cycles C1 only has to charge from 1/3 to 2/3 of the battery voltage.

IC1 Runs Continuously. With switch S2 in the upper position IC1 puts out 120 pulses-per-minute (ppm). These pulses, every half-second, are counted in IC2, a divide-by-ten counter, and also by IC3, a divide-by-12 counter. When 60 pulses are counted, pin 9 of IC3 goes high, and a half-minute pulse is passed through IC4 to the calculator, if S4 is in the lower position a one-minute pulse is fed to IC4 and thence to the calculator.

If switch S2 is in the lower position, R4, R5, and R6 cause IC1 to send out pulses at the rate of 120 pps (pulses-per-second) and half-second pulses occur, after 60 counts, at pin 9 of IC3. One-second pulses appear at pin 9 of IC3 after 120 counts.

Starting and stopping MTI is accomplished by S3, which grounds or ungrounds pins 2 and 3 of IC2 and 6 and 7 of IC3, which are the reset-to-zero terminals of the counters. The counters count when these pins are grounded, and are inhibited from counting (and reset to 0) when these pins are allowed to go high (are ungrounded). Note that S3 is a DPDT switch—since only one set of contacts is needed for the timer circuit, the other contacts are available to switch an external device simultaneously with starting and stopping the time. The author uses this set of contacts to turn his enlarger on and off precisely when the timer is started and stopped.



Experimenter's printed circuit board from Radio Shack is convenient mount for MTI's parts, which go on the blank, (non-foil side of board. When you mount the components trace all connections carefully, referring frequently to schematic diagram.

Since both terminals of J1 (at the calculator) are above ground potential during switching, connecting either of them directly to the output of IC3 would interfere with the counting action. IC4 provides the necessary electrical isolation between the calculator and IC3.

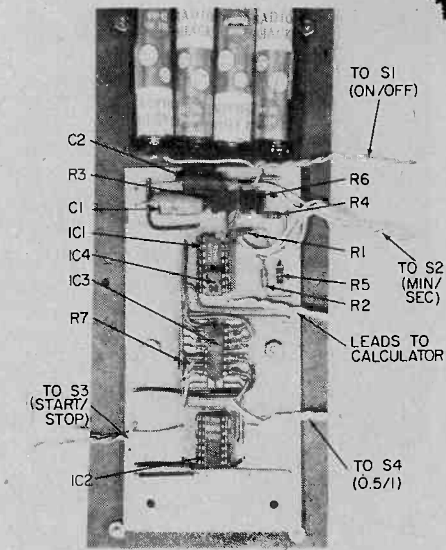
Opto-Isolator. IC4 is an opto-isolating device consisting of two parts. First there is a light-emitting diode (LED) which produces light pulses when it is driven by pulses of current from terminal 8 or 9 of IC3. These light pulses fall on the base of a light-sensitive transistor in IC4, whose output is taken from terminals 4 and 5 of IC4. Actually there is no "output" from 4 and 5 of IC4. It is built so that light rays from the LED in it fall on the base of the transistor, biasing it *On* or *Off*. When the LED is *Off* (or dark), the emitter-to-collector resistance of the transistor is extremely high (effectively an open circuit). When the LED is energized, the emitter-collector junction resistance drops to a moderately low value (around 1000 ohms). This emitter-collector junction acts like a diode, and if voltages of the proper polarity are applied to the emitter and collector, current will flow through the junction. In other words, it will act like a closed switch. Since the transistor in the opto-isolator is NPN, a positive voltage must be applied to the collector and a negative voltage to the emitter. In the case of the Radio Shack EC-220 calculator = key leads, both of the voltages are negative (as measured with respect to the battery + terminals, which is the ground for this calculator). However, one of these voltages is less negative (more positive) than the other, and that one is connected, through the plug, to the collector of the isolator transistor, and the other, more negative, voltage goes to the emitter.

Other Calculators. The MTI output circuit as shown (using Opto-isolator IC4) works well with the Radio Shack calculator and others with = keys having similar voltages. However, some calculators have been found to require a small relay in place of IC4. If this should be the case (checking first to be sure that the Opto-isolator is clocking signals out properly) you can substitute either of two relays for IC4, as shown in the Parts List.

One is a standard mechanical relay sold by Radio Shack. The other is smaller, and costs less, but is not as readily available. It's a low-voltage, low-current relay made in the shape of a little cylinder about 1-in. long by ⅜-in. in diameter, and has stiff wire leads, about ¾-in. long projecting from either end—these are the SPST contact connections of the relay. At one end of the cylinder, one white and one black stranded wire, about 2¾-in. long protrude—these are the relay coil connections. Assemble the relay and diode in place of IC4, using the IC socket for convenience. R7 is eliminated, too.

Construction. The circuit of MTI is built on a Radio Shack experimenter's circuit board, with the parts placed as shown. The etched side of this board, in addition to solder tabs for the IC pins, has several rows of large square solder tabs, and 2 bus strips for power Vcc) and ground. The various components in MTI are connected by being soldered to the same square tab, or via jumper wires soldered between the tabs. These jumpers are visible in the photo. All the ICs are oriented so that pin 1 is at the upper left as viewed in the photo.

The connections between pins 2 and 6, and between 4 and 8 of IC1 were made by burning the insulation off the ends of short lengths of varnish-insulated #28 wire, bending them into a "U" shape and inserting the ends of the "U" into the appropriate holes from the top of the board before soldering in the IC socket. IC3 is mounted to a separate mini-board, which has an adhesive backing, permitting it to be stuck to the main board. If the Calectro board shown in the prototype is not available you may substitute the Radio Shack printed circuit board listed.



The four ICs, two capacitors, and six resistors mount easily on the non-foil side of circuit board. Trace out connecting leads between the parts carefully.

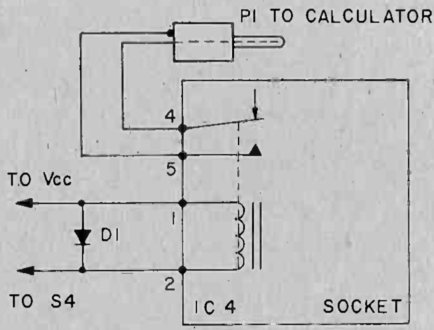
It's a good idea to use stranded hookup wire to connect the switches and the phone plug to the printed circuit board because it's much less likely to break from the flexing and handling it must take during construction and adjustment. Also note that switch S4 must have a middle position which is Off.

The timer case was made of light sheet aluminum, pop-riveted to short lengths of aluminum angle iron. The bottom of the case was a piece of masonite, and the circuit board, battery case, and a set of rubber feet mounted to it with size 4-40 hardware. However, the case is not essential. You can build the circuit on the printed circuit board listed in the Parts List, or even breadboard it if desired, and place the calculator on the bench beside it for connecting it to MTI.

Calibration. When construction is finished plug in the batteries and plug the subminiature phone plug into the calculator's jack. Press the + and 1 keys of the calculator and the *Start* button on MTI. R3 and R6 must be adjusted so the IC1 produces output pulses at intervals of 0.5 second and 1/120 second, respectively. The divider chain (IC2-

IC3) will function if it is wired correctly. The best way to adjust R3 and R6 is with a frequency counter, but another method will suffice if no counter is available. To adjust R3 without a frequency counter, place S2 in the upper (min.) position and temporarily connect a jumper wire between pin 3 of IC1 and the center terminal of S4, thus bypassing IC2 and IC3. MTI will now count by half-seconds, and you can use the following method of calibration.

You'll need a clock or watch with a sweep-second hand, and some patience. Set R3 to its midrange and start the timer. With the calculator display and the sweep-second hand both within your field of view, note the calculator readings at the beginning and end of 30 seconds (60 counts). Better to let the timer run continuously than to try to start and stop it for a 30-second period because your own reaction times will add some definite fractions of a second to the interval you're trying to time. Note whether the timer is running fast or slow, and rotate R3 no more than a quarter of an inch, and time another 30 seconds. It will take several tries to determine which way R3 must be turned to slow down or speed up MTI. When you find the R3 position that makes your timepiece and MTI agree pretty well, try several more adjustments at a one-minute period.



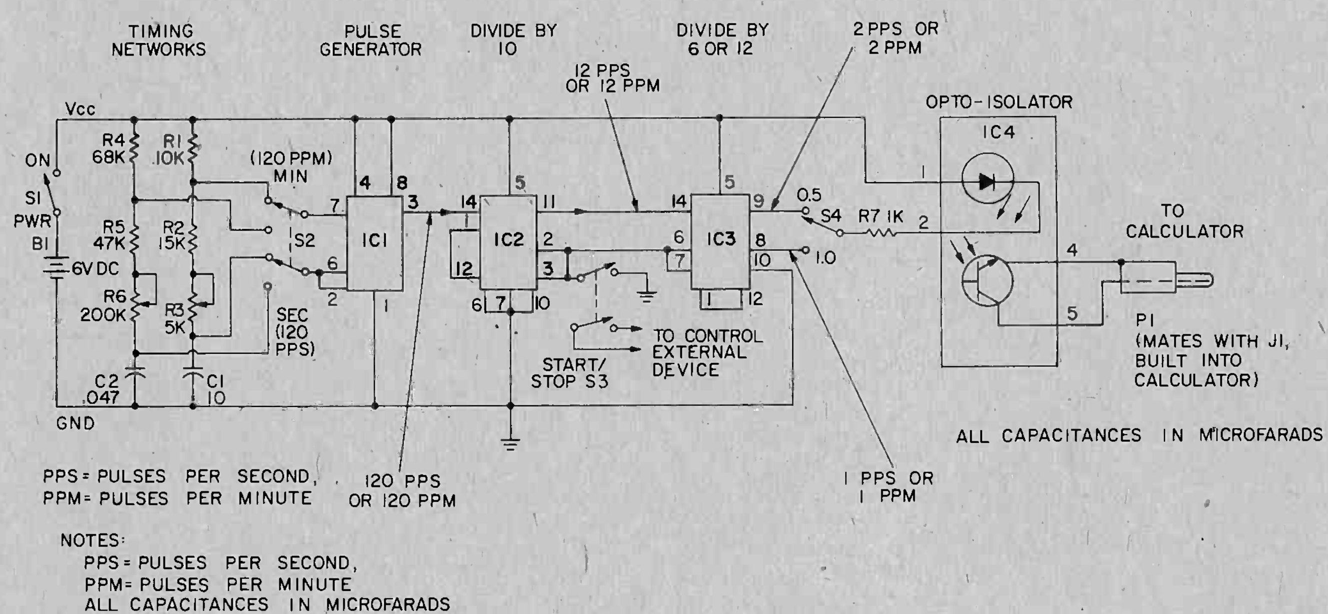
Some calculators may require a small relay in place of IC4. Assemble relay and diode right in socket otherwise used for IC4.

After something like a dozen adjustments my MTI gained less than 1 second in 2 minutes, an error of under 1 part in 120. In a subsequent check with a frequency counter, the period measured 0.994 seconds (frequency of 1.006 Hz). This reading varied ±1 count about every 30 seconds.

When R3 has been adjusted and the jumper wire is removed, half-minute and one-minute pulses are obtained, according to the position of S4. Now you can proceed with the adjustment of R6.

Place S2 in the lower (sec.) position and use the sweep-second hand proced-

(Continued on page 94)



PARTS LIST FOR MARK TIME INDICATOR

C1—10-uF, 15-V or more electrolytic capacitor
C2—0.047-uF, 50-V or more disc capacitor
IC1—555 Timer chip, TTL
IC2—7490 divide-by-10 counter chip, TTL
IC3—7492 divide-by-12 counter chip, TTL
IC4—Opto-isolator chip, TTL
D1—General purpose diode for shunting coil or relay.
R1—10,000-ohm, ½-watt resistor
R2—15,000-ohm, ½-watt resistor
R3—5,000-ohm miniature potentiometer
R4—68,000-ohm, ½-watt resistor
R5—47,000-ohm., ½-watt resistor
R6—500,000-ohm potentiometer
R7—1,000-ohm, ½-watt resistor
RY1—SPST electromagnetic relay, 6-9 VDC coil resistance 500 ohms, current 8-12 mA, or miniature reed relay SP-37A, available from Meshna Electronics, Box 62, E. Lynn, MA 01904.
S1—SPST toggle switch
S2—DPDT toggle switch
S3—Push-on, push-off DPDT switch
S4—SPST, center-off switch

Misc.—Experimenter's printed circuit board (Radio Shack 276-151 or equiv.), miniature phone plug, miniature phone jack, 16-pin DIP socket, mini-mount IC board (Calectro J4-784 or equiv.), battery holder for four AA cells

ATTENTION GRABBER

Synchronized dual duration flash rate for up to 300 watts of incandescent light!

by C. R. Lewart

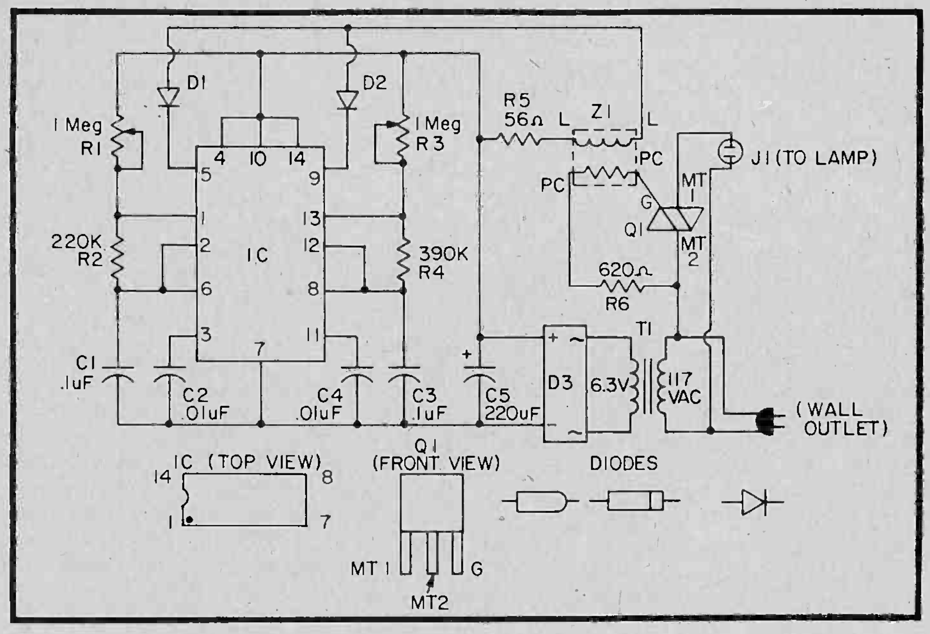
HERE'S A FLASHY project with some interesting and novel features. It can be used to control lamps up to 300 watts. The on-off ratio of the flasher and the relative length of the subsequent "on" times can be adjusted with two controls; thus you create a unique "dot-dash" effect. In addition, the flasher contains only solid-state components for long-term reliability. The flasher can be used for Christmas lights, window displays, Halloween pumpkin illumination, psychedelic lights and many other special effects.

If you watch the blinking lights for a few minutes you will understand the name we gave to this project.

Building it will make you familiar with various solid-state devices such as triacs, timer integrated circuits, opto-isolators and photocells.

How Does It Work? The integrated circuit "556" consists of two "555" timing sections described in previous projects. Its two outputs on pins No. 5 and No. 9 (see schematic) are separately controlled with potentiometers R1 and R3. When any of the outputs is in the "low" state, the pilot lamp in the light coupler lights and lowers the resistance of its associated photocell. A low photocell resistance makes the triac conduct and the circuit supplies full AC voltage to the lamp socket. When both of the timer outputs are "high" the light goes out and the triac stops conducting. The process repeats itself thus giving the flasher effect. The low voltage section of the circuit is separated from AC voltages by the light coupler. The transformer T1 with its associated rectifier bridge and capacitor, C5, supplies DC voltage to operate the integrated circuit and the lamp in the light coupler. The two diodes, D1 and D2, isolate the two timer sections of the IC.

Construction. You can build this circuit easily on a 2½ x 3½-in. perf board using point-to-point wiring. No special wiring precautions are necessary except for the section of the circuit which carries AC voltage. Make sure that it is well insulated and kept away from the rest of the circuit and the cabinet. Use a 14 pin socket for the IC. Insert the IC only when you are ready to test the circuit. If you substitute a



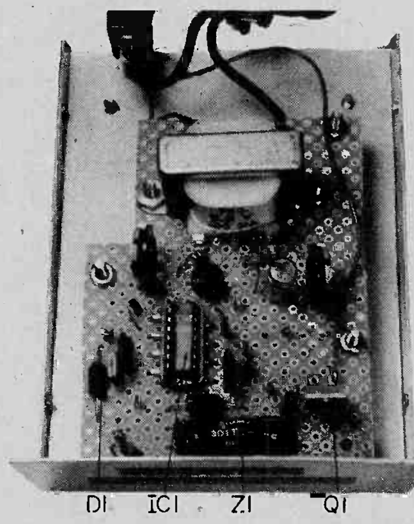


Fig. 1—Inside-chassis view of completed Attention Grabber shows location of parts. Mounting them on perf board is easy because locations are not critical. Larger or smaller board and box can be used, so long as schematic diagram is followed for connections. Any household lamp or bulb up to 300 watts can be turned on-and-off by this unit.

ATTENTION GRABBER

separate pilot light and a photocell for the light coupler, wrap the photocell and the pilot light together with black electric tape. Make sure that the active side of the photocell (the one with the pattern) faces the pilot light and that the photocell pins are insulated and do not touch the pilot light pins. To use this photocell-and-pilot lamp setup in place of the light coupler see the Parts List.

Operation. The only two adjustments for the flasher are R1 and R3. They let you select the on-off times and also to some degree the two different "on" times. If you wish to do some experimenting try different values for C1 and C3 between .01 and 1 *u*F. You may also try different values of R2 and R4 between 50,000-ohms and 1-megohm.

If you would like to be able to change the flasher characteristics while the unit operates, mount R1 and R3 on the cabinet rather than inside the cabinet on the perf board as shown. ■

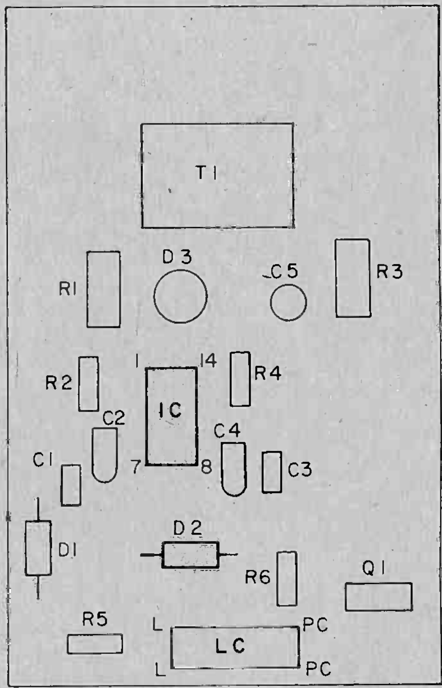


Fig. 2—Parts layout for easy point-to-point wiring is shown above. Inexperienced builders should follow this plan for trouble-free construction. Experienced constructors can use any convenient layout desired.

PARTS LIST FOR ATTENTION GRABBER

C1, C3—0.1 µF capacitor (Radio Shack 272-1069 or equiv.)
C2, C4—0.01 µF capacitor (Radio Shack 272-1065 or equiv.)
C5—220 µF electrolytic capacitor, 35 VDC (Radio Shack 272-1017 or equiv.)
D1, D2—1-amp, 50-PIV silicon diode (Radio Shack 276-1135 or equiv.)
D3—1-amp, 50 PIV bridge rectifier (Radio Shack 276-1151 or equiv.)
IC—556-type timer integrated circudit (Radio Shack 276-1728 or equiv.)
Q1—6-amp, 200 volt triac, GE SC141 (Radio Shack 276-1080 or equiv.)
R1, R3—1-meg potentiometer, PC-type (Radio Shack 271-229 or equiv.)
R2—220,000-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R4—390,000-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R5—56-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R6—620-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
Z1—light coupler, Sigma 301B1-6B1 (Allied Radio 917-1417 or equiv.)
Note—You can make a light coupler see text) with a 6-volt, 25 mA lamp (Radio Shack 272-1140) and a CdS photo cell (Radio Shack 276-116) to use in place of the commercial unit.
Misc.—case 4 x 2⅜ x 6-in. (Radio Shack 270-252 or equiv.), AC socket (Radio Shack 270-642 or equiv.), 14-pin IC socket (Radio Shack 276-027 or equiv.), wire, solder, hardware, etc.

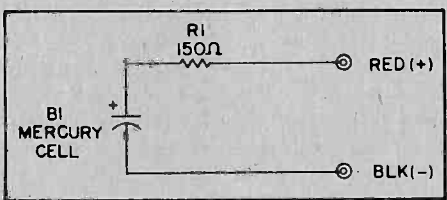
BUILD AN ACU-VOLT CALIBRATOR

THIS EASY PROJECT GIVES YOU A SUPER-ACCURATE VOLTAGE SOURCE FOR CALIBRATING YOUR VOM OR VTVM.

by F. Chapman

☐ You have just finished building that new kit VOM or VTVM and are ready to adjust the calibration. And what do you use—the standard 1.5-volt off-the-shelf dry cell from the local drugstore. Maybe you want to check the accuracy of your meter after a hard bounce in the trunk of the family gas hog. Out comes the slightly used cell from the under-dash flashlight.

Sure, I know, the book says that a fresh dry cell has a terminal voltage of 1.56 volts. But the key word is *fresh*. Just how fresh *is* that cell you are using? How long has it been sitting on the dealer's shelf, or in the flashlight? It *could* be three years old!



Your VOM probably has an accuracy of 2% of full-scale. Why not use a cell whose *known* accuracy is much better than the meter's?

Use a Mercury Cell. Such an animal is the mercury cell, of which there are two types. One has a cell voltage of 1.4 volts, the other 1.35. The latter has an accuracy of about ½% when loaded with one mA or less. Since most VOM's worth calibrating are at least 20,000 ohms per volt, this means they have a full scale deflection current of 50 microamperes. On a 2.5 volt DC scale 1.35 volts will take only 27 microamperes of current from the cell. This allows us to put a resistor in series with the cell and jacks to limit short circuit current to about 10 mA. This insures that the cell will not be damaged by an accidental short. Any of the cells whose voltage is 1.35 volts will do. You will note that they all have an "R" at the end of the type number (Example: An RM12 is a 1.4-volt cell. An RM12R is 1.35 volts.)

Mount the cell, its holder, resistor and red and black pin jacks in a small plastic case and you have a very accurate means of checking your DC meters calibration.

You might feel that it would be good to have several different voltages for calibration. Not so. Most good meters use 1% resistors in the voltage-measuring circuit. Further, they normally only have a single DC adjustment. Set the calibration control on one scale and it should hold within 1% for all other scales. ■

PARTS LIST FOR ACU-VOLT CALIBRATOR

B1—Mercury cell 1.4 volts (Radio Shack 23-1520 or equiv.)
R1—150-ohm, ½-watt resistor, 10% (Radio Shack 271-000 or equiv.)
Misc—Binding posts, one red, one black (Radio Shack 274-662 or equiv.), small box, aluminum (Radio Shack 270-235 or equiv.), or bakelite, (Radio Shack 270-230 or equiv.)

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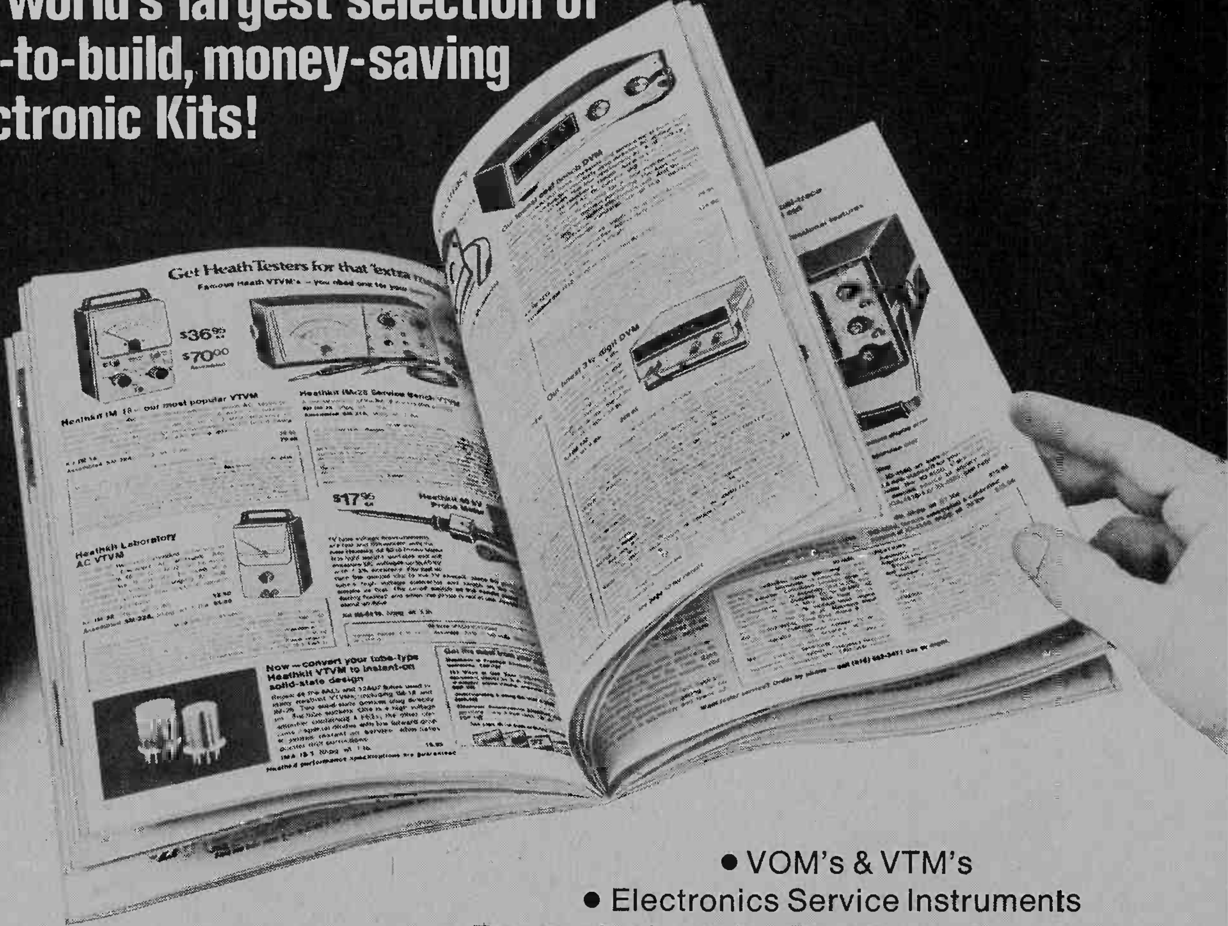

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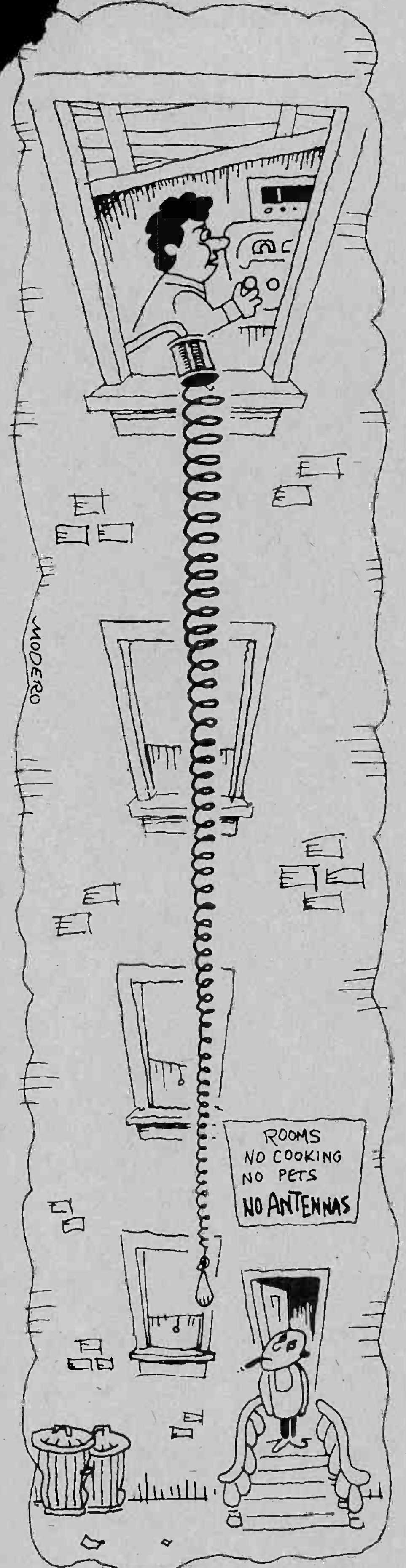


DX with BOINGER

IF YOU'RE an apartment-dwelling DXer, you've no doubt had your share of the age-old antenna hassle. Sad to say, few landlords sympathize with a shortwave listener's need for a good skyhook.

For those of you whose nerves are just about shot from the continual carping about your antenna (". . . that confounded wire of yours was crudding-up Kung Fu last night!"), the "Boinger" will bring fast relief.

What's The Boinger. Simply put, it's an inconspicuous *canned* antenna that'll sit on your windowsill, drawing about as much attention as yesterday's newspaper. Fact is, people just don't notice this little marvel. That's the beauty of it! But at the push of a button, this DX-dangler literally springs into action for you, as it accordions out to a fully-expanded shortwave longwire antenna. "Boinger" will be music to your ears. That's the sound made by the key to this antenna, a super-long spring. And as it unravels, it'll also unravel your aerial problems. And when you're ready to call it quits for an evening, just a few turns of the crank retracts the Boinger back into the hardly-noticeable case, ready for another day. It's been suggested we call this unit the "Candestine" (clandestine can antenna), since it does incorporate a bit of the old cloak-and-dagger. Call it what you may, it works in even the most impossible antenna conditions.

How It Works. Our Boinger is essentially an end-fed helically-wound longwire. The only big difference between it and the longwire most SWLs use is that it is vertically-oriented.

How do you find helically-wound wire? Believe it or not, the first place to check is in Junior's toy-box! Or, head for the local five-and-ten and ask for "the spring that walks down stairs by itself." Right—a "Slinky!"

Since the coil is vertical, gravity will help pull it down for you. Rigging it to a fishing reel will take care of pulling it back up again. You don't have to be 20 stories up to take advantage of this antenna since the helical winding allows you to pack tremendous wire length into a short distance.

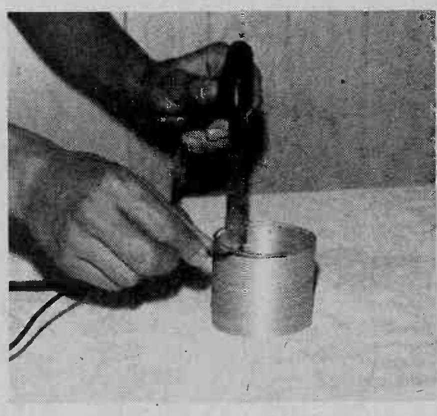
How To Build It. You'll need the following items, all of which shouldn't run more than $6 to $10:

Slinky. Actually it's a highly stretchable coil which folds down to only a few inches, but can stretch clear across the street.

Tin can to house the spring, about four-inches in diameter by five-inches deep. A salted peanut tin is perfect.

Some odds and ends from your fishing gear—a handful of lead weights, and a fishing reel with heavy-duty line. Now don't panic, the cheapest reel available will do. We've seen, and *used* in our own Boinger, a plastic reel that goes

Canning Slinky after it is fixed to a wood insulating block. Here author is checking clearance of block and Slinky from can's inside.



If you decide to solder the leadin wire to Slinky, use an X-rated iron—something that really gets hot. Slinky can draw away lots of heat before the solder flows.

for about $3.

½-in. conduit pipe cut to the length you need. Aluminum electrical conduit is easy to bend, and you'll need a screw-end adaptor to secure it to the can. If you use iron pipe, it can be threaded at the can end, but it's hard to bend. However, elbow pieces are available. Look at ½-in. copper tubing. It's easy to work with and can be soldered to the tin can.

Miscellaneous hardware: clamps, screws, and a piece of ½-inch-thick wood to fit in the can.

Construction. Solder an insulated leadin wire to the top end of the Slinky coil–or secure it with a machine screw. Any way you do it is okay so long as it's mechanically secure. Be sure not to let the antenna leadin wire contact the can or the conduit.

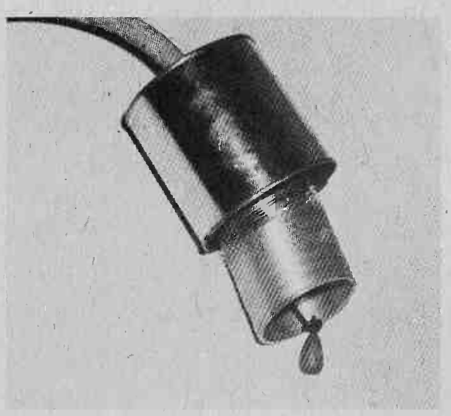
The conduit pipe serves double-duty in the Boinger. It is both the support for the unit and the feeder channel for the fishing line that controls the antenna's ups-and-downs. Bend the pipe into a flattened-out Z, with the center strut at right angles to the ends. Then, lay the pipe down flat and bend one end so it points straight up.

Put the wood-coil assembly into the can, and drill a hole through both, big enough for the pipe to fit through. Slip the end of the pipe (the end you made the last bend in) through the hole in the top of the can and through the wood, clamping both below and above with epoxy glue or threaded pipe and nut so it is solidly joined. Slip the wire through a hole in the can top, and tape it along the length of the pipe. It's a good idea to liberally apply putty or silicone sealer to the can top to seal the cracks–the Boinger will withstand some pretty rough weather.

Now, thread the fishing line into the far end of the pipe and pull it through the coil. Make a cross-hatch with two wires across the *bottom* loop of the Slinky (opposite end from the solder), and tie the fishing line, along with a few weights, here.

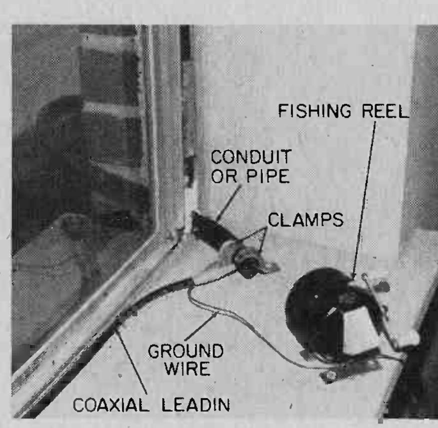
Mount the fishing reel on your inside window sill, and bolt the pipe to the outside wall. Depending upon the type of window, you may have to cut a small piece of glass out of the corner to feed the pipe through. We found that closing the window on the pipe and then trimming a wooden "stopper" to size for the crack is one good way.

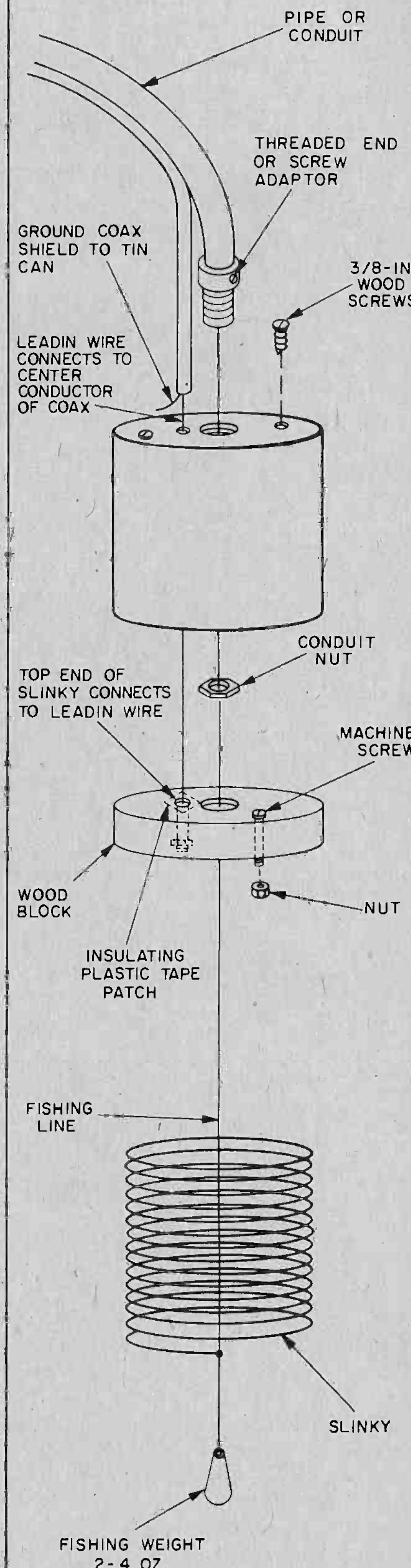
Attach the leadin wire to your receiver and let out some line on the reel. *Boing!* Gravity and the weights will stretch out your mini-antenna as far as you need. When you're finished, the coil will reel up and fit neatly in the can. Paint it a dull black, draw as little attention as possible when you install it and, believe it or not, you'll be surprised when nobody notices all the trouble you've gone to! ■



Boinger is finished and ready for installation. Outside world look out! A coat of black paint will keep down reflections and neighbor's questions. Keep in mind the SWLer's code, "Out of sight, out of mind!"

The finished setup may look a bit weird to the SWL's XYL, but that is the price she must pay to keep the OM at home evenings. Heavy wire running left and down is a shielded coax cable used as the leadin, and thinner wire running left is ground lead.





We blew up Boinger so you could put it together. Electrical connection of Slinky to antenna leadin wire should be insulated from tin can and pipe or conduit.

TRANSTAB

We thought it was just another transistor tester until we used it ourselves! / by Anthony Caristi

ANYONE who works with solid-state circuits has at one time or another needed an instrument to determine if a transistor is good or bad. Most transistors can be checked by making several ohmmeter measurements, but this is time-consuming and inconvenient. There is also the danger of passing too much current through low-current devices if the *RX1* scale of the ohmmeter is used, resulting in a burned-out transistor.

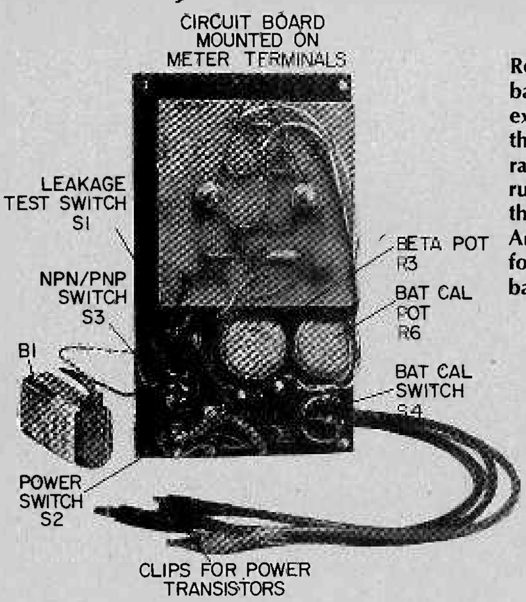
Here is a simple transistor checker, we call it *TransTab,* which can be built at very low cost to quickly perform several useful tests. If TransTab indicates a bad transistor, it will also indicate the type of defect. TransTab is also useful in determining the material and polarity of unknown transistors—a handy feature when checking non-registered transistor types, found in imported radios and TV sets. The gain (beta) of transistors can also be measured with TransTab. This feature is handy when using substitute transistors for replacement, or for matching transistors. Finally, leakage tests can be made. Leakage is defined as current flow between emitter and collector of a transistor with no forward bias applied to the base. TransTab uses a 1 mA full-scale milliammeter, but any meter with greater sensitivity may be used by changing the values of resistors R5 and R6.

Putting It Together. Most of the circuitry of TransTab is on a printed circuit board which is mounted to the positive and negative meter terminals. Four switches and two potentiometers are mounted on the front panel. This construction allows the entire unit to be assembled on the front panel so no mounting holes need to be drilled in the plastic cabinet. One or two transistor sockets—TO-5, the most common size, and TO-18, the smaller, not-so-common size—are also mounted on the front panel as to testing sockets. If you have trouble obtaining the smaller, TO-18-size socket, it may be left out. Three lead transistors of all sizes can be plugged into the common TO-5 socket.

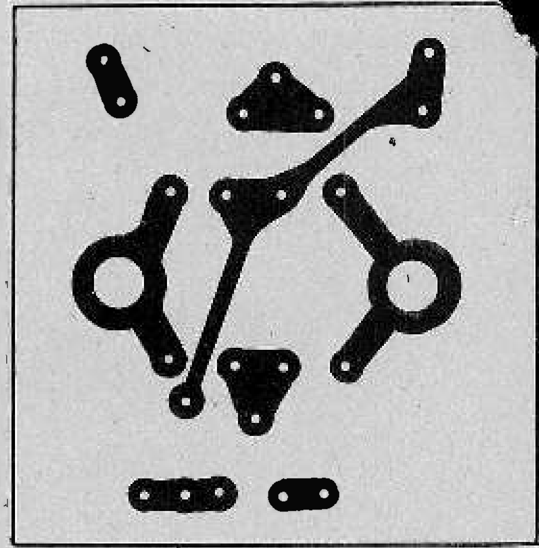
Larger, power transistors, such as the TO-3 and TO-66 sizes, are connected to TransTab for testing by means of three color-coded test leads. The unit is battery-powered with a standard 9-volt battery, and the *power* switch, S2, is spring-loaded so that the instrument cannot be left on by mistake. Under normal operating conditions, the battery in TransTab should last as long as the normal battery shelf life, since a transistor can be fully tested in a few seconds.

Using It. To check a transistor, insert it into one of the TransTab sockets, or connect the color-coded leads to the proper terminals of the transistor. When using the sockets, be sure the transistor leads are properly positioned to connect to base, emitter, and collector. If an error is made in the connection, the transistor will suffer no damage, but you will not get a correct indication.

Calibrate the meter by pressing the *CAL* button, S4, while adjusting the *CAL* potentiometer, R6, for a full-scale (1.0) reading. Set the polarity switch, S3, to *NPN* or *PNP* as required, and set the *BETA* potentiometer, R3, to the maximum counterclockwise position. Press the *power* switch, S2, ON. A good transistor will read about 0.68 if it is silicon, and 0.74 if it is germanium. If the transistor is bad, the meter will read 0, 0.2, 0.9, or 1.0, depending upon the defect. Refer to the TABLE OF DEFECTS AND METER READINGS. For convenient reference, this table should be pasted to the outside of TransTab. You can also paint a green band on the meter scale between the 0.66 and 0.76 scale markings. If the transistor reads good, press LEAKAGE (S1) button. Normal reading for a silicon transistor and low-power germanium transistor will be zero. High-power germanium transistors may show some leakage (about 0.1 to 0.2 meter reading). Such leakage readings on high-power germanium transistors do not necessarily indicate a defective transistor.



Rear view of TransTab with the back case removed. Everything except the battery is attached to the front panel. To avoid battery rattle, stuff in some foam rubber with the battery when the unit is finally buttoned up. Author suggests using black lead for emitter test lead, green for base, and red for collector.



Printed circuit board layout is shown full size with copper foil side up. Experienced experimenters may wish to use perf-board layout with point-to-point wiring. It's up to you!

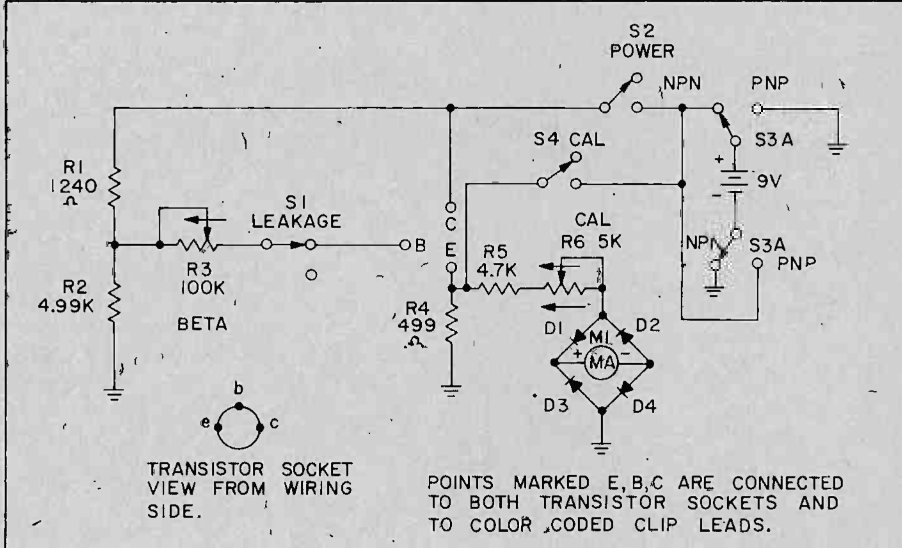
If possible compare the leakage reading with another transistor of the same type known to be good. To measure transistor beta, release the *LEAKAGE* button, S1, and rotate the *BETA* potentiometer, R3, until the meter reading is 0.25. Read the scale around the BETA knob, which has a range of 0 to 100. Higher values of beta can be measured by using the *Bx2* and *Bx4* calibrations on the meter scale. Rotate BETA potentiometer, R3, so that the meter needle rests at either of these points. Read the 0 to 100 beta scale and multiply the reading by 2 or 4, as required.

When testing a transistor of unknown polarity, try it on the instrument using both *NPN* and *PNP* positions of the polarity switch. The correct polarity will be evident when the meter indicates a good transistor (0.68 to 0.74) and the transistor leakage is zero. There is no danger of harming the transistor when the polarity switch is set to the wrong position.

How the Circuit Works. The basic circuit of TransTab is the emitter follower with the meter and multiplier resistors placed across the emitter resistor to measure the voltage from emitter to ground. The actual voltage at the emitter is not important; the meter is calibrated so that it reads 100 percent (1.0) when full battery voltage is applied to the emitter resistor. The transistor under test is operated as an emitter follower with the base connected to a voltage divider supplying a voltage equal to 80 percent of the battery voltage. NPN or PNP operation is achieved by reversing battery polarity.

Figure 1 is a simplified diagram showing the circuit with a NPN transistor. If the transistor is good, the voltage at the emitter will be equal to the base voltage minus a 0.7- or 0.2-volt base-emitter voltage drop, depending upon the transistor material. Thus, the meter reading for a properly operating transistor will be 0.68 for silicon and 0.74 for germanium.

Suppose the transistor under test is not good. As can be seen in the simplified schematic of Fig. 1, an emitter-to-collector short will result in a meter reading of 1.0, since full battery voltage would be applied to the meter through the short. A base-to-collector short will result in a slightly lower reading, 0.9, since there will be the normal base-to-emitter voltage drop through this junction. An open base or an open emitter



PARTS LIST FOR TRANSISTOR TESTER

B1—9-VDC transistor radio battery
D1, D2, D3, D4—Silicon diode, 75-volts PIV (or more), 75-mA (or more)
M1—1 mA DC meter
R1—1240-ohms, ½-watt resistor. If not available, use 1200 ohms
R2—4990-ohms, ½-watt resistor. If not available, use 5000 ohms
R3—100K potentiometer
R4—499-ohms, ½-watt resistor. If not available, use 500 ohms
R5—4700-ohms, ½-watt resistor
R6—5K ohms potentiometer
S1, S2, S3—SPST switch, momentary contact, spring return
S4—DPDT switch, toggle or bat handle

Misc.—Cabinet w/front panel removable, 3¾ Wx6¼ Hx2-in. D; transistor socket for TO-5 size; transistor socket for TO-18 size, if available, (not essential); flexible rubber-covered wire for test leads (three colors—red, green, and black); insulated alligator clips; printed circuit board kit.

transistor tester

will result in no meter reading at all.

