GERNSBACK SPECIALTY SERIES 49604

1991 ELECTRONICS EXPERIMENTERS handbook™

Radio Electronics

164 PAGES!

BUILD THIS LIGHT-BEAM COMMUNICATOR

$3.50 U.S.
$3.95 CAN.

BUILD ONE OF THESE!

★SPECTRUM MONITOR
★ALPHA MEDITATION GOGGLES
★REMOTE A/B SWITCH

TECHNOLOGY

★TRACKING DOWN EAVESDROPPING BUGS
★FMX NOISE REDUCTION
★CHOOSING SHORTWAVE ANTENNAS

VIDEO PROJECTS

★AMATEUR TV TRANSMITTER
★SCENE SWITCHER
★REMOTE-CONTROL EXTENDER

ELECTRONIC HOW-TO

★SOLVING VCR TAPE-LOAD PROBLEMS
★SERVICING DIGITALLY TUNED RADIOS
★AUTOMATED TEST EQUIPMENT

COMPUTER PROJECTS

★RGB-TO-NTSC CONVERTER
★68705 MICROCONTROLLER
★D/A CONVERTER

AUDIO PROJECTS

★ACOUSTIC FIELD GENERATOR
★SUBWOOFER SIMULATOR
★PHONE-ACTIVATED AUDIO MUTE

Countersurveillance

Never before has so much professional information on the art of detecting and eliminating electronic snooping devices—and how to defend against experienced information thieves—been placed in one VHS video. If you are a Fortune 500 CEO, an executive in any hi-tech industry, or a novice seeking entry into an honorable, rewarding field of work in countersurveillance, you must view this video presentation again and again.

Wake up! You may be the victim of stolen words—precious ideas that would have made you very wealthy! Yes, professionals, even rank amateurs, may be listening to your most private conversations.

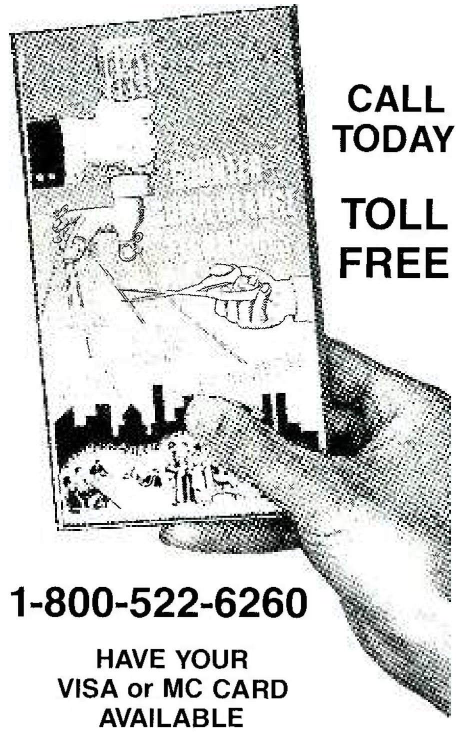
Wake up! If you are not the victim, then you are surrounded by countless victims who need your help if you know how to discover telephone taps, locate bugs, or "sweep" a room clean.

There is a thriving professional service steeped in high-tech techniques that you can become a part of! But first, you must know and understand Countersurveilance Technology. Your very first insight into this highly rewarding field is made possible by a video VHS presentation that you cannot view on broadcast television, satellite, or cable. It presents an informative program prepared by professionals in the field who know their industry, its techniques, kinks and loopholes. Men who can tell you more in 45 minutes in a straightforward, exclusive talk than was ever attempted before.

Foiling Information Thieves

Discover the targets professional snoopers seek out! The prey are stock brokers, arbitrage firms, manufacturers, high-tech companies, any competitive industry, or even small businnesses in the same community. The valuable information they filch may be marketing strategies, customer lists, product formulas, manufacturing techniques, even advertising plans. Information thieves eavesdrop on court decisions, bidding information, financial data. The list is unlimited in the mind of man—especially if he is a thief!

You know that the Russians secretly installed countless microphones in the concrete work of the American Embassy building in Moscow. They converted what was to be an embassy and private residence into the most sophisticated recording studio the world had ever known. The building had to be torn down in order to remove all the bugs.



CALL TODAY TOLL FREE

1-800-522-6260

HAVE YOUR VISA or MC CARD AVAILABLE

Stolen Information

The open taps from where the information pours out may be from FAX's, computer communications, telephone calls, and everyday business meetings and lunchtime encounters. Businessmen need counselling on how to eliminate this information drain. Basic telephone use coupled with the user's understanding that someone may be listening or recording vital data and information greatly reduces the opportunity for others to purloin meaningful information.

RADIO-ELECTRONICS VIDEO OFFER EEHB
500-B Bi-County Blvd.
Farmingdale, NY 11735

Please rush my copy of the Countersurveillance Techniques Video VHS Cassette for $49.95 plus $4.00 for postage and handling.

No. of Cassettes ordered ________
Amount of payment $________

Bill my ☐ VISA ☐ MasterCard
Card No. ________
Expire Date ____ / ____

Signature ________
Name ________
Address ________
City ________ State ____ ZIP ____

All payments in U.S.A. funds. Canadians add $4.00 per VHS cassette. No foreign orders. New York State residents add applicable sales tax.

The professional discussions seen on the TV screen in your home reveals how to detect and disable wiretaps, midget radio-frequency transmitters, and other bugs, plus when to use disinformation to confuse the unwanted listener, and the technique of voice scrambling telephone communications. In fact, do you know how to look for a bug, where to look for a bug, and what to do when you find it?

Bugs of a very small size are easy to build and they can be placed quickly in a matter of seconds, in any object or room. Today you may have used a telephone handset that was bugged. It probably contained three bugs. One was a phony bug to fool you into believing you found a bug and secured the telephone. The second bug placates the investigator when he finds the real thing! And the third bug is found only by the professional, who continued to search just in case there were more bugs.

The professional is not without his tools. Special equipment has been designed so that the professional can sweep a room so that he can detect voice-activated (VOX) and remote-activated bugs. Some of this equipment can be operated by novices, others require a trained countersurveillance professional.

The professionals viewed on your television screen reveal information on the latest technological advances like laser-beam snoopers that are installed hundreds of feet away from the room they snoop on. The professionals disclose that computers yield information too easily.

This advertisement was not written by a countersurveillance professional, but by a beginner whose only experience came from viewing the video tape in the privacy of his home. After you review the video carefully and understand its contents, you have taken the first important step in either acquiring professional help with your surveillance problems, or you may very well consider a career as a countersurveillance professional.

The Dollars You Save

To obtain the information contained in the video VHS cassette, you would attend a professional seminar costing $350-750 and possibly pay hundreds of dollars more if you had to travel to a distant city to attend. Now, for only $49.95 (plus $4.00 P&H) you can view ***Countersurveillance Techniques*** at home and take refresher views often. To obtain your copy, complete the coupon below or call toll free.


East of the sun.
West of the moon.
Windjammer.
A place to live your fantasies.
A place to free your soul.
To cozy up to the Caribbean sun.
To dance among a thousand stars
to the rhythms of steel drums.
To play on sparkling white and
pink sand beaches.
To discover the underwater
paradise of the reefs.
To find a new friend and share the
intimacies of a sensuous night.
To come alive and live.
To remember for a lifetime.
6 days and 6 nights. From $675.
Reservations toll free
1-800-327-2600
In Florida 305/373-2090.
Windjammer 'Barefoot' Cruises
Post Office Box 120.
Miami Beach, Florida 33119
"Cap'n Mike, rush me my free, full color 'Great Adventure' booklet and sh
me the way to Paradise for 6 days and 6 nights from $675."
Windjammer 'Barefoot' Cruises.
P.O. Box 120. Dept. 1642 Miami Beach, Fla. 33119.
Name
Address
City
State/Zip

HOBBY ELECTRONICS

From the Publishers of Radio-Electronics

Hands-on Electronics

THE MAGAZINE FOR THE ELECTRONICS ACTIVIST!

$2.50 U.S.
WINTER 1985
$2.95 CANADA
48784
3

BUDGET ROBOTICS

There are a few robots that you can take home, but you may have to assemble them!

LOW-COST TEST GEAR

Tips on setting up the beginner's basic test bench will get you more gear per dollars.

WHAT IS E.M.P.?

Electromagnetic pulse—It can stop your car, destroy your computer and bring a nation to a standstill.

DIGITAL FUNDAMENTALS

We kick-off with Binary Numbers in our initial basic theory course.

PLUS PROJECTS—

- Hands-Free Telephone
- Computer RF Modulator
- Stereo Power Meter
- One-Octave Toy Organ
- Tri-Waveform Generator

Plus—Articles on Ham Radio, computers, scanners, tools, shortwave, and much more!

JACOB'S LADDER

Build this project that repeatedly generates a climbing electric arc, and amaze your friends!

A GERNSBACK PUBLICATION

0 71896 48784 03

Now! Tek quality and expert advice are just a free phone call away!

100 MHz dual time base scope. Easy-to-read CRT; bright, full-sized 8x10 cm; 14 kv accelerating potential complete with BEAM FIND, separate A/B dual intensity controls, FOCUS and TRACE ROTATION.

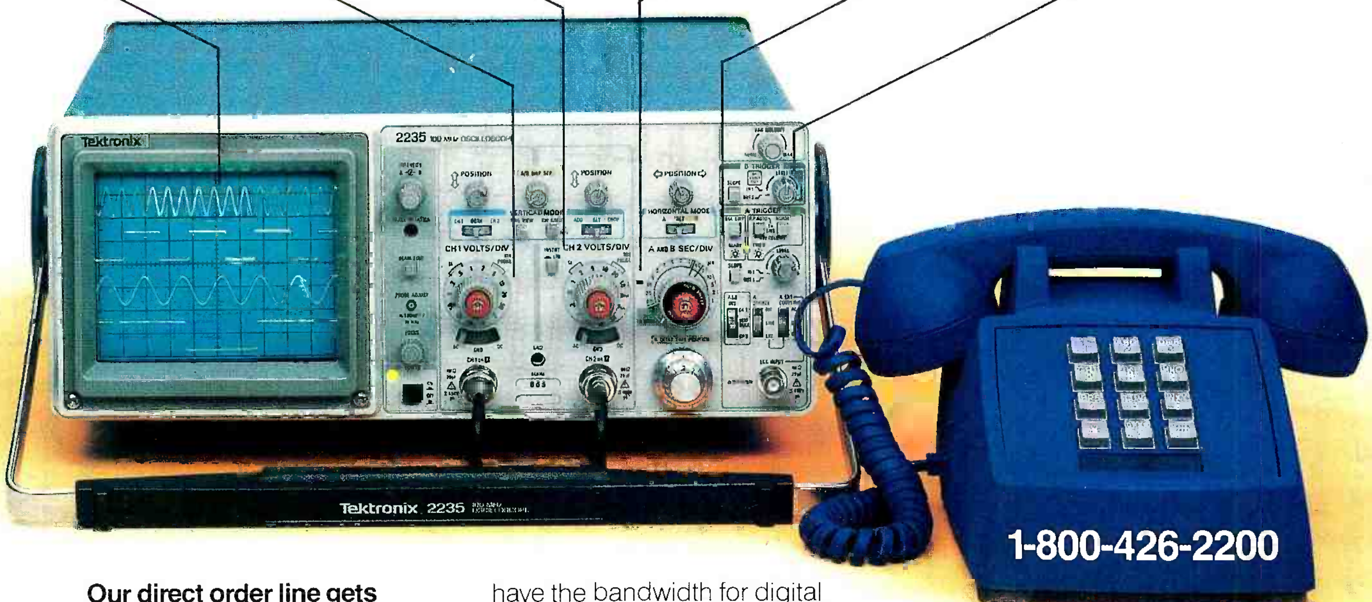
Wide range vertical sensitivity. Choose from 2 mV/div (1x probe) to 50 V/div (10x probe); color-keyed for 1x and 10x probes; variable control increases scale factor by 2.5 to 1.

Two 100 MHz, high sensitivity channels. 3.5 ns risetime; dc to ≥ 100 MHz bandwidth from 5 V/div to 5 mV/div; extended sensitivity of 2 mV/div at ≥ 90 MHz.

A/B sweep selection. Calibrated A sweeps from 50 ns/div to 0.5 s/div; B sweeps from 50 ns/div to 50 ms/div; variable control for up to 2.5 to 1 reduction and 10x magnification for sweeps to 5 ns/div.

Dual time base measurements. Select either A or B sweeps, or both alternately with A intensified by B.

B trigger slope and level. Use B trigger level to select B-triggered or run-after-delay modes; use B TRIGGER SLOPE to select transitions.



Our direct order line gets you the industry's leading price/performance portables... and fast answers from experts! The 60 MHz single time base delay 2213A, the 60 MHz dual time base 2215A and the 100 MHz dual time base 2235 offer unprecedented reliability and affordability, plus the industry's first 3-year warranty* on labor and parts, CRT included.

The cost: just $1200 for the 2213A, $1450 for the 2215A, $1650 for the 2235.† Even at these low prices, there's no scrimping on performance. You have the bandwidth for digital and analog circuits. The sensitivity for low signal measurements. The sweep speeds for fast logic families. And delayed sweep for fast, accurate timing measurements. All scopes are UL Listed and CSA approved.

You can order, or obtain literature, through the Tek National Marketing Center. Technical personnel, expert in scope applications, will answer your questions and expedite delivery. Direct orders include comprehensive 3-year warranty*, operator's manual, two 10X probes, 15-day return policy and worldwide service backup.

Order toll free: 1-800-426-2200, Ask for Rick.

In Oregon, call collect (503) 627-9000.
Or write Tektronix, Inc.
P.O. Box 500, Delivery Station Y6-088
Beaverton, OR 97077

Tektronix®
COMMITTED TO EXCELLENCE

Don't miss out again!

Send away today for your 36-page booklet containing a complete reprint of all seven articles in the series on Backyard Satellite TV Receivers by Robert B. Cooper Jr.

This all-inclusive report gives you all the data you need to build your own Backyard Satellite TV Receiver.

■ TELLS ALL ABOUT domestic satellite communications, with full details on how you can pull those elusive TV signals from space.
■ LEGAL REQUIREMENTS, technical specifications, and how you, the home constructor, can meet them. Find out what mechanical and electronics skills you need.
■ RECEIVER CHARACTERISTICS, technical details and specifications, along with examples of actual receivers built at comparatively low cost.
■ ANTENNA DESIGN... and exactly how you can build a spherical antenna, while keeping total earth-station cost for the complete system under $1,000.
■ THE FRONT END is critical when you build your own system. We help you explore several different approaches to making one that will work for you.
■ RECEIVER-SYSTEM hardware, and how it goes together to bring you direct-from-satellite TV reception in your own home.

To order your copy:
Complete coupon and enclose it with your check or money order for $7.00, plus $1.00 for postage and handling. We will ship your reprint within 6 weeks of receipt of your order. All others add $4.00 for postage. New York State residents must add 58¢ sales tax.

Radio-Electronics
Satellite TV Reprints
45 East 17th Street
New York, N.Y. 10003

Please print HOE#3

________________ (Name)

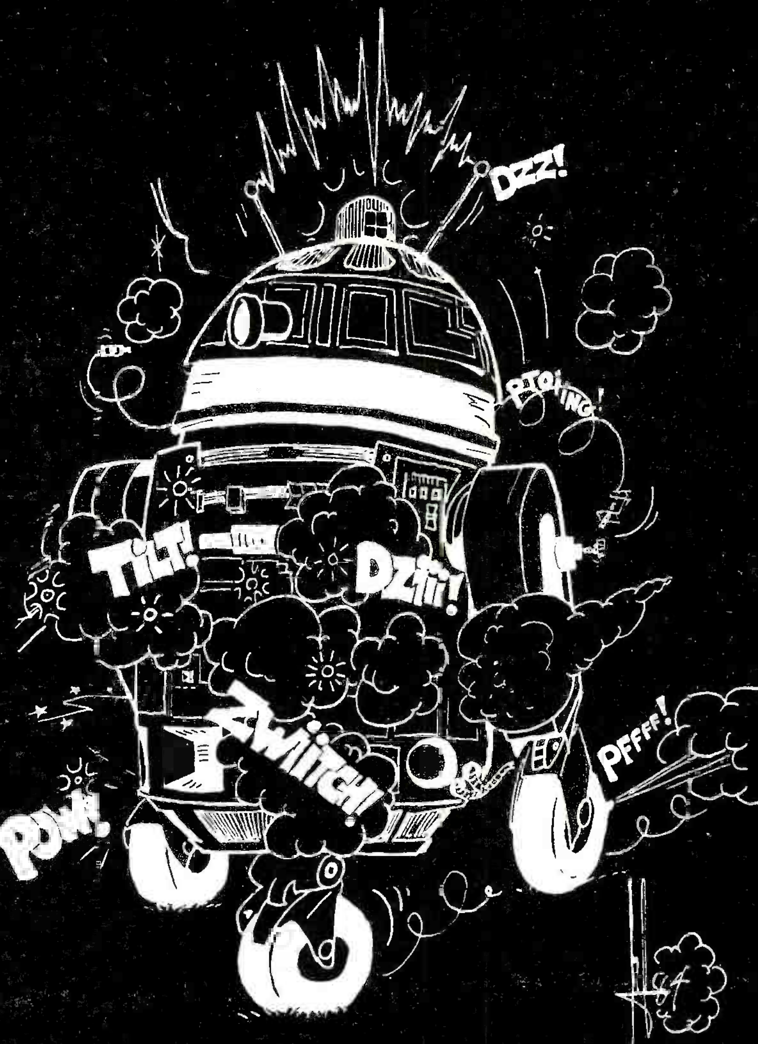
________________ (Street address)

________________ (City) (State) (Zip)

I want ________ reprints @ $7.00 each, plus $1. Handling & Postage.
I have enclosed $ ________. N.Y. State residents must add sales tax.

Hands-on Electronics
WINTER 1985

BUDGET ROBOTICS



Robots, the lifelike vision from our imagination, is the workman of our industry today, assembling consumer products as small as pocket radios and as large as automobiles!

By Robin J. Dunitz

Drawing courtesy of Nation Research Council of Canada

☐HOBBYISTS AND EXPERIMENTERS ARE KEY PLAYERS IN today's infant robotics field. Current robots are still only pale shadows of such fictional heroes as *Star Wars'* C3PO or Robbie the Robot of *Forbidden Planet*. It only has been in the last few years that computer advances, especially the microprocessor, have made it possible to build a machine that is both programmable and mobile. While some very expensive, and mainly experimental, equipment does have advanced capabilities in fields such as vision and speech recognition, what is available to the hobbyist on a limited budget is not nearly so sophisticated.

At the same time, today's robots can be extremely valuable as a means to delve into the new and exciting field of robotics. Commercially sold kits, and even already-assembled robots, can introduce the novice to programming, or show the advanced programmer whole new applications. And problems like robot locomotion through the obstacle-filled home environment offer a real challenge, one that occupies commercial developers and garage tinkers alike. So, here, then, are some of the products available today for those anxious to be part of the future.

Industrial Robots

It is in factory settings that robots are finding their first practical applications. Such industrial machines more resemble metallic arms than the androids of science-fiction lore. Their mobility is generally limited to movements of one or more joints, and so far they are proving most useful at single-task operations like parts manipulation, welding, handling dangerous substances, and painting. Those robots can cost tens of thousands of dollars and up, and thus are not in the reach of hobbyists.

It is predicted that use of industrial robots in the United States will increase dramatically in the next several years. According to one report (by Prudential-Bache Securities and Daiwa Securities America), use of robots in American factories is expected to go from 8100 units in 1985 to 21,575 units (of all types) by 1990.

There are only a few low-cost robotic arms of possible interest to the experimenter. Armatron, currently distributed by Radio Shack, costs just $31.95. It is battery-operated and controlled by two joysticks. The rubber-coated grippers can pick up, rotate, grip, move, and release. It is 14-inches tall at maximum arm extension. According to one-seventh grade science student in New Mexico, it is possible to make an interface to connect Armatron to a home computer. He spent only an added $30, connecting six motors to control the robotic arm's six joints. Using wood as bearing blocks, he connected motor shafts to the robot's gears. He used transistors as switches to power the motors with 6-volt power supplies. A 4-bit word from his Commodore Vic-20's port is decoded into 12 lines of data. Two lines are used to give the forward and reverse commands to each motor.

For the less adventurous, it is also possible to obtain a commercially produced interface from Analog Micro Systems in Colorado.

Spectron Instrument of Denver, Colorado, sells two robotic arms. The first is called Robot I and is a two-axis articulated arm. Under computer control, it can simulate general material handling operations as done by industrial models. Motion is accurate to ±1 inch. Reach is 7-inches square. The gripper can carry a one-ounce load. Robot I sells for $125 in kit form, $210 fully assembled and tested.

Robot I is also available with vision module, called VIS. Included is a photo sensor with a close-up lens, and illuminator LED's. VIS can view a .04 inch spot on a table, can resolve black—as well as 256 gray levels. Each arm position can generate a vision input of up to 64,000, although only a few points can be examined each second. Using an interface adaptor to a home computer, and the BASIC language, data is entered using PEEK commands. The combination Robot-VIS kit sells for $160, fully assembled $265 ($200/330 with computer adaptor).

Robot IV is a four-axis articulated arm, which can grip small objects and manipulate them in three dimensions. It has a two-fingered gripper, having 180-degree rotation capability. The arm can cover an area about 6 inches by 6 inches, and can carry a one-ounce load. The servo-drive circuit requires at least four analog inputs for lateral motion, lift motion, radial motion, and gripper rotation, as well as a single digital input for gripper operation.

To connect Robot IV to a home computer, two interface boards are necessary. POKE commands into five separate address locations determine arm motions. Robot IV costs $250 for the kit, $415 assembled. The combination package, including sensors and computer adaptors, sells for $400 as a kit, $660 tested and assembled.

Spectron Instrument also sells a variety of vision and automation kits separately, plus servo motor actuators and drive circuits. For more information contact them at 1342 W. Cedar Ave. , Denver, CO 80223: (303) 744-7088.

Personal Robots—are they good for anything?

During April, 1984, more than 1000 robotics experimenters, exhibitors and other enthusiasts met in Albuquerque, New Mexico at the First International Personal Robot Congress and Exposition. Most people who spoke there seemed to agree that personal robots can't help much yet with housework, or cook dinner, or even get the newspaper—if there are any obstacles, like steps, in the way. Limited home security is one possible use for some of the more sophisticated types. Really, though, for the time being, one of the best applications for personal robots is as a tool for learning.

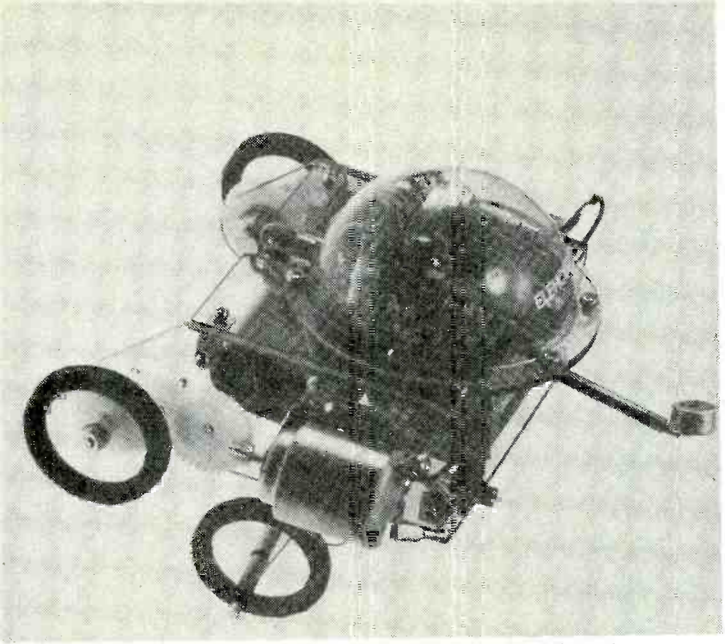
Robots are computers that move. Some of the biggest challenges facing the designers of home robots involve figuring out how such a machine can move effectively on different surfaces (for example, over carpet as well as linoleum), and how it might sense and react to such common obstacles as furniture, walls, doors, toys, and people.

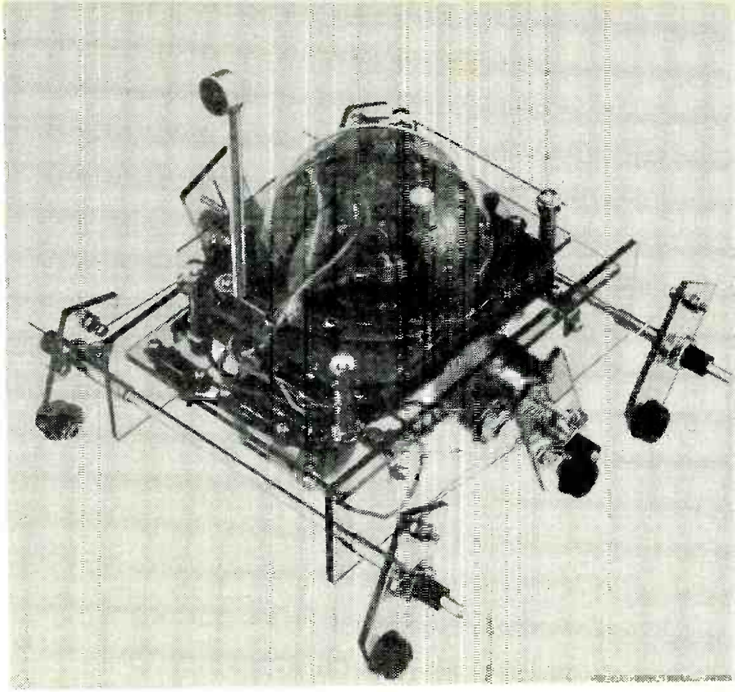
In order to move and detect external interference, a robot must have sensors of some kind. Most commonly used are sonar, light, tactile, and to a lesser extent, heat. A robot might use one, all, or a combination of such sensors. How it responds to an obstacle, upon detection, depends on how it has been programmed.

Software is the key in robotics, just as it is for computers generally. Once certain minimal hardware requirements are met, how intelligent a robot actually behaves depends on its

COMPARISON OF HERO I AND HERO JR.

Feature	Hero I	Hero Jr.
CPU	8-bit 6808	8-bit 6808
Memory	RAM = 4K ROM = 8K	RAM = 8K ROM = 32K (built-in routines)
Program Language	Machine language	Full pre-programmed (English) RS-232 port + BASIC cartridge
Input Devices	Hexadecimal keypad Remote control pendant RF Cassette recorder (not incl.) via serial port	17-key keypad for modifying personality Extra cartridges available
Power Supply	Rechargeable gel batteries, including external charger	Batteries operate 4-6 hrs (incl. 2) plug-in wall charger included
Movement	3 wheels Front wheel has 12 in. turning radius	3 wheels Single articulated rear-drive wheel 12V DC motor plus stepper for steering
Sonar Sensor	2 sensors; determines range and direction of object between 4-in. and 8-ft.	Ultrasonic Polaroid transceiver works with motion detector judges distances between 4-in and 25-ft.
Photo Sensor	1 sensor detects whole visible spectrum	1 256-bit resolution sensor—adjustable range 25 degree reception angle
Sound Detector Sensor	1 sensor hears sounds from 300-5000 Hz.	1 sensor with 256-bit resolution adjustable range 200-5000 Hz.
Speech	Optional synthesizer, 4 pitch levels Votrax, with 64 phonemes	Standard, 4 pitch levels Votrax, with 64 phonemes
Arm	Optional; includes gripper 5 stepper motors, 5 axis of motion opens 3½ in.; can lift 1 pound when fully extended	None
Clock	Includes calendar—real time	CMOS processor (Motorola 146818) 100-year calendar
Price	kit: $799.95 assembled: $2199.95 w/arm and voice	Not available About $1000





The Pipe-Mouse (above) and Turn Backer (right) are two Movit Kits you can build and operate in one day!

in demonstration ROM is available for Hero I. Speech capability is built into Hero-Jr, as he can sing songs, speak and play games. Several independent developers have produced add-on products for Hero I. It is expected that the same will soon be true for Hero-Jr, although more entertaining.

Commercial Kits that Teach Robotics

Movit kits are inexpensive, computerized (and logic-controlled), battery-operated robot kits. They are manufactured in Japan in two forms. They come either needing both the electronics and mechanical parts assembled, or else with the electronics already soldered and in place. Movit kits have been distributed in the U.S., since Fall 1983, and there are now 11 kits available (see chart for descriptions). According to Bruce Sanchez, President of New Tech Promotions, their major independent West Coast distributor, Avoider and Memocon Crawler are the two most popular kits. His favorite is the newest kit, Circular. The 11 kits (so far) teach the fundamental principles of robotic sensing and locomotion.

