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CIRCLE NO. 15 ON PAGE 17

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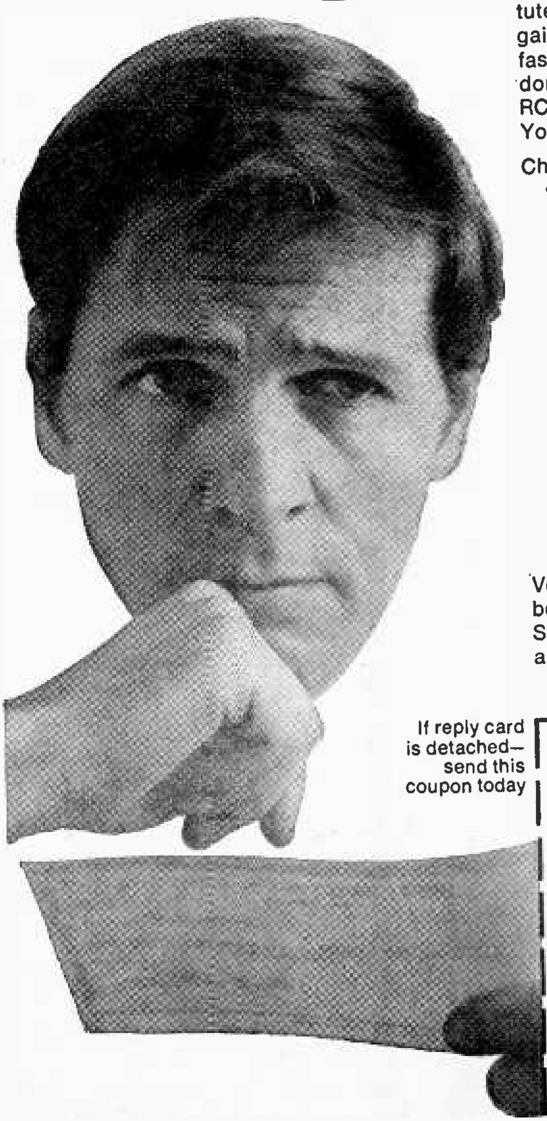

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• January/February 1972 • Vol. 11 No. 6

elementary Electronics

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CITIZENS BAND RADIO

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elementary Electronics

INCLUDING SCIENCE AND ELECTRONICS

Jan./Feb. 1972 Vol. 11/No. 6

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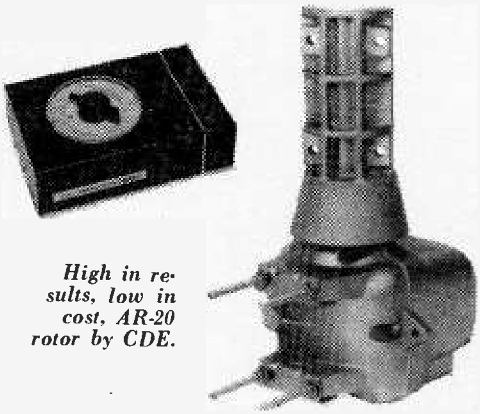
CIRCLE NO. 8 ON PAGE 17

Hey, look me over

Showcase of New Products

Great for CB Beamers

A new economy-priced antenna rotor has been introduced by Cornell-Dubilier Electronics. The AR-20 antenna rotor system has many of the best features of other rotors in the CDE line. The rotor is housed in heavy-duty, die-cast aluminum, gold colored to match today's color antennas. Quick mounting is provided for through positive grip U-bolt clamps on the cast aluminum housing. A positive braking system kills any chance of drift due to wind. The control is fully automatic and of the same type as the well known AR-22 rotor. After the desired direction is set, the unit stops automatically and with great accuracy. The dial face is illuminated when the system is in operation. The AR-20 is packaged in a full color container which illustrates the most common reception problems. The container comes with a pop-up handle for easy carrying. Priced at $49.95.



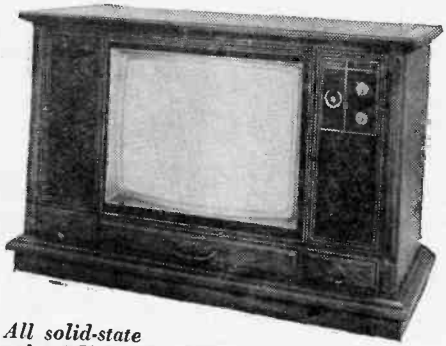
High in results, low in cost, AR-20 rotor by CDE.

Circle No. 50 on Page 17.

Color TV

Heath Company has just announced the addition of a new 25" ultra-rectangular "square-corner" model to its line of solid-state color TV kits. The new model, GR-371MX, uses the exclusive Heath MT-5 picture tube that provides increased viewing area, brighter picture, better contrast and vivid, lifelike color reproduction. Ten modular circuit boards in the GR-371MX snap in and out in seconds for fast easy assembly and simplified periodic maintenance and adjustment. The circuit uses 45 transistors, 55 diodes, 2 SCRs and 4 advanced integrated circuits. Among the numerous standard features of the GR-371MX are

push-button automatic fine tuning that locks in perfect picture and sound instantly . . . exclusive Heath MOSFET VHF tuner and completely shielded 3-stage IF (both factory assembled for superior performance) . . . built-in power tuning that lets



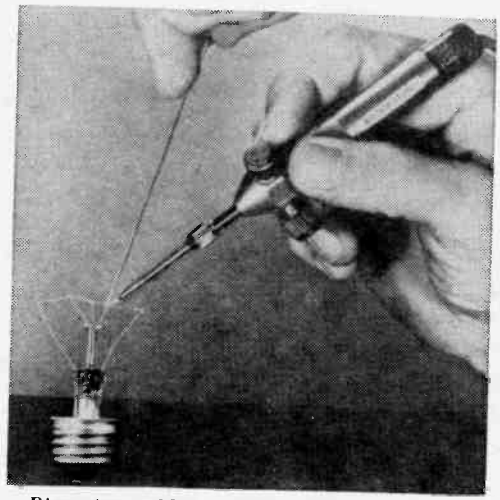
All solid-state color TV has MOSFET tuner.

you scan all VHF and one preselected UHF channel automatically. Automatic color control, adjustable noise limiting, adjustable video peaking and "instant on" are all standard too. The new GR-371MX is priced at $579.95 without cabinet. Mediterranean, Contemporary Walnut and Early American cabinet styles are available, starting at $79.95.

Circle No. 7 on Page 17.

Carry a Torch

The Brookstone Company has introduced a new miniature welding torch capable of precision microjoining of all weldable materials. Called the "Mini-Pro", the torch features a controllable stable flame down to 1/32 of an inch and smaller. It is ideal for applying flame temperatures up to 6300°F to extremely localized areas on all metals and can also be used to soften or melt plastics, glass and other materials. Perfect for



Pin-point welding with Mini-Pro gas torch.

★★★★★★★★★★★★★★★★★★★★★★★★★★★★★★★★★★★★★★

making and repairing miniature parts and equipment of all kinds. The Mini-Pro comes complete with a set of 5 interchangeable copper tips—4 with drilled synthetic ruby nozzles to insure precise gas flow and longest possible tip life. Also comes with 5½ feet of color coded hose and $\frac{9}{16}$"-18 thread brass fittings for attachment to standard regulators. $50.75 postpaid. Free literature available.

Circle No. 49 on Page 17.

There's Gold Out There

There is adventure, fun and profit in treasure hunting or prospecting with a revolutionary new featherweight metal and mineral detector, White's Electronics, Inc. Coinmaster IV. More sensitive and lighter in weight than most others in its class, the Coinmaster IV has a highly tuned semi-3 coil, ultra-sensitive 6-in. loop developed

Find it fast with lightweight metel detector.

for maximum depth efficiency when searching for coins, and other small metal objects. The device also is designed to detect at greater depths larger items such as treasure chests, iron pots, etc. Use of all transistor solid state circuitry makes the Model 4 a very compact and lightweight detector. It is a joy to women treasure hunters and youngsters. The detector weighs only 4-lbs. 6-oz., complete with loops and batteries, which reduces fatigue on extended searches. White's new all-transistor transmitter-receiver Coinmaster IV metal detector comes complete with mineral and metal samples, super-sensitive multi-coil 6-in. loop, detailed instructions and a two-year warranty. It is retail priced at $199.50 f.o.b. factory.

Circle No. 48 on Page 17.

Laser Science Kits

Metrologic Instruments, Inc., Bellmawr, N.J., is presently introducing 11 new Laser Science Kits for the Christmas gift market. No longer a laboratory curiosity, the Laser is being manufactured in large quantities by Metrologic for the

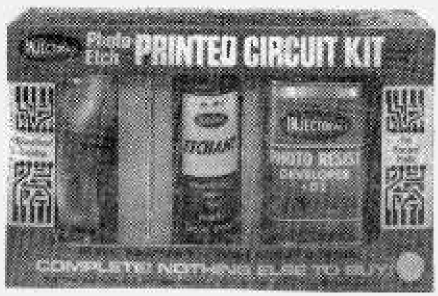
HEY, LOOK ME OVER ★★★★★★★★★★★★★

education and hobby markets. The New Jersey firm has completed its retail packaging program and for the first time is making its laser science kits available through department, variety, and hobby store outlets. Student hobbyists have demonstrated unusual interest in lasers this past year. Many have won school science fair awards, simply by assembling a laser and demonstrating some of its unique features. Several of Metrologic's laser science kits are specially designed for the science fair enthusiast. Each kit includes a loose-leaf manual outlining a range of experiments. With Metrologic's Laser Optics Kit, for example, hobbyists can progress from the beginning concepts of light, through geometric optics, and on through physical optics, including, holography (three-dimensional photography). Use of lasers with these educational kits is completely safe. The power levels possible are well below those that can cause eye damage, and the lasers are strongly encased to prevent electrical accidents. Each kit is built on a modular concept that allows expansion of the range of experiments as interest grows. Lasers are not supplied with the kits but are available from Metrologic at prices ranging from $99.50 and up; lasers in kit form are available at $49.50 and up.

Circle No. 47 on Page 17.

PC Kit Aids Beginner

At one time building an electronics project was hard work for it involved drilling, cutting, reaming and deburring a metal chassis. Some of those early chassis weren't aluminum either, but were steel, and so electronics construction meant sore muscles, cut and bleeding fingers,



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and frazzled nerves. Injectorall Electronics Corp. has taken the sweat out of electronics and put pleasure back in. Now, with Injectorall's new No. 650 photo-etch printed-circuit kit, anyone, beginner or professional, can make professional printed circuits first time, every time. Injectorall's 650 is a completely packaged kit (nothing else to buy) using a photosensitive method for producing professional quality printed circuits. It can be used with assurance by engineers developing a prototype or a hobbyist constructing a home-lab project. This low-cost easy way of making quality printed circuit boards is now available at all major distributors and retails for only $10.80. ■

Circle No. 46 on Page 17.

BOOKMARK
BY BOOKWORM

Experimenter's Dream. It seems the engineers at General Electric have as much fun fooling with simple circuits as do the editor's of ELEMENTARY ELECTRONICS. The boys at GE's Tube Department in Owensboro, KY have prepared and updated *The Electronics Experimenter's Circuit Manual, Third Edition,* and its packed with new circuits that not only use vacuum tubes but thyristors, diodes,

**Soft cover
252 pages
$2.00**

transistors SCR's and the like. Over 41 projects like a two-compactron stereo amplifier, battery charger, audio dancing lights, motor control, temperature regulator, CD meter protection and more. If you enjoy reading e/e, you'll want this GE book in your collection. Published by General Electric Company Tube Products Department.

For Beginners Only. Rather than simply tell how to build some gadget, and leave one wondering why he bothered, *Electronics Self-Taught with Experiments & Projects* offers a much more worthwhile challenge, and greater assurance of gaining useful knowledge from its use. Written by Jim Ashe especially for serious experimenters, hobbyists and students, here at last is a book that shows *why* certain things are done, tells *how* devices and circuits

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CIRCLE NO. 10 ON PAGE 17

work, and suggests innovations that spur the reader forward to more important work in electronics. Even with no prior knowledge of electronics, a reader will quickly acquire practical know-how which can be put to immediate use. The text divulges many fascinating tricks with ordinary "garden variety" diodes and transistors. Expensive, special-purpose types are not needed. In fact, the author continually stresses the importance of keeping things simple and inexpensive. There are circuits and projects using integrated circuits, plus communications devices, logic circuits, "industrial" devices, and lab-type equipment the reader can build and calibrate himself. Truly unlike most hobby or project book ever published. Published by Tab Books.

Answer This One. Do you believe a person can stand on the third rail of an electric railroad system without being electrocuted? Why airplanes cause TV "flutter"? Why does an atomic bomb explode? The answers to these questions and many, many others are

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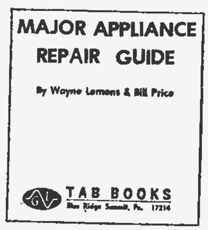
answered in a new book, *Science in Everyday Things* written by William C. Vergara. The author, an engineer by profession and a general scientist by avocation, explains natural phenomena in nontechnical language for readers with little scientific background. Published by Harper & Row, Publishers.

For Mr. Fix-its. *Major Appliance Repair Guide* by Wayne Lemons & Bill Price is a complete guide to the service and repair of all major electrical appliances—from automatic washers to refrigerators. This comprehensive, up-to-date volume contains all the know-how needed to fix any major electrical appliance. The authors explain every step in minute detail and illustrate typical situations with over 260 photos and drawings. Numerous troubleshooting charts are included to aid in pinpointing the cause of virtually any problem.



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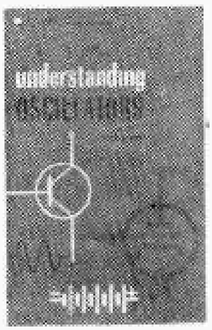
The content begins with a discussion of basic techniques and procedures, evolved from years of practical experience. It tells exactly what tools and test instruments are needed and how to use them. Since many appliances contain motors in various shapes and sizes, a complete chapter is devoted to electric motor test and repair. The authors explain how each type works and what usually goes wrong, thus enabling the reader in a matter of minutes to determine whether or not a motor is repairable. Published by Tab Books.

It Swings. Oscillator circuits seem to pop up almost everywhere you look in electronic devices, in a seemingly endless variety of forms and sizes. Yet, in spite of this variety, the ancestry of each one can probably be traced back to one of the basic oscillator circuits found in *Understanding Oscillators* by Irving M. Gottlieb. These circuits include well-known oscillators, such as the Hartley and the Colpitts, as well as some not quite as well-known, e.g., the Meissner, the Meacham Bridge, the Franklin, and the Butler oscillators. Here is what the technician and engineer want to know about oscillators —how they work, their personalities, their strong points and weak points, and how they are used in practical applications. Published by Howard W. Sams & Co., Inc. ■



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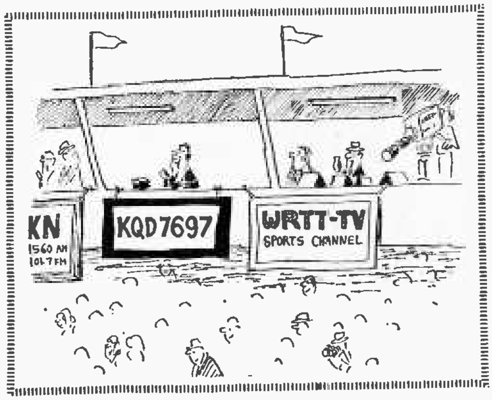

CIRCLE NO. 21 ON PAGE 17

DX central reporting

A world of SWL info!

By Don Jensen

DXing tends to be a "lone wolf" proposition; the usual ratio is one listener to one receiver. As a result, DXers know relatively little about others in this wide world who share their enthusiasm for tuning distant stations.

But a recent study by the Association of North American Radio Clubs (ANARC) has answered some of the questions about who we are, what we do and how we do it. The survey, compiled by ANAC'ers Phil Sullivan and Gray Scrimgeour, brought answers from a significant sample of listeners, nearly 1,300 of them. The findings are interesting.

Though the DXers surveyed ranged in age from 13 to over 80, the hobby is essentially a youthful one. Nearly half (48 per cent) are under 21. Twenty-one percent fall in the 21 to 30 age bracket, 11 percent between 31 and 40, and 20 percent over 41. The sex bias is definitely masculine. Only two percent of those responding to the ANARC study are women.

The most popular type of DXing is shortwave broadcast listening. Some 87 percent reported they tuned the broadcast station programs on shortwave. Medium waves (540-1600 kHz) attract 47 percent. Other percentages are amateur radio listening (not transmitting) 28 percent; tuning utility communications stations, 16 percent; TV and FM DXing, 13 percent; and longwave (below 540 kHz) listening, seven percent. They total more than 100 percent because many tune more than one segment of the radio frequency spectrum.

What equipment do DXers use? Twenty percent use non-communications receivers, table models, portables and the like. Half do their tuning on communications receivers, those designed for DXing or ham radio, costing under $125. A quarter of the survey respondants use more expensive communications sets. The remaining handful listen with surplus military equipment. Approximately two-thirds have at least one tape recorder in their DX shack.

The typical DXer is non-technical. Fifty percent build none of their own gear; another 27 percent build only simple projects or kits. When it comes to repair work, 75 percent don't, or tackle only simple maintenance of their radios.

(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.

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DX CENTRAL REPORTING

Continued from page 16

Four of every five DXers are listeners only. Twelve percent have CB licenses, another eight percent are hams as well.

Of the more serious DXers, those belonging to radio hobby clubs, 41 percent say that they read either ELEMENTARY ELECTRONICS, or our former sister publication, SCIENCE AND ELECTRONICS (now COMMUNICATIONS WORLD). Three-quarters enjoy feature articles on radio stations, while 40 percent read the how-to-build-it construction projects and 30 percent like the more theoretical articles.

The limitation of the ANARC survey is that it reached only those who consider their listening efforts as a hobby, in other words, DXers. But another study, by Florida State University sociology professor, Don D. Smith, measured another facet of shortwave listening in the United States.

Professor Smith's research, published in Public Opinion Quarterly, was designed to show how many Americans, *other than SWL hobbyists*, listen regularly to foreign shortwave programs for their political content.

It indicated that approximately two million adult listeners tune such programs at least once a week. And more than four times that number have listened to shortwave broadcasts, of whatever type, for whatever reasons, at some time during the year.

What does this all mean? Is it just another numbers game? Maybe so, but the "lone wolf" simile now seems inappropriate. You're running with a pretty large pack!

Tiptopper. Do you sometimes feel you're a day late and a dollar short when it comes to DXing? Well, here's your chance to be a DX trailblazer by being one of the first to hear a brand new, rare station!

For SWL's, the impossible dream is logging Swaziland, that tiny landlocked nation completely surrounded by the Republic of South Africa. In the past it was represented on shortwave only by a mini-powered religious station, never heard in North America.

But a brand new shortwaver, Swazi Radio is scheduled to begin operation any day now, perhaps early in December, and you could be the first North American DXer to hear it!

Swazi Radio will be an all-English commercial service, with contemporary music, aimed at South African audiences. The venture is jointly owned by U.S. broadcasting executive Mark L. Wodlinger and the Swaziland government.

Eventually the station will use three transmitters, 50 kilowatt medium-wave stations on 1376 and either 539 or 602 kHz, and a 10 kilowatt shortwave station, simulcasting the medium-wave programs. Particular targets of the stations will be the South African cities of Durban and Johannesburg. At first the programs will be broadcast from 0500 to 0000 GMT, but eventually they will be extended to 24 hours.

According to Wodlinger, one of the medium-wave transmitters was in place in Swaziland's western Sandlane district, near the South African border, by mid-September. The shortwave unit was to follow it to Africa upon completion of transmitter tests Stateside.

Frankly, I haven't any idea where this new station will turn up on the dial. So you, and other DXers around the world, will have to hunt the bands for Swazi Radio. And you could be the lucky one to find it first. It's just a guess, of course, but I'd suggest prowling around 60 meters (around 4,750 to 5,060 kHz) around 0500 GMT.

Bandsweep. Frequencies in kilohertz, times in GMT. **1020**—For West Coast MWers only, look for ZCO at Nuku'alofa, Tonga just before sign off at 1000 GMT. By the way, would you believe that this Pacific islander has a tuning signal played on a Tongan nose flute? . . . **4930**—One Latin American broadcaster that has been just booming in lately is Radio Mil in Santo Domingo, Dominican Republic. You should find its Spanish language programming almost any time during the early evening hours . . . **6,093**—A nice piece of DX is Radio Somali at Mogadishu along Africa's northeast coast. New England listeners have been hearing it signing on at 0300 . . . **9,505**—A Sudanese station, announcing as "Huna Omdurman" in the Arabic language, has been heard here at 2045, with what one DXer describes as "swinging Sudanese hit tunes." Hmmm! . . . **12,175**—The only way to log Iceland these days is to catch the tests from Reykjavik's point-to-point utility station at various times during our afternoons . . . **15,084**—A brief announcement at 2025 seems to be all that's left of an English language program formerly aired by Radio Iran, Teheran . . . **17551.5**—Though seldom reported, you can hear an Argentine standard time station ticking away at 1145 to 1150 GMT. (Credits: Roy Millar, Washington; George Schnabel, New York; Mike Macken, Massachusetts; Chris Lobdell, Massachusetts; Gladys Martin, New York; Alvin Sizer, Connecticut; National Radio Club, Box 99, Cambridge, Massachusetts)

Backtalk. Congrats to Don Erickson, Riverside, California, named 1971 Man of the Year by the Association of North American Radio Clubs. The coveted award is given annually by ANARC, the organization affiliating all the major DXing clubs in North America, to a person who has contributed significantly to the listening hobby.

Erickson was cited for his work with ANARC and the International Radio Club of America, whose bulletins he publishes.

Ralph Lose, Aransas Pass, Texas, writes to ask if there's such a thing as a shortwave listening log book, a publication that gives data on

(Continued on page 106)

stamp shack

Philatronics Today!

BY ERNEST A. KEHR

●● It is surprising to witness the speed with which the Intelsat communications network is knitting the widely scattered insular specks of the Pacific into a single unit. And for the stamp collector, it's interesting to note how almost each new facility is advertised with special commemoratives.

● Latest of the islands to open an earth station and issue postage stamps to mark its dedication, is New Zealand. On July 14, 1971, the dominion released a pair of multi-color designs created by Auckland artist Mark Cleverley. The eight-cent denomination, for use on air-mail letters to some Pacific islands, or surface mail to overseas destinations, shows the station's parabola receiving antenna, while the 10-cent features the Satellite itself. Both designs include patterns of colored dots, each representing the various earth stations presently in operation around the Pacific and to which the New Zealand one now may communicate.

● Like the other earth stations around the world (and some of which already have been described in this column,) New Zealand's is equipped to transmit and receive signals from other places that are bounced off the satellites placed in Space by the International Telecommunications Satellite Consortium. Presently it is working with Intelsat III, which can handle 1,200 voice circuits and a single TV channel. Once the new Intelsat IV is placed over the Equator above the Pacific it will add that to its facilities as the latter promises to handle more circuits and two TV channels.

● The New Zealand station has been built on a 41-acre site near Warkworth, about 50 miles north of Auckland on the dominion's North Island. Since it is being operated as part of the Government's Post and Telecommunications Ministry, its own architects developed the plans. Wiles and Jones, Ltd., of Auckland, erected the various control buildings. The Nippon Electric Co., of Japan, supplied the technical equipment and antenna. This firm has supplied similar equipment for stations in Japan, Taiwan and a few other Pacific and African nations.

● The immensity of the operation is revealed by some statistics. The administration and equipment building alone comprises more than 13,000 square feet of space in which a staff of 18 persons can do all the necessary control work on the automated instruments.

● The antenna, which is really the heart of the system, is an architectural behemoth. Its 52-foot circular base required 2,400 tons of concrete to support the antenna, its motors and other machinery.

● Almost 400 tons of steel were required to construct the 120-foot facility which, of course, is dominated by the parabola with its 300 aluminum reflecting panels built into the 100-foot wide dish.

● Connections are possible throughout the Pacific area and the stations that already are in operation: Bartlett, Alaska and Jamesburg, Calif., in the east; at Kum San, South Korea; Ibaraki, Japan; Taipei, Taiwan; Tanay, in the Philippines; Hongkong and Sri Racha, Thailand, in the West, and Carnarvon and Moree, in Australia. Pulanta, in Guam, and Paumalu, in Hawaii, also can be reached.

All possible services will be made available to the public by the New Zealand Ministry of Posts: telephone, telex, telegraph, photograph and data transmissions. Service in the TV and motion picture film area will be offered to the N.Z. Broadcasting Corportation or other interested parties on a leasing basis.

●● During 1971, Czechoslovakia issued six special stamps in connection with Soviet Satellite communications projects generally known by the name, "Interkosmos." And while no specific technical descriptions could be obtained from Prague, we can provide Stamp Shack readers with only generalities concerning the designs: we quote:

—20 haleru, a stylized picture of a Space telecommunications centre.

—40 haleru, Interkosmos 3, a geophysical satellite designed to study propagation of radio waves about the earth and cosmic radiation. Background shows stylized version of earth with magnetic north pole. Interkosmos 3 functioned between June and November, 1970.

—60 haleru, Meteorological, satellite, used by Socialist countries for study of cosmic meteorology. Background shows map of polar regions charted by the satellite.

—1 koruna, A Cosmonaut with sensors hitched to him for checking of vital body functions, with charts tracing heart, brain and other organs' reaction to Space travel. In background is Voschod satellite.

—1.20 koruna, Interkosmos 4, which operated from October 1970 to January, 1971, to measure short-wave solar radiation.

—1.60 koruna, The rocket used in Interkosmos experiments to launch satellites into orbit from a launching pad.

●● Monaco is another country that issued a couple of "communications" design stamps, but couldn't provide details when asked for them. Both are intended to mark the 25th anniversary of UNESCO. The 40-centime depicts an ancient alchemist in his laboratory while surrounded by such modern things as a Space rocket, telecommunications antenna and transmitter.

● The 80-centime has a medieval monk at his

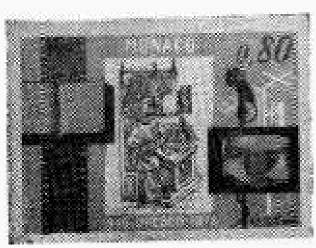
Czech issues expound Russian Satellite communications projects.

writing desk and flanked on the left, by motion picture film and an open book, and on the right, by symbols of communications: a radio microphone, TV antenna, telephone and Space Satellite.

● **What's New?** Although the use of full color already has been widely adopted by stamp magazines in Europe and Asia, American publications have remained with their staid black-and-white. The announcement by Scott Publications, Inc., that its "Scott's Monthly Journal" and some parts of its "Standard Postage Stamp Catalogue" series would henceforth be produced in color, was hailed by the philatelic world. Early samples of the publications give promise of an entirely new era in philatelic literature and probably will encourage competitors to give American readers something to which foreigners have become accustomed. ■

From Liechtenstein comes word that the late Theodore E. Steinway will be honored by a stamp to be issued in September, 1972. Mr. Steinway, who headed the Steinway & Sons piano firm until his death in 1956, was selected as the first American in the principality's "Pioneers of Philately" series because of his many contributions towards the progress of stamp collecting. He is shown here looking at a Polish stamp portraying Ignace Paderewski when the pianist was president of his homeland and signed by him for Mr. Steinway, a long-time friend. *(Photo by Kehr)*

Then and now. Communications through the ages depicted by Monaco for UNESCO.



LITERATURE LIBRARY

61. Kit builder? Like wired products? *EICO's 1972* catalog takes care of both breeds of buyers at prices you will like.

62. Want some groovey PC boards plus parts for communication projects? Then get a hold of *International Crystal's* complete catalog.

63. Now available from *EDI (Electronic Distributors, Inc.)*: a catalog containing hundreds of electronic items.

64. Bargains galore, that's what's in store! *Poly-Paks Co.* will send you their latest 8-page flyer.

65. *Dynascan Corp.* has released a new catalog of *B&K* precision test equipment for a variety of uses.

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

67. Get your copy of *Hallicrafters'* "Shortwave Puts You Where It's At." Get started today on shortwave radio for more fun tomorrow!

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

69. Get the scoop on *Versa-Tronics'* Versa-Tenna with instant magnetic mounting.

70. Prepare for tomorrow by studying at home with *Technical Training International.* Get the facts on how to step up in your job.

71. Pep-up your CB rig's performance with *Turner's* new M+3 mobile microphone.

72. CB at its best! See the whole lineup in *Midland's* colorful new CB brochure on high-power transceivers and automatic scanning monitors.

73. CB antenna catalog by *Antenna Specialists* makes the pickin' easy. Get your copy today!

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

75. *Olson's* catalog is a multi-colored newspaper that's packed with more bargains than a phone book has names.

76. *Custom Alarms* reveals how inexpensive professional alarms can really be. Install one yourself. Circle 76 for exclusive catalog.

77. New magnetic nutdrivers 1/4 in. and 5/16 in. are available from *Xcelite.* They are color-coded with fixed handles in regular, extra long, and super long styles.

78. Troubleshooting without test gear? Get with it—let *Accurate Instrument* clue you in on some great buys for your test bench.

79. *Burstein-Applebee* offers a new giant catalog containing 100s of big pages crammed with savings.

80. Two leaflets by *R. L. Drake Co.* are available. One is on their SPR-4 communications receiver; the other on the SW-4A international shortwave broadcast receiver.

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

82. Pick *Cornell Electronic's* 10th anni. catalog and discover yesterday prices. Tubes go for 36¢ and 33¢. Plus many other goodies!

83. *Allied Radio Shack* wants to introduce you to the colorful world of electronics. Discover great buys from wide selections. Get the details from *Allied* today!

84. It's just off the press—*Lafayette's* all-new 1972 illustrated catalog packed with CB gear, hi-fi components, test equipment, tools, ham rigs, and more.

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

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

87. 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.

88. *GC Electronics* has the part you are looking for! Pick up their free catalog and build again without worry.

89. CBers, Hams, SWLs—get your copy of *World's Radio Labs* 1972 catalog.

90. *Hy-Gain's* new CB antenna catalog is packed full of useful information. Get a copy.

91. *B&F Enterprises* has an interesting catalog you'd enjoy scanning. Goodies like geiger counters, logic cards, kits, lenses, etc. pack it. Get a copy!

92. *Heath's* new *1972* full-color catalog is a shopper's dream. Its pages are full of gadgets and goodies everyone would want to own.

93. For a whole packet of information on how to succeed in electronics, contact *Cleveland Institute of Electronics.* An application for enrollment is included.

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

95. Free 1972 Catalog describes 100s of *Howard W. Sams* books for the hobbyist and technician. Includes books on projects, basic electronics and many related subjects.

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1-2/72

Not Valid After July 31, 1972

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

Oh, The L With It!

I haven't the time or the patience to wind coils for radio projects. Local parts stores seldom have the coils I need, only a couple of types of Miller coils. Where else can I get coils?

—A. G., New York NY

We have found that most stores in relocated Radio Row in New York City carry *too few* parts. A lot of goodies are listed in a catalog you can get from Hazelton Scientific Co., Box 163, Hazel Park, Mich. 48030.

Ah, So!

I'm having trouble finding replacements for Japanese transistors. Where can I get them?

—F. A., Bronxville NY

Write to Semitronics Corp., 265 Canal St., New York, NY 10013. Send them 25 cents for a catalog which lists over 100 basic types of semiconductors which can be used as substitutes for more than 12,000 types. Also, your local HEP (Motorola) dealer has a HEP Substitution Guide that'll save you grief and money, too!

They Got Em!

A few issues back, one of your readers needed a 41 tube. Barry Electronics, 512 Broadway, New York NY 10012 has 'em for only $1.25 each.

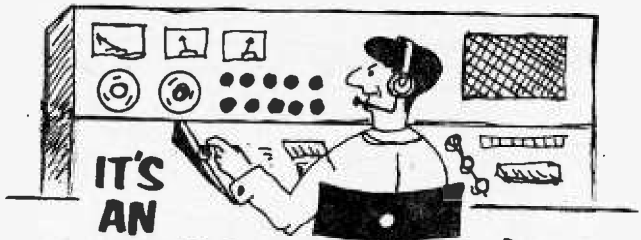
—C. F. M., Clarkton NC

We have friendly readers. My Thanks.

Pile of Iron

I have acquired a number of used transformers and chokes most of which have no manufac-

(Continued on page 104)



IT'S AN ENGINEER'S LIFE

by Jack Schmidt

"You shouldn't dress like that—
someone will mistake you for an announcer."

". . . and when I run this one up and down
real fast, the guys downstairs know
it's time for their coffee break."

"Don't you just love these remote jobs
that get us out of the studio?"

"I got the job, Hon . . . but it's not
real TV . . . it's educational television!"

"I know what they told you in school, kid,
but when Mr. Markum says 'Turn up the
volume', you turn up the volume.
Markum owns the station."

'No. I thought you had the new bulb!"

elementary Electronics JAN-FEB 1972

the ABC's of CITIZENS BAND ANTENNAS

BY LEN BUCKWALTER

Everyone in CB starts out with approximately five watts of transmitter power—actually 2 to 4 watts output but who's quibbling. But after the power leaves the set, the differences become enormous. Your signal may reach out ten miles, while a neighbor easily communicates forty miles. Results of that same power in the hands of NASA engineers can be phenomenal; space men can take five watts and relay data from a craft circling Venus 22 million miles away!