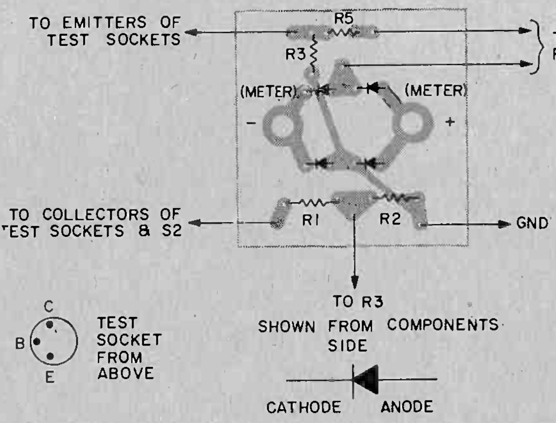
Other possible defects are an open collector, or emitter-to-base short. Either of these defects will result in a meter reading of 0.2. This is caused by current through R1 flowing from the base-emitter junction to the meter. Exactly 80 percent of the battery voltage is lost across R1, leaving 20 percent for the meter. When the transistor has an emitter-to-base short, collector current is zero due to lack of forward bias. Thus, the circuit acts as though the collector circuit were open, resulting in a meter reading of 0.2.

A leakage test is made by simply breaking the base connection to R1 and R2. In this condition the transistor has no forward bias and the circuit will be open between collector and emitter. The meter reading will go to zero. Some low-power germanium transistors, particularly those found in imported equipment, may exhibit some leakage with this test. Any transistor showing more than a 10 percent full-scale reading should be suspect.

Simplified Circuitry. In the simplified circuit of Fig. 1 potentiometer R3 is omitted. When making Good-Bad transistor checks, this potentiometer must be turned fully counterclockwise so that its resistance in the circuit is zero. After the transistor has been determined to be good, R3 is rotated until the meter reads 0.25. The amount of resistance added to the base circuit, in thousands of ohms, is the beta, or gain of the transistor. This measurement is accomplished by the proper choice of values for emitter resistor R4 and voltage dividers R1 and R2.

Fig. 2 is a simplified equivalent circuit of the emitter follower. By making R4 equal to 500 ohms, and the parallel equivalents of R1 and R2 equal to 1000 ohms, the value of beta is approximately equal to the resistance of R3 in thousands of ohms, when R3 is adjusted to give a meter reading of 0.25. Thus, by using a 100,000-ohm potentiometer for R3, a convenient 0 to 100 beta scale is obtained when R3 is rotated over its entire range. In addition, multiplier ranges for the beta scale are obtained by using scale calibrations of 0.375 for beta times 2, and 0.5 for beta times 4.

Checking Beta. When measuring beta with this instrument, bear in mind that about 4.5 milliamperes current is going through the transistor. The beta of a transistor will vary as the collector current changes. This test for beta is therefore most useful for small transistors which operate in the 0-to-10 milliampere range. ■



Location of components on flip (foil down) side of printed circuit board. Layout is not critical—any convenient location of parts will do. Circuit is DC-operated, so spread parts out.

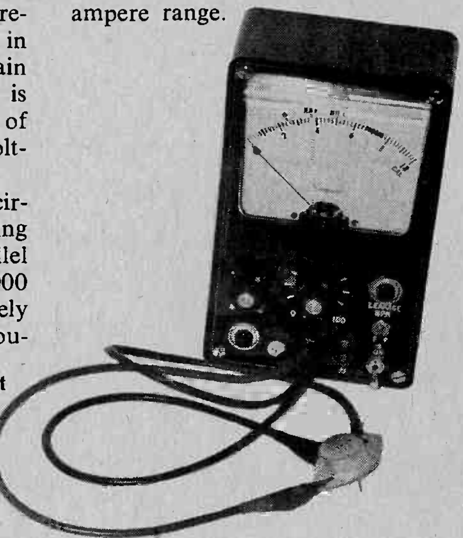
OPERATING INSTRUCTIONS

1. Press BAT CAL button (S3) and adjust BAT CAL knob (R6) for full-scale meter reading.
2. Set BETA control (R3) fully counterclockwise to zero position.
3. Set NPN/PNP switch as required.
4. Insert transistor in socket or connect leads to the alligator clips. (Connect green lead to base, red to collector, black to emitter.)
5. Turn power ON (S2). Transistor is good if meter reads between 0.66 and 0.75 (green area). If there's no reading, or improper reading, flip NPN/PNP switch (S3) to other position. If there's still no reading, or improper reading, transistor is defective.
6. Press LEAKAGE button and have power switch (S2) ON. Meter should read zero, except on power transistors, which will show low reading.
7. Adjust BETA control knob (R3) until meter reads 0.25. Read beta directly on the 0-to-100 scale around BETA knob. If the transistor's beta is above 100, set the BETA knob for a meter reading of Bx2 or Bx4, and multiply the BETA knob scale reading by 2 or 4 (see meter indication) for the value of beta.

TABLE OF DEFECTS AND METER READINGS

Condition	Meter Reading
Good silicon transistor*	0.68
Good germanium transistor*	0.74
Open base	0
Open collector	0.25
Emitter-to-base short	0.25
Emitter-to-collector short	1.0
Base-to-collector short	0.9
Emitter open	0

*A green area can be inked in on the meter face between the .68 and .74 indices on the meter scale. This visual indicator will speed up rapid identification of good-bad transistors.



Color-coded TransTab leads connect to power transistor terminals. A more elaborate unit would have transistor sockets for every possible transistor type—but cost is an important factor.

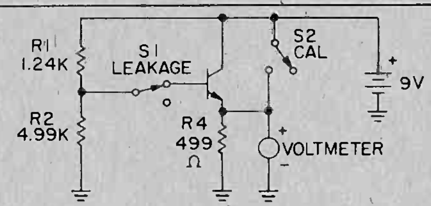


Fig. 1. Simplified schematic diagram of TransTab showing test circuit for good-bad, and leakage tests. Pot R3 is omitted for simplicity.

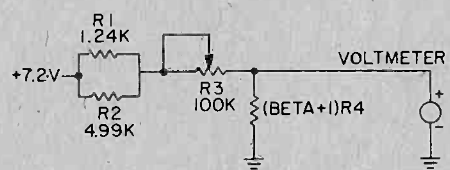


Fig. 2. Here's TransTab set up for testing transistor's beta. Simplified circuit is explained in text.

WAAAT'S THAT SOUND!

Simple circuit uses variable tuning slug coil to get foot-pedal wah-wah sound.

by Steve Daniels

A MOST POPULAR gadget in the well-equipped guitarist's sound effects bag is the Wah-Wah pedal, a foot-controlled, one-transistor (FET) amplifier which can produce many different effects, from plaintive wailings to blatantly sexy "wow-wow" sounds. If used in conjunction with a fuzzbox, even such off-the-wall sounds as that of a sitar can be closely approximated. Experimentation and imagination are all that are needed.

Commercial Wah-Wah pedals run 35 bucks or more, but you can build our goody for about $15. If you can find a breadpan and a used AM radio antenna loopstick lying around, you can do it for less than ten—a darn cheap way to beef up the sound of the old axe.

How it works. The Wah-Wah pedal control is an amplifier whose frequency response peak can be varied by an RC (resistance-capacitance) or LC (inductance-capacitance) circuit connected as the load (at the output) of a transistor. The circuit chosen here uses a variable inductance coil which is operated by a foot-pedal. Changing the size of the capacitor in the LC circuit could have been used to alter the output sound, but it would be more complicated mechanically, and would cost much more.

FET (field-effect transistor) Q1 is connected as a common-source amplifier with resistor R2 adjusting for differences in individual gain. Switch S2 couples signal to your guitar amp either from the instrument directly or from the drain of transistor Q1. The switch is a push-push type, so be sure to use the one specified in the Parts List.

Loopstick Lowdown. Commercial coils don't have as much "Q" as is required for this application, so we roll our own, starting with an old AM antenna ferrite loopstick, taken from any old broken AM radio. Remove the original windings, clean the terminals, and remove the metal collar from the slug by just screwing it off. Cut two discs about ¾-in. in diameter from thin cardboard, and nibble out a hole in the center of each so that they fit snugly on the loopstick. Position one disc right up against the collar that holds the terminals of the form and place the other disc about 3/16-in. from the opposite end. Cement the discs in place with just a few drops of household cement or good glue to hold them until the winding is complete. When the cement is dry, punch a pinhole through the cardboard at a point as close as possible to one of the coil terminals. Using a small piece of fine sandpaper strip the enamel from the end of the spool of fine (no. 28) wire. Thread this end through the pinhole to the coil terminal. Tin the bare wire end and solder it in place using as little solder as possible. Now chuck the longer end of the coil form in an electric drill. Stick a dowel through the center of the spool of wire and hold this between your knees, leaving your hands free to hold the drill with one hand and guide the progress of the winding with the other hand. The exact number of turns isn't critical—just distribute the turns evenly and fill the entire space between the cardboard discs. Finish the winding at the terminal end and bring the ending lead through a second pinhole. Strip the end with sandpaper and attach through the opposite pinhole to the other terminal.

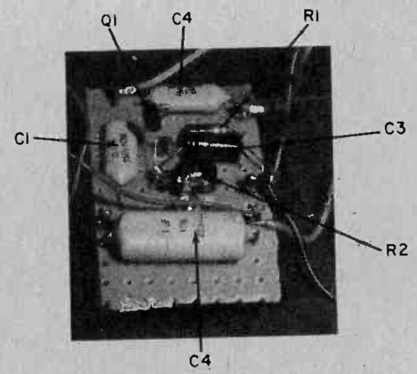
Wire the FET transistor Q1 and the other electronic parts together on a small piece of perf board (the one shown in the picture is 1½-in. x 2½-in.). If this is one of your first projects it might be wise for you to use a transistor socket instead of wiring directly to the transistor itself (because you could overheat the transistor if you don't take the precaution of a socket—or of using a pair of long-nose pliers as a temporary heat sink when soldering to each lead of Q1). Use flea clips to assist in soldering to the various components on the board. The layout isn't critical since there are no radio frequencies involved.

Be sure to use the capacitor specified for C2 because it packs the required amount of capacitance into a very small space. Bring out tie points to the edges of the board to permit conveniently connecting them to the other parts of the circuit (switches, jacks, variable control inductor coil and battery).

Experiment for best sound. Varying the "Q" of the coil can change the sound, so you may wish at this point to experiment to find the exact LC combination that gives the sound that you want. If so, breadboard the circuit together on your workbench, but keep your leads fairly short. Connect up your guitar and an amplifier and turn S1 on. Set R2 to its midrange, and play a few notes while moving the slug of L1 in and out. If there is no effect, press S2. The Wah-Wah should now be heard. After adjusting R2 for the best effect, you may still want to experiment for a different sound. If so, unsolder the end of L1, unwind about 100 turns and reconnect the end. Replace L1 in the circuit and add capacitors in parallel with C2 in intervals of 0.05 uF until the Wah sound returns. Repeat this procedure until you get the effect you want, then find a single capacitor to use for C2. What you are actually doing is raising the "Q" of the tuned circuit while keeping the resonant frequency about the same.

Breadpan to Bandstand. The breadpan that we used for our model measures 9½-in. x 5½-in. x 3-in., but anything in this range will serve. The pedal itself is made from a piece of masonite about 3½-in. x 6-in. Cut a piece of thin sheet metal the same size and screw the two together with the shortest 4-40 hardware that will work. Cut off or file down the ends of the screws as much as possible when this is done. The hinge that allows the pedal to move up and down can be an ordinary butt-hinge from your local hardware store. It is secured in the center of the pedal from the underside, using 4-40 hardware. Here again, file down the screw shanks as short as possible. The rubber matting that we use as a covering also came from a hardware store. Cut a piece exactly the size of pedal and glue it on the metal side with rubber cement.

Using the photographs as a guide, position the pedal assembly on top of the breadpan and mark the position of the mounting holes with a scriber or awl. Drill and deburr these holes. The hinge is supported off the pan by ⅛-in. spacers and secured with 4-40 hardware, but only mount it temporarily at this time. Let the pedal lie flat. Take a pencil, and gently draw a line across the pan to indicate where the business end of the pedal rests in the full-down position. Find the center of this line, move in toward the hinge about ⅛-in. and you have located the center of one side of the slot through which the coil slug passes. The one we used measured 7/16-in. x 7/8-in. The slot is best cut with a nibbling tool. Now locate and drill holes for the two switches and two jacks, and the screw holding the circuit board. If it's going to be painted, now's the time to do that.



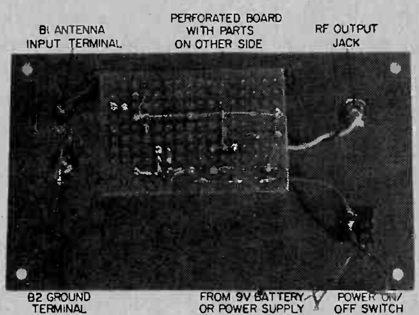
The layout of components on perfboard is not critical. Use any handy arrangement.

Build the bracket. The support for the variable inductance control coil, L1, is made from 18-gauge aluminum. The dimensions may be adjusted to your convenience and taste. Find the exact center of the bracket and bore a ¼-in. hole there. Get a large rubber grommet which just fits comfortably onto the tubing of L1. Ream out the hole in the bracket so that the grommet fits in with just a little bit of slack. If you now slip the long end of the coil into the grommet, it should move easily back and forth. The coil form should project about 5/16-in. above the top of the grommet. A small bracket of sheet metal is used as the stop for the coil slug. It's held with two 4-40 screws as the photo indicates. Solder two 6-in. leads to the coil terminals and you are ready to mount the whole assembly in the pan.

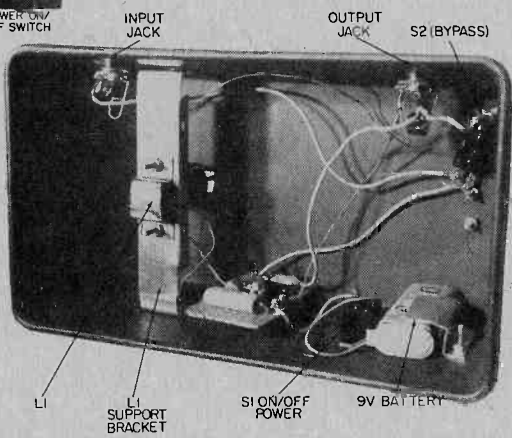
Final assembly. Remount the pedal and drill a small hole through the masonite about ⅛ in. from the business end, right on the center line. Don't go

(Continued on page 101)

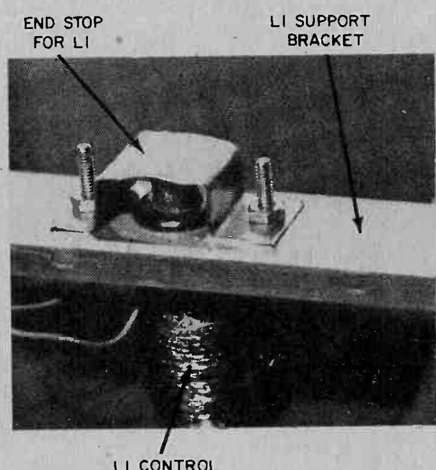
WAAAHS SOUND



Point-to-point wiring is used to connect the FET, the input and output jacks, bypass switch, battery, and the few components on the small perf-board. Layout on the board is non-critical. Just position parts for convenience.

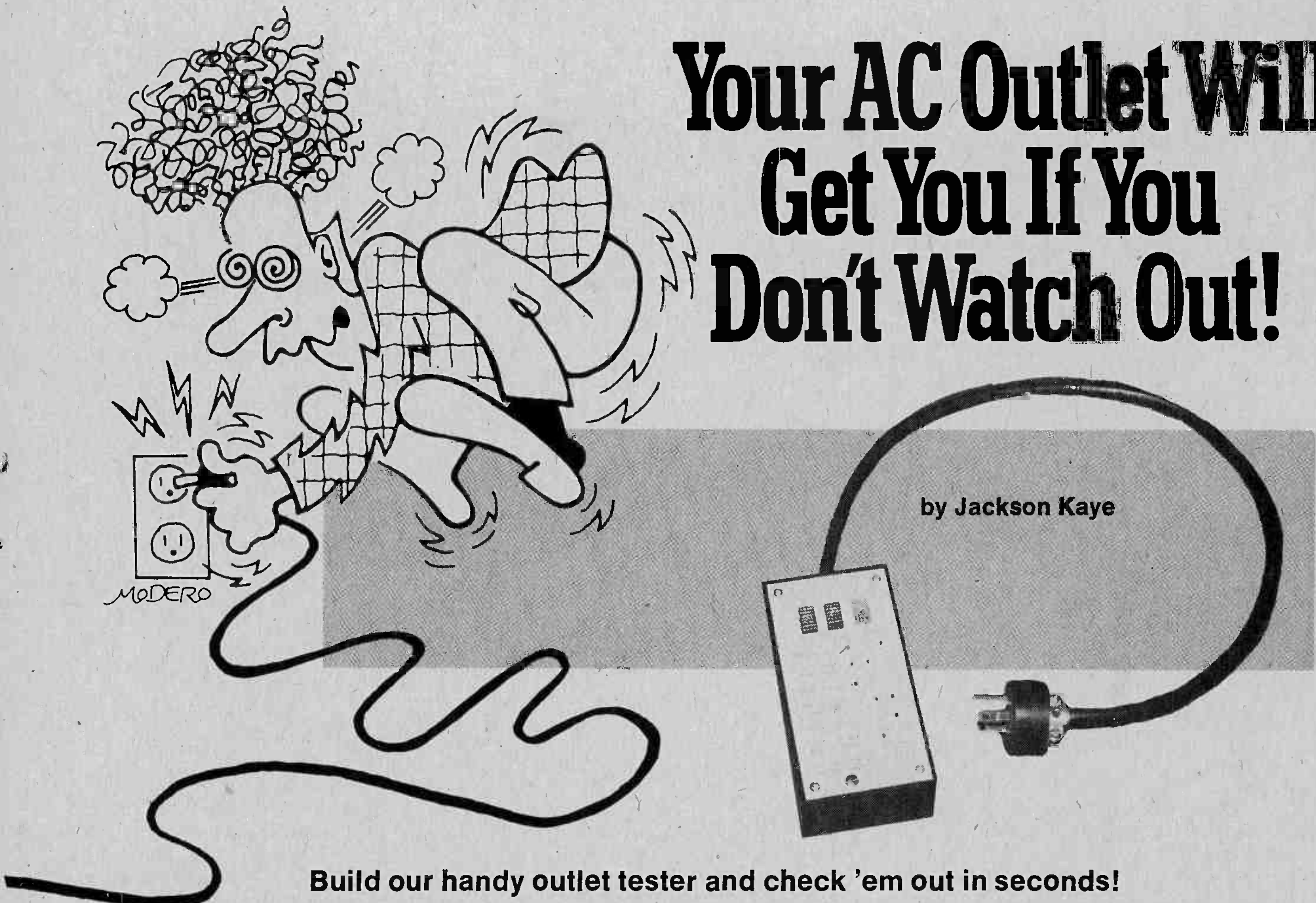


Inside view of Wah control box, showing the few parts needed. Bypass switch S2 is a push-push type which can be foot-operated to cut the control in, or let your instrument (guitar or other) feed directly to your amplifier-speaker.



Upside-down view of the support bracket for control coil L1, with small end-stop for the coil. Both are aluminum strip.

Your AC Outlet Will Get You If You Don't Watch Out!

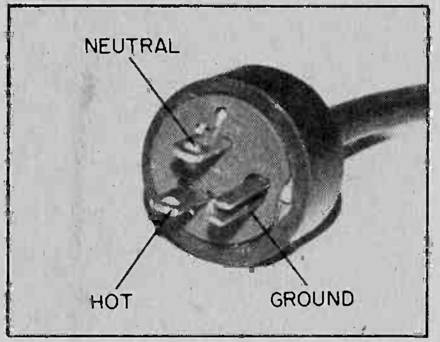


by Jackson Kaye

Build our handy outlet tester and check 'em out in seconds!

☐ The convenient, apparently very friendly, three-prong AC power outlet in your home may *kill* you! Yes, it sits in the wall waiting for you to plug in a power tool or household appliance complete with three-prong plug, you trusting to all of its safe outward appearances and ending up shocked to death's door.

The three-slot AC power outlet offers considerable protection to appliance users provided the outlet is connected correctly to the AC lines. But we all know hardly anybody is going to pull all the outlets from their wall boxes in one's home and check the wiring—it's too much work. And what about your neighbors, relatives and friends who don't know what to check or what to do! You don't want to pull their outlets also?



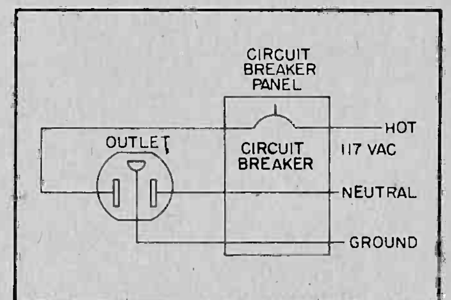
The business end of a line cord. Prong wiring must match outlet's for safety.

The obvious answer is a "quickie" test set that you can plug in safely to a wall outlet to give you a visual indication that the outlet is wired correctly. That's what Test-Out, a handy self-contained visual indicator, does in seconds and you can build it cheaply.

What It Does. Test-Out is a neon bulb indicating device that is plugged into the wall outlet. When the indication is normal, the outlet is wired correctly and you can so unplug it and go to the next outlet. When the indication is other than normal, the color-coded neon indication lets you know what's wrong and tells you what to do to make it safe.

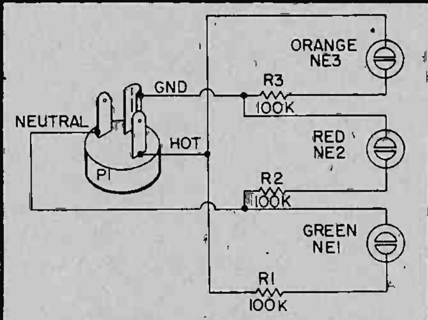
The AC outlet is where it's all at, so you have to know about its wiring hookup before you proceed. This drawing shows the wiring of typical outlet. In your home almost all of the outlets are in-wall installations with the wall plate flush against the wall and duplex outlet plastic mold protruding slightly. The three wires in the box connect to the outlet—the black (hot) wire to the brass screw, the white (neutral) wire to the chrome-plated screw, and the green or bare (ground) wire to the green-painted screw. When wired in this fashion, the outlet is connected as shown at upper right, page 66.

A lamp connected to the hot terminal and to either remaining slot, neutral or ground, will be illuminated. This is exactly what happens in Test-Out. When Test-Out is plugged into an outlet that is correctly wired, both the



Here's how your house's wiring diagram would look if it had only one outlet.

green and orange lights come on. See the schematic diagram on the next page. Trace the circuit for yourself. Now imagine that the outlet into which Test-Out is plugged has the *hot* and *neutral* wires reversed. The *green* and *red* lights will come on. This is a common wiring fault, and should be corrected whenever it occurs. Some other less common, but still dangerous wiring faults or bad connections Test-out can detect in a wall outlet are: *open ground* circuit, *hot* and *ground* connections *reversed, open neutral* connection, *neutral* connection *hot* while the *hot* connection is *open,* and *hot open* or no-power. Each possible fault has its own light pattern



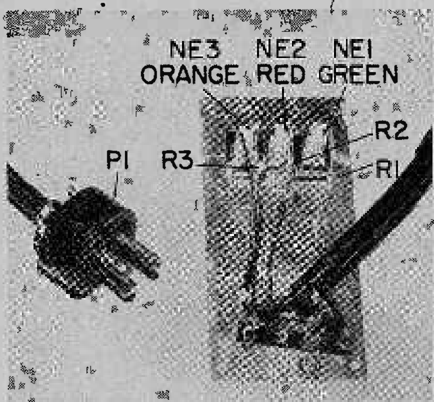
PARTS LIST FOR TEST-OUT

NE 1-3—Neon lamp indicator with 100,000-ohm, ½-watt current-limiting resistor (Radio Shack 272-338 or equiv.)

P1—AC line plug, 3-pronged.

R1-3—100,000-ohm limiting resistor (supplied with neon lamp indicators under Radio Shack #272-338)

Misc.—Plastic case with aluminum cover, approx. 5-in. x 2½-in. x 1⅝-in. (Radio Shack #270-233 or equiv.); heavy duty, 3-wire rubber-covered line cord about 3-ft. long; 3-terminal strip; hardware; wire; solder; etc.



Wiring is simple, but don't rush ahead. Wire neatly and recheck wiring carefully.

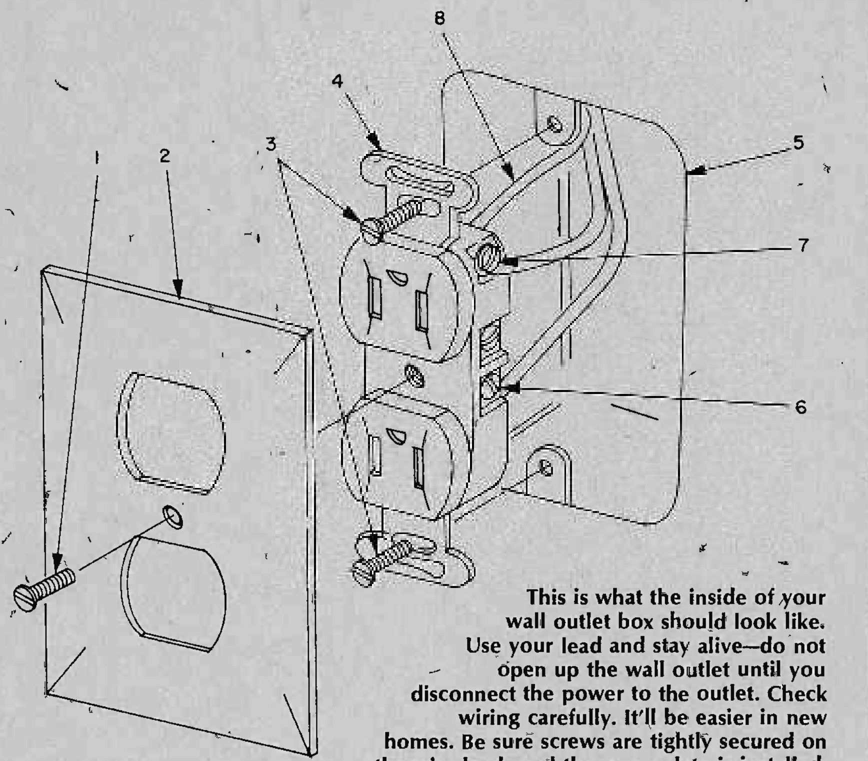
indication which is given in the Table. When you make your own Test-Out unit, copy the Table and paste it on the case for rapid trouble and correction information.

Assembly of Test-Out. Building Test-Out is as simple as stepping in a bucket. The black plastic case with aluminum cover measures approximately 5 x 2½ x 1⅝-in. and has three rectangular neon lamp sets with external limiting resistors mounted on the aluminum cover, with the green lens on the left, red in middle, and orange (amber) at right. A hole is drilled in the box for the heavy-duty line cord to pass. The line plug is also heavy-duty type with built-in wire clamp. Overbuilding here is important because the line cord and plug will take considerable pulls and strain in the normal course of using Test-Out. Don't get cheap material here! A three-terminal strip will make wiring easier (see photo).

Paint the aluminum cover any light color and screw cover to box when wiring is complete. Check unit by applying power first to hot prong and neutral prong on the plug. The green light should go on. Now switch the neutral connection to the ground prong. The orange light should come on. Lastly, the power leads should be connected across the neutral and ground leads—the red light should come on. If all is well, Test-Out is ready for work after the handy-reference Table is copied and cemented on Test-Out's aluminum panel.

Put Test-Out to work at once. You will be surprised how many outlets are improperly wired. Be sure to throw off the circuit breaker before rewiring an outlet. ■

1—Cover plate screw
2—Cover plate
3—Outlet mounting screws
4—Outlet
5—hole for box in wall
6—White wire connected to chrome-plated screw
7—Green or bare wire connected to green screw
8—Black wire connected to brass screw (screw not shown)



This is what the inside of your wall outlet box should look like. Use your lead and stay alive—do not open up the wall outlet until you disconnect the power to the outlet. Check wiring carefully. It'll be easier in new homes. Be sure screws are tightly secured on the wire leads and the cover plate is installed.

AC OUTLET FAULT TABLE

WHAT IT MEANS	GREEN	ORANGE	RED
WIRING OKAY	●	●	◎
HOT & NEUTRAL REVERSED	●	◎	●
OPEN GROUND	●	◎	◎
HOT & GROUND REVERSED	◎	●	●
OPEN NEUTRAL	◎	●	◎
NEUTRAL IS HOT HOT IS OPEN	◎	◎	●
HOT OPEN OR NO POWER	◎	◎	◎

BULB ON ● BULB OFF ◎

BUILD LITE-COM!

Photo-transistor receiver and LED transmitter work on visible or invisible light, with or without fiber optics.

by C. R. Lewart

AT THE SAME TIME that food and drink prices keep going up, and UP, the cost of electronic components keeps going lower and lower. You can now communicate over a beam of light for less than ten dollars using two electro-optical semiconductors which weren't even available except in development labs a few years ago. These transducers* convert electrical signals into light, and then convert light back into electrical signals. Thus you can use the Lite-Com to send messages and music over a beam of light without most of the previously-required circuitry.

Less-sophisticated light detecting devices have been available to the experimenter for some time. There are photocells made of selenium and of cadmium sulfide which have been off-the-shelf items for years. They are used in light meters and in cameras to measure light. However, their response time is much too slow for accurate transmission of sound. Photo-transistors, on the other hand, have excellent audio frequency-response characteristics, and are ideal for the project which we describe here.

The Lite-Com uses two electro-optical transducers: the *photo-transistor,* which converts light variations into electricity, and the LED (Light-emitting diode), which converts electrical signals into changes in light intensity. Lite-Com is an easy-to-construct project using those transducers which will give you the basic circuitry for many other projects you will think of after you've put it together and seen how well it works. Combining these two circuits with other equipment should make some interesting Science Fair and other experimental (and practical) systems.

Light Detector. The basic detector used in the Lite-Com is the photo-transistor. Every transistor is sensitive to light when its cover is removed. Light falling on the base region of a transistor has the same effect as electric current being "pumped" between its base and emitter. This effect was recognized early in the development of transistors. Because transistors were not intended to be light-sensitive in their original applications (how would you like your radio to quit when exposed to light?) they are mounted in hermetically-sealed, non-transparent metal or plastic enclosures.

You could of course cut through the transistor enclosure to make a regular transistor into a photo-transistor but in the process more likely than not you would destroy the transistor. But for little more than a dollar you can buy a photo-transistor specially designed to do the job. It is hermetically sealed but has a small glass window on top to permit light to fall directly on its base region. Most commercially-available photo-transistors use the NPN config-

* A *transducer* is any device which accepts energy in one form, such as heat, light, or electricity, and converts it into some other form of energy, such as mechanical motion. Telephone receivers (and transmitters) as well as loudspeakers, are widely-used transducers.

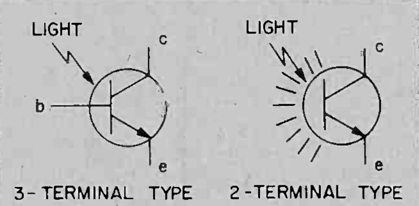
BUILD LITE-COM

uration. Some photo-transistors have three terminals, emitter, base and collector, while others have only two terminals, the emitter and collector. In either case light falling on the transistor generates the base-emitter current.

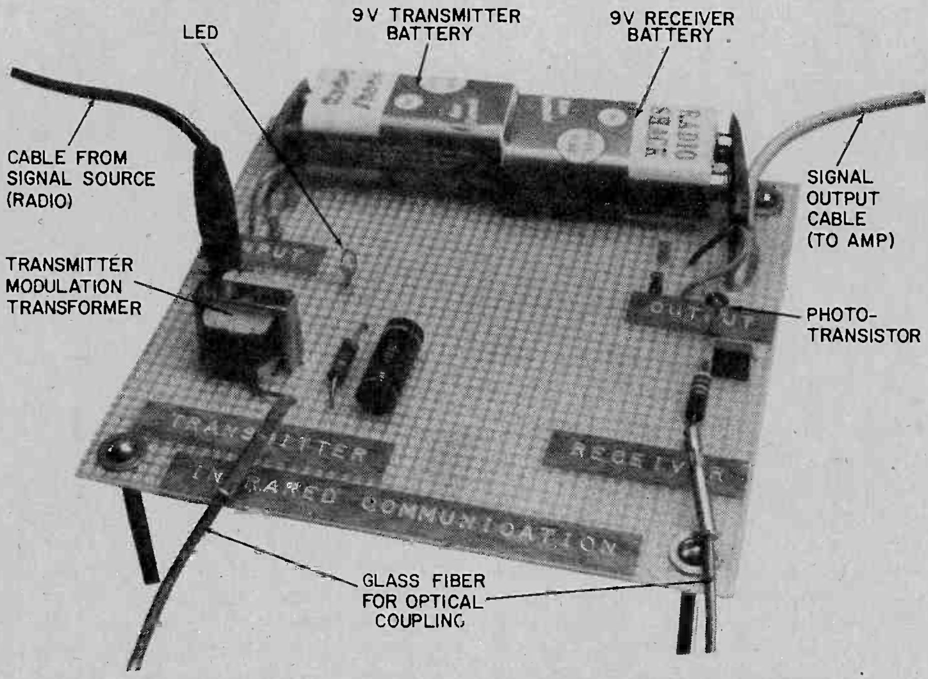
In a three-terminal photo-transistor there are other ways to control the base-emitter current. You can bias it by connecting a resistor between the base and collector, or you can vary the light sensitivity of the photo-transistor by connecting a potentiometer between the base and emitter. However, for Lite-Com either a two- *or* a three-terminal photo-transistor will do the job. Another option the photo-transistor designer has lies in the light region for which the photo-transistor is most sensitive. The two usual choices are in the visible light spectrum or in the infrared region as shown in the Spectral Response Graph To be able to operate with "invisible" infrared light we selected an infrared sensitive transistor with its peak sensitivity at 0.9 microns.* The visible light region extends from about 0.4 microns to 0.7 microns (violet to purple). If you want to experiment with visible light our infrared transistor will still work, as its sensitivity stretches into the visible region. However, a different photo-transistor (see the Parts List) will give you better results with visible light.

Light Sources. To generate a signal proportional to the sound energy Lite-Com uses an infrared LED. The LED generates light when it is forward-biased. That is, when its anode (+) is connected to the positive battery terminal (and its cathode, of course to the negative). Be careful, however, not to connect an LED (or any other diode) *directly* to a source of positive voltage. Doing so will burn the diode out at once, because it will draw too much current. This is because the LED (just as other diodes) has a very steep voltage/current curve. Unless you put a

*one micron = 10^{-6} meters (one millionth of a meter)



Ordinary transistor—light-sensitive, if open. Phototransistor has clear window, omits base connection.



Closeup of transmitter and receiver built on one chassis for demonstration. Units may be separated by any distance provided light path is provided from transmitter's LED to receiver's phototransistor.

current-limiting resistor in series with the diode any battery voltage larger than about 1.5 volts will cause the current drawn to exceed the maximum allowable value, and the diode will burn out. When in doubt always figure the size of the resistor required, using Ohm's law:

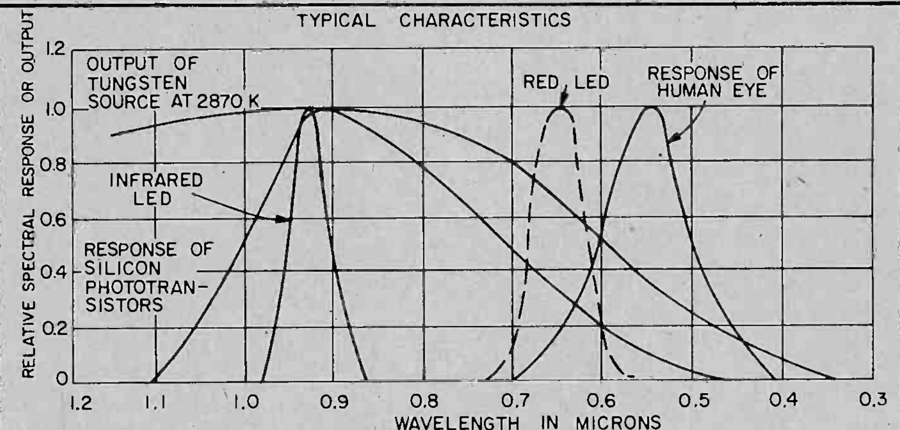
$$R = \frac{E(\text{volts})}{I(\text{amps})}$$

For example, for a battery voltage of 9 V, with the maximum allowable current through the diode 30 mA, assume a voltage drop across the diode of 1.5V. The limiting resistor value in this case would be found by using these figures in the formula:

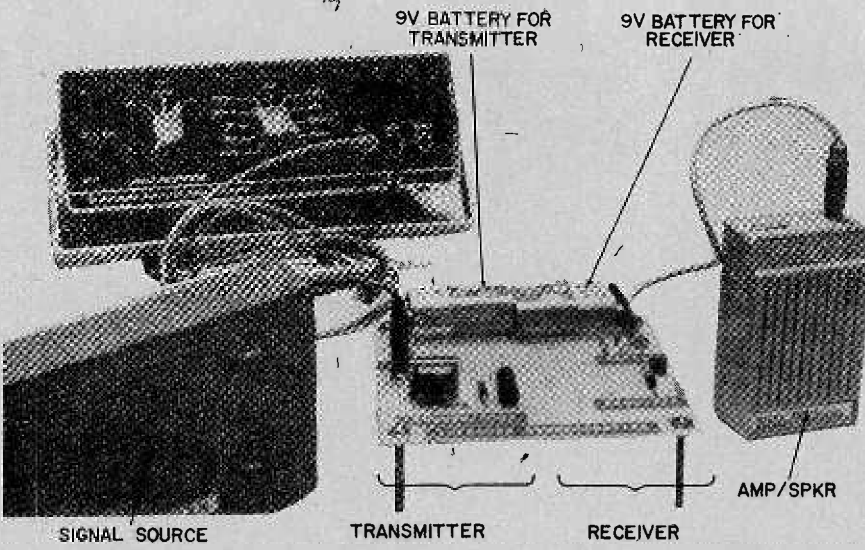
$$R = \frac{(9\text{-}1.5)}{0.030} = 250 \text{ ohms}$$

Just as photo-transistors can work in various light regions, LEDs can also be designed for various light frequencies or colors. Currently you can buy red, orange, green, and infrared LEDs. Light-emitting diodes generating invisible infrared light are particularly useful for building burglar alarms, or in areas where ambient light would be disturbing. Under such conditions an infrared filter can be used to attenuate the visible ambient light and pass only the infrared radiation. Common features of LEDs, as compared to incandescent light sources, are fast response up into *megahertz* region, and low power consumption. Thus they are ideally suited to transmission of voice frequencies.

Transmission Medium. Both infra-



Wavelength of infrared LED, visible-light LED, and tungsten filament emissions, compared with wavelengths of silicon phototransistor and human retina.

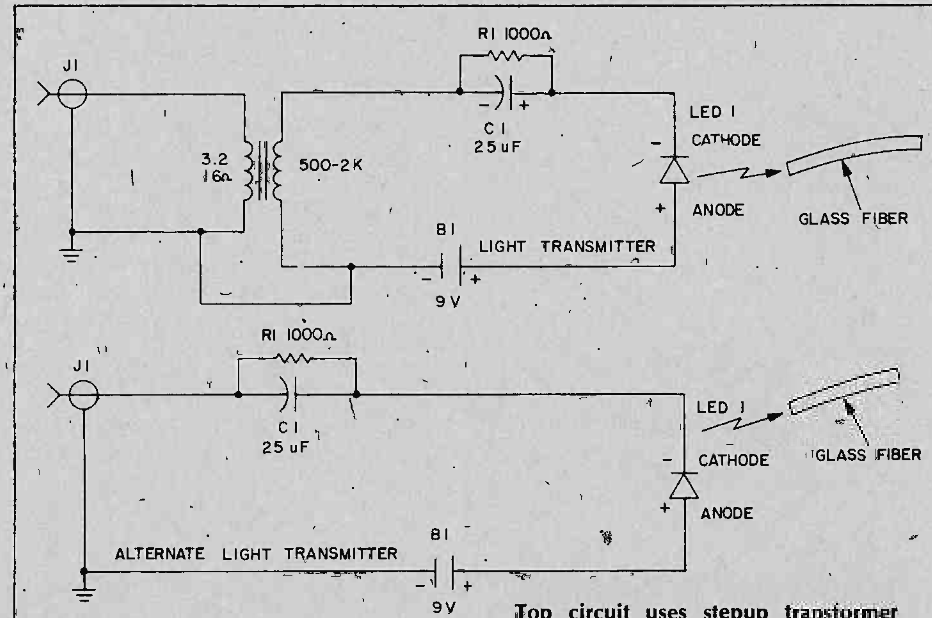


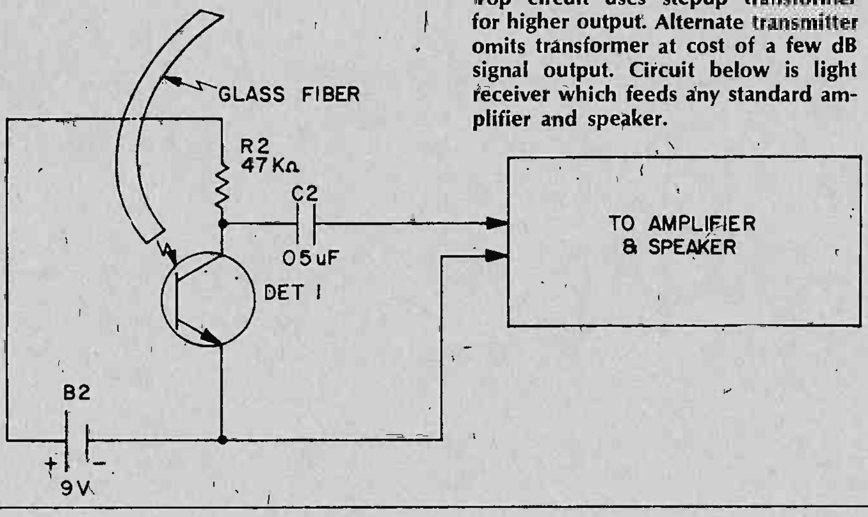
Lite-Com uses electrical signals from radio (or other source) to modulate infra-red LED transmitter. Receiver phototransistor senses infra-red light variations, feed external amplifier/speaker. LED and photo-transistor may be coupled directly, with lenses, or with glass fiber optics.

red and visible light propagate along straight lines through the air. This path can be bent by prisms, mirrors, lenses or bundles of glass fibers. In fact you will have the most fun by using one or more glass fibers between the transmitting LED and the receiving photo-transistor. You can tie the glass fibers in knots and they will still pass the visible or infrared light energy. Our Parts List gives suppliers of glass fibers for experimenters. You can even use just one glass fiber about 1/16-inch in diameter, and any convenient length.

Setting It Up. To use the Lite-Com we modulate the output of the LED with sound signals such as the output of a radio, a tape machine (connect from the earphone output jack), a ceramic phono pickup, or a microphone and mike amplifier. The light can be transmitted directly (by placing the LED face-to-face with the photo-transistor), or more conveniently by transmitting the light signals through a glass

(Continued on page 96)

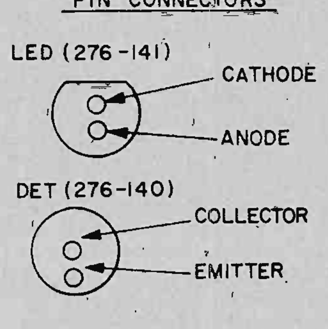


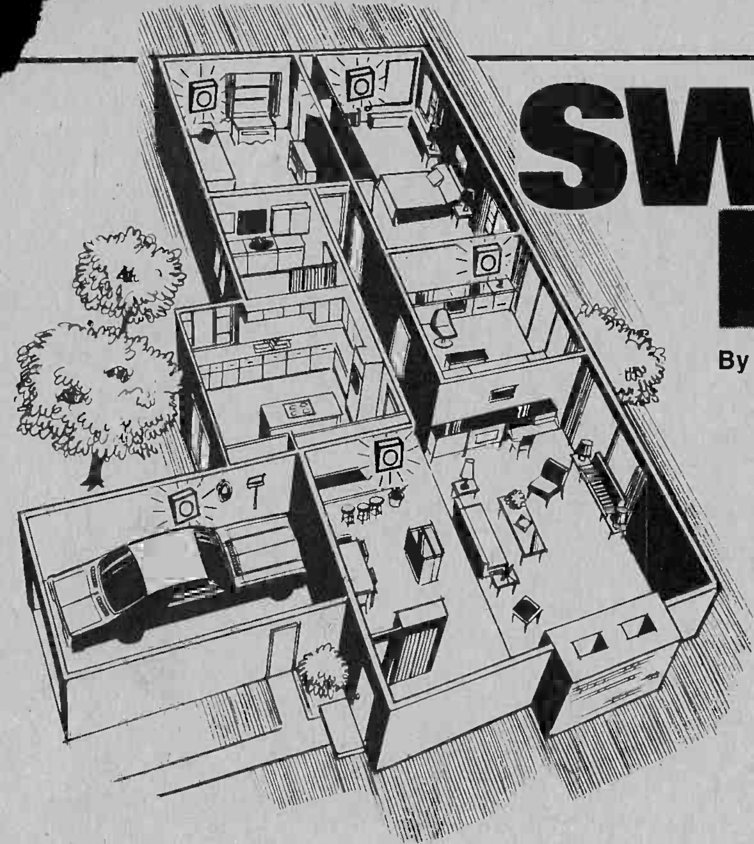


Top circuit uses stepup transformer for higher output. Alternate transmitter omits transformer at cost of a few dB signal output. Circuit below is light receiver which feeds any standard amplifier and speaker.

PARTS LIST FOR LITE COM

AMP—transistor amplifier with speaker (Radio Shack 277-1008 or equiv.)
B1, B2—9 V transistor radio batteries
C1—25-uF, 35-VDC capacitor
C2—0.5-uF, 35-VDC or more capacitor
DET 1—Infrared photo-transistor (Radio Shack 276-140 or equiv.) or photo-transistor for visible light (Radio Shack 276-130 or equiv.)
J1—phono jack
LED 1—infrared light-emitting diode (Radio Shack 276-141 or equiv.), or visible light LED, Radio Shack 276-026 or equiv.)
R1—1,000-ohm, ½-watt resistor
R2—47K-ohm, ½-watt resistor
T1—audio output transformer. Primary may be anywhere from 500 to 2,000 ohms, secondary between 3.2 and 16 ohms
Misc.—Perfboard, battery connectors. A selection of glass fibers (also called **fiber optics**) can be obtained from Radio Shack (page 72 in the 1976 catalog) or from Edmund Scientific, Barrington, N.J. 08007. Edmund also carries many optical components for the hobbyist.

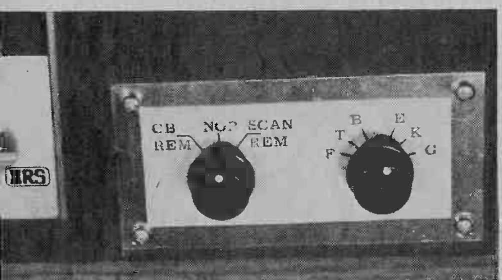




SWITCH-A-BAND

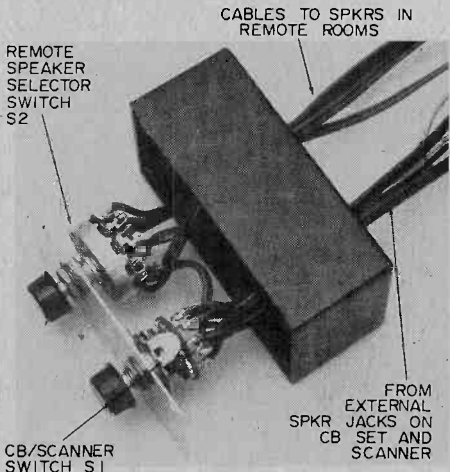
By Jorma Hyypia

SWITCH-A-BAND LETS YOU HEAR CB talk or monitor radio talk (Fire, Police, Aero, etc.) from your scanner set anywhere in your home, as well as over outdoor speakers at your front door or patio, or anywhere else you want to install them, such as the garage or near the sandbox or swimming pool. In addition, you can call anyone in these places using the PA (public address) feature of your CB set when you need to communicate with them in a hurry—for example when there's a telephone call in the kitchen for someone in the basement or outdoors. You can even yell at stray dogs digging up your flower beds, or tell unwanted salesmen that you don't want whatever it is they're selling—or tell them you can't talk to them because there's nobody at home! You can do all this the way I do, without moving from your easy chair, once you've installed your Switch-A-Band system. Of course you *will* have to move from that ol' rockin' chair a little bit at first, while you're actually setting up and installing your Switch-A-Band.



