02342

MAY-JUNE
1973
75c

elementary Electronics

Including ELECTRONICS DIGEST®

She's tuned to her

Alpha Waves

Discover how electronic bio-feedback helps you explore your body's complex electro-chem activities—monitor the complex signals from your brain!

BASIC COURSE

UNDERSTANDING BRIDGE CIRCUITS

INSIDE SQ

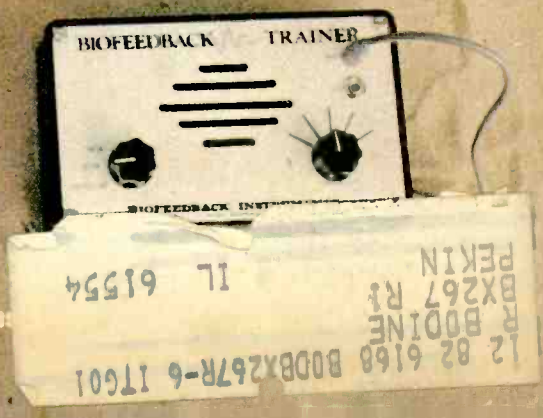
Matrix 4-channel sound has come a long way! We show the true story with scope pictures.

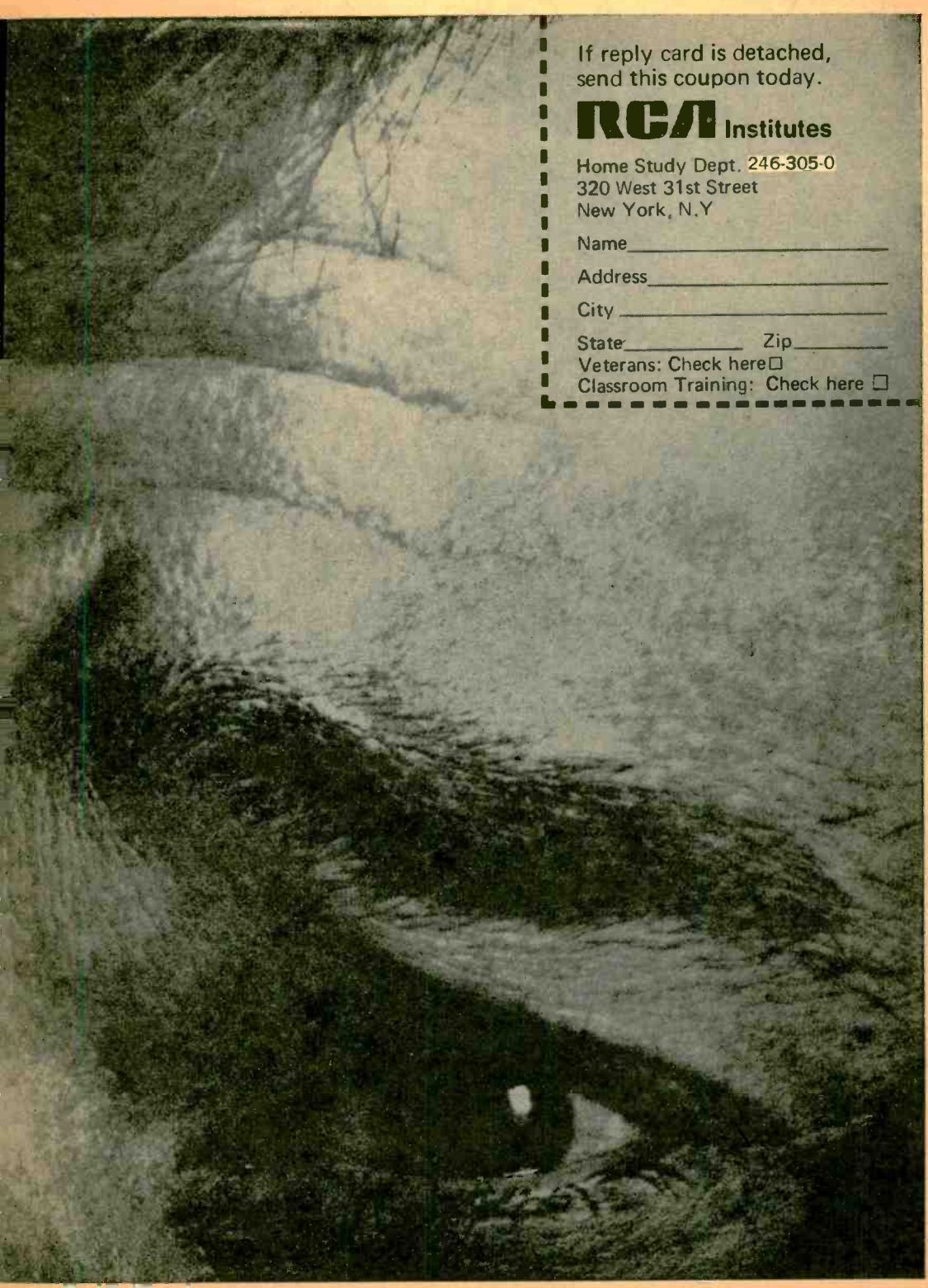
SSB—the CBers ELIXER

Improve reception, reduce noise, get more mileage from each channel!

LAB CHECKED in this Issue

- Heathkit GC-1005
- B&K 501A Curve Tracer
- JVC 4-Ch Disc Demodulator
- Panasonic SL-1100 Turntable
- Antenna Specialists Hi and Lo Band Tran





If reply card is detached, send this coupon today.

RCA Institutes

Home Study Dept. 246-305-0
320 West 31st Street
New York, N.Y

Name_____

Address_____

City _____

State_____ Zip_____

Veterans: Check here ☐

Classroom Training: Check here ☐

ELEMENTARY ELECTRONICS including **SCIENCE & ELECTRONICS** (Vol. 13, No. 3) is published bi-monthly by Davis Publications, Inc., at 229 Park Ave., S, New York, N.Y. 10003. One year subscription (six issues)—$4.00. Second class postage paid at New York, N.Y. 10003 and at additional mailing offices.

• May/June 1973 • Vol. 13 No. 3

e/e elementary Electronics

Dedicated to America's Electronics Hobbyists

☆ Cover Highlights

AUTHORS IN THIS ISSUE

Elmer C. Carlson, Travis E. Carsons, Emmett Fluffin, Herbert Friedman, Don Jensen, Kathi Martin, Alexander N. Retsoff, Jack Schmidt, Hank Scott.

Cover photograph by Leonard Heicklen

BUILD 20 RADIO and Electronics Circuits

PROGRESSIVE HOME RADIO-T.V. COURSE

Reg. U. S. Pat. Off.

Training Electronics Technicians Since 1946

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

- ★ No Knowledge of Radio Necessary
- ★ No Additional Parts or Tools Needed
- ★ EXCELLENT BACKGROUND FOR TV
- ★ SCHOOL INQUIRIES INVITED
- ★ Sold In 79 Countries

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

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

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

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

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

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

THE KIT FOR EVERYONE

You do not need the slightest background in radio or science. Whether you are interested in Radio & Electronics because you want an interesting hobby, a well paying business, or a job with a future, you will find the "Edu-Kit" a worth-while investment. Many thousands of individuals of all ages and backgrounds have successfully used the "Edu-Kit" in more than 79 countries of the world. The "Edu-Kit" has been carefully designed, step by step, so that you cannot make a mistake. The "Edu-Kit" allows you to teach yourself at your own rate. No instructor is necessary.

PROGRESSIVE TEACHING METHOD

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

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

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

THE "EDU-KIT" IS COMPLETE

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

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

FREE EXTRAS

• SET OF TOOLS

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

SERVICING LESSONS

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

FROM OUR MAIL BAG

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

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

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

PRINTED CIRCUITRY

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

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

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

Progressive "Edu-Kits" Inc., 1189 Broadway, Dept. 561DJ, Hewlett, N.Y. 11557

UNCONDITIONAL MONEY-BACK GUARANTEE

Please rush my Expanded Radio-TV Course with "Edu-Kits"® to me.

☐ Send Course with Edu-Kits postpaid. I enclose full payment of $34.95.

☐ I enclose $5.00 deposit. Send Course with Edu-Kits C.O.D. for balance of $29.95 plus postage.

☐ Send me FREE additional information describing Course with Edu-Kits.

NAME .....

ADDRESS .....

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

PROGRESSIVE "EDU-KITS" INC.
1189 Broadway, Dept. 561DJ, Hewlett, N.Y. 11557

CIRCLE NO. 4 ON PAGE 17 OR 103

elementary Electronics

May/June 1973 Vol. 13/No. 3

Dedicated to America's Electronics Hobbyists

ELEMENTARY ELECTRONICS is published bimonthly by Davis Publications, Inc. Editorial, Business and Subscription offices: 229 Park Avenue South, New York NY 10003. One-year subscription (six issues)—$3.95; two-year subscription (12 issues)—$7.95; three-year subscription (18 issues)—$11.95; and four-year subscription (24 issues)—$15.95. Add $1.00 per year for postage outside the U.S.A., its possessions and Canada. For change of address, please advise 4 to 6 weeks before moving. Send us your current mailing label with new address. Advertising offices: New York, 229 Park Avenue South, 212-673-1300; Chicago, 520 N. Michigan Ave., 312-527-0330; Los Angeles; J. E. Publishers' Rep. Co., 8560 Sunset Blvd. 213-659-3810; Long Island: Len Osten, 9 Garden Street, Great Neck NY 516-487-3305; Southwestern advertising representative: Jim Wright, 818 Olive St., St. Louis, 314-CH-1-1965. Second-class postage paid at New York NY and at additional mailing office.

Super Sidekick, it's everybody's gain

Turner's new amplified Super Sidekick has **two** gain controls: one on the top for normal volume adjustments and another on the bottom for matching the Super Sidekick microphone to your particular transceiver.

If you operate AM on a tube set, you might need all the gain you can get. On a transistorized SSB rig, you probably need just a little. That's what's so super about the new Super Sidekick. You get a modulation-boosting match for any set and a dynamic cartridge for clarity.

Talk it up. The new Super Sidekick amplified microphone lists for $80, and it does make an understandable difference. See a Turner dealer for details, or write to Turner, 909 17th St. N.E., Cedar Rapids, Ia. 52402.

TURNER
MICROPHONES

CONRAC
CORPORATION

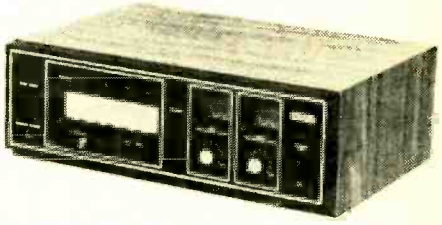
CIRCLE NO. 24 ON PAGE 17 OR 103

Hey, look me over

Showcase of New Products

Get on the Right Track

Introducing the new Craig Model 3304 Eight-Track (8T) Stereo Recorder Deck. The 3304 not only provides entertainment from pre-recorded tape cartridges through existing stereo sound systems, but also enables high-quality recording from a stereo record player, other



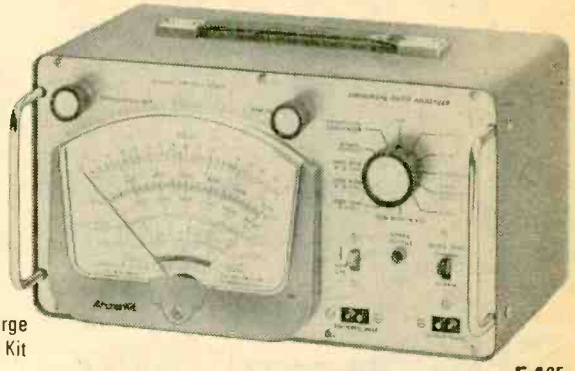
signal source, or optional microphones. Separate recording level meters and controls for each channel permits private listening or monitoring while recording. Flexible operating modes include Repeat, Continuous, Fast Wind, and Autostop operation. The Fast Wind feature is a convenience when looking for a particular selection to be played, and is especially valuable when indexing the tape in preparation for recording. Priced at $119.95. For further information, circle No. 56 on Reader Service Page.

Cassettes Get Better

Called "the Audiophile Tape", the new TDK Extra-Dynamic (ED) cassettes offer a new dimension in cassette recording fidelity for optimum performance on *any* cassette recorder/player. TDK ED cassettes provide a usable frequency response range of 20 to 23,000 Hz—the broadest range in the cassette industry. In addition to extended frequency range, TDK-ED cassettes offer greater dynamic range, higher saturation levels for improved transient characteristics, and TDK claims it has the industry's best signal to

THESE RADIO SHACK ARCHERKITS ARE "SWELL" ON WHEELS!

Deluxe Capacitive Discharge Ignition System Kit **39.95**



Portable Auto Analyzer Kit **54.95**

Auto/Marine Tachometer Kit **19.95**

Automatic Windshield Wiper Delay Control Kit **12.95**

Driver Alert Radar Sentry Kit **24.95**

SCR Electronic Ignition System Kit **12.95**

Capacitive discharge ignition system puts more power in your car, cuts maintenance and boosts gas mileage!

Auto analyzer measures rpm, volts, amps, ohms, dwell angle, plus spark output and leakage.

Tachometer is designed for all 12-volt systems, reads 0-8000 rpm with ±2% accuracy. 240° deflection angle.

Wiper delay control is an essential aid for driving safety. Ends "dry wiper" action in light rain or mist!

Driver alert sentry gives an audible warning of radar within a 1/2-mile range. Promotes safer driving. Clips on visor.

SCR ignition system electronically fires spark, extends dwell angle for improved power.

FREE '73 CATALOG! AT YOUR NEARBY STORE OR SEND IN THIS COUPON 207

180 pages! Stereo Hi-Fi, CB, Ham, Kits, Radios, Recorders, Tools, More!

Name _____ Apt. # _____

Street _____

City _____ State _____ Zip ☐☐☐☐☐

NOTE: PRICES SLIGHTLY HIGHER IN CANADA

Radio Shack®

and ALLIED RADIO STORES

A TANDY CORPORATION COMPANY

P. O. Box 1052, Fort Worth, Texas 76107

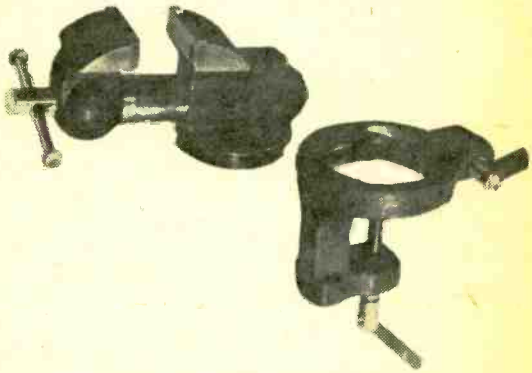
CIRCLE NO. 32 ON PAGE 17 OR 103

HEY, LOOK ME OVER

noise ratio. Because of the tape's higher saturation level (MOL), a higher level of recording signal can be applied to the tape without causing distortion, resulting in lower noise level during playback. The new TDK ED cassettes are available in 40, 60 and 90-minute lengths: C-40ED, C-60ED and C-90ED. They are packed in factory-sealed, dustproof, hinged, clear plastic boxes. Retail prices are $3.75 for the C-40ED, $4.50 for the C-60ED and $6.00 for the C-90ED. Try one, you'll like it. For additional information, circle No. 59 on Reader Service Page.

Get a Grip on It

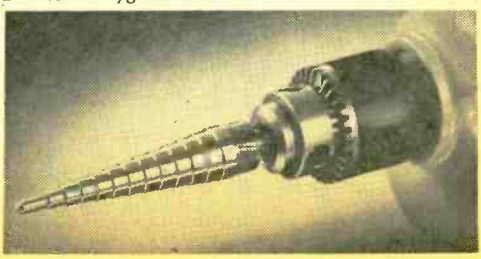
A new miniature bench vise with 360 degree swivel base comes in two parts, the mounting base and the vise. The two part construction enables the user to remove the vise with workpiece in position for close inspection and as a hand-held work holding device. The jaws are 2-in. wide, fully hardened and replaceable, with a maximum opening of 1-½-in. Other features are covered drive screw for maximum protection, ground anvil and fine black krinkle finish. Shipping weight 5 pounds.



Price: $11.95. Available from stock direct from The Tool Crib, 17 Thayer Circle, Randolph, MA 02368.

What's in a Hole?

The Unibit is a versatile single flute step drill that does the work of thirteen conventional twist drill bits. The first Unibit model, designed to fit any three-jawed ¼-in. (or larger) chuck, is intended primarily for use with hand-held electric drills. It has a starting diameter of ⅛-in. and each of twelve succeed-



BE AMAZED! ADD STARTLING FOUR-CHANNEL SOUND TO ANY STEREO ... HOME OR CAR ... THE EASY, LOW-COST RADIO SHACK WAY!

Built-In Hang-On

HOME ADD-ON SYSTEM

Your stereo system is ready and waiting for easy changeover to the "Sound of the Seventies": Our Quatravox four-channel synthesizer and two Solo-103 speakers recover ambient sound previously "hidden" in ordinary stereo records, FM and tapes . . . from right, left, front and rear, just as it's "reflected" in theaters, clubs, concert halls. No internal rewiring. Six audio cables and plugs are included. Save $5! $54.95

Realistic Quatravox™ Alone. Add quatravox and two extra speakers to your present system for four-channel enhancement of all stereo. $24.95

AND "ONE FOR THE ROAD"

If you already have stereo in your car, there's no need to miss out on the joys of four-channel. Our Auto Quatravox, plus two flush-mount speakers, connects easily to your present stereo radio or tape player for startling four-channel enhancement of any program or recording. Listen to front speakers only, rear only, or balance all four. 18-foot cables, hardware included. Save 10%! $16.11

Above system with "Hang-On" Speakers. Just hang speakers anywhere in car without installation. Save 10%! $15.21

Realistic Auto Quatravox Alone. Just add two speakers of your choice. Takes minimum space, only 5½ x 2½ x 1-3/4". $9.95

FREE '73 CATALOG! AT YOUR NEARBY STORE OR SEND IN THIS COUPON 206

180 pages! Stereo Hi-Fi, CB, Ham, Kits, Radios, More!

Name_____ Apt. #_____

Street _____

City_____ State_____ Zip

NOTE: PRICES SLIGHTLY HIGHER IN CANADA

Radio Shack

and ALLIED RADIO STORES

A TANDY CORPORATION COMPANY

P. O. Box 1052, Fort Worth, Texas 76107

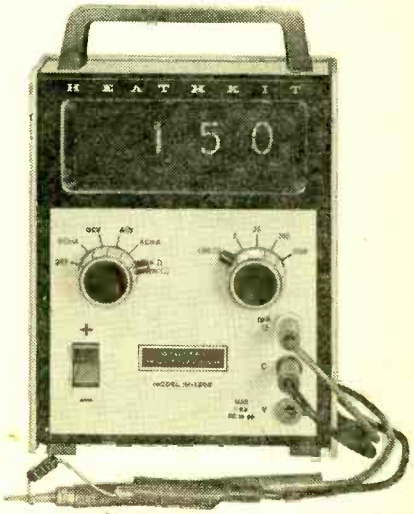
CIRCLE NO. 32 ON PAGE 17 OR 103

HEY, LOOK ME OVER

ing steps removes material in 1/32-in. increments up to ½-in. diameter. Each step penetrates material up to ⅛-in. thickness. The Unibit is made of industrial grade high-speed steel, heat treated and tempered to assure maximum strength for long wearing, rugged use. It displays superior characteristics in drilling thinner gauges of sheet metals such as steel, copper, brass and aluminum as well as most plastics and wood. The Unibit is unconditionally guaranteed and is available by mail for $4.95 (plus 25¢ postage and handling). Orders, information and specific literature can be obtained by writing Harry C. Oakes, Inc., Box 331, Wyoming, New York 14591.

The Numbers are Up

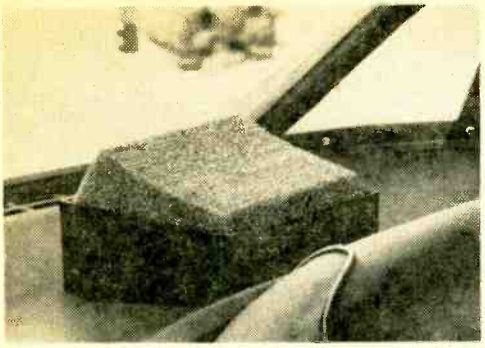
Heath Company sets a new low price for digital instrumentation with the IM-1202 2-½-Digit Multimeter kit, priced at just $79.95 mail order. This easy-to-build kit can be assembled in two or three evenings, yet boasts an accuracy and versatility never before available at this low price. A 2-½-Digit cold-cathode readout ends parallax and interpolation errors, and make maximum use of the overall precision of the solid-state Digital circuitry.



Accuracy is within 1% on DC volts, 1-½% on AC volts and AC/DC current, 2% on ohms. Exclusive built-in calibration standards simplify assembly and set-up of the IM-1202, and make periodic adjustments easy. For further information, circle No. 1 on Reader Service Page.

Two for the Rear Deck

Sound West has its solution for anyone looking for a quality automobile speaker. It's "The Car Speaker", a black plastic enclosure in a square shape, designed to offer optimum sound in cars and other vehicles. Priced at $39.95 a pair, suggested retail, "The Car Speaker" provides thunderous bass response,



clean midrange and airy highs through a heavy duty full-range acoustic suspension speaker with a 12-ounce ceramic magnet. Power handling capacity is 25 watts RMS. A design and engineering breakthrough, the speaker has a distinctive sloping foam grille, like a high performance car scoop, angled perfectly for optimum sound dispersion. Acoustic foam grilles are available in choice of black or the *world's first* "chromefoam" chrome plated grille. Every grille has a unique appearance and deep, rich, transparent-like texture which does not fade or flake off. Another advantage of these low-profile speakers is that they are surface mounted and can easily be installed in minutes. For all the facts, circle No. 57 on Reader Service Page.

For Fish Fanciers

With its new MI-1031, Heath Company breaks a precedent in an audible alarm depth sounder at kit-form savings. The MI-1031 features a bright flasher-type readout that shows what's below—depth to bottom, terrain and vegetation, even shoals and individual fish as well as submerged floating objects. A beep tone alerts the skipper to shallow waters or objects above any preselected depth from 5 to 240 feet. Two switch selected ranges make reading in depths to 240 feet easier, and permit more accurate readings in depths of 60 feet or less. Kit goes together in a couple of evenings, is available with either thru-hull or

HEY, LOOK ME OVER

transom mount transducer, and is mail-order priced at $99.95 F.O.B. A lower-cost version, the Heathkit MI-1030 without audible alarm, is also available at only $69.95. For more information on both units, circle No. 1 on Reader Service Page.

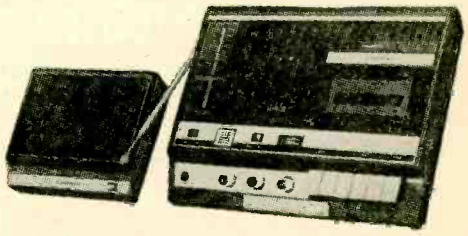
What a Beat it Has

The new Kenwood KR-6170 is an electronic marvel that permits the widest scope of musical fun and creativity. It incorporates such unique features as an Electronic Rhythm Composer, Reverberation Unit, front panel jacks for one or two electric guitars, multiple mixing of "live" and source sound, Multi-Presence Control, and an array of level, frequency, volume, balance and tone controls

that offer unlimited possibilities for unique effects. The Electronic Rhythm Composer itself "plays" five electronic percussion instruments (Bass Drum, Conga, Claves, Snare Drum, and "High Hat" Cymbal) in any of 12 different rhythms, including March, Rock, Ballad, Latin, Waltz, Rhythm and Blues, Fox Trot, Shuffle, Mambo, Jazz, and two Bossa-novas. Two rhythms can be selected simultaneously to create further variations. A slide lever varies the rhythm tempo from 20 to 200 beats per minute. The Rhythm Composer can be used to accompany one or two electric guitars, with further mixing available through the front panel microphone jacks for voice or additional instruments. The full effect can be recorded through special front panel "mixed recording" output jacks. So much more can be said for this Kenwood receiver but we'll let Kenwood tell you after you circle No. 58 on Reader Service Page.

Double for your Money

Pioneer has announced a new portable cassette recorder, the KT-401, that combines an AM/FM radio with an intercom. The KT-401 has practical applications in the home, office



or afield. The home user can keep an ear on infant or invalid, or the executive can dictate or confer without leaving his desk. The KT-401, which operates on batteries or AC, records directly from the radio or intercom, has battery level meter, built-in condenser microphone and remote microphone jack, both featuring automatic level control and telescopic AM/FM antenna. Features include piano-key controls, press-to-talk bar for intercom, and digital tape counter. The intercom speaker is equipped with a 50-ft. cord; separate recording preamp. Price: $129.95. For more facts and info on the KT-401, circle No. 60 on Reader Service Page.

Digital Multimeter

Dynascan Corp. has added a new solid-state digital multimeter to its popular B&K line of test instruments. It's the Model 281. Fea-

tures include a large, 2½ digit numerical display with automatically positioned decimal point, 100% overrange capability, full overload protection, positive overrange and wrong polarity indication, high sensitivity, 1% accuracy and 10 megohms input impedance. The large readout is easily read at a distance, making it unnecessary to be right on top of the unit to take a reading. This is a great advantage at all times, but especially when monitoring—you can be working on something else and still be able to read the 281 without being close to it. The 281 is lightweight and easily portable; the convenient 5-position handle doubles as a stand, for comfortable eye-level viewing. It operates from 105-125 VAC, 50-60 Hz and is supplied with test leads and B&K's PR-21 probe with switchable 100K ohm isolation resistor that prevents capacitive loading when measuring DC in RF circuits. Selling price of the Model 281 Digital Multimeter is $169.95. For more information, circle No. 42 on Reader Service Page. ■

Quicky Book Review

● *Basic Color Television Course* by Sam Prentiss, published by Tab Books; this textbook gives the student a complete background in television receiver basics; soft cover, 420 pages, 300 illustrations, $6.95; circle No. 49 on Reader Service Page. ■

Hank Scott, our Workshop Editor, wants to share his project tips with you. Got a question or a problem with a project you're building—ask Hank! Please remember that Hank's column is limited to answering specific electronic project questions that you send to him. Sorry, he isn't offering a circuit design service. Write to:

Hank Scott, Workshop Editor
ELEMENTARY ELECTRONICS
229 Park Avenue South
New York NY 10003

Something's Wrong

I have a CB base station with a range of about five city blocks. I would like to know if I could build or purchase a CB booster to boost the signals. —*J. S., Masontown PA*

You didn't give me the make and model number of the rig you have, but never mind. Even the worst rig on the market can get out further than five city blocks. Something is wrong. I bet your problem is the antenna system. Call in a few fellow CBers and together examine the antenna system. In fact, maybe one of your friends will loan you a rig to operate on the antenna for comparison purposes. If the substituted rig goes only five blocks—get rid of that antenna system.

He's Learning

I learned from the Basic Course in the back of every issue of ELEMENTARY ELECTRONICS *that the peak voltage of 115-Volts AC is 162 Volts. If that is so, how come a voltmeter reads only 120-Volts AC?* —*J. K., Trenton NJ*

The lowest possible reading of an AC voltage at any instant is zero, how come the voltmeter reads 115 Volts AC? I'm only trying to point out that your logic is faulty. An AC voltmeter's characteristics are such that, at every instant of time, the meter takes a sample voltage from the line, gets the square root of it, then averages all the values so obtained over a complete cycle, and then squares the result. Sounds complicated, but that's what happens in an AC meter. That's where the term *root-mean-square* came from, or simply, *rms*. Now this rms value of a sine wave voltage is exactly equal to a DC voltage

(Continued on page 22)

ELEMENTARY ELECTRONICS

READER SERVICE PAGE

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

• The coupon below is designed for your convenience. Just circle the numbers that appear next to the advertisement or editorial mention that interests you. Then, carefully print your name and address on the coupon. Cut out the coupon and mail to ELEMENTARY ELECTRONICS, Box 886, Ansonia Station, New York, N.Y. 10023. Do it today!

MAY/JUNE 1973 — Void after September 30, 1973

ELEMENTARY ELECTRONICS

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

Please arrange to have literature whose numbers I have circled at right sent to me as soon as possible. I understand that this is a free service offered by the magazine.

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70

• Please limit circled items to 12 maximum.

Name (Print Clearly) _____

Address _____

City _____ **State** _____ **Zip Code** _____

Heathkit GR-900 25V Color TV with total-tuning convenience.

It's the most advanced TV circuitry you can build. Yet everything goes together with traditional Heathkit simplicity. And the built-in convergence board and test meter for at-home maintenance and self-service add further savings over the life of the set. With the GR-900 you pre-set any 12 UHF stations for positive pushbutton power tuning, and you can scan both UHF and VHF channels in either direction. An ultra-rectangular black matrix tube, voltage controlled varactor UHF tuner, MOSFET VHF tuner and an exclusive angular tint control for consistently better flesh tones combine to produce an absolutely brilliant color picture. There are four preassembled and finished cabinets to choose from, plus the Heathkit Wall Mount and wireless remote control option. Any way you look at it, the Heathkit GR-900 is one of the most rewarding kits you can build. Mailing weight, 125 lbs.

New Heathkit Solid-State B&W 19V Portable TV — a truly extraordinary set

The new Heathkit GR-1900 is like no other B&W portable! With advanced solid-state "modular" design — most circuitry mounts on just four plug-in boards. Dependable solid-state circuitry, including 23 transistors, 13 diodes, 2 ICs, and just 2 tubes; picture & high voltage. Total detent tuning on all 70 UHF channels as well as VHF. "Instant-On" for sound and pictures at a touch — plus other "big-set" front panel control features such as VHF/UHF fine tuning; brightness; contrast; master on/off; vertical hold; AGC; and height. New Ultrarectangular picture tube for a full 184 sq. in. viewing area. Automatic Vertical Linearity for rock-steady pictures — a feature usually found only on expensive color sets. Dual-Controlled AGC for improved picture/noise ratio — another "big-set" bonus feature. Extra-wide Video Bandwidth for theater-quality black-and-white pictures. Four circuits (most sets have only 3) in the grounded base VHF tuner for superior cross modulation in dense station areas. With all this, the GR-1900 is a kit even the novice can build. Both tuners come preassembled and aligned, transistors & ICs plug into sockets, and all chassis wiring is color coded. For truly extraordinary performance in B&W TV, you've got it all in the GR-1900. Mailing weight, 56 lbs.

New Heathkit Desk-top Calculator — an outstanding kit-form value.

The Heathkit IC-2108 features a sleek, low-profile case with bright ½" readout tubes in an 8-digit display — one of the largest, most legible in the industry. The color-coded keyboard is human engineered to slope down to the desk so you can rest your arm while using. And the IC-2108 is loaded with features: Four arithmetic functions. Floating and fixed decimal. Constant key. Chain calculation capability. Clear display key. Entry and result overflow indicators. Negative number indicator. 120/240 VAC operation. In addition, the IC-2108 is amazingly simple to build. Two spare evenings will do it. **Kit IC-2108, 4 lbs.**

New Heathkit "Pocketable" Calculator — you can service it yourself

The Heathkit IC-2009 is first a self-contained portable, weighing in at 11 oz. and small enough to fit in your coat pocket, but it's a desk-top calculator too. The internal Nickle-Cadmium battery gives five to eight hours use between charges. Or, the IC-2009 can be left connected to its charger for indefinite operation. And unlike other pocket calculators, the Heathkit IC-2009 is designed to be maintained by you. Plug-in keyboard and display boards, plus a complete troubleshooting section in the manual, make it easy — and economical. Add up the features for yourself: 8-digit capacity. Four arithmetic functions. Full floating decimal. Constant key. Chain calculation capability. Clear entry key. Entry and total overflow indicators. Negative answer indicator. Battery-saver circuitry. Low battery indicator. Tactile-feedback keyboard for positive entry indication. Order your IC-2009 now. You'll have it built in two or three evenings. Mailing weight, 3 lbs.

Heathkit 4-Channel Amplifier with Universal Decoder...359.95* (less cabinet)

You select discrete 4-channel, or switch-in the "Universal" decoder for reproduction of all the matrixed 4-channel discs now on the market, plus "derived" 4-channel from conventional stereo. Four solid-state amplifiers produce 200 watts (4x50 IHF) into 8 ohms, with power bandwidth on all channels from less than 5 Hz to greater than 45 kHz at 0.25% distortion. **Kit AA2010, 37 lbs. AAA-2004-1, pecan cabinet, 7 lbs. 24.95***

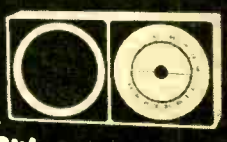
Heathkit Universal Decoder for 4-channel conversion . . . 39.95*

Reproduces all matrixed discs, plus "derived" 4-channel from conventional stereo materials. Plug it into your receiver's tape monitor circuit, add a second stereo amp and speakers and you're set. **Kit AD-2022, 4 lbs.**

New

Heathkit Ultrasonic Intrusion Alarm looks like a book . . . 49.95*

Disguised as an ordinary library book, this novel device fits unobtrusively anywhere in the home. Transmitter disperses a 41 kHz signal which bounces off walls and returns to the receiver where it's monitored for any change in amplitude. Triggers lights and any conventional alarm device — just plug them into AC outlets on the rear panel. Can be installed anywhere there's a 120 VAC outlet. An enjoyable 2-evening kit. **Kit GD-39, 4 lbs.**



New

Heathkit GR-1008 AM Radio can be built in one evening . . . 14.95*

A smartly styled, great sounding solid-state radio that makes a great introduction to Heathkit building. Eight-transistor circuitry mounts on one printed board, big 3½" speaker mounts in high impact plastic case. If you've never built a kit before you can probably have this one together in one fun evening. Uses 9-volt battery (not supplied). Order the Heathkit GR-1008 for yourself or the kids. **Kit GR-1008, 2 lbs.**

CIRCLE NO. 1 ON PAGE 17 OR 103

ASK HANK, HE KNOWS

(Continued from page 16)

potential to do work like creating heat in a resistor. Hence, DC and AC-rms readings can be used in Ohm's law for resistance without any special equations. This makes life very simple except that, in all averages, some values are big and some are small. The biggest value, or peak voltage of an AC sine wave is 162 Volts when the rms value is 115 Volts. In fact, for all sine wave voltages, the peak voltage is always 1.414 (*that's the square root of 2*) times larger than the rms value.