The difference, of course, is in the transmitted frequency and antenna system. It's the antenna that is the single most influential item and the one you can do something about. Proper antenna selection, installation and operation explain why some people put out a pounding signal, while others drown hope-

lessly in the noise. Maybe you can't construct a multimillion-dollar receiving horn (NASA's secret for getting 4-million miles per watt), but there are things you can do to improve range. A good place to start is with some info on how these CB sky hooks operate.

The Dynamic Duo. Two members of radio's nobility, Hertz and Marconi, lend their names to principles concealed in today's antennas. The Hertz antenna, or *half-wave dipole,* unlocks the theory behind almost all others. If you think of radio signals as a series of water waves—a comparison, incidentally, that makes professors wince—you can get a half-decent view of the half-wave at work. One complete radio-wave cycle is shown in Fig. 1A. As it emerges from the transmitter it travels down the coax in a

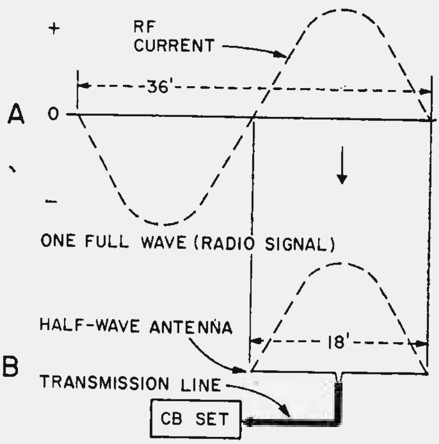


Fig. 1. RF current distribution in half-wave antenna at maximum positive peak sine-wave.

succession of waves that measure 36 feet in length for CB. Instead of crests and troughs of water, each wave consists of electromagnetic energy which constantly reverses its polarity—the number of polarity changes in each second gives us the frequency.

Half a Dipole. Consider a basic antenna for sending or receiving such a wave. It's the *half*-wave dipole, or one that's cut to 18 feet for CB. As we'll see, it's all that is needed to accommodate the complete 36-foot signal since only one polarity of the wave is present at any given time. Refer to Fig. 1B. Note that the antenna is capturing the positive portion of the signal in our example. An instant later, the wave will change polarity—to its negative phase—and excite the wire with current of the opposite polarity. Thus each half of the wave takes its turn occupying the wire.

The half-wave dipole is not only an efficient antenna for its length, but it's a standard against which the engineers measure the performance of all others. It is not a practical CB antenna because better performance is possible by special designs which evolve from the half-wave idea.

For cars, a half-wave CB antenna would be mechanical folly; an 18-foot rod would take a real beating from trees, power lines and underpasses. Fortunately, it's possible to cut a half-wave antenna in half to shrink its proportions to reasonable size. The result, shown in Fig. 2, is the basic Marconi

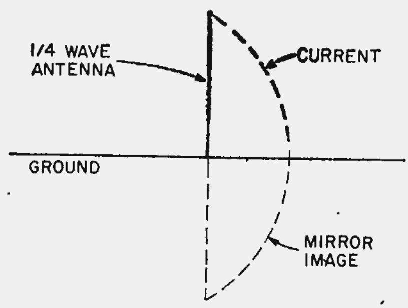
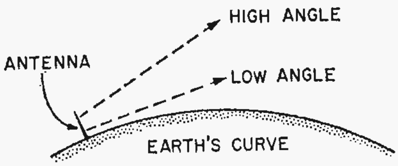


Fig. 2. ¼-wave antenna is popular for mobile. May be physically shorter with loading coil.

antenna, known now as the quarter-wave whip. The ground portion of the system simulates the missing half of the original antenna (note the mirror image) and the radio wave gets the same treatment as before. Now a mobile antenna can be half the height—9 feet—and still be tuned to the signal.

Technical Considerations. Before we see how manufacturers take these basic antennas and come up with dozens of variations, consider some restrictions. Although radio waves of lower frequency hug the earth and travel around its curve, the 27-MHz CB variety are propagated mainly line-of-sight. When sunspots are numerous, there is much long-range skip as signals bounce back to earth. Sunspots are now diminishing and the mid-70's should create poorer hunting grounds for illegal skip-workers. But the horizon, hills and other obstructions restrict normal range unless the antenna is placed at the highest possible location within the legal limit. This is basically 20 feet over a man-made or natural formation.

Radiation angle is another quality. Antennas vary in their ability to launch a signal



that remains close to the earth's surface, as illustrated in Fig. 3A. Note that a high angle of fire causes loss of coverage—so the lower the angle, the better.

Polarization tells whether the radio wave is transmitted along a horizontal or vertical path. Usually this is determined by how the antenna is mounted: in the horizontal or vertical plane. The standard for CB operation is vertical polarization because it's not only easy to mount a vertical whip on a car, but the antenna radiates in every direction. This is important for mobile operation since the base station may not know where the car is located, although there are CB communications on certain horizontally polarized and directional CB antennas, as described in a moment. With this basic theory we can analyze major CB antenna types now being offered, starting with the base station.

An Old Timer. Once a popular antenna, the *ground plane* is waning because improved models can put more metal in the air where it counts. The ground-plane occasionally appears as an economy model because it's simple to construct and the cost is low. It is usually a 9-foot vertical whip similar to the quarter-wave antenna described earlier. But when placed atop a building, there's no metal car roof to supply the missing ground, so the ground-plane antenna must have *radials*. These are three or four horizontal rods which droop out of the base of the antenna. Though widely spaced, they electrically perform as though solid ground surrounded the antenna at the bottom. Effectively, they supply that mirror image aloft, where it's needed.

The Big Stick. An antenna which outwardly resembles the ground-plane, but has features of its own, is the half-wave vertical shown in Fig. 3B. Instead of 9 feet tall, it's double that height and thus presents greater area for signal radiation. The radials stemming out from the bottom contain *loading coils*

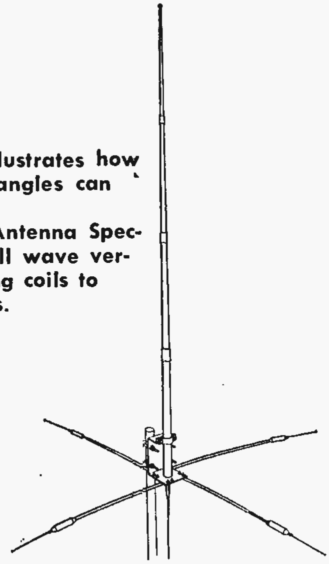


Fig. 3A., left, illustrates how high radiation angles can waste power.
Fig. 3B, right, Antenna Specialists M-317 full wave vertical uses loading coils to shorten radiaals.

which provide the electrical effect of much longer rods. One item not visible in Fig. 3 is a matching coil inside the fiberglass base. It's there for a good reason. Recall that the basic half-wave antenna shown earlier had

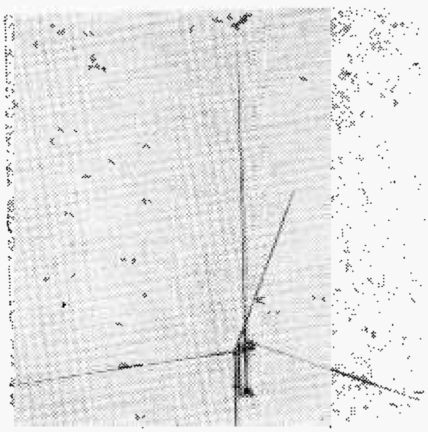


Fig. 4. Another version of groundplane, ⅝ wave provides gain. By Hy-Gain, the CLR2.

a transmission line connected at the *center* of the dipole. The reason is that the half-wave antenna at this point displays an *impedance*, or electrical load, very close in value to that of the transmission line. The standard line for CB is 52-ohm coaxial cable and such a line may connect directly to the center of the half-wave antenna for maximum transfer of energy. But try to connect coaxial cable to the *end* of a half-wave antenna and a tremendous mismatch wastes almost all the power. So the manufacturer installs a matching coil at the base to transform impedance and come up with a proper electrical match.

Another model is the 5/8-wave antenna shown in Fig. 4. It reaches up to just under the maximum height of 20 feet and uses radials for an electrical ground. (The radials also prevent the radiated power from being wasted in the cable coming up from below.) This model, incidentally, uses the designation "colinear," which means it electrically operates with elements stacked in the vertical direction. The antenna, however, incorporates coils which shorten the total height to keep it within the regulations.

A variation in base antennas is the one shown in Fig. 5. Most antennas tend to radiate strongest signals near the base where the cable is attached. This is where maximum electrical currents usually exist and it's current that's converted into the radio wave. In this antenna, the designers raise the radiating point toward the top. They state the higher position raises the signal so it's better able to clear nearby obstacles.

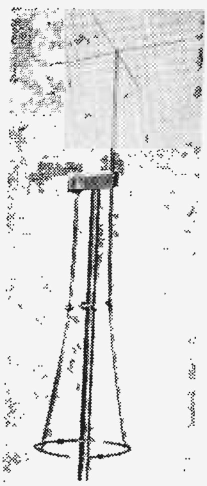


Fig. 5. A new twist in CB antennas, this vertical radiator pumps power from near its top to skim nearby obstacles. From Avanti, its the Astro-Plane.

Power Booster? Search through antenna literature and you'll see statements that promise to "convert your 5-watt signal into 40 watts." How's it possible without violating the 5-watt law? The answer is that radio signals are squeezed into a narrow arc instead of radiating in every direction at once. The idea is not unlike a bare light bulb whose illumination is focussed by lenses or reflectors into the slim beam of a spotlight. The concentrated light is many times brighter—but only over a small area.

The same effect is easy to achieve with radio signals by adding elements which are slightly longer and shorter than the basic half-wave dipole. For example, look at the five-element beam in Fig. 6, which is aiming toward the left. The Driven element, which is a half-wave dipole, receives the signal

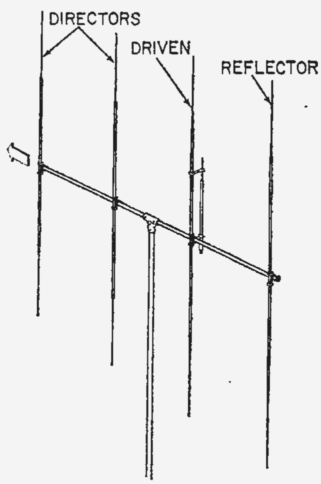


Fig. 6 Additional elements direct and reflect to provide greater Effective Radiated Power.

from the transmitter and emits it to the right *and* left. The part of the signal that strikes the Reflector is reflected back in the desired direction (leftward). The first Director also intercepts part of the signal from the Driven element, only this time the signal is radiated again, but in the desired direction. The remaining Director does the same thing as its neighbor. The secret of the elements ability to reflect or direct is in their length and spacing. These factors cause the wave to be delayed (or phased) just the correct amount to cause reinforcement or cancellation in the desired directions. The result is a powerful "lobe" of concentrated wattage.

A beam can only have one reflector, but the number of directors vary. (The 5-element beam, for example, has three directors.) In the example shown, the manufacturer states a 9.4 dB gain, which means the 5-watt signal has the effect of about 20 watts. Highest gain occurs when two complete beams are "stacked together." You must, of course, use a rotator motor with most beams to direct the lobe of energy to the desired direction. Little signal is sent and received from the sides or back of the array. Some CBers use two antennas for this reason: a non-directional type to first acquire the distant station, followed by a switch to a beam for better communications. Note in Fig. 7 that loading coils are used in a 3-element beam to reduce its overall size to about two-thirds that of a conventional beam.

selecting horizontal polarization, for example, he might reduce interference from signals transmitted in the vertical mode. He might obtain better communications with another beam that can also select the polarization to produce strongest signals. The cubical quad (Fig. 10) is another beam

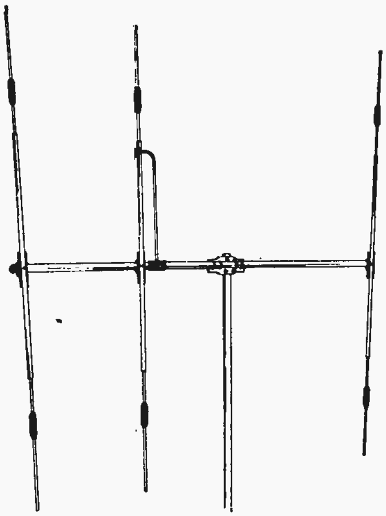
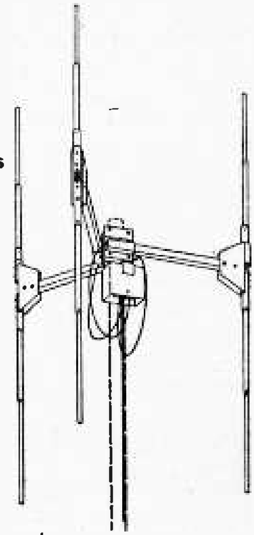
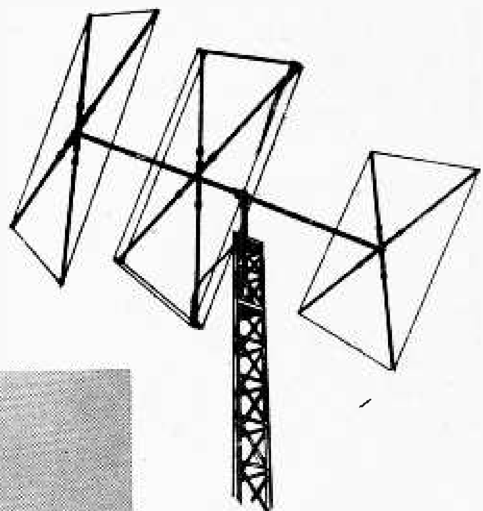


Fig. 7., left, Mosley GA-3D Mini-beam uses loading coils to simulate longer elements. Fig. 8., right, Antenna Specialists M-219 has electronic switching for non-mechanical beam rotation.



A beam which needs no rotator is the three-element "scanner" shown in Fig. 8. The CBer has a control box next to his rig to switch in pairs of elements which determine the desired direction. One position is "omni" to energize all three rods for conventional reception and transmission in all directions (omnidirectional).

Several other beam antennas include one model that contains both horizontal and vertical elements (Fig. 9). The CBer has a control box that selects either set for choosing the direction of polarization. By



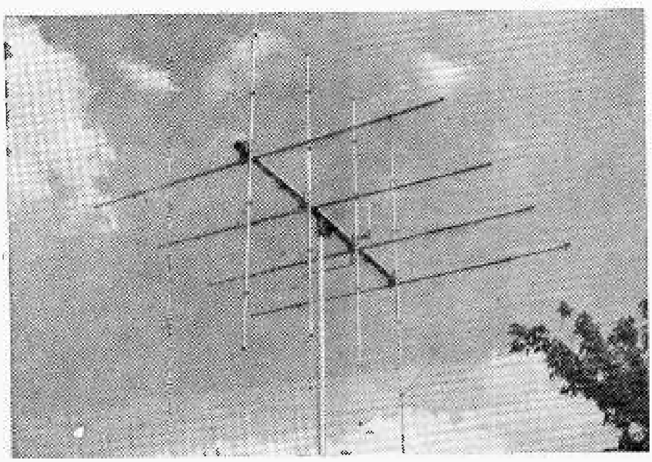
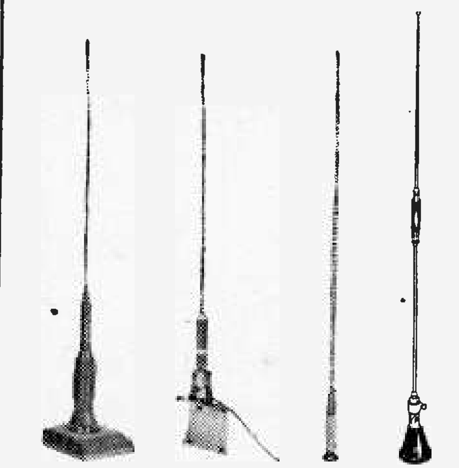


Fig. 9. Multi-polarized beam, Cush Craft CFB-8 lets CBer select best polarization mode to fit conditions, left. Fig. 10. Cubical Quad by Mosley adapted to dual polarization. This model is MCQ-27 VH.

whose mode is switch-selectable.

The Mobiles. Antennas for the automobile do not have the variety of shapes enjoyed by their brothers on base, but they show plenty of ingenuity. The reason is that mobile signals would best be transmitted and received from a 9-foot rod growing out of the center of the car roof. Since this is thoroughly impractical, a full-size quarter-wave whip ends up on the bumper. There it may suffer from low position and distortion in its pattern; the signal tends to travel best in the direction of most metal. For example, a whip on the rear right bumper operates strongest toward the front left. This has led to a variety of shortened whips for mounting in more favorable positions.

Shrinking an antenna down from the



Array of mobile antennas. Left to right: Avanti AV-527, Antenna Specialists M-189 and M-303, Mosley Marine type CC-278

CB ANTENNA GLOSSARY

Beam Antenna
An array of elements, approximately one-half wave in length, which concentrate the transmitted and received signal into a narrow arc.

Bi-directional
Transmits (or receives) in two directions, usually 180 degrees apart. This is pattern of the half-wave dipole.

DB Gain
The power increase of an antenna compared to that of a standard half-wave dipole (or what engineers may call an "isotropic radiator"). For each 3 dB (decibel) increase, power is **doubled.** For example: If a 10-watt signal is increased 3 dB, it becomes 20 watts; for 3 db more, it becomes 40 watts.

Dipole Antenna
A basic half-wave antenna (approximately 18 feet long for CB) fed at the center. It forms the driven element of the beam antenna and is the standard against which other antennas are measured.

Direct Wave
The portion of the radiated signal which travels directly, or via line-of-sight, between transmitter and receiver. This is the principle path taken by CB signals. The "ground wave," which follows the earth's curve, is extremely limited on CB.

Effective Radiated Power (ERP)
The CB transmitter produces a fixed amount of watts, but this may be varied by antenna gain, height and other factors. ERP is the result of these variations. For example: A 3-watt signal applied to a directional antenna with 3 dB gain has an ERP of 6 watts. The gain, however, occurs within a confined pattern.

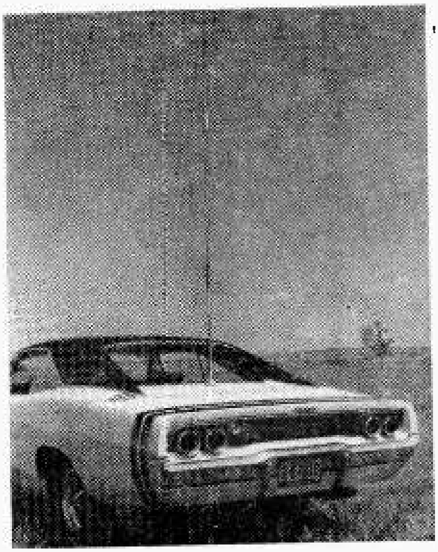
Front-to-Back Ratio
Applied to directional beams, this rating describes the amount of signal pickup from the front compared to that picked up at the rear. Stated in dB, the higher the better. High ratios (say 30dB instead of 20dB) mean less signal is lost to the rear during transmission. Less interference is also heard during reception.

Gamma Match
This is a special rod assembly added to the driven element of a beam antenna for impedance matching. It allows a 52 ohm coaxial cable to be connected to the driven element at a 52-ohm point for best transfer of energy.

Ground Plane
A basic antenna type, usually 9 feet in height with three or four drooping radials to form an electrical ground.

Impedance
A rating, given in ohms, which describes the amount of opposition to a flow of AC current. The most common impedance in CB is 52 ohms: the rating for transmitter outputs, receiver inputs, coaxial cables and antennas. These items may be interconnected for maximum power transfer since their impedances are the same or "matched".

Loading Coil
Turns of wire embedded or positioned in an antenna element to electrically create the effect of a physically longer antenna. Although the



Hot car, hot rig. CBers on the road are recognized by characteristic antennas. Shown, DX Cat by Hy Gain, 88" tall, it folds.

9-foot size is done by the loading coil, but the position of the coil is subject to much variation. A low point is good for mechanical stability and protection. A high point, on the other hand, is good because it lifts the signal further above the roof—but it's more susceptible to damage. Another problem with a lofty coil is that it is electrically sensitive to any swaying in the antenna. It could cause fluttery signals by detuning the rod. A compromise chosen by some manufacturers is the *continuously loaded* whip. The whole antenna is a coil—a wire embedded in plastic which spirals all the way up.

Which way to go?

One controversy that's hard to settle, though, is what's better, a small antenna (say 2½ feet) with a large loading coil placed atop the roof, or a 5-foot whip with a smaller coil placed lower on the trunk deck? Both antennas are electrically similar, but a larger loading coil tends to waste slightly more energy than the longer rod. Yet the smaller antenna permits a higher mounting point. Consider, also, that a roof-

coil consumes part of the energy, the loss is often outweightd by such advantages as a smaller antenna for roof-top mounting on a car or compact elements in a beam.

Lobe

The area of an antenna pattern of maximum power concentration. Used to describe the strongest radiation from a directional antenna.

Null

The area of an antenna pattern of little or no signal, usually due to cancellation by two opposing, or out-of-phase, waves.

Omnidirectional

Transmits (or receives) equally well in all directions. Also known as non-directional.

Phasing Harness

A device which permits two antennas to be connected together to a common line without creating an impedance mismatch.

Polarization

The relative position of the lines of force which emanate from the antenna as a radio signal. Polarization is usually vertical if the antenna is a vertical rod; horizontal if the antenna lies parallel to the earth's surface. Most CB'ers use vertically polarized waves because a vertical antenna lends itself best to mobile mounting. Some antennas offer both modes.

Sky Wave

The part of the antenna signal which travels above the horizon and is lost to space unless reflected back toward earth by the ionosphere. Communication via sky wave, or "skip", is illegal in CB.

Splitter

A device which recovers AM and FM broadcast signals from a CB antenna for reception on the car radio. Also prevents CB transmitter from overloading the car radio when antenna is shared.

SWR

Standing Wave Ratio, or the amount of forward power compared to reflected power. This figure tells the efficiency of the antenna system; the lower the ratio, the better. High SWR means something's mis-matched and line or antenna are reflecting power back to the transmitter. The result is power loss due to heating in the line or signal cancellation. An SWR of 1:1 is theoretically perfect, while 3:1 means about 25 percent of the power is being lost. Your system should be less than 2:1.

Transmission Line

A pair of wires designed to transfer radio-wave currents between transmitter and antenna. Most common pair for CB is the coaxial cable constructed of an outer shield and inner conductor and rated at 52 ohms (RG 58/U). Because of its electrical shield, the line may run close to other wires, metal or underground.

Wavelength

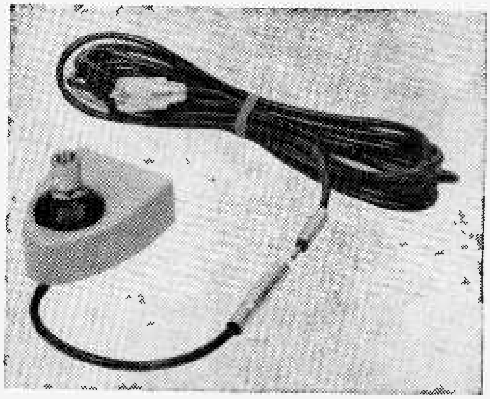
The distance, usually measured in meters, between corresponding points of radio wave. It is also the distance travelled during one cycle (one Hertz). The wavelength of CB is 11 meters, or approximately 36 feet. The basic half-wave antenna is 18 feet; the quarter wave is 9 feet.

top mounting involves a more lengthy installation since you'll have to fish a coaxial cable through the car headliner. And so the dilemma continues. . . .

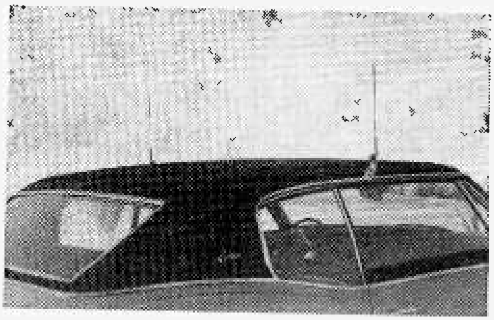
On the problem of antenna mounting the news is good. You'll find a tremendous variety of mounting styles. There are mobile antennas which grip the car through magnetic pull, clip on in moments, insert into the trunk-lid crack with no holes, while others neatly fasten to campers or trucks. As our photos show, these and other mounting styles offer something for everyone. There's even a double-whip arrangement which derives a beam-like effect on an automobile.

A Pattern Emerges. In preparing this article, I asked several major CB antenna manufacturers the same question: "Where does the CBer go wrong in his antenna installation?" The most frequent cause of trouble isn't the antenna, but the coaxial cable. The line develops short circuits through poor soldering technique at the connectors, or sometimes the cable is crushed during installation and its electrical value changes. If soldering isn't your dish, purchase one of the prewired cable assemblies now widely available. Solderless coaxial connectors also ease the job.

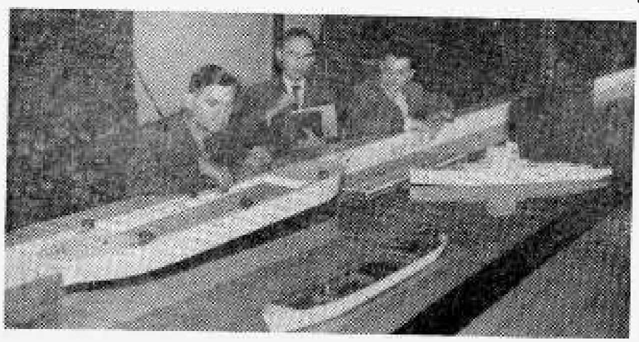
One complaint echoed by some manufacturers is that the new CBer is usually surrounded by buddies with helpful advice on antenna installation. Bitter experience suggests something's amiss. If all manufacturers could sing one line of good advice, the lyrics would surely be: *Read the instructions!* ■



Break Cable, above, eases installation for Newtronics Hustler. Below, Model DTG Double Talk reduces fading from motion.



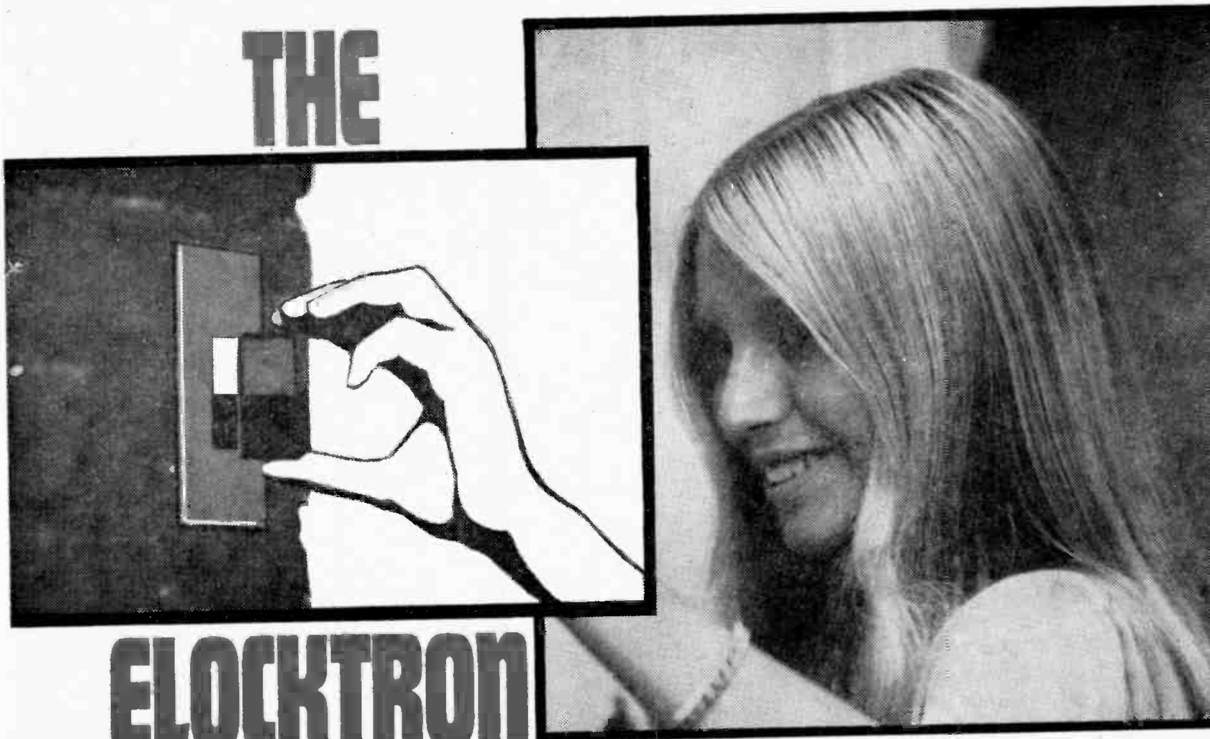
Moby Dick's play pen is Captain's Paradise



They go down to the sea each day and play with radio-controlled model boats to earn their masters license. Model size, water flow and time duplicate sea conditions. It's cheaper that way and also a lot safer.

Imagine, all these men do is play with boats all day! But these men are future sea captains studying at navigation school in Bremen, West Germany. Here they learn the fine points of navigation on a miniature sea, equipped with artificial currents simulating oceanic conditions. They maneuver their ships with the aid of radio control. There's even a tiny harbor where they learn to dock. Some work is fun, I guess. —*Myrtle Gronk*

THE ELOCKTRON



Makes a door open as if by magic!

—by Herb Cohen

What's an Elocktron? A misspelling of "electron"? No, it's an electronic lock, just like you may have seen in some science-fiction movies, where the hero makes a door open by simply putting a small piece of plastic next to a plate near the entrance.

You can make a door open the same way! The Elocktron key is actually a tiny crystal-controlled tuned circuit in a small plastic box. When you put this key next to a plastic panel mounted in the wall near the door, the power circuit behind the panel will activate the latch release, and open sesame!

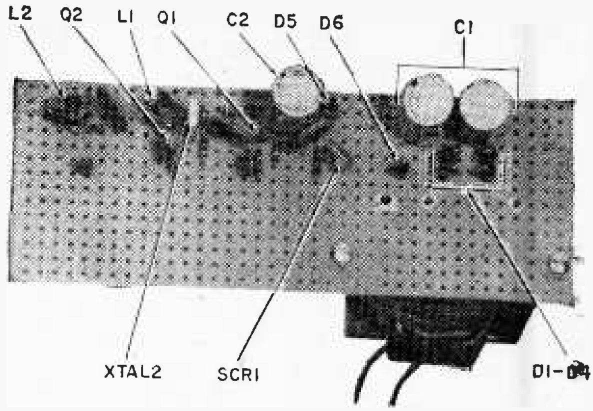
Where can you use the Elocktron? How about your front door? Even better, a door you want to keep your little brother (or your kids, or maybe even your wife) from opening, such as the door to your lab or workroom, or to your gun closet.

How It Works. The power circuit consists of a transformer-operated fullwave power supply (transformer T1, diodes D1 through D6, filtering capacitors C1 and C2), two oscillators, an amplifier, and an SCR. The 117-to-12 VAC stepdown transformer isolates the power circuit from the line, for shock protection. Transistor Q3 is a power oscillator at 18 MHz, generating a strong magnetic field around its tank coil, L2.

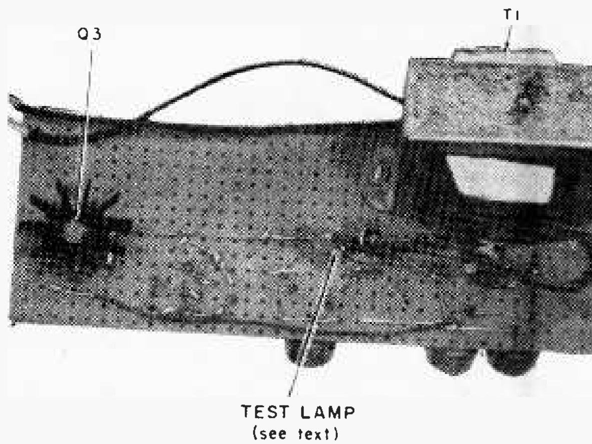
The key contains a small resonant circuit consisting of L4 and C12, tuned to 18 MHz, with a 1N34A diode that rectifies any current induced in the LC circuit. When the coils in the key are brought close to the coils in the power circuit, and the key's L4 is then close to L2, current through diode D4 activates the other circuit in the key, which is a crystal-controlled citizen's band oscillator, Q4. The oscillator radiates a signal, at the crystal frequency, from coil L3.

When the key is next to the power circuit and L4 is next to L2, then L3 in the key should be next to coil L1. Coil L1 is associated with Q2, a crystal-controlled oscillator tuned to the same frequency as the key oscillator, L3 and Q4. When L3 is near L1, their signals will mix. Slight differences in frequency between the two signals will appear at the base of Q1 as an audio signal, and will be amplified by Q1 to fire silicon controlled rectifier SCR1 and actuate the solenoid that releases the door latch.

