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Radio-TV EXPERIMENTER

AUGUST-SEPTEMBER 75¢

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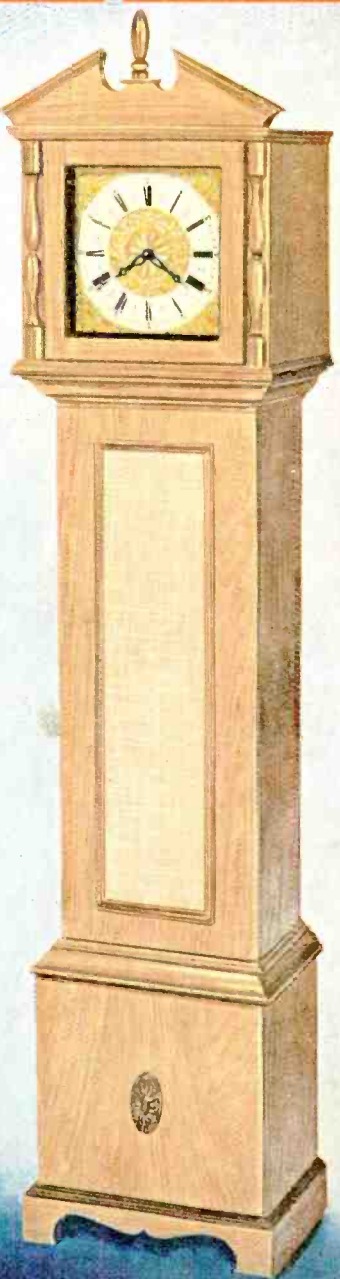

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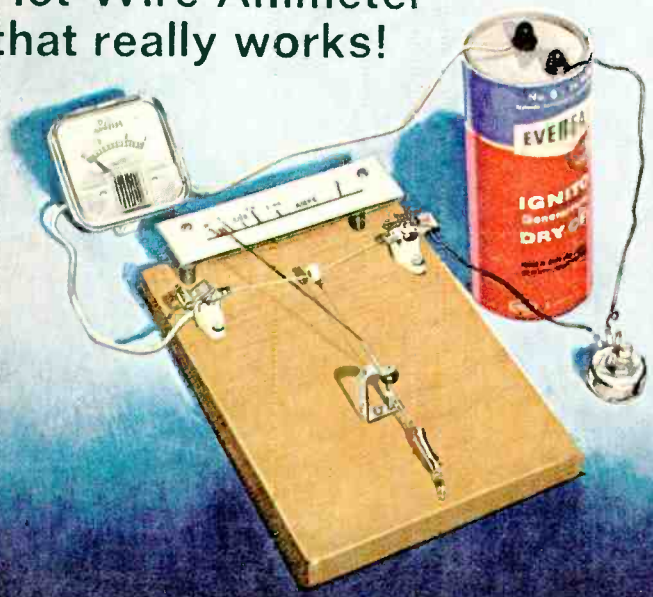

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A Silicon Solid-State 70-Watt Stereo Amplifier for $99.95 kit, $139.95 wired, including cabinet. Cortina 3070

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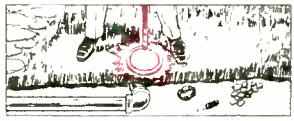

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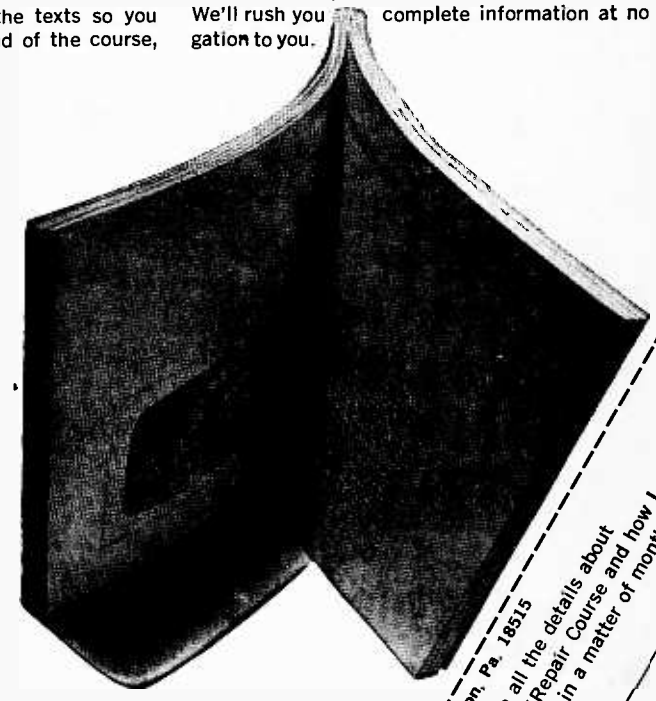

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Radio-TV and Science and Electronics EXPERIMENTER

August/September 1969

White's Radio Log, Vol. 51, Part 4—page 81

Emergency Radio Services—Boston Area—page 92

★ Cover Highlights

Cover drawing by Len Goldberg

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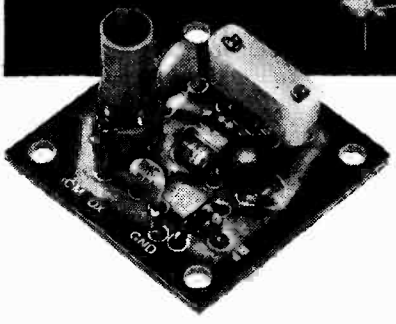

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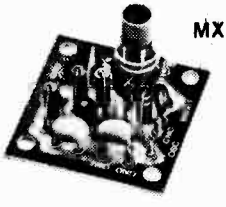
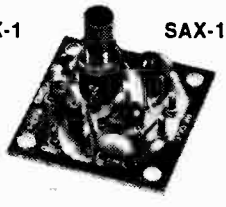
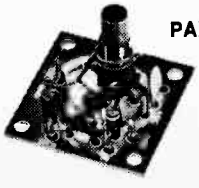


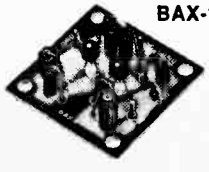
MXX-1



SAX-1



PAX-1



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A single tuned output amplifier designed to follow the OX oscillator. Outputs up to 200 mw can be obtained depending on the frequency and voltage. Amplifier can be amplitude modulated for low power communication. Frequency range 3,000 to 30,000 KHz.

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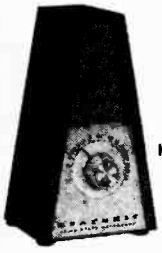

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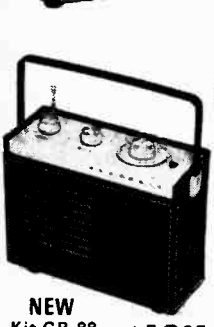

NEW
Kit GR-98

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Kit GR-88
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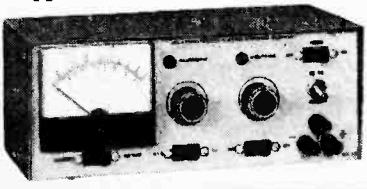

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The new Heathkit ID-29 is most versatile . . . really three automotive test instruments in one . . . and its low price makes it even a better value. Measures Dwell on all 4-cycle 3, 4, 6, or 8 cylinder engines . . . measures RPM in two ranges 0-1500 and 0-4500 . . . measures DC voltage from 0 to 15 volts. And no batteries are needed . . . running engine provides both signal and power. Easy to use . . . on both 6 and 12 volt system without changing leads. It's lightweight, easy to carry . . . comes equipped with black polypropylene case that has a built-in lead storage compartment and is resistant to virtually everything. Fast, simple assembly . . . takes just one evening. The perfect accessory for the handyman who wants to do his own car tune-up, emergency road service personnel, or shop mechanics . . . order your ID-29 now. 4 lbs.

NEW Heathkit GD-48 Solid-State Metal Locator

A low cost, versatile, professional metal detector at one-third the cost of comparable detectors. Packed with features for long life, rugged reliability, and dozens of uses. Completely portable, battery operated and weighs only 3 lbs. The GD-48 is highly sensitive, probes to 7 feet, and has an adjustable sensitivity control. Its built-in speaker signals presence of metal; front panel meter gives visual indication. Other features include built-in headphone jack, telescoping shaft for height adjustment, smartly styled and smartly designed for easy in-hand use and easy assembly. Whether you're an amateur weekend hobbyist or a professional treasure hunter the GD-48 is for you . . . also a great help to contractors, surveyors, Gas, Electric, Telephone and other public Utility Companies. 4 lbs. GDA-48-1, 9 Volt Battery $1.30*; GD-396, Headphones, 2000 ohm (Superex) $3.50*

NEW Heathkit Electronic Metronome

The new Heathkit TD-17 is a low cost, precise performing electronic Metronome . . . a handy helper for any music student. Battery operated . . . no springs to wind . . . accurate, steady calibration is always maintained . . . from 40 to 210 beats per minute. Instruction label on bottom gives conversion from time signature and tempo to beats per minute. Stylish fruit wood finished cabinet. Easy solid state circuit board construction . . . assembles and calibrates in only 2-3 hours. The new Heathkit TD-17 Electronic Metronome is so low in cost every music student can afford one . . . order yours now. 1 lb.

NEW Heathkit GR-88 Solid-State Portable VHF-FM Monitor Receiver

Tunes both narrow and wide band signals between 154-174 MHz . . . for police, fire, most any emergency service. Exceptional sensitivity and selectivity, will outperform other portable receivers. Features smart compact styling . . . with durable brown leatherette case, fixed station capability with accessory AC power supply, variable tuning or single channel crystal control, collapsible whip antenna, adjustable squelch control and easy circuit board construction. The new GR-88 receiver is an added safety precaution every family should have . . . order yours today. 5 lbs.

NEW Heathkit GR-98 Solid-State Portable Aircraft Monitor Receiver

Tunes 108 through 136 MHz for monitoring commercial and private aircraft broadcasts, airport control towers, and many other aircraft related signals. Has all the same exceptional, high performance features as the GR-88 above. The perfect receiver for aviation enthusiast . . . or anyone who wants to hear the whole exciting panorama of America in flight. 5 lbs. GRA-88-1, AC Power Supply $7.95

NEW Heathkit GD-69 "Thumb Tach" . . . An Accurate, Low Cost Tachometer To Measure RPM's On Any Model Engine

The new Heathkit GD-69 "Thumb Tach" Tachometer is an accessory every R/C modeler should have. An accurate, inexpensive and easy way to make sure your model engine is giving maximum performance (also suitable for measuring RPM's of any rotating shaft). Features all solid-state design and battery operation for long life reliability. Simple to use . . . set the slide switch to the meter scale you want to use, aim the lens at the propeller or flywheel. The meter reads directly in RPM from reflected light for precise, accurate measurements . . . doesn't load engine. Easy 2 or 3 hour assembly. Raise your engine performance standards now . . . with the new Heathkit GD-69. 1 lb.

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From The Leader

HEATHKIT®

NEW Heathkit Ultra-Deluxe "681" Color TV With AFT ... Power Channel Selection & Built-In Cable-Type Remote Control

The new Heathkit GR-681 is the world's most advanced Color TV with more built-in features than any other set on the market. Automatic Fine Tuning on all 83 channels ... eliminates touchy fine tuning forever, power push button VHF channel selection, built-in cable-type remote control ... or you can add the optional GRA-681-6 Wireless Remote Control any time you wish ... plus the built-in self-servicing aids that are standard on all Heathkit color TV's but can't be bought on any other set at any price. Other features include a bridge-type low voltage power supply for superior regulation; high & low AC taps to insure that the picture transmitted exactly fits the "681" screen. Automatic degaussing, 2-speed transistor UHF tuner, hi-fi sound output, two VHF antenna inputs, top quality American brand color tube with 2-year warranty.

GRA-295-4, Mediterranean Cabinet shown **$119.50***

Heathkit "295" Color TV

Big, Bold, Beautiful ... with the same high performance features and built-in servicing facilities as the GR-681 above ... but less the Automatic Fine Tuning, push button VHF power tuning and built-in cable-type remote control. You can add the optional GRA-295-6 Wireless Remote Control at any time.

GRA-295-1, Contemporary Walnut Cabinet shown **$62.95***

Both the GR-681 and GR-295 fit into the same Heath factory assembled cabinets; not shown, Early American style at $99.95.*

NEW Deluxe Heathkit "581" Color TV With AFT

The new Heathkit GR-581 will add a new dimension to your TV viewing. Brings you color pictures so beautiful, so natural, so real ... puts professional motion picture quality right into your living room. Has the same high performance features and exclusive self-servicing facilities as the GR-681, except with 227 sq. inch viewing area, and without power VHF tuning or built-in cable-type remote control. The optional GRA-227-6 Wireless Remote Control can be added any time you wish. And like all Heathkit Color TV's you have a choice of different installations ... mount it in a wall, your own custom cabinet, your favorite B&W TV cabinet, or any one of the Heath factory assembled cabinets.

GRA-227-2, Mediterranean Oak Cabinet shown **$99.50***

Heathkit "227" Color TV

Same as the GR-581 above, but without Automatic Fine Tuning ... same superlative performance, same remarkable color picture quality, same built-in servicing aids. Like all Heathkit Color TV's you can add optional Wireless Remote Control at any time (GRA-227-6). And the new Table Model TV Cabinet and roll around Cart is an economical way to house your "227" ... just roll it anywhere, its rich appearance will enhance any room decor.

GRS-227-6, New Cart and Cabinet combo shown..... **$49.95***

Both the GR-581 and GR-227 fit into the same Heath factory assembled cabinets; not shown, Contemporary cabinet $59.95.*

NEW Heathkit Deluxe "481" Color TV With AFT

The new Heathkit GR-481 has all the same high performance features and exclusive self-servicing aids as the new GR-581, but with a smaller tube size ... 180 sq. inches. And like all Heathkit Color TV's it's easy to assemble ... no experience needed. The famous Heathkit Color TV Manual guides you every step of the way with simple to understand instructions, giant fold-out pictorials ... even lets you do your own servicing for savings of over $200 throughout the life of your set. If you want a deluxe color TV at a budget price the new Heathkit GR-481 is for you.

GRA-180-1, Contemporary Walnut Cabinet shown **$49.95***

Heathkit "180" Color TV

Feature for feature the Heathkit "180" is your best buy in color TV viewing ... has all the superlative performance characteristics of the GR-481, but less Automatic Fine Tuning. For extra savings, extra beauty and convenience, add the table model cabinet and mobile cart. Get the value-packed GR-180 today.

GRS-180-5, Table Model Cabinet & Cart combo..... **$39.95***

Both the GR-481 and GR-180 fit the same Heath factory assembled cabinets; GRA-180-2, Early American Cabinet $75.00.*

Add the Comfort And Convenience Of Full Color Wireless Remote Control To Any Rectangular Tube Heathkit Color TV ... New Or Old!

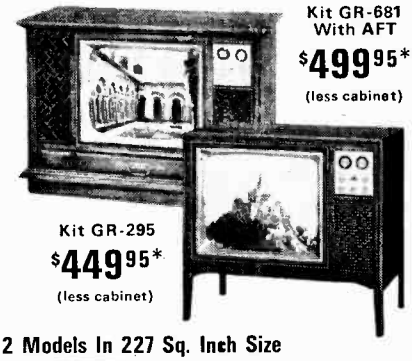
Kit GRA-681-6, for Heathkit GR-681 Color TV's..... **$59.95***

Kit GRA-295-6, for Heathkit GR-295 & GR-25 TV's..... **$69.95***

Kit GRA-227-6, for Heathkit GR-581; GR-481 & GR-180 Color TV's..... **$69.95***

Now There Are 6 Heathkit® Color TV's To Choose From

2 Models In 295 Sq. Inch Size



NEW Kit GR-681 With AFT **$499.95*** (less cabinet)

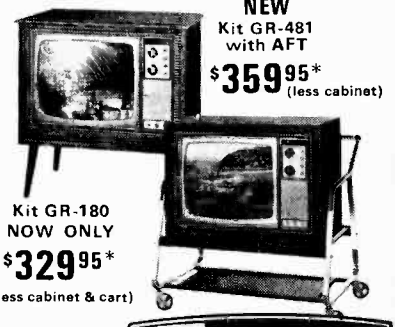
Kit GR-295 **$449.95*** (less cabinet)

2 Models In 227 Sq. Inch Size

NEW Kit GR-581 with AFT **$419.95*** (less cabinet)

Kit GR-227 NOW ONLY **$379.95*** (less cabinet & cart)

2 Models In 180 Sq. Inch Size



NEW Kit GR-481 with AFT **$359.95*** (less cabinet)

Kit GR-180 NOW ONLY **$329.95*** (less cabinet & cart)

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POSITIVE FEEDBACK

Julian M. Sienkiewicz
EDITOR-IN-CHIEF

A leading trade newspaper headlined a startling fact a few months ago—over 600 hospital patients were electrocuted last year.

And a few days ago a press release crossed my desk stating that an estimated 1200 patients are accidentally *shocked to death* each year in our hospitals. The recent accidental electrocution figures were compiled by Dr. Carl W. Walter, a surgeon at Peter Bent Brigham Hospital, Boston, Massachusetts. Dr. Walter said the figures were based on a study made by an actuary for a national insurance company in the U.S.

Accidental electrocutions in hospitals aren't new, but the probability of these deaths has risen sharply during the last ten years. New analytical techniques which rely on the insertion of catheters into the body to measure the performance of vital organs have increased the risk of these electrocutions. The heart is the organ most probed by these catheters and is also the most sensitive to small electrical currents. When there is a direct line into the heart, a current as small as 20 microamperes—less than needed to operate a hearing aid—can be deadly. The fatal current which normally gets into the catheter is caused by leakage or stray currents, generated because of poor circuit grounding.

Many of the accidents occur when a patient, undergoing treatment, inadvertently touches a metal basin or other piece of equipment which acts as an electrical ground and becomes part of the circuit.

Some of the more common causes for accidental electrocutions are:

- Improper use of diagnostic equipment
- The use of separate and incompatible instruments simultaneously on the same patient, causing a lethal current to flow through the patient's body
- Occasional poor circuit or equipment design or defective unit, producing a high degree of current leakage.

As every electronics hobbyist knows, the use of line isolation transformers would substantially reduce the danger of electrocution by the first two causes simply by inserting the transformers between the wall outlet and the equipment. The incorporation of isolation transformers in instrumentation design would help overcome the third cause. In addition, because the isolation transformer excludes extraneous current, it will improve measurement data.

Elsewhere, Richard Lloyd, assistant to the president of Underwriters Laboratories, Inc. proposed some immediate changes in the design of instrumentation systems. His recommendations included:

- Installation of a ground-fault detector indicator
- Limiting each isolation transformer to serving one patient area and providing the transformer with a grounding shield between primary and secondary windings
- Restricting the size of the isolation transformer, the length of the circuit, and the type of insulation on the conductor to keep leakage down
- Providing surge or overload protection on all circuits serving the patient area
- Using double-insulated equipment where grounding doesn't provide the necessary protection.

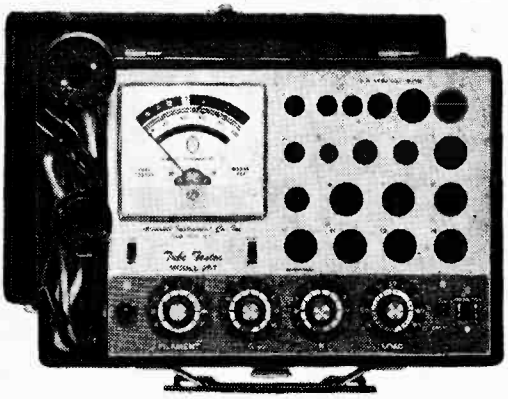
The problem will eventually be solved by better equipment design, doctor and nurse training programs in the use of electronic patient devices, and the addition to the hospital staff of an electronics technician, possibly with an engineering degree, who will service the delicate electronic instruments, vouch for their safety and accuracy, and advise the hospital, in concert with doctors, on the purchase of new equipment and the adoption of new patient procedures. Naturally, this will mean that the technician must be oriented to the medicine field. Hence, our technician may require 20 or more college credits toward a nursing degree. This is only the beginning. Electronic engineers and technicians with specialties in medicine may, in the future, earn their degrees from medical colleges with engineering annexes, or vice versa.

Play Ball. Westinghouse scientists have proposed new ideas about the strange, sometimes frightening balls of light that many people claim to have seen floating in the air. The new suggestion is that ball lightning may be a mixture of extremely hot air and soot or similar material caused by an ordinary lightning stroke hitting a tree or other object. This would explain some—but not all—of the features of ball lightning.

Ball lightning typically drifts horizontally near the ground during a thunderstorm, has an orange glow about as bright as a 100-watt light bulb, and lasts about five seconds before disappearing suddenly. *(Continued on page 100)*

The New 1969 Improved Model 257

A REVOLUTIONARY NEW TUBE TESTING OUTFIT



- **Tests all modern tubes including Novars, Nuvistors, Compactrons and Decals.**
- **All Picture Tubes, Black and White and Color**

ANNOUNCING... for the first time

A complete TV Tube Testing Outfit designed specifically to test **all** TV tubes, color as well as standard. Don't confuse the Model 257 picture tube accessory components with mass produced "picture tube adapters" designed to work in conjunction with all competitive tube testers. The basic Model 257 circuit was modified to work **compatibly** with our picture tube accessories and those components are not sold by us to be used with other competitive tube testers or even tube testers previously produced by us. They were custom designed and produced to work specifically in conjunction with the Model 257.

COMPLETE WITH ALL ADAPTERS AND ACCESSORIES, NO "EXTRAS"

STANDARD TUBES:

- Tests the new Novars, Nuvistors, 10 Pins, Magnovals, Compactrons and Decals.
- More than 2,500 tube listings.
- Tests each section of multi-section tubes individually for shorts, leakage and Cathode emission.
- Ultra sensitive circuit will indicate leakage up to 5 Megohms.
- Employs new improved 4½" dual scale meter with a unique sealed damping chamber to assure accurate, vibration-less readings.
- Complete set of tube straighteners mounted on front panel.

BLACK AND WHITE PICTURE TUBES:

- Single cable used for testing all Black and White Picture Tubes with deflection angles 50 to 114 degrees.
- The Model 257 tests all Black and White Picture Tubes for emission, inter-element shorts and leakage.

COLOR PICTURE TUBES:

- The Red, Green and Blue Color guns are tested individually for cathode emission quality, and each gun is tested separately for shorts or leakage between control grid, cathode and heater. Employment of a newly perfected dual socket cable enables accomplishments of all tests in the shortest possible time.

The Model 257 is housed in a handsome, sturdy, portable case. Comes complete with all adapters and accessories, ready to plug in and use. No "extras" to buy. Only **$47.50**

NOTICE

We have been producing radio, TV and electronic test equipment since 1935, which means we were making Tube Testers at a time when there were relatively few tubes on the market, 'way before the advent of TV. The model 257 employs every design improvement and every technique we have learned over an uninterrupted production period of 32 years.

Accurate Instrument Co., Inc.

SEND NO MONEY WITH ORDER
PAY POSTMAN NOTHING ON DELIVERY

Try it for 10 days before you buy. If completely satisfied, you may remit $47.50 plus postage and handling charge, or you may pay in easy monthly payments until the total price of $47.50 plus postage, handling and budget charge is paid.

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Please rush me one Model 257. If satisfactory I agree to remit $47.50 plus postage and handling charge or pay in easy monthly payments until the total price of $47.50 plus postage, handling and budget charge is paid.

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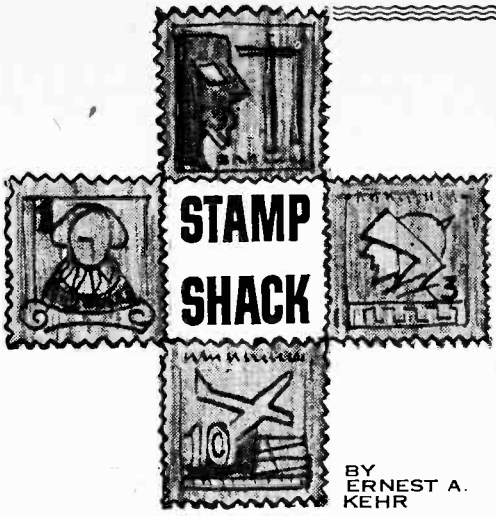
Address _____

City _____ Zone _____ State _____

☐ Save Money! Check here and enclose $47.50 with this coupon and we will pay all shipping and charges. You still retain the privilege of returning after 10 day trial for full refund.



BY ERNEST A. KEHR

●● Two new stamps have been issued recently to mark the progress of broadcasting facilities in the Caribbean area.