Three-position switch on left is at NOR(mal) position in center when no remote speakers are needed. Remote speaker in use is indicated by letters around knob of switch at right. CB set is on shelf at left.

Switch-A-Band provides instant switching to permanently-installed speakers in the living room (the "main" speakers), kitchen, garage workshop, son's room, rear terrace and the front door area. I also have a branch line to the basement where a roving single speaker can be plugged into any one of four outlet jacks located in the office, art studio, photo darkroom, and game room. Use of a roving speaker cuts down initial installation costs by making one speaker do the job of four.



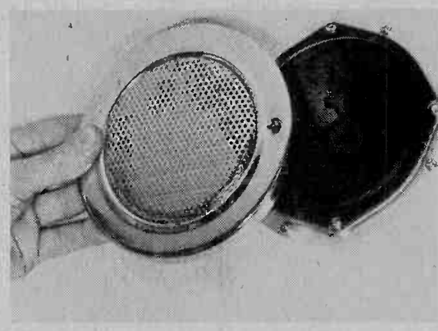
The two selector switches mount in small metal enclosure with cables coming from CB and scanner radios, and going to remote and main speakers going out rear. Terminal strips (optional) at rear would make wiring more convenient, but would add a bit to the expense.

If you have a CB transceiver but not a scanner radio, you can dispense with the CB/Scanner selector switch and just connect your CB set's *External Speaker* jack to the X and Y terminals of the Remote Speaker selector switch. See the schematic diagram.

If you use a selector switch which has more terminals than you actually need for the remote speakers you can easily block the switching action to prevent switching to unused terminals on the switch.

CB/Scanner Selector Switch. This 4-pole, 3-position switch feeds the output of either the CB set or the scanner radio into the remote speaker system. Although it may look a bit complicated the first time you look at it, you'll find it's really quite logical and easy-to-understand after you study the diagram for a few minutes.

Note that this switch has four terminals, 1, 2, 3, 4, in the center of the switch, as viewed from the rear, surrounded by 12 other terminals around the outside. The four terminals in the middle are switched, each one to one



For remote listening in rooms with cabinets or boxed-in areas like kitchen cupboards these flush-mounting speakers work well.

or another of four sets of three outside terminals each. For example, center terminal 1 is in contact, depending on the position of the knob which turns the switch, with either contacts 5, 6, or

It lets you monitor your CB or scanner all through the house 24 hours a day.

7. The arrows in the schematic diagram show which terminals are connected when the switch is in its CB/Remote position.

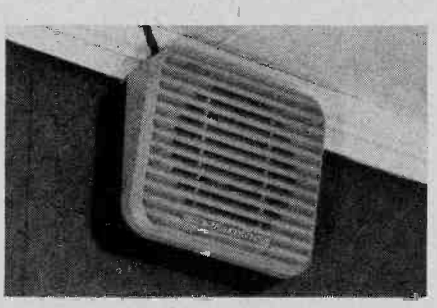
A two-conductor cable leading from the *External Speaker* jack on the rear of the CB set goes to terminals 1 and 2—the output of the scanner radio is similarly connected to terminals 3 and 4. When the switch is in its normal (center) position no signal is fed to the Remote Speakers selector switch. Signals from the CB set and scanner go to small separate speakers at this base (main listening) location. These are required because the built-in speakers in the two radios are silenced when the extension speaker jacks are in use. Although these also are "remote" speakers, in one sense, I refer to them as "main" speakers to differentiate them from the true remotes in locations outside the room.

Remote Speaker Selector Switch. 2-pole, 6-position switch S2 routes the signals from terminals X and Y to remote speakers which are connected to the six pairs of terminals labeled 1 through 6.

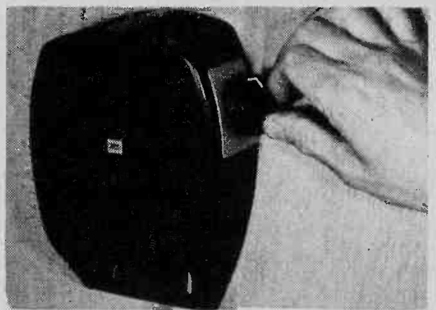
In my Switch-A-Band the number 3 terminals of S2 lead to four outlet jacks J1 through J4, in the basement of the house instead of to a single speaker. These outlet jacks are in the office, art studio, photo lab, and the game room. The jacks are wired in parallel, as shown in the diagram. Choose a layout which keeps the wires as short as possible. Do *not* install permanent speakers at each (or even two) of these locations. To do so without connecting them to separate positions on selector switch S2 would result in paralleling the speakers and the audio output stage of the CB set or scanner would feed into too low an impedance, and might easily burn up the output stage (or at least blow out the protective fuse in the set, if it has one).

Use only one roving speaker to carry about and plug into whichever one of the four (or more, if desired) outlets you're going to be working near for a while. Permanent speakers are installed

(Continued on page 95)

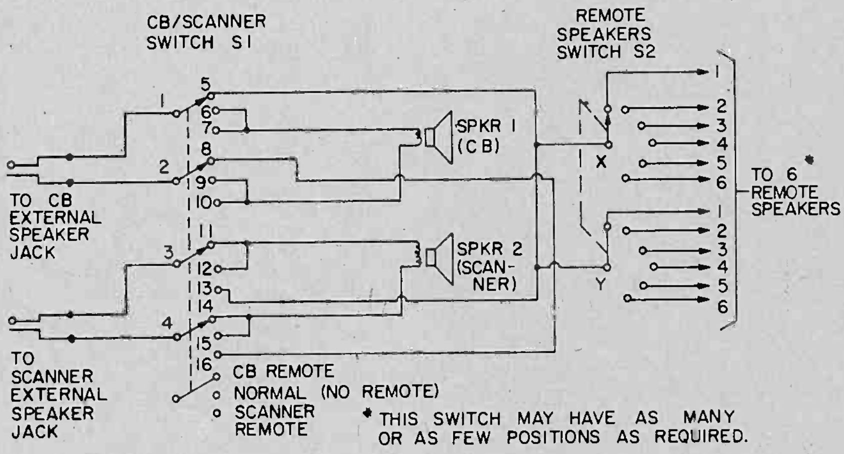


Compact outdoor/indoor speaker has 4-in. cone which is moisture-resistant. Mounts on screw or nail anywhere.



Surface-mount speaker in its own enclosure may have optional volume control.

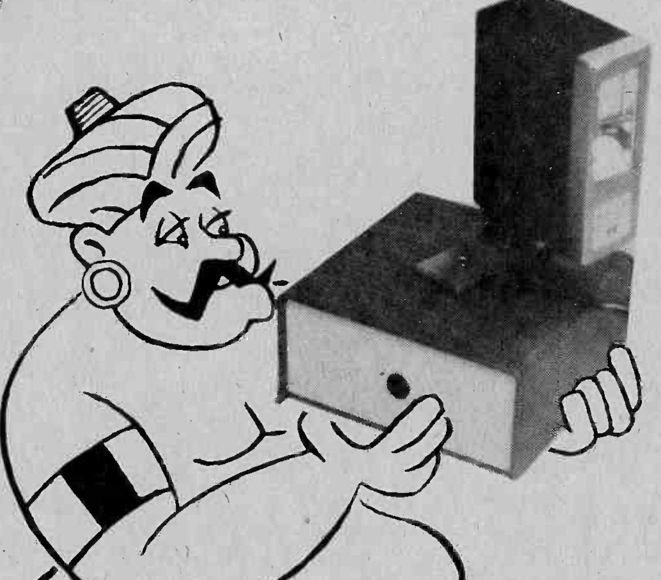
Volume control and stereo headphone jack mount readily on receptacle plate, connect to speaker mounted higher on wall.



PARTS LIST FOR SWITCH-A-BAND

J1-J4—¼-in. phone jack, mono, open-circuit
J5—Optional phone jack, stereo, closed circuit
P1, P2—¼-in. phone plugs, mono
S1—4 pole, 3-position rotary switch, non-shorting
S2—2-pole, 6-position rotary switch, non-shorting
*Your local parts supplier may have speaker switches designed to switch several pairs of remote stereo speakers. These often come already mounted in a small metal box with convenient screw terminals for making connections. One of these may be suitable in place of the S2 switch listed above.
SPKR 1, 2—5-in. diameter surface-mount speaker, in enclosure

sc. Aluminum switch enclosure 5-in. x 2-in. x 2-in. or larger; 20-gauge, 2-wire speaker cable; 24-gauge, 2-wire speaker cable; volume control, 8-ohm L-pad; barrier terminal strip, optional, for making convenient connections to speakers.



LET LIGHT/JINN SERVE UP SNAPPIER SNAPSHOTS

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

by C. R. Lewart

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

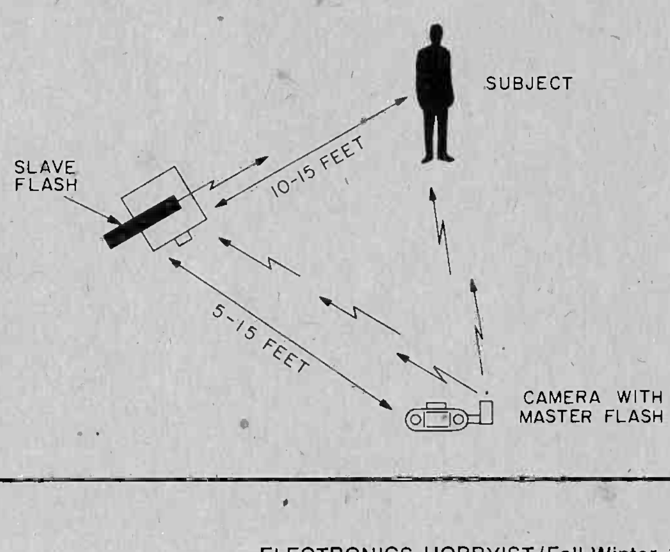
Multiple Flash is Better. If you compare most ordinary flash pictures to other shots taken with photofloods (high intensity incandescent lamps, such as are often used for motion pictures, as well as for professional still pictures) the single flashgun-illuminated photographs usually come out second best.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

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

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

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

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



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

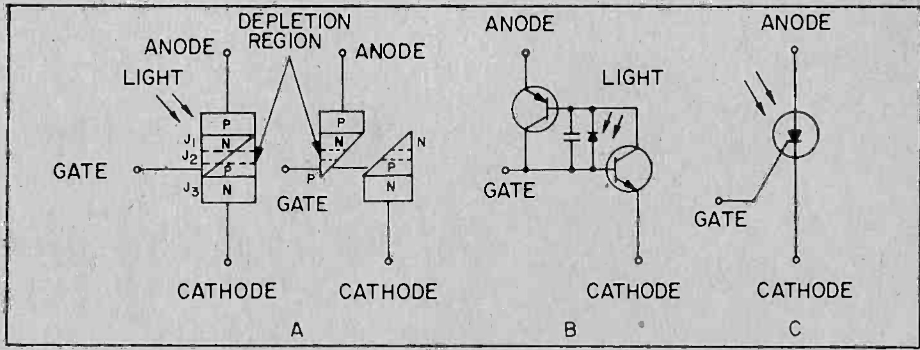
Better Flash Shots. To take such pictures you need one more flash unit and some way to support it, and of course some way to make it fire at the same time as the main flash. The first flash unit mounts in the usual way on the camera (or slightly off it, with an extending bar), while the second flash,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

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

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

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

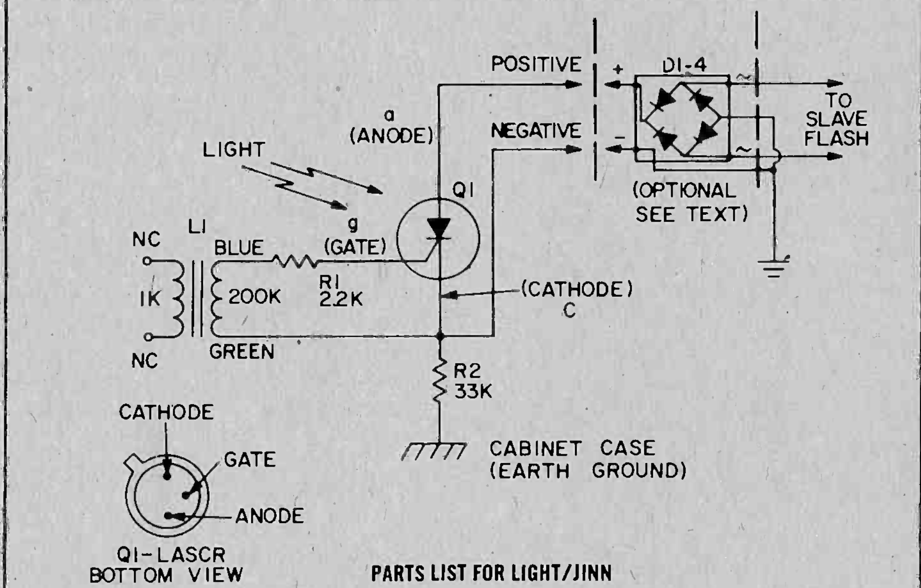
What Is An LASCR? Its tongue-twisting name, Light Activated Silicon Controlled Rectifier, explains its function. It is an SCR (silicon controlled rectifier) operated by light falling on its sensitive area. The LASCR is the brain of our project, the understanding of which, though not essential for successful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



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

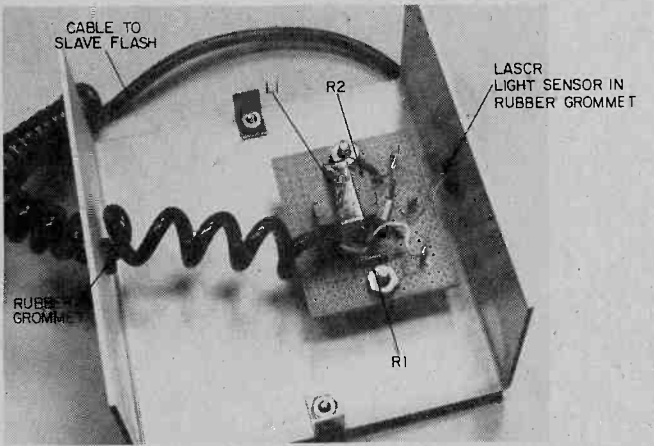
Refer to the three small drawings (above the schematic diagram) marked A, B, and C, for a description of how the LASCR works. With positive voltage applied to the anode, junctions J1 and J3 are forward-biased, and they will conduct if sufficient free charge is present. Junction J2 is reverse-biased however,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

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



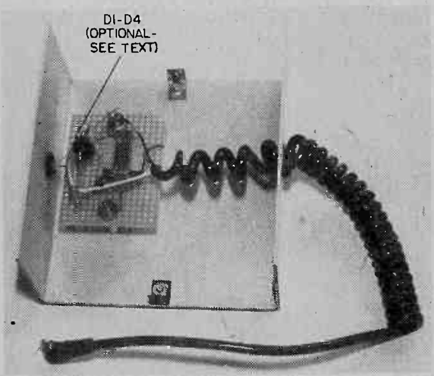
PARTS LIST FOR LIGHT/JINN

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



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

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



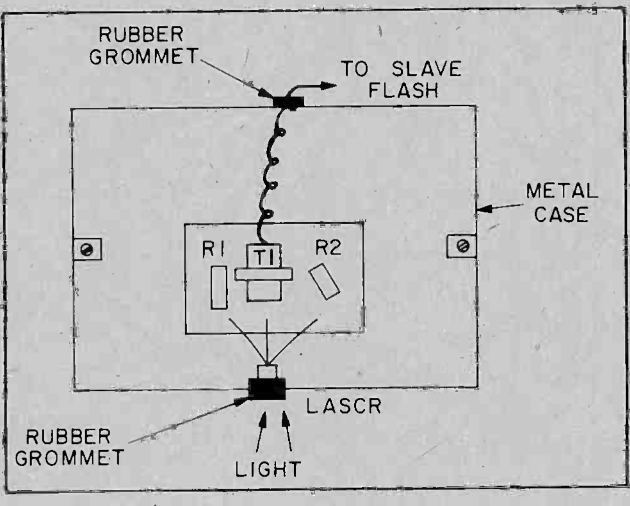
This photograph shows the unit including the diode bridge rectifier, which is needed if Light/Jinn will be used with flash units whose polarity is unknown.

possibility of flashes caused by static electricity.

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

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

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



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

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

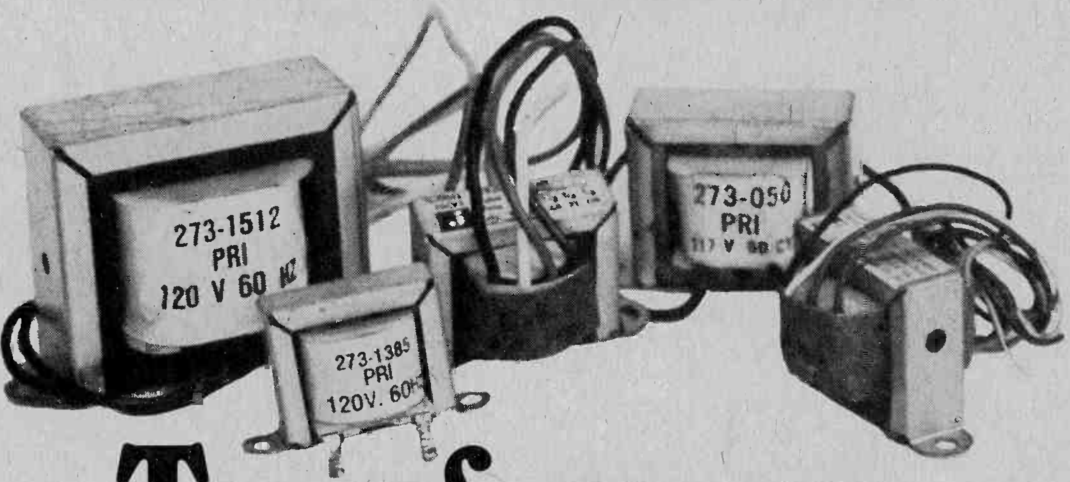
The key to success in multiple flash photography is correct placement of the flash units. If you follow the basic rules for good studio photography you'll be able to take much improved flash photographs. The basic studio setup calls for just two lamps. In our setup the basic, on-camera flash becomes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

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

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

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

You Can Custom Build



Transformers

Save money on hard-to-find units with this easy method

by John E. Portune, WB6ZCT

TRANSFORMERS called for in electronic projects are often the most difficult components to find. The effort to locate anything but common, low-voltage types is enough to discourage many would-be constructors.

Fortunately, there is an answer—rewind your own. You may have never considered rewinding a transformer, but it's a lot easier than you might imagine and a real money saver. Small 6-, 12-, and 24-volt transformers available at most electronics outlets can easily become a complete range of custom audio and power supply transformers.

Radio Shack stores, for example, offer a selection of small low-voltage transformers the author has found extremely suitable. Other brands are equally good provided they are not held together by varnish and brown paper. It is almost impossible to successfully unwind this type and it is usually wise to avoid surplus and older transformers for this reason.

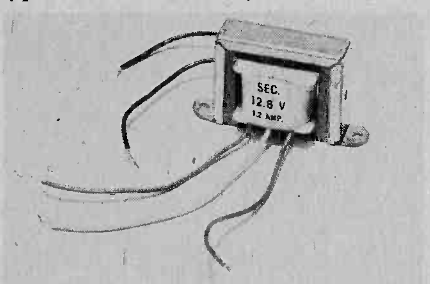


Fig. 1. Typical filament transformer has current and voltage ratings printed on side providing data needed to calculate wire size and turns ratio modifications for constructing a transformer with different voltage, impedance or power rating.

Taking Your Transformer Apart. First, remove the core clamp. Bend-over tabs hold it at the bottom. Next, disassemble the core. The laminations, which are stuck together with varnish, can be separated with a knife blade. The outer laminations are securing laminations and should be the first pushed out through the coil bobbin (See Figs. 2 & 3). The remaining laminations are then easy to remove.

It is wise, as you disassemble the core, to take a few notes. Putting the core back together can be a little like a puzzle if you don't pay attention during disassembly (see Fig. 2).

Unwinding the Bobbin. The windings on Radio Shack transformers are held on with tape. The first layer is an outside covering printed with transformer data. Unwind it carefully and stick it, along with all other tape pieces, to a clean surface for reuse. Under the next layer or two you'll find the bent-over connections of the external wire leads to the actual transformer windings. (Fig. 3). Bend them up to allow you to remove the tape and expose the windings. Then, unsolder the external leads and lay them aside.

The outside (secondary) winding is wound with only a few feet of relatively heavy wire. Unwind it in a straight line on the floor, avoiding tangles. For the primary (if you are removing it), it is better to unwind the wire onto a spool. It is finer wire, and there is more of it. Be sure to count the number of turns on each coil as you unwind it. This is critical data for modification.

Reassembly is a matter of reversing the process, including the necessary changes in the number of turns and wire size. Here are some tips in making the modifications.

Adding A Center Tap. The simplest modification is the addition of a center tap. You can solder a new lead at the half-way point in the winding, but it is better to double (bifilar) wind the center-tapped coil.

Simply cut the wire into two equal-length pieces and rewind them both together onto the bobbin to form the new center-tapped winding. Connect the ends as shown in Figs. 4 and 5. This provides a more accurate and balanced center tap.

Changing the Voltage. For power supply use, changing the transformer's voltage may be desired. Suppose, for example, you need a transformer with

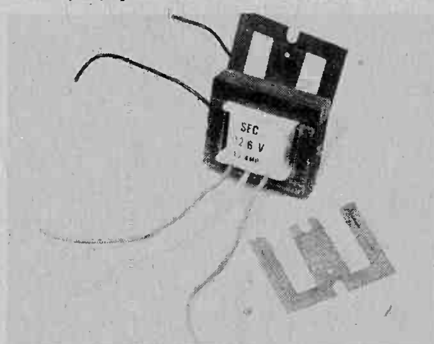


Fig. 2. After loosening the bent-over tabs of the core clamp and removing it the laminations are separated with a knife blade and pushed out through the core's bobbin.

twice the original output voltage. Basic transformer theory tells us that twice the voltage requires twice the number of turns. But to make the new secondary fit in the same space as the one it replaces, smaller wire must be used. If you own an accurate caliper or micrometer to measure the wire diameter, a standard wire table will tell you which smaller wire size to use. In practice, however, the author has been entirely successful with visual estimates at the wire rack at the local radio store.

In the transformer shown in Fig. 1, the 117 volt primary winding needed to be replaced with a 6.3 volt winding. Since 6.3 volts is exactly half the existing secondary voltage, the new primary was wound with half the number of turns of the secondary, using wire about 50% larger in diameter, or slightly more than twice the cross-sectional area. Following this technique of using the existing wire sizes and number of turns on the unmodified transformer as a guide, it is simple to create new windings of exactly the voltage required for a specific project. Remember, the voltage ratio is equal to the turns ratio.

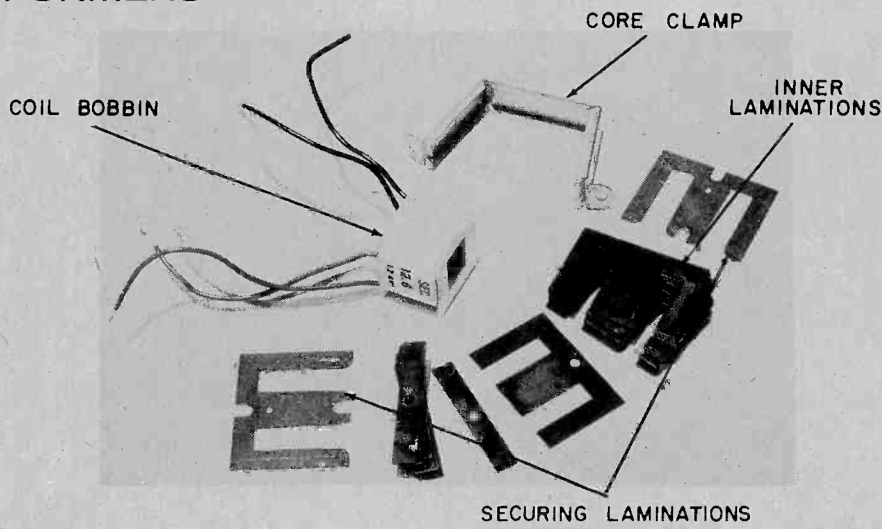


Fig. 3. Transformer is completely disassembled here. The coil assembly has been removed and is ready to be rewound. Be sure to make a diagram of the relative position of the laminations so they can be fitted back together again. Failure to do so will result in having extra pieces left over!

Audio Transformers. Except for extreme high-fidelity applications, small filament-type transformers work well in audio applications. Normally, however, audio transformers are rated by impedance rather than voltage and current. But Ohm's law tells us that:

impedance = voltage ÷ current

Therefore, the illustrated 12.6 volt, 1.2 amp transformer has a secondary impedance of 10 ohms (12.6 V ÷ 1.2 A). This would be quite suitable for a loudspeaker output, for example.

To find the primary impedance, we use the formula:

$$Zp = \frac{Vp}{Vs} \times Zs$$

where Zp is the primary impedance, Vp and Vs stand for primary and secondary voltages, and Zs is the impedance of the secondary winding.

Stated in another way, the impedance ratio of a transformer is equal to the square of the voltage ratio.

$$\frac{Zp}{Zs} = \left(\frac{Ep}{Es}\right)^2$$

Our example transformer has a turns ratio of about 9 to 1 (117V to 12.6V). Therefore, it has an impedance ratio of 81 to 1. Multiplying the 10 ohms secondary impedance by 81, we find that our primary has an impedance of about 810 ohms. Then by rewinding, using these relationships, we could create any desired set of impedances.

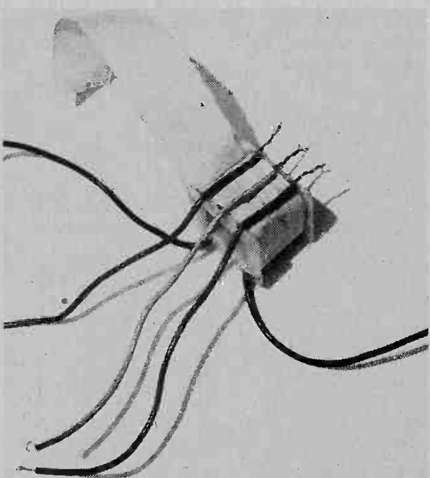


Fig. 4. Coil bobbin with first layers of tape removed shows the connections of the heavy wires which run to other components outside the transformer to the internal transformer windings. Caution: Some of the windings are made of very fine wire. Be very careful in handling this wire not to break it.

Physical Size. The final consideration in selecting a transformer for modification is its physical size. This is determined almost entirely by the power (watts) it must handle. In audio service this is usually known directly from the application. For power supplies, the power can be found by multiplying the supply voltage by the current it supplies.

For maximum efficiency, it is best to select a transformer only slightly larger than required. A core that is too small will result in damage to the windings or too little voltage. Too large a core will waste power. There are formulas for determining the core size, but it is far easier to multiply the voltage and the current printed on the transformer secondary. The manufacturer has provided a core that will handle this power correctly, so it's a good indicator of the core's wattage capacity. Pick one slightly larger than required, especially for audio applications.

Much more can be said about transformer modification. But to the electronic constructor willing to undertake the simple job of rewinding, the otherwise limited number of easy-to-obtain low voltage transformers becomes a whole range of custom-designed power supply and audio transformers for specialized applications. And the cost savings will be substantial. Wind on! ■

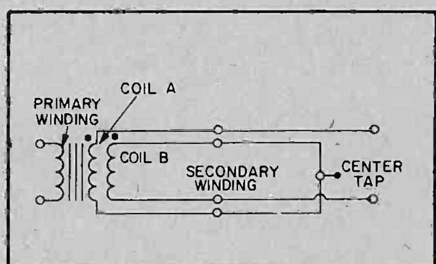


Fig. 5. This diagram shows how a bifilar winding of the secondary coil provides exactly even lengths of wire for the center-tap connection, yielding exact balance of the two secondary halves. Coil A and coil B are wound together starting and stopping at the same place.

RIG-KWIK

BEGINNER'S ECONOMY PROJECT

Flexible breadboard system uses low-cost power supply kit. Handles ICs with +5, and ±15 V DC power. Easy to build, and cheap!

Rig-Kwik, is a modern version of the experimenter's "breadboard" which can be used for a wide variety of projects, ranging from the simplest which use only one power supply voltage to those advanced ones which need plus and minus voltages up to 15 volts as well as a third supply of plus five volts.

Though we still use the term "breadboard" to describe anything used to wire experimental or prototype circuits, it's been a long, long time since kitchen breadboards actually were used to develop circuits. While Grandpa used to drive nails into the board to hold down coils, capacitors and tube sockets, today a complete circuit often takes up less space than the nail itself.

Over the years specialized electronic breadboard systems were developed to keep pace with new technologies. As the transistor replaced the tube the breadboard hardware was changed, eliminating the special clamps needed for heavy wire and substituting miniature multi-wire locking terminals that could handle the extra fine wire of solid state devices. Finally, we now have the integrated circuit (IC), and even solid-state electronic breadboards are too large—the hardware just doesn't make for easy breadboarding with subminiature components.

Now that solid-state component terminals are mostly standardized on 0.1-in. spacing, it has been possible to come up with a "breadboard" that accommodates virtually all the small signal solid state devices of the types used by hobbyists. A typical example is the QT socket strip from Continental Specialty Corp. These American-made QT sockets are available in many different configurations, but basically they all allow any component or wire lead to be plugged into a "board" and instantly get four multiple terminals for additional connections. Use a small U-shaped jumper and you have eight connections—and you can add jumpers until you get as many terminals as needed. The QT sockets snap together so you can easily construct a breadboard of any size or configuration needed, and if you look carefully at those professional-type developmental kits costing many hundreds of dollars you'll find many of them use the very same QT breadboard socket strips.

Along with the standardization of solid-state component lead spacing there are "standard" hobbyist voltages in the sense that many, though not all, projects use 5, 15, ±15 (bipolar) or 24-30 volts as the required DC power. By combining such a power supply with a matrix of Continental Specialty QT sockets we have come up with a prototype breadboard unit for well under $50 that compares favorably with larger laboratory breadboard kits that are priced well into the hundreds of dollars.

Just such a unit is shown here. Costing less than

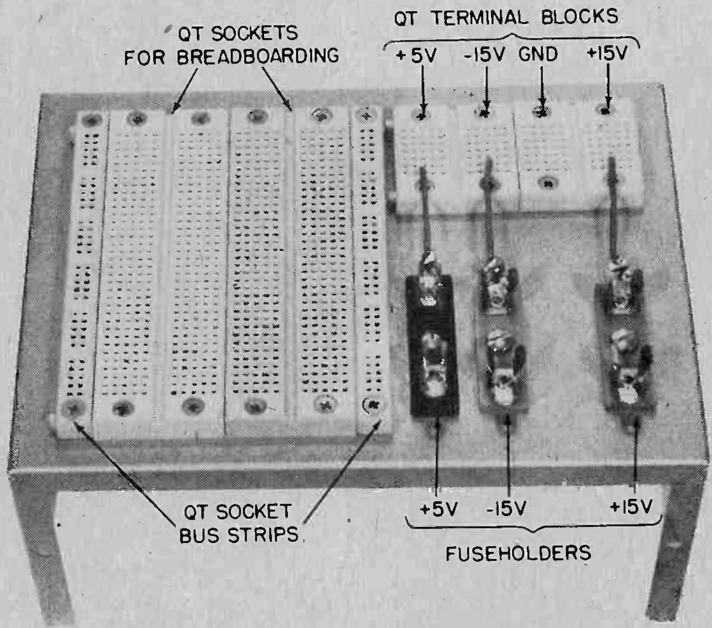
RIG-KWIK

$40 (the final price depends mostly on how many and which QT sockets are used), Rig-Kwik provides regulated power supplies of 5.0 volts at 1.5 amperes, and ±15 volts at 150 mA. QT sockets have been used in Rig-Kwik to provide two component boards for transistors, diodes and ICs, two power distribution rails (one on each side) and three power distribution pads for the power supplies.

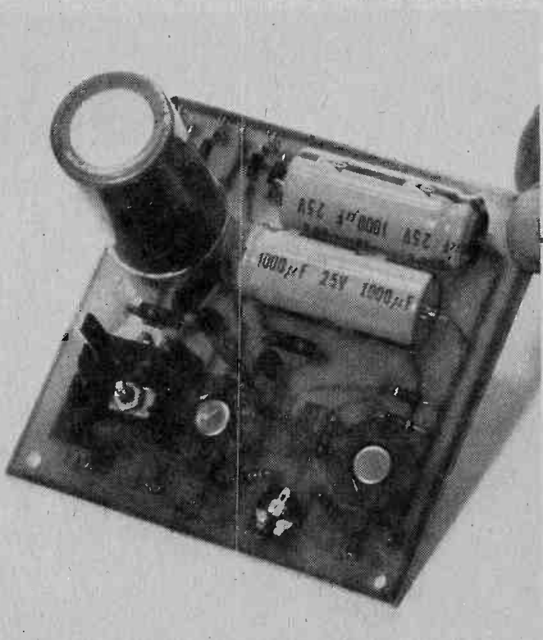
QT test socket strips. (Quick Test) These sockets let you breadboard any circuit as fast as you can stick short pieces of #22 solid wire into the holes in the sockets. Each temporary terminal consists of five connected solderless tie points. The individual points are spaced so that standard DIP-packaged ICs, transistors, Op Amps, all resistors (under 1-watt size), capacitors, and other small components can be directly plugged in and then interconnected. When the circuit has been tested, improved and finalized, the components are simply pulled out and the breadboard is ready to go again with another experimental circuit.

The drawing shows how the QT socket strips are hooked up internally. There are ten different kinds of QT sockets (strips), ranging from $3.50 to $12.50 each, and carrying from 14 to 108 5-point terminals (holes) each.

Our Rig-Kwik uses two each of the following QT strips: QT-35S (70 terminals x 5); GT-35B (two bus strips each, for GND or power voltages); and QT-7S (voltage bus pads). This configuration would cost you $27.00 for the breadboard strips, and it can accommodate about six or seven IC packages plus lots of associated circuitry. You could save $8.50 by getting just one QT-35 now, and leave room to add more later when your breadboard work gets more complicated. The choice of sockets is an entirely individual matter. Just be

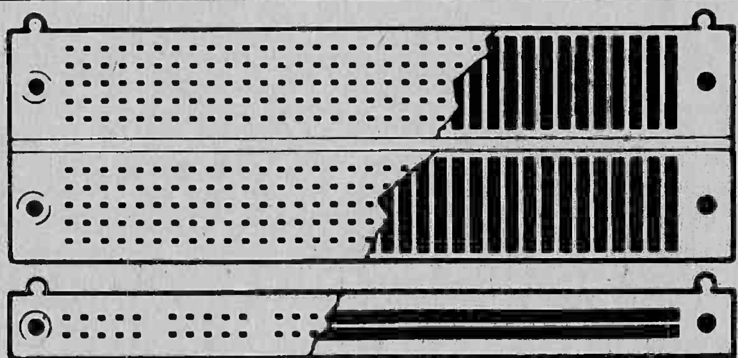


Each of the three power supplies has its own fuseholder, permitting use of fuses of correct size to protect components for whatever project is being built on Rig-Kwik. The four small QT sockets at upper right let you run up to 27 leads from each to QT sockets at left, where breadboarding takes place.



Compact power supply board mounts all components except power transformer, supplies regulated power: +15 VDC and –15 VDC at up to 150 mA, and 5.0 VDC up to 1.5 amperes. Kit for this supply includes transformer, and costs $12.95 from Bullet Electronics (address in Parts List).

These cutaway views of Continental Specialties QT sockets show (at right) how metal strips under the connecting holes hook rows together. B-voltages come from smaller, individual 28-hole strips.



sure you use a chassis box large enough to accommodate at least one more QT socket (or more) than you think you might need at first.

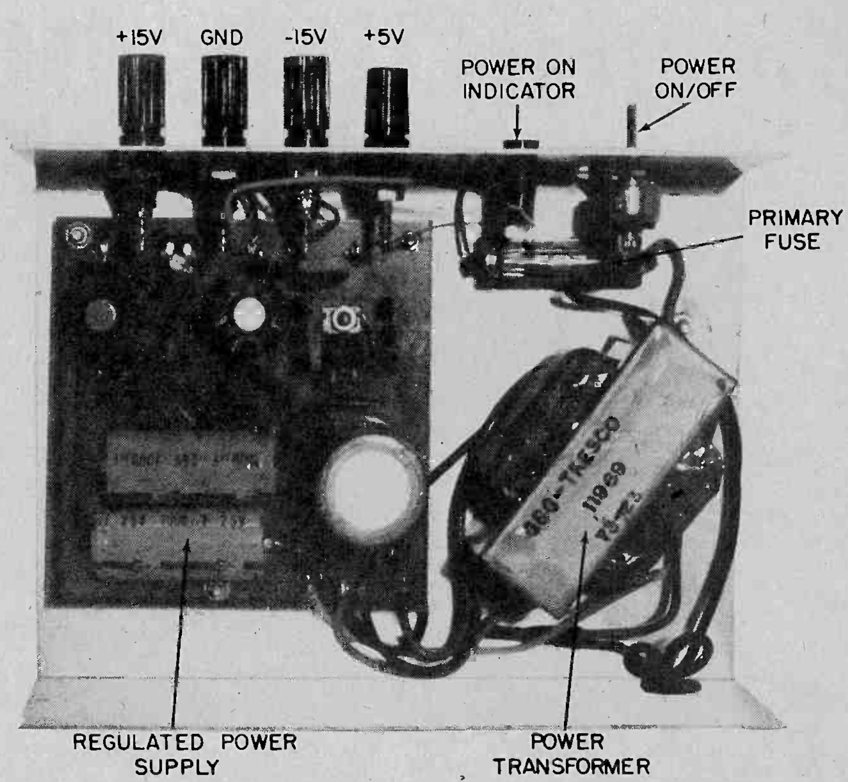
The chassis shown is a small deluxe Rig-Kwik so most of its available top surface space is taken up by the two QT sockets. But you can use only one, or as many more, QT sockets as you think you may need.

Fuse blocks are provided so both of the power supplies, which are not themselves internally short-circuit protected (to keep the price down), as well as the experimental circuit of the moment can be protected. More on the fuse setup later.

Construction. Our Rig-Kwik was assembled inside and on top of the two parts of an aluminum box whose dimensions are 7-in. W x 5-in. D x 3-in. H. The power supply is inside, and the QT sockets and fuse holders mount on top of the cabinet.

While the QT sockets aren't inexpensive, they are a permanent investment because they will be used many times. Figure out what you think you'll need, and add, say, one extra QT socket for more complicated projects later. Before you start construction you should get the catalog of these sockets from Continental Specialties by circling number 75 on the Reader Service Coupon. If you prefer getting the catalog even faster you can write direct to Continental Specialties Corp., 44 Kendall St., New Haven, CT 06509. They sell direct so you can select those sockets you want and order from Continental if they aren't stocked locally.

D.C. Power. The power supply is available in kit form from Bullet Electronics for $12.95. The kit includes the power transformer and the printed circuit board which mounts the entire power supply (except the transformer). This is a good deal because it saves you money (the transformer alone would cost five or so dollars) as well as the time and trouble of getting the parts together and etching the circuit board. Those who have a good junk box of spare parts can of course put it together for even less than the cost from Bullet Electronics. The Bullet kit has all the parts needed to build the regulated power supply which makes available (with one per cent load regulation) (a) a +5-VDC supply at up to 1.5 amps, (b) a +15-VDC supply at up to 150 mA, and (c) a negative −15 VDC supply, also up to 150 mA. The two 15-volt supplies can be hooked together to provide one 30-volt supply if desired. Finally, the two 15-volt supplies are so designed that they *track* each other. That is, if anything should happen to cause one or the other 15-VDC source to go slightly high or low, the other supply will follow it, in the opposite direction to minimize the effect on the circuit they are powering.



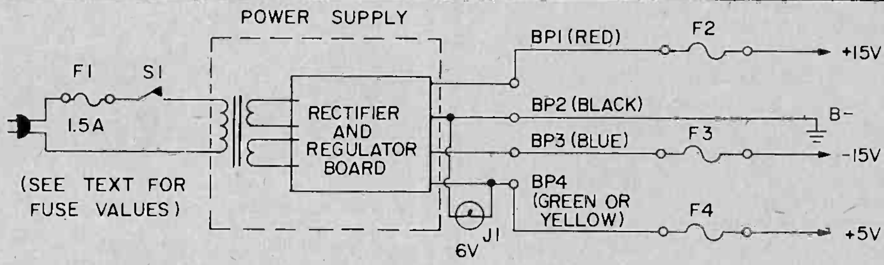
Inside view of Rig-Kwik shows fuse for protection of power supply transformer (upper right). Neat construction is easy if you use the power supply kit. If you plan to use more Continental QT sockets for elaborate projects you'll use a larger metal cabinet than this one.

To keep the cost down, these regulated supplies are not internally protected against short circuits. That's why the fuse sockets shown are provided. This is a better way of protecting the supplies, because the fuse sizes can be chosen for each particular project to protect the parts in the project, and they will also at the same time protect the supplies.

The printed circuit board that comes with the power supply kit has a few component lead holes which need slight enlarging. Don't try to force a lead into a hole as you might wind up breaking the printed circuit board. Instead, use a #56 drill bit to enlarge the hole.

It will be easier to install and connect

(Continued on page 93)



PARTS LIST FOR RIG-KWIK

F1—1.5-A fuse
F2, F3, F4—various size fuses, depending on external circuit—see text.
I1—6-V pilot lamp
QT experimental hook-up socket strips—Continental Specialties Corp. 44 Kendall St., New Haven, CT 06509. This project uses two each QT-35S, QT-35B, QT-7S.
Power Supply Kit, Bullet Electronics, Box 1465, Lake Worth, FL 33460—$12.95 postpaid.
MISC. Metal Cabinet—3-in. H x 5-in. D x 7-in. W. **Push-in terminals** (eight required) 1/13-in. or 3/64-in. diameter or Vector T-28 flea clips, 1-in. #4 machine screws, nuts and lockwashers (3 each needed), plus ¼-in. aluminum standoff spacers (3 needed).

CB NEW PRODUCTS

Electronics Hobbyist looks over some of the newest transceivers, antennas and accessories for you to use in CB contacts this year!

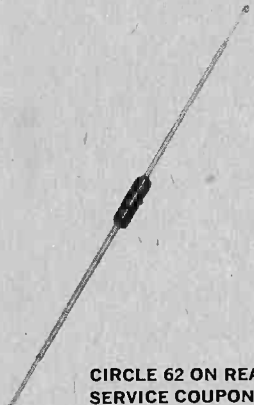
Mobile CB Preamp

"If you can't hear 'em, you can't work 'em!" is an old radio operator's adage. This usually applied to the new operator who would invest a fortune in his transmitter, and simply overlook the quality of his receiver. Today's CB operator cannot increase his transmitter power. However, receiver efficiency can be increased by improving the sensitivity and selectivity, which is precisely what the EICO Long Ranger CB Preamp accomplishes. The Model LR-3 Preamp mounts out of sight and out of the way, for it has no operating controls. It simply plugs in the line between the antenna lead and the antenna jack on the transceiver, connects to the car's 12-volt battery system, and is controlled by incoming signals. When a signal is sensed by the "sniffer" circuit, the unit turns on and boosts the signal level by 20 dB gain on all 23 channels. It operates with all systems, both positive and negative ground. You'll find yourself working stations that other operators in your vicinity cannot even hear. The EICO Model LR-3 is priced at $29.95. For further info, contact EICO Electronic Instrument Co., Inc., 283 Malta Street, Brooklyn, NY 11207.

CIRCLE 63 ON READER SERVICE COUPON

Base Station Antenna

Airequipt, Inc., for more than 40 years a leading manufacturer of electronic and photographic equipment, has entered the expanding CB equipment marketplace with 5 new, omnidirectional, dipole base antennas that range from 9.2 dB gain in a compact size to 19.2 dB gain in a 3-way cross-polarized version. The new antennas consist of three full-sized, 18-ft., 3-in. models and two campact sized, 6-ft., 1-in. units, all designed by Dr. Carl Gallo, W2WAI, noted RF equipment design innovator. First of the full-sized, half-wave base station antennas introduced by Airequipt is the Hercules-180 which incorporates a Cycolac center insulator sealed to prevent RF leakage across the anodized aircraft aluminum elements. The Hercules has a 12.7 dB gain. The unit may be used vertically or horizontally, mounts in minutes upon a window sill, fence or pole and is rated for winds up to 90 mph. Suggested retail is $49.95. All sections are pre-tuned and assembled at Airequipt's New Rochelle plant. The company has also developed a universal, one piece mounting bracket applicable for use with any antenna. It is optional and lists for less than $16. For more information on all of the CB products by Airequipt, write to them at 1301 Brummel Ave., Elk Grove, IL 60007.



CIRCLE 62 ON READER SERVICE COUPON

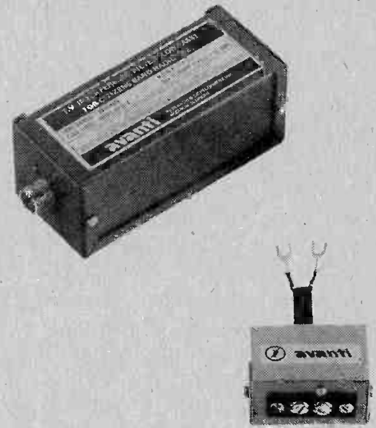
CB Billboard

A new accessory for mobile CB operators, featuring a digital display for twenty-three CB channel numbers makes CB monitoring that much more fun. The CB Billboard Channel Advertiser will indicate the selected channel in bright 2-inch tall numerals—highly visible day or night. By advertising the channel he is monitoring in this way, the mobile CB operator invites contact by other CBers on the road and increases his enjoyment of CB radio. It is especially practical where regular channels of contact are overcrowded. The Billboard package comes complete with digital display box, flat-lying cable, connector, control box, mounting brackets, mounting hardware, and installation instructions. The digital display mounts easily in the back window or any readily visible location. The control box, installed next to the CB radio, turns the Billboard on or off and selects the channel number to be displayed. The Billboard is powered by 12 VDC from any car or truck. The Billboard sells for $39.95. The unit is available at CB retail outlets or write Controls/Inc., P.O. Box 522, Consumer Sales, Dept. 17, Logansport, IN 46947.

CIRCLE 69 ON READER SERVICE COUPON

TV Filters

If you've ever had a neighbor "get on your back" because your transmitting interfered with his TV reception, you'll be glad to know about these two new Avanti filters. If the problem is caused by the transceiver radiating harmonics of the same frequency assigned to a TV channel, installation of the low-pass TV interference filter on the transceiver should clear up the problem. If the problem is at the TV receiver due to so-called "front-end" overloading, installing the Avanti 27 MHz CB signal rejection filter on the TV set lead-in should do the job. The low-pass TV interference filter (AV-800) sells for $24.95, and the 27 MHz CB signal rejection filter (AV-811) sells for $14.95. For more information, write to Avanti, 340 Stewart Ave., Addison, IL 60101.