One of the simplest, called Turn Backer, includes a small *(turn to page 30)*

MOVIT KITS

Name	Movement	Control	Batteries Required (not included)	Price (mech. assy/mech + electronics)
Turn Backer	3 legs on each side—crank motion	sound sensor including condensor microphone	4—1.5-V "AA"	$39.95
Piper-Mouse	3 wheels driven by 2 DC motors	super sonic sound sensor including condensor mike	2—1.5-V "AA" 1—9-V	$44.95
Sound Skipper	2 alternatively moving legs driven by crank motion	sound sensor including condensor mike	2—1.5-V "N"	$24.95
Peppy	3 wheels driven by 2 DC motors	2-way sensor, responds to sound and solid objects in path	2—1.5-V "AA"	$24.95/$18.95
Memocon Crawler	3 wheels driven by 2 DC motors	Memory/electronics circuit through keypad—4-bit static RAM	2—1.5-V "AA" 1—9-V	$74.95/$46.95
Avoider	3 legs on each side crank motion	Infrared sensor including infrared diode/photo diode/IC	4—1.5-V "AA" 1—9-V	$44.95
Line Tracer II	3 wheels driven by 2 DC motors	Infrared sensor incl. infrared diode/photo diode/IC	2—1.5-V "AA" 1—9-V	$39.95/$28.95
Monkey	2 alternatively moving gripper arms driven by crank motion	sound sensor including condensor mike	2—1.5-V "N"	$24.95
Mr. Bootsman	6 legs—2-speed movement	control box	2—1.5-V "AA"	$30.95
Circular	2 large wheels	hand-held remote control box	3—1.5-V "AA" 2—9-V	$67.95
Medusa	2 legs on each side crank shaft	sound sensor including condensor mike	2—1.5-V "N"	$27.95

Updating the EXPERIMENTER'S SHOP

Today's budget test equipment and tools make your hobby fruitful!

By Herb Friedman

IF YOU'VE BEEN KEEPING YOUR SHOP UP TO DATE WITH modern technology, it's more than likely you've been out shopping for new hand tools and test equipment. Those purchases are necessary to bring your shop into the digital era, to what some are calling the *age of computers*. And if you're like most experimenters, you probably thought you were having a nightmare when you read the price tags. The cost of both hand tools and test equipment now represents a substantial investment rather than pocket change or a few hours of overtime or a part-time job.

When this writer was starting out in hobby electronics, I purchased my test-bench tools and accessories as the urge struck. If I saw a particularly intriguing tool or gadget, I would generally buy it for pocket change, or a dollar or two—at most, three dollars. Same thing occurrred with test gear. If it struck my fancy, I could usually buy it then and there! And if the equipment I wanted couldn't be squeezed into the budget, I could generally buy it *used* at an electronics flea market for a fraction of its cost.

Fortunately, upgrades to electronic circuits and hardware were few and far between, so the same test gear and tools could be used year after year.

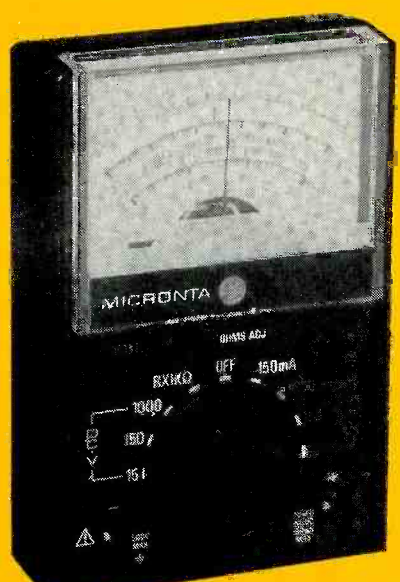
Unfortunately, that is no longer true, because the tolerances of the modern sophisticated solid-state circuit is often several magnitudes greater than that of older test equipment: the coarse tolerances of the older test gear can often conceal a defect in modern equipment.

Also, modern circuit components are smaller, more delicate, and highly sensitive to static-voltage damage. A large tool can easily crush several perfectly good components; an oversize test probe can overlap solder contacts and zap a handful of integrated circuits, before you even know that you've done something wrong—and walking across a carpet just before you touch certain components can instantly destroy them.

As a general rule, modern circuits require both new tools and test equipment. While the cost of both are often astronomical—thereby foreclosing the casual or impulse pur-

ANALOG MULTIMETERS

Radio Shack Multimeter 22-212—$10.94

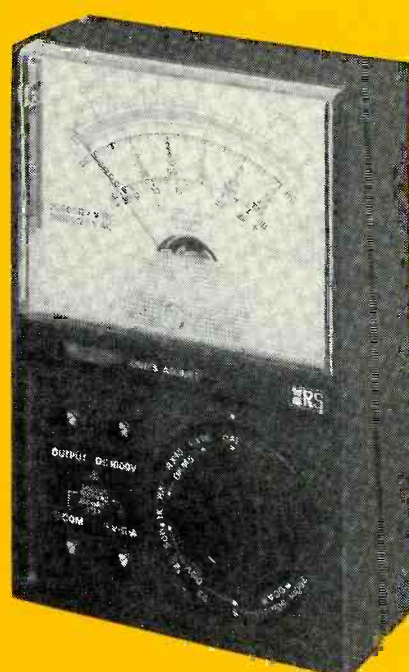


CIRCLE 957 ON FREE INFORMATION CARD

The famous Simpson 260-5—$65.00

CIRCLE 955 ON FREE INFORMATION CARD

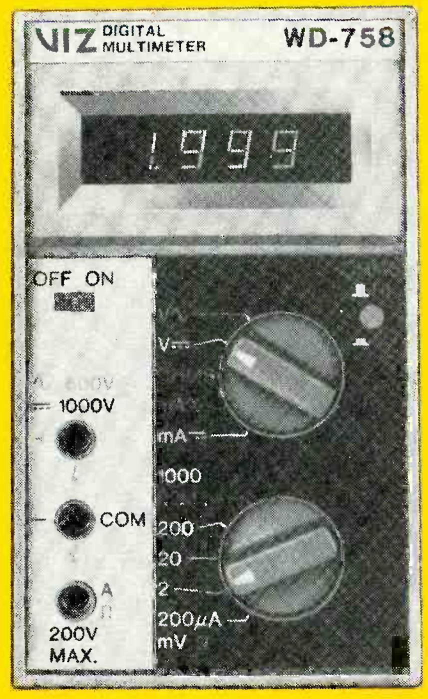
Radio Shack Multimeter 22-201—$19.95



CIRCLE 957 ON FREE INFORMATION CARD

DIGITAL MULTIMETERS

VIZ DMM WD-785—$99.00

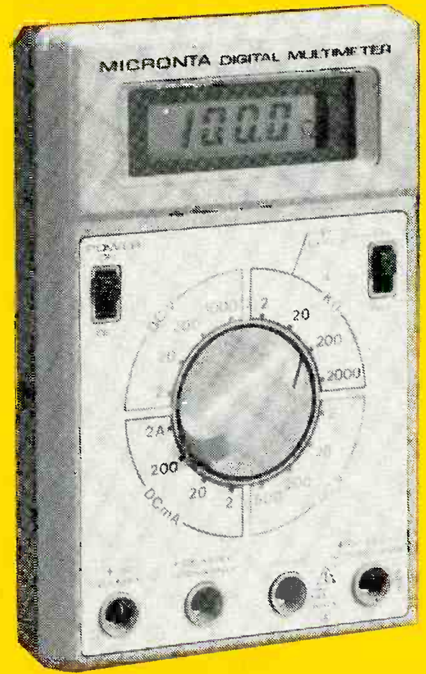


CIRCLE 954 ON FREE INFORMATION CARD

B&K-Precision DMM 2806—$75.00

CIRCLE 953 ON FREE INFORMATION CARD

Radio Shack 22-189—$49.95



CIRCLE 957 ON FREE INFORMATION CARD

chase—it's still possible to equip the shop for modern technology without having to take out a second mortgage on the farm.

Analog

Even though the world is fast becoming all digital, there's still need for the old-fashioned analog VOM (the Volt-Ohm-Milliammeter)—the kind whose reading is displayed on a meter having several range scales.

Why buy an analog meter when, dollar-for-dollar, a digital display meter provides greater accuracy and convenience? Because, it's hard to track a varying voltage with a digital meter. The reading of a typical experimenter-quality digital meter is upgraded every 1.5 to 2.5 seconds. A transient circuit disturbance that self-clears almost the instant it occurs will rarely be displayed by a digital meter. However sophisticated the test-bench setup, you'll need an analog VOM when you have to track a varying value.

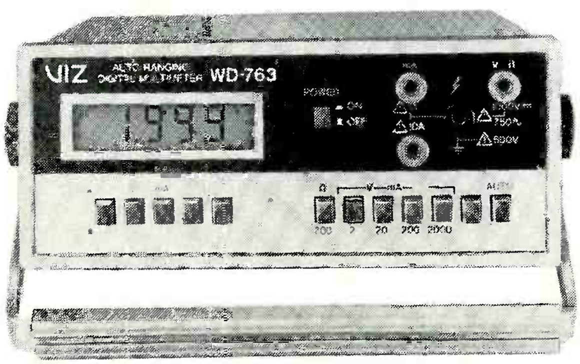
While the *legendary* Simpson 260 VOM is still available, the various models are priced from $100 up. That is often not only beyond the budget of most experimenters—the VOM's performance is well beyond what's needed. If you have no need for the high-performance features of a Simpson 260, or its equivalent, you're probably better off opting for a digital meter and a very low-cost VOM for those times you'll need to track a varying value.

Low-cost VOM's start out at $8, the price rising very slowly as features are added. All models will measure voltage with an acceptable degree of accuracy and convenience for *brute-force* tests, such as checking the voltage of a car battery, the powerline, or the output of a battery eliminator. Resistance measurements are what create problems for the lowest priced VOM's. They generally have only one resistance range, which jams low and high values into a teeny area at the ends of the scale. Accurate, or even useful readings, are possible over a somewhat limited range of resistance. About $15 or $20 will buy a VOM with several resistance ranges, providing a finer resolution of low and high resistance values.

Also, there's the question of *meter loading*. Except for the current measurements, VOM's represent a resistance connected in parallel with the circuit being tested. The least expensive VOM's generally represent 1000-ohms-per-volt sensitivity for the total range. If your meter is set for a full-scale range of 5 volts, the meter represents a resistance of 5 × 1000 or 5000 ohms. If the full-scale range is 15 volts, the meter represents a load of 15,000 ohms.

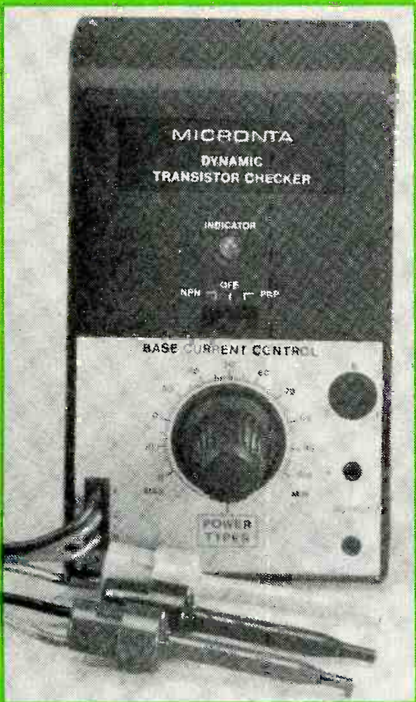
Obviously, if you're trying to read the collector-to-ground voltage of a transistor with a 10,000-ohm collector-load re-

The VIZ bench-top/carry digital multimeter WD-763 is an auto ranging device that sells for $249.00.



CIRCLE 954 ON FREE INFORMATION CARD

SPECIALIZED BUDGET TEST EQUIPMENT



Radio Shack
Dynamic Transistor Checker
Model 22-025—$14.95

CIRCLE 957 ON FREE INFORMATION CARD

Radio Shack Digital Logic Probe 22-302
with simultaneous tone—$19.95

CIRCLE 957 ON FREE INFORMATION CARD

B&K-Precision Model 1042 analog
telephone line analyzer—$19.95

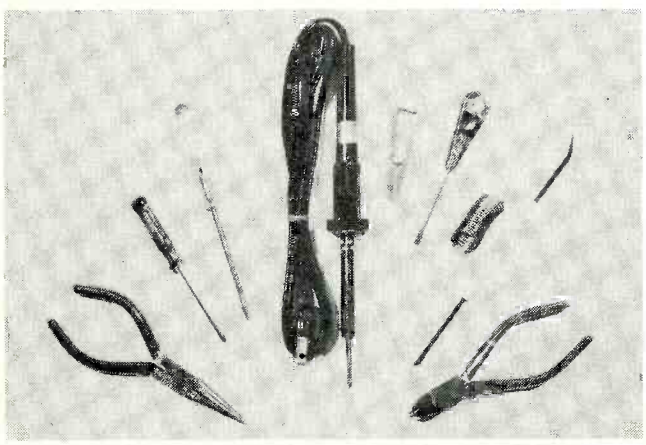
CIRCLE 953 ON FREE INFORMATION CARD

sistor, the 15,000-ohm load of the VOM is going to affect the circuit's operation, because it will appear in parallel with the 10,000-ohm circuit resistance.

About $20 to $30 will buy a meter rated anywhere from 20,000- to 50,000-ohms-per-volt sensitivity. If your test gear will be limited initially to only a VOM, it's probably better to trade-off features for a higher ohms-per-volt rating. Even the most sophisticated meter isn't too valuable if it seriously disturbs the circuit being tested.

Normally, when someone will be working with circuits that will be unusually sensitive to circuit loading, a special kind of analog meter called an FET solid-state VOM is recommended. The input to those meters is a field-effect transistor, which provides a load impedance of approximately 10 Megohms—which won't have any effect on the average experimenter circuit or project. Unfortunately, those meters are rather expensive. The least expensive falls into the range of $150 to more than $350. On the other hand, a DMM—a digital multi-meter—with the same input impedance sells for well under $100. Other DMM's are closer to $50. For many experimenters, and even service technicians, the DMM will be the better buy, even with its lack of ability to track continuously varying values.

Most DMM's work extremely well, regardless of price. As a general rule: If you're on a tight budget, don't buy the best meter hoping to save up for the other items you'll need. That idea rarely works out well. Instead, purchase the least expensive DMM, because, more often than not, all you will sacrifice is an accuracy that you probably won't need and possibly better overall construction. But if you give a DMM the same care you would an ordinary analog VOM, it will probably last one day short of forever.



Science Fair 10-piece electronics tool set (64-2801) is a starter's set that sells for $14.95.

CIRCLE 957 ON FREE INFORMATION CARD

Logic Probes

Next item on your list should be a *logic probe*. Digital circuits, from your home computer to the rare-roast-beef selector on the microwave oven, work by digital pulses rather than voltage levels. The pulse is over and gone before your meter—even a digital meter—gets a chance to respond. Logic probes stretch the displayed pulse so that an indicator—usually an LED—stays on long enough to be observed. Depending on the particular probe model, the LED might indicate single pulses or pulse trains, or lock on until manually released. Naturally, the more features, the higher the price—which starts at about $20 and goes up, depending on features and the frequency rating. That's an indication of how fast a pulse it can freeze.

Batteries Low?

To get away from high-tech for a moment, the lowly battery checker that sells for about $10 should have a prominent place on any experimenter's test bench. Much equipment—from home-brewed projects to a portable DMM—is powered by batteries, and many of such equipment don't have a low-battery indicator. Many are the hours spent troubleshooting a project or a perfectly good piece of equipment whose only problem is weak batteries. The first thing to check when anything goes wrong with battery-powered equipment are the batteries. Use one of the multi-volt, multi-load meters which allow you to switch-select a light, medium, or heavy current drain. Don't try to check batteries with your VOM or DMM because a battery will always indicate the proper voltage when it's unloaded (not supplying current).

Pictures Tell The Story

Every electronics teacher worth his paycheck always tells his class that if stuck on a desert island the one piece of test equipment he'd want is an oscilloscope, because it not only measures voltage but tells you what it looks like. If you're into audio, RF (low-band), even digital, a scope shows precisely what the signal waveform looks like.

Back in the the early days of electronics, any general-purpose scope was all the average hobbyist needed. Today, a general purpose scope is almost useless. For digital work the scope must be triggered; for just about anything it needs a frequency response to at least 20 MHz. And for *serious* work, the scope should have a delayed sweep, possibly dual trace, and a calibrated time base. The price of such a scope is about \$500-\$900—not inexpensive by any means. The general rule here is if you can't afford at least that minimal performance and features don't buy anything! Wait until you can afford a decent scope. While you might get by with a what is called a TV service scope, for digital and RF work you'll need the features of the laboratory-type scope. It's best to wait until you can afford what's really needed. Of course, if your main interest is TV, get a TV scope. Their convenience of switch-selected H and V sweeps is a big advantage for TV work.

1...2...3...

A digital frequency counter should be on every experimenter's wish list. Other than the megabuck laboratory signal generators, few are accurate enough for modern circuits, whether it be an audio null filter to squash hum when dubbing a friend's tape, or an RF-notch filter to keep the broadcast station down the block from swamping an FM receiver. But almost any signal source, no matter how inexpensive, can be accurately set to the desired frequency(s) by checking its output with a frequency counter.

Most hobbyists can get by with a battery-powered portable counter that covers from slightly above DC to about 100 MHz. Low-cost frequency-extender accessories are available for those who need coverage above 100 MHz. Several counters are available for about \$100-\$160 depending on the number of display digits (which determines the resolution) and the operating features.

When it comes to frequency meters and counters, anything is better than nothing. If you can't afford the best, try to get something.

But It Looks OK.

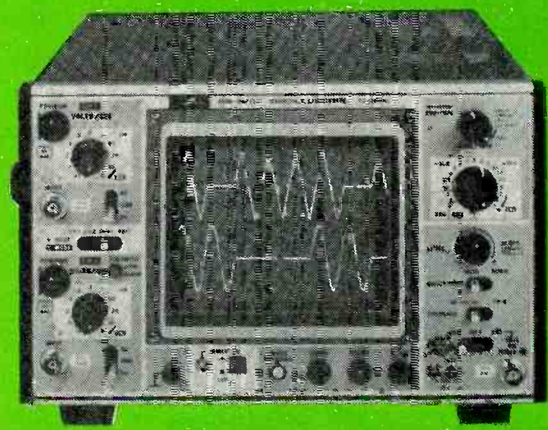
You can't tell if a transistor is defective just by looking at it, but fortunately most either work or don't work. There is rarely such a thing as a *weak* transistor. While it's advantageous to know the transistor's actual leakage and beta values, in most instances all you really need to know is that the transistor is working. That is, it is neither *burned* or open, and that can be determined by an under-\$20 transistor checker. The instrument won't measure beta, but it will tell you if

(Continued on page 98)

OSCILLOSCOPES

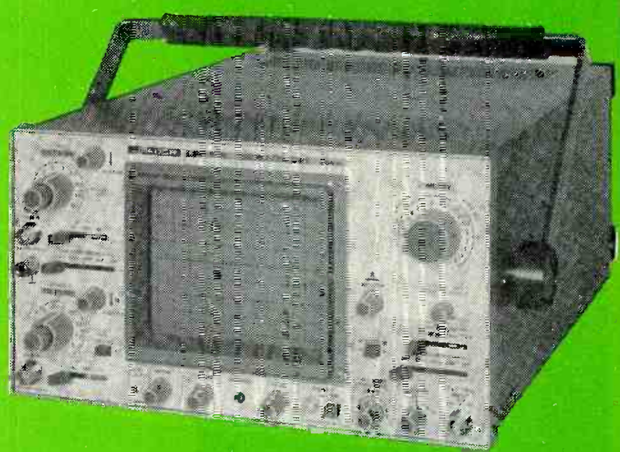
Hameg 60-MHz HM605—\$965.00

CIRCLE 9[illegible] ON FREE INFORMATION CARD



Iwatsu DC-20-MHz SS-5702—\$[illegible]35.00

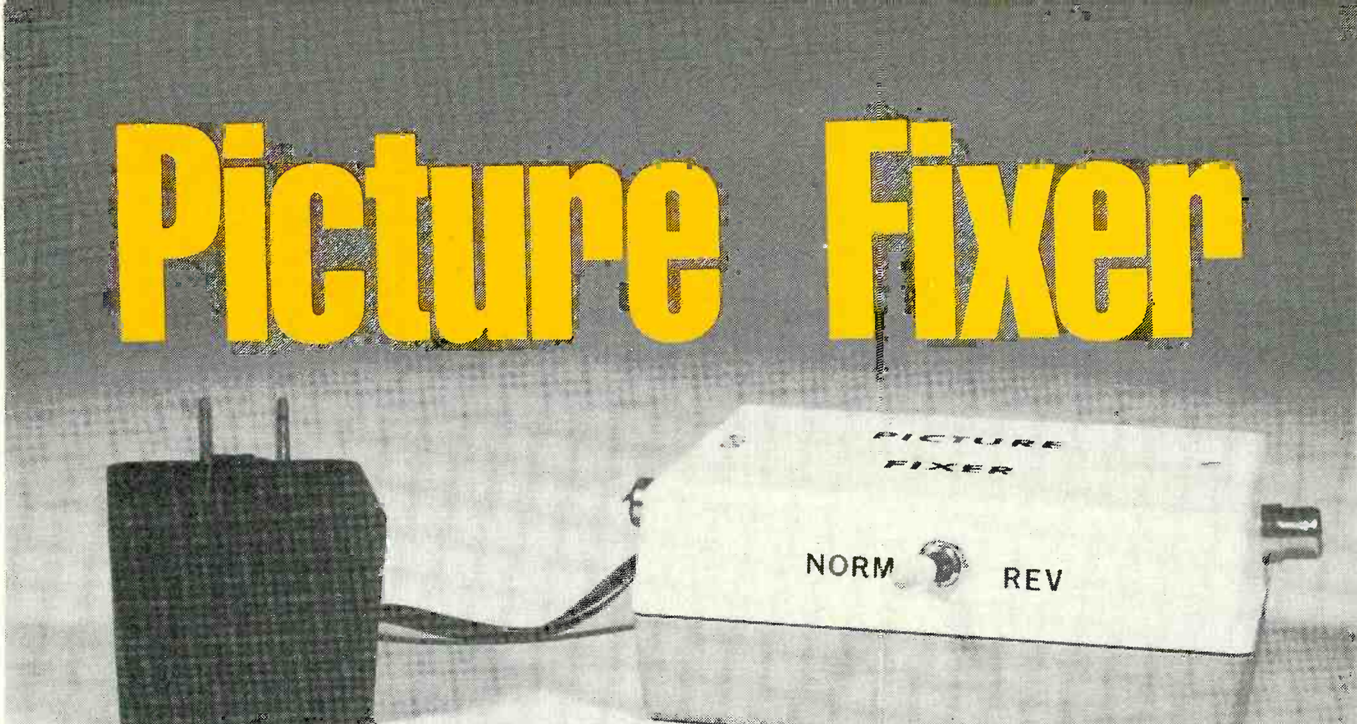
CIRCLE 949 ON FREE INFORMATION CARD



Leader LBO-522 20-MHz—\$470.00

CIRCLE 945 ON FREE INFORMATION CARD

Picture Fixer



By Steve Pence

☐MOST HOME COMPUTERS HAVE AN RF OUTPUT THAT ALlows them to be connected to a standard TV receiver via the antenna terminals. That allows you to use your TV set as a monitor, saving you extra cost. Unfortunately, after the novelty of the new computer wears off (about an hour at our house), the rest of the family wants the TV for something frivolous such as network programming.

Along with an RF output, many computers also have a direct video output designed to drive a standard monitor. So it's usually not long before you begin looking for just such a monitor.

Most surplus computer monitors will use either a green or amber phosphor for the screen. That is great if your computer's video format provides for bright characters on a dark background. Many computers do not follow that format and you soon find out that no one knows how to correct the situation. The project we're about to describe, solves that problem.

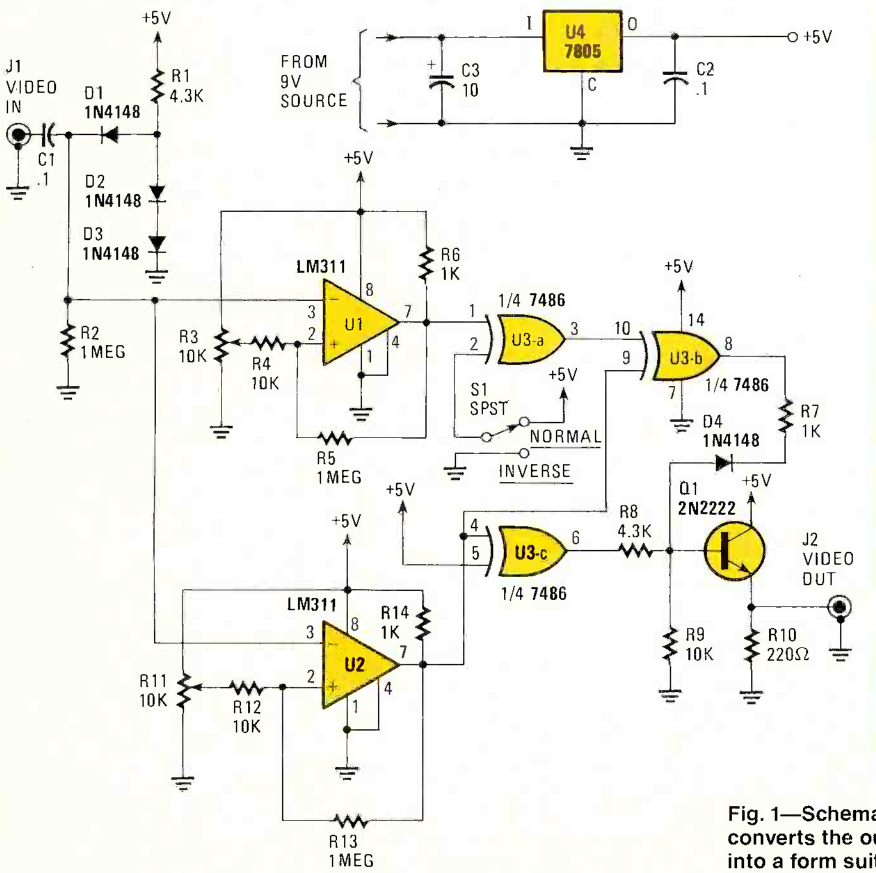


Fig. 1—Schematic diagram for the Picture Fixer. The circuit converts the output from a color computer such as the *TI-99/a* into a form suitable for display on a monochrome monitor

PARTS LIST FOR PICTURE FIXER

SEMICONDUCTORS

D1–D4--1N4148 diode
Q1—2N2222 NPN transistor
U1, U2—LM311 comparator integrated circuit
U3—7486 or 74LS86 EXCLUSIVE-OR integrated circuit
U4—7805 5-volt regulator integrated circuit

RESISTORS

(Fixed resistors are 1/4-watt, 5%, units)
R1, R8—4300-ohm
R2, R5, R13—1-Megohm
R3, R11—10,000-ohm, linear-taper, trimmer potentiometer
R4, R12, R9—10,000-ohm
R6, R14, R7—1000-ohm
R10—220-ohm

CAPACITORS

C1, C2—.1-µF, polyester, 10%
C3—10-µF, 25-WVDC, tantalum

In the upside-down computer world this project flips your video right-side up!

The simple circuit, shown in Fig. 1, that makes up the Picture Fixer will accept the video signal from your computer, separate the sync pulses, invert just the video, add the new video to the old sync pulses, and then send them on to your newly acquired monitor.

Circuit Description

Refer to the schematic shown in Fig. 1, and the waveform timing-diagram shown in Fig. 2, for the following discussion.

The video signal is brought in through J1 and applied to a clamping circuit consisting of C1, D1, D2, D3, R1, and R2. The clamp circuit forces all of the sync pulses to line themselves up at the same DC voltage level.

With the video voltage clamped, the trip points of the comparators that follow can be set with trimmer resistors R3 and R11, and will not have to be readjusted. One comparator, U1, is adjusted to change states with a change in either video or sync-pulse levels. The other comparator, U2, is adjusted to trip on changes of sync-pulse levels only.

The output of U1 now consists of a logic level (0 to +5 volts) signal that contains both sync pulses and video. The composite signal is coupled to an EXCLUSIVE-OR gate, U3-a, where it is either inverted or not inverted, depending upon the position of switch NORM/REV S1. The output, at pin 3 of U3-a, is next sent to U3-b. There the composite signal is combined with the *sync-pulse only* signal from U2. The EXCLUSIVE-OR action of U3-b cancels out the sync pulses leaving only video at its output.

Since the sync pulses are inverted as they pass through U2, they must be inverted once more before being combined with the video signal. That final inversion is performed by U3-c, and that device's output is combined with that of U3-b via D4, R7, R8, and R9. The newly combined signal is buffered by emitter-follower Q1 and sent to the outside world via J2.

The circuit can be powered by a 9- to 12-volt wall-mount power supply. The supply voltage is regulated down to five volts by U4.