● The first is a 10-centime denomination of a gaily colored set intended to publicize the great strides made in Haitian educational programs. Produced by the Geisecke & Devrient Typographical Institute, in Munich, Germany, the stamp shows a native family peering into the

Haiti 1969 Educational Series

screen of a Westinghouse TV receiver as a French "Diamond Craft" rocket is seen streaking towards outer space.

The first TV facilities were installed in Haiti just ten years ago and have developed phenomenally; in the last year the number of sets imported from the United States doubled. Under the control of the Government, TV programs are specially designed as an integral part of the national program to increase educational and cultural standards among the populace; these for many years were rather low.

● The second one was released by the Netherlands Antilles, to mark the opening of the latest telecommunications facilities. The design is a creation of Oscar Ravello, a Curacao artist; the 25-cent stamp was printed in Holland. It features, in bright colors, a map of Bonaire Island with an antenna superimposed by concentric lines representing radio waves enclosing the inscription, "Netherlands Worldwide Radio."

Because of its importance as a trade center

Netherlands Antilles 1969 Telecommunications

for nearly three centuries as a Dutch colony, Curacao was among the world's first to develop its long-distance communications services. As long ago as 1887, its capital, Willemstad, was directly linked with the first trans-Atlantic cable that spanned the ocean's floor only a year before. In 1908, the Netherlands Antilles Radio and Telegraph Administration opened the first wireless transmission facilities to place the islands right behind the United States and Canada in the lead of this then-new service in the Western Hemisphere. The event was commemorated on Oct. 16, 1958, with a pair of stamps (7½ and 15¢, Scott #258-9) issued for the golden jubilee. Its coastal radio station PJC was the very first established in the entire Caribbean. By 1926, daily radio contact was begun with The Hague and later in the same year its regular programs were beamed all the way to Java in the Dutch East Indies, more than 13,000 miles distant.

The equipment for these pioneer facilities was provided by the Philips Company, of Eindhoven in Holland.

Until the end of World War II, all of the transmissions were out of Curacao, largest of the three islands, which form half of the Netherlands Antilles (Aruba, Bonaire and Curacao; St. Maartens, St. Eustatius and Saba are the other three, located east of Puerto Rico, 1500 miles north.) In 1964, Trans World Radio, an United States firm, surveyed the geography and decided on Bonaire for the locale of a new, powerful radio station for commercial communications. This led to the signing of a contract between the firm and the Dutch World Broadcasting System through which it used the TWR transmitters when they were not in use to dispatch radiograms. The equipment served as a relay station, carrying programs that originated in Holland and beaming them throughout the Western Hemisphere and even West Africa. Until then, Radio Nederland had to rely solely on its homeland senders whose power was insufficient to reach all those destinations.

It was the success of these relays that encouraged Radio Nederland to build its own facilities on strategic Bonaire.

What's Available. Collectors interested in

(Continued on page 100)

BOOKMARK
BY BOOKWORM

6W4GTA in for 6AX4GTB. You can't tell the substitutes without a scorecard, and H. G. Cisin's all new *14,000 Direct Tube Substitutes* manual belongs in the hands of all tube swappers. Some of the substitutions offered have been registered only a few months prior to date of publication. Some have not been produced as you read this review, but will be on the market before 1970 is out! All the vacuum

Soft cover
80 pages
$2.00

tube substitutes have been carefully checked as to matching characteristics. Hence, they should perform as well, and in some cases, even better than the tubes originally used. Where substitutes are not listed, this may be because no direct replacements are available. Get your copy today by writing directly to the publisher, Harry G. Cisin, Amagansett, N. Y. 11930. ■

Chip Off the Old Block. The purpose of *integrated Circuits, Fundamentals & Projects* is to help hobbyists and experimenters get acquainted with integrated circuits (abbreviated ICs). While a great deal of literature already has appeared, there is relatively little material in print for non-industrial user—the hobbyist. This gap has been closed by this book.

IC background material is presented in the first two chapters, and practical projects which may be built with simple tools and tested with common instruments are offered in the remaining ones. Each project uses only one IC. The devices described in the projects can be made much smaller than shown—no attempt has been made to push miniaturization to its limit. On the other hand, the aim of the author, Rufus P. Turner, has been to keep each project small

Soft cover
95 pages
75¢

enough to exploit the small size of the IC, while at the same time keeping the device large enough that no special tools and skills are required to build them.

Don't let the low price of this book fool you —it's worth many times more. You'll find this book listed in Allied Radio's catalog. What, no catalog? Then write to Allied Radio Corporation, Dept. 20, 100 N. Western Avenue, Chicago, Ill. 60680. ■

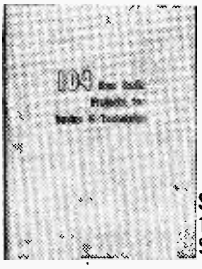
What's Up Top That Counts. We're all experts when it comes to selecting and installing a home TV antenna, not to mention an FM job. Few of us know enough to write a book on the subject, but when Lon Cantor is the author—we're all amateurs by comparison. In Lon's new book *How To Select and Install Antennas,* we have a very practical guide to antenna installation. The do-it-yourselfer may never install more than a few antennas in his life, but he wants all the facts a pro knows—and fast. This *how to* book was written to en-

Soft cover
106 pages
$3.95

able the reader to make a successful installation simply by following the instructions given. Besides telling you what to do, it guides you in choosing the right antenna and accessories. Pick up this book before you put up your next antenna. Available from the publisher, Hayden Book Company, Inc., 116 West 14th Street, New York, N. Y. 10011 or at local or mail order electronic parts distributors. ■

Hamming By the Numbers. Hams can get more fun out of their hobby and add to their knowledge of electronics at the same time by picking up a new Tab book. *104 Ham Radio Projects for Novice & Technician* is a

handbook of circuits for useful devices. It's definitely not a "beginner's" book! The reader gets schematic diagrams, parts lists, and constructive guidance. Particular emphasis has been placed on transmitting and receiving gear, including several simple one- and two-tube devices. Also included is an extensive grouping of semiconductor devices using readily-available transistors. There are projects for 80, 40, 15, 6, 2, 1¼ and ¾ Meters, and 1296 MHz. Broken down into logical equipment categories,



Soft cover
192 pages
$3.95

there are devices for antenna systems, audio circuits, CW, interference suppressors and eliminators, and numerous other essentials such as power supplies. There are preamps and preselectors, converters, receiving and transmitting accessories, and many specialized items hams will want to build. To help the reader gain more experience, the volume includes a host of useful wiring and construction hints, especially for the higher frequency projects. A book every knowledgeable ham will want to own. Prepared by Bert Simon, W2UUN, *104 Ham Radio Projects* is available from the publisher, Tab Books, Blue Ridge Summit, Pa. 17214.

Beginners Only. Over the past 60 years or so the science of electronics has made important changes in our way of life. Such developments as ship-to-shore and ground-to-air communications, radar, etc., have contributed to the safety of travel and transportation. Elec-

Soft cover
112 pages
50¢

tronics has made vital contributions to the military, medicine, and countless other fields. Everyone is familiar with the impact radio and television broadcasting have had on our every-

BOOKMARK

day life. Amateur radio, high fidelity, and now Citizens band radio make it possible for every one to take part in this fascinating activity.

Whether you are interested in electronics as a career or as an exciting hobby. you need to know something about both the "how" and the "why" of electronic equipment. It is the purpose of Allied Radio's new book, *Getting Started in Electronics,* to give you a start in your study of electronics. The text of this book has been written for the beginner in electronics. No assumptions of any previous knowledge have been made. The theory chapters are intended to provide only the background necessary for the construction projects. Thus, the book will help start you down the right path in your study of electronics. Get your copy of *Getting Started in Electronics* by writing directly to Allied Radio Corporation, Dept 20, 100 North Western Ave., Chicago, Ill. 60680.

For the 10-4 Crowd. Citizens Band two-way radio has taken the United States and Canada by storm. Only eleven years after the inception of examination-free CB licensing, there are over 4-million CB transceivers in operation. CB licensing has passed the one-million mark! CB radio operators outnumber all the other radio services licensed by the FCC and DOT combined. Naturally, there are many operators in this crowd who want to build assisting and associated equipment to add to their CB station. Many, within the framework of the

Soft cover
128 pages
$3.25

FCC Rules and Regulations, wish to improve their current CB rigs. With this in mind, Robert M. Brown, KOD2239 (a frequent contributor to SCIENCE AND ELECTRONICS and its sister publication, ELEMENTARY ELECTRONICS) has written *101 Easy CB Projects.*

Many of the parts you need to build units from plans in this book may be salvaged from discarded radios and TVs. If you must buy parts, many projects cost less than five dollars using new parts. To get your copy of this CB experimenter's manual write to the publisher, Howard W. Sams & Co., Inc., 4300 W. 62nd St., Indianapolis, Ind. 46268. Sams books are sold in retail and mail order electronic parts stores throughout the country.

SCALED-DOWN TURNTABLE

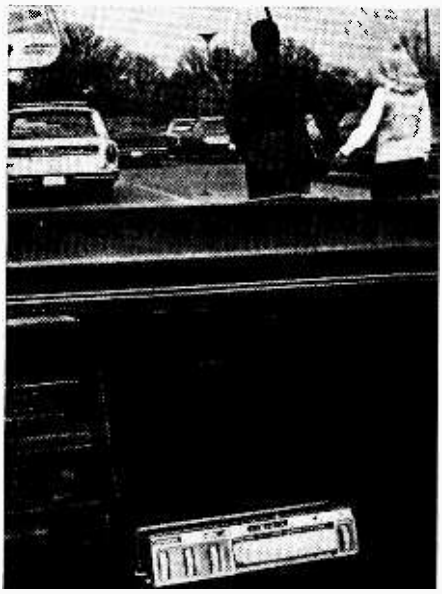
Elpa Marketing has brought out a smaller model of their PE-2020 automatic turntable, the PE-2018. It's a 3-speed unit, which, they say, incorporates all the advanced features of the PE-2020. They point to such exclusive features as 15° vertical tracking angle adjustment, gentle lowering action of the tone arm, stylus protection, and automatic selection of record size. Also contained is anti-skating, pitch control,

Elpa PE-2018 Automatic Turntable

and automatic cueing. The unit uses the same tone arm and motor as the PE-2020, which sells for $30 more. Price of the PE-2018 is $99.50; for more details, write Elpa Marketing Industries, Inc., Thorens Bldg., Dept. JS, New Hyde Park, N.Y. 11040.

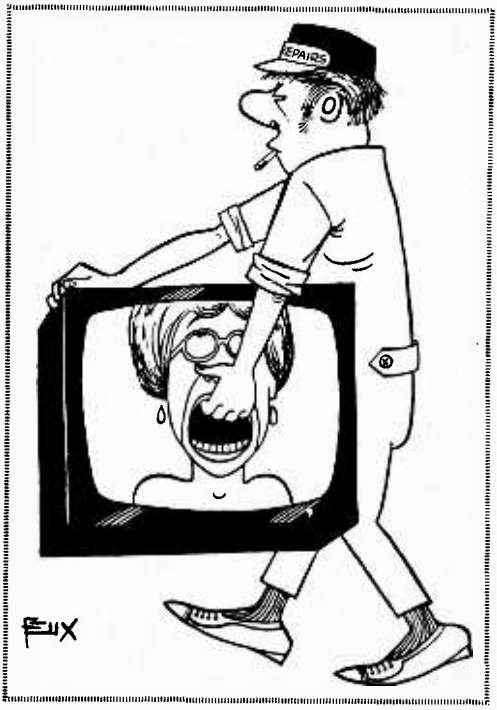
HANDS OFF, VANDALS!

Tenna Corporation has come up with a very bright idea—a car stereo tape player with a built-in burglar alarm. Any attempt to remove



Tenna Untouchable Car Stereo Player

the player triggers a loud alarm to frighten off would-be thieves. They call this line the Untouchables, and there are 12 players in the series. They include 4- and 8-track stereo tape players with FM radio, compact 4- and 8-track car stereo tape players, 8-track car stereo tape cartridge players with FM radio, 4- and 8-track car stereo players, and compact 8-track players. Retail prices range from $59.95 to $179.95, including speakers. For details write to Tenna Corp., Dept. SE, 19201 Cranwood Parkway, Cleveland, Ohio 44128.



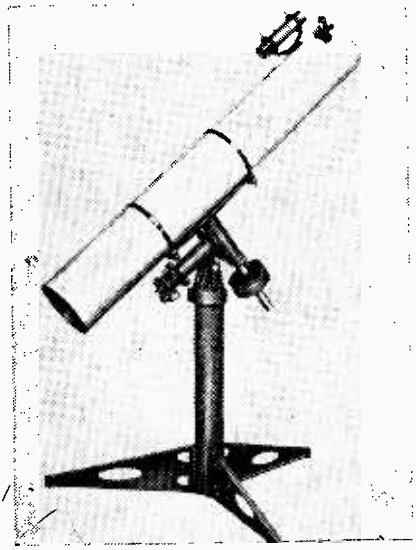
UPDATED SWLING

Hallicrafters has brought out an advanced version of its SX-122 receiver. Dubbed the SX-122A, it features dual conversion on all bands and has provision for AM, CW, and SSB reception in the frequency range from 540 kHz to 34 MHz. Domestic or foreign overseas broadcasts, military communications, ship-to-shore broadcasts, aircraft, the Citizens Band, and amateurs can all be monitored with the SX-122A, which covers the standard broadcast band plus the shortwave bands in four tunable ranges. Some of its features: tracked RF stage for maximum sensitivity; variable selectivity for separating closely spaced stations; antenna trimmer; separate RF gain control; automatic noise limiter; S meter; dual illuminated circular dials; dual detection system; premarked BFO; voltage-regulated oscillator circuitry; and much more. Power source, 105-125/220 V, 50/60 Hz; power consumption, 85 watts. Size is 8 x 18¾ x 19$^{13}/_{16}$ in.; weight is 28¾ lb. The SX-122A requires an external 3.2-ohm speaker. Price is $350.00, and for additional data, write The Hallicrafters Co., Dept. SE, 600 Hicks Rd., Rolling Meadows, Ill. 60008.

Hallicrafters SX-122A Receiver

WATCH ASTRONAUTS LAND ON MOON

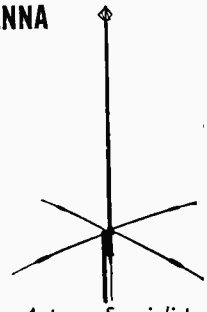
You can be there with Apollo 11 if you have Edmund's 8-in. reflector telescope, No. 85,171. Assuming atmospheric conditions are right, you'll be able to see the Apollo spaceship orbiting the moon, landing, or lifting off the moon and returning to earth. The brightness of the Apollo on the way home will vary from 12th magnitude, well within the range of this telescope, to a 1st magnitude easily seen with the naked eye. Some features: aluminized and overcoated hand-corrected (better than ¼ wave) f/8 parabolic Pyrex mirror with 64-in. focal length; three matched 4-element orthoscopic eye pieces; deluxe wide field 5.5 power finder telescope; pedestal and extra heavy duty equatorial



Edmund 8-in. Reflector Telescope

mount with clock drive and specially designed setting circles; 63-in. phenolic tube. It weighs 210 lb. and sells complete for $464.00. For more data, write Edmund Scientific, Dept. HP, 380 Edscorp Bldg., Barrington, N.J. 08007.

THIRD GENERATION ANTENNA



Antenna Specialists Mighty Magnum III

Antenna Specialists have a new antenna, the Mighty Magnum III (M-227), a half-wave, 4 dB gain, omnidirectional job with new configuration. Variation on previous versions is in the loading static arrestor assembly at the top of the 5-section aluminum dipole to a diamond-shaped double loop, and in the Power Tip radials. These radials are substantially shortened and are therefore more rugged. This was accomplished by means of four small loading coils which lengthen the radials electrically to full ¼-wavelength, making for a low radiation angle and 4-dB omnidirectional gain. Mighty Magnum III also has a waterproof coax connector jacket and chemically welded dual phasing coil jacket. Price is $36.95, and you can get complete information from Antenna Specialists Co., Dept. RT, 12435 Euclid Ave., Cleveland, Ohio 44106.

BLESS MY STARS!

Now you can have a planetarium at home

Nova Home Planetarium

with the Nova Home Planetarium kit! It shows more than 60 constellations as they appear in the Northern Hemisphere, plus all major southern constellations. A lighted pointer points out stars and constellations in the news. The Nova Home Planetarium adjusts for any latitude north of the equator, any month of the year, any hour of the night. Star motion in daily increments can be tracked manually. A built-in horizon maintains proper perspective regardless of latitude setting. The kit, priced at $14.88, comes with star charts and instructions. It's distributed through the Allied Radio Corp., Dept. 20, 100 N. Western Ave., Chicago, Ill. 60680.

SIXTY-WATT STEREO CENTER

The Claricon people have put their latest 60-watt stereo music system in some very contemporary cabinetry. Integrated with the stereo receiver is a Garrard automatic changer with

Claricon 35-160 Stereo Music System

magnetic cartridge. Sound is delivered by two acoustically suspended speaker systems with a front-loaded 8-in. woofer and 3½-in. tweeter with electrical crossover. Amplifer: 60 watts

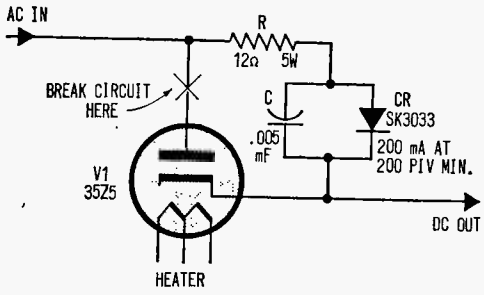
(Continued on page 99)

Modification

How can I use a solid-state rectifier to replace a 35Z5 tube?

—R.A.E., Suring, Wis.

Leave the 35Z5 tube in the socket. Its heater is a voltage dropping device in the series tube heater string. Add a resistor, capacitor and rectifier diode as shown in the diagram. The tube will light but will run cooler and last longer since no plate current will flow.



If you insist on getting rid of the tube, pull it out of its socket, add R, C, and CR, and connect a 220-ohm 10-watt resistor across the outer heater terminals at the tube socket. The resistor is apt to get hot so watch its placement with respect to other parts.

2N698 Anyone?

I am building a carrier current transmitter using 2N698 transistors. As of now I have not been able to locate this number. Could you name a company that makes the 2N698, or better yet, another unit that will work?

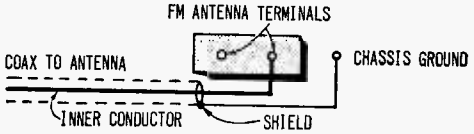
—B.N., Oradell, N.J.

Allied Radio Corp., 100 N. Western Ave., Chicago, Ill. 60680, lists the 2N698 in its catalog for $1.57. It's a Texas Instruments transistor which should be available at some New York City and New Jersey parts stores. However, Texas Instruments transistors are hard to come by over the counter in small quantities. Why not try a 2N1975, as exact replacement, available from Allied, Radio Shack, Lafayette?

Cable FM

I want to use 75-ohm coax instead of twin-lead to connect my FM receiver to its antenna. However, my receiver only has antenna terminals for 300-ohm twin-lead. How can I do it?

—D.E.R., Hollywood, Calif.



You can connect the center conductor of your coax to one of the 300-ohm antenna terminals and the coax shield to the receiver chassis, as shown in the diagram. Better still, purchase two 300-ohm to 75-ohm matching transformers. Connect one to the antenna and the other to your FM set. (It's a good idea for TV, too!) Run the coax lead-in from transformer to transformer. Check your Allied Radio and Lafayette catalogs for what's available and prices.

Eucchh, What a Job!

I have an AM radio to which I wish to add FM and shortwave. Could you tell me how to make detectors to accomplish this?

—R.L., Utica, N.Y.

Your present AM diode detector will work for shortwave. If you mean FM broadcast, your set won't do since an FM broadcast signal is 150 kHz wide and your receiver's IF amplifier won't pass the signals. It's designed to pass 10-kHz wide AM signals only. Or, if you mean FM mobile radio signals, your AM detector will demodulate them without modification. These signals deviate only ±5 kHz and can be demodulated with an AM detector by means of slope detection. Why not buy a ready-made unit or kit? It'll be cheaper.

We've Been Doing That

I am a novice but can't buy a receiver or transmitter. The only equipment I have is from old radios and television sets. I wonder if you could give me plans for a receiver (no transmitter) for the 2, 6, 10, 15, 20, 40, and 80 meter bands that can be built with parts from old radios and television sets.

—D.J., Lufkin, Texas

That's a big order. It would take quite a few days to design what you want. Instead, we suggest you read SCIENCE AND ELECTRONICS and ELEMENTARY ELECTRONICS every issue. These two magazines publish plans for receivers in almost every issue. As for second-hand parts, be careful—select carefully and test before installing any used part in a circuit.

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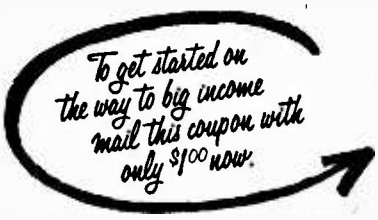
How to get your share of the multi-billion dollar advertising specialties industry which offers unlimited opportunities to salesmen. Commissions on matchbooks alone run to more than $7,000,000...sources for profit making in major areas.



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20 FASTEST GROWING RETAIL BUSINESSES!

Survey and report of independent businesses which are currently booming—coin-op car wash, beauty/wig salons, poodle grooming parlors... economic indicators to help you to make the wisest choice for a profitable business!

22 MONEY-MAKING HOBBIES!

Hobbies are not only for fun, but can be profitable as well! Here's how to turn your coin/stamp collecting, your tropical fish or even your own art and craft items into a substantial secondary source of income!

33 PART TIME, FULL TIME VENDING MACHINE OPPORTUNITIES

Learn the secrets to big steady income with your own vending machine operation. Get the inside information on: types of machines, kinds of products, investment needed, potential income, how to select locations—and much, much more!

22 LOW-COST, HIGH PROFIT FAST FOOD FRANCHISES

How you can cash in on the great fast food restaurant boom. Details on types of opportunities such as: Barbecue, burgers, franks, Cantonese, donuts, etc. with information you need on investment and how to project profits.

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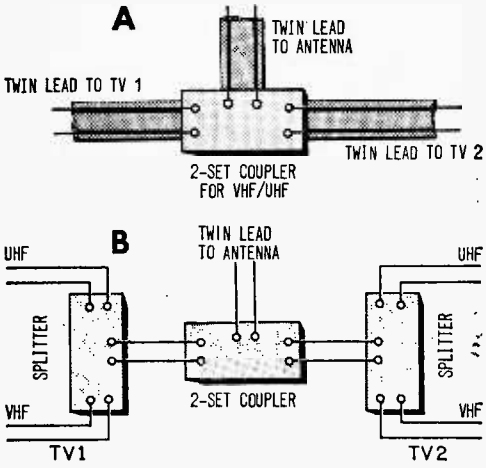
RTV-869

TV Split-Up

At our home we have two television sets operated from one outdoor antenna. Could you please draw a circuit which could be used to run both sets at the same time?

There is also a new station coming to the area. It is a uhf station. The antenna I mentioned previously is an all-channel antenna. I would like a second circuit which would enable me to use the antenna on both terminals for the best reception on both vhf and uhf.

—J.E.B., Pittsburgh, Pa.

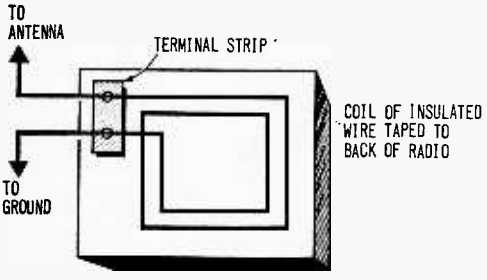


Use a two-set coupler Blonder-Tongue A-102 U/V to split the antenna transmission line, as shown in the diagram. Then split each receiver feed line with a VHF/UHF splitter (Blonder-Tongue UV-CS). It would be a good idea to think about coax cable leadins. They're more efficient. When switching to cable be sure to use impedance-matched couplers and splitters.

Loop It!

Is there any way to connect an antenna to an ordinary table radio that does not have antenna connection?

—Mrs. A.C., Odessa, Texas



Sure! Take a piece of insulated wire and form it into an oblong coil and tape it on the back of the radio. Connect one end to an outdoor antenna and the other end to a ground using a terminal strip as shown in the diagram. The ground is very important. The coil will be magnetically coupled to the receiver's built-in loop antenna.

Stick to Code

I have built the "No-Ticket Rig" (RADIO-TV EXPERIMENTER, *February/March 1969) which works very well. If modified to use a microphone, can it be used to communicate up to about 260 feet using a small transistor radio for a receiver? Would this interfere with FCC rules?*

—L.M.J., Tampa, Fla.