CIRCLE 71 ON READER SERVICE COUPON

CB Base Station

Many features required for continuous heavy-duty, two-way radio operation are built into SBE's Trinidad Citizens Band AM base station. It features a double-conversion receiver, adjustable squelch and volume controls, and delta tuning. In transmit mode the Trinidad delivers maximum legal power, high level AM modulation for optimum efficiency. The Trinidad, identified as Model SBE-11CB, comes ready to plug into any 117 VAC outlet. Among its many special features is an emergency power "fail-safe" cir-

CIRCLE 64 ON READER SERVICE COUPON

CB NEW PRODUCTS

cuit, which automatically switches the SBE-11CB from 117 VAC to 13.8 VDC battery operation in the event of a power failure. Other convenience features include an illuminated triple function front-panel meter which monitors power output, relative strength of incoming signals and voltage standing wave ratio. The SBE Trinidad is housed in a walnut-finished cabinet. The unit measures 5.75-in. high, 17.75-in. wide and 8.75-in. deep. It comes complete with dynamic microphone and four-conductor coiled cord with plug. It sells for $269.95. For complete information and specifications, write SBE, Inc., Dept. P., 220 Airport Blvd., Watsonville, CA 95076.

Two New CB Antennas

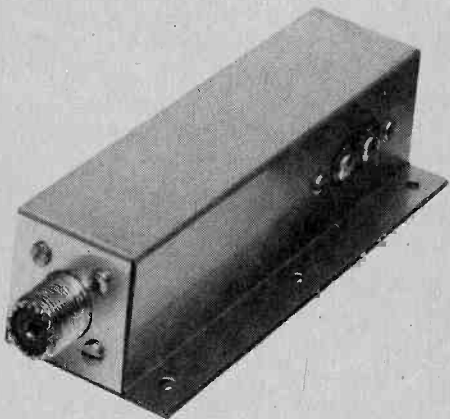
Anixter-Mark has two new CB antennas. "The Champ" is the first CB antenna designed not to look like a CB antenna. It's top loaded with the loading coil wound on a high

CIRCLE 70 ON READER SERVICE COUPON

quality fiberglass whip attached to a heavy chrome plated metal mast and sturdy spring. It is designed for easy installation. The mount and cable pig-tail install to trunk lip simply by tightening two set screws. The Champ is ready for the new channels as they are released. Maximum height: 54-inches. Tuning range: 26.9–27.5 MHz, which is more than enough range for 40 channels. In addition to The Champ, Anixter-Mark is also introducing a new Tunable Stainless Steel Antenna which is base loaded and can easily be adjusted to cover all present channels. A simple turn of the frequency adjustment screw brings in the channel you want clearly. It is also capable of tuning in all new channels when they become available. It has a long lasting stainless steel whip and deluxe mount with coaxial cable. Mounts easily to any trunk lip with no drilling needed. Maximum height: 60-inches. Tuning range 26.9—27.5 MHz. Get the facts direct from the maker by writing to Anixter Bros., Inc., 4711 Golf Road, One Concourse Plaza, Skokie, IL 60076.

CB Channel Monitor

EICO's new Model CM-2 Channel Monitor operates in conjuntion with the automobile's car radio and your own CB transceiver. When a CB call is received, the car radio cuts out so that the call is heard. After a short delay, following the call, the car radio returns to normal operation. As the CM-2 is sensitive to both audio and RF, it will also silence when you transmit. This is a new convenience for CB operators. An operator who wanted to know if there was somebody on the air, previously had to turn off his car radio, turn on his CB transceiver, and then, if nobody was on, he had to reverse the process. The CM-2 will operate with any car radio that has an external speaker, and any CB radio, marine radio, or ham radio that is equipped with an external speaker jack.

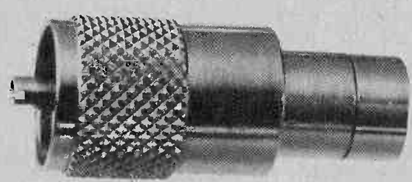


CIRCLE 63 ON READER SERVICE COUPON

The CM-2, equipped with all necessary mounting hardware and full installation and operating instructions, is priced at only $29.95. For further information, contact EICO Electronic Instrument Co., Inc., 283 Malta Street, Brooklyn, NY 11207.

Dummy Load

A dummy load that can be used to prevent unlawful transmission during tuning or testing of a citizens band or ham radio transmitter has been introduced by Bunker Ramo RF Division. Designated Amphenol Model 83-887, the new device properly terminates a CB or QRP ham rig into a 52-ohm resistive load, allowing the transmitter to be keyed without causing annoying and illegal interference with other stations. Providing maximum legal CB power handling capacity—four watts output continuous —the dummy load also can be used to check the antenna system by comparing transmitter performance into the antenna with transmitter performance into the dummy load. It can also be used with an SWR bridge or wattmeter

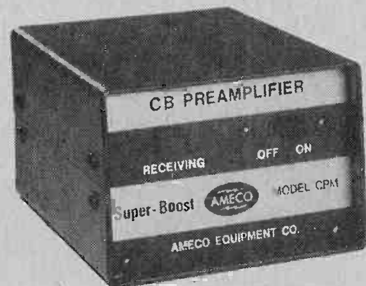


CIRCLE 68 ON READER SERVICE COUPON

to make precise transmitter adjustments. Impedance is 52 ohms nominal, the frequency range is 0-500 MHz, and VSWR is 1.1:1 or less at 27 MHz. The body is brass, the dielectric is Bakelite. Exterior plating is Amphenol's lustrous non-tarnishing finish. Center contact is silver-plated brass. Sells for $2.44. For more information about the new Amphenol Model 83-887 dummy load, contact: Bunker Ramo RF Division, 33 East Franklin Street, Danbury, CT 06810.

CB Preamp

The Ameco Model CPM is a preamplifier which can easily be added to any CB transceiver to improve the performance of its receiving sec-

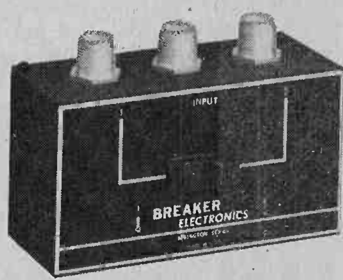


CIRCLE 74 ON READER SERVICE COUPON

tion. This will enable the CB operator to hear weak or distant signals. The CPM preamplifier contains a tuned RF circuit. This rejects interference on either side of the CB band while, at the same time, boosting the desired signal. The Ameco preamplifier is easy to install. The mounting bracket and hardware are included. While this preamplifier is primarily designed for mobile use, it may also be used at a fixed station by obtaining 12 volts DC from a readily available 12-volt power supply, or by taking power from the transceiver power supply. The size of Model CPM is 3¾ wide by 2½ high by 4-in. deep. Sells for $39.95. For more data, write to Ameco Equipment Co., 275 Hillside Avenue, Williston Park, NY 11596.

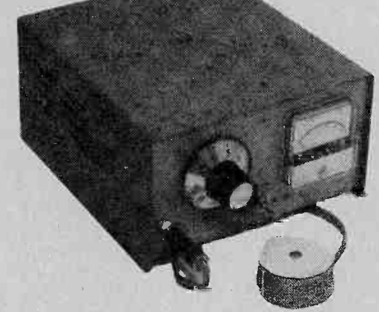
CB Coax Switch

Quick change-over from single to duals, or other CB antenna arrangements, can be accomplished with the flick of a switch on the new Model 13-200 coax antenna switch just released by Breaker. Ideal for mobile or base station usage, the Breaker switch eliminates tedious changes in transmission line connections and concern about proper impedance matching when it is desirable to utilize a different antenna. The Model 13-200 lists for only $7.95. For further information, contact the



CIRCLE 60 ON READER SERVICE COUPON

Breaker Corporation, Marketing Department, 1101 Great Southwest Parkway, Arlington, TX 76011. ■



DARKROOM PRINTING METER.

Print-paper saver gives you fine B&W prints sooner!

by Herb Friedman

TRY TO grind out wallet-size prints or enlargements from a full 36-exposure roll in only one evening and you'll know just how frustrating life can be. Every change in magnification and negative density means a different exposure. And if you use test strips or exposure guides to hit the correct exposure you're making at least two prints for every one you need.

The way to take all this drudgery out of your darkroom work is to use an electronic printing meter, a device that takes only seconds to indicate the correct exposure, regardless of whether the enlarger is at the top or bottom of the rack, or whether the exposure and negative development is over or under.

A quick example will illustrate how easy it is to make prints with a printing meter. Let's assume you have just chocked the negative in the enlarger and have cropped the picture exactly the way you want it. Now you take the probe from a printing meter—which you have previously calibrated for a 10 or 20-second exposure—place it on the easel at the point of maximum light transmission through the negative (the black reference in the print—deepest shadow) and adjust the lens diaphragm until the printing meter's pointer indicates some reference value you have previously selected.

That's the whole bit. Expose the paper for your normal 10 or 20-second exposure and the first print will be a good print. Maybe even a great print. If you're grinding out wallet-size jobs for the whole family, each print from each frame will have the same excellent quality.

A Hint. The key to successful use of a printing meter lies in the fact that, except for some particularly artistic work, any print will look decent to excellent if there is some deep black, even if it's just a spot of black; for the black to highlight or border-white contrast gives the visual appearance of a full contrast range, even if the greys are merged. For those who do portraiture, a printing meter can be user-calibrated for "flesh tones."

The printing meter shown in the photographs has been especially designed for construction and use by the typical e/e photographer/electronics hobbyist. It features a calibration—called "speed"—adjustment to accommodate slow to fast enlarging papers (such as Polycontrast and Kodabromide) and readily available parts, many of which will be found in the typical experimenter's junk box. The layout is non-critical—any cabinet can be substituted; there are no critical shielded circuits (not even shielded wire is used); and except for the photoresistor sensor, just about any component quality will do. There is absolutely no sense in building the project with the best components money can buy because the best components won't affect the final performance one iota.

Construction. The unit shown is assembled in a 5¼ x 3 x 5⅞-in. metal utility cabinet. Connecting jack J1 is optional as the photoresistor sensor, PR1, can be hard-wired into the circuit. If you use a jack, note that it must be the three-terminal type such as is used for stereo connections; the ground connection is not used since neither PR1 lead is grounded. Do not use an ordinary phone or phono jack as they will ground one of the PR1 leads. Plug P1 must similarly be a matching three-terminal stereo type. Either miniature or full-size jacks and plugs can be used.

Power switch S1 can be anything you care to use—lever, slide, or toggle. Use the least expensive slide switch if you're trying to keep the cost down.

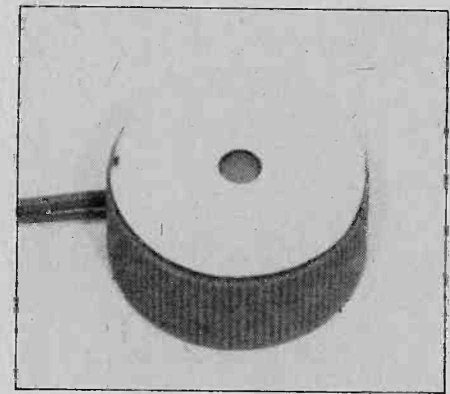
The meter, M1, is a Lafayette Radio 99-26262 illuminated 0-1 mA S-meter. This meter was selected because it has built in pilot lamps with 6 and 12-volt connections. When 12-volt-connected to T1, which is 6 volts, the pilot lamps are dim enough not to affect the sensor and bright enough so that you can see the pointer in the darkroom. Meter M1 mounts in a 1½-in. hole, which can be cut with a standard chassis punch (if you have the punch).

Sort Them. The meter scales are jammed with numerals that can be confusing in the darkroom so the best bet is to paint out the unwanted "calibrations" using Liquid Paper or Liquid KO-REC-TYPE, products used to correct typewriter errors (available in stationery stores). First, snap the plastic cover off the meter. It might feel secure but it's not. Grasp the top of the cover and force the cover outward and down, taking care that when it snaps free the pointer isn't damaged. Next, remove the scale by taking out the two small screws and sliding the scale out from under the pointer. Do not attempt to paint the scale while it is mounted in the meter as a single drop of the fast-setting correction fluid can ruin the meter if it gets into the pivot bearing. When reinstalling the scale, hold the screws with a tweezer or long-nose pliers until you "catch" the first few threads. When the scale is secure, snap the meter's cover into position. (On the unit shown all scales and markings other than 0-to-1 have been painted out, as the 0-to-1 scale is the most convenient to see under dim lighting.)

Note that meter M1, power switch S1, and jack J1 have been positioned on the front panel so as to provide the maximum room for the speed control's calibrated knob. Use the largest possible knob as the greater the calibrations the easier it is to reset the control to a desired paper speed.

Power transformer T1 can be any 6.3-volt filament transformer rated 50 mA or higher. (A 6-volt transformer scrounged from a portable cassette recorder will work just fine.)

Power Filter. If the line voltage in your home is known to be reasonably constant, assemble the unit as shown in the schematic. If your local utility likes to bounce the line voltage, or if appliances cause your line voltage to vary (indicated by dimming lights), install zener diode D5 across points A and B.

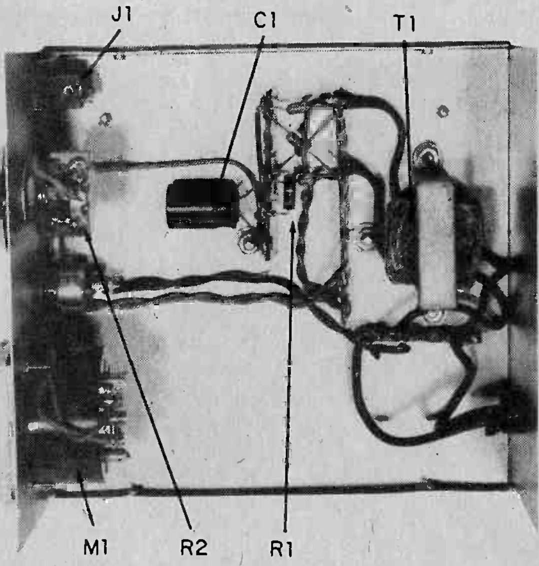


The sensor is really a large tuning knob with photoresistor PR1 embedded in epoxy, plastic or RTV rubber adhesive.

The zener will provide a regulated 6 volts, with the slightly lower circuit voltage (6 VDC rather than 9 VDC) providing slightly reduced sensitivity. Normally, you will not need D5, so there's no need to get it unless you're certain you need it.

In order to get speed control R2 to increase sensitivity in the expected clockwise direction, its ground terminal is opposite to the usual volume control ground. Facing R1's shaft with its terminals sticking up, the ground terminal is the one on the left.

Meter M1 has five terminals. The one designated "+" and the one adjacent to it are the meter terminals. The three terminals above the meter terminals are the pilot lamps. The extreme end pilot lamp terminals are the 12-volt connections. The center terminal is not used for the 12-volt connection.



DARKROOM ECONOMY PROJECT

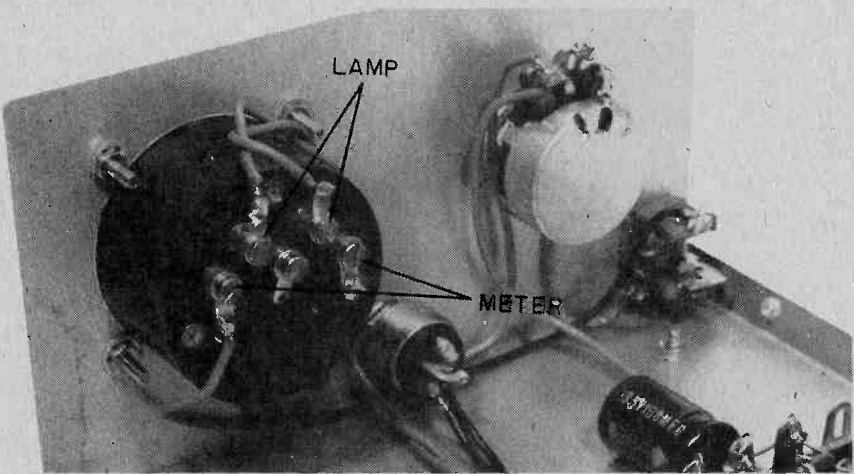
Nothing is critical so don't crowd the layout. Two parallel terminal strips provide the tie points for the rectifier diodes and power supply

The Eye. The only assembly that requires some care is the sensor. The sensor itself is a photoresistor; however, the photoresistor doesn't have enough heft to maintain its position on the easel, so it must be mounted in a support that can maintain its position without falling over. The sensor assembly shown consists of PR1 epoxy-cemented into a relatively large knob. The knob must be plastic—not metal, though it can have a metal decorative rim—and it's best if there is a recess on the top even if the recess is produced by a rim. Remove the set screw and drill out the set screw hole with a bit approximately 3/16-in. (not critical). Then, using a ⅜-in. bit, drill through the shaft hole clear through the top of the knob. If the shaft hole has a brass (or other metal) bushing make certain the drill bit removes all the metal.

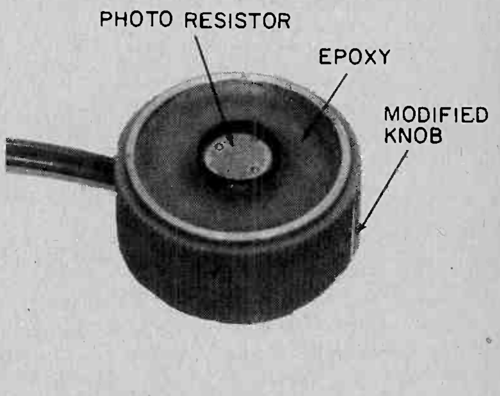
Pass the PR1 leads through the hole in the knob from the top. Tape it in position. Feed a section of linecord or speaker wire through the setscrew hole and solder the wires to PR1 as close as possible to the knob. Trim away the excess PR1 leads; they should not protrude below the knob. Remove the tape holding PR1, get PR1 as close to the center of the knob as possible, and then pour in a quantity of fast-setting epoxy or liquid plastic from a knob repair kit or plastic modeling kit, and let it set a few minutes until the plastic hardens. Keep the level of the epoxy or plastic below the top of PR1—use less rather than more. If you can't get epoxy or plastic you can use G.E.'s silicon RTV rubber (adhesive, caulk, window sealer, etc.); but the RTV rubber must cure for at least 24 hours. Similarly, pack the bottom of the knob with epoxy, plastic or rubber.

Mask Down. Now, the surface area of the photoresistor is too large for small prints—4 x 5 or smaller—and even some 8 x 10s. So cut a disc the diameter of the knob from shirt cardboard or a manila file folder (but not oak-tag) and using a standard hand punch (such as used in schools) punch a hole in the center of the disc. Apply rubber cement to the rim of the knob and the inside rim of the disc. When the cement is dry drop the disc on the knob so the hole exposes a small part of the photoresistor's surface. It's not all that critical; the hole doesn't have to be precisely over the center of the photoresistor. However, the unit is calibrated for a punch-size hole and might not work properly if the disc is not used, or if the hole is a hand made "pinhole." Use the punch.

Using the Meter. The first step is to select a decent reference negative and make a good print using a 10, 15, or 20-second exposure. We suggest 20 seconds as it will become your standard exposure, and will be

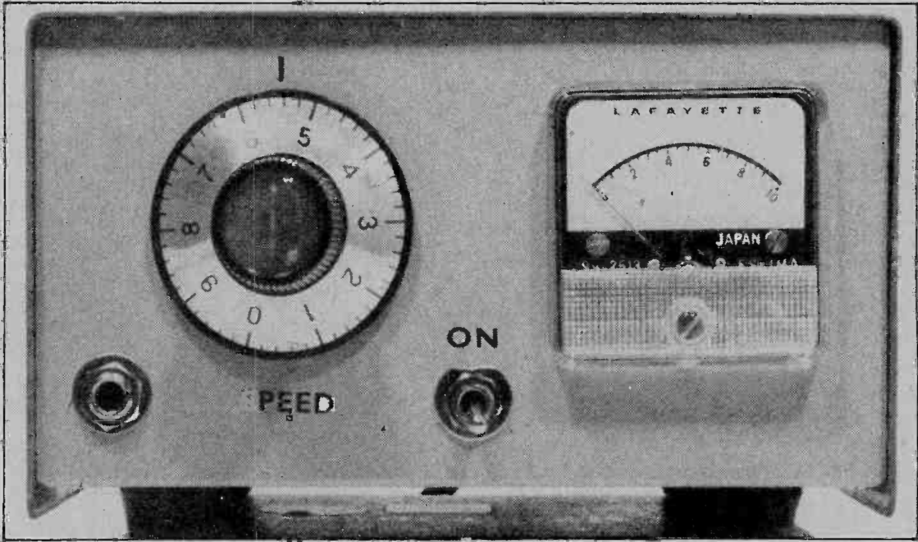


The specified meter has five terminals. The two on the bottom row are for the meter movement. The top row terminals are for the 12-volt lamp connection. The remaining terminal is for a 6-volt lamp connection and is not used.



After the sensor is completed, punch a hole in a matching cardboard disc and cement the disc over the sensor. The hole provides a smaller sensitive area required for prints 4 x 5 or smaller. Better results with larger prints are also obtained with the mask.

sufficiently long to allow moderate dodging. When you are certain you have a print exactly the way you want it, and without disturbing the enlarger's controls, place the printing meter's sensor under the *brightest* light falling on the easel—it produces black (maximum shadow) on the final print. Now turn on the printing meter and allow about five seconds for warm up. Adjust speed control R2 so the meter pointer indicates any meter reading you want to use as a reference. It doesn't matter what the reading is as long as you always use the same reference for the standard exposure time. For example, 0.2 on the meter scale is a good choice because it is well illuminated by the meter lamps. But you might just as easily select mid-scale as the reference meter reading. It doesn't make any difference; just be consistent.



Use the largest calibrated knob you can install without interference by other panel components. The greater the calibration area on the knob the easier it is to preset the paper speed with accuracy.

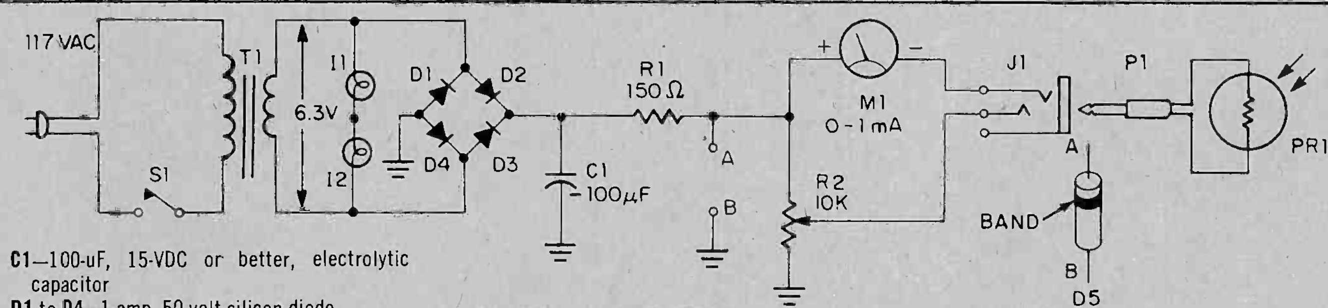
Once you have adjusted the speed control for the reference meter reading note on a piece of paper or in a notebook the dial reading from the speed control's calibrated knob. This is the reference speed value for the particular printing paper. For example, let's say you made the test print on Polycontrast using the #2 filter, and the speed knob indicates 5.6. Next time you want to print using Polycontrast with a #2 filter you simply set the speed knob to 5.6, put the sensor under the darkest shadow area and adjust the lens diaphragm for a reference meter reading. Everything will be set for your standard exposure time.

Changing Filters. Kodak provides a speed rating for all their papers and you can easily work out the correct (or close) speed control settings without making a "perfect" test print for each type and grade of paper. For example, changing from a #2 to #4 filter usualy means increasing the exposure by a 3.5X factor. If your #2 exposure is 10 seconds, the #4 exposure will be 35 seconds—somewhat long. You can, however, open up the lens diaphragm for a 3.5X light increase (close enough value) and adjust the speed control for the reference meter reading. The new speed control setting is the speed value for the #4 filter. You can do this with variable contrast filters or numbered printing paper.

While the most pleasing print usually has some black, there are times when there can be no black, such as snow scenes, portraits, etc. You can peg the speed control's calibration to a grey corresponding to a skin tone, or any other degree of grey you might desire. The only thing you cannot do is calibrate the meter for highlights, since the meter might not have enough sensitivity for slow papers, and highlights can completely fool the meter.

If desired, you can take a speed control calibration reading for each type of paper (using your standard negative) for both shadow detail and intermediate grey. This way, you can quickly set up for typical snapshots, scenics, or portraits.

Keep In Mind. The sensor has a slight light memory, so we suggest the sensor be turned face down when not being used and the power switch be turned on and off in the dark, though you can keep the darkroom illuminated by a safelight with the power switch on. Meter readings, however, must be taken with all room lights off; only the enlarger should be on and the print meter should be positioned so that its meter lamps do not illuminate the sensor (even slightly). ■



C1—100-uF, 15-VDC or better, electrolytic capacitor
D1 to **D4**—1-amp, 50-volt silicon diode
D5—6-volt, 1-watt zener diode (optional, see text) (Radio Shack 276-561 or equiv.)
I1, I2—meter lamps, part of M1 (see text)
J1—3-circuit jack and plug set (optional, see text)
M1—0-1 mA movement, illuminated S-meter (see text)
PR1—photoresistor (National 4941 or equiv.)
R1—150-ohm, ½-watt resistor
R2—10,000-ohm audio taper potentiometer
S1—spst switch
T1—transformer: 117 volt primary, 6.3 volt at 50 mA or better secondary
Misc.—large knob for mounting photoresistor, case 5¼ x 3 x 5⅞-in., 5-lug terminal strips for mounting components, wire, etc.

The National 4941 photoresistor is available from Electronics Hobby Shop, Box 192, Brooklyn, NY 11235 for $3.85. New York State residents add sales tax. US orders add $1.25 for postage and handling; Canadian orders add $3.00. No foreign orders, please. Postal money order speeds delivery; otherwise allow 6-8 weeks for delivery.

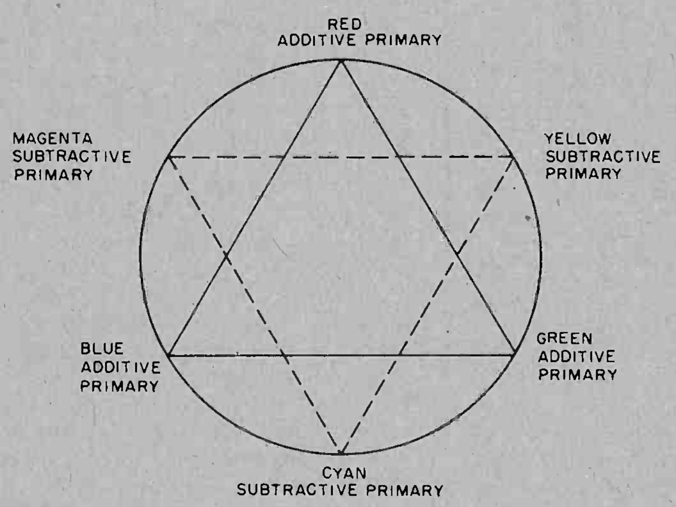
Darkroom Color Analyzer

by Herb Friedman

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

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

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



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

Color Analyzers Are Not Cheap. A decent one costs well over $100, and a good one runs well over $200. But if you've got even a half-filled junk box you can make your own color analyzer for just the junk parts and perhaps $10 to $15 worth of new components.

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

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

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

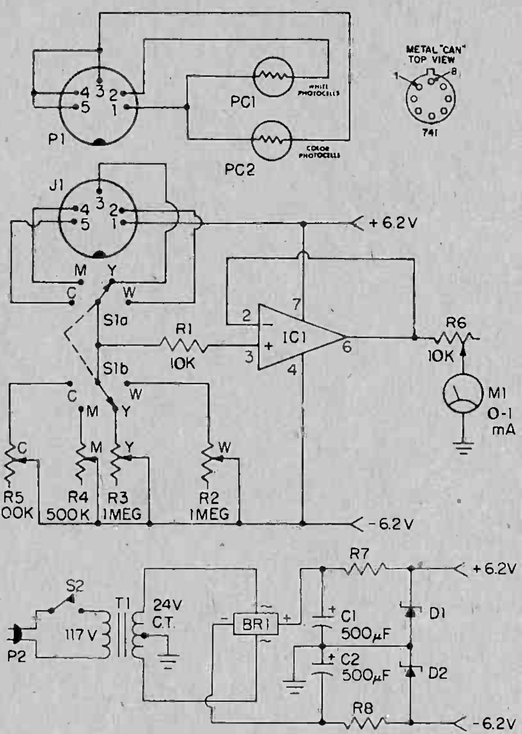
You can either buy or make the printed circuit board (see parts list). Either way, the first step is to prepare the printed circuit board. If you do it yourself, make it any way you like, using free-hand or template resist. Nothing is critical, but be certain there are no copper shorts between the terminals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

Assemble the power supply and check it out before any other components are installed. Install transformer T1 first. Any 24-volt or 25.2-volt center-tapped transformer that will fit on the board will be fine. Get something small, like 100 milliamperes. A Wescom 81PK-100 is a perfect fit.

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

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

Initial PC Checkout. When the power supply is completed, temporarily connect a linecord. Connect the negative lead of a meter rated 10 volts DC or higher to the foil between T1's mounting screws (that's ground). Connect the meter's positive lead to the junction of R7 and D1, which is in the center of the board; the meter should indicate approximately +6.2 volts DC. Then connect the positive meter lead to the R8 and D2 junction, which is near the edge of the board. You should get approximately −6.2 volts DC. If the voltages

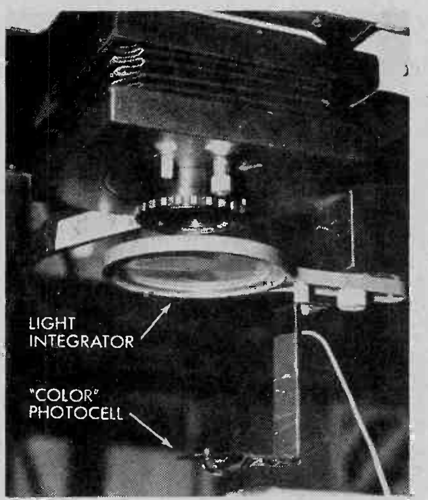


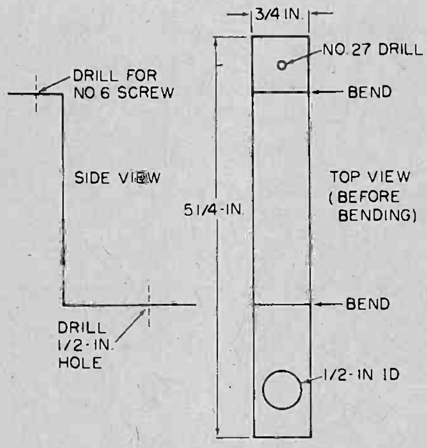
PARTS LIST FOR COLOR ANALYZER

BR1—50-PIV, 0.5-amp or higher silicon bridge rectifier
C1, C2—500-uF, 10-VDC or better electrolytic capacitor
D1, D2—6.2-volt, 1-watt zener diode
IC1—type 741C operational amplifier, see text
J1—5-pin socket, DIN-type (optional, see text)
M1—0 to 1-mA DC meter, see text
P1—5-pin plug, DIN-type (optional, see text)
PC1, PC2—Clairex CL5M5L photocell, **do not substitute**
R1—10,000-ohm, ½-watt resistor
R2, R3—1-megohm potentiometer, see text
R4—500,000-ohm potentiometer, see text
R5—100,000-ohm potentiometer, see text
R6—10,000-ohm trimmer potentiometer (Mallory MTC-14L4 for exact fit on PC board)
R7, R8—820-ohm, ½-watt resistor
R9—100,000-ohm, ½-watt resistor
S1—2-pole, 4-position rotary switch (Allied Electronics 747-2003; adjust stops for 4 positions)
S2—spst switch
T1—117-volt primary, 24 to 26.6-volt secondary transformer, see text for point-to-point wiring (Note: you can also use two less expensive 12-volt transformers with secondary windings connected in series-aiding, if you have the space.)

The printed circuit board for the Color Analyzer is available direct from Electronics Hobby Shop, Box 192, Brooklyn, NY 11235 for only $5.50. US orders add $1.00 for postage and handling; Canadian orders add $3.00. No foreign orders, please. Postal money orders will speed delivery; otherwise allow 6-8 weeks for delivery.
If you cannot obtain the Clairex Type CL5M5L photocell locally, write to Electronics Hobby Shop at the above address, enclosing $3.50 for each photocell. Postage and handling are included. No Canadian or foreign orders. New York State residents add sales tax. Postal money orders speed delivery; otherwise allow 6-8 weeks for delivery.

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





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

are far apart in value, or if the polarity is wrong, make certain you find the mistake *before* installing IC1.

Disconnect the linecord and complete the PC assembly. If you use a 24 or 28-volt pilot lamp to illuminate the meter you connect to the holes adjacent to T1's secondary (24-V) leads. If you plan to use a neon illuminator, install a 100,000-ohm resistor (R9) on the PC board and connect the lamp to the holes marked "neon." The lamp must have as little illumination as possible. Incandescent 24 or 28-volt lamps must be the miniature or "grain of wheat" type rated approximately 30 to 60 mA; the lamps come with attached leads. Do not use pilot lamps of the 100 to 500 mA variety. The excessive light will confuse the analyzer.

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

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

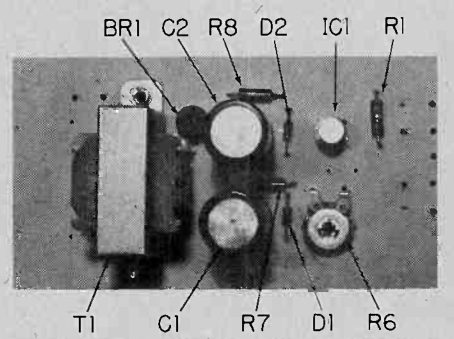
Potentiometers R2 through R5 can be linear or audio taper, though audio taper gives a slightly smoother adjustment; use whatever you have in stock.

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

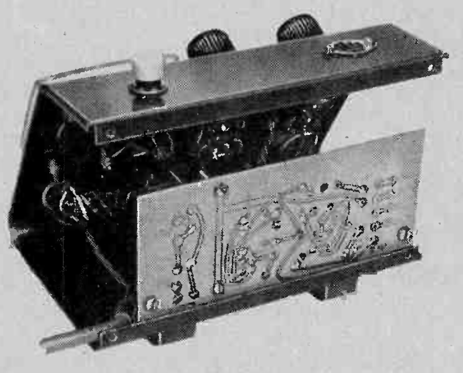
Meter M1 should be O-1 mA with a zero-center scale. But these are expensive, so you can substitute any standard 1-mA meter you want. You will simply calibrate the instrument for zero-center.

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

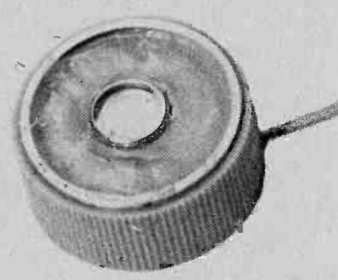
The Comparator. The photocells used for the comparator and exposure sensor, P1 and P2, must be Clairex type CL5M5L. Make no substitutions. From a piece of scrap aluminum ¾ to 1 inch wide, fashion a Z-bracket to the dimensions shown. Drill a ½-inch hole close to the end of the longer Z-leg. Fasten the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

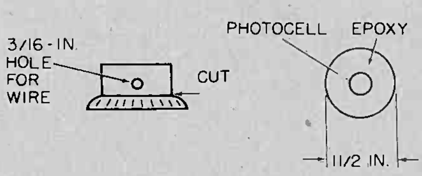


This is the parts location when our PC board is used. To get a free template of the PC board, send a Self-Addressed Stamped Envelope to: Davis Publications, Dept. T, 229 Park Ave. South, New York, NY 10003.



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





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

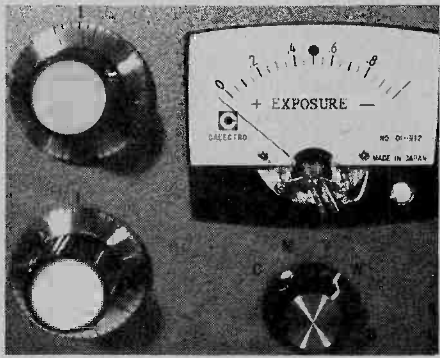
holder, or if it has a permanent swing-away red filter under the lens, mount a Paterson swing-away light integrator (available from local photo shops) under the lens. Fasten the short leg of the Z-bracket to the integrator—which has pre-drilled holes—so that the ½-inch hole is on the optical center of the lens. Then cement photocell P2 in the hole and attach the connecting wires; these can be extra-thin zip cord such as used for short-length speaker connections. (This whole bit reads a lot more complicated than it is. Use the photographs as a guide.)

Photocell P1, which measures the exposure light, can be mounted in anything heavy enough to hold it in place on the easel. The photographs show the photocell epoxy-cemented in an oversize control knob.

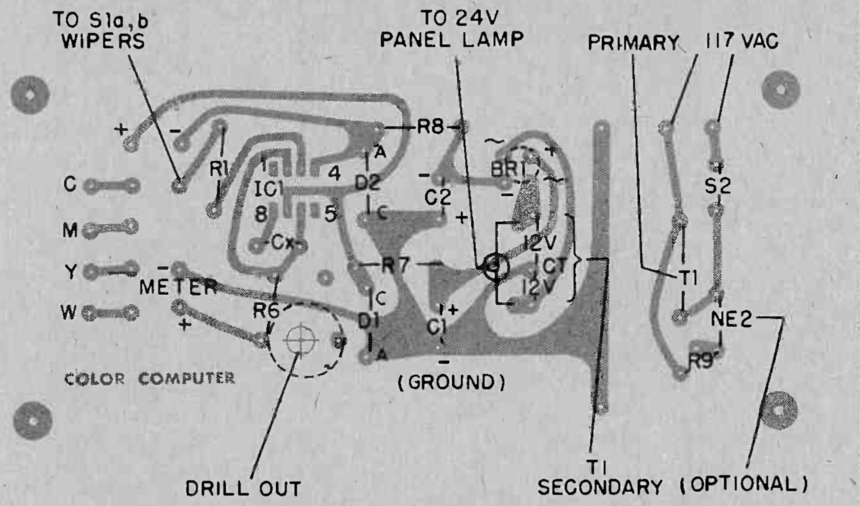
When the complete analyzer is assembled, attach oversize calibrated knobs such as the Calectro E2-715 to R2 through R5. The knob calibrations are important so they should run out to the very edge of the knob skirt. If the calibrations don't run to the edge you won't be able to preset the controls with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

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

Set S1 to any position, set all other controls to their mid-position, and turn on bright room lights. If the meter pins out or approaches full scale deflection, adjust trimmer control R6 so the meter pointer just pins (don't be afraid to pin the meter). Depending on the amount of light the meter pointer will pin right (for bright light) and left (for dark or very low light). This is normal and there will be no damage to the circuit or the meter. (Note: If you use a zero-center meter the pointer will barely pin on both sides.)



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



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

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

The first thing you need to make fine quality color prints is a high speed chemistry, such as the two-step Beseler system which can produce a finished print in two minutes. The second item you need is the electronic color analyzer for which we've already given you the plans.

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

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

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

One way we can correct for these variables is through an *additive* exposure, exposing the paper through blue, green, and red filters for differing lengths of time. Since blue, green, and red create all the colors in additive printing, any correction can be obtained by controlling the precise timing of each exposure. The additive system is a pain in the neck for the hobbyist, for the slightest desired change in the color rendition or saturation (exposure) can involve changes in the exposure through all three filters.

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

More Info. A full and complete treatment of both types of color printing is contained in the Kodak publication *Printing Color Negatives;* this book is a required reference for anyone who wants to make quality color prints. The book also gives the most convenient operating procedures for electronic color analyzers.

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

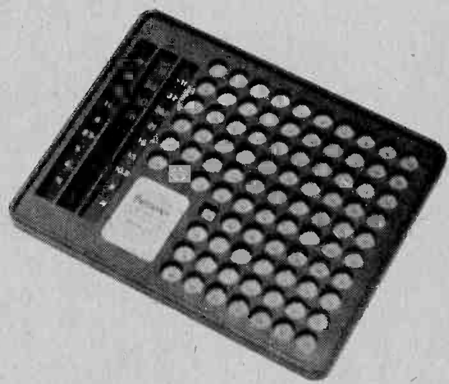
An electronic color analyzer basically consists of a photocell (vacuum tube photomultiplier or photoresistor) positioned under the lens, blue, green, and red filters mechanically positioned over the photocell (or positioned over the cell by hand) and a meter that indicates the amount of light falling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

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

To Continue. . . . Place the color analyzer's probe on the easel or swing it under the lens (if it is mounted on the enlarger). Install a light integrator—which is nothing more than a piece of ground glass or its equal—under the lens, between the lens and the analyzer's probe. The light integrator scrambles the picture into a diffused "white light" which contains all the color elements of your negatives and the filter pack. Place a blue filter (Kodak Wratten No. 98) on top of the light integrator. (Note that most hobbyist analyzers have a selector switch that also mechanically positions the correct filter over the photocell.) Turn on the enlarger and adjust the analyzer's *yellow* control for a convenient reference meter reading. (Usually, center-scale or "null" is used as the reference reading, but any meter reading can be used as a null.)

Remove the blue filter, install a green filter (Kodak Wratten No. 99), switch the analyzer to MAGENTA and adjust the *magenta* control for a null meter reading. Remove the green filter, install a red filter (Kodak Wratten No. 70), switch the analyzer to CYAN and adjust the *cyan* control for a null meter reading (the color controls yellow, magenta, and cyan refer to the color of the subtractive filters in the filter pack). Finally, remove all filters from under the lens, switch the analyzer to WHITE and adjust the *white* control (exposure control) for a null meter reading.

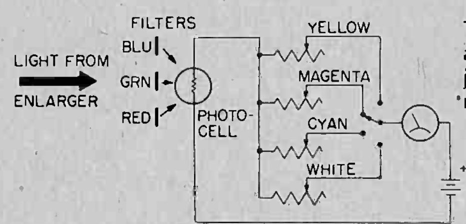
(The color analyzer in this project uses a separate photocell for the exposure. If you look at the easel you'll see a shadow cast by the Z-bracket holding the color comparator cell. Position the exposure cell on the easel so it is just off the edge of the shadow. If you prefer, you can place several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



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

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

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

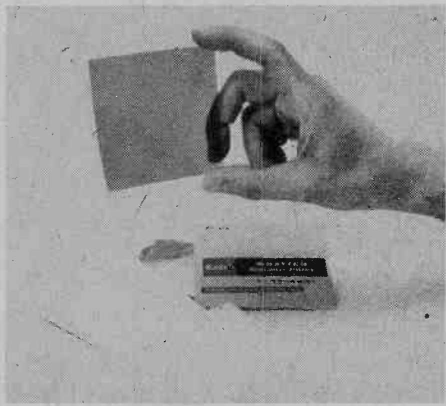


The basic color analyzer. Once controls are matched to a "standard" negative, just select filters for a null on the meter for each individual color and white.

modify the yellow filtration in the filter pack until the meter shows a null. Finally, set the analyzer to WHITE, remove all reading filters and adjust the lens aperture for a null indication.

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

Swinging Filters. In the previous example the filter pack would wind up with magenta and yellow filters—which is what is generally needed. Some Kodacolor negatives, however, might require cyan lters plus magenta *or* yellow (but never all three). This information will have been programmed into the color analyzer, so you will have no difficulty if you make a slight modification in procedure. The first meter reading, the one where you adjust the lens's aperture, should be made for the filter you are *not* using in the filter pack. For example, if your basic filter pack has cyan and magenta, switch the analyzer to YELLOW, place the blue-reading filter in position on the light integrator, and close down the lens for a null indication. Then proceed with the other readings. If your reference negative did not require cyan in the filter pack, if it had yellow, magenta, or both, and you find a new negative just can't be pulled in for null meter readings with yellow and magenta filters, it indicates the new negative requires cyan filtration, so start with the assumption that yellow is not required. If you still can't null the meter, it means magenta should *not* be in the filter pack.



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

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

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

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

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

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

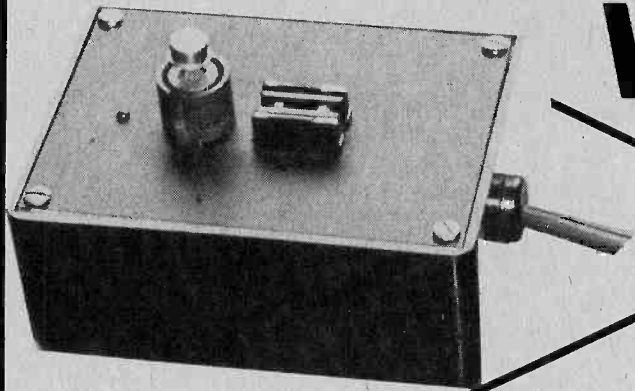
The Pro Shop. We could not close without some words on commercially processed color prints such as you might order from a drugstore or camera shop. Commercial color labs have as high (if not higher) a remake rate than the amateur if *quality* color prints are desired. As a general rule, it takes two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

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

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

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

TEST SURPLUS OP AMPS WITH THE GO/NO GO TESTER



You can build this money saver in a few hours and turn 10-cent surplus op amps into units worth bucks!

by R. M. Stitt

MOST ELECTRONIC DEVICES can be divided into either analog (linear) or digital circuitry. *Digital circuits* operate largely by means of switches—which are most of the time in one of two quite different states (high or low, plus or minus, or one of two substantially different voltage levels). *Analog, or linear, circuits* generally function by amplification (or reproduction) of signals in as nearly an exact manner as practical. That is, signals within the circuit(s) are changed, amplified, or transformed according to an infinitely small series of changes of one or more input signals. This is the kind of circuit which we most often run into outside of digital devices, and it is in these circuits that the operational amplifier is most frequently used.

Operational amplifiers were developed into practical devices in the Fifties, and first found their applications in scientific and industrial instruments, where their ability to amplify, add, subtract, multiply, or divide by precise quantities was valuable. Those op amps used vacuum tubes, of course, and required the usual accompanying capacitors and resistors. With the coming of integrated circuitry in the Sixties op amps began to appear in chip form, and today op amps are used in circuits almost as readily as individual transistors.

How Op Amps Work. If you're new to operational amplifiers, which everybody calls op amps, you can get a good basic course in how they work and what they can do by reading articles ELEMENTARY ELECTRONICS has run in the past couple of years—"Op-Amp and Diode Circuits," pages 47-50, Nov./Dec. 1974, and "Op-Amp Insights," Sept./Oct. 1975.

Briefly, an op amp has two inputs, one output, and plus and minus power supplies (most often +15 and −15 volts). The inputs are called the plus and the minus input, or the inverting input and the non-inverting input. If the op amp is to be used as a simple amplifier the non-inverting input (usually) is grounded. In addition, the op amp has feedback from the output to the inverting input, and the amount of feedback is precisely controlled, generally by careful selection of the value of the feedback resistor. The amount of feedback determines the amount of gain of the op amp in any particular circuit.

In recent years, then, op amps have become one of the most important building blocks in many circuits. They are produced in IC form at low cost, and are readily available on the surplus market, often for less than 10 cents a piece, in quantities, and *untested—as is.*

When you buy a bunch of op amps at a good price from surplus houses, most of them will turn out to be perfect, and you can use them as well as if they'd been bought from the factory, individually sealed and guaranteed (at much higher prices, of course). It's therefore necessary to have an easy way of testing op amps before they're put into working devices.

One way to test an op amp is to plug it into a typical circuit, feed it a signal and observe both the input and output signals on an oscilloscope. Since this takes a fair amount of time (and a generator as well as a 'scope), a simple plug-it-in, go/no-go tester has been developed by this writer, and you can make one just like it at low cost, in just a few hours. When you've finished it you'll know a fair amount about how op amps work and how to test them. And you'll be able to make each test in three to five seconds apiece, using this handy instrument.

How It Works. The circuit of the op amp tester may be broken down into five sections, as follows: power supply, voltage divider, test circuit, error amplifier and display circuit.

