

2 Great Burglar Alarm Projects for Your Home

MARCH-APRIL
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Plus...

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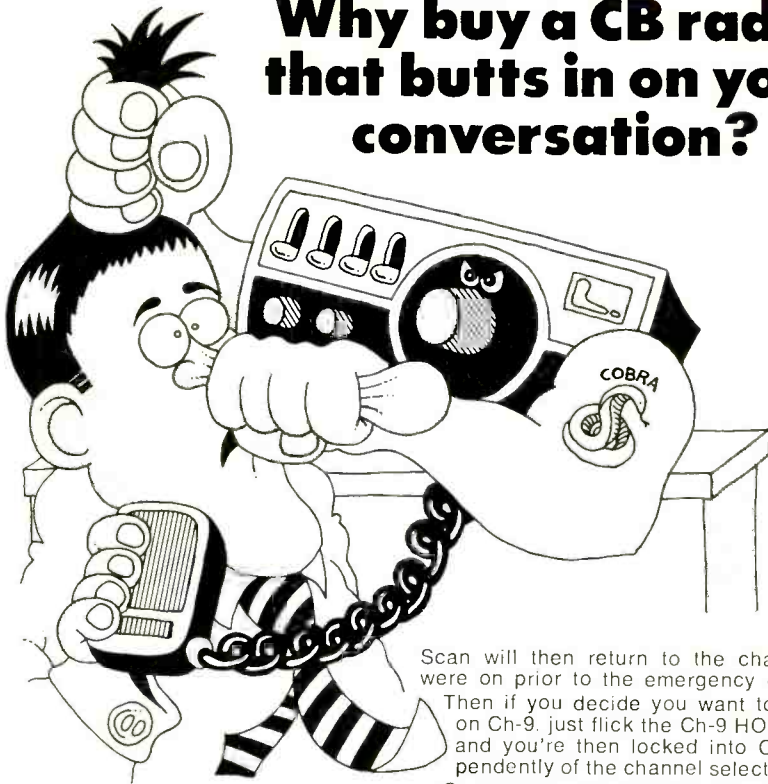
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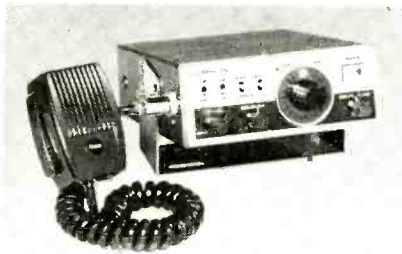
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MARCH-APRIL, 1972



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★
Cover
Highlights



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Heicklen

AUTHORS IN THIS ISSUE

Webb Garrison, Charles Green, Joe and Myrtle Gronk, Don Jensen, Ernest Kehr, James E. Lockridge, Kathi Martin, Charles D. Rakes, Jack Schmidt, Hank Scott and the ELEMENTARY ELECTRONICS' editorial staff.



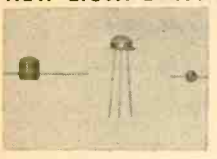


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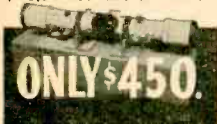


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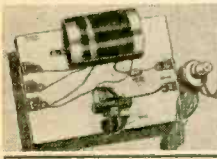


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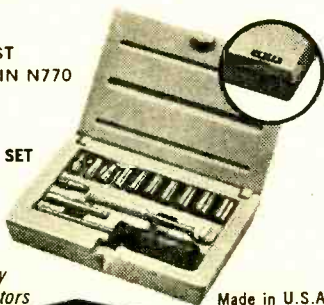
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March/April 1972 Vol. 12/No. 1
Dedicated to America's Electronics Hobbyists

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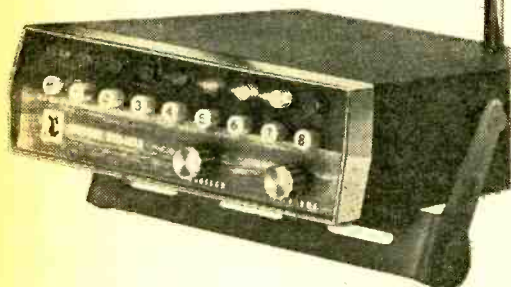


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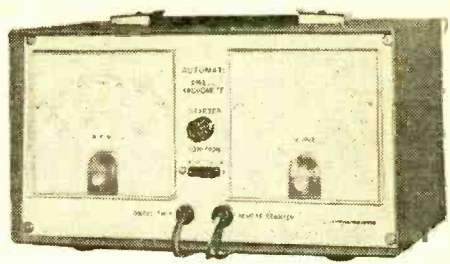
City

State Zip

CIRCLE NO. 11 ON PAGE 17 OR 103

HEY, LOOK ME OVER *****

Shack. This solid-state unit features two large 4½-inch double-jeweled D'Arsonval meters for simultaneous readings of engine speed and dwell angle. A built-in starter switch makes it possible



to start, stop or crank the engine from outside the vehicle. Meters read 0-3000 rpm and 0-45° on 8-cylinder engines, 0-4000 rpm and 0-60° on 6-cylinder engines and 0-6000 rpm and 0-90° on 4-cylinder engines. For 6, 12, or 24-volt electrical systems. Color-coded leads with insulated heavy-duty clips simplify connections. The Micronta Automatic Dwell Tachometer is priced at \$29.95 with complete instructions and tune up chart. Metal case, 11¼ x 5½ x 6. Available at Allied Radio Shack stores. For more information, circle No. 54 on Reader Service coupon on page 13 or 103.

Hot Tip

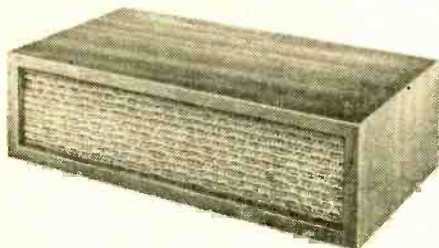
For hobbyists or professionals, Wen Products is now offering an all purpose Soldering Gun Kit, Model 222K25, in a compact, lightweight, unbreakable plastic carrying case to sell at \$7.95. This new soldering gun, with 20 assorted soldering lugs, fits in a protective custom-fitted case. Ready to take on hundreds of home soldering jobs, it is an equally effective tool for professional-type printed circuit work, wire splicing, TV, radio, appliance and other electrical repairs and industrial applications. The Model 222 Hot



 Rod Soldering Gun features exclusive Automatic Thermal Regulation, delivers up to 200 watts of heat power on a current draw of only 55 watts. For more information, circle No. 50 on Reader Service coupon on page 13 or 103.

Sonic Alarm

The new Protector electronic security system from Radatron Corporation is designed to protect the home or office from intruders. It incorporates the features of a sophisticated commercial ultra-sonic electronic security system while being small and economical enough to be used in the



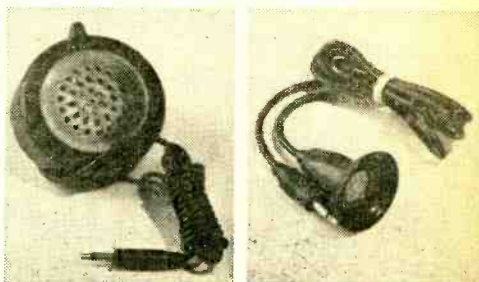
home or office. The Radatron Protector emits ultra-sonic waves which blanket an average sized room . . . about 300 square feet. Once an intruder enters the protected area, he breaks the wave pattern and triggers the alarm. Almost any type of alarm . . . sirens, lights, bells . . . can be easily attached to the Protector. In addition, a special accessory alarm circuitry permits the installation

of smoke, fire and gas detectors or peripheral alarm systems. The Protector looks like an ordinary table radio and its wood grain cabinet and handsome fabric front let it blend into any room decor.

The Radatron Protector comes fully assembled and a full line of accessories are available through Radatron dealers. For more information, circle No. 43 on Reader Service coupon on page 13 or 103.

Phone Pickups

Two new low-impedance magnetic telephone pickups have been added to GC Electronics Audiotech line. The telephone pickups are designed to be used with the majority of today's transistor tape recorders and amplification devices. One pickup, designated catalog number



*the tape that
 turned the
 cassette into
 a high-fidelity
 medium*



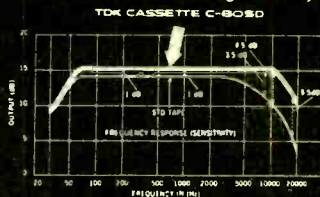
TDK SUPER DYNAMIC (SD) TAPE



TDK

Until TDK developed *gamma ferric oxide*, cassette recorders were fine for taping lectures, conferences, verbal memos and family fun—but not for serious high fidelity.

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The new magnetic oxide used in TDK Super Dynamic tape distinctively differs from standard formulations in such important properties as coercive force, hysteresis-loop squareness, average particle length (only 0.4 micron!) and particle width/length ratio. These add up to meaningful performance differences: response capability from 30 to 20,000 Hz, drastically reduced background hiss, higher output level, decreased distortion and expanded dynamic range. In response alone, there's about 4 to 10 db more output in the region above 10,000 Hz—and this is immediately evident on any cassette recorder, including older types not designed for high performance. There's a difference in clarity and crispness you can hear.

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TDK ELECTRONICS CORP.

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CIRCLE NO. 5 ON PAGE 17 OR 103

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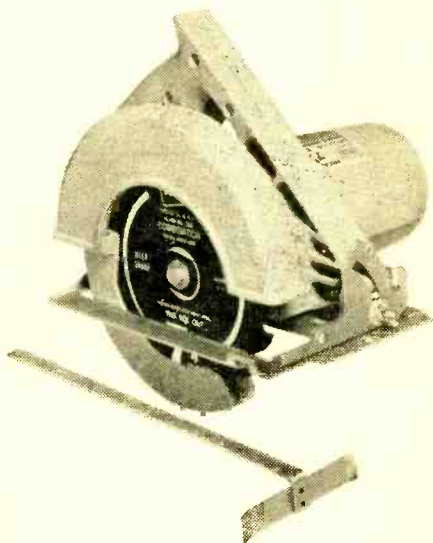
CIRCLE NO. 10 ON PAGE 17 OR 103

HEY, LOOK ME OVER★★★★

30-6000, is a conventional suction-cup-type unit and may be attached wherever there is a reasonably strong magnetic field present in the telephone—at the top of the handset or adjacent to the coil block on the side of the telephone base. The pickup retails for \$2.45. The deluxe model pickup, catalog number 30-6002, slips over the earpiece of the telephone handset. Because the unit is molded to slip over the earpiece with a glove-tight fit, there is no "wrong" position for it, and it minimizes extraneous noise pickup. The price of this pickup is \$2.90. Both units terminate in a miniature phone plug and will fit almost all battery tape recorders. Audiotex products are sold by authorized high fidelity dealers, record, department and chain stores. For more information, circle No. 47 on Reader Service coupon on page 13 or 103.

Buzz Off

Wen will introduce this new 7¼-inch Circular Saw, Model 961 at the National Hardware Show that'll help you build your next speaker cabinet or work-bench. It's double insulated with a 2 HP motor—powerful and rugged yet light at only 8 lbs. The saw also features a rigid shoe plate



and fine balance, to help the professional or amateur saw a straight line. Other features are: safety-sured, shock-proof, hi-impact bright-red housing; powerful 11 A 2-HP motor, 5100 RPM—permanently lubricated bearings; extra safe slip clutch; and calibrated rip fence. Priced at \$29.95. For more information, circle No. 49 on Reader Service coupon on page 13 or 103.

And 2 More Make 4

A new space saving speaker system in a convenient thin-line configuration is the Criterion W4—a thin-line 3-speaker system with unique "drone cone". Its no-compromise design utilizes a "drone cone" which reinforces and increases the low frequency capabilities normally minimized

(Continued on page 92)

stamp shack

Philatronics Today!

BY ERNEST A. KEHR

●● The introduction of sophisticated electronic equipment has enabled mankind to communicate with his neighbors more easily and rapidly. And as a plus, scientific wizardry has been harnessed to give him more effective information about the world in which he lives. This has been particularly conspicuous in the realm of weather forecasting. On Oct. 29, 1971, Portugal released three special, dramatic stamps to commemorate the silver jubilee of its National Meteorological Service, which was created in 1946, to "use the highly useful science for information as a benefit to industry, agriculture, commerce, aerial and sea navigation, hydraulic engineering, military operations, health service and tourism."

● The one-escudo denomination depicts a terrestrial shack housing recording instruments



Portugal
National
Meteorological
Service
Silver Jubilee



and topped by an anemometer, wind-direction indicator and barometer, set against a background of a chart with its graphic imprinted oscillographs.

● A four-escudo features balloon with its sonde released into the upper air to probe wind force, pressure and other pertinent data. The background of this stamp is formed by a weather map with its isobars and meteorological markings.

● Last is a 6½-escudo that depicts a weather satellite floating through the far reaches of space against a map of the Atlantic showing the Iberian peninsula with dots indicating

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CIRCLE NO. 4 ON PAGE 17 OR 103

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CIRCLE NO. 9 ON PAGE 17 OR 103

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TG-34 KEYS: Code practice set used to reproduce signals previously recorded on inked paper tape. Variable speed motor, keying oscillator with speaker & phone jack. Power required: 115 V. 50/60 cyc. Comes in portable carrying case: 15 x 10 x 10".

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| #7 7WPM Numbers & letters | #12 15WPM Tact/Mess. |
| #8 10WPM Coded Groups of 5 | #13 15WPM Tact/Mess. |
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CIRCLE NO. 6 ON PAGE 17 OR 103

STAMP SHACK

Portugal's stations at Lisbon, Oporto and Funchal on which a Satellite cloud photograph is superimposed.

● The trio was designed by architect Luis Chaves, and was printed in multicolor at the National Mint, at Lisbon.

● The need to accompany the development of the meteorological science in theory and application led to the creation of modern weather services within the Ministries of War, Navy, Colonies and Aviation. This dissemination among organisms whose main purposes are totally different militated against those technical and administrative considerations which must be respected to guarantee an efficient and economically viable meteorological service. More recently, with the development of civil aviation, the defects of the immediate past have been overcome.

● Portugal is spread all over the map, for while its base is in Europe, other provinces (they never are called, colonies) are in East and West Africa, in the Atlantic, and in Eastern Asia. This necessitates the maintenance of weather stations in each of the several wide geographical regions for complete national coverage. This has been effected by standardization of techniques, working methods, coordination of supervision and the close cooperation of universities and other relevant bodies.

● In 1946, Portugal's weather services were exclusively local and often haphazard. The decree which established the NMS was intended to replace these with a highly integrated operation placed directly under the Ministry of State and then, the Ministry of Communications. It began on Aug. 3, with Dr. Herculano Amorim Ferreira, then Professor of Physics of Lisbon University's Faculty of Sciences and the Infante Luis Geophysical Institute, as its first director general. He retired only in 1965.

● At first it relied on traditional scientific equipment, but as the launching and orbiting of Space Satellites were developed by the United States, Portugal became an integral part of the Universal Meteorological Union, using the weather satellites and exchanging weather data with other national organizations for their and its own advantage.

●● The East German Postal Administration marked the 1971 Leipzig Trade Fair with a pair of stamps whose designs focus attention on the land's advanced communications equipment. Most of the time, this Fair was only generally commemorated with stamps. Sometimes, specific products made in the Communist Zone were highlighted in an effort to attract foreign customers' interest. It is obvious, then, that East Germany now has developed communications instrument production to a point where it is looking for export business around

the world. The 10-pfenning denomination shows a push-button telephone handset against a background of central office switchboard panels. The 15-pfenning shows a TV-and-radio-telephone antenna, and a transformer required for this wireless means of transmitting vocal messages over long distances.

●● From Melbourne, which has embarked on a rather ambitious stamp-issuing binge to increase its profitable sales to collectors abroad,

East German 1971
Leipzig Trade Fair



comes word that the Postmaster General, Sir Alan Hulme, authorized a special postage stamp which will commemorate the 50th anniversary of the first regular radio broadcasting in Australia.

● He didn't say what design would be used for the proposed stamp, but Sir Alan stressed that it would symbolize his commonwealth's role "in the development of radio transmitting, especially during its introduction."

● What's New?

In its effort to more profitably cultivate business, the Postal Service in Washington, has embarked upon an ambitious philatelic program. In addition to hiring a large staff for its own Philatelic Bureau, Postmaster General Winton Blount commissioned a marketing research office to survey the possibilities of what gimmick ideas could be introduced to sell more stamps to the public, and an advertising agency to stimulate sales.

He began by authorizing the printing of large posters, on each of which a variety of domestic stamps of the past and present are printed in full color. These were intended as decorative items for collector's dens and dealers' shops. Obviously it proved successful, for a press release states that 135,000 were sold and that an additional 80,000 were being readied. And at \$1.50 each, that's not a bad beginning.

Also announced was the preparation of packets of different contemporary commemorative stamps that would be sold at post offices as potential gifts which customers could give to collector friends at Christmas time.

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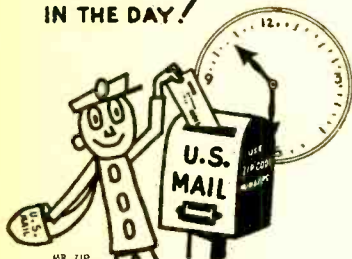
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CIRCLE NO. 22 ON PAGE 17 OR 103

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YOUR POSTMASTER

DX central reporting

A world of SWL info!

By Don Jensen

THE PIRATES have landed. The brand of buccaneers I'm talking about are those mini-watt, unlicensed and thoroughly illegal broadcasting stations that have cropped up all around the country.

Show me any metropolitan area and I'll show you a pirate haven for a handful or more of these illicit broadcasters. Sure, the FCC catches most of them eventually, but by that time, new ones have cropped up to take their places.

A lot of them are operated by high school and college-age guys just because this, "Gee, gang, I'm a deejay too" bit is fun. Others apparently are more serious attempts to slap the establishment that controls radio broadcasting in the U.S.

They've flourished largely because of the availability of reasonably priced equipment which can be used to broadcast, often with few modifications, and because of the relatively high level of electronic know-how among students today.

Most of these pirate stations are low powered and their potential audiences, willing or unwilling, are few because of limited transmitting ranges. But a few manage to get out hundreds of miles. And so, for a while at least, they exist, pumping out their own brand of broadcasting, sophomoric or sophisticated, on the medium-wave AM band.

Perhaps more interesting to the SWL, however, are the relative handful of illegal short-wave pirates.

The first of these to attract much attention was WBBH, which broadcast for several months back in 1967 on 4,970 kHz. The station claimed on the air to be operated by students of the Courtland School of Music in New Brunswick, N.J., and broadcast classical music "for the discriminating shortwave listener."

Boldly, the pirate operation announced its address, a post office box, asked for reception reports and promised a QSL card to those writing in.

The station was heard for several hundred miles up and down the Atlantic coast, and true to its word, it answered listeners reports with a printed QSL card bearing the WBBH call.

(Continued on page 22)

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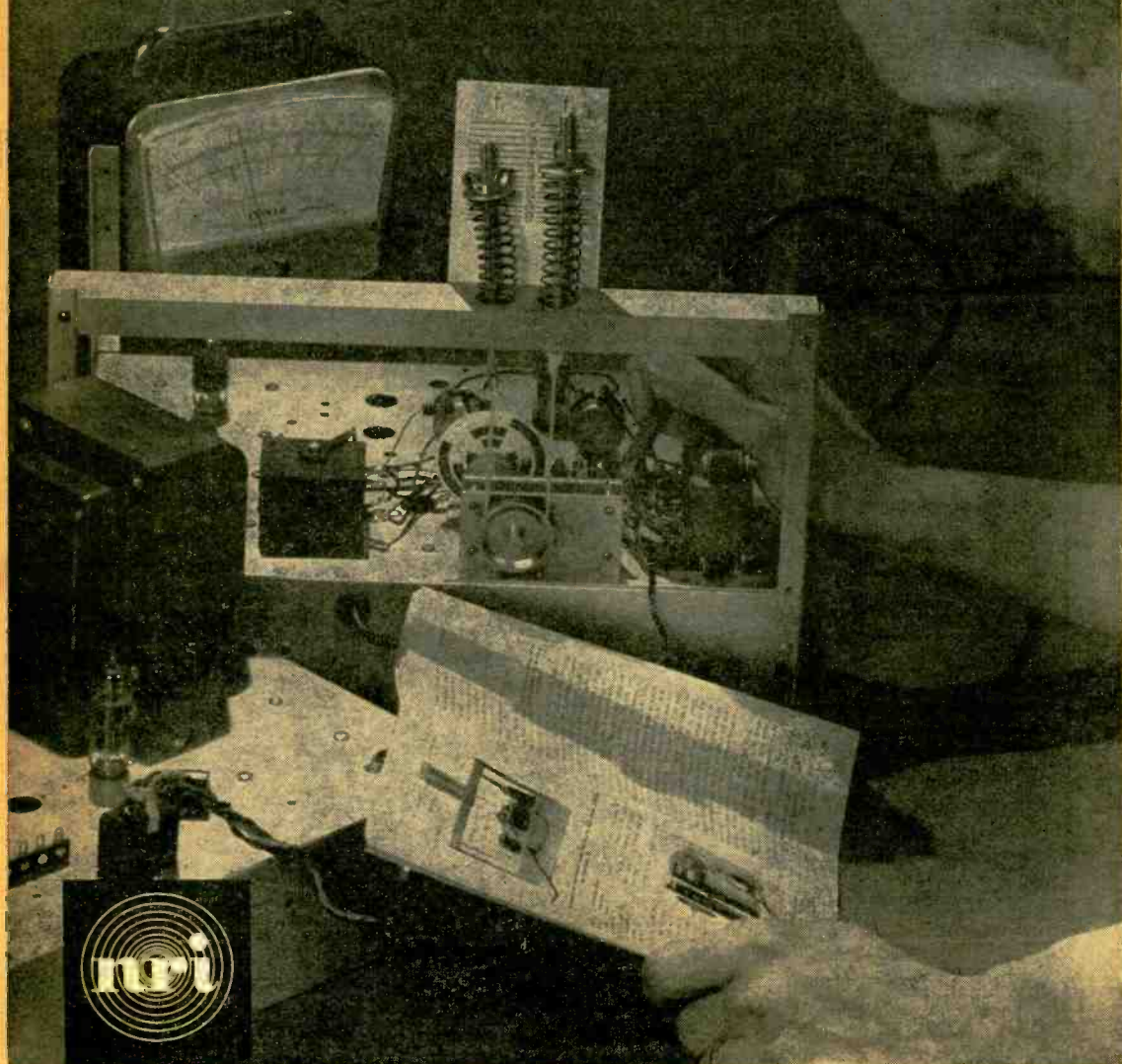
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*You must pass your FCC License exams (any Communications course) or NRI refunds in full the tuition you have paid.

DX Central Reporting

(Continued from page 16)

Then the FCC stepped in. Direction finders pinpointed the transmitting spot and a knock on a door interrupted a classical concert. WBBH's two young operators got a stern official warning letter and they promptly retired from broadcasting. (They got off lightly. Two young men from Yonkers recently were hauled into federal court to answer charges of illegal broadcasting.)

One of the most curious pirate tales involves WJMS, also called, believe it or not, The Voice of the Purple Pumpkin. It appeared on various spots on the shortwave dial, but most recently in the 41-meter band, since around 1965.

Though federal officials are somewhat reluctant to discuss their pirate nabbing activities, it is believed that the FCC located the original operator and warned him of the penalties for illicit broadcasting.

But still the Purple Pumpkin's broadcasts continued sporadically over the years. Since the station received some publicity in various radio magazines, it may well be that the more recent incarnations have been the work of other persons who merely glommed onto the catchy, well-known name. At any rate, it seems that WJMS always has broadcast from the Chesapeake Bay area.

Only last October, DXer Steven Martin of Upper Marlboro, Md., caught the Purple Pumpkin's act on 7,150 kHz one Saturday afternoon.

As Steve tells it, the unknown, but obviously youthful announcer was waxing enthusiastic about EE's sister publication, COMMUNICATIONS WORLD, but had some putdown words for one of our competitors.

And to scotch any rumors in advance, no, we don't advertise on pirate stations!

About the same time, but some 35kHz down the dial, here at DX Central we tuned another pirate shortwaver, this one calling itself WRVU, Radio Voice of the Underground.

Programming was typical of many of the unlicensed operations, plenty of rock music, wacky antics such as a kazoo playing contest and requests for reports. WRVU announced the address of its "QSL manager," who apparently lives in a small, upstate Illinois town. But unlike its predecessor, WBBH, the Radio Voice of the Underground failed to reply to a letter sent to the announced address.

DX Central, by the way, neither condones nor condemns these illegal broadcasting activities. Generally their operators know they're playing with fire and the FCC knows its job in tracking them down. But while they're around, however briefly, SW DXers will be tuning for these mysterious shortwave voices.

Tiptopper. By the time you read this, hopefully, Radio Nederland's new shortwave relay station on the island of Madagascar in the

Indian Ocean will be on the air. For many SWBC listeners, the new station will put an additional country—the Malagasy Republic—in their logbooks.

Planning for the facility, which will relay programs produced in Holland to Africa, South Asia, Australia and Indonesia, began in 1967, with the official go-ahead given the following year.

According to Radio Nederland's H. Van Gelder, the relay consists of twin digital controlled 300 kilowatt Phillips shortwave transmitters, which can be coupled to pump out a mighty 600 kw. The signal is fed into the antenna system; there are 13 self-supporting antennas, some as tall as 330 feet, to choose from.

The relay station, staffed by nine Europeans and 25 Malagasy personnel, is located just six miles northeast of Malagasy's capital, Tananarive. The transmitter site itself is a few miles north of that. Programs are received via point-to-point link with the Netherlands, similar to a system used by Radio Netherlands' other relay facility on Bonaire in the West Indies.

Initially, broadcasts will be aired between 1230 and 2130 GMT, but the full operation is not expected until April when final antenna adjustments have been completed.

Some tentative frequencies have been announced in the 11, 15, 17 and 21 MHz areas. They may be changed, however, as tests progress. Besides, considering the power you shouldn't have much difficulty in finding the station and the hunt can be half the fun of logging a new one. (Continued on page 95)



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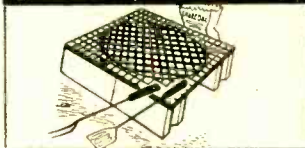
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Bad Image

Why is it that I receive several local radio stations on other than their assigned frequencies with my 200 kHz to 30 mHz Brand "X" receiver? One operating on 1580 kHz, for example, can be heard at about 670 kHz and at other frequencies. I am told this is spurious radiation. Is this true?

—E.V., Jackson Miss.

It is unlikely that spurious radiation is the cause if more than one station can be heard at two or more frequencies. It is more likely due to inadequate "image" rejection in your receiver. If your receiver has a 455-kHz IF amplifier, the local oscillator is tuned to 1125 kHz when the tuning dial is set to 670 kHz. It is the 1590-kHz signal getting through to the mixer, beating with the 1125-kHz local oscillator signal, that causes a 455-kHz IF signal to be produced, just the same as when the dial is set to 1580 kHz and your local oscillator operates at 2045 kHz to produce a 455-kHz IF signal, except that the received signal is weaker.

Since you are experiencing this with several stations, a signal, fixed tuned wave trap at the antenna won't do. Try shortening your antenna in order to reduce pick-up of the strong broadcast signals. Your set has an antenna trimmer which you should be able to attenuate the unwanted image signal and accentuate signals at the frequency to which the dial is tuned.

Would You Believe—220th Harmonic

I can't hear the local FM weather station on 162.55 MHz because my local station

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**

WVLN, 740 on the dial, rides right in blocking the weather forecast.

—W.A.S., Olney IL

Your trouble may be one of location. I don't believe the 219th or 200th harmonic of WVLN will jam your FM hi-band receiver unless you are very close to the station's antenna. The Midland unit you are using, is a good one. Why not pull up stakes and test the rig at another site to prove to yourself the trouble is your location and not the rig.

Bags of Wind

Every now and then I come across a strange station on around 20.5 MHz and on about 13.5 MHz. The station monotonously plays a long interval signal which resembles bagpipes. At first I thought the station could have been an international broadcaster, but after playing the quick, cut-short music for almost 2 hours straight, I am convinced it could be some utility station. Could you help me?

—D.M.B., Easichester NY

Clearly, it is a utility station, not an international broadcaster. But, frankly, I don't know its identity or location. My best guess is that it is an overseas telephone station, probably commercial and the "bagpipes" is a "marker"

signal used to keep the circuit open when there's no traffic. If you asked about a similar type signal played on a horn, I'd say Paris. But "bagpipes" is a new one for me. I've caught something similar at times with weird collections of electronic tones, but I can't identify that either.

With some specific times mentioned I might at least speculated on the general area of the world, based on propagational factors. If anyone can help, please write.

Making Waves

Why do radio signals travel farther over water than land?

—M.K., Washington DC

If the world were a polished metal sphere and the air a perfect insulator, then a signal leaving an antenna would travel close to the surface of the sphere all the way around the surface with almost no loss of power. A radio signal traveling over water sees a low resistance surface. This resistance is much lower than the solid surface of earth. Hence, the signal will go farther over water than land. Land surface offers a high resistance and limits the distance a radio wave can travel

(Continued on page 85)

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25

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Electronics in the News!

IT'S HOW YOU LOOK AT IT!

In its efforts to remove hazards from a patient's hospital room, Sylvania has come up with its new REFLECTA-VISION hospital entertainment system designed to eliminate cross-wiring on floors and across doorways, or attaching TV sets to hospital beds. The system, which attaches to a wall behind hospital beds, provides a reverse image picture which is viewed by the patient via a safety mirror suspended on a lightweight retractable arm. For ambulatory patients, the system contains a switch which converts the picture for normal TV viewing. The rear-wall mounted REFLECTA-VISION system is out of the way and provides flexibility for the patient, as well as doctors and nurses. A remote pillow speaker, containing all TV controls and a nurse call button, allows the patient maximum convenience.

Many hospitals were constructed before the advent of TV. Therefore, no provisions were made for installation of antenna, distribution



The Reflecta-Vision system, which attaches to the wall behind hospital beds, provides a reverse image picture which is viewed by the patient via a safety mirror suspended on a lightweight retractable arm.

cables, and related wiring. As a result, over the years various systems have evolved which either required long cords, or in the case of TV's mounted directly on or over the bed, wiring strung along the bed frame or on swinging arms over the patient's head. Each system contained potential hazards. The Reflecta-Vision system can be installed, serviced, and maintained without cost to hospitals by Sylvania's Hospital Service Division, with a percentage of the revenue derived from patient rentals returned to participating hospitals monthly.

WHAT A RING IT WILL MAKE

Precious jewel lovers throughout the world marvel at the new world's record for growing what is believed to be the largest single crystal of synthetic sapphire in the world. Weighing in at 28,000 carats (12- $\frac{1}{3}$ pounds), the op-



Sapphire weighing 28,000 carats is believed to be the largest such crystal ever manufactured.

tical-quality sapphire crystal is as clear as glass. The crystal's maximum diameter is 3- $\frac{1}{2}$ inches and has a useable length of 8 inches.