Making an Elocktron. The layout is not critical, except for the placement of coils



The large capacitors were later moved to the T1 side of the board, to allow the key to get very close to coils L1 and L2.

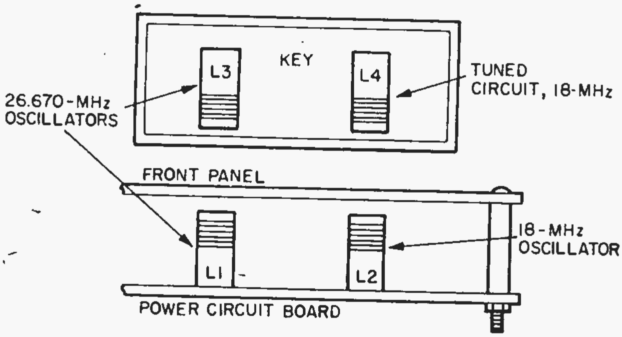


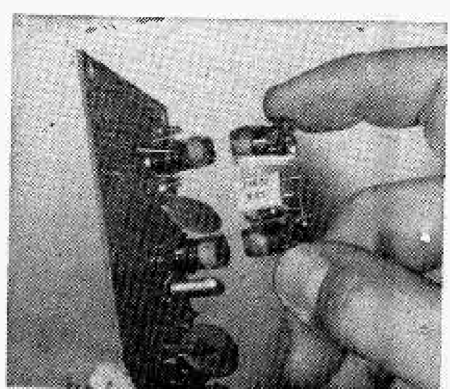
L1 and L2 on the power board. They should be placed rather close together, with the wrapped ends facing the front panel. The author put them 1⅛ in. apart, mounted all the power components on a perforated board 2¾ x 7¼ in., and used ⅝-in. standoffs between the perforated board and the plastic front panel, to allow L1 and L2 to be as close as possible to the front panel.

A heat sink was used on Q3, the 2N2270. Most of the components can be mounted on the side of the perf board next to the front panel, except for Q3, the transformer, and the large filtering capacitors. Incidentally, if 500uf, 15V electrolytic capacitors are more easily obtained than 1000uf types, then use two of the 500uF types in parallel for C1, as the author has done. The SCR should provide about an ampere to open the lock, so that any one of the General Electric C106 series should do the job.

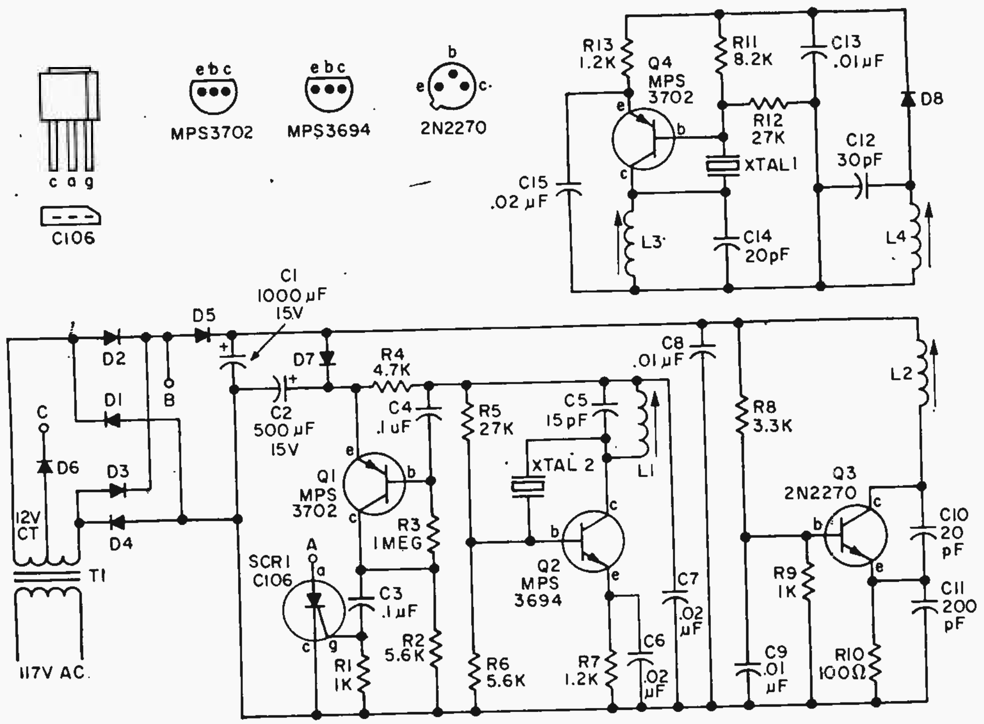
The author used a clear plastic sheet for the front panel, 1/16 x 9 x 4¾ in., but the size is not critical. The panel can be sprayed any color, or covered with decorative material: this depends on the wall in which you flush-mount the power circuit, next to the door. The portion of the front panel in front of coils L1 and L2, next to which the key is placed, can be color-coded to match the key-box. Or it can be colored like the rest of the panel if you want to play it real cool and if your eye is good at judging just where the key should be placed to open the lock.

The electronic key is contained in a small plastic box. The author used one measuring about 2 x 1 x ¾ in. Coils L3 and L4 should be the same distance apart as L1 and L2 are. The key should be marked in some way so that it can be placed quickly in the proper position against the lock. One method is to paint each half of the key-box





Pictorial and photo show relative positions of the four coils when the electronic key is in position to activate the circuit.



Schematic of the Elocktron. The four coils are lined up in position for operating the door-latch release, with L3 close to L1, L4 near L2.

a different color. Use the same colors as on the power-circuit front panel, if you've decided to color-code the section in front of the coils. Also, you'll need another kind of marking to tell which side of the key-box to put up against the lock panel, because the key will work only when coils L3 and L4 in the key are less than half an inch from coils L1 and L2 in the lock panel.

After you've built the Elocktron, you can test it with a meter or by attaching a 6-volt lamp between terminals A and C, or a 12-volt lamp between terminals A and B. The lamp should light when coils L3 and L4 are close to L1 and L2, respectively.

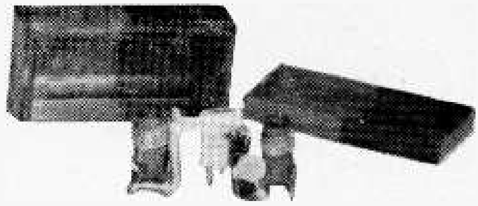
Adjustments. To tune L4 in the key, place

PARTS LIST FOR THE ELOCKTRON

- **C1**—1,000 µF, 15 VDC electrolytic capacitor Lafayette 34F55177 or equiv.)
- **C2**—500 µF, 15 VDC electrolytic capacitor (Lafayette 34F55169 or equiv.)
- **C3, C4**—.1 µF, 75 VDC
- **C5**—15 pF capacitor
- **C6, C7, C15**—.02 µf capacitor
- **C8, C9, C13**—.01 µF capacitor
- **C10, C14**—20 pF capacitor
- **C11**—200 pF capacitor
- **C12**—30 pF capacitor
- **D1-7**—50 PIV, 1A silicon diode, Motorola HEP 154
- **D8**—IN34A silicon diode, Motorola HEP 134
- **Q1, Q4**—Silicon transistor, pnp (Motorola MPS3702
- **Q2**—Silicon transistor, npn (Motorola MPS3694)
- **Q3**—Silicon transistor, npn (RCA 2N2270)
- **SCR1**—Silicon controlled rectifier (GE C106, any suffix—see text)
- **L1-4**—Receiver oscillator coil (Lafayette 99E62028)
- **R1, R9**—1,000-ohm, ¼-watt resistor
- **R2, R6**—5,600-ohm, ¼-watt resistor
- **R3**—1,000,000-ohm, ¼-watt resistor
- **R4**—4,700-ohm, ½-watt resistor
- **R5, R12**—27,000-ohm, ¼-watt resistor
- **R7, R13**—1,200-ohm, ¼-watt resistor
- **R8**—3,300-ohm, ¼-watt resistor
- **R10**—100-ohm, ½-watt resistor
- **R11**—8,200-ohm, ¼-watt resistor
- **T1**—Power transformer: primary, 117 V 50-60 Hz; secondary, 12 V @ 2 A (Stancor P-8130 or equiv.)
- **XTAL1, XTAL2**—26.670 MHz
- Misc.—Perforated board, sheet plastic, small plastic box, standoffs, bolts, nuts, hookup wire, line cord.

the key next to the front panel, in the "operate" position, with L4 about half an inch from L2 (and L3 the same distance from L1). Put a DC voltmeter across C13 in the key, and adjust the slug in L2 until the voltmeter peaks, which will be at 2 to 5 volts, depending on, among other things, your estimate of half an inch. If the voltmeter does not peak, set the slug in L4 to the center of the coil and adjust the L2 slug until the meter peaks. If needed, adjust both slugs for peak. If you can peak L2, you know that Q3 is oscillating. If you can then peak L4, you know that the L4-C12 tuned circuit is operating correctly by picking up the 18-MHz signal radiated from L2.

Oscillators Q2 and Q4 can be aligned with a grid-dip meter set to the crystal frequency of 26.670 MHz, if you happen to have a grid-dip meter. Another alignment method is to use a CB transceiver with a very short antenna. First disconnect the wire between R8 and C8 on the power circuit, disabling the Q3 oscillator. Bring L1 near the receiving antenna of the CB rig, set to channel 2 or to whichever channel gives you a rushing noise when L1 approaches the antenna. That noise is the clue that Q2 is oscillating. Reconnect the wire between R8 and C8, put L1 near the CB antenna again, and bring the key close. If you hear an audio tone that varies with the distance between L1 and L3, then you know Q4 is oscillating, because you hear the beat frequency. The tuning slugs in L1 and L3 need not be as accurately positioned as those in L2 and L4.



The size of two packs of razor blades is about as small as the electronic key can be made, with all the components involved.

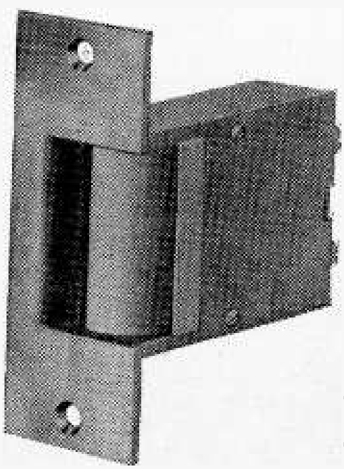
You need only adjust the L1 and L3 slugs so that they're the same distance inside their respective coils, or both protruding the same distance from the coils.

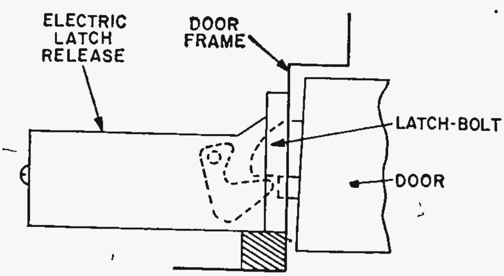
The Door-Latch Release. The device that allows the door to be opened is an *electric latch release*. This is simply a solenoid-operated catch that, when actuated, pulls back to release the lock-bolt, allowing the door to be pushed open from outside. Connect a 12-volt latch release between A (the SCR anode) and B, or connect a 6-volt latch release between A and C.

Electric latch releases are available to work with almost any type of door lock, and are mounted in the door-frame opposite the lock. The frame may have to be cut in deeper to accommodate the solenoid, and has to be cut out in front to allow the latch-bolt to clear the frame when the solenoid pulls back the catch. Note that when the electric latch release isn't used, a key must be used to open the door from outside, as the latch release canot be pushed back by hand.

Many hardware stores carry electric latch releases, such as those made by the Trine Manufacturing Corp. Trine has nine models

(Continued on page 106)





The Trine 005 electric door opener at left is one of several types that can be used, depending on the lock and door-frame. In the top view of the installed opener (above), the shaded portion indicates the small section of door-frame to cut out for the latch-bolt clearance.

e/e snaps in a...

Toyo Cassette Pack Adaptor

IT MAKES YOUR 8-TRACK PLAYER GO CASSETTE

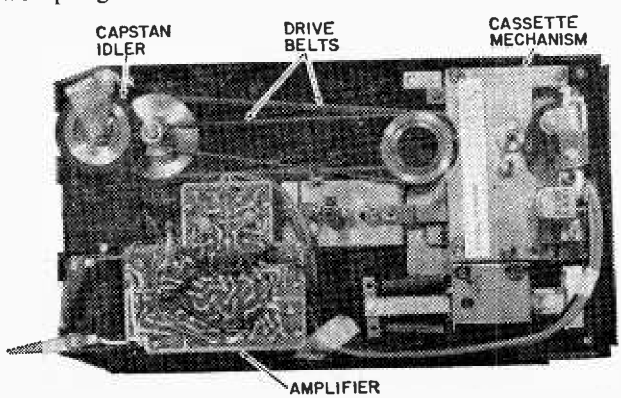
What do you do when you're fully geared to 8-track cartridges and the hit album you want is available only on cassette? You can either cry or utilize a Toyo model SCP-580 Cassette Pack.

The Toyo Cassettt Pack is an adaptor for playing cassettes on any 8-track cartridge player or recorder. It closely resembles a standard cartridge with a bulge up front. To play a cassette, you simply load it into the Cassette Pack and then insert the pack into the player just like any other 8-track cartridge. Press the one (and only) control button and the cassette starts to play. Press the button again and the cassette stops.

How It Works. The Toyo Cassette Pack contains a built-in solid state amplifier with a voltage-regulated power source. When the pack is plugged into the cartridge player two spring loaded fingers press against the player's program shift contacts (the ones tripped by the foil on the cartridge tape). The fingers pick up the voltage across the contacts and feed it to the pack's voltage regulator. The pack can work with any cartridge player having 9 to 24 volts across the contacts,—which covers just about every player currently available.

Inside the cassette pack is a capstan idler wheel, an exact duplicate of the one inside an 8-track cartridge. The wheel is turned by the player's capstan. Two rubber drive belts wrapped around the capstan idler drive the cassette player's capstan and the cassette take-up spindle.

The signal from the cassette pack is fed to two induction coils positioned where the cartridge tape normally passes over the playback head. The induction coils *induce* the cassette's signal into the cartridge player's head (there is no direct connection).



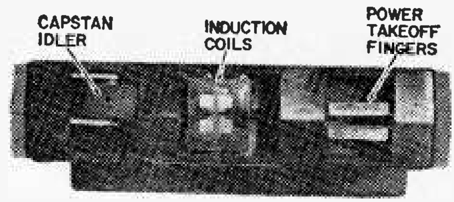
Inside the cassette pack is a stereo amplifier, cassette mechanism and a drive system for the cassette capstan and take-up reel. The drive system is via rubber belts from the capstan idler.

TOYO CASSETTE PACK ADAPTOR

How It Handles and Performs. Unlike earlier attempts at cassette packs, the Toyo SCP-580 does not stick way out in front of the player where it can interfere with a gearshift or a passenger's knees. The Toyo sticks out but two inches, because half the cassette is inside the cartridge slot.

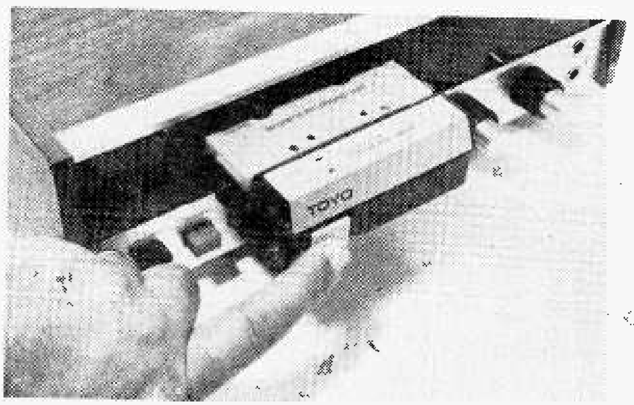
As far as we could determine the Toyo Cassette Pack adds no extra wow and flutter to the player; the total wow and flutter is essentially that of the cartridge player. The Toyo's frequency response was at least the equal of most 8-track players (and cartridges): ± 3 db 50 to 6000 Hz (using standard test tape).

With one exception the Toyo Cassette Pack could be used with any 8-track cartridge player (mono, stereo or 4-channel). The exception was the 8-track player supplied as standard equipment on Plymouth autos (probably applies to all Chrysler players); the cassette pack would not lock into the Plymouth player.

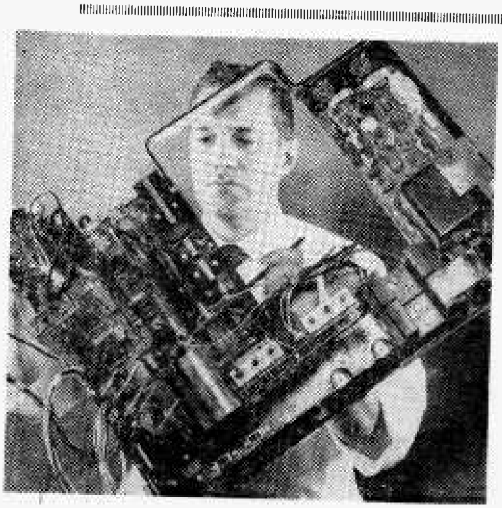


Business end of the Toyo cassette pack has a capstan idler, induction coils where the cartridge tape usually passes over the player's head, and power take-off fingers that take operating power from the player's track switching contacts.

Priced at $29.95, the Toyo SCP-580 Cassette Pack is just about the cheapest way to enjoy both 8-track cartridges and cassettes. For additional information circle Reader Service No. 52 on page 17.



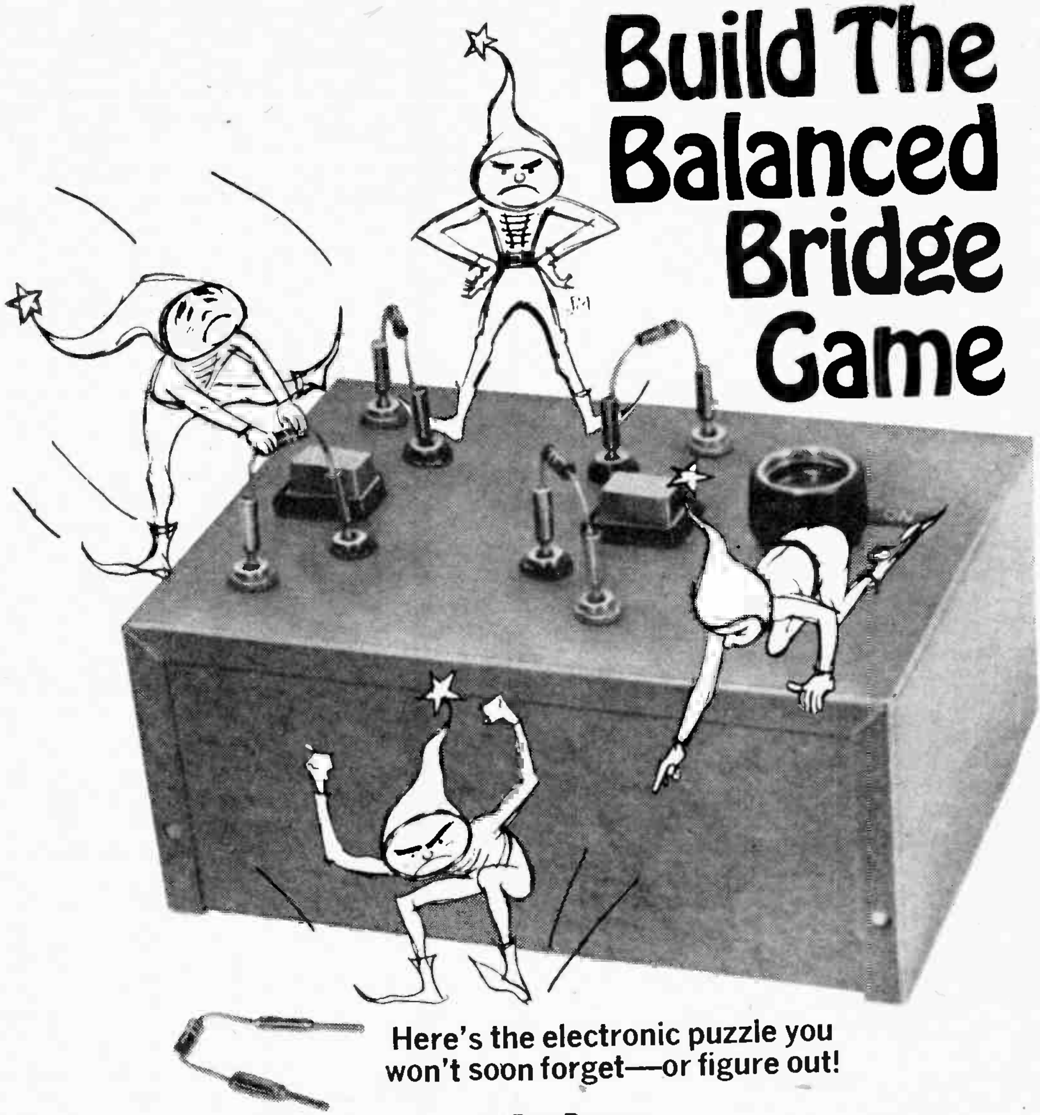
To play a cassette you simply insert the loaded cassette pack into the cartridge slot and press the start-stop button. There are no fast speeds, but then 8-track players don't usually have them either.



100% SOLID COLOR

Can you pick up the components of your color television with one hand? And, that's only one advantage, and a minor one, of the new RCA 100 per cent solid state AccuColor set. Solid state technology also means easier at-home servicing since the AccuCircuit modules are interchangeable from set to set. So if anything goes wrong, just plug in the new part. Some of these models also include an AccuMatic Color Monitor which automatically locks in the proper color level. By the way, the five sets with this automatic tuning device also require 35 per cent less electrical power to operate than the vacuum tube variety. —*Myrtle Gronk*

Build The Balanced Bridge Game



Here's the electronic puzzle you won't soon forget—or figure out!

by Ron Benrey

How's your sense of balance? We mean, your ability to mentally balance our electronic bridge game. If it's good, you might find the key and unlock this fascinating puzzle's mystery in a few moments. But, we're warning you—even veteran mah jongg experts have been known to throw up their hands in utter disgust, after trying their skill at our little game of chance. Is it skill that rewards the player with the sweet sight of victory, or plain old-fashioned rabbit's-foot luck? Try our *Balance Bridge* game, and see for yourself!

Besides being great fun, this easy-to-build electronic game teaches you all about one of the most important electronic circuits yet devised: the Wheatstone Bridge. But, let's talk about fun first. The game is deceptively simple to play. The contestant starts out clutching a fistful of resistors (with their identifying color bands obliterated by painting them over). Four resistors will, when plugged in the *correct* terminals on the puzzle, cause the internal bridge circuit to be *balanced*.

So far, you'd figure that even your kid brother stands a winning chance. But, in order to complete the game and win points, he's got to make both "error" lamps go out. That's the hitch. If the wrong resistors are plugged in, or, if the right resistors are plugged into the wrong terminals, one of

e/e BALANCED BRIDGE GAME

the error lamps will light. Better give your brash kid brother a healthy handicap!

The idea, of course, is to find the correct —or, winning—resistor combinations. And, then insert them into the correct terminals, so that both lamps remain unlit. You can make the puzzle as easy or hard as you wish. Just vary the number of resistors that the player has to work with! See our table of resistor values to get some idea of the several variations of puzzle complexity you can create.

The real trick, incidentally, to winning this puzzle is to set up a methodical approach by trying the various possible resistor combinations until you find one that works. Since most people don't work in a methodical fashion . . . well, we needn't say any more. And, to further confuse the head scratchers and nail biters even more, all the camouflaged resistors look alike, so it's impossible to memorize a solution to the puzzle. Luckily for you, though, head scratching isn't necessary in order to understand the Wheatstone Bridge.

Sir Charles' Bridge. The Wheatstone Bridge, as you probably guessed, is named after its inventor, the English physicist, Sir Charles Wheatstone. This basic circuit is used to measure electrical resistance with great accuracy. Figure 1 shows the drawing of Sir Charles' bridge in its most familiar form. It's traditionally drawn in the shape of a four-sided diamond, each leg representing a resistor element.

A voltage source connects to the "top" and "bottom" points of the diamond; a sensitive voltmeter (or, more often, a sensitive current-measuring instrument called a *galvanometer*) is hung across the diamond's side points A and B. Actually, the diamond configuration is a bit confusing, since it hides the fact that a Wheatstone Bridge is really only two voltage dividers connected back-to-back to a voltmeter or galvanometer.

We've redrawn the circuit in Fig. 2, showing how the Wheatstone Bridge works. Note that the voltmeter is simply indicating the voltage potential *difference* between the outputs of both dividers. Clearly—and this is an important point—if the outputs of the two voltage dividers are equal, the voltmeter will read zero volts.

Suppose the lefthand pair of dividers has a higher voltage output than the right-hand pair. Now the meter reads a positive voltage. If the right-hand pair's voltage output is higher than that of the left-hand set, then the meter will read a negative voltage.

Piecing the Puzzle Together. If you examine the schematic diagram of our electronic puzzle, you'll see that its heart is the basic Wheatstone bridge configuration—with one important difference. Instead of fixed resistances, the arms of our *Balanced Bridge* game consist of a pair of pin jacks. They're arranged so that leads of a resistor can be plugged into them. When the player inserts four appropriate resistors so that he produces a balanced bridge, he has solved the puzzle. More likely, though, he will create an unbalanced bridge, lighting one of the two error lamps.

These lamps are controlled by two darlington amplifier transistors, each wired to the two side points of the bridge diamond. One lamp lights when the bridge is unbalanced on one side of the diamond. The other lamp lights when the bridge is unbalanced in its other side.

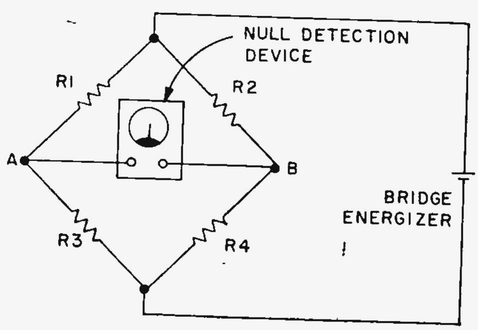


Fig. 1—The Wheatstone bridge, as it is usually drawn, in a diamond configuration. When R1/R3=R2/R4, the meter will read zero volts.

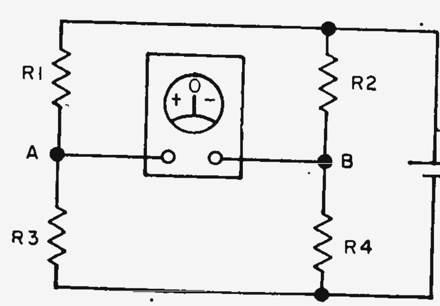


Fig. 2—The Wheatstone bridge, drawn to show that it is really a pair of voltage dividers with a voltmeter between the two.

Both lamps extinguish when the bridge is balanced, or when one or two resistors are inserted into pin sockets, but still don't provide electrical continuity within the bridge!

Groups of resistors can be plugged into the *Balanced Bridge* game in several "correct" ways. Reason is, the bridge is a symmetrical circuit. Left and right sets of bridge arms, as well as the upper and lower pairs, can be integrated without unbalancing the circuit.

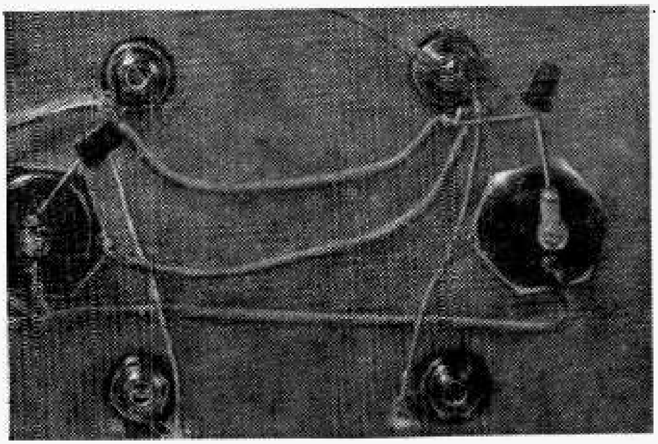
Note that the lamp circuits are not sensitive to slight inbalances due to the nature of the driver transistors. If you decide to experiment and produce your own game resistance values, here is the general formula for bridge balance.

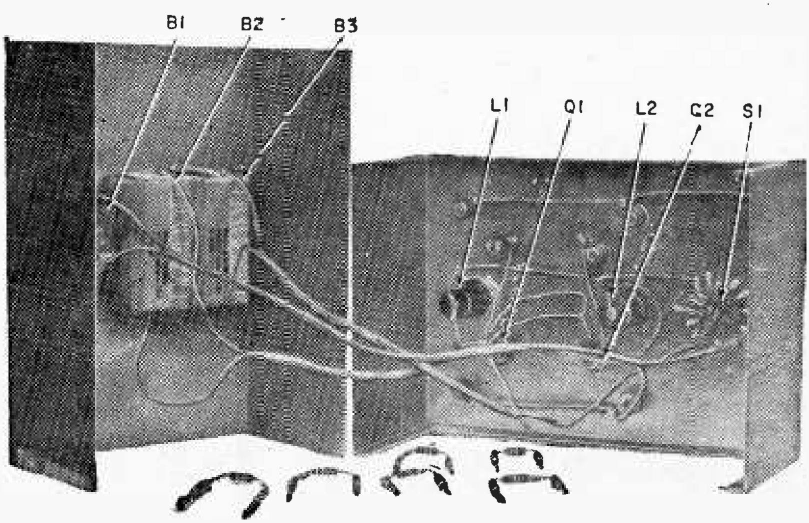
At balance: $R1/R3=R2/R4$

Jigsaw Gyrations. Our *Balanced Bridge* game is housed in a 3-in. X 5-in. X 7-in. aluminum minibox. As our photos show, both transistors and all associated interconnection wiring are mounted between the terminals on both pilot-lamp holders, the pin jacks, and S1. Parts placement is entirely non-critical; feel free to alter the layout if you wish. Keep one precaution in mind. Slip lengths of wire insulation over the transistor leads to eliminate any chance of accidental short circuits.

Three batteries are necessary for this project. Reason is, the bridge, itself, requires a "floating ground"; the 22½-Volt battery takes care of this. Next, two 6-Volt voltage sources are needed to provide power for both lamp-driver transistor circuits. Special biasing techniques are used for both transistors; separate batteries perform this function. Cement all batteries in place on the top-half of the minibox with general-purpose cement. Solder connecting leads directly to

In the close-up at right, note that all the transistors are mounted between the pilot-lamp holders and the nearest pin jacks. The photo below shows one possible layout of parts, but the placement isn't critical. Just be sure to put pieces of wire insulation on the transistor leads to prevent any chance of short circuits.





e/e BALANCED BRIDGE GAME

the terminals. Construction of the *Balanced Bridge* ends after you've soldered pin plugs to the wire leads of each resistor needed to play the game.

To Find or Not to Find. Not everybody's parts collection has a pair of 2N5306 darlington transistors floating around. Looking in *Motorola's* HEP Replacement Semiconductor catalog, you'll see that the nearest NPN darlington amp listed is their type S-9100. Its characteristics are close enough to the author's original type specified.

And don't make the mistake of thinking that just any transistor will do in this circuit. A bi-polar transistor's input bias current flow will upset the delicate balance of the bridge.

Darlington amps, have exceptionally high gain and very high input impedance; this solid-state configuration neatly fits the bridge's bill for a no-load, on-off transistorized switch. You can order the HEP S-9100 from *Lafayette Radio Electronics* on special order. Also, try *Burstein-Applebee* as an alternate source for the S-9100. Again, ask to have the transistor placed on special order for you.

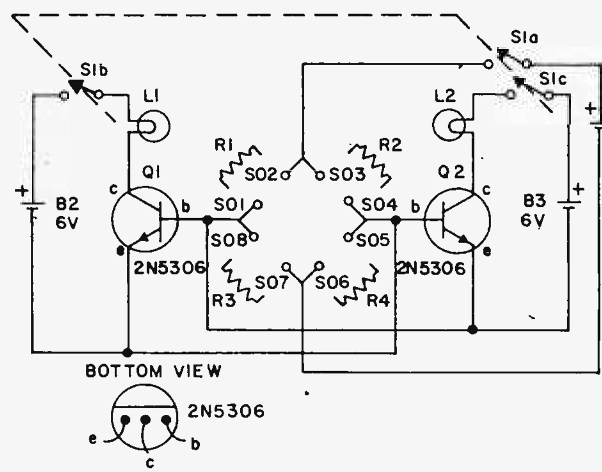
One final point. If electronics buffs will be playing the game, paint all resistor bodies as suggested earlier. For your other friends, leave the resistors alone. The mysterious colored bands will probably add an additional note of confusion to the game. ■

Balanced Bridge Game Resistor Combinations

A simple game for the kids:
R1=47K, R2=100K, R3=22K, R4=47K

Slightly harder for your friends:
R1=1K, R2=10K, R3=47K, R4=100K, R5=5K (or 4.7K). There are many workable combinations in this group.