The operation of these sections can best be understood if the following paragraphs are studied in conjunction with the schematic diagram.

Power Supply. This is a conventional supply, consisting of a small power transformer (T1), which is the only part of the instrument not actually mounted on the printed circuit board. The low-voltage secondary of T1 feeds the bridge rectifier D1-D4. The bridge is shown here arranged differently from the customary one. But comparing its actual connections with the usual arrangement you will see that they are the same. This drawing has the advantage that it's easier to trace out the current flow to see the complete path for current flow from *both* sides of the center-tapped secondary, at *all* times.

Voltage Divider. By tapping off the power transformer secondary winding we can obtain a 60-Hz sine wave signal for use as a test signal. The effective voltage is 18 volts, which must be dropped to 0.06 volts. This is accomplished by using a simple voltage divider, R3 and R4.

Test Circuit. The *Device Under Test*, DUT, is placed in the circuit as an inverting amplifier. In an ideal inverting op amp, the output is described by the simple formula:

Output voltage = −input voltage times R8 divided by R7.

Put another way,

$$V_{out} = -V_{in} \times R8 \div R7.$$

With the values in this circuit, this would be −(0.06) times 1 megohm

TEST SURPLUS OP AMPS

divided by 10,000 ohms, or −6 volts.

Notice that the output is the negative (inversion) of the input. This inversion is important in the operation of the tester, as is explained farther on.

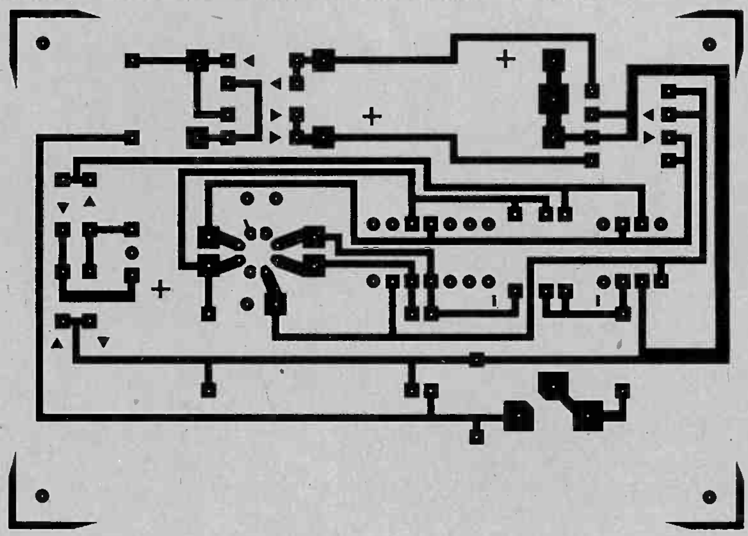
Error Amplifier. The error amplifier in this circuit is a *summing* amplifier—it sums (adds together) the two signals applied to the junction of R9, R10, which come from output of the DUT and from R6, respectively. In other words these two signals are mixed together, where they add (or in this case, cancel, if the DUT is working properly). The summing amplifier is made up of IC1, R5 (or J1), R6, R9, and R10.

Display Circuit. The display circuit consists of diodes D3 through D6, and indicator LED 1. Diodes D3-D6 make up a full wave bridge rectifier (just like the bridge rectifier circuit in the power supply) which converts positive or negative signals, which are present at the display circuit input, into positive signals (just the way the bridge in the power supply converts AC into positive DC) which will turn on indicator LED 1. If bridge D3-D6 receives a positive input, current flows through D5, LED 1, and D8, and diodes 6 and 7 are reverse-biased. If the display circuit receives a negative signal, current flows through D7, LED 1, and D6, while diodes D5 and D8 are reverse-biased. The current through LED 1 is limited by the components inside IC1, the op amp, which is part of the test circuit.

How the Circuit Works. The input signal which comes from the voltage divider (R3 and R4) is applied to the DUT through resistor R7. The same signal is also applied to the error amplifier through resistor R6. The DUT inverts this signal and amplifies it. The amount of amplification is equal to −R8/R7, which is 100, since R8 is one megohm (a million ohms) and R7 is 10,000.

This is stated, for op amps, as V/V, a way of expressing gain. It means volts of output for each volt of input. If a circuit has 100 volts of output for each volt of input, it is said to have a gain of 100V/V. The error amplifier sums the voltage divider signal with the signal from the output of the DUT. The signal at R6 is amplified by a gain of −100, since R6 is 10,000 ohms, and R10 is one megohm. The signal at R9 is amplified by a gain of −1, the minus sign indicates a signal inversion.

If the DUT is working properly there will be no error (the two signals will exactly cancel out) at the output of the error amplifier, IC1. This is because the input to the error amplifier at R9 will exactly cancel the input to the error amplifier at R6.



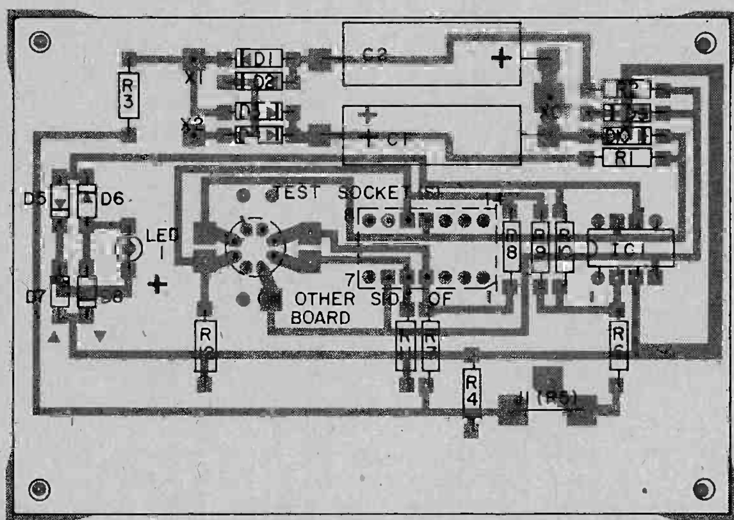
Full-size pattern for making your own printed circuit board for the Op Amp Tester. Finished board may also be purchased from supplier listed in Parts List.

Output Current. The DUT must be able to supply output current equal to at least Vp/Rt, which means, where Vp is the peak output voltage of the DUT, and Rt is the load on the DUT output (R8, R9, and R12 in parallel), we get 6V divided by 1,790 ohms, which is 0.0034 amperes, or 3.4 milliamps. If the DUT cannot supply at least 3.4 mA, an error signal will be developed, and the LED indicator will go ON, telling us that the DUT is faulty.

Input Voltage Offset. This is the input voltage required to provide zero output voltage in the absence of intentional signal input on the + or − inputs of the op amp under test. It will appear as an error signal at the output of the DUT, amplified by the gain of the test circuit, plus one; 1 + R8/R7. An error voltage of 4V will appear at the output of the DUT when the input voltage offset exceeds 40mV.

Input Bias Current. In an ideal op amp, no bias current flows between the two input terminals. In actual amplifiers, however, there is always some current flow between them. This current is similar to the base current which flows when a bipolar transistor is used as the input of an amplifier, or the gate current when an FET is used at the input of an amp. In this circuit input bias current will flow through R8, and will show up at the output of the DUT as an error signal. Bias flow from the positive input will cause a voltage drop across R11 which will be amplified by an amount equal to the gain: 1+R8/R7 which is 1,000,000 divided by 10,000 plus 1; or 101. This signal will appear at the output of the DUT as an error signal.

A bias current of 4 microamps will cause an error signal at the output of the DUT if R7 and R11 are equal, and R8 = 1 megohm. Notice also, if the bias



Drawing above shows where components go on printed circuit board. Drill holes halfway through board because parts mount on the foil side.

currents at the input terminals of the DUT are equal, they tend to cancel, and no error signal is developed. Thus, only mismatches of input bias currents are treated as errors in this test circuit.

For the test circuit to work properly the actual values of resistors R6 through R10 must be pretty close—5 percent resistors at least, or resistors of greater tolerance which have been measured and found to be within 5 percent or better of the nominal value.

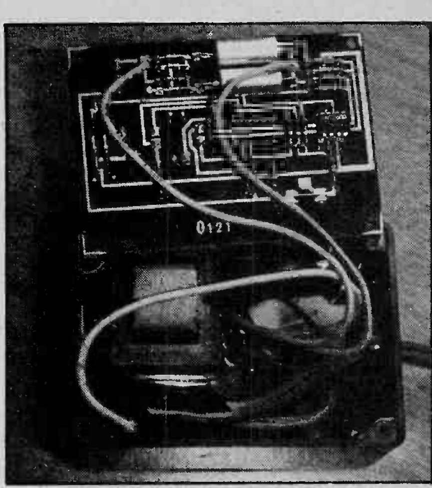
With an overall test gain of 100 or less, the 5 percent components specified will be adequate. In this case, jumper J1 is installed, and R5 will equal zero ohms. If higher test sensitivity is desired, then closer matching is required. This is accomplished by reducing R6 from its nominal value of 10K to, say, 8K and adding an adjustable resistor, R5 of about 3K ohms in series with it so that a closer match can be achieved by adjusting R5. When R5 is used, it can be adjusted by placing an op amp known to be good into the test socket and adjusting R5 to the center of the range in which failure indicator LED 1 stays off.

Errors at the output of the DUT will be amplified by the error amplifier at a gain of one (R10/R9) and will drive the display circuit. When the error at the output of the error amplifier, IC1, exceeds the forward voltage of LED 1 plus the forward voltage of the bridge diodes, LED 1 will turn on, indicating a bad DUT. This occurs at about 4 volts. The following DUT difficiencies can contribute to the error signal.

Open Loop Gain. If the open loop gain of the DUT is not adequate to accurately amplify the input signal, an error signal will develop. A gain error approximately equal to 3.0 V will be developed if AOL of the DUT is equal to 200.

Output Voltage Amplitude. The output of the DUT must swing at least as much as the amplitude of the input signal multiplied by the gain of the test circuit. If it does not, an error signal will be developed. Since R7 equals 10,000 ohms, and R8 is one million ohms, we get 1,000,000 divided by 10,000, or 100 times 0.06. This equals a swing of ±6.0 volts.

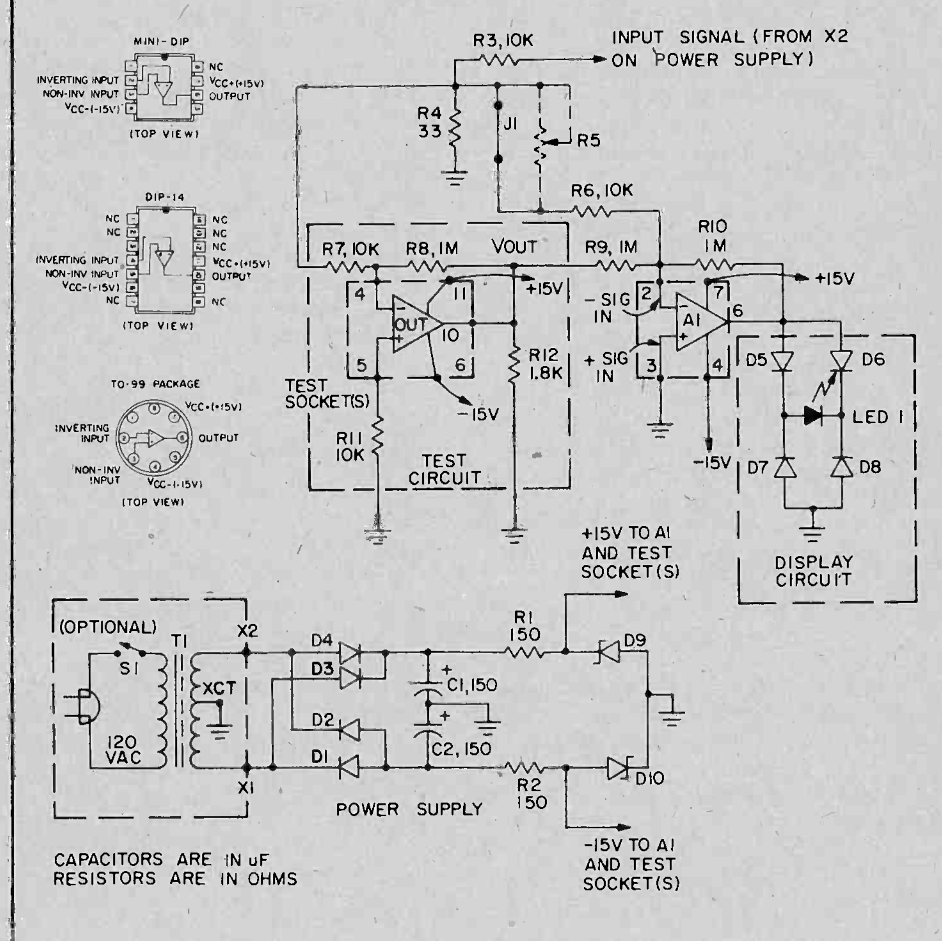
Stability. An unstable amplifier will oscillate even if it has no external signal input. This oscillation will directly cause an error signal. Op amps tend to be more stable at higher gains, and tend to be least stable at unity gain. So, this is not really a very strenuous stability test circuit, and op amps which are stable in this test circuit may not be in lower gain circuits. On the other hand any op amp which is supposed to be un-



Tester show front panel inverted. Foil side mounts components. Secure transformer with epoxy or potting mix.

conditionally stable and is not so in this circuit, is certainly defective. Some experimenters may want to put a switch on the tester so that the DUT can be momentarily placed into a unity gain configuration for more exhaustive stability testing. This would be done by opening the inputs to R6 and R7. This would place the DUT in a non-inverting gain of one with a one megohm resistor in the feedback, and the input tied to ground through R11 (10

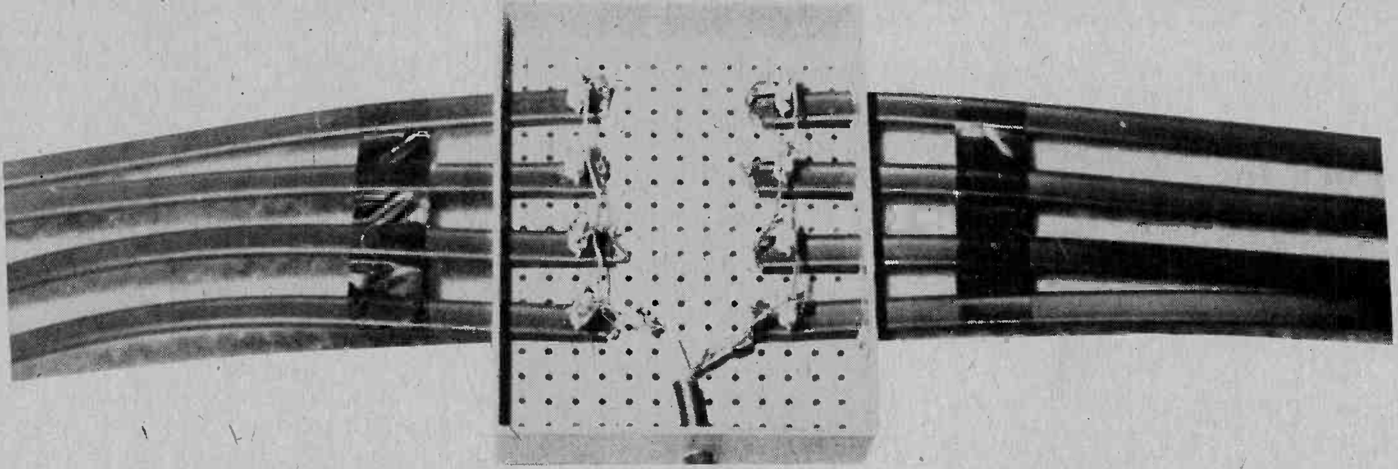
(Continued on page 95)



PARTS LIST FOR OP AMP TESTER

C1, 2—150-uF, 16-V electrolytic capacitors
D1-4—Bridge rectifier diodes, one amp, 50-V PIV or more
D5-8—Diode rectifiers, general purpose, for display LED, 1 amp or more
D9, 10—Zener diodes, 15-V, 1-watt or more
IC1—LM741 mini-dip Op Amp
LED 1—⅛-in. diameter LED (or any convenient small size)
R1, 2—150 ohms, ¼- or ½-watt, 5% resistors
R3, 6, 11—10,000-ohms, ¼- or ½-watt, 5% resistors
R4—33 ohms, ¼- or ½-watt resistor
R5—1,000 ohm potentiometer; optional—see text.
R8, 9, 10—1 megohm, ¼- or ½-watt, 5% resistors.
R12—1,800 ohms, ¼- or ½-watt resistor
T1—Power transformer, 120 VAC primary, 30 V center tapped secondary, 100 milliamp or more (Radio Shack 273-1386 or equiv.)
Misc.—Case, any convenient size (about 5-in. by 2½-in. by 1½-in. or more; 14-pin Op Amp socket; TO-99 Op Amp socket; Printed Circuit Board (undrilled) $2.95 postpaid, from Techniques, Inc., 236 Jackson St., Englewood, N.J. 07631.

Mini-Cost Multiband Antenna



Easy-to-build, inexpensive SWL skyhook covers 8 bands!

by Dan Ramsey

NEARLY EVERYBODY knows that dollar-for-inflated-dollar your best SWL investment is a good antenna system. But, you ask, what is a really "good" antenna? It's one that's easy to construct, inexpensive to build and will pull in stations on all of your favorite bands equally well without a complicated switching system. And that's a good description of our Mini-Priced Multi-Band antenna system.

For less than $20 you can construct this simple-to-build and easier-to-operate antenna on even the smallest of lots. With an overall length of less than 80 feet, this home-made DX chaser will bring in each of the seven major international shortwave bands *plus* CB for fun when nothing else is cooking. A couple of hours on a Saturday afternoon will put it up and you'll soon wonder how you ever eavesdropped the ether without it.

Technically our Mini-Priced Mutli-Band is a resonant dipole antenna with eight different-length half-wave legs and low-loss coax leadin to match. But what makes the system unique is that the antenna needs only 180 feet of popular 300 ohm TV twinlead (lead-in) wire available everywhere. Other easy-to-get parts include a perf-board box to house the center taps, a few solderless terminals to hold things together and 25 to 50 feet of RG-59/U coaxial cable to bring the signal down to your receiver. It's about the simplest, most practical and least costly SWL antenna a hobbyist can build.

Antenna Theory. The resonant-dipole antenna has won universal acceptance, literally, as SWLers the world over rely on its simplicity and sensitivity It's easy to understand why.

A half-wavelength dipole (cut to half the *electrical* length of the incoming shortwave, then tapped in the center) offers the advantage of receiving one group of frequencies, or a band, stronger than others striking your antenna at the same time. It is frequency-sensitive. As opposed to the popular longwire, which is a "general" antenna, the dipole is a *specialized* antenna. It specializes by resonating—being most efficient in receiving a particular band, for which it was designed. It is frequency-selective. And because it is physically little more than a longwire antenna tapped in the center rather than on the end, the dipole is nearly as easy to construct.

However, the dipole does have certain disadvantages. The problem is that, though a dipole is usually most sensitive to whatever signal range you have cut it to receive, its frequency range is rather narrow, and it is much less efficient on outside frequencies than the general-coverage longwire antenna.

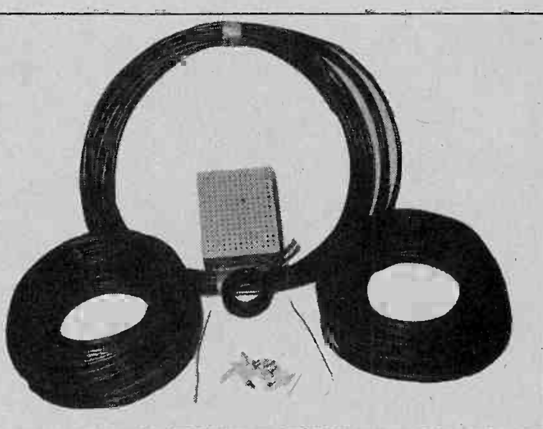
You can turn this fact to your advantage by setting up a resonant half-wave dipole for *each* of your favorite bands. This will insure that you can listen to any one of these bands with top sensitivity while attenuating signals from outside the band so they don't interfere with your listening pleasure. The bands you'll probably choose are the seven international shortwave bands (49, 41, 31, 25, 19, 16 and 13 meters) plus something just for fun, like eavesdropping on the CBers (11 meters).

So what we've designed is an eight-band resonant half-wave dipole antenna. And it's engineered for low cost, selectivity, sensitivity, and efficiency. Now that we've designed our "perfect" antenna, in theory, how can we make it actually fly?

Simple! By using various lengths of 300 ohm TV twinlead wire we can have four parallel sets of double wires that will resonate in the middle of each of the eight bands we've chosen. Why twinlead? It's easy to obtain for one thing. Nearly every town has at least a TV repair shop where you can usually buy twinlead in 50 and 100 foot rolls or cut to specific lengths for about 4 to 9 cents a foot. Also, it offers two insulated antenna wires in one weatherproof package.

When buying your twinlead, you won't want the best, the shielded type, because that would defeat your purpose of getting the signal to the enclosed wire with the least amount of loss. And you won't want a low-grade type either, because of the brittleness of the wire and insulation. About the best wire for a shortwave antenna is 7-strand number 20 or 22 wire. And the better-grade foam-insulated TV twinlead is made up of 7x22 copper wire. Perfect! It's highly-conductive, weatherproof, self-supporting and inexpensive.

Let's go back to resonance. Engineers have come up with a simple formula that will help you decide what length you will want to cut each of your antennas to in order to make them *resonant* (most sensitive to one frequency



Basic parts for your Mini-Priced Multi-Band are two rolls of 300 ohm TV twinlead, about 50 feet of coax cable, perf-board box, electrical tape and solderless spring terminals. The two short pieces of rigid wire are used for making the common connections at center of the antenna array.

range) half-wave dipoles. The formula is:

$$\frac{468}{F\,(MHz)} = \tfrac{1}{2} \text{ wavelength.}$$

which means: one-half a wavelength is equal (electrically) to the magic number of 468 divided by the frequency you desire (measured in Megahertz). The answer is in feet. Example: for the 49-meter band (5.95 to 6.2 MHz), use the approximate center frequency (6.075 MHz) in the above formula and you will come up with 77 feet. That's the length of wire you'll need to make your antenna resonant, or most sensitive, to that frequency band. It's a simple process to choose the lengths you'll need for each of the eight shortwave-bands we've decided on. (See our *Resonant Antenna Table*)

Construction. Putting the whole thing together is easy. The 49- and 41-meter band wires will be mated in one twinlead, the 31 and 25 meter bands go in another, 19 and 16 share a twinlead, and 13 and 11 meters take the final length.

Steps: Cut each twinlead to the longer of the two resonant lengths (Cut the 49-41 meter twinlead to 77 feet.). Then figure the difference between the two resonant lengths (41 meters should be 65 feet long, so the difference is 12 feet. Divide the difference by two (answer—6 feet) because you are eventually going to cut the whole twinlead in the center to tap it and will want an equal amount of resonant antenna on each side of the center tap. Come in that distance (6 feet) from each end and snip the *bottom* wire of the twinlead at that point. Then go to the closer end, cut the *bottom* wire back, take a firm grip on it and zip it out through the side of the insulation to the point where it was snipped.

Do this with each of the four twinleads according to the lengths in the *Resonant Antenna Table.* Remember, if you have purchased your twinlead in two 100 foot rolls to cut the 77 foot and 21-ft. 8-in. lengths out of the same roll.

To make your antenna a dipole you must tap it in the center. This is done by first folding each twin-lead exactly in half and cutting it. With 178 feet of wire all over the floor, you should tape appropriate sections together and label them as they are cut to avoid later confusion. When you lay the antenna system out on the ground it should look like the spread wings of an eagle, tapered inward from top to bottom and with the center tap cuts all meeting in the middle. Now it's time to tie it all together.

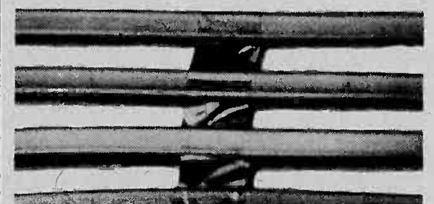
Here's where the other parts come in: the perf-board box, the solderless spring terminals, coax cable and the electrical tape.

First, open up the perf-board box and lay the gray or perforated section open end up. (You can use a hobby box and a perforated board also, but the Archer brand Experimenter's P-Box, distributed by Radio Shack, has a distinct advantage in that necessary holes can be cut in the gray portion of the box with a hot soldering iron.)

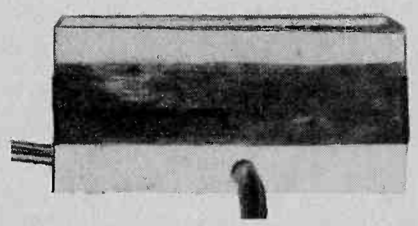
Next, cut four holes in each side of the box for the twinlead, and one at the bottom edge for the coax. Then bring the four half-sections of twinlead into each side of the box, strip all wires back about one inch, make a hole in the center of the insulation another ¼-in. back for the spring terminals and insert them into the insulation. Next, put the two loose wires from each twinlead into its respective terminal, push the terminal into the correct holes in the perf-board box and connect the terminals on each side with a common wire. Now you have all wires from one side of the box connected commonly, and all wires from the other side connected at another common point.

The next step is to bring the coax cable in from the bottom, connect the center wire to one common set of taps and the outer (shield) braid to the other set. You should spot solder the terminals when you've completed your work to assure a good electrical bond. Close the box and seal it with electrical tape. You're just about finished.

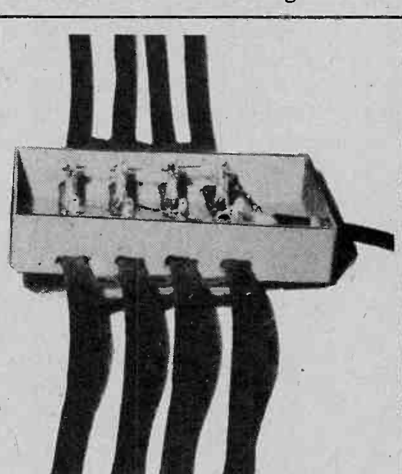
Stretch all of the twinleads out in parallel from the box. Every three feet or so, wrap electrical tape from the top to the bottom twinlead leaving about an



Short lengths of electrical tape help space out the twin-leads to keep them isolated and to support them in place properly.



After final assembly the perf-board box is closed and sealed with black plastic electrical tape. Coax cable leadin is shown exiting at center front.



Twin-leads enter box at side—coax exits at bottom. Spring terminals conduct signals, also serve to secure twin-leads.

inch between each one. This is done so the top twinleads will support the bottom ones. For further support, use a short cord to tie the top two ¼-wave legs together on the outside of the box. This will minimize stress on the top twinlead center connections when it is installed.

The next step is rigging up your antenna. You will need 80 feet of space, lengthwise. A strong nylon cord tied from each end (egg insulators not needed) and to a nearby support will do the trick. Make sure you raise the antenna to a height of at least 20 feet and away from obstacles that would attenuate the incoming signals. The higher it is, the better it will be. Carefully run your coax in to tne shack, hook it up and stand back.

Signal Tracing. To see how your Mini-Priced Multi-Band works, let's follow an incoming signal. It hits your antenna along with a hundred others, but your dial is tuned to 9.690 MHz in the 31-meter band. Because signals follow the path of least resistance and because the lowest resistance is between your top wire on the second-from-the-top twinlead and your receiver, that particular signal is chosen. It runs towards the center of your dipole. At the same instant, the identical signal is coming in from the other half of your half-wave dipole and rushes towards the perf-box. They haven't met yet.

Even though you are using what's called *300 ohm* twinlead, the actual impedance (resistance of an AC circuit) of each dipole is about *70 ohms* as it is in every center-tapped half-wave dipole antenna. (The impedance would be about 300 ohms if the farthest ends of the twinlead were loaded or connected together, but they are not.) And so your 72-ohm coaxial cable is a near-perfect match. The signal again takes the path of least resistance, down the coax to your receiver.

Some inexpensive communications-*type* receivers have higher input impedance, but most better-quality communications receivers have an input impedance of about 75 ohms. Again, a very close match for your incoming signal and it rushes into your tubes and/or transistors to be amplified, rectified and certified "good SWLing." No loading coils or bandswitches necessary.

Hints. Remember that the dipole antenna, while able to detect signals from just about any direction, is most sensitive to signals coming in broadside (at right angles) to the antenna. So try, if you can, to run your antenna basically north and south if you want to receive most signals from the east and west.

Another plus for the dipole is its noise-cancelling characteristic. Each of the ¼-wave legs brings the signal to your receiver as a mirror of the other. One runs down the center wire of the coax and the other moves via the outside coax braid. When they meet in your receiver they mix and cancel much undesired amplitude-modulated impulse noise. Another good reason why the dipole is so popular.

Horizontal and vertical polarization? Don't worry about it! After skipping off the ionosphere a time or two, it doesn't make any difference whether the station sent the signal out with a horizontal or vertical antenna. It's flip-flopped through the atmosphere enough before it gets to you so the signal is virtually omni-polarized.

While you're installing your Mini-Priced Multi-Band, don't forget the value of an antenna lightning arrester. It may save your receiver from an overload of a few thousand volts. And it doesn't take lightning to make it a useful gadget. It will also discharge the static electricity that can bulid up on a wire during an electrical storm. It's great insurance!

Long-time SWLers know that one dollar in the antenna system is worth about ten dollars in the receiver. So this less-than-$20 project may just inflate your shack's value by almost $200. And that's a good investment in *any* economy! ■

PARTS LIST FOR MINI-PRICED MULTI-BAND ANTENNA

178 ft. 300-ohm foam TV twinlead (Radio Shack 15-1175 or 1203, or equiv.)
25-50 ft., as needed for lead-in, RG-59U coaxial cable (Radio Shack 278-1327 or equiv.)
Perfboard box or experimenter's P-box (Radio Shack 270-105 or equiv.)
Solderless spring terminals (Radio Shack 270-1547 or equiv.)
Roll electrical plastic tape

RESONANT ANTENNA TABLE

BAND (meters)	FREQ. (MHz)	LENGTH (Ft.)	TRIM (ends)
49	5.95-6.2	77	none
41	7.1-7.3	65	6 ft.
31	9.5-9.775	48⅔	none
25	11.7-11.975	39⅔	4½ ft.
19	15.1-15.45	30⅔	none
16	17.7-17.9	26+2 in.	2¼ ft.
13	21.45-21.75	21⅔	none
11	26.965-27.225	17+6 in.	2 ft.

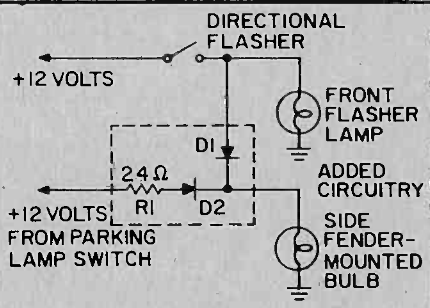
Turn Signals from Side Marker Lights

☐ Side clearance lights are the lamps usually mounted on the front and rear fenders. These lights can be made to provide additional driving safety by adapting them to flash *in unison* with the directional flashers if the auto does not now have rear flashers.

The circuit diagram shows how the present auto or pick-up electric wiring is modified so the side lights will also flash. A 24 ohm resistor is added in series with each side-clearance lamp bulb filament. This reduces the brilliance of the side bulb to about half of what it was originally. An epoxy diode is used to isolate the parking lamp filament from the flashing light circuit.

A separate wire lead is run from the side lamp to the directional flasher lamp on the same side of the auto. The side clearance lamp will then flash in unison with the front directional flasher lamp. A second diode is used to isolate the flasher filament from the parking light circuit so that it will not turn on when the parking light turns on.

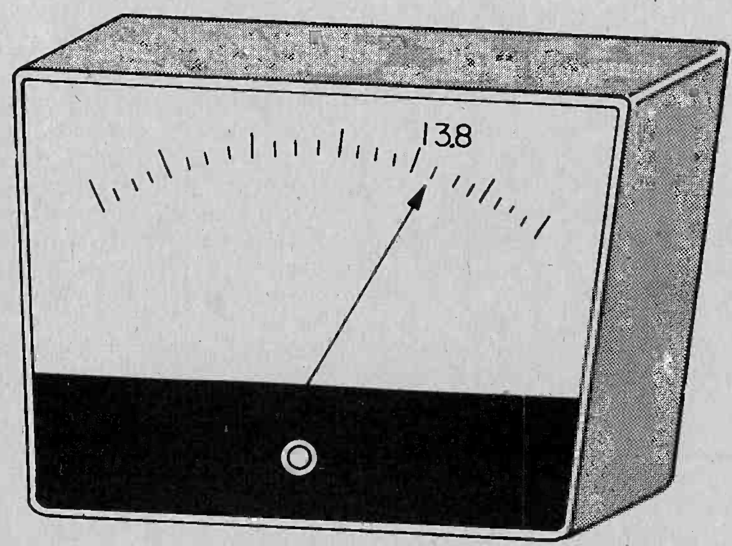
Make good electrical connections by using instant auto electric comectors or soldering with a good soldering iron. Wrap all connections and components with a good amount of black plastic electrical tape so that they will withstand the weather. The side clearance lights will now flash not only with the directional signals but also when the emergency 4-way flasher is turned on. ■



PARTS LIST FOR ADD-ON TURN SIGNALS

D1, D2—Diode 1 amp, 50 PIV or better (Radio Shack 276-1135 or equiv.)
R1—24-ohms, 1-watt resistor (Radio Shack 271-1000 or equiv.)
Misc.—wire, electrical tape.

CB Power Mate for Maxi-Output



Here's the partner to power your mobile CB rig at home to its maximum capability—four watts RF output.

By Herb Friedman, W2ZLF

So YOU'VE JUST upgraded your Citizen's Band setup with a shiny new transceiver specified to give you four watts out—the legal maximum—or perhaps, if you've converted to the more efficient SSB (single sideband) operation, as many progressive CBers are doing these days, 12 watts, P.E.P. You've paid a couple of hundred dollars for this new equipment and are going to use it at home as your base station—even though it could be operated mobile, in your car, from its 12-volt system.

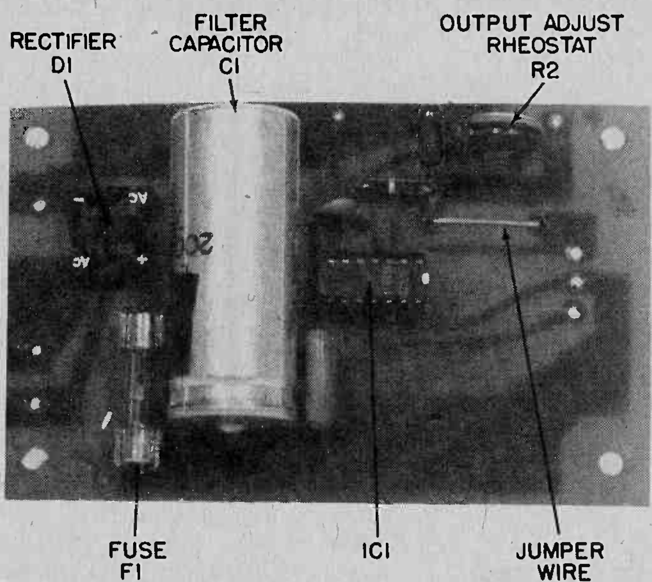
You hook it up to the 12-volt DC power supply you used at home with your old, lower-powered rig and it seems to work fairly well. You contact a few nearby CBers easily enough. But it doesn't seem to be getting out much farther than your earlier transceiver, which has considerably lower power output. What's wrong? Where did the power go?

You're probably not feeding the new set the 13.8 volts it was designed to get from the electrical system of your car when the generator is running, charging the battery, as well as powering the rest of the electrical system in addition to accessories like a mobile transceiver.

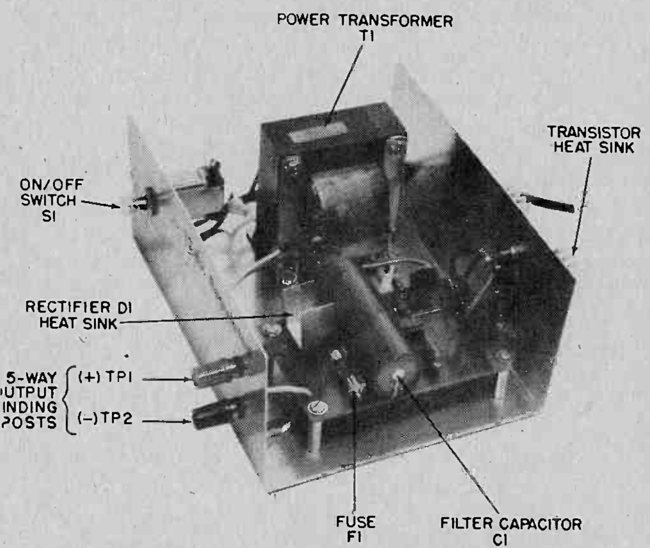
The 117-volt AC to 12-volt DC power supply you used with the earlier transceiver may have supplied it with current at 12 volts, but it can't provide the 13.8 volts, at higher current, which your new set needs to put its rated power on the air.

To be sure, check the actual power supply voltage you're feeding to the CB set.

What Voltage? To check the actual output of your old power supply, get out your voltmeter and measure the voltage being fed to your transceiver. It probably reads around 12 volts (maybe a bit more when the transceiver isn't turned on). You turn the CB set on to *Receive* and get a good solid 12 volts (or maybe as high as 13). So far so good. Now switch the set to *Transmit*.



13.8-volt regulator parts mounted on circuit board. Low-powered (1.5 amp) model does not require heat sink for rectifier.



Complete CB Power Mate, top removed. Higher-current (3-amp model), with U-shape heat sink (homemade) for rectifier. Large heat sink on rear is for transistor.

CB POWER MATE

The input power voltage drops to around 10 volts! Turn it off.

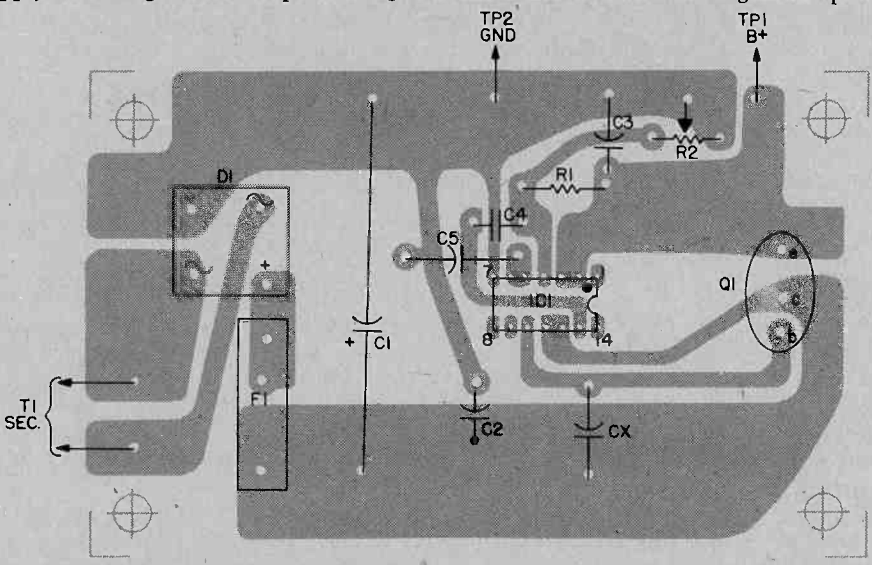
That power supply might have been OK with a lower-powered unit, but it just doesn't make it with this higher-powered job. The four watts of transmitting output you paid for when you bought this new rig is only 2.5 to 3 watts now. This is because your power supply hasn't got the output *voltage regulation* it needs—the ability to put out constant voltage, within its specified limits, regardless of variations in the required current. In addition, your mobile transceiver was designed to work from a DC power supply of 13.8 volts; when the car is running that's what it gets, to charge the battery. (Ever notice how the lights are dimmer when you run them without the motor turning over? That's the difference between 13.8 and 12 volts (or even less, if your battery is on low charge or about to conk out with a weak cell).

It's Only 1.8 Volts. "So what's 1.8 volts?" some people may ask. "Most electronic components are manufactured to a tolerance of 10%, and we see that most schematics have their voltages specified "± 20%."

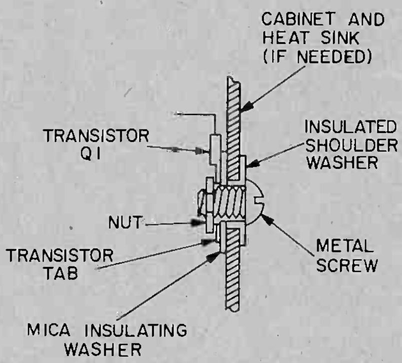
Won't most equipment and circuits operate over a wide range of voltages from their power supplies? Yes, they will often operate, in many cases quite well, but not power output circuits. They just won't deliver the specified output. Equipment which draws substantial current can only produce its rated output when it gets power at the voltage specified by the design engineers. The difference between 12.0 and 13.8 volts amounts to 15% less transmitter power. If the supply puts out only 10 or 11 volts when it's under a heavier-than-usual load the loss can be as high as 25 percent. It could be a lot less. If that power supply's output regulation is so poor that it puts out only eight or nine volts with your new CB transceiver the transmitter might not work at all.

To insure maximum performance from your mobile transceiver when powering it with AC house current, you must use a 13.8 volt *regulated* power supply. Regulation provides exactly 13.8 volts under a wide variety of loads —from full load to no load—and also compensates for AC line voltage fluctuations if they occur.

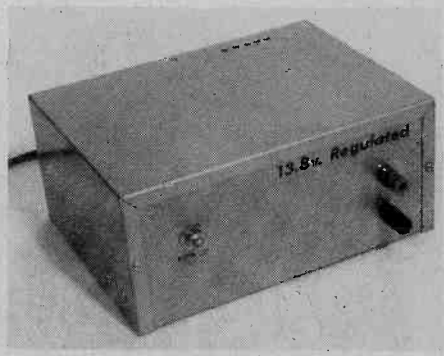
Although a regulated supply can cost from $50 to $100, you can build the *CB Power Mate*, as shown in the photographs for about $20 to $25 (or even less if you're good at scrounging parts or have a junkbox of used components). The same supply can be used as an AC-to-DC power source for high power walkie-talkies (one-watt or more output) which require exactly 12 volts, because this supply can be adjusted at the flick of a finger to any mobile power voltage—even six volts. Your regulated supply can be built to handle any current needed, up to three amperes. The current capacity is determined by the output of the power transformer, T1, and filter capacitor C1, the two most costly items in this project. Thus you can save money by building only the current capacity you actually need.



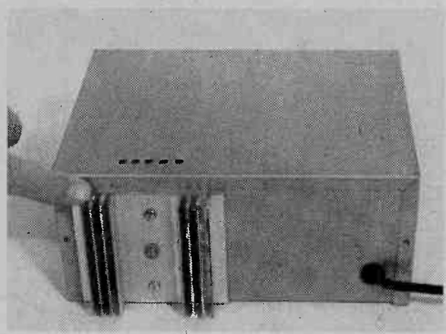
You can make it easily from kit purchased at electronic parts stores. Positions of parts shown actually are located on back side of board. See full size template in story. Copper foil side of board is shown down.



How to mount transistor to dissipate heat into metal cabinet (and external heat sink, in 3-amp model). Use silicone grease on both sides of insulating mica washer. Tape over screw head (outside case) to protect against external short.



Front view of CB Power Mate shows On/Off switch, red (+) and black (–) power output binding posts. Rear view of higher-powered version has finned heat sink to dissipate heat from regulating transistor. Quarter-inch holes on top of unit are for ventilation.



How It Works. The first section of the CB Power Mate (the 117-volt step-down transformer T1, the rectifier, and the large capacitor, C1) supplies *unregulated* current at between 15 and 35 volts, depending on the number of turns in the secondary of T1. The rest of the supply is the regulator section. The size of the voltage drop across the regulator depends on the resistance of transistor Q1, which varies according to its base bias. The bias is controlled by the action of the IC, which gets its commands from the voltage applied to pin 4. This voltage is taken from the junction of R1 (1800 ohms) and R2 (500-ohm rheostat), which are a voltage divider across the power supply output. Initially R2 is set to provide the desired voltage—13.8 or whatever—at the emitter of Q1 (the supply output).

When the load (the transmitter) starts to draw more current, the voltage at the power supply output begins to drop. This lowers the voltage at IC pin 4. The IC then applies a higher (more positive) voltage to the base of Q1 (IC pin 10). Since the transistor is an NPN, the positive-going base signal lowers Q1's collector-emitter resistance, increasing the collector current and raising the voltage at the emitter (power supply output). When a change in load draws less current, tending to raise the supply voltage, this increase is sensed by the voltage divider, which now applies a lower (more negative; less positive) voltage to IC pin 4. This increases Q1's collector resistance, lowering the voltage at the supply output.

This all takes place almost instantly, so the output voltage remains steady, at the value at which it was originally set. This happens even though the transmitter current (the load) is changing all the time.

Two Versions Can Be Built. The schematic diagram shows the supply for loads up to three amperes at 13.8 volts. For lighter loads, up to 1.5 amperes (still 13.8 volts) capacitor Cx is not needed, and the power transformer can be a lighter, less expensive one. In addition, capacitor C1 can be rated at 25 VDC, instead of the 35 or more required for the higher-powered version. Also, the smaller power supply doesn't need heat sinks for the bridge rectifier and the series transistor (also called a "pass transistor") because all the current used by the transceiver passes through it.

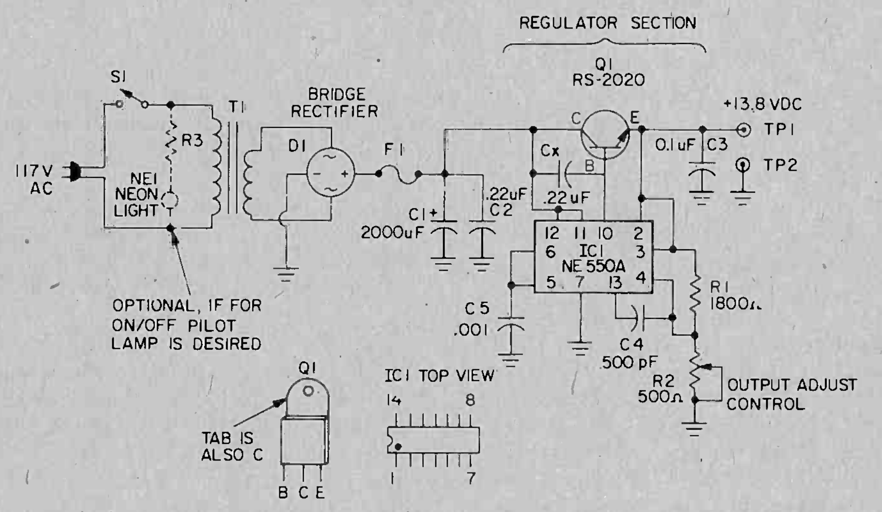
Check the Voltage. First you should find out what the power requirement of your transceiver is when you are transmitting. It will usually be one amp or more (*receiving* will take much less current). It may be as high as 2.5 amps. Once you know how much current your transceiver needs, you'll know whether to build the model which supplies up to 1.5 amps or the three-amp one. Now take the parts list and check your junk box for parts you can use.

Construction. The heart of the CB Power Mate is the regulator, which consists of integrated circuit IC1, series regulating transistor Q1 (which is controlled by IC1), and their associated resistors and capacitors. C1 is the main filter capacitor, which initially smooths the varying DC supplied by the bridge rectifier from the AC output of the power transformer secondary.

The printed circuit board, which you can easily make with a kit from any parts distributor, has been designed to work in either the 3-amp model or the 1.5-amp unit. The photograph, showing the board with its components mounted, is of the lower-powered one. The completed supply pictured is the higher-powered unit. You can see that the assembled boards for both versions are almost identical. One difference is that the 3-amp supply (completed unit) has a piece of U-shaped aluminum you can bend to make the heat sink for the bridge rectifier. This is not needed for the lower-current supply. The photograph of the completed unit also shows the fins of the large heat sink for the transistor mounted on the back of the box behind the transistor. This heat sink isn't needed in the 1.5-amp power supply.