You can use an AM voice transmitter legally. However, 260-foot range when using a transistor radio without an external antenna is doubtful. And if you can do it, you can be sure you're breaking the FCC rules, Part 15, Section something-or-other. Just don't do it unless you look good in stripes.

A Big IF

Could you diagram a circuit for a heterodyne converter for connecting a 1.65 MHz IF signal to a 30 MHz IF?

—E.J.S., Ashland, Wis.

While it can be done, you're going the wrong way. You ordinarily convert to a lower frequency to get better gain and selectivity. Sounds like you have a surplus radar IF amplifier with a bandpass several MHz wide. It wouldn't work worth a darn. You would have to use a 28.35 MHz or 31.35 MHz local oscillator whose signal would pass right on through the IF amplifier along with the 30-MHz IF signal. Why not bronze the IF strip and use it as a bookend?

"Due to interference, the remainder of this broadcast will be taped!"

LITERATURE

ELECTRONIC PARTS

135. Get with ICs! *RCA's* new integrated Circuit Experimenter's Kit KD2112 is the first of its kind and should be a part of your next project. Get all the facts direct from *RCA*. Circle 135.

★140. How cheap is cheap? Well, take a gander at *Cornell Electronics'* latest catalog. It's packed with bargains like 6W4, 12AX7, 5U4, etc., tubes for only 33¢. You've got to see this one to believe it!

★2. Now, get the all-new 512-page, fully illustrated *Lafayette Radio* 1969 catalog. Discover the latest in CB gear, test equipment, ham gear, tools, books, hi-fi components and gifts. Do it now!

★5. *Edmund Scientific's* new catalog contains over 4000 products that embrace many interests and fields. It's a 148-page buyers' guide for Science Fair fans.

★4. *Olson's* catalog is a multicolored newspaper that's packed with more bargains than a phone book has names. Don't believe us? Get a copy.

7. Before you build from scratch, check the *Fair Radio Sales* latest catalog for electronic gear that can be modified to your needs. *Fair* way to save cash.

8. Get it now! *John Meshna, Jr.'s* new 46-page catalog is jam packed with surplus buys—surplus radios, new parts, computer parts, etc.

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23. No electronics bargain hunter should be caught without the 1969 copy of *Radio Shack's* catalog. Some equipment and kit offers are so low, they look like misprints. Buying is believing.

106. With 70 million TV and 240 million radios somebody somewhere will need a vacuum tube replacement at the rate of one a second! Get *Universal Tube Co.'s* Troubleshooting Chart and facts on their $1.50 flat rate per tube.

10. *Burstein-Applebee* offers a new giant catalog containing 100s of big pages crammed with savings including hundreds of bargains on hi-fi kits, power tools, tubes, and parts.

11. Now available from *EDI (Electronic Distributors, Inc.):* a catalog containing hundreds of electronic items. *EDI* will be happy to place you on their mailing list.

6. Bargains galore, that's what's in store! *Poly-Paks Co.* will send you their latest eight-page flyer listing the latest in available merchandise, including a giant $1 special sale.

CB—AMATEUR RADIO—SHORTWAVE RADIO

102. No never mind what brand your CB set is. *Sentry* has the crystal you need. Same goes for ham rigs. Seeing is believing, so get *Sentry's* catalog today. Circle 102.

146. It may be the *first—Gilfer's* speciality catalog catering to the SWL. Books, rigs, what-nots—everything you need for your listening post. Go *Gilfer*, circle 146!

100. You can get increased CB range and clarity using the "Cobra-23" transceiver with speech compressor—receiver sensitivity is excellent. Catalog sheet will be mailed by *B&K Division of Dynascan Corporation.*

141. Newly-designed CB antenna catalog by *Antenna Specialists* has been sectionalized to facilitate the picking of an antenna or accessory from a handy index system. Man, *Antenna Specialists* makes the pickin' easy.

130. Bone up on the CB with the latest *Sams* books. Titles range from "ABC's of CB Radio" to "99 Ways to Improve your CB Radio." So Circle 130 and get the facts from *Sams.*

107. Want a deluxe CB base station? Then get the specs on *Tram's* all new Titan II—it's the SSB/AM rig you've been waiting for!

96. Get your copy of *E. F. Johnson's* new booklet, "Can *Johnson* 2-Way Radio Help Me?" Aimed for business use, the booklet is useful to everyone.

129. Boy, oh boy—if you want to read about a flock of CB winners, get your hands on *Lafayette's* new 1969 catalog. *Lafayette* has CB sets for all pocketbooks.

46. Pick up *Hallicrafters'* new four-page illustrated brochure describing Hallicrafters' line of monitor receivers —police, fire, ambulance, emergency, weather, business radio, all yours at the flip of a dial.

116. Pep-up your CB rig's performance with *Turner's* M+2 mobile microphone. Get complete spec sheets and data on other *Turner* mikes.

48. *Hy-Gain's* new CB antenna catalog is packed full of useful information and product data that every CBer should know. Get a copy.

111. Get the scoop on *Versa-Tronics'* Versa-Tenna with instant magnetic mounting. Antenna models available for CBers, hams and mobile units from 27 MHz to 1000 MHz.

45. CBers, Hams, SWLs—get your copy of *World Radio Labs'* 1969 catalog. If you're a wireless nut or experimenter, you'll take to this catalog.

★101. If it's a CB product, chances are *International Crystal* has it listed in their colorful catalog. Whether kit or wired, accessory or test gear, this CB-oriented company can be relied on to fill the bill.

103. *Squires-Sanders* would like you to know about their CB transceivers, the "23'er" and the new "S5S." Also, CB accessories that add versatility to their 5-watters.

TOOLS

★78. Need a compact screwdriver kit? *Xcelite's* 99PV-4 and 99PV-6 kits consist of handle, 3 and 5 blades, respectively, in a see-thru zipper case. Get *Xcelite's* catalog 166!

118. Secure coax cables, speaker wires, phone wires, etc., with *Arrow* staple gun tackers. 3 models for wires and cables from 3/16" to 1/2" dia. Get fact-full Arrow literature.

ELECTRONIC PRODUCTS

★44. Kit builder? Like wired products? *EICO's* 1969 catalog takes care of both breeds of buyers. 32 pages full of hi-fi, test, CB, ham, SWL, automotive and hobby kits and products —do you have a copy?

144. Hear today the organ with the "Sound-of-Tomorrow," the Melo-Sonic by *Whippany Electronics.* It's portable—take it anywhere. Send for pics and descriptive literature.

★42. Here's colorful 116 page catalog containing a wide assortment of electronic kits. You'll find something for any interest, any budget. And *Heath Co.* will happily send you a copy.

128. If you can hammer a nail and miss your thumb, you can assemble *Schober* organ. To prove the point, *Schober* will send you their catalog and a 7-in. disc recording.

12. *C. B. Hanson* new Automatic Control records both sides of a telephone call automatically—turns off automatically, too! Get all the details —today!

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126. Did you dig *Delta's* new literature package chucked full of pics and specs on such goodies as an FET-VOM, SCR ignition system, computerized auto tach, hi-voltage analyzer, etc.? Man, then let *Delta* know you're alive! Circle 126 now!

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104. You can't hear FM stereo unless your FM antenna can pull 'em in. Learn more and discover what's available from *Finco's* 6-pages "Third Dimensional Sound."

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30. *Shure's* business is hi-fi — cartridges, tone arms, and headphone amps. Make it your business to know *Shure!*

17. Mikes, speakers, amps, receivers—you name it, *Electro-Voice* makes it and makes it good. Get the straight poop from *E-V* today.

99. Get the inside info on why *Koss/Acoustech's* solid-state amplifiers are the rage of the experts. Colorful brochure answers all your questions.

26. The all new, lavishly-illustrated, full-color brochure, "At Home With Stereo" clues you in on *H.H. Scott's* 1969 stereo consoles. Discover how to pick a hi-fi console for your living room.

TAPE RECORDERS AND TAPE

14. You just gotta get *Craig's* new pocket-size, full-color folder illustrating what's new in home tape recorders—reel-to-reel, cartridge and cassette, you name it! It looks like a who's who for the tape industry.

123. Yours for the asking—*Elpa's* new "The Tape Recording Omnibook." 16 jam-packed pages on facts and tips you should know about before you buy a tape recorder.

31. All the facts about *Concord Electronics Corp.* tape recorders are yours for the asking in a free booklet. Portable, battery operated to four-track, fully transistorized stereos cover every recording need.

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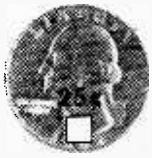

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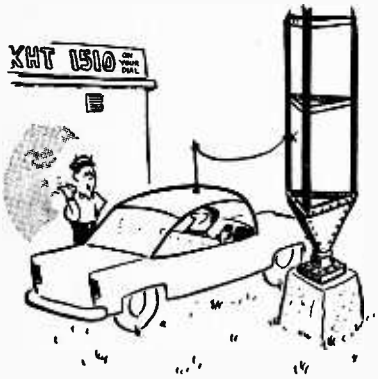
TOWER POWER

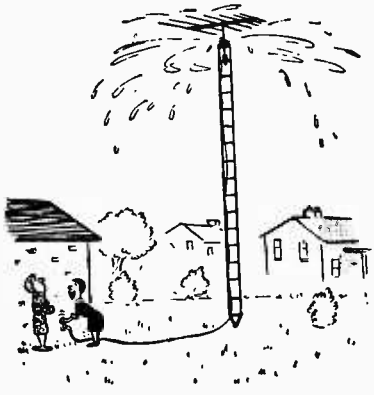
by Jack Schmidt



"Okay, beat it..."

"Look'it this, Gladys, the antenna never even moved in all that wind!"

"And now Mr. Hertz, how much would you estimate it's worth as scrap?"



"It's great, Martha! I use it to water the lawn while Harold's at work."

"That wouldn't, by any chance, be the level you picked up for just a buck?"

The shocking facts to date: that magnets can make you live longer!

MAGNETS AND HUMAN LIFE

by Webb Garrison

Had you been wandering about the University of Illinois's Medical Center seven years ago, you might have chanced upon something a mite unusual. Hungarian-born Jeno M. Barnothy, a physicist with an international reputation for cosmic-radiation research, displayed two mice on the palm of his hand. There was a gleam of triumph in the scientist's eyes.

"These mice," he told colleagues and visitors, "are *(Continued overleaf)*

precisely the same age—400 days. But they don't look it, do they?"

Even a person unfamiliar with mice of the sort commonly used in laboratory tests could have distinguished between the two animals at a glance. One showed all the typical signs of aging: wrinkled skin, lustreless fur, relatively passive acceptance of the situation at hand. The other mouse boasted smooth fur of uniform color and seemed ready for anything. Eyes agleam, she wriggled vigorously.

Both animals had been reared under identical conditions in cages of the same size. Both had received the same diet. But for a few months in early youth, one had been subjected to a magnetic field of 4200 oersted. The other had been reared in a normal magnetic environment.

Incredibly, the mouse that ate, slept, and played within the magnetic field appeared much younger than she actually was. (Mice of this sort have an average life span of 370 days.) She gave every appearance of having drunk from Juan Ponce de Leon's ever-illusive fountain of youth.

Slower Aging. Is it possible that an artificially-produced magnetic field (superimposed within our natural geomagnetic field) can actually slow the aging process? Barnothy wasn't sure—and there are no positive answers today. But Barnothy's experiments made it abundantly clear that the special environment had done *something* to the mouse. Whatever the effect, it created a striking change in the mouse's appearance and could have affected her life expectancy.

Mice still play major roles in the work of Jeno M. and Madeleine F. Barnothy. Late last year, for example, husband-and-wife team, both physicists and both pioneers in the exciting new field of biomagnetic research, performed autopsies on ten male Swiss mice. For 13 of his 47 days, each mouse had been kept in a vertical, homogeneous magnetic field of 9000 oersted. Such a field represents a force roughly twice that employed with the mouse just mentioned. Moreover, it's about 20,000 times stronger than the geomagnetic field that is an ever-present aspect of all life on earth.

Of the 10 animals exposed to this relatively powerful magnetic field, nine exhibited adrenal glands with marked abnormalities. Bone marrow of the treated animals showed significant reduction in number of megakaryocytes (specialized cells believed responsible for production of blood platelets). Clearly, life expectancy for these animals had been reduced rather than increased.

How can we account for these paradoxical results? What are some of the variables in biomagnetic research, and where will the inquiry lead us?

As recently as the 1930s, most scientists would have dismissed the suggestion that magnets affect human life as absurd or meaningless. Today, the idea is being taken seriously by a growing number of investigators. All evidence supports the conclusion that magnetic fields exert a variety of effects upon organisms of every kind. Some such effects are fairly well understood; others still lie beyond the fringes of present-day knowledge. But they are so numerous, so pervasive, and so important that future generations may well regard the magnetic field as one of the major environmental variables.

False Trails. Paracelsus, a noted 16th-

Bettmann Archive engravings

Friedrich Anton Mesmer, also known as Franz, did more to promote magnetism as effective medicine than any other individual in history, though his "cures" were apparently more psychological than real. Sketch (far right) shows visitors at one of Mesmer's seances grouped around row of bottles charged by Mesmer with his personal magnetic fluid.

century Swiss alchemist, founded a cult of persons who claimed they could achieve marvelous effects from use of magnetism. Though they but dimly understood its true nature, they represented themselves as masters of the mysterious force. Magnetic iron was administered to the sick as a cure-all.

Two centuries later, a Jesuit priest, Maximilian Hell, suggested that magnets be used in medical treatment. His ideas were expanded by Franz Mesmer, who claimed that a healing fluid is found in the human body. This fluid, said the Austrian, responds to the mysterious cosmic energy that is manifested by a magnet.

To cure a person of any ailment whatever, he reasoned, it was only necessary to place two magnets in contact with the body. Their mysterious pull, said Mesmer, caused this even more mysterious healing fluid to flow and resulted in restoration of health. Contemporary reports indicate that many persons actually had their maladies (or their symptoms!) removed by magnetic treatment.

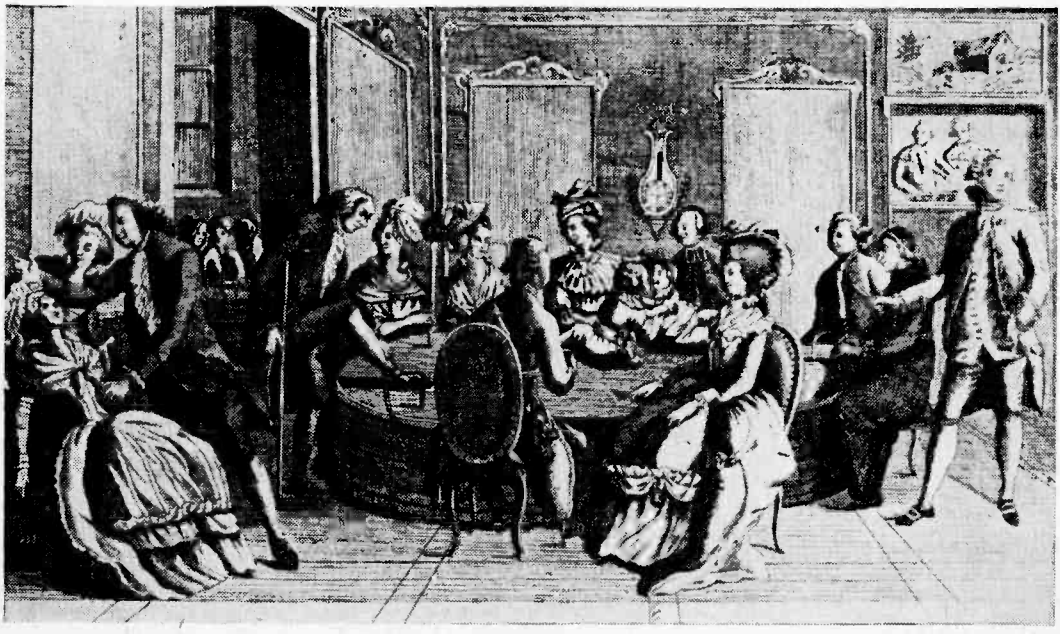
As might be expected, Mesmer made a great splash at the French court. Marie Antoinette, the Duke of Bourbon, and the Marquis de Lafayette were among his patients. They joined thousands of ordinary folk in praising him for having "mastered the most potent of all healing forces."

Since magnets were scarce and costly in those days, it occurred to Mesmer that by making suitable gestures and reciting a secret formula he could invest ordinary objects with a magnetism all their own. Accordingly, mirrors, wash basins, and wooden wands were transformed into do-it-yourself instruments—which often proved fully as potent as ferrous magnets themselves!

Patients paid big fees for the privilege of sitting half an hour in front of a tub that contained bottles Mesmer said he had filled with "animal magnetism." And when he "magnetized" musical instruments, their notes served to reduce the pain of patients who listened to them.

The French Academy of Science and most physicians denounced Mesmer as a quack, insisting that his cures were a result of the power of suggestion. Still, the French government offered him a large pension and the directorship of an institute if he would agree to transfer his powers to men selected by the state. At the height of the craze, "magnetized" curative devices were employed throughout western Europe. Madame DuBarry, King Louis XV's mistress, kept a magnetic apparatus in her bedroom—but complained because it had cost her one hundred louis.

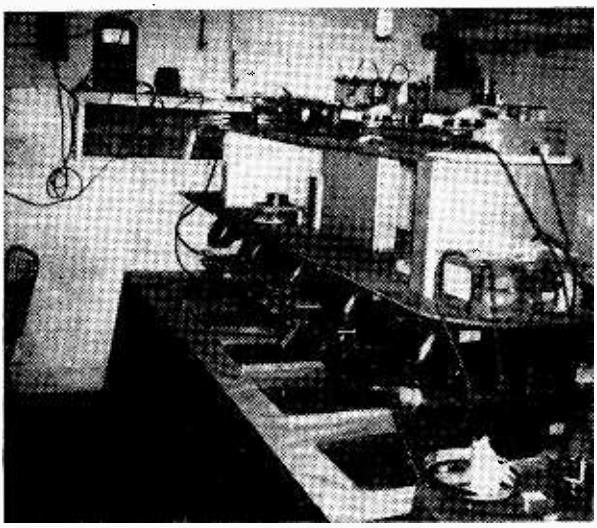
Eventually the mania for magnetic treatment passed. But many persons remained convinced that magnetic forces somehow actually do affect living things. Numerous notables—Charles Dickens among them—made it a rule never to travel without a compass. Such persons always aligned their



MAGNETS AND HUMAN LIFE

beds with heads to the magnetic north and feet to the south, thus permitting geomagnetic forces to "flow harmoniously" through their bodies!

Today we know that in a powerful magnetic field the orientation of an organism really does affect the results that are achieved in an experiment. But the wildly unscientific goings-on of Mesmer and his followers made the whole matter of biomagnetism suspect. As a result, serious investigators tended to ignore stray clues that suggested animals and even plants sometimes respond to magnetic forces. In such a climate, it was not strange that only a few bits of authentic information were accumulated.



Portion of laboratory at University of Illinois where Barnothys conducted their experiments with magnets and mice.

A New Frontier. In 1896, D'Arsonval (better known for his meters) reported sure evidence that a flash of light may be seen when a person's head is placed within an undulating magnetic field. Four years later a Swiss engineer, Muller, confirmed discovery of this magnetic phosphene (or "flicker"). What's more, he demonstrated that brightness of the flash increases instead of diminishes when the experimental room is more highly illuminated. The possibility of a health hazard to operators of Marconi's wireless telegraph equipment was seriously discussed.

By 1903, a few pioneers were trying to determine whether long-term exposure to a strong permanent magnet affects the life conditions of simply-organized life forms. French biologists Cheneveau and Bohn triumphantly concluded (60 years before Barnothy's most striking findings with mice) that static fields do, indeed, affect development and reproduction of protozoa. But few persons within the scientific community paid any attention.

Depression-plagued 1932 marks the real beginning of modern biomagnetic research. That year, Julia Lengyel of the University of Budapest came to Jeno M. Barnothy and asked for permanent magnets—plus advice on how to produce strong magnetic fields. Using his equipment and following his guidelines, she exposed several kinds of tissues to static fields. Her findings, still not fully confirmed, helped convince Barnothy that more work should be done. In this early period he suggested that it might some day be possible to retard development of malignant tumors by magnetic treatment.?

Today, it has been clearly shown that strong magnetic fields do, indeed, have far-reaching effects upon both cells and tissues.

Cells and Fields. Examined under high-powered microscopes, cultures of numerous one-cell organisms show random arrangement. There is no detectable form or pattern to the cluster.

But when exposed to relatively low magnetic fields (700 oersted or less) in the radio-frequency range, many cells behave like polystyrene spheres. They align themselves with the magnetic field, and long chains are sometimes formed. This phenomenon is neither uniform nor universal. But among the cells known to be affected are young erythrocytes—highly specialized bodies that serve to transport oxygen in the bloodstreams of humans and other mammals.

Uncharged particles whose dielectric constant differs from that of the surrounding medium are typically polarized so that they form chains parallel with magnetic lines of force. But elongated particles with fixed structural charge tend to align themselves at right angles to the field they are placed in. Many plants, for example, show a tendency

to grow *across* a static magnetic field.

Until comparatively recently, biologists regarded a cell as a minute bag of fluid that is relatively simple in structure. But under the electron microscope, cells were seen to be exceedingly complex. What earlier seemed to be a "simple cell wall" is likely to be folded and convoluted—precisely the right kind of structure to serve as a semiconductor. And components of the cell are likely to include organic semiconductors in the form of liquid crystals. To complicate matters even more, many cells have a double outer membrane; electrically, such a membrane functions as a capacitor.

Viewed as a minute but extremely elaborate electrical system, the living cell (like all electrical systems) is obviously subject to the influence of magnetic fields. And these fields may induce not just one but a complex system of currents.

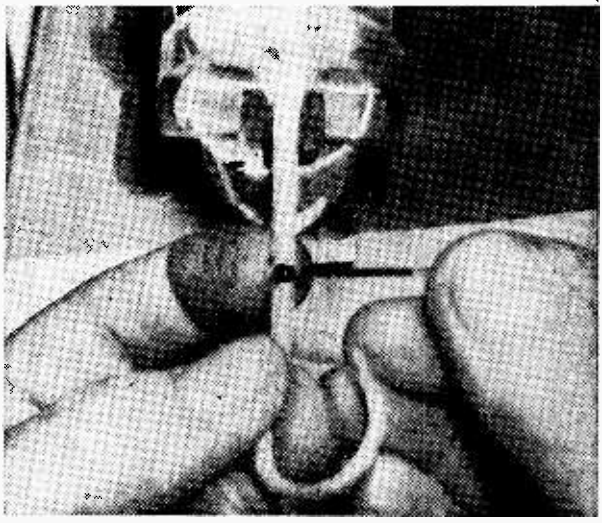
Small wonder, therefore, that reported effects of magnetic fields at the cellular level are diverse and debatable. Even a weak magnetic field may retard bud formation by yeast cells. But compared with tissues and organs, cells are simple and can be studied with relative ease and precision. What happens when organized clusters of cells are subjected to magnetic fields?

Tissues And Organs. Megakaryocytes (those specialized cells mentioned earlier) in the bone marrow of mice studied by Barnothy last year seem to behave like independent cells. But the adrenal gland is a highly complex organ composed of great numbers of associated cells. Gross changes in the adrenals of animals kept within a magnetic field for only 13 days testify that *something* happened as a result of exposure to the field. A tentative conjecture concerning the mechanism of the effect centers in the likelihood of a hormone imbalance.

Twenty years ago, Barnothy had suggested that the most tangible biological effect of a magnetic field is the slowing down of cell division. Impact of the field, he said then, is most obvious in the case of rapidly-dividing cells. (There remains the distinct possibility that in some cases a magnetic field may increase the death rate of cells.)

Since cells within an organism, or even a section of tissue from an organism, may vary widely in their growth rate, it follows that "concentration of effect" is to be expected. Bone marrow and adrenal glands examined last year showed far more pronounced effects than did other organs and tissues. Earlier, though, mice that died from prolonged exposure to magnetic influences were found to have livers only 50% as large as those of animals in the control group.

At the Institutum Divi Thomae in Cincinnati, the 7300-oersted field of a permanent magnet "significantly depressed" oxygen consumption of both kidney tissue and tissue from a malignant tumor. But the same influence seemed to stimulate oxygen intake of baker's yeast.



Closeup showing mouse undergoing tests by Barnothys. Yet to be completed are studies of effects of magnets on humans.

Earlier, Cincinnati scientists had found no significant effect from a constant field of 6 kG magnetic induction. Then they thought of applying the field intermittently so that the tissue would receive a series of pulses as a result of their alternately building up, then collapsing the magnetic field. This procedure caused "a definite stimulatory "effect" to appear.