Manufactured at San Diego, Calif. by Union Carbide, the large crystal will be used for precision optical components after being fabricated with diamond saws and diamond polishing techniques. Sapphire is widely used in military research and industrial applications.

Sapphire, the single crystal form of aluminum oxide, melts at 3722 degrees F. A special electrically-heated furnace is required to melt the aluminum oxide raw material contained in a

(Continued on page 97)



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 groovy 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 bargains.
64. A pamphlet from Electra details the 6 models of the Bearcat III, a scanning monitor receiver.
65. Dynascan's new B&K catalog features test equipment for industrial labs, schools, and TV servicing.
66. Before you build from scratch, check the Fair Radio Sales latest catalog for surplus gear.
67. Hallicrafters' literature features new SR-400A, "Cyclone III", 550 watts P.E.P., SSB/CW, 5 band transceiver for OM or YL amateur.
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. A fully illustrated brochure from Midland gives readers a look at their new, complete line of radio monitoring receivers and CB transceivers.
73. The MONitor antennas—keys to superior reception—are available from Antenna Specialists in their catalog.
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. You can do all kinds of jobs with Xcelite's new 19-piece midget reversible ratchet offset screwdriver set and 5-piece pocket kit.
78. Troubleshooting without test gear? Get with it—let Accurate Instrument clue you in on some great buys for your test bench.
79. Keep up-to-date on latest electronics bargains with Burstein-Applebee's '72 catalog and supplements.
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 short wave 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's 1972 Electronic Equipment Catalog features all-new 4-channel quadraphonic stereo equipment. The 92-pages include exclusive audio equipment.
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. Radio monitoring enthusiasts. "You're in on the action" with Petersen monitors. Send for catalog having full descriptions of VHF and UHF models.
89. Avanti's catalog describes and illustrates their complete line—mobile base CB antennas many others.
90. A new free catalog is available from McGee Radio. It contains electronic products bargains.
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—chock-full of gadgets and goodies everyone would want to own.
93. E. F. Johnson's 1972 line of CB transceivers and CB accessory equipment is featured in a new all-line brochure. Send for your free copy today.
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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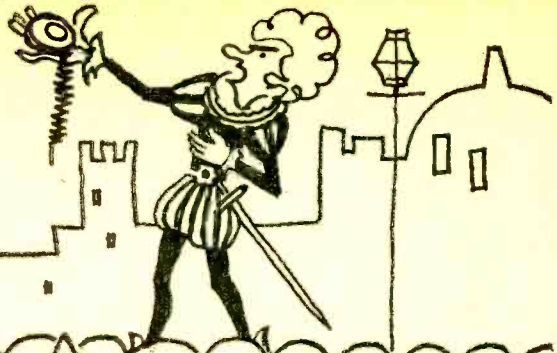
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3-4/72



CB or not CB

by Jack Schmidt



"Oh, that! It has something to do with antenna height..."



"No, Dear, I didn't damage the radio."



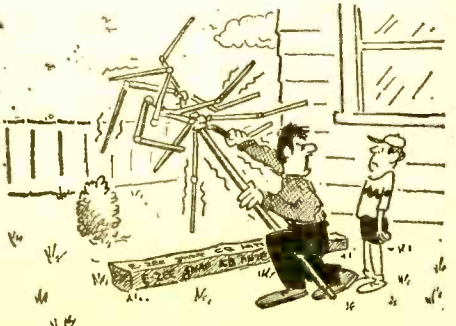
"Quit complaining, there's plenty of room in the back seat!"



"Single sideband!"



"Okay, I'll bring home the pizza, but don't call me on this freq again."



"No, it's not a ring toss game. It's an easy-to-assemble CB antenna!"



Music-Music-Music

Try Our SCA Adaptor On for Size, Sound, and Cost

by Charles Green, W6FFQ

WHAT does a corner supermarket, a friendly dentist's office or your local hash-house have in common?

Remember when you switched from AM to FM to duck an ack-ack barrage of commercials that drove you up the wall—only to find you were followed!

Well, here's a project-solution for hobbyists that has this common denominator: "music without commercials." The same quiet background music found in offices and shopping centers can be yours, for private non commercial use, with our Music-Music-Music SCA adaptor.

Phase Locked Loop (PLL) SCA multiplex adapters have become widely accepted in the last year or so. But those of you with PPL

(Turn page)



e/e SCA ADAPTER

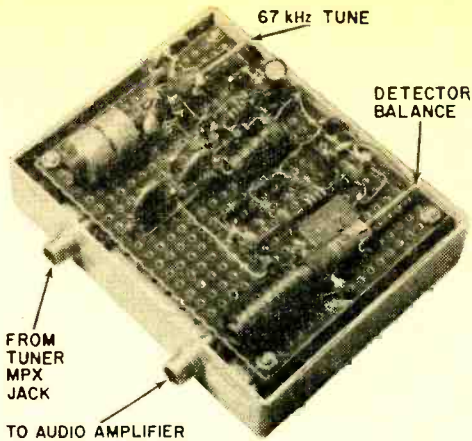
experience know that distortion can be a problem. The loop seems to lose its "lock" on a subcarrier with heavy modulation. No such problem with our unit. The simple amplifier-discriminator approach keeps distortion and cost down.

An SCA background music program is usually a carefully chosen mixture of popular tunes and older semi-classical favorites. It is transmitted around the clock by FM broadcast stations in many cities in the USA. But you can't hear this background music with your standard FM receiver because the background music is transmitted via a 67 kHz subcarrier piggy-back on the normal FM program.

The background music is transmitted under an FCC Subsidiary Communications Authorization, or SCA for short. This SCA background music is used by subscribers who pay a fee to the music service enterprises that supply special SCA receivers. But you can listen in to an SCA broadcast—as long as you do not use it in a public place for the entertainment of others.

You can experiment with SCA reception by building our simplified SCA adapter unit. It can be used with an FM tuner that has a detector MPX (multiplex) output. The SCA adapter unit connects between the MPX output and the input of your audio amplifier.

Our SCA adapter uses an insulated-gate

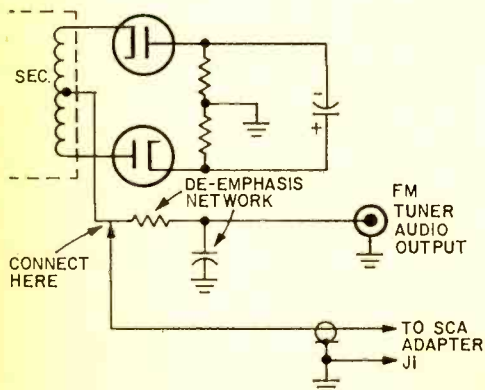


Only two TV-replacement type inductors and a standard 2.5 mH RF choke are used with a MOSFET and some R'nC components

field effect transistor and two matched germanium diodes in a no-frill, simplified, rf amplifier and FM detector circuit. Perf-board construction is used for easy building and the components are housed in a compact Radio Shack P-Box. An external 9-volt battery or DC power supply is required to operate the SCA adapter unit.

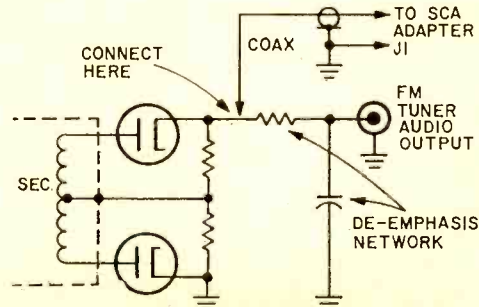
How-it-Works. The 67 kHz frequency-modulated subcarrier (from the FM tuner multiplex output) is fed into J1 and tuned by L1-C2. Q1 amplifies the 67 kHz signal, which is then coupled from the capacitive divider of C5-C6 to the series tuned circuit of L2-C9. D1 and D2 detect the 67 kHz signal as follows.

At center frequency (zero frequency deviation), the detected signal voltages across L2-C9 are equal and opposite in polarity. Therefore, the resultant detected output is zero. As the modulated signal



SIMPLIFIED RATIO DETECTOR

Tuners, receivers without MPX output jack provision require simple modification shown above. Important point to remember is—connect a MPX adapter before de-emphasis network. Typically, it is an RC circuit whose time constant (TC-RC) is around 75 usec. (A 75,000-ohm resistor with a 0.001 μ F capacitor equals 75 usec.)



SIMPLIFIED DISCRIMINATOR

frequency deviates to a higher frequency, the reactance of C9 decreases (lowering the D2 detected voltage) and the reactance of L2 increases (increasing the D1 detected voltage). As the modulated signal frequency deviates to a lower frequency, the L2 and C9 reactances change in the opposite direction. Therefore, there is a resultant detected output voltage across R6-R7 that is fed to a low pass filter (R5-C10) that connects to J2 and the external audio amplifier.

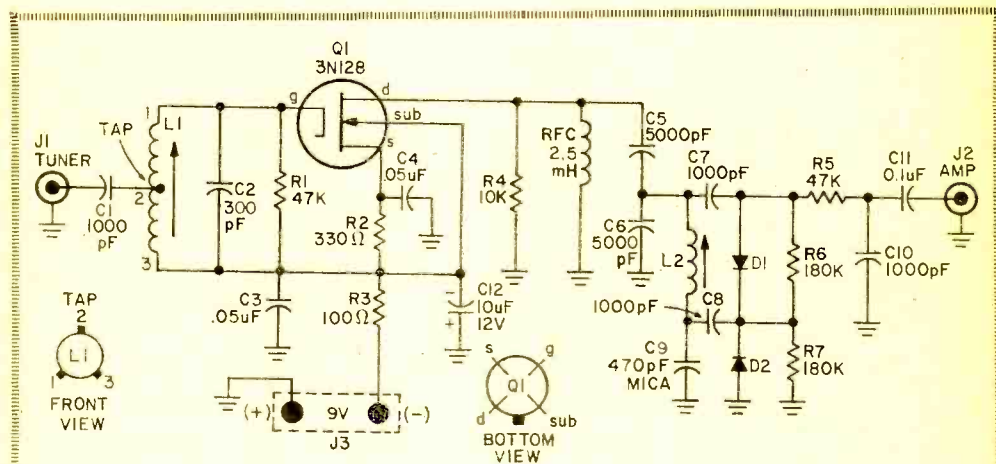
Construction. The SCA Adapter is built in a 3 $\frac{3}{8}$ -in. wide x 1 $\frac{1}{2}$ -in. high x 4 $\frac{5}{8}$ -in. long plastic box. But any other type of plastic or metal box can be used as long as the components are placed in the same relative position as in our model. Follow our component layout photo on the next page for best results.

The components are mounted with push-in clips on one side of a 4 $\frac{1}{4}$ -in. x 3 $\frac{1}{4}$ -in. section of perf-board; J1, J2 and J3 are mounted on the box sides. Best way to start construction is to cut the perf-board

to size and drill corner mounting holes.

Layout and mount the components as shown in the photo. L1 and L2 are installed with short lengths of bus wire connected to push-in clips near the perf-board ends. Position L1 and L2 as close as possible to the board to minimize movement. Do not remove the shorting wire around the leads of Q1 until all board wiring is completed. Wire the remaining components, keeping the leads as short and direct as possible. We wired our unit with No. 22 bus wire and used insulated tubing as necessary to prevent shorts. Mount J1 and J2 on front of the plastic box, and mount J3 at the rear of the box. Connect leads to J1, J2, and J3, and then mount the perf-board in the box with $\frac{3}{4}$ -in. spacers. Complete wiring and then remove the shorting wire from Q1.

Applying Screwdriver Drift. Connect a 9-volt battery or a DC power supply to J3, and connect a signal generator to J1. Adjust the signal generator controls for a 67 kHz unmodulated output. Connect a



PARTS LIST FOR SCA ADAPTER

- C1, C7, C8, C10—1000 pF, 12-volt ceramic disc capacitor
- C2—300 pF, 12-volt ceramic disc capacitor
- C3, C4—.05 uF, 12-volt ceramic disc capacitor
- C5, C6—5000 pF, 12-volt ceramic disc capacitor
- C9—470 pF, mica capacitor
- C11—.1 uF, 12-volt ceramic disc
- C12—10 uF, 12-volt, electrolytic capacitor
- D1, D2—Matched germanium diodes (Sylvania ECG-110 or equiv., similar to IN541 or IN542 or Motorola HEP-134)
- J1, J2—Phono jacks
- J3—Dual, screw type terminal strip
- L1—12 to 40 mh, tapped adjustable inductance (J. W. Miller 9016)

- L2—4 to 30 mH, adjustable inductance (J. W. Miller 6315)
- Q1—3N128 insulated gate field effect transistor (RCA)
- R1, R5—47,000-ohms, 1/2-watt resistor, 10%
- R2—330-ohms, 1/2-watt resistor, 10%
- R3—100-ohms, 1/2-watt resistor, 10%
- R4—10,000-ohms, 1/2-watt resistor, 10%
- R6, R7—180,000-ohms, 1/2-watt resistor, 10%
- RFC—2.5 mH, rf choke (J. W. Miller 6302)
- Misc.—Perf-board and push-in clips, plastic box 3 $\frac{3}{8}$ W x 1 $\frac{1}{2}$ H x 4 $\frac{5}{8}$ L-in. (Radio Shack P-Box, 270-105), $\frac{3}{4}$ -in spacers, 9-volt battery.

e/e SCA ADAPTER

VTVM (set to a low DC volts range) probe to the junction of R6-R7 and D1-D2 cathodes. Connect the VTVM common lead to the J3 (+) lead (common ground).

Adjust L1 for maximum DC voltage indication, and then connect the VTVM probe to the junction of R5-C10 and C11. Adjust L2 for a zero center (0-voltage) VTVM indication. Disconnect the VTVM and signal generator from the adapter.

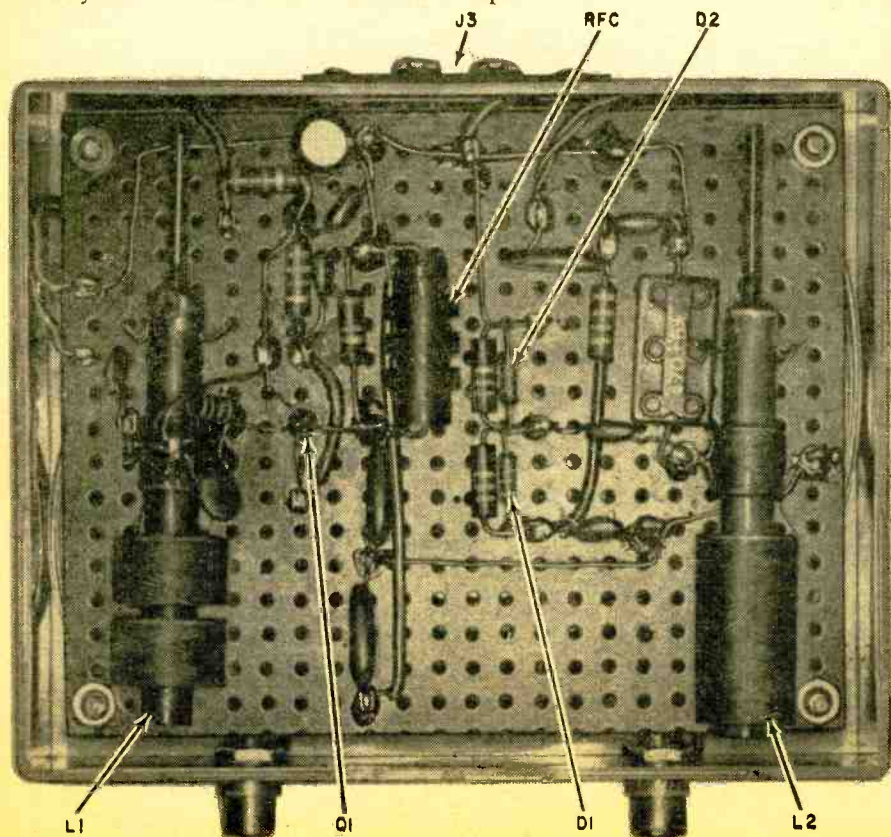
Make Tuner Connection. If your FM tuner does not have a multiplex output jack, but does have a wideband ratio or discriminator detector, connect the SCA adapter unit ahead of the FM tuner de-emphasis network. See the typical simplified detector circuit schematics for connection details.

Connect J1 to your FM tuner (MPX output) with coaxial cable (RG-58 or equiv.), and connect J2 to your audio amplifier. Tune the FM receiver until you hear an FM station broadcasting an SCA program. Since your signal generator 67 kHz may not be as accurate as the FM

station 67 kHz subcarrier, the adapter L1 may require peaking for maximum output, and L2 may require readjustment for best sound quality. This adjustment may be done by ear, or by connecting a VTVM to the adapter and repeating the alignment procedure using the FM subcarrier in place of the signal generator.

For best reception, a good quality low-drift FM tuner and a good antenna are necessary. The adapter will work best with strong local broadcasts. Careful tuning is necessary for good reception. The higher audio frequencies are not transmitted on the narrow 67 kHz subcarrier, so adjust the treble control on your audio amplifier for minimum background noise.


A moderate audio output permits this adapter to be used with the AUX, TUNER or TAPE inputs of your amplifier. If you have an unused magnetic phono input with a separate level control, try connecting your unit to it. The RIAA equalization provides a softer background sound by cutting the high and boosting the bass. You will have to adjust the level control though, since the adaptor output can overload this type of input. ■



ELECTRONICS BATTLES THE HAILSTORM

That bolt in the blue may blow your fuse
and a lemon-size hailstone can kill you too!

by Webb Garrison



EARTH'S turbulent atmosphere is plagued with many different kinds of destructive storms. Some of the more familiar types are tornadoes, hurricanes, blizzards, typhoons, and hailstorms.

Atmospheric scientists of the 70's are giving hailstorms more attention than any of the others. Research has been under way for several years. Now all-out war on hailstorms has been declared in

HAILSTORMS

the U.S., Canada, the Soviet Union, France, Italy, and even in tropical Kenya.

Why the sudden interest in hailstorms?

Stepped-up activity makes the scientific assault seem sudden; actually, for centuries men have dreamed of escaping the onslaughts of this atmospheric foe. Tradition says that wandering tribesmen of the near-east shot arrows at hailstorms more than three thousand years ago. Late in the fifteenth century Leonardo da Vinci considered using artillery to shoot down hailstorms, but never got around to putting the idea to test.

Using sophisticated electronic equipment and employing silver iodide or a similar substance as a weapon, hail fighters are now taking the bite out of some potentially destructive storms.

This is only a beginning. In order to make real progress, we must know a great deal more about hail: how it is formed, and why. Better understanding of still-unknown basic forces is the goal of current probes by the Joint Hail Research Project. This cooperative hail season program is pulled together each summer by the Environmental Science Services Administration (ESSA), Colorado State University (CSU), and the National Center for Atmospheric Research (NCAR). All three organizations participate on an equal basis.

It Takes all Kinds of Hail to Make a Storm



A research assistant separates recently collected hailstones in a mobile "cold room" built into a trailer.

Would you believe . . . a collection of hailstones? You're absolutely right. It does sound like a yarn from the pages of Jules Verne or H. G. Wells. But it's a sober fact of science rather than a tale from science-fiction: Dr. and Mrs. Charles A. Knight have a huge collection of hailstones. They keep 'em in cold storage, of course. With the collaboration of professionals and amateurs throughout the nation they have gathered more than 500 especially interesting specimens.

How in the world does anyone go about assembling such a collection? The Knights collect their hailstones in a variety of ways. They usually begin when they hear a report on the radio or television about a severe hailstorm. As soon as possible, they telephone persons in towns where the storm struck. Often they talk to the sheriff or the justice of the peace and ask him to get some of the hailstones that fell in his area into a freezer as soon as possible.

Specimens secured in this fashion are supplemented by others secured through professional chan-

Directed from the Greeley, Colorado, radar facilities of NCAR, this year's research is centering on probing hailstorms with radar, aircraft, and dropsondes with the hope of learning more about the structure and behavior of storms.

This much is certain: a hailstorm involves unbelievably complex and large-scale reactions within an atmospheric cell.

General outlines of the cell and its behavior are fairly clear. Precise details are fuzzy.

Where Hail Comes From. Thunderheads, or cumulonimbus clouds that may reach ten miles above our planet's surface, are the chief source of hail. But two apparently identical thunderheads may produce quite different effects. One discharges rain, while

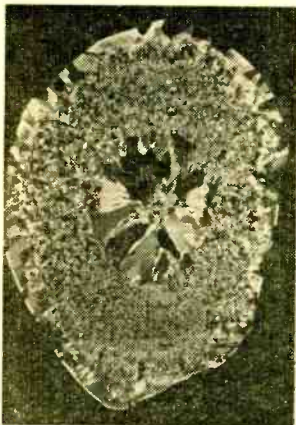
the other buffets the earth with hail.

Specialists are at loss to account for the difference. About the best that can be said is that "the essential factor for hail formation is a critical combination of updraft velocity and temperature within the storm."

Dr. Helmut K. Weickmann of ESSA compares the behavior of a hailstorm with that of a runaway locomotive. Updrafts produce condensation, which releases heat, which strengthens the updrafts, which produces more condensation . . . in a cycle that becomes increasingly rapid.

Individual cells develop, drop their destructive pellets, then wane away. Meanwhile other cells are forming. Complex feedback effects create a build-up, or chain reaction. Throughout the life of a hailstorm

nels. Lots of meteorologists in the U. S. know of the Knights' special interest. Occasionally one of them happens to be in an area where a storm drops big quantities of hail. When that happens he tries to get specimens and



Cross Section of a hailstone.



Hailstone with five fingers.

keep them in good condition.

Most hailstones will remain intact for a day or two in an ordinary cooler chest chilled with dry ice.

As a husband-and-wife scientific team, Charles and Nancy Knight regard the hailstone collection of which they're custodians as intensely interesting. Photographed under polarized light, a cross-section of a hailstone is shown to be almost unbelievably intricate. According to the 34-year-old ice scientist, "We have yet to learn why one thunderstorm will produce hail and another seemingly identical nothing but rain."

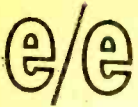
All hailstones—even the most pudgy ones—are believed to tumble to some extent. Fresh layers of water gathered during this process quickly freeze. Tumbling seems to diminish as stones become increasingly oblate. Some big ones apparently fall most of the time with their short, or minor, axes vertical. Air seems to force spongy ice on the upstream face of the stone toward its sides; there it hardens, and the difference between breadth and height increases.

If the precise forces that operate to give particular hailstones their characteristic shapes are still largely unknown, the electrical forces involved in formation of hail are beginning to be understood.

Sparks actually appear, as raindrops with relatively high charges converge. Great numbers of microdischarges plus charge transfers below the sparking mode probably contribute to development of high electrostatic fields in thunderstorms. Some such thunderstorms—but not all of them—yield hail. Seen in cross-section, many hailstones have rings almost as distinct as those of a tree trunk.

Some layers of ice may be crystal-clear, while others are so full of air bubbles that they are opaque. Variations in electrical environment during growth periods may contribute to this state of affairs.

Regardless of electrical, thermal, and other forces that enter into their formation, there's no debate on one matter. A real whopper of a hailstorm—not one of your run-of-the-mill pellet producers—is never forgotten by a person caught in it. ■



HAILSTORMS

total energy involved greatly *exceeds* that of our biggest atomic bombs.

Uneven heating of the atmosphere creates convection currents powered by thermal energy. A column of rising air is often measured in cubic miles rather than cubic yards; it may be two or three miles in diameter and eight or ten miles high.

Water carried upward by such a column begins to condense. As more and more vapor gathers to form cloud droplets, great quantities of energy are released. This energy leads to acceleration of updrafts in the central "chimney."

When this cyclical process has been in operation for a time, the updraft may be so violent that air pulled into the atmospheric "cell" involves millions of tons per minute.

Especially on muggy days, the amount of water transported by this system is stagger-

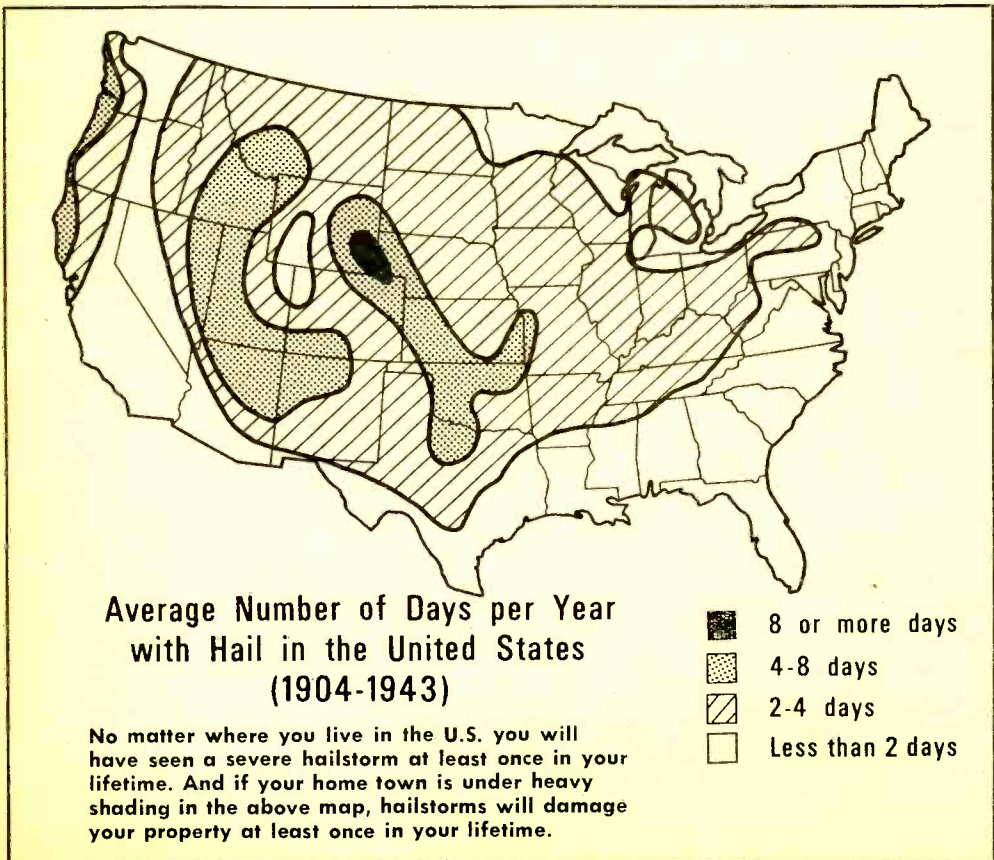
ing. An atmospheric scientist has estimated that a medium-size hailstorm—not one of your truly big ones—draws to itself a volume of water equivalent to half or two-thirds the flow over Niagara Falls.

The Electronics of It. Electrical processes within the vast cell are beginning to be understood.

Each droplet is charged. When two drops with sufficient charge difference converge, sparks appear between them. Sparks have been observed even in the case of drops as small as 8×10^{-3} cm radius. Great numbers of microdischarges, says NCAR program scientist J. Doyne Sartor, can have significant effects on both growth of high electrostatic fields and separation of charge in thunderstorms.

Positive and negative charges are in continuous process of separation. When the potential gradient becomes high enough to cause a large-scale discharge the stage is set for one of nature's grandest displays: lightning.

With lightning blasting now at a nearby



cloud, again at the ground below, the hailstorm continues to gather momentum. Eventually the point of no return is reached: the system has pulled into itself more water than it can hold.

It's What at Top that Counts. By now, though, much or all of the water is five to ten miles above the earth. Energy from airborne droplets is transferred to supercooled clouds when water undergoes a change of state—turning into ice. Such released energy accelerates the process of cloud-building.

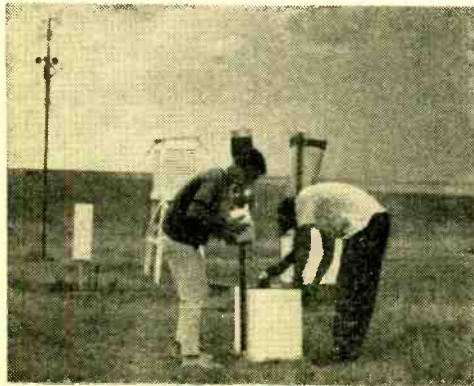
Whatever its size or shape when it reaches the ground, each hailstone starts as a small ice crystal. Transported upward and downward with the cell that produced them, crystals actually "grow." Onion-like layers—ten, twelve, occasionally as many as twenty-four—are added. Eventually the weight of the hailstone exceeds the ability of the updraft to hold it up. When tens of thousands of stones reach this point within a short time, ice plummets from the sky in vast quantities. A hail volume of several million tons per hour is not unusual.

Typical city dwellers regard hail as a petty annoyance. Actually, in the U.S. its annual toll is in the range of 200 to 300 million dollars.

Tornadoes get more publicity, but do less damage to crops and property.

Hail Everyone. In spite of the fact that the region roughly centered around the point where Colorado, Nebraska, and Wyoming join is famous as "Hail Alley," Americans have no monopoly on ice from the sky.

Russia gets at least its share of damaging hail—maybe more than its share. The Kericho area of Kenya in East Africa experiences about 200 days per year with

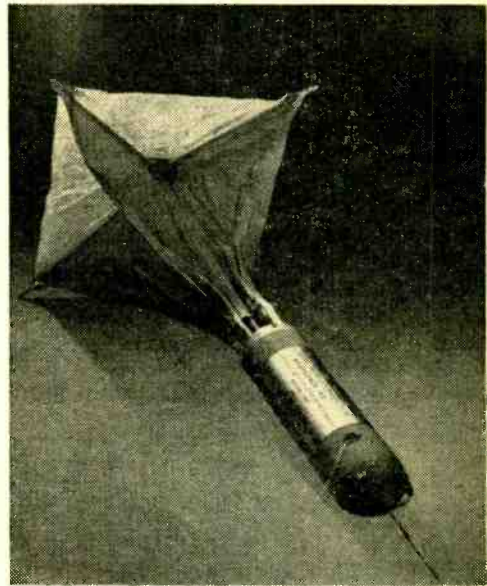


Members of a field crew drop dry ice in a "hail catcher" which is designed to collect and freeze falling hailstones.

thunderstorms—more than 85 percent of which produce hail at some time in their life cycles. Since tea is the chief crop and its leaves are fragile, economic impact of hail is enormous. Canada, Switzerland, France, Italy, and England are often pounded by stones of various sizes.

About 99 per cent of all pellets have a diameter well under one inch when they reach the ground. Some are much bigger.

During a storm at Potter, Nebraska, on July 6, 1928, one icy missile practically buried itself in the ground. Druggist J. J. Norcross dug it up, measured it at 17" in circumference. By the time he got it to his



Hailstorm data is supplemented by the use of numbered dropsondes which are radiosondes dropped by high-flying aircraft.

scales, the hailstone still weighed 1½ pounds—the biggest authentic find in the U.S.