Fuse F1 is a fast-acting type which protects the bridge rectifier and the power transformer from blowing out if you should make a wiring error or short-circuit the output. The fuse listed will blow out before the components, so don't use any other kind of fuse, even if it has the correct current rating (three or five amps). Use only type AGX, not slow-blo or 3 AG. Try to get a fuse-holding clip made for soldering to the printed circuit board. That kind is easier to install than those which mount with screws.

Solder the pins of the 14-pin IC socket to the board, but don't insert the IC into its socket until the socket has cooled off. Heat can ruin an IC or a tran-



Ultra-simple circuit delivers regulated output.

PARTS LIST FOR CB POWER MATE (3-AMPERE MODEL)

C1—2000-uf, 35-VDC electrolytic capacitor
C2—0.22-uF, 100-VDC capacitor
C3—0.1-uF, 100-VDC capacitor
C4—500-pF, 100-VDC capacitor
C5—.001-uF, 100 VDC capacitor
D1—Bridge rectifier diode package, 6-amp rating, 100 PIV (peak inverse volts)
F1—Fast-acting fuse, 5-A rating
IC1—Voltage regulator integrated circuit, NE550 (DIP package, Hamilton Avnet, 364 Brookes Drive, Hazlewood, MO 63042. NE550 or equiv.)
Q1—NPN silicon transistor (Radio Shack RS-2020 or equiv.)
R1—1800-ohm, ½-watt resistor
R2—1000-ohm printed circuit (end mounting) potentiometer
S1—SPST power switch, 120 VAC. If self-illuminating switch with built-in neon light is desired, use Radio Shack 275-671 or equiv.)
T1—Power transformer, 117-120 VAC primary, no center tap needed. Secondary 18 to 21 VAC at three amperes (Allied Radio 705-0133 or equiv.)
TP1, TP2—Binding posts, 5-way, one red, one black
Misc.—Printed circuit board materials, or perf board; fuse clip for mounting on PC board; heat sink for transistor Q1; heat sink compound (Radio Shack silicone grease 276-1372 or equiv.); IC socket for integrated circuit IC1 (Radio Shack RS276-027 or equiv.); scrap aluminum piece approx. 1-in. x 3-in. x ⅛-in. thick; standoffs (aluminum) four, ½-in. for mounting pc. board (Radio Shack 270-1394 or equiv.) with machine screws, nuts, and lock-washers.

PARTS LIST FOR CB POWER MATE (1.5-AMPERE MODEL)

Use all same parts as above, except for the following changes:

C1—Same, or use 25-VDC rating, which costs less
C2—Cx is not needed
F1—As above, except 3-ampere rating
T1—As above, except 12.6 to 16 VAC, at 1.5 amperes (Allied Radio 705-0121, or equiv.)
Heat sink for transistor not needed
Scrap aluminum for heat sink not needed

sistor. Also be sure to hold each transistor lead with a pair of long-nose pliers as a heat sink when you solder to the transistor leads.

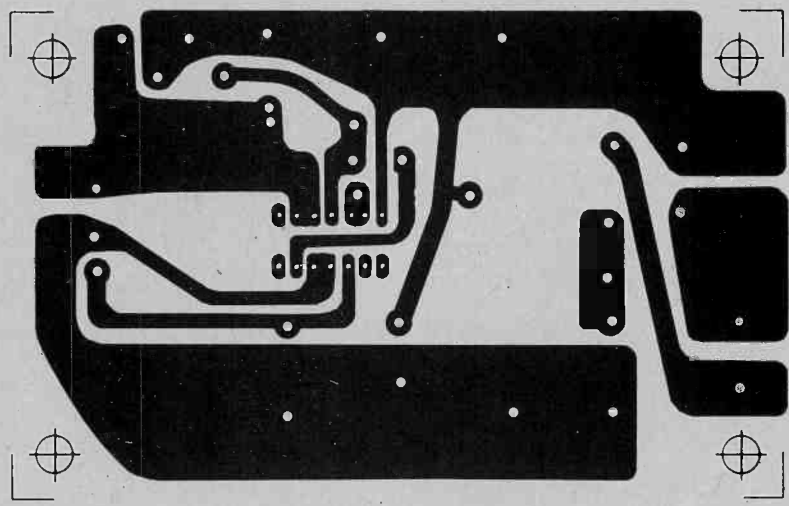
For the high-current CB Power Mate the bridge rectifier has a hole in the center to which you can secure the homemade heat sink. To make this, take a piece of scrap aluminum the width of the sink or larger and bend it in a U-shape with the ends sticking up in the air about an inch. Secure the sink to the rectifier with a #6 screw, a lockwasher between the screw and the rectifier, and a lockwasher and a nut on top of the heat sink. (The screw feeds in from the terminal or lead side of the rectifier.)

Also, for the high-current Power Mate the transistor uses the special heat sink with fins on the back of the cabinet (as shown in the picture). Q1 is installed the same way for both models. Drill a ¼-in. hole through the sink and the cabinet. Bend Q1's leads outward, away from its mounting tab. Using a mica insulator from a power rectifier (preferably) or a power transistor mounting kit, coat both sides of the mica with silicone heat sink grease. Position the insulator over the hole in the cabinet and place an insulated shoulder washer (from a 5-way binding post) in the cabinet hole, from outside the cabinet. Pass a #6 screw through the sink, the cabinet, and the mica insulator.

Then install Q1, a lockwasher, and a nut. Tighten the screw slightly more than hand tight. Check with an ohmmeter to be sure there's no short between the tab of Q1 and the cabinet. You should read infinity—no connection. If you have a short (one ohm or less) look for an improperly-seated shoulder washer or for a metal chip from the drilling.

Final Assembly. Before final assembly, with the parts *not* mounted in the box, drill a row of five ¼-in. holes in the cabinet directly over Q1, and five more holes in the lower left of the cabinet, near the transformer. These will provide adequate ventilation. Then put a small piece of tape over the head of the screw which secures the transistor, to prevent a (possible) external short.

Complete all wiring before installing the IC. Plug it into its socket so that pin 1, which has a dot molded next to it, faces the edge of the printed circuit board farthest away from the rectifier. Pin 1 should be toward the wires going to the board from the transistor. Install the fuse in its clips, set the rheostat,



Exact-size template for printed circuit board you can make. Location of holes for integrated circuit are critical—exercise care in drilling. Copper foil side is shown up.

R2, to its mid-position, and connect the voltmeter to the output of the power supply (the binding posts). Plug in the CB Power Mate's AC cord and observe the meter. It should rise to some value and stay there. If it wanders, or rises and falls back down to zero, disconnect the AC power and check for a wiring error. If the voltmeter remains steady, adjust R2 very slowly for the desired voltage, 13.8 volts (or 12, or whatever depending on the set you are going to power with it). That's it—your CB Power Mate is ready to use.

Optional Protection. If you want to build-in the *maximum current limiting* (to make sure the supply will turn off if a short suddenly appears outside it), you can substitute a resistor for the jumper on top of the board. To figure the value of the resistor, follow these steps:

1. Find the value in ohms of the resistor, which we will call "R." The formula is: $R = \frac{0.6}{X}$ where "X" is the current the transceiver draws when transmitting.

2. If the current is 2 amps, then the formula gives us: $R = \frac{0.6}{2} = 0.3$

3. Now we must find the power rating of the resistor. Power is $W = I^2R$, where I is the current. Since we know that R is 0.3 ohms, and that the current is 2 amps, we get: W = 2 x 2 x 0.3 or W = 4 x 0.3 = 1.2 watts. For safety we double the rating, giving us 2.4 watts.

4. So, we need a 0.3 ohm, 2.4 watts (or more, since that exact wattage isn't available). The nearest larger wattage rating should be used. Two 0.6 ohm, 2-watt resistors in parallel would do nicely.

In Use. Now plug your CB Power Mate in, connect the positive and negative leads of the 13.8-volt power supply to the Plus and Ground connections on your transceiver, and start contacting your fellow CBers . . . with the maximum legal power which you paid for with your new set. Why not get it?

Of course the CB Power Mate is only needed in your home. In your car the transceiver will be getting the 13.8 volts it needs, if that electrical system is operating correctly.

Caution: Don't try to use the CB Power Mate at settings higher than 13.8 volts with a transceiver which requires that voltage. Trying to increase a transmitter's RF power output that way will probably result in blowing out components in the transceiver, because many transceivers are designed to just accept 13.8 volts, with not much safety factor above that. Be sure the Power Mate is set for exactly 13.8 volts before you turn on the transceiver, not any higher.

If you're not certain that your voltmeter is reading DC volts accurately, you can calibrate it very closely by using several new flashlight cells (not nicads—just ordinary, good condition—tested in flashlight—batteries). These cells, in good condition, put out exactly 1.56 volts each. Four cells in series should read 6.24 volts. 8 x 1.56 V = 12.48 V. Or you can get 13.94 V from nine cells. ■

THREE SHORTCUTS TO YOUR FIRST SHORTWAVE ANTENNA

by Hank Scott

BEGINNERS to the shortwave listening (SWL) hobby have no difficulty in obtaining good receivers, either budget jobs or gold-plated specials, when starting their first listening shack. Putting up antennas is their downfall.

Antenna theory is beyond the grasp of most novices. It is very complex at the beginning and rapidly becomes incomprehensible as different antenna types are introduced. So, why not take a shortcut approach to your first antenna installation. Get your new receiver pulling weak signals as you pile up listening hours with exotic DXing. What about antenna theory? It'll come if you work at it by reading theory books, but in the meantime here are three recorded case histories to low-cost antenna shortcuts which may be profitable.

Case No. 1—The Dangler. Harry is a youngster I met while giving a talk to the local high school student body during Science Fair Week. Harry was fascinated by the idea of English language newscasts from far-away places, so he bought a Realistic DX-160 receiver and set up a listening corner in his upstairs room in his folks' Colonial-style house. For an antenna, he dangled an odd length of wire out the window, letting it drop to the ground. The BBC and Radio Moscow came in fine except on rainy nights. In fact, it was a rainy evening when he rang my doorbell for help.

Harry's long wire was long and that's all it had going for it. It was vertically polarized (wrong) by hanging down and shorted out to ground (not good either) on damp nights. What Harry needed was a length of wire extended from the window to a distant pole, outbuilding, garage, or tree. In Harry's case, some sturdy trees outlined the houses's property line and he could run a 60-foot antenna with no difficulties. The antenna pointed due North-West and in his area of the U.S. was able to pull in Europe, North Africa, and the Near East with ease. Here's how we went about licking Harry's problem.

First, I told Harry that a good long-wire antenna should be at least 30 to 100 feet long for good reception performance on 2 to 30 megaHertz (MHz). As mentioned earlier, a 60-foot run was possible. A sturdy tree was selected because it hardly swayed in strong winds at the 20-foot level where the antenna would be secured. Some slack (one foot of droop) was left in the antenna to compensate for tree sway and strong winds. Harry's antenna details can be seen in Fig. 1.

Antenna wire and antenna long wire kits are available everywhere. Harry actually used the Radio Shack shortwave antenna kit (278-758) which consists of 75 feet of bare copper antenna wire, 50 feet of lead-in wire, four insulators, and instructions. Harry had no trouble at all getting the antenna up.

Harry was a little smarter than me. He remembered to protect against lightning. Since shortwave lightning arrester kits are usually not available locally, Harry made do with lightning arrester parts made for TV. The parts available from Radio Shack include the arrester (15-911), ground rod (15-530), 40 feet of aluminum wire (15-035), and other small parts. The TV arrester has two screw-tight terminals with star washers for the 300-ohm TV line, however Harry only used one for his antenna and the other was left unused. The whole lightning installation bit came to about $5.00. That's cheap. To bring the antenna lead-in into the house, Harry used a "Wall-Thru" tube

FIRST SHORTWAVE ANTENNA

(Radio Shack 15-1200).

Now I don't see much of Harry. Maybe once in a while he's at the Pizza joint with a date, but you can be sure Harry's getting a lot of DXing and veries every week.

Case No. 2—The Specialist. I've known Mort for over 20 years. We knocked about through high school and somehow the paths of our lives are forever crossing. At one such juncture, Mort invited me to his home to see his new shortwave listening shack which sported a brand-new freshly assembled Heath GR-78 receiver. The GR-78 is a hot receiver. Unfortunately, I couldn't say the same for Mort's antenna. Mort was always inclined to specialize, and he had rigged up a dipole antenna with 300-ohm TV antenna lead-in wire. Mort wanted to log the 41-meter band and found it offered poor reception in his area. Besides, the noise was too high. He was asking, if not pleading, for advice.

First of all, I told Mort that dipole antennas are cut to exact dimensions for specific frequency bands as shown in Fig. 2. The dipole consists of a wire of a specific length which is cut in half. At the mid-point and both ends, each half of the wire is insulated from each other and insulated from ground. The lead-in cable from the antenna is actually two wires, and it's best to use a 73-ohm coaxial cable (coax) because it is inexpensive and commonly avail-

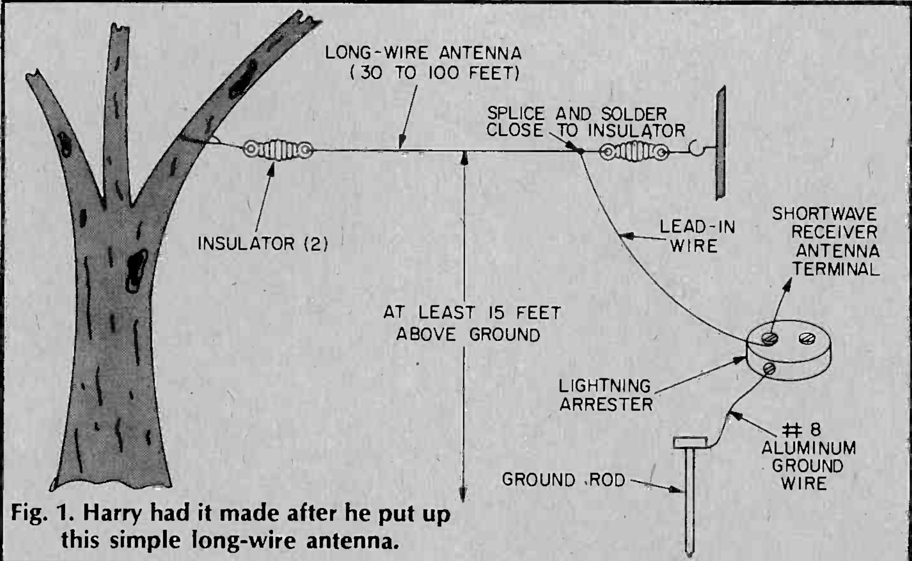


Fig. 1. Harry had it made after he put up this simple long-wire antenna.

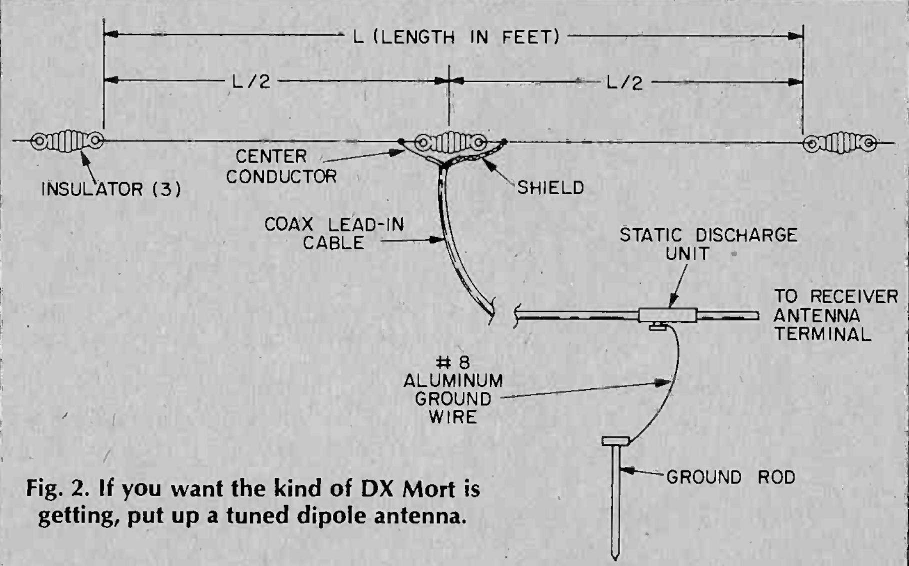


Fig. 2. If you want the kind of DX Mort is getting, put up a tuned dipole antenna.

Dipole Overall Length for the Shortwave Broadcast Bands

Band	Frequencies (kHz)	Mid-Frequencies (kHz)	Length (feet—inches)
120	2300-2495	2397.5	195—2
90	3200-3400	3300	141—10
75	3800-4000	3900	120—0
60	4750-5060	4905	95—5
49	5950-6200	6075	77—0
41	7100-7300	7200	65—0
31	9500-9775	9637.5	48—7
25	11700-11975	11837.5	39—6
19	15100-15450	15275	30—8
16	17700-17900	17800	26—3
13	21450-21750	21600	21—8

Coax Lead-in Cable

Cable Type	Typical Ohms
RG-11/U	75
RG-59/U	73
RG-59A/U	75
RG-59B/U	75
F-11/U	75
F-59/U	73

able. Without getting into theory, let me say that a 73-ohm coax lead-in cable "matches" a dipole antenna with less signal loss than does a 300-ohm TV twin-lead cable. On the design board, dipoles have a 75-ohm impedance and match pretty well into 73-ohm coaxes. The 300-ohm cable Mort was using was a bust.

The equation for determining the overall length for a dipole antenna at a given frequency is determined by dividing the given frequency in kiloHertz into the number 468,000. Or, as seen in the text books:

$$L = \frac{468{,}000}{f}$$

Where L is the overall length of the dipole in feet and f is the desired reception frequency in kiloHertz (kHz). I computed the overall length for dipole antennas to receive the international shortwave broadcast bands using the mid-frequencies of each band and listed them in a table that appears on this page.

When buying materials for a dipole antenna, wire and insulators are the same type as required for the long wire antenna. The lead-in coaxial cable should be RG-59/U or RG-11/U, each of which exhibits 73-ohms impedance. Stay away from unknown coax types or those with different impedances (ohms). As a guide, a table given on this page lists commonly available coax cables and their impedances. Any coax exhibiting an impedance in the 70's is good for the purpose. Let price dictate your selection.

I did not forget the lightning arrester in Mort's antenna. At the window, out of reach of the rain, I installed a Radio Shack coax static discharge unit (21-1049). This gadget requires PL-259 connector on the coax lead-in cable. It's worth the trouble. A grounding screw on the connector attaches to the

(Continued on page 97)

How I Got Started in CB Radio

Here's how one beginner installed CB rigs in his car and home, with a few pratfalls along the way!

by Jorma Hyypia, KZH5783

☐ ONE FINE DAY, when my life was still smooth and uncomplicated, the editor of BUDGET ELECTRONICS called me on the phone and said to me, "I think that you should get into CB radio."

So I got.

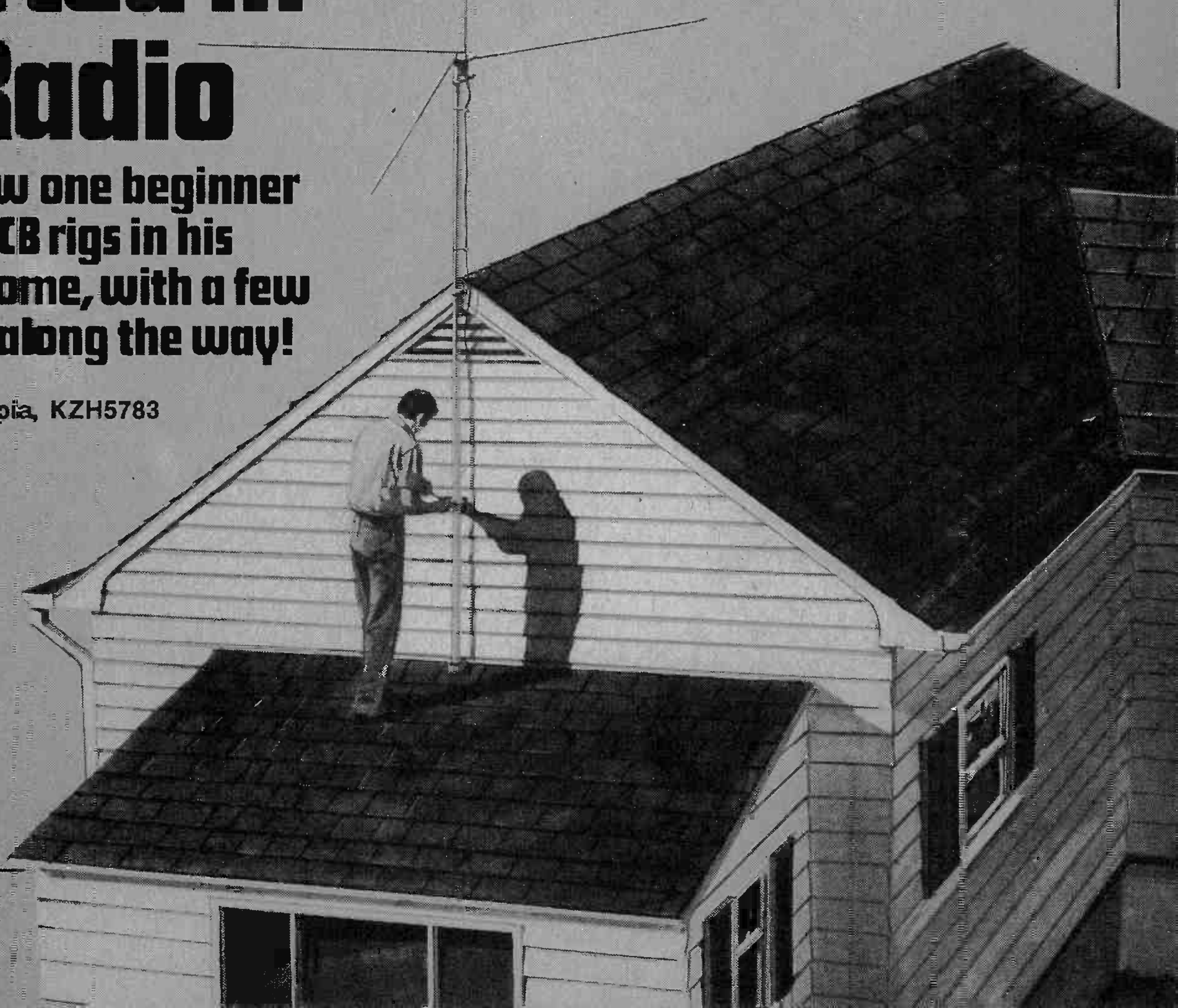
That's the weird kind of relationship we have. When Polish Ham (that's my editor's CB handle) wants to find out what problems a newcomer to some area of radio or electronics might conceivably run into, he nudges me into action. He figures that if I muddle through on my own, just like any other novice, I will be willing to blab my goofs as well as my successes for the benefit of his readers. He's right, of course. We freelance writers have bills to pay, too.

I received no expert guidance from my knowledgeable editor, other than an offhand suggestion about what equipment I should consider using as a base station. After that he kept himself pretty much inaccessible for several months. I gained my knowledge the same way you do—by reading a few magazine articles and the CB YEARBOOK, and by trying to carefully follow installation directions provided with the equipment I bought. Despite all my advance research and planning, I managed to make enough interesting mistakes to justify Polish Ham's faith in my ability to discover some of CB's potential pitfalls, and I've lived to tell about them, too!

Lest you construe that last remark a bit *negatory* (that's CB lingo for "negative"), let me say that setting up my CB system was fun, illuminating in some surprising ways, and all-in-all a success. Though I'm far from being a CB nut, I'll admit I would hate to have to give up the electronic umbilical cord that keeps me in contact with my home base when I'm tooling around town in my mobile-equipped four-wheeler.

Talk About Chatter. At times I still find it difficult to decide whether teenagers ever actually report emergencies. I found they can grunt, wheeze, and make other strange noises for half an hour or more without ever repeating themselves, and without uttering anything even remotely comprehensible to ordinary folk. I also discovered there is a twelve-year-old junior high school girl in town who imagines that she knows how to sound like a French cinematic sex kitten. She coos and gurgles to any male willing to listen, at all hours from 6:30 AM to midnight.

The true value of CB communication is most apparent when real emergency conditions arise, as during severe winter storms. The public service provided unfailingly by volunteer REACT organizations is impressive, to say the least. Also, time and again, I've seen drivers with mobile CB units stopping along highways to radio for tow trucks, police, or ambulances needed by other motorists. (Turn Page)



GET STARTED IN CB

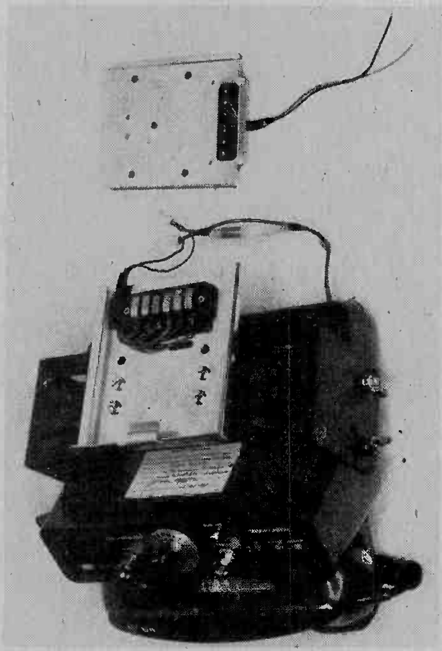
Getting Started. My first choices consisted of a popularly priced Realistic TRC-55 transceiver for use as a base station, a 5/8-wave omnidirectional antenna, and a 40-foot telescoping mast on which to mount the antenna. This package, purchased from Radio Shack in the U.S., costs just under three hundred bucks, plus taxes. There was an additional outlay for a connecting cable, according to the length needed.

For a mobile unit, I chose Realistic's TRC-56 rig, not because I knew beans about the quality of the electronics it contained (it was then so new that there were no published test reports), but because I could see definite advantages in the telephone type handset that is used for both talking and listening. Initially, my teenage son wanted a set with a regular microphone, but he fast became a handset convert. He discovered that he could ride in the car and listen privately to CB chatter that I would not tolerate on the loudspeaker. The loudspeaker can be on or off when the handset is in use.

Soon after I installed the mobile unit, I discovered an unexpected use for the handset. I was on the way home on a snowy afternoon when I spied a half dozen or so local juveniles waiting at a corner to peg ice balls at my car. As I approached, I picked up the handset and pretended to talk while running a cold eye over each foe. They were so stunned by the idea that I had a "telephone" with which to send information about their intended shenanigans that they just stood there, mouths open and ice balls in hand as I disappeared down the road. I exited laughing.

What to Buy? The right equipment for you isn't necessarily the kind I happened to select. Pick what best meets your personal needs and pocketbook. However, I'll itemize my acquisitions in order to make the discussion that follows more meaningful.

The author slides his CB rig into place after plugging in the antenna lead on the rear of the set. Total installation (or removal) operation takes about four or five seconds, protects the set totally.



Half of the slide mount attaches to the set's mounting bracket with three or four screws. Slide contacts at rear are wired to the ground and plus 12-V leads of the set. Mating slide at right is bolted under car's dash.

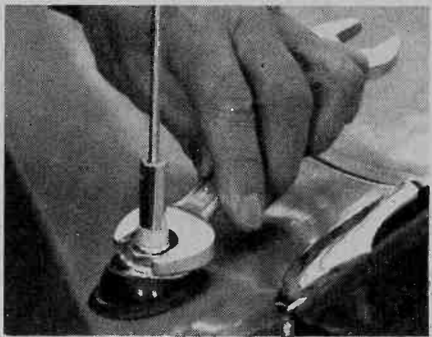
Incidentally, I laid out $179.95 for the TRC-56 and another $11.95 for a mobile antenna. There were other expenses, but we will note those later on in context with specific installation problems.

Getting The CB License. Obtaining my FCC ticket took top priority because I just won't transmit without such legal sanction. Sure, the air waves are populated with dum-dums (so-called "bootleggers") who are too cheap to part with four bucks for a license that is good for five years and easier to obtain than a library card. Some bootleggers seek anonymity because they are sickies using language that, for obvious reasons, is forbidden by FCC. It's very juvenile and stupid, especially because the FCC is really cracking down on violators, even though you often don't read about such action in your local newspaper.

It's Against the Law! Illegal operation of CB equipment can get you up to a year in jail and up to a $10,000 fine, though admittedly few judges impose such heavy sentences. Fines running up to $500 and confiscation of equipment is more common, however, than you might think. Consider the ding-a-ling out on the west coast who compounded his felony as an unlicensed operator by boosting his transmission power above legal limits with a linear amplifier—he got socked with a $2,000 fine and a year in the jug! So send for your FCC license as soon as you latch onto the application form which comes with your new CB set. Send it out pronto because you will have to wait a month or more for your Glory Card because the FCC is being flooded with *hundreds of thousands* of applications every month. But don't fret. You can go on the air as soon as your application is in the mail by obtaining and filling out a copy of the FCC's new Temporary Permit Form (555-B) for CBers. The form is intended for use only by those who have applied for a CB license using Form 505, but who have not yet received their license. The Temporary Permit is valid for a maximum of 60 days from the date you mail your regular CB license application to the FCC. Copies of the form should now be available from most CB dealers and from the FCC.

As soon as your license application is in the mail and you have completed the Temporary Permit Form, the next step is to start installing your equipment, and the first step in the installation process is locating your antenna.

Antenna Location. Locating my antenna was easy because there was just one really good place for it, on the end of the house, just above the garage roof. A ground location was out of the question because most of our land is either too heavily wooded, or too low for antenna erection. Fortunately, the highest point on the property is directly behind the house, so naturally I used that as my ground level reference from which to measure the maximum permissible height of 60 feet for the top of the antenna. In the end I actually dropped it a few feet lower than the maximum so there would be no qeustion about my full compliance with FCC regulations.



Tightening the cowl-mounted CB antenna. This location was chosen because it's easy to run lead-in cable from antenna to set.

Author mounted his base station with its antenna matcher in a custom-made cabinet. Underneath is his VHF police-fire scanner.

The lower section of the telescoping mast was separated from the rest of the assembly for mounting against the wall of the house. To mount it I used long U-bolts fashioned from ⅜-inch diameter, threaded rod obtained at a local hardware store. The two legs of each U-bolt pass through the wall of the house, into the attic, where they straddle a two-by-four in the wall. Flat metal straps and nuts pull everything tight. The bolt holes drilled into the wall were caulked carefully. The bottom of the mast fits into a wood block with a hole drilled half way through it to protect the garage roof shingles from damage.

The other mast sections were dropped into the mounted lower section, the pre-assembled antenna was clamped in place and the end connector of the lead-in cable was screwed to the antenna connector. The coupling was weatherproofed by wrapping with electrical tape. I also used a spray-on material to weatherproof the vital connections.

Four guy wires of coated steel were fastened to the mast so they could later be run to anchor points located at ninety degree intervals. Turnbuckles were added to the guy wires to make tension adjustment easier. It was then a simple matter to run the mast up in sections while adding stand-offs to hold the coaxial lead-in cable away from the mast and to keep the cable from flopping about in a strong wind. The guy wires were fastened in place, and a heavy aluminum ground wire was run from the mast to a cold water pipe feeding an outside faucet. I managed the entire job alone without working up a sweat.

The RG-8U coaxial cable was run into the house through an attic louvre, then dropped down to the living room inside a partition. For short runs the less-expensive RG-58U cable is adequate, but I'm not one to take chances so I put out for the heavier stuff.

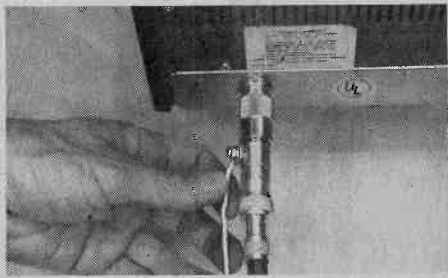
I Thought I Was Smart! A bright idea that fizzled on me shows why it's best to stick with straightforward installation methods and no fancy new ideas of your own. Our CB base unit was to be placed on a shelf under a table next to my favorite chair. However, I could foresee that our teenager would want to make extended use of the CB rig just when I wanted to sit in my chair to watch some important TV program.

It seemed to me that the obvious simple solution was to run a branch coaxial cable to another room where the CB rig could be transferred when the family generation gap was about to be put under stress. This was easily accomplished by breaking into the coaxial cable, up in the attic, and adding a T-connection to accommodate the branch line.

When the time came for the big test, at first there seemed to be no problems. With the set turned on, we scanned the 23 channels in the hope of picking up at least a few signals. There were plenty, many coming in strongly enough to bounce the RF-S meter, which measures the strength of incoming signals, up in the 7 to 9 range. On one channel a housewife was nagging her husband to stop at the supermarket. Truckers were trading gossip about Smokey (highway police) on channel 19. The remaining twenty-one channels, including channel 11 which is for calling only, and channel 9 which has been designated for emergency use only, were in use by teenagers.

Going On the Air. Our first transmission attempt was less than a resounding success. When I finally thumbed the mike, my well-rehearsed FCC call letters firmly in mind, we saw the SWR meter needle jump close to the top of the scale. Now that's bad! Since the meter measures the relative amount of output energy *that comes back down to the CB set,* instead of joyfully leaping into space in search of other antennas, the meter reading should be as *low* as possible. A reading close to 1 would be phenomenal, a reading of 2 is good, but when the needle creeps past 3 it's time to start worrying about impedance mismatches. When the needle goes off the scale transistors can start popping. I've heard that when the mismatch is really bad, even the coaxial cable can start burning up.

I won't dwell on the agonizing and theorizing that followed. Finally, I remembered that branch antenna lead to the other room. You guessed it! When the branch lead was disconnected, the SWR meter dropped to a phenomenal 1.1—no kidding! It seems that our output signals kept getting curious about that dead end street, went to investigate, got confused, and came back home to the CB set. We can still make use of the branch circuit, but it calls for a quick trip up to the attic to switch the leads, which takes only seconds.

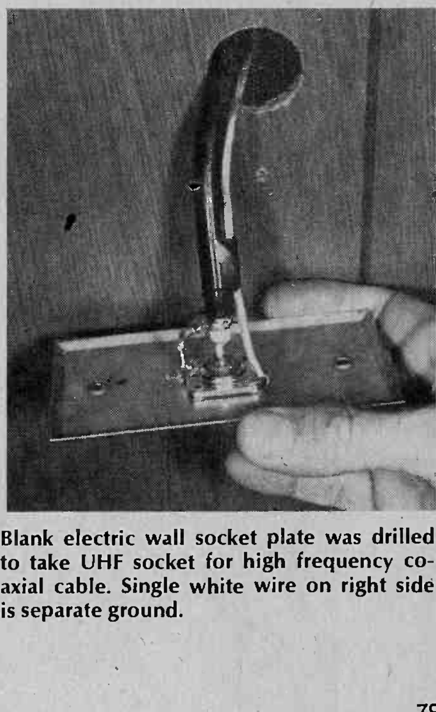


On the back panel of base station the author ran a ground wire from a nearby pipe.

The Car Installation. It was easy to mount the mobile CB set under the car dash, using a mounting bracket supplied with the radio. The negative power lead from the set was grounded to the dash, and the hot lead, which was red, was run to the car fuse box where it was connected to the hot end of the regular car radio fuse holder.

Although I prefer the fuse box connection, because the power to the CB set is automatically cut off when the ignition switch is off, I experimented with a hot lead running directly to the car battery because this can sometimes eliminate some background noise. I observed no improvement, so the fuse box connection remains.

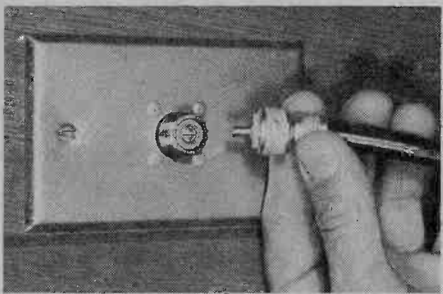
The best place for an antenna on our station wagon would have been in the middle of the roof, but this would have required drilling a hole into the bottom of our aluminum canoe which we frequently transport atop the car. This idea seemed to have little merit, so we opted for a top-loaded, cowl-



Blank electric wall socket plate was drilled to take UHF socket for high frequency coaxial cable. Single white wire on right side is separate ground.

mounting antenna, mainly because it was so easy to feed the cable the short distance to the CB set.

As expected, we had to cope with receiving a lot of background noise interference with reception, caused by the car's ignition system. I tried all sorts of gizmos supposed to cure such noise problems. The best results were obtained with a small suppressor unit that I installed, in seconds, on the distributor. I also installed resistor type spark plugs, an alternator noise filter, and an ignition coil capacitor. I'm not sure just how much they help to suppress noise, but at least they did no harm, and the car runs as well as ever. Aside from the distributor suppressor, the best noise reducer turned out to be the "blanker" button built right into the front of our CB set.



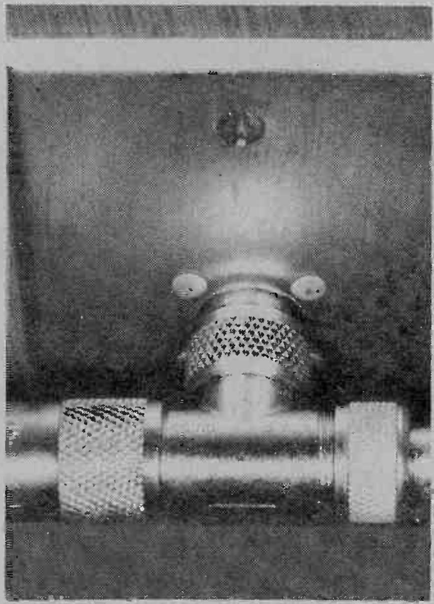
High quality UHF connectors ensure low-signal loss and ease inspection and repair.

Recalling the traumatic experience we had on the first attempt to transmit with the base-station CB unit, I pushed the mobile unit's mike button with crossed fingers. The needle indicating transmit power jumped to the upper section of the scale!

As I stared at the hastily-turned-off set, and wondered where to hunt for the trouble, a logical notion began to force its way into my consciousness. The base station has two meters, one to indicate *incoming* signal strength, the other to show *either* the SWR (standing wave ratio), or how much transmitting power is getting out to the antenna system.

However, the mobile unit has only one meter, with two scales indicated by the single needle. The top scale indicates the strength of incoming signals in S units. Good enough. The second scale, labeled *Power,* shows the relative power output of the transceiver.

Now one needle can't simultaneously point to a high RF-S reading and a low SWR reading, which is what you look for when using a two-meter system. This particular meter is *supposed* to read a high power value instead of a low true SWR value when all is well. Now why can't the people who write instruction manuals *say* things like that? Anyway, subsequent transmission tests confirmed that we had a properly functioning two-way CB system after all.

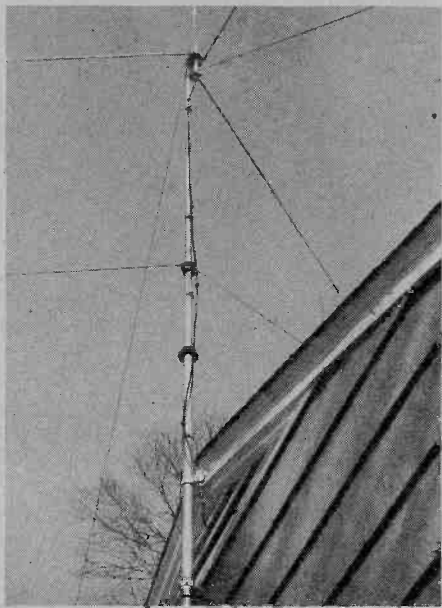


T-adapter at wall outlet of antenna cable permits use of two feed-off cables so that a scanner radio may be operated off the CB antenna. CB set works normally even when scanner is on at the same time.

How to Foil Thieves. The next problem arose while I sat in the local high school auditorium, one night, watching a fund-raising program. I got to thinking about that brand new CB set out there in the dark parking lot, and about all the news reports about CB mobile units being ripped out of cars by the thousands.

Bottom of antenna mast fits into hole drilled part way through a wedge-shaped block protecting roof shingles. U-bolts pass through wall of house into attic. Note spacer block between the mast and wall to keep the mast vertical.

The next morning I bought a Radio Shack slide-out mount that permits speedy removal of the mobile unit for storage in a locked car trunk or in an even safer place like inside the coat you hold in your lap in a high school auditorium. This tension-easing accessory, costing only $7.95, consists of two metal plates that make a series of electrical contacts when they are slid together in latching position. One plate bolts onto the CB set, and the set's two power leads connect to short wires attached to the plate's electrical contact block. The other plate bolts onto the underside of the car dash (another version can be floor-mounted), and the hot lead from the car fuse box and its associated ground lead connect to pre-attached wires coming off a second contact block. To mount the CB set, attach the antenna connector in the usual manner, then just slide one metal plate into the other. Electrical power connections are made automatically. Removal of the unit is just as easy.

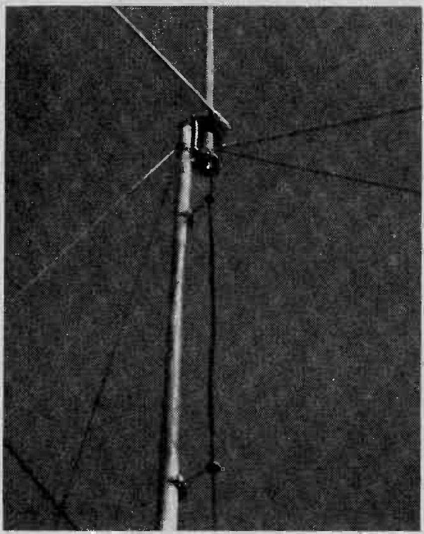


Telescoping mast can be lowered in minutes without disconnecting guy wires, to bring the antenna within reach for maintenance and troubleshooting.

We Hit Another Snag. My biggest goof came when everything was finally working perfectly, a couple of days after the editor finally reappeared and asked if I felt ready to write an article about how I went CB.

Although the system was working

(Continued on page 94)



Stand-offs keep antenna lead-in away from mast and from flapping in the wind. The coupling which attaches cable end to antenna should be weatherproofed.

room wall. Being under the table, it was quite unnoticeable. But if the table were ever relocated, the cable would dangle from the wall like a skinny, black snake. So I decided to install a more visually acceptable cable connector to keep my editor happy with the pictures I would send him.

After installation, I confidently checked the CB system. The SWR meter, which in this case is supposed to read low, was back up to around six again! I spent hours trying to find out what I had done wrong while installing that simple wall connection. All the while my teenage son kept munching cookies and suggesting that maybe the trouble was up in the antenna. No way! Nothing had been done to the antenna, and the problem appeared right after the wall connector had been installed.

To prove my point, I lugged the CB unit into the attic, disconnected the antenna cable at the T connection, and plugged in the CB set so that it was now attached to a stretch of cable leading directly to the antenna. I jabbed the mike button, and the SWR meter flopped down to an aggravatingly nice 1.5 reading. My son went in search of more cookies. I went back on the roof.

The connector attaching the cable to the antenna was now suspect, so I decoupled it, dried it with a portable hair dryer, then carefully weatherproofed the recoupled connection with a wad of caulking compound, plastic sheeting and electrical tape. The initial test showed an SWR reading that was still down in the 1 to 2 range. Moments later, when the equipment was being put back in place, the meter needle started bouncing as if it had been connected to a Mexican jumping bean.

Up on the roof again, I had just completed tearing off the electrical tape, plastic sheeting and caulking compound when my eye wandered about ten inches higher along the antenna system and focused in disbelief on a plastic ring that was hanging at an angle on the lower part of the antenna. This ring is supposed to insulate the antenna from the mast. I can't imagine what happened to the three retaining nuts that were missing, but because the ring was clearly out of place, the antenna made momentary contact with the mast every time there was a slight breeze. Small wonder that the meter was going crazy; the antenna was being intermittently grounded to the mast. Replacement of the ring brought the SWR reading down to a nice, steady value just under 2. The addition of a ten-the eighteen inches of antenna cable protruded from our mahogany living

Kathi's CB Notes E3E7
ELECTRONICS HOBBYIST
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New York, N.Y. 10003

☐ Yes, I'd like to receive the EIA booklet about CB radio.

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State Zip

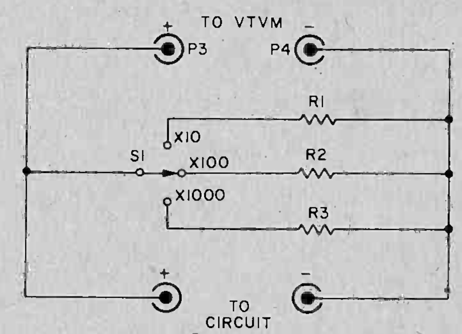
buck antenna matching unit brought the SWR back down, close to 1.

There never had been anything wrong with the wall cable connection. The antenna insulating ring just happened to drop out of place at the very time I chose to work on the wall connection. You figure the odds for or against such a coincidence. I have a bigger problem: figuring how to cope with a smug teenager who now thinks *he* is the hot-shot CB expert in the family.

The editors of ELECTRONICS HOBBYIST are providing readers with a free booklet from the Electronics Industries Association (EIA) about CB radio. If you would like a copy, just fill out the coupon below, check the correct box, and send it in. Don't forget "Kathi's CB Notes" for straight info on how to get and fill out an FCC license application, and if you want to stay current on what's happening in CB, follow Kathi Martin's CB column in every issue of ELEMENTARY ELECTRONICS. ■

Miladaptor for VTVM

☐ Less than $2 worth of parts is all it takes to convert your VTVM into a DC millammeter. To use the Miladaptor you simply multiply the VTVM reading by X10, X100 or X1000 to obtain the DC current. For example, if the VTVM indicates 0.1 volt and S1 is set to X100, the current is 0.1 X100 or 10 milliamperes. If the VTVM indicates 0.25 volts and S1 is set to X1000, the current is 0.25 X 1000 or 250 milliamperes.



PARTS LIST FOR THE MILADAPTOR

P1, P2, P3, P4—Insulated 5-way binding post
R1—100-ohm, 1-watt, 5% resistor
R2—10-ohm, 1-watt, 5% resistor
R3—1-ohm, 1-watt, 5% resistor
S1—rotary switch 3PST

The circuit under test connects to binding posts P1 and P2; the VTVM connects to binding posts P3 and P4. Switch S1 must be the make-before-break type. To avoid damage always start with S1 in the X1000 position and downrange until the VTVM indicates a convenient reading. ■

SUPER DXER

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

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

Well, more often than not those outboard boxes, with their 6J6s in push-pull tunable circuits, didn't amount to the proverbial hill-of-beans. Those World War II vintage tubes were not at all well suited to the new-fangled wide-band requirements of TV. But later on as the technology advanced, and more powerful transmitters were built, good, solid pictures became the rule.

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

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

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

The SUPER DXER output circuit is a low impedance emitter follower, and it will match, with a reasonable degree of performance, just about any receiver input impedance. As long as your receiever has two antenna terminals, one "hot" and one ground, you can use the SUPER DXER.

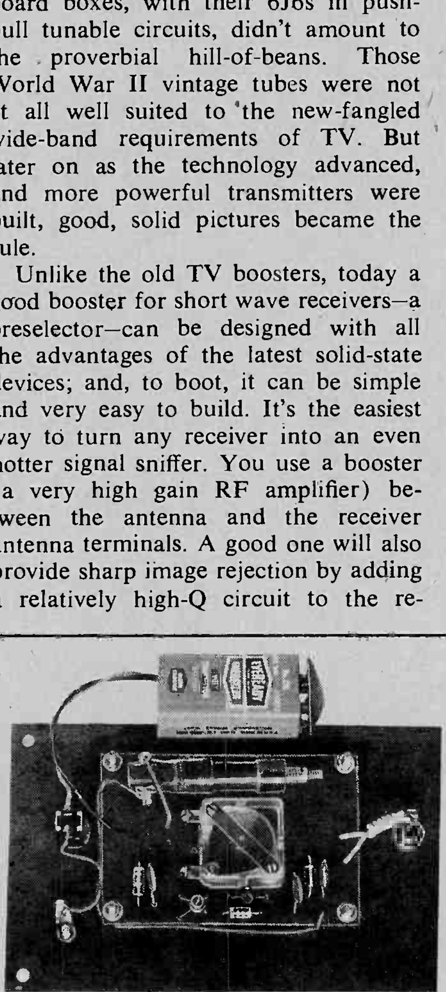
Optimum performance will be obtained if your receiver is equipped with an antenna trimmer. Just as the antenna trimmer peaks the receiver for use with any type of antenna, it also adds something extra when matching the SUPER DXER.