Their studies showed oxygen intake to be relatively constant in a static magnetic field. But significant variations in respiration appeared when a 6-kG permanent magnet was moved so as to bring the field to and away from the specimen at 10-minute intervals. Even more pronounced variations

(Continued on page 38)

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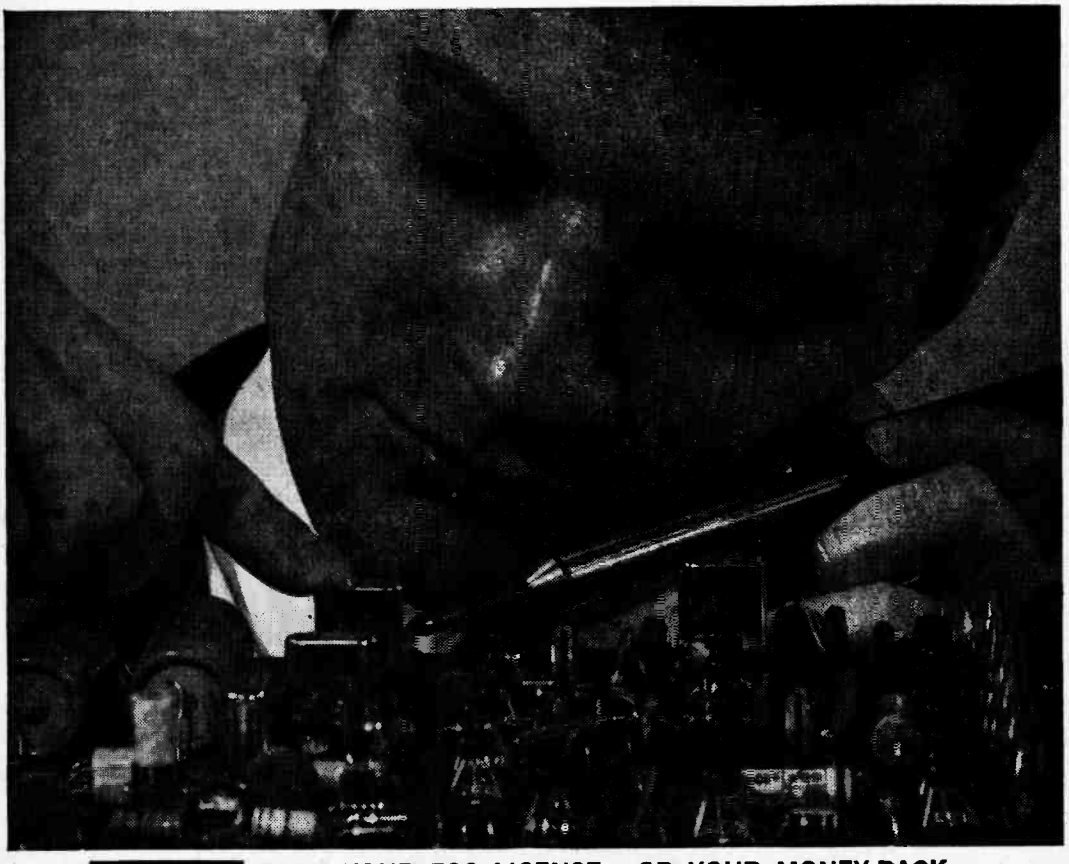

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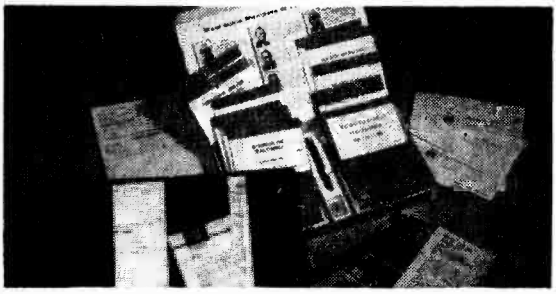

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MAGNETS AND HUMAN LIFE

Continued from page 33

occurred when a 10-kG electromagnet was turned *on* and *off* at 10-minute intervals.

Effects on respiration and cell division have obvious implications for cancer research, but no one knows where the trail will lead. Barnothy performed tumor inoculation experiments in which mice developed extremely large tumors during their first 10 to 14 days within a magnetic field. Thereafter, the tumors began to shrink and eventually were reduced to wounds that healed completely. Significantly, the lifespan of these animals was 45% greater than other mice remaining outside the magnetic field.

Enter Humans. With mice, both cells and tissues are clearly affected by magnetic fields —with a growth disturbance of some sort being the most commonly-observed effect. But what about their gross impact upon humans?

Answers are hard to come by.

One research worker obtained cost estimates for a proposed magnetic facility large enough and powerful enough for use with humans—operating at a low noise level and having accurate temperature controls. He estimated that the required coil and core would weigh more than 5 tons, occupy a room 4 x 6 ft. A suitable electromagnet would cost at least $75,000, and its accompanying power supply would drain the coffers of another $600,000.

Though laboratory tests involving the entire human body aren't yet feasible, some intriguing results have been achieved with selected organs. At Syracuse University, for example, Robert O. Becker and colleagues placed persons so that their heads were within a sinusoidally modulated field of 5-11 gauss at 0.1 to 0.2 Hz. Compared with controls, both male and female subjects showed marked response to effects of the magnetic field. Influence of the magnet reduced capacity to respond quickly to a stimulus; the variation between 0.1 and 0.2 Hz was pronounced.

Such slowing-down of bodily reactions may be due to what Madeleine F. Barnothy labels "sensory effects." Many organisms—including man—have built-in electrical systems that respond to magnetic fields, though no chemical or biological processes are permanently affected.

Ability to "see" a magnetic phosphene, or flicker, falls within this category. The flicker is experienced as a result of an induced current in the optical nerves and can be produced by an alternating field (best results: 200 gauss, 30 Hz). The hearing of radar—a well-documented contemporary experience —probably stems from current induced in bodily systems connected with auditory nerves.

For more than a century there have been sporadic reports of "hearing" auroras and meteors. Since meteors travel far faster than sound, these reports have until recently been dismissed as unfounded. But present theories support the view that under some circumstances some persons hear not the rushing meteor, but the magnetic field it creates.

Cornell's Allan H. Frey found that both normal and deaf persons "perceive sound" as a result of exposure to extremely low average power densities of electromagnetic energy. Sound level appears to be a function of carrier frequency and modulation.

Of academic interest, only? By no means!

As early as the 1930s, German scientists Düll and Düll studied 40,000 medical records. They found a statistical correlation between magnetic storms (which can cause compass needles to shift, black out radio signals, even blow telegraph line fuses by inducing voltages in wires) and suicides, mental and nervous disorders.

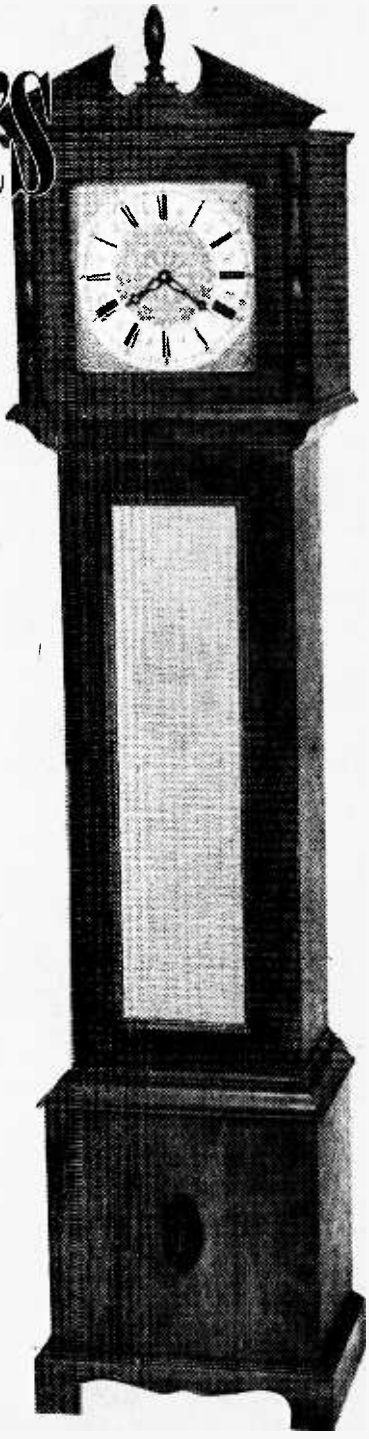
Recent studies have confirmed the correlation. In one of them, the coefficient of correlation between magnetic-field variations of our planet and incidence of hospital admissions for neuropsychiatric disturbances was calculated as +0.26. The probability of obtaining this result by chance is less than 1:10,000.

No one has a reasonable explanation why, but it is known that a person under hypnosis or in a state of mescalin intoxication can often perceive a static magnetic field—through modification of visual images. (The flicker effect is associated with an undulating field.)

Experiments haven't yet been made on humans, but at the U.S. Naval School of Aviation Medicine a series of studies have shown that strong magnetic fields have a marked effect on the cardiac rhythm of squirrel monkeys. For consistent results, it is essential that the position of the experimental animal be carefully controlled.

(Continued on page 96)

AUTHENTIC GRANDFATHER'S CLOCK doubles as hi-fi SPEAKER



by John Capotosto

Old Father Time was never more at home than in this replica of yesteryear gone sonic!

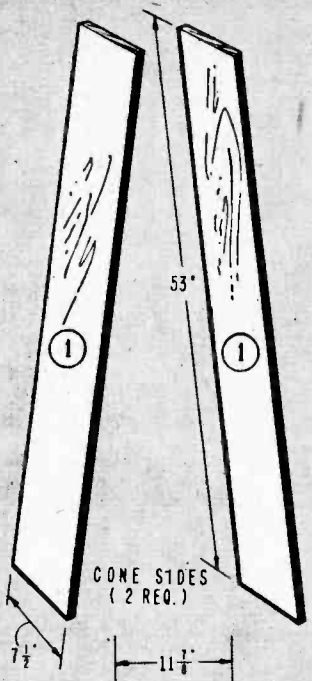
Here's a beautiful grandfather's clock that does more than tell time! Deep down inside it contains a speaker—mounted not just in an ordinary enclosure, but in a modified tapered pipe which offers very bright tone reproduction as well as efficient acoustic output.

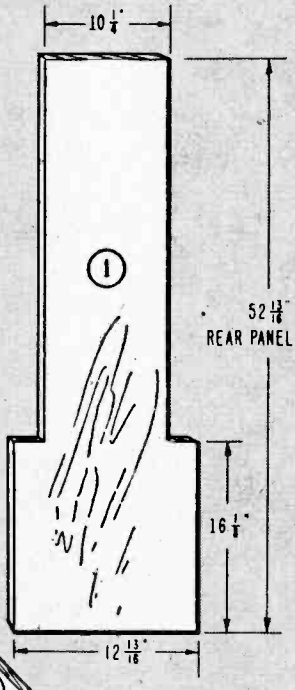
Why a pipe as opposed to the entire mid-section of the clock? Explanation runs this way: a pipe closed at one end produces third and fifth harmonics. But by placing the speaker a third of the way down, the third harmonic is eliminated. All things considered, the tonal results are remarkable. To be sure, a speaker with a larger cone would be even better, but we are limited to the confines of a well-proportioned clock.

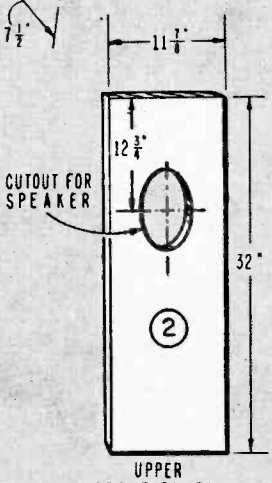
Though the clock looks fairly complicated, it's actually extremely easy to build. Reason is that we deliberately designed it so that even without previous experience anyone can easily build it. If you can build a box, you can make our grandfather's clock. It's that simple!

Decorative spin- *(Continued on page 41)*

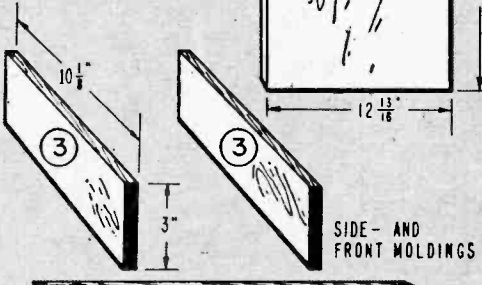
GRANDFATHER'S CLOCK...

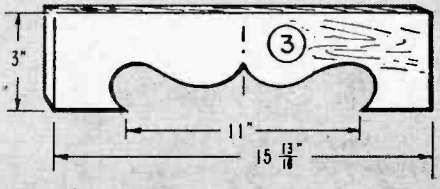


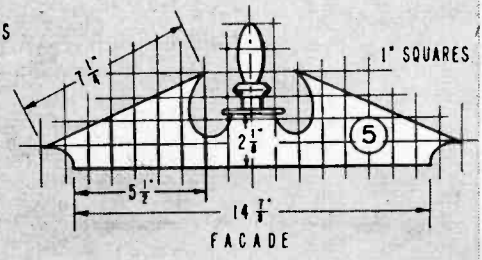


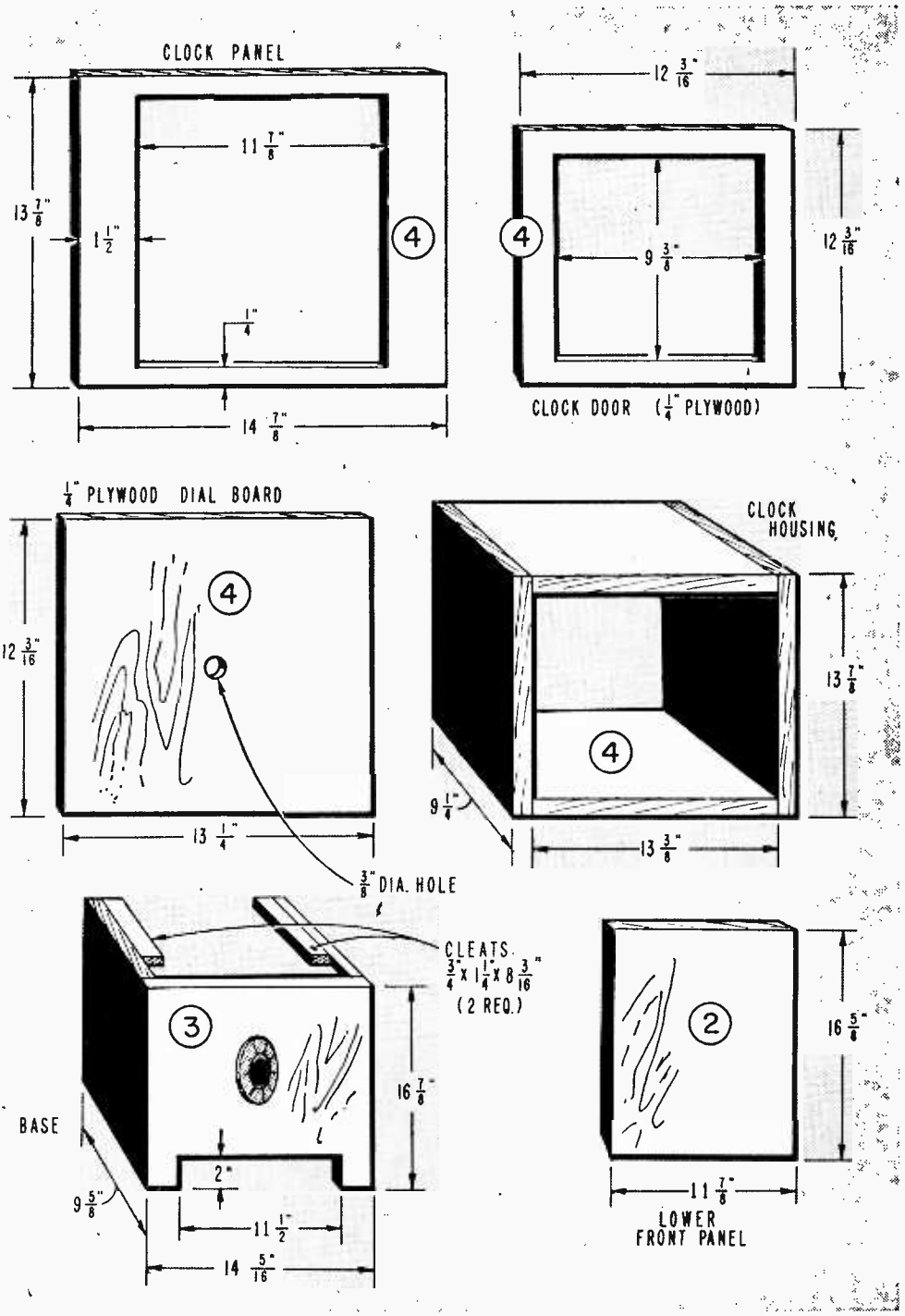


ALL LUMBER 3/4" THICK









dles as well as the movement and dial are available from one source so that you won't have trouble locating the parts. Unlike the kind grandpappy was familiar with, the movement in our clock is battery-powered and transistorized. Winding you don't have to do since like the electric watches now in vogue it'll run a whole year on a single battery.

If you own a table saw you can cut the plywood yourself; otherwise have

GRANDFATHER'S CLOCK...

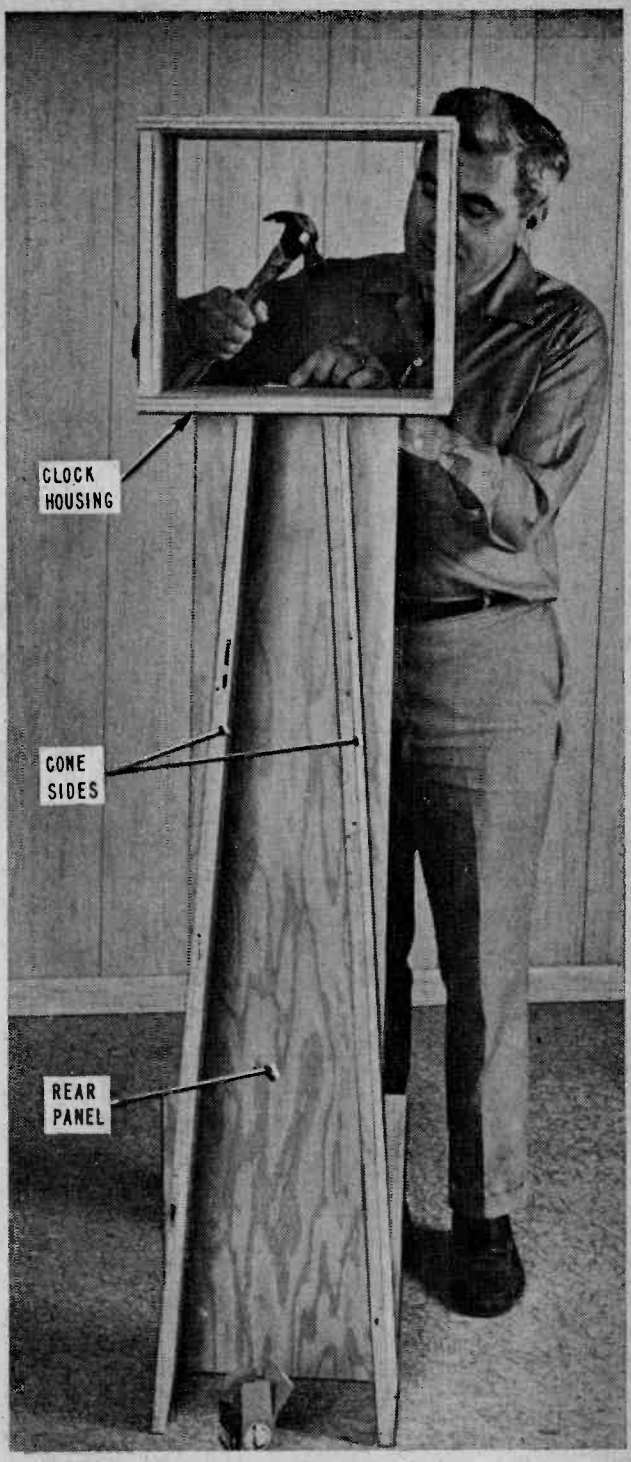
your lumber dealer cut the panels for you. Most lumber yards will cut the panels without cost, though others have a minimal charge.

Butt joints are used throughout, eliminating fancy miters. Nails, white glue, and hot glue combine to further simplify construction.

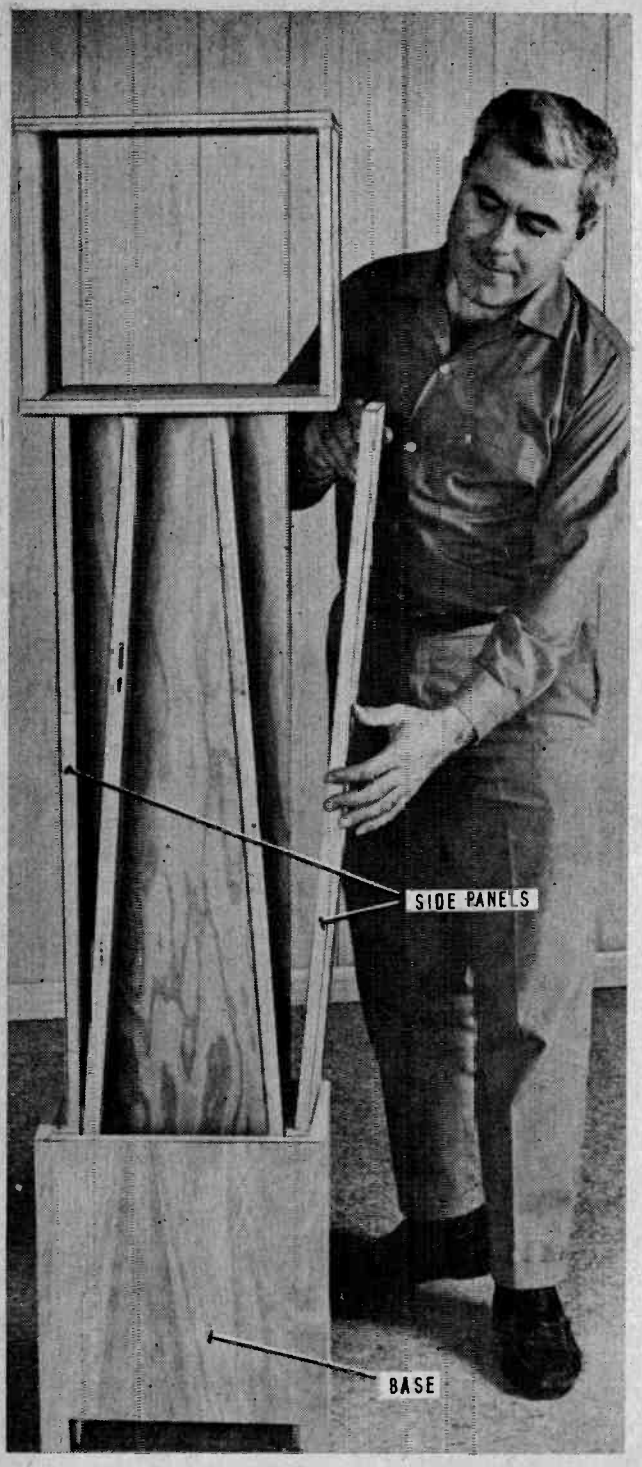
Start by assembling the cone sides to the rear panels as shown. (Note that all parts bear numbers—these relate to the final placement of the parts concerned.) Run a bead of glue along the joint, then nail with 2-in. finishing nails. Most nails will be hidden, but those few that do show should be set below the surface and their holes filled with a putty stick.

The curved shapes at the top and bottom and the speaker opening itself can be made with either a sabre saw or coping saw. Be certain to use a fine blade, and take time to sand the edges after cutting.

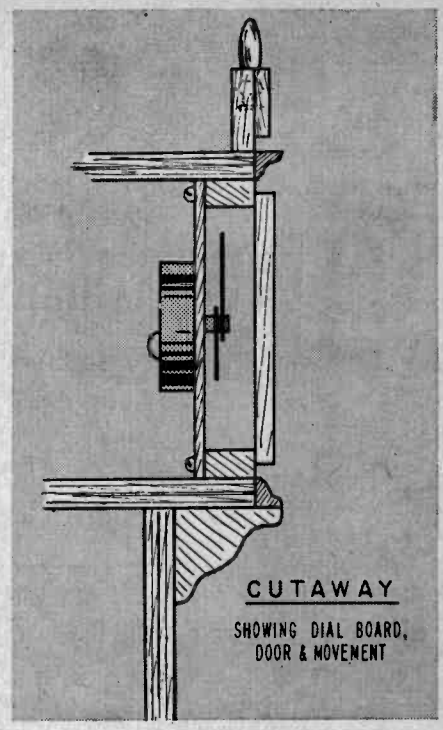
Before installing the front speaker panel, mount the speaker and run the wire leads from it to the rear panel. Solder the wires to a terminal strip mounted behind the rear panel. Be sure the wires are properly soldered, since the only access to the speaker after



Once plywood has been cut to sizes indicated on previous pages, actual assembly can begin. Pre-cut parts fit together like jig-saw puzzle: cone sides (1) are first attached to rear panel (1), then clock housing (4) is placed on top.