Much smaller stones—say, about the size of a lemon—can be lethal. There's just one recorded instance of death from hail in the U.S., but in other lands the toll has been much greater.

Scripture is the authority for the fact that in an ancient battle more Canaanites were killed by hailstones than by swords of Israelites (Joshua 10:11). Even though Jehovah was credited with having thrown the hail, the account sounds like a patriotic yarn—until you check the actual scores from some more recent storms.

Stones no bigger than the eggs of a hen killed six children in Romania in 1928.

e/e HAILSTORMS

Chunks of ice produced by a single storm killed nineteen natives of the Transvaal in 1936. Half a century earlier, on April 30, 1888, hail claimed the lives of 246 victims in Moradabad, India. So the next time you find yourself under a thunderhead, it might be a good idea to take cover.

Radar Probes! Operators of early PPI radarscopes found it difficult or impossible to distinguish between hail echos and echos from thundershowers in which only rain was present. Still, radar was helpful in paving the way toward elementary understanding of some aspects of hail formation.

Years before radar was perfected, Gustav Mie proposed "the Mie theory." That was in 1908. It proved valid in a variety of situations where electromagnetic waves are scattered by spherical particles. In the period just after World War II, electronic analysis of back-scattering from dry and wet ice spheres at the University of Arizona showed the Mie theory to apply to hail.

Dr. William Swinbank, who heads the National Hail Research Experiment group at NCAR, says that a hailstone of given size returns to the radar receiver about one-fifth

of the power returned by a raindrop of the same size.

As soon as the hailstone begins to melt, the scattered power increases rapidly. A hailstone covered by a thin layer of water is 90 per cent as effective a back-scattering agent as a water drop of the same size.

According to Dr. Swinbank, this factor makes it difficult to distinguish between a water drop and a hailstone of comparable size by means of radar.

As a result, under "ideal" conditions (a minimum of water on hailstones) radar remains a valuable but uncertain tool with which to probe for the presence of hail in the making.

Successful "seeding" of hailstorms with silver iodide causes super-cooled water to crystallize and fall before pellets become destructively large. This technique, now being used on a world-wide basis, has led to Russian claims of more than 70 per cent reduction in hail damage in the Caucasus. These reports haven't been authenticated by western observers. Even if they had, it wouldn't mean that hailstorms are licked.

Ultimate triumph over this most devastating foe of farmers and hot-house operators will come only by the route of greater knowledge concerning electrical and thermal processes. ■



Dr. Guy Goyer of NCAR and George Fisher of CSU man the radar scope seeking hailstorm data.

We dare you to take the...

CB IQ QUIZ

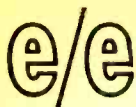
Prove to the Editor that you know and understand the Citizens Band Rules and Regulations and win a colorful CB IQ Genius Citation!

OKAY, so you've been on the CB channels since 1958. You've 10-4ed through six different base station rigs not to mention mobiles. Not once did the FCC ever send you a nasty note. Big deal! That still does not prove you know the FCC Rules and Regs, Part 95.

How'd you like to test your knowledge and win a CB IQ QSL from e/e? Man, we use up a lot of the alphabet in the last sentence, but what it means is **ELEMENTARY ELECTRONICS** will send you a congratulatory QSL card indicating that you successfully passed our Citizens Band IQ examination. No gimmicks, no fees, nothing much to do except take the test and if you get 36 to 40 correct answers, let us know about it by sending a letter with your score, a self-addressed, stamped business-size envelope and *the top of your friendly CB dealer*. It's that simple! Address all replies to: The Great CB IQ Quiz, **ELEMENTARY ELECTRONICS**, 229 Park Avenue South, New York, New York 10003. Sorry, no self-addressed, stamped envelope, no QSL. Your letter must be postmarked on or before May 31, 1972.

To take the test is simple. Just read the questions below and place a *T* or *F* in the adjacent boxes to indicate your answers—*True* or *False*. The answers to the quiz are on page 41. Numbers in brackets refer to the applicable section in Part 95, FCC Rules and Regulations. You should have a copy. If not, pick up an issue of the 1972 CB YEARBOOK





We Dare You to Take the CB IQ Quiz

for \$1.25 at your favorite newsstand or check with the FCC field office near you. They'll tell you how to get a copy of Part 95 for only \$2.00.

Scoring is by the honor system. *We trust you!* A score of 36 to 40 correct answers makes you a CB genius. 30 to 35 means you're fit to continue operating your CB rig but some homework is required. Below 30, yank the fuses from your rig and dig deep into Part 95 until you can pass this quiz.

Good luck and begin the quiz *now!*

- 1. Your Citizens Radio Service Class D station will be required to operate on authorized frequencies in the 26.96—27.26 MHz band.
- 2. An alien may hold a Class D Citizens Radio Service station license.
- 3. An individual must be 16 years of age or older to be eligible for a Class D radio license.
- 4. You may hold only one Class D station license.
- 5. You should mail your application for renewal of your Class D station license to the FCC in Washington, D.C.
- 6. Your station license renewal application should be sent to the FCC at least 60 days prior to the license expiration date.
- 7. Your FCC Class D station license will normally be issued for a period of 5 years.
- 8. If you want to add another transmitter (unit) to your network, thereby increasing the total number authorized by your license, you must first obtain FCC approval.
- 9. The top of your Class D station antenna must not be higher than 20 feet above the manmade structure on which it is mounted.
- 10. As used by the FCC, a "man-made structure" is any construction other than a tower, mast or pole.
- 11. The Class D radio channels that you may use for non-emergency communication with stations outside of your own network are Channels 10, 11, 12, 13, 14, 15 and 23.
- 12. You may use Channel 9 to render necessary assistance to a motorist.
- 13. You are not permitted to use Channel 9 for marine emergency traffic.
- 14. The Coast Guard has stated that it will not regularly monitor Channel 9.
- 15. Channel 9 may be used to report fires, automobile collisions or tornadoes.
- 16. You are not authorized to use tone signals on Class D radio channels.
- 17. If the FCC notifies you that one of your Class D transmitters is not operating properly, you must have a person holding an FCC first or second class commercial radio-telephone operators license make any required tests of or adjustments to the faulty transmitter.
- 18. You are permitted to contact another station for the purpose of requesting a confirmation (QSL) card.
- 19. You are not permitted to contact another Class D station for the sole purpose of asking for a report on how your new microphone sounds.
- 20. The FCC specifically prohibits your using obscene, indecent or profane words, language or meaning while you are transmitting.
- 21. You are permitted to charge a nominal fee for calls you make for others using your citizens radio station.
- 22. As a licensee, you are permitted to use your mobile station to make a general call to any station in the area able to provide you with routing directions or information concerning the availability of food and lodging.
- 23. You are not permitted to whistle into your microphone to attract the attention of the operator of another station.
- 24. If you use nationally or inter-

nationally recognized operating signals such as "10-4" or "QSL", in lieu of plain language, you must keep a list of such abbreviations and their meanings with your station records.

- 25. You are permitted to use your Class D station to contact a "skip" station 700 miles away if all you want is to obtain a signal report.
- 26. The FCC imposes no limit on the time you may use your Class D station to furnish emergency communications involving safety of life or the immediate protection of property.
- 27. Each user of a Citizens Radio Service unit is responsible to the FCC for its proper operation.
- 28. You may allow your employees to operate units of your citizens radio station.
- 29. You are permitted to install a unit of your Class D station on the premises of a telephone answering service to be used to contact any units of your station.
- 30. You are not permitted to be in continuous contact with another Class D station for a period longer than 5 minutes.
- 31. If you complete your contact with a Class D station in 2 minutes, you are then free to contact another station on the frequency immediately thereafter for an additional 3 minutes before you begin your required 5 minute silent period.
- 32. If you complete a 5 minute contact on Channel 11, you may switch immediately to Channel 13 and begin another 5 minute contact.
- 33. If you have just completed your 5 minute operating period and you receive a call from another Class D station, you are permitted to acknowledge the call and to request that the caller stand-by for the duration of your silent period.
- 34. The call sign of a citizens radio station consists of three letters followed by four numbers.
- 35. When you are making your final transmission of a series, you are not required to give the call sign of the station you have contacted.
- 36. You may file your Citizens Radio Service license with your other important papers or you may carry it with you in your wallet, if you wish.
- 37. A photocopy of your FCC station license need not be posted with each of your mobile units.
- 38. You are required to maintain a current copy of Part 95, Citizens Radio Service, FCC Rules and Regulations, with your station records.
- 39. You will not be permitted to operate your Class D mobile unit in states that border on Canada and Mexico.
- 40. You may operate your Class D station by remote control, if you wish.

(Turn page upside down for answers)

(Continued on page 104)

- 15. True. [95.41(d)(3)(Note)].
- 16. False. [95.47(d)]. Tone operated squelch and selective calling circuits used to establish or to maintain voice communications are permitted.
- 17. True. [95.53(c)].
- 18. False. [95.83(a)(1)(Note)]. Community calling with other licensees for the sole purpose of exchanging so-called "QSL" cards is prohibited.
- 19. True. [95.83(a)(1)(Note)].
- 20. True. [95.83(a)(3)].
- 21. False. [95.83(a)(4)]. You are not permitted to carry on communications for hire.
- 22. True. [95.83(a)(6)(iii)].
- 23. True. [95.83(a)(11)].
- 24. True. [95.83(a)(16)].
- 25. False. [95.83(b)]. A Class D station may not be used to call or communicate with any station located more than 150 miles away.

- 1. True. [95.3(b)] and [95.35(b)].
- 2. False. [95.7(a)] Neither an alien nor his representative may hold a Citizens Radio Service license.
- 3. False. [95.13(a)]. The minimum age for a license of a Class D radio station is 18 years.
- 4. True. [95.13(c)].
- 5. False. [95.15(b)]. Your renewal application should be submitted to the FCC office at 344 York Street, Gettysburg, Pa. 17325.
- 6. True. [95.15(c)].
- 7. True. [95.33].
- 8. True. [95.35(a)(1)].
- 9. True. [95.37(c)(2)].
- 10. True. [95.37(c)(Note)].
- 11. True. [95.41(d)(2)].
- 12. True. [95.41(d)(3)(Note)].
- 13. False. [95.41(d)(3)(Note)]. Although Channel 9 may be used for marine emergencies, it is not a substitute for the authorized marine distress system.
- 14. True. [95.41(d)(3)(Note)].

Answers to the CB IQ Quiz

Beat the Machine and... **WIN A DRIVER'S LICENSE**



NEVER driven a car? Fear not, you can still get a license *if* the computer approves. That's really about all there is to it. In Tacoma, Washington, a computer has taken over the testing and licensing of drivers with the use of simulators and push-buttons.

It is still a two-part test. But instead of a road test, you sit behind a simulator with all the necessary equipment and a motion picture screen (instead of a windshield). Filmed situations are flashed on the screen, and while you react the computer judges

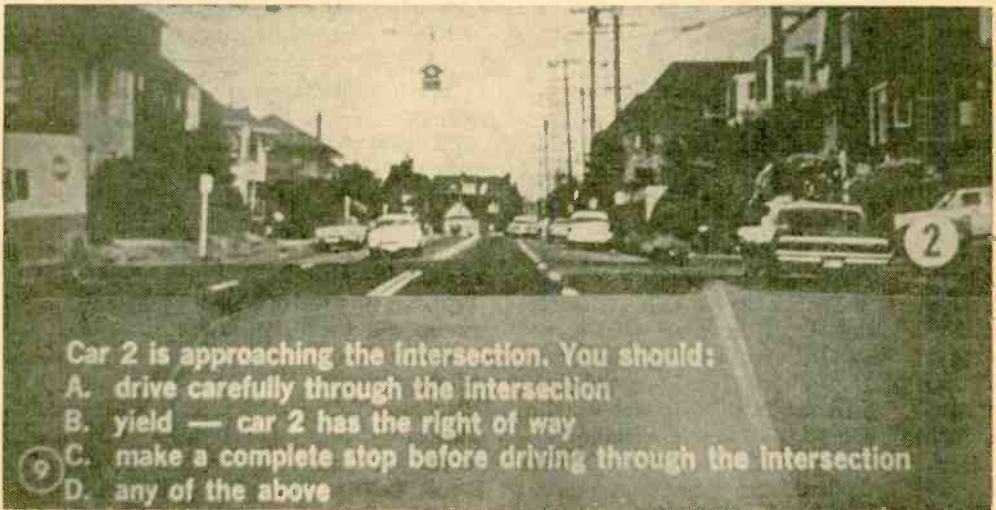
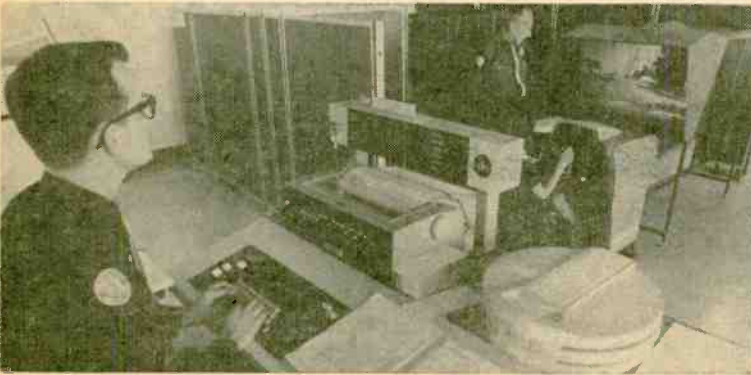
your performance. In many ways it's a better test of driver competence since it shows reactions to emergency situations, never previously tested—such as a child running out in a road. The written part consists of a multi-choice push-button test in which traffic situations are flashed on a screen with solutions listed below. The computer also rates these choices. But the irony in all this testing is that you can actually win a license if you've never driven a car, if you beat the machine! —Myrtle Gronk



During the first part of the test, the applicant is seated behind a simulator and told to drive (right). As the test proceeds, one officer monitors her performance, while another, seated on a raised platform (below), controls what sort of traffic situations this woman will have to handle.



Stage two of the test, the written part, is a multi-choice question-and-answer machine. It consists of a viewing screen showing motoring situations with a series of answers listed below. This closeup (below) shows a typical question presented to the applicant. All he must do is push the correct number button.

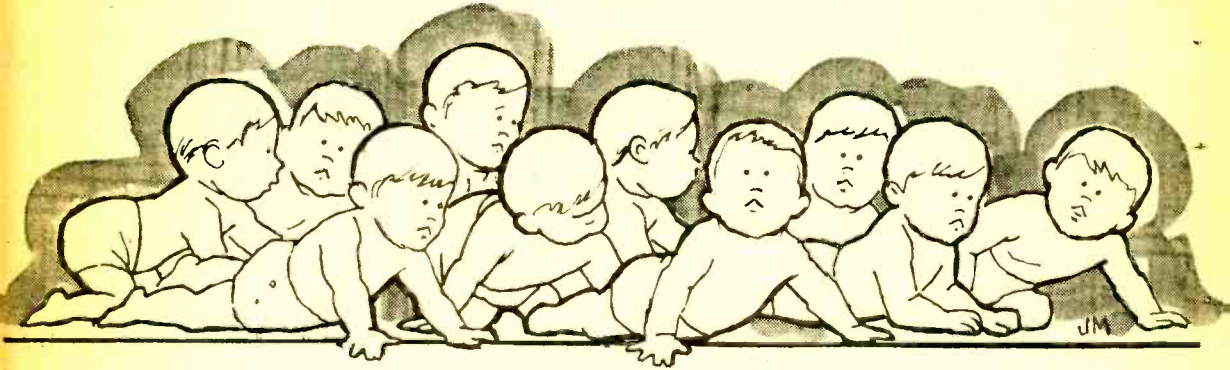


The use of these push-button machines (right) allows one instructor to test ten people at the same time. Once a driver has gone through these two stages, he finally arrives at the only personal part of this driving test (left). At this stage, he must answer a few last questions. And if all goes well here, he wins his license.



Diaper Snooper

It's time for a change



by James E. Lockridge

IT'S POKER NIGHT. The boys are at your house. You've just drawn your fourth King and, while your wife is playing bridge at the neighbors, you put on your best poker face to get ready for the kill.

Then the phone rings just as Junior starts screaming. The phone can wait, but what about Junior? If it's a wet diaper it can wait two or three minutes; Junior's done it before and besides, you can get him something nice with what four Kings can draw. What'll it be, Junior, the phone or four Kings?

Well, perhaps the problem would be simpler if Junior were equipped with a little gadget we call a Diaper Snooper. It's a remote radio moisture alarm that's fun, useful, and easy to build. It senses moisture and produces a tone on any FM radio tuned to its transmitting frequency. Or, if you want to indicate a remote occurrence, a minor *circuitectomy* turns the unit into a switch operated, remote radio alarm and reduces the already rock bottom cost of components. It is completely silent in operation and produces no electrical hazards such as shock, sparks, or heat build up. No relay is used, which contributes to keeping size and cost to a minimum, and it uses a very inexpensive FM transmitting module.

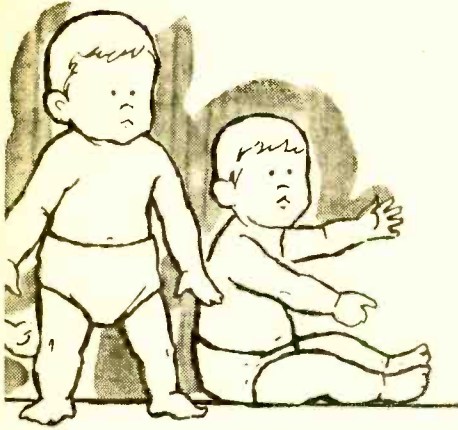
The Pink Pampers. Originally, this gadget was designed for use in baby's diapers. It's an excellent device for alerting a parent to wet diapers as soon as possible to prevent

diaper rash. It would be useful in initial potty training, in training older children with bed wetting problems, or with geriatric patients. One major advantage of its use with children or sick people is that the alarm is actually heard over the radio in another room.

The transmitter, limited in radiation to comply with FCC standards, will broadcast loud and clear about 300 feet. The more powerful the receiver, the longer the range and the louder the signal. By varying resistor R1 slightly from unit to unit, a different identifying tone would tell which one of a multi-unit installation was transmitting. Try changing R1 in 20 per cent steps; an increase will lower the tone.

Inside Story. The circuit is composed of four simple circuits working together. They are a DC amplifier, a UJT (unijunction transistor) relaxation oscillator, a voltage divider, and an FM transmitter module. A 9-volt battery was chosen because of its availability and compactness. The entire unit can easily be constructed in a space no larger than the battery, with the finished unit plus battery in a plastic box about the size of two batteries.

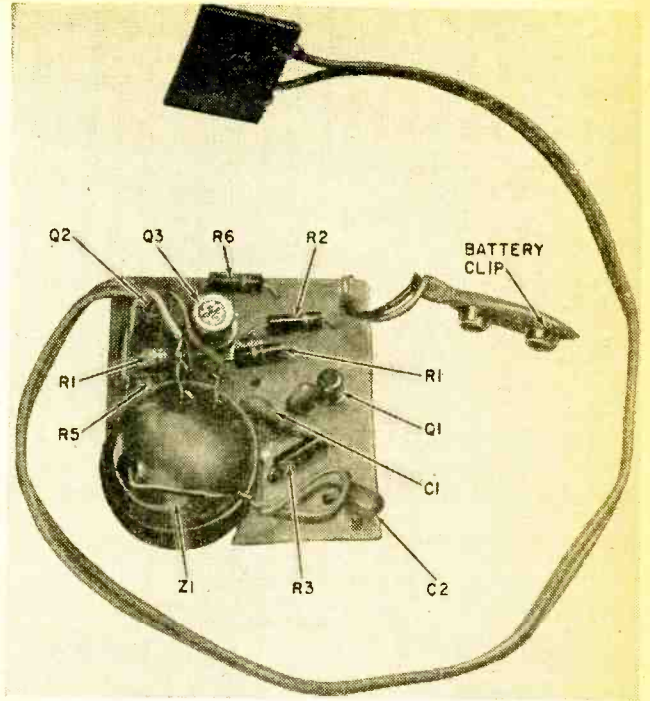
The first simple circuit is the moisture detector-DC amplifier. The moisture detector plate (WP1) is simply two conducting plates held close together, but not touching. You can buy the detector for a buck from a source noted in the Parts List or make one



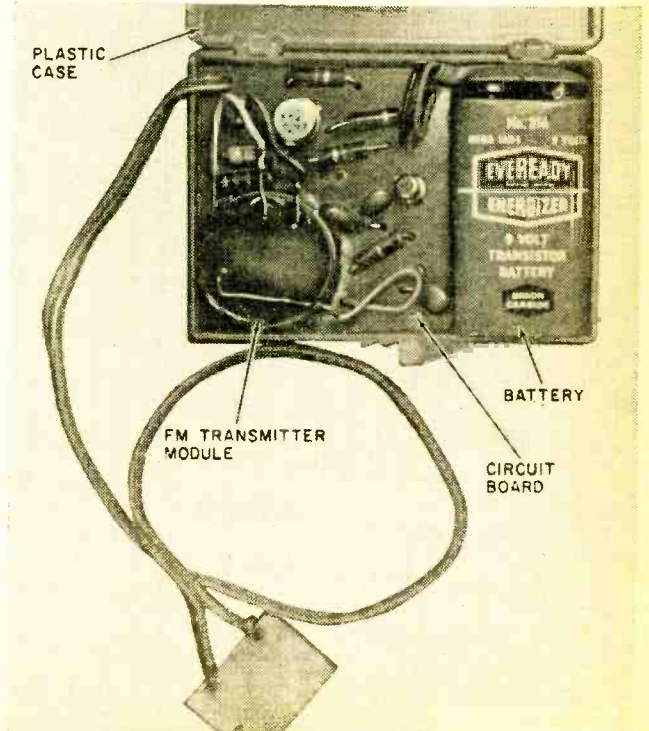
from a small (1-in. x 3/4-in.) piece of unused printed circuit board. Simply etch, cut or file a 1/32-in. groove down the middle of the plated side and connect a lead to each half.

When wet, some current is passed across the insulation and is amplified by Q2 and Q3. Resistor R6 protects Q2 and provides for better differentiation between wet and dry. When Q3 is forward biased by Q2, current is passed to two other simple circuits: the UJT relaxation oscillator and voltage divider. (The voltage divider provides the lower voltage required by the FM transmitter module.)

The heart of the oscillator is Q1, a unijunction transistor. An RC network consisting of R1 and C1 determines the audio frequency to be heard over the FM receiver. This frequency can be so low that separate, individual clicks are heard or it can be as high as you desire. Values given provide a pleasing "warning horn" tone. The output of this oscillator feeds through



Junior, upper left, points to completed snooper before installation in plastic case, below. FM module is seen in lower left of circuit board.



e/e DIAPER SNOOPER

C2 to the audio input (mike input) of a small FM transmitter module.

Low Cost FM. Let's go back to the front of the oscillator circuit now and pick up where the voltage divider circuit taps off. This circuit steps down the 9-volt battery voltage to the 1½-volts required by the FM module.

The FM wireless mike transmitter module is an amazing little gem available at the remarkably low price of \$2.98. Its performance is commendable, even for transmitting music. In our application, fidelity isn't important, but the potential is there. The module is a small, thick black plastic package with four wires protruding from one side. The wires are: the antenna (no connections here), the audio input (from the oscillator circuit), the power input (from the voltage divider circuit), and the common ground. The module transmits on an FM frequency around 95 MHz, but the frequency can be adjusted by changing the length of the short antenna wire or by placing a coin behind

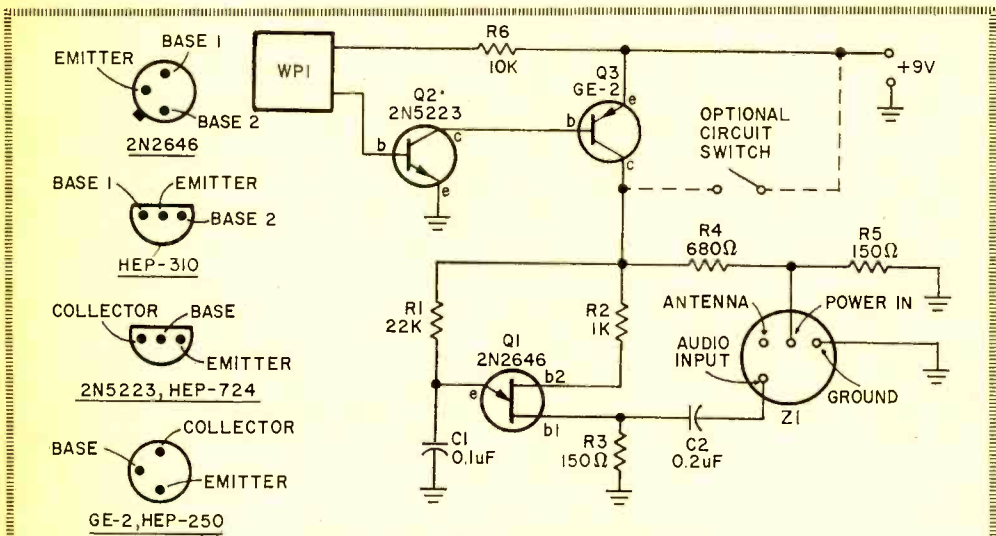
the module opposite the side the wires are on; instructions are included with the module. In use, consideration should be given to the fact that the capacitance of a thumb or hand on this side of the module will change the transmitting frequency slightly.

The 9-volt transistor radio battery lasts for many weeks if WP1 is wetted only occasionally. What leakage exists across Q3 with WP1 dry doesn't appear to affect battery life much. As battery life deteriorates after several weeks, simply turn the volume up on the receiver.

The *circuitectomy* referred to earlier for converting the unit to a switch operated remote radio alarm simply requires the replacement of the DC amplifier portion of the circuit (R6, WP1, Q2, Q3) with a switch of your choice: mercury, push-button, any kind will do; it depends on your application, needs, and imagination.

Catch 88-108. A good example of a potential application for the modified circuit would be a situation in which the writer found himself while stationed overseas. I was exasperated by the neighborhood hood-

(Continued on page 102)



PARTS LIST FOR DIAPER SNOOPER

- C1—0.1 uF, 12-VDC disc capacitor.
- C2—0.2 uF, 12-VDC disc capacitor.
- Z1—FM Wireless Microphone Transmitter Module (Lafayette Radio Cat. #19-55277, \$2.98)
- WP1—Moisture detector plate, see text (Science Fair Electronics, 2615 W. Seventh St., Ft. Worth, Texas 76107, \$1.00 each)
- Q1—Unijunction transistor, 2N2646, HEP-310 or equiv.
- Q2—NPN transistor, 2N5223, HEP-724 or equiv.

- Q3—PNP transistor, GE-2, HEP-250 or equiv.
- R1—22,000-ohm, ½-watt resistor, 10%
- R2—1,000-ohm, ½-watt resistor, 10%
- R3—150-ohm, ½-watt resistor, 10%
- R4—680-ohm, ½-watt resistor, 10%
- R5—150-ohm, ½-watt resistor, 10%
- R6—10,000-ohm, ½-watt resistor, 10%

Misc.—Perforated board, wire, solder, small plastic box (2x2½x1-in.), etc.

e/e
checks
out
a...



TEAC AN-180 Noise Reduction System

Your cassette recordings take on new fidelity with this Dolby B system

THE CASSETTE has come of age. While its age is nowhere near 21 (or even 18), like Topsy, "It just grewed." Today cassette tape machines are used in telephone answering devices, auto stereo installations, by kids in school taking electronic notes, by kids on the beach taking in the sun; even computers record digital data on cassettes. In the home, cassette recorders and playback units have taken a place in the stereo system as a quality sound-source.

A modern cassette recorder is perfectly able to turn out recordings that sound as good as the best of records, and as good as a tape made on a \$500 reel recorder. The only real difference in quality is the cassette's noise level—actually high frequency

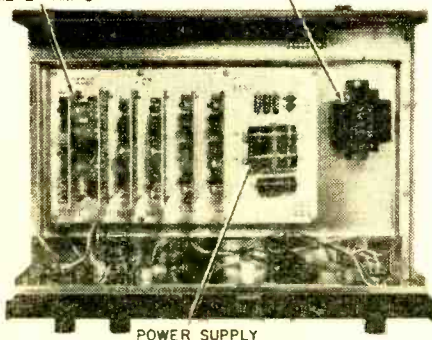
hiss; even on the best of cassette recorders the hiss is annoying. But all it takes to squash the hiss into the quiet background is a Dolby B amplifier such as the TEAC AN-180. Matter of fact, the AN-180 is so effective at squashing cassette hiss that you can actually dub from disc to cassette and not be able to tell which is which. Naturally, the AN-180 is just as effective with reel recorders, which start out with even less background hiss.

Down With Hiss. For those of you unfamiliar with the Dolby recording process, we'll take time out to explain. An engineer named Ray Dolby was searching for a way to make the master studio tape so quiet there would be no trace of hiss in the final record which is made from the master tape. Since the only way to reduce existing high frequency hiss was to increase the high frequency recording level, the logical solution was to employ high frequency pre-emphasis; then de-emphasis on playback would restore the original high frequency balance while simultaneously reducing the hiss level. Also, the same technique could be used to reduce amplifier hum and low frequency room rumble picked up by the microphones.

Unfortunately, tape recording levels were already running at tape saturation, so boosting the highs and lows would only create more distortion. But Mr. Dolby added another thought to an idea tried many times, although unsuccessfully, by others. His logic was that at very high recording levels the hiss, hum and rumble are completely masked; it is only on very low

PLUG-IN AMPLIFIERS,
OSCILLATORS AND
METER AMPS

POWER TRANSFORMER



POWER SUPPLY

This add-on Dolby B system is a high quality device designed for maximum flexibility and ease of operation. No time-consuming switching from record to play here. It's automatic.

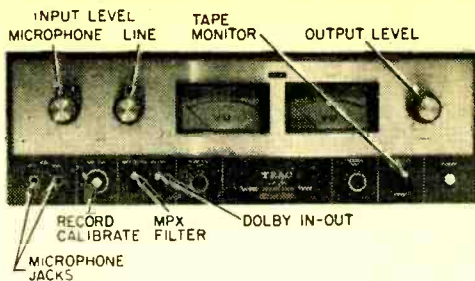
e/e TEAC AN-180

recording levels that the program information gets down into the noise level. So Dolby simply invented a device that automatically pre-emphasizes the highs and lows at low recording levels, and de-emphasizes the same highs and lows to the original low levels during playback.

The device that handles both highs and lows is called a Dolby A. It is very expensive and used almost exclusively by recording studios. Since only hiss is the amateur tape enthusiasts problem, Dolby designed the relatively low cost Dolby B noise suppressor, which handles only the high frequency hiss.

Inside Story. The Dolby B system, such as used in the TEAC AN-180, primarily consists of a differential control amplifier, a high-pass equalizer and a fixed reference level. The fixed reference is adjusted to equal the recorder's maximum recording level. An input signal that is at maximum level passes through the Dolby unequalized. As the recording level falls off the Dolby automatically cuts in high frequency boost; the lower the recording level the greater the boost that can be used. In effect, the pre-emphasis strives to bring all high frequency information up to the maximum recording level.