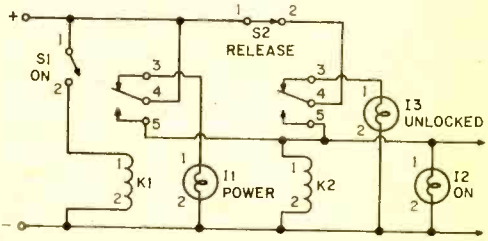
Few Are Chosen

How come all the reviews in ELEMENTARY ELECTRONICS *are always positive, if not great? Never a bad word. Everything can't be good. A few lemons always pop up! Explain, please.*
—R. N. Washington, DC

There are hundreds of products on the marketplace that compete with most of the products reviewed in ELEMENTARY ELECTRONICS. What would you like to read about, the many bad, poor, mediocre and just fair products, or do you want to know about the best? You can't get both because space is limited. The Editor decided to be positive in his editorial approach and I agree with him.

Relay This Message

In the March-April issue of ELEMENTARY ELEC-



TRONICS *I offered a relay circuit and asked you readers to tell me when lamp I1, I2 and I3 come on and off. Here are the answers.*
—Hank Scott

In the above diagram, power lamp I1 will go out only when power is removed from the circuit or when pushbutton *ON* switch S1 is held down. This is caused by the energizing of relay K1 coil (terminals 1-2) and the opening of relay K1 contacts 3 and 4. The *ON* lamp I2 comes on when relay K2 is energized. This happens by the pressing of pushbutton *ON* switch S1. The clapper terminal of relay K1 (terminal 4) contacts relay terminal 5 and momentarily energizes relay K2. Relay K2 terminals 4 and 5 close, providing another DC path for power to energize relay K2. When *ON* switch S1 is released, power is supplied to relay K2 coil (1-2) via terminals 4 and 5 of that relay—this is commonly called a latching relay circuit. When-

(Continued on page 96)

DX central reporting

A world of SWL info!

☐ While our bandsweeps here at *DX Central* sometimes take us across the amateur radio bands, usually we leave coverage of this field to the excellent ham magazines. However, every now and again, some earthshaking event brings ham radio to the front pages of the daily newspapers.

One such event—literally earthshaking—was the series of earthquakes that devastated Managua, the Nicaraguan capital, last December 23. The tremors killed thousands, toppled buildings, knocked out power and virtually all regular communications facilities.

As in past disasters, hams around the world have been ready, willing and able to pitch in and provide emergency communications.

The first contact with the outside world was made by a Nicaraguan ham, Enrique, YN1AGL, operating with mobile equipment in his automobile. For the first 20 hours after the earthquakes began, information about what had happened and requests for assistance and emergency supplies reached the U.S. through Enrique.

Stateside, hams began setting up emergency communications nets to handle the radio traffic out of Nicaragua. A Nicaraguan ham, Antonio, YN1ARG, vacationing in Houston, was able to provide the essential Spanish-speaking link, and Andrew Clark, W4IYT, Miami, along with Leopole Kerbel, W4EDE, Washington, D.C., Jose Samper, HK3BQF, Bogota, Colombia, Daniel Martinez, XE1CW, Mexico City, amateurs at KZ5USA, Canal Zone, and many others, swung into action.

Four hams from Miami flew into Managua, with a complete portable station, via a special Lanica Air Lines flight, and set up station YN1SIRA. U.S. hams collected gear, generators, antennas, walkie-talkies and other supplies to equip other Nicaraguan amateurs. These were flown to Managua by a Lanica pilot, a ham, Miguel Murciano, YN1MO.

General Anastasio Somoza, former Nicaraguan president and military head of the beleaguered country relied heavily on a portable ham station established at his home by Benjamin Elizondo, YN1BE. Also active in this work was YN1YN, the official Nicaraguan amateur society station. *(Turn page)*

DX CENTRAL REPORTING

Continued from page 23

American hams probably never realized until then that there were so many Nicaraguans and persons of Nicaraguan ancestry living in the United States. Naturally these persons were frantic to learn whether relatives and friends living in the quake-torn nation was safe. Inquiries were relayed by hams to stations such as YN1YN. A network of those Nicaraguan medium wave stations still operating was formed and persons with loved ones in the U.S. or elsewhere were asked to contact the stations concerning their safety. These messages were sent on to their worried relatives by the ham radio link-up.

Shortwave listeners tuning the ham bands during the hectic days following the quake, were able to follow the message exchanges, the arrangements which resulted in a C-130 aircraft flight from the Canal Zone to bring in a 100-bed hospital, two portable power plants, medical supplies and more than 400 quarts of blood from Venezuela and Colombia.

Here at *DX Central*, most of our listening hours were spent following the nearly continuous action around 14,295 to 14,305 kHz, in the 20-meter band.

Unfortunately, for each ham we've mentioned by name or call, there were dozens we can't recognize. But all of them deserve such recognition for putting aside their personal concerns, including food and sleep, to help out when disaster struck.

Tip Topper. In the spotlight this month is not a single station, but a whole country, the Dominican Republica.

The Dominican Republic is a Caribbean nation, sharing the island of Hispanola with Haiti. It is, of course, a Spanish-speaking land, so don't expect to find any English language programs on the Dominican stations.

Now this can scare off some listeners who say, "I only know English and the rest is all gibberish to me."

But, if you try, you'll find you can pick out enough Spanish words to at least identify some stations. And if you don't try, you'll forever limit yourself to only those stations that use English. That means missing out on a wealth of DX!

Dominican shortwave stations number approximately 20 frequencies. Some are very tough to hear, others operate only irregularly. But here are a few of the best heard shortwavers in the Dominican Republic. For this data we are indebted to Cesar Objio, a resident of the country, and to the North American SW Association.

Radio Libertad is located in the Dominican city of Santiago, the second largest city in the country. The station broadcasts on 3,215 kHz, and while not the most commonly heard, still it puts in a decent signal on many occasions.

As with most stations in Latin America, evening reception is best.

Radio Exitos also is located in Santiago. Its frequency is 3,365 kHz and it normally signs off about 0500 GMT.

Onda Musical—the name means "musical wave"—is operating from Santo Domingo, the Dominican capital on 4,775 kHz. Generally speaking, it is the strongest, clearest of all the nation's SWBC outlets and is the best bet for inexperienced DXers.

La Voz de las Fuerzas Armadas also is located in Santo Domingo. If you know a bit of Spanish you know its slogan translates as the *Voice of the Armed Forces*. Yes, the station is operated by the Dominican military but its programs sound like any of the other stations in the country. Its frequency of 4,825 kHz is often interferred with, but when the channel is relatively clear you should log this one.

Radio Cristal is another Santo Domingo station that has operated on 5,010 kHz for many years and is often heard by Stateside DXers.

Bandsweep. Frequencies in kHz, times in GMT: **2,390**—It is rare to find a shortwave broadcast station way down here in the 120-meter band. One of the handful of such stations heard, but only when conditions are especially good, is the Guatemalan, *La Voz de Atitlan*. . . . . **3,385**—Radio Rabaul is one of those exotic stations that is especially interesting from a program content. Pidgin-English announcements, Polynesian tunes and, yes, even good ol' country and western music are frequent fare just before dawn wherever you live. . . . . **4,972**—If you're trying for Africans, try for the shortwave outlet at Yaounde, Cameroun on this frequency during late afternoon in the U.S. and Canada. Programming is in either French or native African languages. . . . . **5,960**—The Greek broadcasting authority, NHBI has a new 100 kilowatt shortwave transmitter that should make reception on this side of the Atlantic much better. This is one of the frequencies it has been trying out. Look for it around 1500 and later. . . . . **10,090**—The strange Portuguese language transmissions that have turned up on this off-beat frequency lately have been identified as the second harmonic repeating of a station at Bissau, Portuguese Guinea, whose fundamental frequency is 5,045 kHz. . . . . **11,949**—The best way to log the elusive South American country of Paraguay is still via *Radio Encarnacion*. Programming is in Spanish, of course, and good signals have been reported at times around 2345. . . . . **15,170**—A favorite station of most DXers is *Radio Tahiti* which can be heard quite regularly signing on at 0300. (Credits: Dan Henderson, Virginia; Edward Shaw, Virginia; Dan Ferguson, West Virginia; A.V. Sizer, Connecticut; Glenn Hauser, Texas)

Feedback. "I read your column regularly to

keep informed about my favorite hobby, SWL'ing," writes Gary Ashley of Wichita Falls, Tex. "But I have received what seems to be a time station on about 8,000 kHz and I can't find it listed anywhere. I heard it from 1015 until 1030 GMT, without any announcements. Could you tell me its name and location?"

What you heard, Gary, was the Japanese station JG2AE, at Koganei, just outside Tokyo. The frequency is 8,000 kHz on the nose and you caught it at just about the optimum time; it leaves the air at 1059 GMT. There are no voice identifications, just a series of 1,600 Hz pulses, with a lower pitched 600 Hz tone just before each minute.

Reception reports can be sent to Frequency Standard Division, Radio Research Laboratories, Ministry of Posts and Telecommunications, Midori-cho, Koganei, Tokyo 184, Japan.

Floridian Jay Garlitz has sent us another question about those standard time and frequency stations.

"I'd like to know about a time station on 15,000 kHz. It was heard at 0800 GMT, very weak, barely registering on my S-meter. It is not WWV or WWVH, but something else, probably in Asia."

It sounds like JJY, another Japanese outlet run by the same organization mentioned above. Keep after it, Jay, and good luck!

A Bay Shore, N.Y., SWL, Charles Wilson asks about the addition of a leap second to correct the world's clocks. In *DX Central Reporting* (ELEMENTARY ELECTRONICS, November-December 1972) we told of the time signal modification made last June 30, when an extra second was added to make the world's longest day.

Charles queries, "Do you know if this is a yearly occurrance or when the next 'additional second' is to be added to our clocks?"

Well, Charles, another leap second was added—and very alert listeners may have noted this as an additional silent second on WWV transmissions—on December 31. Additional leap seconds will be added to our days as the need arises. We can only suggest you keep tabs on these matters by carefully reading your newspapers.

And, finally, Paul Sagi of Wayne, Pennsylvania, writes about medium-wave broadcast band (BCB) listening.

"I've heard most of the eastern states with my radio, but I'm greatly puzzled by my not being able to receive any stations west of the Mississippi. Is the Mississippi some sort of a barrier to radio waves?"

No, Paul, the Big Muddy may be wet and wide, but it won't stop radio signals.

Why don't you try listening at night to one of the so-called clear channel frequencies where interference from other stations is minimal. Two good bets to try are KSL, Salt Lake City, Utah, on 1160 kHz, and WOAI, San Antonio, Texas, on 1200 kHz. ■

newscan

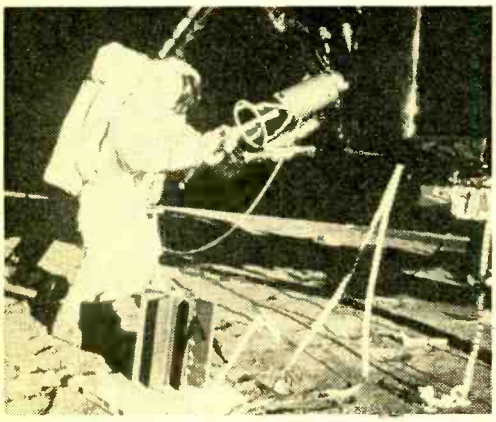
Electronics in the News!

Atom Power Pack

Nuclear energy marks its 3-½ years of continuous operation on the lunar surface. An atomic battery, technically known as a radioisotope thermo-electric generator and designated SNAP-27, was deployed on the moon on November 19, 1969, by the Apollo 12 astronauts Charles Conrad and Alan Bean to power a science station. The nuclear power source had a one-year life requirement of 63.5 watts.

The generator, fueled with the plutonium-238 isotope, produced about 73 watts of electric power when it first began operation. It is now supplying more than 69 watts of electricity, five watts above its one-year mission objective.

It was Astronaut Alan Bean who removed the plutonium fuel core from its cask attached to the Intrepid, the moon lander vehicle, and inserted the fuel core into the generator located nearby on the moon's surface. The Apollo Lunar Surface Experiments Package, including the generator, was subsequently carried some 600 feet from the lunar module to the far side of a small crater when the science station was deployed and began transmitting data to earth. Four other nuclear-powered lunar experiment stations, deployed during the Apollo 14, 15, 16 and 17 missions, continue to operate. ■



Nuclear electric power arrived on the moon for the first time on November 19, 1969, when Apollo 12 astronauts Charles (Pete) Conrad and Alan Bean deployed the AEC's SNAP-27 nuclear generator on the lunar surface.

LITERATURE LIBRARY

101. Kit builder? Like weird products? *EICO's 1973* catalog takes care of both breeds of buyers at prices you will like.

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

103. See brochures on *Regency's* 1973 lineup of CB transceivers & VHF/UHF receivers (public service/business bands—police, fire, etc.)

104. A pamphlet from *Electra* details the 6 models of the Bearcat III, a scanning monitor receiver.

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

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

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

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

109. "Meet the Metrics," *Xcelite's* broad line of metric hand tools and compact interchangeable blade sets for driving hex head screws, nuts, and hex socket screws. They're a 'must' for tinkering with import equipment.

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

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

112. *Midland* has recently published a 4-color brochure that folds out to 17" x 21", printed on both sides. Over 40 CB and scanner products are featured.

113. *EDI* (*Electronic Distributors*) has a catalog with an index of manufacturers' items literally from A to Z (ADC to Xcelite). Whether you want to spend 29 cents for a pilot-light socket or $699.95 for a stereo AM/FM receiver, you'll find it here.

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

115. *Olson Electronics'* 188-p. fully-illustrated 1973 catalog has leading national brands, all in the electronic product categories.

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

117. Get the free, new twenty-four page *HUSTLER* CB and Monitor antenna catalog featuring improved antennas and accessories for base station and mobile operation.

118. *Teaberry Electronics* has information on CB radios—Twin "T," Big "T," Mini "T" II, and Five by Five; also information on Scan "T" Monitor radio receiver.

119. *Burstein-Applebee's* new 1973 catalog has over 280 pages of Radio-TV/Electronics bargains. Selling for $2, it is offered free to our readers.

120. For a colorful leaflet on the Golden Eagle Mark III SSB receiver and the Mark III SSB transmitter, write to *Browning Laboratories*.

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

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

123. *Radio Shack's* 50 Anniv. cat. has 180 pages, colorfully illustrated, of complete range of hi fi, CB, SWL, ham equip. and parts (kits or wired) for electronics enthusiasts.

124. It's just off the press—*Lafayette's* all-new 1973 illustrated catalog packed with CB gear, hi-fi components, test equipment, tools, ham rigs, and more.

125. *Mosley Electronics, Inc.* is introducing 78 CB Mobile Antenna Systems. They are described and illustrated in a 9-page, 2-color brochure.

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

127. You can become an electrical engineer *only* if you take the first step. Let *ICS* send you their free illustrated catalog describing 17 special programs.

128. *Avanti* antennas (mobile and base for CB and VHF/UHF) are fully described and illustrated in new catalog.

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

130. Semiconductor Supermart is a new 1973 catalog listing project builders' parts, popular CB gear, and test equipment. It features semiconductors.—all from *Circuit Specialists*.

131. *Heath's* new 1973 full-color catalog is a shopper's dream—chockful of gadgets and goodies everyone would want to own.

132. E. F. Johnson's 1973 line of CB tranceivers and CB accessory equipment is featured in a new all-line brochure. Send for your free copy today.

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

134. Free 1973 Catalog describes 100s of *Howard W. Sams* books for the hobbvist and technician. It includes books on projects, basic electronics and many related subjects.

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

Please arrange to have this literature whose numbers I have circled at right sent to me as soon as possible. I am enclosing 25¢ to cover handling. (No stamps, please).

M/J-73

101 102 103 104 105 106 107 108 109 110

111 112 113 114 115 116 117 118 119 120

121 122 123 124 125 126 127 128 129 130

131 132 133 134

☐ **Indicate total number of booklets requested**
Sorry, only 15 circled items maximum.

NAME_____

ADDRESS_____

CITY_____

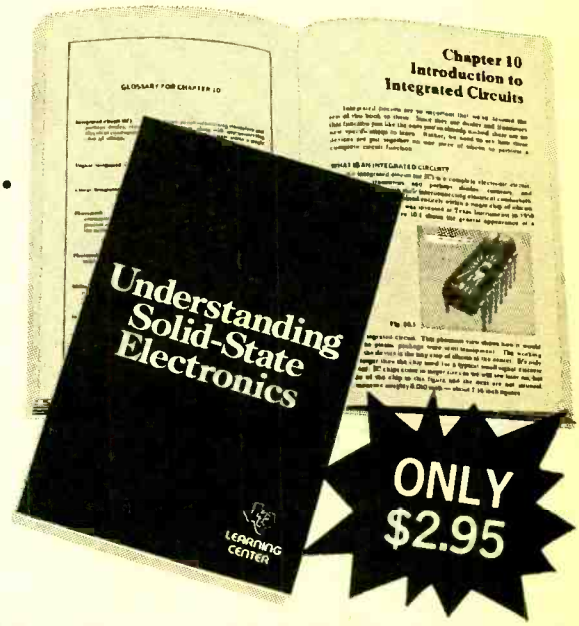
STATE_____ **ZIP**_____

Not Valid After September 30, 1973

"This pocket-sized masterpiece explains what electronics is all about...a marvelous little book..." *Electronic Buyers' News*

"From basic electricity through MOS and linear ICs... as good a basic book as we've seen."
Electronics magazine

"Best beginner's text of 1972."
Elementary Electronics



Understanding Solid-State Electronics **is a self-teaching text which begins at the beginning and explains every new idea and technical subject in terms you can understand.**

This book was created for anyone who wants or needs to understand solid-state electronics, but can't devote years to the study.

Texas Instruments prepared the course for its own non-engineering employees and customers – and thousands have proven its effectiveness.

It's a practical course. Engineering concepts are explained without using mathematics – just a little simple arithmetic. Technical terms are used, but each one is explained – in plain English.

12 lessons plus quizzes, glossaries – 250 pages

The lessons cover: What Electricity Does in Every Electrical System • Basic Circuit Functions • How Circuits Make Decisions • Relating Semiconductors to Systems • Diodes: What They Do and How They Work • Transistors: How They Work, How They Are Made • Transistor Specifications • Thyristors • Optoelectronics • Introduction to Integrated Circuits • Digital Integrated Circuits • MOS and Linear Integrated Circuits.

Award-winning course

Tens of thousands of readers have followed the serialization of this book in *Electro-Procurement* magazine – for which it won the 1972 Jesse H. Neal Editorial Achievement Award, the "Pulitzer Prize" of the business press.

Send coupon today for your copy

LEARNING CENTER

Texas Instruments Learning Center
P.O. Box 3640 · Dallas, Texas 75222

Please send_____copies of **Understanding Solid-State Electronics.** I have enclosed $2.95 for each copy ordered (check or money order only). Total amount enclosed is $_____

NAME_____

ADDRESS_____

CITY_____ STATE_____ ZIP_____ EE

TEXAS INSTRUMENTS
INCORPORATED

87226

EVEN IF THEY NEVER SEE YOUR SLEEK NEW COBRA 135, THEY'LL KNOW YOU HAVE THE BEST.

They'll know by listening. Because you'll send with all the power allowed—15 watts P.E.P. input. Plus the extra authority of 100% modulation with Dynaboost speech compression.

You'll transmit on 23 AM and 46 SSB modes. Two separate transmitters give you the best of each, with overload protection.

Your own ears will confirm what we say. This Cobra has the crispest, cleanest sound ever. Over 60 dB cross modulation interference rejection completely eliminates bleedover.

Cobra's drift-free Voice Lock lets you locate and lock-in sideband signals over a wide range. Three filters—one crystal, two ceramic—keep adjacent channels under wraps.

And Cobra's noise blanker really punches holes in noise, both AM and SSB.

The control console has everything. Adjustable AM/SSB RF gain control. Backlit RF output/SWR/S meter. 24-hour digital-leaf clock. Illuminated mode selector. And full-function controls.

Both talking and listening, it's the first base station to combine all the features you want in one package. And as for looks—wow!

Ask your CB dealer to show you the best. Cobra 135.

COBRA 135
AM/SSB
$419.95

microphone included

Product of Dynascan Corporation, 1801 West Belle Plaine Avenue, Chicago, Illinois 60613

CIRCLE NO. 23 ON PAGE 17 OR 103

elementary Electronics
MAY/JUNE 1973

I Heard the Sounds of Silence

First hand report on an electronic brain wave detector from Edmund Scientific Company—a Biofeedback trainer.

by Travis E. Carsons

FOR ALMOST AS MANY YEARS as I can remember I have been entranced for days on end by the latest editions of Edmund Scientific's catalog. Each new issue presaged scientific advances that would eventually shape or influence my life, and there was always an "experimenter's kit" to help me to better understand these wonders of modern science.

But all of the previous Edmund kits paled in comparison when I ran across their Biofeedback Trainer; here was a device that could reproduce those electrical messages sent from brain to muscle and from nerve to brain. In actual fact, these messages are electrical impulses generated through the very processes of life. Man's brain, the most complex device created, generates many different types of electrical impulses: when sleeping, the brain produces waves in the range of 0.5 to 3 Hz, termed *delta waves;* when creative, the brain produces *theta waves* of 4 to 7 Hz; when you're totally relaxed *alpha waves* of 8 to 12 Hz are

Turn Page

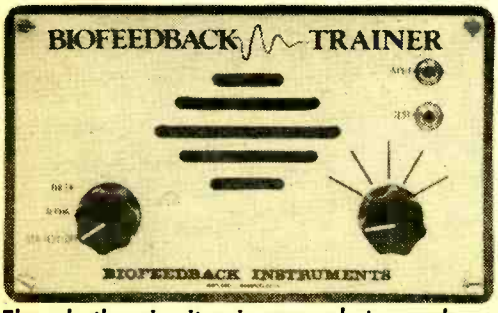
generated; and just everyday activity produces *beta waves* from 13 to 30 Hz.

Well Known Effect. Other parts of the body also produce electrical impulses. Move your neck and with the proper equipment you can sense electrical impulses flying around your head. Heartbeats produce an electrical current easily sensed at many points around the body. And, of course, there is the common galvanic skin response where the skin's electrical resistance varies in response to the activity of the sympathetic nervous system, the basic idea behind the modern lie detector.

Normally, these electrical effects pass unknown and unfelt because they can be neither sensed nor heard; yet some scientists, among others, claim certain effects accurately reflect certain states of mind, which if controlled can lead to a richer feeling of well-being and tranquility. For example, anything that promotes physical relaxation similarly promotes alpha wave generation, while creative meditation promotes alpha and theta output.

Research has shown that through practice —actually through mental relaxation—it is possible to increase alpha output, which is thought to increase theta output, the product of a creative mental state. Some test subjects have reported hypnagogic, dreamlike images when deliberately producing alpha and theta waves. Sort of like a high without recourse to dangerous drugs; and, unlike drugs, alpha and theta wave generation is the product of a creative, *alert* mind.

But how could I, without expensive laboratory instruments, make my life more tranquil by deliberately generating alpha and theta waves? Alpha and theta cannot be sensed or heard, the waves might be pouring from my brain but to me it was a thundering silence.

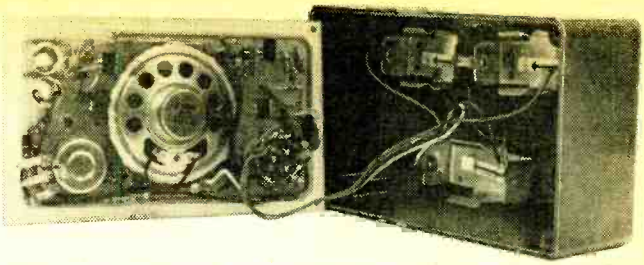


Though the circuitry is somewhat complex, there are only two operating controls—a theta or alpha filter and sensitivity pot.

Electronic Triggers. I found the answer in Edmund Scientific's Biofeedback Trainer (see why I was excited), a device that recreates the subaudible electrical effects which are too low in frequency to be heard even when amplified. Basically, the Biofeedback Trainer consists of two sections: 1) an audio oscillator feeding a loudspeaker and 2) a detector that converts the low frequency body impulses to DC impulses used to trigger the oscillator. When the trainer senses a body current, the resultant DC output triggers the audio oscillator, thereby producing a *beep* tone in the speaker. The greater the body's electrical impulses, the greater the number of beeps. Through suitable switch selected filters in the detector, sensitivity is made to favor the alpha or theta frequencies. A third switch position connects the oscillator in such a manner that it can be used to indicate body galvanic reactions, so that the greater the reaction, the higher the oscillator frequency becomes.

Since brain waves are easily sensed around the back of the head from essentially ear to ear, one set of electrodes is also backed with Velcro so it can be precisely positioned on the headband for maximum sensitivity. The second set of electrodes consists of individual fingertip sensors used for measuring galvanic skin reactions. Wrist electrodes connected to the theta sensing input allow monitoring of the electrical currents generated by a heartbeat. The saline solution is placed on the electrodes or skin to increase the contact sensitivity.

How It Worked. My first tries at producing alpha were utter failure! Stretched out in what I thought was a totally relaxed position I produced nothing but random beeps, my thundering silence was nothing more than thundering squawks. Gradually I realized that each time I twitched, moved my head even a fraction, or squinted my eyes, the box emitted a string of beeps. Since every action of the body produces electrical impulses, it was obvious I was working overtime trying to relax. Finally, just as my mind slipped into that zone before sleep sets in, the box quieted down to intermittent beeps, just loud enough to keep me awake. In that dreamlike zone of total relaxation *I was producing alpha.* However,



For maximum safety the trainer is battery powered. Standard transistor radio type batteries plug into the holders shown, which are marked for polarity.

as I struggled to increase my relaxation, the roar of beeps returned; it was obvious that *trying* to relax is work, not relaxation! The obvious question here is, "Why did the beeps increase if the trainer is only sensitive to alpha or theta?" The answer lies in the random impulses generated by muscles. Each twitch is an impulse rather than a train of impulses at some specific frequency, and a single impulse will ride through most filters. It is amazing how much twitching goes on when one is making a conscious effort to relax. The eyes blink, the head moves ever so slightly, a finger twitches, the elbow quivers; all these movements send out impulses heard on the trainer. Only when I was totally relaxed, in that haze before sleep, was there no twitching to obscure and interfere the trainer, and the alpha was audible.

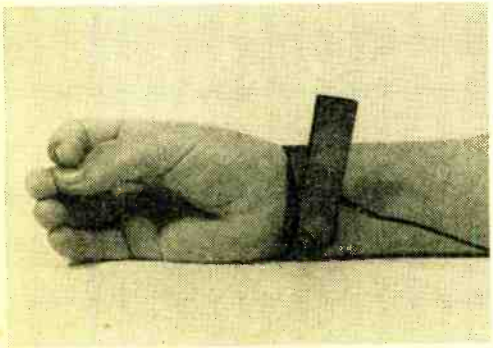
With each practice session I was able to enter the alpha-producing tranquil zone more quickly, until I could consciously produce alpha; with eyes half closed, body at complete rest, I could slightly increase or decrease the alpha beeps at will.

According to researchers, Zen masters with considerable experience in tranquil meditation produce copious alpha and theta waves, so perhaps I am on my way to mastering a mystical state of mind.

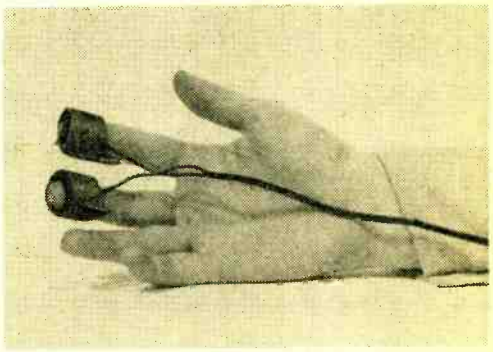
Heart Rhythm. Another way I found to use the Biofeedback Trainer for meditation was to count my heartbeats. With the electrodes attached to my wrists and the trainer's sensitivity reduced to eliminate other impulses generated by my body, I could clearly discern the rhythm of my heartbeats, which varied in both rate of frequency and magnitude depending on my thoughts, concentration and physical activity.

Though I have just begun to scratch the surface as far as understanding the silent messages of my body, scientists and laymen much more knowledgeable than I are already applying the meaning of those tiny electrical impules towards a better life. The EEG (electroencephalogram) recorder commonly used by medical researchers is simply a hard copy, or written record, of the brain waves, more often than not used to discover or determine unusual brain activity or abnormalities. On the other side of the coin, investigators are looking into conscious production of alpha and theta waves as a substitute for tranquilizer pills, so that anxieties can be relieved without medication—or pill popping.

In The End. The Biofeedback Trainer is not a cure for anything, neither is it a *gimmick*; I found it was an opening to a better understanding of those silent messages which reflect *me*—what I am and what I can be. Edmund will send you more information about their Biofeedback Trainer if you are interested. You can get it by circling No. 55 on the Reader Service Page. ■



Use wrist electrodes for monitoring heartbeat. Velcro-type bands permit a tight fit and good contact between skin and electrode



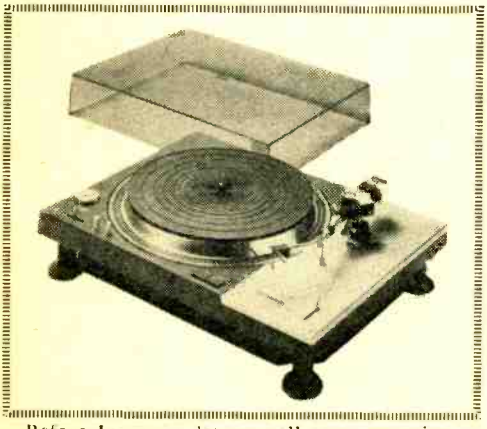
Fingertip electrodes are used for measuring GSR—galvanic skin reaction. When skin reacts, tones from the speaker increase pitch

HEY HERB

THE AUDIO ANSWER MAN

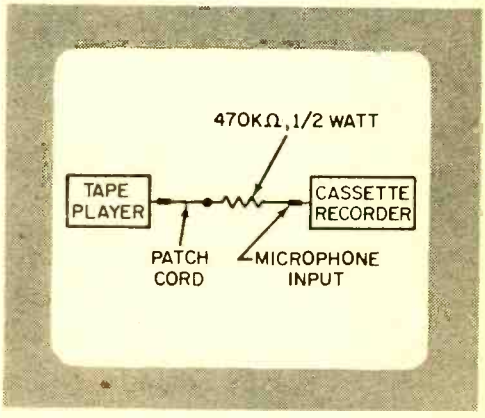
by Herb Friedman

Hey Herb: Some fantastic claims are being made for direct drive turntables such as the Panasonic SL-1100. Do they really deliver higher performance in comparison to models with belts and pulleys?



Before I answer, let me call your attention to the fact that modern turntables such as those from AR, Garrard, Dual, Thorens, etc., are of the highest quality, delivering a level of perperformance thought to be impossible just a few years ago. The fact is it will take tremendous engineering advances to improve the wow and flutter from these units as they normally run about 0.1% or, less. Now, the direct-drive turntables I've seen are at best a smidgen better when it comes to wow and flutter. Their big plus feature is the DC motor which of course produces considerably less rumble than even a multi-pole AC motor. However, I must say that the motor rumble from the better turntables with AC motors is generally so low as to cause no problem. Of course, without the AC motor, the direct drive turntables cannot induce hum into a pickup which might be hum sensitive (which are few and far between, anyway). What is left for the direct drive system is excellent speed regulation because the DC comes from a voltage regulator. The direct drive motor speed holds rocksteady over an extreme range of line voltages. Though line voltage regulation is not a problem in the U.S., there are areas where the power line tends to wander 15 to 20 volts within a few minutes, and it is in this circumstance that the direct drive pays big dividends. Also, direct drive is generally used in top-of-the-line equipment, so you're starting out with some high performance before you ever get to the motor. Since direct drive has the makings of another hi-fi fad, you'll most likely see many of the larger manufacturers offering this feature later this year.

Hey Herb: I've tried just about everything but I cannot dub from another recorder to my cassette. Why does every dub come out distorted even though microphone recordings are clean?



This is a common problem when trying to dub on an inexpensive cassette recorder that is equipped only with a microphone input. Usually, you feed the mike input from another recorder's "monitor" output, which is really the speaker terminals. The speaker's signal level is simply too high for the mike input and overloads the mike preamp which is ahead of the volume level control. Generally, you can get sufficient attenuation of the input signal by installing a 470,000 ohm resistor in series with the patch cord, as shown in the drawing above. If the signal level is still too high, just increase the resistor to 1 megohm. A simple note—insert the resistor into the center lead of the shielded lead. Do not add the resistor to the braided shield.

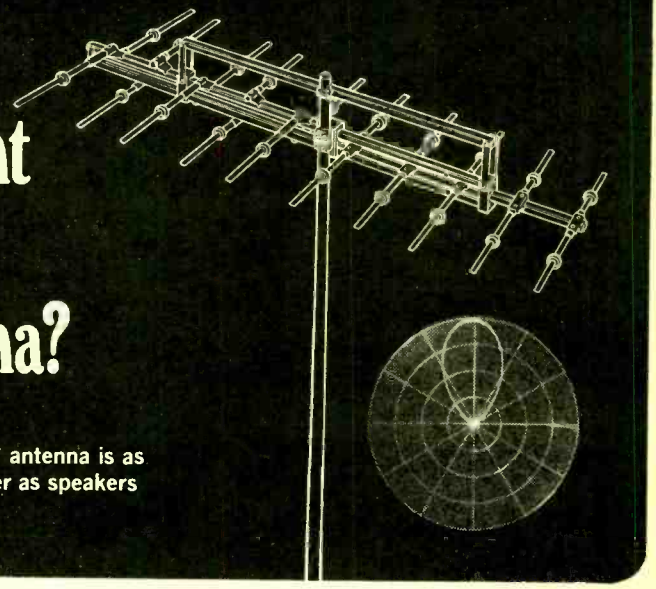
Hey Herb: I have a Sony battery powered cassette recorder that produces static on the recordings. I've checked the motor and the problem isn't from brushes. Any ideas?