Construction

Although a printed-circuit board makes assembly much more convenient it is not a necessity. The project can be built on perfboard using wire wrap since layout and wiring are not critical. If you wish to use a printed-circuit board, an appropriate foil pattern is shown in Fig. 3; the corresponding parts-placement diagram is shown in Fig. 4.

Regardless of the construction technique you use, here is a pointer to keep in mind: Trimmer resistors R3 and R11 should

ADDITIONAL PARTS & MATERIALS
S1—SPST, miniature toggle
J1,J2—Phono jack
Wall plug transformer (Radio Shack 273-1455 or equivalent), printed-circuit board, enclosure (Unibox #120 or equivalent), etc.

The following are available from Elephant Electronics Inc. P.O. Box 41770-P, Phoenix, AZ 85080: PF-1B—Printed-circuit board, $6.55 each; PF-1—complete kit of all parts listed above, $19.95; PF-1A—assembled and tested unit, $29.95. Arizona residents add 6% sales tax. Please add $2.50 per kit for first class postage and handling in the U.S., Canada, and Mexico. Other foreign orders add $6.00 for shipping and handling, and remit payment via a cashier's check or international money order drawn on a U.S. bank. All orders allow 4 to 6 weeks for delivery.

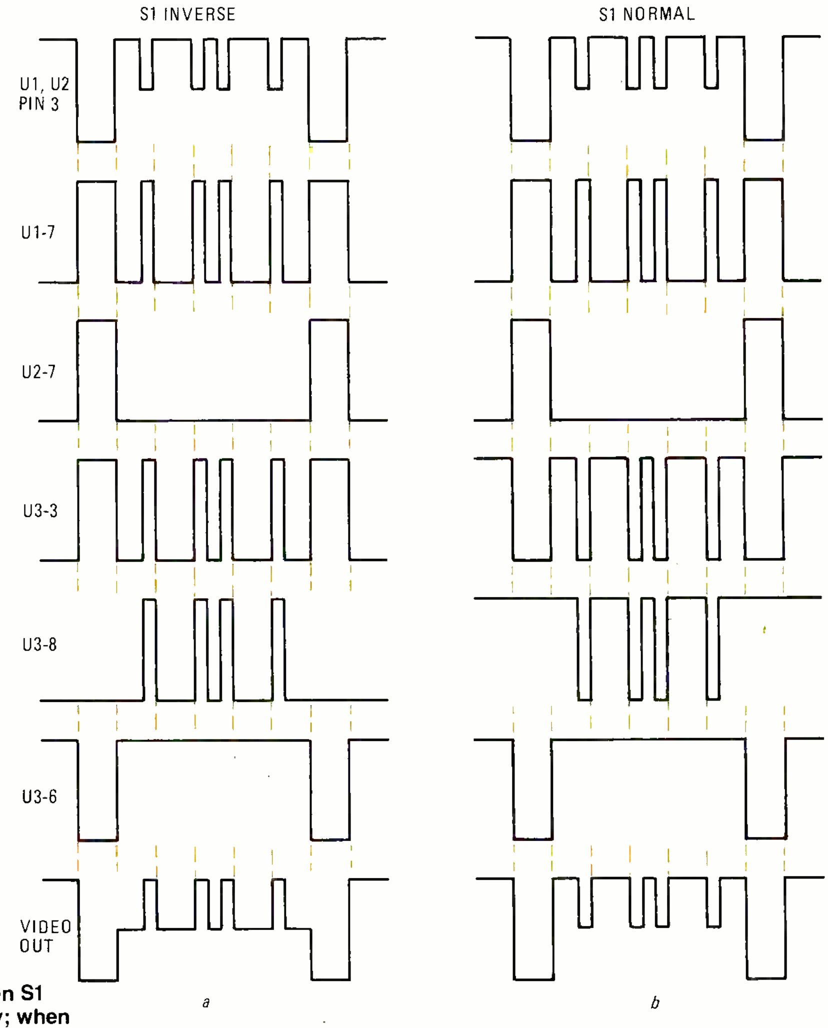


Fig. 2—Timing diagram for the Picture Fixer. When S1 is set to INVERSE, the diagrams shown in A apply; when it is set to NORMAL, the diagrams shown in apply.

BRITISH HEE-HAW SIREN

By Robert F. Scott **Add this Scotland Yard touch to your burglar-alarm system!**

☐A PAIR OF TIMER IC'S ARE THE HEART OF A CIRCUIT THAT simulates the warbling *hee-haw* of a British police siren. The schematic diagram of the circuit is shown in Fig. 1. One of the 555 timers (U2) is wired as an astable multivibrator operating at about 900 Hz. The other U1, operates at approximately 1 Hz. Its output at pin 3 is a squarewave with a 50% duty cycle (on and off cycles of about 0.5 second each). The output of U1 is applied to pin 5, the CONTROL VOLTAGE terminal of U2.

The frequency of a 555 timer IC is relatively independent of supply voltage but can be varied over a fairly wide range by applying a variable voltage between pin 5 and ground. When

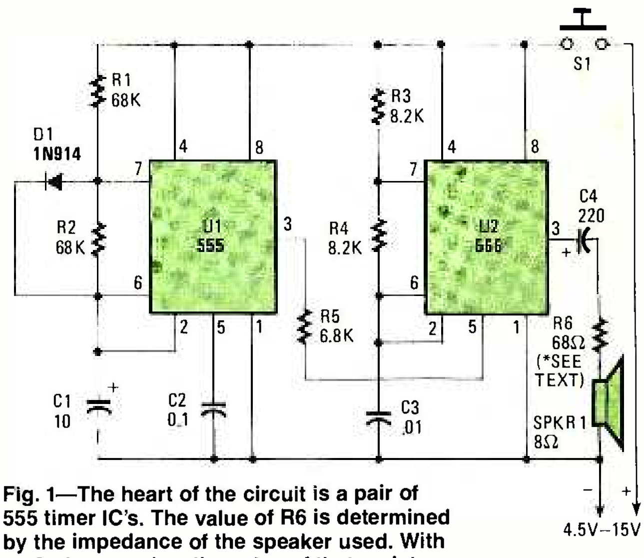


Fig. 1—The heart of the circuit is a pair of 555 timer IC's. The value of R6 is determined by the impedance of the speaker used. With an 8-ohm speaker, the value of that resistor is 68 ohms, as shown. For more information, see text.

U1's output goes low, U2 operates at about 1 kHz. When U1's output goes high, U2 operates at about 800 kHz. That switching between two frequencies produces the warbling *hee-haw* signal.

You can have quite a bit of fun by experimenting with various component values. For instance, you can vary the timing of the warbling by changing the value of C1 or by replacing R2 with a 200,000-ohm potentiometer. The range of frequencies covered by the warbling signal can be changed by selecting other values for C3.

When operating from a 15-volt DC supply, the 555 can deliver nearly 1 watt into a 75-ohm load, which is the ideal

(Continued on page 95)

PARTS LIST FOR BRITISH HEE-HAW SIREN

SEMICONDUCTORS
D1—1N914 diode
U1, U2—555 timer IC

CAPACITORS
C1—10-µF, 25-WVDC, electrolytic
C2—.1-µF, disc ceramic
C3—.01-µF, disc ceramic
C4—200-µF, 25-WVDC, electrolytic

RESISTORS
(All resistors ¼ watt or larger, 5%)
R1, R2—68,000-ohm
R3, R4—8200-ohm
R5—6800-ohm
R6—See text

ADDITIONAL PARTS AND MATERIALS
S1—SPST normally-open pushbutton switch
SPKR1—8-ohm speaker
Experimenter's prototype board (see text), 4.5- to 15-volt DC supply, wire, etc.

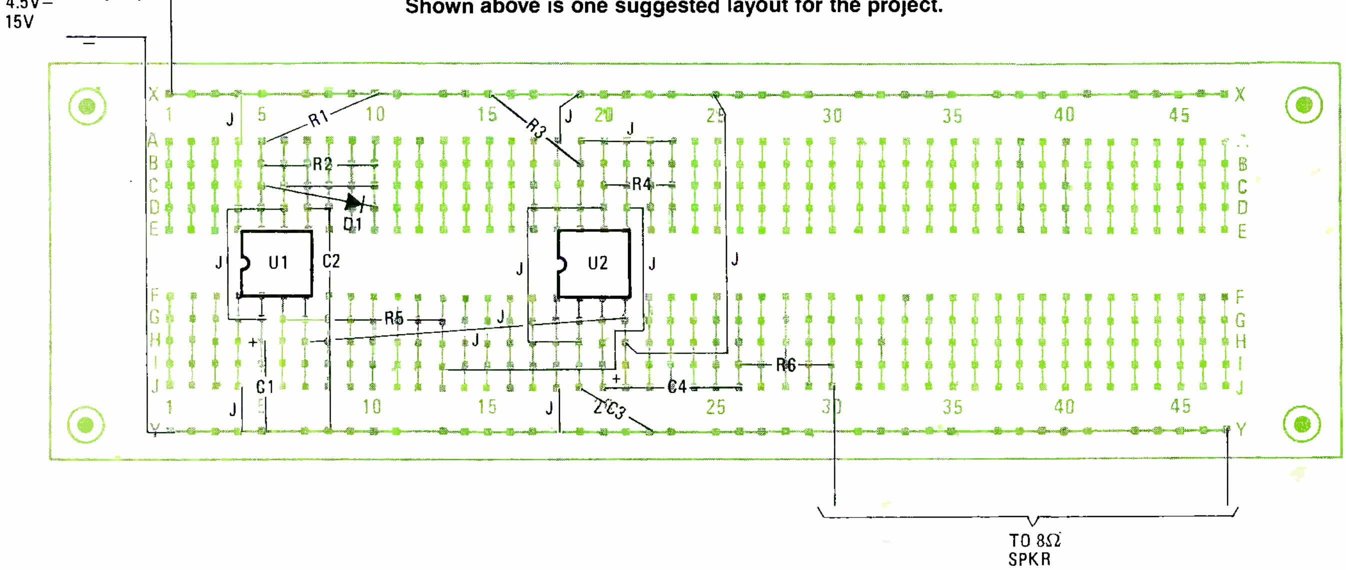
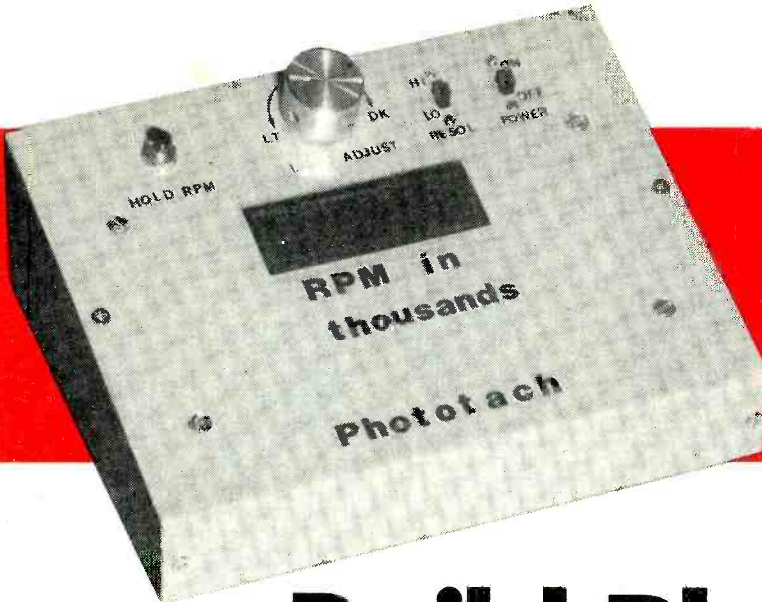


Fig. 2—To get the most of the "hee-haw" siren, you may want to build the circuit on some type of prototype board. That will let you experiment with various component values. Shown above is one suggested layout for the project.



Why spend $300 or more on a phototachometer when you can build this unit for less than $70? It is easy to build, easy to adjust, and even easier to use!

Build PhotoTach

By W.N. Hubin*

☐ALTHOUGH IT HAS MANY MORE APPLICATIONS, PHOTOTACH evolved from an urgent need to accurately measure the maximum propeller *rpm* (*r*evolutions *p*er *m*inute) of an experimental aircraft. That *rpm* was the sole indicator of engine output, but the tachometer used to measure it was suffering from vibration-induced fatigue and its readings were more than a little suspect. Another important use for Phototach has been the calibration of commercial mechanical tachometers used on certificated aircraft. That calibration is particularly critical for aerobatic aircraft that commonly have a narrow range of propeller speeds that must not be used because of propeller/engine resonances.

You may still be asking what a phototachometer is. Well, it's not a device to measure how fast you can take photographs! A phototachometer (and the Phototach) can be used for the precise measurement of the frequency of any periodically varying light source—that light can be either reflected or emitted. Phototach is easily adapted to measuring a varying voltage originating from sources other than a light source, as will be discussed later.

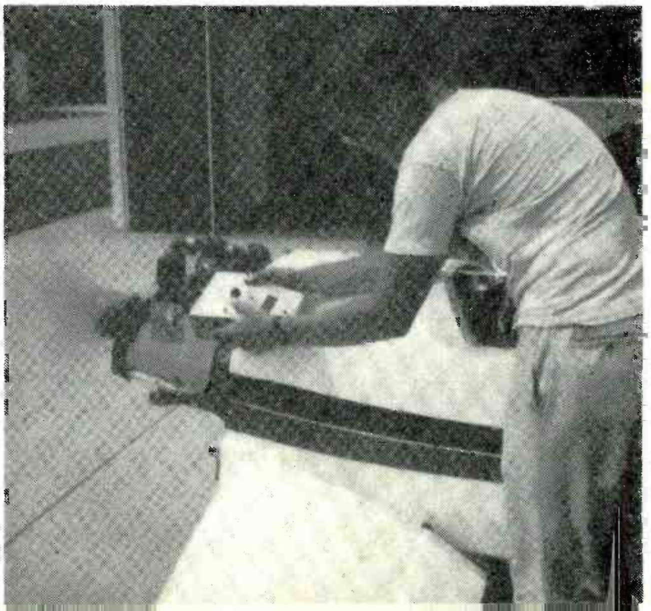
While commercial digital phototachometers will set you back about three hundred dollars, Phototach can be built for about seventy dollars from readily available components. It features two measuring ranges, a maximum count of 19999, crystal-based precision, and a large 0.75-inch liquid-crystal display for fine readability in the brightest sunlight. It is usable over a wide range of light intensities, and its power requirements are extremely modest. Phototach draws about 9.5 milliamperes from a 9-volt transistor-radio-type battery. That means that even a standard battery will give about 50 hours of use. Calibration is easily accomplished with the help of a fluorescent light.

*Professor, Kent State University

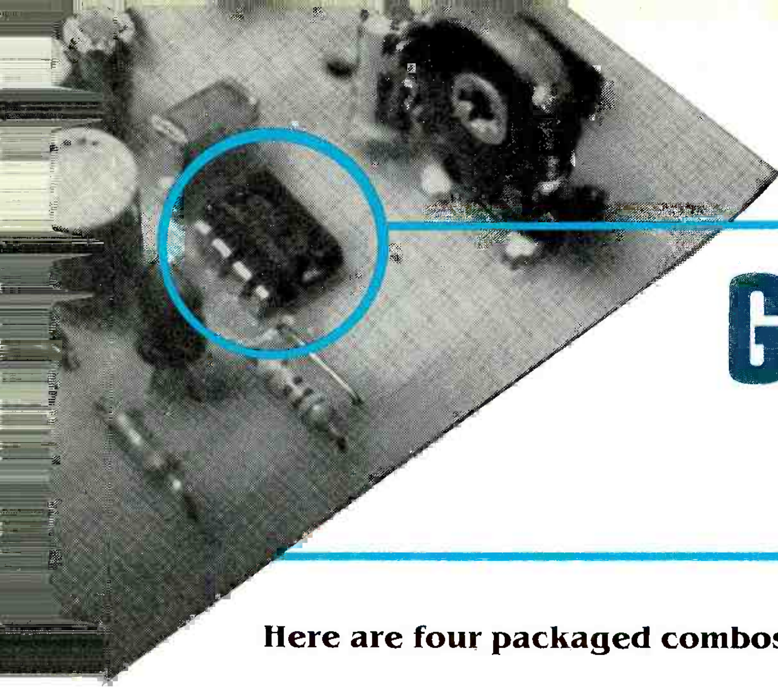
Light Pulses to Counts

Because it is inherently a digital measurement, Phototach will provide just as much accuracy as one wishes to wait for, unaffected by the electrical and mechanical gremlins that plague normal tachometers. The common two-bladed propeller interrupts the light from a source between you and it exactly two times for every complete revolution. To obtain the average number of revolutions per minute (±1 *rpm*) we would count those interruptions for a period of one-half minute, or 30 seconds. However, if we are willing to settle for ±10-*rpm* precision, we need count light interruptions for only 3 seconds; for ±100-*rpm* precision we need count for only 0.3 second.

Phototach is based on an LSI integrated circuit that combines a 4½-digit counter with all the drivers needed for a full liquid-crystal display of the count. The supporting IC's condition the signal from the phototransistor used as a sensor, provide a precisely-timed gating signal for the counter, transfer the count to the display at the proper time, and then reset the counter for the next timed interval.



In the darkness of a hanger, the author uses Phototach to count the number of times the propeller blade interrupts the light coming through the open hanger door.



By Ed Noll

GATE/POWER DRIVERS

Here are four packaged combos that will interface logic to action circuits!

☐A COMBINATION GATE AND DRIVER IN A SINGLE CHIP IS A handy item for applications such as driving incandescent lamps, relays, solenoids, and other interface devices. The Sprague Electric gate/power drivers discussed in this article have inputs compatible with DTL/TTL, PMOS, and CMOS devices. Power supplied to the devices can be as high as 80-volts DC, and the device has a 500-milliampere output heat-sink-current capability per gate. The M suffix after each gate/power driver indicates a low-cost plastic case, ideal for experimenter's applications, and each device can be operated in the −20°C to +85°C range. The devices have no suppression diodes for transient protection, so those must be included in the circuit when the load to be switched is inductive. Sprague Electric makes available four gate/power driver chips that will be discussed in this article. They are:

UDN-3611M Dual AND Driver
UDN-3612M Dual NAND Driver
UDN-3613M Dual OR Driver
UDN-3614M Dual NOR Driver

The Dual AND Driver

Pin-out and basic circuit of the dual AND driver version are given in Fig. 1. Each of the dual sections consists of a NAND gate and a follow-up bipolar transistor output. Check out the logic of the AND driver with the appropriate logic chart in Table 1 and Fig. 1. There is no direct pin-out for the output of the NAND gate. The Y output of the NAND gate (Fig. 1) is connected internally to the base of the bipolar transistor. The following bipolar transistor results in a logic inversion. Therefore, the output has a logic corresponding to that which would be obtained from an overall AND gate. Treating the UDN-3611M chip as a black box with one output, it appears to be an AND logic device. The AND operation is the result of the inversion of the logic that appears in the Y output of the NAND gate.

Pin-outs are identical for the AND, NAND, OR and NOR drivers. However, internal gate for the NAND driver has AND logic; internal gate for the OR driver, NOR logic; and, internal gate for the NOR driver, OR logic. Those relations are shown in the remaining truth listings in Tables 2, Table 3, and Table 4.

Gate/power drivers of that type are useful in driving peripheral loads such as incandescent lamps, displays, heaters,

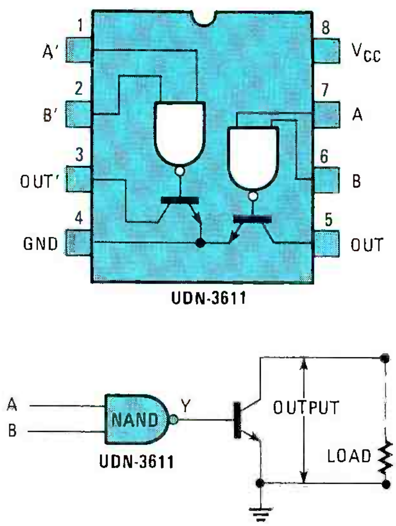


Fig. 1—The UDN-3611M dual gate/power driver is shown schematically (A) within the physical outline of its DIP configuration. A simplified diagram (B) of one driver section is shown. Point Y is not electrically connected to one of the output pins. It is identified for circuit discussion in text.

TABLE 1
AND Gate/power Driver Truth Table

A	B	Y	OUT
0	0	1	0
0	1	1	0
1	0	1	0
1	1	0	1

TABLE 2
NAND Gate/power Driver Truth Table

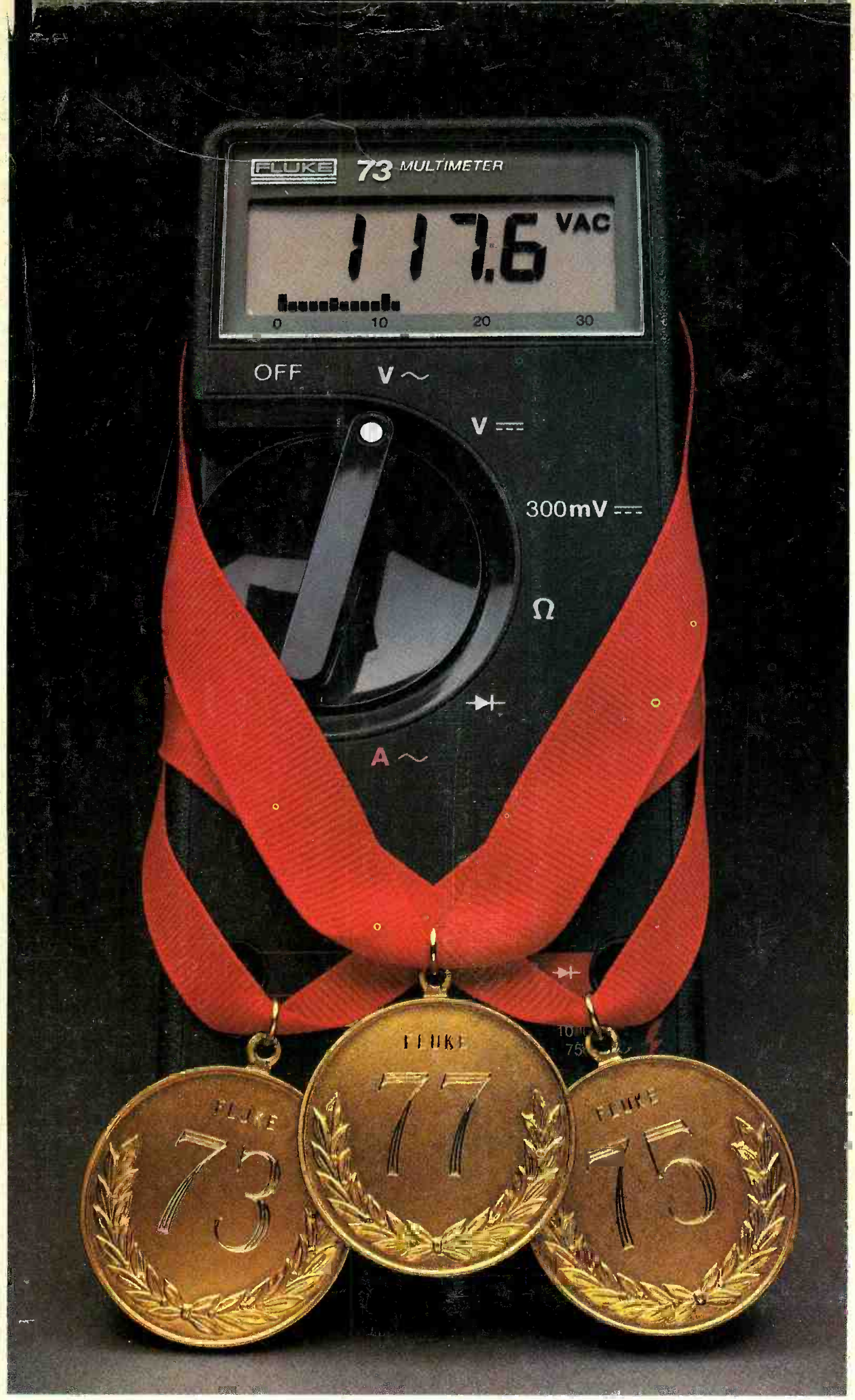
A	B	Y	OUT
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

TABLE 3
OR Gate/power Driver Truth Table

A	B	Y	OUT
0	0	1	0
0	1	0	1
1	0	0	1
1	1	0	1

TABLE 4
NOR Gate/power Driver Truth Table

A	B	Y	OUT
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0



Take home a world champion.

$85* gets you a technical knockout. **The Fluke 70 Series. Winners of the digital vs. analog ba**

Since their debut, they've become the worldwide champions of the industry.

Never before have such tough, American-made meters offered so many professional features at such unbeatable prices.

Each comes with a 3-year warranty, 2,000-hour battery life, and instant autoranging.

You also get the extra resolution of a 3200-count LCD display, plus a responsive analog bar graph for quick visual checks of continuit peaking, nulling and trends.

Choose from the Fluke 73, the ultimate in simplicity. The feature-packed Fluke 75. Or th deluxe Fluke 77, with its own protective holste and unique "Touch Hold" function** that captures and holds readings, then beeps to alert you.

So don't settle for just a contender. Take home a world champion.

For your nearest distributor or a free brochure, call toll-free anytime **1-800-227-3800, Ext. 229.** From outside th U.S., call 1-402-496-1350, Ext. 229.

FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.

FLUKE 73	FLUKE 75	FLUKE 77
$85*	$99*	$129*
Analog/digital display	Analog/digital display	Analog/digital displa
Volts, ohms, 10A, diode test	Volts, ohms, 10A, mA, diode test	Volts, ohms, 10A, m diode test
Autorange	Audible continuity	Audible continuity
0.7% basic dc accuracy	Autorange/range hold	"Touch Hold" functio
2000+ hour battery life	0.5% basic dc accuracy	Autorange/range hol
3-year warranty	2000+ hour battery life	0.3% basic dc accur
	3-year warranty	2000+ hour battery
		3-year warranty
		Multipurpose holster

* Suggested U.S. list price, effective July 1, 1984.
** Patent pending.