On playback the signal is again compared to the reference level, and high frequencies are de-emphasized in exact proportion to the original pre-emphasis. The final result is a flat frequency response with the high frequency noise attenuated an average of



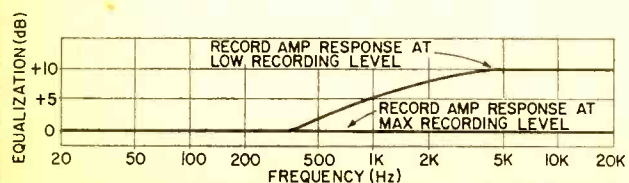
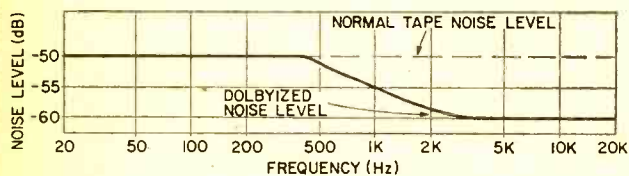
AN-180's controls provide full operator conveniences including both microphone and line input jacks. Two VU meters on AN-180 are used to monitor record levels.

10 dB. For example, the Dolby B actually will improve a cassette's -50 dB high frequency noise level to -60 dB—and that's dead quiet.

Unlike other noise suppression systems which somehow, somewhere also attenuate the low-level playback highs, the Dolby has no effect on the recorder's overall frequency response even when the full 10 dB of noise suppression is obtained. It makes no difference to the Dolby whether there is a high, medium or low recording level, the playback is always flat.

An Ability to Perform. Unlike other add-on Dolbys which have some effect either on frequency response, distortion, or both, or maybe require manual switching from record to play, the TEAC AN-180 switches automatically and adds no sound coloration of its own. Also, the AN-180 works on both microphone and line level inputs, not line level alone. With the AN-180 you are not limited to recording only signals passing through the main amplifier; the AN-180

(Continued on page 102)



Two graphs demonstrate Dolby operation in TEAC AN-180. Upper shows improvement with AN-180 to overall noise level. Lower graph shows how max-level signals are passed without change. Low-level high-freq sigs are boosted. Equal but opposite equalization at playback provides an overall flat response.



KATHI'S CB CAROUSEL

By Kathi Martin, KAI0614

HI AGAIN! It's great to be able to bring you up-to-date on a subject close to CBers. I'm going to talk about a piece of gear whose operation depends on something close to the heart of every YL and XYL: *talk power!* But before you gals get together and put up a picket line or something, let me say that voices, whether spoken in breathy whispers or basso profundo blasts, are just not ideally suited for communications on our technically restricted CB channels. As a technician at our test lab with former experience in the broadcast industry told me, radio stations always use a type of *peak limiting* to increase their talk power. This, he pointed out, simply means that modulation of normally soft sounds can be greatly increased without fear of overmodulation from the peaks or loudest points present in your or my voice.

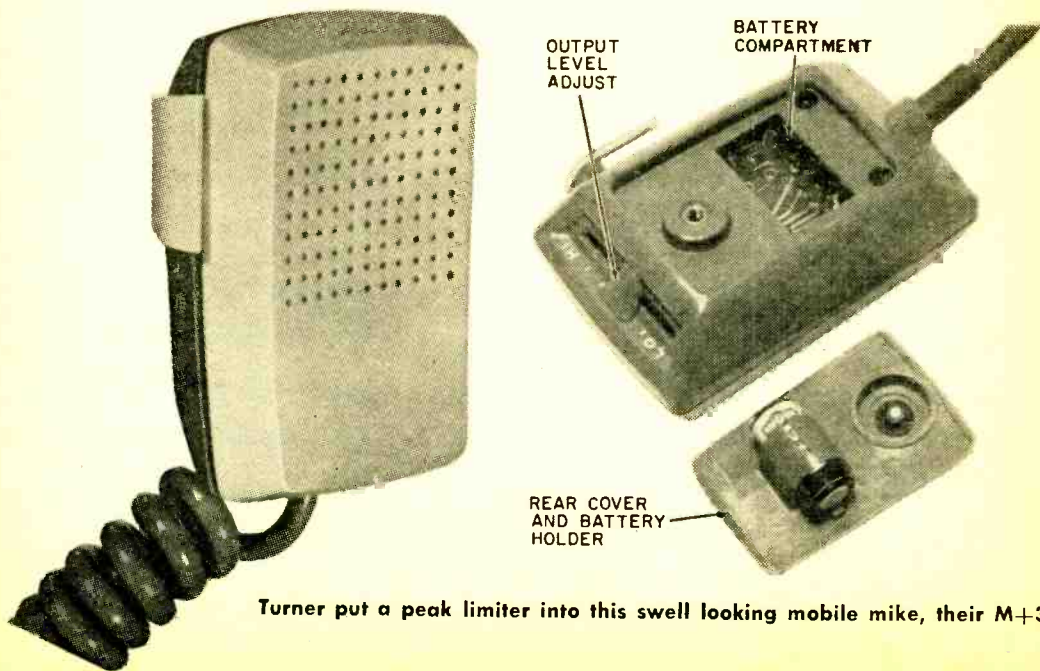
Through the Noise Levels. The purpose of CB is communication—getting the message *through!* Any radiophone signal booming in

at 20 dB over S9 is intelligible whether undermodulated, overmodulated, high pitched, low pitched, or whatever. But when signals get down into the noise levels the only thing that gets the message through is talk power—lots and lots of talk power.

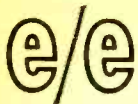
Technically, we don't need the deep bass voice of a smooth announcer to understand what he's saying. Sure, it might sound fantastic, but it wastes power that could be used elsewhere to improve intelligibility. In short, the frequency response can be electronically tailored to improve communications.

Wouldn't it be great if peak limiting were available to CBers? Well, as you know by now, that's the subject of my report in this issue.

One of the hottest talk power boosters we've yet come across is Turner's *M+3 Amplified Mobile Microphone*. Fact is, whether you're a CB'er, Amateur or just a mobile P.A. (public address) operator, the



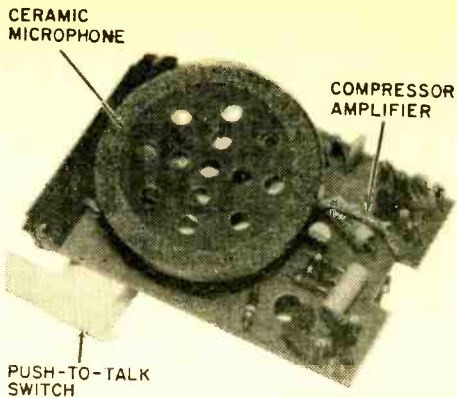
Turner put a peak limiter into this swell looking mobile mike, their M+3.



KATHI'S CB CAROUSEL

Turner M+3 will really make your signal.

Points to Ponder. The M+3 is more than just another microphone with a built in amplifier or add-on booster. First of all, the M+3 contains a 4-stage compression amplifier built right into the case; even the battery is in the case. Next, the frequency response is tailored to the 300 to 3500 Hz maximum intelligence speech range. Thirdly, it contains its own built in volume control, push-to-talk switching leads and automatic shut-off for long battery life. Finally,



Rugged ceramic mike element and printed circuit board amplifier are inside M+3.

phone. The flip side of the board contains the PTT switch, slider-type volume control and battery terminals.

The PTT switch provides the following functions: connection of microphone amplifier to equipment, application of battery power to M + 3 amplifier, and either relay or electronic PTT switching.

The switching system can be easily user modified to provide either 2-wire on-off (such as for relays), or one of two wires can be opened or shorted to ground for electronic switching (and this covers just about every possible relay and electronic switching arrangement). Notably clear instructions are provided for the wiring connections.

How It Works. When our technician fed a tone at standard voice levels from our special microphone coupler, the M+3's maximum output level was some 14 dB higher than the output of a so-called high-output standard microphone.

The M+3's compression performance was very good as shown in Fig. 1. Note that our applied sound level is linear but the M+3's output is sharply limited (continued on page 92)

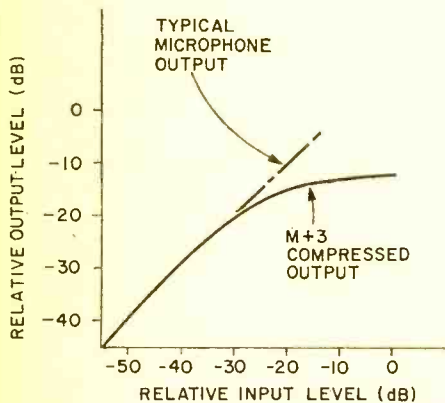


Fig 1. M+3 output is lowered on loud sounds for more CB talk power. See how in text.

and most important of all, the M + 3 is essentially distortion-free even through most of its compression range. Hang the M+3 on your rig and all you'll get is a big boost in talk power, with no screeches, whistles or gurgles.

As shown in the photos, the M+3's case is jammed packed with electronic hardware, with all components mounted on a single printed circuit board. One side of the board contains the amplifier and micro-

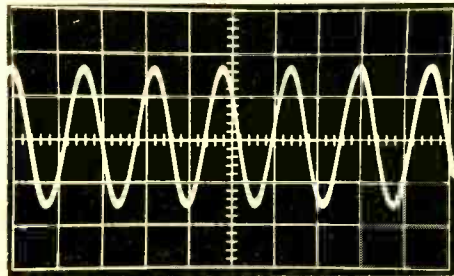
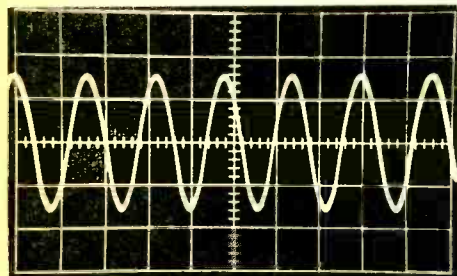
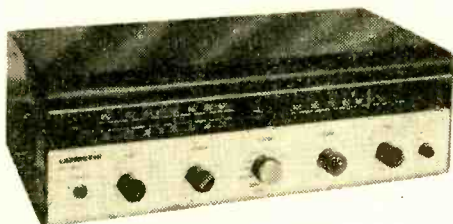


Fig 2. There's no detectable distortion on this actual scope photo. At near max output, Fig 3 right, only a sharp eye can catch a slight waver on upper peaks.

E/E looks at new...



An amateur's dream machine—Hallicrafters SR-400A Cyclone III. Great new ham transceiver from Hallicrafters features 550 watts of SSB power and other dandy features like—good looks, ± 3 kHz receiver incremental tuning, common or separate antennas. Circle No. 45 on page 17 or 103.



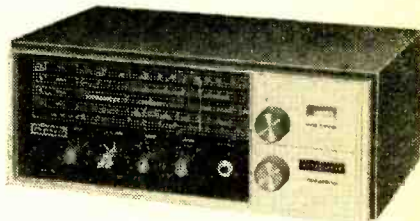
HF/VHF/UHF coverage in one unit—Lafayette PF-300 FM monitor. Top-grade monitor receiver has adjustable selectivity control. Great for high-use areas, slices through adjacent channels. 3 FET's, 2 IC's, dual power, crystal and tune on each band. For more info, Circle No. 11 on page 17 or 103.



High-power wattmeter by Antenna Specialists—Model 257. It's a highly accurate in-line wattmeter. Measures transmitter power in 14-30 MHz range. Switch selected ranges of 250 and 500 watts are accurate to $\pm 5\%$. Circle No. 46 on page 17 or 103.



Many are heard with this one—Hustler Monitor-match, Model 5-M. Use your regular cowl-mounted or new-style window auto antenna for complete HF/VHF/UHF plus AM/FM broadcast coverage. Want more information? Circle No. 48 on page 17 or 103.



Shortwave listener budget bargain—Heathkit SW-717 receiver. For less than many a ready-made receiver, you can build a radio with MOSFET mixer, 0.55 to 30 MHz coverage and more! Circle No. 18 on page 17 or 103.

Communications Gear



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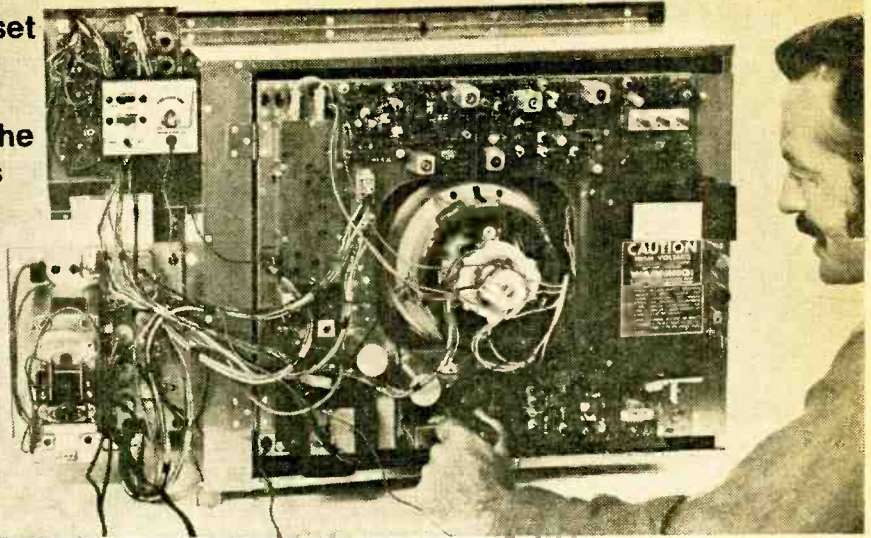
This solid-state color set contains: 45 transistors, 55 diodes, 2 silicon controlled rectifiers, and 4 advanced Integrated Circuits representing an addi-

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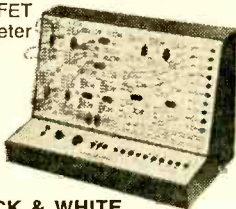
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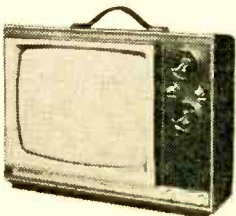
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CIRCLE NO. 15 ON PAGE 17 OR 103

e/e etymology

How about a word with us?

HERTZ

▲ Heinrich Rudolf Hertz went to Munich to study engineering in 1877. Soon he decided that this was not his cup of tea, and switched to theoretical physics.

Before he was thirty he had started publishing papers that few physicists of the era understood. This brash boy, one of his colleagues said, didn't know enough to keep his mouth shut.

Hertz ignored this rebuff—common enough in scientific circles—and plunged into a study of the kinetic energy of electricity in motion. He won a professorship at the Berlin Institute, where he was assistant to the great Helmholtz.

Many bearded savants had tried to find experimental proof of then-controversial "Maxwell's Law" according to which every part of an electric circuit tends to move in such a direction as to enclose the maximum magnetic flux. At thirty Hertz supplied the proof.

He barely missed discovery of x-rays, and died years before he could have made a success in the car rental business. But in the realm of electric waves he remains No. 1. For a period his name was attached to all waves in the RF band. Though this usage has been abandoned, *hertz* remains the world-wide label for one cycle per second. Just to be sure he's never topped, admirers have successfully insisted that one trillion cycles per second be designated *terahertz*.

Science has found no radiation even close to the terahertz level—but carbon monoxide molecules radiate at 115 billion hertz. Not a bad tribute to the memory of a man whose colleagues considered him a bit on the brash side.

CELSIUS

▲ Swedish astronomer Anders Celsius was much longer coming into his own. He built and directed an observatory at Uppsala, was an early advocate of making the radical change to the Gregorian calendar, and even described a thermometer divided into one hundred units between the melting point of ice and the boiling point of water.

Because he had selected such a nice, round number (by comparison with the clumsy Fahrenheit scale) scientific workers insisted on dubbing his scale *centigrade* ("divided into 100").

With the metric system gradually toppling all barriers as it moves toward global conquest, "centigrade" is in process of being ousted by *Celsius*. Officially adopted in 1948, the label still hasn't won general acceptance. In time it is all but certain to do so, however, since officials of the temperature section, Institute for Basic Standards, National Bureau of Standards, firmly insist that "the temperature unit 'degree centigrade' no longer exists.

SEYFERT GALAXIES

▲ A group of galaxies characterized by compact and extremely bright nuclei bear the label *Seyfert*.

Even astronomers couldn't have pulled such a name as that out of the blue; it looks very much like the surname of some discoverer—but whose?

A thoroughly modern investigator, far removed from the world of Celsius and Hertz.

Carl Seyfert identified the first of these unusual galaxies in 1943, and they were immediately tagged with his name. Early in 1971, the radio source known to astronomers as Perseus #3C-84—a mere 200 million light years away—had the honor of being the first Seyfert galaxy to show up in the x-ray range of the spectrum. So it seems that the *Seyferts* will be rolling along for a long time to come.

ALFVÉN WAVES

▲ Hannes Alfvén became immersed in such exotic fields as plasma physics, space physics, and astrophysics while still very young.

He got the foolhardy idea that there might be some flaws in Maxwell's long-established and thoroughly-accepted theory of electromagnetism. According to it, electromagnetic waves can penetrate only a very short distance into a conductor. Ergo, given a perfect conductor there can be no penetration at all by EM radiation.

Alfvén didn't buy this idea. He looked for and found what he called "hydromagnetic waves"—as a result of pondering the nature of sunspots.

Many physicists were so sure Maxwell was right that they didn't bother to try to prove or disprove Alfvén's ideas. All this changed when Enrico Fermi heard a lecture on "hydromagnetic waves." Endorsed by Fermi, the concept quickly won world acceptance and brought Hannes Alfvén a Nobel Prize in 1970—the first ever given to a space physicist.

Belatedly, the physicists of the world revised their understanding of electromagnetic theory—and dropped "hydromagnetic wave" in favor of *Alfvén wave*. ■

Hour Master... A Super Timer

Turn off to
Electronics?

by Steve Daniels

HOW WOULD you like an electronic watch-dog for your CB equipment, Channel 9 monitor or household appliances that will keep them turned on a specified length of time, then shut them off automatically? Could you use something to turn a TV or Stereo off at night after you've fallen asleep? What about an electric nap alarm to wake you from a snooze with music from your radio or Hi-Fi?

Well, here's one answer. It's our electronic Hour Master. Or should we say, *Your Master!* Hour Master is a wide range electronic timer and Diac-Triac full-wave speed control combined in one compact unit. It will handle literally any timing job from seconds to hours whether time-in or time-out is required. If you wish, you can even add a speed control by just adding one variable resistor to the circuit; the result is a flexibility applicable to dozens of jobs in home and shop.

The Old Timers. Many electronic timers up to now have been limited in length of time delay because huge capacitors were required. Hour Master can easily provide delays of an hour or more with its average



e/e HOUR MASTER

sized 200 uF timing capacitor. The schematic shows how it's done. Diac D1 and Triac Q3 form a standard AC phase control which can be turned off through the contacts of relay K1. For use as a speed control, R4, a 250,000-ohm linear pot, is added as shown to points A and B. With mode switch S3 in the *out* position, you have a regular speed control. When battery switch S2 is closed, the timing circuit is armed. By pressing time-start switch S1, timing capacitor C1 is charged by the battery; when S1 is released, C1 slowly discharges through time-set pot R1 and source-follower Q1.

Time-set potentiometer R1 can be either 5 or 10 megohms. Resistor Rx sets the low limit of the timer and may be selected to

fit your needs. It was 100,000-ohms in the author's model giving him a minimum time delay of 30 seconds. Capacitor C1 may also be changed in value to modify the delay time. With a 200 uF capacitor and a 10 megohm pot, the maximum delay is well over an hour and over a half-hour with a 5 megohm pot.

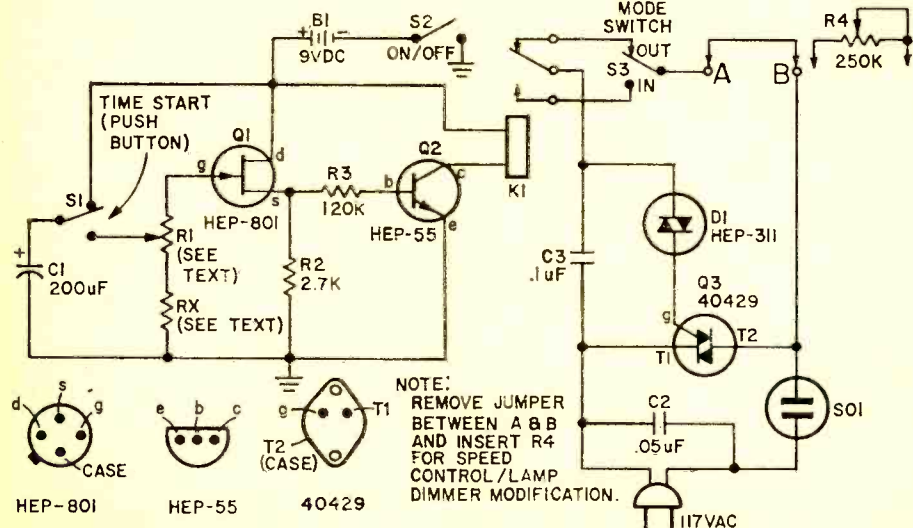
Getting Busy. The author's model was housed in a 6¼-in. x 3¾-in. x 1⅞-in. plastic case with an aluminum panel used as the top plate of the unit. You may want to start by drilling holes in the cover for switches, pot(s), and socket. Be sure to add an extra hole for potentiometer R4 if you want the speed control feature.

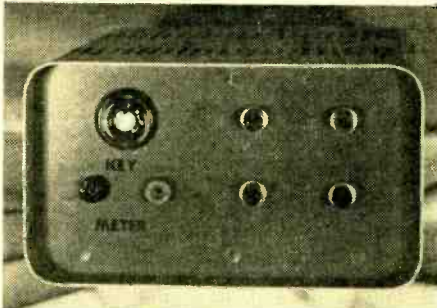
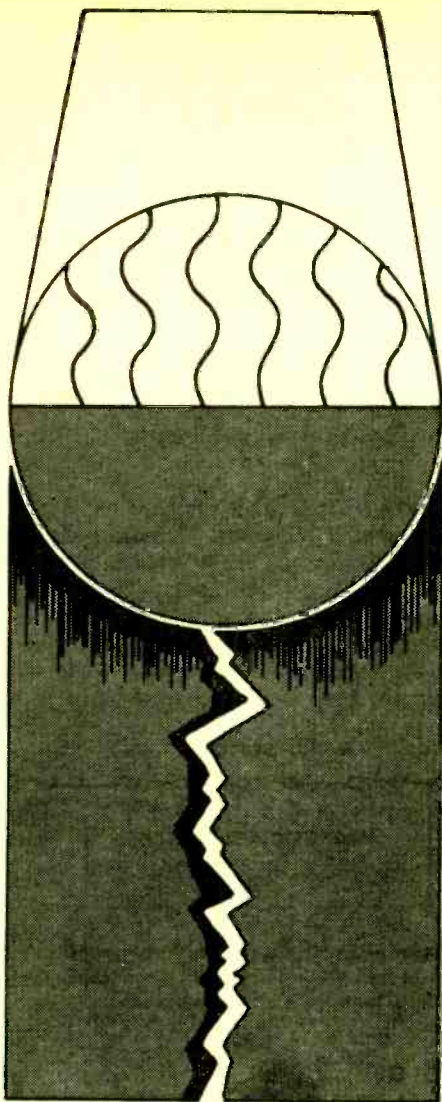
Go to work on the circuit board; you can use about a 2-in. x 4½-in. piece of perforated phenolic board. Wiring is straight-forward, but keep the triac circuitry and the FET at opposite ends of (Continued on page 93)

PARTS LIST FOR HOUR MASTER

- B1—9-volt battery, Eveready 216 or equiv.
- C1—1 to 1000 uF, 12-VDC electrolytic capacitor (see text)
- C2—0.05 uF, 600V disc capacitor
- C3—0.1 uF, 600V disc capacitor
- D1—Diac, Motorola HEP-311
- K1—Sensitive SPDT relay (Potter & Brumfield type LM5 or equiv.) (see text)
- Q1—N-channel FET, Motorola HEP-801
- Q2—NPN transistor, Motorola HEP-55
- Q3—Triac, RCA 40429
- Rx—100,000-ohm, ½-watt resistor, 10%

- R1—5 megohm to 10 megohm, linear taper potentiometer (see text)
- R2—2,700-ohm, ½-watt resistor, 10%
- R3—120,000-ohm, ½-watt resistor, 10% (see text)
- S1—SPDT pushbutton switch (Switchcraft 1002 or equiv.) (time-start switch)
- S2—SPST toggle switch (power switch)
- S3—SPDT toggle switch (mode switch)
- SO1—AC receptacle, chassis mount
- Misc.—Hardware, knobs, perforated board, flea clips, wire, solder, etc.





Interrupting the light from an ordinary bulb activates this alarm driver. Connect it to the Magnum alarm, and you've got a combination that will stun any burglar!

Operate a burglar alarm with the

LIGHT SENSOR

by Charles D. Rakes

If it's protection you need, don't pay the mob! Take the money and build the *Light Sensor*, an unusual burglar alarm you can construct in a few hours and which will give protection for years to come.

The *Light Sensor* is a solid-state, battery-operated, light-activated intrusion burglar alarm system that's different from other light-alarm systems in use today. As a starter, there isn't an obvious light-beam that a burglar might notice and try to avoid. Neither is a special light source required—any common 117-vac lamp will do. And to top it off, the *Light Sensor* requires so little power that a single low-cost battery will operate it for months.

How it works. Perhaps the best way to explain the operation of the *Light Sensor* is to compare it to the human eye in a stationary position, looking at a light. All is fine as long as the light isn't interrupted, but let an object pass between the light source and the eye, and at that instant the light level reaching the eye is reduced, so the eye signals the brain to sound an alarm. Add to the alarm as many as three more such eyes and you have a system that compares to four tireless guards that cannot sleep or be diverted in any way.

Protection need not stop here. You can add as many closed-circuit protection switches as desired for both window and door protection, such as magnetic reed switches, pressure-sensitive switches, lead foil (used for glass-breakage detection), and any other suitable closed circuits, all of which must be wired in series and connected to one of the remote inputs, J1 through J4.

Putting it together. Today's burglar alarms need not have that typical "plain-Jane square-box" look as did the alarms of yesterday. You can go modern and build yours

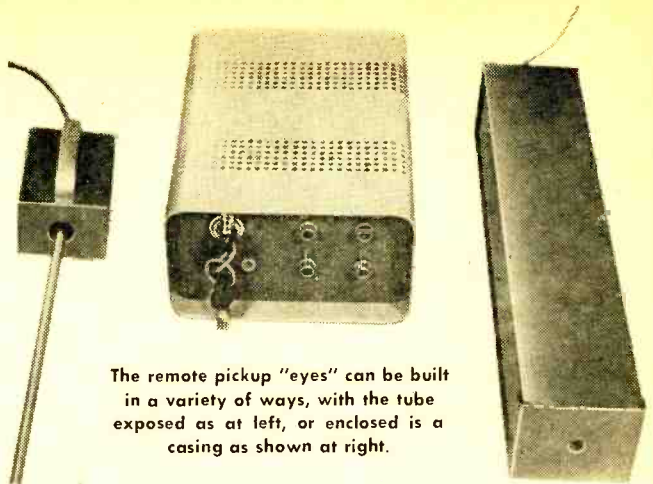
e/e LIGHT SENSOR

in a LMB CO-3 cabinet to match the author's model. Since housing or circuit layout isn't critical you can, if you wish, build your alarm in any suitable inclosure and use perfboard for the circuit wiring.

A printed-circuit board is available, with or without components, from Krystal Kits. See the parts list for the details.

If a printed-circuit board is used, just follow the component layout diagram, mount all parts on the board, and solder in place. Care should be taken when installing the semiconductors to insert the leads in the correct holes. Heat-sink each lead during soldering.

Lock switch S1 can be replaced by a lower cost switch, such as a standard toggle, hidden in an out-of-sight location so that it will

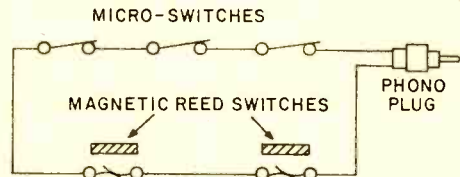
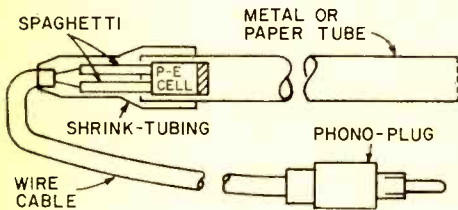


The remote pickup "eyes" can be built in a variety of ways, with the tube exposed as at left, or enclosed in a casing as shown at right.

not be obvious to an intruder.

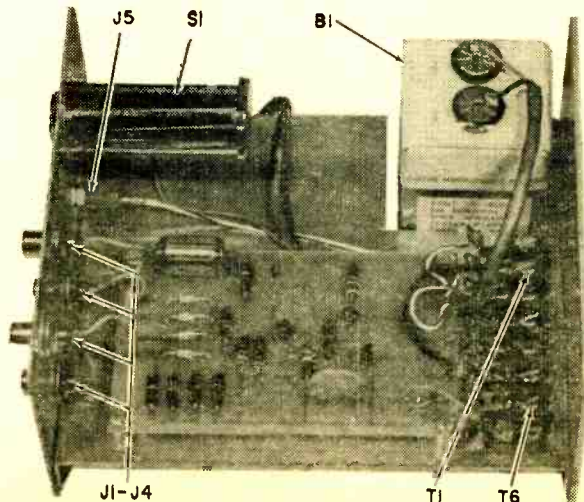
Photocell Mounting. Remote pickup eyes PE1-PE4 can be constructed in a variety of shapes to meet almost any specific requirement. Constructing the eyes is easy—just glue the photocell in one end of a light-tight paper or metal tube of the desired length, bring out the leads through spa-

Construction details for a remote eye. Electrical tape can be used instead of shrink tubing to seal the end.



Doors and windows can also be protected with the Light Sensor by wiring normally closed switches in a closed circuit.

The circuit layout isn't critical, so the components could be mounted on perfboard and put in any convenient housing. Jack J6 is hidden by lock switch S1.



ghetti, and seal the end with either shrinkable tubing or electrical tape.