(Continued on page 96)

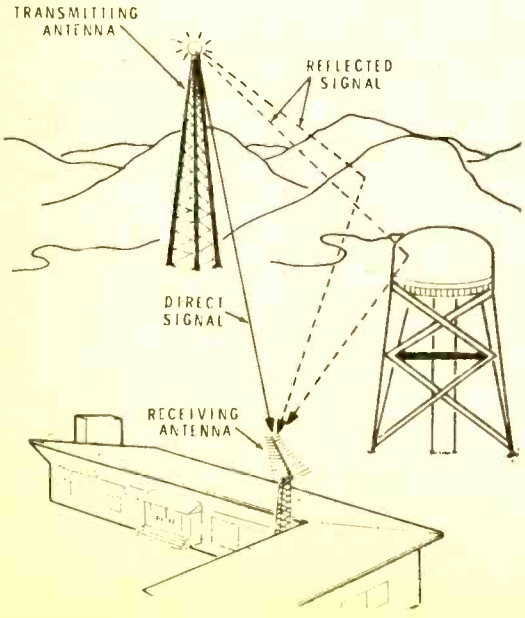
How Important Is An FM Antenna?

by Alexander N. Retsoff

Believe it or not—your FM antenna is as important to your FM tuner as speakers are to an amplifier!



You wouldn't buy a Lincoln Contintal and have a Pinto engine installed. You wouldn't power your cabin cruiser with a 5-Hp outboard. But many a hi-fi enthusiast tries to get by on the T-shaped twin-lead folded dipole than comes part and parcel with almost every FM turner and receiver. Why spend money on a good tuner and cheat on the antenna? There's practically no locale in which you can get even close to optimum performance from your set without an outside antenna. Here's why.



Urban Reception. Let's take the city first. Many of us rationalize using the twin-lead dipole in the city on the basis that we don't need antenna "gain." Signal levels are strong near the transmitter, so why both with a multi-element rig on the roof? True enough. Signal levels are high in the city *but* they're being bounced at you from all directions.

You've probably heard of *multipath*. Some of the new high-priced tuners are coming with built-in *multipath indicators*. What it means is this: A direct signal is beamed at you from the transmitter. This is the signal you want to pick up and feed to your tuner. But, although radio waves in the FM band travel pretty much in straight lines, they do reflect very well off buildings, water tanks, etc. So, in addition to the direct signal, your antenna may be picking up reflected signals. Since these latter have traveled a longer distance, they arrive a little late. On television you see them as "ghosts." In FM, these late and out-of-phase signals cause partial cancellations at different frequencies. If the reflected signals approach the strength of the direct one—and this is very likely in urban

FM band multipath refers to a condition where multiple signal paths exist between a transmitting and receiving antenna. Reflected signals arrive at the receiving antenna later than the main, or direct, signal and can cause audio distortion. In TV, multipath results in "ghosts."

NRI's "discovery" method is the result of over half a century of leadership simplifying and dramatizing training at home

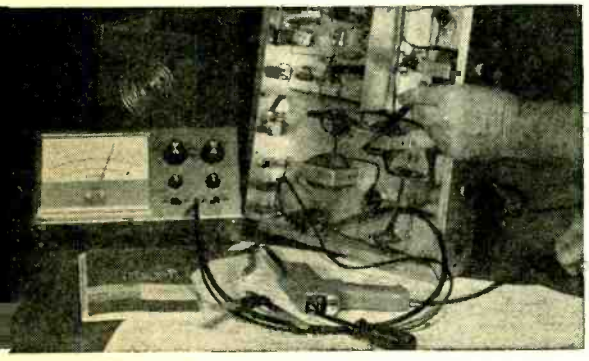
The FIRSTS described below are typical of NRI's ha[illegible]ry of leadership in Electronics home training. When you enroll as an NRI student, you ca[illegible]sure of gaining the in-demand technical knowledge and the priceless confidence of "hands-[illegible]perience sought by employers in Communications, Television-Radio Servicing and Ind[illegible]al and Military Electronics. Everything about NRI training is designed for your education . . . from [illegible] much-copied, educator-acclaimed Achievement Kit sent the day you enroll, to "bite-size" well-illustrated, easy to read texts programmed with designed-for-learning training equipment.

YOU GET YOUR FCC LICENSE OR YOUR MONEY BACK

There is no end of opportunity for the trained man in Electronics. You can earn $6 or more an hour in spare time, have a business of your own or qualify quickly for career positions in business, industry, government. And if you enroll for any of five NRI courses in Communications, NRI prepares you for your FCC License exams. *You must pass* or NRI refunds your tuition in full. No school offers a more liberal money-back agreement. The full story about NRI leadership in Electronics training is in the new NRI Catalog. Mail postage-free card today. No salesman is going to call.
NATIONAL RADIO INSTITUTE, Washington, D.C. 20016

APPROVED UNDER NEW GI BILL If you have served since January 31, 1955, or are in service, check GI line on postage-free card.

designed from chassis up for your education

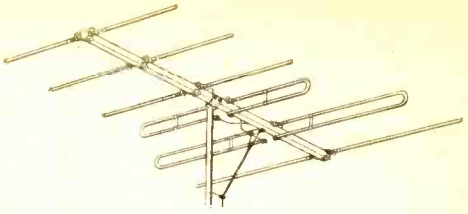


first to give you true-to-life experiences as a communications technician. Every fascinating step you take in NRI Communications training, including circuit analysis of your own 25-watt, phone/cw transmitter, is engineered to help you prove theory and later apply it on the job. Studio equipment operation and troubleshooting become a matter of easily remembered logic.

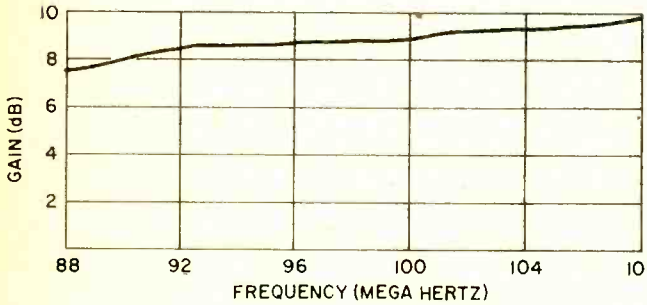
first to give you completely specialized training kits engineered for business, industrial and military Electronics. Shown above is your own training center in solid state motor control and analog computer servo-mechanisms. Telemetering circuits, solid-state multi-vibrators, and problem-solving digital computer circuits are also included in your course.

areas—distortion and loss of stereo separation result. Your tuner's front-end can't reject them because they are on the same frequency as the desired signal. They're just a little late. A tuner with a good capture ratio, say 1.5 dB, and good AM rejection will be less susceptible to multipath than a poor one. Nevertheless, all tuners are susceptible to multipath probems in one degree or another.

No Other Way! Your solution is to install a highly directional antenna that will accentuate the direct signal and attenuate those coming from different directions. The twin-lead dipole which the manufacturer so carefully included is equally sensitive front and back, with pretty broad "lobes." It rejects only those signals approaching it from its *ends*. It's simply not capable of coping with a multipath problem.



Yagi type antenna has two driven elements, one reflector and three director elements. Standard 300-ohm TV-type lead-in is used.



Graph illustrates an important antenna characteristic: flat response for entire FM band. Slight tilt to more gain at higher frequencies helps to overcome increasing loss due to transmission line length. A second important antenna characteristic is directivity: the ability of an antenna to "see" signals from one angle, or direction, only. See text.

Now if all the stations you're interested in listening to are transmitted from the same place, you're all set. Just have the directional antenna installed pointing towards the transmitter to maximize the direct signal and minimize the reflections. If different stations originate from different directions, you should have a rotor installed so you can turn your antenna towards the desired station from the conveniences of your living room.

You Always Can't Win. The above solution is ideal. But what if you live in an apartment complex that forbids individual installations on the roof and provides a master TV antenna? Unfortunately these are seldom optimized for good FM reception. Although the FM band is sandwiched in between channels 6 and 7, most TV antennas are designed to reject this region in favor of the TV bands 2-6 and 7-13. Some master antenna systems have an FM antenna as well to supplement the TV one, but all too frequently it is omnidirectional—hardly apropos in a multipath situation. Whereas all TV stations in a city tend to broadcast from a single location, FM stations are scattered around. To provide the greatest number of FM stations regardless of their quality, an omni antenna gets put up. It's just impractical to have directional antennas for everyone's favorite station.

Fringe-Area Reception. Out in the country, multipath problems tend to be less severe. There are few large structures around to reflect signals but the signals themselves are weak. Every time you double the distance from you to the transmitter, the signal level drops 6 dB. Here's where you need the multi-element directional antenna for the *gain* it provides.

The gain of an antenna is defined relative to that of a simple dipole. That is, a dipole has no gain (0 dB). Putting a *reflector* in back of it can provide up to 3 dB of gain; that is, the voltage produced by the antenna from a given radio wave is about 40 percent greater with the reflector than without. Such an antenna also rejects signals coming from the rear and so has improved directional characteristics. Adding *directors* in front of the dipole further increases the gain and sharpens the directional pattern in the front.

A well-designed six-element antenna can provide almost 9 dB of gain and effectively

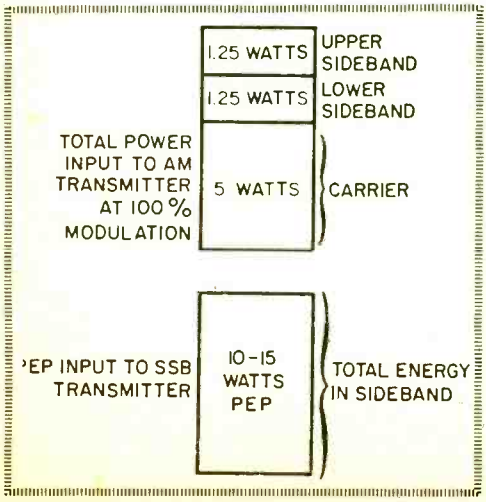
(Continued on page 102)

SSB "That's a big 10-4"

Choose a speciality rig like this Raytheon marine unit or any one of nearly two dozen others

by Herb Friedman

NOT TOO LONG ago a wit claimed that if the communicators on the NASA moon shots were upgraded, they might sound almost as good as a CB rig. Our friend really wasn't being facetious, for much in the way of modern communications technology can be traced directly to the Citizens Radio Service.



When CB first broke on the scene with its surplus-parts superregenerative receivers and carbon-miked transmitters there was virtually no high-performance communications gear available at consumer prices. What little Amateur Radio equipment could really be termed high-performance had a price tag to match. It was CB that first brought super-sensitive and superselective receivers down below $100. It was CB that first employed the inexpensive mechanical filter in consumer equipment; CB that featured all electronic switching; CB that put double-conversion in budget equipment, CB that made the speech compressor almost universal; CB that led in crystal synthesis; CB that. . . . Well, you get the picture. In short, CB is the leader in communications equipment.

And it is precisely because CB equipment is so effective that many operators fail to realize the almost quantum jump in communications effectiveness that is obtained

SSB packs all its energy into one sideband and one is all it takes for communication.

e/e SSB

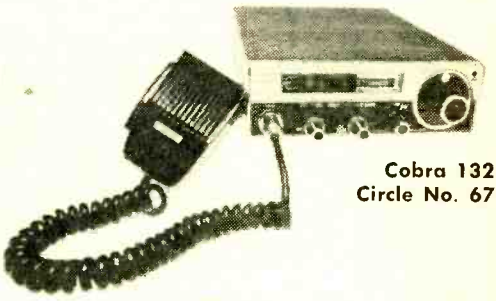
from Single-Sideband transmission—on SSB as it is more commonly termed. Compared to SSB, that old reliable AM rig is back in the dark ages, for SSB equipment can double or triple your working range, and do it legal ly without a booster amplifier. Putting it another way, switching to SSB—if there were no other considerations—is like adding a supergain antenna to your present AM rig.

How It Happens. SSB's power gain comes about as follows. In the typical AM (amplitude modulated) transceiver, the transmitter section takes 5-watts power input to the RF final amplifier just to produce a carrier *wave* which has the capacity to carry intelligence *if* audio frequencies are impressed on the carrier; otherwise, the carrier serves no really useful purpose. During 100 percent modulation, the modulation amplifier impresses 2.5 watts of audio on the carrier, producing radio frequency sidebands on both sides of the carrier. If the modulation frequency is 1000 Hz, sideband frequencies —called the upper and lower sidebands— will appear 1000 Hz above and below the carrier frequency. Since there were only 2.5 watts of modulation to start with, each sideband represents exactly 1.25 watts of intelligence-carrying audio.

Now a receiver needs only the power in one sideband (1.25 watts in our example) to produce an intelligible output. The remaining sideband isn't needed, nor is the carrier which just goes along for the ride. But, because the receiver needs a carrier for converting the radio frequency sideband(s) back to audio, the carrier can be generated by a local, or injection, oscillator built right into the receiver; the receiver doesn't care where the carrier signal comes from just as long as there's a carrier from someplace. So, effectively, the only part of

SSB FOR HIGHWAY

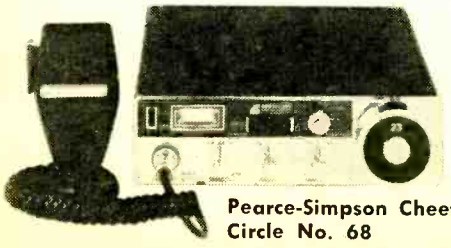
SBE Sidebander II
Circle No. 70



Cobra 132
Circle No. 67

Lafayette SSB-50
Circle No. 69

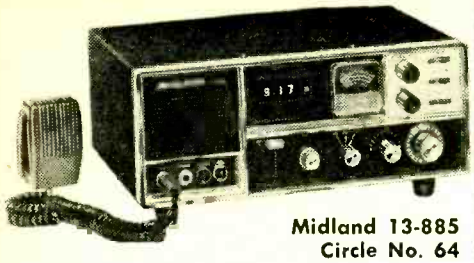
Pace Sidetalk 23
Circle No. 66



Pearce-Simpson Cheeta
Circle No. 68

Courier Gladiator
Circle No. 65

SSB BASE

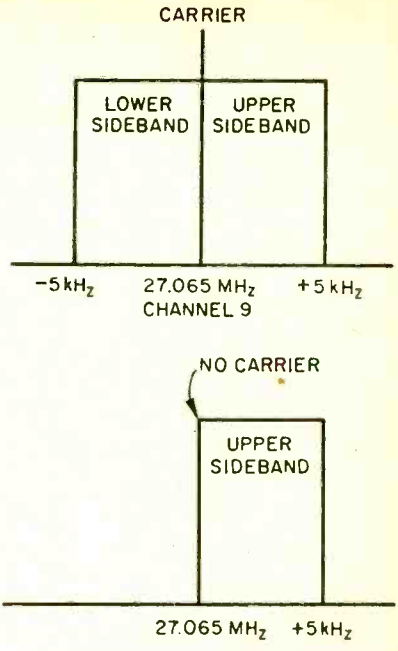


Midland 13-885
Circle No. 64

Cobra 135
Circle No. 67

SBE Super Console w/VHF Scanner
Circle No. 70

Base stations shown here and on the next page all run 15 watts PEP—the maximum permitted. These full feature rigs all include 5-watt AM modes as well as SSB.



Note how only one (could be either upper or lower) of the two sidebands is used in SSB. That results in double the channel space.

the total AM signal that we need, to carry intelligence, is one sideband.

But it takes 7.5 watts total power input—5 watts carrier and 2.5 watts of modulation—just to get 1.25 watts to the receiver. Surely there's a more efficient way to do things? There is, and it's what we call single sideband transmission.

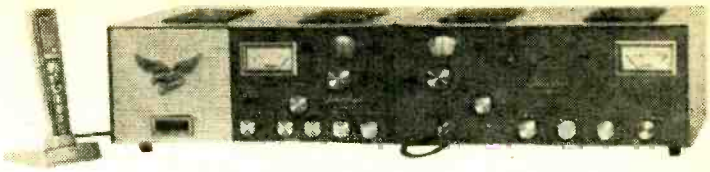
Since we don't need one sideband, let's eliminate the power used to generate it, that's 1.25 watts. Since we don't need the carrier let's get rid of it too, we can always reinsert the carrier in the receiver with a local oscillator. Well that's 5 watts power input saved. In all, we can take the unneeded 6.25 watts and put it in the single intelligence carrying sideband. Increasing the sideband power from 1.25 to 7.5 watts is a direct power gain of 7.8 dB, essentially 8 dB for all practical purposes.

Power Up. Now just imagine what it would take to increase the power output from your AM rig by 8 dB—a mighty big antenna with all the hardware that goes with it!

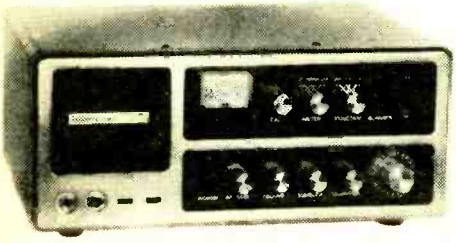
What's that you ask? How can a 15 watt SSB rig be legal? Simple. Just don't be confused by SSB PEP rating, meaning *peak envelope power*. Since an SSB has no power output when there is no modulation, the power input to the RF final amplifier cannot be measured in terms of *average input power*—current times voltage. SSB requires a different type of power intput measurement, something called peak envelope power (PEP), and depending on the equipment and measurement conditions, the PEP equivalent of 5 watts AM power input is 10 to 15 watts PEP—all very legal.

While it's pleasant to think of getting an extra 8 dB of power output legally, that missing carrier does a lot more towards getting your signal out where it's needed.

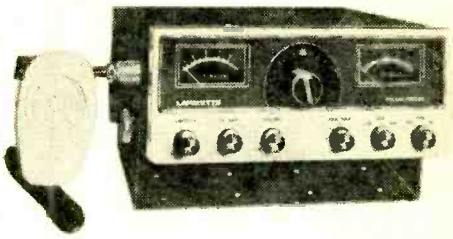
e/e SSB



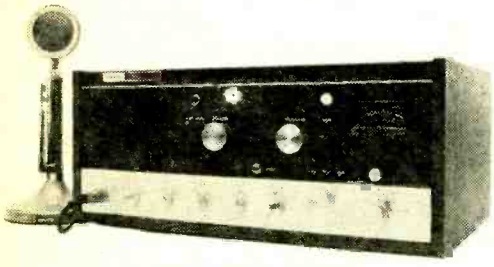
Browning Golden Eagle
Circle No. 61



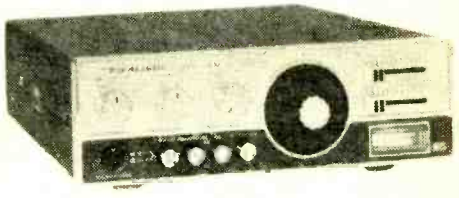
Teaberry Twin T
Circle No. 37



Lafayette SSB-25A
Circle No. 69



Tram Titan IV
Circle No. 38



Radio Shack TRC-46
Circle No. 63

If you recall the last time you tried to push a signal through the QRM on a busy channel, you remember that it wasn't the modulation from the many stations using the channel that caused the most interference, rather, it was the heterodyne whistles from all the carriers that chopped up the transmissions. But SSB has no transmitted carrier, so there can be no continuous heterodynes to cause whistles and squeals. Now a while back we said that only one sideband is needed for SSB transmission. But each channel is 10 kHz wide, wide enough for two sidebands, and since there's no carrier to produce heterodyne interference, it's possible for two stations to share a single channel at the same time, one using the upper sideband and the other the lower sideband. Instead of 23 channels there are now 46 SSB channels. If you're working, say, channel 14 and your signal is interfered with, you can easily shift to the lower sideband at the flick of a switch.

What You Have. So now you have two direct, personal benefits from SSB: 8 dB more effective output power and sharply reduced interference possibility.

Finally, we must take into account the advantages of SSB reception. Because the radio frequency sideband is converted back to an audio output at the receiver with the aid of a local oscillator, there is less noise interference to the signal, and the received signal strength need only be 60 percent (or less) of an AM signal for the same percentage of intelligence extraction. In nontechnical terms, it means that if the minimum signal strength a receiver needs for AM reception is 1 μV, a 0.6 μV. SSB signal will produce the same degree of signal read-

ability. That's another 4.4 dB gain in performance, a big boost when your signal is coming in just over the noise level.

Another big plus for SSB is equipment reliability. Because SSB requires precise alignment and frequency control, all SSB rigs are high-performance models. Differences between the various SSB transceiver models are more a question of operating features than reliability, for SSB is synonymous with reliability.

Added Circuits. As you have probably surmised, SSB equipment has a lot more circuitry than the best of AM transceivers, and it is natural to expect an SSB transceiver to have some unusual front panel controls which are not found on the typical AM models. But just because there are a few extra controls is no reason to assume that SSB operation is any more difficult than ordinary push-to-talk AM. The best way you can see for yourself that there's no hassle to SSB is to go over all the controls on a typical SSB transceiver.

First off, all SSB transceivers have the three standard controls: Channel Selector, Volume and Squelch. On some feature-packed base station models you might find a transmit channel selector and separate receive tuning control, this isn't really unusual because some feature-packed AM transceivers also have two channel selectors or tuning controls.

Heading the list of different controls—different in the sense they are not usually found on AM transceivers—is the sideband selector, generally a three position switch that selects SSB operation on the upper or lower sideband, or compatible AM. Compatible in the sense that you can use SSB equipment to communicate with ordinary stations having only AM transceivers.

Proper Pitch. Another unusual feature is a clarifier or fine tune, or some similar descriptive term that implies precise tuning. If you recall, we said that in SSB the carrier is reinserted by a local oscillator built into the receiver. In order to obtain clean, undistorted reception the injected carrier must be reinserted in precise relationship to the original transmitter carrier. If the injected carrier is ever so slightly off frequency, the voice frequencies become distorted, eventually becoming unintelligible monkey chatter. The clarifier, then, is simply a fine tuning device used to adjust the received signal to the proper carrier relationship. Fact is, it is no different in results from the fine tuning or Delta tune found on more expensive AM transceivers.

In some SSB models the clarifier only affects the receiver tuning, in other models the clarifier works on both the transmitter and receiver tuning. Either way, the end result is optimum received sound quality.

An RF gain is another control common to SSB equipment, though again, it is used on full-feature AM transceivers. For several technical reasons it is unnecessary to go into at this time, it is often easier to tone-down a strong SSB signal by adjusting the RF gain rather than the audio volume control, hence, the RF gain control is provided on most SSB transceivers.

Full Feature. The sideband/AM selector, clarifier and RF gain control are the only controls which differ from those on the typical AM transceiver. But because all SSB transceivers are high performance models, you'll find a host of other features rarely found together on AM equipment. For example, a noise blanker is often provided in addition to a standard noise limiter. The blanker is particularly effective against sharp impulse noise because it literally punches a hole in the received signal corresponding to the noise pulse; and if there's a *hole* there's no pulse of noise. Another goodie common to most SSB equipment is a built in SWR meter, often combined with a calibrated output meter, the usual S-meter and a modulation meter. Often, to provide maximum operating convenience there is a separate combination RF output S/Modulation meter in addition to the SWR meter.

In addition to the specialized operating features common to high-performance equip ment, the SSB transceivers might also be provided with the usual niceties such as PA (public address) and remote speaker outputs, headphone jacks, combination AC/DC power supplies (in universal models) and plug-in microphones. A base station might even contain a built-in VHF Scanner for the public service bands, or even a Channel 9 Monitor.

The list of covenience features to be found in SSB equipment in almost endless, because just about every new and useful idea is immediately incorporated into the best equipment, and for CB single-sideband is best.

Summing Up. Maximum convenience, maximum operating range, and maximum performance; they all come together in an SSB transceiver. So if you want the best and most reliable in CB communications, then you're ready to move up to SSB. ■

Four Ways To 4-Channel

◀ Wollensak's 8060 cartridge deck will record and play back conventional 2-channel stereo, record matrixed/stereo FM broadcasts and play them back either in stereo or 4-channel with some channel separation, record and play back matrixed discs, and play pre-recorded discrete 4-channel tapes. The 8060 is $199.95.
Circle No. 44 on the Reader Service Page.

◀ The Teledyne Olson RA-660 receiver features a 4-channel amplifier for discrete quadraphonic sound from tapes, and a universal decoder for matrixed or synthesized 4-channel sound from broadcasts, records and tapes. A joystick permits simultaneous balancing of all four channels. The RA-660 is priced at $189.50.
Circle No. 45 on the Reader Service Page.

◀ From Sony, the SQD-2050 quadraphonic decoder is all that's required, along with a pair of extra speaker systems, to turn a stereo system into a universal 4-channel music system. There are pushbuttons for SQ decoding, regular matrix decoding, 4-channel enhancement of 2-channel sources, and discrete four-channel tape inputs; $99.50.
Circle No. 46 on the Reader Service Page.

◀ The Grandhaven, model SE-4340, by Panasonic can play any kind of music currently available, including discrete 4-channel records (by adding the SE-405 demodulator). The SE-4340 has a 9-inch changer, 2- and 4-channel 8-track cartridge player, AM/FM-stereo radio, and four air-suspension speaker systems. The Grandhaven is $329.95.
Circle No. 47 on the Reader Service Page.

e/e checks out a...

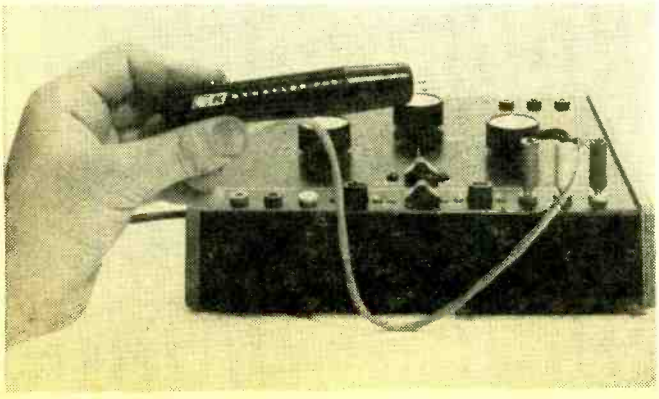
B&K 501A Semiconductor Curve Tracer

There are many inexpensive ways to check semiconductor devices such as transistors and diodes on a good-bad basis; even your ordinary bench VOM can be used, and with a few simple calculations the DC gain of most transistors can be interpolated from VOM readings.

But what do you do when a transistor's characteristics must be precisely matched for proper operation—say when half of a complimentary amplifier stage blows-out, or when you can't be certain of the avalanche voltage of an unmarked or unreferenced Zener diode? And how would you match ordinary detector diodes for a high-performance FM detector? If you're a laboratory technician, you do these things with a transistor curve tracer costing several thousand dollars. If you're a service technician or hobbyist, you simply plug in a B & K 501A Curve Tracer to your 'scope and instantly observe a *family of curves* for transistors, or avalanche curves for diodes.

Need to match transistors? Just install the desired, or reference, transistor in one socket and your replacement in the other. Then simply switch back and forth until a replacement transistor matches the curve of the reference transistor. Same goes for signal diodes and Zeners. Fact is, when connected to your bench 'scope, the 501A becomes a laboratory instrument, but at a technician's cost of $129.50.

How? The 501A tests semiconductors by



This auxiliary device turns your oscilloscope into a full fledged dynamic testing device for solid-state components. And this special plug checks semi-conductors in-circuit without removal. A valuable A-B switch lets you check two semiconductors alternately. For more info—Circle No. 42 on page 17 or 103

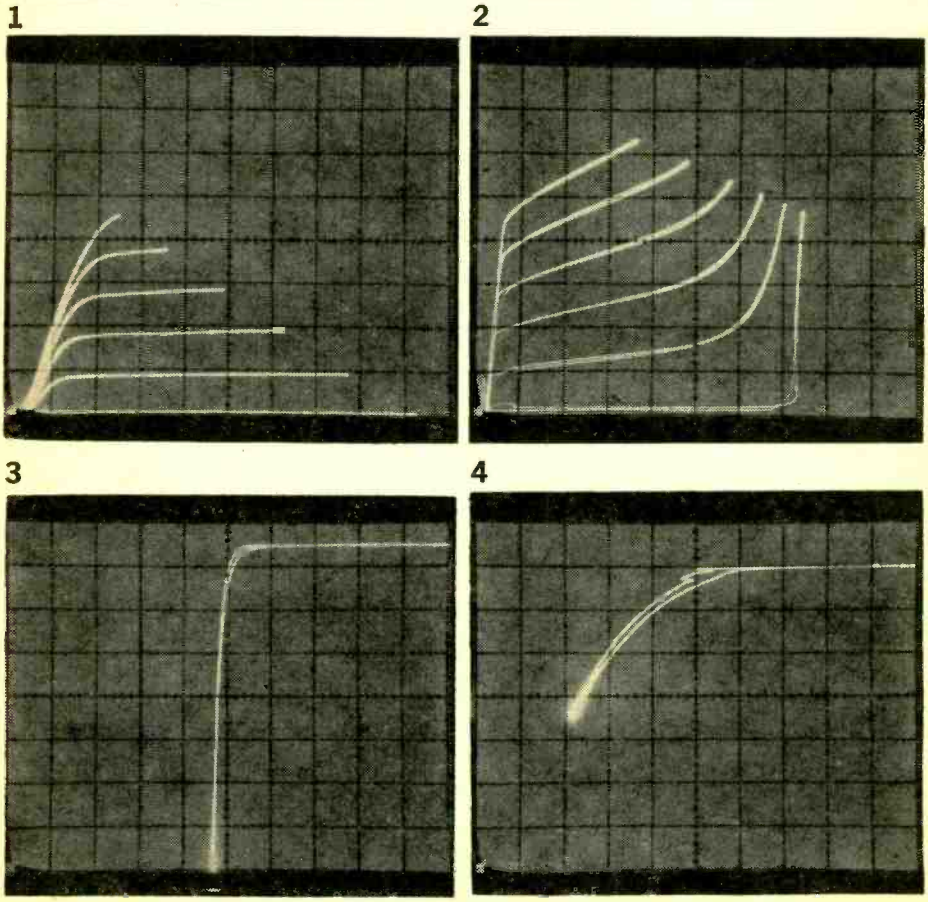
making them work just as they would in a circuit at currents up to 100 mA. It indicates instantly if the device being tested is good, leaky, shorted, open, or off specs.

For routine tests, the curve tracer is equipped with matched pairs of slip-in sockets and banana jacks for test leads. A selector switch determines which of the socket/lead combinations is being tested. By switching from one socket to the other, the 'scope can display each device alternately for balance or matching.

One really outstanding feature is that it isn't necessary to remove a semiconductor from equipment when checking suspected components. The 501A is supplied with a test tube probe, having three swiveled, spring-loaded, sharp points, which plugs into the curve tracer. The points can be oriented to dig into printed circuit solder connections, so the tested device can be checked in-circuit. Unlike other so-called in-circuit testers that check on a go/no-go basis, the 501A actually checks the in-circuit device under dynamic operating conditions.

Basically, the 501A applies a sweep voltage to a transistor collector (up to 100 V at 100 mA) and a staircase current to the base at from 1 *u*A to 2 mA per step. This results in the 'scope displaying a family of curves, one curve for each step of the

(Continued on page 102)



Shown in Figure 1, a family of curves traced by the "501" of a good variety pack transistor. Figure 2 shows another 10-for-a-$ transistor breaking down at about 35 volts. One good (Fig. 3) and a bad Zener diode (Fig. 4) are shown from the same 15-for-69¢ lot. (Six were good 9 were duds)

by Kathi Martin KAI0614

KATHI'S CB CAROUSEL

SOMETIMES things get so dull around here I could just cry. (Women's Lib or not I've still got the right to cry from sheer boredom.) If some new transceiver comes in loaded front panel-to-antenna jack with all new features, I could give 100 to 1 odds I'll get five more just like it before the week is out.

Well, there I was, day after day, staring at a stack of transceivers with absolutely no inclination to turn one on, when through the rain, sleet and snow came our intrepid mailman, carrying a couple of the cutest gadgets seen in these parts since Big Julie painted my mike in Day-Glow colors.

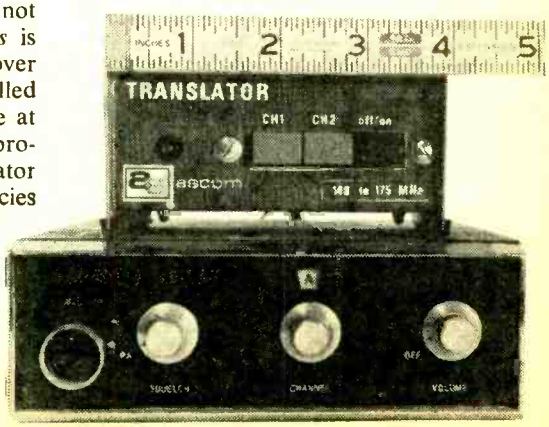
Talk about ideas whose time has come. Here we've been buried under mountains of reader mail complaining about the prices of public service scanner receivers when all the user needs is one or two frequencies, and *voila*—as the office magician would say—Antenna Specialists came up with Lo and Hi band 2-channel *translators*, at an almost ridiculous price of $39.95 each.

Low Cost 'n Little. Here is a package not much larger than a pack of *coffin nails* is the solution for the CB'er who needs to cover just one or two channels on the so-called police bands. Now how can this be done at a $39.95 price? It's easy, your CB rig provides most of the electronics. The translator just beats the public service frequencies down to channel 9 (27.065 MHz) and your CB transceiver provides the IF amplification, detection and audio output.