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

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

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

Cover the copper with a piece of carbon paper—carbon side against the



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

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

After all foil outlines have been traced, remove the PC board from under the template and, using a resist pen, fill in all the desired copper foil areas with resist. Make certain you place a dot of resist over the indents at each of the corner mounting holes. Pour about one inch of etchant into a small container and float the PC board—copper foil down—on top of the etchant. Every five minutes or so gently rock the container to agitate the etchant. After 15 or twenty minutes check the PC board to see if all the undesired copper has been removed. When every trace of the undesired copper is gone, rinse the board under running water, and then remove the resist with steel wool or a resist "stripper."

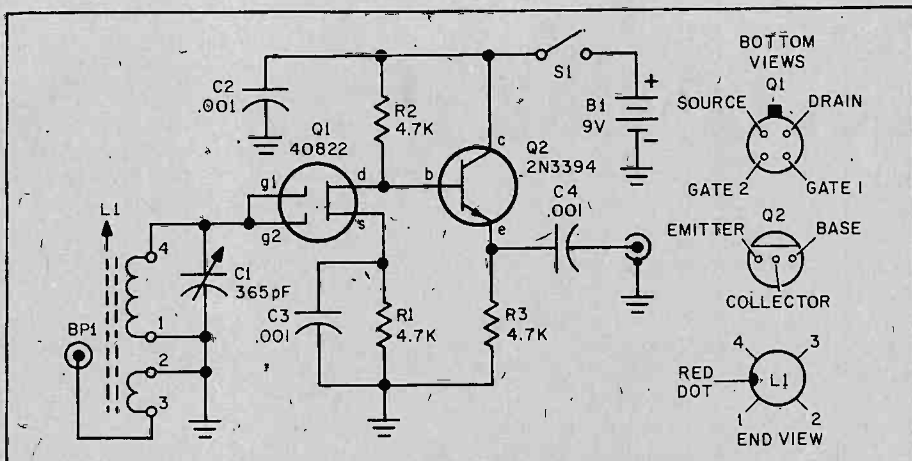
Continue. Drill out all the mounting holes marked by an indent with a #57, 58, or 59 bit—this includes the corner mounting and C1 mounting holes. Then drill the corner mounting holes for a #6 screw, and use a 5/16-in. bit for the C1 mounting hole.

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

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

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

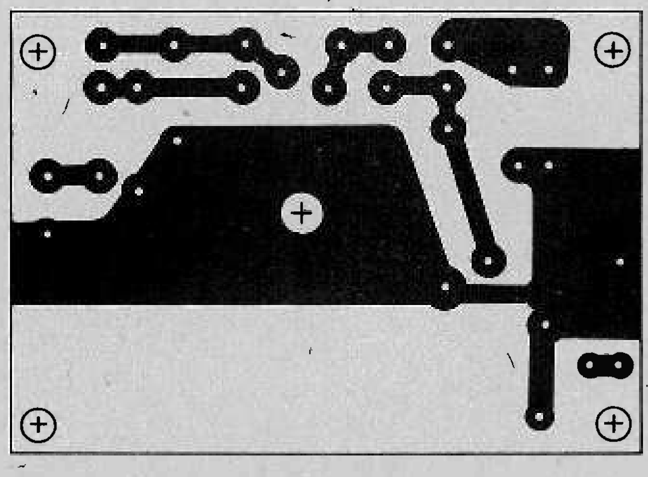
The SUPER DXER is mounted in a standard plastic or Bakelite case approximately 6⅜-in. x 3 3/16 -in. x 1⅞-



PARTS LIST FOR SUPER DXER

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

The printed circuit board for the Super DXer is available from Electronics Hobby Shop, Box 192, Brooklyn, NY 11235 for only $4.95. US orders add $1.00 for postage and handling; Canadian orders add $3.00. No foreign orders, please. Postal money orders will speed delivery; otherwise allow 6-8 weeks for delivery.



Exact PC board size. Transfer image to copper-clad board using carbon paper. This is the bottom (copper) side of your board. Mount it to the front panel with ¼-in. spacers between board and panel at each mounting screw. Secure the battery to the back of the cabinet with tape.

SUPER DXER

in. The front panel must be aluminum. If the cabinet is not supplied with an aluminum panel, obtain an optional or accessory metal panel. Do not use a plastic panel.

Drill a ⅜-in. hole in the center of the front panel. Position the PC assembly over the hole with C1's shaft fully inserted through the hole, and mark the locations for the four PC board mounting screws. Drill the panel and temporarily secure the PC board to the panel. Then locate the positions for power switch S1, antenna input binding post BP1, and output jack J1. Make certain J1 is as close to the PC board output terminals as is possible—within 1½ inches.

Remove the PC board and drill the holes for the panel components. Power switch S1 can be any inexpensive spst type such as a slide switch. Install the panel components and then the PC board. To prevent the copper foil on the underside of the PC board from shorting to the panel, place a ⅜-in. plastic or metal spacer, or a stack of washers, between the PC board and the panel at each mounting screw. Connect the panel components to the appropriate wires extending from the PC board and the SUPER DXER is ready for alignment.

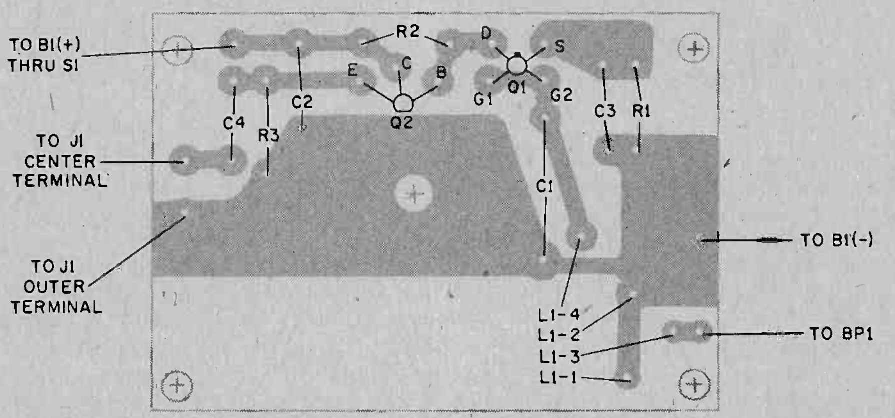
Alignment. Prepare a length of 50 or 52-ohm coaxial cable (such as RG-58) that will reach from the SUPER DXER's output jack to the receiver antenna input terminals. Solder a standard phono plug to one end. Take care that you do not use ordinary shielded cable such as used to interconnect hi-fi equipment;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

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

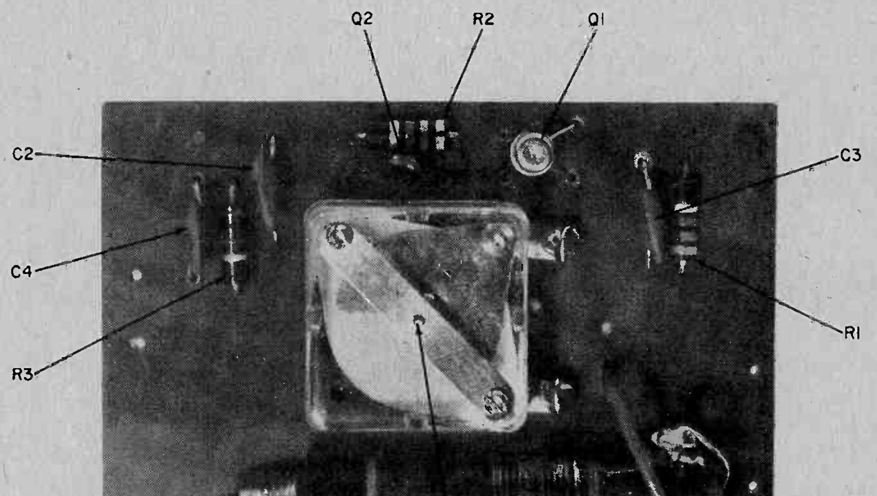
Turn on the receiver and booster, and set the receiver tuning to 5 MHz, or whatever frequency you selected for the "bottom end." Adjust C1 for maximum received signal or noise and mark the panel accordingly. Repeat the procedure at approximately 7, 10, 14, and 15 (or 20) HMz. The panel markings are important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

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

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



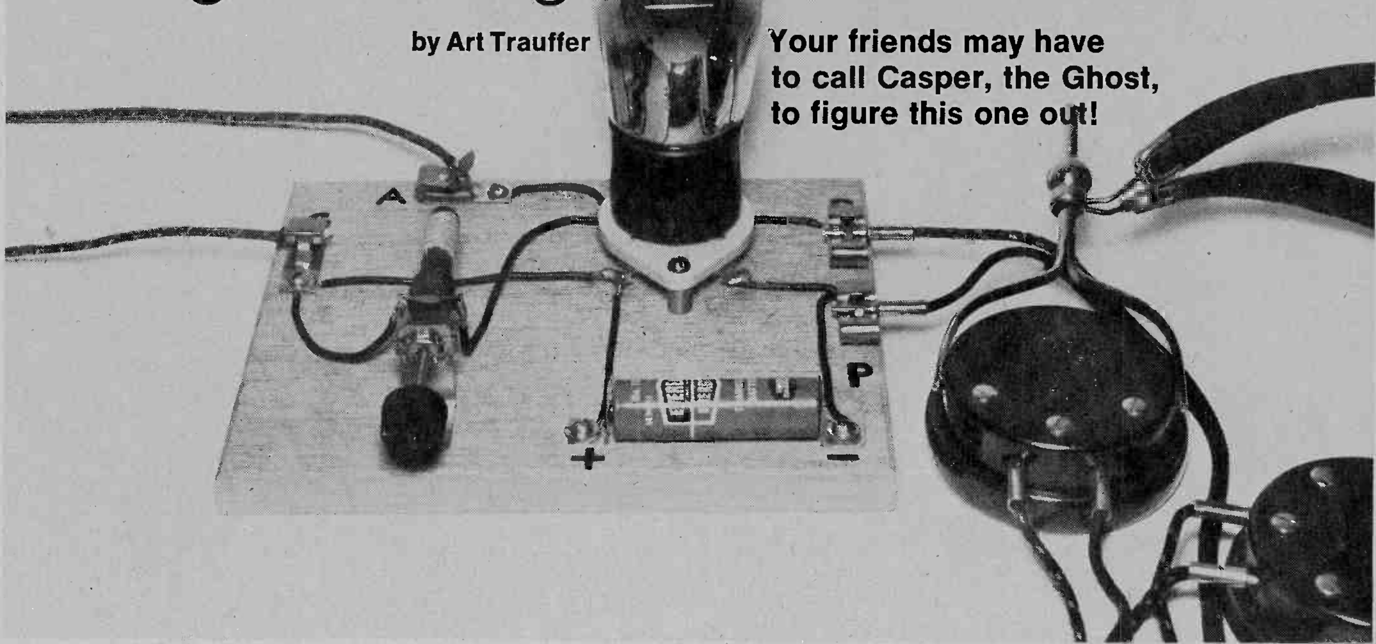
For exact part placement on PC board, see diagram above. View is from component (top) side of your Super DXer board. Layout below shows a completed Super DXer. Pins 3 and 4 of the dual winding coil L1 are shown in an end view for clarity.



Mystery Radio

by Art Trauffer

Your friends may have to call Casper, the Ghost, to figure this one out!



BUILD THIS MYSTERY RADIO. It uses a radio vacuum tube that doesn't glow in the dark. See if your friends can figure out how it works before you reveal the trick. It's a fun project, educational as well as entertaining—a good choice as first receiver for the beginning constructor.

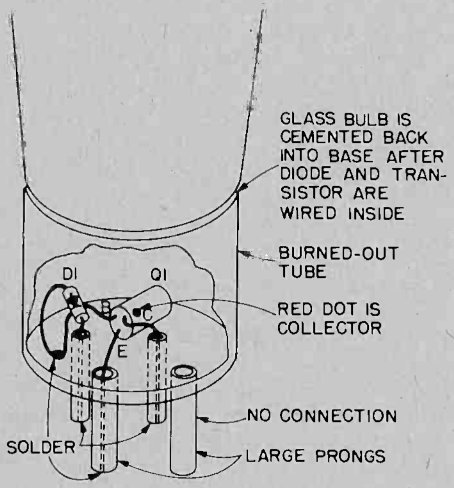
Take a quick look at the photo and you see a one-tube radio tuned by a common ferrite loopstick antenna coil. Nothing too unusual about that. But wait a minute—all there is to power the tube is a small penlight battery of 1½ volts. There is no B battery for the plate of the tube, and there is no grid leak and capacitor going to the grid of the tube—yet you get a good signal in the phones from local broadcast stations! How can this be?

The secret is revealed when we examine the pictorial drawing. We see a germanium crystal diode detector, with a transistor serving as an audio amplifier. These two units are hidden inside the base of the tube. Looking at the schematic diagram you will see that we have a perfectly conventional crystal detector radio driving a one-transistor amplifier. The tube is a dummy, and can even be one which is burned out. It isn't in the circuit at all. If your friends can't guess the answer, there's the mystery in this "one tube" radio receiver.

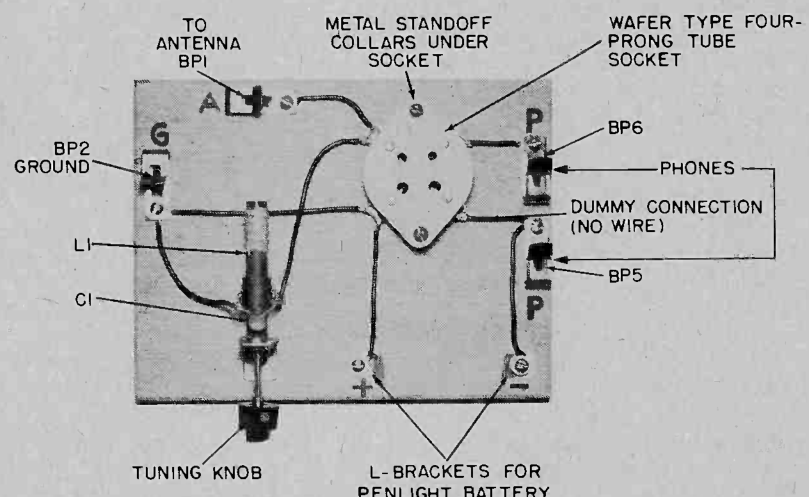
Construction. You can use most any 4-prong (or 4-pin) tube you can find which has a loose bulb. The larger the base the better as it gives you more room inside to wire in the diode and transistor. The writer used a dead 201-A having a loose bulb which was easy to remove from the base.

To remove the glass bulb from the base heat the ends of the pins with a soldering iron and shake out the solder, then carefully twist and pull the bulb out of the base. Caution: For safety wear a pair of gloves when removing the glass bulb from the base of the tube. Use a tube that has a loose bulb to start.

(Continued on page 96)



The trick is in the base of the radio vacuum tube. Diode and transistor in its base replace the tube in receiving circuit.



Beginner's one-transistor project uses easy-to-assemble breadboard construction just like the one- and two-tube sets Dad built in the Twenties and early Thirties.

USE THIS LED/CHIP PHOTO HELPER

Easy-to-build indicator uses two ICs and Stop-Go readout for perfect enlargements every time!

by David A. Duncan

Quality control is especially important in operating a darkroom, and of all the various meters, controls and other instruments employed in making enlargements, the most important and useful one is the photometer.

This light-measuring instrument indicates numerically, via a meter movement or other readout indicator, the amount of light from an enlarger lens striking the enlarging paper on the easel below the lens. This is done by using a light-sensitive device to generate or regulate an electrical signal, which in turn is amplified and indicated by a display mechanism. After reading the indication of light intensity coming from the enlarger, one opens up (or closes down, as required) the diaphragm opening of the enlarger to get the right amount of light. After that, each time a new negative is put in the enlarger the photometer is placed under the enlarger for a moment, the photometer readout is examined, and the enlarger diaphragm is again made larger or smaller to produce the desired reading on the photometer. This ensures that the same amount of light will come from the enlarger on exposures made with the new negative.

During several years' use of such instruments, it was found that most photometers on the market today have at least one drawback. If the meter uses a mechanical movement, the meter face is difficult to read accurately. Even with special glow-in-the-dark faceplates or internal illumination one still has to get inconveniently close to the meter to be able to read it in the subdued illumination of the darkroom. Some meters employ a special mechanism on the meter movement that will lock the needle in place during a measurement, allowing the user to turn on the room lights to read the meter. However, these are expensive, and are thus out of the question for most experimenters. Another system often found in darkroom equipment employs digital readout with seven-segment LEDs for the display. While this is fine, being very easy to read in the dark, it also carries a high price tag, as it requires elaborate analog-to-digital (A-D) converters and digital circuitry. Still another, and from the author's experience the best, is the LED/chip Photo-Helper described here.

The most noticeable feature of this LED/chip meter is, of course, the display. In place of a meter or number readout, one of five light-emitting diodes (LEDs) indicates the degree and the direction the aperture of the enlarger lens must be stopped in order to project a predetermined amount of light to the easel, and subsequently to the photographic paper. By using the calibrated control on the LED/chip the projected light can be accurately measured.

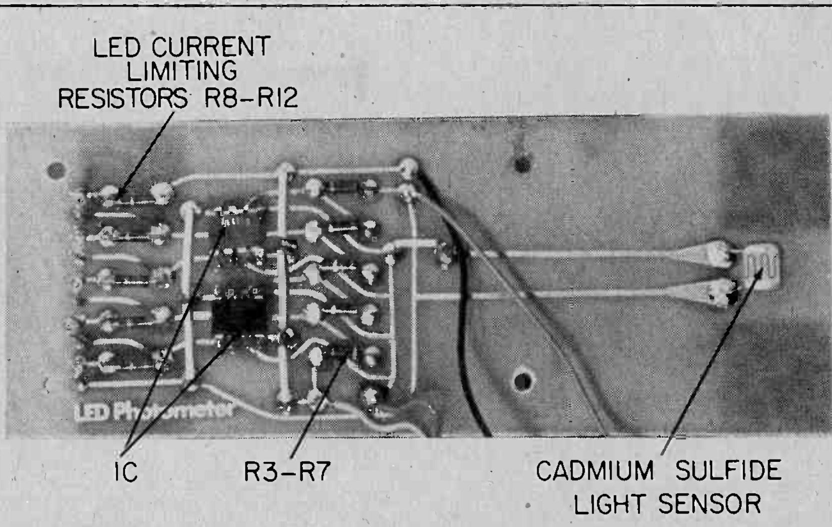
The display comprises five red LEDs, each of which represents a deviation of one f/stop from the values indicated on either side. The center LED represents the null—the desired light intensity. Those to the right indicate that a high f/stop is being used (not enough light projected) and those to the left signify a low f/stop (too much light projected). This system has recently been adopted by a major camera manufacturer in Japan in one of its cameras as a light-metering system.

About the Circuit. Refer to the schematic diagram of the LED/Chip. The heard of the meter is the simple A-D (analog-to-digital) converter, and the LED display which it controls.

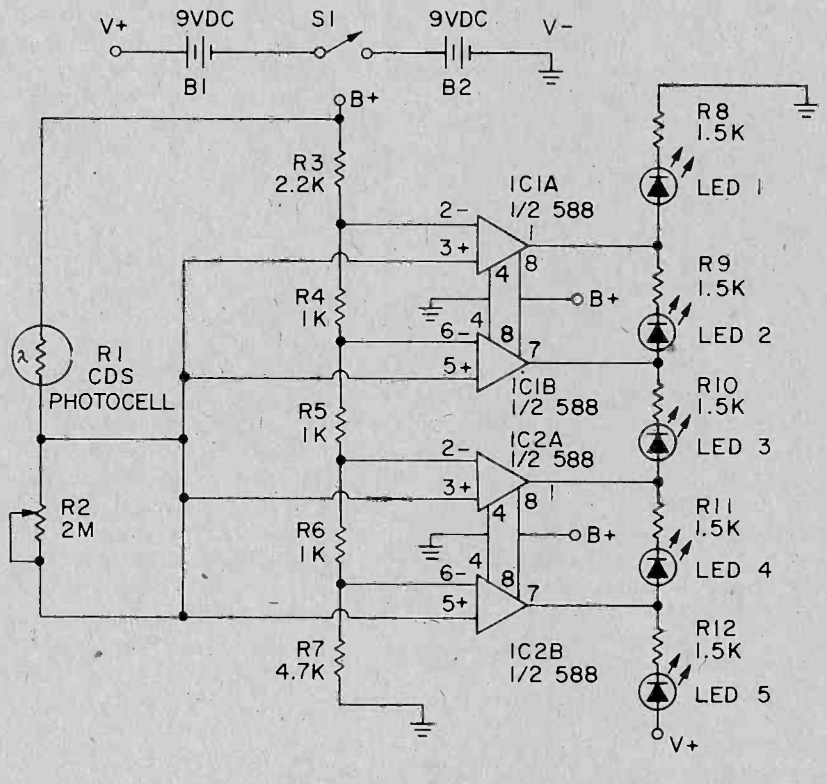
The A-D converter uses four operational amplifiers (OP-amps) as voltage comparators, and a voltage-dividing ladder made up of resistors R3 through R7. The voltage divider supplies positive reference voltage ratios of 0.78, 0.68, 0.58 and 0.47, which amount to 14, 12.2, 10.4 and 8.5 VDC, respectively, when used with an 18-volt supply, to the inverting (—) inputs of comparators A, B, C, and D. Photocell R1 and control R2 make up a second voltage divider, the tapped voltage of which is dependent on the amount of light striking R1, and the setting of R2. The output of this divider is applied commonly to the noninverting (+) inputs of all four comparators. The LEDs and their current-limiting resistors are connected between the outputs of the comparators, with one LED going to the V+ line and another to the V— line, as indicated in the schematic diagram. The operation of this display circuit is described later in this article.

In order to simplify the discussion, the operation of the A-D converter and the LED/chip meter are analyzed in terms of a typical measurement. Let's assume there is enough light falling on the cadmium sulfide photocell, R1, to give it an effective resistance of 318 Kohms (the effective resistance of such a photocell varies directly with the amount of light falling on it). Control R2 is set for half a megohm, resulting in an output of 11 volts which is applied to the + inputs of the comparators. On the — inputs, remember, there is 14-volts at the comparator A, 12.2-volts on comparator B, comparator C has 10.4-volts, and 8.5-volts is being applied to comparator D. These voltages come from resistor ladder R3-7, derived from the 18-volt V+ supply. With each comparator, if the voltage level on the + input is greater (more positive) than the voltage on the — input, the output of the comparator will go to the level of V+. If however, the + input sees less voltage than does the — input (— input is more positive), the output will drop to the value of V- (zero). With this in mind, consider the example. Comparators A and B have 11 volts on their + inputs, but have 14 volts and 12.2 volts on their — inputs. Since the — inputs are more positive than are the + inputs, the outputs of these comparators will be at zero. However, while comparators C and D also have the common 11 volts applied to their + inputs, only 10.4-volt and 8.5-volt signals are being sent to their — inputs. As the + inputs of these comparators are the more positive, their outputs will go to V+ (18 volts).

Now consider the LEDs, beginning with LED1. The cathode of LED1 is tied to V—, and its anode to the output of comparator A. As shown above, this output is at V— potential, so no current can flow through the LED: it remains Off. Limiting resistors R8 through 12 can be disregarded in this discussion as they only serve to limit the current through the LEDs and in no way affect the operation of the A-D converter or display. The cathode of LED2 is connected to the output of comparator A (at V—) and its anode to comparator B, which is also at V— level. Again, no current flows through the diode, and it remains unlit. LED3 is connected be-



Assembled LED/chip Photo-Helper has light sensor on board, at right. Five LEDs are mounted under the transparent window at left. Only one LED lights at a time. View of the printed circuit board with components in place. Light sensor is at right end, five LEDs at left.



PARTS LIST FOR LED/CHIP PHOTO-HELPER

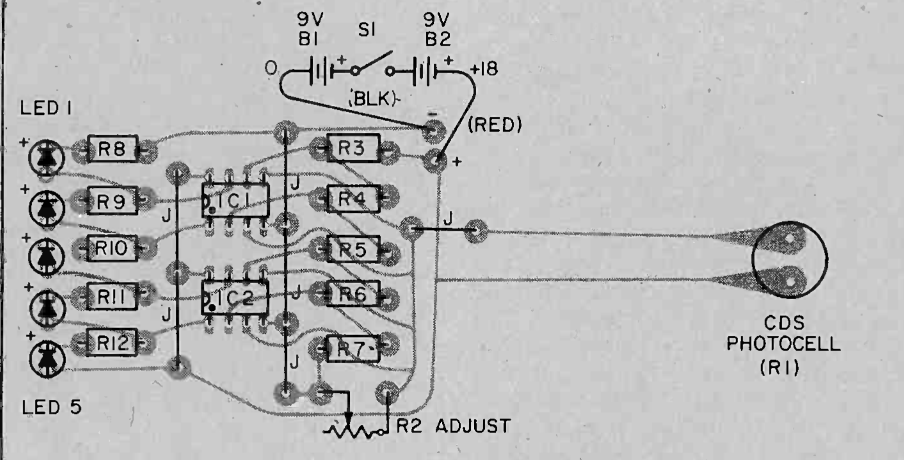
B1, B2—9-VDC transistor radio batteries
IC1, IC2—dual-741 integrated circuits, packaged as 558
LED1 through 5—Light-emitting diodes 1.6 to 1.75 volts at 20mA
R1—Cadmium sulfide photocell
R2—2,000,000-ohm, potentiometer
R3—2,200-ohm, ½-watt resistor
R4 through 6—1,000-ohm, ½-watt resistors
R7—4,700-ohm, ½-watt resistor
R8 through 12—1,500-ohm, ½-watt resistors
Note: ¼-watt resistors acceptable if available
S1—SPST toggle switch
Misc.—Plastic cabinet 3¼-in. D x 1¼-in. H x 2-in. W, etching kit for printed circuit boards, control knob.

USE THIS LED/CHIP PHOTO HELPER

tween comparator B (V—) to comparator C (which is now at V+). The voltage difference between these two outputs causes current to flow through LED3, turning it On. LED4 is positioned between the outputs of comparator C and comparator D, both of which are at V+. This LED sees no current between the two V+ (leveled) outputs, and therefore does not come On. Finally, LED5 is located between the V+ output of comparator D and the V+ line itself, and also remains Off. This system will result in one (and only one) LED being lit at any one time, under normal conditions. (Under a fluorescent or Xenon light source, which flashes at a rate of 120 Hz, the LED/chip meter sees the lights as both On and Off and will display this by turning On two or more LEDs).

As the intensity of light at the photocell is altered, or control R2 is changed, each comparator will go from V— to V+, or vice versa, according to the change in voltage level at the output of the R1-R2 voltage divider. If each situation is carefully analyzed it can be seen that only one LED will be On, all others remaining Off.

Note that since the two voltage dividers R1/R2 and R3 through R7 are connected to the same V+ source, and since the resultant output of the A-D converter is dependent only on the voltage differences between the various points in these dividers, changes in the supply voltage will not affect the operation or calibration of the LED/Chip Photo-Helper unless of course such extremes are reached that the circuits cannot operate or are destroyed). Also, since no "ground" reference is needed,



Location of components on printed circuit board. Foil is placed on top of board, as are components.

a single voltage supply, such as a single battery, may be used.

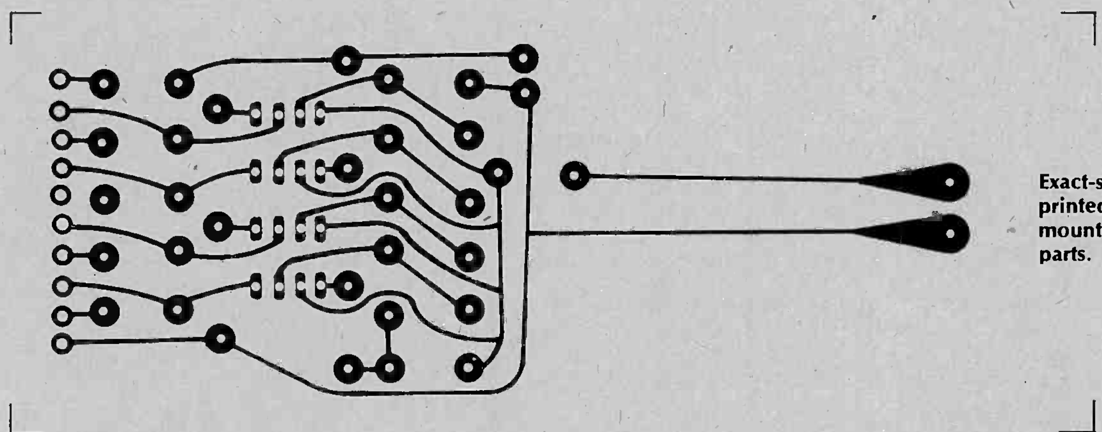
Construction. Except for the battery, power switch S1 and control R2, the entire circuit of the LED/chip is built on a single one-sided printed-circuit board. Any means of construction may be used, as dress is relatively unimportant. However, the LED/chip using a printed-circuit board is easier to build and to use in the darkroom.

Position and install the resistors, jumper wires, integrated circuits and LEDs on the circuit board as indicated in the component location chart immediately following the printed-circuit foil pattern. Pay special attention to the polarities of the light-emitting diodes, and **use heat sinks** (such as a pair of longnose pliers) when soldering these devices in place, as they are easily destroyed. Also note the orientation of the integrated circuits. IC sockets may be used for the ICs if desired, and they make it easy to construct with no danger of destroying the ICs while soldering them in place.

Prepare a suitable enclosure for the LED/chip by drilling holes for control R2 and switch S1. Drill or cut a window at the position where the five LEDs will be visible when the PC board is mounted in place, and another opening to allow the light from the enlarger to reach the photocell. The cabinet for our prototype was prepared so that the end of the PC board bearing the photocell projects beyond the side of the enclosure. The prototype's printed circuit board was manufactured as a mirror-image (reverse) of the foil pattern shown here, and the components mounted on the foil side, so the PC board itself is the bottom of the cabinet, and is secured to the cabinet just as its original bottom was, using the same hardware. Mount four rubber feet to the underside of the cabinet to prevent the cabinet marring the easel of the enlarger.

Testing and Using. To test the

(Continued on page 99)



Exact-size template for printed circuit. Foil mounts same side as parts.

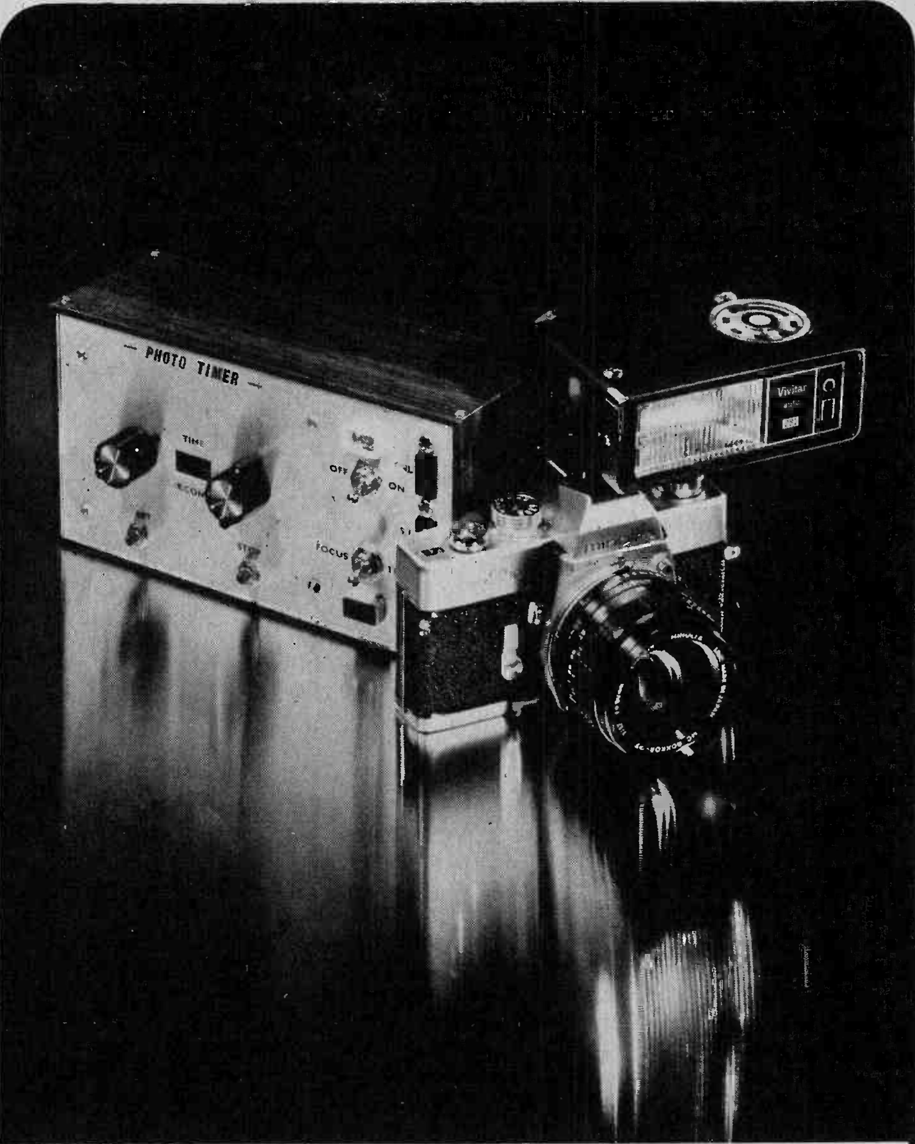


PHOTO TIMER

Designed for your creative difference by a darkroom craftsman. This precision tool does everything but turn off the lights!

by Adolph A. Mangieri

FEATURING illuminated digit-set dials, automatic reset, and safelight control, the PHOTO TIMER eliminates error-prone juggling of room light, safelight, and timer switches and dials. You can set the timer in complete darkness and you can be sure the safelight was off when you used your enlarger printmeter. The large easily-read dial indications make the timer a joy to use. The timer also includes push-to-start and push-to-stop buttons.

Using the 555 precision IC timer, the timer circuit is not affected by line voltage changes. Timing is adjustable from 1 to 119 seconds in one-second steps. Accuracy and repeatability depend only on the accuracy of the timing resistors and quality of the timing capacitor. The PHOTO TIMER is easily constructed at low cost.

Circuit Operation. The schematic diagram shows a 555 precision timer connected as a one-shot timer with automatic reset. The timing interval is determined by timing capacitor C1 and by timing resistors selected by switches S1 and S2. Assuming pin 5 of IC1 is disconnected from calibration pot R9, the time interval T (seconds) equals 1.1 times R (megohms) times C (microfarads). Timer-output at pin 3 controls both normally-off load relay K1 and normally-on load R6. If one load is de-energized, the other is energized and vice-versa.

With C1 initially held discharged by IC1, timing commences when start button S4 is depressed causing a triggering pulse at trigger pin 2. The relay closes instantly and C1 begins to charge through the timing resistor. When the voltage of C1 rises to two-thirds of the DC supply voltage, IC circuits are activated causing the relay to open and C1 to discharge completing the cycle with automatic reset. A timing cycle in progress may be terminated by depressing stop button S3.

Calibration pot R9 varies the timing control voltage at pin 5 accounting for tolerances of timing capacitor C1. Provided with both normally-on and normally-off loads, the IC circuit draws a

PHOTO TIMER

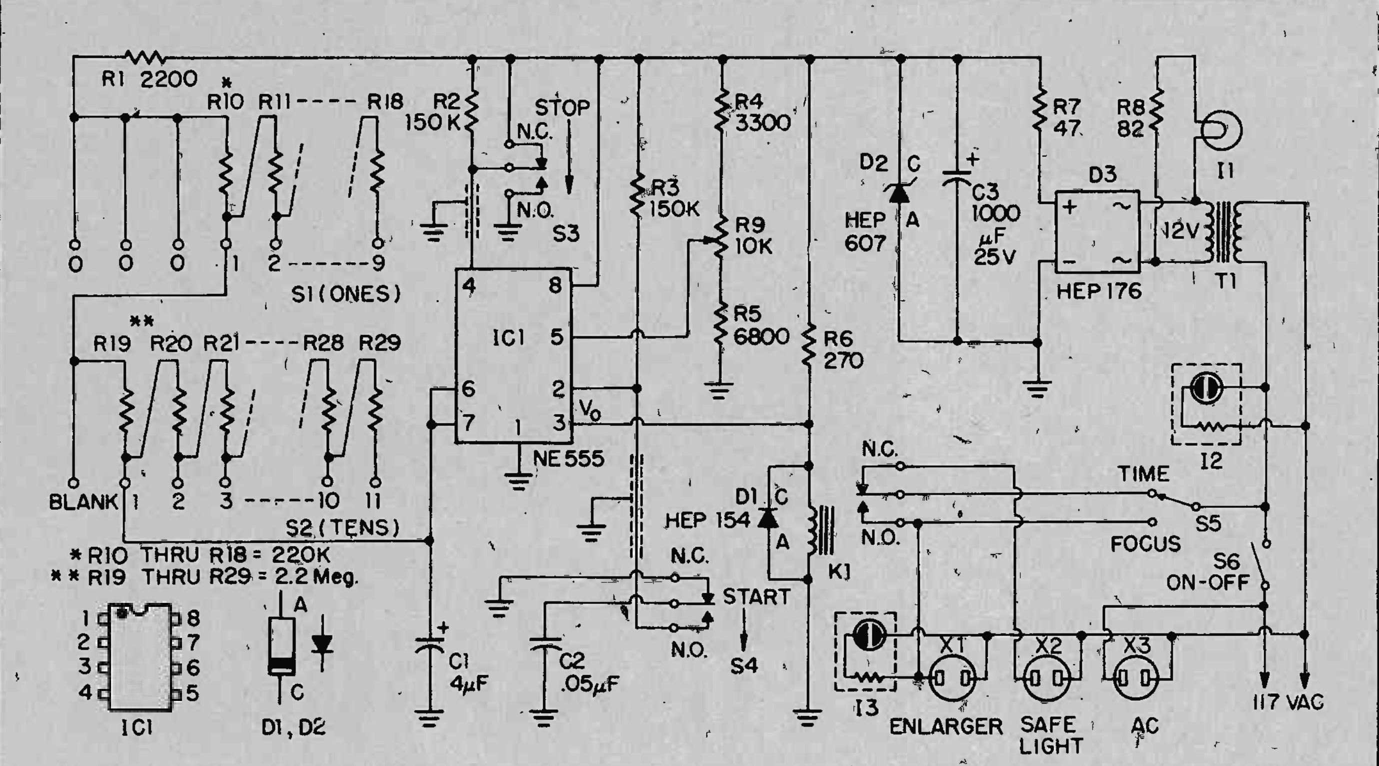
fixed load current from the power supply. Resister R7 sets the DC supply voltage to about thirteen volts. Voltage clamp zener diode D2 limits the supply voltage to safe values if the supply voltage should rise. Timing is not affected by changes in supply voltage. Rectifier diode D1 eliminates voltage spikes at K1 which would re-cycle the timer.

Construction. Build the PHOTO TIMER in a 9 x 5 x 3 in. metal cabinet. Begin construction by cutting out two 2½ in. dial discs from 1/16 in. thick red or white transluscent plastic. The discs are easily cut using a holesaw. Chuck the discs in a mandrel and true up the edges. Ream the center hole to clear the shafts of switches S1 and S2. Drill through a pair of small panel knobs and cement a knob to each disc using epoxy cement.

Drill suitably spaced (one disc diameter) slightly undersize holes in the panel and ream for a close fit for the shafts of the switches. Cut the perforated board to size and drill four holes for 6-32 x 2 in. spacer bolts which support the board behind the panel. Drill four matching holes in the panel, bolt the board directly against the panel, and locate and machine holes in the board to accept the switches. Cut out a ⅜ by ¾ in. window in the panel midway between the switch shaft holes. Complete machining of the panel and apply panel labelling and a clear protective coating.

Install switches S1 and S2 on the board, dial discs on the switch shafts, and trial mount the assembly on the panel. The dial discs should rotate with little wobble and no contact with the panel. If needed, enlarge a switch hole on the board to correct any disc tilt by shifting the switch slightly. Remove the circuit board assembly from the panel and affix the discs at the top end of the shafts. This simplifies application of dry transfer numerals at the edges of the discs while using the switches to index the disc for each position. Label the "ones" dial with three zeros and 1 through 9. Label the "tens" dial 1 through 11 leaving a blank space. You can remount the assembly on the panel and check and correct any badly aligned numerals.

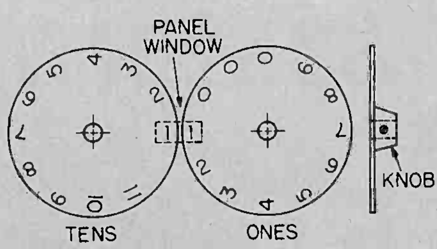
Using 1/16 in. aluminum, make the compartment partition supporting trans-



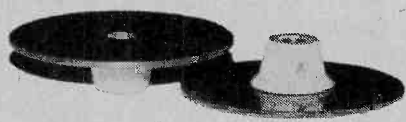
PARTS LIST FOR PHOTO TIMER

C1—4-uF, mylar capacitor, 50-VDC (Cornell Dublier WMF or similar)
C2—0.05-uF, capacitor, 100-VDC or better
C3—1000-uF, electrolytic capacitor, 35-VDC or better
D1—1-amp, 50-volt silicon rectifier (HEP 154)
D2—15-volt, 1 watt zener diode (HEP 607)
D3—1-amp, 50 volt bridge rectifier
I1—see R8 note or #47 panel lamp
I2, I3—neon panel lamps
IC1—555-type integrated circuit
K1—dpdt relay, 12-volt DC, 3-amp contacts, coil resistance 350 ohms, coil current 50 mA. (Radio Shack 275-206 or equiv.)
R1—2200-ohm, ½-watt resistor
R2, R3—150,000-ohm, ½-watt resistor
R4—3300-ohm, ½-watt resistor
R5—6800-ohm, ½-watt resistor
R6—270-ohm, 1-watt resistor
R7—47-ohm, 1-watt resistor
R8—82-ohm, 3-watt ww resistor. Note—delete if 14 volt lamp such as #53 is substituted for I1.
R9—10,000-ohm trimpot
R10 to R18—220,000-ohm, ½-watt resistors, 5% or better
R19 to R29—2.2-megohm, ½-watt resistors, 5% or better
S1, S2—single-pole, 12-position switch, shorting type
S3, S4—spdt momentary pushbutton
S5—spdt toggle switch (FOCUS/TIME)
S6—spst toggle switch to match S5 (ON-OFF)
T1—miniature transformer, 117-VAC pri., 12-VAC sec, 300-mA
X1, X2, X3—AC chassis receptacles
Misc.—panel knobs, case 8½ x 4½ x 3-in. (Vector W30-86-46), perf board, push-in terminals; translucent plastic sheet 1/16-in. thick for dial, small knobs, line cord, IC socket, spacer bolts (4), wire, solder, etc.

IC-design photo timer features backlighted digit-set dials, pushbutton start and stop buttons, and safelight control. Modern circuitry provides high accuracy and repeatability over the 1 to 119 second timing range. Home darkroom using our photo timer is equipped with Omega B color enlarger.



Digit-set discs can be made at home from a plastic sheet. Press-type numerals can be used for neat job after cutting out the discs if you draw a temporary base line for each double digit and use it to align numbers.



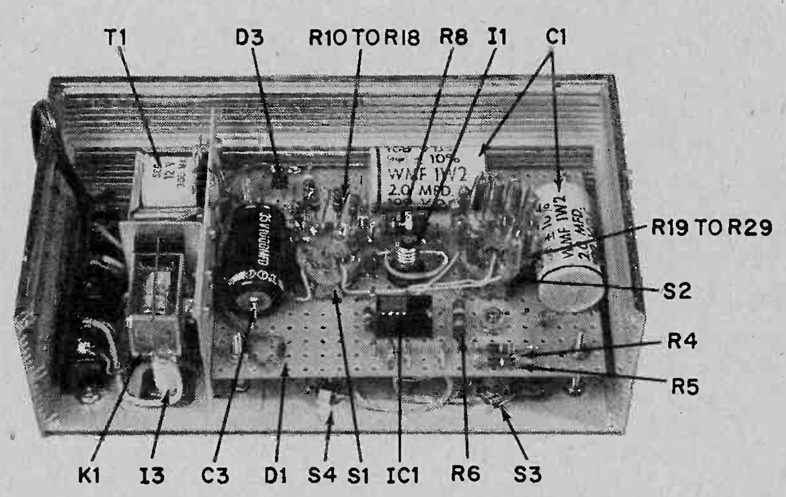
former T1 and relay K1. The partition is secured by two of the spacer bolts. Cut out a portion of the flange of the partition to avoid interference with the "ones" dial disc. Make a bracket to accept the socket of K1 and affix to the partition. Wire the AC sockets, neon panel lamps (supplied with external voltage dropping resistors), and toggle switches before installing T1 and K1. Wire the normally open poles of the DPDT relay in parallel to double the current rating.

Install a large rubber grommet on the circuit board directly behind the panel window to accept panel lamp I1. Tint the lamp with red transparent lacquer. Complete wiring of the board using a socket for IC1. Carefully observe polarities of D1, D2, and C3. Use shielded wire for connections to pushbuttons S3 and S4. Install resistors R10 through R29 directly on the switches. It's usually a simple operation to defeat the switch detent stops on S1 and S2 allowing continuous rotation of the dials. Set the switches to pick up R10 and R19 and position and secure the dial discs for 11 seconds readout.

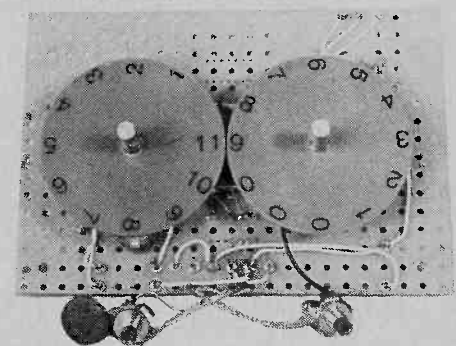
Capacitor C1 should be a mylar, polycarbonate, or polystyrene low-leakage, low-loss type. C1 was made up by connecting two 2 uF capacitors in parallel but you can use a single 4 uF capacitor. You can use a 5 uF capacitor by changing R10 through R18 to 180,000 ohms and R19 through R29 to 1.8 megohms.

Checkout And Calibration. Using a VOM, verify the presence of approximately thirteen volts DC across C1, about fifty milliamperes current in R7, and about five volts AC across lamp I1. If you have substituted for T1, it may be necessary to resize R7 and R8 accordingly. To calibrate the PHOTO TIMER, plug a sweep second electric clock into socket X1. Turn S6 on and set S5 to time. Set the dials for fifteen seconds. Depress start button S4 and observe elapsed time on the clock. By trial settings, set R9 so that the clock runs for fifteen seconds. Next, set the dials for 119 seconds and observe elapsed time. If you have used high quality capacitors for C1 the interval should check close to 119 seconds with

(Continued on page 93)



Major parts layout showing author's use of two 2-uF caps in parallel for C1.