Hardest yet, for MENSA types:
R1=10K, R2=100K, R3=68K, R4=33K, R5=220K
Add as many additional odd-valued resistors as you like. The more, the merrier!



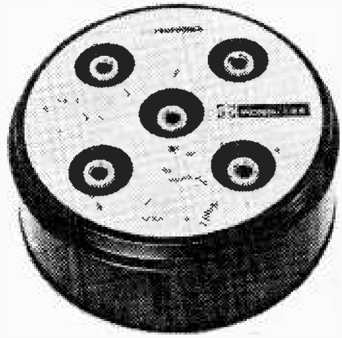
PARTS LIST FOR THE BALANCED BRIDGE GAME

B1—22½-Volt battery (RCA type VS084 or equiv.)
B2,B3—6-Volt battery (RCA type VS068 or equiv.)
L1,L2—6.3-Volt @ ¼ amp pilot lamp—type 46 (Calectro E2-441 or equiv.)
Q1,Q2—darlington amplifier transistors (GE 2N5306 or Motorola HEP series S-9100). See text
S1—4-pole, 2-position rotary switch (Calectro E2-167 or equiv.)
S01-S08—panel-mount pin jacks (Calectro F2-879 or equiv.)
1—pilot light socket assembly with red lens (Calectro E2-407 or equiv.)
1—pilot light socket assembly with green lens Calectro E2-408 or equiv.)
1—1-in. diameter knob (Calectro E2-720 or equiv.)
Misc.—3-in. x 5-in. x 7-in. aluminum minibox (Bud type CU-2108-A or equiv.), #22 stranded wire, pin plugs (Calectro F2-872 or equiv.), solder, etc.

E/E looks at new...

Here is true four-channel sound, for only $174.95. Toyo's Quadio 707 cartridge tape player produces four discrete channels of sound, through four separate amplifiers, and also plays 2-channel sound from any stereo source, such as phono, FM-stereo tuner, or reel-to-reel deck. Circle No. 57 on Reader Service Page.

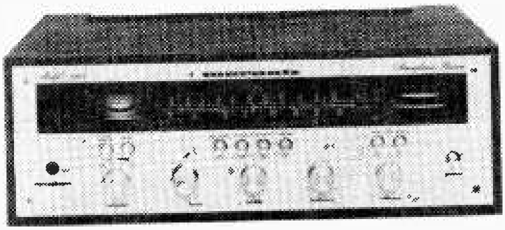
Have a group "listen-in" with the Koss T-4A connector box, which provides private stereo listening for up to five people at a time. Six inches in diameter, the T-4A has a walnut-like base and a spun aluminum panel, costs $12.95. Circle No. 58 on Reader Service Page.



A Marantz receiver for only $199? The AM/FM-stereo 2215 is rated at 30 RMS watts continuous power (15 per channel), and offers tape monitoring, speaker switching, high and low filtering, and controllable FM muting, plus the tuning, tone-control and switching facilities expected in more expensive receivers. Circle No. 59 on Reader Service Page.

⊠

A four-speaker headphone is the latest addition to Lafayette Radio's line. The F-500 coaxial stereo headphone, priced at $49.95, has a woofer and a tweeter in each earpiece, along with a crossover network. Circle No. 60 on Reader Service Page.



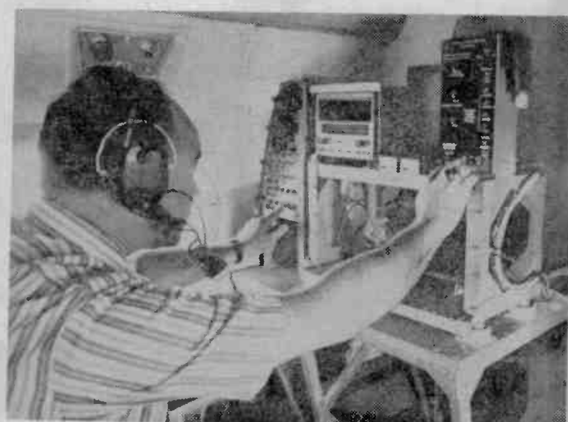
HI-FI COMPONENTS

The pollution is as high as an airplane's eye

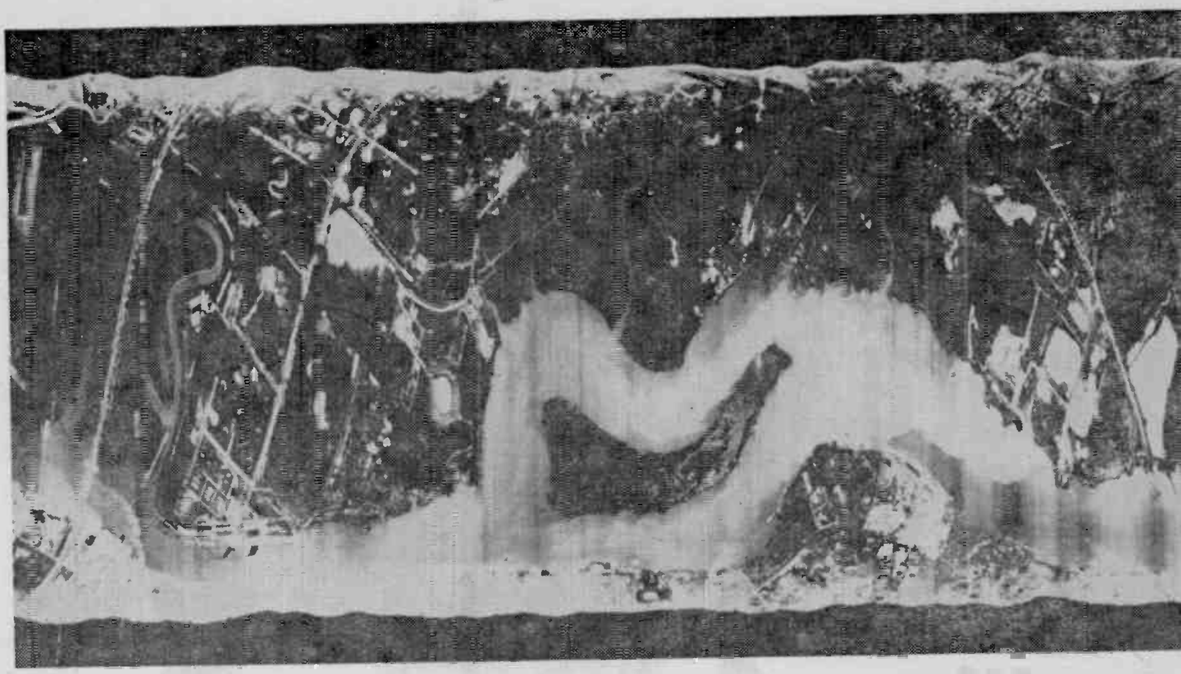
☐ Massive air strikes are being launched against one of our most deadly enemies—the polluter! Grumman Ecosystems is leading these strikes with high-flying photo-planes, like those used in the hotter wars to track down polluters from the air, electronically. These spotters are equipped with side-looking radar systems, topographical mapping equipment and other electronic and photographic detection devices. After hours of surveillance, these airborn laboratories return to their base loaded with all the necessary ecological data from the surrounding area.

These spy planes carry sensitive electronic gear which is effective day or night. Cameras equipped with infrared film can pick up oil slicks above and below the surface of the water, even at altitudes up to 2,000 feet. Cameras with polarizing filters can catch the glint of the sun's rays off pollution on the surface of the water as well as under it. Infrared film can detect variation of color—the non-polluted areas will appear red while instances of dumping will appear off-color. These planes also have a "Thermal Infrared

The Grumman Ecosystem aircraft, once an effective espionage aid in wartime, are now loaded with electronic devices to track down new enemies—polluters.



This spotter maps and records the ecological condition of the area below. All data is kept in this recording equipment.



Line Scanner," capable of mapping thermal anomolies indicating moisture and ground water temperature changes; these in turn indicate plant dumpage since the water from plant deposits is warmer than the river into which it is flowing.

All these electronic devices enable the spotters to map, record, and take back information to the home base where it is put through a computer for further study. By correlating all this data, the Grumman engineers are able to track down the enemies polluting our land and waterways daily.

Thermal scanning devices can detect pollution by thermal variations which show up as different hues on infrared film. Bandit dumpage was discovered in this shot (above) by the use of this equipment.

The need for an escalated war against pollution is obvious. Efforts such as these spotters are encouraging signs that man is learning to use his technology wisely. Peaceful applications of our aerospace and electronics programs seem to be a step in the right direction—to track down pollution at its sources. —*Myrtle Gronk.*

The Daedalus Thermal Line Scanner (above left) and the Wild RC-8 Aerial Mapping Camera (above right) are just two of many electronic devices used to track the polluter.

Sophisticated electronics allow the operators to work even during poor visibility.

the Shock Room that'll save your life

Electronic medicine? Essentially that's what the Shock Room at the City Hospital of Elmhurst is all about. It's all part of the Intensive Care section equipped with special electronic-medical machinery that means a breakthrough in the treatment of traumatic or accidental injuries—one of the most "neglected" diseases.

Truama from accidents is the number

Doctors can examine records of arterial and venous pressures and cardiac output with the aid of this multiple channel electronic recording device (left). The gas analyzer (above) is a device used to determine a patient's blood level of oxygen, carbon dioxide and acity.

four killer in the country, and so the importance of this new unit is obvious. Doctors at Elmhurst claim it saves 98.5% of those who would have normally died from these wounds. The Shock Room contains all the necessary equipment in one room, surrounded by specialists geared to this treatment, monitoring devices and 24-hour surveillance. Doctors and nurses constantly record and regulate all the vital functions. The instruments used are all hooked up to the IBM computer at Mt. Sinai in New York, which has over 260 categorized diagnostic patterns to draw on.

Smaller hospitals can take advantage of this service by cable connection. But at present, if you're going to be in an accident, be near the Shock Room. —*Myrtle Gronk.*

Technicians work in conjunction with nurses while treating patients suffering from traumatic injury in the Shock Room (far left). Here, the patient receives constant care, both personal and electronic. Dr. Brown who helped set up the Shock Room (left) uses one such device, hooked up to the Mt. Sinai computer, which is capable of sending back instantaneous circulatory and respiratory measurements.

Since all the instruments in the Elmhurst Shock Room are hooked up to the Mt. Sinai computer, doctors can rely on instantly relayed information needed in the treatment of their patient (left). This nurse in the Surgical Intensive Care Unit (below), which is in direct contact with the facilities of the Shock Room, can now receive any needed assistance while attending her patient.

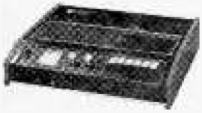
new Heathkit ideas

Meet the second generation AR-15 ...new Heathkit AR-1500!

From the AR-15, hailed at the time of its introduction in 1967 as the most advanced receiver of its kind, comes the AR-1500... with impressive improvements in every critical area! *180 Watts Dynamic Music Power,* 90 watts per channel (8 ohm load); 120 watts dynamic music power per channel under 4 ohm load, with less than 0.1% intermod distortion, less than .25% harmonic distortion. A 14-lb. power transformer and massive output transistor heat sink are mute testimony to the power at your command. Direct coupled output and drive transistors are protected by limiting circuitry that electronically monitors voltage and current. *FM selectivity greater than 90 dB,* better phase linearity, separation, and less distortion are the result of two computer-designed 5-pole LC Filters. An improved 4-gang 6-tuned circuit front end offers better stability, 1.8 uV sensitivity, 1.5 dB capture ratio, and 100 dB image and IF rejection. Four ICs are used, three in the IF and one in the Multiplex. Patented automatic FM squelch is both noise and deviation activated, fully adjustable for sensitivity. *Vastly Superior AM,* an "also ran" with many receivers, has two dual-gate MOSFETS in the RF and Mixer stages, one J-FET in the oscillator, 12-pole LC Filter in the IF, and broad-band detector. Result: better overload characteristics, better AGC action, and no IF alignment. *Greatly simplified kit construction.* Ten plug-in circuit boards, two wiring harnesses and extensive use of pre-cut wiring with installed clip connections make the AR-1500 a kit builder's dream. Built-in test circuitry uses signal meter to make resistance and voltage checks before operation. *Other advanced features* include Black Magic panel lighting that hides dial markings when set is not in use; flywheel tuning; pushbutton function controls; outputs for two separate speaker systems, bi-amplification, oscilloscope monitoring of FM multipath; inputs for phono, tape, tape monitor and aux. sources — all with individual level controls. *Versatile installation* in optional new low-profile walnut cabinet, in a wall, or black-finish dust cover included. Join the "NOW" Generation in audio technology...order your Heathkit AR-1500 today!

Kit AR-1500, less cabinet, 42 lbs. **349.95***
ARA-1500-1, walnut cabinet, 6 lbs. **24.95***

New Heathkit Stereo Cassette Recorder



119^95*^

Frequency response of ±3 dB, 30-12 kHz, brings your stereo system into the cassette age. Features built-in bias adjustment to accommodate the new chromium dioxide tape; counter; automatic motor shutoff; preassembled and aligned transport mechanism. The AD-110 offers fidelity recording and playback of stereo or mono when used with your stereo system.

Kit AD-110, 10 lbs. **119.95***

New Heathkit Stereo-4 Decoder

29^95*^

Compatible with your present stereo system and FM receiver, lets you hear all Stereo-4 material currently being broadcast by a number of stations across the country. Additionally, imparts a 4-channel effect to your existing stereo library. Requires second amplifier and 2 speaker systems for installation with conventional stereo system.

Kit AD-2002, 5 lbs. **29.95***

New Heathkit Stereo Phonograph with AM Radio

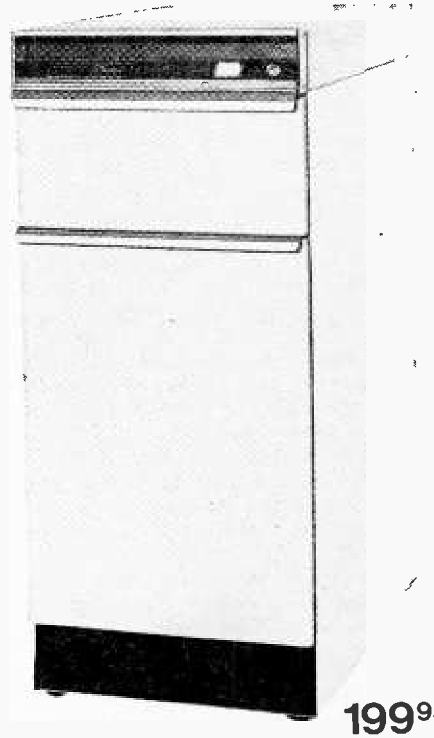
109^95*^

Gets it together in a portable package with a purple plum snakey skin that's as far out as today's sounds. Solid-state 18-watt amplifier, fold-down 4-speed automatic changer and swing-out high compliance speakers. Speakers can be separated up to 5'. A flip of the mode switch and you're into AM radio! 45 spindle adapter included.

Kit GD-111, 50 lbs. **109.95***

for every age, every hobby!

New Heathkit "Minimizer" kitchen waste compactor...



199⁹⁵*

Today's most modern refuse handling method in easy-to assemble kit form! Now you can own the most exciting kitchen appliance on the market for less than you'd pay for any other comparable compactor. The Heathkit Minimizer lets Mom throw out the unsightly waste baskets and garbage cans for the latest in clean, convenient, odor-free disposal. The Minimizer handles all normal household trash — food wastes, glass and plastic containers, tin cans, wrappings, boxes, floor sweepings, light bulbs, etc. The packing ram descends with 2,000-lb. force to reduce refuse to almost ¼ of its original size, packaging the material in a strong disposable bag — one bag holds an entire week's trash for a family of four! When the bag's full, Mom simply folds over the top and removes a neat, dry package for normal rubbish pickup. And the Minimizer deodorizes the contents each time the drawer is opened and closed. The sanitation man will love Minimizer, too!

Simple, safe operation! To use, Mom merely inserts a Minimizer plastic-lined bag in the drawer and starts the compacting cycle. In less than a minute the ram forces down the trash, returns to its normal position, and the Minimizer shuts itself off. For maximum safety, the Minimizer uses a key lock switch and an interlock which automatically turns unit off if drawer is not fully closed or is accidentally opened during cycling. Your Heathkit Minimizer can be built-in under the kitchen counter or left free-standing. Its bright white enamel finish with marble-tone vinyl-clad top complements any decor. And you can build it yourself in 6 to 10 hours. Has long-life ⅓ hp motor, plugs into 110-120 VAC conventional household outlet. Kit includes 5 plastic-lined bags, one 9 oz. aerosol can of deodorant. Minimizer measures 34⅜" H x 15" W x 25½" D.

Kit GU-1800, 203 lbs. 199.95*
GUA-1800-1, 15 plastic-lined bags, 5 lbs. 4.99*

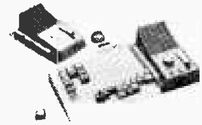
New Heathkit Slotless 1/32-Scale Raceway

129⁹⁵*

You race up to 4 GT cars — each with independent acceleration, deceleration and steering! Make all the maneuvers of real high-speed drivers. You can even turn around completely and backtrack. Kit includes track sections for 8'x4' oval, power transformer, 2 cars and controllers.

Kit GD-79, 13 lbs., mailable 129.95*
Kit GDA-79-1, extra car and controller, 3 lbs., mailable . . 21.95*

New Heathkit Electronic Workshops



Completely self-contained electronics labs teach youngsters the basics of electronics. Each contains basic electronic components in easy-to-work-with module form. Kids simply follow the instructions, arrange the blocks on the board to form actual working circuits for code flashers, timers, alarms, etc.

Kit JK-1033, 36 experiments, 11 lbs. 29.95*
Kit JK-1022, 25 experiments, 8 lbs. 24.95*
Kit JK-1011, 12 experiments, 6 lbs. 19.95*

SEE THESE KITS AT YOUR LOCAL HEATHKIT ELECTRONIC CENTER... or send for FREE catalog!

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Retail Heathkit Electronic Center prices slightly higher to cover shipping, local stock, consultation and demonstration facilities. Local service also available whether you purchase locally or by factory mail order.

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*Mail order prices; FOB factory. CL-424
Prices & specifications subject to change without notice.

CIRCLE NO. 7 ON PAGE 17

CB coffee break

BRAND NEW!

This Issue's Columnist—Julian S. Martin, KMD4313

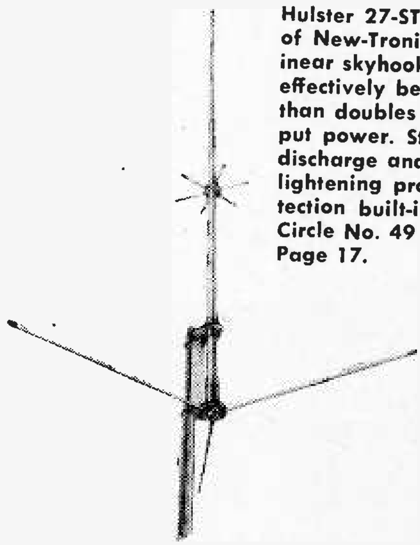
Here I go with a new column written exclusively for the Citizen Bander and *no one else*. Naturally, I would like to pack this CB column with all sorts of goodies but space is limited. I plan to give you new product info, FCC happenings, mini-theory that'll set you straight, what's available, club news, operation reports and more! But, not all at once. I plan to go my merry way as I see a CB column should go and wait for your comments. That's right, folks, keep those cards and letters coming except for that blond bombshell in Wala. Honey, you send your letters to Dear Abby!

Would You Believe. *100-watts effective input power on Class D—and it's legal.* On 27 MHz, 100 watts can put a 40 dB over S9 signal into Australia, England or Japan when the skip is open; imagine what it can do on the other end of town.

No, this is no con job. I'm not going to tell you about the allowable input power for CB rigs in some mythical country. Right now, *you* can zap out 100 watts effective input power *from your present CB rig.*

Aha! You have the catch . . . "effective" input power. True, when we speak of *effective power* the soup into the final is still only 5 watts, but with the proper antenna—one you can obtain from local distributors—your signal will bang in at the receiving station just as if you were pumping 100 watts into the final RF amplifier. And after all, it's what is received that counts: as far as the receiving station is concerned he doesn't know whether you're blasting the ether with a 100 watt linear or shouting through a large megaphone; all he knows is that you have one hell of a signal.

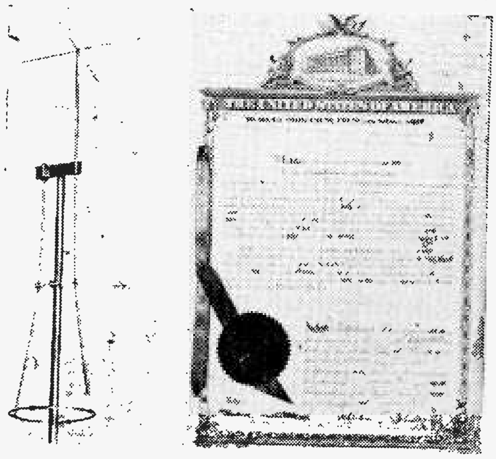
The trick, if you want to call it a trick, is to use the same stunt as the commercial broadcasters. . . . boost the *effective* power with a *beam antenna*. For example, UHF TV stations need a powerhouse signal just to get over the snow: if they need 100 kW to put a picture into your TV they are not going to subsidize the local electric company by using a 100 kW transmitter. More likely, they will run a 25 kW transmitter and use an antenna with a power gain of 4. As far as your receiver is concerned the station is running a 100 kW transmitter, and the pix comes in just as it would from a 100 kW transmitter feeding a turnstile antenna (no gain).



Hulster 27-STR, one of New-Tronics colinear skyhooks, effectively better than doubles output power. Static discharge and lightening protection built-in. Circle No. 49 on Page 17.

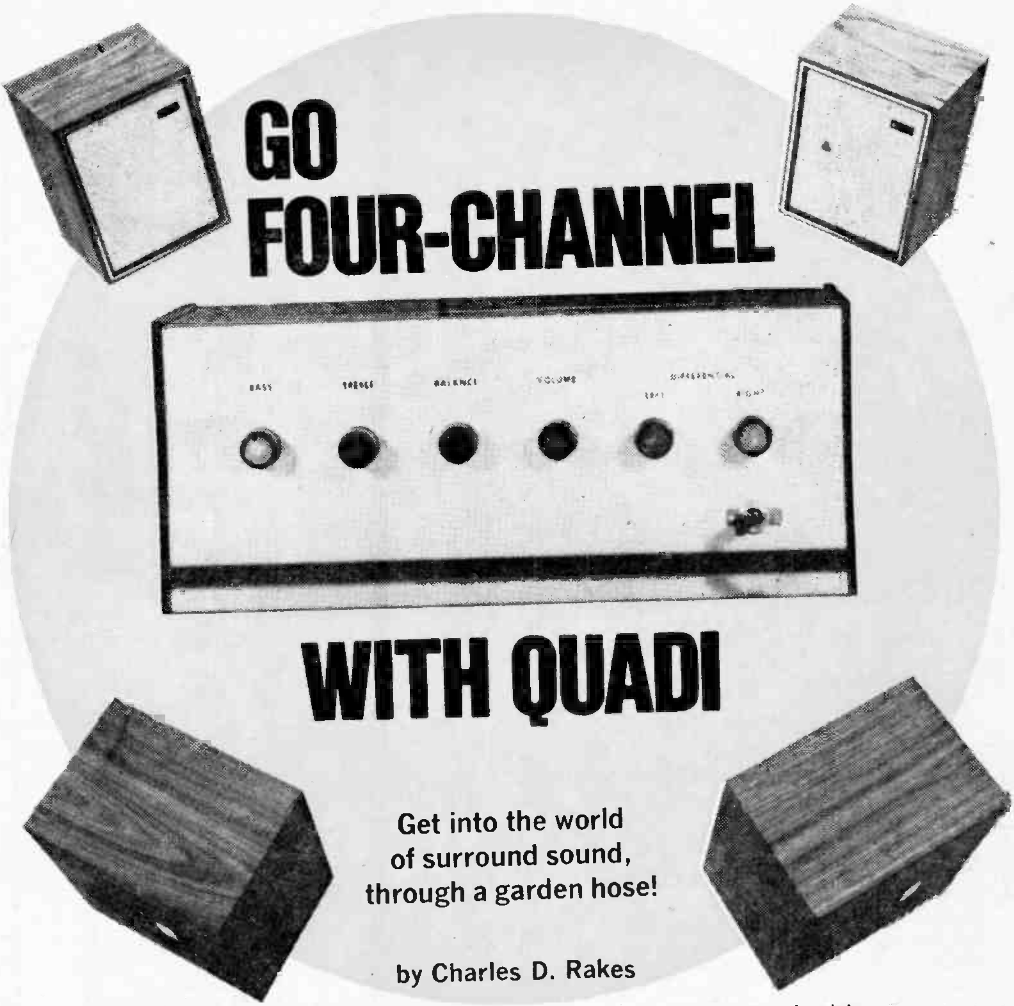
Antenna gain comes about in this way. The typical "all purpose" CB antenna is the "ground plane", consisting of a ¼-wave vertical radiator and three or four horizontal ¼-wave radials at the base which act as a ground plane. The

Continued on Page 102



Gain antenna with a real difference, this Patented Avanti Astro Plane radiates primarily from antenna top, thereby gaining about fifteen extra feet in height. Circle No. 48 on Page 17.

GO FOUR-CHANNEL WITH QUADI



Get into the world of surround sound, through a garden hose!

by Charles D. Rakes

Place yourself in a galaxy of surrounding sound with the "Quadi" quadrasonic amplifier that can turn a standard stereo system into a listening wonderland! Quadrasonic stereo, or four-channel stereo as it is often called, is probably the greatest new home-entertainment item devised since the crystal set came into being. One session with our Quadi stereo system and you'll agree that the two-channel stereo system is as obsolete as the dodo bird.

Whoa! Don't yell uncle yet. This quadrasonic terminology doesn't mean complicated expensive equipment or circuits—all that's involved is an additional pair of audio channels connected to the existing stereo system. The two-channel stereo system is unchanged and operates in a normal manner. The two new channels take information from the speaker output terminals of the two-channel system, process it and feed it to two speakers located in the *rear* of the room at opposite corners.

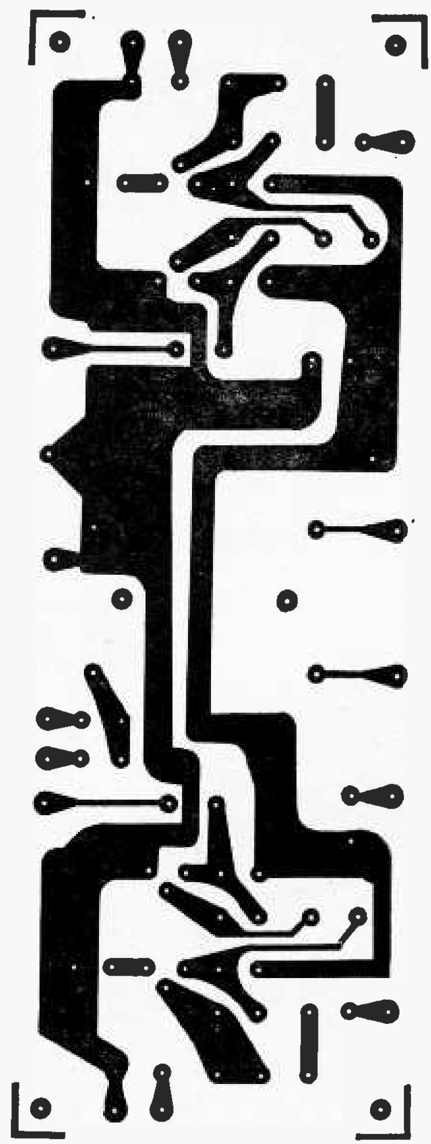
How it Works. The method of processing the two audio signals is the secret to the success of the Quadi. Each channel's audio output is delayed approximately 15-milliseconds to produce a realistic reverberation effect. This is done with a simple acoustical delay line fabricated from a section of a plastic garden hose, fed at one end with a small earphone and picked up at the opposite end with a crystal mike.

The echoes created by the delay lines effectively place the two rear speakers at an additional acoustical distance of 15 feet behind their physical location. This helps in reproducing small echoes that are normally lost in the standard two-channel stereo system but which were present when the original recording was produced.

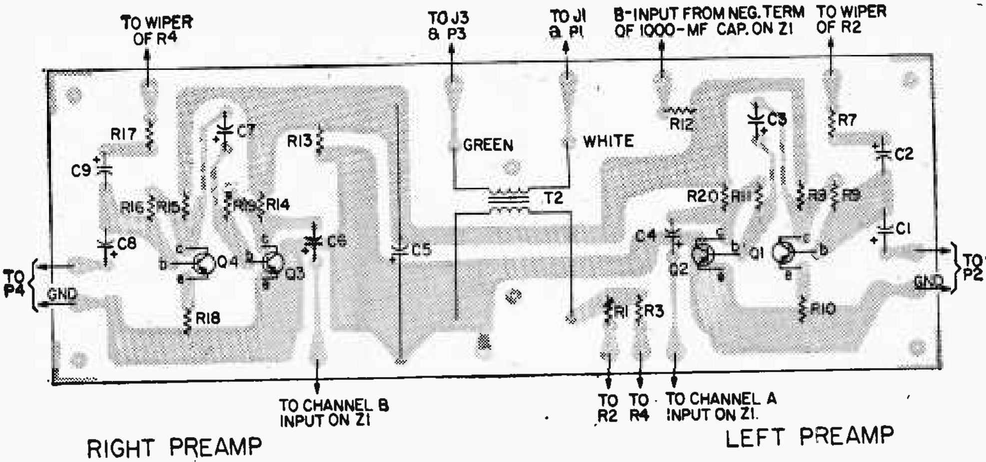
Additional depth and ambience are produced by taking the differential output from both channels of the two-channel stereo

PARTS LIST FOR QUADI

C1-C4, C6-C9—5 uF, 25 VDC electrolytic
C5—500 uF, 25 VDC electrolytic
EP1, EP2—Dynamic earphone with 6-ohm to 15-ohm impedance
J1-J6—Phono jacks
P1-P4—Phono plugs
Q1-Q4—MPS3638 transistor (Motorola) or HEP 716 (Motorola)
R1, R3—27,000-ohm, ½ watt
R2, R4—Potentiometer, 5,000 ohms
R5, R6—Potentiometer, 150 ohms
R7, R17—150,000-ohm, ½-watt
R8, R14, R15, R20—4,700-ohm, ½-watt
R9, R11, R16, R19—470,000-ohm, ½-watt
R10, R18—330-ohm, ½-watt
R12—1,000-ohm, ½-watt
R13—3,300-ohm, ½-watt
S1—Switch, SPST
T1—Filament transformer: 115V: 26.8, center-tapped secondary (Triad F-40X or equiv.)
T2—Driver transformer: 10,000-ohm primary; 2,000-ohm secondary (Calrad CR70 or Midland 25-619 or equiv.)
XTL1, XTL2—Crystal microphone (Realistic 33-907 or equiv.)
Z1—Amperex PCA-3B-18-1 stereo amplifier
2—15-foot sections of plastic garden hose, ½ inch I.D.
2—Wood boxes, 3-in. x 11½-in. x 11½-in.
1—Cabinet, 12-in. x 4½-in. x 6¼-in. or similar housing of metal or wood (Ten-Tec MG-12 or equiv.)
Misc.—Hardware, shielded cable, wire, solder, knobs, power cord, speaker cable, terminal strip, etc.
Note: An etched copperclad printed circuit board is available for $2.95 undrilled, and for $3.95 with all holes drilled. A pre-drilled PC board, plus all the components that mount on it, is available at $11.95 from: Krystal Kits, Box 4232, Little Rock, AR. 72204. All prices include postage and handling.



The foil pattern for the Quadi printed-circuit board is reproduced here full-size. The corner holes are for mounting.



Where to mount components on the printed-circuit board. Be sure the capacitors are installed according to the indicated polarity, and that the transistor leads are in the right holes.

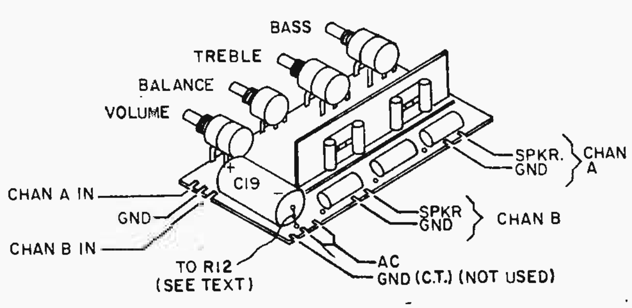
system and mixing it in with each of the two new channels.

The delay-line drive and differential levels are adjustable to allow for a balanced output in both of the new channels. Treble, bass, balance, and volume controls are also provided on the stereo amplifier assembly.