Side panels (1) effectively conceal tapered cone which houses speaker. Base (3) is mounted first, then side panels glued and nailed to rear panel. Cutout at bottom of base allows sound to emerge from end of tapered pipe.



BILL OF MATERIALS

1—4 x 8 ft. sheet of ¾-in. plywood or other wood (see text)
1—4 x 4-ft. sheet of ¼-in. plywood (see text)
1—5 x 7-in. oval speaker (Lafayette 32T0109 or equiv.—see text)
*2—Turned spindles
*1—Battery-driven clock mechanism, dial, finial, decorative applique
1—1½-V battery (Eveready 935 or equiv.)
Misc.—2-in. finishing nails, 3-in. cove molding, glue, solder, grille cloth, terminal strip, stain, shellac, paste wax, etc.

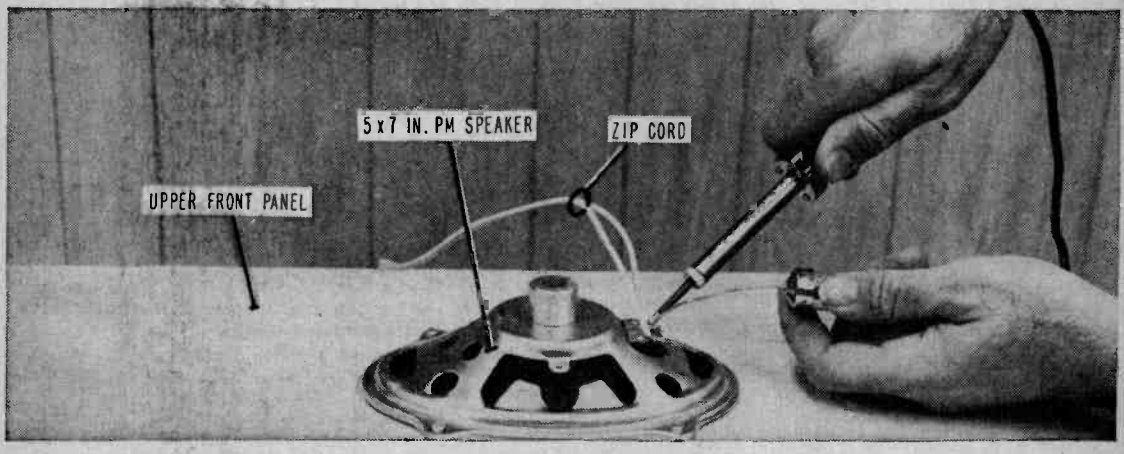
* Parts identified by asterisk are available for $28.00 postpaid from The Armor Co., Box 290, Deer Park, N.Y. 11729 (N.Y. Residents must include sales tax).

mounting the panel is through the opening at the bottom. And this is a very tight squeeze indeed!

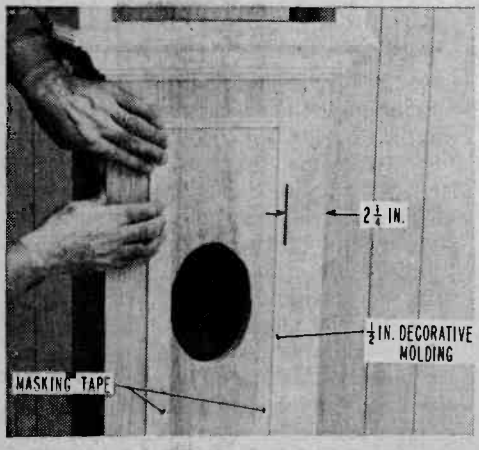
The decorative molding is best cut with a simple miter box and hacksaw, available at hardware stores and lumber yards. Support the molding at the same angle as it will be mounted and cut with slow, steady strokes. To eliminate unsightly nails on the molding, use a glue gun. Since this glue dries in roughly 60 seconds, there's no need for clamps. Run a bead of glue along the joint, then quickly join the parts. The finial, spindles, and decorative appliques at the

GRANDFATHER'S CLOCK...

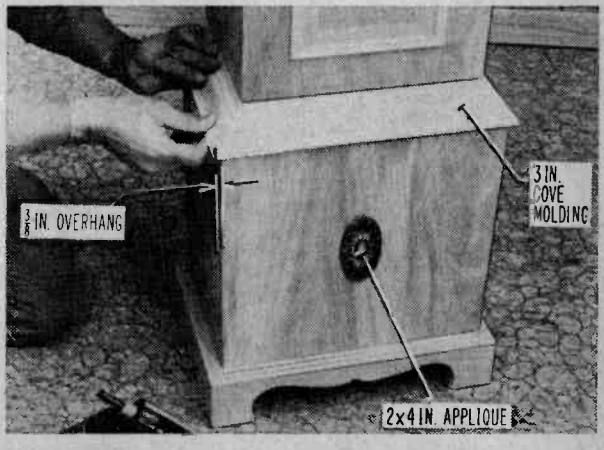
With lower front panel (2) in place, side moldings (3) can be attached to bottom of clock body. Front molding has cutout to free sound from pipe.



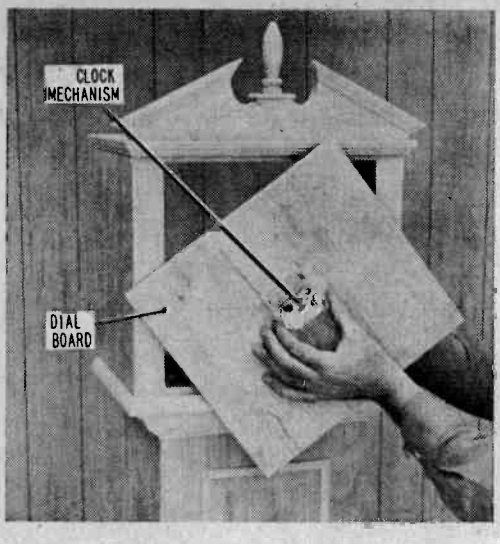
Speaker must be installed on upper front panel (2) before panel is mounted. Zip cord, soldered to speaker terminals, is then routed to terminal strip affixed to rear panel (1).



Outlining area with masking tape aids in applying molding to upper front panel (2).



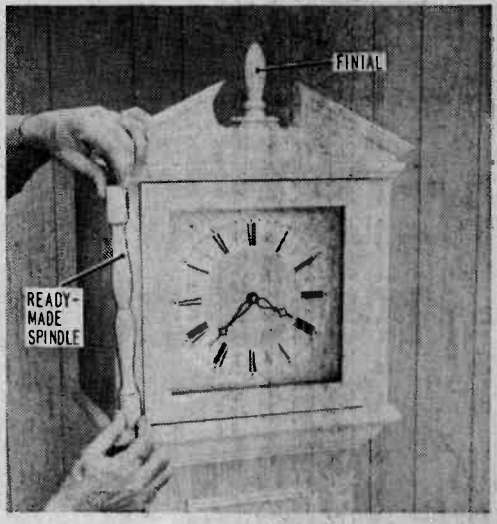
Cove molding and applique are best applied with hot glue: it sets in just 60 seconds.



Heart of clock is transistorized movement which runs for a year on flashlight cell.

Dial and mechanism are mounted on ¼-in. panel, then inserted through rear opening.

Dummy door (4) must be cut to fit opening, since it is glued permanently in place.



Ready-made spindles and finial (from source cited on page 43) dress up face of clock.

base are mounted in the same way.

The grille cloth is cut to size but not mounted until after the clock has been finished. Finishing depends on the wood used. If walnut, birch, or other cabinet woods are used, these can be stained, then given several thin coats of shellac. After the final shellac coat, rub down with fine steel wool, then follow with paste wax.

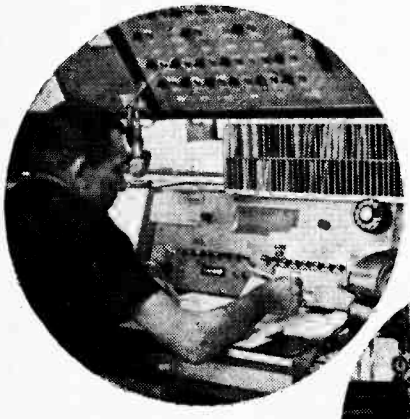
The grille cloth should be cut to fit within the opening provided. Brush on a coat of white glue that has been thinned down with water, then press the cloth firmly into place. The area of wood covered by the grille cloth shouldn't be stained or otherwise finished or the glue won't adhere properly.

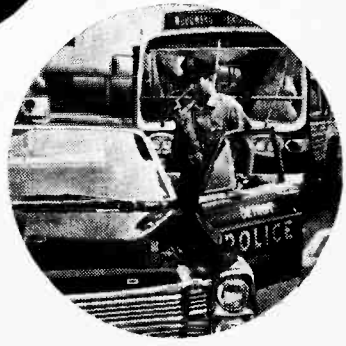
And that's it! You've just completed a highly functional, highly decorative addition to your home that you can be justly proud of! We suggest placing it where an extension speaker will prove most useful—in the rec room, say—but that's up to you. In any case, we'll bet even grandpa himself couldn't have scored better, though we'll have to concede that he didn't have an electrical mechanism to work with. ■

by C.P. Stedmeyer

RADIO: ready for rescue

Now well into its third year of operation, Motorola's award-winning, crime-busting Community Radio Watch has been formally adopted by nearly 700 U.S. cities and towns!



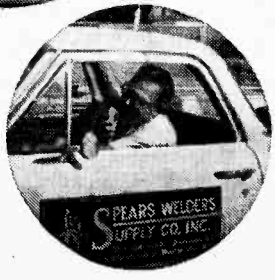


America's largest and most widespread plan for encouraging citizen participation in the fight against crime, Motorola's Community Radio Watch program now stretches from Seattle, Washington, to Miami, Florida, and from Old Town, Maine, to Honolulu, Hawaii. Here's how it works.

Each mayor of a participating city enlists the cooperation of individuals and companies with two-way radio-equipped vehicles, asking each driver to act as additional eyes and ears for the police. Drivers of trucks, buses, taxicabs, and other vehicles use their two-way radios to report crimes in progress, suspicious characters, dangerous situations—gang gatherings for example, civil disorders, fires, accidents, and other emergency situations to their dispatchers. The dispatchers in turn relay the calls by telephone to the appropriate local authority: police, fire department, ambulance squad, and so on.

During its terse but triumphant existence, CRW has seen no less than 28 drivers win Distinguished Service Awards for notable public service. Their radio reports brought

(Continued on page 100)



Facts and photos courtesy the Boeing Company

Our solar system, argues at least one author, consists of Jupiter plus debris. To test this and other theses, NASA has already set out to lock down plans on

How We'll Put a Spacecraft on Mars

In four years a spacecraft will land on Mars.

The possibility of life on other planets has fascinated man for centuries, of course. But only recently has he been able to send a flying machine millions of miles into space, place it in a precisely determined orbit around a planet, or land it on the surface of another world.

In mid-1973 two unmanned spacecraft, developed for the National Aeronautics and Space Administration's Viking program, are scheduled to leave Cape Kennedy for Mars. Nearly eight months after launch, 10 days apart, the two spacecraft will intercept the Red Planet in its nearly 900-million-mile swing around the sun. By that time they will have traveled more than 265 million miles in a looping trajectory. Their straight-line distance from Earth will be about 150 million miles.

At the proper moment, braking rockets will fire and both spacecraft will enter orbits around Mars. Each Viking spacecraft will survey potential landing sites from orbit. When a suitable site has been determined, a lander will detach from each orbiter and ease down softly on the surface of Mars.

Mariner First. The exact nature of the experiments to be carried on by the Viking spacecraft will not be determined for some time. The Mariner spacecraft flights of 1969 and 1971 will influence these decisions. But the general purpose of the Mars landing is to increase man's knowledge of the Martian surface and atmosphere, with particular emphasis on information about planet life.

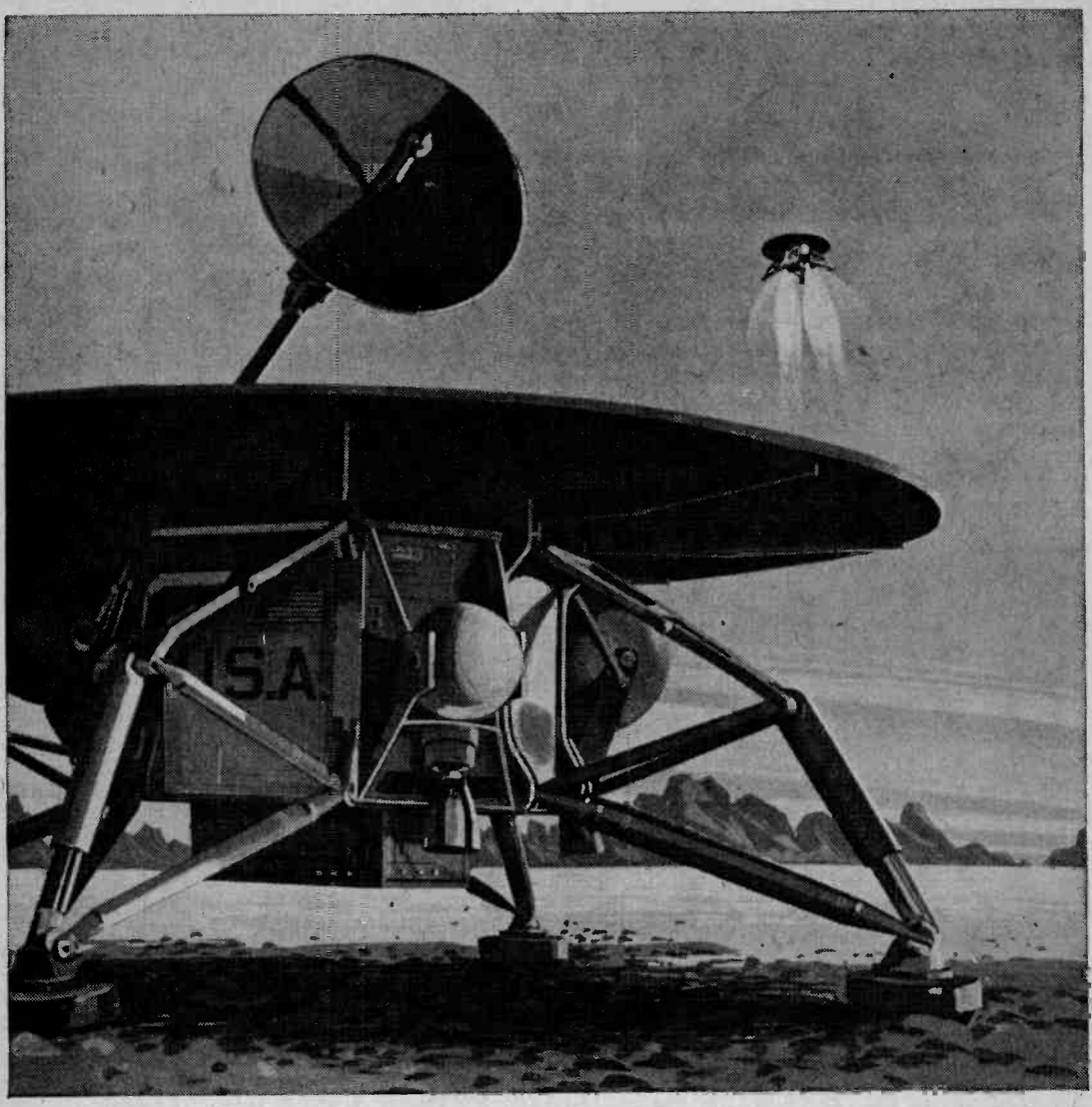
Viking is an important step in a carefully planned NASA program of Mars exploration. This year, two Mariner spacecraft will be launched on trajectories which will swing them past Mars at a distance of about 2000 miles. Pictures taken during the fly-by missions are expected to show surface features, such as craters, measuring 800 feet or more in diameter.

In 1971, two more Mariners will go to Mars, this time to be placed in orbit, providing a tenfold increase in scientific information about the planet. Two years later the Viking missions, with their soft landings on the planet, will add still more information including the Martian conditions which might support life.

Such scientific seek-and-fetch is not expected to show that little green men with waving antennas scuttle across bleak Martian deserts. Life, in the sense used by the scientists, is not that limited in scope. Biological experiments in the planet's atmosphere and on its surface are designed to detect both the presence of living organisms and the conditions which might be suitable for life.

Origin And Evolution. The goals of NASA's planetary exploration programs are much broader than the search for extraterrestrial life, important as that is. These goals include a better understanding of the origin and evolution of the solar system and the dynamic processes within it which control man's home—the Earth.

Last year a select group of the National Academy of Sciences pointed out in a special report that investigation of planetary



atmospheres, surfaces, and interiors not only will help unravel the complex history of the solar system, but also will lead to a better understanding of processes now under way in the Earth's atmosphere, oceans, and deep interior. In short, finding out what's happening out there will help explain what's happening here.

It seems likely that all nine solar system planets and their 32 satellites—including Earth and its moon—were formed of the same basic material. That material was probably primordial hydrogen and the time was roughly several million years ago. Dr. Isaac Asimov, a Russian-born American author of books on science and science fiction, simplified one creation theory thus: "The solar system consists of Jupiter plus debris." As riders on part of that debris, the human race needs to know more about the processes which are shaping—or have shaped—Earth and its planetary neighbors.

Germ-free. Viking will challenge even the most formidable collection of talent. Engineers and biologists must join forces during spacecraft design and construction. One such cooperative effort involves preventing the contamination of Mars with life from Earth. The Committee on Space Research (COSPAR) has decreed that spacecraft must be sterilized to prevent the transport of live Earth micro-organisms to Mars.

Communication between Earth and the spacecraft will impose another restraint—

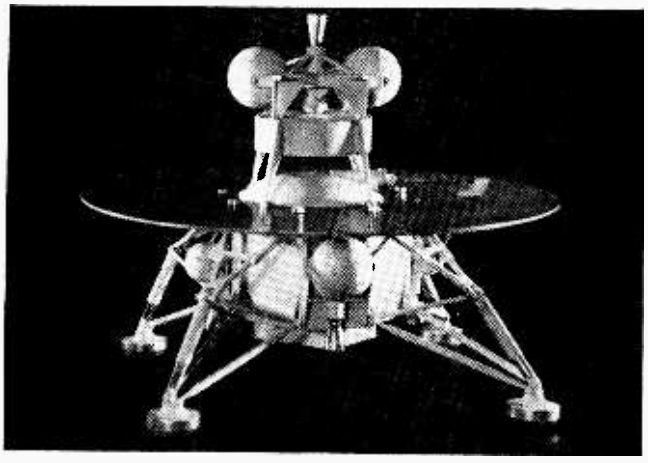
Spacecraft on Mars

a time lag of 13 minutes. Telemetry radio signals travel at the same speed as light—186,000 miles per second. But even at that speed these signals require about 13 minutes to traverse the 150 million miles from Mars to Earth. This means that Mars flight operations cannot be conducted in "real time." Events must be predicted and programmed.

Learn And Live. Though it is widely agreed that the Mars landing is technologically feasible, it is not universally accepted that such a program is reasonable and necessary. Arthur C. Clarke, an English scientist-writer who believes man's drive for knowledge is essential to his life, says:

"Though man and civilizations may yearn for rest, for the dream of the lotus-eaters, that is a desire that merges imperceptibly into death. The challenge of the great space between the worlds is a stupendous one; but if we fail to meet it, the story of our race will be drawing to a close. Humanity will have turned its back upon the still untrodden heights and will be descending the long slope that stretches, across a thousand million years of time, down to the shores of the primeval sea."

Dr. Frederick Seitz, president of the National Academy of Sciences, can see no alternative to pushing ahead to new knowledge. With this in mind, he said recently, "Our children will wonder what manner of people we were, that we ever questioned the value of space exploration." ■



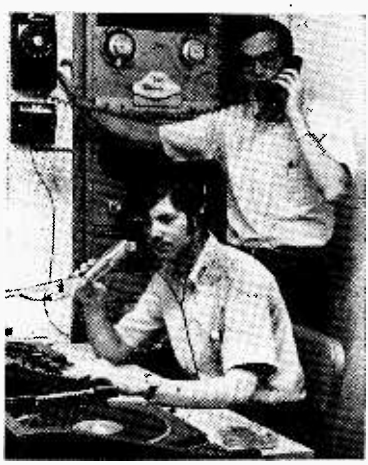
Artist's rendering on previous page shows how Viking spacecraft might appear during landing on Mars; photo at left reveals actual structure of vehicle. Note that device is comprised of two distinct sections: upper portion remains in orbit around Mars, while lower section effects landing.

Round-the-Clock from Non-Uglysville

For $200 a year—a mere 3¢ an hour—you have to love the work. That's the annual salary allotted the manager of the largest-staffed radio station on the West Coast—KUCR, the campus station of the University of California at Riverside. Bob Stubenrauch, UCR junior from Palo Alto, works 30 to 50 hours a week managing the station's staff of 120 students. But he doesn't complain about money.

"My philosophy is you have only one life to lead, and you may as well lead an exciting one," says Stubenrauch, "even if it kills you."

Stubenrauch and his staff operate on a $3500-a-year budget provided by the student government organization, the Associated Students of UCR. At 88.1 on the FM dial, the station is on the air 24 hours a day offering a wide variety of programming. Each student is responsible for his own show and its contents. There are no pressures—either from the UCR administration or the station's staff—to adhere to any particular kind of programming. And therein lies the success of KUCR, Radio Non-Uglysville. ■



A hot wire usually heats something or other. This one measures amperes!

Build a hot-wire ammeter *that really works*

by Charles Green, W6FFQ

IN THE early days of radio, hams were forced to be good constructors. Because of unavailability or excessive cost of commercial parts, they made capacitors and coils, and even built meters to measure the RF output of their transmitters.

The type of RF output meter that the old timers built is known as a Hot-Wire Ammeter. Operation of this ammeter is based on the physical expansion of a wire heated by current flowing through it. The wire is indirectly coupled to a pointer and dial to measure the flow of current. You can have fun building and experimenting with this type of ammeter.

Our model of a hot-wire ammeter is built on a wooden baseboard very much the same as those built in the old days and is designed for easy con-

hot-wire ammeter

struction. Most of the parts can be obtained in a hardware store. It can be calibrated easily with a DC ammeter and dry cell battery. We have included, also, an experiment board to show how the Hot Wire Ammeter reads current on an AC line with various lamp loads.

How It Works. When electric current flows through a resistance, heat is generated, as, for example, in an electric iron or toaster. If the resistance is a fine steel wire drawn taut between two supports. the generated heat will make the wire expand, causing it to stretch and sag. The Hot Wire Ammeter uses this stretching of a fine steel wire linked to a pointer to serve as a measure of the amount of electrical current flowing through it, which heats the wire.

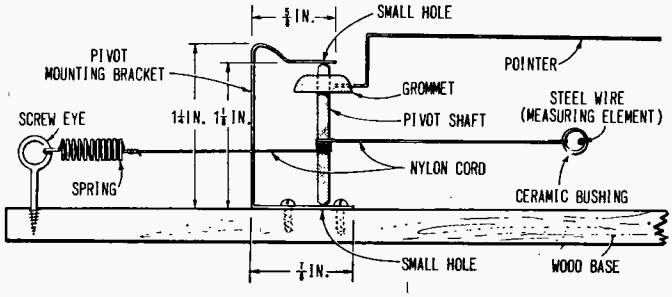
By referring to the *assembly drawing* you will note that our construction project follows closely the basic principle of a hot wire ammeter. A fine steel wire is tautly stretched between two fixed positions and has clips attached to connect it into an electrical circuit so that current flowing in the circuit can flow through the resistance wire. A ceramic bushing or bead, through which the steel wire passes, is held tightly against the wire by a spring-loaded nylon cord. When current flows the steel wire is heated and expands, thus reducing the pull against the bushing and its spring-loaded nylon cord. The cord has been tightly wrapped three or four turns around a short steel shaft that freely rotates on supporting pivots and is held taut by a spring at the end opposite to the bushing (or bead). A pointer fastened to this shaft changes its position on a calibrated scale, as the shaft is turned, to indicate current is flowing.

Since we are measuring, in a fixed length of steel wire, the relative mechanical reaction to expansion and/or contraction (caused by temperature changes created by current flowing in the wire) this instrument will react the same to either AC or DC current. The return to zero of the pointer depends on the natural expansion/contraction characteristic of the fine steel wire. Expansion and contraction may vary depending upon the quality of the steel. The meter is not usable near zero because small changes in current are not readily transferred to proportionate mechanical changes due to mechanical losses in our model.