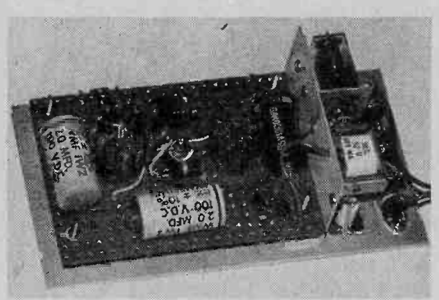


Dial discs are labeled 0 to 9 (units) and 1 to 11 (tens) with discs positioned at top of switch shafts while using the switches to index the discs. Illustration shows 119 seconds. This system allows resetting to the exact time within the resolution and accuracy of the system's electronic timer.

PHOTO TIMER

(Continued from page 91)

Our amateur home darkroom includes the e/e Color Analyzer featured in the Sept.-Oct. '74 issue. It's located in the background to the right of the dry chemical (fixer) box.



Line (117 VAC) circuits and relay are placed at left side of the partition. Heavy-weight perforated board supports rotary switches S1 and S2. Timing resistors mount on switches.

some allowance for inaccuracy of timing resistors.

Put It To Work. Plug the enlarger into socket X1 and safelight into socket X2. Plug the enlarger exposure meter into socket X3. Set S5 to Focus when focusing or using the exposure meter. The safelight will now be off as is required for use with any enlarger exposure meter. To expose the print to the set time interval, switch S5 to Time and depress the start button S4. During exposure, the safelight will be off but will return automatically upon completion of the exposure. Panel lamp I3 will be on during the exposure interval. If you have inadvertently overlooked setting of the timer or lens opening and have initiated the exposure, you can terminate the exposure with return of safelights by depressing stop button S3.

By the way, photo fans, check out our B&W photo print analyzer coming soon in a future issue of e/e. It's the complement to our very popular "Darkroom Color Analyzer" project in the September-October 1974 issue of e/e. ■

ASK HANK, HE KNOWS!

(Continued from page 16)

▲ If you have a schematic diagram of the Hammarlund HQ—129X receiver, send it to John Bolt, 519 DeFoerd, Hockenssin, DE 19707.

▲ Jeffrey C. Miller, 10210 Wish Avenue, Northridge, CA 91324 needs the schematic diagram and additional technical information on the Crosley Model 66TW radio.

▲ John D. Baniak would like to obtain his FCC First Class Radiotelephone License from a resident school in the New York, New England area. If you know of a school, write to John at 654 4th St., Troy, NY 12180.

▲ Have any info on a CB rig identified as Falcon by Tecraft? If yes, write to Stewart Rohner, 425 St. Thomas, Lafayette, LA 70501. He'd like to hear from you.

▲ Joe Crowley of 3340 Courtney Rd., Portsmouth, VA 23703 needs a manual for a tube tester made for Western Electric by Hickok Electrical Instrument Co. It is Model KS-5727-L1, serial #938.

▲ Frank Evenden needs the dial glass for the Model S107 by Hallicrafters. Write to him at RR 6, Box 218, Newton, NJ 07860.

▲ Brad Outer, 11407 Colleen Dr., Savannah, GA 31406 needs schematic diagram for the Knight Safari I CB transceiver.

▲ Michael DeVita would like to obtain an owner's manual for a Monarch 4-band shortwave receiver. Write to Michael at 1505 No. West St., Lima, OH 45801.

▲ Has anyone info on the Scott auxiliary receivers used on WWII merchant ships? If yes, write to Nathan Copeland, 72 Groveside Road, Portland, ME 04102.

▲ Walter Harley would like to join our advanced electronics club. Okay, membership chairman, write to Walter at 2436 Streetsboro Rd., Peninsula, OH 44264.

▲ J. Jarvis of Box 247, Cibolo, TX 78108 needs operation manual and wiring diagram for a Radson radio-telephone, #RT-70A.

▲ If you know where to get MAW-64A LEDs, write to John Sterrett, P.O. Box 2314, USAF Academy, CO 80840.

▲ Paul Prinke would like to get his newly acquired Philco Model 37-670 receiver working. If you can help, write to Paul at 34 Ferndale Rd., No. Caldwell, NJ 07006.

▲ Jerry Allgire, Rt. 3, Montpelier, OH 43453 needs a schematic diagram for a Windsor stereo 8-track player for the auto.

▲ Have you anything on an old Echophone Commercial Model EC-3 communications receiver? If yes, write to Peter N. Dutton, RFD 3, Box 428, Rochester, NH 03867. ■

Rig-Kwik

(Continued from page 51)

the power supply printed circuit board if you hold off soldering the power transformer and output connection wires until later. The best bet is to provide tie points for the input and output connections. Use Radio Shack #270-1392 terminals and enlarge the connecting holes with a 3/64-in. drill bit. Don't try to jam the terminals into the holes—they just won't go without damage. Solder the terminals to the foil and then cut off any remaining terminal material on the foil side of the board. The printed circuit board has no mounting holes—Bullet Electronics lets you do it your way. Use a three point mounting. Drill holes for #6 screws (but use #4 screws to mount the board) at two corners away from the ground foil running around the perimeter of the board. Drill the third mounting hole on the opposite edge approximately midway between the two sides—anyplace you can get clear of the foil.

To avoid shorting the foil to the cabinet the board must be mounted on standoffs at each mounting hole. A ¼-in. standoff spacer is sufficient. (Do not use a stack of metal washers unless you are certain no washer comes in contact with the foil on the board.)

Protection. In the unit shown we have provided three fuseblocks on top of the cabinet. These fuseblocks are made for the ¼ x 1¼ inch fuse (3AG) type, and will accommodate both the 8AG and 3AG sizes. In this way you can use either size fuse without using two sets of fuseblocks. Note, however, that two different types of fuseholders have been used. When working with experimental circuits requiring two or more power supply voltages it is possible to get the wiring crossed when the power wires come from the same general location—and a crossed power wire can wipe out a handful of components. So a different fuseholder was used for the 5-volt power supply. If you can only get hold of one kind of fuseholder paint the 5-volt one a distinctive color that cannot be confused with the fuseblocks used for the two 15-volt supplies. The fuses must be fast-acting (8AG) because solid-state components will blow out long before a standard fuse (such as the 3AG) blows.

Though the power supply kit is not supplied with a fuse for the power transformer's primary (AC power-line side), the instructions included with the kit suggest the use of a fuse, and a fuseholder should be installed in the base of the cabinet, as shown.

To avoid confusing the power output connections the use of different-colored 5-way binding posts is suggested. The standard colors for a bipolar power supply are *Black* for negative (ground) and, *red* for positive and *blue* or *green* for negative voltage. The 5-volt power output should be any other color (don't use *red* again). If you cannot locate binding posts in assorted colors paint them with Testor's model paints, which come in very small bottles for about 25 cents each. Model paints are available in hobby stores which stock model trains, planes, rockets, etc.

Using Rig-Kwik. The QT socket terminals can handle wire sizes #22 (solid) and #24. You can insert a #20 wire but it takes a strong push with long-nose pliers. The QT sockets provide a firm grip on the wire and can be re-used indefinitely after the breadboard is cleared—this is not a one-shot project board. Most transistor, resistor, capacitor and connecting wires will fit the QT terminals. The wires on high power SCRs and transistors, 1 watt resistors, and high-voltage (250 V and higher) capacitors are just a shade too large for the QT terminals, and if you try to force them in you'll either break the component or damage the socket. If, for some reason, you must use oversize components solder a short piece of #22 wire to their leads so they can be easily connected to the sockets.

Choosing Fuses. Fuses should never be rated higher than the maximum rated current of the associated power supply. For example, if you are using an *external* 5-ampere/5-volt supply the fuse should be no larger than 5-amperes. If you are using the internal 1.5-ampere/5-volt supply the fuse should be no larger than 1.5 amperes. But fusing for the supply's maximum rating protects only the power supply, not the circuit you're building. Such fusing in the presence of a wiring error could lead to an undamaged power supply—with crispy-fried experimental components! It is better to fuse so that the experimental circuit gets full protection, or as much protection as you can give it. For example, assume you are building a TTL project whose maximum current including the readout display is 150 mA. Using the next higher fuse value, in this instance 3/16 or 2/10 ampere, will protect both the project and the power supply. Thus, whenever you use the Rig-Kwik for breadboarding a project you can protect the project, as well as the power supply, by choosing a fuse just large enough for the project itself (each time). You now have a fast, convenient, and inexpensive laboratory breadboard. Enjoy! ■

Digital Egg Meter

(Continued from page 20)

thor's model did not include resistors R1, R2, R3, R10, R11 and R12 on the circuit board. These parts along with diodes D1, D2 and D3 were wired to switch S1 or stuck into the wiring between the board and LED display LD1. Now all these parts can be assembled to the board. Resistors R10, R11 and R12 have only one lead soldered to the board. The other lead is cut short to ¼-in. and used as a terminal to interconnect LED display LD1 to the board.

Operation. Now, you're ready to plug in the ICs and give it a try. But before you do, double check all wiring and component placement. One wrong wire can blow an IC and ruin your fun for a while. Now plug in only IC1, then connect the battery, and be very sure the battery clip is not wired in backwards which would put the wrong polarity across the ICs. Also, make sure the ICs are not in backwards.

Now put a voltage across the probe and clip (10 volts or so). Press S1 and see if the voltage across IC2, pins 1 and 2, is 1/100 of the input volts voltage (0.10 volts in this example). If this is not the case, you either have some wiring error or a fault in IC1. Also note that as S1 is pressed LED diode D2 should light. This diode simply provides a voltage drop of about 2.0 volts and can be mounted inside the egg since it is not needed as an indicator. But if it fails to light, you have a wiring or component fault.

Adjustment and Calibration. If IC1 is working properly, take out the battery and carefully plug in IC2, 3, and 4. Replace the battery, and with no input voltage, press S1. Display LD1 should light up and settle down to a constant number within about 3 seconds. This settling time is only needed when S1 is first pressed because the ICs are "cold." Now adjust R5 until the reading is "00.0". If the reading will not quite get to zero, either because it only gets to 00.1 or (from the other side of zero) 99.9, replace R7 with a 200 ohm (or 100 ohm resistor, respectively). If LD1 does not light at all, check out the display by driving one of its segments with 0.9 ma after LD1 has been removed from its socket. This can be done by placing a 9-volt battery and a 10,000-ohm resistor in series with pins 1 and 10 of LD1. Be sure the *positive* terminal of the battery feeds pin 10 of LD1.

After adjusting R5 for a zero reading, R6 can be adjusted for a proper full scale reading by simply applying a known voltage across the clip and probe and turning potentiometer R6 until the desired reading appears. A re-adjustment of potentiometers R5 and R6 is generally needed only if there is a large change in room ambient temperature (winter to summer, for example).

If the digits flash too quickly, that is, the values bounce around too much, increase C1 slightly, or try changing C2. If the unit is accurate up to some high voltage like 80 volts DC but not accurate above that, C1 is saturating and should be increased slightly or, at least, replaced. If the unit gives readings that behave strangely, check LED diode D2 to be sure it is dropping between 1.5 and 2.5 volts (about 2.0 is best). If not, replace it. Also remember that this unit is meant for DC inputs, so don't try reading AC unless you want to design your own op amp-rectifier front-end. ■

Mark Time Indicator

(Continued on page 24)

ure to obtain 0.5-second and one-second pulses.

If an oscilloscope is available, R6 can be adjusted very quickly and accurately. Set up the scope to display one cycle of the 60-Hz line frequency, either by means of the scope's own test jack if it has one, or by connecting it to the secondary of a low-voltage transformer. Carefully note where the beginning and end of this sine wave trace are on the scope face. Then, without readjusting the scope's horizontal gain or sweep controls, connect it to pins no. 1 and 3 of IC1. Vary the scope's positioning controls to center the trace, and the vertical gain and sync controls as appropriate. Now adjust R6 until two square waves of the IC1 output occupy exactly the same distance on the scope face as the sine wave did. R6 is now adjusted. While this method is not as exact as using a frequency counter, it will get you within half a cycle.

Programming Your MTI. To program the calculator to count, proceed as follows:

To Count Up:

1. Place S4 in the *Set* (center, off) position.
2. Press –, 1, +, and 1 (or –, 0.5, +, and 0.5, if desired).
3. Place S4 in the desired position.

Step 3 will cause the calculator readout to go to 0, and MTI is now ready to count as soon as S3 is pressed.

To Count Down:

1. Place S4 in the *Set* position.
2. Press the calculator keys for a

number one digit higher than the timing period desired. That is, to time 15 seconds, enter the number 16.

3. Press –, 1, (or –, 0.5).
4. Place S4 to 0.5 or 1.0.

Step 4 will cause the calculator to display the desired number (15 in our example), and the calculator is ready.

Since the calculator display does not automatically clear when the timer is stopped, any timed interval can be interrupted and restarted. This is convenient if you are part way through a timed operation and have to stop (to answer the telephone, maybe) and want to pick up where you left off.

Timing Variations. Several operating variations are possible. Timing ranges can be changed during a timed interval. For instance, if 20 seconds is to be timed, the first 15 seconds could be timed with the timer in the 1-second position, and the last 5 seconds in the 0.5-second position.

Since the calculator will count by negative numbers as well as by positive numbers, it is possible to time two intervals consecutively without having to re-initialize the calculator. For example, if you want to time one event for 10 seconds, and then another event for 20 seconds, you can enter –10, and count up from –10 to 0 for the first event, and from 0 to 20 for the second. Or, you can enter 10, and count down from 10 to 0 for the first event, and from 0 to –20 for the second event.

Still another possibility is counting by numbers other than 0.5 and 1. The calculator will count by 5s, 10s, 100s, or any other number, although the time period between any two counts will always be one of the ranges determined by timer switches S2 and C4. ■

OP AMP TESTER

(Continued from page 67)

Kohms). The error amp would be disconnected from the voltage divider and would just look for any voltage output at the DUT which exceeded 4V divided by R10/R9 (or just 4V if R9 = R10).

With the circuit values shown, the DUT is tested for the following approximate conditions:

Open Loop Gain	200V/V (min.)
Output Voltage Swing	±6V
Output Current	±5mA
Input Voltage Offset	40mV (max)
Input Bias Current	±4uA (max)
Stability	Good at gain of 100.

While these test conditions are good for general purpose testing, an unlimited number of test parameters can be programmed by altering the component values.

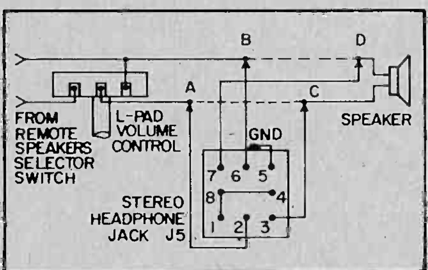
Two test sockets are provided, wired in parallel, so that practically any op amp with standard pin configuration can be tested easily whether it is in a TO-99, 14 pin DIP, or mini-DIP. Op amps requiring external phase compensation can also be tested. In these cases, the phase-comp components are plugged into the socket not occupied by the DUT. Never plug in two op amps at the same time.

Construction. Neither parts layout nor lead dress is critical. When using the printed circuit board shown here, be certain that holes for the components are drilled at least half way, but not all of the way through the board. Bend the leads of the components and clip them flat so that the bodies of the components lie about 1/32-in. above the board, supported by the leads. Carefully solder the components in place. Take care when soldering the components not to get them too hot. Use a low wattage soldering iron and rosin core solder. ■

Switch-A-Band

(Continued from page 43)

at all other house locations. The weather-resistant speakers on the patio and near the front door are mainly for public address use, to call people in from the yard, to turn away salesmen, or to shoo away stray dogs. Of course the patio and front door speakers can also be used to monitor the CB and scanner radios.



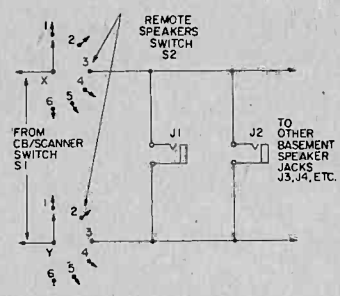
Wiring an L-pad volume control to a speaker is easy using upper left part of diagram above. To add headphones, wire rear of Radio Shack jack 274-376 as shown. It will silence speaker when using phones.

Volume Controls. Another feature of my Switch-A-Band system is the use of volume controls at selected locations. I added an 8-ohm L pad to the roving remote speaker, and also to the speaker permanently installed in our son's room. In the latter the speaker was mounted up toward the top of a wall, so the volume control was placed in a box down lower, where it can be operated from the bed or a chair. Of course, these L pads are optional.

Miscellaneous Equipment. 20-gauge speaker wire was used through the Switch-A-Band system, to avoid loss of power in the fairly long runs of wire throughout the house. Lighter wire (24-gauge) would be acceptable for remote locations only 15 or 20 feet away, but heavier wire never hurts, and it costs only a little bit more. The two selector switches which are the heart of the Switch-A-Band setup mount easily in a mini-size utility case.

To let our son monitor late at night without disturbing us I mounted a stereo headphone jack on the same small panel along with the volume control. This automatically disconnects his wall speaker when he plugs in his stereo headphones. We used a stereo jack even though the audio signals from the CB and scanner radios are mono, because he had stereo headphones.

Switch-A-Band works fine with any standard automobile or replacement-grade loudspeakers four or five inches in diameter. These units are 3.2 to 8-ohms (nominal) and will work with any CB and scanner radios when connected to the *External Speaker* jack. Using better-quality speakers here is foolish, because we're concerned only with reproducing voice frequencies, not high fidelity music.



Any number of jacks may be wired in parallel in the various basement (or other) rooms to accommodate a "roving" remote speaker which you then carry about when working in various locations.

Which Speakers? I used these speakers: 5-in, surface mount automobile units in the main living room area, in the garage, and for the roving basement speaker (Radio Shack 12-1842) because they have their own small enclosures. In the kitchen and our son's room 5-in. flush-mounting auto speakers worked out well. And on the patio and near the front door we found that a pair of 4-in. surface-mounting units made for indoor/outdoor use are fine.

One final tip. When you use Switch-A-Band as a public address system—by turning your CB set to its PA position—you should get sound only from the remote speakers because plugging into the CB set's *External Speaker* jack usually turns off the set's built-in speaker. If your set doesn't work this way, and the built-in speaker keeps on working even when the External Speaker jack is being used, thus causing a feedback howl, there's a trick you can use to silence the built-in speaker. Get hold of a "Y" audio connector and wire it to plugs which will fit into both the *External Speaker* jack and the *PA* jack. Then connect the remaining, third leg of the "Y" connector the input leads from the number 1 and 2 terminals of the CB/Scanner selector switch. This will disable the CB set's built-in speaker and prevent acoustic feedback.

Once you've installed your Switch-A-Band you will undoubtedly find other ways to make use of it. Enjoy! ■

MYSTERY RADIO

(Continued from page 85)

PARTS LIST FOR MYSTERY RADIO

C1—250 pF. disc capacitor, see text (Radio Shack 270-1430 or equiv.)

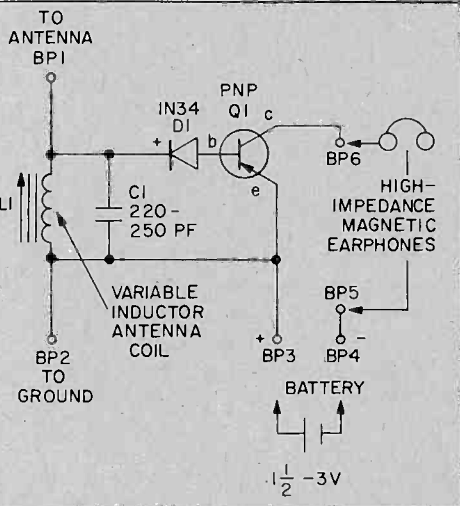
D1—1N34A germanium diode (Radio Shack 276-821 or equiv.)

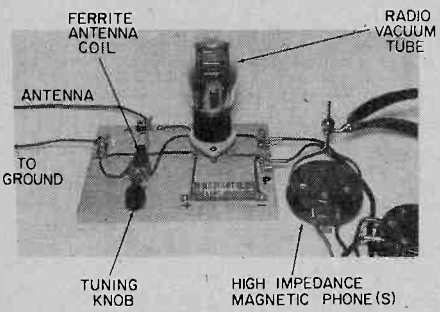
Q1—CK-722 or similar general purpose PNP transistor (Radio Shack 276-2004 or equiv.)

L1—Ferrite rod antenna coil for broadcast band, preferably with mounting bracket (Radio Shack 270-1430 or equiv.)

Phones—Any high impedance magnetic single or pair of phones, 1K to 2K or so. Cannon model CF (Lafayette Radio 40R81048-AN-151 or equiv.)

Misc.—four-prong vacuum tube (see text), four-prong wafer type tube socket (Burstein-Applebee 12A93, Lafayette Radio 32 E 20415 or equiv.), several feet of insulated hookup wire, 3-in. length of strap brass ⅜-in. or ½-in. wide for making battery holder (see text), nine ⅜-in. round-head wood screws, two metal collars for mounting tube socket (see text), 6¼-in. x 5-in. x ½-in. hardwood breadboard, knob to fit L1 adjustment screw. Binding posts (Fahnestock clips). Medium or large size (Radio Shack 270-393 or equiv.)





"One tube" receiver uses any old radio vacuum tube (even a burned-out one). Circuit is up-to-date, using hidden diode and transistor.

with. Clip off the leads going up into the glass bulb. Now solder the diode (D1) and the transistor (Q1) into the pins as shown in the pictorial drawing. To do this put a drop of solder on the end of each pin, as shown. Note that the right-hand filament pin is not used at all.

Check to see that there are no shorts in the wiring, and then cement the glass bulb back on the base using Duco Cement.

Follow the photograph which shows how the parts are mounted and wired onto the wooden baseboard. The diagram shows two Fahnestock clips (BP3 & BP4) to connect your 1½ volt battery to, but if you prefer you can screw a factory-made battery holder onto the base instead. I made two L-brackets from strap brass and screwed them to the base to hold a size AA penlight cell, as shown.

Use any 4-pin socket you can get. If the socket is a wafer type, as shown, use metal collars as stand-offs, and mount the socket with round-head wood screws. If the ferrite loopstick antenna coil (L1) that you buy doesn't have a mounting bracket, simply bend an L from strap brass, drill the necessary mounting holes, and screw the L-bracket to the base.

To Listen. Use a pair of *magnetic* high impedance (1000 to 2000) headphones. A single headphone is fine, too, only these aren't as easy to find as they were when crystal detector radios were all the rage. For your ground connection run a wire to the nearest cold water pipe. A length of wire 25 feet long (or more) will serve as the antenna for local stations.

This radio will pick up some local stations if you're near any strong ones without the long outdoor antenna which you'll need for weaker stations. Just hook any piece of wire to the antenna terminal. In some situations you can even get reception by connecting the antenna terminal to a water pipe and forget about the ground connection. For best results of course use the longest antenna you can, as high as possible, and use a good water pipe for ground.

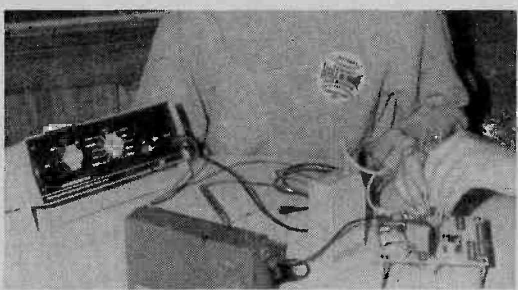
To turn the set on and off just remove one headphone plug from its terminal. This saves the cost of a switch to turn the penlight battery on and off. ■

Lite-Com

(Continued from page 41)

fiber. The signal output of the phototransistor is then amplified by an external amplifier to drive a loudspeaker.

Although we used a handy pocket-size amplifier with built-in speaker (see the Parts List), there's no reason you can't design and build your own small



Lite-Com demonstration using single optical glass fiber to feed infra-red light from transmitter to receiver. Music signals fed from portable radio travel over glass fiber and are heard through small amp/speaker. Optional digital voltmeter at left shows interesting amplitude variations at receiver output.

amplifier. You can also use the *Tape* or *Aux* input on your hi-fi receiver or amplifier. Try bending the light fibers, and you can show how light goes around corners.

Simple Circuits. Lite-Com's two circuits are quite simple and straightforward. Resistor R1 and the DC resistance of T1's secondary winding determine the quiescent current through the LED (5-10 mA). C1 bypasses R1 to increase the AC gain of the circuit. Transformer T1 matches the low impedance of the radio output circuit to the relatively high impedance of the LED circuit thus providing voltage amplification. An alternate circuit shown in the same diagram does away with T1 at the expense of a few decibels of gain.

The receiving photo-transistor is connected in the common-emitter configuration with RC coupling. Capacitor C2 leads to the amplifier-speaker. You can increase R2 and C2 from the values shown and observe the effect of changes on sound quality. To simplify the circuit we use separate power supplies for the transmitter and receiver. This avoids the problems of coupling through the battery.

Construction. Wiring and length of the connections are not critical. You can build the whole unit (receiver and transmitter) on a single perf board as shown in the illustrations or you can use separate boards. After checking your wiring, connect the output of the receiver to whatever amplifier-speaker combination you've decided on. Turn the volume of the amplifier up to full, and place the light receiver under an AC light source. Best is a fluorescent or neon light, but even a normal incandescent light bulb will do. You should hear a loud hum or buzz. Covering up the photo-transistor with your finger will kill the hum or buzzing.

Now connect the output of a radio, tape machine, ceramic phono pickup (most hi-fi systems use magnetic pickups, which must be amplified before they're strong enough to drive the transmitter) or amplified microphone output to the input of your LED transmitter. You will not see any light coming from the LED if you are using the infrared LED. If you are using the visible-light LED you should see red.

Now you can connect the light (visible or infrared) from the LED to the photo-transistor by placing one end of a glass fiber atop each so as to connect them. You will find that the glass fiber transmits the light waves perfectly from the LED transmitter to the photo-transistor receiver, and you will hear the sounds coming from your amplifier-speaker (or hi-fi system) with perfect fidelity. ■

FIRST SW ANTENNAS

(Continued from page 76)

grounding wire and ground rod. An ounce of prevention can save your home.

A dipole has some bonuses. For example, a dipole works equally as well on frequencies three times the designed frequencies. Thus, a 41-meter band dipole which will pull in 7100-7300 kHz signals will also receive 21300-21900 kHz which covers the 13-meter band. Or, if there is sufficient space to string a 195-ft. 2-in. antenna for the 120 meter band (2300-2495 kHz), then you could pull in the 120, 41 and 13-meter bands. Of course, if you want all the shortwave bands, then your best bet is a commercial dipole antenna with built-in wave traps.

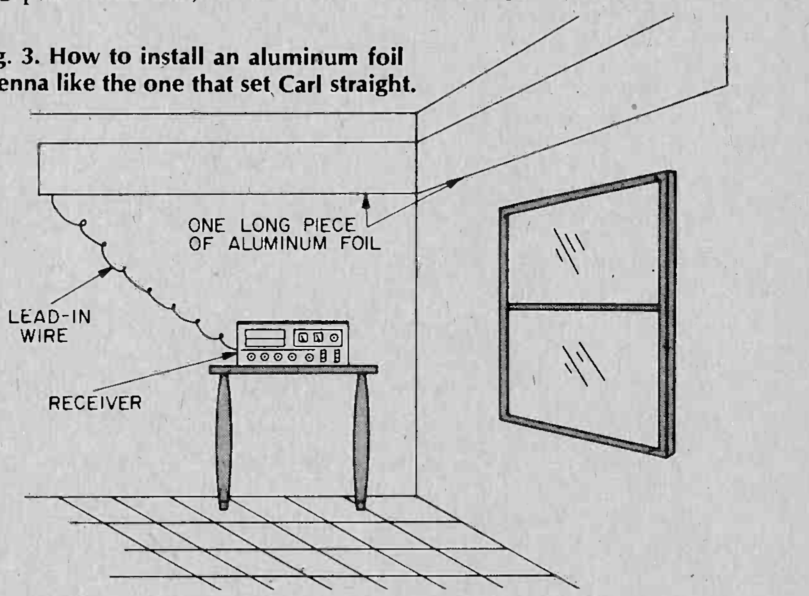
Don't see much of Mort anymore except at the supermarket. Seems he's a "stay-at-home" type lately. Happy DXing, Mort.

Case No. 3—The Cave Dweller. Carl is a fun guy to know except when he's upset. For example, Carl drove over on Sunday afternoon to tell me a story he was barely capable of getting out. He had picked up a used Drake SPR-4 receiver at a fantastic price at a flea market and wanted to get involved with DXing in a hurry. It was important to Carl since he teaches French and German, and shortwave DXing would keep his foreign language skills sharp. Unfortunately, Carl lives on the 14th floor of a 24-story apartment house near the city center. His landlord, actually an agent representing the owner, refuses to let any tenant hang anything out of the windows, let alone permit Carl to install an antenna on his patio. In fact, the American flag is taboo.

I heard his sad story and told him to have his lease available when I visited him the following weekend. When I came to visit, I could see that the lease was "ironclad", so much so that it made baseball's reserve clause seem wishy-washy. That was it, no outdoor antenna for Carl.

I did make him somewhat happy by showing him an old trick. I connected the antenna lead-in wire to the metal finger stop on his phone's dialing mechanism. Reception was good considering the construction of the building, which killed reception even for parts of the AM broadcast band. This was a temporary measure since Carl was soon to get pushbutton phones.

Fig. 3. How to install an aluminum foil antenna like the one that set Carl straight.



Carl was all set to return to the flea market and unload his Drake receiver. He even told me he had planned to panel his room to give the listening shack a comfortable air, but now he wouldn't. "Now just a minute, before you quit," I said to Carl, "let's give it a try." We swiped his wife's kitchen roll of wrapping aluminum and hung it on the wall with masking tape. Two walls were outside walls, so this is where we placed the foil. Fig. 3 shows what we did. It looked kind of silly until we attached a clip lead from the foil to the antenna post of the receiver. Wow! Carl practically cried as he tuned the bands. His wife practically cried too when she saw the wall but calmed down once she realized that wall panels were going up. This antenna cost only 59¢ for the aluminum foil and $45 for the wall panel job.

The last I heard from Carl was he was planning to move to the suburbs where he had purchased an old homestead on six acres. I wonder what he had in mind. ■

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302. *International crystal* has illustrated folders containing product information on radio communications kits for experimenters (PC boards; crystals; transistor RF mixers & amplifiers; etc.).

303. See brochures on *Regency's* 1977 line-up of CB transceivers & scanner receivers (for police, fire, weather, & other public service emergency boadcasts).

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

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

306. Get *Antenna Specialists'* catalog of latest mobile antennas, test equipment, wattmeters, accessories.

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

310. *Turner* has two booklets on their Signal Kicker antennas. They give specifications and prices on their variety of CB base and mobile line. Construction details help in your choice.

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

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

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

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317. *Teaberry's* new brochure presents their complete lines of CB and marine transceivers and scanners for monitoring police, fire and other public service frequencies.

318. CBers, *GC Electronics'* 16-page catalog offers the latest in CB accessories. There are base and mobile mikes and antennas; phone plugs; adaptors and connectors; antenna switchers and matchers; TVI filters; automotive noise suppressor kits; SWR power and FS meters; etc.

319. *Browning's* mobiles and its famous Golden Eagle base station, are illustrated in detail in the new 1977 catalog. It has full-color photos and specification data on Golden Eagle, LTD and SST models, and on "Brownie," a dramatic new mini-mobile.

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.

322. *Radio Shack's* 1977 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. Get *Lafayette Radio's* "new look" 1977 catalog with 260 pages of complete electronics equipment. It has larger pictures and easy-to-read type. Over 18,000 items cover hi-fi, CB, ham rigs, accessories, test equipment and tools.

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329. Semiconductor Supermart is a new 1977 catalog listing project builders' parts, popular CB gear, and test equipment. It features semiconductors—all from *Circuit Specialists.*

330. There are over 400 electronic kits described in *Heath's* new catalog. Virtually every do-it-yourself interest is included—TV, radios, stereo & 4-channel, hi-fi, etc.

331. *E. F. Johnson* offers their CB 2-way radio catalog to help you when you make the American vacation scene. A selection guide to the features of the various messenger models will aid you as you go through the book.

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.

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

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

337. *Pace* communications equipment covers 2-way radios for business, Industrial and CB operations. Marine radiotelephones and scanning receivers are also in this 18-p. book.

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.

342. *Royce Electronics'* new full-color catalog updates information on their CB transceivers (base, mobile, handheld). It also describes new product lines—CB antennas and a VHF marine radiotelephone.

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

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.

350. Send for the free *NRI/McGraw Hill* 100-page color catalog detailing over 15 electronics courses. Courses cover TV-audio servicing, industrial and digital computer electronics, CB communications servicing, among others. G.I. Bill approved, courses are sold by mail.

352. Send for the free descriptive bulletin from *Finney Co.* It tells all about their new auto FM radio signal booster (eliminates signal fading).

353. *MFJ* offers a free catalog of amateur radio equipment—CW and SSB audio filters, electronic components, etc. Other lit. is free.

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LED/Chip Photo-Helper

(Continued from page 88)

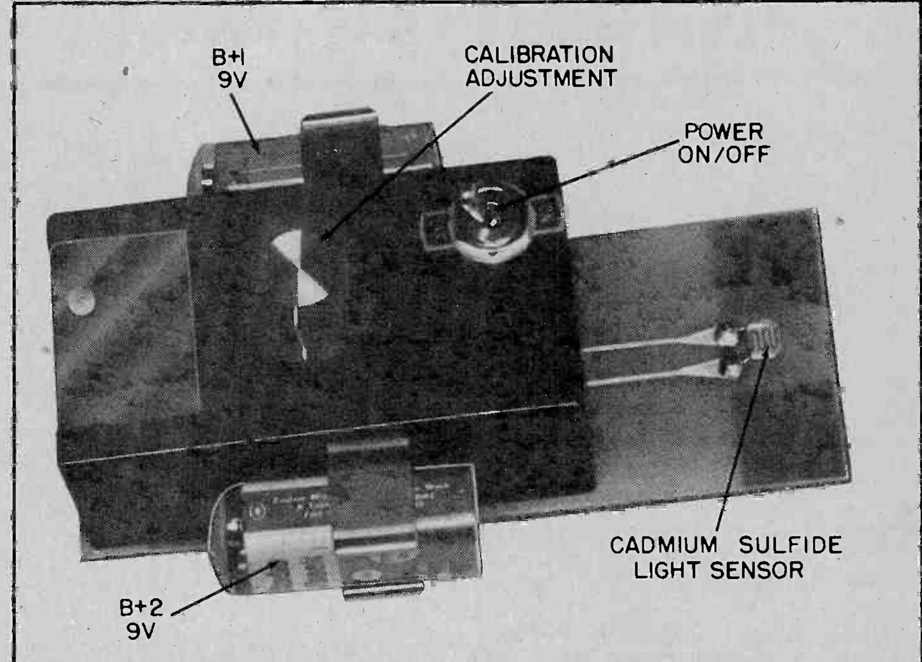
LED/Chip Photo-Helper, connect the batteries and turn the power switch On. One LED should immediately come On. Rotate the control from one extreme to the other, and note that at some point each LED will come On in succession, but only one LED will be On at any given time. If more than one LED lights at a time, check whether you are working under fluorescent lighting. If so, move to a room lit with an incandescent lamp and repeat the test. If there is no fluorescent light near, the fault is in the circuit itself. Check the PC board for solder bridges, loose pigtails or wires, or defective foil traces. If none of these can be found, the fault is in one of the integrated circuits, and it should be replaced with another of the same type. If one of the LEDs fails to light, but otherwise the circuit operates normally, exchange the LED for another one known to be good. When the LED/chip meter is operating properly, proceed with calibration.

The Photo-Helper was designed to be used with a photographic enlarger, to ensure making black-and-white and color prints with repeatable success. If a good-quality enlarger is available, and you have access to a transparent step-tablet (gray scale), calibrate the LED/chip as follows.

Calibration. With the step-tablet in the enlarger's negative slide, measure each segment, using the LED/chip by noting the setting of the control that causes the center LED (LED3) to come On. Next, make a series of test prints, using different exposures and development times, to produce a succession of prints of the step-tablet of differing contrasts. Note on the print the exposure and development used, and beside each segment of the step-tablet note down the setting of the LED/chip control.

When ready to print a negative, measure the lightest and darkest areas of the negative with the LED/chip. Select the test print (made earlier) with the most desirable contrast range within the measured values, and use the exposure and development information recorded on the test print to determine the exposure to be used.

When setting the LED/Chip control with light from the enlarger, you can use a diffusion lens in conjunction with the enlarger lens to average out the illumination from the various parts of the negative. This ensures that the light being measured is a fair sampling from the entire area of the negative, and avoids measuring a too-dark, or too-light part of the picture. Of course the diffusion lens is swung out of the way after the LED/Chip Photo-Helper is calibrated, so that the negative may be properly exposed.

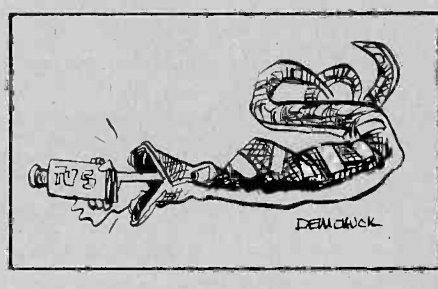


Assembled LED/chip Photo-Helper has light sensor on board, at right. Five LEDs are mounted under the transparent window at left. Only one LED lights at a time.

Transparent step-tablets can be purchased at any photo-supply shop or graphic-arts store for a few dollars. They come in a number of types, from some with 25 or more segments to those that include a color analyzing section containing color spots. Most low-cost step-tablets are not calibrated for their photographic densities but have instead an arbitrarily-numbered scale on one side. Calibrated step-tablets are available, of course, but their high cost makes them unreasonable for use with the LED/Chip. An inexpensive step-tablet can be calibrated by placing each segment under a transmission densitometer and recording each reading. Most newspaper and many color printing shops usesuch a desitometer.

Another useful function the photometer has is to ensure that a constant amount of light will reach the enlarger easel, regardless of the lens used or the magnification (enlargement). Make a mark on the LED/Chip control scale at the setting that corresponds to the desired light intensity, reading the LEDs as before. In most cases, this may be a particular segment in a step-tablet. When making a print or, in the author's case, a process color separation, include the step-tablet with the negative. With the desired lens in place and the enlarger set to the correct enlargement, locate the photocell under the same segment in the step-tablet that was used earlier. Adjust control R2 to the mark made earlier, and then set the lens aperture until the center LED comes on. This feature is especially useful in the graphic arts, where a common set of exposures is desired for any type of halftone or color-separation work done on a particular enlarger.

Using the components in our parts list, the LEDs will automatically respond at increments of one f/stop (f/stop is the term used to describe the setting of the lens aperture, one f/stop higher or lower means that either half or double the amount of light is transmitted by the enlarger lens.) If another type of CdS cell is used in place of the photocell listed in the Parts List, the values of resistors R3 through 7 may have to be changed to allow for the different response characteristics of the new photocell. All the components are easy to come by, and the total cost of the LED/Chip Photo-Helper should not be more than $10.00—considerably less if parts are scrounged from your junk box. ■



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RADIO & TELEVISION

"DISTANCE One Tuber" Handbook—50¢. 15 Distance one tube plans—25¢. Catalog 25¢, refundable. Laboratories, 1477-EH, Garden Grove, Calif. 92642.

TV TUBES 36¢ each. Send for Free 48 page color catalog. Cornell, 4217-W University, San Diego, California 92105.

CBer's! Personalized CB decal with a 1-year subscription to Elementary Electronics only $3.97. E/E, the magazine that covers CB and all areas of radio communication. Send check: Elementary Electronics, Decal Dept., 229 Park Ave., S., New York, NY 10003.

MONEYMAKING OPPORTUNITIES

STUFF, MAIL ENVELOPES!! $250.00 profit per thousand possible. Offer details: Stamped, self-addressed envelope. Kinks, B-21487K-EH-106, Fort Lauderdale, FL 33306.

MONEYBROKERS needed! Large earnings guaranteed! Full training! JLS Associates, 391 Gregg, Buffalo Grove, IL 60090.

$500.00 PROFIT Stuffing 1000 envelopes, 25 Cents Details: Canapro Enterprises, Box 215C, Station "H," Montreal, Que., Canada.

$CASH$ CLIPPING NEWSPAPER ITEMS/Addressing envelopes. Information Free! Income, Box 721D, Lynbrook, NY 11563.

I make $52,000 yearly mailing letters. How? Write: Sandco-IO, Ceres, CA 95307.

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SELL YOUR PHOTOS. Informative report tells how and where to make money with your camera. Reveals color slide markets. Order now! Only $1.50. Products International, Dept. D-4, 5242 Bungalow Ln., Houston, TX 77048.

INCREDIBLE guarantee highlights valuable newsletter free. Gentry Publications, P.O. Box 4163DG, Atlanta, GA 30331.

BIG $$$ mailing letters. Free details. Shields, 18653 Groverdale, Covina, CA 91722.

FREE "1001 ODDS"! It's about $10,000-$100,000 actually made at home by certain oddballs! You'll never get over it! Publico-E, Carlsbad, CA 92008.

SALE: $50 worth money makers regularly $5, now $3: details 25¢! Seidel, Stanhope, NJ 07874.

SELL YOUR PHOTOS. Report tells how and where. Send $1.50. Thurber, Box 27559, San Francisco, CA 94127.

HOMEWORKERS! Big $$$ stuffing envelopes. Write: Woodco, 2513 Furmint, Codova, CA 95670.

PERSONAL

SINGLE? Widowed? Divorced? Nationwide introductions! Identity, Box 315-DC, Royal Oak, MI 48068.

JAPANESE introduction! Girl's photographs, descriptions, brochure, details. $1.00. INTER-PACIFIC, Box 304-SC, Birmingham, MI 48012.

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DATES GALORE! Meet singles-anywhere. Call DATELINE. toll-free (800) 451-3245.

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LIVE longer! Booklet reveals secrets of a long and healthy life. Send $1.50 to David Rowland, 139 East Grand, Springfield, OH 45505.

"DATE WITH DIGNITY" Professional Matching. Drawer 6765, Fort Worth, 76115 (817) 921-0281 Anytime.

OVER 1000 beautiful ladies photos, world's largest matrimonial catalog $5.00. Interpress: Box 12, Toronto M4A 2MB or Box 737, Ft. Lauderdale 33302.

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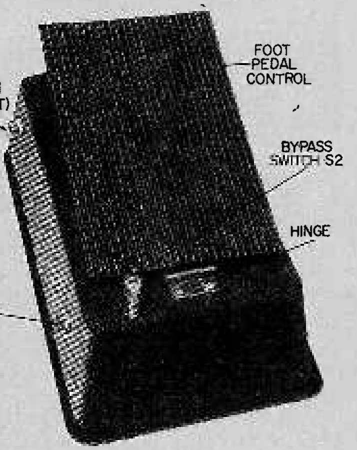
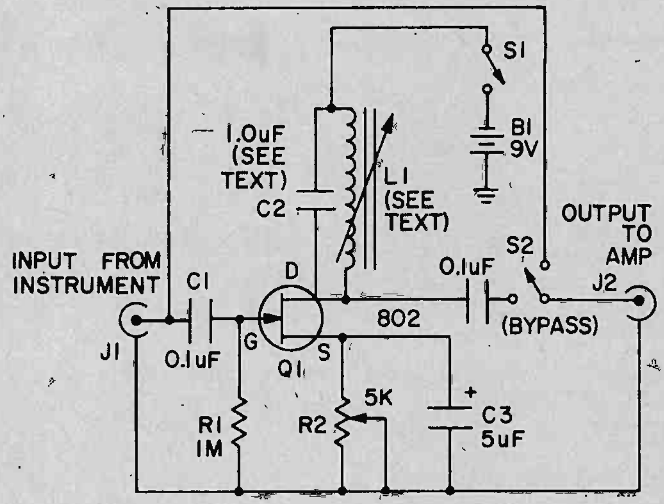
WAAAT'S THAT SOUND

(Continued from page 36)



Wah-sound foot pedal control ready to work. Your instrument (guitar or whatever) plugs into the rear-side jack, and connecting cable to your amplifier-speaker plugs into the front side jack. Bypass switch is foot-operated to cut the foot-pedal in.



PARTS LIST FOR WAH-WAH PEDAL

B1—9-volt transistor radio battery
C1, C4—0.1 uF tubular capacitor—any voltage over 50.
C2—See text. 1.0 uF (not electrolytic) capacitor any voltage over 50.
C3—5.0 uF, 15 VDC miniature electrolytic capacitor
L1—Inductor, home brewed on old AM antenna ferrite loopstick
Q1—Field Effect Transistor (FET) Motorola HEP 802
R1—1-megohm ½-watt carbon resistor
R2—5K miniature potentiometer printed circuit board mtg.
S1—SPST power On/Off switch
S2—SPDT push On, push Off switch
Misc.—Connecting clip for battery, small perfboard; perfboard terminal clips, push-in type; aluminum strip 18 gauge, 1-in. x 6-in. approx.; small piece rubber matting; masonite or thin composition board (see text); small breadpan.

through the sheet metal because this is where the slug shaft is anchored, using sweat soldering. The slug is properly positioned when it is perpendicular to the top of the pan with the pedal at a 40-degree angle. Bring the bracket with the coil in from the bottom, slip the slug into the form, and find a mounting angle for the bracket that allows the slug to travel freely up and down. Bore mounting holes for the bracket and screw it securely in position. Remove the slug from the coil momentarily and drop a small spring into the form. Find a spring size that allows as much travel vertically as possible. The rest of the assembly should be clear from the photos. The circuit board is held off the pan with a small spacer, and the battery clamp is bent from sheet aluminum.

It will take some practice to coordinate the use of the Wah sound with your playing, but once you have the trick, you'll have the listeners all asking *Waaah's that Sound?* ■

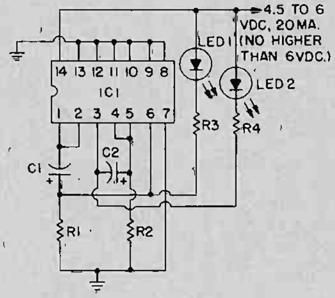
Low Power Blinker

☐ Sometimes things that start out as toys wind up as circuit hardware. This device started out as winking bow-tie lights, but its low current consumption of 20 mA or less makes it ideal as a power indicator for "dangerous" or portable equipment where something more is needed than a light that just glows. If you purchase the IC, LEDs and capacitors from a "surplus" dealer the whole thing should cost less than $2. The circuit uses a standard 7400 IC as a multivibrator, and the values shown cause the lamps to alternate at a rate of approximately once a second. The timing is determined by the values of R1, R2, C1 and C2, but it's best not to make the resistance values higher than 4700 ohms. So if you want to change the timing rate you should change the values of C1 and C2. Increasing the capacitance slows down the rate of change.

Any LED indicator rated from 20 to 40 mA can be used. Use whatever is least expensive. Four penlight batteries (6-VDC) can be used as a portable power supply, but the circuit will work with only three penlights (4.5-VDC). If you use 4.5-volts try to use 20 mA LEDs for greatest brightness. Ground all unused IC terminals. ■

PARTS LIST FOR LOW POWER BLINKER

IC1—Type 7400 integrated circuit
LED1, LED2—see text
R1, R2—4700-ohms, ½-watt resistor
R3, R4—120-ohms, ½-watt resistor
C1, C2=50-uF capacitor, rated 6-VDC or higher



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Experience is the best teacher. You might settle for any CB first time around. Understandably. A lot of people think they're all pretty much alike. But you'll soon discover that, like everything else, there are exceptions.

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Talk to Cobra. And you know you're punching through. One glance at the 29's over-sized illuminated meter tells you just how much power you're punching out and pulling in. For voice modulation the DynaMike delivers at 100%. Same way with power: The 29 transmits at maximum power levels.

Sooner or later you'll get a Cobra. And you'll get engineering and craftsmanship second to none. Performance that will make your first CB seem obsolete. Reliability and durability that have set standards for the industry. Above all, you'll get power. The power to punch through loud and clear like nothing else. Because when it comes to CB radio, nothing punches through loud and clear like a Cobra.

Cobra

Punches through loud and clear.

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IF YOUR FIRST CB ISN'T A COBRA YOUR SECOND ONE WILL BE.