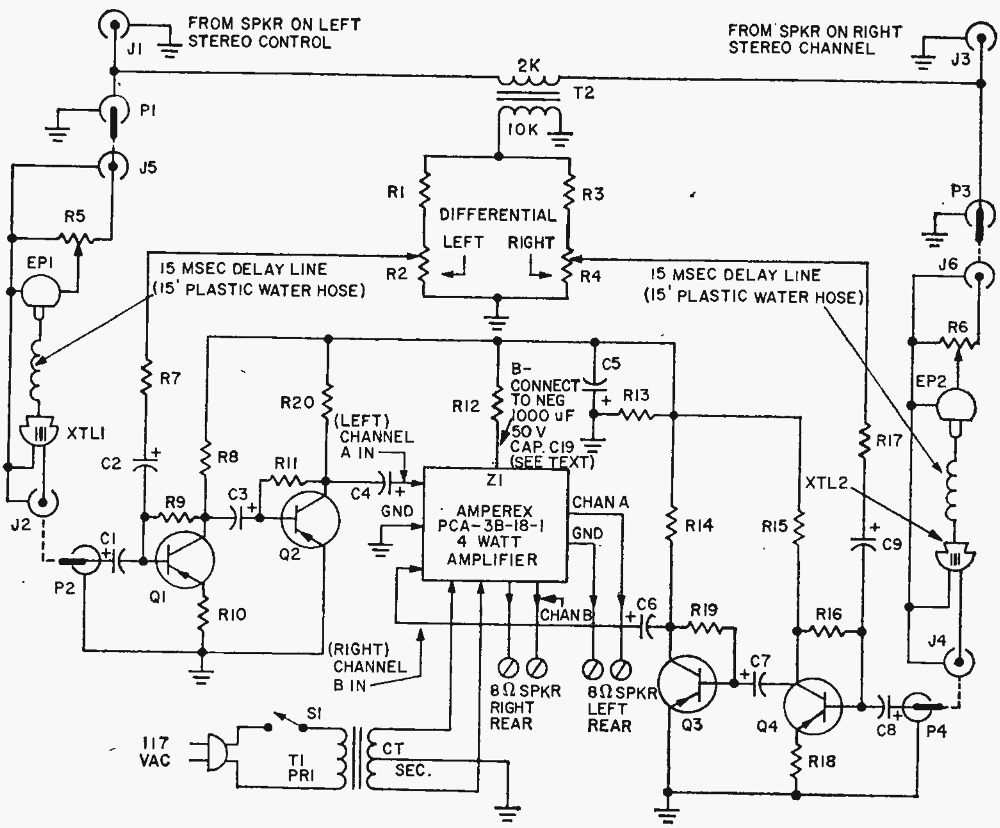
Enough about the unit's operation—on with the construction of your very own Quadi! If you are a good parts scrounger, the cost should be below the fifty-dollar mark, excluding the two additional speakers. You can purchase an etched printed-circuit board, drilled or undrilled, or a drilled board along with all components that mount on it, from Krystal Kits (see Parts List). The Amperex amplifier is available from Lafayette Radio, stock number 19U09142, at $15.95 plus postage.

Dual Preamplifier. A good starting place is to construct the dual preamplifier that raises the audio signal from each of the delay-line outputs to a level sufficient to drive the power amplifiers. All the preamplifier components are mounted on a printed-circuit board, but if you will follow the same parts layout a perfboard may be used. When it comes to installing the coupling capacitors, carefully observe the polarity before soldering in place. Same goes for the transistors—be sure that the emitter and collector don't get switched in the process of installing them.

Stereo Amplifier. The stereo amplifier is duck soup, because we got smart and used a ready-made Amperex 8-watt complementary stereo amplifier assembly (four watts per channel)—for less than twenty dollars who could fool around building one? Only one slight modification is required on the stereo amplifier assembly: connect a wire to the negative terminal of the 1000 uF



One of the three speaker grounds on the Amperex amplifier is not used. The circuit is a DC-coupled three-stage amplifier with negative feedback.



Construction of the Quadi is simplified by using an Amperex amplifier, which is modified by adding a wire from capacitor C19 (on the amplifier). This connects to resistor R12.

filter capacitor, C19. This wire supplies battery negative to the dual preamplifier.

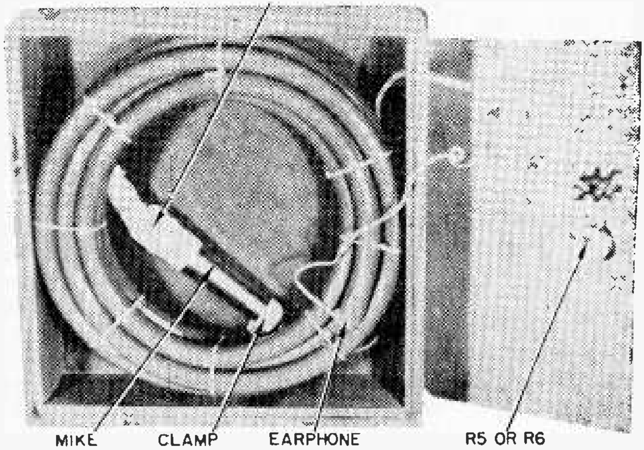
The two amplifier assemblies are housed in a metal and plastic cabinet 12 in. x 4½ in. x 6¼ in., as shown in the photos. Any similar enclosure large enough to house all of the components will do just as well.

The two preamplifiers inputs are connected to P2 and P4 through two 4-foot sections of shielded mike cable. Most any 4-foot section of two-wire cable will do for P1 and P3. The stereo-amplifier outputs are connected to a four-terminal barrier strip.

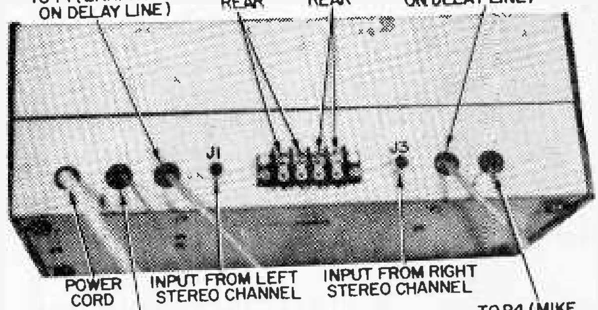
Delay Lines. Cut two 15-ft. sections of ½-inch I.D. plastic garden hose and form each section into a roll that will fit snugly in the 3 in. x 11½ in. x 11½ in. wooden box. Make sure that no kinks appear anywhere in the coil of plastic hose. Use the photos as a construction guide when needed. The earphone is placed in one end of the coil and held in place with silicon rubber. The crystal mike is butted up against the opposite end of the coil and is kept in place with shrink-tubing or plastic tape. A plastic cable-clamp holds the mike in place. Wire the earphone and mike to match the diagram, leaving enough slack in the wires to allow removal of the front cover.

Putting it All Together. With the power turned off, connect up the following leads. Connect the input of J1 to the left channel speaker (on your existing stereo system) and J3 to the right channel speaker. Plug P1 into J5 and P2 into J2 of one of the delay units. Plug P3 into J6 and P4 into J4 of the other delay unit.

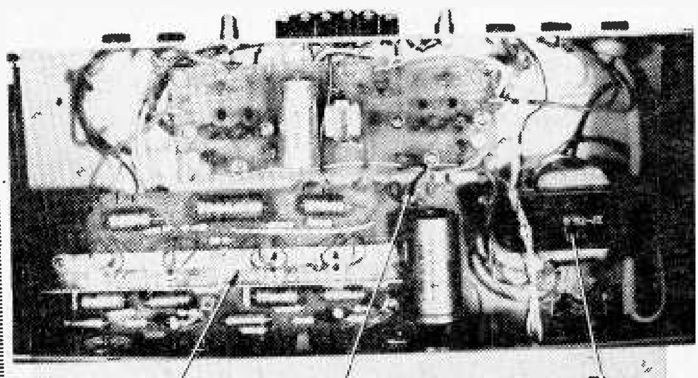
Connect the rear speakers to the output terminals of the Amperex amplifier. The left speaker goes in the left rear corner and the



When coiling the two 15-foot sections of garden hose, make sure there are no kinks in the tubing, as these could affect the quality of the sound being piped through.



Instead of wires running directly to plugs P1, P2 P3 and P4, jacks could have been used instead, mounted on the rear of the cabinet, to simplify connecting up the various Quadi units.

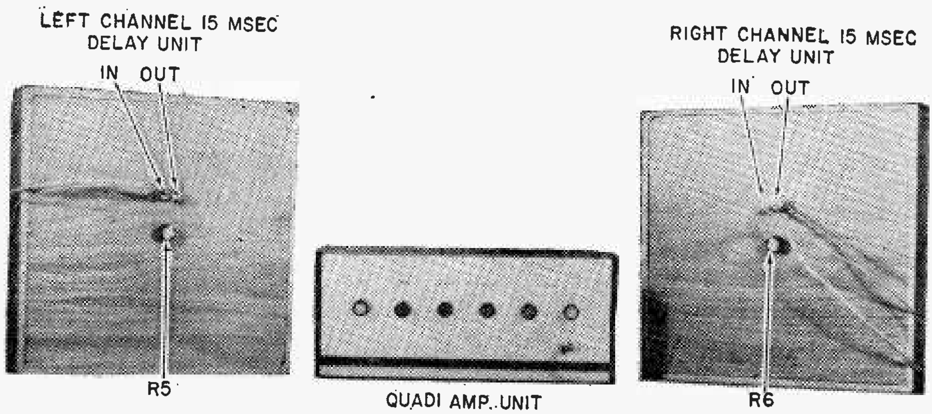


The large capacitor at lower right is C19 on the Amperex amplifier, to whose negative terminal (upper end here) is added a short wire for connection to R12 in the Quadi.

right speaker in the right rear corner of the room. The speakers should be separated by at least the same distance as are the front speakers.

Set both earphone drive pots, R5 and R6, to maximum. Set the differential level controls to a minimum. The bass and treble controls may be set to suit your own taste. Select either an FM-stereo broadcast station or a stereo record and adjust the controls for proper stereo listening. Apply power to the Quadi and you should hear the delayed output of each channel coming from each of the rear speakers. Set the balance and volume controls on the Amperex stereo amplifier to the desired levels and slowly turn R2 and R4 up until the desired ambience and depth are obtained. If the delayed output level is too high in relation to the differential level, reduce the drive to the earphones with R5 and R6.

Trying This and That. Just for kicks you can switch the rear speakers around so that the left channel is coming from the right rear and the right channel from the left rear. With the speakers connected in this manner, a delayed crisscross sound effect will be produced. Another mode of operation you can try is to delay only one channel and feed the other channel with the differential input. Since there is no fixed recipe, mix the signals anyway you please to produce the type of sounds you like best. Have fun. ■



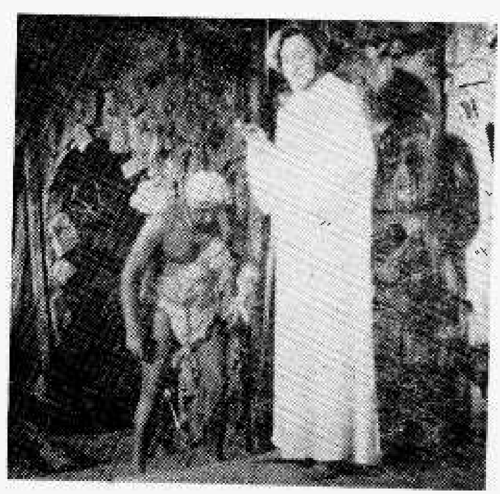
The four controls at left (bass, treble, balance, volume) are on the Amperex amplifier; the other two are R2 and R4, the left and right differential controls.

"The Tempest" in Quadriphonic Sound

☐ The Shakespeare Society of America recently presented "The Tempest" in an unusual stage production. Their private theater in West Hollywood, California, was the stage for a classic rendition of the play accompanied by a very contemporary light show, stage effects and *quadriphonic* reproduction of specially created electronic sound effects and music.

The sound system consisted of four JBL studio monitor loudspeakers and four Spectra Sonic modular power systems. Critics were not unanimous on whether this was what the Bard had in mind, but the audience received the sounds of the storm, waves crashing and electronic music with enthusiasm. Photo at right shows Vincent Mongol as Caliban and Rand Bridges as Prospero in the Shakespeare Society of America's production of "The Tempest."

—*Joe Gronk.*



Weekend Carpenter Special...

BOOKSHELF SPEAKER FROM BOOKSHELVES

by Herman F. Johnson

Your speakers are finished before you start!

Want to build a great bookshelf speaker system—one with professional looks, feel and sound? You can do it with our easy-to-build bookshelves. The secret for weekend carpenters is in the pre-finished material. Ready made bookshelves—real *book*-shelves—are available in hardware and building supply stores and make an ideal building material. You will also use unfinished shelving. For utility use, it is made of plain material ¾-in. thick and 11½-in wide. Both are accurately cut in the lumber mill to even footage lengths.

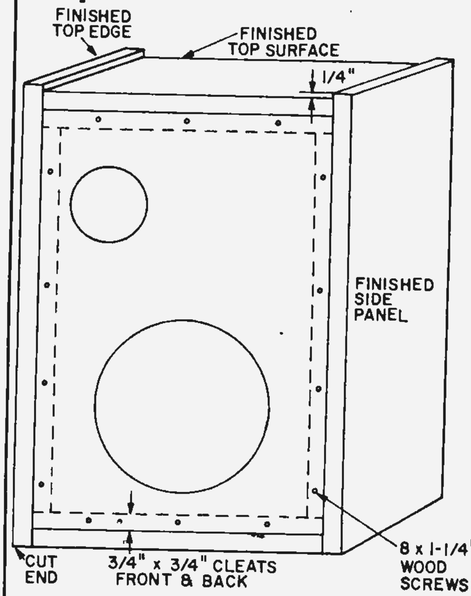
The use of finished stock makes it possible to determine the appearance of an enclosure before it is built. A variety of wood grain finishes is available. The type that can withstand considerable handling and is impervious to scratching is vinyl-clad walnut wood grain—the same material used on side panels of modern station wagons. As with the plain, finished shelving is ¾-in. thick, at least 2-feet long and between 6 and 12-in. wide.

An important requirement for a speaker box is solid construction; it must be made as non-resonant as possible. Particle board is ideal for this purpose because, unlike most plywood, it has no cavities. It is a higher density material than plywood, easy to cut, and both sides are smooth and parallel. Also, the cost is low.

This article covers the construction of an acoustic suspension 2-way system

e/e BOOKSHELF SPEAKER

1



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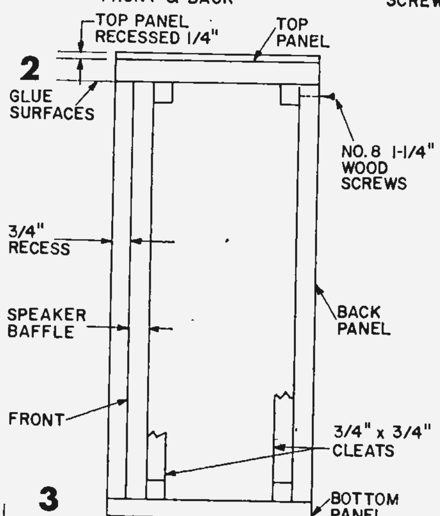

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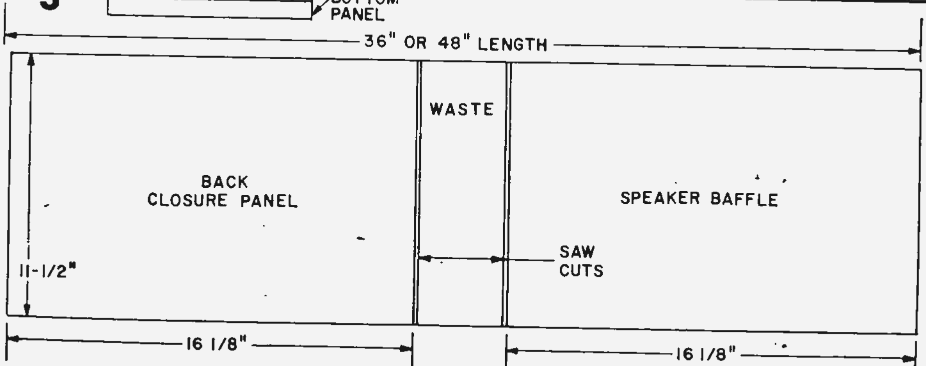


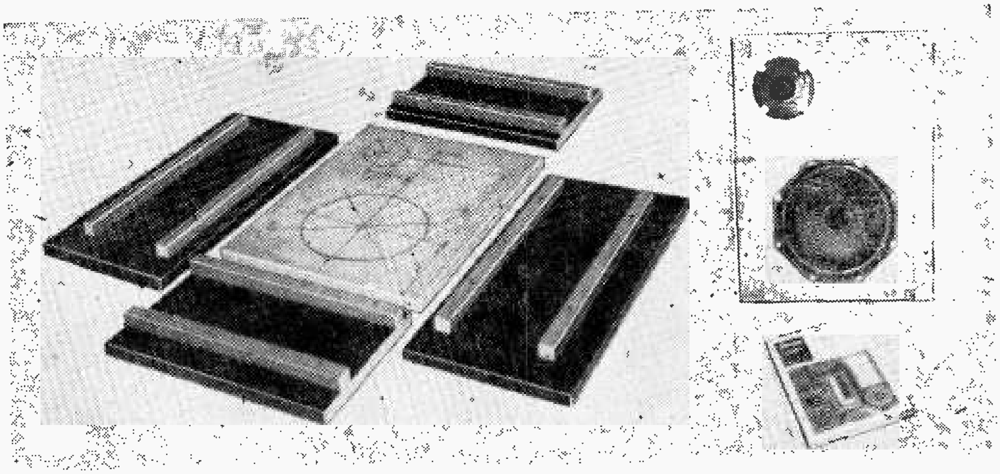
housed in a bookshelf-sized cabinet. The size is convenient for stereo in an average size listening room. To insure good performance from a small package, a high compliance woofer and a dome-type tweeter were selected. The woofer was designed to operate in an air volume of only half a cubic foot. In fact, the power handling capability (20 watts) is obtained when it is operated with just that volume.

The Saw Dust Flies. Because ready made shelves are used, only five cross cuts are required to form the panels. Precautions, however, are necessary. When shelving is selected, it is important to observe that finished pieces will be solid throughout. Hollow lightweight shelves are now available; these cannot be used. Check to see that the two finished shelves are the same width and that the ends are square on both the finished and unfinished pieces. Some shelves may be found where the ends are not quite square with the side edges.

Note in Fig. 1 that the side panels extend one-quarter of an inch above the top. This provides a more modern cabinet design than the usual run-of-the-mill bookshelf speaker. Exposed cut edges are at the bottom where they cannot be seen.

Square cleats are used at the front and back of the enclosure (Fig. 2) to hold the cabinet together. Note that the short cleats are the same length (11½-in.) as the top and bottom panels. The long cleats are fitted between the short ones.

To make maximum use of machine-cut square ends, cut the plain shelf as indicated in Fig. 3. This provides us with a speaker mounting board. Cut the 36-in. finished shelf into two parts of equal length (Fig. 2) to make the sides. These will be slightly less than 18-in. high due

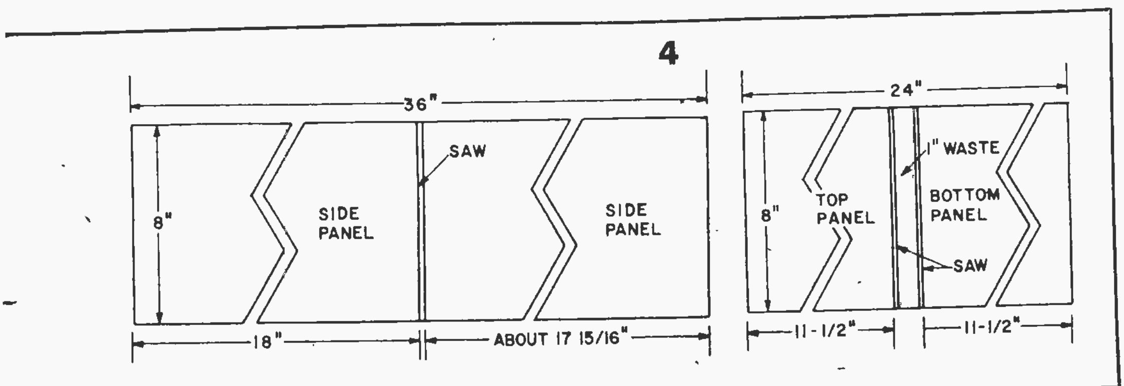


Fast and simple to build, 2-way speaker system has woofer designed for bookshelf-size enclosures. Finished outside material gives professional, factory-made look. Here are the parts prior to assembly.

to the width of the saw. Cut the 24-in. finished shelf as indicated in Fig. 4 to make the top and bottom panels. Note the length; it is the same as the width of the speaker baffle and back. These cuts can be made by following a scribed pencil line with a saber saw. A fine-tooth saw should be employed to insure a clean cut.

Putting It Together. When handling the finished panels, it is a good idea to place a piece of cardboard on the work bench to prevent abrasion of finished surfaces. Drill small holes at about an inch from the ends of the cleats and tack them in place, first the short ones and then the long ones. Hold one of the plain panels flush with a back edge as a spacer to locate the back cleats ¾-in. from the back edges. Place both plain panels together to space the front cleats 1½-in. from the front edges. When tacking, use 1¼-in. finishing nails but do not drive them down tightly. This tacking idea provides a trial assembly to insure that all parts fit properly.

Make certain that the ends of the top and bottom panels make contact with the sides, and that the outside cleat faces line up all around. If necessary, move and/or cut the cleats. When all parts are fitted properly, strike pencil lines on the panel surfaces along both sides of each cleat, and mark the four panel junctions 1-1, 2-2, etc. (This will insure that all parts can be returned to the same position for final assembly.) Remove the cleats, coat all mating surfaces with plastic resin glue, then reinstall. Add another nail or two, at about 6½-in. centers, and drive the cleats down tightly. Nails are used in place of screws to simplify the work since their purpose is to hold the cleats until the glue has set. Plastic resin provides a joint stronger than the wood if the parts



are held tightly during drying.

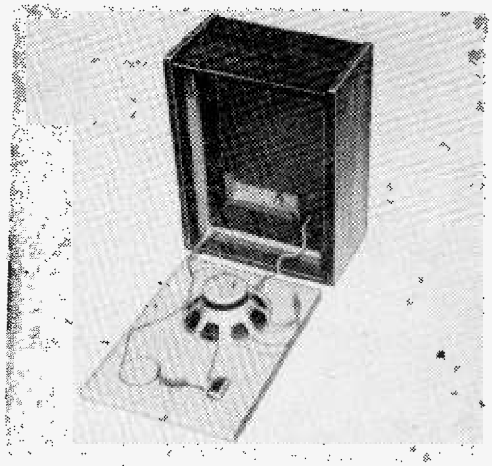
Scribe pencil lines along all four edges of the two plain panels ⅜-in. from each edge, and drill $\frac{3}{32}$-in. pilot holes at about 5-in. centers. Reassemble the enclosure and insert the plain panels, front and back. Mark the hole locations on the side faces of the cleats with the $\frac{3}{32}$-in. drill by turning it in each hole. The enclosure should be resting upon a flat surface in the upright positon of Fig. 1 with the side panels held firmly together as the locations are marked. It is a good idea to drill the holes in the side of the cleats about ⅜-in. deep and remove the displaced wood. This will insure seating of the front and back panels to the cleats when they are screwed in place.

A Little Bit of Electronics. For wiring hookup, drill two ⅛-in. holes about 2-in. apart near the bottom edge of the back panel for No. 6 brass screws.

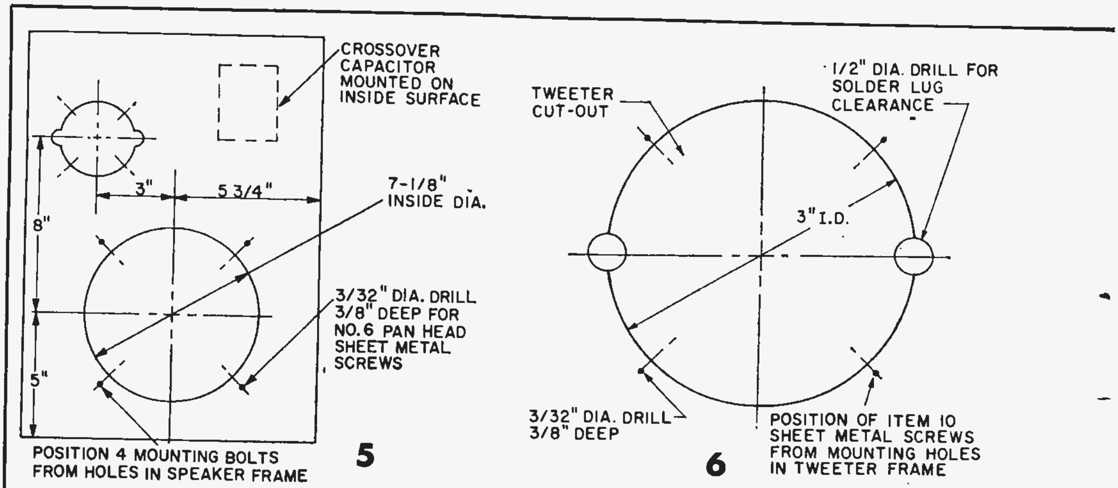
Scribe pencil lines on the other panel (speaker baffle) to indicate the openings shown in Fig. 5 and 6. Drill the two ½-in. holes before making the circular cuts for the tweeter cutout. These speaker openings can be made with a saber saw by slowly cutting along the scribed pencil line. Designate the marked face as the front. Speaker openings can also be made with a circle cutter or a router with a center guide attached. A cabinet shop in your town will cut the openings for a small fee.

The edge holes should then be enlarged to $\frac{3}{16}$-in. diameter for shank clearance of No. 8 wood screws; countersink for flat head screws if used. When all of the parts are ready for final assembly, coat the mating surfaces at the back with glue and screw the back panel in place. Insert the screws for wiring hookup and place the box on its back. Fit fiberglass damping material on the back, one side, and the top over the cleats. Thumbtacks or spots of glue are sufficient to hold the fiberglass in place.

The baffle can also be glued and screwed down, but both speakers should be fitted into the openings and the capacitor installed prior to the permanent installation of the baffle. Pan-head No. 6 sheet-metal screws ½-in. long are ideal for mounting the speak-



Simple, direct, point-to-point wiring, shown schematically in Fig. 7, uses brass screws for convenient speaker-to-amplifier connection.



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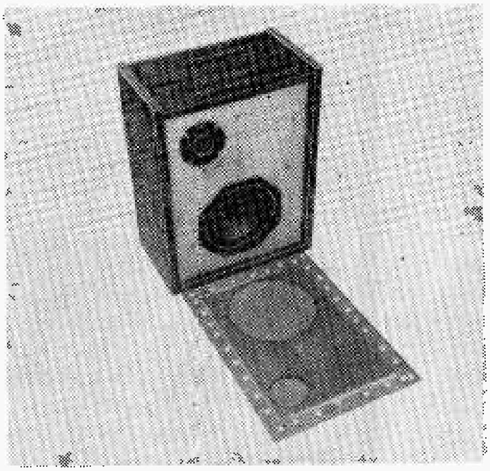
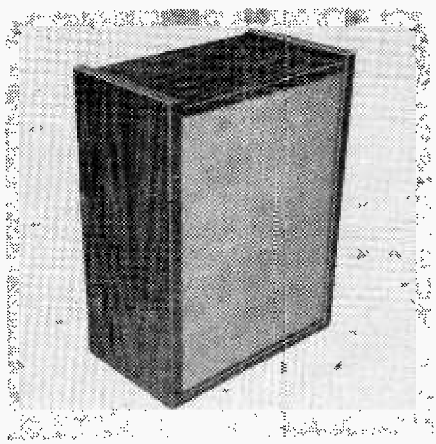
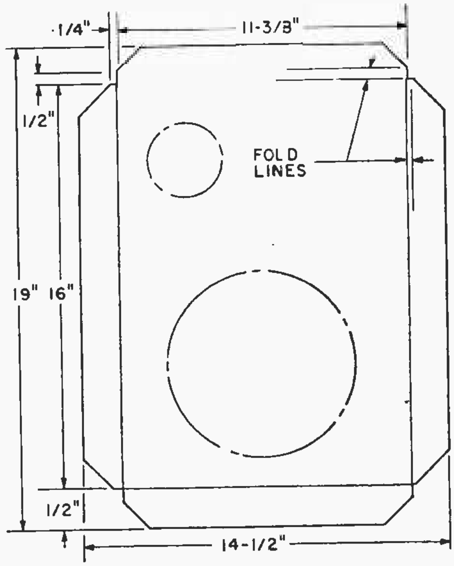


Thumbtacks secure grill cloth to ¼-inch hardboard frame. Hefty enclosure has professional wood grain appearance, photo at right.



ers. Use the holes in the speaker frames as a template for centermarking each screw location. Drill $\frac{3}{32}$-in. holes to avoid the possibility of puncturing the woofer's cone by the slip of a screw driver. A "fail-safe" way to mount a woofer is to drill four $\frac{7}{32}$-in. holes and insert 8-32 tee nuts on the back side for machine screws.

The Speakers. An 8-in woofer, such as the type used here, can be capable of better transient response than larger woofers if it is equipped with a strong magnet to influence the voice coil. The 8-in. Philips (Norelco) AD8065/W8 is recommended due to its very low free-air resonance, rated at 28 Hz. Low free-air resonance is a necessity to hold down composite resonance which re-



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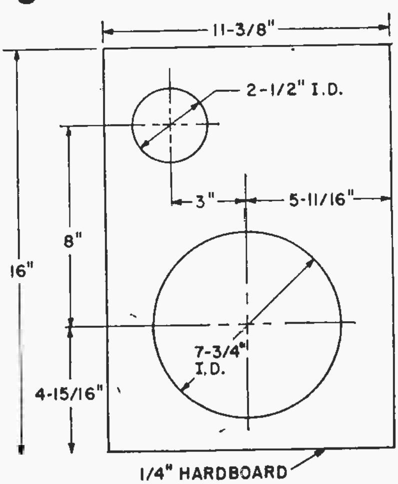
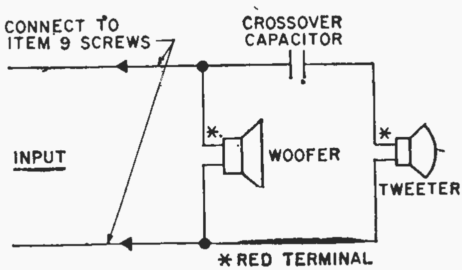


Substitute phone jack, terminal strip, fahnestock clips or your favorite binding post for Item 9 screws if desired; observe "red terminal" connections for proper speaker phasing.



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sults when a woofer is backed into a small volume of air inside a box. In this enclosure the composite resonance value was found to be 58 Hz. If a new woofer is installed, the composite resonance can be expected to drop about ten percent after a year of use.

The 1-in. dome tweeter, Philips No. AD0160/T8, is a fine high frequency unit (dome type) available to home constructors. The dispersion characteristics are excellent and its range extends to 20,000 Hz. As with all high-frequency reproducers, it must be protected or isolated from low frequencies by a series crossover capacitor. Fig. 7 shows the wiring hookup.

Finishing Up. For grille-cloth mounting, a ¼-in hardboard frame is recommended. Lay-out lines to the dimensions indicated in Fig. 8 and cut the frame and cloth. If the grille material has a tendency to fray, spread a bead of rubber cement along the edges. Use the embossed pattern side (back side of the hardboard) for the front. Spread rubber cement around the two speaker openings to hold grille material tight to the hardboard. Use small thumbtacks on the back of the frame and more rubber cement along the edges. Hardboard is tough—thumbtacks must be hammer driven. The frame dimensions provide 1/16-in. clearance all around inside the opening. This dimension provides a snug fit with cane type cloth. Add masking tape to an edge if necessary for others.

Hope you've had fun building one or two of these speakers—maybe even four for Quadi which appears in this issue. They should provide many hours of fun-filled listening for "serious" and "pop" music listeners alike.

Bill of Materials for Bookshelf Speaker

Item	Description
1	Plain particle board shelf, ¾-in. x 11½-in. x 36 in. One required.
2	Finished particle board shelf (must be solid), ¾-in. x 8-in. x 36. One required.
3	Finished particle board shelf (must be solid), ¾-in. x 8-in. x 24-in. One required.
4	Fir cleat material, ¾-in. x ¾-in. x 10 ft. total.
5	Masonite sheet, ¼-in. x 11⅜-in. x 16-in. One required.
6	Grille cloth, 14½-in. x 19-in.
7	Steel wood screws, No. 8, 1¼-in. long. Twenty required.
8	Steel finishing nails, 3-D, 1¼-in. long. Thirty required.
9	Brass machine screws. No. 6-32, 2-in. long. Two required.
10	Sheet-metal screws. No. 6, ½-in. long. Ten required.
11	Speaker, woofer. Norelco Model AD8065/W8 (McGee Radio Co., 1901-07 McGee St., Kansas City, MO 64108).
12	Speaker, tweeter. Norelco Model AD0160/T8 (McGee Radio Co., 1901-07 McGee St., Kansas City, MO 64108).
13	Crossover capacitor, non-polarized 4-ufd electrolytic
14	Miscellaneous: Hook-up wire, plastic resin glue, 1-in. thick fiberglass damping material, thumbtacks.