FLUKE®

1989

Radio-Electronics

ELECTRONICS EXPERIMENTERS handbook™

JANUARY

164 Pages Crammed With More Than 31 Articles Including 17 Exciting Projects and Lots of Electronics Know How!

TELEVISION
- Stereo Sound Decoder
- Commercial Zapper
- High Definition

YOUR HOME
- Acid Rain Monitor
- Electronic Xmas Tree
- Outdoor Light Controller

HOW TO
- Soldering Technology

YOUR CAR
- World of 21st Century
- Digital Tachometer
- Digital Speedometer
- Headlight Alarm

TELEPHONE
- Phonlink
- Cellular Phones
- Blue Box & Ma Bell

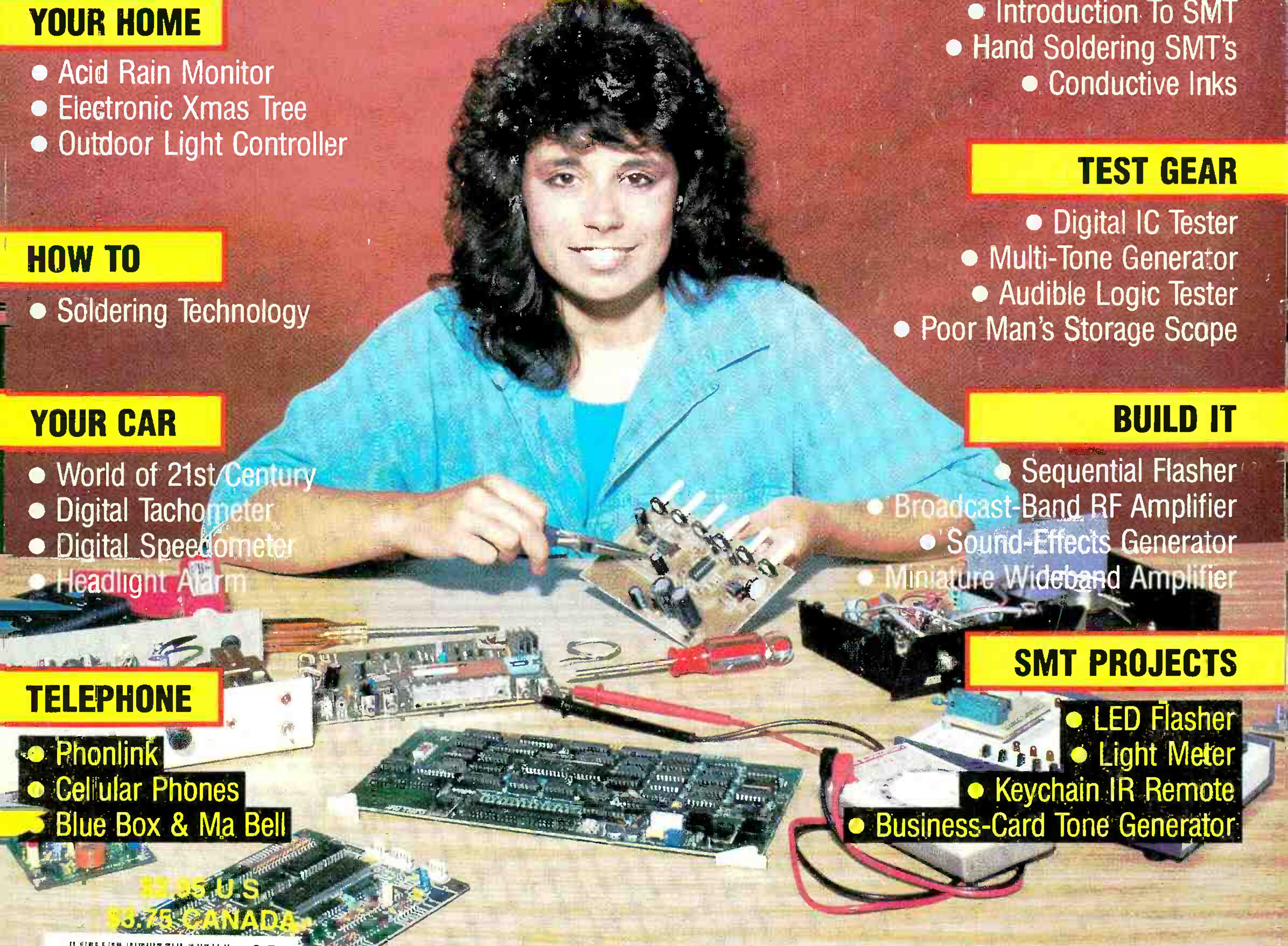
TECHNOLOGY
- Triac's and SCR's
- Conductive Inks

SURFACE MOUNT
- Introduction To SMT
- Hand Soldering SMT's
- Conductive Inks

TEST GEAR
- Digital IC Tester
- Multi-Tone Generator
- Audible Logic Tester
- Poor Man's Storage Scope

BUILD IT
- Sequential Flasher
- Broadcast-Band RF Amplifier
- Sound-Effects Generator
- Miniature Wideband Amplifier

SMT PROJECTS
- LED Flasher
- Light Meter
- Keychain IR Remote
- Business-Card Tone Generator



$2.95 U.S
$3.75 CANADA

PLUS—
- New Products
- New Books
- New Ideas
- And Much Much More

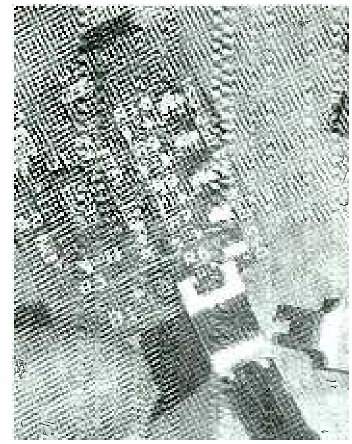
CIRCLE 21 ON FREE INFORMATION CARD

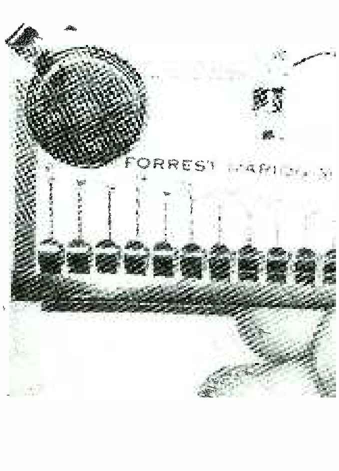
Radio-Electronics

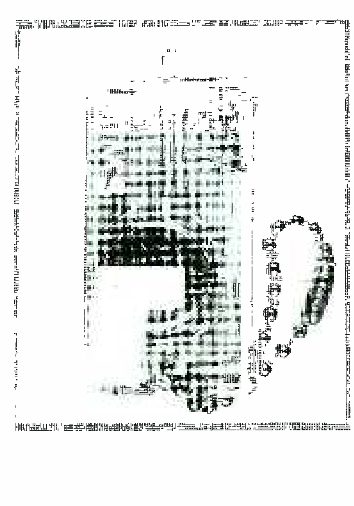
SURFACE-MOUNT TECHNOLOGY

AN INTRODUCTION TO THE PACKAGING REVOLUTION

SURFACE MOUNT TECHNOLOGY



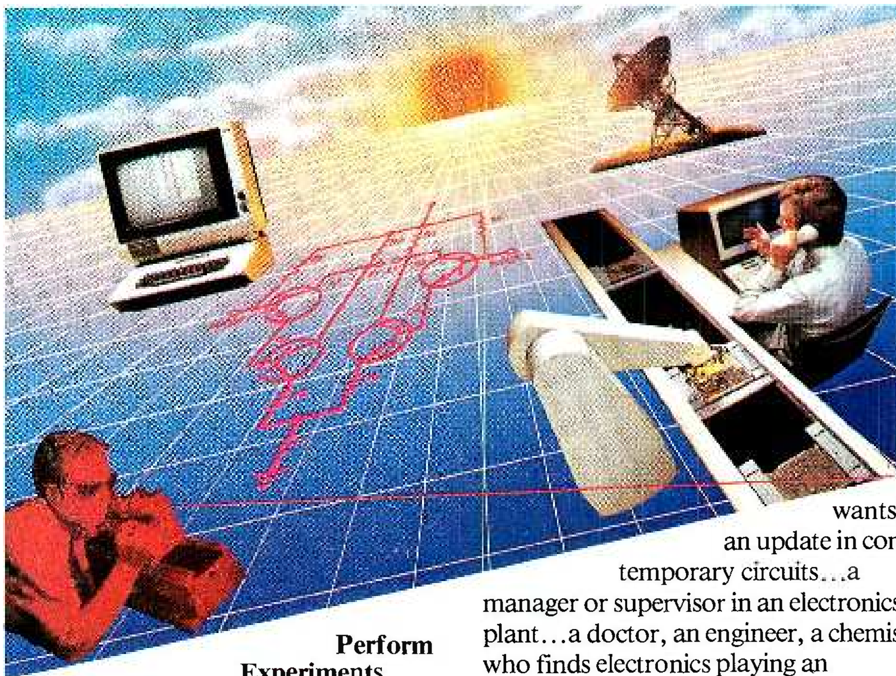




MASTER THE NEW ELECTRONICS WITH McGRAW-HILL'S

Contemporary Electronics Series

The fast, easy and low cost way to meet the challenges of today's electronic innovations. A unique learning series that's as innovative as the circuitry it explains, as fascinating as the experiments you build and explore.

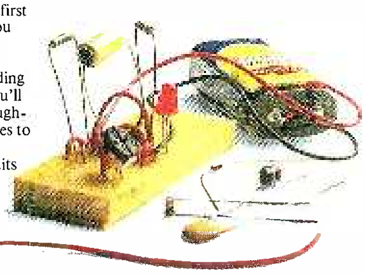


From digital logic to the latest 32-bit microprocessor, the McGraw-Hill Contemporary Electronics Series puts you into the electronic picture one easy step at a time. Fifteen unique Concept Modules, sent to you one every 4–6 weeks, give you a handle on subjects like optoelectronics, robotics, integrated circuits, lasers, fiber optics and more.

Each Concept Module goes right to the heart of the matter. You waste no time on extraneous material or outdated history. It's a fast, efficient, and lively learning experience...a non-traditional approach to the most modern of subject matter.

Unique Interactive Instruction

With each module, you receive a McGraw-Hill Action Audio Cassette. Each tape is a dynamic discussion that drives home the key facts about the subject. Your learning experience is reinforced through interaction with vividly illustrated text, audio cassettes, and actual electronic experiments. Indexed binders preserve backup material, notes, and tapes for convenient referral.



With your first module, you get this solderless breadboarding system. You'll use it throughout the series to build electronic circuits and bring concepts to life.

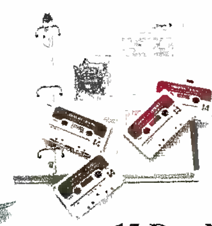
Perform Experiments in Contemporary Electronics

Throughout your series, laboratory experiments reinforce every significant point. This essential experience ...dynamic, hands-on demonstrations of theory in practice... will help you master principles that apply all the way up to tomorrow's latest VLSI (Very Large Scale Integrated) circuitry.

In your very first module, you'll use integrated circuits to build a digital oscillator, verifying its operation with a light emitting diode (LED). You'll learn to identify passive and active components, understand concepts common to all electronic circuits.

For Anyone Interested in Electronics

The Contemporary Electronics Series is designed for anyone from hobbyist to professional. It's for you if you're looking for new fields of interest...if you're a teacher who wants an update in contemporary circuits...a manager or supervisor in an electronics plant...a doctor, an engineer, a chemist who finds electronics playing an increasingly important role in your work. It's even for electronics engineers or technicians who feel their training needs freshening up. It's the quickest, most convenient, probably least expensive way to do it. And the only one that gives you hands-on experience.

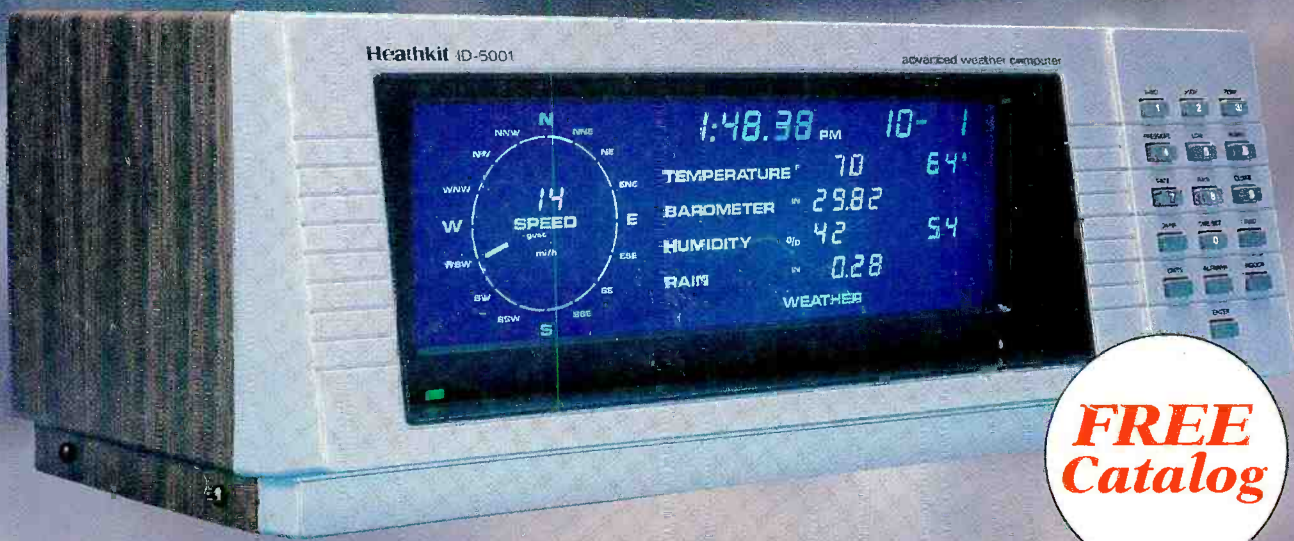


15-Day No-Risk Trial

To order your first module without risk, send the card today. Examine it for 15 days under the terms of the order form and see how the Contemporary Electronics Series gets you into today's electronics. If card has been used, write us for ordering information.

McGraw-Hill
Continuing Education Center
3939 Wisconsin Ave.
Washington, D.C. 20016

Heathkit®



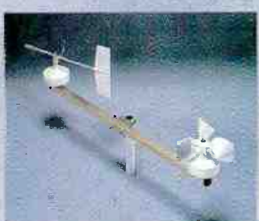
FREE Catalog

Track The Weather With Your Own Personal Weather Station

Don't let the weather catch you off guard. Plan your activities using the precision-crafted Heathkit® ID-5001 Advanced Weather Computer.

Powerful enough for commercial use, the ID-5001's striking cobalt blue liquid crystal display indicates wind speed, humidity, rainfall, high and low temperatures, and more. You'll find at your fingertips everything you need to keep you up-to-date on changing climate conditions.

The Advanced Weather Computer is an intelligent system, sounding alarms whenever threatening weather approaches. In addition, the ID-5001 is the only weather instrument known which automatically averages wind speed and direction to FAA/NWS standards and gives true values for wind speed and wind direction.



Includes precision wind sensor assembly.

The ID-5001 features: • High accuracy digital barometer • Display of indoor and outdoor temperatures • Push-button display of minimum and maximum readings • 32-point wind direction resolution • Display of indoor and outdoor relative humidity • Digital clock/calendar and much more!

Attractive enough to display in your home, the Advanced Weather Computer is just one of many exciting products in the Heathkit catalog. You'll discover 108 color pages packed full of electronic products in kit and assembled form including TVs, VCRs, computers, test instruments, as well as our new high-tech audio line.

The ID-5001 and all our other fine electronic products can be found in our *FREE* Heathkit catalog. For your copy, call 24 hours a day TOLL FREE:

1-800-44-HEATH

(1-800-444-3284)

Heath Company

CL-797R1 A subsidiary of Zenith Electronics Corporation

CIRCLE 27 ON FREE INFORMATION CARD

BUDGET Electronics

FIRST EDITION

1976 EDITION $1.35 02040

by the Editors of ELEMENTARY ELECTRONICS

INFLATION-FIGHTING IDEAS

- Troubleshooting your home appliances
- Picking up electronic parts cheaply
- Adding rear speakers to your car
- Building projects that save you money
- Cutting the cost of TV repair bills
- Fixing your dead receiver

- Installing a home radio/intercom
- Tuning the police/fire/aero bands
- Hiding antenna cables in walls
- Selecting the right home study course
- Putting in a home wall ventilating fan
- Making a buck on antique radios

CB

HAM

SWL

New! Rugged! Reliable!

NEW! Royce Model 1-601
23-Channel Mobile CB Transceiver

Loaded with features, too. Such as a great fine tuning system, tone and ANL pushbutton switches, and an extra large S-RF meter.

But, that's only the beginning. Check the features at right. See how much this new mobile CB has to offer you in ratio to cost.

Then, hurry to your Royce Dealer's, and see and hear for yourself. Thousands of CB-ers—beginners and professionals—will join you there. Your dealer can tell you and our sales figures prove it—Royce is the new trendsetter in the CB field!

Royce electronics corporation
1746 Levee Road
North Kansas City, Missouri 64116
CALL (816)842-7505 • TELEX: 426-145

Check Royce features...then compare!

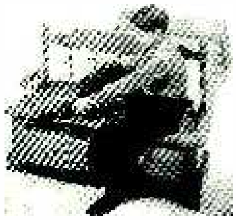
- **PUSHBUTTON ANL (AUTOMATIC NOISE LIMITER)** reduces static to nearly zero.
- **FINE TUNING** with continuous receiver for better receive clarity.
- **EXTRA LARGE (1½"x¾") S-RF METER.** Indicates transmit and receive signal strength.
- **FULL-SIZE, PLUG-IN MICROPHONE.**
- **POSITIVE AND NEGATIVE GROUND OPERATION.**
- **PUSHBUTTON HIGH-LOW TONE SWITCH** for noisy locations.
- **AMC CIRCUIT** for full audio punch, without perils of overmodulation.
- **PUSHBUTTON CB-PA SWITCH.** Presto! It's a full, 4-watt P.A. system.
- **PLUS SO MANY MORE FEATURES WE DON'T HAVE SPACE** to tell you about them. You'll want to see them in person, anyway. Do that soon—at your Royce Dealer's. See for yourself! Compare for yourself!

CIRCLE 6 ON READER SERVICE COUPON

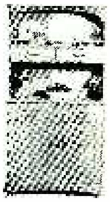
Our 10 Best Selling Craft Projects

NOW YOU CAN ENJOY CLASSIC-DESIGN FURNITURE AT A FRACTION OF STORE RETAIL PRICE! BUILD WITH CRAFT PLANS! Craft Plans are the hottest thing going today! Yes, thousands of spare-time craftsmen are finding they can easily move up to making a style of furniture they believed beyond their ability to handle. Well-known designers have now created a variety of plans that are exceptionally easy to follow and will assure you beautiful, finished pieces, at tremendous savings!

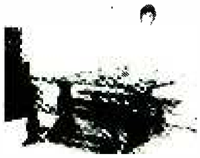
Get started today by ordering one or more of these award-winning Craft Plans.
Only $2.50 each!



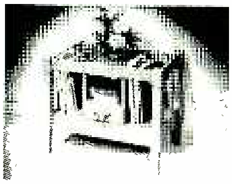
D-3
Child's Footlocker
No specialized tools are required to make this attractive child's footlocker. Spindles are assembled from stock items and except for some scroll cuts made with a saber saw, construction is done with hand tools. Lumber-plywood combination eliminates the usual craftsmen problems.



D-8
Colonial Hutch
This fair-sized hutch is dimensioned so that it can be built by using one panel of 4′ x 8′ plywood for the main assembly. Basic colonial design is revised so it blends in with any decor. Upper section has two good-sized shelves and a wide single drawer disguised as a double one.

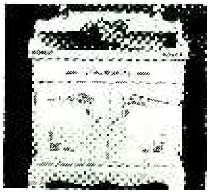


D-10
Trestle Table Set
This Early American table and bench set sells for well over $250 in fine furniture stores, but you build it for about $60, even less! Carefully select lumber, choosing boards that are fairly flat and avoid those with sap streaks.

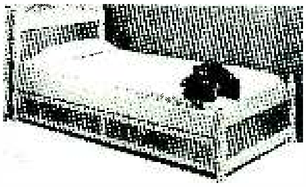


D-13
Magazine End Table
You build this fine piece of furniture from pine or the wood of your choice without fancy equipment—just with simple tools. Even the Italian provincial legs are not difficult; they are built-up using a technique called post blocking.

D-16
Corner Bookcase-Desk
This dual-purpose piece fits neatly into wasted corner space. Easy to build from pine with ordinary tools and ready-made turnings. Desk top has ample writing space and storage for stationery supplies. Two bottom shelves hold books within easy reach.

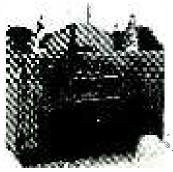


D-18
Colonial Dry Sink
You can build this versatile and serviceable piece of Americana inexpensively from pine. With its recessed lined well, it can be used as a bar, a buffet-server, a plant stand, or a simple storage cabinet. Easy to work with pine. Stain or antique it.

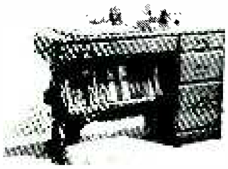


D-22
Captain's Trundle Bed
Common lumber is used to build this fine piece of furniture which has a lower drawer that rolls out to be used as an extra bed or as a bin for clothes, bedding, toys or whatever. Both upper and lower sections take a 39″ x 75″ mattress (standard twin size).

D-23
Elegant Bar
Originally built from plywood for less than $27! It would cost you about $125 to buy this handsome bar ready-made! Special features include padded vinyl rails, padded front panel and a brass foot rail. Decorative self-adhesive plastic can eliminate finishing.



D-25
Wall-Hung Sewing Center
This attractive colonial wall-hung sewing center stores all things needed for a well organized sewing room. It also delights those sewers who have limited floor space. There is no stooping to find things as drawers and storage shelves are at eye-level.



D-26
Colonial Desk with Book Rack
This attractive and functional desk enhances any room in your home. It has four roomy drawers, the largest one at the bottom made to hold letter-size folders. Pedestal support serves as book rack to hold a good supply of reading materials.

New! Money-saving, Easy-to-build Craft Plans!

HOW TO ORDER

CRAFT PLANS
Davis Publications, Inc.
229 Park Avenue South
New York, N.Y. 10003

Complete and mail today!
OUR GUARANTEE:
Money back if not
completely satisfied!

BE76

I have checked the appropriate box below and have enclosed payment. ALL PLANS $2.50 each, plus 50¢ for one plan (first-class) postage and handling, two or more $1.00.

☐ D-3 ☐ D-8 ☐ D-10 ☐ D-13 ☐ D-16 ☐ D-18 ☐ D-22 ☐ D-23 ☐ D-25 ☐ D-26

I have enclosed a total of $__________ (check or money order).

Name__________________ Address__________________
(please print)

City__________________ State__________ Zip__________

Budget Electronics

BUDGET Electronics

GUARANTEED TO SAVE MONEY

1978 EDITION $1.35 CC 02040

by the Editors of ELEMENTARY ELECTRONICS

HOUSEHOLD PENNY-PINCHERS

High-technology burglar protection
Bargain Hi-Fi beats yesterday's best
Install energy-saving ventilation
Keep those appliances running

PLUS MONEY-SAVING PROJECTS

No-meter light meter
Pro power from salvaged parts
Customized switches and relays
Paper-saver for color darkrooms

KIT SAVES CASH

Space-age TV now with Heath GR-2001

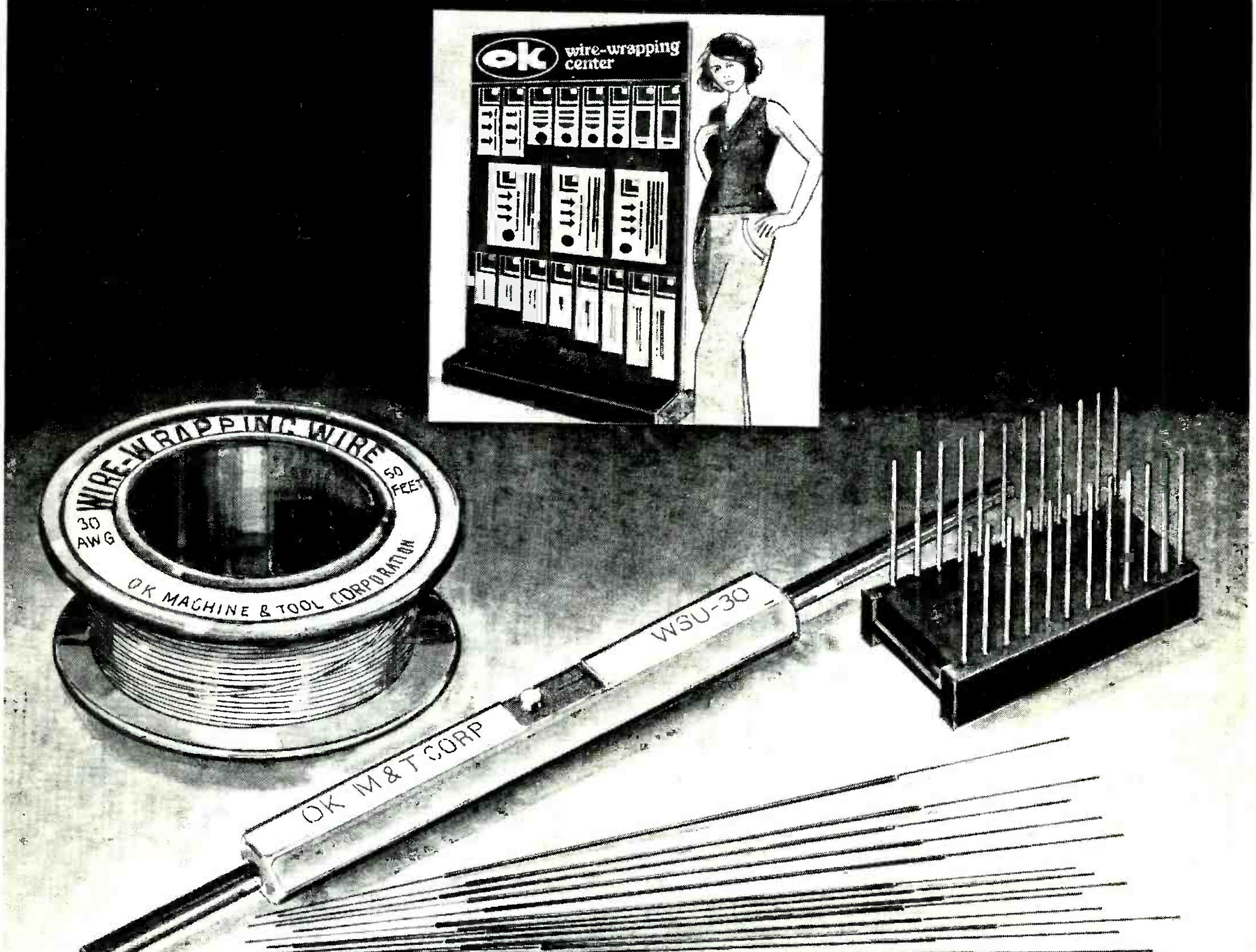
Get DX with that old FM portable

75
0 71486 02040

A DAVIS PUBLICATION

ok®

wire wrapping center...



for quality electronic parts and tools.

OK MACHINE & TOOL CORPORATION
3455 Conner St., Bronx, N.Y. 10475 / (212) 994-6600 / Telex 125091

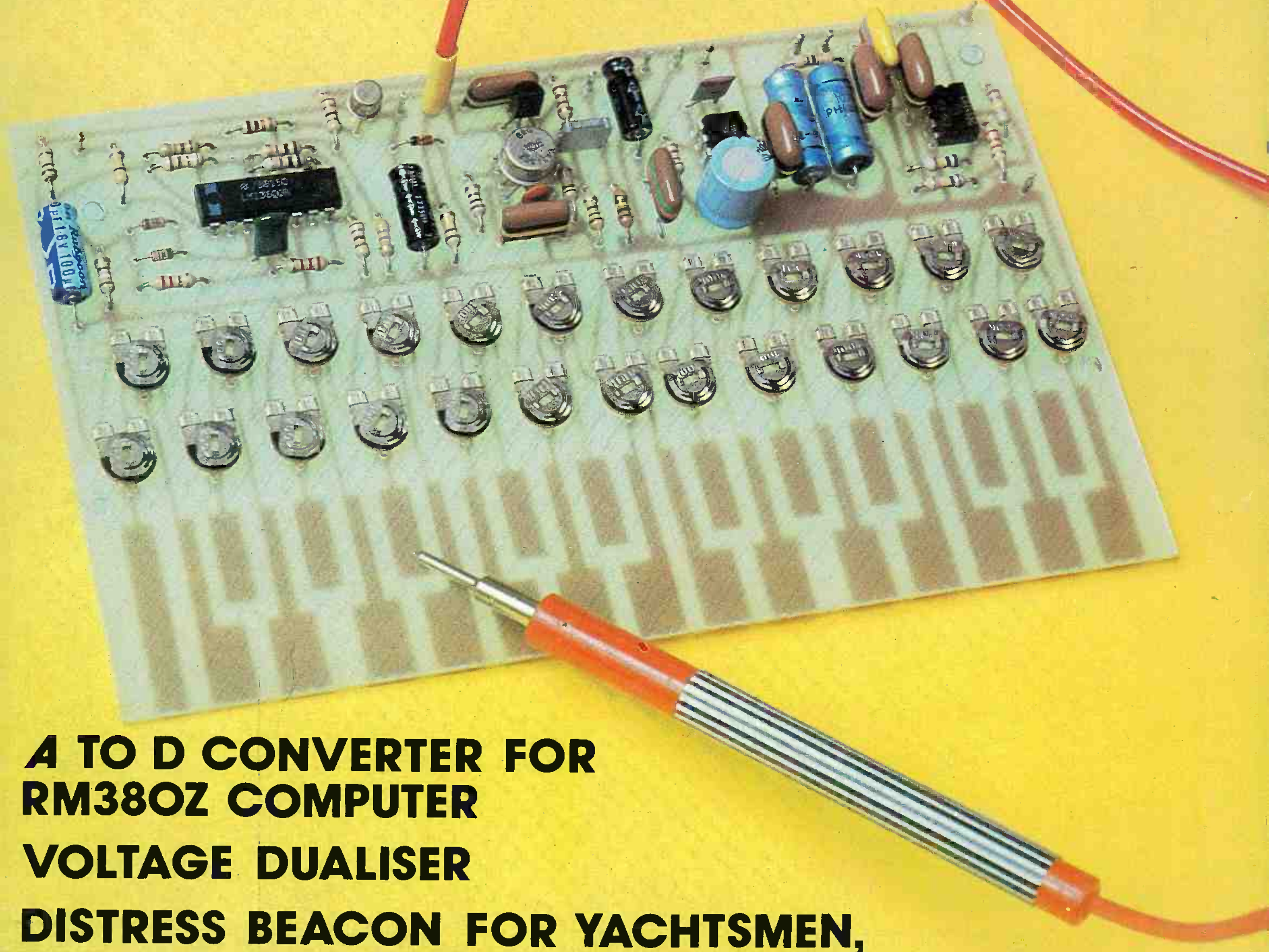
CIRCLE 6 ON READER SERVICE COUPON

EVERYDAY ELECTRONICS and computer PROJECTS

SEPTEMBER 1983

85p

STYLUS ORGAN
WITH VIBRATO AND DECAY



A TO D CONVERTER FOR RM380Z COMPUTER

VOLTAGE DUALISER

DISTRESS BEACON FOR YACHTSMEN, FELL WALKERS AND MOUNTAINEERS

Australia $1.50 New Zealand $1.60 Malaysia $4.95 IR £1.23 (inc. VAT)

electronize

AUTO-ELECTRONIC PRODUCTS

KITS OR READY BUILT

TOTAL ENERGY DISCHARGE ELECTRONIC IGNITION

IS YOUR CAR AS GOOD AS IT COULD BE ?