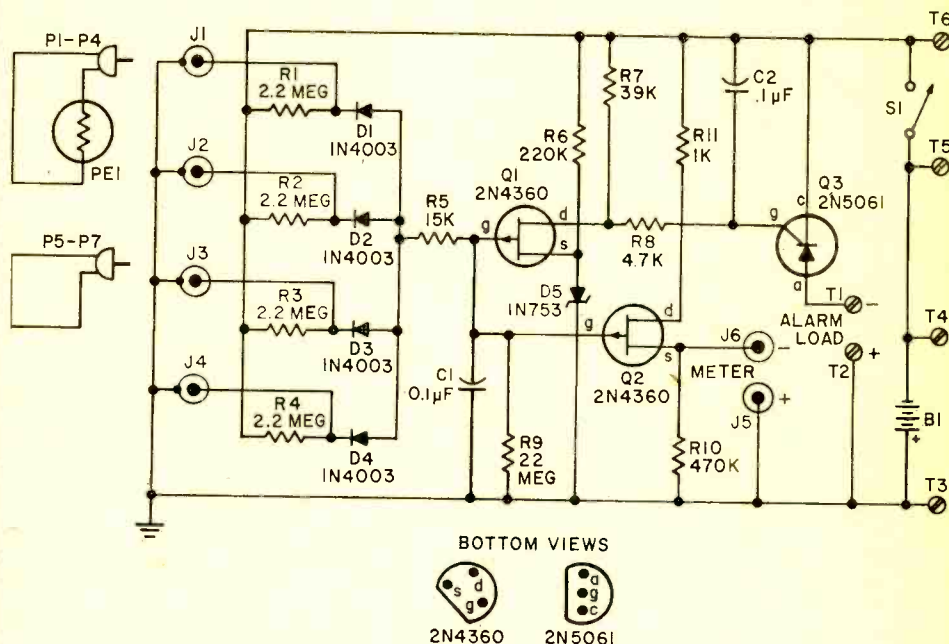
Sealing of the tubing is necessary to reduce the light leakage to the back end of the photocell that would cause a loss in sensitivity. It is very important that the *dark* resistance of the photocell be as high as possible for proper operation of the remote eye.

If the distance from the light source to the remote eye is great (over 25 feet) then the tubing should be 6 to 18 inches long. A 3- to 6-inch tube is suitable for shorter distances. The correct length of tubing can be determined by experimenting with different

tube lengths and various light sources.

To simplify mounting of the remote eye, the photocell tubing can be assembled in a small mini-box with a two-wire cable connected to the photocell at one end and to a phono plug at the other.

If a low-wattage light source is used, or if the distance from the light to the photocell pickup is great, then the more sensitive CL603AL photocell should be used. If the distance is small, then use the less sensitive CL603A cell. These two photocells are far from being the only suitable ones. You may find that most similar types of cells will work just as well.



PARTS LIST FOR LIGHT SENSOR

- B1—9-volt transistor battery (Eveready 276 or RCA VS306)
- C1—.01- μ F, 600-volt polystyrene capacitor (Mallory)
- C2—.1- μ F disc capacitor
- D1-D4—Silicon rectifier (Motorola IN4003 or HEP-156)
- D5—Zener diode (Motorola IN753 or HEP-Z0214)
- Q1,Q2—P-channel field-effect transistor (Fairchild 2N4360)
- Q3—.8 amp 60 PIV silicon-controlled rectifier (Motorola 2N5061) or HEP-R1002)
- R1-R4—2,200,000-ohm, 1/2-watt 10%
- R5—15,000-ohm, 1/2-watt 10%
- R6—220,000-ohm, 1/2-watt 10%
- R7—39,000-ohm, 1/2-watt 10%
- R8—4,700-ohm, 1/2-watt 10%

- R9—22,000,000-ohm, 1/2-watt 10%
 - R10—470,000-ohm, 1/2-watt 10%
 - R11—1,000-ohm, 1/2-watt 10%
 - PE1—CL603AL or CL603A (see text) Clairex Photocell
 - P1-P4—Phono plugs
 - P5-P7—Phono plugs with shorting wire
 - J1-J4—Phono jacks, chassis-mount type
 - S1—Lock switch
 - Misc.—Six-terminal barrier strip, LMB type CO-3 cabinet, wire solder, hardware, PE-cell housing (see text), etc.
- Note:** An etched copperclad printed-circuit board is available for \$2.50 undrilled, \$3.50 drilled, or \$11.55 with all components that mount on the PC board, from Krystal Kits, Box 4232, Little Rock, Ark. 72204. Canadian residents add \$1.00 additional. No foreign orders.

LIGHT SENSOR

Setting up the Alarm System. The alarm unit can be placed in almost any convenient location, although it should not be placed in front of any of the remote eyes. Short all four input jacks J1-J4 and connect the battery to the alarm. Turn key switch S1 to the *on* position and monitor the voltage at the meter jacks J5 and J6, with a voltmeter set to the 10-VDC range. The voltage reading will represent the minimum reading obtainable under a non-alarm condition, and should be between one and five volts with all inputs shorted. Remove one of the jumpers from ground, and plug a remote eye into the jack. Carefully adjust the remote eye at the selected light source for the minimum voltage reading. This voltage must be five volts or below. If the reading is too high, then increase the size of the light source or use a more sensitive photocell in the pickup. With the remote eye plugged in and adjusted, blocking the light should cause the meter to indicate more than 6 volts. The alarm is now in *alarm* condition.

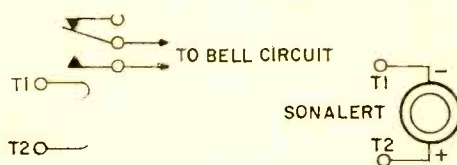
The remaining remote eyes must be adjusted in the same manner. If any of the J1-J4 input circuits are not used, then the unused inputs must have a shorting plug inserted in each jack. A shorting plug can be made from a phono plug by soldering a jumper wire between the two plug terminals.

Input Switches. One of the input circuits

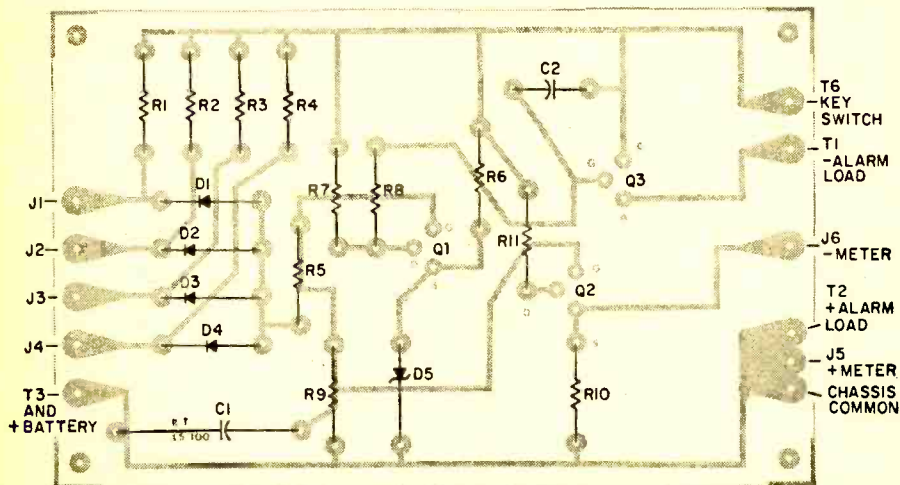
can protect all your doors and windows with either pressure-sensitive switches (such as Microswitches) or magnetic-reed switches, all connected in series and wired to a phono plug. As long as all of the switches remained closed, the alarm is set. If only one of the switches opens, the alarm is then latched in the *alarm* condition and will remain so until reset with the key switch.

Alarm Sounder. When it comes to choosing the type of audible alarm that may be connected to the *Light Sensor*, it's dealer's choice. By far the cheapest and simplest alarm sounder to connect directly to the unit is a Mallory *Sonalert* solid-state audible warning device, which is just great for in-house use. If a much louder alarm is needed, then hook up the *Magnum* (see next page).

Low-voltage alarm bells may be connected to the unit by using a low-current relay, such as a Sigma 11F-1000-G SIL, to control the bell's current. Other types of alarm sounders could also be controlled by the relay—the choice is up to you! ■



For an audible alarm, connect a relay and bell circuit, or a Sonalert, to T1 and T2.



Placement of parts on printed-circuit board. Drill holes in corners for mounting. The board is available, with or without parts—see parts list for details. The foil pattern is exact size, and can be used to make your own printed-circuit board.

For an
ear-shattering
racket, try the

MAGNUM ALARM

by Charles D. Rakes

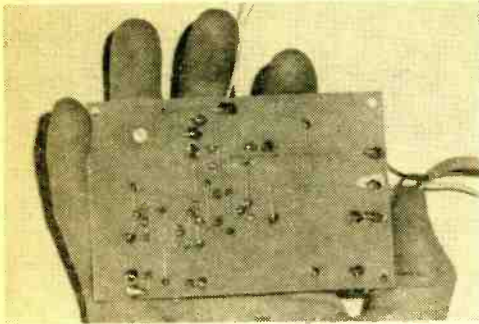
Pick the noise you want by varying components!

The best way to turn a would-be burglar into a failure is to scare the hell out of him before he can break into your home or business. Sure, you can use a silent alarm to notify the police. And maybe they'll show up before the burglar takes your goodies or wrecks the place in the process and makes his escape. But if you use the *Magnum*, which shrieks like a lunatic, no burglar alive will stay about for another second to steal anything; the only damage that's likely to be done is to the door as he disappears into the night.

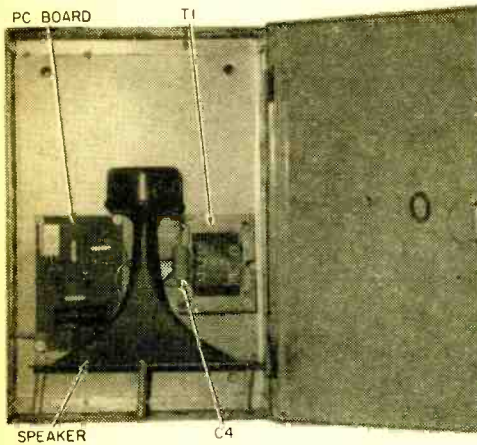
The *Magnum* is an all-solid-state electronic alarm sounder that is best suited to replace the troublesome mechanical bell used in 99 percent of all burglar-alarm systems. As a companion for the *Light Sensor* activator, the *Magnum* makes a perfect marriage of solid-state equipment, and as a combination furnishes the ultimate in protection.

The *Magnum* can produce a variety of unusual sounds by the proper selection of components, as will be discussed later. Not only is the sounder loud; it is also very economical—it will sound off for about an hour on a 9 volt transistor battery. The *Magnum* will perform with a battery voltage as low as 1½ volts (moderately loud) and as much as 18 volts (ear-shattering) without fail or fault.

e/e MAGNUM ALARM



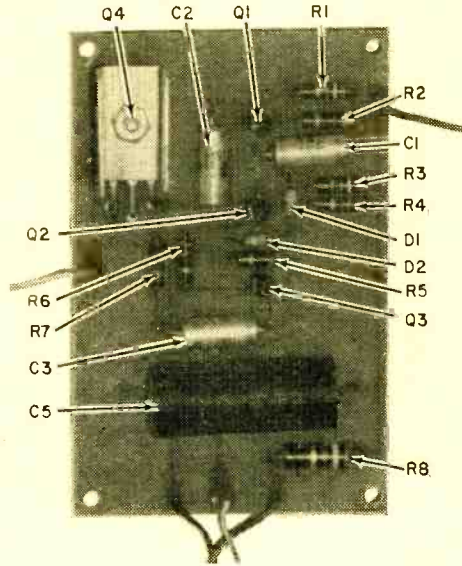
Back of printed-circuit board.



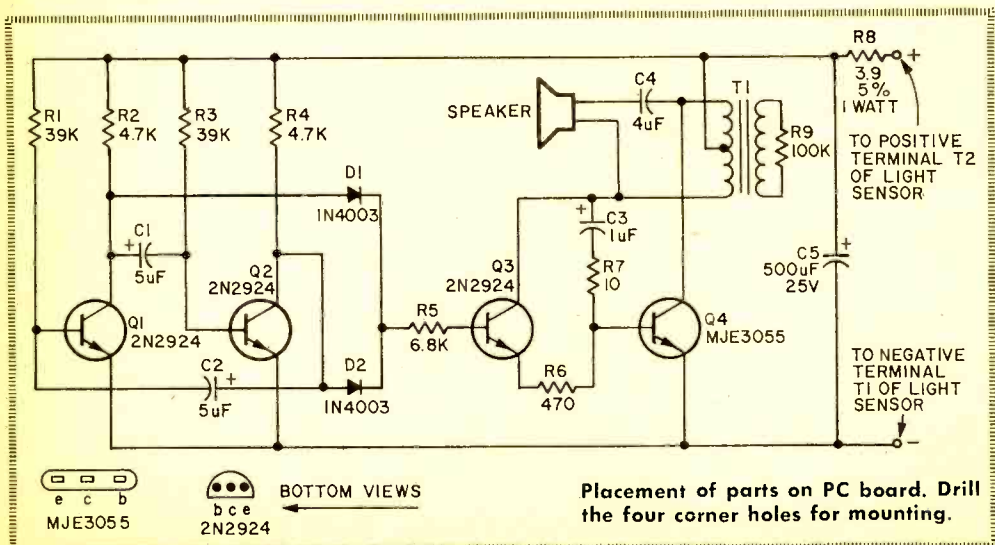
The author used an electrical junction box to hold the speaker, PC board, transformer.

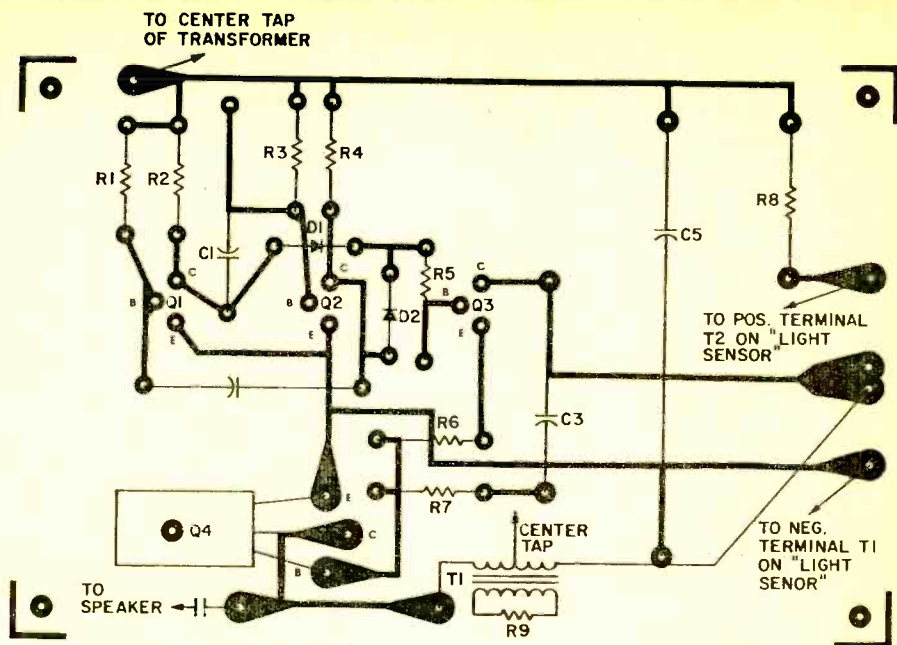
Construction. The circuit is a simple one and can be constructed on perboard or printed-circuit board; the choice is yours because the layout isn't critical and the circuit will operate in most any configuration. A printed-circuit board is available, with or without parts, from Krystal Kits. See the parts list for details.

A metal or plastic case will do fine for a housing, but in either case allow plenty of open area facing the tweeter horn, for maximum sound transmission into the surrounding air. A two-wire circuit is all that's



The parts are mounted on a PC board, although perboard could have been used.





PARTS LIST FOR MAGNUM

Battery—6 to 18 volts—almost any type will do
 C1,C2—5-uF, 50-volt electrolytic (Lafayette 34-85786)
 C3—1-uF, 50-volt electrolytic (Lafayette 34-85711)
 C4—4-uF, 50-volt non-polar electrolytic capacitor (comes with Allied speaker)
 C5—500-uF, 25-volt electrolytic (Lafayette 34-55243)
 D1,D2—Diode (1N4003 or similar)
 Q1, Q2, Q3—NPN transistor (General Electric 2N2924 or Motorola HEP 724)
 Q4—NPN power transistor (Motorola MJE-3055)
 R1,R3—39,000-ohm, ½-watt 10%
 R2,R4—4,700-ohm, ½-watt 10%
 R5—6,800-ohm, ½-watt 10%
 R6—470-ohm, ½-watt 10%
 R7—10-ohm, ½-watt 10%

R8—3.9-ohm, 1-watt 10%
 R9—100,000-ohm, ½-watt 10% (see text)
 SPK—Horn tweeter, 8 ohms, 30 watts (Allied Radio Shack 40-1228 or equiv.)
 T1—Transformer (filament): primary, 117 Volts, 50-60 Hz; secondary, 6.3 VAC at 3 amps, center-tapped (Stancor (P-6466 or equiv.)
 Misc.—Hardware, metal enclosure to fit, heat sink for Q4 made from 1 x 1½ x ¼-in. aluminum bent U-shaped and pre-drilled, one-inch standoff spacers (Burststein-Applebee 12A1390 or equiv.), solder, wire, etc.

Note: An etched copperclad printed-circuit board is available for \$2.95 undrilled, \$3.95 drilled, or \$10.95 with all components that mount on the PC board, from Krystal Kits, Box 4232, Little Rock, Ark. 72204. Canadian residents add \$1.00 additional. No foreign orders.

required in hooking the *Magnum* to the *Light Sensor* (see page 59) or almost any similar alarm system.

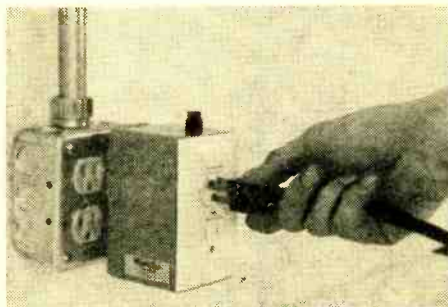
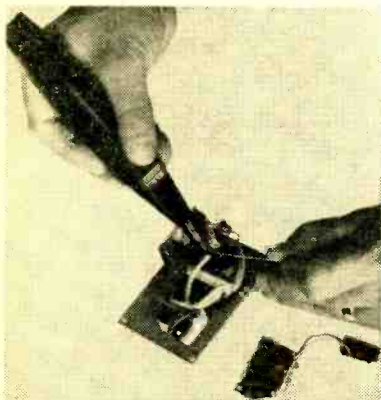
How it Works. Take a look at the circuit diagram and you will quickly see that Q1 and Q2 are connected in a standard multi-vibrator configuration. The output of the oscillator is coupled through two steering diodes and current-limiting resistor R5 to the base of Q3, turning it on and off at a high rate of speed. Now forget the above circuit and take a gander at the circuit surrounding T1 and Q4. If you remove Q3 from the circuit and place a short between where the collector and emitter of Q3 were connected, you have just completed a

simple and powerful oscillator that will produce a loud and continuous tone. Reinsert the multi-vibrator and the switching transistor, and you have created a new and wonderful monster that should give the shakes to any crook. There is no easy way to describe the racket it generates—you'll just have to build your own and enjoy the results yourself.

Variations. Before you go and wire the *Magnum* on a printed-circuit board, you might like to breadboard the circuit first so you can tinker around with it to obtain that just-so sound effect. You can change the basic tone of the sounder by changing
 (Continued on page 96)

E/E looks at new...

Cool desoldering with the DST tool leaves boards and circuits undamaged. Just heat unwanted solder with the tip, pull the trigger to release a regulated amount of CO₂ and disperse the solder. From Wall for under \$50. Circle No. 51 on Reader Service Page.



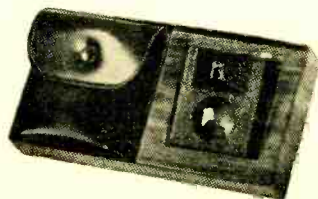
The Wahl Iso-Tip cordless soldering iron eliminates electrical leakage and the need for grounding. At \$19.95 including recharging stand. Circle No. 53 on Reader Service Page.

Plug-in AC overvoltage surge suppressor prevents overvoltage burnouts and erratic malfunctions, can handle 36-amp surges for 10 msec; \$39.95 from Transtector. Circle No. 56 on Reader Service Page.



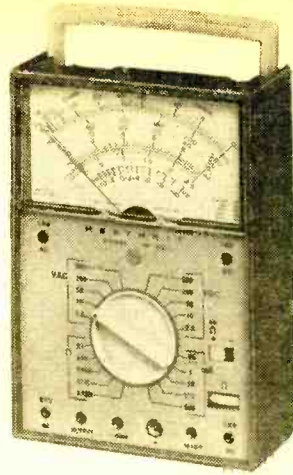
Electric scissors from Wen make accurate pattern cutting much easier, without frayed edges, and handle heavy-duty jobs precisely. A two-speed switch controls the cutting speed. Contoured to fit the hand, the scissors are \$7.95. Circle No. 57 on Reader Service Page.

A pocket-size magnifier with built-in illumination, the Scanner permits close-up inspection of tiny details not easily seen otherwise. From Flex with a 5X lens, \$3.95; with a 10X lens, \$4.95. Circle No. 59 on Reader Service Page.



TOOLS AND GADGETS

e/e
checks
out
the...



Heathkit IM-105 VOM

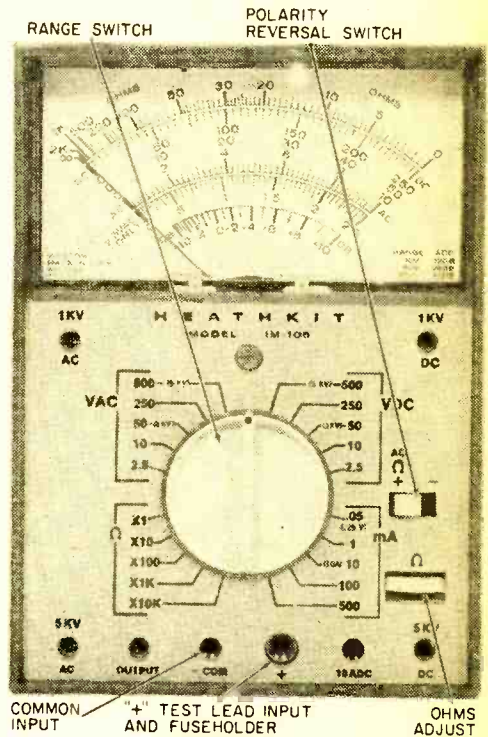
A Volt-Ohm-Milliammeter is one piece of test gear the electronic hobbyist cannot do without!

WHETHER YOU'RE WORKING on a homebrew one transistor project or the most sophisticated avionic equipment, the basic test equipment is still the VOM (volt-ohm-milliammeter). And just because it is so basic to the technician, a VOM must have the features of *accuracy*, *ruggedness*, and most especially, long-term *reliability*. Put all three features in one meter and the price approaches \$100. But if you go the kit route with a Heathkit IM-105 VOM you get all the features *and* the performance of a professional's VOM for only \$47.95, about half the usual price for a wired model of equivalent performance and reliability.

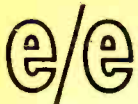
First off, the Heathkit features the most convenient "single switch" operation; meaning, once you plug in the test leads nearly all functions—AC, DC and ohms measurements—are selected by a single switch. There is no need to move the test leads from jack to jack or throw an AC-DC switch. You need move the test leads only when measuring voltages in excess of 500 or current in excess of 500 mA.

More Features. For convenience, a polarity reversal switch is provided that interchanges the test leads inside the meter for reversed polarity DC measurements.

Most important, the Heathkit IM-105 features 0.25 VDC and 0.05 mA ranges,



All AC, DC and ohms measurements are single switch selectable. The 50 μ A meter movement gives a 20K ohms-per-volt rating.



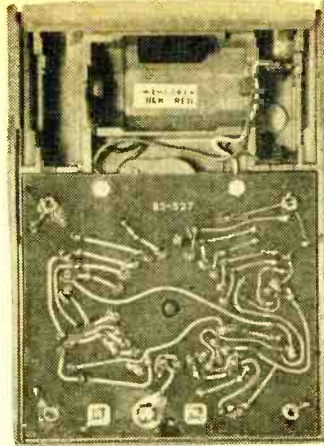
which are needed for solid-state equipment testing. And in case you get sloppy with the connections, there's an external fast-acting fuse and diode meter protection.

Ranges provided are: 0.25, 2.5, 10, 50, 250 and 500 DC volts full scale, with plug-in ranges of 1 and 5 kVDC full scale; the same ranges are available for AC; DC current in five ranges to 10 amperes; five ohm-meter ranges to $R \times 10K$ with 20-ohms at center scale. A DC blocked (capacitor input) AC input is also provided for output level measurements.

The wide, 4 1/2-in. meter is the taut-band type, which in plain terms means it is much more rugged than the common jeweled or D'Arsonval type. The scales are uncluttered and highly legible, even from a distance. A dB scale under the voltage scales is calibrated for the usual 1 mW in 600-ohms reference level.

The meter movement, in combination with 1 percent divider resistors, provides a basic accuracy of 3 percent on the DC ranges and 4 percent on the AC ranges (typical lab VOM accuracy). Sensitivity is 20,000-ohms per volt on DC and 5000-ohms per volt on AC.

The entire construction is printed circuit, and nothing "hangs loose" or floats. An unusual bit of construction is the fuseholder, which is accessible without dismantling the case. The fuseholder is actually part of the positive test lead jack. Should the fuse blow you simply insert



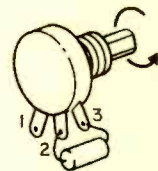
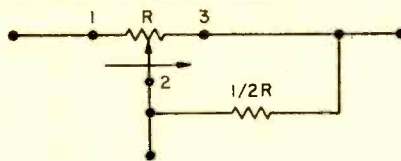
Circuit board construction makes assembly simple. The range switch plugs directly into the board to eliminate loose wires.

an allen wrench into the banana-type test lead socket and unscrew the socket, which also serves as the fuseholder. You insert a new fuse and then screw the socket back into the panel.

Built-in Protection. The fuse is the fast-acting 8AG type, which is fast enough to protect solid state devices so it's fast enough to protect the VOM. In the event of overloads not sufficiently heavy to blow the fuse, but which could possibly damage the meter, the excess current is shunted around the meter by protective diodes.

The meter is housed in an impact resistant case having a built in collapsible carrying handle. For further information circle No. 18 on Reader Service coupon on page 17 or 103. ■

Log Pot



If your working late some night on that *ultimate* project, you might find our little conversion technique helpful. In about four minutes you can change a linear taper potentiometer to a log taper by following the circuit shown at right and a simple formula.

Simply use a fixed resistor whose value is half that of the potentiometer. You must remember to use terminals 3 and 1 as

the input and 3 and 2 as the output. As an example, let's say you have a 100,000-ohm linear taper pot and you want one with a log taper. Just solder a 50,000-ohm fixed resistor across terminals 2 and 3.

The disadvantage of this circuit is a changing input impedance as the control is varied; but then it's a stop-gap measure until your friendly parts dealer opens in the morning. —Joe Gronk

CB coffee break

THIS ISSUE'S COLUMNIST—JULIAN S. MARTIN, KMD4313

In some ways it is unfortunate that CB equipment is generally well made, often approaching the reliability of commercial radio communications equipment. With transceiver performance and reliability running at an all time high—and in fact often surpassing the reliability of commercial equipment—the CBer often forgets about connections and mountings that *must* go bad at some time or other. And you can always expect trouble when you can least afford it.

For example, if you take the cover off your mobile rig you'll most likely see that every component is tied down (or well soldered), the transformer adjustments are wax sealed and the transmitter adjustments are most likely also sealed. And the odds are that the crystals are soldered into the circuit. Put this package in your car, bounce it around for a few years and it's a safe bet it will never give you trouble.

But what about the ancillary equipment, in particular the antenna system and power supply cables and connections? Ever see what road salt and grime does to an antenna connector? It eats away until the contacts are rusted and corroded. And how about battery fumes on power cables tapped in at the battery? That white powder was your wiring. Tuneable noise filters are also prone to "damage", actually a change in tuning. After all, the capacitor's adjustment isn't sealed, you have to make the final adjustment or trimming. Imagine how far out the capacitor tuning drifts after miles and miles of pounding and vibration.

In short, it's the often ignored, taken-for-granted equipment that degrades mobile performance for both transmit and receive: anything that causes a loss of outbound power causes a similar loss in inbound power (signal strength).

The only way to insure that your mobile gear will *always* work when needed it to have some sort of periodic maintenance and inspection program. And we don't mean the sort of "clean the terminals every week" nonsense. Few, if any CBer is going to spend half his free time servicing the mobile rig. As far as we are concerned, "periodic" means once or twice a year: at the least, at the end of winter after the city or town has done its

best to salt your car from the underside up.

The Big Eye. All the inspection takes is a few minutes. Do the antenna connectors or the ground connections look well salted or corroded? Ordinary clean water is a wonderful cleaning agent. Is the antenna ground rusty or corroded? Simply disconnect the ground, sand the surfaces clean—down to bare metal—and reassemble. The battery terminals? Simply mix up a paste of bicarbonate of soda, vasaline, and smear it completely over the terminals and wire connections. The *bicarb* will neutralize the acid and the paste will give you long-term protection.

One of the best ways to keep track of a slow but steady loss in mobile performance is to employ an *in-line wattmeter* such as the Antenna Specialists model M252. The in-line wattmeter is permanently connected in series with the transmission line and antenna (it has coaxial connectors) and continuously indicates the forward power *fed into* the antenna system. If anything, such as poor power connections, weak crystals or amplifiers or corroded antenna connections tend to reduce your rig's output signal it is immediately indicated

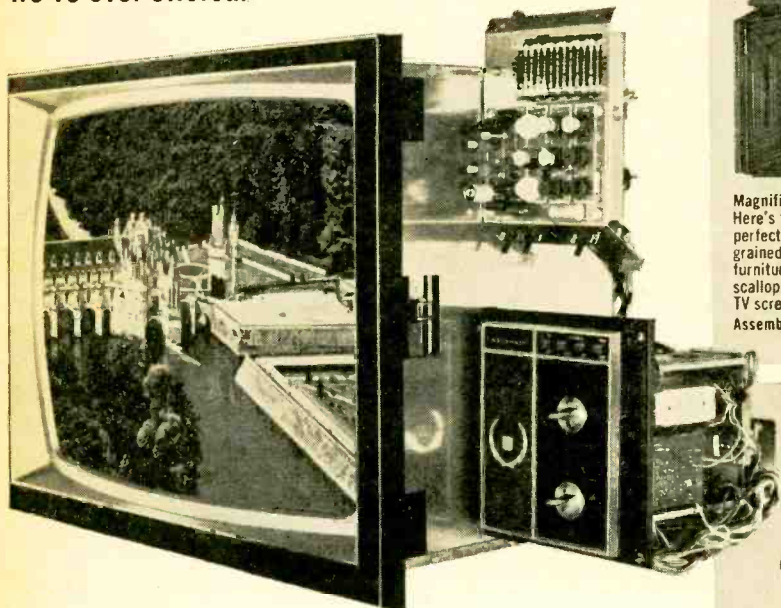
(Continued on page 74)



Antenna Specialists Model M252 in-line wattmeter.