"Aha!", you think. "Old Kathy finally made a boo-boo; the public service stations are narrow-band FM while the CB rigs are AM—so how can we hear an FM signal on channel 9?"

Aha, yourself. We can tune in FM by using *slope* detection, and before I confuse you any further let me go back to the very beginning and explain how the Antenna Specialists' translator system works.

Both the model MON-40 LO Band (30-50 MHz) and model MON-41 HI BAND (148-174 MHz) translators are basically three transistor converters. One transistor (a dual gate MOSFET) is the RF amplifier, one transistor is the mixer and the remaining transistor is a crystal controlled oscillator. Two plug-in sockets are provided for the crystals, each socket (crystal) being selected by a front panel switch. The crystal frequencies are selected so that the public serv-



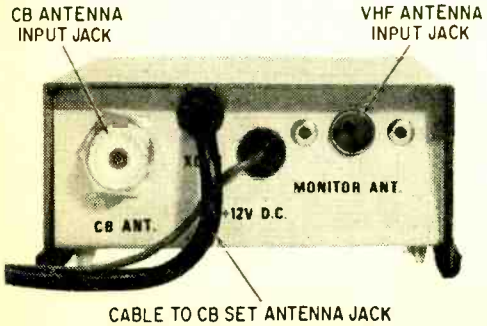
Sitting pretty on top of the mini-rig it feeds, an Ascom VHF to CB channel 9 translator by Antenna Specialists sends two Action Band VHF frequencies to any Citizens Band transceiver. For more information read on, then Circle No. 39 on pages 17 or 103.

ice stations are beat down to 27.065 MHz. The output of the mixer transistor now contains a channel 9 representation of the public service station, carrying the FM modulation. The translator output is fed into your CB receiver, and as far as the receiver is concerned, it's just another channel 9 signal—but the modulation is FM. If the signal center (carrier) frequency is very slightly shifted so it appears on the slope of the IF curve, the FM modulation produces a voltage output representing the modulation; hence, your AM rig is "slope" detecting FM modulation.

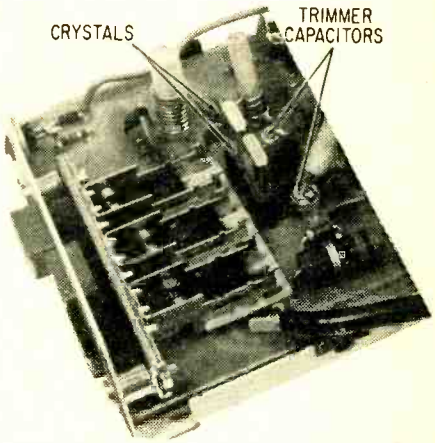
The Secret! Since there is no way for a crystal controlled CB rig to have the IF center frequency easily tuned, Antenna Specialists has provided the tuning inside the translator. Actually, it's just a small trimmer capacitor (one for each crystal) in the crystal oscillator circuit.

When the trimmer is adjusted by the user, the crystal's resonant frequency is changed by an almost insignificant amount, not enough to lose the station, but just enough to pull the translator output frequency down the IF selectivity slope, so the audio comes out of the speaker clean and undistorted. (The trimmer for each crystal must be specifically adjusted by the user at the time of installation for the particular CB rig used with the translator.)

A really top feature of the Antenna Specialists translators is the automatic antenna switching. On the rear apron you'll find an auto radio type antenna jack for use with a Lo or Hi band antenna, a standard coaxial socket for connecting the CB antenna, and an output cable with a standard coaxial connector. On the front panel are three switches: *CH1, CH2* and on-off, with a pilot lamp to indicate the unit is on. When the translator power switch is *off* the CB antenna is connected directly through to the CB transceiver. When the power switch is *on* it provides power to the translator and connects the translator output to the CB transceiver—disconnecting the regular CB antenna.



Easy hook-up to any rig with its completely automatic operation. Use CB set normally or switch on the translator for VHF reception.



Set-and-forget cap trims translator crystal to your CB set for solid copy Action Band slope detection of Hi and Lo VHF FM calls.

To Power Up. The translator requires 12 volts positive; it's attached power lead can be spliced into the same power supply wire feeding the CB transceiver. If you're using a DC transceiver with an AC power pack for the base station, you can splice the translator power wire into the power supply cable running to the transceiver. The negative power supply connection is through the translator cabinet; actually it can be secured through the shield of the coaxial connecting cable. For mobile use, the translator is supplied with two miniature mounting brackets which also provide a negative battery connection to the auto's body.

Surprising Performance. Naturally, when one considers add-on equipment so nominal in cost, there's not much in the way of performance expectations. Surprisingly, the Antenna Specialists translators deliver very good results; in fact, I would say that when used with even a moderate-priced CB rig, the public service reception very closely approximates that of VHF receivers in the

Continued on page 104)

A Designer's ±15V POWER SUPPLY

Read about new standards you build into a simple lab-grade supply

by Herb Friedman

WITH VERY FEW EXCEPTIONS, equipment and projects using operational amplifiers require a bipolar power supply, that is, a power source with both positive and negative voltage outputs in relation to ground. While it is generally possible to power an opamp from a single-ended power source, this technique requires a lot of extra hardware and filtering, and more often than not causes more problems than it's worth. The best way to power an opamp or a project using an opamp is with a dual tracking bipolar supply. Now, thanks to the latest in IC technology you can build a ±15V dual tracking supply for well under $20.

It's Short Proof. The bipolar supply shown in the photographs puts out up to 100 mA with full overload protection; in the event of a short circuit, the supply automatically shuts down before it's damaged. The really big plus in operation is *dual tracking*, which requires an explanation. The usual way to obtain a dual voltage output is shown in Fig. 1; a center-tapped transformer, bridge rectifier and Zener diode regulators do a mighty fine job in non-critical circuits. This circuit is usually used for audio preamplifiers. However, suppose you power not only an opamp but a relay amplifier connected across half the output; the opamp might pull 10 mA while the relay amp pulls 60 mA from one half the supply. This will usually cause a voltage drop on one half of the supply. If the opamp is in a critical circuit, the voltage unbalance between each side of the supply can cause improper circuit operation. Further, internal power supply heating can change the characteristics of the Zener

diodes, again causing voltage mismatch.

A dual tracking supply, on the other hand, does just what it says, tracking one side against the other. Any voltage change on one side of the circuit automatically corrects the voltage on the other side to match. Heating effects are also compensated for on the opposite side, so that regardless of load current, ambient heat or whatever, the voltages on both sides of the supply track together. In the model shown the worst-case mismatch is 0.15 volts (150 milivolts). If one side is −15.00 volts, the other side can be, worst-case, +15.15 volts.

Two more big pluses for the bipolar supply are voltage regulation and extra, electronic filtering. Within the power line range of 100 to 135 volts, the bipolar supply output will not vary more than 0.004 volt (typical), nor will current output changes from zero to full load (100 mA) cause more than a 0.005 volt typical variation. There is better than 120 dB filtering, with the ripple components less than 20 μV.

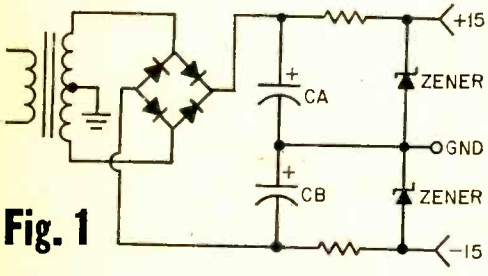


Fig. 1

Simple Zener-regulated shunt-type supply lacks regulation, tracking ability and stability necessary for precision use.

Smaller Caps. In short, this is an ideal supply for the lab and experimenter as it eliminates any worry about the power supply; you can spend your time checking and developing the circuit rather than fussing with power supply regulation and filtering. Actually, the circuit is not much more expensive than a cheap diode-type supply because it doesn't require brute-force filter capacitors which often cost more than an integrated circuit regulator.

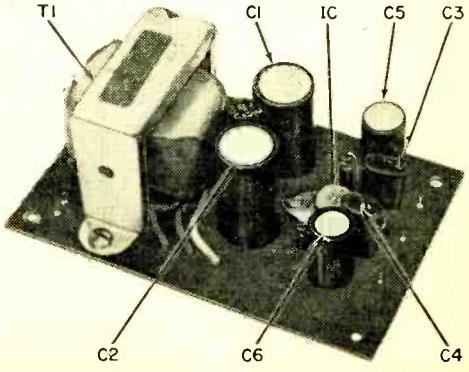
The heart of the bipolar supply is IC1, a complete integrated regulator that replaces 21 transistors, 7 Zener diodes and 11 resistors. Until this IC was made available a dual tracking bipolar supply took all these parts. In addition to regulation, IC1 also features current limiting; just two ½ watt resistors protect IC1 against damage if the output current attempts to exceed 100 mA. Though the worst-case regulation is specified as 1 percent, in actual tests on complete supplies the regulation was better than 0.5 percent.

Construction. The entire power supply is built on a 2⅞-in. x 4-in. printed circuit board which can be mounted inside any cabinet along with the equipment it is powering. Alternately, it can be installed in a small cabinet as shown for use as a bench or test supply. The cabinet shown in the photographs is a DeLuxe Metal Utility Cabinet from Radio Shack priced well under $3.

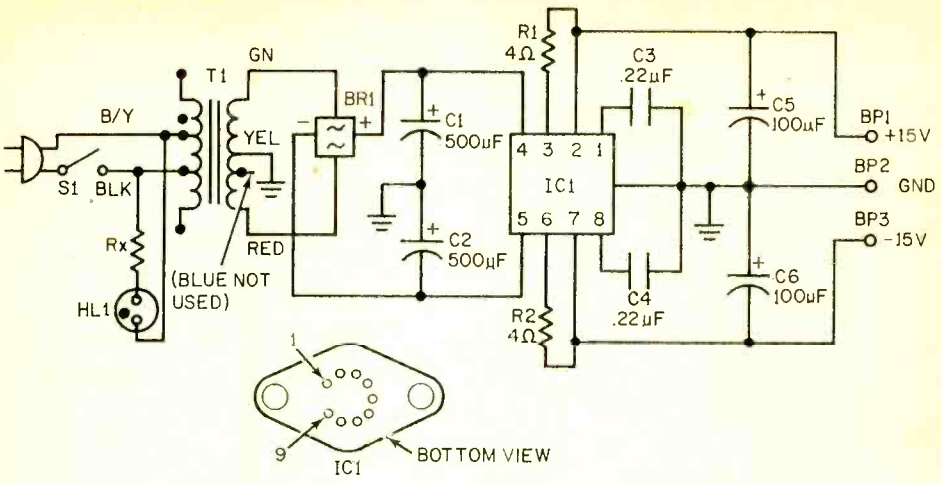
If you use the template available in the parts list to lay out your PC board, we suggest you use the Radio Shack parts specified in the parts list since lead spacing matches the printed circuit board component mounting holes. No components other than IC1, however, are critical and substitutions can be made.

First step is to prepare a printed circuit board. Cut a section of copper-clad board—any type, to size and scrub the copper clean with steel wool or a strong household cleanser such as Comet. Place a piece of carbon paper, carbon side towards the copper, on the board and tape the board under the full-scale template provided and secure the board in position with a few strips of Scotch or masking tape.

Using a sharp pointed tool such as a scribe, indent the copper at each mounting hole by pressing the point of the tool firmly through the template and into the foil. The



The printed circuit board template is available free. Check details at the end of the parts list on the opposit page.



PARTS LIST FOR ±15V BIPOLAR POWER SUPPLY

BP1, BP3—Insulated binding post (any style)
BP2—Grounding binding post (any style)
BR1—Bridge rectifier, 100 PIV, 500 mA or better (Rodio Shock 276-1148 or equiv)
C1, C2—500 uF electrolytic capacitor, 35 VDC or better (Radio Shack 272-1030 or equiv)
C3, C4—0.22 uF mylar capacitor, 50 VDC or better (Radio Shack 272-1070 or equiv)
C5, C6—100 uF electrolytic capacitor, 35 VDC or better (Radio Shack 272-1028 or equiv)
IC1—Integrated circuit regulator, Motorola 1568R
L1—Neon pilot lamp assembly with internal resistor (Radio Shack 272-328 or equiv)
R1, R4—4 or 5 ohms, see text
Rx—Part of NL1 assembly
T1—Low voltage rectifier transformer (Allied Electronics, No. 705-0127. 401 E. 8th Street, Fort Worth TX 76102)

Misc.—Printed circuit materials, cabinet, wire, solder, etc.

For a free full-size drawing of the circuit board used in the project, send a Self Addressed Stamped Envelope to Elementary Electronics, Template Offer, 229 Park Avenue South, New York, NY 10003.

indents will provide the markings for the component mounting holes. Using a ball point pen and a lot of pressure, trace the foil outlines on the template. Remove the copper-clad board from under the template and using a resist ink pen trace the foil outline on the board; then fill in the areas with resist. No foil should be less than 1/16-in. thick as undercutting by the etchant will produce a slightly thinner foil.

Pour enough etchant into a container slightly larger than the PC board so there's at least ¼-in. depth. Then float the PC board on top of the etchant with the copper side down into the etchant. Every few minutes agitate the etchant container to speed up removal of the undesired copper. After all the undesired copper has been removed (about 20 minutes) rinse the board under running water and remove the resist with a small rag soaked with resist remover, resist solvent or acetone.

Holes And Such. All component mounting holes are drilled with a #55, 56 or 57 bit. The board's corner mounting holes should clear a #4 screw; the transformer's and IC1's mounting holes should clear a #6 screw. Do not make the holes larger than needed.

Install bridge rectifier BR1 first, using extra care in orientation. The usual terminal arrangement of the low cost "surplus" bridges available to the experimenter usually have a similar lead arrangement. Note that one terminal is marked +, indicating the positive DC output. Two other terminals are generally marked with a "~" (sine wave) or the letters AC indicating the connections from the power transformer. The fourth lead, the one diagonally opposite from the + lead, is the negative DC output. Make certain your bridge rectifier has this terminal arrangement. If it has any other lead arrangement you must modify the PC board template (if you use it) to correspond to the difference. Install BR1 so that when the leads pass through the board to the foil side the + lead comes through the "plus" hole.

Allow about ¼-in. space between the bottom of BR1 and the PC board and solder the leads to the foil. Then install and solder IC1. IC1 can fit the board both right and

(Continued on page 98)

Let the man from Bell & Howell Schools show you how you can get ready for a bright new career...

...as you build yourself a Bell & Howell solid state color TV!

Bell & Howell Schools can help you build a new career with learn-at-home programs that prepare you for a brighter future in electronics. And you get lots of "hands on" experience with electronic equipment. The man from Bell & Howell Schools has all the facts for you. Mail the postage-free card now.

If you like fixing things with your hands...

...you could have the kind of basic skill and talent that could lead to a more exciting, better paid career in electronics. Next year, the world will buy about $17 billion worth of consumer electronics equipment. Somebody's going to make a lot of money servicing it when it breaks. How about you?

Mail the card for all the facts about...

...growing opportunities in electronics and how you can start to get ready for them now. A trained Bell & Howell Schools representative will call you and arrange to visit your home at a convenient time with all the facts you need. He's got some fascinating details to show you about what lies ahead in electronics for the man with the right kind of training. And he can answer all your questions about the Bell & Howell Schools learn-at-home programs that can give you that training. He'll even show you an actual-size color illustration of the Bell & Howell solid state color TV you build and keep as part of your program! Mail the postage-free card now.

If you'd like to start a business of your own...

...start a full or part time color TV service business. Americans own more than 94 million TV sets – and *more than half* of new sets are color! Being your own boss needn't be just a dream. Some of our graduates are doing it right now!

Beyond color TV, there's a whole new world...

...of home entertainment electronic equipment – from stereo systems to the new home videotape players. By 1985 the world will be spending about $35 billion a year on consumer electronics equipment!

One thing's certain, you're going to need...

...something to *sell* if you want to build yourself a future. That's what this Bell & Howell Schools program is designed to give you – up-to-date technical skills that employers are looking to buy.

Getting ready for a career means you have to start with...

...a hard look at what's happening in growth industries – like solid state electronics. Today, there's hardly an industry – or a leisure-time activity – that isn't touched by electronics technology. That spells "opportunity" for you – with the right training!

The Bell & Howell solid state color TV you build and keep is...

...an important part of your training because it gives you "hands on" experience with solid state equipment. Here are the technical details:

- Ultra-rectangular tube
- 25-inch picture measured diagonally
- full 315 sq. inch viewing area
- solid state modular circuitry
- 4 advanced IC's
- 100 transistors
- 72 diodes
- individual plug-in circuit boards
- special UHF/VHF tuning features
- built-in self-service components.

If you'd like some personal advice on your program...

...talk over problems with a qualified instructor at one of our special "help sessions" – scheduled at the Bell & Howell Schools and in many other cities. And you're only a toll-free telephone call away whenever you'd like to discuss your program with an instructor!

NEW... with your first lesson, you get...

...the brand-new Laboratory Starter Kit! A volt-ohm-meter (VOM) with design panels, modular connectors, experimental parts, battery power source. Gives you *immediate* "hands on" experience with your very first lesson.

NEW.. you also build and keep the newly-improved...

...Bell & Howell Schools Electro Lab®! Gives you "hands on" experience with precision instruments you assemble and keep:

Design Console. "Breadboard" circuits without soldering for both solid state and vacuum tube experiments. Patented modular connectors... transistorized dual-range regulated DC power supply ... 12.6 volt center tapped AC power supply... sine and square wave signal generator... test speaker.

Oscilloscope. Professional technician's diagnostic instrument. 5-inch screen... wide-band... sharp screen images... calibrated for peak-to-peak voltage and time measurements... 3-way jacks for leads, plugs.

Transistorized Voltmeter. Measures current, voltage, resistance on large dial... combines vacuum-tube voltmeter with multimeter... sensitive, 4-inch, jewel-bearing d'Arsonval movement.

(25-inch picture measured diagonally)

Get the facts. Mail the postage-free card now.

If card has been removed, write:

An Electronics Home Study School

DeVRY INSTITUTE OF TECHNOLOGY

503

ONE OF THE

BELL & HOWELL SCHOOLS

4141 Belmont, Chicago, Illinois 60641

HEY YOU— PULL OVER!

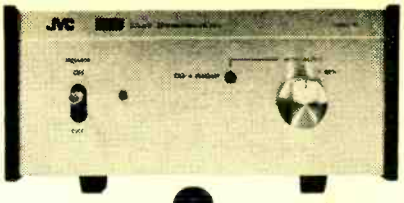
by Emmett Fluffin

Tickets for speeding are a normal hazard for drivers, but tickets for speeders behind the tiller of a boat . . . ? But one would at least suppose that one was safe aboard a boat in the harbour gently bobbing up and down with the tide. Not so. Even the harbours have fallen victim to the speed merchants. On the Manasquan River in New Jersey boat owners have been suffering from the effects of the high waves and turbulence created by power boats speeding along the river at rates that are far in excess of normal safety requirements. So, in an attempt to control the speed merchants of the river, the local council there has slapped a speed limit of 6 m.p.h. along the whole stretch of water and enlisted the aid of local policemen and radar traps to see that the limit is obeyed. If you're caught speeding

(Continued on page 104)

With the bitter downhearted expression of speed hawks the world over, the offending boat owner waits as a harbor cop writes ticket. A radar trap had done him in!

e/e plays 4-channels of an RCA quadradisc with a...



JVC DISC DEMODULATOR

MODEL 4DD-5 SEPARATES 4-DISCRETE HI-FI CHANNELS PACKED INTO ONE RECORD GROOVE!

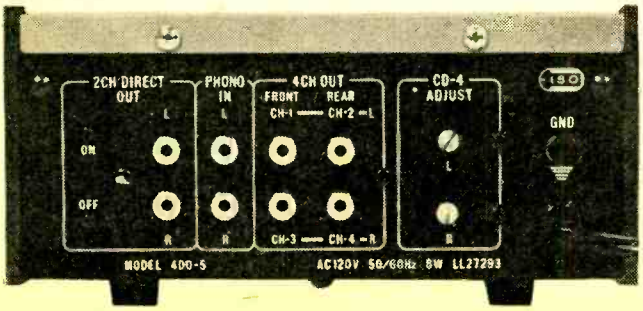
□ After much talk, hope, and speculation, CD-4 has made the quadraphonic scene in the form of well-proven equipment, actually an add-on that brings discrete record reproduction to any quadraphonic amplifier or receiver. All you now need to add CD-4 to your present quad installation is a JVC CD-4 Disc Demodulator System which comprises the model 4MD-20X magnetic pickup, 4DD-5 demodulator and a set of low capacity turntable cables.

The pickup, which resembles any other magnetic cartridge, is equipped with a *Shibata* stylus, a special truncated design that provides optimum groove contact with minimum wear (compared to a standard stylus). Because the pickup output signal contains frequencies as high as 45 kHz, the narmal audio output cables from the turntable must be replaced with the special low capacity cables provided. If the low capacity cables are not used, there will be considerable high frequency loss, which can interfere with proper operation of the demodulator. The cables are about ¾ length compared to standard cables, and if they don't reach the equipment, you must use special optional low capacity extensions; you cannot use standard audio patch cords as extensions.

Interface. With very few exceptions, all hi-fi turntables use plug-in pickup cables; the phono jacks might be concealed under the base, but they are there. The only major exception is the Empire turntable which uses its own special combination plug and cables. JVC has an optional adaptor plug for the Empires.

The matching demodulator has a *Power* switch, a *CD-4 Radar* (a lamp which indicates CD-4 operation) and a two position selector switch labled *4CH Auto* and *2CH*. When set to the *4CH Auto* mode, the demodulator automatically switches from stereo to CD-4 operation when a CD-4 record is played. When set to the 2CH position, both stereo and CD-4 records are reproduced in stereo only.

Two sets of output jacks are provided—a discrete 4-channel (*4CH Out*) output at line level, and a *2CH Direct Out*. The 4-channel output jacks normally connect to the amplifier aux, tape, or tape monitor



The difference between 2 and 4-Channel sound from quadradiscs is a demodulator like this JVC unit—Model 4DD-5. 4-CH out jacks are high level while DIRECT jacks provide a low-level unequalized output. Circle No. 43 on the reader service pages for more info.

inputs jacks. The 2CH jacks provide a direct output from the pickup when the front panel selector is set to 2CH and a small slide switch adjacent to the direct output jacks is set to *on*. The direct output connects to your amplifier normal magnetic phono input. When the slide switch is set to *off*, the equalized phono signal is amplified and appears at the 4-channel line level outputs.

More. In addition to the output jacks, the rear-apron contains two screwdriver adjustments called *CD-4 Adjust, L* and *R*. These controls match the demodulator to the pickup and provide front to rear balance. A 45 rpm test record is supplied with the demodulator for adjustment of these controls as well as for setting overall volume balance and minimum distortion. When the record left test cut is played, the L channels control is adjusted for minimum rear left output. The R channels control is adjusted in a like manner.

What About Stability. Since many pundits have downgraded the stability of the CD-4 system, we figured the best way to check it out was simply to use the system. After more than 100 hours use (4 hours a day for 30 days) in which the equipment was automatically recycled by a record changer, we found the adjustments were exactly on the mark; if there's any lack of stability in this CD-4 system, we couldn't find it.

As far as record wear was concerned, it is true that after about 50 plays the sound got a little *fuzzy*. A check with JVC brought the advice to simply wash the record with mild detergent and play through once to remove dust that accumulated in the bottom of the grooves. Wonders of wonders, this trick did restore what we consider original sound performance. However, aside from bathing the record, optimum sound quality depends to a very high degree on a clean stylus tip, and we would suggest a *dust bug*, or similar device, tracking the grooves ahead of the stylus.

Cartridge Test. The JVC pickup requires between 1.5 and 2 grams of stylus pressure. It produces a frequency response within +3/−2 dB from 20 to 50,000 Hz, and it's a noticeably smooth response. When operating into a *standard* magnetic input, the frequency response was within ±2 dB from 20 to 15,000 Hz, with a gradual 6 dB (averaged) roll-off to 20,000 Hz. The response was again notably smooth, and even as a standard stereo pickup, the JVC 4MD-20X ranks as a top quality pickup, though its stylus pressure is about 1 gram higher than usually used with the highest quality pickups.

One of the first discrete RCA 4-ch discs.

As far as the surround-sound effect is concerned, the JVC CD-4 system is everything claimed for it. There is, essentially, a total discrete quality—just as one would expect from a 4-channel tape. With a good recording, one that utilizes all the potential of quadraphonic sound, the sound is spectacular. Definitely three-dimensional, or spacial, if you prefer those terms. Unfortunately, most of the demonstration records supplied with the equipment left a lot to be desired in the way of recording techniques: either the sound was lifeless or tended towards gimmickry. One unidentified record, however, turned out to be a CD-4 version of the musical show *Hair*, a truly overpowering sound. This record was exceptionally clean, with an intimate, modern sound quality. But most of all it used the total capacity of surround-sound, producing a vast spacial effect that appeared to be larger than the room itself. For those who like to think of new dimensions in sound, the CD-4 version of *Hair* is it.

Summing Up. The JVC 4DD-5 CD-4 system should put to rest any doubts concerning discrete surround-sound from records. The system works well, is stable, and most important, its sound quality meets high fidelity standards. It is an add-on accessory to be used with any 4-channel equipment, adding another perspective to the outstanding merit of quadraphonics. ■

HERE'S LOOKING AT 4-CHANNEL MATRIX SOUND

by Herb Friedman

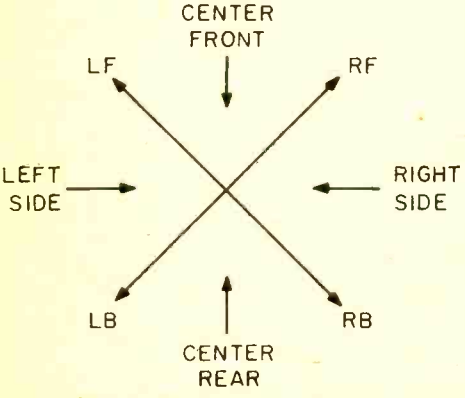
When faced by an inexplicable situation, some people are apt to answer that "aero-dynamically, the bumble-bee can't fly, but it does." What he means is that *he* does not know a rational reason for an event, but he does know *it can happen*. Fortunately, we in the hi-fi game do not need to fall back on something like "the bumble-bee can't fly." We can give a perfectly logical explanation for anything—if we can't come up with a logical answer, we simply make one up by falling back on the term *psychoacoustics*.

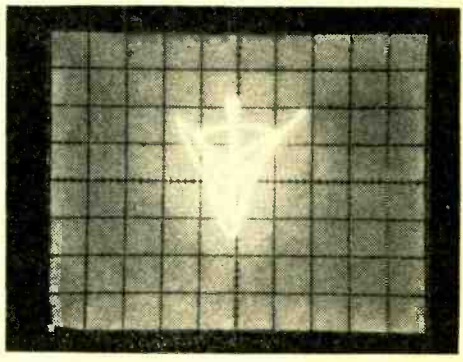
Yes, *psychoacoustics* has carried us safely through many rough seas, such as cassette noise reduction: "if you kill the highs, at low volume you won't really miss them." Fortunately, we usually luck out, as the hi-fi really flies. But unfortunately, *psychoacoustics* did not quite carry us through matrix surround-sound. All the present matrix systems depend to a major extent on what the originators term psychoacoustic effects. With absolutely rotten separation inherent in the 4-2-4 matrices, it was determined that if the listener held his head *rigidly* positioned in the center of the round field—looking neither to the right nor left but straight ahead—he would hear surround-sound. This is known as the "kitchen-chair-in-the-middle-of-the-living-room syndrome," the *logical* reason for the audiophile's initial lack of enthusiasm for surround-sound, not to forget the distributor's avoidance of 4-channel caused by his customer's lack of enthusiasm.

The Big Hang-up. To give you a rough idea of what the potential quadraphile faced, the original SQ papers (theory presentations) "proved" conclusively that the SQ separation was more than adequate because of psychoacoustic effects when the listener faced forward. (And let us not heap all the abuse on SQ, for we use it only as a convenient example; all the matrix systems suffer from the poor-separation-let's-use-psychoacoustics characteristics. The other matrices just push the lack of separation into different quadrants.) Well, if the system was so good, why are we on the third *blend factor* in decoders to produce acceptable separation? Why are the other matrix systems changing the blend, encoding mixing ratios and using rotating mixing

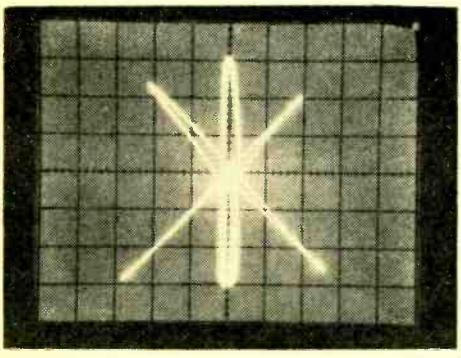
angles? The answer is, of course, to improve separation; while psychoacoustics resolves the *kitchen-chair syndrome* it does not provide sufficient quadrant separation for a *walk-through sound field*, one in which a listener in any location will hear a distinctive point-source origination for a specific sound or sounds.

In addition to a high degree of separation, any surround-sound system requires a more or less true playback or decode representation of the original (live) quadrant sound distribution for proper perspective. However, the fact that one might not attain proper perspective does not reduce the possibility of program enjoyment or acceptability, because if the listener has no idea of the original quadrant sound distribution he cannot know something is amiss. Admittedly, any matrix surround-sound sounds good to the ear; the most we can do is provide additional quadrant enhancement—usually termed separation. In fact, the greater the degree of separation, the greater the listening pleasure—the more spectacular the surround-sound effect-even when matrices are intermixed, such as SQ played through QS or QS through an EVX-44. While quadrant information might shift position due to intermixed matrices, who is

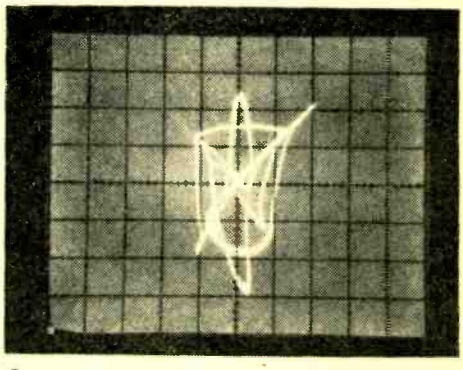




2



1



3

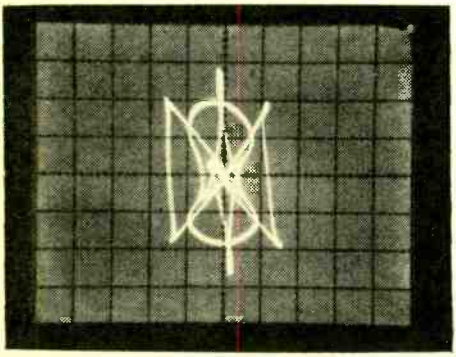
Each photograph represents the sound field that would be established by a quadraphonic system. The upper left is left-front (LF), the upper right is right-front (RF), the lower left is left-back (LB), the lower right is right-back (RB). The center of the picture—actually the center of an oscilloscope display—is the sound center mid-point between all outputs. Center-front information is created when the LF and RF signals are equal and in-phase. If the signals are in-phase but unequal in amplitude, the centered signal moves towards the stronger of the two sides. The same is true of center-rear signals developed between LB and RB. Information shown at the extreme sides between LF and LB and RF and RB are developed when information in the two paired corners (such as LF and LB) are in phase—as occurs with front and rear signals. No information is displayed between the two associated corners (paired corners) when the corner signals are out of phase.

The length or excursion of the oscilloscope display indicates the relative sound level from the quadrant. The absence of a display in a particular corner quadrant does not indicate no output;

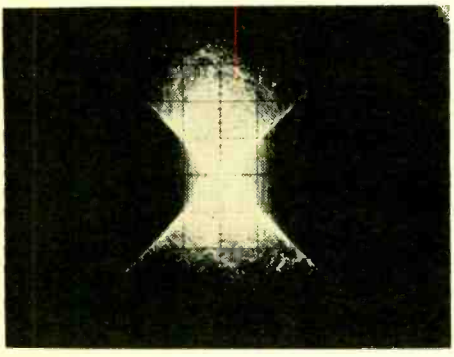
to say what is correct? If it's enjoyable, so what!

Getting Apart! Several different methods have been tried to increase separation, as we'll illustrate. Since the SQ system presently has a competitive edge both with manufacturers and consumers, we will concentrate primarily on SQ equipment. The first attempts to increase SQ separation from front to rear involved changing the blend factors, the amount by which one quadrant is blended into another. Most all late-model equipment uses the third and latest blend factor, which provides from 4 to 8 dB separation, depending on who built the decoder. While one might assume all decoders should deliver essentially similar results, such is not the case, as illustrated in Figs. 1 through 4, with multiple exposures of an SQ "star" representing the information in the primary sound field quadrants.

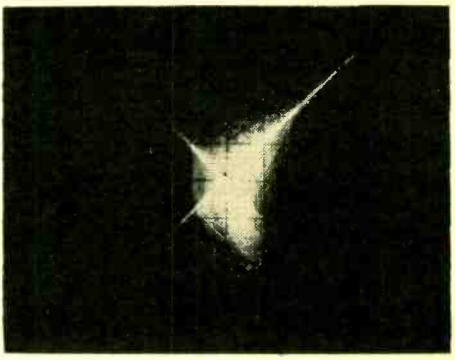
The almost perfect representation in Fig. 1 was provided by the full-logic wavematching SQ decoder in a Lafayette LR-4000B receiver. (We'll get to logic circuits later.) The loops indicate approximately 5% phase shift somewhere in the system; either in the pickup or amplifier—a typical low degree of expected phase shift. Note that side information—quadrant information appearing in other quadrants—is almost negligible, represented by the small blur in the center of the sound field (center screen).