SPECIAL OFFER

★ Is it **EASY TO START** in the cold and the damp? Total Energy Discharge will give the most powerful spark and maintain full output even with a near flat battery.

★ Is it **ECONOMICAL** or does it "go off" between services as the ignition performance deteriorates? Total Energy Discharge gives much more output and maintains it from service to service.

★ Has it **PEAK PERFORMANCE** or is it flat at high and low revs. where the ignition output is marginal? Total Energy Discharge gives a more powerful spark from idle to the engines maximum (even with 8 cylinders).

★ Is the **PERFORMANCE SMOOTH**. The more powerful spark of Total Energy Discharge eliminates the "near misfire" whilst an electronic filter smoothes out the effects of contact bounce etc.

★ Do the **PLUGS and POINTS** always need changing to bring the engine back to its best? Total Energy Discharge eliminates contact arcing and erosion by removing the heavy electrical load. The timing stays "spot on" and the contact condition doesn't affect the performance either. Larger plug gaps can be used, even wet or badly fouled plugs can be fired with this system.

★ **TOTAL ENERGY DISCHARGE** is a unique system and the most powerful on the market - 3½ times the power of inductive systems - 3½ times the energy and 3 times the duration of ordinary capacitive systems. These are the facts:

Performance at only 6 volts (max. supply 16 volts)
SPARK POWER — 140W, SPARK ENERGY — 36mJ
SPARK DURATION — 500µS, STORED ENERGY — 135mJ
LOADED OUTPUT VOLTAGE
50pF load — 38kV, 50pF + 500k — 26kV

We challenge any manufacturer to publish better performance figures. Before you buy any other make, ask for the facts, its probably only an inductive system. But if an inductive system is what you really want, we'll still give you a good deal.

★ **All ELECTRONIZE electronic ignitions feature: EASY FITTING, STANDARD/ELECTRONIC CHANGEOVER SWITCH, STATIC TIMING LIGHT and DESIGNED IN RELIABILITY (14 years experience and a 3 year guarantee).**

★ **IN KIT FORM** it provides a top performance system at less than half the price of comparable ready built units. The kit includes: pre-drilled fibreglass PCB, pre-wound and varnished ferrite transformer, high quality 2µF discharge capacitor, case, easy to follow instructions, solder and everything needed to build and fit to your car. All you need is a soldering iron and a few basic tools.

Most **NEW CARS** already have electronic ignition. Update **YOUR CAR**

PROTECT YOUR CAR WITH AN ELECTRONIZE ELECTRONIC ALARM

★ **2000 COMBINATIONS** provided by an electronic key - a miniature jack plug containing components which must match each individual alarm system. (Not limited to a few hundred keys or a four bit code).

★ **60 SECOND ALARM PERIOD** flashes headlights and sounds horn, then resets ready to operate again if needed.

★ **10 SECOND ENTRY DELAY** allows owner to dis-arm the system, by inserting the key plug into a dashboard mounted socket, before the alarm sounds. (No holes in external bodywork, fiddly code systems or hidden switches). Re-closing the door will not cancel the alarm, before or after it sounds, the key plug must be used.

★ **INSTANT ALARM OPERATION** triggered by accessories or bonnet/boot opening.

★ **30 SECOND DELAY** when system is armed allows owner to lock doors etc.

★ **DISABLES IGNITION SYSTEM** when alarm is armed.

★ **IN KIT FORM** it provides a high level of protection at a really low cost. The kit includes everything needed, the case, fibreglass PCB, CMOS IC's, random selection resistors to set the combination, in fact everything down to the last nut and washer plus easy to follow instructions.

FITS ALL 12 VOLT NEGATIVE EARTH VEHICLES. SUPPLIED COMPLETE WITH ALL NECESSARY LEADS AND CONNECTORS PLUS TWO KEY PLUGS

Don't Wait Until Its too Late ~ Fit one NOW!

fill in the coupon and send to:

ELECTRONIZE DESIGN Dept C · Magnus Rd · Wilnecote · Tamworth · B77 5BY · tel 0827 281000

TOTAL ENERGY DISCHARGE (6 or 12 volt negative earth)

☐ Assembled ready to fit ~~£26.70~~ £19.95
☐ D.I.Y. parts kit ~~£15.90~~ £14.95

TWIN OUTPUT for cars and motor cycles with dual ignition

☐ Twin, Assembled ready to fit ~~£36.45~~ £29.95
☐ Twin, D.I.Y. parts kit ~~£24.55~~ £22.95

☐ PLEASE SEND MORE INFORMATION

Goods normally despatched within 7 days.

Prices Include VAT. P+P £1-00 (UK)

C

CAR ALARM

☐ Assembled ready to fit £37.95
☐ D.I.Y. parts kit £24.95

I enclose cheque/postal order OR debit my Access/Visa card

VISA

Name ____________

Address ____________

____

____________ Code ______

MAKE ALL THE RIGHT CONNECTIONS

with a MAPLIN MODEM KIT

Exchange programs with friends, leave or read messages from the various Billboard services, talk to computer bureaux, or place orders and check stock levels on Maplin's Cashtel service. A Maplin Modem will bring a whole new world to your computer and vastly increase its potential.

Now you can exchange data with any other computer using a 300 baud European standard (CCITT) modem and because the Maplin Modem uses this standard, you could talk to any one of tens of thousands of existing users.

Some computers need an interface and we have kits for the ZX81, VIC20/Commodore 64, Dragon and shortly Spectrum and Atari, whilst the BBC needs only a short program which is listed in Projects Book 8.

A Maplin Modem will add a new dimension to your hobby.

Order As LW99H (Modem Kit) excluding case. Price £39.95.
YK62S (Modem Case). Price £9.95.

Full construction details in Projects Book 5.

Maplin's Fantastic Projects

Full details in our project books. Price 70p each.

In Book 1 (XA01B) 120W rms MOSFET Combo-Amplifier ● Universal Timer with 18 program times and 4 outputs ● Temperature Gauge ● Six Vero Projects.

In Book 2 (XA02C) Home Security System ● Train Controller for 14 trains on one circuit ● Stopwatch with multiple modes ● Miles-per-Gallon Meter.

In Book 3 (XA03D) ZX81 Keyboard with electronics ● Stereo 25W MOSFET Amplifier ● Doppler Radar Intruder Detector ● Remote Control for Train Controller.

In Book 4 (XA04E) Telephone Exchange for 16 extensions ● Frequency Counter 10Hz to 600 MHz ● Ultrasonic Intruder Detector ● I/O Port for ZX81 ● Car Burglar Alarm ● Remote Control for 25W Stereo Amp.

In Book 5 (XA05F) Modem to European standard ● 100W 240V AC Inverter ● Sounds Generator for ZX81 ● Central Heating Controller ● Panic Button for Home Security System ● Model Train Projects ● Timer for External Sounder.

In Book 6 (XA06G) Speech Synthesiser for ZX81 & VIC20 ● Module to Bridge two of our MOSFET amps to make a 350W Amp ● ZX81 Sound on your TV ● Scratch Filter ● Damp Meter ● Four Simple Projects.

In Book 7 (XA07H) Modem (RS232) Interface for ZX81/VIC20 ● Digital Enlarger Timer/Controller ● DXers Audio Processor ● Sweep Oscillator ● CMOS Crystal Calibrator.

In Book 8* (XA08J) Modem (RS232) Interface for Dragon ● VIC Extendiboard ● Synchime ● Electronic Lock ● Minilab Power Supply ● Logic Probe ● Doorbell for the Deaf.

*Projects for Book 8 were in an advanced state at the time of writing, but contents may change prior to publication (due 13th August 1983).

NEW MAPLIN STORE OPENS IN MANCHESTER

Our new Manchester store offering the full range of Maplin's electronic components, computers and software will be opening 16th August, 1983. Part of the new store will be a self-service area where you can browse around and choose the parts you want. Counter service will be available as well. Upstairs you will find our computer demonstration area with displays of hundreds and hundreds of different software packages for Atari, BBC, Commodore 64, Dragon, Sord M5, Spectrum and VIC20.

You will find us at 8, Oxford Road opposite the BBC, between Piccadilly and the University complex. We're just a few steps from

Manchester's Oxford Road station and about five minutes walk from the city centre. There is excellent parking on meters in the adjacent sideroads and we're about five minutes drive straight in from junction 10 on the M63 at the start of the M56.

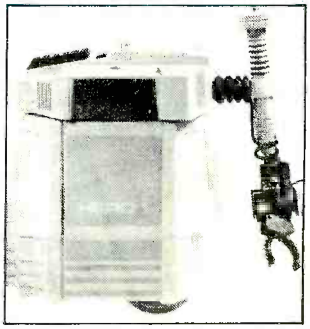
Call in and see us soon!

LEARN ROBOTICS

– with Hero 1; the new robot who sees, hears, speaks and detects movement!

This remarkable microprocessor-controlled robot is the perfect robotics training system for industry, home and schools. Hero 1 can see, hear, speak, detect moving and stationary objects and determine their distance, pick up small objects, move in any direction and can learn from your instructions.

Hero 1 is a superbly documented Heathkit kit.



Order As HK20W (Robot Kit) Price £1,599.95.

Great Projects From E&MM

Our new book "Best of E&MM Projects Vol. 1" brings together 21 fascinating and novel projects from E&MM's first year.

Projects include Harmony Generator, Guitar Tuner, Hexadrum, Syntom, Auto Swell, Partylite, Car Aerial Booster, MOS-FET Amp and other musical, hi-fi and car projects.

Order As XH61R. Price £1.

1983 CATALOGUE

Over 390 pages packed with data and pictures and all completely revised and including over 1000 new items. On sale in all branches of W.H. Smith. Price £1.25. Or send £1.50 (including p&p) to our mail-order address.

MAPLIN
ELECTRONIC SUPPLIES LTD

Mail Order: P.O. Box 3, Rayleigh, Essex SS6 8LR. Tel: Southend-on-Sea (0702) 552911.
Shops at: 159-161 King Street, Hammersmith, London W6. Tel: 01-748 0926.
284 London Road, Westcliff-on-Sea, Essex. Tel: (0702) 554000.
Lynton Square, Perry Barr, Birmingham. Tel: 021-356 7292.
8 Oxford Road, Manchester. Tel: 061-236 0281. (Opens 16th Aug. 1983)
All shops closed Mondays.
All prices include VAT & carriage. Please add 50p handling charge if total order value is under £5.

ELECTRONICS HOBBY THEORY PROJECTS

C&E HOBBY HANDBOOKS

WPS 36286 $2.95

ELECTRONICS HANDBOOK

OCTOBER 1986 IN CANADA $3.50

THE BEST OF THE BEST!

PREMIERE ISSUE

OSCILLATING AMPLIFIERS

PRIMER ON BASIC MAGNETISM

80-TUNE COMPUTER

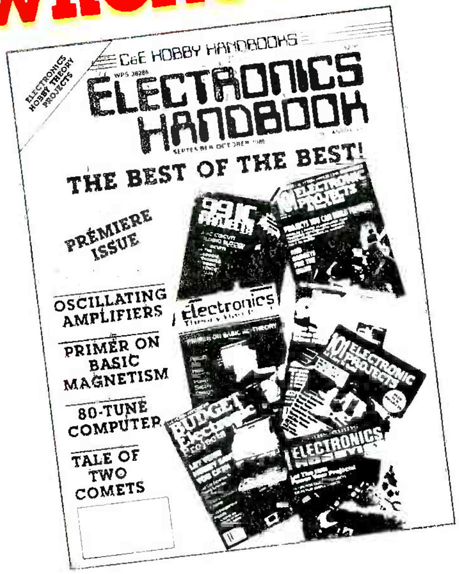
TALE OF TWO COMETS

10

0 70989 36286 4

Lab Test ELECTRONICS HANDBOOK For Yourself

Get switched on



In case you're not all that familiar with us, we're not a publication for electrical engineers and other wizards. No way, ELECTRONICS HANDBOOK is expressly for people who like to build their own projects and gadgets—and maybe get a little knee-deep in tape, solder and wire clippings in the process.

In fact, we have a sneaking suspicion that our readers like us because they think we're just as bug-eyed and downright crazy over great new project ideas as they are. And I guess they're right!

ELECTRONICS HANDBOOK thinks of you who dig electronics as the last of a special breed. It's more than just the "do-it-yourself" angle—it's also the spirit of adventure. In this pre-packaged, deodorized world, building your own stereo system, shortwave receiver, darkroom timer or CB outfit is like constructing a fine-tuned little universe all your own. And when it all works perfectly—it really takes you to another world.

ELECTRONICS HANDBOOK knows the kinds of projects you like—and we bring 'em to you by the truckload!

Ever hanker to build a sharp-looking digital clock radio? Or to hook up an electronic game to your TV? Or an easy-to-build photometer that makes perfect picture enlargements? Or a space-age Lite-Com so you and the family can talk to each other on a light beam? We've got it all to get you started.

Has your sound system gone blooey just when the party's going great? Do you shudder when your friendly neighborhood electrician hands you the bill? ELECTRONICS HANDBOOK can help.

Of course, we can't make you a master electrician overnight. But we can show you the fundamentals of repair plus maintenance tips.

IF YOU'RE NEW TO ELECTRONICS YOU GET A "BASIC COURSE"!

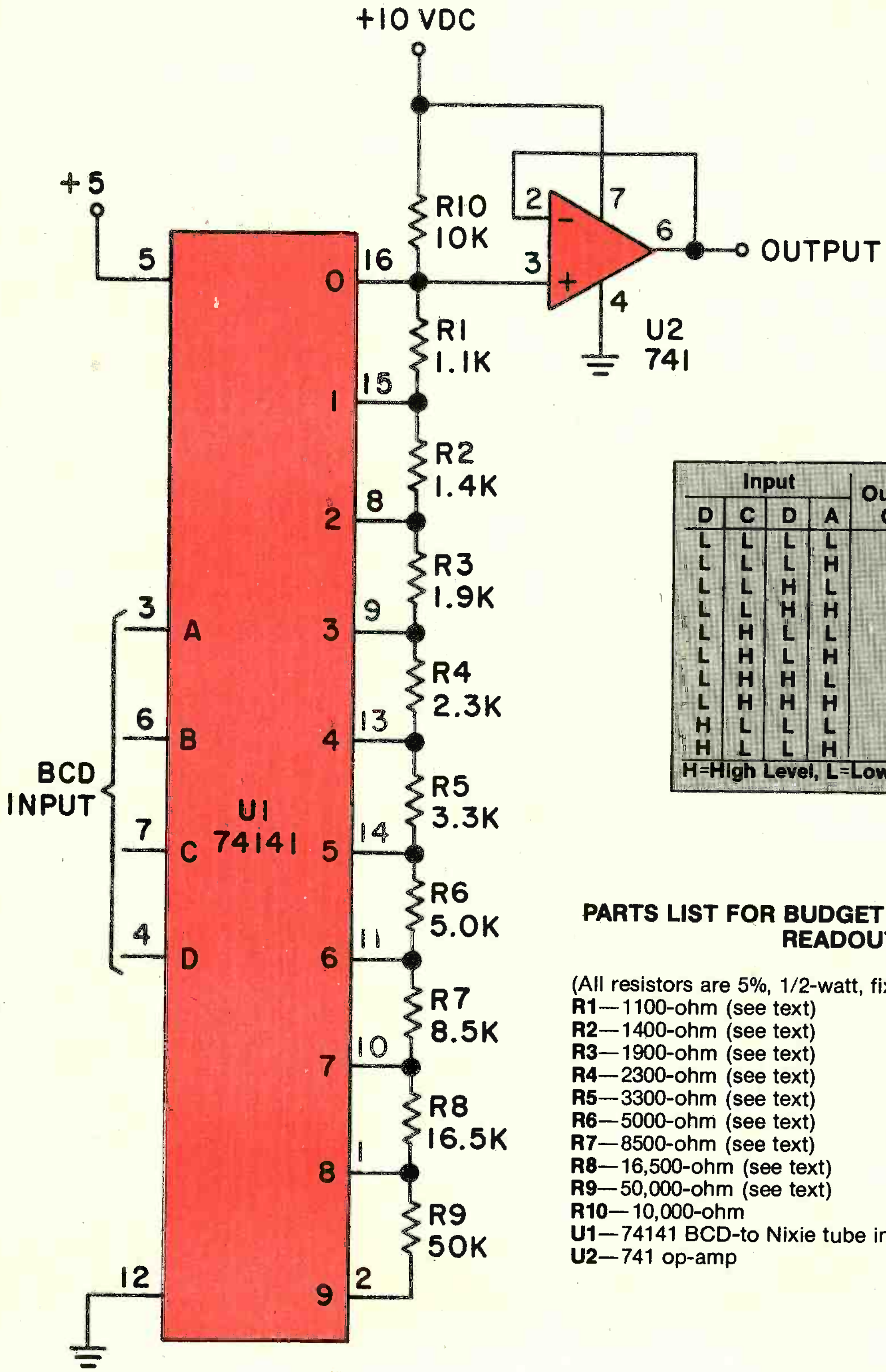
It gives you a complete, ground-floor lowdown on a variety of important electronic subjects. For example—Understanding Transistors...How Radio Receivers Pull in Signals...Cathode Ray Tubes Explained...How Capacitors Work...Using Magnetism in Electronics, and much, much more!

TRY A FEW ISSUES AND EVALUATE OUR...

- **HOW-TO-DO-IT HELP**. Tips and pointers that **add** up to money saved. For example—tuning up your tape player...all about radios ...whys and hows of turntables...care and feeding of speakers.

- **EXCITING DISCOVERIES**. Whatever your particular interest in electronics, you'll be entering a world of discovery in the pages of the ELECTRONICS HANDBOOK

IC TESTBENCH



Input				Output On
D	C	D	A	
L	L	L	L	0
L	L	L	H	1
L	L	H	L	2
L	L	H	H	3
L	H	L	L	4
L	H	L	H	5
L	H	H	L	6
L	H	H	H	7
H	L	L	L	8
H	L	L	H	9

H=High Level, L=Low Level

PARTS LIST FOR BUDGET BCD-TO-ANALOG READOUT

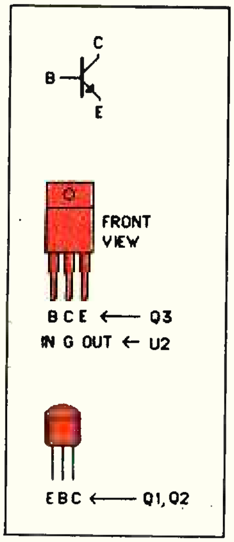
(All resistors are 5%, 1/2-watt, fixed units)
R1—1100-ohm (see text)
R2—1400-ohm (see text)
R3—1900-ohm (see text)
R4—2300-ohm (see text)
R5—3300-ohm (see text)
R6—5000-ohm (see text)
R7—8500-ohm (see text)
R8—16,500-ohm (see text)
R9—50,000-ohm (see text)
R10—10,000-ohm
U1—74141 BCD-to Nixie tube integrated circuit
U2—741 op-amp

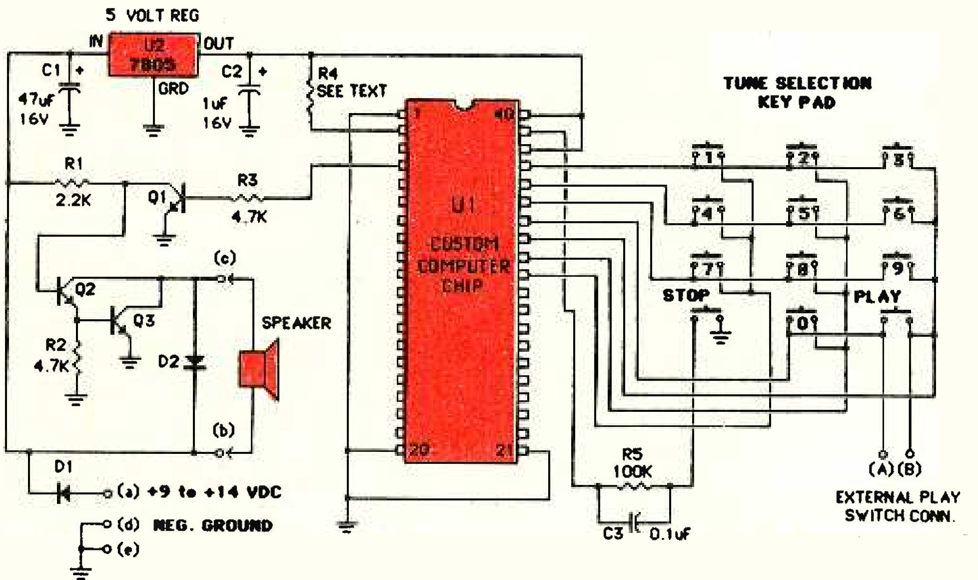
with the panel. The holes for the panel can be located by using the circuit board as a template. Use either the left solder tab hole or the right solder tab hole and mark the panel of the selected chassis for each of the twelve switch positions.

Resistor R5 and capacitor C3 form a *Reset* time-delay RC network. Pin 39 of U1 is the *Reset* pin of the microprocessor. This pin has an internal pull-up resistor which keeps the terminal at 5 Volts. The *Stop* button places a brief pull-down path on the reset pin through C3. The momentary ground resets the system as C3 charges. When the *Stop* button is released, the charged capacitor discharges through R5. The *Play* switch has two extra solder pads marked A and B which allow an external switch to be wired in parallel with the *Play* switch so that the circuit can be activated remotely.

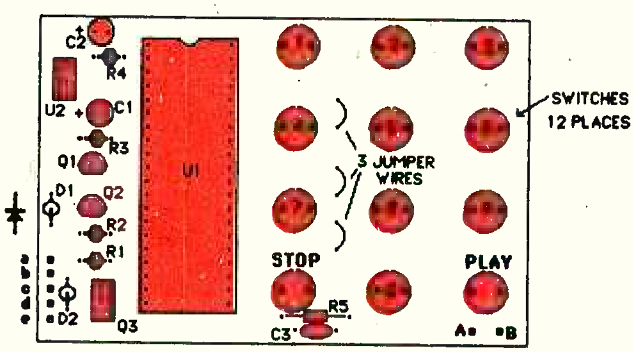
The microprocessor requires +5 volts, which is connected to pins 38 and 40 of U1. The 5-V supply is regulated by U2, a 7085 voltage regulator IC.

80 TUNE COMPUTER





80 TUNE COMPUTER CIRCUIT CARD COMPONENT PLACEMENT



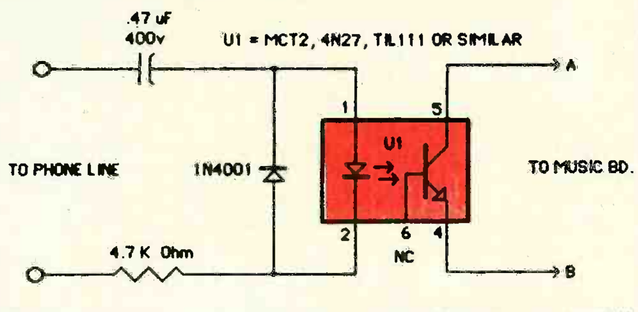
PARTS LIST FOR 80 TUNE COMPUTER

R1—Resistor, 2.2K, ¼W, 5%. Radio Shack 271-1325
R2, R3—Resistor 4.7K, ¼W, 5%. Radio Shack 271-1330
R4—Resistor 6.8K, ¼W, 5%. Radio Shack 271-1328 (2)
R5—Resistor 100K. ¼W, 5%. Radio Shack 271-1347
C1—Capacitor, 47uF, 16V. Radio Shack 272-1027
C2—Capacitor 1uF, 16V. Radio Shack 272-1434
C3— Capacitor 0.1 uF, 50V. Radio Shack 272-1069
D1, D2—Diode 1N4001, 1 AMP, 50V. Radio Shack 276-1101
Q1, Q2—Transistor, 2N2222. Radio Shack 276-2009
Q3—Transistor, TIP31. Radio Shack 276-2017
U2—7805 Voltage Regulator. Radio Shack 276-1770
S1-S0—Key pad switches (12). Radio Shack 275-1574
SPKR—Car Horn. Radio Shack 40-1244
SPKR—Door Bell. Radio Shack 40-246

U1 Custom Microprocessor $6.00.
PCB Printed Circuit Board $3.95.
Add $1.50 for postage and handling.
For above, send check or money order to
C & E Hobby Handbooks, Inc.
P.O. Box #5148 North Branch, NJ 08876

HOBBY DEPARTMENT

ALTERNATE RING DETECTOR CIRCUIT



Capacitors C1 on the input to the regulator and C2 on the output of the regulator act as filter capacitors to remove high frequency noise. Pins 1, 20, and 21 of U1 are grounded. Pin 2 of U1 is connected through R4 to the +5-V supply. The value of R4 is typically 6.8 K ohms but can be decreased to cause the microprocessor to play faster, or increased to make the songs play slower. Pins 31, 32, and 33 of U1 are the column connections for the switch matrix. Pin 31 is column one, and requires three jumper wires to connect it to the top three switches in the matrix. Pins 34, 35, 36, and 37 the row connections to the switch matrix. The processor scans these lines to sense a closed switch.

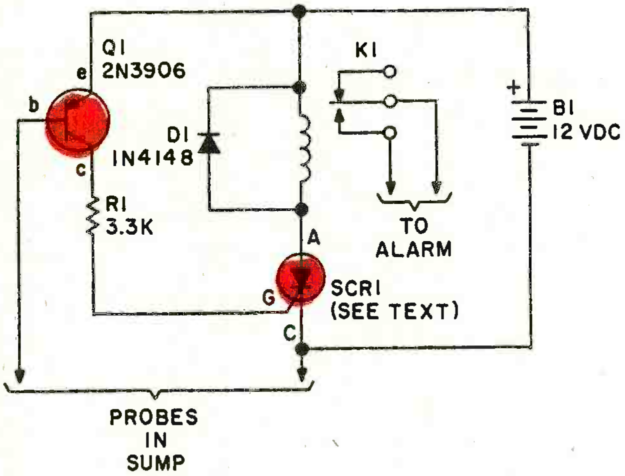
The main power input is connected through diode D1. This is a 1N4001 rated for 50 volts at 1 amp. This diode protects against accidental voltage reversals. It can also be used as a rectifier diode for connecting a doorbell transformer as a power source. The doorbell transformer should not exceed 10 VAC, and C1 may need to be increased for extra filtering. The processor output is pin 4 which drives the three output transistors, Q1 Q2 and Q3. One side of the speaker connects to the positive supply voltage. Transistor Q3 switches the other side of the speaker to ground at a rate controlled by the processor. A four ohm, five-watt horn speaker will produce the highest sound level. If lower sound level is acceptable, a resistor can be connected in series with the speaker. Q3 is a power transistor capable of switching a 3-amp load; however, no heat sink is required for Q3 or U2. If extra clearance is required, Q3 and U2 can be mounted below the board as long as the same pins are soldered to the same pads on the circuit board and the metal tabs do not touch any metal surface. When Q3 switches open, the flyback voltage generated by the speaker can be quite high. Diode D2 is used to discharge this flyback transient pulse which might otherwise damage Q3.