More kits than ever...over 350...all in your

The most advanced color TV kit we've ever offered.



The new Heathkit GR-900 25V Color TV has UHF/VHF detent tuning & varactor UHF tuner, angular tint control — more features than any other color TV kit! Better performance than any other set.

UHF/VHF detent power tuning. Push a button and you scan the channels in either direction with detent action locking in on VHF channels 2-13 and any 12 preselected UHF stations. A pushbutton selects either UHF or VHF mode, and a lighted dial indicates tuner position. And you can have full remote-control selection too for just a few dollars more.

New voltage-controlled varactor UHF tuner and specially designed VHF tuner with MOS Field Effect Transistor contribute to better fringe-area reception, increased sensitivity.

New angular tint control. A switch now gives you either "normal" or "wide angle" color demodulation to reduce tint and flesh tone change when changing stations and when programs change. Other deluxe features include "instant on" operation with override for conventional on/off operation; automatic fine tuning; adjustable tone control, and an output for playing TV audio through your stereo hi-fi system.

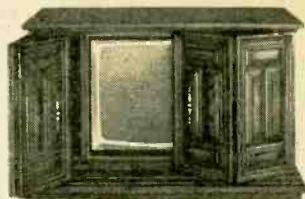
Exclusive Heath MTX-5 ultra-rectangular tube. It's the largest color screen you can buy anywhere, with a full 25 inch meas. diag., 315 sq. in. viewing area. You see virtually everything the station transmits, in the corners and at the sides. The specially etched face plate cuts glare, and reflection, increases contrast without sacrificing brightness, and each dot is projected through a matrix screen to stand out crisply against a solid black background.

Modular solid-state circuitry. Plug-in circuit boards and plug-in transistors make assembly, adjustment and servicing easy. There are 46 transistors, 57 diodes and four ICs — making this one of the most reliable sets we've ever designed.

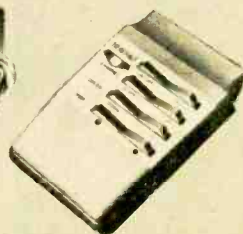
Other features include automatic chroma control, adjustable video peaking, adjustable noise limiting and gated AGC.

Exclusive Heath self-service built-ins. Your Heathkit GR-900 includes built-in dot generator, tilt-out convergence panel for set-up and periodic adjustments. A handy volt-ohm meter included in the circuitry helps you check your work during assembly, and can be used in conjunction with the manual for any servicing. Like all Heathkit color TVs, the GR-900 gives you complete installation flexibility. There are four beautiful Heath cabinets to choose from plus the new built-in electronic wall mount with hide-away tambour doors. Or you can custom install your GR-900. We think you'll agree, the GR-900 is truly the most impressive color receiver we've ever offered.

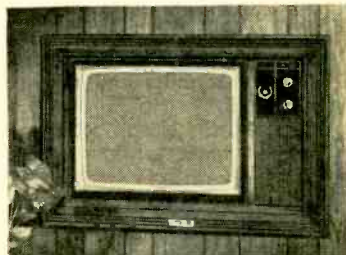
Kit GR-900, TV less cabinet, 125 lbs. 599.95*



Magnificent Mediterranean Console. Here's the finest TV cabinet we offer, a perfect choice for a GR-900. Has deep-grained peccan veneers on hand-rubbed furniture grade hardwood solids. Two scalloped double-hinged doors hide the TV screen when not in use.
Assembled GRA-405-25, 100 lbs. 179.95*



Wireless Remote for your GR-900. The ultimate in armchair viewing. Gives you eight-function across-the-room control of on/off, three preset volume levels, power tuning (up or down), color, tint, UHF/VHF channel selection. Also activates Custom Wall Mount doors.
Kit GRA-900-6, 6 lbs. 79.95*



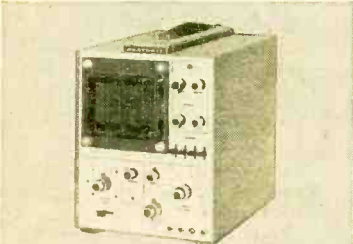
New Custom Wall Mount. Touch a button on the frame or on your Heathkit Remote Control unit and the folding tambour doors open to reveal your color TV. Kit includes everything needed to build your Heathkit GR-371MX or GR-900 into a wall.
Kit GRA-402-25, walnut finish, 50 lbs. 114.95*
Kit GRA-407-25, unfinished, 50 lbs. 109.95*

FREE '72 HEATHKIT Catalog



New Heathkit Digital Multimeter 229.95*

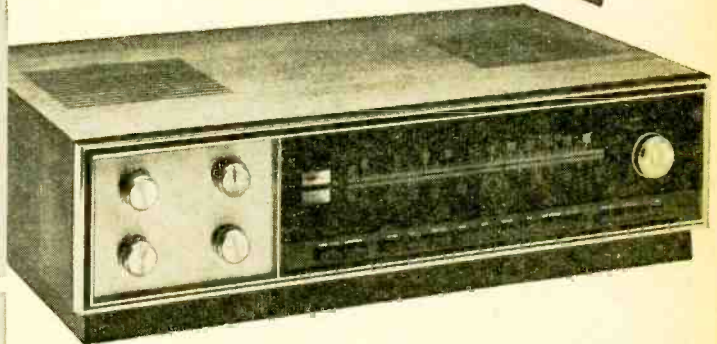
A kit-form multimeter that meets lab specs. Has 3½ digits for 100 uV resolution on the 200 mV range, 1V on 1000 V. Five overlapping ranges measure voltage from 100 uV to 1000 V on DC (either polarity); 5 ranges cover 100 uV to 500 V on AC; 10 ranges measure 100 nA to 2A AC or DC; and 6 ranges measure resistance from 0.1 ohm to 20 megohms. Input impedance is approx 1000 megohms on 2V range, 10 megs on higher ranges; with overload protection built-in. DC calibrator supplied permits 0.2% accuracy without external equipment. Can be lab calibrated to 0.1%. For lab performance at a budget price, order your IM-102 today. Kit IM-102, 9 lbs. 229.95*



New Heathkit 10 MHz Triggered Sweep Scope. 229.95*

Here's a five-inch triggered sweep scope at a price you can't afford to pass up. Has DC-10 MHz response, calibrated attenuator. 50 ns sweep rate with magnification. AC-DC coupling, 50 mV sensitivity. It's the ideal instrument for general service and design work... and its quality design, easy assembly, simple operation and self-service capability make the Heathkit 10-103 one of the greatest scope values on the market today. Order one for your shack, shop, lab or classroom, now. Kit 10-103, 37 lbs. 229.95*

The better-than-ever '72 Heathkit Catalog has the world's largest selection of fun-to-build, money-saving electronic kits...including color TV, stereo/hi-fi, organs, home appliances, engine tune-up tools, radio control, portables, shortwave, marine gear, metal locator, instruments, hundreds more. If you don't have this catalog, you've missed seeing over 50 new kits, introduced since the last edition. Send today for your free copy.



The most powerful and sensitive stereo receiver they've ever tested.

Heathkit AR-1500 AM/FM/FM-Stereo Receiver — ranked by independent experts as the best ever. Here's 180 watts dynamic music power, 90 watts per channel into 8 ohms, 120 watts per channel into 4 ohms. Less than 0.1% intermod distortion, less than 0.25% harmonic distortion. FM selectivity greater than 90 dB, outstanding phase linearity, separation, and low distortion result from two computer-designed 5-pole LC filters. A 4-gang 6-tuned circuit front end offers rock-solid stability, 1.8 uV sensitivity, 1.5 dB capture ratio and 100 dB image and IF rejection. Automatic FM squelch is both noise and deviation activated, fully adjustable for sensitivity.

The AM section, overlooked in most receivers, boasts 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 for good overload characteristics, proper AGC action, no IF alignment and high-fidelity performance. The AR-1500 is an easy kit to build, ten plug-in circuit boards, two wiring harnesses and extensive use of pre-cut wiring with installed clip connectors make assembly fun. Built-in test circuitry uses the signal meter to make resistance and voltage checks as you go. Other features include Black Magic panel lighting that hides the dial markings when the 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 auxiliary sources — all with individual level controls. The AR-1500 is the critics choice, and with no reservations, the best stereo receiver we've ever designed.

Kit AR-1500, less cabinet, 42 lbs. 379.95*
ARA-1500-1, walnut cabinet, 6 lbs. 24.95*

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CIRCLE NO. 18 ON PAGE 17 OR 103

e/e CB Coffee Break

Continued from page 69

by the meter. For example, if the usual power output is 3 watts RF, and you suddenly note the power is dropping day-by-day you know there's a headache brewing.

It might happen that one day you will note the rig is putting out a lot more than 5 watts, and you know this just can't be. What you *will know* is that something has gone wrong with the antenna system because a high SWR can cause an in-line wattmeter to read erroneously high, something that can't be shown by the standard "load type" wattmeter.

A big plus going for the Antenna Specialists M252 Wattmeter is that it doesn't steal any appreciable power from your signal. Fact is, the RF power needed to drive it is so insignificant there isn't a receiving station anywhere that can tell whether or not the meter is cut into your transmission line. Another big plus is its small size and vertical mounting that makes it easy to hang the M252 on the wall or dashboard. While the M252 has two ranges: 0-10 and 0-100 watts, and you will never need the high range unless the FCC changes its rules or you experiment with relatively high power Class C equipment, the high range is most convenient for handling SSB signal peaks (yes, it can be used with SSB equipment).

The M252 wattmeter is priced at \$27.95. For additional information—circle No. 58 on the Reader Service Coupon on page 17 or 103.

More on Class E. The FCC is being pressured to take quick action on establishing the *Class E citizens band*. Reliable sources say the FCC staff has been reluctant to act on Class E because of inability to enforce its rules on the existing Class D band, and as one informant said—because of fear that opening up the Class E band will clear up much of the chaos on the Class D band and cause Congress to *appropriate less money* to the FCC for rules enforcement. If this is true, the FCC staff is more concerned about its budget than the public interest. *We don't believe it.*

To refresh readers about what Class E CB is all about, here are the facts. The Electronics Industries Association petitioned the FCC early in 1971 to reallocate the 220-222 MHz portion of the 220-225 MHz amateur radio band to the Citizens Radio Service and to divide this 2-MHz wide "Class E" band into 80 channels. The petition calls for the use of FM and authorized RF output power or up to 25 watts.

Many got the impression that the petition called for moving of all Cbers from the 27-MHz band to the 220-MHz band. *This is not so.* The new 80-channel Class E band would be in addition to the existing 23-channel

27-MHz Class D band! Fear not! If you are a 27-MHz band Cber, you will be able to continue to operate in that band. A move to the 220-MHz band is at your option. And if you do move, it'll be for the best!

When the Class E band is established, expect a lot of Cbers to abandon the 27-MHz band. This is good. There will be less congestion on both bands.

Who's against Class E? The American Radio Relay League (ARRL) can be expected to protest the loss of any frequency space. The ARRL which is the unofficial but powerful ham lobby, looks out for the hams, as it should. However, the hams should not complain because very few of them use the 220-225 MHz band. Cbers have lost 384 channels because they didn't make adequate use of them. Until 1958, Cbers had the entire 460-470 MHz band—room for 400 channels—and have lost all of that band except for 16 channels. Under the EIA petition, the hams would still have room in the 222-225 MHz band for 120 channels.

The Class E band will be better than the Class D band—no skip—much less noise—controllable range. *Equipment will be available* in abundance as soon as the FCC gives the green light. E. F. Johnson has a Class E rig ready for production—Pace can be expected to be ready—Lafayette has announced it will be—and Sonar, RF communications, Hallicrafters and Standard can easily modify their business radio transceivers for Class E use. It is even rumored that Motorola is looking into Class E.

Johnson says it's new Class E rig will sell for about \$200. It won't be long before lower-priced rigs reach the market. Using ICs and other modern techniques, an FM rig should cost no more than an AM rig.

Class E antennas will be smaller and can provide more gain. A full quarter-wave whip is only a foot high. A yagi beam will be almost nine times smaller than for the Class D band.

Class E equipment can be designed for full-duplex operation just like a telephone without a push-to-talk switch—mobile units transmit on one frequency and base stations transmit on another. This makes phone patches more practical.

To get the Class E citizens band established soon requires letting the FCC know the public wants it and that the public needs it. The radio spectrum belongs to the people—it is they that should have the power to determine how it is to be used. If you want the Class E band established with a minimum of procrastination by the FCC, write or phone your Congressman and ask him or her to contact Chairman Dean Burch or the Commissioners, not the FCC staff, and demand immediate hearings on the EIA petition to establish the
(Continued on page 92)



No Knocks for Electric Beetle

□ Just unplug her and you're ready to go! That's all it takes with this electric beetle built by Capt. Joe Allred of the U.S. Air Force. The beetle can reach speeds up to 40 *mph*, it's good on hills, and even better on gas. After a trip, all you need to do is reach into the back seat for an electric cord attached to a battery charger built into the car, and "fill it up!" Why? Because it's powered by 6 six-volt golf cart batteries housed in the body of a 1962 Volkswagen.

The "motor" consists of a scrapped aircraft generator which can be used as the drive motor. Unlike other electric cars, this bug uses a shunt motor instead of a series

motor. Although lighter and more efficient, this hookup presented a speed-control problem. Capt. Allred solved this by adding a 17-position rotary switch and an array of relays.

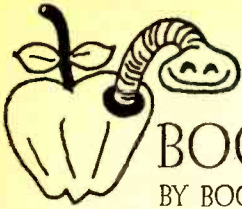
According to Joe's calculations, his six-pack of power should provide a cruising range of fifty miles. However, at present he is limited to 15 miles with a top speed of 40 *mph*. Then, it must be recharged. Four hours later, just unplug it and Joe's off again. The vacuum cleaner sound you hear as you drive along is the cooling fan motor. When the car is ready for production, this noisemaker will be replaced by a loud ticking clock. —Myrtle Gronk.



Joe can cruise along pollution-free because his electric car is out of gas—permanently!



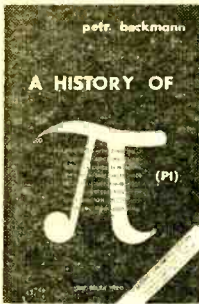
Joe's six-battery beetle is lighter than other electric cars using 20 to 24 batteries.



BOOKMARK

BY BOOKWORM

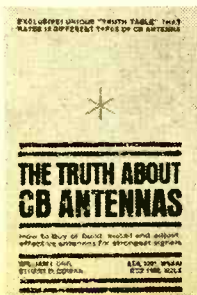
All About Pi. Did you know that in 1897 the Indiana House of Representatives passed a bill defining the value of pi, and that it was the incorrect value? This is only one of the many facts in *A History of Pi*, which covers the 4,000-year history of the circle ratio. Author Petr Beckman, Professor of Electrical Engineering at the University of Colorado, starts with the Babylonian value of $3\frac{1}{8}$ and traces the increasingly accurate approximations down through the centuries, including the Egyptian, Chinese and Indian values, the Greek geometric approaches, the 19th century trigonometric formulas, the calculus series, and the computers that have generated values of more than 100,000 decimal places. (The first



Hard Cover
196 pages
\$6.30

10,000 decimal places are printed in the end papers.) Many great names in mathematics and other sciences are involved, including Gauss, Huygens, Descartes, Pascal, Leibniz, Newton, Euler, and Laplace. If you're a math buff, this book belongs on your shelf. Published by The Golem Press.

Let the Buyer Be Wise. It's been a long time since last this magazine published an article of William Orr's. Our loss is the book industries gain for Bill teamed up with Stuart D. Cowan to co-author *The Truth*



Soft cover
240 pages
\$4.95

About CB Antennas. To fully understand the greatness of this book, one must read it. However, here are a few glimpses of what it contains: a truth table which unmask false antenna manufacturer's claims, how to build your own *Monster Quad* cheaply, how to build a balun for improved CB antenna performance; plus clear explanations of SWR, how SWR meters work, how to tune your transmitter with an SWR. And there's a heck of a lot more! Published by *Radio Publications, Inc.*

Home Electrician. Here is a new book that is one of the best sources containing concise interpretations of the National Electrical Code. *House Wiring* by Roland E. Palmquist,



Hard cover
183 pages
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presented in plain, simple language, giving the reader answers to many often asked questions about all phases of house wiring. Each of its fifteen chapters covers such essential topics as load calculations, services, cable varieties, circuits, receptacle spacing and much more. Also included is an important chapter on the wiring of mobile homes. A comprehensive appendix features charts and graphs explaining electrical symbols, properties of conductors and conductor dimensions. Published by *Howard W. Sams Co., Inc.*

Red, Green, Blue. This new, up-to-date, easy-to-follow guide, *How to Use Color TV Test Instruments*, provides TV service technicians with the information they need to use modern, up-to-date equipment designed specifically to save time and money. Written by one of the country's foremost color TV ex-
(Continued on page 94)



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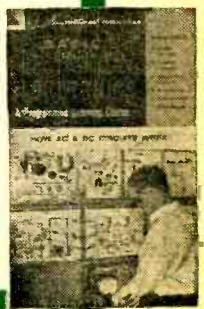


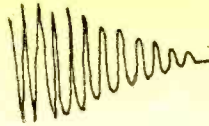
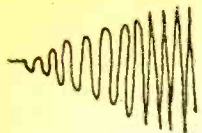
all *NEW* BASIC COURSE in ELECTRICITY & ELECTRONICS *

PART 1 UNDERSTANDING SEMICONDUCTORS

What You Will Learn. In this part you will learn about N- and P-type semiconductor materials, what the differences are between them and what happens when the two are joined to form a PN junction. You will also learn about the elements of a transistor and what the arrow head on the emitter lead is all about. You will learn the difference between forward and reverse bias. Of course, diodes and their characteristics are discussed. In Part 2, you will learn about how a transistor is biased and how it amplifies. The three basic types of transistor amplifiers are also discussed along with transistor specification sheets.

* This series is based on Basic Electricity/Electronics, Vol. 2, published by Howard W. Sams & Co., Inc.





WHAT IS A SEMICONDUCTOR?

Materials can be classed in three groups according to their electrical properties—conductors, semiconductors, and insulators. Metals such as silver, copper, and aluminum have many free electrons. This makes it easy for current to flow through them. For this reason these metals are called **conductors**.

Materials such as glass, rubber, and many plastics have practically no free electrons. This makes it very difficult for current to flow through them. These materials are known as **insulators** and are used in a variety of applications ranging from the covering on conductors to the dielectric in capacitors.

Materials such as selenium, silicon, and germanium have some free electrons—more than an insulator but fewer than a conductor. These materials are generally referred to as **semiconductors**.

WHY SEMICONDUCTOR MATERIALS ARE IMPORTANT

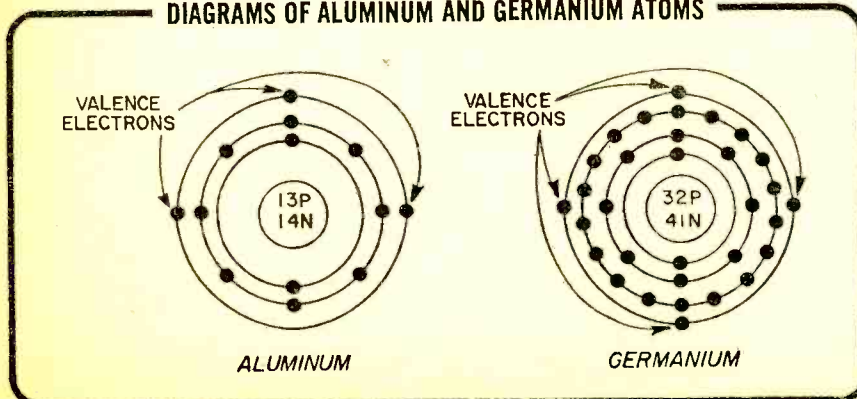
A diode made of semiconductor material is called a **solid-state diode**. Semiconductor materials are also the basic ingredients of transistors. Solid-state diodes can replace vacuum-tube diodes, and transistors can replace vacuum-tube triodes. Why is this important? Solid-state diodes and transistors are smaller, weigh less, and use less power than their vacuum-tube counterparts. They are also more rugged and last longer than vacuum tubes. In addition, they do not require a filament-supply voltage.

How do solid-state diodes and transistors work? How can a solid substance maintain unidirectional current flow in the same manner as a vacuum-tube diode? How can a solid substance amplify like the triode? To answer these questions we must first go back and examine the basic building blocks of matter—atoms.

The Aluminum Atom

The aluminum atom has thirteen electrons circling in orbits around a nucleus of thirteen protons and fourteen neutrons. The negative charges on the thirteen electrons are exactly balanced by the positive charges on the thirteen protons. It is a natural characteristic of an aluminum atom that three **valence** electrons in the outer shell, or ring, are loosely bound to the atom and are easily dislodged. This is important. These three loosely bound electrons are the reason why aluminum is a conductor. It is a dislodging of these electrons and their subsequent capture by

DIAGRAMS OF ALUMINUM AND GERMANIUM ATOMS



another atom that is the basis of electrical flow. An electron can pass from one orbit to the next until it eventually arrives at the positive terminal of a power source, say a battery. Of course, this shifting and exchanging of electrons does not start until some external energy is applied. It could be in the form of light, heat or, as in our illustration, a battery that provides electrons from its negative terminal.

Aluminum has a valence of minus 3. This means that aluminum easily gives up the three electrons—also called free electrons—in its outer ring.

The Germanium Atom

The nucleus of the germanium atom is larger than the aluminum nucleus. It has thirty-two protons and forty-one neutrons. There are thirty-two orbiting electrons, of which four are in the outer ring. These four electrons make germanium a semiconductor. The germanium atom can either give up these electrons or take on more to complete its outer ring.

- Q1. Copper is a(n)
- Q2. Glass is a(n)
- Q3. A conductor has many
- Q4. Silicon is a(n)
- Q5. The electrons in the outer shell of an atom are known as
..... electrons.

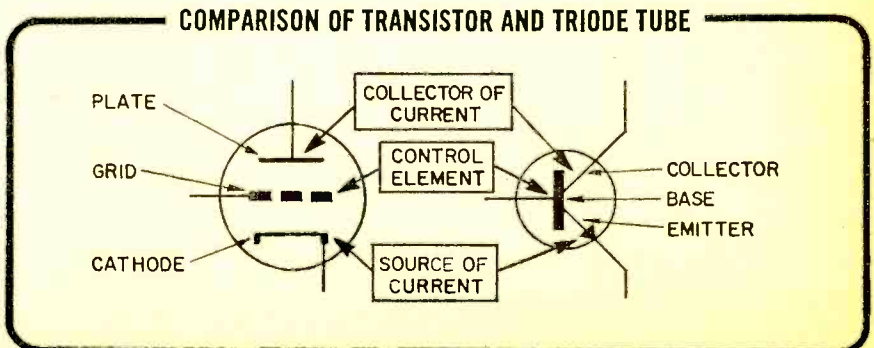
Your Answers Should Be:

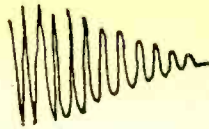
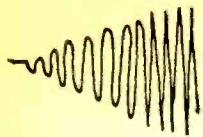
- A1. Copper is a **conductor**.
- A2. Glass is an **insulator**.
- A3. A conductor has many **free electrons**.
- A4. Silicon is a **semiconductor**.
- A5. The electrons in the outer shell of an atom are known as **valence electrons**.

THE TRANSISTOR

In a sense, a transistor is a valve. It controls the movement, or flow, of either positive or negative charges through the semiconductor crystal of which it is made. The transistor can be compared to a triode. In fact, it is convenient to think of the transistor as a solid-state triode.

The symbols for the triode and the transistor can be compared in the figure. Each has three elements, one of which acts as a source of current. In the triode, this element is called the cathode; in the transistor, this element is called an **emitter**. (The arrow in the symbol points in the direction of positive charge—called *hole*—movement.) Both the transistor and triode vacuum tube have a control element. In the triode, it is called the grid, and in the transistor it is called the

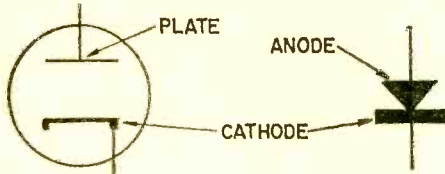




base. The tube and transistor each have a current collector, called the plate in the triode and the collector in the transistor.

In a similar fashion, a solid-state diode may be compared to a vacuum-tube diode. Here there are only two elements.

COMPARISON OF TUBE AND SOLID-STATE DIODES



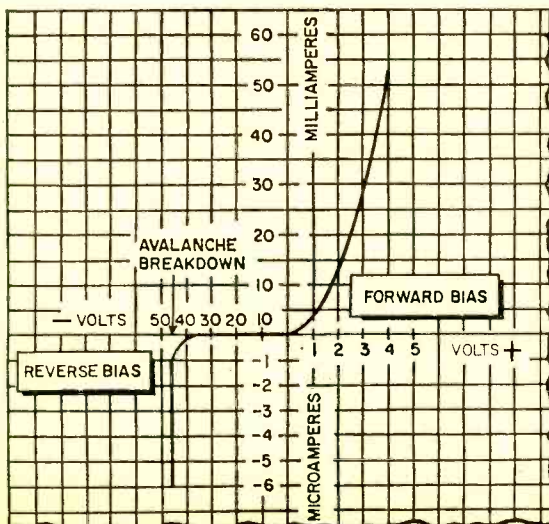
DIODE CHARACTERISTICS

Some of the important characteristics of a solid-state diode will be examined. These are the current-voltage, resistance, temperature, and capacitance characteristics.

Current-Voltage Relationships

The graph represents the amount of current that will flow through a typical diode when various voltages are applied. The positive-voltage region is the area in which the diode is forward-biased and current flows. The reverse-bias region is to the left of the origin. Remember that the diode will not conduct in the reverse direction. This is true on the graph up to almost 40 volts of reverse bias. Above

CURRENT-VOLTAGE CHARACTERISTIC CURVE



this value, small currents in the order of a few microamps start to flow. This current flow is due to the leakage. When the reverse bias reaches about 45 volts there is a sharp increase in reverse current. This is called **avalanche breakdown**.

Resistance

The resistance of solid-state diodes varies with the applied voltage. Resistance is high for low forward-bias voltages and is low for high forward-bias voltages. For reverse biases, the resistance is very high until avalanche breakdown occurs.

Temperature

Solid-state diodes have a negative temperature coefficient. This means that as the temperature increases, the resistance of the diode decreases. Within certain limits the effects of resistance changes due to temperature change are not detrimental to the operation of the diode. However, when a very high temperature is reached, the resistance of the diode decreases so much that the current through the diode may be high enough to permanently damage the crystalline structure. This action is called **thermal runaway** and presents a serious problem in circuit design.

Q6. The condition in which the current through a reverse-biased, solid-state diode sharply increases is called

Q7. The resistance of a solid-state diode varies with the

Q8. Solid-state diodes have a temperature coefficient.

Your Answers Should Be:

A6. The condition in which the current through a reverse-biased, solid-state diode sharply increases is called avalanche breakdown.

A7. The resistance of a solid-state diode varies with the applied voltage.

A8. Solid-state diodes have a negative temperature coefficient.

Capacitance

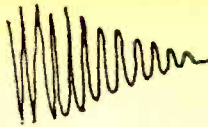
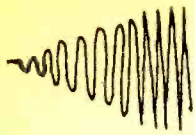
Two conductors separated by a dielectric constitute a capacitor. A solid-state diode is a capacitor in which an NP junction serves as the dielectric. At low frequencies the effects of this capacitance need not be considered. At high frequencies, however, this capacitance (in the order of about 3 to 5 micromicrofarads) becomes an important factor.

SEMICONDUCTOR-DIODE DATA

Most electronic parts catalogs have several pages devoted to semiconductor diodes. An example of some of the data you will see in such a catalog is shown in the table below. Notice that diodes are designated 1N34, 1N58, etc. Just as with vacuum tubes, manufacturers have agreed to call diodes having the same characteristics by the same type number.

SEMICONDUCTOR DIODE CHARACTERISTICS

TYPE	Peak Ambient		Forward Peak	CURRENT	
	Inverse	Temperature		AVERAGE	CAPACITANCE
	Volts	Range—°C	mA	mA	pF
1N34A	60	-50 to +75	150	50	1.0
1N58A	100	-50 to +75	150	50	1.0



The table shows some of the characteristics for the 1N34A and 1N58A. Peak inverse voltage (PIV) is the reverse bias at which avalanche breakdown occurs. The ambient temperature range is that range of temperatures over which the diode will operate and still maintain its basic characteristics. Forward current values are given for both the average current (that current at which the diode is usually operated) and the peak current (that current which, if exceeded, will damage the diode). The only difference between these two diodes is in the peak inverse voltage. Therefore the 1N34A could be substituted for the 1N58A in applications involving signals of less than 60 volts peak-to-peak.

SEMICONDUCTOR TYPES

There are two types of semiconductor material of interest to us—P-type and N-type. This simply means that a slice or piece of semiconductor, say N-type germanium, has been atomically altered to include an extra electron in the orbits of some of the atoms. So, whenever a current is passed through an N-type semiconductor, it is the result of *excessive* free electrons moving from orbit-to-orbit.

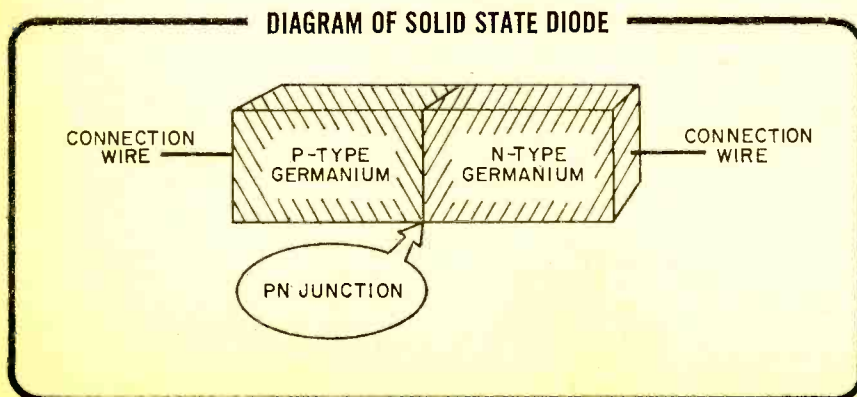
On the other side of the coin, a piece or slice of P-type germanium has been atomically altered to have one *less* electron than normal in some of the orbits. Whenever external energy is applied to a P-type semiconductor, the shifting and exchanging of free electrons again takes place, but it does so by filling and then emptying the holes caused by the missing electron.

So, a double view of electrical flow in a P-type semiconductor is possible. Electrons still flow toward the positive energy source, but holes also effectively flow in the opposite direction—toward the negative energy source.