Building the Hot-Wire Ammeter. The dimensions and construction of this Hot-Wire Ammeter are not critical and can be varied to suit the constructor's preference. Our model was built on a soft wood base 8 x 6 x ⅝-in. The current measuring range is dependent on the length, diameter and resistance of the steel wire through which current to be measured must flow.

Nail To Pivot Shaft. After fashioning a base make the moving element next. The shaft pivot is made from a 1⅛-in. long straight section of a smooth 8-penny box nail. Each end of the nail should be filed or ground to a point. Then make a metal bracket to fit the shaft with two small holes for the pivot points and two holes to mount the pivot assembly to the base as shown in the *assembly drawing*. Bend the bracket to fit and make sure that the pivot shaft can rotate freely.

Spring Making. The spring, that maintains tension on the nylon cord, was made by winding 0.015-in. diameter music wire for a length of ¾-in. on an 8-penny nail. The best way to wind the spring is to place a hand drill in a vise and fasten one end of the music wire tightly in the drill chuck along with a large diameter nail, a rod or drill shaft. Hold the other end of the wire perpendicular to the nail with pliers and slowly rotate the drill, thus winding the spring. Remove the spring from the nail and bend out a small end loop at each end of the spring to permit fastening it to the nylon drive cord at one



Detail drawings of Hot-Wire Ammeter, showing construction of pivot and pointer activated by nylon cord. As explained in text, spring (left) is constructed from length of music wire.

end and a screw eye in the wooden base at the other end.

Before installing the pivot shaft into its mounting bracket, force a ⅜-in. diameter rubber grommet, rubber washer or bumper on one end of the shaft and position it as shown in the detail drawing. It may be necessary to cement this to the shaft to prevent slippage. This should not be done until after assembly has been completed and the pointer has been installed. Place a small amount of grease in the pivot holes.

The Measuring Element. The measuring element we used is made from one strand of steel wire (0.01-in. diameter) extracted from a length of stranded picture wire, obtainable in a variety or hardware store. The diameter of the wire is not critical; however, the thinner the wire, the more sensitive will be the meter; a larger diameter wire will require more current to heat it. After slipping it through the ceramic bushing or bead, stretch the wire tightly between the lugs mounted on the stand-off insulators and solder it to the lugs, as shown in the assembly drawing.

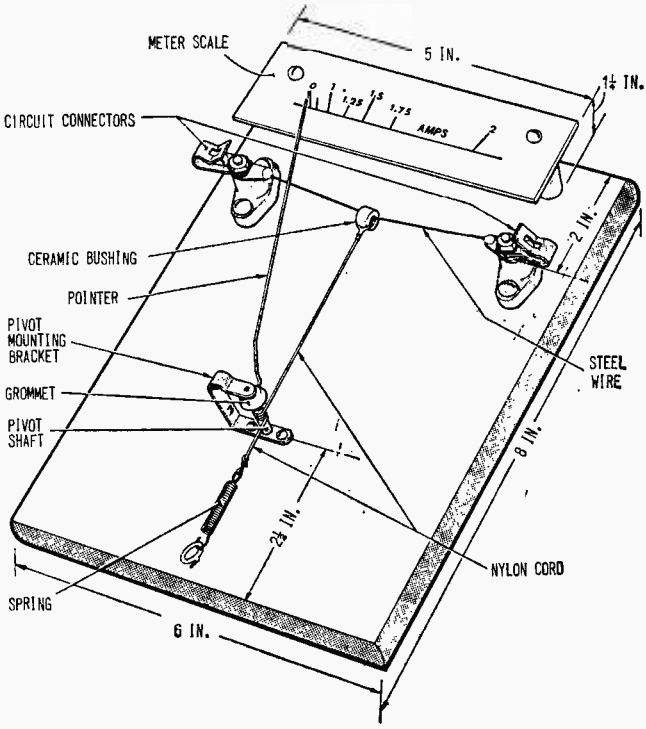
Tie one end of the nylon cord to the ceramic bushing, as shown, bring it down to the pivot shaft and wind it around the pivot shaft three turns in a clockwise direction. Fasten the other end of the line to one end of the spring and attach the other end of the spring to a screw eye on the base board. Make certain that both ends of the line are taut or the ammeter will not work. The eye screw is turned, as necessary, for minor adjustment of the line tension to zero the pointer. Cement the nylon tie-points at each end of the line to keep from loosening. If the pointer reads below zero when a measurement is made, in all probability, you have wound the nylon cord around the pivot shaft in the wrong direction. Be sure it is wound as shown in the *assembly drawing.*

The Pointer. After all the components have been assembled, make the pointer from a length of #22 gauge bus wire and force one end into the rubber grommet on the pivot shaft. Form the pointer as shown in the drawing before inserting it into the rubber grommet and cement the pointer to the grommet after positioning it properly. Paint the end of the pointer black to make it easier to see the pointer against the scale background.

Calibration. To calibrate the Hot-Wire Ammeter you will need a DC ammeter, a 15-ohm rheostat (or potentiometer), and a DC source such as a #6 dry cell (1½ V).

The Hot-Wire Ammeter scale is made from a 5 x 1⅜-in. piece of white cardboard supported approximately 1¼-in. above the base by suitable bushings through which wood mounting screws pass to the wooden base. For a more professional look use DATAK instant letters to mark calibration points on scale.

Keep Wire Taut. Next make sure that the steel current measuring wire of the Hot-Wire Ammeter is taut, as should be both sections of the nylon wire. Set the pointer to zero by holding the pivot shaft with long-

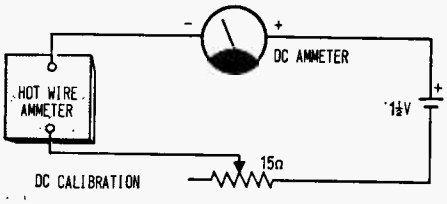


Assembly drawing for Hot-Wire Ammeter. Steel wire stretched between Fahnestock circuit connectors is measuring element: current flow causes it to expand, driving pointer up scale.

hot-wire ammeter

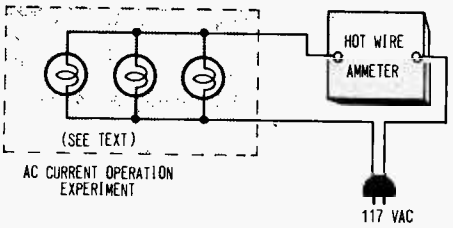
nose pliers and move the rubber grommet so that the pointer is at the left end of the scale. (To ensure that the pointer will not slide down the pivot shaft, it's a good idea to cement the grommet to the shaft after setting the pointer.)

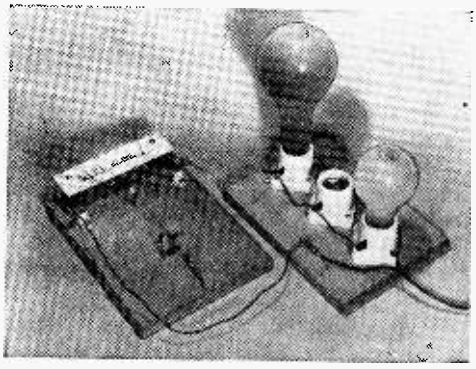
Connect the rheostat (adjusted for maximum resistance), battery, AC ammeter and



Hookup for calibrating Hot-Wire Ammeter.

the Hot-Wire Ammeter in a closed loop series circuit as shown in the schematic. Then adjust the rheostat so that the DC ammeter measures 2 amperes. Note the position of the pointer on the scale. You can add the lettering later. For other calibration points adjust the rheostat and mark the Hot-Wire Ammeter scale in accordance with the readings on the DC ammeter. There will be very little movement of the Hot-Wire Ammeter pointer between zero and approximately ½ ampere, then the meter pointer will move more and more non-linearly as the wire becomes hotter and hotter as a result of higher current passing through it.





Though essentially a DC device, Hot-Wire Ammeter will also measure AC current flow. In setup here, unit indicates current drawn by lamp bulbs of various wattages.

We calibrated the scale of our unit at ¼-ampere points from 1 to 2 amperes and at the ½-ampere point between zero and 1 ampere.

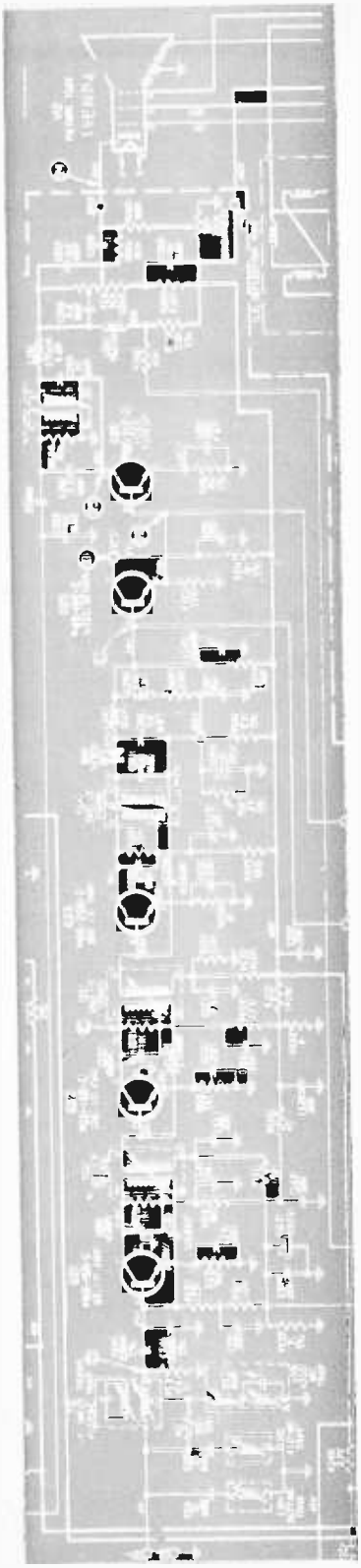
When all calibration points have been marked on the scale remove the battery, DC ammeter and rheostat from the Hot-Wire Ammeter. Dismount the scale and apply appropriate markings at each of the calibration points noted above and then remount

(Continued on page 95)

PARTS LIST FOR HOT WIRE AMMETER

2—1 ¼ x ⅜-in. fiber, ceramic or metal bushing for mounting meter scale (use one ¼-in. and one 1-in. to make required height) (Allied 47E4711 @ ¼-in. and 47E4716 @ 1-in. or equiv.)
1—¼ x ¼-in. fiber or ceramic bushing for terminating nylon cord (Allied 47E4657 or equiv.)
1—5 x 1 ⅜-in. piece, white cardboard for meter scale (see text)
4—Type 2 Fahnestock clips (Allied 47E1700 or equiv.)
3—Edison base lamp socket (Allied 60E7661 or equiv.)
1—8-penny smooth box-type nail (for pivot shaft—see text)
1—6-in. length nylon fish line—30-lb. test
1—⅜-in. diameter rubber grommet, faucet washer or bumper (see text and detail drawing)
1—3 x ⅜-in. strip, #16 or #18 gauge steel or aluminum for pivot mounting bracket (see text and detail drawing)
1—4 to 5-in. length of 0.01-in. diameter steel wire for hot wire measuring element (see text)
1—3 to 4-in. length of 0.015-in. diameter steel music wire for spring (see text)
2—8 x 6 x ⅝-in. soft wood block
1—6-ft. AC line cord (Allied 26E2854)
1—#6 battery, 1.5V (Allied 18E5641)
1—15-ohm, 4-watt rheostat (Allied 46E3400)

Misc.—Hardware, #22 gauge bus wire, solder, solder lugs, GE-RTV or Duco cement or Elmer's Glue, Datak press-on numerals of appropriate size (available from Allied Radio, Lafayette Radio or stationery supply store)



HOW TO DESIGN SOLID-STATE CIRCUITS ...the easy way!

We conclude our primer on Q-circuits with hard-core info most anyone can put to use

by Herb Cohen

Ready for our big transistor circuit hunt? You'll recall that on our last safari we bagged some circuits that proved to be a bit unstable (see *How To Design Solid-State Circuits . . . the easy way!*, SCIENCE & ELECTRONICS, June/July '69, p. 67). But now we've developed a feel for the trapping methods and the terrain. What we're after this time is that mythical critter called the stable amplifier circuit. Ohm's Law oiled up? Voltmeter at the ready? C'mon then . . . let's go!

The Ground Rules. Before getting down to the nitty-gritty let's review a few of the rules we must go by:

1. The base/emitter voltage (V_{BE}) for a germanium transistor is 0.2V. For a silicon transistor, it's 0.6V. These voltages are constant for wide ranges of base currents.

2. There are two basic currents that flow in a transistor: the base current (I_B) and the collector current (I_C). But hold on—both these currents must flow through the emitter. Take a gander at our chart on page 57 (reprinted from the last issue), and you'll see that this means:

$$I_E = I_B + I_C$$

3. The basic transistor formulas are:

$$I_C = I_B(H_{FE})$$

and its reverse: $$H_{FE} = \frac{I_C}{I_B}$$

Putting it simply, the H_{FE} or current gain of a transistor is always equal to the base current (I_B) divided into the collector current (I_C).

Where the Action Is. Since we've established that all current flows via the emitter (see rule **2** above), might the emitter have something to do with stability? That it does—and the secret of designing a stable amplifier lies in finding a way of controlling *emitter current*. For argument's sake let's say we've discovered a method of doing this.

Using two transistors, one with an H_{FE} of 20 and one with an H_{FE} of 100, we control the I_E of both of them to the same value—say 1 mA. With an H_{FE} of

20, I_B will be about 5% of the total IE, which means that the Ic component will be roughly 95%. With an HFE of 100, I_B will be only 1% of I_E, with Ic accounting for the remaining 99%.

What's the point? Just this—that even for transistors with HFEs differing by as much as 5 to 1, Ics change less than 5%. In other words, simply by controlling I_E we also control Ic!

Great as this finding may seem, we still have to work out our circuitry. Let's do so now.

Follow the Emitter. In Fig. 1 we see the basic emitter-follower circuit. It consists of a 3-V battery across the base, a 1000-ohm emitter resistor (R1), and a 9-V collector supply.

Since I_E must flow through R1, the big question here is, what is I_E? The voltage across R1 will give us I_E. Let's start by adding the voltage drops. The base voltage is fixed at −3 volts by the base battery. This being the case, the base-to-emitter voltage (V_{BE}) plus the voltage across R1 (V_{R1}) must equal the base battery voltage:

$$V_{BE} + V_{R1} = V_B$$

In Ground Rule No. 1, we said that the V_{BE} for a germanium transistor is 0.2V for practically any value of I_B. Let's plug this into the formula:

$$\textit{If } V_B = 3V$$
$$\textit{and } V_{BE} = 0.2V$$
$$\textit{then } 0.2V + V_{R1} = 3V$$

Since we are interested in the value of V_{R1}:

$$V_{R1} = V_B - V_{BE}$$
$$V_{R1} = 3V - 0.2V$$
$$V_{R1} = 2.8V$$

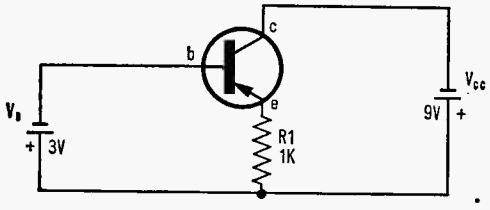


Fig. 1. A basic emitter/follower circuit. We derive formula for base current predicated on VBE being 0.2V for any germanium transistor.

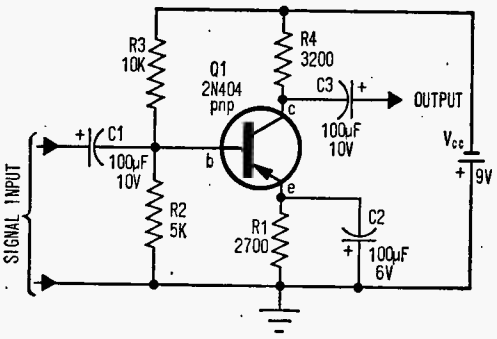


Fig. 2. Amplifier using emitter/follower principle. Basic e/f is unsuitable as amplifier.

The next step is easy—we just call in our old friend, Ohm's Law:

$$I_E = \frac{V_{R1}}{R1} = \frac{2.8V}{1000} = 2.8\ mA$$

Let's have a closer look at this and try to set up an equation to solve for I_E. Since V_{R1} is equal to $V_B - V_{BE}$, we can substitute this latter quantity in our equation:

$$I_E = \frac{V_B - V_{BE}}{R1}$$

Notice in this formula that the only transistor specification is V_{BE}, and that this is held constant. *The circuit is independent of* H_{FE}. We can plug in any pnp germanium transistor and get the same I_E. In short, we now have a circuit that controls the emitter current.

Tieing It Down. An interesting feature of this circuit is that if I_E is held constant, and Ic is held to within 5%, then the base takes just enough I_B from the base battery to meet the I_E requirements. This comes out roughly to be:

$$I_B = \frac{I_E}{H_{FE}} = \frac{V_B - V_{BE}}{\frac{R1}{H_{FE}}}$$

Again, this is all great theoretically. Big catch is that the circuit in Fig. 1 is totally useless as an audio amplifier. For one thing, audio signals applied to the base would be shorted out by the base battery. Then, too, an emitter follower has no voltage gain. In order to get both voltage and current gain we have to take our output from the collector.

The Great Leap Forward. Fig. 2 shows us a complete amplifier circuit using the emitter-follower principle for stabilizing IE.

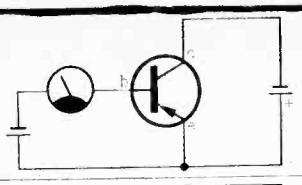
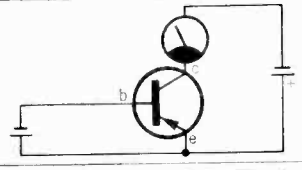
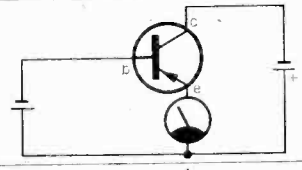
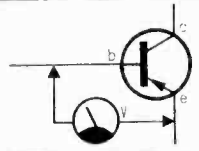
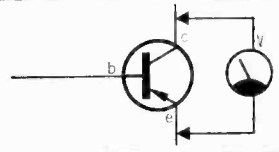
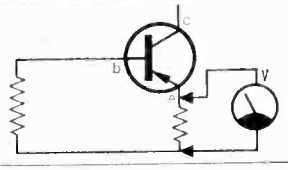
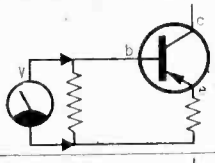
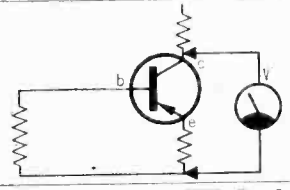
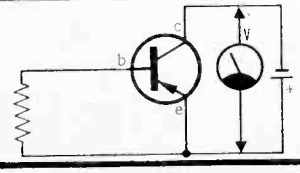
Base Current		I_B
Collector Current		I_C
Emitter Current		I_E
Base-to-Emitter Voltage		V_{BE}
Collector-to-Emitter Voltage		V_{CE}
Emitter Voltage		V_E
Base Voltage		V_B
Collector Voltage		V_C
Collector Battery Voltage		V_{CC}

Chart depicts transistor terminology, symbols, and schematics applicable for measuring basic voltages and currents mentioned in this article for designing solid-state circuits.

HOW TO DESIGN ...

Let's start by exploring the role of R2 and R3, the resistive divider which has replaced the base battery.

We can begin by calculating the currents and voltage in the divider, ignoring the base current for now.

$$R2 + R3 = 15k$$

$$I = \frac{E}{R} = \frac{9V}{15k} = 600\ uA$$

The Hookup. The voltage across R2 is:

$$I \times R2 = 600\ uA \times 5k = 3\ volts$$

If we assume an HFE of 40 for the transistor, we can connect the base divider network and calculate all the voltages and currents in the circuit.

Let's simplify some of the math. We know that the emitter voltage will be 2.8 volts. If we make R1 2700 ohms, IE will be a little more than 1 mA.

Now we can connect the base. IB is approximately:

$$I_B = \frac{I_C}{H_{FE}} = \frac{1mA}{40} = 25\ uA$$

If IB is 25 *u*A, the current through R2 is 600 *u*A minus 25 *u*A, or 575 *u*A.

As for the actual voltage across R2,

$$VR2 = 575\ uA \times 5000 = 2.875V$$

a change of 0.125 volt. IE now equals:

$$\frac{2.875 - 0.2V}{2700} = \frac{2.675V}{2700}$$

or within 1% of 1 mA.

Though IB did load the circuit somewhat, our circuit is reasonably stable as long as the HFE is above 20.

Out the Collector. We're in the home stretch now. We have just to calculate the value of the collector load resistor (R4) and the values of capacitors C1, C2, and C3.

First, what is the maximum collector voltage swing we can expect? Remember that the emitter voltage must be treated as a fixed voltage now that the emitter has been bypassed for AC. Since the collector must always be negative with respect to the emitter, our VE of roughly 2.7V means that the collector can swing from 9 to 2.7 volts or a total swing of 6.3V.

If we set the collector voltage at half of the collector swing, we can get maximum undistorted output. This would be 2.7 volts plus 3.15 volts or about 5.8V.

Now for the value of R4. First let's re-

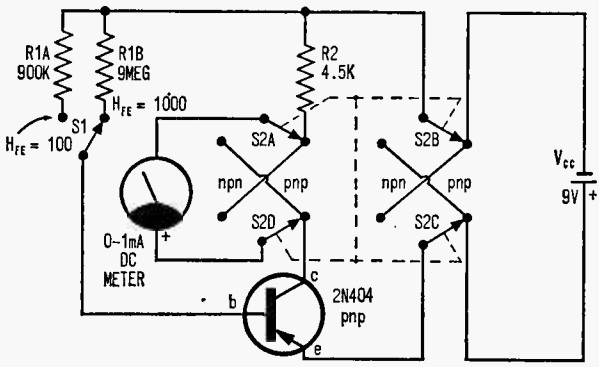
(Continued on page 98)

ANSWERS TO QUIZ IN PREVIOUS ISSUE—HOW DID YOU SCORE?

1. Extending scale range. In a test set up, where only a low-range meter is available and we want to have the capability to read an HFE of 1000, we must change the base resistor to a value that will limit the IC to the same range as that for a transistor having an HFE of 10. Employing the formulas for calculating IB and R1, given in previous issue, we arrive at the following:

$$I_B = \frac{I_C}{H_{FE}} = \frac{1}{1000} = 0.001\ mA$$

$$R1 = \frac{V_{CC}}{I_B} = \frac{9}{0.001} = 9.0\ megohms$$



2. Since the polarity of the emitter and the collector of pnp and npn transistors is opposed, in order to read the collector current in our circuit, regardless of the type of transistor under test, we must be able to reverse the battery polarity within the circuit. We accomplish this through S2A/S2B, a sp4t switch, which transposes the battery positive and negative as applied to both the emitter and the collector for proper polarization of the transistor being tested. By adding the two switches and R1a and R1b we have been able to build a transistor test set that will be far more useful because it now has a range for testing transistors having an HFE from 10 to 1000. Should you want to make this test setup even more valuable, change S1 from a spdt to a sp4t or a sp6t switch and calculate resistor values for R1c, R1d, R1e, R1f if you care to provide readings that fall within midrange of your meter scale.

by Wilbur Conrad

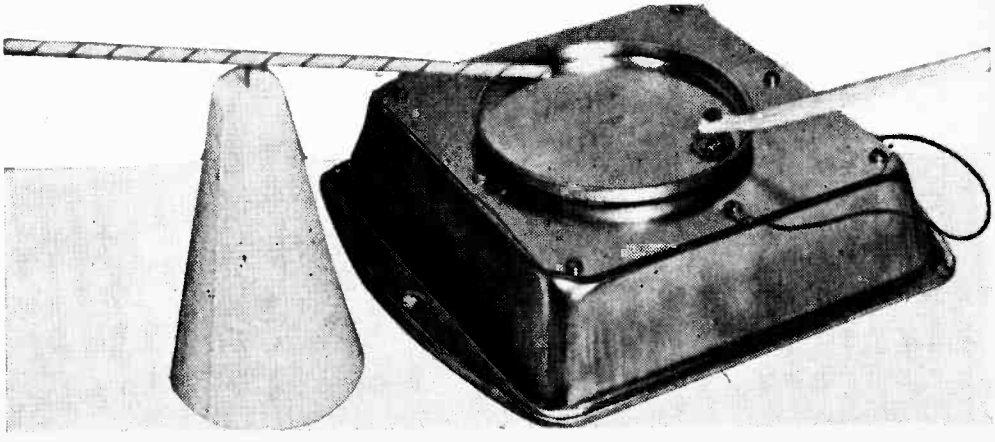
ELECTRO-STATIC BATTERY BOUNCE WITH

Build our electrophorus, then put it to work with a straw electroscope

Count Alessandro Volta (1745-1827) is best known for having invented the first electro-chemical battery, commonly called the voltaic pile. Before developing the voltaic pile, Volta discovered the electrophorus. The electrophorus is a source of electrostatic energy, or, an electrostatic battery.