A wall charger type 9V, 200 mA power supply will make a good source for many of the projects such as this telephone ringer. A simple telephone ringer can be made by using a glass reed switch conected with a

80 TUNE COMPUTER SONG LIST

0 AMERICA
1 ANCHORS AWEIGH
2 BATTLE HYMN REPUBLIC
3 CAISSONS GO ROLLING
4 CALL TO COLORS
5 CAVALRY CHARGE
6 DIXIE
7 HAIL BRITTANIA
8 YANKEE DOODLE DANDY
9 LA MARSEILLAISE
10 MARINE HYMN
11 REVEILLE
12 STARS & STRIPES
13 TAPS
14 WILD BLUE YONDER
15 ALOUETTE
16 AREVEDERCHI ROMA
17 CAMPTOWN RACES
18 CANDY MAN
19 CHATTANOOGA CHOO-CHOO
20 CLEMENTINE
21 DALLAS THEME
22 EL PASO
23 THE ENTERTAINER
24 JOLLY GOOD FELLOW
25 FUNERAL MARCH
26 HAVA NAGILAH
27 IN HEAVEN IS NO BEER
28 JIMMY CRACK CORN
29 JINGLE BELLS
30 KING OF ROAD
31 LA CUCARACHA
32 LONE RANGER
33 MODEL T
34 THE OLD GREY MARE
35 POPEYE
36 RAINDROPS
37 SAILORS HORNPIPE
38 SAN ANTONIO ROSE
39 SEE THE USA
40 OUT TO THE BALLGAME
41 TIJUANA TAXI
42 TWO BITS
43 WABASH CANNONBALL
44 SAINTS GO MARCHING
45 WOODY WOOPECKER
46 YELLOW ROSE OF TEXAS
47 ACROSS THE FIELD
48 AGGIE WAR HYMN
49 ARKANSAS FIGHT SONG
50 BE SHARP
51 BOOMER SOONER
52 BOW DOWN WASHINGTON
53 BUCKLE DOWN WINSOCKI
54 CHARGE
55 DEAR OLD NEBRASKA U.
56 THE EYES OF TEXAS
57 ABOVE CAYUGA'S WATERS
58 FIGHT ON USC
59 GO, NORTHWESTERN
60 HAIL PURDUE
61 HEY LOOK ME OVER
62 HOLD THAT TIGER
63 ILLINOIS LOYALTY
64 INDIANA, OUR INDINA
64 I'M A JAYHAWK
66 IOWA FIGHT SONG
67 LOVE YA BLUE
68 MICHIGAN STATE FIGHT
69 MINNESOTA ROUSER
70 NITTANY LION
71 NOTRE DAME FIGHT
72 OLE MISS
73 ON, BRAVE ARMY TEAM
74 ON WISCONSIN
75 WRECK FROM GA. TECH
76 ROLL ON TULANE
77 THE VICTORS
78 WASHINGTON/LEE SWING
79 YEA ALABAMA

The alarm you select is up to you. The minimum should be a flashing bulb rated at 15 watts or more located where you can't miss it when in or entering the house. Maybe two or more bulbs are needed. As for a gong—that's up to you!



PARTS LIST FOR OVERFLOW INDICATOR

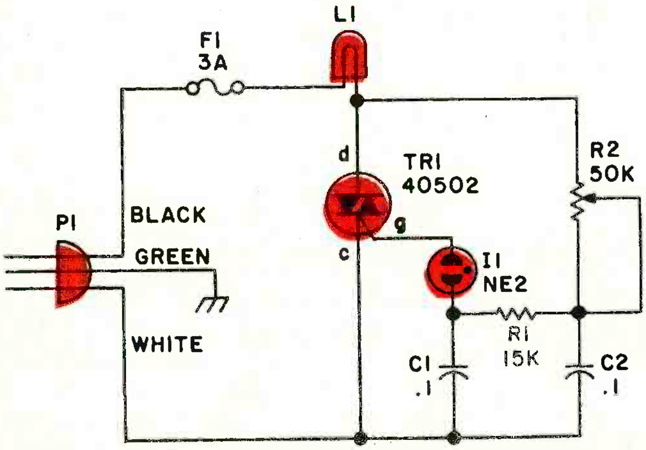
B1—12-volt battery (to match coil of relay K1)
D1—1N4148 diode
K1—SPDT, 12-volt DC, miniature relay with contacts rated at 125-VAC at 3 amperes (Radio Shack type 275-206, or equivalent)
Q1—2N3906 switching PNP transistor
R1—33,000-ohm, ¼-watt, 10% resistor
SCR1—Silicon-controlled rectifier, any low-current type to match relay used (see text)

BUDGET LAMP DIMMER

No group of projects on lamp control can be complete without a budget lamp dimmer as shown in Fig. 5. The circuit does not go from full dark to full brightness immediately, it first must trigger TR1 at a medium-brightness level and then the potentiometer (R2) positioned to attain a suitable level of illumination from L1, either above or below the initial brightness level.

What is nice about this circuit is the cost—it's mighty low and most of the parts are usually found in the junkbox. The neon gate serves the same function as a triggering diode (bi-directional avalanche switch), such as the D3202U and 276-1649 (Radio Shack).

Assemble the device in a plastic or aluminum chassis box. Triac TR1 can handle up to 400 watts of a resistive load without a heat sink.



PARTS LIST FOR BUDGET LAMP DIMMER

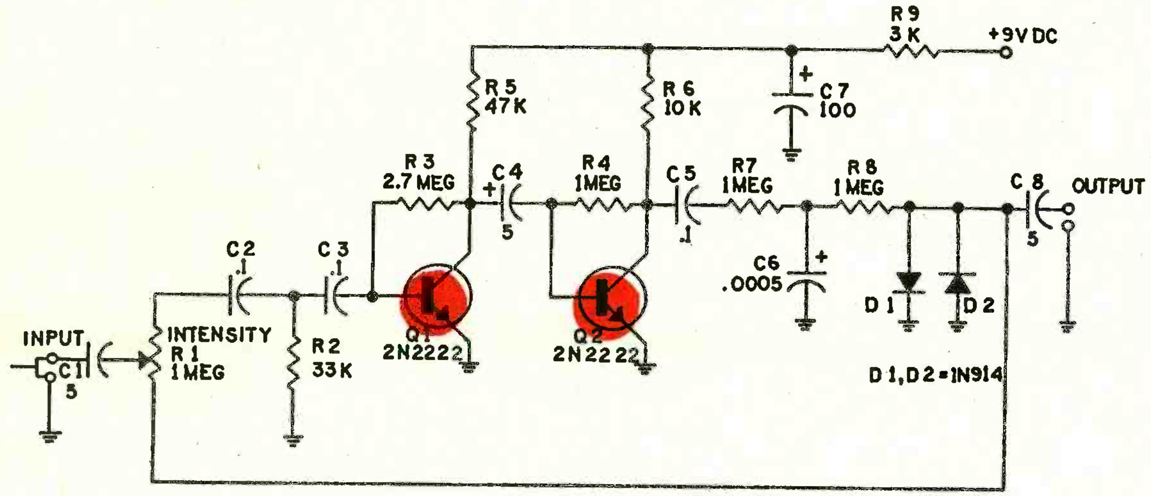
C1, C2—.1-uF, ceramic capacitor
F1—Fuse, 3 amperes, 3AG type with holder
I1—NE-2 neon bulb with wire leads
L1—Household light bulb up to 400 watts may be paralleled together
P1—power cord with molded power plug, 3-wire
R1—12,000-ohm, ½-watt, 5% resistor
R2—50,000-ohm, linear-taper potentiometer
TR1—Triac 40502 (RCA), or equivalent

ANOTHER FUZZ BOX

Here's Another Fuzz Box, a simple low-level output circuit that can be added to an existing amplifier or outboarded in an aluminum chassis box with a battery power supply. The drain is low so that a transistor-radio battery will last several sessions with the band.

The quality of the two amplifying stages leave much to be desired, however, in a fuzz circuit they fill the bill. Diodes D1 and D2 clip the output. Capacitor C6 rolls off the high frequencies. When intensity potentiometer R1 is at the bottom of its travel (see Fig. 6), all of the input signal is fed directly to the output terminal. As the potentiometer's wiper is advanced upward, an increasing amount of signal is fed to the fuzz circuit and less is fed to the output terminal directly. The degree of mix, if any is left to the musician's desires!

As in all audio projects, ground loops will degrade the program, so some careful work is in order. Connect a No. 14 or No. 12 solid copper wire between the ground terminals of the input and output connectors. The ground connections in the circuit should progress on the copper bus an seen in the diagram from left to right. The battery's negative terminal should be connected close to the gout terminal's ground.



PARTS LIST FOR ANOTHER FUZZ BOX

C1, C4, C8—5-uF, 16-WVDC, electrolytic capacitor
C2, C3, C5—.1-uF, ceramic capacitor
C6—.0005-uF, ceramic capacitor
C7—100-uF, 16-WVDC, electrolytic capacitor
D1, D2—IN914 diode
Q1, Q2—2N2222 transistor
R1, R4—1-Megohm, linear-taper potentiometer
R2—33-ohm, ½-watt, 5% resistor
R3—2.7-Megohm, ½-watt, 5% resistor
R5—47,000-ohm, ½-watt, 5% resistor
R6—10,000-ohm, ½-watt, 5% resistor
R7, R8—1-Megohm, ½-watt, 5% resistor
R9—3000-ohm, ½-watt, 5% resistor

PORTABLE POWER FREQUENCY CHECKER

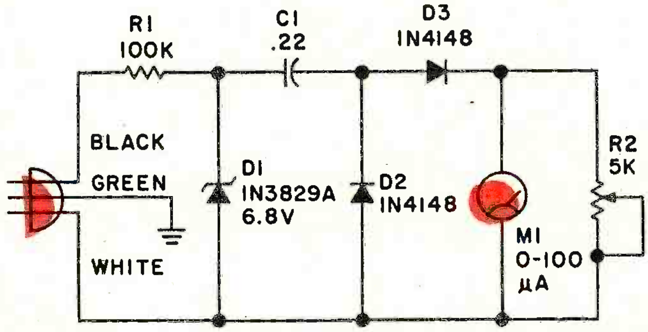
The hurricane passed you by with only some blown trash on the lawn and loss of power,. No problem at all. All you have to do is power up the gasoline-driven power supply and tie in the house's freezer and refrigerator to the supply. Your frozen food supply will be safe and the trash in the yard can wait till tomorrow. Life can be beautiful.

Sure it can! But not for you! The power supply starts up quickly and seems to be working fine. A 100-watt light bulb tied to it burns brightly indicating that the voltage is good—the unit's meter attests to that! But—why did the refrigerator's motor overheat during the night and burn out; and why is the freezer motor laboring so hard? Oh! Oh!—more smoke coming from the freezer!

If you had a frequency meter to connect to the power-supply line you would have noted that the line frequency was about 47 Hertz—much too low. Sixty-cycle motors can't operate for long at reduced line frequencies. If you only had a frequency meter.

Well, for a few pennies you an make your own! Refer to Fig. 7. The Power-Line Frequency Meter samples the 117-volt AC LINE by dropping the voltage across R1 and developing 6.8-volt square waves with Zener diode D1. The square wave is differentiated by capacitor C1. The meter circuit and the diodes (D2 and D3) average the current and an indication is obtained. In the low power frequency range, the average current through the meter is proportional to the frequency of the AC line. Calibration is simple: connect the circuit to the utility's power line (pre-hurricane) and adjust R2 for 60 milliamperes. Now, over the top two-thirds of the meter dial (on a 100-milliampere scale) will indicate power-line frequency very accurately within the 3% rating of the meter. You could use your multimeters 100-mA scale setting should a 0-100 mA DC meter be unattainable.

Make you Power-Line Frequency Meter today. Put into a metal or plastic box and include a 3-wire power cord with plug so that connection to the power-line's outlet can be done quickly. The power cord can be as as short as one foot. Now your family and home will be ready for the next tropical storm coming your way!



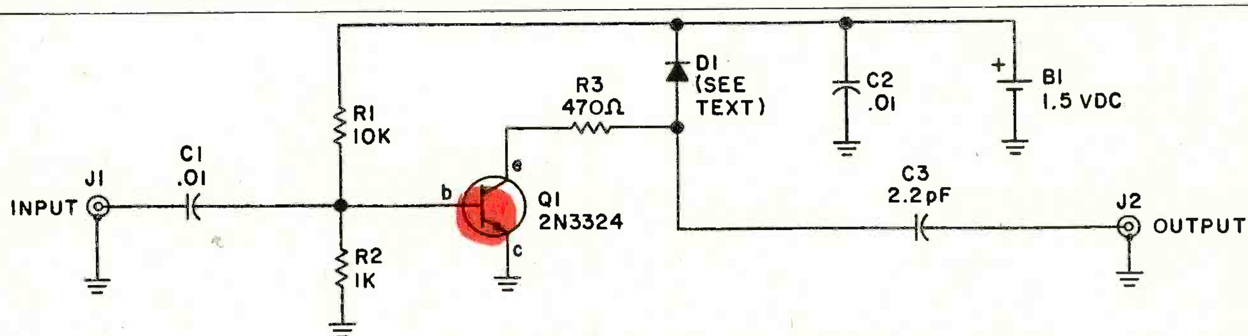
PARTS LIST FOR POWER-LINE FREQUENCY METER

C1—.22uF, ceramic disc capacitor
D1—IN3829A Zener diode, 6.8-volt, 1-watt
D2, D3—IN4148 diode
M1—0-100-mA DC meter (see text)
P1—power cord with molded plug, 3-wire
R1—100,000-ohm, 2-watt resistor (use four 390,000-ohm, ½-watt resistors in parallel)
R2—5000-ohm, linear-taper potentiometer

HARMONIC GENERATOR

If you are into shortwave listening, amateur radio, and other high-frequency activities, here is a harmonic generator that will produce harmonics up to 150 MHz from a 1000-Hertz input signal. See Fig. 8. Don't try to improve on the circuit by switching the germanium diode (D1) with a silicon type—that's a big mistake! The input signal required to drive the circuit can be between .15 to 1.0 volts input. If your interest lie in the broadcast band or there about, increase the size of C3 for more output.

Since the power required for the circuit can be delivered by a dry cell, use one and keep it simple. If you must get into circuit improving, try a tunnel diode in place of the germanium diode—if you can find one.



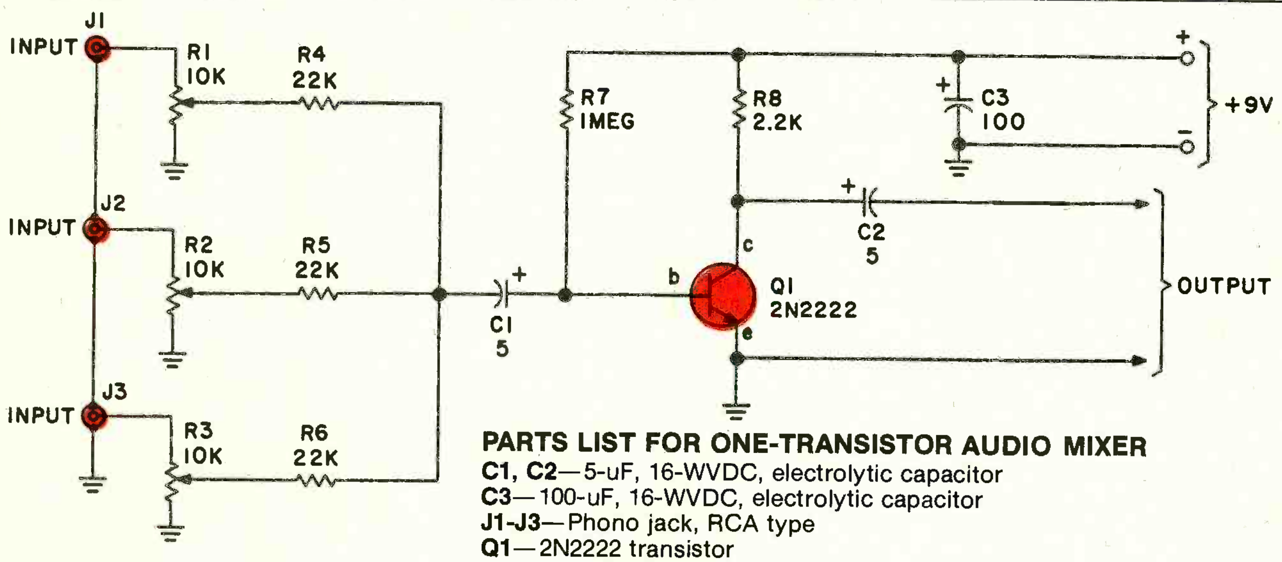
PARTS LIST FOR HARMONIC GENERATOR

B1—1.5-volt DC dry cell, AA- to C-type
C1, C2—.01-uF, ceramic capacitor
C3—2.2-pF, ceramic capacitor
D1—IN34 germanium diode (see text)
J1—Phono jack, RCA type
J2—BNC connector (male or female)
Q1—2N3324 transistor, or equivalent
R1—10,000-ohm, ¼-watt, 5% resistor
R2—1000-ohm, ¼-watt, 5% resistor
R3—470-ohm, ¼-watt, 5% resistor

PROJECT WORKBENCH

ONE-TRANSISTOR AUDIO MIXER

Sometimes we resort to whole console of circuitry to do the job that can be done by one transistor. In the example shown in Fig. 9, one transistor, Q1, and its associated circuitry is all that is required to mix three audio channels into one output line. It's a simple summing circuit with the base-emitter resistance being the summing resistor. The circuit offers a gain of about 20.



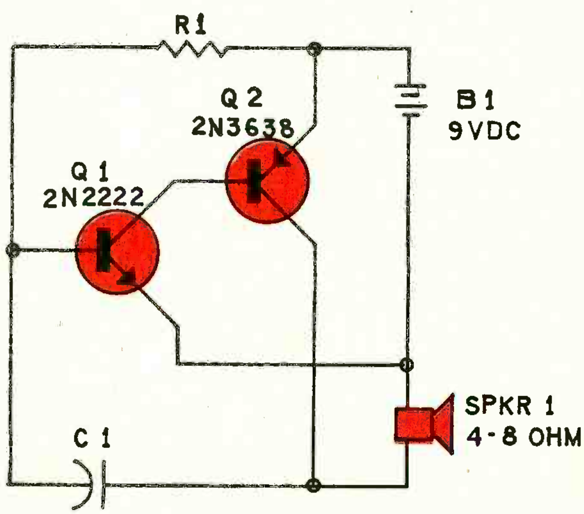
PARTS LIST FOR ONE-TRANSISTOR AUDIO MIXER

C1, C2—5-uF, 16-WVDC, electrolytic capacitor
C3—100-uF, 16-WVDC, electrolytic capacitor
J1-J3—Phono jack, RCA type
Q1—2N2222 transistor
R1-R3—100,000-ohm, audio-taper potentiometer
R4-R6—22,00-ohm, ¼-watt, 5% resistor
R7—1-Megohm, ¼-watt, 5% resistor
R8—2200-ohm, ½-watt, 5% resistor

AUDIO OSCILLATOR

The simple two-transistor circuit shown in Fig. 10 produces enough volume to drive a small 4- to 8-ohm loudspeaker. The values of R1 and C1 may be varied over a large range and still get an audio output. The transistors used are not critical to the circuit operation so that you can make substitutions with similar audio-type transistors. A 9-volt transistor-radio battery can power the circuit.

Inset a key into the battery circuit and the device can be used to practice Morse code. Make the battery leg a perimeter loop and the device can be used to announce visitors and detect intruders.



PARTS LIST FOR AUDIO OSCILLATOR

B1—9-volt transistor-radio battery
C1—.02-.06-uF, disk capacitor
Q1—2N2222 transistor
Q2—2N3638 transistor
R1—5000-150,000-ohm, ½-watt, 10% resistor
SPKR1—Loudspeaker with 4- to 8-ohms voice coil

CIRCUIT FRAGMENTS THAT DO THINGS

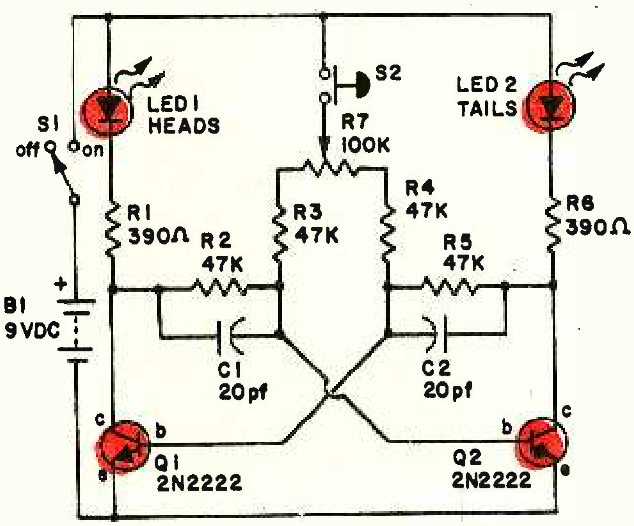
By Curt Sim

The design of projects usually takes the form of an idea and a circuit fragment. The fragment is usually a circuit that is complete in that it does something all by itself, however, it can be expanded to do bigger and better things. This article will present some circuit fragments that are useful projects in themselves. Nevertheless, with a little thought, these circuits can be made part of a larger project that provides many more useful functions or improved performance.

The parts used in these circuits are common and may be available in your spare-parts box. The use of a solderless breadboard will give you an opportunity to play with each circuit without damaging the parts or leads from constant soldering and desoldering. The experience you obtain will be invaluable in future projects...Enough chit chat—on with the projects!

SIMPLE COIN TOSS

For just the price of a pushbutton switch (S2 in Fig. 1), an ordinary multivibrator circuit can be converted to something else, and you can flip electronic coins as long as you want until the battery drains dead! When the button of S2 is depressed, the circuit is a squarewave multivibrator running at about 800 Hz. Release the button and the circuit becomes a stable one shot-device that has only one transistor conducting. Under this condition, one of the light-emitting diodes (LED1 and LED2) will be on. The symmetry of the circuit indicates that the 800-Hz squarewave will have a 50-percent duty cycle. That is, the squarewave will be high for one half of the time, and low for the remaining half. Thus, when S2 is released,



PARTS LIST FOR SIMPLE COIN TOSS

B1—9-volts DC, transistor-radio battery
C1, C2—22-picaFarad disk capacitor
LED1, LED2—Light-emitting diode, 20 mA, one red, one yellow or green
Q1, Q2—2N2222, 2N2222A or BC108 PNP audio-switching transistor
S1—SPST, on/off switch (any suitable type will do)
S2—Normally-open, single-pole, pushbutton switch
(All fixed resistors are 5%, ¼-watt fixed units unless otherwise indicated)
R1, R6—390-ohm resistor
R2—R5—47,000-ohm resistor
R7—100,000-ohm linear-taper potentiometer

Fig. 1. This free-running multivibrator switched the LED1 AND LED2 "on" and "off" alternately when S2 is closed. When S2 opens, only one light-emitting diode remains illuminated.

the transistor that was on will continue to conduct.

You could expect 50 heads for every 100 "tosses!" But, that will only occur when potentiometer R7 is so set that all unbalances in the circuit are equaled. With R7 set to some unbalance, the number of heads verses tails will be other than 50-50. The device could be adjusted for 60-40 splits, or other desired ratios. Don't try this with friends who become upset when they discover that you hoodwinked them!

If you want to slow down the free-running frequency to as low as one Hertz or less, increase the value of C1 and C2 equally to 10 microFarads. Of course you will be able to see the light-emitting diodes switch on an off so that releasing S2 can control the indication read out of either heads or tails. In this case, use a remote switch so the player cannot see the readout until after he releases the switch.

Potentiometer R7 may be any taper type, but linear potentiometers are best. Values from 50,000- to 100,000-ohms may be used. If you wish, two series 50,000-ohm resistors may replace R7. The center tap comets to S2.

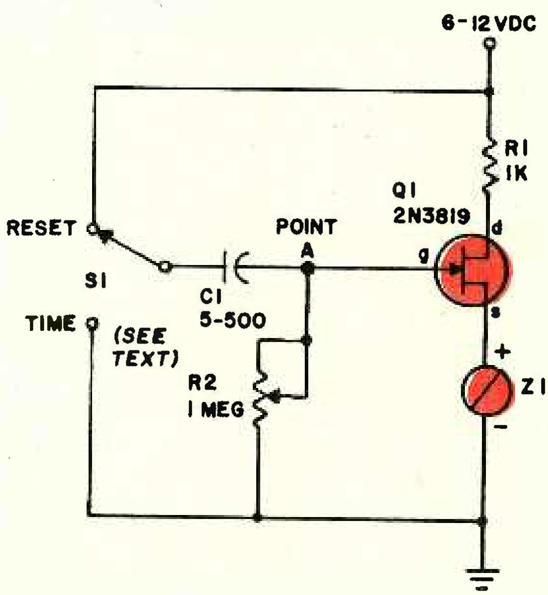
FET AWAY TIME

Why is it that whenever a timer circuit is required the IC is called to do the task even when simpler ways are available? By that we mean, take a gander at Fig. 2 for the FET Timer and compare it to any other circuit using a chip. Which one is simpler? Now you know the answer, and you know why the circuit appears here.

Note that the junction FET, Q1, serves as a switch that turns on high-impedance piezoelectric buzzer, Z1. Do not use a mechanical buzzer here for fear that the device's low impedance would burn out Q1.

Using a capacitor, C1, rated at 500-uF and a 1-Megohm potentiometer, R2, a time delay of more than two minutes is possible. A SPST toggle switch, S1, is kept at the reset position until the timing cycle is to begin. When S1 is set at TIME, C1 discharges through R2. To decrease the delay, reduce the setting (resistance) of potentiometer R2. When the potential at point A is near ground, the FET will conduct and the piezoelectric buzzer, Z1, will sound until S1 is returned to RESET, or the power is removed.

For much briefer periods, reduce the size of C1 so that the adjustment range of the potentiometer will be in the mid-range position. Resistor R1 limits the current flow through Q1 so that its rating will not be exceeded. Should a mechanical buzzer be used, and it worked, the inductive kick caused by the counter-electromotive force produced by its inductance would destroy the FET. Also, since R1 is required in the circuit to protect Q1, there would not be enough current flow to actuate the buzzer. In other words, stick with the diagram the way it appears!



PARTS LIST FOR FET TIMER

C1—5- to 500-uF, 16-WVDC, electrolytic capacitor
Q1—2N3819 junction field-effect transistor (FET)
R1—1000-ohm, ¼-watt, 5% resistor
R2—1-Megohm, linear- or audio-taper potentiometer
S1—SPDT toggle switch
Z1—Piezoelectric buzzer (almost any hobby type will work)

Fig. 2. Capacitor C1 charges to the battery potential with S1 at "RESET". Then C1 discharges through the variable resistor, R2.

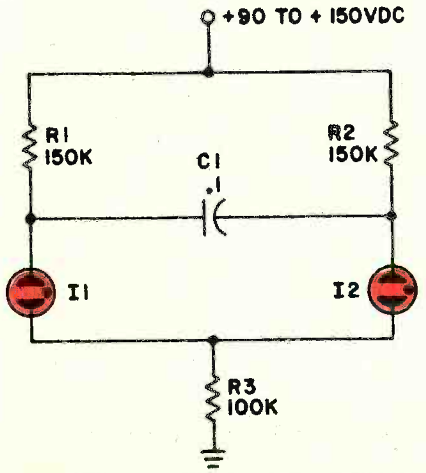
CIRCUIT FRAGMENTS

BLINKING NEONS

The bow-tie blinker circuit (Fig. 3) was first used by the editor to blink two lights in a bow tie, and we have since seen it used in eyeglasses, ear rings and other personal applications to raise excitement. Lets assume that I1 is on first so that C1 will charge through R2 and I1. When the voltage across C1 exceeds the firing potential of I2, that neon lamp will fire and I1 will be turned off. Now C1 takes a reverse charge through R1 and R2 until the firing potential of I1 is exceeded, causing to fire, and I2 to go off. That cycle will continue as long as power is supplied to the circuit by B1.

Each lamp will be illuminated for an equal period provided that R1 and R2 are equal in resistive value. This selection is usually preferred. However, you may want to experiment with different timing periods so that different effects may be obtained for special purposes. Vary the resistive value(up and down) of R1 or R2 about ten percent and observe light action.

Why neon bulbs? The main reason is that no amplifier or electronic switching device is necessary.



PARTS LIST FOR BLINKING NEONS

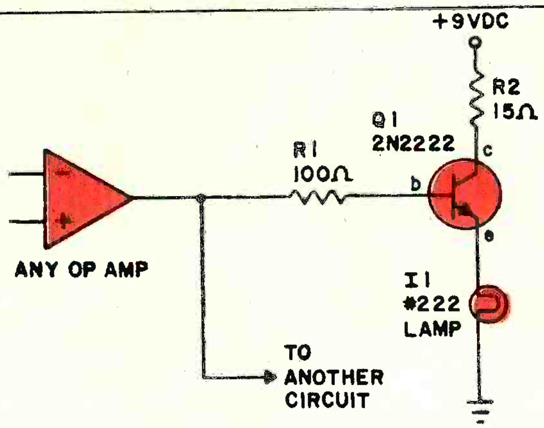
C1—.1-uF, 200-WVDC ceramic capacitor
I1, I2—NE-2 neon bulb
R1, R2—150,000-OHM, 1/2-watt resistor
R3—100,000-ohm, ½-watt resistor

Fig. 3. This circuit could be possibly the first electronic multivibrator.

MORE LIGHT

The output of an CMOS circuit may require a visual indicator brighter than a light-emitting diode to indicate a circuit high on a test panel or remote site. However, should you connect a filament lamp directly across the opamp output without regard for the remaining circuit, you most probably would introduce problems that are not tolerable.

The diagram in Fig. 4 shows how a buffered lamp can be connected so that it will cause no problem to the circuit to which it is connected. When a circuit high is present (+5-volts DC) the transistor will conduct and the lamp, I1, IN Q1's emitter circuit will be powered on. Actually, this circuit is a relatively simple logic probe you may want to construct for other purposes.



PARTS LIST FOR BUFFERED LAMP

I1—No. 222 Light bulb
Q1—2N2222 NPN transistor
R1—100-ohm, ¼-watt resistor
R2—15-ohm, ½-watt resistor

Fig. 4. Package R1, R2, Q1, I1 and a 9-volt battery into a hand-held status probe for checking out logic circuits.