DIODE OPERATION

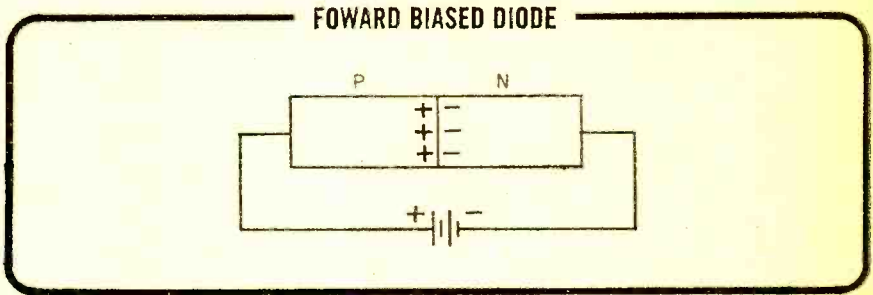
Early radios used crystal diodes to detect radio signals. These diodes allowed current to flow in one direction but not in the other. This **unidirectional** current capability is, of course, the distinguishing feature of the diode.

A solid-state diode consists of a section of P-type semiconductor material joined to an N-type section. The activity occurring at the junction of the materials is responsible for the unidirectional property of the diode. The contacting surface is called the **PN junction**.



Forward Bias

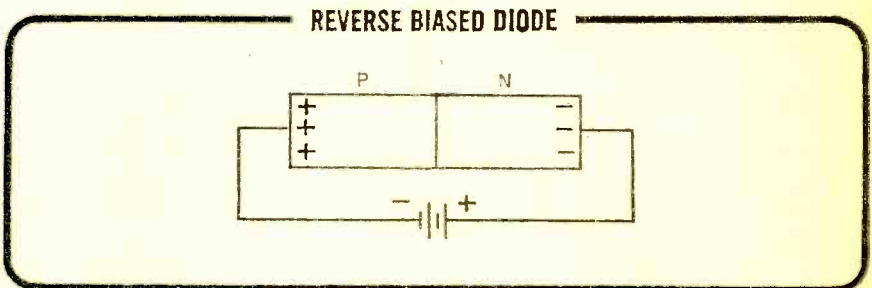
In order to produce a flow of current across the junction, the diode is forward biased by a battery connected as shown. The negative terminal connects to the N-type semiconductor while the positive terminal connects to the P-type. Free electrons in the N section move toward the junction because they are repelled by negative voltage from the battery. Simultaneously, holes in the P-type semiconductor are forced toward the junction by the positive battery voltage. If the



voltage applied to the diode is great enough to overcome a natural junction barrier (about 0.3 volt for germanium), electrons from the N-type semiconductor will begin to fill holes in the P-type. For each electron-hole combination at the PN junction, an electron enters the diode from the negative battery terminal, while another leaves the diode for the positive terminal. Thus, current flows through the diode.

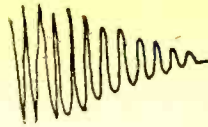
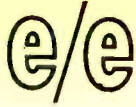
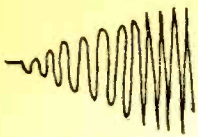
Reverse Bias

When the battery connections are as shown, the diode is reverse biased. With the negative battery terminal connected to the P-type semiconductor, holes are attracted away from the junction. At the same time, the positive battery voltage attracts free electrons in the N-type semiconductor *away* from the junction. The result is an absence of current flow because electrons and holes are not at the junction area and cannot, therefore, combine.

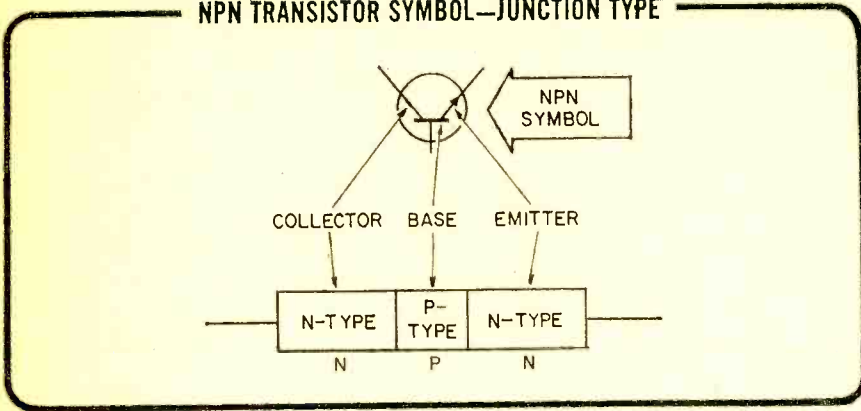


NPN TRANSISTORS

By sandwiching a very thin piece of P-type germanium between two slices of N-type germanium, an NPN transistor is formed. A transistor made in this way is called a **junction transistor**. The symbol for this type of transistor showing the three elements (emitter, base, and collector) is shown. The three elements correspond to the cathode, grid, and plate, respectively, of a vacuum-tube triode.



NPN TRANSISTOR SYMBOL—JUNCTION TYPE

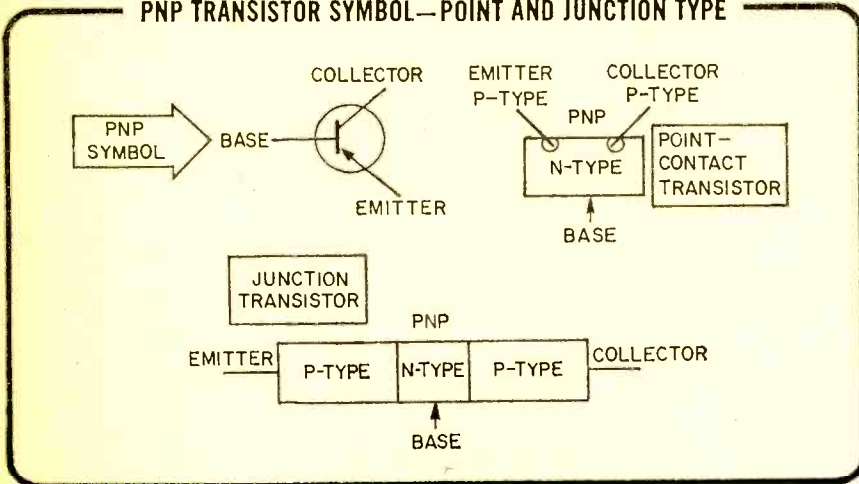


PNP TRANSISTORS

By placing N-type germanium between two slices of P-type germanium, a PNP junction transistor is formed. A PNP point-contact transistor can be made by fusing two catwhiskers to a large N-type base.

The symbol for the PNP transistor is almost identical to that of the NPN transistor. The only difference is the direction of the emitter arrow. In the NPN transistor it points away from the base, and in the PNP it points toward the base. Electrons always flow *into* the arrow. If the arrow points toward the base, the electron flow is from base to emitter.

PNP TRANSISTOR SYMBOL—POINT AND JUNCTION TYPE



Q9. The capacitance of a solid-state diode must be considered at frequencies.

Q10. The three elements of a transistor are the,, and

Your Answers Should Be:

- A9. The capacitance of a solid-state diode must be considered at high frequencies.
- A10. The three elements of a transistor are the emitter, base, and collector.

WHAT YOU HAVE LEARNED

1. Semiconductors are materials that are neither good conductors nor acceptable insulators.
2. Transistors and solid-state diodes replace vacuum tubes because they are smaller, weigh less, are more rugged, use less power, and have a longer useful life.
3. Holes behave as though they were positively charged particles.
4. Current flows through a forward-biased PN junction but not through a reverse-biased PN junction.
5. Transistors function like valves to amplify signals.
6. The emitter, base, and collector of a transistor correspond to the cathode, grid, and plate of a triode tube.

Ask Hank, He Knows

Continued from page 25

before it is dissipated. Also, the irregular surface of land chops up the ground wave and breaks it up much the same way a hurricane is broken up over land.

Sounds Like an Old Timer

My old Cannonball headphones have had it. I've got to spring for a new set, so what's good?

—J.K., Miami FL

Just stay away from hi-fi headphone—they are for the birds. By that I mean, they will chirp a lot because they are too darn good for the job they have to do. Something to do with frequency response when you don't need it. Instead, pick up some literature from Telex and Superex. These firms make good communications headphones you'd be proud to slip on your noggin.

Why Buy, I've Got Last Year's Issue

Let's be honest with the readers. You publish COMMUNICATIONS WORLD twice a year when all a fellow really needs in one issue maybe every other year. Hows about it, will you level with me?

—R.F., Greenwich CN

Look, you buy what you need and no more. In fact, I suspect there are about 200,000,000 potential readers who pass newsstands during the year and pass us by. That's life! But if you are a serious DXer, let's talk about it. First, White's Radio Log is updated every issue with a minimum of 700 to 1000 corrections. If you tune the BCB, FM or TV for

DX, we'll see you every six months. You need White's! If you are a beginner, then you will need the next several issues just to get oriented. Only the old pros would pass us by, but they don't. It seems the old pros realize they can never learn enough about their hobby. Okay, so I leveled. Get up the scratch for the next issue.

Sun Spots

When will the sun spot frequency be low again?

—H.P., Dallas TX

They are getting lower and lower each month. The high was during 1968 and the low is expected about 1974-5. But don't wait till then, start DXing today.

They Are Still Around

I heard that the XYZ Radio Company is out of business. I still see some of their gear on dealer shelves. Is there anything wrong with their products?

—B.B., Newark NJ

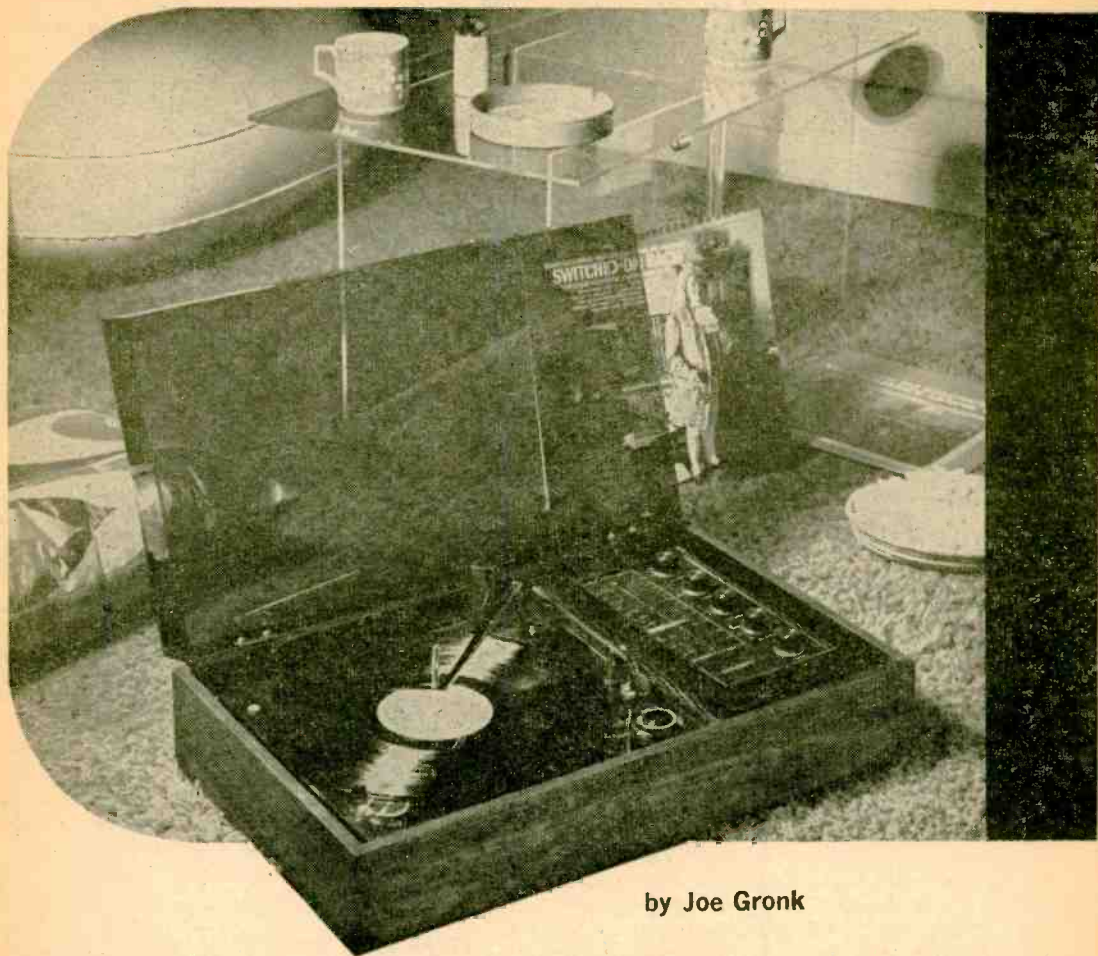
Heck no—there is nothing wrong with their product, but let me explain. A few shortwave receiver manufacturers have ceased production due to hard times in the consumer receiver industry due to imports. However, their products are still available because they have many fine items in warehouses. Don't worry, these manufacturers will snap back when times get better because their products are good.

Testing 1, 2, 3, 4—

The big catch for a BCB DXing comes when that "daytime only" 1000 or 5000-watt takes to the air at 2 AM for a frequency check. Finding these stations is hit or miss

(Continued on page 96)

Build an Ecology Cover for your



by Joe Gronk

Soot, dog's hairs, lint, dust, beach sand, not to mention martini and mustard stains, mar the surface of your LPs because your phono is not topped off with an ecology cover. Don't yield to record surface noise or skipped grooves—fight back with a home-brew Plexiglas cover you can knock together in one evening.

You can design your cover. All it takes is four sides and a top. Unsure? So was I, so I cut up some cardboard to the sizes required and Scotch-taped it together to be sure of the dimensions. Nothing like a good fit with a prototype before buying the Plexiglas. Next stop was the hardware center where the Plexiglas was available along with a cutting tool and some sand paper.

Scribing and breaking Plexiglas is easy. With the cutting tool, scribe a straight

line about seven times for a deep groove in the Plexiglas. Then, the scribed line is placed over a $\frac{3}{4}$ -in. dowel running the length of the break. To break, hold the sheet with one hand and apply downward pressure on the short side of the break with the other. The hands should be kept adjacent to one another and successively repositioned about 2 inches in back of the break as it progresses along the scribed line. All this is done with the protective masking paper on the Plexiglas.

Rough edges can be scraped with a sharp knife, then sanded with a medium grit (60-80) paper. Once smooth, continue with "wet or dry" (150) grit sand paper. For a transparent edge, follow this step with grits to 400 and buff with a clean muslin wheel dressed with a good grade of

Turntable



Working with plexiglass is as simple as *one, two, three, four*. After determining top and side measurements, scribe cuts (1) and snap clean (2) with original masking paper on Plexiglas. Use masking tape to assemble phono cover (3) after edges are sanded smooth. Next, apply cement (4) with a solvent applicator which provides a professional touch.

fine grit buffing compound. Inexpensive kits with compounds and wheel are available at Plexiglas dealers.

Assemble the Plexiglas pieces to shape with strips of masking tape with the protective paper removed from the Plexiglas. Apply solvent (solvent and applicator are available where you buy Plexiglas) to the joint with a solvent applicator—a syringe-like device for applying small amounts of solvent without dripping. A small drop will spread in the joint and go a long way. First practice on some scraps. You'll be a pro in no time.

The Ecology Cover is now finished. Remove the masking tape and place the cover on top of your turntable or phono. If you wish, install hinges so the lid can be lifted with ease. To do so, drill holes in the Plexi-

glas with a hand or twist-drill. Use a sharp bit and slight pressure. Select either brass or "silver" hinges to go with the motif.

Like beautiful wood or fine silver, Plexiglas can be scratched. But unlike most other materials, a scratch on the surface of Plexiglas can be removed. Minor surface scratches can be visibly removed by waxing. Deeper scratches can be removed by sanding lightly with 400 grit paper and buffing compound. A periodic waxing with a good grade of automobile wax (not of cleaner-wax combination) will protect the surface of Plexiglas. Apply a thin, even coating with a soft clean cloth.

A full-color illustrated brochure entitled *Do It Yourself Acrylic Sheet* is available by circling No. 52 on the Reader Service Coupon on page 17 or 103. ■

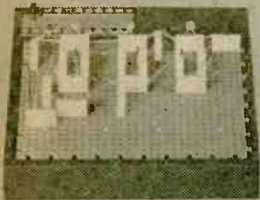
Let Bell & Howell Schools help you get ready for a rewarding Color TV Service Business of Your Own

This new program brings you a complete Bell & Howell Color TV kit—plus additional Bell & Howell Schools materials—which you receive a step at a time. The Color TV kit offers an ultrarectangular 25" diagonal picture tube with 315-sq. inch screen. Lets you view more of the transmitted image. 25,000 volts. 45 transistors, 55 diodes, 4 advanced IC's. 3-stage, solid-state IF. Solid-state VHF/UHF tuners. Automatic fine tuning and many other quality features.



BUILD, KEEP
THIS COMPLETELY NEW
BELL & HOWELL
25" DIAGONAL SOLID-STATE
COLOR TV
(315-sq. inch)

**BUILD, KEEP, USE ALL FOUR OF
THESE PRECISION QUALITY KITS**



INCLUDES—
Design Console with built-in power supply, test light and speaker. Plus patented plug-in Modular Connectors.



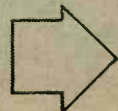
INCLUDES—
Portable 5-inch, wide-band oscilloscope calibrated for peak-to-peak voltage and time measurements.



INCLUDES—
Transistorized Meter . . . a multimeter for current, voltage and resistance measurements registered on a large, easily-read dial.

FREE! MAIL CARD TODAY FOR ALL THE FACTS

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YOU'LL BE READY FOR COLOR TV . . . B&W AND MOST HOME ENTERTAINMENT ELECTRONICS DEVICES

This exciting new program offers you the *first* 315-sq. inch Solid-State Color TV available for at-home training.

As you follow the simple, step-by-step assembly procedures, you become thoroughly familiar with the most advanced solid-state TV circuitry. And as you build this kit you'll prepare yourself for a profitable Color TV service business of your own—either full or part time.

Why Color TV pays better.

Today, Color TV is the big seller. As Color Television goes completely solid-state, the man who has mastered this type of circuitry will be in demand. Obviously, this is where the money is going to be made.

This new Bell & Howell Schools program will also give you an in-depth knowledge of the basics as well as TV circuit theory and analysis. You'll get the theory and practical experience you need to handle radios, hi-fis, stereos, and tape recorders.

You will also receive three precision quality instrument kits which you assemble and keep. These are highly sensitive professional instruments which you'll use constantly.

**EXCLUSIVE ELECTRO-LAB®
IS YOURS TO KEEP, USE**

This unique at-home laboratory comes to you in 16 shipments and includes a remarkably instructive *design console*. You can rapidly "breadboard" a great variety of circuits without soldering. The *Oscilloscope* offers 3-way jacks to handle test leads, wires, plugs. Images on screen are bright, sharp. Your *Transistorized Meter* is fully portable, features a sensitive, 4-inch, jewel-bearing d'Arsonval meter movement. It's a multimeter for current, voltage and resistance measurements.

CONSIDER THESE ADVANTAGES:

Bell & Howell Schools' Electro-Lab-at-Home Plan gives you the most thorough background possible in solid-state Color TV. Everything

Note: TV picture is simulated.

comes to you by mail and you go at your own speed. You'll be prepared not only for a service business of your own but for many positions in the Electronics and Television industries. All without missing a paycheck!

When you have completed your program our *Lifetime National Placement Service* will help you locate in an area that interests you. This service is available at any time—now or in the future.

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Our programs are approved for Veterans' Benefits. If you're a Vet, check the space in the card at left for full details.

Student Loans now available

If you are a non-veteran and need financial assistance, you may qualify for Student Loans, which are also available.

Special Help Sessions. These are scheduled regularly (Saturdays) at seven Bell & Howell Schools and in many other cities. Here you can get expert guidance by top instructors to help you over the rough spots.

Bell & Howell Schools offer you even more. Once you have finished your program at home, you may decide you want more advanced preparation. In this case, you may transfer to any one of our seven schools which are located all across the country.

Mail the postage-free card today for all the facts. There is no cost or obligation of any kind.

DEVRY INSTITUTE OF TECHNOLOGY

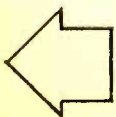


ONE OF THE

BELL & HOWELL SCHOOLS

(TV kit is not available in Canada)

325



FREE! MAIL CARD TODAY FOR ALL THE FACTS
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Kathie CB Carousel

Continued from page 50

pressed) at peak sound levels. This type of operation—rather than compressing the entire sound level range—is virtually identical to a broadcast-type limiter and provides the maximum degree of talk power. Jeff, our technician, says that if you drop into your local AM broadcasting station you'll find the same type of limiter in use.

Most important feature of all is the M+3's unusually low compressed distortion, as shown in Figs. 2 and 3. Figure 2 is the M+3's output well below compression—note that it is notably clean and undistorted. Figure 3 is almost maximum compression, the equivalent of shouting directly into the microphone. Only by looking real hard can you note any distortion on the positive waveform peaks. This is outstanding performance.

Modulation Meters. Even though the M+3 has an output level control, the level applied to the transceiver can be considerably higher than from the microphone normally supplied, and there is a possibility the transmitter will be overmodulated. For this reason some sort of modulation meter is required for the initial M+3 output level adjustment. Once the adjustment is made the level control can be taped in position because the M+3's amplifier power is controlled by the PTT switch.

Summing Up. The Turner M+3, priced at \$33 CB net, passed every test we could think of with flying colors. It produces a clean, highly intelligible signal that's all *far out* talk power. For additional information circle No. 44 on our Reader Service Coupon on page 17 or 103. ■

CB Coffee Break

Continued from page 74

Class E citizens band. It is Congress that controls the FCC budget. And when a Congressman talks, the FCC listens.

It isn't that the FCC is made up of bad guys. To the contrary, the FCC has a lot of good guys. But, they're being pressured by a lot of wanters of this and that. For years, the FCC has bowed to broadcast industry pressure. The broadcast industry is concerned about profits. Now, we're talking about *public necessity and convenience*. Class E CB will be good for the public. Let's get it—*now!*

Hey, Look Me Over

Continued from page 12

in an ultra thin enclosure. Bass response goes down to 50 Hz with the powerful 5-in. high-compliance woofer and 5-in. drone cone. The two high frequency tweeters disperse crystal clear, brilliant highs up to 19,000 Hz. Electrical crossover is present at 4 kHz. An ideal choice for rear speakers in 4-channel stereo systems where compact size and high quality sound is a must. Can be hung on walls, placed on bookshelf, or stood on floor (with legs supplied) if desired. Cabinet is hand finished in oiled walnut with a luxurious textured brown grille cloth. Impedance: 8 ohms. Built-in adjustable high frequency level control. Size: 19-13/16 x 14-27/32 x 2-15/32-in.D. Priced at \$34.95. For more information, circle No. 11 on Reader Service coupon on pages 13 or 103. ■

DX Guide

Continued from page 76

they have been logged in North America on frequencies as low as 2868 kHz. All reports should contain two International Reply Coupons available from any post office for 15-cents each. This is of course less than you would pay a dealer for the equivalent stamps, and in most cases he couldn't provide the rare postmarks.

Stamp collectors turned DXers will encounter a completely different kind of problem if they tackle the Spanish held Canary Islands and British owned Ascension. These are the sites of widely heard international relays operated by R. Nacional Espana and the British Broadcasting Corporation. It is official policy of both these organizations to issue all QSLs from their headquarters in Madrid and London respectively. However some reports addressed to Sr. J. de Rojas Mora, Director, RNE Canarias. Santa Cruz de Tenerife have been answered directly from the islands. RNE Canarias is easily heard evenings in North America with Spanish transmissions beamed to Latin America on 11,800 and 15,360 kHz.

Electronic QSL's? When the BBC'S S. Atlantic Relay Station first appeared on the scene in 1966, the staff planned to issue special QSL cards directly from Ascension island at their own expense. However the quantity of mail, among other factors, soon became so overwhelming that the project had to be

abandoned. As giant interrelated networks of SWBC relays, of which BBC Ascension is a part, become ever more all-encompassing and politically intricate, DXers will find it increasingly difficult to obtain QSLs representing any individual transmitter site. This same "transmitter explosion" is part of an overall technological trend which, ironically, may eliminate the postal system entirely as we know it. If that happens collectors will have to abandon stamps, except as high priced historical artifacts of an antique communications system, and concentrate entirely upon the QSL which by then would reach the DXer electronically via a myriad of completely interchangeable facilities.

In other words, the very problems posed for stamp collectors by RNE Canarias and BBC Ascension suggest yet another reason why all philatelists should also now become QSL connoisseurs. On the other hand, if you are unable to receive a reply directly from RNE Canarias, you can always try for Canarias Aeradio working South Atlantic traffic on 8882 kHz. Unfortunately, Ascension Aeradio won't do you a bit of good as it is operated by

the USAF and would use U.S. stamps.

Early Morning Goodies. With the exception of ultra-rare St. Helena, Bermuda is least involved in political/technological issues of all the islands covered in this article and therefore, once you log it, it will be the easiest from which to receive a QSL with the island's own individual stamps affixed. But even here, ZFB1, a MW Broadcast Band station (960 kHz) at Hamilton, sometimes acts as an unofficial Voice of America relay. Early in 1971 they were reported by members of the International Radio Club of America with VOA English language transmissions during the wee hours of the morning; QSLs for these can be obtained directly from ZFB1. If you live East of the Mississippi and don't have an all night local on 960, you should eventually bag this one.

Meanwhile, during the evening hours Eastern collectors, depending upon the selectivity of their receivers and local QRM situation, might also be able to hear ZBM1 on 1235 kHz, half way between two graveyard channels. Or, if you can hear neither ZFB1 nor ZBM1, Kindley Aeradio is widely heard days on 8871 kHz and 2868 kHz at night. ■

Hour Master

Continued from page 58

the board to prevent AC fields from affecting the FET's gate. Regarding relay K1, sensitive types with coil resistances of 1000 to 2500-ohms will work if R3's value is adjusted to give the proper drive to relay-driver transistor Q2. (decrease R3 in 20% steps for more drive). The triac is mounted on perforated board together with a heatsink of 15 gauge aluminum. No insulating washer is needed, but be sure that other parts do not touch the heatsink. Diac D1 is mounted under the board. It isn't polarized so just wire it in. When the board is all done, mount it in the case on a pair of fiber or metal spacers. Make the bracket for the battery from a scrap of aluminum and screw it in place.

Operating Info. The triac specified is good for 600 watts, and the phase control will handle anything but fluorescent lamps and induction motors. If you want to handle more power, use a bigger triac in the same series. You will have to if you want to

extend control to such high power items as household irons or hotplates. Now, wire the system together being careful to use heavy leads in the power control section.

Connect a floor lamp or worklight to receptacle SO1 and apply primary power to the system. The lamp should now light,



"It's hard to believe, Angus, you have three speeding tickets this month."

and if you've included control R4, the brilliance should be variable. Now set power switch S2 to *on* and mode switch S3 to *in*; the lamp will go out. Press time-start switch S1, hold it for a moment and release. The lamp will light and remain on for a period determined by the setting of R1, the time delay control. By plugging a clock into the output and noting when it turns off at various settings of time delay pot R1, it should be a simple matter to calibrate the control for various settings.

With S3 in the *in* position, the load will be on for the time you select. In the *out* position, the load will turn on after the desired interval. This will allow you to snooze for a preset time before being blasted out of bed by Zarathustra, the Grateful Dead, etc., from your radio or phonograph.

You will no doubt find your own uses for this versatile electronic control; while it isn't exactly a genie in a bottle, perhaps the butler can be given an extra night off. ■

Bookmark

Continued from page 76

perts, Robert L. Goodman, the content emphasizes common-sense approaches to using the right instruments, thereby helping the technician get the most out of his investment in test gear. The reader will improve his ability to use an oscilloscope, color bar generator, alignment generator, vectorscope, and other such test instruments. Also included are techniques involving the use of the TV Analyst and sine square-wave generators. The author also describes his "curve tracer," which can be quickly assembled from a small handful of components. With this simple scope attachment, the condition of diodes, transistors—even ICs—can be assessed quickly and accurately. Published by *Tab Books*.

Beginners Only. All the mystery and confusion is taken out of getting a Novice license and learning the simple theory involved in the FCC exam with a new book—*Amateur Radio Novice-Class License* prepared by the staff of 73 Magazine. The lack of books written for the rank beginner have made it difficult for the newcomer to surmount the Novice exam theory requirements, forcing all but the most eager bookworms to find a friendly ham or radio club to fill in the perplexing gaps. This book was not written by an engineer or a technical writer; it was written by an average ham to be read by absolute beginners. It is not for engineers, nor for children, but for the reader with the equivalent of a high school education and the interest to think things

through. Many thousands of Novices will be able to easily pass their FCC exams after just a casual reading of this book. The theory is simple, and there is no reason why just about anyone cannot get an amateur Novice license after just a few days study. Published by *Tab Books*.

Very Basic. Today, electricity affects the lives of almost everyone. It lights our homes, cooks our food, runs our machines, provides us with entertainment, and even prolongs our lives. So important, in fact, is electricity to us nowadays that each and everyone of us should learn at least something about what electricity is, how it works, and how it is utilized.

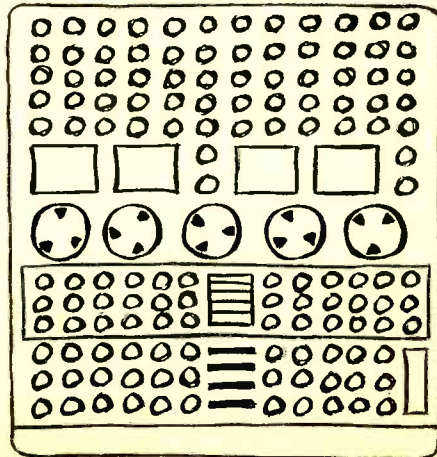
In 101 Questions & Answers About Electricity, author Leo G. Sands answers often-asked questions about electricity. The questions and answers cover various aspects of electricity ranging from the most elemental to the somewhat more complex. All questions, however, are answered in a fundamental easy-to-read style that even the most uninformed layman can readily understand.

The book is divided into five parts with the questions and answers in each part



Soft cover
160 pages
61 illustrations
\$3.95

THINK



arranged in as logical a sequence as possible. Part 1 covers basic concepts; Part 2 covers batteries and transformers; Part 3 covers rectifiers and motors; Part 4 is about switching devices; while Part 5 contains information of a general nature.

Anyone who wishes to learn something about the basic and practical aspects of elec-



Soft cover
112 pages
\$3.50

tricity, regardless of their present occupation, will find *101 Questions & Answers About Electricity* to be both useful and instructive. Published by *Howard W. Sams & Co., Inc.*

Quick Reviews

● *Beginner's Guide to TV Repair* by George Zwick (published by *Tab Books*) offers a

"short course" in TV receiver operation and preliminary trouble diagnosis for beginning technicians and students: soft cover; 179 pages; \$3.95.