Volta's original electrophorus consisted of a cake of rosin held in a metal container. The rosin was electrically activated by rubbing it with fur. When a metal disc, having an insulated handle, was placed on the rosin, the disc was charged electrically. The original electrical charge created by rubbing fur on the rosin cake was of sufficient magnitude to charge the metal disc many times without requiring additional rubbing of the rosin surface to recharge it.

You can conduct many experiments with static electricity by building our simple elec-



ELECTROSTATIC BATTERY

trophorus, and a soda-sipping straw electroscope to test the electrostatic charge on the electrophorus. The drawings on page 62 detail how our electrophorus works.

Constructing the Electrophorus. We used a 7 x 7 x 2-in. metal cake pan as the base for our electrophorus. To the outer bottom surface of the baking pan we fastened a section of clear plastic acetate sheet 0.03-in. thick, large enough to cover the bottom of the pan. Fasten the plastic to the pan with sheet metal screws along the edges of the plastic sheet (do not place any screws in the middle of the plastic sheet).

The size of the baking pan and the thickness of the plastic sheet are not critical, but the thicker the plastic the better. We used acetate sheets similar to the type used for heat-forming canopies for models or that used to protect artwork, readily available from hobby or artist supply shops.

Connect a 12-in. clip lead to one of the sheet metal screws holding the plastic sheet to the baking pan. Alternatively, the clip lead may be fastened with a separate sheet metal screw to a side of the pan instead of the bottom.

BILL OF MATERIALS FOR ELECTROPHORUS AND ELECTROSCOPE

1—7 x 7-in. acetate sheet 0.03-in. thick (see text)
1—12- to 14-in. clip lead (Lafayette 99T0057 or equiv.)
1—Metal cake pan 7 x 7 x 2-in. (see text)
1—Metal disc 4½-in. diameter (see text)
1—Styrofoam cone 5-in. high, 3-in. base (see text)
Misc.—Hardware (sheet metal screws), solder lug, long needle, plastic and paper soda-sipping straws, wool, cotton, nylon, or fur scrap (for charging acetate sheet), VTVM

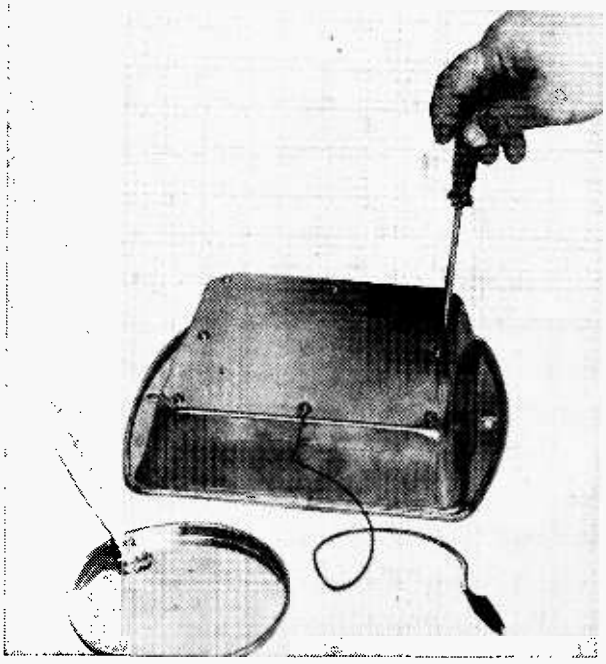
For experiments you will need a large metal disc, preferably with upturned edges and a flat bottom (such as a metal paint can cover). The metal disc should fit the center of the plastic sheet without touching the sheet metal screws that hold the plastic to the baking pan. Our can cover disc is approximately 4½-in. in diameter.

Near the outer edge of the disc solder a flat head machine screw to the top surface of the disc for fastening a plastic handle to it. We used an old plastic toothbrush handle with the bristle end cut off.

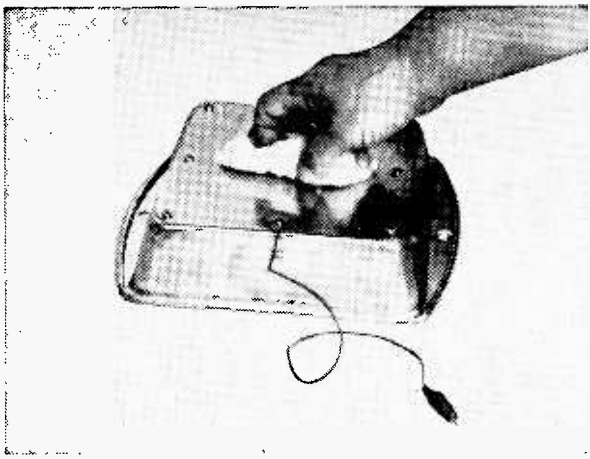
Constructing the Straw Electroscope. The electroscope is constructed by inserting a large needle into the top of a styrofoam cone approximately 5-in. high and 3-in. diameter at the base. Balance a paper drinking straw on the needle point so that it swings freely.

Experiment 1. Before trying any experiment make sure that the styrofoam surface of the electroscope is perfectly dry. If necessary, heat up the surface with a heat lamp or hair dryer to drive off any moisture. A dry environment is necessary; experiments may not work in a humid area.

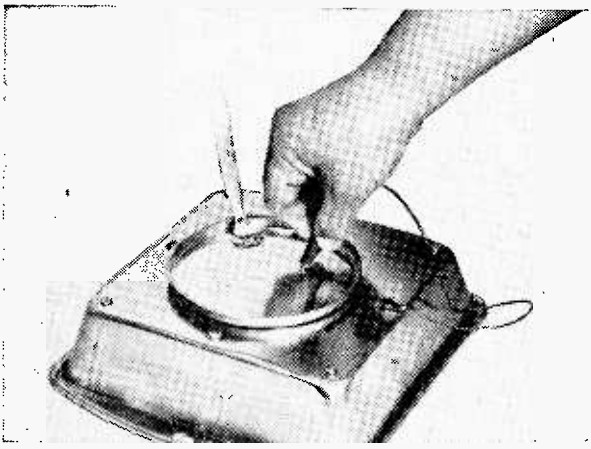
Briskly, rub the plastic surface of the electrophorus with a dry cloth for about two minutes and then set the



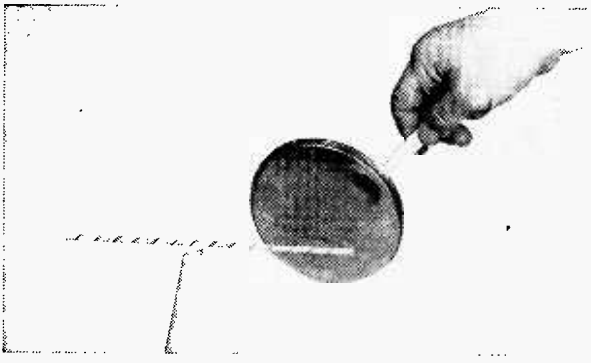
Electrophorus consists of 7 x 7 x 2-in. metal cake pan with sheet of clear plastic attached to its bottom side. Though size of pan and thickness of plastic aren't critical, try to use as thick a plastic as possible.



To charge electrophorus, rub plastic sheet briskly with dry cloth for roughly two minutes, taking care not to touch plastic with hands.



To charge metal disc, place it in center of plastic sheet, then touch center of disc with clip lead which runs to baking pan proper.



To charge straw electroscope, allow one end of straw to touch charged metal disc, then carefully rub disc along same end of straw.

cloth aside. The metal baking pan can be held while rubbing the plastic surface with the cloth but do not touch the plastic surface with your fingers.

Charging Metal Disc. Now, holding the metal disc by the insulating handle, place the disc in the center of the acetate sheet making up the electrophorus. Do not touch the metal disc with your fingers, and do not let the disc touch the sheet metal screws that fasten the plastic sheet to the pan.

Touch the center of the disc momentarily with the clip lead and remove the disc from the electrophorus plastic surface by holding the insulating handle. Do not let the disc touch the sheet metal screws. The disc is now charged. Move the edge of the disc very close to any grounded metal object and observe that a small spark will jump from the disc to the object. Recharge the metal disc by again placing it on the electrophorus' plastic surface and quickly touching the disc center with the clip lead and then removing it. Hold the charged disc very close to the metal side of the electrophorus and observe that a small spark will jump from the disc to the side of the pan.

This experiment shows how we can build up electrical charges on the metal disc from the electrophorus without the necessity of recharging the electrophorus each time. The electrophorus has a much greater capacity than does the disc, which explains why you do not have to recharge the electrophorus as frequently as you do the metal disc. Of course, you will eventually have to recharge the electrophorus after numerous chargings of the metal disc from it because after a period of time its total charge will have been drained off.

If you'd like to get an indication of what kind of voltage appears on the disc, try connecting an NE-2 neon lamp between the disc and the baking pan. It will light for only a very brief instant, of course, but the fact that it does indicates a voltage in excess of 60 volts.

Experiment 2. If you have a VTVM, set it to the low negative DC volts range, place the metal disc in the center of the electrophorus but do not charge the disc by touching it with the clip lead. Connect the ground lead of the VTVM to one side of the metal pan of the electrophorus, then touch the VTVM probe to the center of the metal disc and observe that the VTVM indicates, for a very short period, a negative voltage. This shows that the electrostatic charge on

ELECTROSTATIC BATTERY

the surface of the plastic sheet is negative.

Charge the metal disc with the clip lead and hold the disc by its plastic handle in the air, away from the electrophorus. Set the VTVM to a low positive voltage range and touch the probe to the charged disc. Observe that the VTVM momentarily indicates a positive voltage. This shows that the metal disc had changed the polarity of its electrical charge to be opposite that of the polarity of the electrophorus charge.

Experiment 3. Charge the metal disc and hold it near the freely rotatable straw of the electroscope. Observe that one end of the straw is attracted to the charged metal disc. Allow an end of the straw to touch the disc and rub the disc along the end. Then remove the disc from the straw without touching the straw or the metal disc.

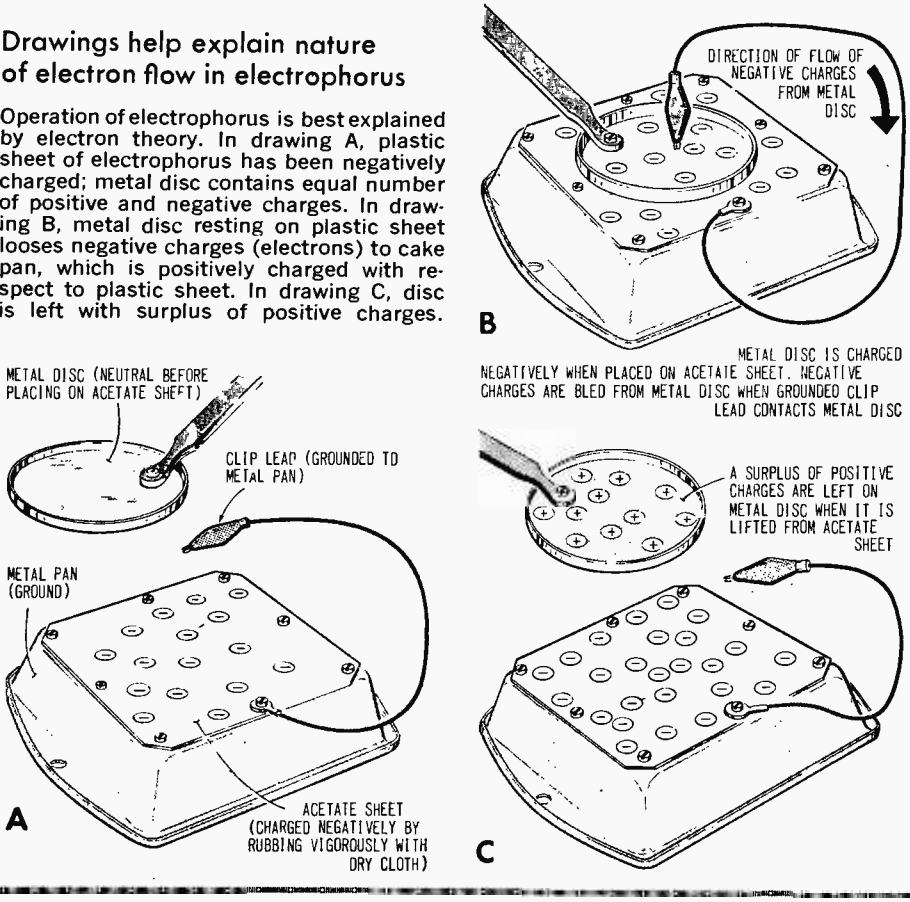
Recharge the disc and hold it near the straw electroscope. Observe that the straw is now repelled by the disc, indicating that the straw has taken on an electrical charge having the same polarity as the metal disc.

Other Experiments. Repeat Experiment 3 after adding small sections of aluminum foil wrapped around the ends of the straw. Also, repeat the experiment using a plastic drinking straw substituted for the paper straw.

Since the straw electroscope is not as sensitive as an aluminum foil electroscope, you may care to experiment with an aluminum foil electroscope. The March/April issue of Elementary Electronics details a construction project for an aluminum electroscope, written by the author of this article. The electrophorus you have just built can be used with this more sensitive electroscope for many more experiments. ■

Drawings help explain nature of electron flow in electrophorus

Operation of electrophorus is best explained by electron theory. In drawing A, plastic sheet of electrophorus has been negatively charged; metal disc contains equal number of positive and negative charges. In drawing B, metal disc resting on plastic sheet looses negative charges (electrons) to cake pan, which is positively charged with respect to plastic sheet. In drawing C, disc is left with surplus of positive charges.



By ARTHUR S. COOKFAIR

FAMOUS PATENTS

No. 307,031

WORLD'S FIRST ELECTRONICS PATENT

Thomas Alva Edison was an inventor—not a scientist. He was a *practical* man, more intent on making useful inventions than contributions to basic science. So practical was he that when he made one of the greatest scientific discoveries of all, he wasn't aware of it.

In 1883, fourteen years before the existence of the electron was known, Edison chanced upon *electron emission*—the key to electronics—and he didn't even know it.

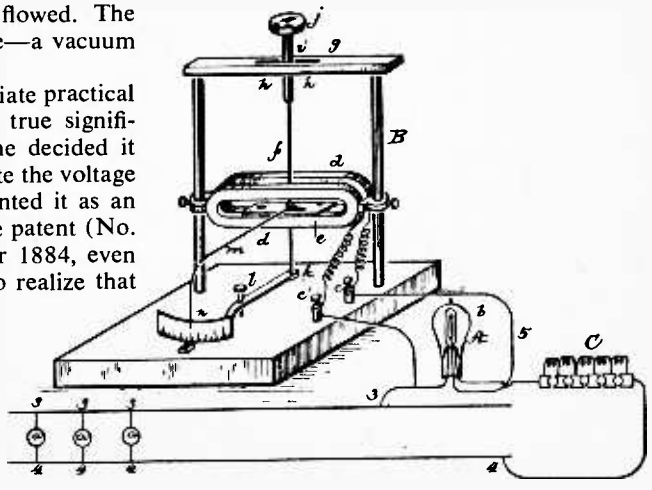
It happened while he was experimenting with improvements on the electric light. Taking a standard light bulb, he added a small metal plate near the filament and connected it to the positive leg of the filament circuit. When a potential was applied, a small current flowed *across the vacuum* from the filament to the metal plate. When the connections were reversed, no current flowed. The device acted as a one-way valve—a vacuum tube diode.

Edison, looking for an immediate practical use for the device, missed the true significance of his experiment. But he decided it might have some value to indicate the voltage of a lighting circuit, so he patented it as an "Electrical Indicator." When the patent (No. 307,031) was issued in October 1884, even the U. S. Patent Office failed to realize that they had granted the first *electronics* patent.

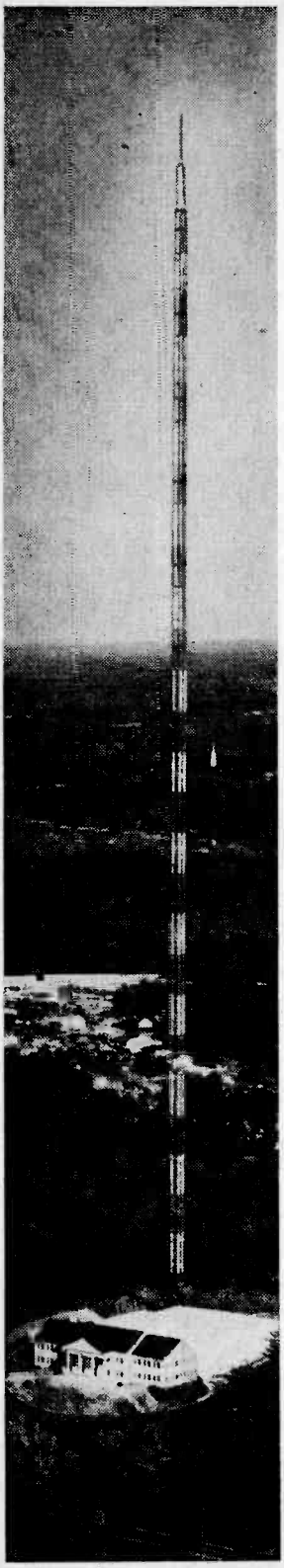
The great inventor soon became absorbed in other, more "practical" matters and paid little more attention to the unusual experiment or to the patent he had received. The strange phenomenon, which in later years became known as the *Edison Effect,* wasn't explained until 1897 when British scientist J. J. Thomson discovered the electron. Within a few years Ambrose Fleming and Lee De-Forest found what Edison had missed—the use of the *Edison Effect* in vacuum tube circuits for wireless.

The rest of the story, of course, includes the whole history of the development of radio and the science of electronics. And the story still isn't complete. In advanced research labs, a search is on for new power

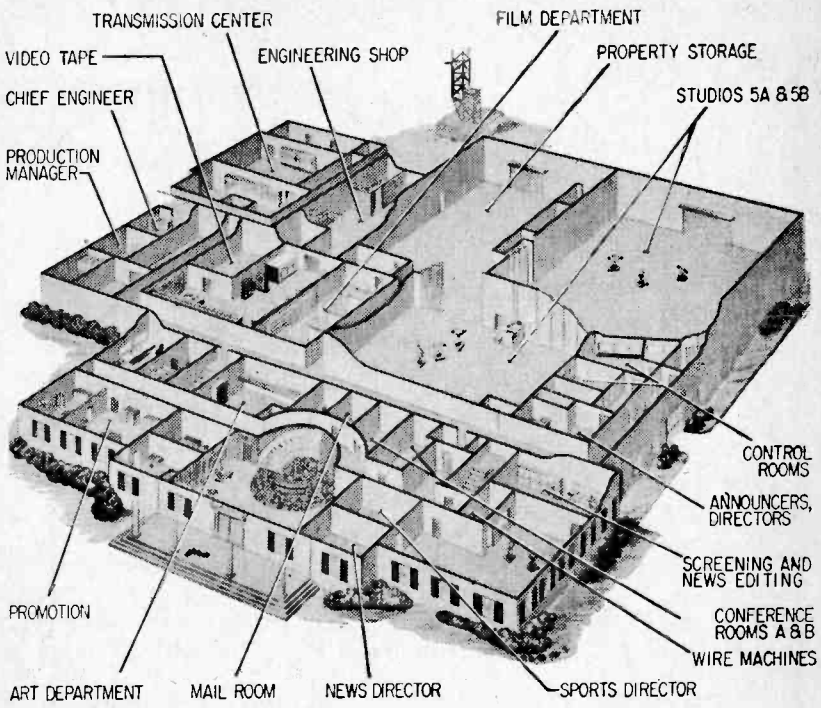
(Continued on page 98)



The gentleman identified as "T. A. Edison" submitted this sketch when he patented his "Electrical Indicator," but he included no model. The date: October 21, 1884.



Studios, offices, and transmitter for Atlanta's WAGA-TV are now on single site (left). Below, exploded view of plant's first floor.



WAGA

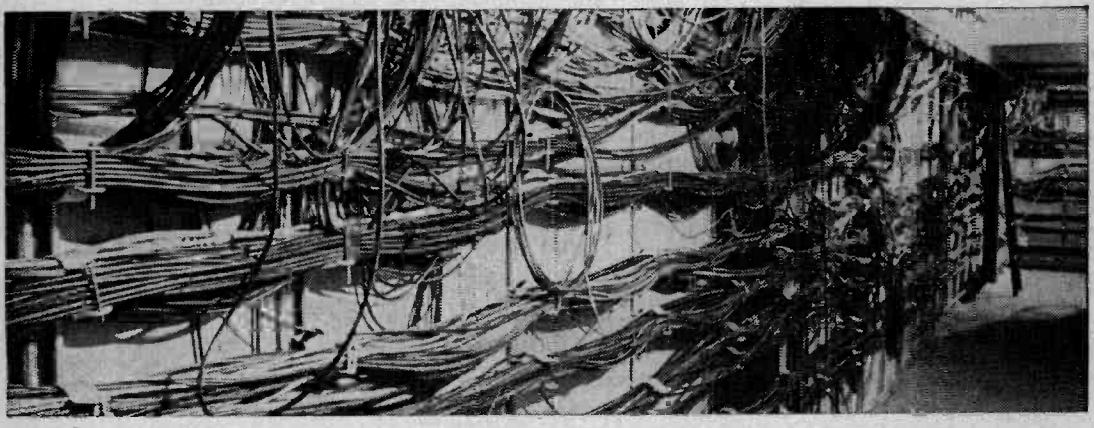
the stately station that home-brew built

Many's the DXer who pulls 'em in on a set he built himself. But a commercial television station designed and built by the station's own engineering staff is rarer than an Eskimo in Escanaba. Thing is, Atlanta, Ga.'s WAGA-TV is exactly that. As such, it must rank as one of the most ambitious do-it-yourself projects ever attempted.

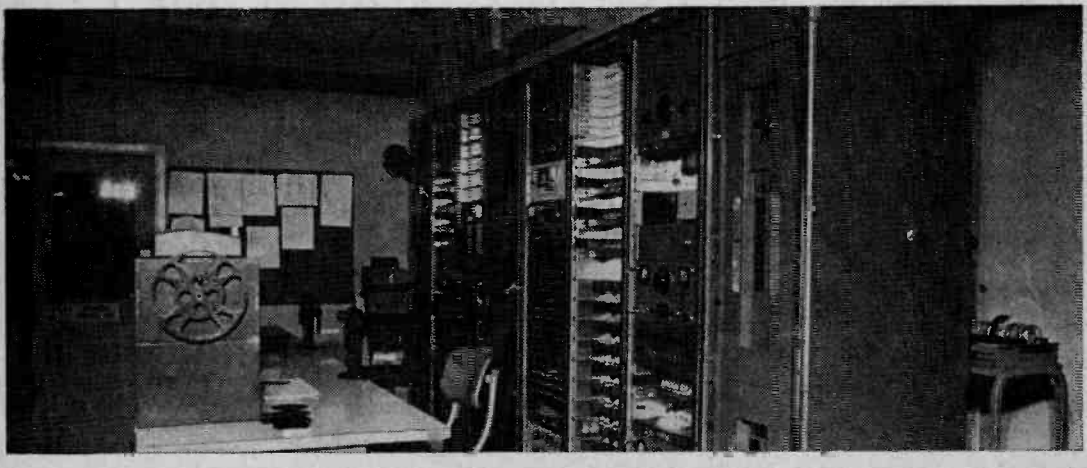
WAGA-TV's chief engineer, Hugo Bondy, calls the undertaking "the industry's first major Heathkit project" and explains that all of the video distribution amplifiers, video switchers, relay decks, video cross bar switchers, audio switchers, audio distribution decks, and most power supplies were designed and built by the WAGA-TV engineering staff. Why? Because the staff "had always been somewhat disenchanted with most of the available commercial equipment" and "knew that (they) had a better knowledge of (their) requirements and how to meet them than any of the manufacturers."

Concludes Bondy: "Every engineering department . . . should be doing something of this sort . . . especially when the 'store boughten' stuff doesn't fill the bill." ■

Master control area at WAGA-TV includes racks 28 through 38, with Switcher C in foreground. All of equipment installation and wiring was done by WAGA-TV's 30-man engineering staff.



Easy access to any and all wiring was accomplished by hanging all inter-rack and inter-unit wiring along one wall of 7-ft-deep trench deliberately placed under master control area.