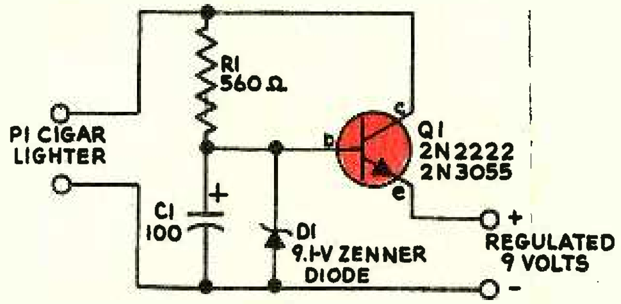
CIRCUIT FRAGMENTS

9-VOLTS MOBILE

One big problem with 9-volt batteries is that they often go dead just when you need them most. If you are a highway dictator you record business letters and notes while driving from one business appointment to another, then use the car's power to drive the recorder and save the batteries for those moments when no other power source is available. The car power tap (see Fig. 5) delivers up to 800 milliamperes of regulated 9-volt power from your car's cigar lighter or any power jack you may install.

Just plug in the circuit (see Fig. 5) and a 2N222 NPN transistor in conjunction with a 9.1-volt Zener diode does all the work. Should you need a bit more than 80 milliamperes, then use a 2N3055 for Q1. Play it safe, be sure to attach either transistor to a heat sink. The heat sink may be a store-bought item or made from a piece of copper sheet approximately 2 square-inches in surface area.

It is always a good idea to include a protective fuse in the circuit. Try one that is about .5 amperes. Stay away from slow-blow types or else you may pop some fuses in the car during an accidental short.



PARTS LIST FOR CAR POWER TAP

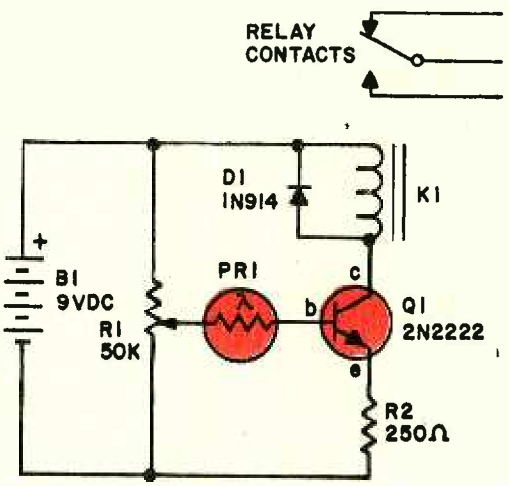
C1—100-uF, 25-WVDC electrolytic capacitor
D1— Zener diode, 9.1-V at ¼-watt
P1—Cigar lighter plug
Q1—NPN transistor, 2N2222 or 2N3055 (see text)
R1—560-ohm, ½-watt, 10% resistor

Fig. 5. Be careful when you connect the polarized components of this circuit.

MOST POPULAR CIRCUIT

Here is a simple light-activated relay circuit that is sensitive to room light conditions. (See Fig 6.) The light-sensitive device is PR1 a CdS- or CdSe-type photoresistor that is placed in the base circuit of an NPN transistor, Q1. When no, or insufficient, light falls on the photoresistor, PR1 transistor Q1 is biased to cut-off and the solenoid of the relay, K1, is unenergized.

As light strikes the photoresistor the base current in Q1 begins to flow and Q1 conducts enough current to



PARTS LIST FOR A MOST POPULAR CIRCUIT

B1—9-volt transistor battery
D1—1N914 rectifying diode
K1—Refer to Radio Shack catalog
PR1—CdS or CdSe photoresistor (Refer to Radio Shack catalog)
Q1—2N2222 NPN audio-switching transistor
R1—50,000-ohm, linear-taper, potentiometer without switch
R2—250-ohm, ¼-watt resistor

Fig. 6. Direct a beam of light onto PR1 and when it is interrupted the normally-closed contacts can set off an alarm—"a budget alarm system".

energize the coil of K1, pulling down the relay contacts to the energized position. The contacts are electrically isolated from the circuit, and they can be used to provide control of a circuit using standard line voltages and even high currents. As the light diminishes, the photocell internal resistance increases, reducing the current to the base of Q1 and shutting down the transistor, and the relay.

The relay should be a low-current type so that the normal non-destructive current through Q1 is sufficient to power on the relay. Relays of this type can be found in Radio Shack's catalog.

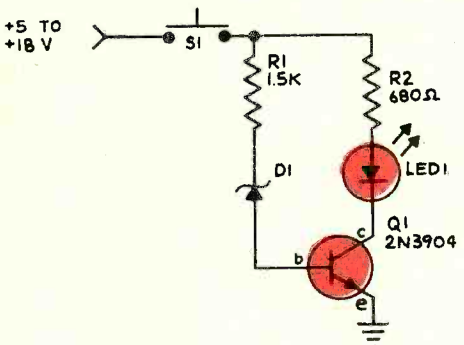
Diode D1 eliminates the bucking voltage created by the relay coil when the relay is turned off, thus preventing the destruction of the transistor. Adjust potentiometer R1 so that the circuit actuates at the light level you desire. Also, mask photoresistor PR1 should the light intensity be too high to turn off the circuit at the level you desire.

BATTERY-VOLTAGE MONITOR

Tired of playing guessing games with your batteries? With this battery-voltage monitor (See Fig. 7) you'll know at a glance whether or not batteries need replacement. The circuit's compact size, which comes about because it's a meterless voltage monitor, makes it easy to build into an existing piece of equipment. To use the device, press S1 and, if LED1 lights up, your batteries are still good. If not, get ready to throw them away.

Transistors Q1's gain makes the monitor very sensitive to changes in voltage. Consequently, LED1 is either ON or OFF with little ambiguity most of the time. The voltage level being sensed is determined by Zener diode D1's rating and the base-emitter voltage drop of Q1. Specifically, the switching point is equal to the Zener voltage plus 0.75-volts. For example, a 5.6-volt Zener diode will set the trip level at approximately 3.35-volts.

The voltage level you choose should be less than the battery's nominal voltage when fresh. A 9-volt battery, for example, might be useless when its voltage drops to 7.5-volts; however, the exact point at which a battery becomes useless depends both on the battery and on the application. Finally, it's best to test the battery with a normal load current being drawn from it by the project or gear.



PARTS LIST FOR BATTERY-VOLTAGE MONITOR

D1—Zener diode (see text)
LED1—light emitting diode rated 20-mA @ 1.7-VDC
Q1—2N3904 NPN transistor
R1—1,500-ohm, ½-watt, 5% resistor
R2—680-ohm, ½-watt, 5% resistor
S1—Normally open, SPST pushbutton switch

Fig. 7. Be sure to use a pushbutton switch for S1, otherwise the circuit will slowly drain the battery during down time.

LED DISPLAY

Who said you need an IC chip to operate a LED-bar graphics display? The diagram in Fig. 8 takes advantage of the forward voltage drop exhibited by silicon diodes. Each leg of the circuit showns a light emitting diode in series with a current limiting resistor and a different number of diode voltage drops, from 0 to 5. You may use any kind of diode you wish, including germanium, silicon, even expensive hot carrier types (although they won't exhibit quite as much drop, they're very expensive, and too large a current could burn them out).

Depending on the diodes you choose, each will exhibit a forward voltage drop between 0.3 and 0.7 volts! For consistency, stay with diodes of the same type, or at least the same family. Those twenty-for-a-dollar "computer" diodes will do just fine. To expand

INDUCTANCES & CAPACITANCES

By Jan Drover

The lowly resistor is the solid citizen of electronics. It can be relied upon the behave with the same, predictable performance, whether confronted with AC or DC. Unruffled by excursions into the higher frequencies, it continues to live by the guiding rule—Ohm's law—and declares that, no matter what, the current (I) it permits to flow shall depend solely on the applied voltage (E) divided by its own resistance (R).

However, the resistor's component cousins—the inductor and the capacitor—are by no mens so stolid in the face of changing frequencies. The inductor, for example, grouchily shuts off more and more of the current flow as the frequency of the current passing through it gets higher and higher; while the capacitor reacts to higher frequencies in just the opposite manner—it happily allows more and more current to flow as the frequency rises.

Fortunately, the reactionary behavior of these components is just as predictable as is the single-mindedness of their resistive cousin. If we study the strange conduct of these apparently erratic citizens, we not only discover the rules which govern their odd behavior, but also perceive that ultimately, they too, are faithful to Ohm's law—in their fashion—just as are all electronic components and circuits.

Reactionaries in the Lab

To begin our study, let's set up the lab experiment shown in Fig. 1.

Here, we have an audio oscillator set to produce an output of 60 Hz, and a power amplifier to amplify that signal to the 100-volt level. The power amplifier drives a load consisting of a large, 25-watt, 390-ohm resistor connected in series with an ordinary 1½-volt (0.25-ampere) flashlight bulb. An AC meter reads the output voltage from the power amplifier.

Turning on the equipment, we set the audio oscillator to 60 Hz, and gradually turn up the amplifier gain till 100 volts appears at the output. (Note: The ordinary hi-fi amplifier won't do this—you will need a public-address amplifier with a high-voltage (70-volt, or 500-ohm) auxiliary output if you actually want to carry out this experiment.) At this point, the bulb will light to its normal brightness, indicating that the 100 volts is pushing about 0.25 ampere through the combined resistor/light-bulb circuit. Using Ohm's law, we can easily check this:

$$\begin{aligned} I &= E/R \\ &= 100\ \text{volts}/(390\ \text{ohms} + 6\ \text{ohms}) \\ &= 0.252\ \text{amperes} \end{aligned}$$

Note that light bulb's resistance, R, is

$$\begin{aligned} R &= E/I \\ &= 1\tfrac{1}{2}\ \text{volts}/\tfrac{1}{4}\ \text{ampere} \\ &= 6\ \text{ohms} \end{aligned}$$

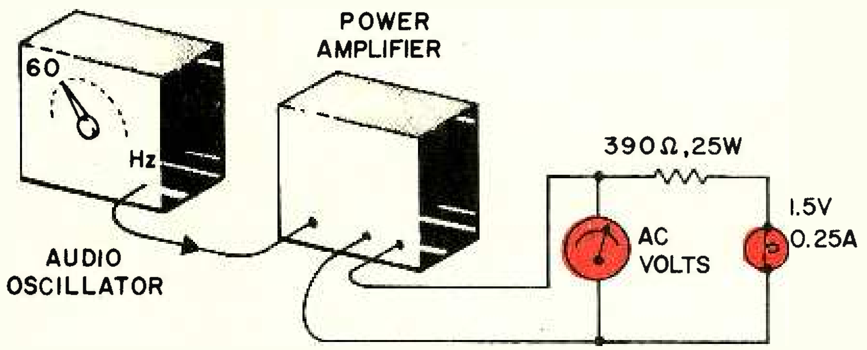


Fig. 1. Practical laboratory setup to demonstrate Ohm's law. Power audio amplifier must have a 70-volt output or a 500-ohm output transformer tap. Ordinary high-fidelity amplifiers cannot be used.

Please also note that it's the 390-ohm resistor, not the bulb, which is the chief authority in establishing the current. The lamp current will change very little, whether the bulb is 6 ohms, 12 ohms, or near zero ohms.

Next let us vary the frequency of the audio oscillator; first down to 30 Hz, and then, up to 120 Hz. We notice that the bulb stays at the same brightness, indicating that the 390-ohm resistor is behaving in its normal, stolid fashion—that is, it is steadfastly ignoring frequency changes, and permitting its current flow to be determined solely by Ohm's law. Even if the frequency were zero (which is another way of saying DC), the bulb's brightness would, remain the same, if we applied 100 volts to it.

Enter the First Reactionary

Now let's go to our parts supply bin, pick up a 1-Henry inductor, and make a few preliminary measurements on it. Using an inductance bridge, we discover that its real value is 1.05 Henry. We next connect it to an ordinary ohmmeter as shown in Fig 2, which informs us that the inductor has a resistance of 45 ohms.

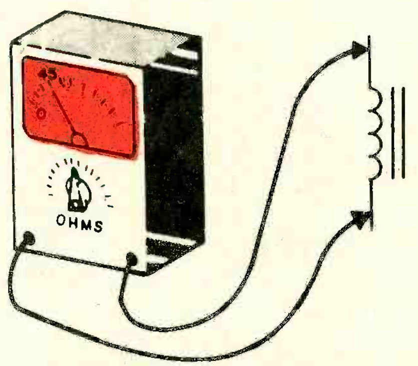


Fig. 2. Measuring the DC resistance of a one-Henry inductor (choke coil) shows it has 45 ohms of resistance in its copper winding.

Now, let us replace the 390-ohm resistor of Fig. 1 with this 1-Henry inductor as shown in Fig. 3, and predict what will happen when we turn on the equipment. Since the ohmmeter said "45 ohms" we can predict that the current will be

$$\begin{aligned} I &= E/R \\ &= 100 \text{ volts}/45 \text{ ohms} + 6 \text{ ohms} \\ &= 1.96 \text{ amperes!} \end{aligned}$$

With this large current—nearly 8-times normal—the light bulb should burn out almost instantly! However, when we apply 100 volts of 60 Hz to the inductor-plus-bulb, we are surprised to see that the bulb lights to normal brightness! This means that the inductor is behaving like a 390-ohm resistor, and is establishing a ¼-ampere flow of current—not the nearly-2 amperes calculated from the above ohmmeter measurement.

To compound the mystery, let us now vary the frequency of the oscillator, first, up to 120 Hz—and the bulb gets dimmer!—and then gingerly, down, just a little, to 50 Hz—and the bulb gets uncomfortably brighter. Here, in the lab, is the actual behavior forecast

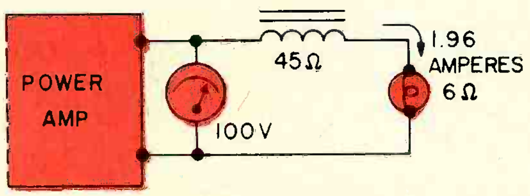


Fig. 3. Substituting the 1-Henry inductor in place of the 390-ohm resistor of Fig 1 offers the same opposition of the circuit to AC, hence the same current flows.

by theory—the inductor grouchily shuts down the current flow for high frequencies, causing the bulb to go dim at 120 Hz, but it is willing to let low frequencies through, thus allowing the bulb to get brighter for 50-Hz input.

A Little Compassion for the Reactionary

To understand this "reactionary" behavior, we must understand how an inductor "feels" about an alternating current. An inductor is, after all, an electromagnet. If a steady direct current flows through it, it fills the space in its vicinity with a magnetic field.

If we attempt to cut down the inductor's current, it reacts, quite understandably, by collapsing its magnetic field. But this collapsing field moves across the inductor winding in just the same way that a dynamo or generator field moves through the generator windings to make an output voltage. The inductor, then, reacts to any attempt to change its current by *acting as its own generator*, generating a new voltage of the correct polarity *to try to keep its own current from changing*. So, in its own way, the inductor is a solid, but *conservative* citizen—a citizen who tries to maintain the *status quo*.

Furthermore, the faster we try to change its current, the harder the inductor works to keep the current from changing. Therefore, the inductor sees a high frequency as an attempt at rapid changes—a threat to the *status quo*—so it works very hard to generate an opposing voltage (a 'counter-EMF' or 'counter-electro-motive-force') to keep its current from changing. This internally-generated voltage opposes the applied voltage more and more as the frequency rises; hence the actual current which flows drops lower and lower as the frequency rises. *This means that the apparent resistance of the inductor rises with frequency.* But this apparent resistance is not called *resistance*—since it is the inductor's reaction to the frequency applied to it, it is called *inductive reactance*.

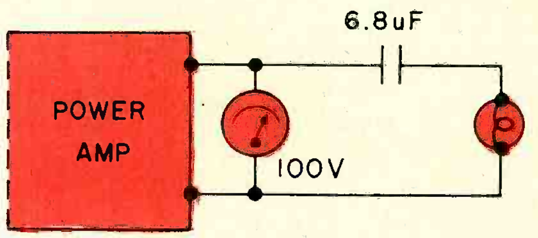


Fig. 4. A 6.8 uF capacitor substituted in the test circuit for the inductor. If the capacitor acted as an open (as it would for DC) no current would flow.

A Resistance by Any Other Name

But whether you call it "apparent resistance" or "inductive reactance", it is still measured in ohms, and can be used as a part of the familiar Ohms law formula. Where a simple resistive circuit answers to the expression.

$$I = E/R.$$

A similar circuit with resistor replaced by an inductor (coil) is described by the formula:

$$I = E/X,$$

where X is the symbol for reactance. But since the amount of reactance (X) changes according to frequency, we must have a way to calculate its value at the frequency we are using. The following simple formula does that for us:

Inductive Reactance = 2 × 2 × π × frequency × inductance or, in the familiar algebraic shorthand, or

$$X_L = 2\pi fL$$

where, L is the inductance in Henrys, and the subscript $_L$ following the X indicates we are talking about *inductive* reactance. Therefore, the current in an inductive circuit is:

$$I = E/X_L$$
$$= E/2\pi fL$$

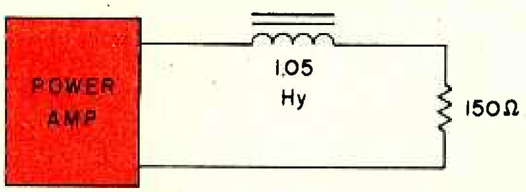


Fig. 5. Test circuit load is now the combination of the inductor (1.05 Henry) and the resistor (150 ohms). As the text explains, their combined reactance is computed by adding them at right angles!

For Example

Let's take the 1.05-Henry inductor and calculate its reactance at 60 Hz:

$$X = 2\pi fL,$$
$$= 2 \times \pi \times 60 \times 1.05$$
$$= 395.8 \text{ ohms.}$$

which, as you can see, is very close to the 390 ohms of the resistive circuit of Fig. 1. This explains why the bulb lit to about the same brightness for the inductor as for the resistor. (This also explains why we selected a 1.05 Henry inductor—we wanted you to see like values in examples.)

When we cranked the audio oscillator up to 120 Hz, the inductive reactance became.

$$X_L = 2\pi fL,$$
$$= 2 \times \pi \times 120 \times 1.05$$
$$= 791.7 \text{ ohms.}$$

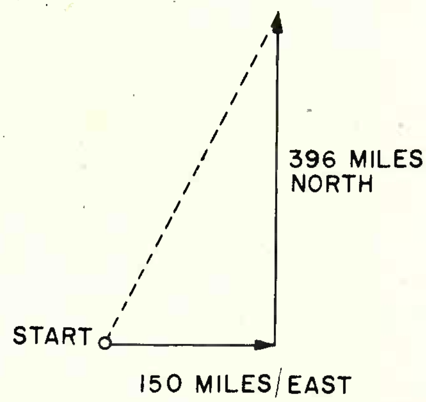


Fig. 6. Adding traveling distances in different directions yields resultant which is the diagonal (the shortest distance between the two points), also a right triangle. Back to the Pythagorean theorem!

The new current becomes, ignoring, for the moment, the 6-ohm bulb:

$$I = E/X$$
$$= 100 \text{ volts}/791.7 \text{ ohms,}$$
$$= 0.125 \text{ ampere.}$$

which is about half the rated current of the bulb. Hence, it would be dim at this frequency. You can easily calculate that at 50 Hz, the X becomes 329.9 ohms and the current rises to the excessive value of .303 amperes; any further lowering of frequency could burn out the bulb!

Enter the Capacitor

Returning to the parts-supply bin, we now take a large, *oil-filled* (—Don't try this with an electrolytic!) capacitor, and, measuring it on a capacitance bridge, find that its true value is 6.8 uF. An ohmmeter placed across the capacitor's terminals registers an upward 'kick' of the needle as the ohmmeter's internal battery charges the capacitor, but the ohmmeter then settles down to indicate that, as far as *it* is concerned, the capacitor is—as it should be—an open circuit.

We now replace the 390-ohm resistor of Fig 1. with the 6.8 uF capacitor, as shown in Fig. 4.

Again set the oscillator to 60 Hz, and turn on the equipment. Since the capacitor is really an open

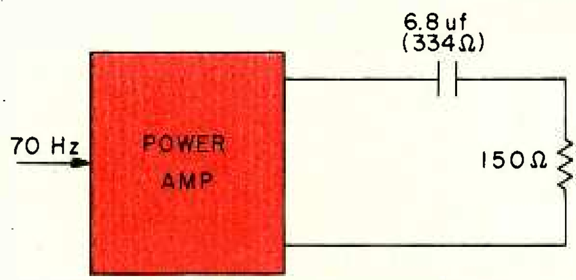


Fig. 7. The reactance of the capacitor at this frequency (70 Hz) is 334 ohms. This may be combined with the pure resistance, 150 ohms, by using the formula discussed in the text of this article.

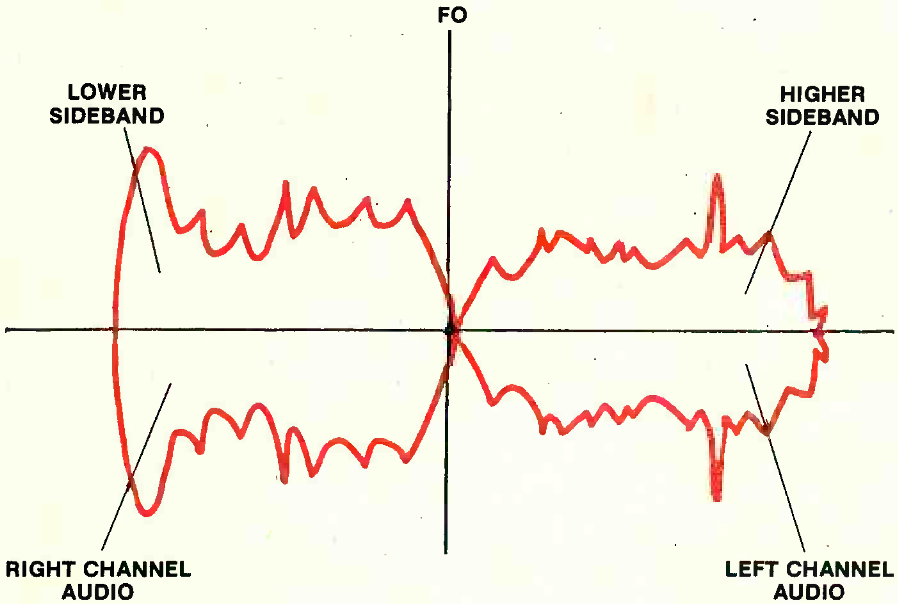


Fig. 2 . The Kahn-Hazeltine system amplitude modulates the lower sideband with the right channel audio and the upper sideband with the left channel audio. Conventional receivers mix both sidebands resulting in L+R (mono) audio.

sound and signal that we are accustomed to hearing, and that the existing receivers are capable of decoding. See Fig. 1 The *Left* minus *Right* (L-R) Portion of the signal is then used to frequency modulate the carrier. The composite radiated signal is then a combination of AM and FM.

When this combination is carefully and properly balanced, the mono signal sounds at least as good as the pre-stereo transmission. In addition receivers with the proper decoding circuits can "hear" the signal in stereo.

In Practice, this system has proven to have some faults. A phenomenon known as *platform motion* occurred. This cause a very undesirable sensation that as one listens, the platform that the musicians are on is shifting from side to side. When I experience this phenomena, I feel that I am falling to one side or the other. Perhaps this is akin to vertigo. There are several causes of platform motion, but for this brief discussion, suffice it to say that it is phase related.

In the Kahn-Hazeltine system, a somewhat different approach is used. Mr. Kahn decided to put the left channel on the upper sideband and the right channel on the lower sideband. See Fig 2.

The envelope detectors that are in common use today hear the two sidebands as the composite or monoural signal. By using the proper circuitry, the two independent sidebands are heard as the two channels of stereo. Since the sidebands are independent of each other, this system is often referred to as the *independent sideband system*. Two of the advantages of this system are that there is no platform motion and the stereo effect is present even at extreme broadcast range.

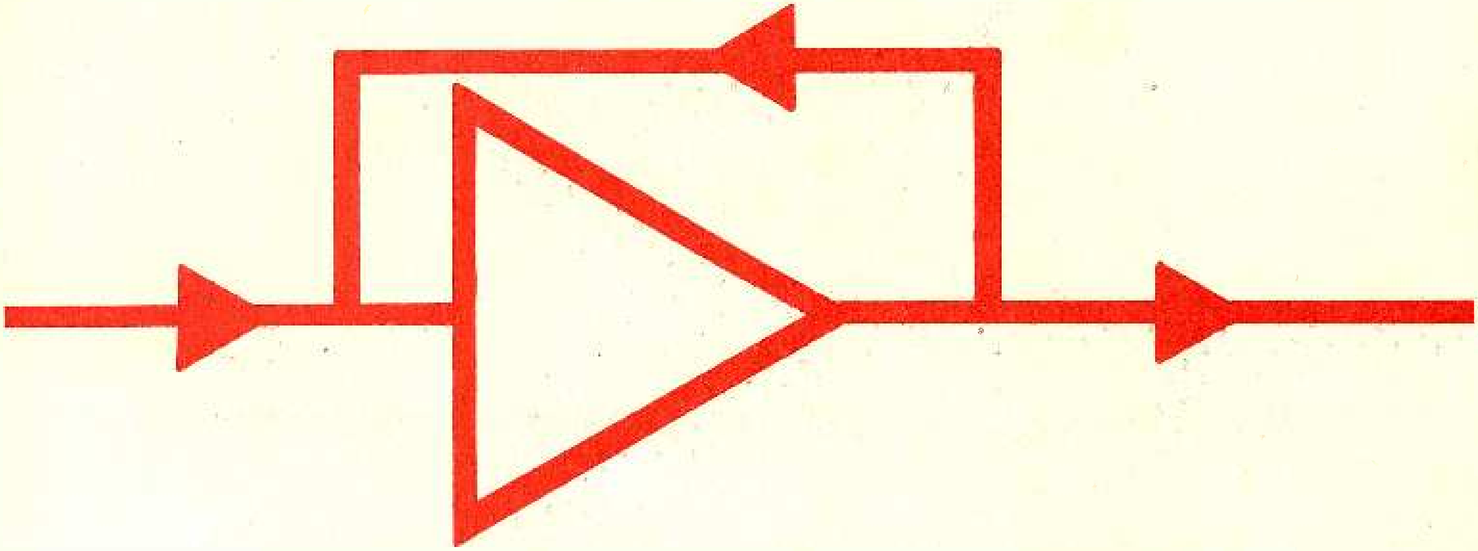
They Are There!

There are presently well over 400 AM stations in the U.S. and Canada that are transmitting in AM stereo using one of the systems that we have discussed here or one the other systems that had been produced earlier, but are no longer in competition. Some that have dropped out of the running are Magnavox, Belar and Harris. All of these used some form of the AM/FM method of stereo transmission.

At this time, the two remaining contenders for the AM stereo market are Motorola and Kahn. A recent poll of broadcast engineers revealed that they favor the Kahn system by a margin of 12 to 1, a most interesting finding since Motorola has over 200 system in service while Kahn has about 100. Perhaps the station owners are not listening to their engineering staff.

At this writing, receiver manufacturers have been somewhat slow to place receivers on the market that have AM stereo capability. Perhaps this can be blamed partly on the unavalaibility of an IC chip that will decode all of the system. However, Kahn Communications recently introduced a chip that will decode all of the system in present use. The manufacturing rights were given to Sony and the chip will be available to all interested manufacturers. The cost is comparable to the one presently offered by Motorola so we should soon see receivers on the market that can hear all of the AM stereo systems.

What system will emerge as the dominant one? I surely can not say. However, it seems that with advent of multi-mode receivers (five manufacturers are expected to be in production soon) the listener will have a strong voice in the matter and will vote with the tuning knob for the system that sounds best to him. ■



OSCILLATING AMPLIFIERS

By Rodger D. Connith

As any slightly cynical experimenter can tell you, if you want an oscillator, build an amplifier—it's sure to oscillate. Conversely, if you want an amplifier, (this same cynic will tell you), build an oscillator—it's sure to fail to oscillate, and you can then use it as an amplifier! This is well known as a corollary to Murphy's famous law, "If anything *can* go wrong—it *will*!"

Our informed cynic must have had long and unhappy experience with negative-feedback amplifiers, which are known to have at least two outstanding characteristics:

1. They function beautifully if carefully designed and built.
2. Otherwise, they oscillate!

Why do they oscillate? Or, more basically, how does a feedback amplifier differ from an oscillator?

The fundamental block diagrams of an oscillator and an amplifier with feedback bear a strong resemblance to each other, as you can see from Fig. 1. From a block diagram viewpoint, both diagrams are *very* similar. Both contain some type of amplifying device, and both have part of their output signal fed back to their input. There are only two major differences between them:

1. The amplifier with feedback contains an *inverting* amplifier; the oscillator contains a *non*-inverting amplifier.
2. The oscillator doesn't have an input.