● *Radio Control Handbook* by Howard G. McEntee (published by *Tab Books*) has been completely revised—aimed at tinkerers, the hobbyists who much prefer to make their own equipment; soft cover; 320 pages; \$5.95.

● *Simple Transistor Projects for Hobbyists and Students* by Larry Steckler (published by *Tab Books*) offers many tried and true projects known to operate by the author who is the Editor of *Radio Electronics* magazine: hard cover; 192 pages; \$7.95.

● *ABC's of Tape Recording* by Norman H. Crowhurst (published by *Howard W. Sams & Co., Inc.*) is of great value to anyone becoming interested in tape recording: soft cover; 112 pages; \$2.95.

Book Publishers' Addresses

Howard W. Sams & Co., Inc.—4300 West
62nd St., Indianapolis, Indiana 46268
Tab Books—Blue Ridge Summit, Pa.
17214

Radio Publications, Inc.—Box 149, Wil-
ton, Conn. 06897

Bookmark

Continued from page 76

Bandsweep. (Frequencies in kHz, times in GMT); 690—Especially for western medium wave listeners, try Hawaii's KKUA. There may be some interference, but its rock music programming may cut through around 0800. . . .

1367—If you live in the east, try the offshore pirate station, Radio Nordsee International, also with up-tempo music, just before 0200. By the way, remember those fellows who fire-bombed this radio ship early last year? Well, three of them wound up with jail terms, we understand. . . . 4,788—A rarie that pops up only a couple times a year, Turks Island Radio in the Caribbean, was heard on a couple of evenings in November 6,093—A nice piece of DX is Radio Mogadishu in northeast Africa's Somali Republic, which has been heard after 0300 with weird chanting. . . .

6,155—Need Austria in your DX log book? Try Vienna between 0000 and 0030 when they broadcast in English. . . . 9,540—You'll have to lose some sleep to hear Radio New Zealand. You can find its Pacific area beam around 0815. . . . 9,625—A popular DX target for many is Israel's IBA, which puts in a good signal in English at 2100. . . . 11,810—All India Radio at Delhi has been widely heard, particularly in the eastern states, signing on in

English at 1330. . . . 15,165—One of the few times you can hear an English identification from Radio Denmark is at 1915, when the station signs off after its program to Africa.

(Credits: A.R. Niblack, Indiana; Jerry Berg, Massachusetts; Howard Stevens, Michigan; William Conner, Pennsylvania; John Alcock, Florida; Edward Shaw, Virginia; Kim Elliot, Indiana; Bill Willis, California; Page Taylor, New Jersey; National Radio Club, Box 99, Cambridge, Mass.; International Radio Club of America, 6059 Essex St., Riverside, California; Gladys Martin, Brooklyn, N.Y.; North American SW Association, Box 989, Altoona, Pennsylvania)

Backtalk. First, let's handle a couple of queries. Herbert Storm of Randolph, Vt., asks about obtaining a chart showing the types of services using all the wave lengths across the entire radio frequency spectrum.

Well, Herb, you can order such a chart, "The Electromagnetic Spectrum," from SWL GUIDE, 414 Newcastle Rd., Syracuse, N.Y. 13219.

And Californian Walt Marx asks about "the listing book called WRT which has all of the radio stations all over the world."

Actually, Walt, it's WRTH, short for World Radio-TV Handbook. Published annually in Denmark, it is one reference volume all DXers should own. It costs \$6.95, plus postage costs, and can be obtained from SWL Guide (see address above), Gilfer Associates, Inc., P.O.

Box 239, Park Ridge, N.J. 07656, or from a number of the larger ham radio stores around the country.

VOLMET, the aeronautical weather services, apparently interests a number of readers, particularly since we mentioned the Anchorage, Alaska aero station in a recent DX Central column.

Seattle's Henry Stowell sends along addresses of a couple of other VOLMET stations which also operate on the same frequencies, 5,574 and 8,905 kHz. They are the Air Ground Radio Station, Tokyo International Communications Station, Tokyo International Airport, Tokyo, Japan, and the Aeronautical Information Center, Civil Aviation Department, Hong Kong International Airport, Kowloon, Hong Kong.

Tokyo transmits the weather for aircraft on the Pacific routes at ten and 40 minutes past each hour; Hong Kong at 15 and 45 minutes past the hour. Early mornings are the best times to try.

What are DX Central reporters hearing? For one thing, the powerful Radio Nacional de Nicaragua in Managua on 11,875 kHz. You, like readers Tim Fisher of Columbus, Ohio, and Robert Vance of Kansas City, should find them broadcasting in Spanish almost any time during the evening.

Another fine DX club is in the spotlight this month. It is the National Radio Club, the oldest hobby organization in the world devoted exclusively to medium-wave listening.

The club's printed—not mimeographed—

bulletin, DX News is published 32 times a year, weekly during the busy winter medium wave listening season. You'll find plenty of information of use to you if you DX the frequencies between about 540 and 1600 kHz. There is reception data on U.S., Canadian and other Western Hemisphere BCB'ers. And if you believe that Trans-Atlantic and Trans-Pacific medium wave listening is impossible, you should just see NRC's foreign DX column! In addition, there are numerous feature articles that will help you soup up your equipment, build specialized BCB (that's broadcast band or medium wave, in case the abbreviation is new to you) antennas, and learn more about why distant medium wave reception is possible. If you'd like to join, or get more information about the National Radio Club, use the handy form on this page. Remember, send it directly to NRC and not to DX Central Reporting. ■

NATIONAL RADIO CLUB

BOX 99

CAMBRIDGE, MASS. 02138

I read about NCR in ELEMENTARY ELECTRONICS "DX Central Reporting." (Please check one)

I want to join. I am enclosing \$7.50 (third class mail) or \$10 (first class mail) for one year's membership.

Please send me more information about NRC.

Name _____

Address _____

City _____ State _____ ZIP _____

Ask Hank, He Knows

Continued from page 85

unless one knows where and when to look. Where is this information available?

—D.J.F., Brooklyn, NY

Do what I do—write a letter to the station and ask them. However, you can catch as catch can at 0200 local time on Mondays. So take a nap on Sunday after dinner and stay up late.

DXing Home

I want to buy a radio with shortwave bands that will get broadcasts from the Philippines. Are the radios from Sears-Roebuck or Spiegel any good?

—P.F.Z., Ellwood City, PA

What you really need is the Spring Summer 1972 COMMUNICATIONS WORLD magazine especially prepared for new shortwave listeners like you. Not only do you get "what to buy" info, the issue gives tips on antennas,

when to listen; in general, the right things to do with the right equipment. Get a copy today. ■

Magnum

Continued from page 65

the value of the R9 resistor across the secondary of transformer T1 (117-VAC winding), but no lower than 39,000 ohms. If you desire a more interrupting sound, just leave out one of the steering diodes. If you vary the base resistors of Q1 and Q2 between 22,000 and 220,000 ohms, you will vary the rate of interruption.

The *Magnum* may be used as a direct replacement for most all DC-operated alarm bells operating on 6 to 18 volts; the higher the voltage the louder the racket. Just connect terminal 2 to the positive bell lead and terminal 3 to the negative bell lead, and you're in business. ■

NewsScan

Continued from page 26

crucible of precious iridium metal. Iridium is one of the few materials which can withstand this temperature and not react with the sapphire melt.

A sapphire "seed" is inserted into the molten sapphire and then slowly withdrawn while the sapphire freezes or "grows" on the seed. A week is required to allow the crystal to grow to full size. Just a small variation in the electrical power supply will cause the loss of the whole crystal due to thermal shock stresses. The iridium crucible to grow the large crystal has a value of \$50,000.

The "growth" of this sapphirecrystal represents a milestone in the development program at Union Carbide's Crystal Products Department in San Diego. Only two years ago, 2-pound sapphire crystals were the limit of capability. It was not until 1960 that sapphire crystals weighing more than a fraction of a pound were regularly manufactured.

Clear or "white" synthetic sapphire has good optical transmission in the visible, infrared and ultraviolet portions of the radiation spectrum. It is the hardest, strongest and highest-melting optical component known. As a result, sapphire finds use in extremely tough environments such as are seen in missile, space and high-temperature requirements.

Laser ruby crystals differ only from clear sapphire by the addition of a fraction of one percent of chromium metal "dopant" to the crystal growth melt resulting in the characteristic ruby color.

Union Carbide uses the same crystal growth process to make Linde simulated diamonds for jewelry, known industrially as yttrium aluminum garnet or YAG. While the growth time requirement for YAG is much greater than for

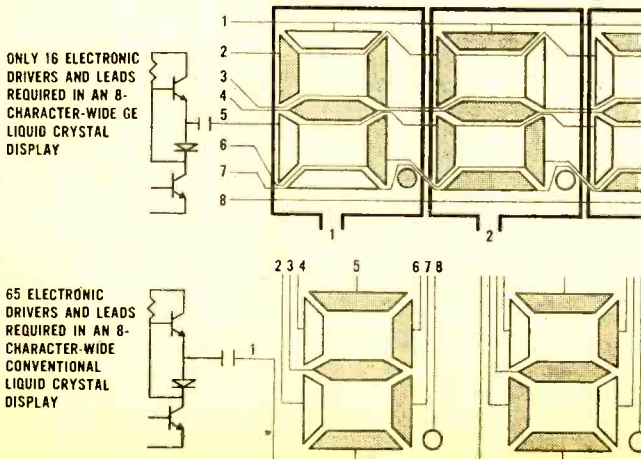
sapphire, YAG crystals can only be grown in smaller sizes because of a more complicated crystal structure.

NUMBER PLEASE

Electronic display panels that use liquid crystals instead of lamps or tubes to flash alphanumeric messages are moving closer to market because of new and simplified circuitry. New GE advances require only 16 electrical leads for an eight-character-wide display, compared to the 65 needed for similar liquid crystal displays. The development is expected to speed applications of liquid crystals in advertising displays, computer time-sharing terminals, hand-held calculators, and electronic wristwatches.

Liquid crystals are fluids that flow like a liquid but have some of the optical characteristics of solid crystals. They scatter available light when voltage is applied, becoming turbulent and changing in appearance from transparent to opaque or frosty. Thus, images can be created according to predetermined patterns. Since no light is emitted or generated, very little power is required to operate liquid crystal displays (only about 300 microwatts per square inch of area to be activated). Up to now, liquid crystals have not been widely used in displays because of the high temperature at which they performed (about 230 degrees Fahrenheit), plus the high cost of the complex electronic circuitry required. The temperature problem was solved a few years ago when liquid crystals were found that performed at room temperatures.

The new GE development, called "AC coincidence addressing for liquid crystal displays," greatly reduces the number of electrical connections to the display cells. The eight-character-display cells. The eight-character-display was made by sandwiching a thin liquid-crystal layer between two plates of glass. The top plate is coated with a conductive film, patterned to form eight separate blocks. The lower plate is coated directly beneath each block to fashion seven segments grouped in a figure-eight pat-



The big plus in the General Electric's new electronic display panels is in the reduction of electrical leads from 65 needed in similar systems to 16. This development, aside from saving miles of copper wire, will bring the application of display panels to many consumer uses.

tern. When various combinations of segments are activated, a specific numeral—ranging from 0 to 9—can be formed, along with a decimal point.

Key to the GE display is a single lead linking all common segments and decimal points along the horizontal row. In addition, each of



General Electric computer programmer Linda Thumhart (left) and secretary Donna Rhodes play a noontime game of tic-tac-toe on a first-of-its-kind liquid crystal display at the GE Research and Development Center, Schenectady, NY. Along with the game, the girls are demonstrating a "first" with liquid crystal displays—that each character can be activated independently or simultaneously.

the eight characters across the display has a separate lead, so that each character can be activated independently or simultaneously. Each character is scanned electronically in sequence to determine which ones are to be activated. By changing the frequency of the alternating current on the leads, the liquid crystal film behind each of the eight blocks can be made to appear either transparent or opaque. A high-frequency pulse makes the liquid crystal film appear transparent or clear. A low-frequency pulse makes it opaque or frosty. Thus, messages or displays can be created as desired. Now you can look forward to many and varied consumer applications that heretofore were never imagined.

HERE'S LOOKING AT YOU

A new video communications system now permits businessmen in the United States and overseas points to exchange virtually instantaneous views of products, charts of other sub-

jects as they talk via telephone.

The system, called Videovoice, is based on the premise that leased channel subscribers and other members of the world-wide business community can benefit from the added dimension of visual communications utilizing their present voice circuits.

Once two locations are equipped with Videovoice units, operation of the service is simple. A subscriber wishing to transmit visual information to an overseas location places a call in the usual manner over his private network. He then trains the Videovoice TV camera on the subject to be transmitted. If the subject is fixed, such as a chart, the subscriber merely pushes the transmit button. If the subject is live, such as individuals around a conference table, the sender pushes a freeze button to "snap" a picture, looks at a small monitor to see the picture and then transmits it.

The Videovoice receiving unit at the distant terminal displays the picture on a TV screen until a new frame is transmitted. A two-way discussion can proceed while the pictures are being exchanged if a full duplex system, which



The Videovoice system transmits still black-and-white TV pictures over the same circuit used for a voice conversation. The photo above illustrates how a diagram under discussion could be transmitted. The photo below demonstrates the receiver end.



consists of two circuits, is being used.

If only one circuit is being used, the transmitting party must discontinue his voice conversation during the brief 30-second transmission period. The full two-way conversation then can resume after the picture is received and is being displayed.

Videovoice also can be used to transmit any type of graphic or printed material, including cardiograms, blueprints, schematics, data print-outs, stock quotations, educational and training materials, and airline arrival and departure information.

The service can be conducted as a two-way exchange of visual information by having transmitting and receiving units at both locations, or as a one-way service with a transmitter at one site and a receiver at the other.

ECOLOGY PLUS

A new 30,000-ton-per-year steel-making plant here produces no smoke, no fumes and no ash. As extra ecological and industrial bonuses, the profitable plant dumps no industrial wastes to pollute nearby San Francisco Bay, and its daily waste metallic condensate is recycled. The plant's only waste is an occasional wisp of cleansteam.

The Airco Vacuum Metals revolutionary plant replaces coal or other polluting fossil fuels with a new process incorporating a battery of Varian super power tetrodes to regulate the power that fires its giant electron beam furnace.

The \$15 million plant produces 120 tons per day of super-pure stainless steel with the strength and corrosion resistance for such critical applications as chemical process piping, marine hardware, food processing equipment and water-treatment equipment.

At the 75-foot-tall furnace, technicians peer through portholes to direct electron beam guns at the molten metal, literally stirring the white

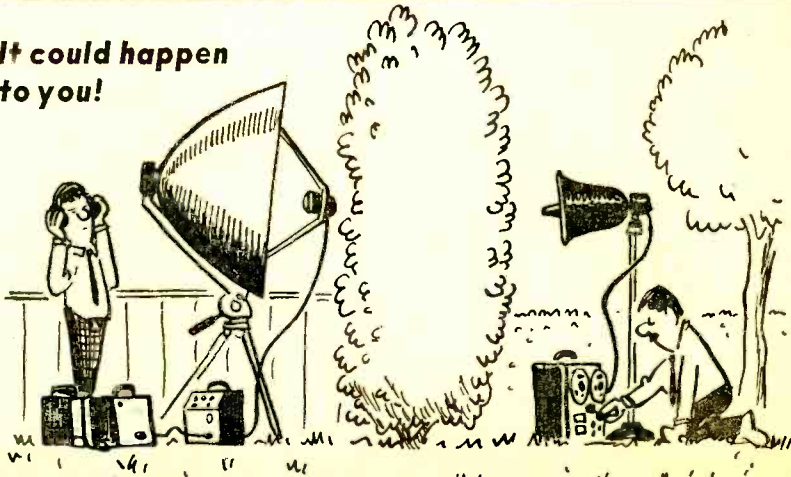
hot river of steel and boiling away impurities into a 0.1 micron vacuum.

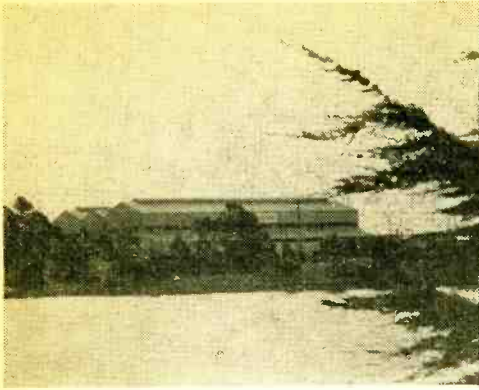
Each of the 22 electron beam guns is controlled by super power tetrodes, each rated at 200 kW. Varian/Eimac super power tetrodes are used in Airco Temescal systems as high-speed switches in the high-voltage leads at a point between the power supply and the vacuum system. These devices also act as isolators of radio-frequency waves to minimize their flow back into the power-supply system. This switching action also stops the current flow into the vacuum system wherever there is an incipient arc. Before an arc can become fully developed and self-perpetuating at low voltage, it is starved by the fast shut-off action of the tetrode. Since this fast action occurs within microseconds, the power can be restored to full value after an interval of only about 10 milliseconds.

In addition, several guns may be operated in parallel on one tetrode system without significant interaction between guns. Electron-beam guns can be in the same or in separate vacuum chambers. Where guns are located in different chambers, Airco Temescal provides safety disconnects in the high-voltage lines so that operators can work on electron-beam guns in the unit that is down to air while other systems continue to operate. Maintaining a constant voltage is critical, because too little voltage will yield imperfect ingots while too much will burn out the electron guns. The Varian/Eimac tetrodes allow less than one percent voltage out the electron guns. The Varian/Eimac deviation.

Airco's new steelmaking plant, which went on-stream earlier this year, uses a process developed by Airco researchers called electron beam, continuous hearth refining. According to Airco spokesmen, this is the world's first continuous steelmaking process conducted entirely in a high vacuum. The combination of electron

**It could happen
to you!**





New smokeless steelmaking plant and Berkeley's Aquatic Park recreational area (in foreground) are environmentally compatible. Now in full production of 120 tons per day of high purity stainless, the giant furnace is powered by Varian high power radio broadcast tubes.

superheat and high vacuum permits the manufacture of steel of high purity and corrosion resistance. An increasingly important side benefit is that the process permits the manufacture of stainless steel without the addition of nickel—a very costly element of unpredictable supply.

Celestial Detectives

The birth of stars, the explosion of supernovas, and the occurrence of star quakes all are under the continuous, watchful eye of celestial detectives armed with new electronic tools. Scientists at Lick Observatory and Lawrence Radiation Laboratory are not the first to observe strange celestial events in the sky. In 1054 AD, Chinese scientists and historians ably recorded their observations of the birth of the Crab Nebula in a supernova, the most spectacular kind of star explosion. The supernova at birth was so bright that it could be observed in broad daylight with the naked eye, even though it was over 6 light years away.

After 900 years, the Crab Nebula has lost much of its original brightness and no longer is titled a supernova. Had it merely faded into an expanding gas cloud, as most exploding stars do, it would have become simply the Crab Nebula. But several years ago astronomers detected pulsing radio signals coming from a spot near the center of the dense nebula. At first there was speculation that these signals might be messages from a distant intelligence. Scientists now believe the signals occur naturally, caused by activity within the core generates a beam of radiation. As the core rotates, the beam sweeps past earth, and therefore seems to us to be pulsing.

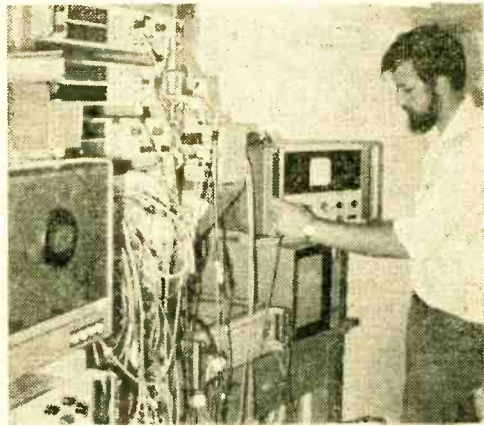
The pulsing signals, since identified optically, blink approximately 30 times per second. The rate is changing very slowly, about 1 part in

2,400 per year. Scientists estimate that at birth the supernova was pulsing at around 50 times per second. With 900 years of age under its belt the pulsar just doesn't have its old zip!

Scientists are focusing their attention both on the Crab Nebula pulsar and a newly formed supernova identified as M101. Supernova M101 is more difficult to see since it is over 1,000 times farther away than the Crab Nebula pulsar, and hence only 1 millionth as bright. At its full brightness shortly after birth, it was difficult to see with a powerful telescope.

The birth of a supernova seems to be characterized by an explosion, a several week period when the star becomes as much as 1 million times brighter than normal. Then it gradually fades and the gas cloud surrounding the nucleus expands. As the gas expands it becomes transparent, exposing the densely-packed nucleus. After nearly a thousand years of expanding, the gas surrounding the Crab Nebula pulsar is transparent enough that astronomers are just able to locate and photograph the densely-packed pulsar in its center.

Astrophysicist Jerry Nelson, who is directing pulsar and supernova studies from Lawrence Radiation Laboratory, believes with most other astronomers that the pulsars resemble large



Technologist Jerry Nelson sets up the HP Correlator in his cramped quarters below the 36-inch Crossley Telescope in preparation for a night of measuring signals from the Crab Nebula Pulsar, and searching for signals from Supernova M101 shown below.



beacons in the sky. As they rotate, the beacons shine beams of radio signals. In the case of the Crab Nebula pulsar, it sends a beam of light also, toward earth. How the pulsars manage their feats is a mystery to the scientists and astronomers, a mystery they hope their instruments will help them solve.

Their observations have uncovered, so far, what they call a "star quake" on the Crab Nebula Pulsar. By carefully monitoring the pulsar over a period of weeks, and by accurately recording the timing of the pulsar's rotation, using their precision atomic clock, they have noted occasions when there is a period of instability followed by a relatively sharp decrease in speed.

Nelson theorizes that the change in speed of the normally highly stable pulsar is caused by a collapse of the exterior crust of the pulsing star. He believes that in the center of the pulsar is a liquid core of densely packed neutrons which supply the energy that keeps the pulsar pulsating or rotating. Eventually, the liquid center loses so much energy that it decreases in size and no longer supports the exterior crust. The crust therefore collapses, causing the star quake; a new interior and exterior form, and an equilibrium state is reached again.

By proving many of their analytical techniques on the known Crab pulsar, the scientists hope to apply them to uncovering secrets of the newest such mysterious member of the heavenly bodies—the supernova M101. By watching it from its birth, they hope to improve our understanding of the development and evolution of the universe.

A GIRL'S BEST FRIEND

A collection of General Electric's famous gem diamonds—carat-sized crystals created in the laboratory—was presented to the Smithsonian Institution. The diamonds—produced from graphite, the soft black substance used in "lead" pencils—represent a scientific achievement that comes very close to fulfilling the dreams of alchemists.

Scientific attempts at gem diamond synthesis date back to 1797, when diamond was first shown to be a form of carbon, an abundant and inexpensive substance, the GE executive explained. During the next two centuries, scientists repeatedly tried—and repeatedly failed—to convert carbon into gem diamond, the world's most glamorous material. This tantalizing and frustrating quest finally came to an end in 1970. That was when GE scientists announced that they had created gem diamonds in the laboratory by subjecting graphite, a form of carbon, to extreme pressures and temperatures in special apparatus.

Earlier, in 1955, the company had announced another "first"—the creation of tiny diamonds (a thousandth of a carat or less in weight) by a reproducible laboratory process. GE put man-made industrial diamond abrasives on the mar-

ket three years later, and has since become one of the worlds' major producers of this critically needed industrial material.

GE's role in diamond-making dates back to 1951, when a major investigation into the effects of superpressures was launched at the company's Research and Development Center. In GE's famous process for making industrial diamond abrasives, announced in 1955, graphite and a molten metal catalyst are subjected to the simultaneous application of pressures of nearly one million pounds per square inch and temperatures above 2200°F.

Because of diamond's unsurpassed hardness, it is ideal for grinding, polishing, sawing, and other industrial applications. Over the years, GE's Specialty Materials Department in Worthington, Ohio, has become a major producer of man-made industrial diamonds, marketing more than 15 tons of these abrasives and freeing U.S. industry from total dependence upon foreign sources of supply which can be suddenly interrupted.

Since the largest industrial crystals are typically only about a thousandth of a carat in weight, it was difficult to experiment with them. So the GE researchers set out to grow larger ones—a process that took several years of intensive research and required the design of apparatus that could withstand extreme pressures and temperatures for long periods of time. The starting material for GE's gems is graphite, which is first converted into man-made diamond powder. With the aid of a molten metal catalyst, the powder is then slowly converted into a gem crystal in a long and complicated process that may take several days. The process requires temperatures above 2500°F. and pressures approaching one million pounds per square inch.

GE's first large gem crystals were yellow in color. Additional work showed that the yellow





A praying mantis, a common sight in June, takes a look at another familiar June object, a diamond. But this is a diamond with a difference. It's one of the famous gem diamonds that General Electric has created in the laboratory from graphite, the soft black substance used in "lead" pencils.

coloration was caused by nitrogen impurities. Once these impurities were removed, it became possible to grow "white" diamonds. The GE scientists also discovered that they could grow "blue" diamonds by adding boron impurities to the starting mixture. GE researchers also have learned how to control the electrical—as well as the optical and mechanical—properties of their large crystals. The company's white and blue diamonds are semiconductors of electricity. Only one percent of natural diamonds (certain blue crystals) are semiconductors.

Another major objective of GE's continuing superpressure research is the achievement of large diamonds sufficiently free of imperfections to have the mechanical strength needed for industrial applications such as oil well drilling and mining operations. ■

Diaper Snooper

Continued from page 46

lums who repeatedly rifled my car at night and stole anything that wasn't welded to the floor. The door locks didn't work because they had been broken by thieves months before. Try as I would, I could never catch them in the act. The local police department didn't speak English, and wasn't interested in my problem anyway, so I tried to avoid the problem by keeping all loose items out of the car. I finally solved the problem by moving to a less infested neighborhood, but had I built a switch operated version of

this remote radio alarm, it would have enabled me to catch 'em red handed. It could easily be wired to the courtesy light system with a voltage divider to step down the car battery to the voltage required by the unit. Tape the unit to a car window on the side towards the house so the auto frame won't block the transmitted energy.

The radio moisture alarm is practical and simple to construct. While many of its potential applications would provide a great deal of enjoyment for the experimenter, it is also a very useful tool and could well provide the solution to many problems.

Who knows? Maybe some of your green-thumbers can use it around the garden or hot house. Use it to check for excessive rain water in the vegetable patch. Last spring I lost my entire planting of beet greens during a heavy rainfall. A piece of plastic could have prevented my mini-washout if I had realized how much and how hard the rain was falling.

Let's hear how you propose to use this remote alarm. Could be others will benefit from a brainstorm of yours. ■

TEAC AN-180

Continued from page 48

can record from microphones, from line level and even directly from a stereo receiver because an MPX filter is built into the Dolby to prevent *beating* between its reference level oscillator and stereo pilot leakage.

The AN-180 contains a built in calibration test signal, a built-in recorder calibration oscillator and is supplied with both cassette and reel calibration tapes. There is no guesswork or compromise, you can use an AN-180 with any cassette or reel recorder and get optimum results every time. The only particular requirement is that the associated recorder must have signal source monitoring at its playback jacks during recording. With very few exceptions all recorders have this feature, but doublecheck your equipment first.

All set-up and *input* level controls, Dolby *in-out* switch and *MPX filter* selector are on the front panel. A special test switch for setting the reference level oscillator is on the rear apron along with the line level and output jacks. (The microphone jacks
(Continued on page 104)

READER SERVICE PAGE

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

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

MARCH/APRIL 1972

Void after September 30, 1972

ELEMENTARY ELECTRONICS

Box 886, Ansonia Station, New York N Y 10023

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

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

Name (Print Clearly) _____

Address _____

City _____

State _____

Zip Code _____

TEAC AN-180

(Continued from page 102)

are on the front panel.) Individual L and R microphone and line record level controls are provided, as well as individual output level controls.

Unlike some other add-on Dolbys the AN-180 has separate stereo record and play amplifiers, thereby allowing the unit to switch automatically from play to record. (That's a total of four amplifiers.)

Once the AN-180 is set up, its adjustment is good for all time if the controls aren't disturbed. You can occasionally check out the reference oscillator by depressing the rear panel switch and noting if the meters indicate O VU.

Can't Tell the Difference. We tested the TEAC AN-180 by recording dubs of several wide-range records and then comparing the two in an A-B test; and, we made the test particularly difficult by using some of the best hi-fi equipment available. With rare exception it was impossible to tell the difference between the cassette copy and the disc. Fact is, in all instances where the tape was not directly compared to the record the tape was accepted as a full-fidelity record. And best of all, there wasn't the slightest trace of tape hiss. Any hiss heard was the original un-Dolbyized master tape hiss from the record.

Summing Up. There is no longer any reason to think of a cassette recorder in terms of convenience or compromised performance. With TEAC's AN-180 Dolby Amplifier a cassette recorder becomes a true hi-fi component, suitable for the best installations and the most serious of listeners. The TEAC AN-180 costs \$299.50.

For additional information circle No. 60 on the Reader Service Coupon on page 17. ■

CB IQ QUIZ

(Continued from page 41)

26. *True.* [95.85(c)]. However, you are required to notify the FCC if such emergency use of your station lasts 12 hours or longer.
 27. *False.* [95.87(a)]. The person *owning* the station license is responsible to the FCC for the proper use of all units operated under his station license.
 28. *True.* [95.87(b)(5)]. But such operation

is permitted only while your employees are acting within the scope of their employment.

29. *True.* [95.89(a)].

30. *True.* [95.91(b)].

31. *False.* [95.91(b)]. The required 5 minute silent period begins upon completion of a contact whether or not it lasted the full, allowable 5 minute period.

32. *False.* [95.91(b)]. The time limitation rule cannot be avoided by changing operating frequencies. In the example used here, you would be required to wait for 5 minutes before you attempt to establish contact on Channel 13.

33. *True.* [95.91(b)].

34. *True.* [95.95(a)].

35. *False.* [95.95(c)]. You are required to announce both your own call sign and that of the station you are contacting at the beginning and at the end of each series of transmissions.

36. *True.* [95.101(a)]. However, you are required to display a photocopy of your FCC license at each fixed station location in your network. A note written on the photocopy should state where you keep the original license.

37. *True.* [95.101(b)].

38. *True.* [95.105].

39. *False.* [95.117(c)]. You may operate your Class D mobile station anywhere in the United States.

40. *False.* [95.119(d)]. Remote control of a Class D station is prohibited.

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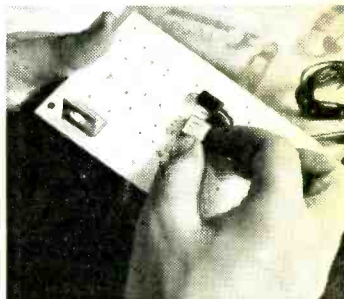
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