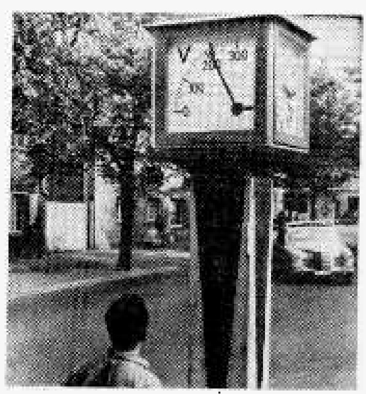
V is for Voltage—not Vedder

The people of the industrial town of Erlangen, Germany have a clock with a difference. One face tells the time as do all other clocks in the town—but the other face tells a different story and it's not the weather. It shows what voltage is going through the town's power lines at that instant.

A large scale and pointer read out voltage so that the people going home in the winter can make any adjustments to ensure that a power cut won't happen. The town is surrounded by heavy industry which heavily drains the electrical supply. In this way the people of Erlangen can be forwarned should the worse happen.

One little footnote is that to date there has yet to be a power cut in this town. The people of Erlangen are quick to turn out a light that's not needed.

—Joe Gronk



e/e etymology

How about a word with us?

BY WEBB GARRISON

Silver

▲ Among the elements that play a big role in electronics, silver was probably the first to be refined and named.

It was available in relatively pure state so early that no scholar knows precisely where it got its name. A Hittite term, *hattus*, designated the shiny metal and may have passed through half a dozen languages to enter medieval English as *seolver* or *selver*.

The earliest written occurrence in English was in a Psalter issued about 825 A.D., where the element was called "seolfur."

Designated by the symbol Ag (abbreviation for its Latin name) and having an atomic weight of 107.88, native silver occurs in small quantities in most parts of the world.

Medieval alchemists considered it a "noble" metal—a particularly appropriate title in view of the fact that no other naturally-occurring metal matches silver in its capacity to conduct heat and electricity.

Gold

▲ Until quite recently, gold has been too expensive to play a significant role in the electronics industry.

This situation changed when Bell Labs came up with what they called "beam leads"—gold conductors plated into place on silicon circuits. Western Electric developed ways to bond these minute components into circuits, and gold suddenly took on an entirely new role.

Practically all specialists in word lore agree that the precious element got its name from its color. A north-European suffix, *ghel-*, was tacked on to names of many things of yellow hue.

Because the yellow metal was prized so highly, it was mentioned so often that its name was abbreviated to *gull* in Old Norse and to *gulp* in Gothic. Apparently the Dutch form *goud* was the ancestor of Old High German *gold*.

At least one English-language reference to gold has been preserved from about 725 A.D.—more than twelve centuries before the industrial value of the metal so greatly exceeded its utility as a medium of exchange that gold coins have disappeared from world commerce.

Zinc

▲ As the name of a hard bluish-white metal, *zinc* entered English during the seventeenth century. Scientists of that era borrowed it from Greek *zink*, whose origin is unknown.

Some properties of the metal were exploited very early. It wasn't until very recent times, however, that anyone considered it of remote interest in the electronics field.

Today the element whose atomic number is 30 is mostly used as a negative electrode in electric dry cells. Far more important, one of its many compounds—zinc telluride—is a basic ingredient in many semiconductors.

Because of special traits of the element whose name can't be traced beyond classical Greek, a zinc telluride semiconductor has a "forbidden band" of 2.2 electron-volts and operates as a transistor at temperatures up to 780°C.

Oxygen

▲ Oxygen was discovered—and named—long after silver, gold, and zinc were household words.

Antoine Lavoisier, whose head was chopped off by the guillotine on a bright May morning in 1794, made some of the most original discoveries of his day.

One of them came to focus upon the mysterious stuff called "phlogiston," long supposed to be a volatile constituent of combustibles that was liberated by burning.

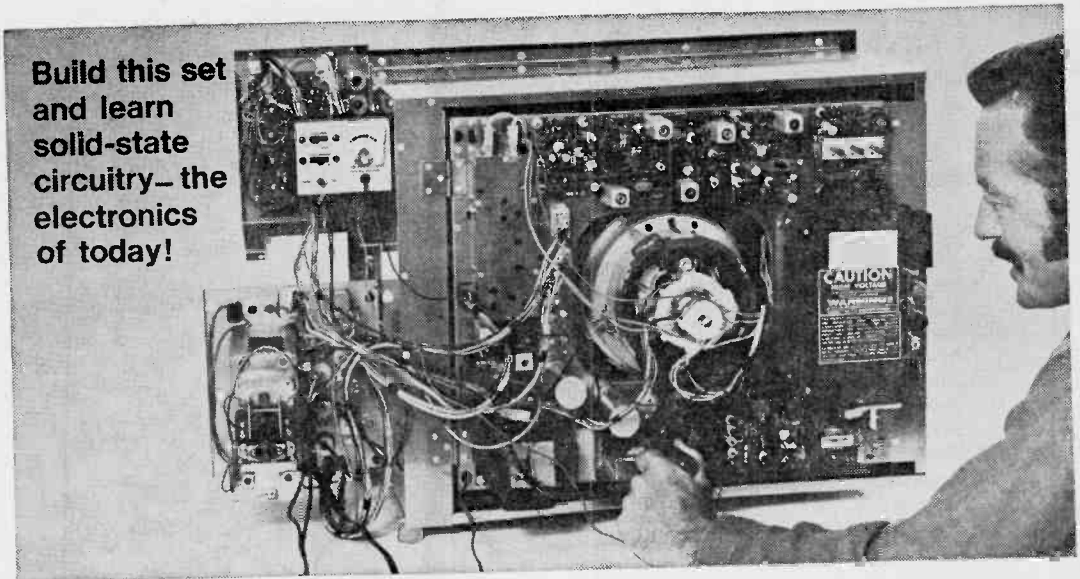
In one of the most elegant experiments in the history of chemistry, Lavoisier demonstrated (to his own satisfaction) that there is no such thing as phlogiston. Instead, he insisted, the fraction of air that is vital to combustion and to breathing is a *principe oxygene*.

Many distinguished men hooted at such a notion. Even the great Joseph Priestley clung stubbornly to the inherited phlogiston theory.

Within a decade, however, world opinion began to swing over to the side of the daring Frenchman. With its cumbersome title shortened to *oxygen* Lavoisier's new "principle" was shown to be a gaseous element.

Experiments demonstrated that oxygen has almost demonic capacity to unite with zinc (as well as copper, iron, and other metals). Capacity of an oxidized metal to conduct heat and electricity is greatly reduced.

Alone among the more common naturally-occurring metals, gold and silver are scarcely affected by oxygen— but zinc oxides so readily under normal atmospheric conditions that the pure metal is useless in electronics. ■



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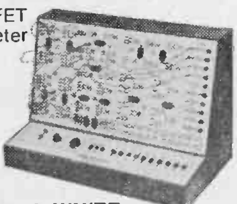

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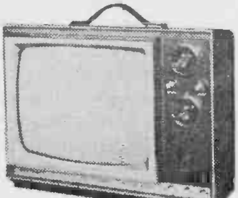

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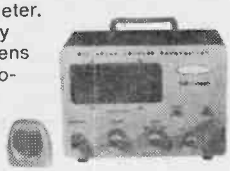

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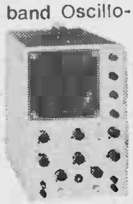

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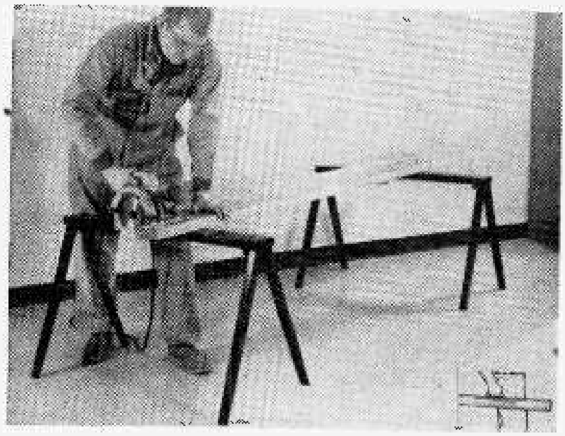
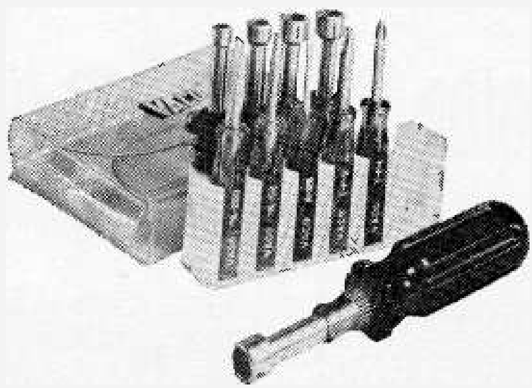
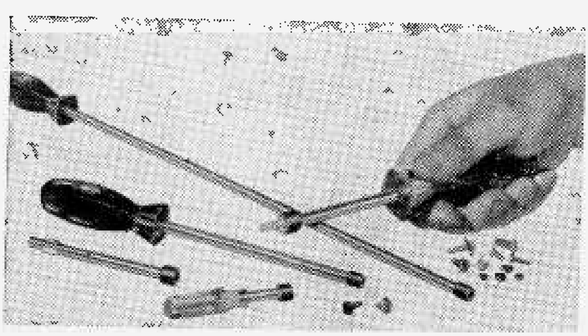


These heavy-duty Porta-Horse sawhorses will fold up into a size 38 by 2 by 4 inches, and can be hung on the wall by a built-in handle. The fold-up legs are spring-loaded and lock in place for rigid support. Cost is $32.50 per pair. Circle No. 53 on Reader Service Page.



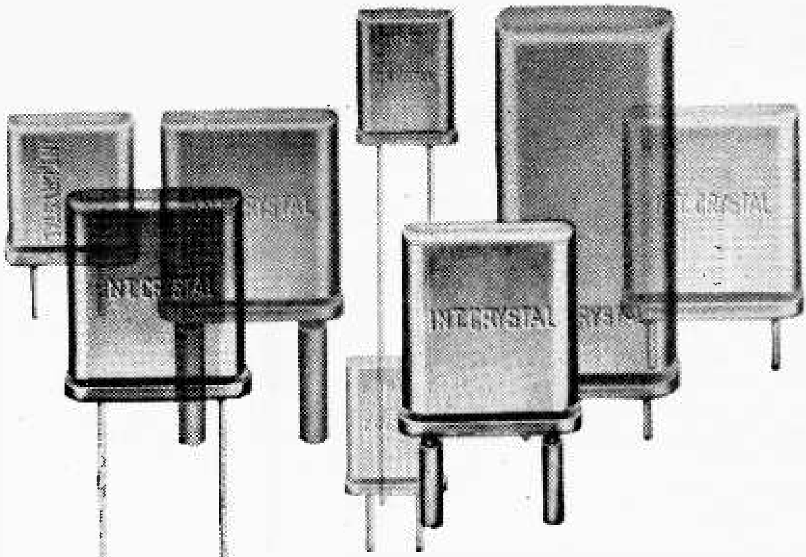
Ten Torque Commander mini drivers by Vaco fit into the one handle. You get two Phillips, three regular slot, and five nut drivers, for $8.95. Circle No. 54 on Reader Service Page.

Sold in light, unbreakable, one-piece plastic cases, Wen Pro-Power Tools are double-insulated for maximum safety, and have half-horsepower motors for powerful performance. The variable-speed ⅜-inch drill kit, model 801K12, consists of the drill, the red plastic case, nine drill bits from 1/16 to ¼ inch, and a chuck key, for $25.95. Circle No. 55 on Reader Service Page.



Magnetic nutdrivers in the ¼-in. and 5/16-in. hex-socket sizes have been added to the Xcelite line of tools. An Alnico magnet in the socket holds fasteners firmly for easy retrieving hex screws, bolts and nuts. Circle No. 56 on Reader Service Page.

TOOLS AND GADGETS



all about crystals

Discover that Electronics is more rockbound than the State of Maine

BY TED MANN

Can you imagine the chaos on the AM broadcast band if transmitters drifted as much as those inexpensive table radios? The broadcast station engineer must keep his station carrier within 20 Hertz of its assigned frequency. How does he do it? What about the CB'er unable to contact his base station with an unstable, super-regen walkie-talkie. Lost calls don't often happen to a CB'er who can keep his receiver frequency right-on the assigned channel center.

This and much more is, of course, all done with a little help from a very basic material, the Quartz crystal. It is the single component that serves to fill a basic requirement for precision frequency control. Quartz crystals not only fix the frequency of radio transmitters (from CB installations to multi-kilowatt-broadcast installations), but also establish the frequency of timing pulses in many modern computers. In addition, they can provide the exceptional selectivity required to generate and receive single-sideband signals in today's crowded radio spectrum. Yet this list merely touches upon the many uses of quartz crystals. No exhaustive list has ever been compiled.

(turn page)

e/e ALL ABOUT CRYSTALS

A Real Gem. This quiet controller is a substance surrounded by paradox. While quartz composes more than a third of the Earth's crust, it was one of the three most strategic minerals during World War II. And despite its plenitude, several semi-precious gems (including agate and onyx) are composed only of quartz.

Unfortunately, quartz exercises its control in only a relative manner. When it's misused, the control can easily be lost. For this reason, if you use it in any way—either in your CB rig, your Ham station, or your SWL receiver—you should become acquainted with the way in which this quiet controller functions. Only then can you be sure of obtaining its maximum benefits.

What Is It? One of the best starting points for a study of quartz crystals is to examine quartz itself. The mineral, silicon dioxide (SiO_2), occurs in two broad groups of mineral forms: crystalline and non-crystalline. Only the large crystalline form of quartz is of use as a controller.

The crystalline group has many varieties, one of which is common sand. The variety which is used for control, however, is a large, single crystal, usually six-sided. The leading source of this type of quartz is Brazil. However, it also is found in Arkansas. Attempts have been made to produce quartz crystals in the laboratory, but to date synthetic quartz has not proven practical for general use.

A property of crystalline quartz, the one which makes it of special use for control, is known as *piezoelectricity*. Many other crystals, both natural and synthetic, also have this property. However, none of them also have the hardness of quartz. To see why hardness and the piezoelectric property, when combined, make quartz so important, we must take a slight detour and briefly examine the idea of resonance and resonators.

Resonators and Resonance. As physicists developed the science of radio (the basis for modern electronics), they borrowed the acoustic notion of resonance and applied it to electrical circuits where it shapes electrical waves in a manner similar to an acoustic resonator. For instance, both coils and capacitors store energy and can be connected as a resonator (more often termed a resonant circuit). When AC of appropriate frequency is applied to the resonator, special things happen.

Pendulum Demonstrates. The principle involved is identical to that of a pendulum, which is itself a resonator closely similar in operation to our quartz crystals. To try it you can hang a pendulum of any arbitrary length (Fig. I), start it swinging, then time its *period*—one complete swing or cycle. The number of such swings accomplished in exactly one second on the *natural* or *resonant* frequency of the pendulum in cycles per second (Hertz).

You can, by experiment, prove that the frequency at which the pendulum swings or oscillates is determined by the length of the pendulum. The shorter the pendulum (Fig. 2), the faster it swings (the greater the frequency). The weight of the pendulum has no effect on frequency, but has a marked effect upon the length of time the pendulum will swing after a single initial push—the heavier the pendulum, the greater the number of cycles.

A Real Swinger. Once the pendulum begins to swing, very little effort is required to keep it swinging. Only a tiny push is needed each cycle, provided that the push is always applied just as the pendulum begins to move *away* from the pushing point. If the push is given too soon, it will interfere with the swinging and actually cause the swing to stop sooner than it would without added energy; while if too late, added push will have virtually no effect at all. It is this principle—a tiny push at exactly the right time interval—which makes a resonator sustain sound or AC waves. You can prove it with the pendulum by first determining the resonant frequency of a pendulum, then stopping it so that it is completely still. A series of small pushes, delivered at the natural resonant frequency, (each too tiny to have more than a minute effect) will very rapidly cause the pendulum to swing to its full arc again. Pushes of the same strength at any other frequency will have little or no effect.

The pendulum is an excellent control mechanism for regulating a clock to keep time to the second, since the resonant frequency of the pendulum can readily be adjusted to be precisely one cycle per second. However, for control of audio frequencies from tens of Hertz (cycles per second) up to tens of thousands of cycles per second (kilohertz), or for radio frequencies ranging up

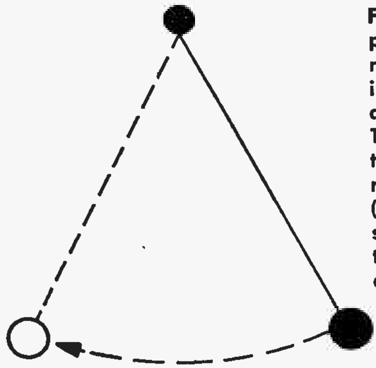


Fig. 1. A long pendulum swings at a rate determined by its length and weight at the end of the arm. To experiment at home, the arm should be made of light thread (no weight) and a small heavy mass (all the weight concentrated at one point).

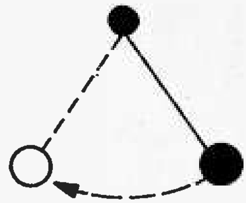


Fig 2. A short pendulum swings at a faster rate no matter what the weight is. The heavier the weight, the longer the pendulum will swing at the faster rate.

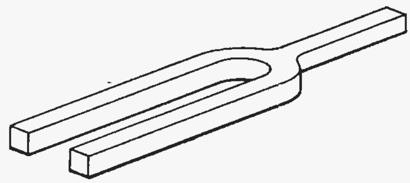


Fig. 3. The geometry of the tuning fork produces a continuous pure tone for a long time when struck gently. It is favored by piano tuners as a convenient way to carry a source of accurately-known tone or pitch.

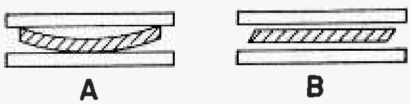


Fig. 4. Depending on how the crystal is cut or sliced from the mother crystal, some crystals warp or bend as in A and others shear as shown in B. Each of the many cuts have special characteristics.

to hundreds of millions of cycles per second (Megahertz), the pendulum is too cumbersome a device.

The Tuning Fork. In the audio range, the equivalent of the pendulum is the tuning fork. This is an extremely elongated U-shaped piece of metal (Fig. 3), usually with a small handle at the base. When struck, it emits a single musical tone.

The operating principle is exactly the same as the pendulum. Each of the arms or tines of the fork corresponds to a pendulum arm. But here the arms are extremely short and much heavier in proportion to their size than the pendulum. (The shorter the arms of a tuning fork, the higher the resonant frequency in the audio range.) This greatly increased mass causes them to oscillate much longer when struck.

Not all tuning forks operate precisely like pendulums. The pendulum principle is based on a *flexing* of the arm upon its long dimension. While this is the most common operation, the fork may flex along any dimension.

It's even possible for a single, solid resonator such as a tuning fork to flex along several dimensions at once. A main part of the design of a good tuning fork is to insure that only a single dimension flexes or, in the language of resonators, only a single mode is excited.

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Now, with the principles of resonance firmly established, we can return to the quartz crystal and its operation.

Quartz Crystals as Resonators. Like the tuning fork or, for that matter, any sufficiently hard object, the quartz crystal is capable of oscillation when struck physically or in some other way excited.

But unlike the tuning fork, or indeed any other object except for certain extremely recent synthetic materails, the quartz crystal is not only sufficiently hard to oscillate at one or more resonant frequencies, but is piezoelectric.

Piezoelectricity. The piezoelectric property means simply that the crystal generates an electric voltage when physically stressed or, on the other hand, will be physically deformed when subjected to a voltage (See Fig. 4). Other familiar objects making use of piezoelectricity include crystal and ceramic microphone elements and phonograph cartridges.

This virtually unique combination of properties (sufficient hardness for oscillation and piezoelectricity) found in quartz crystals, makes it possible to provide the initial push to the crystal by impressing a voltage across it. To provide the subsequent regular pushes, a voltage can be applied at appropriate instants.

Quality Factor. Almost any discussion of resonance and resonant circuits (or for that matter, inductance) eventually gets to a rather sticky subject labelled in the earliest days of radio, *quality factor* but now known universally as *Q*.

As used in radio and electronics, *Q* is usually defined by other means. Some of the definitions put forth at various times and places include:

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An Interesting Fraction. The greater the *Q*, the narrower the band of frequencies which can affect the resonator. Specifically, the so-called half-power bandwidth (Fig. 5) of a resonator (that band in which signals are passed with half or more of the power possessed by signals at the exact resonant frequency) is expressible by the fraction Fo/Q, where Fo is the resonant frequency and *Q* is the circuit *Q*. Thus a 455 kHz resonant circuit with a *Q* of 100 will have a half-power bandwidth of 455/100 kHz, or 4.55 kHz. This relation is an approximation valid only for single-tuned circuits; more complex circuits are beyond this basic discussion.

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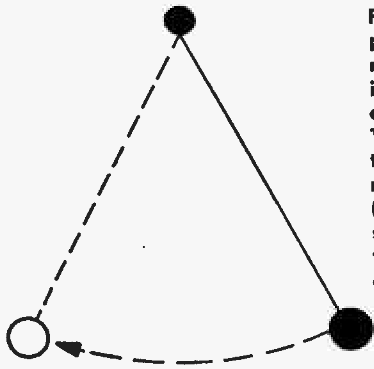

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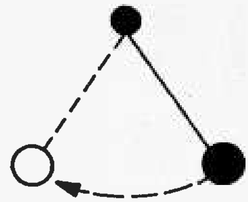

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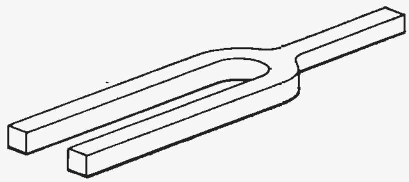

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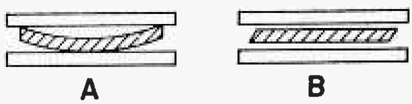

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The crystal plate is known as a *blank* when it is sliced from the raw crystal. The blank is cut at a precise angle with respect to the optical and electrical axes of the raw crystal, as shown in Fig. 8. Each has its own characteristics for use in specific applications. Some, notably the *X*- and *Y*-cuts, are of only historic interest. The *Y*-cut, one of the first types used, had a bad habit of jumping in frequency at critical temperatures. The *X*- cut did not jump, but still varied widely in frequency as temperature changed.

Today's crystals most frequently use the *AT* cut for frequencies between 500 kHz and about 6 MHz, and the BT cut for between 6 and 12 MHz. Above 12 MHz, most crystals are specially processed *BT*- or *AT*- cuts used in *overtone* modes. These

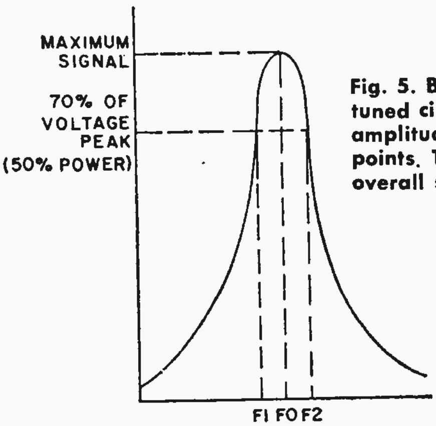


Fig. 5. Bandwidth characteristic of a typical tuned circuit shows the peak or maximum signal amplitude and the 70% voltage peak (50% power) points. This is the characteristic that determines overall selectivity.

Fig. 6. Diagram is a typical equivalent circuit for a crystal. As resistance is lowered to near zero, crystal efficiency increases. In use, the crystal holder and external circuit add some capacitance across the entire circuit.

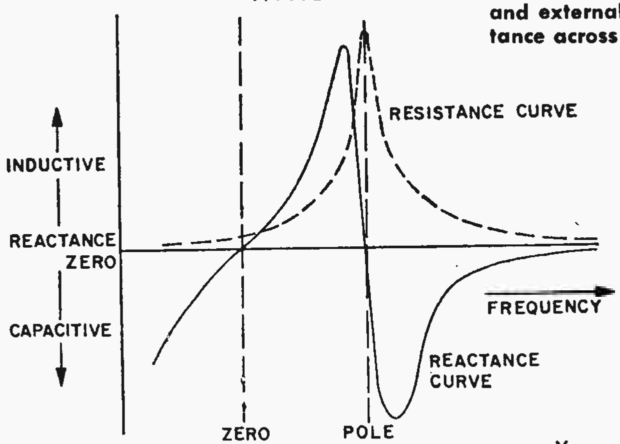


Fig. 7. Some characteristics of a quartz crystal. When slightly off resonant frequency (at the pole) a crystal exhibits inductive or capacitive reactance—just like an LC circuit.

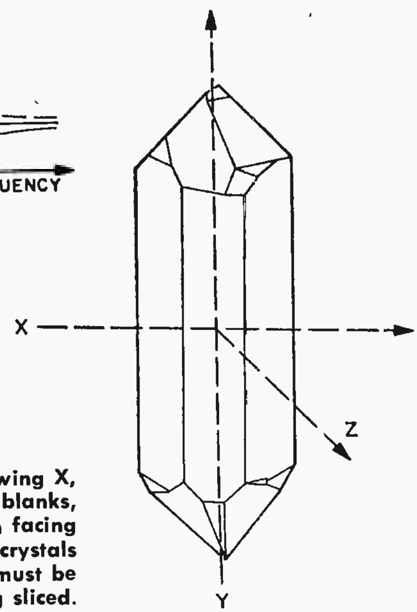


Fig. 8. A view of a mother crystal showing X, Y and Z axes. Crystal is sliced into blanks, ground to frequency, polished and plated (on facing sides) to make permanent electrodes. All crystals are not made perfect by Mother Nature and must be examined optically before being sliced.

cuts are important to crystal makers and not relevant to our layman's theory.

The blanks are cut only to approximate size. The plates are then polished to final size in optical "lapping" machines which preserve parallelism between critical surfaces. During the final stages of polishing, crystals are frequently tested against standard frequency sources to determine exact frequency of operation.

If electrodes are to be plated onto the crystal surfaces, frequency cannot be set precisely by grinding since the electrodes themselves load the crystal slightly and cause a slight decrease in operating frequencies. These crystals are ground just a trifle above their intended frequencies, and the thickness of the electrodes is varied by varying plating time to achieve precision.

Accuracy. The precision which can be attained in production of quartz crystals is astounding. Accuracy of ±0.001 percent is routine, and 10-time-better accuracy is not difficult. In absolute figures, this means an error of one cycle per Magahertz. In another frame of reference, a clock with the same accuracy would require more than 11 days to gain or lose a single second.

However, such accuracy can be achieved only when certain precautions are taken. For instance, the frequency of a crystal depends upon the circuit in which it is used as well as upon its manufacture. For an accuracy of ±0.005% or greater, the crystal must be ground for a single specific oscillator. If ±0.001% (or better) circuit accuracy is required, it must be tested in that circuit only. Thus, CB transmitters are on the narrow edge of being critical. This is why all operating manuals include a caution to use only crystals made specifically for that transmitter.

When one part-per-million accuracy is required, not only must the crystal be ground for a single specific oscillator, but most often the oscillator circuit must then be adjusted for best operation with the crystal; this round-robin adjustment must be kept up until required accuracy is achieved. Even then, crystal aging may make readjustment necessary for the first 12 to 18 months.

Frequency Variation—Causes and Cures.

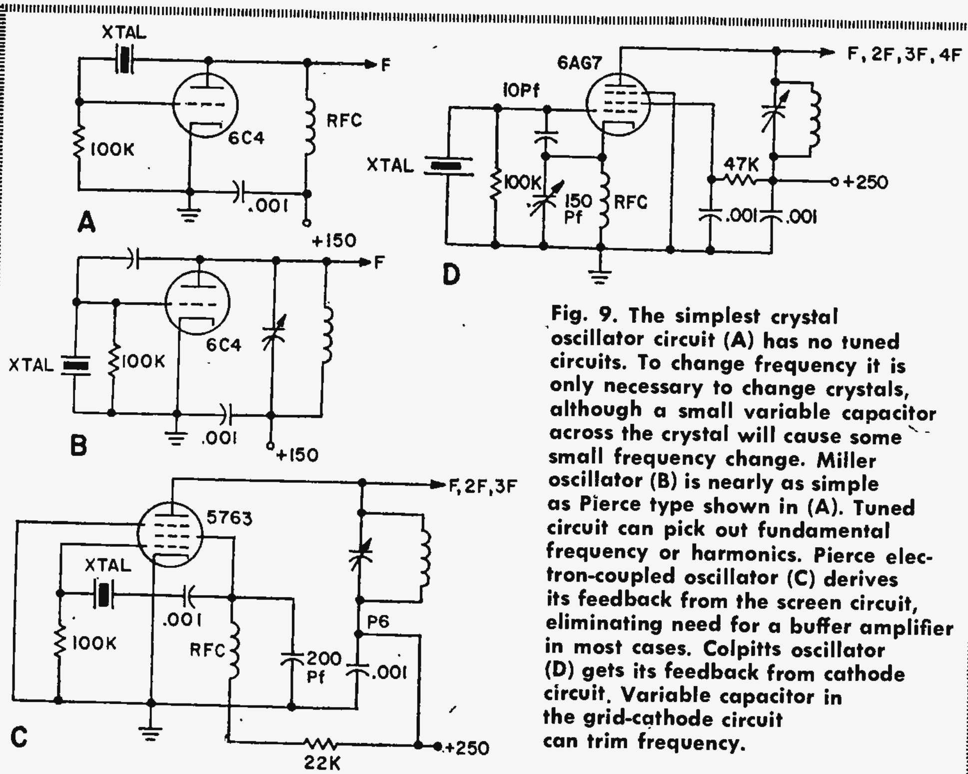


Fig. 9. The simplest crystal oscillator circuit (A) has no tuned circuits. To change frequency it is only necessary to change crystals, although a small variable capacitor across the crystal will cause some small frequency change. Miller oscillator (B) is nearly as simple as Pierce type shown in (A). Tuned circuit can pick out fundamental frequency or harmonics. Pierce electron-coupled oscillator (C) derives its feedback from the screen circuit, eliminating need for a buffer amplifier in most cases. Colpitts oscillator (D) gets its feedback from cathode circuit. Variable capacitor in the grid-cathode circuit can trim frequency.

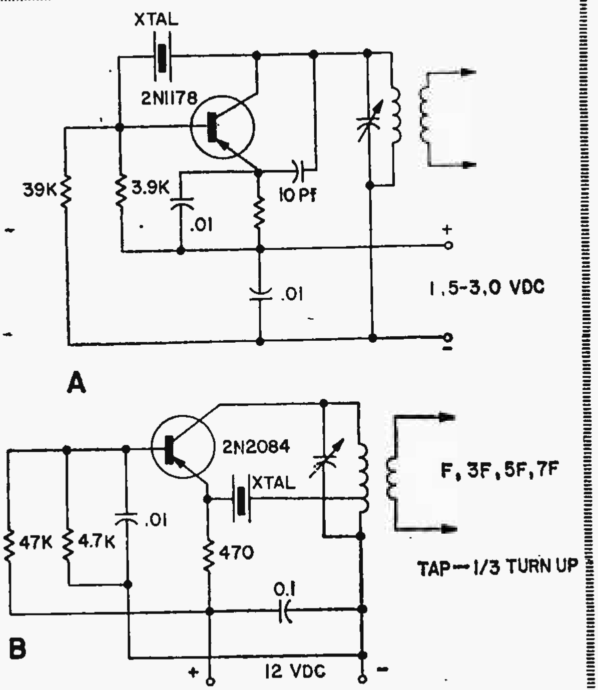


Fig. 10. Fundamental frequency transistorized oscillator (A) is quite similar to that in Fig. 9A. One difference is that tuned circuit in output replaces RFC unit. The overtone (harmonic) circuit (B) uses crystal for odd harmonic feedback. Either circuit can be used for fundamental frequency operation—just tune.

Possible variations in frequency stem from three major causes while cures depend entirely upon the application.

The most obvious cause of frequency variation is temperature. Like anything else, the crystal will change in size when heated and the frequency is determined by size. Certain cuts show less change with temperature than do others, but all have at least some change.

For most noncommercial applications, the heat-resistant cuts do well enough. For stringent broadcast station and critical time-signal requirements, the crystal may be enclosed in a small thermostatically-regulated oven. This assures that the steady temperature will cure one cause of frequency change.

The second well known cause for variation of frequency is external capacitance. Some capacitance is always present because the crystal electrodes form the plates of a capacitor where the crystal itself is the dielectric. Most crystals intended for amateur use are designed to accommodate an external capacitance of 32 pF, so if external capacitance is greater than this, the marked frequency may not be correct. Crystals for commercial applications are ground to capacitance specifications for the specific equipment in which they are to be used. CB crystals also are ground for specific equipment, although many transceivers employ the 32 pF standard set for Ham applications.

Trim a Frequency. When utmost precision is required, a small variable capacitor may be connected in parallel with the crystal and adjusted to change frequency slightly. The greater the capacitance, the lower the frequency. Changes of up to 10 kHz may be accomplished by this means, although oscillation may cease when excessive changes are attempted.