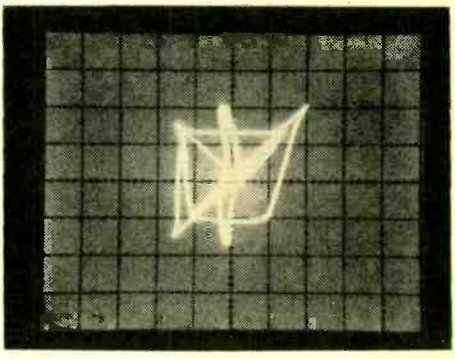
4



5



6



7

rather, it indicates relatively lower output in relation to the other, and in particular its associated, corner.

Illustrations with a gray background were made using sinewave input signals; those with a black background are program material: (1) The SQ "star" pattern obtained through a full-logic decoder shows essentially no side signal spill into other quadrants. The overall effect is almost equal to discrete surround-sound. (2) The SQ star processed through a popular basic SQ decoder results in increased side information and rear output not up to that obtained from the front channels. (3) The SQ star through a more typical basic SQ decoder indicates quite good all-around performance. The in-phase side spill in all quadrants is typical. (4) The SQ star when processed through a basic QS decoder shows substantial reorientation of the original quadrant information. The hourglass pattern indicating an in-phase front and rear signal originally was the left-back. But it all comes out sounding good to the ear. (5) 500 milliseconds

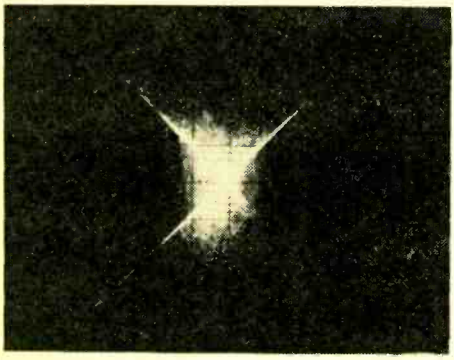
(Continued on next page)

Fig. 2 is the same SQ star processed through a popular, well-known decoder. Very large degrees of side information as well as poor rear-quadrant performance is indicated.

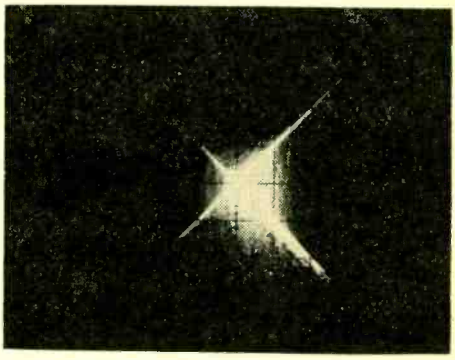
Fig. 3 is another leading SQ decoder. Results are sharply improved (remember, the oscilloscope scale is linear, not logarithmic, in dBs). In fact, Fig. 3 is typical of most SQ decoders.

Fig. 4 is thrown in just to shake you up. Study it closely before reading further; try to figure out what it represents. . . . Fig. 4 is the SQ star through a Pioneer amplifier with a "regular matrix" (assumed SQ) decoder. The so-called butterfly pattern, often confused with proper decoder operation, represents in-phase LF/LB and RF/RB. Center-front and center-back are correct. The hour-glass pattern which is in phase front and rear is supposed to be the RB signal. Sound scrambled? You betcha. Sound good? You betcha. So let's use this opportunity to digress.

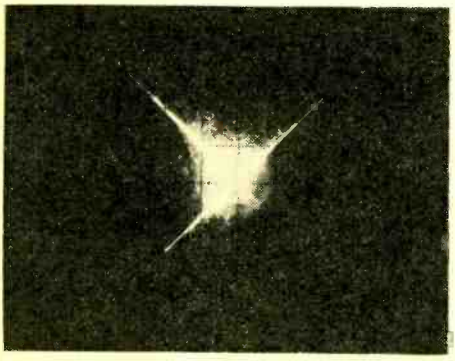
The Picture of Music. Fig. 5 shows 500 milliseconds of program, a vocalist with band recorded in QS and played back through a QS decoder. Note the predominant front-centered information (the singer) with the same information in the center-



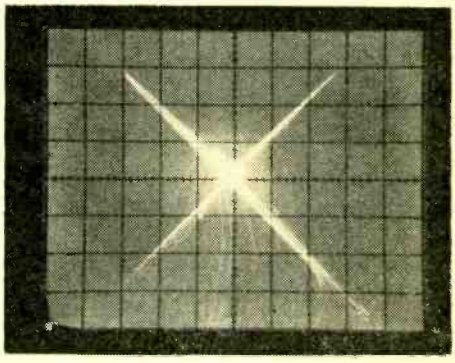
8



10



9



11

(Continued from previous page)

of program material recorded in QS and decoded in QS shows the vocalist at center-front with some separation to the rear. (6) When the QS-recorded vocalist is decoded in SQ, his voice moves toward the center right with increased rear output. (7) SQ star decoded by a logic decoder (compare with 2 and 3) shows increased center-front to center-rear separation, though there is reduced separation at the extreme sides. (8) 500 milliseconds of a band with predominant trumpets at the LF. (9) When the 500-millisecond record of a band is processed through a full-logic decoder, the LF information—the trumpets—is enhanced, creating an almost discrete-appearing sound output. (10) When the QS-recorded vocalist shown in Figs. 5 and 6 is processed through a full-logic SQ decoder, the logic circuits "see" the vocalist at the right center and provides right-side enhancement, moving the vocalist to a decided right location. (11) Even when all four corner signals are sim-

rear at reduced volume. Fib. 6 is the same 500 msec of program, only this time played through an SQ decoder. The vocalist has shifted predominantly right center, with considerable side information at the RB. Yet even with the quadrant shifts the overall sound is good to the ear.

It's obvious, from the SQ star and program waveforms shown in Figs. 1 through 6, that the basic matrix separation is far from outstanding; some might say it's also far from good. Unfortunately, any matrix has just so much inherent separation because the available frequency range determines the *total* separation for all quadrants. The separation can be stretched from side to side with reduced center-front to center-back separation, or center-front to center-back can be stretched with a resulting loss in side-to-side separation. The total available separation can be pushed, squeezed or stretched, but always at a reduction in separation somewhere else.

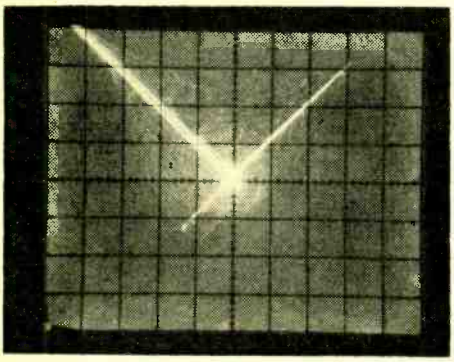
First attempts to improve on the inherent SQ separation involved new blend factors, which were explained back at the beginning of this article. The second serious modification to the SQ system was the so-called *logic decoder*.

Enter Logic. The logic decorder was (and is) a teeter-totter (seesaw) gain-riding amplifier. When the decoder senses predominantly front information, the overall gain is shifted to the front, creating greater front-to-rear separation. Depending on the decoder, the same gain-riding can be applied to rear information. There are a few side effects other than the teeter-totter gain-riding which we won't get into because they don't seriously affect the total enhancement, and the whole idea is passé anyway.

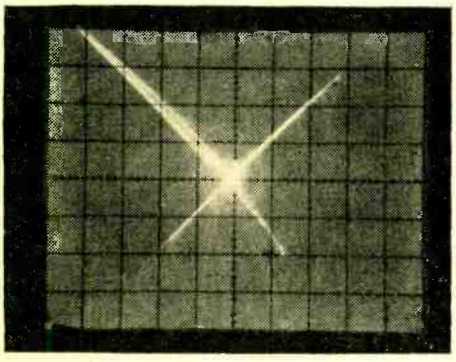
Fig. 7 illustrates the effect of *logic* separation enhancement. Compare Fig. 7 with the basic decoder output shown in Fig. 3; note how much of the "garbage" has been cleaned up by front-to-back logic. The center-front and the center-back signals are particularly clean, with sharply reduced opposite-quadrant spill. Note, however, the increase in the in-phase left and right side signals, a trade-off for increased center-front to center-rear separation.

The ultimate—at least for the present—SQ decoder is the so-called full-logic, which includes wave-matching. In the full-logic decoder, both the center and corner signals are processed for optimum enhancement. Gain-riding is used for the center front and rear signals; a signal that appears primarily in the center-front causes the decoder's gain to shift sharply towards the front, producing a decided forward or center sound. The same effect takes place for center-rear signals. The wavematching handles the corners; signals with predominant corner information similarly shift overall gain toward its corner. The end result of the gain-riding and wave-matching is the SQ star shown 'way back in Fig. 1, the output of the Lafayette LR-4000B. With center front and rear balance set for equal output levels, corner output is very close, and side-effect spill is negligible. Other than the minor phase shifts represented by the loops in

(Continued on page 100)



12

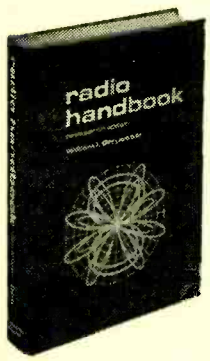


13

ultaneously applied, the full-logic decoder has very little side signals generated—those forming the small smear at the center. (12) When all four corner signals are applied to a popular basic SQ decoder, the result is obviously not what was intended. The sound output is notably front oriented, particularly to the left-front. (13) Simultaneous application of the four corner SQ signals through a universal decoder shows quite good results.

BOOKMARK
BY BOOKWORM

19th Edition and Still New. Here's a completely new and up-to-date edition of the *Radio Handbook*, edited by William I. Orr, written especially to keep the amateur radio enthusiast informed of the latest principles and equipment encompassing the broad radio communications field. In fact, this handbook is recognized as the leading independint authority in the field of radio amateur h-f and vhf communication, covering more than three decades of development in the art of electronic communication. The book contains authoritative, detailed instructions for designing, building, and operating all types of radio communications equipment. A complete understanding of the theory and construction of all modern circuitry, semiconductors, antennas, power supplies, full data on workshop practice, test equipment, radio math, and calculations is provided. Published by Howard W. Sams & Co., Inc. For more information, circle No. 52 on Reader Service Page.



Hard cover
976 pages
$14.95

Instant Library. A six-volume set of 1973 databooks on solid-state devices are available now from RCA. The SSD-200A six-volume, 3,400 page set of 1973 *Databooks* covers RCA Solid-State's complete commercial line of linear integrated circuits, discrete MOS devices, COS/MOS digital integrated circuits, power transistors, thyristors, rectifiers, RF devices, and hybrid circuits. The SSD-200A *Databooks* contain complete technical data sheets and application notes on all commercial types in the RCA inventory as of January 1, 1973. The first volume, SSD-201A ($2.50) contains technical data on linear integrated circuits and discrete MOS devices. SD-202A ($1.50) contains application notes on linear IC's and MOS devices, and is separate from SSD-201A because of the total size of the two volumes. SSD-203A ($2.00) describes RCA's full line of commercially available COS/MOS digital integrated circuits. SSD-204A ($2.00) encompasses power transistors and power hybrid circuits, and SSD-205A ($2.00) covers RF power devices. The final volume, SSD-206A ($2.00), describes thyristors, rectifiers and diacs. The latter four volumes contain both data sheets and application notes. The entire set of SSD-200A may be ordered for $12.00 from RCA Solid-State Division, Box 3200-EE, Somerville, NJ 08876, or from any RCA Solid State distributor. Volumes may be ordered individually. A *Total Data Service* is also available and includes a monthly newsletter on all devcie types being introduced; a fast-response mailing service for new data; and bi-monthly update mailings on all new data sheets, application notes, product guides and other literature for all product lines. To get all the facts, circle No. 50 on Reader Service Page.

Soft cover
6-volume set
$12.00

Fun and Games. The title is a challenge—"Games for the Superintelligent"—by which author James Fixx dares you to match wits with the members of Mensa, the high-I.Q. society, who contributed the puzzles to this 86-page collection of math, logic, and word games. The author says all the puzzles are not as difficult as they seem, which is a small consolation to anybody who has worked for 20 minutes trying to discover the next letter in the sequence: Q T T F F S S. The puzzles are grouped accouding to whether they involve words, logic, drawings, math, etc. Some are puzzles to be solved by the reader ("What is the maximum number of parts into which a circle may be divided by drawing four straight lines?") Others are games, such as "Sprouts" and "Matches in Rows," to be played by two or more people. And some are real stickers that may not have an answer, but the reader is invited to try anyway; for example, "find a formula for calculating the number of possible combinations for a given number of cubes." Some of these puzzles will be familiar. Many of them will give you much pleasure in solving. Others will make you want to tear up the book, especially those in the last chapter, titled "So you think you're pretty bright?" Whether you count youself as Mensa potential, with an I.Q. of 140 or more, or are just a puzzlenut, you'll enjoy answering the challenge. Published by Doubleday & Co., Inc. for more in-

(Continued on page 94)

e/e checks out a direct-drive turntable...

Panasonic's SL-1100 Record Playing System

A home machine that has professional features: Slip-start cue, Rockbottom wow and flutter, Servo motor and more. . . .

☐ In recent years the performance level of record playing equipment intended for home use has been so spectacularly improved that it is not unusual to find hi-fi record players being used in the best of FM stations. The reason for this turn of events is that, for the most part, the so-called *pro* gear stood still, while hi-fi players were continuously upgraded.

It might well be that, henceforth, professional turntables will be compared to home equipment in terms of performance excellence, for the new Panasonic SL-1100 Direct-Drive Player System heralds the latest approach to hi-fi equipment—one that puts total performance well beyond that found in most pro equipment.

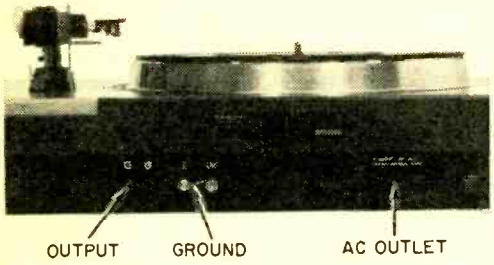
The Panasonic SL-1100 is a two speed (33, 45) manual record player whose primary feature is an electronically regulated direct-drive motor. In the typical turntable, both home and professional type, the relatively slow platter speed is obtained from a high speed motor through one or more step-down pulleys or belts, and it is a fundamental rule of mechanics that any rotating or oscillating intermediate drive component can—and will—generate *flutter* (a periodic speed variation). Motors powered by AC also tend to generate rumble even when large numbers of field poles are used. And, finally, AC motors produce hum fields to which a few phono pickups are extra-sensitive.

Direct Drive. Unlike conventional turntable motors, the motor in the SL-1100 is a multi-pole, brushless DC motor whose armature speed is either 33 or 45 as selected by the user—there are no intermediate step-down devices. This one difference alone essentially eliminates rumble, flutter and hum fields. The motor is powered by a nominal 20 VDC. A supersonic AC signal of nominally 50 kHz is fed to three servo-sensing coils. As the motor turns, part of the 50 kHz energy is coupled into a second set of coils and the output of both coil sets are compared. If the armature attempts to drift off-speed, an external circuit which compares the voltages between the two sets of coils automatically corrects the power applied to the motor. Because the motor control is a closed-loop servomechanism, neither the frequency nor fluctuation of the AC power line affect the motor's rotation. In fact, as long as the power line voltage is high enough to operate the electronic circuitry, the motor operates at a constant performance level.

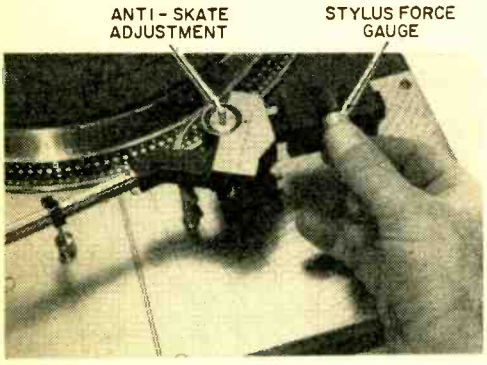
But the motor is not the only good idea in the SL-1100 package. The motorboard itself is massive, almost 15¾-in. D x 20¼-in. W. The oversize is 13 25/64-in. platter is similarly massive, weighing in at 4.4 lbs. Around the outer edge of the platter, etched into the rim, are strobe markings for 33 and 45 rmp at either 50 or 60 Hz. Along the forward edge of the deck are the speed selector, 33 and 45 pitch controls, cueing lever, and microswitch touch buttons for start and stop.

The supplied tone arm is almost as orig-

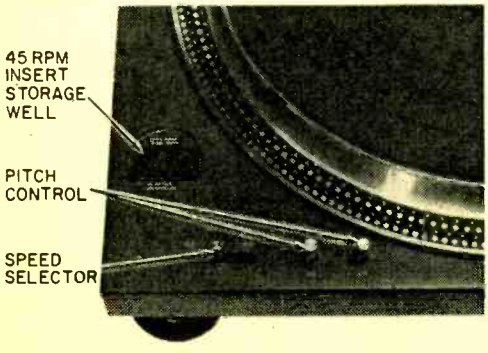
e/e PANASONIC SL-1100



The signal output is available at two phono jacks; there are no attached signal cables. Those two terminals connected with a piece of wire and marked ground are an independent chassis, or frame, ground and a system ground. This quality method squelches hum.



A stylus force gauge built into a counterweight resets to zero when knob is pulled outward. Set anti-skate to the stylus force.

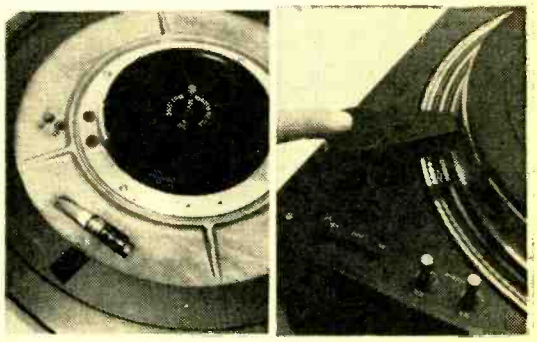


An AC outlet is in the bottom of the 45 rpm insert storage well to power a neon strobe. Photo at far right shows strobe inserted.

inal as the motor. Basic features include a plug-in pickup shell with a stylus overhang adjustment and a calibrated anti-skate device. The big difference is the stylus force adjustment which is part of the micro-adjust counterweight. Incorporated into the counterweight assembly is an automatically resetting stylus force scale. After the arm is counterbalanced, pulling on the adjustment screw causes the scale to reset to zero. Then the screw is rotated until the scale indicates the desired stylus force. If you change pickups you need simply balance the arm, pull on the screw and then reset to the desired stylus force. Total adjustment time? About five seconds!

Performance. Everything about the Panasonic SL-1100 Player System worked well. The motor speed held precisely as set over an AC power source range of 85 to 145 volts (the limits of the test equipment). Even 20 volt variations spaced one second apart had no measureable or listenable affect on the motor's speed. The combined wow and flutter measures a rock-bottom 0.04 percent, which, we suspect, is the inherent warp-wow in the test record. The platter speed comes up in 3/8 of a revolution with virtually no overshoot, and the motor can be stopped by hand while the power is on, allowing slip-start record cues (for those of you who prepare sound tracks, or cue the way most DJ's do).

The 0-5 gram stylus force gauge is the most accurate we have seen; though calibrated in 0.5 gram increments, the stylus force can be accurately estimated to 1/16 gram right from zero.



A special lubricating oil is stored under turntable, left. And on right, the lamp is shown in place. Button on top lights lamp.

Summing Up. If we talk of *real* professional turntable quality, then we are talking about the Panasonic SL-1100. For information circle No. 41. ■

Improve any AM receiver with...

DETECTOR X2

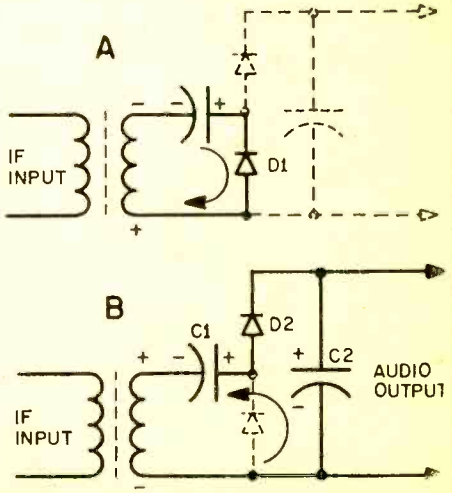
One diode and capacitor added to any AM detector will nearly double the output.

by Elmer C. Carlson

IF YOU CAN SOLDER to printed-circuit boards or build a solid-state electronics kit, you can convert any AM detector to an even better voltage doubler circuit. All you have to do is add two small components to the existing diode detector, and you can get about double the normal audio output. Another big bonus is a lower detector distortion and an intrinsic bass boost that's noticeable mainly on medium-priced table radios. Remember, the new circuit isn't choosy. You can put it in CB mobiles or handi-talkies, table radios or broadcast/shortwave transistor portables. You can even put this circuit in toy-type crystal sets.

Circuitry used for this high-output AM detector is the same as that used as a power rectifier for those transformerless TV power supplies. For over twenty years the circuit has been used to obtain about 240 VDC from 120 VAC power lines. The only difference are the characteristics of the components used. As an AM detector-doubler, the circuit uses high-frequency, low-current diodes instead of 500 or 750 milliampere power rectifiers. Capacitors are small at the higher (RF and IF) frequencies. A .01 μF capacitor is usually enough. Those 80 to 200 μF electrolytic capacitors aren't needed for the AM detector-doubler circuit.

Circuit Operation. Basic circuits for the usual half-wave AM detector, the AM detector-doubler and the crystal radio circuits are given in the schematic diagrams. During

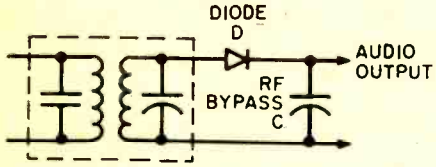


At A, C1 charges as shown for ½ of each IF cycle then aids (B) second ½ cycle, charging C2 to twice the IF.

e/e DETECTOR X2

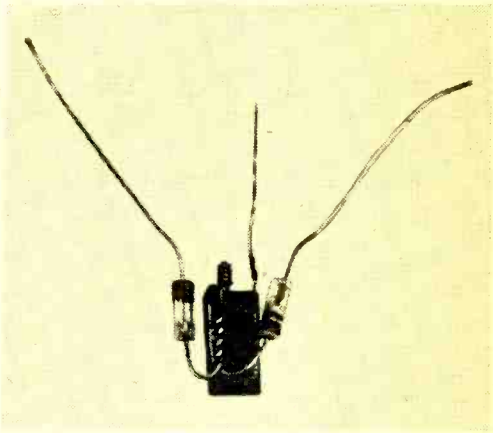
one alternation of the IF carrier, diode D1 of the X2 DETECTOR *conducts*. When diode D1 conducts, it charges capacitor C1 to the peak IF voltage of that half of the cycle of the modulated sine wave. During the second half of the cycle, diode D2 conducts. Capacitor C1 discharges through diode D2, adding its briefly stored charge to that of the peak voltage of the second half of the input sine wave. At the time of discharge, the voltage across C1 is in series with the voltage applied to the secondary of the transformer during the second half of the sinewave alternation. Just as with two dry cells connected in series, these two voltages add and produce about twice the voltage that would be obtained with one diode.

Modification Tips. A pair of identical diodes will work best in this circuit. Any two diodes will work, but identical diodes will give better audio fidelity. Check the forward and back resistance of diodes with an ohmmeter. Select two diodes that are as similar as possible.



This basic AM detector is found in nearly all AM radios. Diode can be connected as shown or reversed with anode at out line.

☞ When removing a diode from the original circuit be sure to check its operating output polarity. Make sure diodes you put into the circuit will give the same polarity audio voltage output. A diode connected



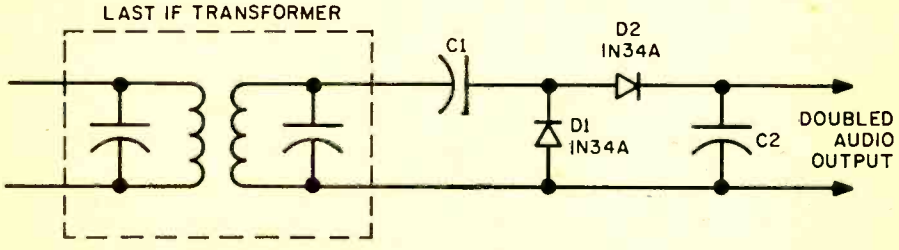
Simple three-terminal design using two new diodes and additional capacitor. Selecting a matched set of diodes drops distortion.

to the circuit in reverse may upset the bias applied to the base of a following, direct-coupled transistor or electrolytic capacitor. It's a lot easier to check the polarity first than to replace a transistor or electrolytic capacitor.

☞ If space permits, larger-sized diodes and capacitors can be used just as effectively as the miniaturized units.

☞ The two diodes and the capacitor can be formed into a neat, compact 3 terminal package as shown in the photo-

(Continued on page 107)



Add just a diode and capacitor to the basic circuit shown above and turn an ordinary AM detector into a doubler. It boosts audio quality by reducing distortion since the load seen by the last IF transformer is equal for both half-cycles of the IF output waveform.

PARTS LIST FOR DETECTOR X2

C1—Capacitor, ceramic or mica. Size depends on C2, see text.
C2—Capacitor in original detector circuit.
D1—Diode, 1N34A or 1N60 (Radio Shack 276-821 or equiv)
D2—Diode in original detector circuit, see text

Checked out by e/e...

HEATHKIT'S ELECTRONIC CLOCK

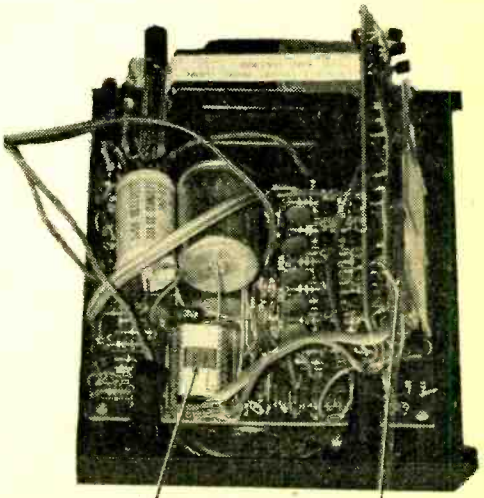
IT'S funny how different hobbyists can look at the same piece of equipment and see completely different uses. For example, to Heathkit, their GC-1005 is an electronic clock. To one of the SWLs in the office it was a time standard as accurate as he could obtain from WWV. Another member of the staff all wrapped up, hobby-wise, in color printing, claimed it was the best darkroom clock and timer he's seen. And yet another staff member, whose mornings are ruined by the raucous buzzing of the standard electric alarm clock, claimed it was the most pleasant wake-up alarm other than a personal maid.

In actual fact, the Heathkit GC-1005 is a highly styled electronic digital clock that indicates in hours, minutes and seconds on ultra-brite seven-segment displays almost one half inch tall. It also features an electronic *beeper* alarm with a snooze switch that recycles the alarm every 7 minutes (approximate) until turned off. The time display consists of six full digits which can be programed by the builder to indicate in a 12 or 24 hour format. A neon indicator lamp, which is also visible through the front panel, is actuated when setting both the time and alarm time-set, and indicates AM or PM; this feature is necessary because the alarm time-set is programed into the clock.

How It Works. All the digital logic is performed in a single LSI (Large Scale Integration) chip in much the same manner as a pocket calculator, which also employs LSI chips. The internal chip circuitry counts the pulses from an internal clock that is syncronized to the power line frequency. Since the power line frequency is held to a close tolerance, the chip accurately triggers the seconds display every second; on every tenth second the *tens* digit is pulsed one number higher. After 59 seconds the minute display is triggered. This sequence progresses until either 12 or 24 hours have passed, at which time the counter recycles.

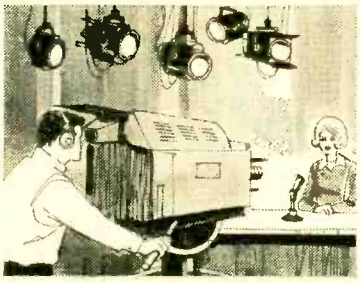
Because the clock is syncronized to the power line frequency, the overall accuracy is that of the power line which is generally maintained with 1 second per month to insure that electric clocks stay accurate. In fact, in the USA the power line accuracy generally insures 1 second accuracy over a time period of many months.

Electronic Reveille. The alarm time-set is programed into the clock by the user. When a switch labeled *alarm* is switched on, the display is changed to indicate the hours and minutes selected by the user for the alarm to "ring." Even though the display no longer indicates the correct time, the internal clock is still running, and when the alarm switch is set to *off* the display picks up the correct time indication. It is during the time or alarm-set operation that the AM/PM indicator lamp is illuminated



The dancing digits craze is on. Here's Heathkit's entry at an easy-on-the-budget (for this sort of thing) $54.95, + postage. Circle No. 1 on page 17 or 103 for info.

Great careers



Join the high-paid electronics technicians who got their start through NTS Home Training.

Your home can become your own private classroom-workshop. NTS sends you everything you need to learn valuable technical skills in electronics. You get easy-to-grasp lessons, comprehensive kit manuals, large fold-out charts, and more. Plus the finest professional equipment available today. It's all included in your tuition, yours to keep.

You'll work with commercially-designed equipment, and school training material. Cash in on the tremendous opportunities in the expanding, exciting world of electronics.

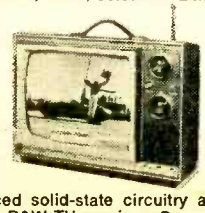
If your field is television, you might decide to join a first-class TV repair center. Or start a shop of your own. Or specialize in industrial applications of television. Once you master an area of electronics, the direction you take is really up to you. And you'll be able to use the test instruments you built yourself.

It all begins at home, with NTS Project Method Training. Check card or coupon today for free full-color NTS Catalog and complete details. No obligation. No salesman will call.

NTS COLOR AND B&W TV SERVICING

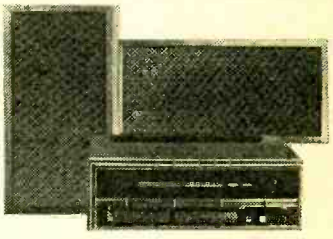
Build the largest most advanced color TV made! It's a Heath! Over-all solid-state design, 315 sq. in. ultra-rectangular screen, 24 channel detent UHF/VHF power tuning, matrix picture tube, built-in self-servicing features, "Instant On," A.F.T., solid-state VHF tuner, and much more! This is a commercial set, the kind you'll encounter in the field — and not for training purposes only. Also build and keep AM-SW Radio, Solid-State Radio, FET Volt-Ohmmeter, and Electronic Tube Tester. Learn trouble-shooting, stereo multiplex systems, radio, color and B&W TV servicing.

Solid-state B&W TV 74 sq. in. picture (cabinet included)



Learn advanced solid-state circuitry as you build this B&W TV receiver. Course covers the full range of home entertainment electronics.

NTS AUDIO ELECTRONICS SERVICING

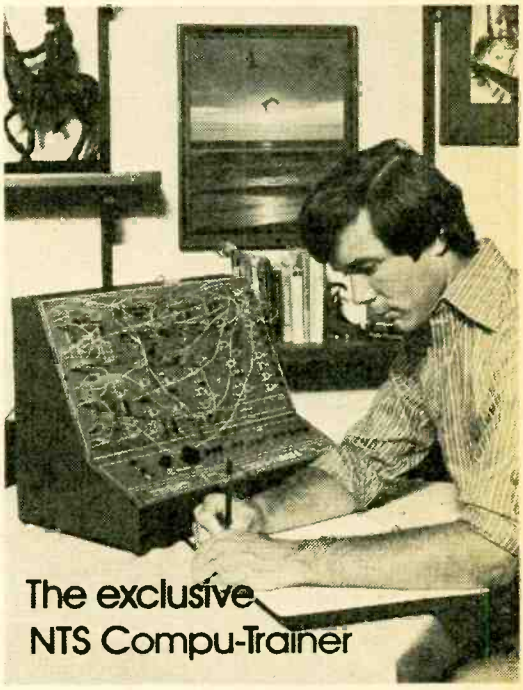


Solid-state Heath Stereo Receiver and Speakers

Learn sound theory — how it works in home radio, 4-channel, and more! Set up a spectacular music system. Learn about sound distortion, amplification and control, loud-speaker baffles, problems of system installation, etc. Included is Volt-Ohmmeter. In-Circuit Transistor Tester and solid-state Radio. Prepare yourself for great opportunities in the Home Entertainment Industry!

begin at home.

New solid-state
315 sq. in. color TV



The exclusive
NTS Compu-Trainer

NTS COMPUTER ELECTRONICS

Build and operate the exclusive NTS Compu-Trainer! Loaded with integrated circuits, it teaches you the how, what, and why of computers — faster, more thoroughly. You perform all wiring and patch-cording. No shortcuts! No pre-wired circuit boards. Also receive an FET Volt-Ohmmeter and a 5" wide-band Solid State Oscilloscope.

NTS ELECTRONIC COMMUNICATIONS

Gain the prestige and earning power of owning an FCC First Class Radio Telephone License! Two exciting courses in the fields of transmitting and receiving. Experiment with an amateur phone 6-meter VHF transceiver, NTS exclusive 6-transistor solid-state radio and a fully transistorized volt-ohmmeter.

5-watt AM transmitter/ receiver.

NTS AUTOMATION/ INDUSTRIAL ELECTRONICS

Systems automation is the future of the industry — and you can play an important role! Enter the age of electronic controls by training on the NTS Electro-Lab — a complete workshop. Also receive a Solid State 5" wide-band professionally rated Oscilloscope. Build five industrial controls to regulate motor speed, temperatures, pressure, liquid level and much more.

5" Solid State Oscilloscope

CLASSROOM TRAINING AT LOS ANGELES

You can take classroom training at Los Angeles in sunny Southern California. NTS occupies a city block with over a million dollars in facilities devoted exclusively to technical training. Check box in coupon.