The circuit action obtained from these two circuits is entirely different. In the amplifier with feedback, the output waveform is upside down with respect to the input, so when it is fed back to the amplifier input, it cancels a portion of the input waveform. The output is less than it would be without feedback. See Fig. 2.

The feedback signals from inverting amplifiers are not "in phase" with the input signal and subtract (or reduce) the input signal level to the amplifier. When a feedback signal does this, it is called *negative feedback*.

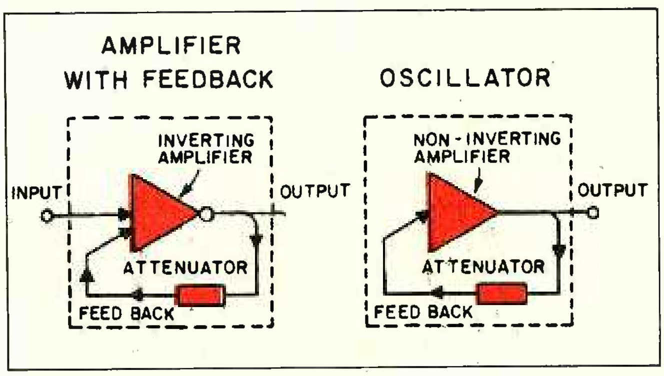


Fig. 1. Two block diagrams compare an inverting amplifier (A) to an oscillator (B).

So Why Negative Feedback?

Of course, if you merely want the biggest possible gain for your money, negative feedback's not your game. However, negative feedback offers other advantages, which can be summed up by saying that the amplifier's output, though smaller, is always nearly constant for the same input signal. For example, if the amplifier weakens, with age, and the output tries to drop, there is less signal to be fed back; hence there is less cancellation, and the output is restored almost to its former level. Similarly, if you feed a high-frequency signal through the amplifier—so high in frequency that the amplifier can barely amplify it—the resultant drop in output reduces the fed-back voltage, produces

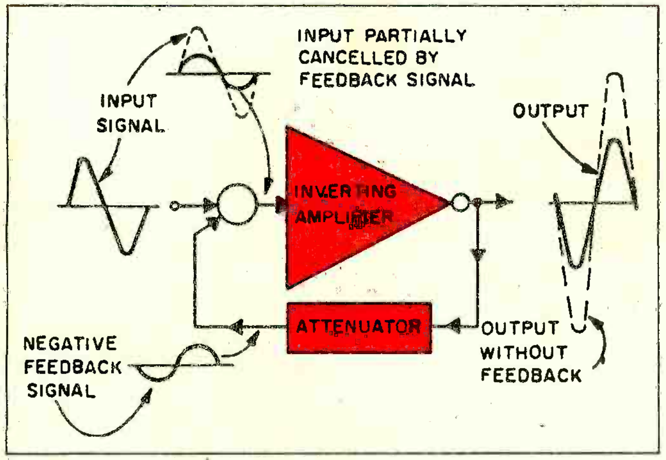


Fig. 2. Signal flow diagram illustrates how feedback in an inverting amplifier circuit reduces overall gain.

almost no cancelling feedback signal, and keeps the output nearly the same as it was at lower frequencies. Moreover, any clipping or other distortion of the waveform inside the amplifier produces an output waveform which does not match the input; hence the non-matching part is not cancelled, and the distortion is removed, or at least greatly reduced. Without this action, hi-fi amplifiers would not exist.

So the loss in output you obtain from negative feedback repays you by providing less distortion, better long-term stability, and better frequency response—that is, the best and most uniform output in response to *all* input frequencies.

On the Flip Side

The oscillator, on the other hand, is not supposed to give the best output from all input frequencies, but is instead made to give an output at a *single* frequency—with no input at all. It's not surprising that the opposite type of internal amplifier (non-inverting) is used to obtain this opposite result. See Fig. 3.

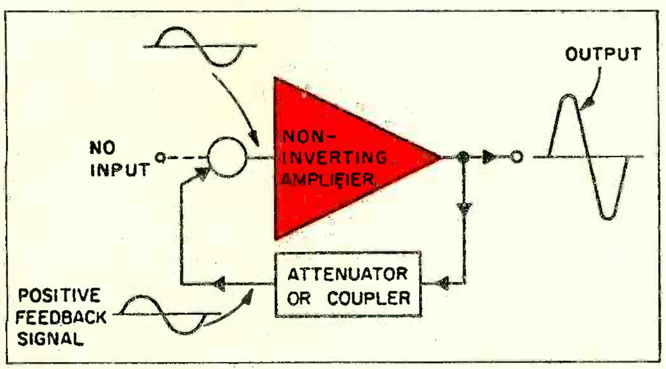


Fig. 3. Signal flow diagrams shows how feedback signal from a non-inverting amplifier provides the positive feedback to produce an output signal larger than it would otherwise be without feedback.

In the oscillator, any output at all (probably the result of some random noise in the internal amplifying device) is fed back, non-inverted, to the input, where it does not cancel but instead serves as the signal at the input. This feedback signal causes an even larger output, which results in an ever larger signal fed back, further reinforcing the input signal, and so on.

You guessed it—this type of feedback signal is commonly referred to as *positive feedback*. In theory, the output waveform should continue to get larger forever. In practice, the amplifier is limited in the maximum size of the signal it can deliver, so the output waveform stops growing in this amplitude. As it stops to grow, so does the positive feedback signal. Now the signal reduces rapidly and the positive feedback signal lends a hand until the signal can get no lower. This is the beginning of the first cycle of many to follow.

All well and good, you say, but if the major difference between feedback amplifiers and oscillators is the inverting or non-inverting nature of their internal amplifiers, why does an amplifier sometimes oscillate? What turns an inverting amplifier into a non-inverting one?

To answer this question, first observe that an inverting amplifier, in passing a sine-wave signal, *effectively* shifts the signals phase by 180° as shown in Fig. 4. We say *effectively*, because it doesn't really shift the timing by delaying the signal (which is what a real phase-shifter does) but, by turning the signal upside

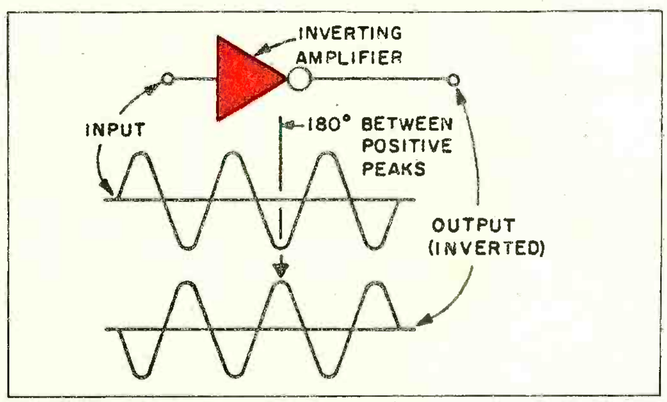


Fig. 4. The apparent phase shift of the output signal from the input signal is 180 degrees.

down, the amplifier makes it look like a signal which has been delayed (phase-shifted) by 180°.

A real phase-shifter, on the other hand, is normally nothing but a fistful of judiciously connected resistors and capacitors (and sometimes inductors) which can be designed to give a 180° phase shift *at a single frequency*, such as 1,000Hz, for example. In contrast to an inverting amplifier, it provides this phase shift by actually delaying the signal. See Fig. 5.

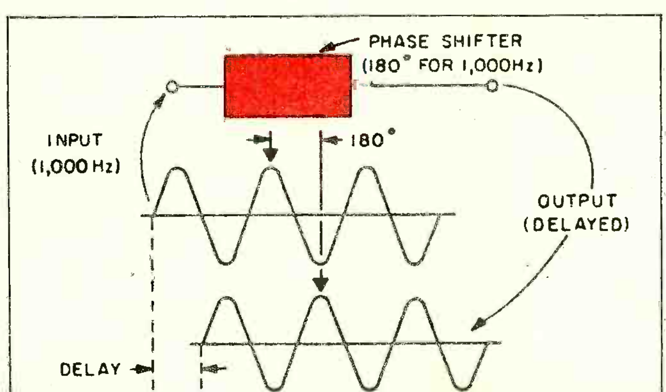


Fig. 5. The passive phase-shift circuit actually delays the output signal by a time interval measured in degrees by that portion of a sine wave so delayed. This effect appears to the apparent delay of an inverting amplifier.

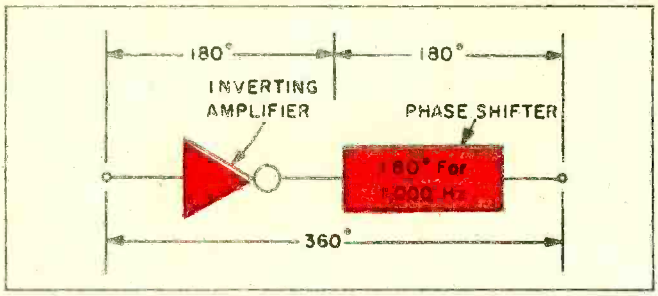


Fig. 6. Combining an inverting amplifier and 180-degree phase-shift circuit results in a 360-degree phase shift at 1000 Hertz only, which results in a non-inverting amplifier circuit.

What happens if we combine an inverting amplifier and a 180° phase-shifter? Take a look at Fig. 6.

This combination will shift the phase of a given frequency by a total of 360° (an entire cycle) so the output is identical to the input. In effect, this combination (at 1,000Hz) *will behave the same as a non-inverting amplifier*. See Fig. 6.

Therefore, if we build a feedback amplifier which contains the normal inverting amplifier but also (inadvertently) contains a 180° phase-shift network, the resultant circuit will oscillate at the particular frequency, (1,000Hz in the figure) for which the phase-shifter provides 180° phase shift. See Fig. 7.

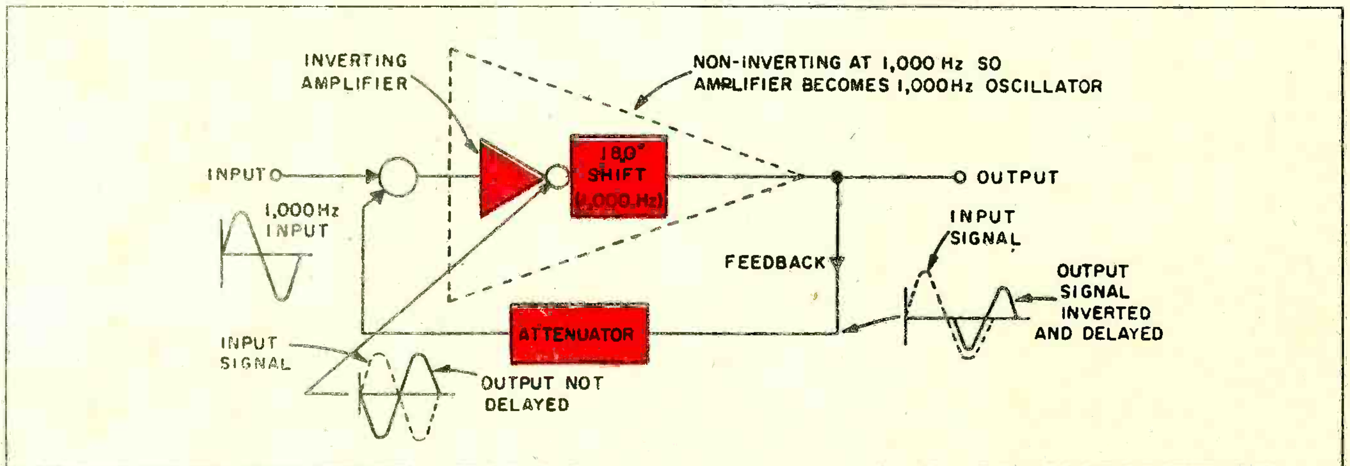


Fig. 7. Since the 180-degree phase shift is frequency selective, this non-inverting amplifier will oscillate at 1000 Hertz.

How can one "inadvertently" make a phase-shifter? It's easier than you might think. The circuit shown in Fig. 8A will provide 60° phase sift, at 1,000 Hz. Three such networks connected in a "ladder" (see Fig. 8B) will provide 3×60°=180° of phase shift. (But not at 1,000 Hz. Because of the way the networks load each other, the 180° shift occurs at 707 Hz. However, if an amplifier were located between each network, then the amplifier will oscillate at 1,000 Hz.) This network, if dropped into a normal feedback amplifier circuit, will convert it to an oscillator.

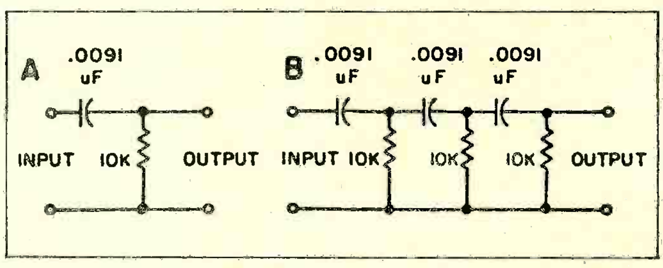


Fig. 8. In this diagram, a simple network (A) offers 60-degrees of phase shift at 1000 Hertz. Ladder three such circuits in series and the total phase shift at 1000 Hertz will be 180 degrees.

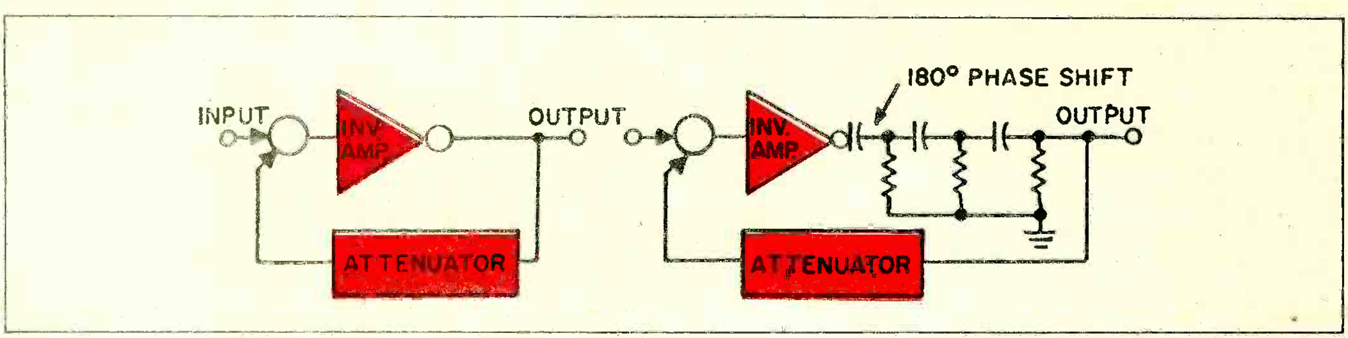


Fig. 9. Two inverter amplifiers are shown here with one having a 180-degree phase-shift network added to induce positive feedback. The RC elements limit this oscillation to a fixed frequency.

Phase-Shift Oscillator

This circuit (Fig. 9) is known as a *phase-shift oscillator* and is widely used in electronics. When you

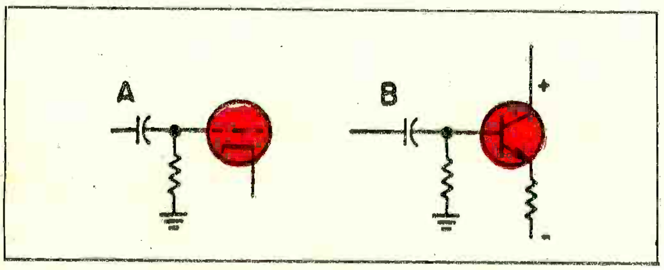


Fig. 10. External parts in this amplifier circuit have the same effect as the phase-shift circuit in Fig. 8A. However, values for the resistance and capacitance are selected to produce almost no phase-shift within the amplifiers normal frequency bandpass.

set out to build a phase-shift oscillator, you *deliberately* insert a phase-shifter to make the circuit oscillate. How could one ever *inadvertently* place such a circuit in a feedback amplifier, thereby producing unwanted oscillations?

Phase-shift circuits can "hide" within an amplifier, posing as other circuits. For example, vacuum-type amplifiers often have grid circuits arranged as shown in Fig. 10A. Does that resistor/capacitor circuit look familiar? In form, it's just like the phase-shift circuit above. And transistor amplifier circuits often take the form shown in Fig. 10B.

Again, the coupling/biasing network looks just like the basic phase-shifter network. At some frequency, this network will provide 60° of phase shift. If we use three such identical networks in a three-stage amplifier we have a 180° phase-shift network "buried" inside the amplifier, masquerading as three normal coupling networks. If this three-stage amplifier is used as part of a feedback amplifier arrangement, the amplifier will

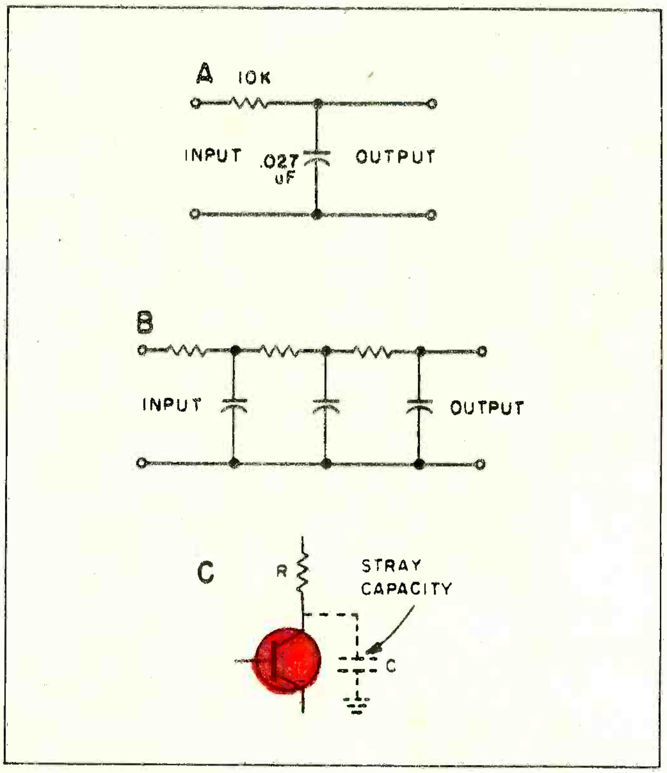


Fig. 11. Don't get confused with the circuit elements shown in (A) with those shown in Fig. 8A. The reversal of parts converts the basic circuit from a coupler to a filter with the attending phase shift. Three series-connected filters have the same effect (B) by providing 180-degree phase shift. Hidden capacitance (C) internal to the circuit element and in the external wiring will provide some phase shift of the output signal in this amplifier.

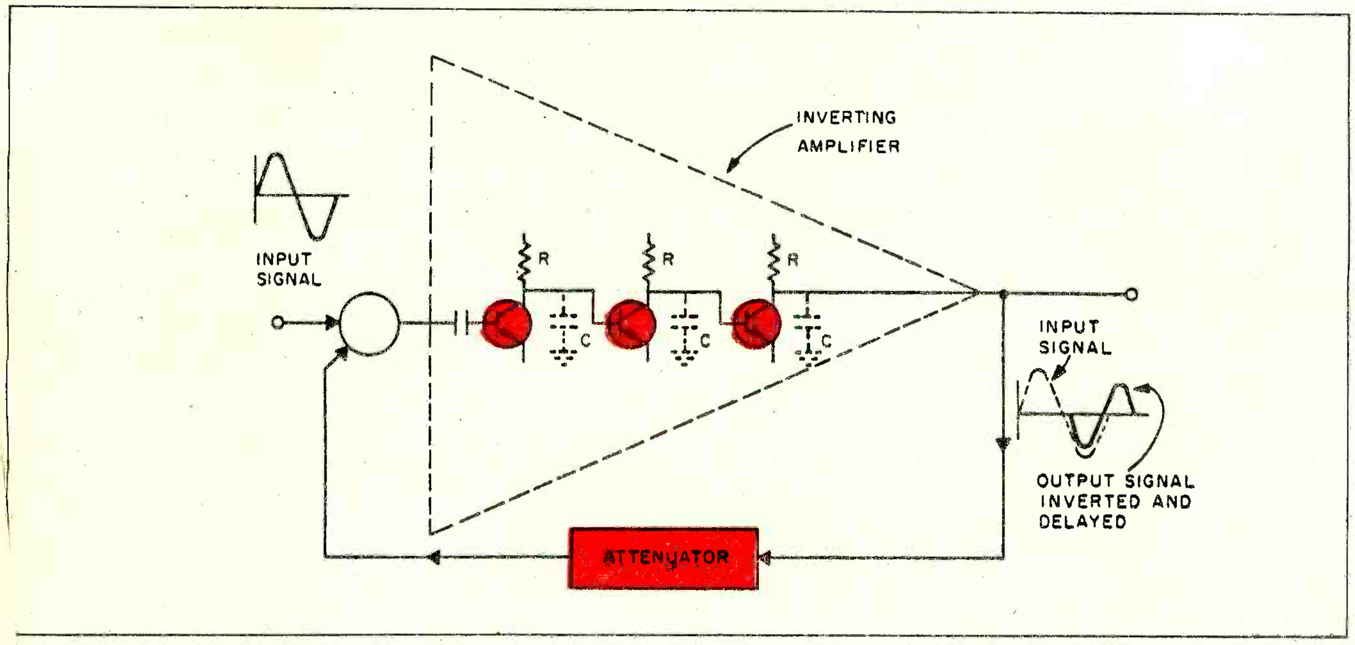


Fig. 12. An inverting amplifier may oscillate do to stray capacitance in these external circuit amplifiers providing a 180-degree phase shift at some very high frequency. Output signal is within frequency bandpass of the amplifier before phase shift causes oscillation (positive feedback).

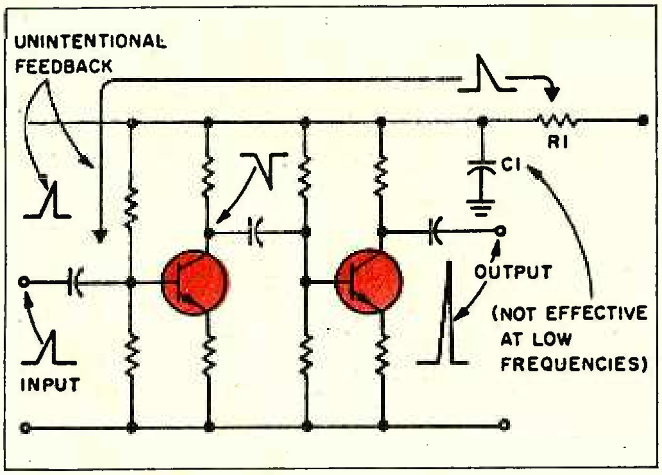


Fig. 13. Low frequency feedback occurs because the capacitor C1 is not effective at these low frequencies. Thus, any portion of the output signal that will cause a ripple in the power supply will serve as a positive feedback.

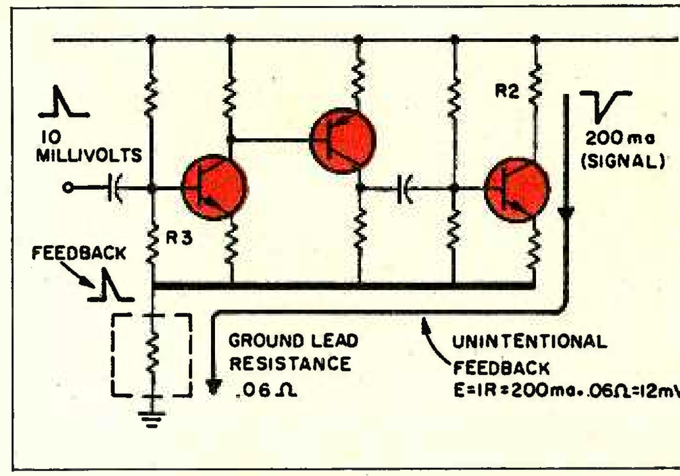


Fig. 14. A ground bus has a finite resistance, and, when high-current output signal mix with low-level signals in the same bus, positive feedback may result with the attending possibility of oscillation.

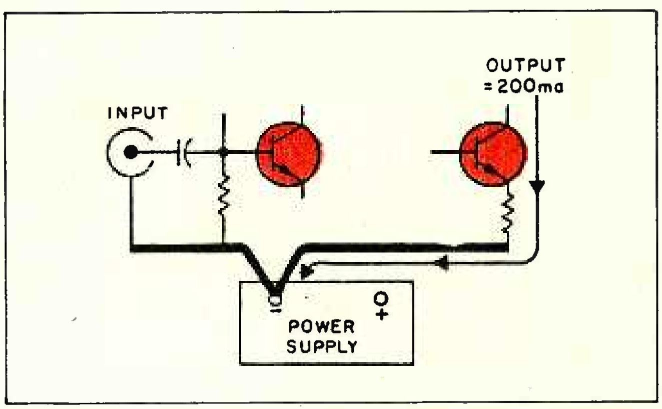


Fig. 15. Divide and conquer—separate input connections from output connections to different buses, and a good deal of the unwanted signal mixing will not occur. The resistance of the power supply must be very low otherwise all that is gained using this construction technique will be lost.

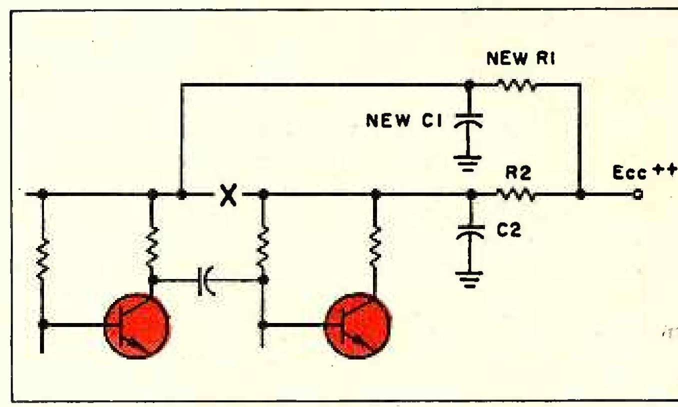


Fig. 16. A good idea is to split up the voltage distribution to many circuit points by two or more power supply decoupling networks. Compare this diagram to Fig. 13.

oscillate at some frequency, and be quite useless for the purpose for which it was intended.

More Trouble

This is not the only way an amplifier can get into trouble. There are other types of phase-shifters that can creep into amplifiers, unrecognized, and drive the unwary experimenter up the nearest wall. This circuit (shown in Fig. 11A) can also produce a phase-shift of 60° at 1,000Hz. Three of them, can produce the 180° phase-shift required for oscillation. See Fig. 11B. This particular network can invade amplifiers in an even more insidious fashion. The "masquerading" part of the circuit is shown heavy in Fig. 11C. The dotted capacitor doesn't appear physically in the circuit, because it is the so-called "stray capacity" associated with wires, sockets, terminals, etc.

Three of these circuits hiding in an amplifier, can produce an unwanted oscillation. See Fig. 12. Since the stray capacities are so small, this "osciplifier" will oscillate at a very high frequency; often so high that it is undetected as an oscillation. However, such oscillation can make an amplifier behave erratically; sometimes distorting, sometimes not; sometimes overheating, sometimes not. Fig. 7 and Fig. 12 have a lot in common.

Are feedback amplifiers the only culprits in this oscillating-amplifier business? Absolutely not! Often, so-called "straight" amplifiers—with no *intentional* feedback—will gaily oscillate away. But watch that word *intentional*. Close inspection of these misbehaving circuits usually uncovers an *unintentional* feedback path hiding within the amplifier.

Consider the innocent-looking circuit in Fig. 13. This is an ordinary two-stage amplifier, obviously assigned the task of converting a small, positive-going signal into a large, positive-going signal. To help it along, the designer has even provided a decoupling network, R1 and C1. At high frequencies, C1 acts like a short circuit, effectively isolating (decoupling) the amplifier's power bus, Ecc +, from the main power bus, Ecc ++. But at low frequencies, the capacitor acts like an open circuit—it just isn't there! A small part of the output voltage now appears across R1, and is coupled through the

(Continued on page 96)

BUILD 20 RADIO
AND ELECTRONICS CIRCUITS

Reg. U. S. Pat. Off.

Training Electronics Technicians Since 1946

PROGRESSIVE HOME RADIO-T.V. COURSE

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

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

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

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

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

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

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

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

THE KIT FOR EVERYONE

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

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

PROGRESSIVE TEACHING METHOD

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

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

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

THE "EDU-KIT" IS COMPLETE

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

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

Progressive "Edu-Kits" Inc., P.O. Box #238, Dept. 501 IJ, Hewlett, N.Y. 11557

FREE EXTRAS

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

SERVICING LESSONS

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

FROM OUR MAIL BAG

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

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

SOLID STATE

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

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.

P.O. Box #238, Dept. 501 IJ, Hewlett, N.Y. 11557

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.