Like temperature caused variations, frequency variations due to capacitance may be useful in special cases. Hams operating in the VHF regions obtain frequency modulation by varying load capacitance applied to the crystal in their transmitters.

The third cause for variation of frequency is a change in operating conditions in the associated circuit. This cause is more important with vacuum-tube circuits than with semiconductor equipment. As a rule, operating voltages for any vacuum-tube oscillator providing critical signals should be regulated to prevent change.

Again, this cause can be used to provide FM by deliberately varying voltages.

Crystal Aging. A final cause of frequency variation, small enough to be negligible in all except the most hypersensitive applications, is crystal aging. When a crystal is first processed, microscopic bits of debris remain embedded in its structure. These bits are displaced during the first 12 months or so of use, but during that time the crystal frequency changes by a few parts per million. Extreme accuracy applications must take this change into account. For most uses, though, it may be ignored.

Using Quartz Crystals.. After all the discussion of crystal theory, it's time to examine some typical circuits. While dozens of special crystal circuits have been developed for special applications, a sampling will suffice for discussion. Fig. 9 shows four typical vacuum tube crystal oscillator circuits.

The simplest of these is the Pierce circuit, Fig. 9A. While at first glance this circuit appears to employ the crystal's *zero* to feed back energy from plate to grid, the *pole* is actually used through a mathematically-complex analysis. This circuit has one unique advantage; it contains no tuned elements and, therefore, can be used at any frequency for which a crystal is available. This makes it an excellent low-cost test signal source. The major disadvantage is that excessive current may be driven through the crystal if DC plate voltage rises above 90 or so.

The Miller oscillator (Fig. 9B) is almost as simple to construct and operate as is the Pierce and has an additional advantage of operation with overtone crystals. This is the circuit recommended by *International Crystal Mfg. Co.* for use with their overtone crystals. The capacitor shown between plate and grid is usually composed of grid-plate capacitance alone. The *pole* is used here also, energy feeds back through the grid-plate capacitance, and the *pole* selects only the parallel-resonant frequency (shorting the rest to ground).

ECO. The electron-coupled Pierce oscillator (Fig. 9C), is similar to the basic Pierce. The tuned circuit in the plate offers the possibility of emphasizing a harmonic —an RF choke may be used instead if freedom from tuning is desired and fundamental-frequency operation will suffice.

GPO. One of the most popular oscillators of all time is the Colpitts Crystal oscillator of Fig. 9D, sometimes known as the *grid-plate* oscillator. The feedback arrangement here consists of the two capacitors in the grid circuit; feedback is adjusted by means of the 150 pF variable capacitor (the greater the capacitance, the less the feedback) until reliable oscillation is obtained. Like the other three oscillators, this circuit employs the crystal *pole* frequency.

Since all four of these oscillator circuits utilize the *pole* for frequency control, exact

(Continued on Page 100)

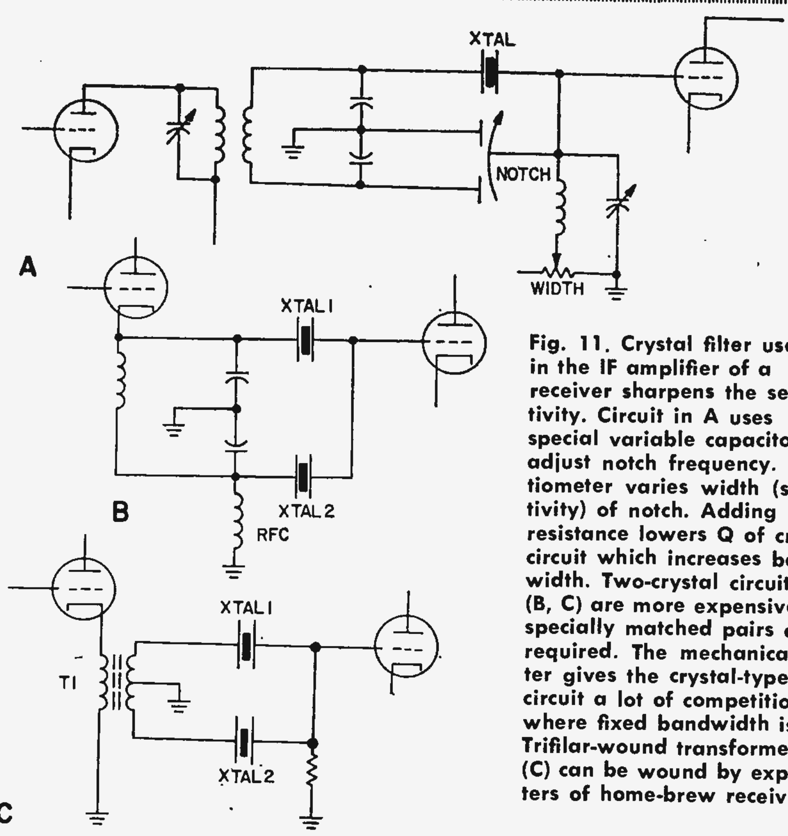


Fig. 11. Crystal filter used in the IF amplifier of a receiver sharpens the selectivity. Circuit in A uses special variable capacitor to adjust notch frequency. Potentiometer varies width (selectivity) of notch. Adding resistance lowers Q of crystal circuit which increases bandwidth. Two-crystal circuits (B, C) are more expensive since specially matched pairs are required. The mechanical filter gives the crystal-type circuit a lot of competition where fixed bandwidth is wanted. Trifilar-wound transformer T1 (C) can be wound by experimenters of home-brew receivers.

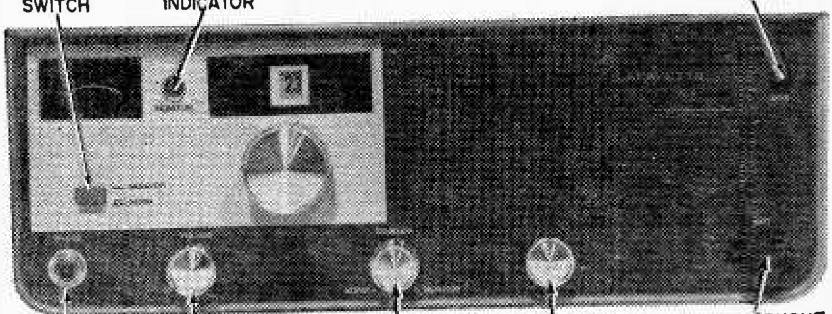
KATHI'S CB CAROUSEL

By Kathi Martin, KAIØ614

Hi fellas. This is Kathi again reporting on something that's really important to me and, I know, to all us CB'ers: How well is the new Channel 9 Emergency Monitor system working?

Well, I'm very happy to say in the opinion of just about all those involved—from the Camden Hills in Maine to Colorado's San Juan National Forest and along Highway 101 in California—it's a Smashing success!!! Our National Calling Frequency in this summer's Channel 9 "rescue" operations here's a great big THANKS for showing that CB is right-on.

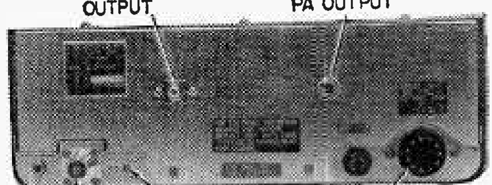
If you haven't joined the Channel 9 Bandwagon, what's holding you up? As we'll see, you don't even have to listen all the time, and if you're upgrading your rig, it costs just a little more for one with a built-in, full time Channel 9 monitor. We've tested just such a rig for this issue, Lafayette Radio's Telsat 924. *(Turn Page)*



This rig is both convenient to operate and attractive. Front of rig has monitor switch, squelch control, and indicator added to the standard operator controls.

Channel 9 passed its first big test, the 1971 vacation and travel season. As politicians say, "From the rockbound coast of Maine to the sunny shores of California . . .", Channel 9 was as hot as toddy on a winter's eve. It seems that just about everybody, from stranded autos to Winnebagos in National Parks, used or helped monitor the channel. Caravans—three or more travel trailers, campers, motorhomes, or tent trailers together—would switch to another channel (often 11) for necessary intra-caravan communications. This is really groovy, for it's this spirit of cooperation among CB'ers that makes Channel 9's purpose workable

If either you or your club were involved



Telsat 924 two channel monitor receiver uses common antenna for both receivers.

KATHI'S CB CAROUSEL

My Report. The Telsat 924 consists of a standard 23 channel high performance transceiver and a completely independent crystal controlled Channel 9 monitor receiver. And just to prove it's a "professional" transceiver, the 924 has a tape recorder output jack for tape-logging all received signals.

The 924 is housed in a 11-13/16-in. W x 4-5/16-in. H x 8-in. D cabinet. The power supply is 117 VAC or 12 VDC. The unit is normally supplied with an AC and 12V negative ground DC cable. A positive ground DC cable is optional. Operating features include a combination S/RF output meter, headphone jack, P.A. output jack, Delta tuning, tape recorder output jack and an external antenna loading adjustment.

A peek inside the box will find a double conversion "standard" receiver with mechanical filter for needle sharp selectivity. Also connected to the antenna input, and in no way affecting the performance of the main receiver, is a crystal controlled, single conversion monitor receiver, with its own squelch and a "channel in use" indicator light. A switch mounted on the front panel selects either the standard or monitor receiver for connection to the speaker. With this feature, an XYL can busy herself around the house without missing a call.

In typical operation, the channel selector determines the transmit and receive frequency, but the Channel 9 monitor receiver is always in operation regardless of the channel being used for routine communications. As soon as the monitor receiver senses a signal on Channel 9, the monitor squelch releases and starts a multivibrator that causes the panel-mounted monitor lamp to blink rapidly. To hear what's happening on Channel 9 you simply push the panel mounted *monitor-norm* switch, thereby switching the speaker output to the Channel 9 monitor. For full time monitoring of Channel 9, either the normal channel selector can be set to Channel 9, or the *monitor-norm* switch can be set to *monitor*.

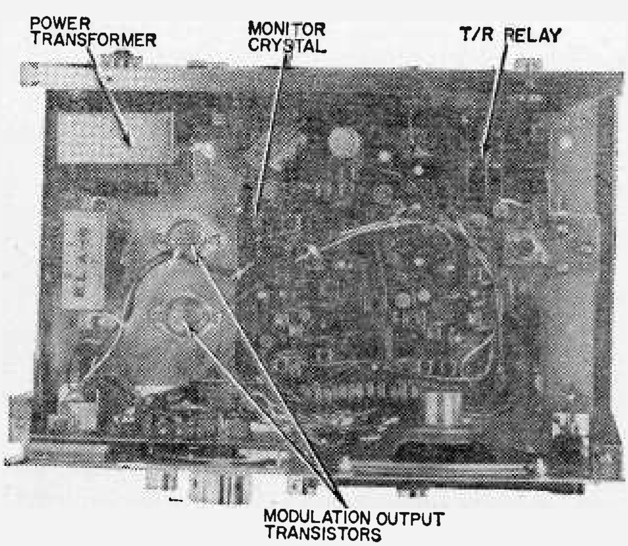
The transmitter is standard; output frequency is determined by the channel selector, so it is necessary to switch to Channel 9 in order to answer an "emergency call".

Easy to use. Though jam packed with circuits, the Telsat 924 doesn't look much different from other transceivers. There is the usual volume, squelch and channel selector controls. The monitor receiver squelch is concentric with the normal squelch, so the only extra hardware on the front panel is the *monitor-norm* pushbutton. (Either the normal receiver or monitor receiver is selected by simply pushing the switch.)

And because the main receiver's selectivity is so high, a ± 1.5 kHz Delta Tune is provided to pull in signals that might be way off the center channel.

Performance is really great. Though the Telsat 924 is budget priced ($139.95 includes microphone, AC and DC power cables, mobile mount and all crystals including the

(Continued on page 101)



A look inside the '924 reveals use of chassis as modulation and audio output transistor heat sink. Adequate "sinking" insures cool components and longer operating lifetime.

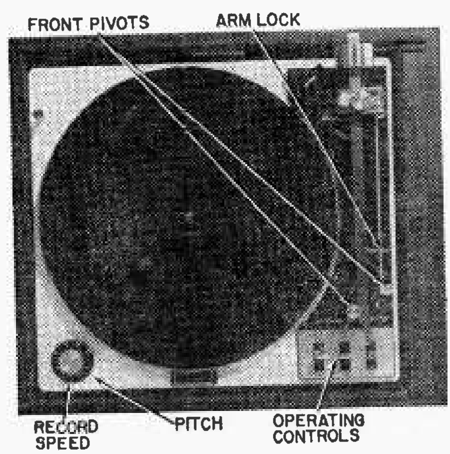
e/e checks out the zero-tracking...

Garrard Zero 100 Automatic Turntable

For almost 25 years, since the beginning of modern high fidelity sound, audio manufacturers have searched for the perfect tone arm; one that would track tangent (at right angles) to the record grooves remained as the last frontier. Most attempts at tangent tracking were noble, valiant efforts that either turned out to have unsuspected problems or were astronomically expensive.

But now, we finally have a viable tangent tracking system of rather simple, trouble-free construction; one easily mated to a quality turntable. Such a system is Garrard's Zero 100 Automatic Turntable.

The importance of tangent tracking lies in the manner by which the record master's grooves are cut. Every modern cutting lathe tracks the cutterhead straight across the disc, with the cutter always positioned at right angles to the cutting stylus motion. On the other hand, standard tone arms are pivoted at the rear; the arm swings across the disc in an arc, so the playback stylus can be at right angles to the record grooves at only two points.



With modern tone arms, pickups and good quality discs the pivoted arm does an excellent job at tracking. But on well worn or poorly pressed, and some high level, discs, the slight tracking error at the inner diameter combined with the high velocity of the inner diameter grooves can cause mind-shattering distortion. But track this mind-shattering disc with a tangent tone arm, in particular the Garrard Zero 100, and the distortion is sharply reduced to an "acceptable" value.

What it is. The Zero 100 is basically two independent systems: 1) a very good automatic turntable mechanism; 2) the articulated tangent tracking tone arm. Garrard simply chose to combine both into a single automatic turntable system.

The Zero 100 provdies for two speeds: 33 and 45 rpm. The multi-position speed selector also determines the indexing for 7 in., 10 in. and 12 in. records. Around (concentric with) the speed selector is a control for varying the speed 3.5% either way. To insure precise setting of the playing speed, a strobe disc is provided on the underside of the turntable that is under continuous illumination. A mirror reflexes the strobe disc so

Simple easy-to-use operator controls are augmented by built-in stroboscope. Speed is variable for a pitch adjustment to one semitone, a boon for professional and semi-professional music use. Arm-lock for safety.

GARRARD ZERO 100

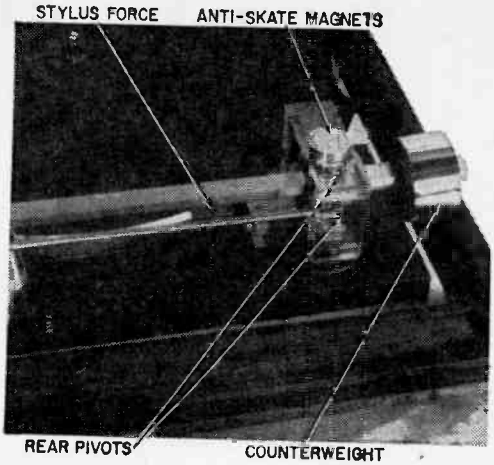
it can be viewed by looking directly at the front of the turntable deck.

Manual or record changer operation is determined by which of two supplied spindles is inserted into the turntable. The short spindle provides single play operation; the long spindle provides the record changer operation (up to 6 records).

Three tabs provide all control functions. One tab is start-stop for automatic, meaning the Zero 100 will continuously repeat a record or shut down automatically after the record is played. The second lever is the start-stop for manual operation whereby the user places the stylus in the groove and lifts the arm clear at the end of the record. The third lever provides a highly damped cueing and pause.

The real heart of the Zero 100, however, is the articulated tone arm, which closely resembles the articulated (dual arm) windshield wiper on larger cars. (It's a simple device, and it's quite likely a Garrard engineer got the idea while driving in an England rainstorm.

The basic, counterbalanced tone arm is as straight as a ruler. A pair of ceramic magnets are located at the rear pivot mount: one on the pivot and one on the arm (the pivot is plastic to avoid magnetic effects). These magnets provide the anti-skating force, with the degree of force determined



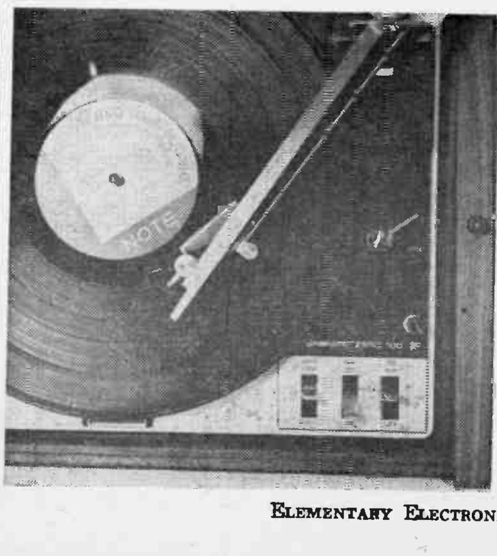
Pivots and magnets, main features of Zero 100, provide both near perfect tracking and common-sense approach to anti-skating.

by a calibrated shield that slides between the magnets. (All in all a far superior system to spring-loaded anti-skating adjustments.) The stylus force is determined by a weight that slides under the tone arm, with engraved calibrations from 0 to 3 grams in ¼ gram segment.

Maintaining a Tangent. At the business end of the tone arm the pickup shell is installed on a pivot so it is free to move. From the outer edge of the shell, running back to the plastic rear pivot, is the articulation control arm. As the main tone arm moves towards the spindle, the control arm rotates

Continued on Page 102

Pivot action responsible for near perfect tracking is illustrated below. Photo, left, shows start of record. Articulating arm pivots cartridge to keep pick-up stylus tangent to record groove. Note change in articulating arm near end of record.



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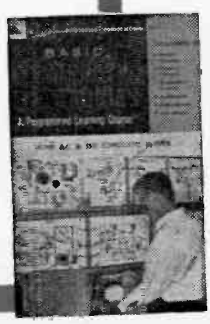
PART 2
UNDERSTANDING POWER SUPPLIES

What You Will Learn. In this part you will learn what filter networks are, and how they work in power supply circuits. There are various kinds of filters made up of passive electronic components, and you will learn how to utilize these components to match the filtering requirements of the circuit. You will see how regulated power supplies work. These power supplies utilize active electronic components to perform the filtering function; you will learn how to match the correct regulated power supply circuit configuration to the electronic load to be energized. *(Continued on page 94)*



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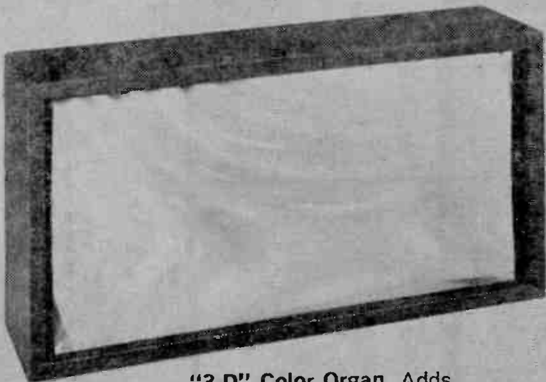

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Continued from page 89

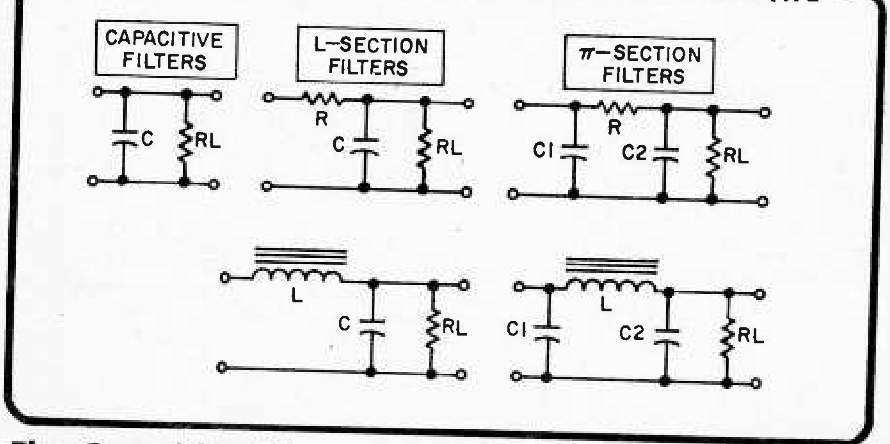
FILTERS

The filter is the section of a power supply that smooths the pulsating DC to make it almost pure DC. The three filter circuit types most commonly used are shown below. As you see, filters are simply circuits made up of resistors, capacitors, and inductors in various combinations. The operation of filters depends on the ways that L, C, and R, affect changing voltages and currents.

Q1. What are the three types of filters most commonly used?

Your Answers Should Be: **A1.** The three types of filters most commonly used are the: 1. **capacitive filter**, 2. **L-section filter**, and 3. π **(pi-section filter)**.

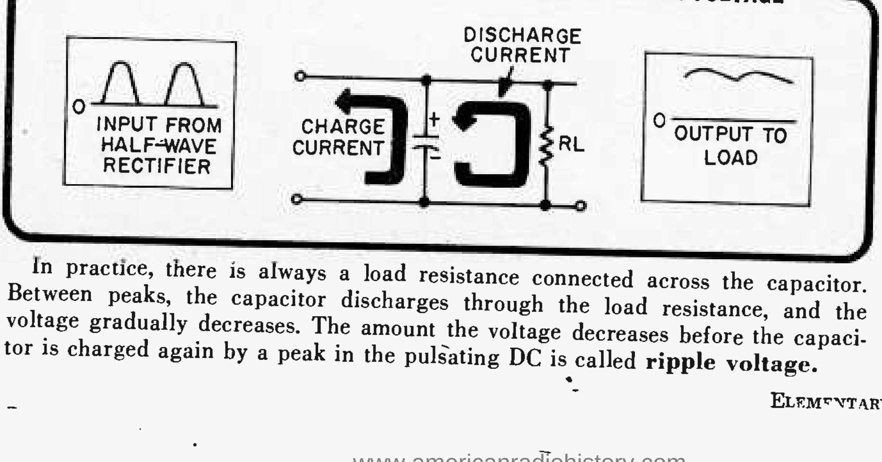
FILTER CIRCUIT COMPONENTS AND SCHEMATICS OF EACH FILTER TYPE



The Capacitive Filter

Basically, the capacitive filter is simply a capacitor connected in parallel with the load resistance. As the pulsating DC voltage from a half-wave or full-wave rectifier is applied across the capacitor, it charges to the peak applied voltage. If there were no load resistance connected across the output, the capacitor would remain charged to the peak voltage.

SIZE OF CAPACITOR ACROSS LOAD DETERMINES RIPPLE VOLTAGE



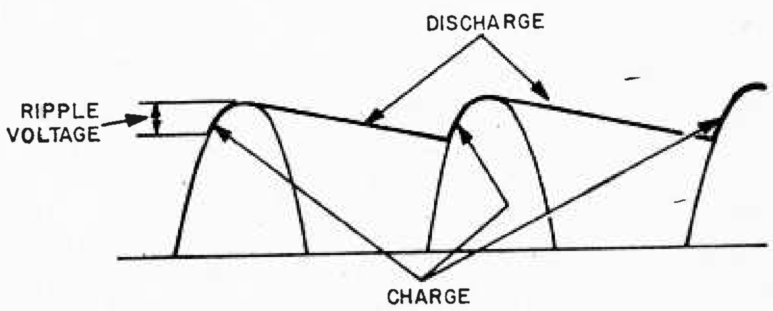
In practice, there is always a load resistance connected across the capacitor. Between peaks, the capacitor discharges through the load resistance, and the voltage gradually decreases. The amount the voltage decreases before the capacitor is charged again by a peak in the pulsating DC is called **ripple voltage.**

The amount of capacitor discharge between voltage peaks is controlled by the RC time constant of the filter capacitor and the load resistance. If the load resistance is large and the capacitance is large, the ripple voltage is small; the pulsating DC has been smoothed out until it is almost a pure, constant DC voltage.

Variations in the output voltage are not desirable because they affect the operation of vacuum-tube or transistor circuits receiving the DC. The increased ripple voltage caused by reduced load resistance is one undesirable feature of the capacitive filter.

A second undesirable feature of a capacitive filter is the large charging current. This excessive current flows into the capacitor to charge it when the power supply is first turned on. This initial current is often called a **surge current.** Over a

TIME CONSTANT OF LOAD RESISTANCE/CAPACITOR DETERMINES RIPPLE



period of time, surge currents can cause injury to fuses and rectifiers, resulting in eventual burnout. Each surge current can cause part of a fuse to melt slightly, for example, until it finally burns out. The same thing can happen to the rectifier. A small surge of current flows through the rectifier during each cycle to recharge the partially discharged capacitor. Under certain conditions these charging surges can become large enough to damage a diode. The remaining two types of filters have components to reduce the effect of ripple-voltage variations and surge currents.

Q2. What will happen to the RC time constant of the capacitor and load resistance if the load resistance is decreased?

Q3. If the load resistance is decreased, the filter capacitor will discharge (more, less) rapidly.

Q4. What will happen to the amount of ripple voltage if the load resistance is decreased?

Q5. The large current that flows for a short time to charge the capacitor is called a(n) ------------.

Q6. If a load resistance is not connected across the filter capacitor, what will happen to the output voltage?

Your Answers Should Be:

A2. If R_L is decreased, the RC time constant will be **shorter.**

A3. If the load resistance is decreased, the filter capacitor will discharge **more** rapidly.

A4. The amount of the ripple voltage **increases** as the load resistance of a capacitive filter is decreased.

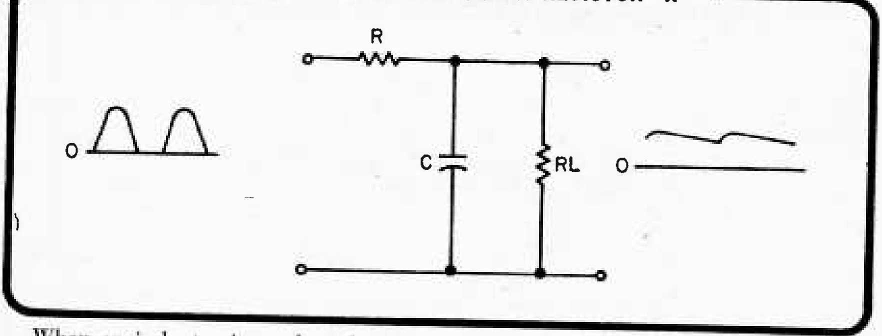
A5. The large current that flows for a short time to charge the capacitor is called a **surge current.**

A6. If a load resistance is not connected across the filter capacitor, the capacitor will charge to the **peak value of the filter input voltage and the output voltage will remain at this value.**

L-Section Filters

An L-section filter reduces surge currents by using a current-limiting resistor or inductor. This limiting resistor or inductor is connected in series with the capacitor. A limiting resistor controls surge currents by introducing an RC time constant to slow the charging of the capacitor.

L-SECTION FILTER WITH SERIES RESISTOR "R"

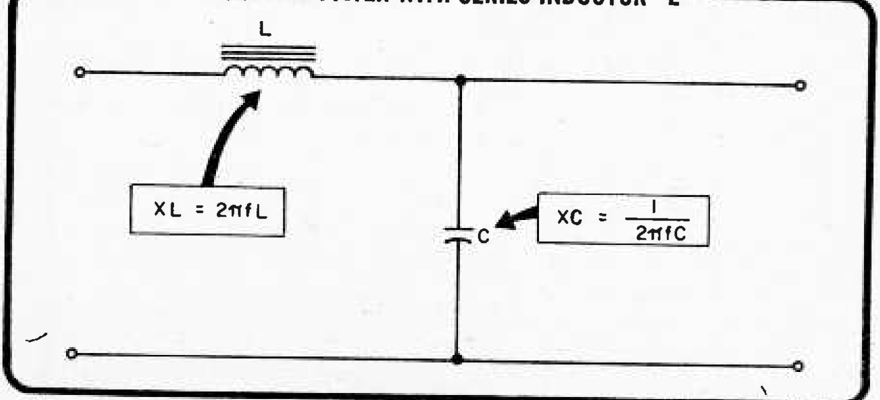


When an inductor is used as the series element, the surge currents are reduced in a different manner. The inductor opposes a change in current by creating a counter emf. As a result, the surge current is greatly reduced and the capacitor charges more slowly.

An inductor used in an L-section filter also adds to the filtering action of the capacitor. The inductor reacts to changes in current caused by the ripple voltage the same way it reacts to the surge current. The counter emf tends to cancel out the effects of the ripple voltage

The operation of the L-section filter can also be explained in terms of reactance. In a simple capacitive filter, and in an L-section filter with a limiting resistor, the filtering action is the result only of the reactance of the capacitor (X_c). The capacitor presents a low reactance to AC and a very high reactance to DC. The AC part of the input is therefore by passed through the capacitor, but the DC part goes directly to the load.

L-SECTION FILTER WITH SERIES INDUCTOR "L"



To understand the L-section filter with an inductor, the reactance of the inductor must also be considered. The reactance is high for AC, but it is nonexistent for DC. The inductor presents a high reactance to the AC current produced by the ripple voltage. The inductor therefore tends to block this current. It presents zero reactance to the DC and allows it to pass readily. The AC that is not blocked by the inductor is mostly bypassed by the capacitor.

Q7. In an L-section filter, AC ripple can be blocked by a(n) ---------.

Q3. In an L-section filter, AC ripple can be bypassed by a(n) ---------.

Q9. An L-section filter with a limiting resistor is (more, less) effective than one with an inductor.

Q10. An inductor has a ------ reactance for AC than for DC.

Your Answers Should Be:

A7. In an L-section filter, AC ripple voltages can be blocked by an **inductor.**

A8. In an L-section filter, AC ripple voltages can be bypassed by a **capacitor.**

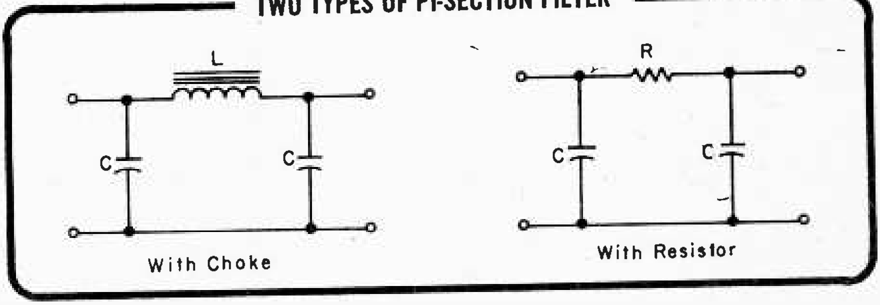
A9. An L-section filter with a limiting resistor is **less** effective than one with an inductor.

A10. An inductor has **higher** reactance for AC than for DC.

Pi-Section Filters

A pi-section filter has three elements—a shunt input capacitor, a series **choke** (inductor), and a shunt output capacitor. As the input voltage reaches the first capacitor, the capacitor bypasses most of the AC ripple current to ground. This presents a smoother waveshape to the choke. The choke presents a high inductive reactance to the AC ripple current and tends to block it. To put it another way,

TWO TYPES OF PI-SECTION FILTER



the choke opposes a change in current, and so it acts to smooth the current passing through it. Finally, the second capacitor is designed to bypass to ground any remaining AC components. The result output is a smooth DC voltage.

To save money, the choke is sometimes replaced with a resistor. This results in less smoothing action. A pi-section filter using a resistor depends for some of its effectiveness on the long time constant of the series resistor and the output capacitor. If this time constant is much longer than the period of the AC ripple, the output capacitor will charge and discharge very little during any one pulse of the ripple voltage. The waveshape will then be smoothed out. However, the resistor also consumes power. This is an important consideration in a power-supply circuit.

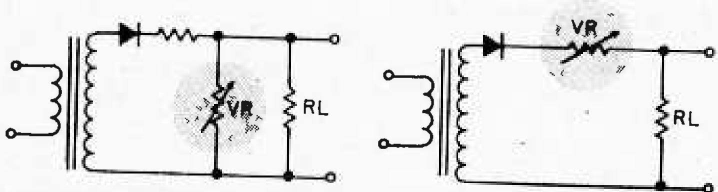
REGULATED POWER SUPPLIES

Regulated power supplies are those that keep the voltage (or current) supplied to the load constant, even if the powersource voltage fluctuates or the load changes.

e/e Basic Course

Basically, the voltage-regulator part of a regulated power supply is a variable resistance that automatically changes as the output voltage changes. (For simplicity, no filter is shown in the figure.)

VOLTAGE REGULATORS REPRESENTED AS VARIABLE RESISTORS



IN SHUNT WITH POWER SUPPLY   IN SERIES WITH POWER SUPPLY

A shunt voltage regular combines with the resistance of the power supply itself, or with an additional resistor, to form a voltage divider. As the shunt resistance increases, more voltage appears across it as an output to the load. As the shunt resitance decreases, less voltage appears across it.