APPROVED FOR VETERAN TRAINING

Accredited Member: National Association of Trade and Technical Schools; National Home Study Council.

NATIONAL TECHNICAL SCHOOLS
World-Wide Training Since 1905
Resident & Home Study Schools
4000 S. Figueroa St., Los Angeles, CA 90037

Please rush Free Color Catalog and Sample Lesson, plus information on course checked below. No obligation. No salesman will call.

National Technical Schools
World-Wide Training Since 1905
Resident & Home Study Schools
4000 S. Figueroa St., Los Angeles, CA 90037

- ☐ Master Course in Color TV Servicing
- ☐ Color TV Servicing (For Advanced Technicians)
- ☐ Master Course in B&W TV & Radio Servicing
- ☐ Master Course in Electronic Communications
- ☐ Practical Radio Servicing
- ☐ FCC License Course
- ☐ Master Course in Electronics Technology
- ☐ Automation & Industrial Electronics
- ☐ Computer Electronics
- ☐ Basic Electronics
- ☐ Audio Electronics Servicing

Dept. 222-053

Name _____ Age _____

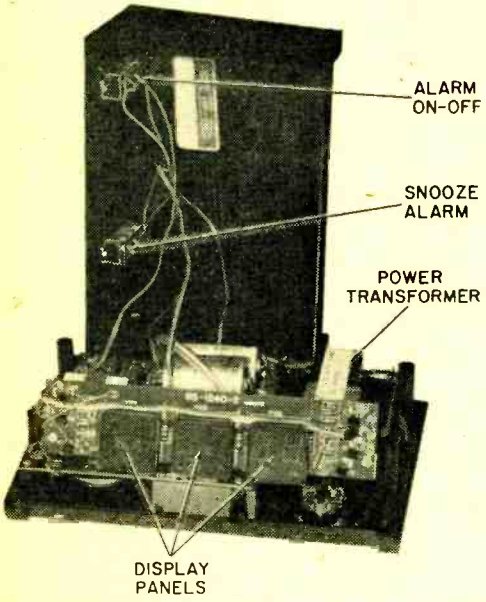
Address _____

City _____ State _____ Zip _____

- ☐ Check if interested in Veteran Training under new G.I. bill.
- ☐ Check if interested ONLY in Classroom Training at Los Angeles.

CIRCLE NO. 13 ON PAGE 17 OR 103

e/e HEATH DIGITAL CLOCK



Flip-up the cover for an inside showing of three dual 7-segment neon display panels and simple one-board construction method.

to insure that the user does not set the alarm for, say, 6 PM when he wants to greet the sun at 6 AM.

The electronic "beeps" from the alarm are also generated by the LSI chip and are syncronized with the seconds display. The electronic oscillator output from the LSI chip is fed to an amplifier and then to a small speaker mounted to the bottom of the cabinet. When the alarm goes off, the user is awakened by a pleasant beep-beep-beep, rather than an ear-shattering growling. A special feature automatically recycles the alarm for 24 hour operation so that the instant the alarm switch is turned *off*, it can be turned *on* for the following day. A separate *snooze alarm* switch will keep recycling the alarm approximately every seven minutes until turned off.

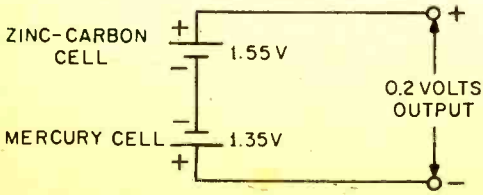
Building The Kit. All the electronics are assembled on two printed circuit boards. Only the power transformer, switches, and speaker are external to the boards. It's not a difficult assembly and construction should take from 4 to 7 hours depending on your degree of experience in kit building. Is it worth the money? The Heathkit GC-1005 Electronic Clock is priced at $54.95 in kit form. The lowest priced commercial electronic digital clocks we have seen of equal performance, in terms of display size and brightness, are priced from $75 up, and they do not include an alarm or a seconds display. If you want all the necessary features, the Heathkit is the only way to get them.

Other Uses. Just on a hunch we checked the Heathkit's red-orange display for photographic safety. With the clock placed immediately adjacent to a sheet of enlarging paper, there was no evidence of fogging, so the GC-1005 can serve as a precision darkroom timer. By request, we also checked the GC-1005 against WWV and found it tracked the WWV time signals perfectly with as much precision as our eyes and ears could detect.

Our local CB REACT Captain got hooked on the 24 hour display for logging emergency calls; and finally, when our budding astronomer next door discovered he could program the Heathkit almost instantly for GMT (Greenwich Mean Time) we had to fight to get it back. Just about everyone who has seen the GC-1005 has found some new use for it.

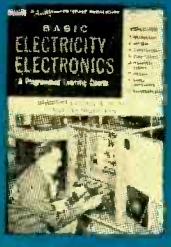
Summing Up. Whether you just want the latest in status symbols, an excellent timepiece or a multi-application programable clock, you'll find it all in the Heathkit GC-1005 Electronic Clock. For additional information circle No. 1 on the Reader Service page. ■

P.S. tunnel diode



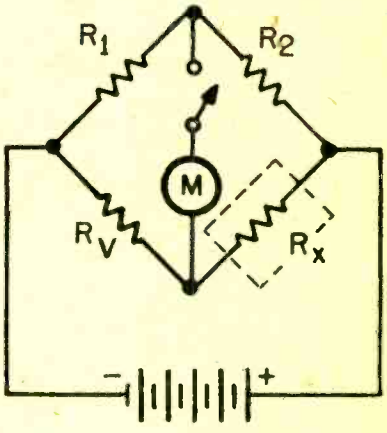
Tunnel diodes would be ordinary everyday run-of-the-mill diodes if it were not for one very curious characteristic—negative resistance. To engineers it means amplification, switching, and even oscillators in the Gigahertz reigon (above 1000 MHz) from simple low-power circuits. Dave Schaller of Milwaukee, Wisconsin, says this circuit is just right for tunnel diode power and offered it to the Editor and you. Tunnel diodes are available for experimenters from General Electric.

e/e's ALL NEW BASIC COURSE in ELECTRICITY & ELECTRONICS



This series is based on
BASIC ELECTRICITY/ELECTRONICS,
Vol. 4, published by
HOWARD W. SAMS & CO., INC.

UNDERSTANDING BRIDGE CIRCUITS

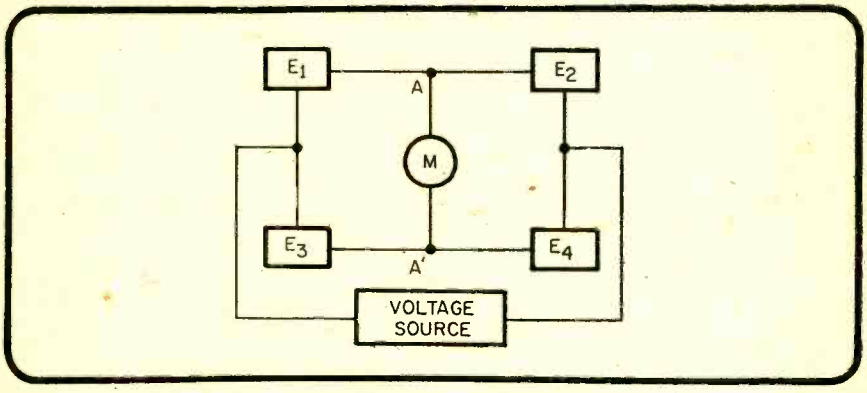


What you will learn. When you have completed this, text, you will be able to explain the fundamental principles on which a bridge circuit is based. You will be able to determine how values of resistance, capacitance, and inductance can be accurately measured by a bridge instrument. You will be able to use a bridge instrument after only a brief period of study of the individual bridge device you intend to use.

WHAT IS A BRIDGE?

A **bridge** is a simple parallel circuit designed with a means of determining a potential difference between two parallel legs, as shown in the illustration below.

WHAT IS A BRIDGE?



If voltage were applied across the bridge (parallel) circuit, current through the voltmeter would be zero only when the voltages appearing at points A and A′ were equal.

Another fundamental principle is that the voltage across a parallel network is the same for either leg. In other words,

$$E_1 + E_2 = E_3 + E_4 = \text{Source voltage}$$

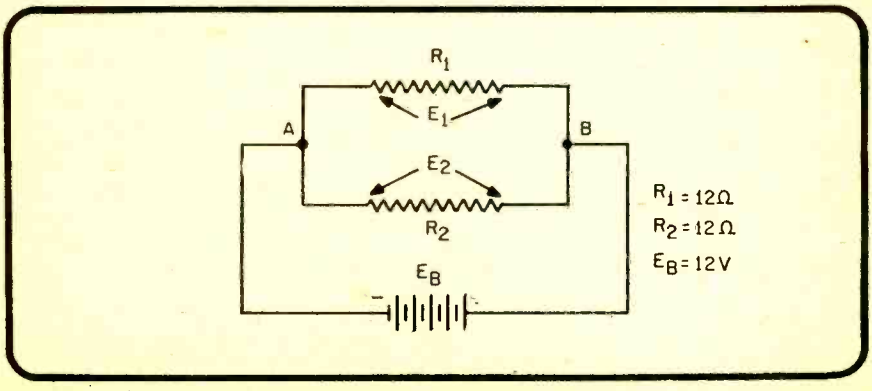
This means that a balance could be achieved between the two legs (no current flowing between A and A′) if the ratio of voltages on either side of A were equal to the ratio of the voltages on the respective sides of A′, or

$$\frac{E_1}{E_2} = \frac{E_3}{E_4}$$

HOW DOES A BRIDGE CIRCUIT WORK?

A brief review of circuit fundamentals may clarify this balance, or equality, between voltage ratios. In the parallel circuit shown below, $R_1 = R_2$.

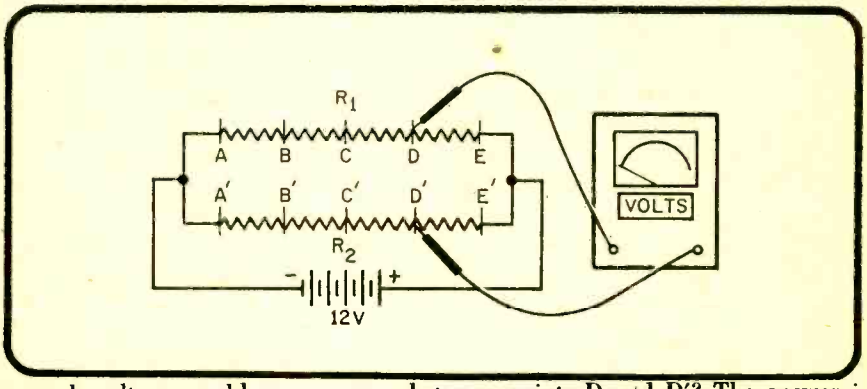
PARALLEL CIRCUIT—EQUAL RESISTANCES



Disregarding the voltage drop in the conductors, the voltage difference between points A and B (above) will be that of the source (12V). The current through R_1 and R_2 will be 1 amp each, or a total circuit current of 2 amps. Since the resistances and currents in both legs are equal, E_1 is equal to E_2. Now divide one resistance into four equal parts.

If the resistance, which shows a voltage difference of 12V from one end to the other, were divided into equal quarters, each quarter would represent 3V. Now divide both resistances of the parallel circuit into equal quarters.

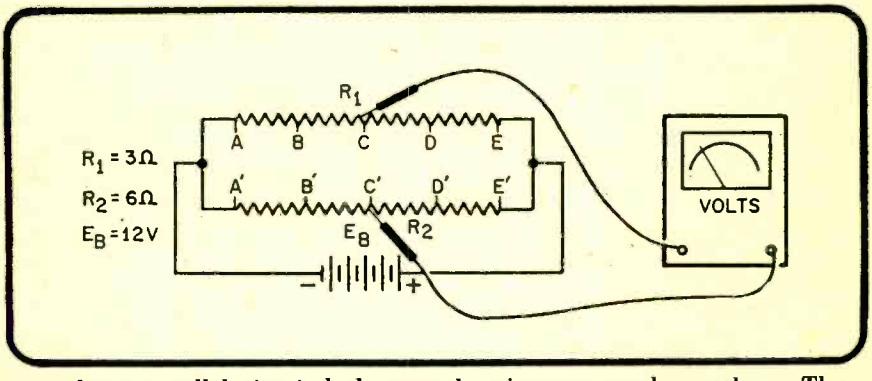
EQUAL VOLTAGE POINTS



How much voltage would you measure between points D and D'? The answer is zero volts. The potential difference between A and D is 9V; this is equal to the difference between A' and D'. Therefore, no potential difference exists.

To show that the measurement works equally well from either end reference point, start from the other end of the network. The voltage at B with respect to E is −9V; the voltage at D' with respect to E' is −3V. Therefore the difference, 6 volts, will be measured from B to D'.

PARALLEL CIRCUIT UNEQUAL RESISTANCES



Suppose that a parallel circuit had unequal resistances, as shown above. The voltage across R_1 or R_2 would be identical, that is, 12V. Again assume quarter-section divisions.

QUESTIONS

Q1. What is the current through R_1? Through R_2?

Q2. What is the value of resistance in each quarter section of R_1? Of R_2?

Q3. What is the voltage difference between A and B (R_1)? Between A' and B' (R_2)?

ANSWERS

A1. The current through R_1 is 4 amps; through R_2 2 amps.

A2. The value of resistance in each quarter section of R_1 is 0.75Ω; of R_2, 1.5Ω.

A3. The voltage difference between A and B (R_1) is 3V; between A' and B' (R_2), 3V.

$I_1 \times R_1 = 4 \text{ amps} \times 0.75\Omega = 3V$

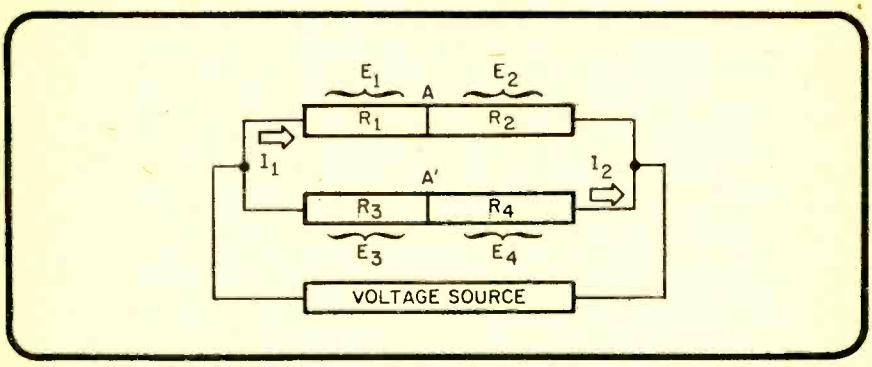
$I_2 \times R_2 = 2 \text{ amps} \times 1.5\Omega = 3V$

Voltage Relationships in Parallel Circuits

For every point on one parallel resistance leg, there is a point on the other leg that is at the same potential. This is true whether or not the total leg resistances are equal.

The voltage across a parallel network is the same for either leg. You can state that

PARALLEL NETWORK VOLTAGE DROP



$E_1 = E_3$ and $E_2 = E_4$ in the figure above if A and A′ are at the same potential. These voltage relationships can be stated in terms of equal ratios:

$$\frac{E_1}{E_2} = \frac{E_3}{E_4}$$

Since E is equal to IR, the above ratios can be stated in another manner:

$$E_1 = I_1 \times R_1 \qquad E_3 = I_2 \times R_3$$
$$E_2 = I_1 \times R_2 \qquad E_4 = I_2 \times R_4$$

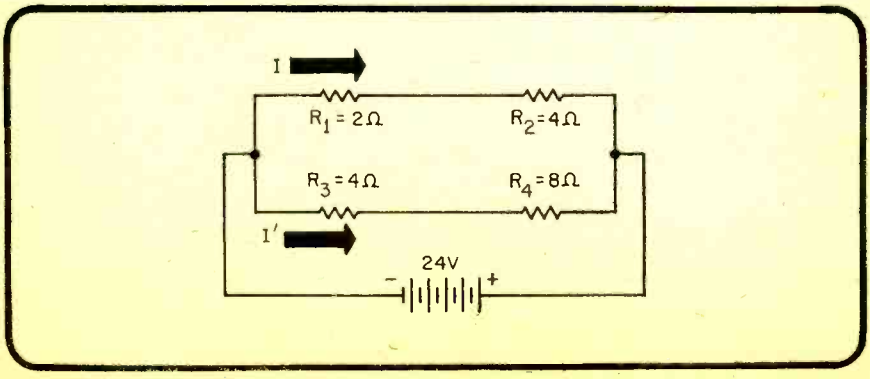
therefore,

$$\frac{I_1R_1}{I_1R_2} = \frac{I_2R_3}{I_2R_4}$$

How could the IR equation be restated in terms of resistance only? I in each ratio is the same, and it can be cancelled. Therefore:

$$\frac{R_1}{R_2} = \frac{R_3}{R_4}$$

EQUAL RESISTANCE/VOLTAGE RATIOS



Since the voltage drop across each resistor equals the leg current times the resistance, the resistances must have the same ratio as the voltages. The ratio can also be reasoned from the example.

Both resistance ratios are equal to ½:

$$\frac{2}{4} = \frac{4}{8} = \frac{1}{2}$$

The current in each leg is:

$$I = \frac{24V}{R_1 + R_2} = \frac{24V}{6\Omega} = 4 \text{ amps}$$

$$I' = \frac{24V}{R_3 \times R_4} = \frac{24V}{12\Omega} = 2 \text{ amps}$$

Both voltage ratios are ½ also.

$$\frac{IR_1}{IR_2} = \frac{I'R_3}{I'R_4}$$

$$\frac{4 \times 2}{4 \times 4} = \frac{2 \times 4}{2 \times 8} = \frac{1}{2}$$

QUESTIONS

Q4. Resistances in two parallel legs of a circuit will have a ---- potential difference between two proportional points on either resistance.

Q5. The voltage ratios in each leg of a parallel circuit must be equal to what?

ANSWERS

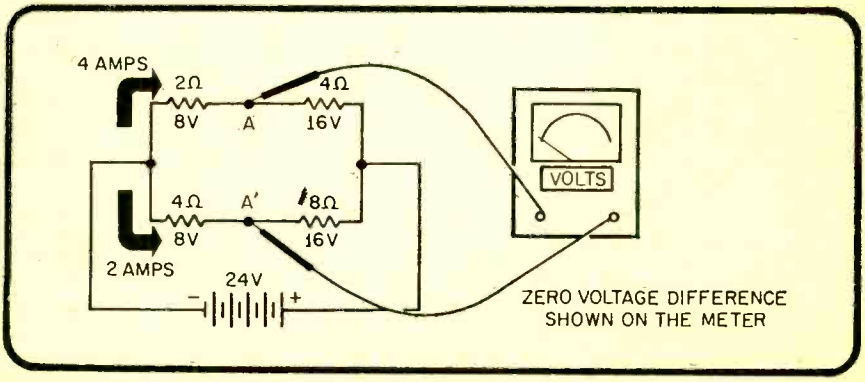
A4. Resistances in two parallel legs of a circuit will have zero potential difference between two proportional points on either resistance.

A5. The voltage ratios in each leg of a parallel circuit must be equal to the resistance ratios of the respective legs.

RESISTANCE BRIDGES

If the ratios of two resistors in each leg of a parallel network are the same, the voltages at each of the corresponding junction points between resistance pairs are the same.

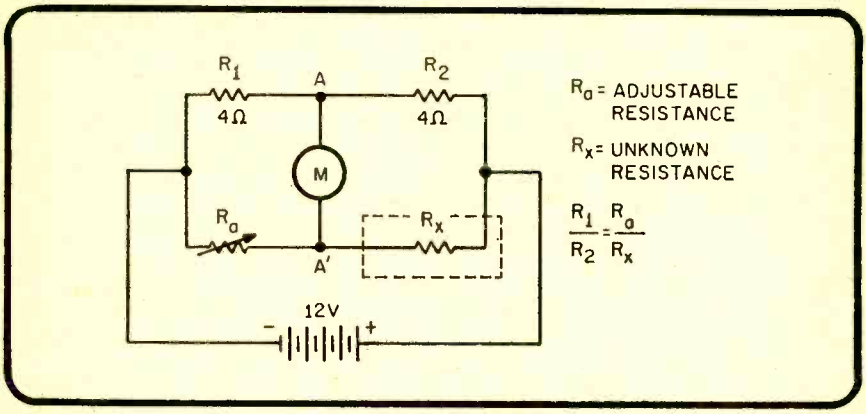
PARALLEL NETWORK RESISTANCE RATIO



Suppose the 8-ohm resistor in the illustration is changed to 4 ohms. The resistance ratios are no longer equal. The current in the lower leg is now 3 amps, and the voltage at A′ becomes 12V compared to 16V at A. The meter now reads 4V.

If you change the circuit as shown, you have a means of measuring an unknown resistance.

BRIDGE MEASUREMENT OF UNKNOWN RESISTANCE



When the resistance ratios in the legs are not equal, there will be a voltage difference between A and A′. Current will flow through the meter. When R_a is adjusted to register zero current, $R_1/R_2 = R_a/R_x$. If there were a means provided to show the value of R_a at this setting, how could you determine the value of R_x?

Assume R_a is equal to 13 ohms:

$$\frac{R_1}{R_2} = \frac{R_a}{R_x} \qquad (1)$$

$$\frac{4}{4} = \frac{1}{1} = \frac{13}{R_x};\ R_x = 13\Omega$$

If R_1 is 4Ω, R_2 is 3Ω, and R_a is 8Ω, what is the value of R_x?

$$\frac{R_1}{R_2} = \frac{R_a}{R_x}$$

$$\frac{4}{3} = \frac{8}{R_x};\ R_x = 6\Omega$$

Both problems were solved by selecting a value for R_x that would make the right-hand ratio proportional to the left. Since R_a was twice R_1, R_2 was multiplied by 2 to get R_x. When ratios do not result in these convenient multiples, the solution becomes more difficult.

Multiply both sides of equation (1) by both denominators:

$$\frac{R_2}{1} \times \frac{R_x}{1} \times \frac{R_1}{R_2} = \frac{R_a}{R_x} \times \frac{R_2}{1} \times \frac{R_x}{1}$$

Cancel like terms in numerators and denominators on either side of the equality sign. This results in:

$$R_x \times R_1 = R_a \times R_2$$

Divide both sides by R_1 to obtain

$$R_x = \frac{R_a \times R_2}{R_1} \qquad (2)$$

QUESTIONS

Q6. R_1 is 200, R_2 is 400, R_a is 80.

ANSWERS

A6. 160 ohms. $R_x = \dfrac{80 \times 400}{200}$

THE WHEATSTONE BRIDGE

You have, in effect, constructed a bridge for measuring an unknown resistance that is quite similar to an actual bridge. You have performed the mathematics required to find the value of the unknown resistance in the same manner as if you were actually using a bridge.

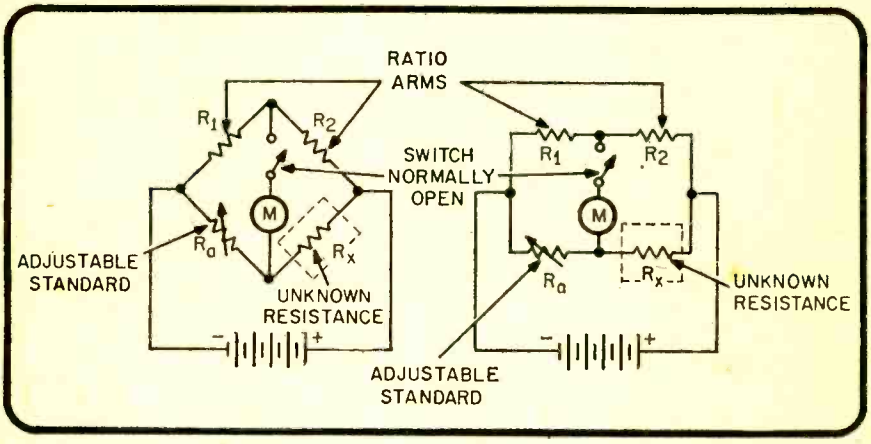
The most common type of bridge used for measurement is the Wheatstone bridge. Commercial models of this type of bridge can measure values of resistance from 1 ohm to 1 megohm with an accuracy of ±1%. More expensive models can accurately measure resistances between 0.1 ohm and approximately 12 megohms.

Necessary components include a voltage source (usually a battery for resistance measurements), an indicating device (usually a sensitive galvanometer similar to those used in multimeters), accurate standard resistances that establish the ratio for measuring purposes (R_1 and R_2), a variable resistance for achieving a voltage balance between the two parallel legs (usually an accurate potentiometer with a scale on the front panel), and a means of connecting an unknown resistance into the bridge. All parts are designed for precise values to insure the highest degree of accuracy. The meter is usually shielded to prevent stray fields from adding error or fluctuation to the reading.

Schematic Representation

In nearly all cases, the commercial bridge is shown schematically in diamond shape. Both diamond and rectangular shapes are shown.

WHEATSTONE BRIDGE CIRCUIT



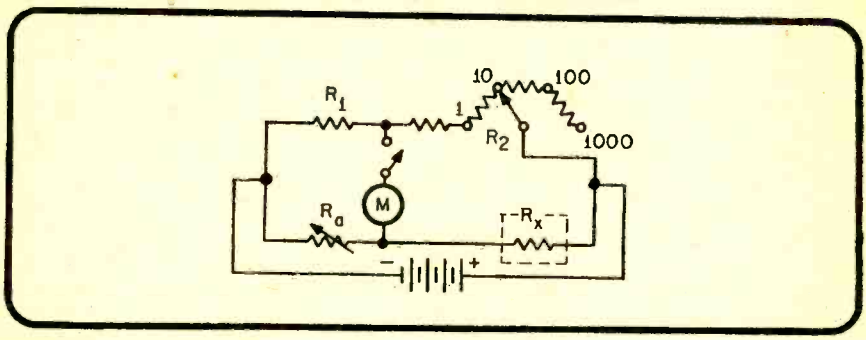
The meter is usually the type that has a center-scale zero. This permits the meter to record current going in either direction between the two parallel legs. A momentary-contact switch in series with the meter is normally open to keep the meter out of the circuit during the setting-up process. The switch is closed momentarily to observe meter deflection. The amount of deflection and its direction provide an estimate of how much R_a should be changed. Adjusting R_a for a zero reading is often called adjusting for a null.

Bridge Operation

In the typical circuit, R_2 can be set at one of four positions to establish the R_1/R_2 ratio. In position 1 the ratio is 1/1; in position 10 it is 1/10, etc.

R_a may be a single wirewound potentiometer with values calibrated on a front-panel scale, or it may be several decade (10-position) switches in series. One switch adds resistances in multiples of one, a second in multiples of 10, etc.

RESISTANCE BRIDGE OPERATION



QUESTIONS

Q7. How accurate is a good Wheatstone bridge?

Q8. What is a decade switch?

ANSWERS

A7. A good Wheatstone bridge has an accuracy of about 1%.

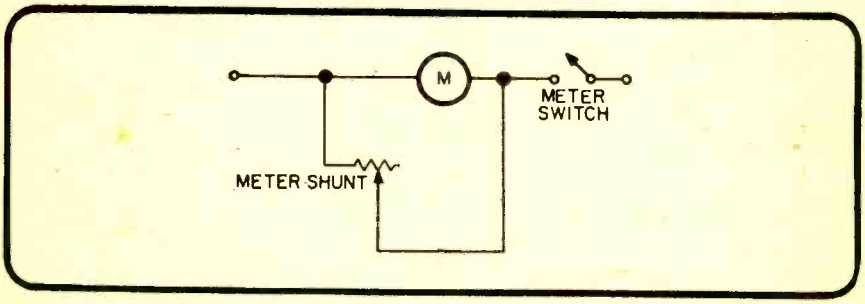
A8. A decade switch has ten calibrated contact positions.

Operating the Wheatstone Bridge

In some bridges the power supplies are variable types to provide low current for low resistances and high current for high resistances. In many models the desired current is obtained by means of a current-limiting resistance.

Since the meter could be damaged if there were a large potential difference between the two legs, the shunt resistance connected to the meter is often made variable.

PROTECTIVE METER SHUNT

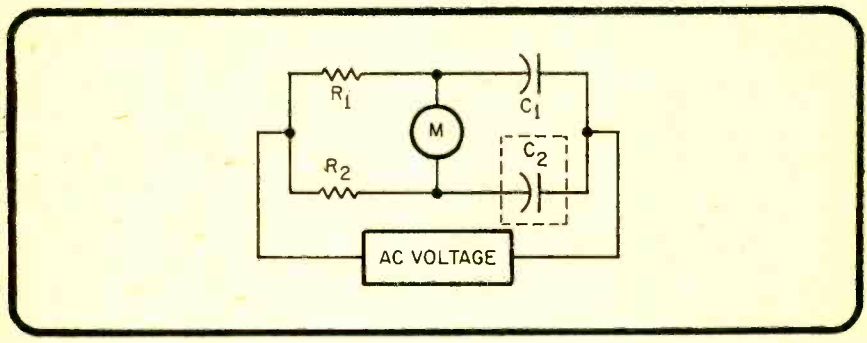


It is not often possible to make a reasonable guess as to the value of the unknown resistance. In such a case, the bridge ratio and R_a cannot be set at values that are close to the unknown, thereby keeping the potential difference across the meter to a minimum. When securing R_x to the measuring-posts, the meter shunt should be moved to its lowest resistance. The meter switch is depressed, and meter deflection is noted. As R_a and the bridge ratio are adjusted closer to the value of R_x (less difference of potential), the meter shunt is increased in resistance to permit greater sensitivity of measurement. During the final adjustment for a meter null (zero), the shunt arm is no longer contacting resistance, and all available current is flowing through the meter.

MEASURING CAPACITANCE WITH A BRIDGE

Using the same ratio principles, a bridge can also be made to measure the value of an unknown capacitance. The basic circuit is shown.

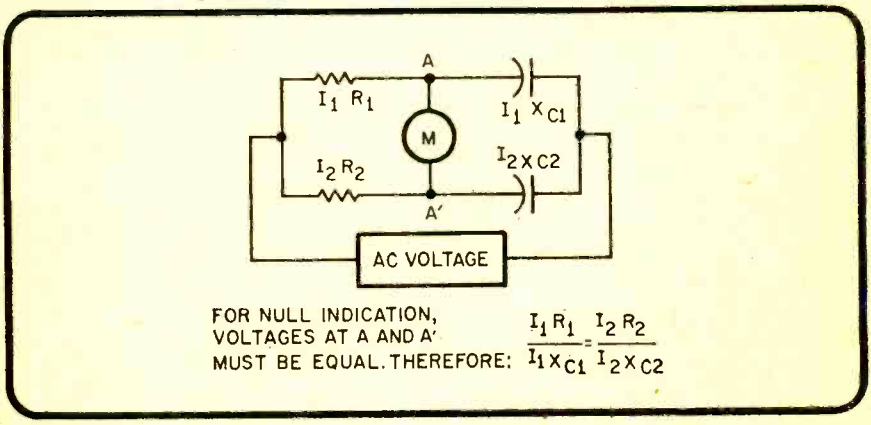
CAPACITANCE BRIDGE BASICS



A DC voltage source cannot be used because of the capacitors. As shown, the source must be AC. Most commercial models employ a frequency of either 60 or 1,000 Hz. If the instrument is designed for a 60-Hz source, voltage may be taken directly from the power line. For 1,000 Hz, some models may have an oscillator built into the bridge, and others may have provisions for connection to an external oscillator.

The principle of voltage ratios that you learned about a resistance bridge applies to the capacitance bridge as well. To obtain a null reading on the indicator, the voltage ratios in each leg of the parallel network must be proportional.

BRIDGE MEASUREMENT OF UNKNOWN CAPACITANCE



QUESTIONS

Q 9. What type of voltage source must be used in the capacitance-bridge circuit?

Q10. What type of indicator offers the greatest accuracy in a capacitance bridge?

Q11. To obtain a null reading on the indicator, the voltage ratios in each leg of the bridge must be----------.

ANSWERS

A 9. An AC voltage source must be used in a capacitance bridge.

A10. A VTVM is the most accurate indicator for a capacitance bridge.

A11. To obtain a null reading on the indicator, the voltage ratios in each leg of the bridge must be proportional.

Determining Capacitance-Bridge Ratios

As before, the current symbols cancel out, leaving ratios expressed in terms of resistance and reactance. If you wish to use the bridge for its intended purpose, reactance must be converted into capacitance.

The expression in terms of C is:

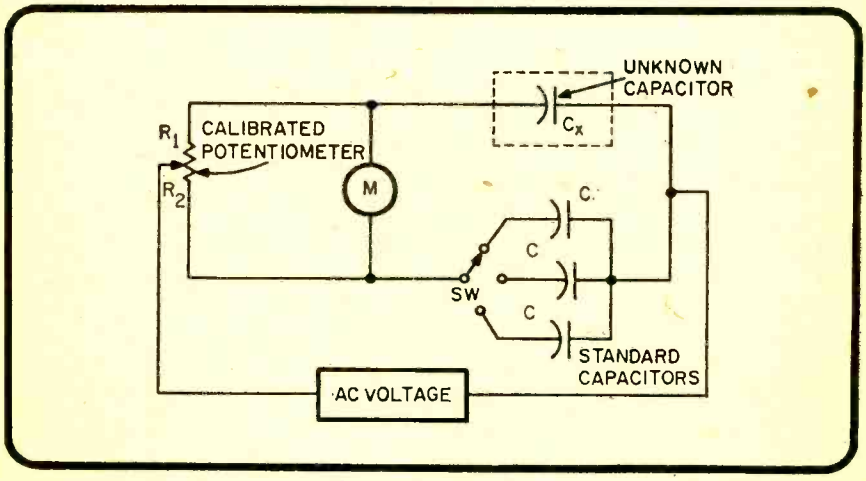
$$\frac{R_1}{R_2} = \frac{C_2}{C_1}$$

The values of C are inversely proportional to the values of R in their legs of the circuit. This makes sense because a large capacitance has a small reactance.

Practical Capacitance Bridge

The schematic for a typical capacitance bridge is shown below. A close study of this illustration will reveal that it is essentially the same type of parallel circuit as those on the preceding pages.

CAPACITANCE BRIDGE CIRCUITRY



By manipulating a switch, one of several capacitors can be selected as a standard, depending on the size of unknown C_x. A calibrated potentiometer adjusts the bridge ratio (R_1/R_2) for a null reading on the indicator. With this arrangement the arm of the potentiometer can be connected to a pointer that moves on a scale calibrated in capacitance values. This will be true only if all of the standard capacitors increase in value by the same multiple.

The above bridge is suitable for measuring capacitors with little or no series resistance and no leakage between the plates. Significant values of either series or parallel resistance (leakage) will prevent balancing the bridge. This bridge can check most paper, ceramic, mica and mylar capacitors.

QUESTIONS

Q12. What must the relationship of the standard capacitors be to permit adjustment of the potentiometer to proportional bridge ratios?

Q13. If R_1/R_2 is 1/10 and C_1 is 1,200 pF, what is the value of C_2?

ANSWERS

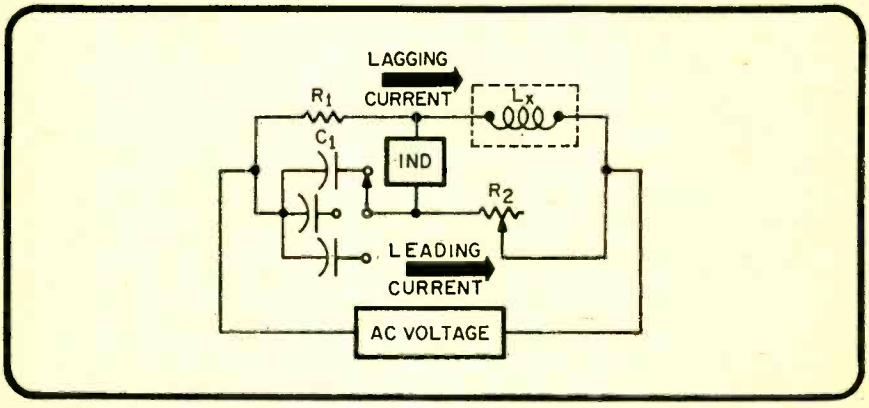
A12. The capacitors must increase in value by the same multiple.

A13. $C_2 = 120$ pF. $\frac{R_1}{R_2} = \frac{C_2}{C_1}$

MEASURING INDUCTANCE WITH A BRIDGE

Inductance can be measured with the bridge shown here. In previous bridges, a resistor was used for balancing a resistor, and a capacitor was used for balancing a capacitor.

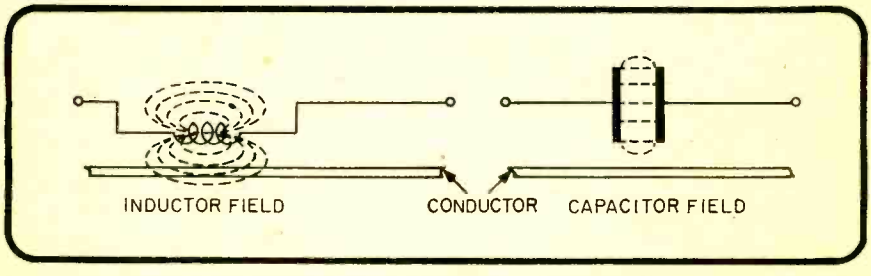
INDUCTANCE BRIDGE CIRCUITRY



In this circuit, however, a capacitor is used to balance the inductance of a coil. A standard inductance could be used in place of the capacitance, but this would result in a few undesirable conditions.

The illustration shows how the electromagnetic field around a coil can cut through a conductor and induce error-producing currents. The capacitor electrostatic field, however, is mostly contained within the capacitor. An additional advantage of the capacitor is that it does not pick up stray fields as a coil does.

INDUCTOR FIELD CAN CAUSE ERROR



If inductors were used to balance the bridge, they would be larger and more expensive than equivalent capacitors. Size and cost of the instrument would be greater. Finally, the same capacitors can be used for measuring both inductance and capacitance in the same bridge.

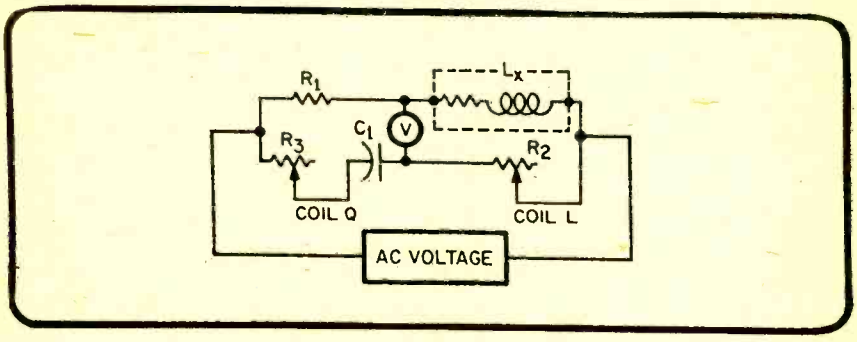
Using a capacitor opposite an inductor in a bridge, however, has one disadvantage. The current through the coil branch lags the current through the capacitor branch. This phase difference makes it impossible to balance the bridge. This condition can be compensated for by placing the unknown coil and the standard capacitor in opposite legs of the bridge across the indicator, as shown.

Typical Inductance Bridge

In the inductance bridge and the one just discussed, a null condition is established by the values of C_1 and R_2. With a proper value of C_1, R_2 (a variable resistance) is adjusted for a zero reading. The position on a front-panel scale of a pointer linked to R_2 indicates

the value of L_x.

Q AND L MEASUREMENT CIRCUITRY



Measuring the Q of an Inductor

An inductor has a Q level, or figure of merit, that is its reactance-to-resistance ratio ($2\pi fL/R$). Resistance is that of the wire used in the coil and is considered to be in series with its reactance. Heavy wire and a small number of turns produce a high Q; a smaller wire and more turns produce a lower Q. Since Q, a measure of quality, is a factor used to determine the sharpness of resonance of a circuit employing both L and C, it is desirable that the Q of the coil be measured. R_3 in the circuit is used for this purpose. Its scale can be calibrated in Q.

QUESTIONS

Q14. What is used to balance the coil inductance in an inductance bridge?

ANSWERS

A14. A capacitor is used to balance the inductance of the coil in an inductance bridge.

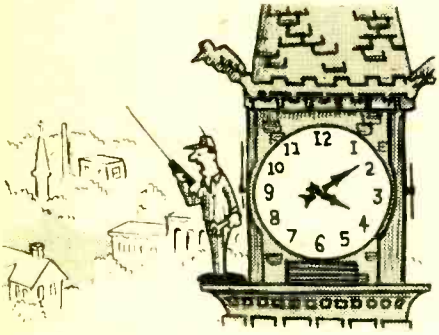
WHAT YOU HAVE LEARNED

1. A bridge is a test instrument capable of accurately measuring resistance, capacitance, inductance, and reactance. Although a bridge may not have a scale calibrated in reactance, you can determine reactance if you know C or L and the frequency.
2. The Wheatstone bridge utilizes the basic principle on which all bridge circuits are built. The arrangement of the bridge elements is such that the voltage ratios between the elements in the parallel legs can be adjustd to achieve a null (zero current) in an indicator placed between the parallel legs.
3. Each bridge requires a source of voltage, a parallel network containing sufficient variable elements to balance the bridge, an indicator to determine when the bridge is balanced (null indication), a scale to determine the ratio of the elements involved or a direct readout of the unknown value, and operating controls and jacks.
4. A resistance bridge contains a DC voltage source, a sensitive DC meter, and a parallel network of resistances. When a condition of balance exists, the unknown resistance can be determined by a direct reading from a calibrated scale or by calculation.
5. A capacitance bridge contains an AC voltage source, a sensitive AC meter (or headphones), and a parallel network of resistance and capacitance.
6. An inductance bridge contains the same voltage source and indicating devices as the capacitance bridge, but its parallel network is normally made up of resistance, capacitance, and the unknown inductance.

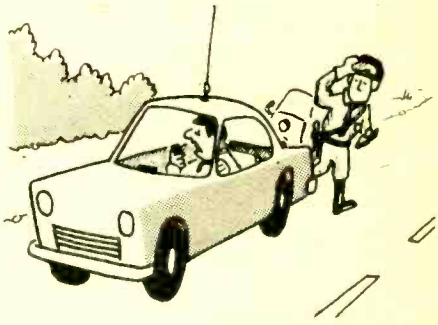
This series is based on material appearing in Vol. 4 of the 5-volume set, BASIC ELECTRICITY/ELECTRONICS, published by Howard W. Sams & Co., Inc. @ $22.50. For information on the complete set, write the publisher at 4300 West 62nd St., Indianapolis, Ind. 46268.

10-10-4-4

by Jack Schmidt



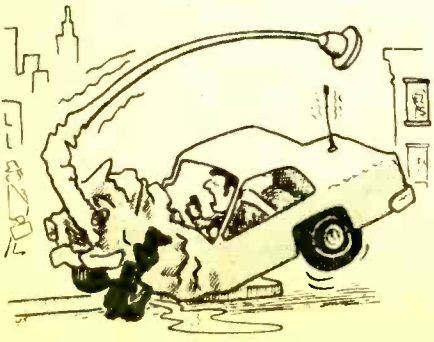
"10-36?"



"10-95 . . . East Main and Union."

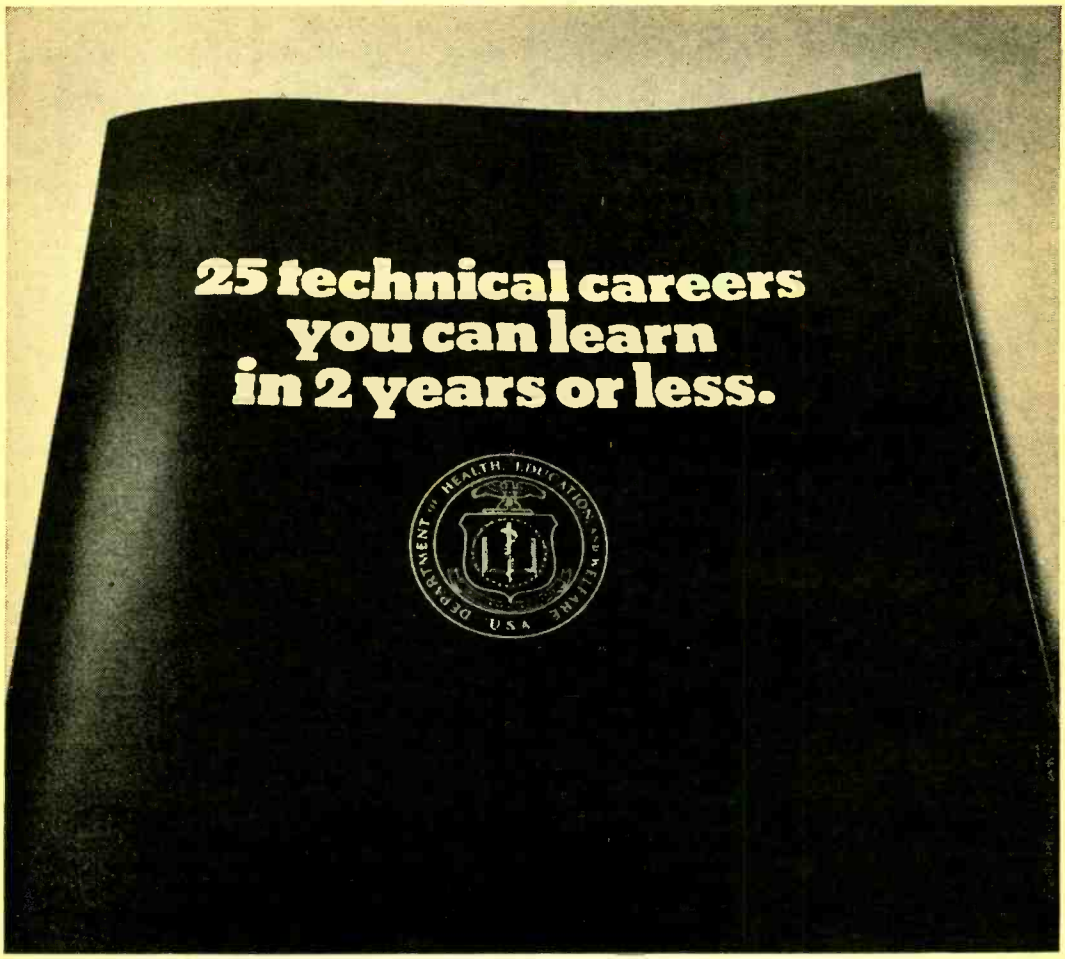
". . . 10-70 . . . 10-70 . . . 10-70!"

". . . 10-35 . . ."



"10-33 . . ."

"10-12!"



How far can you go without four years of college? Here's what the U.S. Government says about it in a booklet published by the U.S. Office of Education:

"A lot of people think that careers are meant for college graduates—jobs are for everybody else.

"Ten years ago, they may have had a point.

"But something's happened recently to change all that. A revolution in science and technology...

"You no longer need four years of college to start out on a scientific or technical career.

"You can break into any field—from medicine to computers to engineering to the space program—with only a year or two of education. Just become a technician."

Free Guidance Materials

To help you select the technical career field that's right for you, we've listed opportunities on the attached postpaid card and in the special coupon, at right. And you can find out what you should know about the field you like best by simply checking off your choice and mailing the card or coupon today.

Free Guidance Booklet

By return mail, you will receive a free ICS Career Guidance Booklet that describes the opportunities, income and job security you might expect in your newly-chosen field. It will also explain how ICS can help you get the training you need to break into this new career field...right in your home...during your spare time...without losing a single day's pay from your present job ...and without ever setting foot in a classroom.

Free "Demonstration Lesson"

In addition, you'll receive a free "Demonstration Lesson" that lets you see for yourself why picking up the job skills you need—the ICS way—may be easier than you think.

More than 8,500,000 men and women have turned to ICS for career training since 1890. Some 2,000 American firms and government agencies are using ICS training programs to upgrade their employees. (Among these firms are such names as Ford, U.S. Steel, Chrysler, Mobil, 3M Company,

Take advantage of this U.S. Government booklet and get started in a big-income career.

"...you no longer need four years of college to start out on a scientific or technical career.

"You can break into any field—from medicine to computers to engineering to the space program—with only a year or two of education. Just become a technician." *U.S. Office of Education*

Alcoa, Pan Am, GE, Motorola and RCA.)

ICS career training is approved for veterans training, and is Accredited by the Accrediting Commission of the National Home Study Council. Just mail the card or coupon for your free guidance materials.

(If card is missing, use coupon and mail to: ICS, Scranton, Pa. 18515) ©1973 I.C.S.

ICS International Correspondence Schools
Scranton, Pennsylvania 18515 RA737Y

Please send me free ICS Career Guidance Booklet and a free "Demonstration Lesson" for the field I have checked below. I understand I am under no obligation.

- ☐ Electronics Technician
- ☐ Air Conditioning, Refrigeration & Heating
- ☐ Automotive Mechanics
- ☐ Auto Body Rebuilding Specialist
- ☐ Engineering (Civil, Electrical, Mechanical, Chemical)
- ☐ Communications/ Broadcasting
- ☐ Computer Servicing
- ☐ Diesel, Gas Mechanic
- ☐ Surveying & Mapping
- ☐ Drafting (Mechanical)
- ☐ Electrician
- ☐ Architecture
- ☐ Engineering Technician
- ☐ FCC Licensing
- ☐ TV Servicing & Repair
- ☐ CATV Tech.

☐ Check here for special information, if age 16 or under

NAME _____ AGE _____

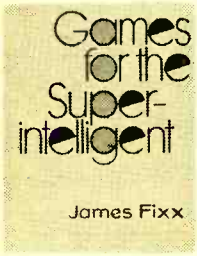
ADDRESS _____ APT. _____

CITY _____ STATE _____ ZIP _____

Bookmark

Continued from page 66

formation, circle No. 54 on Reader Service Page.

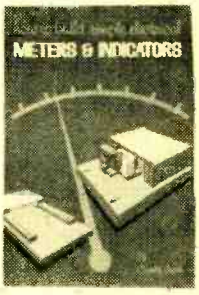


Hard cover
86 pages
$4.95

For the Repairman. Here's a brand-new approach to understanding and troubleshooting all types of solid-state circuits. *Solid-State Circuit Troubleshooting Guide* by Art Margolis helps clear up any misunderstandings any reader may have about solid-state circuits. As is typical of Margolis' books, this new volume is written in simple, easy-to-understand language, and is presented in a way that will sweep away any existing cobwebs one might have. The first four Chapters discuss the various types of solid-state devices—operation diodes, transistors, field-effect transistors, integrated circuits and silicon controlled rectifiers—and tell how they are made. Then, getting into the real meat of the subject, the author describes how these devices work in typical circuits one is likely to encounter, and shows how to go about finding a faulty component. Throughout, the book is literally loaded with actual schematic diagrams of typical solid-state circuits. In every case, Margolis also offers tangible, practical suggestions on how to align and service the circuits described. A unique feature is the many "service thinking" charts included, designed to help the reader understand and refine his troubleshooting logic. Published by Tab Books. Get the details on this and other books by circling No. 51 on Reader Service Page.

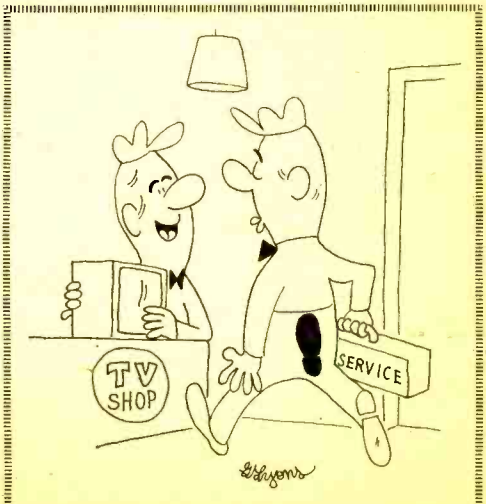
Soft cover
224 pages
150 illustrations
$4.95

Build a Meter. One of our boys, author Charles Green, has written an informative book, *How to Build Electrical Meters & Indicators.* Would you like to build a chemical polarity indicator? How about a thermocouple or heated-wire meter? These and many other simple electrical-meter and indicator projects are presented especially for the hobbyist or anyone who wishes to learn the fundamentals of electrical instrumentation. In fact, this new and easy-to-read book discusses projects that represent steps in the evolution of electricity, from amber heads and lodestones to the alternating-current generators that supply the power for our civilization. Simple projects are covered first, gradually



Soft cover
128 pages
$3.95

increasing in complexity. They range from basic experiments with pith balls, electroscopes, and galvanic cells to a working example of the moving-coil meter. Other projects include the magnetometer, the polarized-vane meter, and the moving-iron meter. The necessary construction materials and tools are found in almost every home workshop or can be easily purchased from hardware stores. The more advanced projects may require borrowing a few meters for calibration. To simplify construction, the projects include parts lists, pictorial sketches, schematic diagrams, and photos. This book is ideal for the beginning technician, hobbyist, instrument maker or future scientist. Your old Bookworm recommends it highly. Published by Howard W. Sams & Co., Inc. Get all the facts direct by circling No. 53 on Reader Service page.

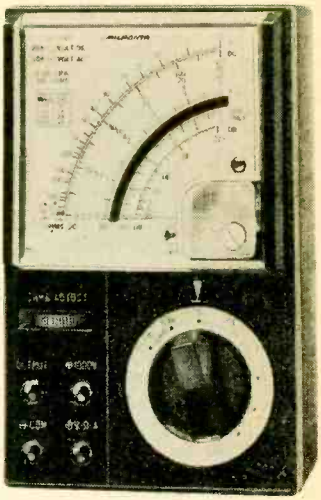


"How'd our new rate hike go over?"

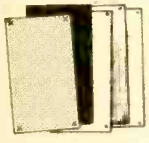
RADIO SHACK IS ELECTRONIC PARTS PARADISE!

WE'RE *"THE PARTS PLACE"* FOR MAGAZINE PROJECTS AND DO-IT-YOURSELF EXPERIMENTS!

VARIABLE DC POWER SUPPLY. Dual voltage range selector for 0-12 and 12-24 volts. Input: 120 VAC at 60 Hz. Output current: 1.0 amp constant over entire range with 1.5 amp surge. Control adjusts output from 0-24 volts. Equipped with circuit breaker and housed in metal case. 7-1/4 x 5-3/8 x 3". U. L. listed. **29.95**

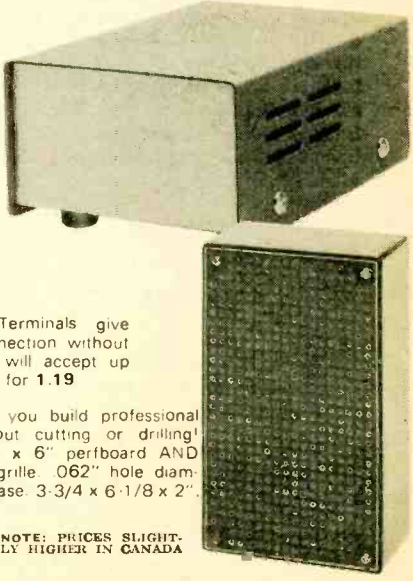


20,000 OHMS/VOLT MULTITESTER. Low-priced VOM has "expensive model" features and 17 ranges. Reads DC volts: 0-5-25-125-500-1000 at 20k ohms/volt. AC volts: 0-10-50-250-1000 at 10k ohms/volt. DC current: 0-50 μA, 0-250 mA. Ohms: 0-6k-60k. dB: — 20 to + 62. Mirrored scale. Leads, battery, instructions. 4-5/8 x 3 x 1-1/8". **11.95**



Five-Piece Panel Set — 3 perf-boards, aluminum panel and bakelite panel. 1/16" thick, 1/16" holes. 6 x 3-1/2" **1.89**

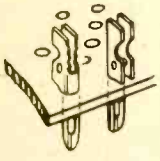
Deluxe Metal Cabinets. Builders' boxes for most any project! Sturdy 2-piece construction. #18-gauge steel cover, aluminum front and real panels. Cabinets are louvered for ventilation. Rubber mounting feet. 3-1/4 x 2-3/16 x 4", **1.69**; 4 x 2-3/8 x 6", **2.59**; 5-1/4 x 3 x 5-7/8", **3.49**



Pre-Punched Perfboards. Mixed sizes, 1½ to 3" square. 1/16" and 3/32" hole sizes. Set of 10. **1.19**

40-Piece "Twin Pack." Transistors. Popular types and packages. For RF and audio uses. **1.98**

Solderless Spring Terminals give strong, positive connection without soldering. Terminals will accept up to 8 leads. Set of 20 for **1.19**



"Push-in Terminals are made for use with pre-punched perfboards and hold multiple leads fast without staking. 1/16" diameter. 100-piece assortment. **1.59**

Perfbox® lets you build professional projects without cutting or drilling! Pre-drilled 3½ x 6" perfboard AND 2¼" speaker grille. .062" hole diameter. Bakelite case. 3-3/4 x 6-1/8 x 2". **1.89**

FREE '73 CATALOG! AT YOUR NEARBY STORE OR SEND IN THIS COUPON 205

180 pages! Stereo Hi-Fi, CB, Ham, Kits, Radios, Recorders, Tools, More!

Name _____ Apt. # _____

Street _____

City _____ State _____ Zip [ ][ ][ ][ ][ ]

NOTE: PRICES SLIGHTLY HIGHER IN CANADA

1600 Stores In All 50 States!

Radio Shack®

and ALLIED RADIO STORES

A TANDY CORPORATION COMPANY

P. O. Box 1052, Fort Worth, Texas 76107

CIRCLE NO. 32 ON PAGE 17 OR 103

Hey Herb

Continued from page 34

Try some rubber dressing on the drive belt. It's not uncommon for a rubber or plastic belt (or pulley) running at high speed to develop high static voltages which eventually arc to a grounded component. I have a Revox reel recorder that does this on rewind. It drives me up the wall (I can't eliminate the discharge), but luckily it doesn't affect the recording.

Hey Herb: My brand new amplifier causes the speaker cone to oscillate at a very slow rate even when there's no signal input. I can't hear anything but knowing it's there disturbs me. Could this oscillation damage the speaker?

Yes or no, depending on the severity of the oscillations. I suspect something is wrong with the filtering in the low level amplifier(s) power source, and I suggest you take the amplifier back to the dealer as you might be literally tearing the guts out of the speakers. (If you had specified whose amplifier I could have given you a better answer.)

Hey Herb: What is the meaning of the term *Dynagroove* that RCA features on their record jackets?

Dynagroove refers to a complete system that RCA developed which they claim results in a quieter disc with reduced flutter and a sound quality that more closely duplicates in the home the characteristics of sound heard in a concert hall. Many things go into the total system such as high speed master tapes, but the predominant feature is a dynamic spectrum equalizer that boosts the bass (on the record) at lower volumes, blending to reduced upper bass and accentuated highs at higher volumes.

Hey Herb: I challenege your denigration of the DIN standards. Don't you believe standards insure a high level of performance?

If you are talking about performance standards the answer is, of course, *yes*. But the DIN, also known as "Das Is Normal" is an industrial, not a performance standard. It insures that the valve used on a tank of gas is always the same, one valve will fit all tanks: not like in this country where the valve you own might not fit the tank you rent. The DIN also insures that every plug and socket for a given purpose fits together regardless who is the manufacturer. And the DIN insures that the output level of one amplifier mates with the input of another, and the DIN insures that all equipment of a given type will be tested the same way, such as film or FM tuners. But the DIN does not specify a good-bad or good-better-best performance standard. This nonsense started with the European publications which would proudly proclaim that such-and-such equipment met DIN standard No. WXYZ. Those folks across the big pond just love standards (a carryover of a respect for authority), but they were hornswoggled into accepting an industrial standard as a performance standard, then some clowns over here latched onto the idea, and there's a sucker born every minute. Contrast this to the Japanese, who latched onto the 20-20 kHz power response, which is really a professional standard.

I also appreciate "standards", particularly when I try to fit my right-hand threaded gas regulator to a tank of nitrogen gas with a left hand thread, but I do not confuse industrial with quality audio performance standards. ■

Herb would like to answer all the questions our readers send. However, he can only sample the questions received and answer as many as possible through this column. Sorry, It's impossible to answer questions by return mail. Questions of a personal listening nature cannot be answered. Send your questions to Hey Herb, ELEMENTARY ELECTRONICS, 229 Park Avenue So., New York NY 10003.

Ask Hank, He Knows

Continued from page 22

ever relay K2 is energized, *ON* lamp I2, which is connected across the coil of K2, comes on and stays on as long as power is supplied to relay K2. When power is first supplied to the circuit *UNLOCK* lamp I3 comes on and remains on except when relay K2 is energized. This action opens contacts 3 and 4 on relay K2 disconnecting *UNLOCK* lamp I3 from the power supply. To deenergize relay K2, depress pushbutton *RELEASE* switch S2 (a normally closed switch) which disconnects power to relay K2. This turns on *UNLOCK* lamp I3 and turns off *POWER* lamp I2. Now dear reader, what happens when both pushbutton switches S1 and S2 are pressed on at the same time? You guessed it—wait til next issue.

They Are All the Same

What causes static in the volume control of a solid-state pocket radio?

—D. G., Camden AK

Back to basics—what causes static in any volume control in any circuit—solid-state or vacumn tube? The answer is—a dirty or loose contact inside the potentiometer. Controls of this type position a contact across the surface of a composition resistor as the shaft is rotated. Spring tension keeps the pressure contact for sure electrical connection. A little dirt or a poor spring will cause some intermittent contact—or the static you hear. Best bet is to replace the control at once. There are a lot of control washers on the marketplace that help remove the static, but, they, at best, are only a temporary solution. Slide controls cause less problems but they go bad, too! ■

free.

We have gathered many important, informative booklets on just about everything that interests a person like yourself. They deal with your leisure. Money. Health. Many other vital matters. You may have any or all of them absolutely free just by mailing in the coupon. No salesman will call and you are under no obligation to buy anything. Please read on.

Consumer Discovery Service was founded to do just one thing: put interesting, valuable information in your hands. Information you might not know how or where to get. We want you to have this material free and not be concerned by salesmen's solicitations. If you decide to buy any of the products or services mentioned in these brochures all well and good. If you don't that's okay with the fine, reputable companies whom we represent, and who prepared them for you. They're grateful for your reading interest.

1. How to find and afford the way-out fun places in the world.
2. How your money can make more money—and pay no taxes.
3. How to learn to ski in one week.
4. How to secure more income from U.S. government securities.
5. Opportunities for executives in quality franchises.
6. Interesting opportunities for attorneys.
7. How to learn about finance and investments.
8. Fascinating one week deluxe winter cultural tours to Europe.
9. Leather crafting projects for the hobbiest.
10. How to learn all about wine.
11. How to invest in a portfolio of high quality common stocks for growth and income.
12. How to invest in a mutual fund that believes todays energy crisis presents an important opportunity.
13. How small portfolios can be custom managed.
14. How to save hundreds of dollars buying a car.
15. Life insurance for people over 55, with no medical exam.
16. How you can enjoy the world's great art in your own home.
17. 101 things you may not know about water.

CONSUMER DISCOVERY SERVICE, INC.
370 Seventh Avenue
New York, N.Y. 10001

Please send me free the kit/kits (up to 6) circled below:

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

Name_____

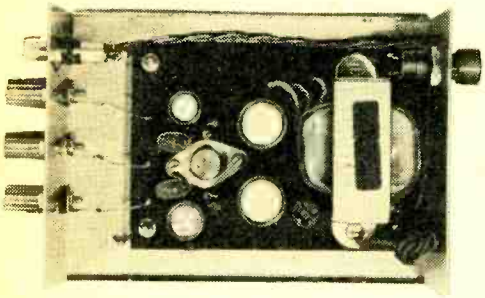
Address_____

City_____ State_____ Zip_____

EE-33

Bi-Polar Power Supply

Continued from page 53



Birds eye view of the 15 V bi-polar power supply for professional-type applications.

wrong. Make certain the space between the pins faces the nearest edge of the PC board, then secure IC1 with two short #6 screws. Install power transformer T1 and all other components. T1 has several unused leads, simply cut them off at the transformer with diagonal cutters.

Current limiting resistors R1 and R2 should be 4 ohms, a somewhat expensive and difficult value to obtain. You can substitute two parallel 10 ohm, 10 percent, ½-watt resistors (Radio Shack series 271-000); the board already has the extra mounting holes for two resistors at R1 and two resistors at R2. The difference between the required 4 ohms and the resultant 5 ohms from the parallel resistors will have no appreciable affect on the power supply operation.

To make a bench supply, the PC assembly can be installed in a metal cabinet as shown. The three output terminals are 5-way binding posts. Two outside posts, used for the + and − voltage outputs, are insulated from the cabinet. The center terminal, the common ground, is connected to the cabinet by its own mounting nut (do not place an insulator under the nut).

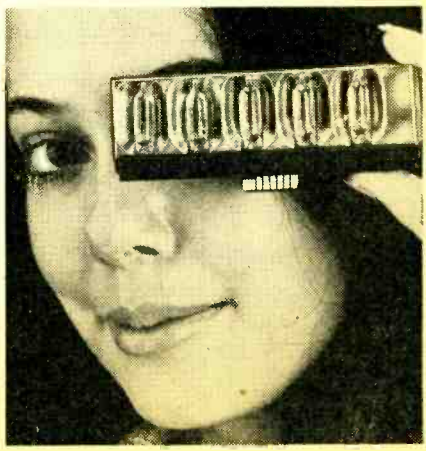
Power switch S1 mounts on the rear apron and can be any type of SPST switch. To prevent the foil on the underside of the PC board from shorting to the cabinet use a ¼-in. metal speacer or stack of washers between the board and cabinet at each mounting hole. If desired, a neon pilot lamp can be installed. Make certain the pilot lamp is the type with a built in current limiting resistors of 56,000 to 200,000 ohms.

Service Note. If the power supply fails to operate properly, if, for example, there is voltage on one side but not on the other, or if both voltages are extremely low, it is most likely that the polarity of C1, C2, C5 or C6 is reversed. Take extra care to check that C2 and C6 have their *positive* terminal connected to ground. If you use the Radio Shack capacitors specified in the parts list, all polarities are correct when the vertical arrow on each capacitor faces the same direction. But don't take chances. The capacitors you get might have the arrow misprinted or used to denote another polarity. Doublecheck that the polarity is correct.

If the capacitor polarities are correct and the output voltage is nearly correct but tends to wander, if the output voltage can't settle down to a rock steady value when current is drawn, it is most likely that you have used the wrong primary connections on T1. The proper wires are color-coded. Use a secondary output voltage of 40 volts rms center-tapped (20-0-20). ■

Fire When Ready

A revolutionary new, rapid-fire photoflash device containing 10 tiny flashbulbs was designed especially for the Polaroid Corporation's new SX-70 camera. The slim, rectangular flash array, dubbed the *FlashBar 10*, is about four inches wide and consists of two rows of five flashbulbs and a reflector unit enclosed in a light blue plastic cover. A tab on the unit's base fits into the camera and provides electrical contact. The remarkable Polaroid SX-70 camera and the automated GE flash system make it possible to fire 10 flash exposures in under 30 seconds. Flash reliability is assured by a fresh battery contained in each new film pack. To operate, *Flashbar 10* is placed on the camera with either side facing the subject. A bulb is flashed each time the button is pressed. ■



Matrix 4-Channel

Continued from page 65

each leg of the star, the decoding is essentially the ultimate that can be expected of a matrix system limited to a 20 to 20,000-Hz bandwidth. Also, accept that other enhanced matrix systems can accomplish the same ends; unfortunately, they take more hardware than the SQ system and are not presently available.