The series voltage regulator forms a voltage divider in series with the load resistance. As the series resistance increases, less voltage appears across the load resistance. As the series resistance decreases, more voltage appears across the load.

Q11. What are the three elements of a pi-section filter?
Q12. A pi-section filter with a resistor gives (better, poorer) filtering action than one with a choke.
Q13. A voltage regulator may be compared to a -------- resistor.

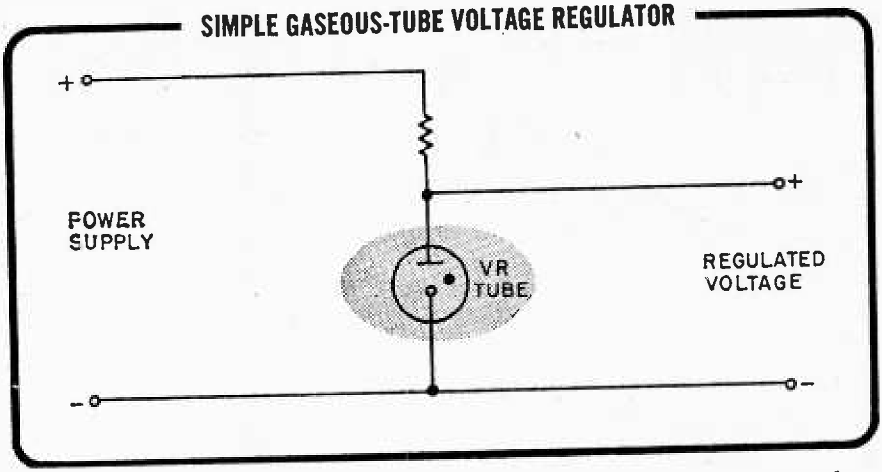
Your Answers Should Be:
A11. The three elements of a pi-section filter are a **shunt input capacitor, a series choke or resistor,** and a **shunt output capacitor.**
A12. A pi-section filter with a resistor gives **poorer** filtering action than one with a choke.
A13. A voltage regulator may be compared to a **variable** resistor.

The resistance of a shunt voltage regulator increases when the output voltage decreases. It decreases when the output voltage increases. Thus, it automatically returns the output voltage to normal. Similarly, the resistance of a series voltage regulator increases as the output voltage increases and decreases as the output voltage decreases.

There are several ways of achieving resistance that varies with output voltage. One of these is the gaseous voltage-regulator (VR) tube. This is a diode filled with a current-conducting gas. As the voltage applied across this tube increases, the gas becomes more ionized, and the resistance of the tube decreases. This type of tube can be used as a shunt voltage regulator.

The limiting resistor in series with the VR tube is selected to limit the current

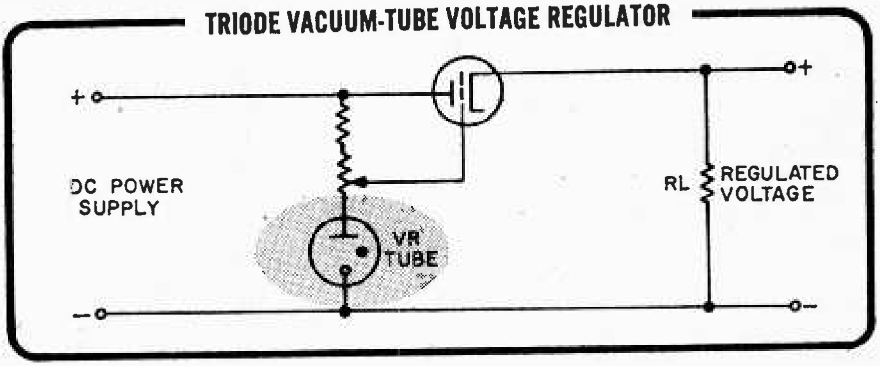
SIMPLE GASEOUS-TUBE VOLTAGE REGULATOR



through the tube to a safe value. Gaseous voltage regulators keep the output voltage constant to within about 1%. They come in a number of specific voltage ratings. To change the constant output voltage, it is necessary to change the tube. To obtain higher voltage ratings, VR tubes can be connected in series so that only part of the output voltage appears across each one.

The regulated voltage from a VR-tube regulator is fixed in value. Vacuum tubes are often used where it is desirable to vary the value of a regulated voltage.

TRIODE VACUUM-TUBE VOLTAGE REGULATOR



A vacuum-tube circuit can be used as a series voltage regulator. The current passing through the tube from cathode to plate depends on the grid bias. Another way to say this is that the resistance of the tube depends on the grid bias. Therefore, by varying the voltage on the grid, the tube resistance can be changed as necessary.

A source for the grid bias is needed. This may be a battery or it can be a VR regulator connected to the power source. A potentiometer in the grid circuit makes it possible to adjust the bias.

If the voltage of the power source rises, the voltage at the cathode of the triode also increases. This causes an increase in the negative grid bias and reduces the current through the tube, effectively increasing the plate resistance. The output voltage is thus reduced. If the power source voltage drops, the opposite action takes place. This circuit will also compensate for changes in load resistance. A transistor instead of a tube can be used in a similar circuit.

Q14. The resistance of a shunt voltage regulator decreases as the output voltage ---------.

Q15. The resistance of a series voltage regulator --------- as the output voltage decreases.

e/e Basic Course

Your Answers Should Be:

A14. The resistance of a shunt voltage regulator decreases as the output voltage **increases.**

A15. The resistance of a series voltage regulator **decreases** as the output voltage decreases.

WHAT YOU HAVE LEARNED

1. The filter smooths out the pulsating DC and provides almost pure DC.
2. Three of the most commonly used filters are capacitive, L-section, and pi-section.
3. The AC component of the filtered DC is called ripple voltage.
4. Voltage regulators are used to provide fairly constant DC.
5. Voltage regulators make adjustments in the power-supply output voltage by varying the resistance of vacuum tubes and/or transistors.
6. Voltage regulators are connected in series or in parallel with the load resistance.
7. Gas tubes and triodes are two commen devices used to provide a variable resistance in regulator circuits.

NEXT ISSUE: Part 2—Understanding the Amplifier

This series is based on material appearing in Vol. 3 of the 5-volume set, BASIC ELECTRICITY/ELECTRONICS, published by Howard W. Sams & Co., Inc. @ $19.95. For information on the complete set, write the publisher at 4300 West 62nd St., Indianapolis, Ind. 46268.

All About Crystals

Continued from Page 84

frequency adjustment capability may be obtained by connecting a 3-30 pF trimmer capacitor in parallel with the crystal.

Crystal oscillators may, of course, be built with transistors, too. Two typical circuits are shown in Fig. 10. Feedback mechanisms differ somewhat because of the basic differences between tubes and transistors. In general, transistorized oscillators are more stable.

As a Clock. To use a crystal as the timing element of a clock, an oscillator identical to those shown in Fig. 9 and 10 is the starting point. Crystal frequency is chosen at a low, easily-checked value such as 100 kHz. This frequency is then divided and redivided by synchronized multivibrators to produce one cycle-per-second pulses. These may then be counted by computer counting circuits.

In addition to being used as oscillators and timing elements, crystals find wide application in filters. Fig. 11 shows some typical crystal-filter circuits. While all circuits shown use vacuum-tubes, transistors may be substituted without modification of the filter circuits themselves if the impedances are right.

The single-crystal filter circuit shown in Fig. 11A provides spectacularly narrow reception. When the notch control is set to precisely balance out the crystal stray capacitance, the resonance curve of the filter is almost perfectly symmetrical. When the notch control is offset to one side or the other, a notch of almost infinite rejection appears in the curve (the *pole*). The width control varies effective *Q* of the filter.

More popular for general usage today is the band-pass filter, shown as Figs. 11B and 11C. These filters pass a band of frequencies without excessive loss and reject all frequencies outside this band. Both circuits make use of matched cyrstals (Xl and X2)—the *pole* of one must match the *zero* of the other for proper results. When this condition is met, the reactances of the two crystals cancel over the passband. The passband is roughly equal to the *pole-zero* spacing.

While the two circuits shown are virtually identical in operation, the transformer-coupled circuit of Fig. 11C is easiest for home construction. The only critical component is the transformer. It should be tightly coupled, with both halves of the secondary absolutely balanced. This is done by winding a trifilar layer of wire (wind three wires at the same time); the center wire becomes the primary winding and the remaining two wires become the secondary. The left end of one secondary half connects to the right end of the other, and this junction forms the center tap. The remaining two ends connect to the crystals. If you have sufficient patience to wind on it, a toriod form is recommended. The only absolutely critical requirement of the transformer, however, is that it have no resonant frequencies anywhere near the operating region. ■

Kathi's CB Carousel

Continued from Page 86

monitor crystal), its performance is right up there with the best. The main receiver sensitivity measured 0.5 uV for a 10 dB S + N/N —beating Lafayette's own spects. Selectivity was a needle sharp 52 dB, with better than 60 dB image rejection. The AGC action scrunched a 2 to 50,000 uV signal range down to an ear pleasing 8 dB: In plain terms, if the volume is cranked wide open to hear a signal just above the noise level, a signal coming on the channel from the station down the block won't ruin your hearing.

Not a "fad" like last year's Hot Pants, the S-meter is really "hot", reading S9 with only 16 uV at the antenna input. Each S-unit in the S6 to S9 range represents a change in signal strength of 6 dB. Below S6, readings are in "relative signal strength".

The monitor receiver's sensivity measured 3 uV with 28 dB selectivity. Sensitivity is generally kept lower than that of a normal receiver so you hear signals within the *working* range of your transmitter. (The mobile will generally not receive your signal if you can barely hear him, so there's no real reason to transmit if you can't be heard.)

The transmitter deliverd 3 watts output to a dummy load. Microphone sensitivity for 85% modulation was −30 dB, a little more sensitive than average, but great for us soft-spoken gals since it allows the Telsat 924's speech compressor (range boost) to put a lot of *talk power* on the signal. There is 100% modulation limiting so you don't have to worry about overmodulation even if you're a shouter.

My View. From any angle, Lafayette Radio's Telsat 924 shapes up as a top performer both for routine CB operations, and, most especially, for you Channel Niner's. For more information circle No. 46 on Reader Service Coupon on page 17. Tell 'em Kathi told you about it. ■

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Garrard Zero 100

Continued from Page 88

the shell on its pivot, thereby maintaining the shell at right angles to the record groove.

A lever under the top of the pickup shell adjusts the pickup's vertical tracking angle to "M" (manual-15°) or "A" (automatic-15° on the third record in the stack).

Performance is outstanding. It is truly amazing, but except for the Hi-Fi Stereo Buyers' Guide, not one single major "hi-fi" publication apparently bothered to listen to a record on the Zero 100. Their instrument measurements, as ours, show the Zero 100 to be the equal of any excellent turntable in its price range, with precisely regulated speeds over a wide voltage range, a zero-error stylus force gauge, and a combined wow and flutter of 0.12%.

In actual listening tests the sound from the Zero 100 is truly outstanding. With new, good quality pressings there is essentially no difference in sound quality between the Zero 100 and any other high quality turntable. But place an older record on the platter, or a favorite played over and over, and the difference in sound quality is immediately apparent. From about the 7 in. diameter to run out, the Zero 100 delivers considerably less distortion and greater definition than with the same pickup mounted in a standard arm. The improvement in sound quality is notably impressive.

The Zero 100 is priced at $189.50. A mounting board, wood and plastic bases, and a hinged dust cover are available. For additional information, circle No. 51 on page 17. ■

CB Coffee Break

Continued from Page 58

signal from this antenna is radiated equally in all directions (omnidirectional); also, a good part of the signal is squirted up towards the sky where it is of no use to anyone. And to make matters worse, the strongest part of the signal is squirted upwards at a slight angle. In short, the radiation pattern from a ground plane looks like a doughnut that is sagging in the middle.

Since the ground plane antenna is the "common" CB antenna, it is used as the basic reference antenna, the one to which all others are compared, and we say it has "unity" gain, or a gain of "1"—in effect, *no gain.*

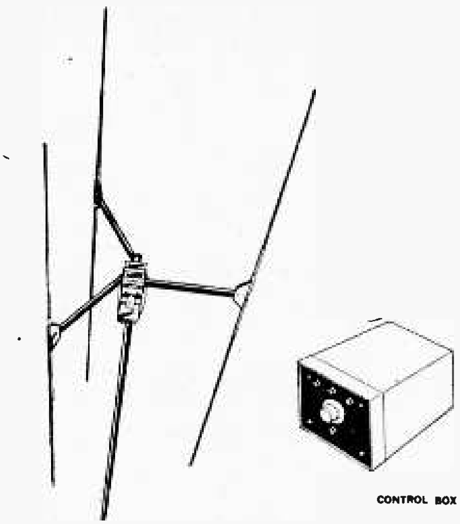
Now along comes *Antenna Specialists* with their M-117 Magnum antenna, *New-Tronics* with their 27-JR and their *Hustler* 27-STR and *Lafayette* with their Range-Boost II; they add a few design gimmicks to the antenna and wind up taking some of that power being squirted up, up and away and beam it down at the ground where it's really needed. In actual practice these antennas put a signal *on the ground* that is 4 dB higher than that of a ground plane antenna. The effect at the receiving station is as if you still were using a ground plane antenna but had increased the transmitter's input power to approximately 12 watts.

Get on the Beam. But 12 watts is still a long way from 100 watts, so to get the effective power up to channel-blaster level we do a little bit more to modify the antenna's radiation pattern. Assume if you will that the station you desire to work lies to the north of your antenna; therefore, power radiated in any direction other than north is totally wasted. If we could only take some of that power heading south, east and west and push it north the receiving station would be crushed under the RF signal. Well that's just what we can do. A *directional beam,* that is, an antenna with two or more vertical radiators can take the RF going to waste and beam it forward. Use a three element beam and the signal going forward can be 8 dB greater than that of a ground plane; that's just like running 31 watts into the final. But there's still some RF being radiated to the back and sides, so let's add another element (4 element beam) to reflect some more energy forward and the signal at the receiving station is almost 9.5 dB higher than that of a ground plane antenna: the equal of running a 44 watt rig into a ground plane antenna.

Still not satisfied, okay, let's try a 5 element *Cush-Craft* antenna with a 10.5 dB forward gain; that's like boosting your transmitter input power to 56 watts.

Well, we're coming close to 100 watts; we need less than 3 dB more antenna gain to hit the equal of a 100 watt rig. Simple: Just stack two 5 element beams for a total of 13.5 dB forward gain; the equal of a 112 watt rig . . . we have done better than 100 watts with an antenna available from local CB distributors.

Of course, many manufacturers other than *Cush-Craft* make sky hooks that put out rock-crushing signals. Just to name a few of the biggies, there's *Avanti* with their quad type directional beams that can transmit either horizontal or vertical polarization, *Antenna Specialists* also has a quad type rock crusher. *Gotham* also grinds out several high gain sky



Operate omni or directional with Antenna Specialists Super Scanner. Non-mechanical signal rotation. Circle No. 47 on Page 17.

hooks, as does *New-Tronics, Hy-Gain* and *Lafayette Radio.*

Fact is, whether your wallet is pinched by an XYL who can't understand why you must drown out every other signal on the band, or you're the last of the big time spenders, there's a super-antenna that will fit your budget.

And while you're sitting back contemplating just how far a 100 watts of effective input power will carry your voice, don't overlook the fact that a directional antenna delivers the same advantage to receiving as it does for transmitting. If the antenna delivers 10 dB forward gain for transmitting it delivers 10 dB forward gain for receiving. In practical terms, it means that a signal which was coming in just over the noise level at 2*u*V when using a ground plane antenna will now come in at 6.32 *u*V.

Don't Look Behind You! Another big receiving plus is front-to-back ratio. Remember we said that directional beams concentrate most of the power forward; taking the back and side power and adding it to the forward power. Well, the same thing applies to receiving: If the antenna concentrates all its sensitivity forward it does so by reducing the back and side sensitivity, and it is not unusual to find a directional antenna is 25 dB less sensitive to the rear than the front . . . called 25 dB front-to-back ratio. Again in practical terms, interfering stations on the same channel in the opposite direction from the desired station would be attenuated 25 dB; you can't accomplish this type of unwanted signal rejection any other way than with a directional beam. And if you want rock-bottom rejection, there are antennas with a 38 dB front-to-back ratio such as *Avanti's* "Moonraker", which can "null out" a 5 watt CB station to the equal of *800 microwatts* (0.0008 watts); now no 800 *u*W station is going to interfere with anybody!

Of course, in this world you get nothing for nothing, so you can't expect to boost your rig's effective power input to 100 watts, or wind up with a super-nulling receiver, without paying something in return. Your payment is *directivity*, meaning the antenna can only deliver phantasmagoric results in a specific direction. In order to cover all points, 360°, you must provide some means to rotate the antenna. While you can put a crank on the bottom of the mast which you can reach by sticking your arm out the window (don't laugh, it is done), an easier way is to use an antenna rotator such as those made by *Cornel Dubilier (CDE)* and *Alliance*. You can either get a model that rotates the antenna as long as you hold down a switch, or one that allows you to preset any desired direction, with the rotator automatically stopping when the antenna swings around to your present bearing.

Okay, now you've got no excuse why your station isn't top gun on the band. And, if you want more info from the horse's mouth, then turn to the pages in this issue devoted to our full scale CB antenna story written by Len Buckwalter. He knows his Cs and Bs, and packs the article with facts every CBer should know.

Attention Clubs. In the very near future I plan to run a listing of active CB clubs throughout the nation in this column. My purpose is simple to understand. With a little publicity, you'll pick up new members that every club needs to grow. You see, in my racket I know it pays to advertise. In fact, in order for me to publicize your club and its activities, you have got to keep me informed. Tell me about your club's activities. Photos are always welcome. So get those cards and letters moving my way today! And remember, we screen our mail from Wala Wala. *—10-7*

"That's great, Dear, just hold 'er there till the cement drys."

Ask Hank, He Knows!

Continued from page 27

turers name, only numbers. Is there any manual available whereby one could determine characteristics and ratings of these components?

—*E. C., Thunder Bay, Ont.*

There was a time when old transformers were worth salvage. Not so today. Power supply requirements for solid-state projects are varied and critical compared to the old brute-force, vacuum-tube days. I haven't used a salvaged transformer this past year. Besides, many units are on the verge of failure. Why build around a part that may not work?

Dead Asleep

Do you know of any place where I could send away for a catalog or a list of all the AM radio stations in the country? Thank You.

—*D. F., Scotia NY*

Man, where have you been. Most cats know about White's Radio Log which is available twice yearly in COMMUNICATIONS WORLD. You can get your copy by sending $1.25 to this magazine.

Tough on Ham Bands

I have a 9 band Zenith Royal 3001 radio. It's a fine radio! I got a verie card (QSL) from R.S.A. (Radio South Africa) South Africa as well as HCJB in South America. My trouble is on the amateur band. I get dozens of Hams, but they overlap and are very hard to understand. Do you think the Zenith is hooked up wrong?

—*C.T.H., Kenora, Ont.*

Zenith makes a great little radio, but for serious shortwave listening, it's time for a switch. I believe you are ready for a $150-200 receiver. Forget about those brand name jobs in department stores. Instead, check a few mail-order parts catalogs for a wired unit or Heath for a kit.

Adventure!

Please tell me if it is possible to convert an old fashioned phonograph which only played 78 speed records, into a turntable which plays the three speeds, 78, 45 and 33⅓. I am not necessarily interested in cutting corners, but more or less adventurous.

—*I.K., Richmond VA*

It's all in the capstan drive. And the chances are that it's impossible to make a three-speed unit unless you are a machinist. The capstan (usually the motor shaft) will drive the turntable slower if its diameter is reduced. What I once did in the early days of the 45 disc was to put a file to the capstan. I constantly checked the speed until I counted 45 revs in one minute. Look at a standard 3-speed machine and see how the capstan has 3 different diameters near the shaft end. Duplicate the mechanism, if you can—good luck!

Whatta Group

I would like to know how to wire a combination of eight 8-ohm speakers to obtain 8-ohms impedance. My amplifier operates on 8-ohms impedance. All of these speakers are 8-ohms. The front and the rear are 5" small speakers (woofers) and the sides are 6 2½-in. tweeters.

—*A. L., Shawinigan, Que.*

Here we go again mixing apples with pears. The best you can hope for is fruit salad! If all the speakers were identical, then the hookup would be *impossible* to get exactly 8-ohms with equal power delivered to all speakers. However, if you slip in an 8-ohm, high-voltage, non-inductive resistor in the group, then it's easy. See our diagram A.

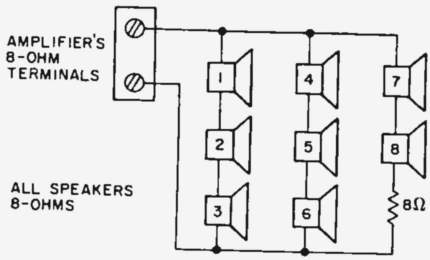


DIAGRAM A

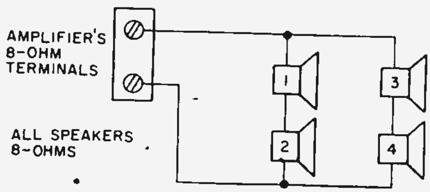


DIAGRAM B

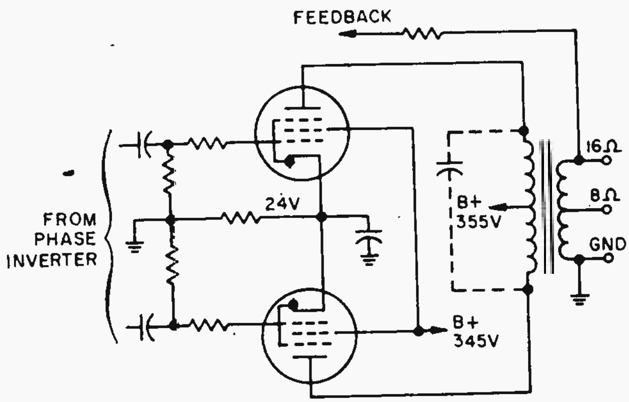
But, two woofers and six tweeters require the use of a complex crossover network. Honestly, it sounds like your using salvage, low-cost speakers and trying for hi-fi sound—if so, you're a loser! Why not pick up four wide range, hi-fi speakers and connect them as shown in diagram B.

Cherry-Red Plates

When I replaced the 7408 tubes in my stereo amplifier, I found that I had to try a dozen tubes to find one that would work. All tubes were tested in various tube testers. No matter into which socket I placed these tubes in the set, the plates would overheat. After the tubes were in the amplifier for ten minutes or more, the plates became cherry red. Up until this time all voltages and resistances checked OK. As the plates overheated, the cathode voltages built up past the rated 24 volts. So I unplugged the set for fear of damage. This happened even if the *tubes were intermixed with the workable ones. The tubes now used work OK and all voltages and resistances are OK. I have ten new tubes whose plates overheat. Can you help me solve this problem?*

—A.G., Linden, N.J.

Looking at the schematic you sent, it is evident that you have a well designed amplifier, except for one thing. The 7408 tubes are being operated at higher than maximum design ratings. Plate voltage should not exceed 350 volts, and



the screen should not have more than 315 volts. But according to your schematic, these voltages are 355 and 345 respectively. Under typical operating conditions, these voltages are both 250 volts, according to the RCA Receiving Tube Manual. If your line voltage is high, as we have found it to be in some parts of Jersey, the actual voltages could be considerably higher. Have the power company check the line voltage. Try a line-voltage reduction transformer to determine if excessive voltage is the problem. Your trouble could be due to oscillation. Try a capacitor across the plates, as shown in the diagram in dotted lines (0.002 to 0.01 mF). Be careful—the voltages are high. If this stops tube overheating, you may not have to leave the capacitor in. Just reduce the line voltage.

Too Young to Snoop

Can you send me a schematic diagram of a police radar detector. This is a project for school.

—L.G., Wentzville MO

A cat souped up with Jonny Walker Black Label doing 105 m.p.h. will do a good job at detecting police radar traps. Do something tough like pulling in some difficult DX or building a home fire alarm, or whatever—but leave the cops alone. But, no matter, as a rule the Editors of Elementary Electronics do not supply diagrams or plans. There are just too many readers requesting this service and too few hours to answer the mail.

QRM in NYC

I own a Lloyds 5-band MB/AM/FM aviational police receiver. Please tell me how I can improve reception between 108 and 175 MHz. My antenna pulls in too much QRM. Can you help me?

—T.G.O., New York, N.Y.

Also living in New York, we know what you mean. In the first place, there are too many signals on the air in New York for a tunable receiver to operate without intermodulation interference. For good reception, you need a professional-grade receiver plus an array of filters, which is an expensive set-up.

Future Yard Bird

I have an 11-transistor Wards Airline transceiver Model 62-574 which runs on CB channel 11 and is a 100MW transceiver, is there a way to increase the range by increasing the watts?

—F.L., Oakland CA

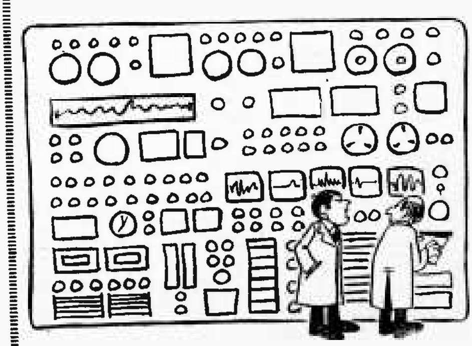
Sure, you may be able to increase your range to the nearest federal prison if you fool around with the transmitter section of your rig. The Editors suggest you pick up a copy of the 1972 CB Yearbook if you are interested in more than 100 milliwatts on channel 11.

Wrong Track

I have heard that Geiger counters operate on the microwave frequencies. Is this true? I would like to know because I am interested in constructing a radio telescope. I would also like to know where a Geiger tube can be obtained?

—K.C., Somers CT

Nope, it's not true. Geiger counters detect and count high velocity particles and rays passing through the Geiger tube. Check your local library for the facts. If you are seriously interested in radio telescopes, I suggest you become acquainted with them by reading books before you proceed with construction. ■



"Look here, Rockingham, solid-state LSI circuits or not, 5+5 is not 13!"

Elocktron

Continued from page 42

of "electric door openers," nearly all of which will work from 4, 12, 24 or 48 VDC. The "reverse-action" types are normally unlocked, and lock only when activated. Trine electric door openers are list-priced from $12.75 to $68, depending on type, metal (brass or aluminum) and finish. Trine also makes a *pusher spring*, which is a simple spring-loaded plunger that pushes the door open when the latch is released. This is often used in apartment-house front doors, because a caller may not have his hand on the doorknob at the moment the latch is released. The effect is spooky if you're not used to it, but Trine says there's a drawback. If the caller doesn't shut the door firmly, it may not close completely because of the spring pressure against it, and so the door can then be pushed open by anybody. But if you do want a pusher spring, try your hardware store, which may also stock some of the other accessories that can be added, such as chimes, or a pushbutton for operating the Elocktron from inside the house at a distance from the door. There's even a silicon rectifier unit from Trine, at $21.35 list, for silent operation of the opener. It's important if you want to sneak in yourself.

Magic. Once you've got the Elocktron assembled and working, you can impress friends and neighbors by making the door open as if by magic. Just don't let them see the electronic key. Hide it in your hand, or in a box or package. Bring it to the right place on the power circuit's front panel, and the door will mysteriously unlock, seemingly all by itself! ■

DX Central Reporting

Continued from page 22

the various stations on the air.

There are two publications that should help, Ralph. One is EE's sister magazine, COMMUNICATIONS WORLD, published twice a year and containing *White's Radio Log*. This includes a list of many shortwave stations currently being logged in North America.

The second is the DXer's "Bible," *World Radio TV Handbook*, published annually in Denmark and distributed here by Gilfer Associates, Inc., Box 239, Park Ridge, New Jersey 07656.

The spotlight falls this month on NASWA, the North American SW Association, an all-shortwave broadcast type club headquartered at Altoona, Pennsylvania.

NASWA's jumbo-sized monthly bulletin is filled with up-to-date shortwave data, logging tips, QSLing information and feature articles submitted by some of America's sharpest SWBC DXers. But NASWA is more than that. Its bulletin is called "Frendx," a reference to its motto, "Unity and Friendship," and its personal approach to the hobby makes both veteran listeners and newcomers feel at home.

If you'd like to see a sample copy of Frendx, or if you're ready to join now, fill in the form above and mail it directly to NASWA, not to Elementary Electronics. ■

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Box 989
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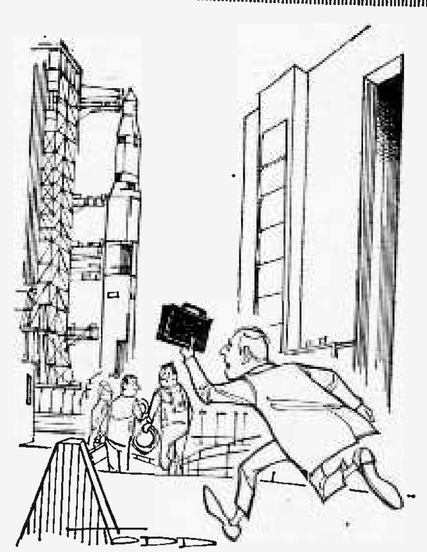

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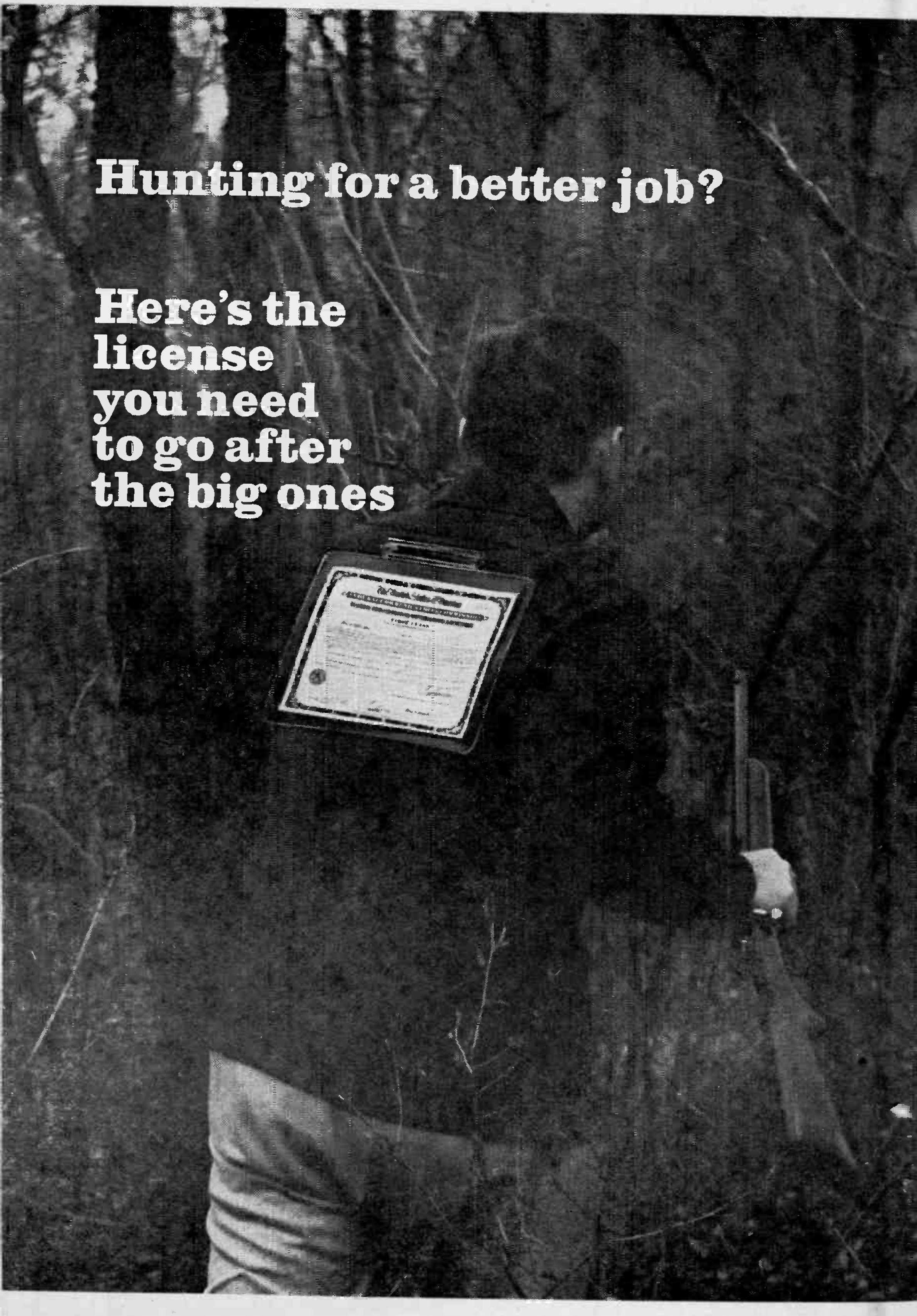
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CIRCLE NO. 1 ON PAGE 17

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CIRCLE NO. 16 ON PAGE 17