Of course, there are people who have the same attitude towards tests run with sinewave signals as those expressed towards psychoacoustics at the beginning of this article. To them, the total sound quality as it affects *program* is the most important consideration. Figs. 8 and 9 represent 500 msec of band music; the trumpets at LF are predominant in the original scoring. Fig. 8 is the program processed by a basic SQ decoder; Fig. 9 is the same 500 msec of program processed by a full-logic decoder. Note how the full-logic enhances the LF trumpets, reducing the spill into the opposite quadrants. The listening effect is almost that of discrete surround-sound.

While we're still on the subject of full-logic let's take a look at what it does to programs recorded with the same QS matrix. Fig. 10 is the same 500 msec of program used to illustrate Figs. 5 and 6. If you recall, the vocalist on the QS recording moved towards the right and rear when processed by an SQ decoder. Now, as shown in Fig. 10, full-logic seizes the SQ's predominantly right-side vocalist and moves him even further to the right with even greater signal strength in the RB. In fact, through speakers the vocalist definitely appears at RB (right-back)—and it's a better, more spectacular effect than originally recorded. (Of course, if we had an enhancement QS decode the program would sound even more spectacular—but there presently is no such thing available.)

Finally, let's end by showing what happens when all four corners receive a simultaneous in-phase SQ signal, as this will show all the "garbage" produced by side signals. Fig. 11 is the full-logic decoder; the output is very good, with the total side effects represented by the small smear at the center. Fig. 12 is the output from a basic SQ decoder produced by one of the most famous names in hi-fi—we will save them embarrassment. Actually, Fig. 12 has considerable rear-quadrant information, but the levels and phasing are so badly scrambled they cancel through the oscilloscope equipment, whose display happens to match what a listener will hear if located at the center of the sound field. Fig. 13 is the SQ output from an EVX-44 decoder. Results are quite good; the *hash* at the right (which might not show in the magazine reproduction) is in-phase information between RF and RB; this degree of in-phase information is not evident from LF to LB. However, as with all things about matrix sound, it sounds very good to the ear.

It's important to take note of the fact that except for laboratory test records which provided the sinewave test signals, and the laboratory prepared 500-msec program tapes recorded on a phase-matched Revox A77 tape recoder, all playback equipment were standard quality items as might be used or purchased by the average stereophile, for the purpose of the tests were simply to show what surround-sound characteristics will be realized from hi-performance consumer equipments. The basic equipment consisted of an Empire Troubador turntable, Empire 1000ZE/X and Shure V15 Type II pickups (and only those results are shown which could be duplicated on both pickups), a Lafayette LR-4000 receiver and the latest Tektronix oscilloscope equipment specially modified for 4-channel display.

If we were forced to select one single outstanding aspect of the matrix situation, it would be that *all* decoders should have full wave-matching logic or any electrical system that could provide essentially the same degree of quadrant enhancement. It is a shame that any matrix systems were released before their overall performance reasonably approached that of full-logic, for not only does full-logic greatly enhance the performance level of its own encoding; it also provides spectacular enhancement and effects from other encoding formulas. And that's the logic of it all. ■

Quicky Book Review

● *Electronic Concepts: A Self-Instructional Programmed Manual* by Jester Robinson, published by Reston Publishing Company, Inc.; essential to the beginning engineers to whom a knowledge of electronic concepts is a prerequisite; hard cover, 465 pages, $9.95; circle No. 48 on Reader Service Page.

FM Antennas

Continued from page 40

bring you closer to the transmitter. If you're thirty miles from the transmitter, such a rig will provide your tuner with the same signal strength as would a dipole slightly more than ten miles out. The six-element antenna brings you almost two-thirds of the way in! It'll make the difference between marginal and excellent performance.

Usually as the gain goes up, so does the directionality. Especially in fringe areas, you will probably be listening to stations originating from several different locations. In that case a rotor is a must.

Avoid the temptation to buy a small antenna with less gain and try to make it up with a *booster*. Unless you have a very poor tuner, the noise figure of the booster will be worse than that of your tuner. That means it will add more noise to the signal than if you didn't have it at all! Assuming you have a good tuner, there are only two valid reasons for having a booster on the antenna.

The first is if you must run in an excessively long lead, say several hundred feet. The signal will be attenuated by the lead-in, so an antenna-mounted booster might help.

The second reason is if you are splitting the signal from one antenna among many sets. The extra boost before splitting it up will give extra signal to each tuner.

In any case you should never expect the booster to substitute for a good antenna. A better antenna is the only way to get more signal without more noise. So a booster should only be considered as a last resort when you already have the best antenna possible. If you do need the booster, it should be mounted right at the antenna, not at the tuner end of the lead-in.

Suburban Reception. Some think all good things come to suburbia and it's true at least as far as FM reception is concerned. The urban multipath problems aren't quite as severe and the signal strength hasn't dropped off to fringe area levels. If you can get by with a twin-lead dipole anywhere, this is the place. It's certainly worth a try, but if you are a suburban dweller and you're not pleased with the FM reception, try at least a simple outdoor antenna, say a dipole with reflector or possibly a three- or four-element Yagi type. You'll be pleasantly surprised.

In a way, it's surprising that tuner manufacturers include the twin-lead dipole with their product. It's rare that it will show off their equipment in its best light and it misleads he consumer in what he can expect from good FM reception. ■

B&K Curve Tracer

Continued from page 48

base current. A graticle overlay is provided for step measurements on 5-in. CRTs, though any present scope calibration can be used, as shown in the photographs.

Scope Photos. Figure 1 is the family of curves from a variety-pack NPN transistor. Note the very bottom curve lying at the bottom of the graticle, evidencing very low leakage. In Fig. 2 we see a collector breakdown; since the graticle is (user) calibrated to 5 V/div we can see that the collector breaks down at approximately 35 VDC, indicating that this 10-for-a-$1 transistor could be used with collector voltages up to 30 VDC. (Though the collector current at breakdown rises sharply, automatic current limiting in the curve tracer prevents transistor destruction.)

Figures 3 and 4 show how the curve tracer can be used to sort the garbage from inexpensive *grab bag* assortments. In this instance, 15 Zener diodes for 69¢. The horizontal 'scope calibration is 2 V/div. Figure 3 shows the reverse avalanche (right to left) of one of the good Zeners, a good clean breakdown at 10 volts. Figure 4 shows another Zener diode from the same assortment; obviously this Zener is defective (there were nine duds out of fifteen), had you used it in a project you would have spent unnecessary hours or days trying to figure out your "wiring error."

Multi-Use Tool. It is therefore plain that not only is the B & K curve tracer valuable as a service tool, it is also of value to the hobbyist since he can check out each device before it is installed in his project.

In addition to transistors, signal, and rectifier diodes, the 501A curve tracer can be used to check FETs, UJTs, SCRs, TRIACS and Tunnel Diodes. Though the curve tracer is intended for use with B & K 'scopes, for which a calibrated external graticle is provided, it can be used with any 'scope having

ELEMENTARY

READER SERVICE PAGE

ELECTRONICS

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

• The coupon below is designed for your convenience. Just circle the numbers that appear next to the advertisement or editorial mention that interests you. Then, carefully print your name and address on the coupon. Cut out the coupon and mail to ELEMENTARY ELECTRONICS, Box 886, Ansonia Station, New York, N.Y. 10023. Do it today!

MAY/JUNE 1973 — Void after September 30, 1973

ELEMENTARY ELECTRONICS

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

Please arrange to have literature whose numbers I have circled at right sent to me as soon as possible. I understand that this is a free service offered by the magazine.

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70

• Please limit circled items to 12 maximum.

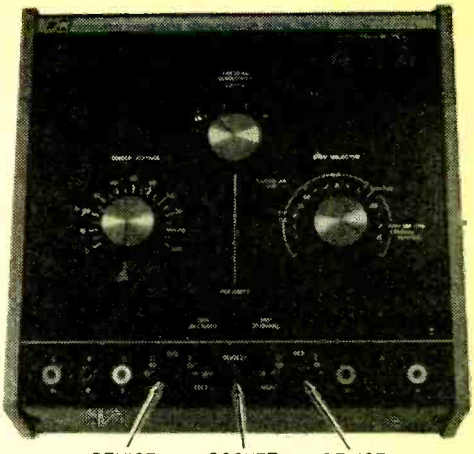
Name (Print Clearly)_____

Address_____

City_____ State_____ Zip Code_____

direct coupled H and V inputs. The graticle overlay can also be adapted to other 'scopes, or the existing graticle can be marked with a grease pencil for calibration.

Summing Up. The B & K 501A Semiconductor Curve Tracer is a valuable addition to any service or experimenter shop; for in this day and age of complex solid-state equipment, it insures the precise match of specifications so often necessary for proper or optimum performance. For additional information circle No. 42 on the reader service page. ■



B & K 501A Semiconductor Curve Tracer

Kathi's CB Carousel

Continued from page 50

$100 price range. And, it was a lot better than many under $100 VHF receivers. I've had the Lo band translator bouncing around in my XKE for over a week, and the frequency stability has been rock-steady.

Of course, the translators are not DX'ers, but they are bringing in the local fuzz, firefighters and forecasts from our local weather station every bit as well as my gold-plated VHF scanner. So what more can I ask of them?

Take a tip from Kathi, however, and don't try to get by with a piece of wire as a VHF antenna. You wouldn't do it with a scanner, so don't do it with a translator. If you use the translator at your base, put up a VHF antenna even if it's on the desk (they're very small). If you go mobile, put a VHF/BCB cowl-mount antenna on the fender (it won't affect the car's trade-in value since it uses the same mounting hole as the regular AM-only antenna).

And don't overlook the fact that you can stack the Lo and Hi band scanners. The CB antenna can feed through both units to the CB transceiver. You'll need separate Lo and Hi band antennas, though you can use a single antenna if you can locate a splitter.

Summing Up. If you're already equipped with a CB transceiver and need VHF coverage of just one or two frequencies, the Antenna Specialists' translators are the best bet for good performance at rock-bottom prices.

For additional information circle No. 39 on the reader service page. ■

Hey You—Pull Over

Continued from page 58

now it will cost you up to $500.

Tickets have already been issued. The police use a radar unit, like the one that is used on the highways, to check the speeds of boats and they have a high-powered launch to pursue malefactors and issue them with tickets and a terse lecture.

"You see, this is quite a serious problem," explained one boat owner in the harbour. "A small minority of speeders are creating a terrible nuisance for the rest of us here. They take no notice whatsoever of the boards asking them to keep their speed down. I've seen kids who aren't old enough for a bicycle, let alone a car, careering around in 100-horse-power speedboats."

But it also has its more serious side. Recently a man was innocently fishing from a small rowing boat on the river. A passing speedboat left a huge wake which capsized the fisherman's boat. He was thrown into the water and knocked himself unconscious against the side of his craft and he was drowned.

"Tragedies like that are what we are trying to avoid," said policeman Vincent Cullen, one of the men who patrols the river. "However, we have left one section of the river reserved for waterskiers with no limit. I have to admit that it's impossible to waterski at 6 m.p.h." ■

SPECIAL INTRODUCTORY OFFER!

Now get ELEMENTARY ELECTRONICS sent to your home all year long for ONLY $2.47! Order Now and Save!

*** * * For beginner or expert EE is valuable * * ***

Written by experts—you get a practical understanding of IC circuits . . . semi-conductors . . . power supplies . . . networks . . . transistors . . . pulse circuitry, much more! Get general rules of electronics, develop trouble-shooting techniques, know how to calculate changing effects. TRY THIS NO-RISK SUBSCRIPTION OFFER TODAY!

PROJECTS IN EVERY ISSUE

•

CB RADIO

•

SHORT-WAVE

•

NEW PRODUCTS

•

BASIC ELECTRONICS COURSE

•

PRODUCT LAB TESTS

PUBLISHER'S DISCOUNT SAVINGS CERTIFICATE

Good for ***$2.03*** *off the newsstand price of* ***ELEMENTARY ELECTRONICS***

☐ Enter my trial subscription for 1 year (6 issues) of Elementary Electronics, for only $2.47. (I save $2.03 off the newsstand price.)

☐ I prefer 1½ years (9 issues) for $3.67 (on the newsstand $6.75).

☐ New Subscription ☐ Renewal Subscription

Name_____

(please print or type clearly)

Address_____

City_____ State_____ Zip_____

SEND NO MONEY, WE'LL BILL YOU LATER

You must seal (staple, scotch tape or glue) before mailing. **Dept. B683**

FOLD HERE

Postage Will be Paid by Addressee

No Postage Stamp Necessary if Mailed in the United States

BUSINESS REPLY MAIL

First Class Permit No. 1050 (Sec. 34.9 P. L. & R.) New York, N.Y.

CUT OUT AND MAIL TODAY!

ELEMENTARY ELECTRONICS
229 Park Avenue South
New York, N. Y. 10003

Dept. B683

CLASSIFIED Market Place

Classified Ads 65¢ per word, each insertion, minimum 15 words, payable in advance. For information on Classified ads—to be included in our next ELEMENTARY ELECTRONICS —write to R. S. Wayner, Mgr., Classified Ad Dept. 229 Park Ave. South, N. Y. 10003.

ADDITIONAL INCOME

WIN ONE MILLION DOLLARS in the New Jersey State Lottery. Rush $3.00 for complete details and instructions. Satisfaction Guaranteed. Davidson's, Box 274-SM, Belleville, Illinois 62222.

AGENTS WANTED

SELL: Personalized, Colored, Social Security Plates. Choice of Fifty-nine Emblems! Big Profits! Free Sample! DRS Specialties, Dept. 201E, 73 Hunter Place Pompton Lakes, New Jersey 07442.

THE BIBLE SPEAKS—On Cassettes. Proven Fast Seller! Atlas, Box 44112-D, Cleveland, Ohio 44144.

AUTHORS SERVICE

PUBLISH your book! Join our successful authors: publicity advertising promotion, beautiful books. All subjects invited. Send for free manuscript report and detailed booklet. Carlton Press, SMH, 84 Fifth Avenue, New York 10011.

AUTO PARTS & ACCESSORIES

"DRY Wash" your car with new, miracle Vacu-Shine in minutes. Gives 50 cleanings. Guaranteed. $2.98. AR-NOR, 20 Bulwer Place, Brooklyn, N. Y. 11207.

BOOKS & PERIODICALS

WIRETAPPNG—National scandal—your privacy invaded. Free brochure. Don-Q, Box 548. Seattle. Wash. 98111.

1973 HOBBY ELECTRONICS DIRECTORY. Hundreds of companies, products, and services. Parts, surplus, test equipment, plans, kits, and more. $1.50, Newcal Enterprises, Box 323B, El Segundo, Cal. 90245.

DIGITAL INTEGRATED CIRCUITS MANUAL—1973 edition—1500 types—double listing by type and wiring diagram number. Many cross-referenced. $3.95. Electronetics, Box 278, Cranbury, N.J. 08512.

BEST Reading in Mechanical Field—Science & Mechanics! $4.00 for year's subscription. Science & Mechanics, 229 Park Avenue So., New York, New York 10003.

BUSINESS OPPORTUNITIES

I made $40,000.00 Year by Mailorder! Help others make money! Start with $10.00—Free Proof! Torrey, Box 318-T. Ypsilanti, Michigan 48197.

MAKE Magnetic Signs. Big profits. Details. Universal, Lenora, Kansas 67645.

1000% PROFIT Bronzing Keepsakes. Free Literature. NBC. Box C-4-0, Coral Springs, Florida 33065.

FREE BOOK "999 Successful, Little-Known Businesses." Work Home! Plymouth P5, Brooklyn, New York 11218.

BUSINESS OPPORTUNTIES—Con't.

HERBALISM! The home gold mine! Free lesson. Herbalism Institute-D, 1339 Remuda, Glendora, Ca. 91740.

ADDRESSERS and Mailers needed. Details 10¢. Lindbloom Services, 3636 Peterson, Chicago 60659.

FREE—Wholesale Catalog and Sales Plan. JAM Enterprises, 3100R Liberty Avenue, Pittsburgh, Pa. 15201.

$1000 MONTHLY from your own home, write: Jordan, 27495 Road 176, Dept. DC-3. Exeter, Calif. 93221.

COMPLETE MAILORDER BUSINESS COURSE $10.00. Information SASE. Raymond Brooks, 7147D, St. Petersburg 33734.

WE NEED GINSENG GROWERS! $3,000-$30,000 annually! We Buy Your Crop. Send $2. For seed sample and information, Glass's Ginseng Exchange, Box 336, Rochdale Station, Jamaica, N.Y. 11434.

MAKE money typing at home! Details for self-addressed stamped envelope and $1.00 to: SC Ventures, 4731 Clinton, Klamath Falls, Oregon 97601.

FREE BOOK "2042 Unique, Proven Enterprises." Beat inflation with fabulous, successful "Little Knowns." Work Home! Haylings-E7, Carlsbad, Calif. 92008.

DO-IT-YOURSELF

DISCOVER how to avoid calling the serviceman. Save by servicing home equipment yourself. Send $1.25 for magazine. RADIO-TV REPAIR—229 Park Avenue South, New York, New York 10003.

WOOD Workers, weekend project. Deacon Bench, ideal for Entry hall, Den, Patio. No special tools needed. Complete plans $2.00. Send to: J. A. Reed, 4110 Key West Street, Corpus Christi, Texas 78411.

BUILD 32-FUNCTION DIGITAL COMPUTER. 24-Pin integrated circuit, 12 transistors, complete instructions, $15.25. Electronetics, Box 278, Cranbury, N.J. 08512.

ELECTRIC Bicycle Plans, $2.96. F. Kielian, 130 Drake, South San Francisco, Ca. 94080.

APPLIANCE REPAIR BOOKS. Written in easy-to-understand language by experts in the service field with illustrations and diagrams! Acclaimed by instructors and professionals alike! How to diagnose and repair refrigerators, air conditioners, washers, dryers, ranges, dishwashers, vacuum cleaners, motors, water heaters, coffeemakers, hair dryers, food mixers, can openers electric irons, floor polishers and many others. Also, fundamentals of solid state, setting up a shop, using test equipment and a lot more. Only $2.65 to $4.90 each! Free price list. C & N, 5841 Montrose, Chicago 60634.

EDUCATION & INSTRUCTION

UNIVERSITY Degrees By Mail. Free Information. Norman, Dept. 63, Box 3199, Pasadena, California 91103.

HIGH SCHOOL DIPLOMA for adults. Earn State Diploma. Accepted by Civil Service, business, colleges. Low Cost. No tedious study. Money-back guarantee. Details: H-S Program, Suite 25 24, 1221 Avenue Of Americas, New York, N.Y. 10020.

LIFETIME Ordination D.D. Charters. Details 25¢. Life Science, 2207 Cardinal, Rolling Meadows, Illinois 60008.

"LOGIC newsletter, design and construction, sample copy, $1.00, Logic Newsletter, POB 252, Waldwick, N.J. 07463."

FREE brochure. FCC license. Key Tests —Answers. Academy of Communications Technology. EE-573, Box 389, Roswell, New Mexico 88201.

EMPLOYMENT INFORMATION

OVERSEAS JOBS. Free "1,000 American Companies Overseas" ($24.00 value) to new subscribers. World's largest international employment monthly. All countries, occupations. Thousands of jobs, articles, free services, discounts. Subscribe today. Year $12. Satisfaction Guaranteed. Overseas Job Journal, Box 25488-E, Phoenix, Arizona 85002.

FARMS, ACREAGE & REAL ESTATE

GOVERNMENT LANDS—Low as $1.25 Acre! Buy, lease or homestead. Free Details! Lands Digest, Box 25561-JC. Seattle, Wa. 98125.

FISHING TACKLE, BAIT & LURES

HANDSOME fishing rod rack—$2.98. Professional dry fly assortment 20-$5.98. Satisfaction guaranteed. Diane N. Anderson, 260 Crittenden Blvd., Rochester, N.Y. 14642.

FOR THE HOME

FOR anyone who wants the satisfaction and economy of repairing, furnishing and maintaining the furniture in his home. Send $1.25 to FURNITURE-229 Park Avenue South, New York, N.Y. 10003.

GIFTS THAT PLEASE

MELODY Phone. Musical phone attachment. Plays three minutes of soft music with the pull of cord. State color to match phone. For just $6.95 plus $1.25 for handling. Two year guarantee. Edd-Lou Enterprises, 4615 N. Braeswood 104D, Houston, Texas 77035.

NOW Free Catalog. Selected gifts for Mother, Father, Relatives, Friends. Teddy's Gifts Division, 586 Tenth Street, Third Floor, Brooklyn, New York 11215.

FOR GREATER CLASSIFIED PROFITS, RESULTS AND SAVINGS

Place your ad in one of our SPECIAL COMBINATIONS: Business, Science & Mechanics, or Dovis Combination. Each Combination is designed to give your ad the largest audience available. For further information write to R. S. Wayner, Manager, Classified Advertising, Science & Mechanics, 229 Park Avenue South New York, N.Y. 10003.

CLASSIFIED MARKET PLACE—Cont.

HEARING AIDS

HUGE SAVINGS! BUY DIRECT! Eliminate dealer markups. 20 days FREE Trial. Terms arranged. No salesman will call. LLOYD'S-79, Rockford, Illinois 61108.

INVENTIONS WANTED

WE either sell your invention or pay cash bonus. Write for details. Universal Inventions, 298-3, Marion, Ohio 43302.

LOGIC

LOGIC NEWSLETTER, Design, Theory, Construction. Sample copy $1.00. Logic Newsletter, POB 252, Waldwick, N. J. 07463.

MAGIC TRICKS, JOKER NOVELTIES & PUZZLES

MAGIC MAGAZINE. Tricks, news, dealers offerings. Monthly since 1936. 2 sample copies $1.00. Genii, Box 36068D, Los Angeles, Ca. 90036.

MAIL-ORDER OPPORTUNITIES

100% PROFIT. SELL SECURITY products by mail. Details, samples free. CSA, Dept. 1C, Box 12127, Dallas, Texas 75225.

MONEYMAKING OPPORTUNITIES

MAKE BIG MONEY raising Chinchillas. Cavies, Rabbits for us. Catalog 25¢ Keeney Brothers, New Freedom, Penna. 17349.

Guaranteed Home Income raising chinchillas. 25¢. Chinchilla, 11DC2, Port Richey, Fla. 33568.

MEN—WOMEN! Start money-making Plastic Laminating business at home in spare time. Material costing 11¢ brings back $2.58. No canvassing or selling but mail orders bring in $20.00 a day. Write for full particulars free. Rush name on postcard to: Warner, Room LC-107-CD, 1512 Jarvis, Chgo., Il. 60626.

Make Your Classified Ad Pay. Get "How To Write a Classified Ad That Pulls." Includes certificate worth $2.00 toward classified ad in S & M. Send $1.25 (includes postage) to R. S. Wayner, Science & Mechanics, 229 Park Ave., South, New York 10003.

OF INTEREST TO WOMEN

$25.00 DAILY Possible addressing-stuffing envelopes. Typewriter-longhand, also Clipping News items at home. Information, Send stamped addressed envelope. Ame-7, Box 310, Le Mars, Iowa 51031.

PERSONAL

ELIMINATE Debts Without Borrowing! Particulars 25¢. Helper, Box 9308, No. Hollywood, California 91609.

ORIENTAL introductions! Photographs, descriptions, questionnaire, brochure, details. $1.00. INTER-PACIFIC, Box 30 SC, Birmingham, Michigan 48012.

IMPROVE your personality, 110 page book "Dynamic Thinking" shows how. $1.00. Anderson, 831 Escuela, San Diego, Ca. 92102.

CONTRACEPTIVES For Men—by mail! Eleven top brands—Trojan, Conture, Jade, and many more. Three samples: $1. Twelve assorted samples: $3. Free illustrated catalogue with every order. Plain package assures privacy. Fast reliable service. Satisfaction guaranteed or your money refunded in full. POPLAN, Box 2556-DCG2, Chapel Hill, N. C. 27514.

PHOTOGRAPHY—PHOTO FINISHING

SAVE HUNDREDS OF DOLLARS!!! Make your own S & M Densitometer. Send $3.00 for detailed drawings and instructions. A must for successful photography in your darkroom. Order direct from: S & M Instruments, Dept. EE5, 229 Park Avenue South, New York, New York 10003.

RADIO & TELEVISION

TV TUBES 36¢ each. Send for Free 48 page color catalog. Cornell, 4217-W University, San Diego, California 92105.

"DISTANCE Crystal Set Construction" Handbook—50¢. "Coil Winding"—50¢. Catalog 25¢, refundable. Laboratories, 1477-G, Garden Grove, Calif. 92642.

FREE Catalog lists resistors, tubes, transistors, rectifiers, condensers, tools, tuners, etc. etc. Hytron Hudson, Dept. EE, 2201 Bergenline Avenue, Union City, New Jersey 07087.

REMAILING SERVICE

RECEIVING - Forwarding - Remailing, monthly rates. Nortex, Drawer 430, Weatherford, Texas 76086.

SCIENCE & CHEMISTRY

ANTIGRAVITY DEVICE. Brochure 35¢. AGD, Box 3062-EE, Bartlesville, Oklahoma 74003.

SURPLUS EQUIPMENT

GIANT 120 Page Canadian Surplus Catalog $1. Etco, Dept. EE, Box 741, Montreal.

TIPS FOR THE HOME, ETC.

PRACTICAL tips for home, garden and workshop are in "1001 How-To Ideas." Send $1.25 for your copy includes Postage, to 1001 How-To Ideas, 229 Park Avenue South, New York, New York 10003.

TOYS, GAMES & ENTERTAINMENT

NEW Hilarious fun item of interest and amusement to all adults and children, anyplace or anywhere. Also has utility value as a superb door-stop. $2.00 introductory offer. Free handling and postage. Creativity Exclusive, Box 9552, San Diego, Calif. 92109 Inquiry Welcomed.

TREASURE FINDERS—PROSPECTING EQUIPMENT

DISCOVER AMERICA'S FASTEST GROWING HOBBY. White's Electronics, Inc., would like to send you absolutely FREE, their 42 page, fact-filled catalog on Mineral and Metal Locating Equipment. Amateurs or Professionals select from world's largest line of metal detectors, priced as low as $79.50, up. Detect Gold, Silver, Copper-Nuggets, Coins, Jewelry, etc. Budget terms available. For your convenience we have three major factory locations in the U.S. and Canada, as well as over 1,000 authorized dealers to serve you. See your local Yellow Pages, under "Metal Locating Equipment", or write: White's Electronics, Inc. Room No. 399, 1011 Pleasant Valley Road, Sweet Home, Oregon 97386-Elk-Air Industrial Park, Dexter Drive, East, Elkhart, Indiana 46514 or White's Electronics Ltd. 33784 Hazel Street, Abbotsford British Columbia, Canada.

INDEX TO ADVERTISERS

Detector X2

Continued from page 70

graph. Once the leads are carefully soldered, the whole unit can be dipped in a potting compound to protect the leads and protect the components themselves from damage and accidental circuits.

☞ Never use a capacitance value for C1 that is larger than that used for the rf bypass capacitor (C2) in the original detector circuit. Try a value about half that of C2, first. A small-value capacitor will charge to the peak voltage faster than one of too much capacitance. A too-small-value capacitance will discharge too soon. Neither value will give maximum audio voltage output.

☞ It may be necessary to "peak" the detector transformer since the added components will have some capacitive loading effect on the transformer tuning.

Voltage Multipliers. It is possible for additional diodes and capacitors to be added for voltage tripling and quadrupling, although selection of capacitors becomes more critical. ■

Join "THE TROUBLESHOOTERS"

They get paid top salaries for keeping today's electronic world running

Suddenly the whole world is going electronic! And behind the microwave towers, push-button phones, computers, mobile radio, television equipment, guided missiles, etc., stand THE TROUBLESHOOTERS – the men needed to inspect, install, and service these modern miracles. They enjoy their work, and get well paid for it. Here's how you can join their privileged ranks – without having to quit your job or go to college in order to get the necessary training.

Just think how much in demand you would be if you could prevent a TV station from going off the air by repairing a transmitter . . . keep a whole assembly line moving by fixing automated production controls . . . prevent a bank, an airline, or your government from making serious mistakes by servicing a computer.

Today, whole industries depend on Electronics. When breakdowns or emergencies occur, someone has got to move in, take over, and keep things running. That calls for one of a new breed of technicians — The Troubleshooters.

Because they prevent expensive mistakes or delays, they get top pay — and a title to match. At Xerox and Philco, they're called Technical Representatives. At IBM they're Customer Engineers. In radio or TV, they're the Broadcast Engineers.

What do you need to break into the ranks of The Troubleshooters? You might think you need a college degree, but you don't. What you need is know-how—the kind a good TV service technician has—only lots more.

Learn at Home . . . In Your Spare Time

As one of The Troubleshooters, you'll have to be ready to tackle a wide variety of electronic problems. You may not be able to dismantle what you're working on — you must be able to take it apart "in your head." You'll have to know enough Electronics to understand the engineering specs, read the wiring diagrams, and calculate how the circuits should test at any given point.

Learning all this can be much simpler than you think. In fact, you can master it without setting foot in a classroom . . . and without giving up your job!

For over 37 years, the Cleveland Institute of Electronics has specialized in teaching Electronics at home. We've developed special techniques that make learning easy, even if you've had trouble studying before. Our AUTO-PROGRAMMED® Lessons build your knowledge as easily and solidly as you'd build a brick wall — one brick at a time. And our instruction is personal. Your teacher not only grades your work, he analyzes it to make sure you are thinking correctly. And he returns it the same day it is received, while everything is fresh in your mind.

The Science of the Seventies

To keep up with the latest developments, our courses are constantly being revised. CIE students receive lessons in Field Effect Transistors, Digital Switching Units, Microwave Systems, Lasers, Binary Coding and Computer Arithmetic.

In addition, CIE offers an exciting Electronics Technology with Laboratory course that includes 161 space-age components to let you perform 242 fascinating electronics experiments. You learn the "how" as well as the "why" of Electronics . . . the Science of the Seventies. Many leading companies use CIE courses to train their own employees who are working on the latest electronic equipment.

Get an FCC License — or Your Money Back!

Two-way mobile work and many other types of troubleshooting call for a Government FCC License, and our training is designed to get it for you. But even if your work doesn't require a license, it's a good idea to get one. Your FCC License will be accepted anywhere as proof of good electronics training.

A good way to prepare for your FCC exam is to take a licensing course from CIE. Our training is so effective that, in a recent survey of 787 CIE graduates, better than 9 out of 10 CIE grads passed the Government FCC License examination. That's why we can offer this famous Money-Back Warranty: when you complete any CIE licensing course, you'll be able to pass your FCC exam or be entitled to a full refund of all tuition paid. This warranty is valid during the completion time allowed for your course. You get your FCC License — or your money back.

Mail Card for 2 Free Books

Want to know more? Then fill out and mail reply card or coupon today. We'll send you our two FREE books on opportunities in Electronics. For your convenience, we will try to have a representative call. Act now, and get a high-paying job that much sooner.

APPROVED UNDER G.I. BILL

All CIE career courses are approved for educational benefits under the G.I. Bill. If you are a veteran or in service now, check box for G.I. Bill information.

CIE Cleveland Institute of Electronics, Inc.

1776 East 17th Street, Cleveland, Ohio 44114

Accredited Member National Home Study Council

Cleveland Institute of Electronics, Inc.
1776 East 17th Street, Cleveland, Ohio 44114

Please send me your two FREE books:

1. Your school catalog, "Succeed in Electronics."
2. Your book on "How To Get A Commercial FCC License."

I am especially interested in:

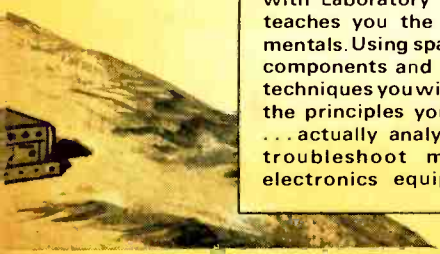
- ☐ Electronics Technology
- ☐ Broadcast Engineering
- ☐ First Class FCC License
- ☐ Electronic Communications
- ☐ Industrial Electronics
- ☐ Electronics Engineering
- ☐ Electronics Technology with Laboratory

Name_____
(PLEASE PRINT)

Address_____

City_____ State_____ Zip_____

Veterans and Servicemen:
☐ Check here for G.I. Bill information. EL-40



Learn By Doing...

Electronics Technology with Laboratory Course teaches you the fundamentals. Using space-age components and testing techniques you will apply the principles you learn . . . actually analyze and troubleshoot modern electronics equipment.

CIRCLE NO. 10 ON PAGE 17 OR 103

If you don't happen to live near one of our 603 service centers . . .

. . . then it's really important to insist on Johnson quality! Because the proven reliability of Johnson CB radios makes it far less likely that you'll ever need service. Which is why we can confidently back our products with a full 1-year parts *and* labor warranty, with over 600 authorized service centers nationwide. And besides reliability, Johnson citizens two-way radios have a well earned reputation for truly outstanding performance. Engineered into all our Messenger radios are advanced features, like speech compression for greater "talk power" and special selectivity filters to cut adjacent channel interference. And that's why U.S.-made Johnson radios are your best CB value . . . *wherever* you live.

Prices start at under $100. Write for free catalog.

JOHNSON

Waseca, Minnesota 56093

Ⓐ **Messenger 120** Built-In Tone Alert selective calling Ⓑ **Messenger 323-M** All the features of the Messenger 323 plus Dual Receive Capability Ⓒ **Messenger 125** Full 5-watts, but just 1 3/16" high Ⓓ **Messenger 111** Rugged, 12-channel mobile Ⓔ **Messenger 223** Powerful hybrid circuitry base station Ⓕ **Messenger 122** New 23-channel mobile with high visibility rotary dial Ⓖ **Messenger 124-M** Deluxe 23-channel base station with Dual Receive Capability Ⓗ **Messenger 109** Professional portable with rechargeable batteries Ⓘ **Messenger 121** With PA and fast push-button channel selection Ⓙ **Messenger 323** Ultimate in 23-channel mobile performance Ⓚ **Messenger 123A** All 23 channels and new improved circuitry.

CIRCLE NO. 8 ON PAGE 17 OR 103