In yet another section of master control area, power distribution rack provides circuit breakers for all associated equipment. Note monochrome slide projector and camera (left).

Propagation Forecast

By C. M. Stanbury II

August/Sept. 1969

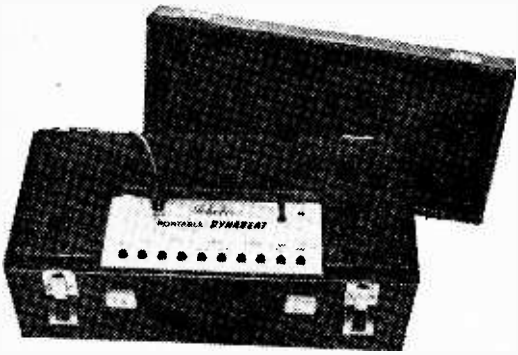
As our regular readers are aware, predictions are based on the best DX available from a specific part of the world during any given time period. This approach takes into account many different factors—everything from the sunspot count to the operating patterns of the stations.

One difficulty we have is that no one quite agrees on what term *DX* actually means, let along what constitutes the *best*. Both the novice and the real old-timer (people who began SWLing in the 20s) tend to think of DX entirely in terms of distance. To them, R. Australia on the other side of the earth is DX even if the transmission received is in fact beamed to North America. But most other SWLs wouldn't consider this station or any other international transmission from Australia as DX. They consider DX as those shortwave stations which are the most difficult to receive, regardless of distance.

But as modern shortwave listening has become so conscious of transmission content, we feel that there is an even more meaningful definition. *DX* can be defined as any abnormal propagation pattern which permits reception of transmissions *not* intended for the listener. And the *best* DX conditions from a given area would be those which permit listeners to overhear the largest number of such transmissions. ■

Aug./Sept. 1969 LISTENER'S STANDARD TIME	ASIA (except Near East)	EUROPE, NEAR EAST & AFRICA (N. of the Sahara)	AFRICA (S. of the Sahara)	SOUTH PACIFIC	LATIN AMERICA
0000-0300	19, 25	31, 41	(31w), 60, 90e	31, 41w (60w)	49, 60
0300-0600	31, 41	31 (poor)	(19w), 31	60, 90	49, 60
0600-0900	25, 49w	13, 16, 19	19, (60w)	25, 31	31, 49
0900-1200	16, 19	13, 16, 19	19, 25	(19), 25	19
1200-1500	16, 19	13, 16, 19	19, 25	19 (poor)	19
1500-1800	16, 19, 41e	19, 25	49, 60e, 31w	25	25
1800-2100	16, 19	25, 31	31e, 60w, 90w	16, 19	25, 49, 60
2100-2400	16, 19	25, 31	60, 90	16, 19	(31), 49, 60

To use the table put your finger on the region you want to hear and log, move your finger down until it is alongside the local standard time at which you will be listening and lift your finger. Underneath your pointing digit will be the shortwave band or bands that will give the best DX results. The time in the above propagation table is given in *standard time* at the listener's location, which effectively compensates for differences in propagation characteristics between the East and West Coasts of North America. Abbreviations: w—Western North America and e—Eastern North America. When w or e follow a band listing, it means the band is only good for that part of the continent. The shortwave bands in brackets are suggested as possible second choices. Refer to White's Radio Log for our world-wide Shortwave list.



SCHOBER DYNABEAT
Portable, Solid-State Rhythm Instrument

The Schober Portable Dynabeat is a solid-state pushbutton device that electronically synthesizes most of the percussive sounds of today's combo music. It can turn even a one-man band into a rock combo by supplying the sounds of a bass drum, tom-tom and snare drums, high and low wood blocks, brush and crash cymbals, bongos and castanets at the touch of a button.

How It's Bagged. The Dynabeat is AC-powered and is housed in a 6⅜ x 15¾ x 6¾-in. cabinet with removable lid. The control panel is located on the top of the device and provides an illuminated power switch, volume control, output jack, and 10-instrument *effect* buttons which key in the desired sound effects. All *effect* buttons are independent of the others and one or more instrument sounds can be obtained. The *effect* button spacing just about matches the finger spacing of the average adult hand, thereby allowing up to four *effects* to be "played" as they would be on a piano.

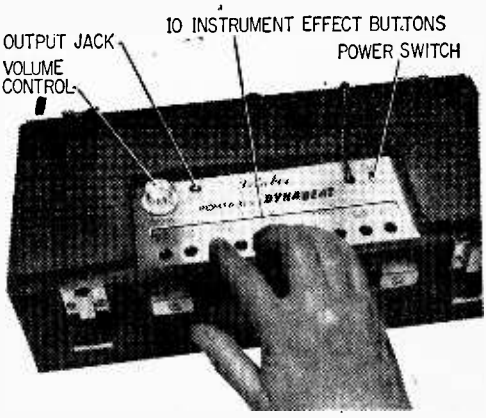
Reading from left to right, the *effect* buttons are 1) bass drum, 2) tom-tom, 3) wood block lo (index finger), 4) wood block hi (ring finger), 5) cymbal brush (middle finger), 6) cymbal crash (ring finger), 7) bongo lo (pinky), 8) bongo hi, 9) snare drum, and 10) castenet.

How It's Designed. The different musical effects are obtained through use of oscillators and noise generators. The bass drum and wood blocks are basically oscillators, while the cymbals are noise generators. The bass drum oscillator is approximately 60 Hz and the stage gain is set to just below the point of oscillation.

When the pushbutton is depressed, a positive voltage spike triggers a pulse shaper that applies a positive pulse to the oscillator. The pulse causes the oscillator to shock-excite a damped wave train—starting and then decaying to zero. The rate of decay produces the long *boom* sound. Other oscillator circuits work the same way with the frequency and rate of decay synthesizing the desired sound.

The cymbal sounds start off as pure white noise generated by a Zener diode. Pressing the pushbutton activates a noise amplifier whose attack time and rate of decay is essentially the same as the instantaneous attack (strike) and decay of a cymbal. The castanet sound is obtained by alternate keying of two oscillators. The snare drum is synthesized by keying in the noise generator and then the tom-tom oscillator. The repetitive effect of the castanet and snare drum sounds is caused by a multivibrator that operates the gate as long as the pushbutton is held down.

The output of each *effect* circuit is mixed



Control panel of Dynabeat. Average adult hand can easily span as many as four buttons to provide combinations of up to four effects.

LAB CHECK

with the others and amplified before being fed to a single output volume control. The *effect* volume relationship is pre-established by design, though each can be individually adjusted by changing a single resistance value (instructions are supplied for making individual volume adjustments).

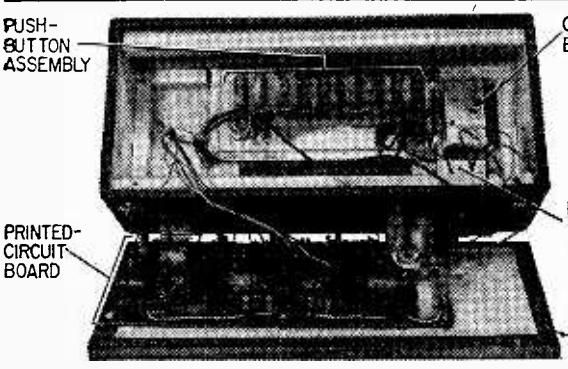
The Freq Out. Because the rhythm effects encompass a wide frequency range, from 60 Hz for the bass drum to 15 kHz for the cymbals, the final sound quality in terms of naturalness depends on the power amplifier the Dynabeat is used with. If the amplifier has a small speaker or lacks bass response, the bass drum will barely be heard. Similarly, an amplifier that lacks high-frequency response will destroy the live quality of the cymbals. An amplifier specifically designed for musical amplification such as a quality guitar amp/speaker will produce a solid, deep bass.

The Dynabeat's maximum output level is somewhere between that of a microphone and a high-level device such as a tape recorder. Therefore it's not enough to fully drive an amplifier through a high-level input. We got best results by connecting the Dynabeat to a microphone input and turning down the Dynabeat's volume control to prevent overloading the mike input. This is how it's done on the music stands in modern groups.

Building the Kit. Since the single printed circuit board is jam-packed with components, Schober makes certain you'll get started out on the right track by providing a separate solder instruction manual and a practice solder board that can be returned to Schober for criticism. The reason for this is that the Dynabeat's circuits are extremely sensitive and are affected by poor solder connections, so Schober wants to make certain you can solder well.

Every component position and connection is printed on the top of the printed-circuit board to ensure error-free assembly. However, take extreme care when assembling the board because the pictorials are unlike those usually supplied with kits. There is no "overlay" pictorial showing the components in their correct position. Instead, the component identification number is shown. This technique does speed up the wiring.

With the unit completed, the builder adjusts the various controls for most natural sound. It's best to make a broad adjustment, then play the Dynabeat for a while before you make the final determination of how the rhythm effects should be adjusted. You might find that you prefer, say, a longer bass drum, or a shorter cymbal sound effect.



Removing four screws from rubber mounting feet exposes bottom panel with attached circuit board, permitting individual volume or effect quality changes. Circuit breaker at right protects against excessive power drain; pushbuttons are mounted directly on top panel and installed as single assembly.

The Whole Bag. Connected to a guitar amplifier of average sound quality, the Dynabeat sounded most effective at providing an authentic sounding rhythm section. People listening to the total sound of Dynabeat plus two guitars were unaware the rhythm section was of electronic origination. Add a Schober Dynabeat to a four-piece band and you have a whole new fifth dimension in sound.

The Schober Portable Dynabeat kit, priced at $139.50, is supplied with a carrying case. A wired model is available for $169.50. Either is available from Schober instrument dealers, including Allied Radio. For more information write the Schober Organ Corp., Dept. 20, 43 W. 61st St., New York, N.Y. 10023. ■

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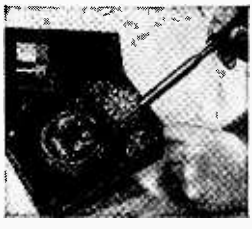

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HAM TRAFFIC DE WZDQS

by MARSHALL LINCOLN

What Are You Doing for Ham Radio?

Many years ago, Will Rogers wrote a simple statement which has invariably captured the interest of everyone who has heard it. He stated, simply and correctly, and with tongue in cheek: "Everybody talks about the weather, but nobody does anything about it."

Will has been gone for nearly 35 years, but that statement still is heard nearly every day somewhere when a couple of people get together to talk over some problem. They generally reword Will's statement to fit their own personal problem, and find it covers the situation pretty well . . . which probably is part of what Will had in mind when he said it in the first place.

We hams could apply this to our interests. We could say "Everybody talks about ham radio, but nobody does anything about it." But then, after we think about it for a while, we realize we should modify that statement just a little . . . by saying *"almost* nobody does anything about it."

For each of us knows of a few folks who are doing something about it . . . folks who really try to *do* something *for* ham radio, rather than just lean back and enjoy it selfishly with no thought for others. These folks are the fellows and gals who make ham radio just a little bit better than it was before they came along.

In One Word. Although you couldn't make up a catalog with a thousand pages listing all the ways a person can do something *for* ham radio, you can cover the entire subject in one word . . . "attitude."

Every piece of so-called "good work" that was ever done in the world started with the solid foundation of a good attitude . . . and ham radio certainly is no exception. This is not to imply that we should all rush to our rigs with pious thoughts on how to perform great bogs of public service or other sterling deeds of daring do. Performing public service certainly is a fine thing to do, if it's done with a sincere attitude of helping someone . . . and my hat is off to all operators who go at it with this as their primary goal . . . they have the right attitude about ham radio.

But I can also say that some of the most obnoxious clods I ever met on the air were operators who also handled big stacks of public service traffic, but did it with an arrogant, selfish attitude. They're the guys with block buster signals and bull dozer tactics, who brag about the amount of traffic they handle, while rudely pushing out of their way the fellows with weak signals and one or two messages. These are the guys who handle a car load of traffic, but do it more out of self glorification than out of a sincere desire to do something worthwhile just because it needed doing and they are able to help.

This type of selfish attitude is not limited to the traffic nets either. You'll find these guys popping up in the DX contests, and the late night ragchew roundtables and in the technical discussions at radio club meetings . . . in short, everywhere that hams congregate, you'll find a few of these fellows.

Take a good look at them, to be sure you recognize the type. Then take a good look in the mirror to make sure their bad attitudes are not rubbing off on you.

Ham radio needs all the good guys it can get, and there's no reason in the world why *you* can't be one of them! How? It's easy . . . just make a point of always thinking about how your actions will affect the other guy . . . and will affect all of ham radio.

This is the key to good attitudes . . . and to being a *good* radio operator instead of

being just another member of the crowd.

What You Can Do. Such seemingly small things as "listen before you transmit," and "keep your transmissions short and allow time for breakers to be heard," and "use the least amount of power necessary to carry on your communication" can be the foundation for a good radio operator to build on. Notice that each of these recommendations involve controlling your actions out of respect for other folks.

That's the key to good attitudes, man. There's no room in ham radio for the selfish, arrogant crowd . . . not as long as each of us makes sure we're carrying our share of the load and doing something about (and *FOR*) ham radio. Then, when someone asks us what our hobby is, we don't have to be embarrassed and mumble, "Oh, I tinker around talking to guys on the radio." Each of us can hold our head up and say proudly, "I'm an amateur radio operator!" For each of us will know that we not only *talked* about ham radio, but we *did* something about it.

This Shack Is a Castle! If you walked into the ham shack of Don C. Miller, W9NTP, Waldron, Ind., and were given permission to operate the rig, you probably wouldn't know where to start. Spread out before you would be equipment for operating SSB, FM, AM, CW, Teletype, and both slow and fast scan TV on all bands from 160 Meters up to 1296 MHz!

A portion of the layout is shown in the photo accompanying this column. You can see it's an impressive layout of both commercial and home brew gear that any of us would be happy to own . . . and know how to operate. Not shown in the picture are such additional items as a phone patch, electronic keyer, tape recorder, teletype machine . . . and a sizable antenna array needed to put all these items on the air.

Don spends much of his time on amateur TV, and is an enthusiastic booster of this field for amateur experimentation. He participates in a local area TV net on 432 MHz each Sunday, as well as long-range TV nets on 80 and 20 Meters.

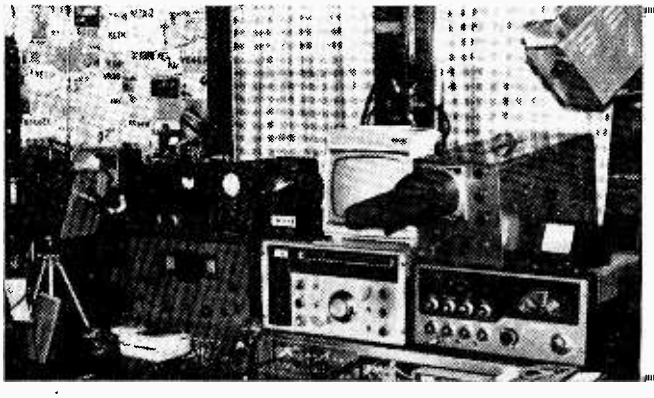
His catchy slogan, which I've reported here before, but which bears repeating, is "Remember, hams should be seen as well as heard."

The Forgotten Men. There's a change in the works for the reciprocal licensing law passed by Congress a few years ago. That's the law which permits the United States to make treaties with other countries permitting their hams to operate in our country, and for our hams to operate in theirs. Before it was passed, no one was allowed to operate a transmitter in the U. S. unless he was a citizen of this country.

However, left out of the original legislation were those persons who have moved to the United States to become citizens, but haven't yet achieved full citizenship. They were not covered by the reciprocal licensing law, and since they were in the process of becoming United States citizens, they probably would not be allowed to operate transmitters in their former homeland either! A bill to cover these folks has been prepared by Barry Goldwater, K7UGA, again a United States Senator from Arizona. He was the man who authored the original reciprocal licensing bill, and he is now taking steps to make this change.

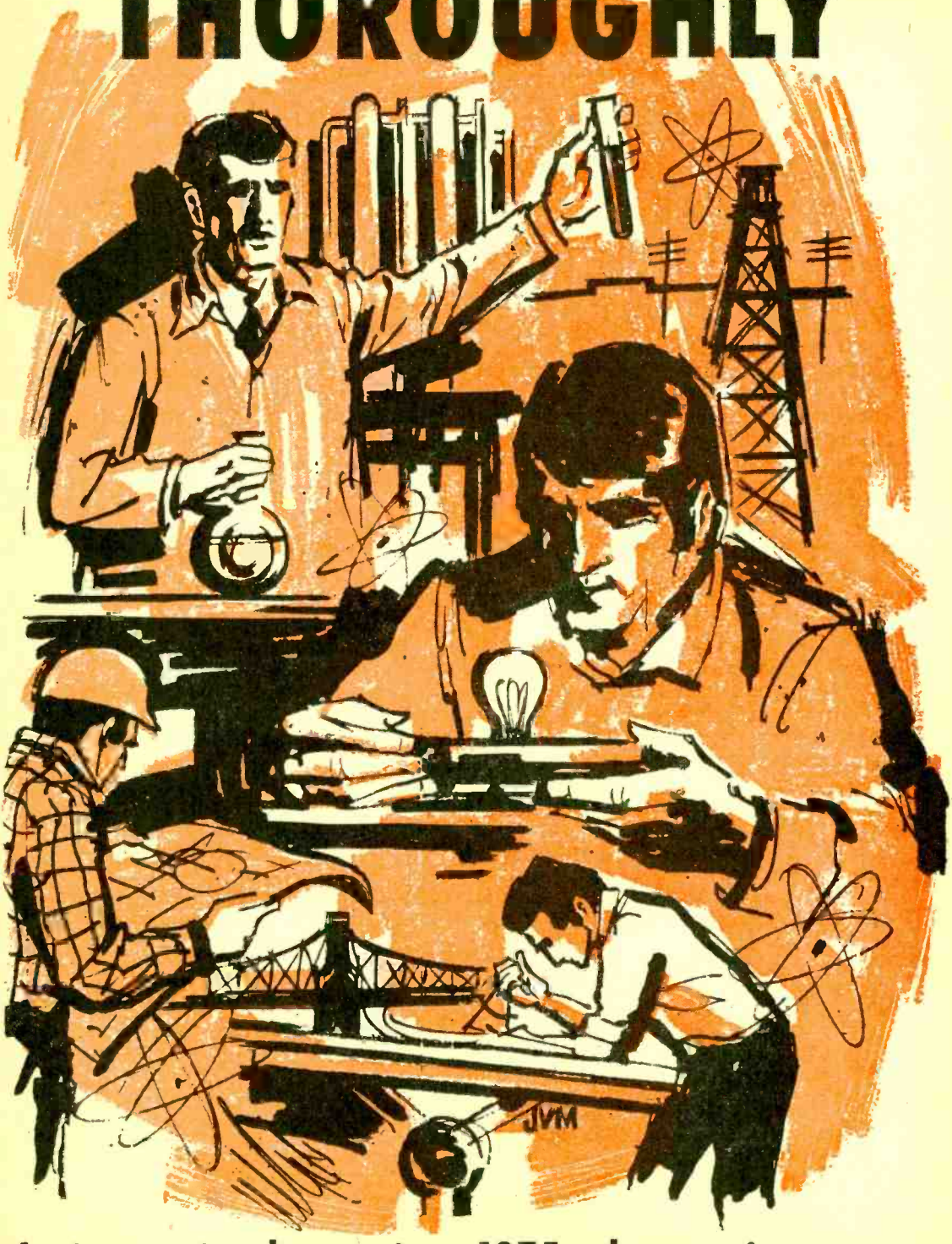
Incidentally, the FCC claims it cannot sift out the various qualifications of aliens operating in this country under terms of the reciprocal licensing law, so it is granting them all full amateur privileges—equivalent to an Extra Class license—whether they deserve it or not! This means foreign visitors

(Continued on page 95)



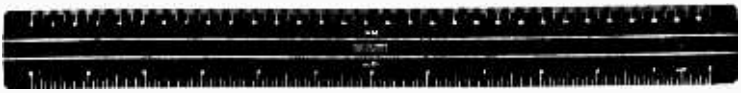
Don C. Miller, W9NTP, boasts all this gear and even more in his shack at Waldron, Ind. A man who believes in having options aplenty at his fingertips, Don is equipped for SSB, CW, AM, FM, RTTY, and even TV on all ham bands from 160 Meters to 1296 MHz. Don is as pro ham-TV as any op alive and argues that any ham worth his salt will be ready and willing to "be seen as well as heard."

THOROUGHLY



In international use since 1875, the metric system

MODERN METRICS



When Noah built his Ark, he measured his lumber in cubits—one cubit being the distance from his elbow to the tip of his middle finger. His 300-cubits-long craft was about 450 feet in length *if* Noah was an average-sized man having an elbow-to-fingertip length of about 18 inches. But if Noah was smaller or larger than average, the 300-cubit length must have been something quite different in terms of our feet.

Whether Noah's cubit was long, short, or average was of little consequence to Noah, provided that he did all the measuring himself. But had an assistant carpenter—a man of different size —made some of the measurments, the two sides of the Ark might not have fit together.

Various body measures, including the length of a man's foot (our *foot*) and the width of his thumb (our *inch*), served well enough in times past, even though the sizes of feet, thumbs, and other organs of the anatomy vary greatly among individuals. But to make any significant commercial or scientific progress, man was forced to develop more accurate and more generally agreed-upon standards of measurement. Laboriously, we have come a long way from the days of Noah. And the most significant advances in measurement have been made within the past couple of decades.

Even in this century, man has done much of his measuring in terms of artifacts—wholly arbitrary standards. Until very recently, for example, the international standard of length—the *meter*—consisted of a carefully preserved metal bar on which two reference marks had been engraved. The distance between these two marks was taken as the true meter, and all other measuring tools were constructed using this artifact as a standard.

Now most such artifacts have been discarded. Scientists have replaced them with standards that can be set up independently, anytime, anywhere. The standards now utilize the unchanging, eternally consistent characteristics of such natural phenomena as electron resonances, light waves and magnetic forces.

Though most of us muddle along with such cumbersome units of measure as the foot and the pound, scientists have long used the far handier metric system. Reason: it permits expression of multiples and sub-multiples in terms of decimal notations. For

grooms for tomorrow's technology/by Jorma Hyypia

MODERN METRICS

example, to convert feet into miles, one must divide by 5280; but to convert meters into kilometers it is necessary to move only a decimal point. Similarly, to convert ounces into pounds, you divide by 16; but grams into centigrams is another story.

Even the time-honored metric system is to a degree out of date. This explains why it's being supplanted by a more modern metric system called the International System of Units, or simply *SI*.

Meter Is Basic. An exact definition of the meter is all-important because it forms the basis of most other primary units of measurement. The meter was originally defined as one ten-millionth of the distance from the north pole to the equator, as measured along a meridian passing near Dunkirk, Paris, and Barcelona. In 1875 the meter was re-defined as the distance between two marks on a standard platinum-iridium bar kept in Paris by the International Commission of Weights and Measures.

But even this standard had obvious drawbacks. It was necessary to make secondary reference standards for use in other countries by comparing them with the basic standard in Paris. This was inconvenient, to say the least. There was clear need of a standard that could be duplicated anywhere at any time without recourse to an artifact standard in Paris or any other place.

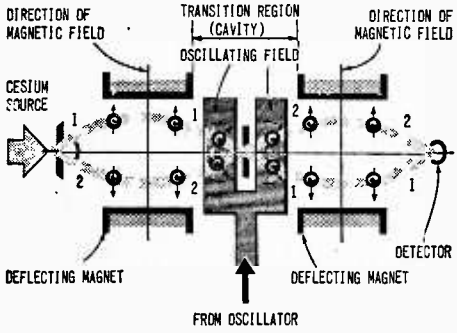
The new SI meter is now defined as 1,650,763.73 wavelengths, in vacuum, of the orange-red spectral line of krypton-86. This means that anyone can generate this spectral line, mark off the specified number of wavelengths, and have a true meter.

Once a definitive standard for the meter was established, it was used to define various units of area and volume. For example, the SI unit of area is the *square meter* (m^2). The SI unit of volume is the *cubic meter* (m^3). Fluid volume is often measured in terms of the *liter* which is one thousandth of a cubic meter.

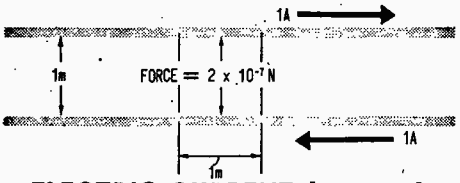
Laser Meter? Ironically, just when the standard meter seems to have been defined accurately enough for all time, a potentially better method crops up. It is quite possible that the krypton meter will also become obsolete. It may be burned out of existence by a laser.

In January of this year, the National Bureau of Standards reported that its scientists had developed a new device which stabilizes the output wavelength of laser light. The laser technique is based on the

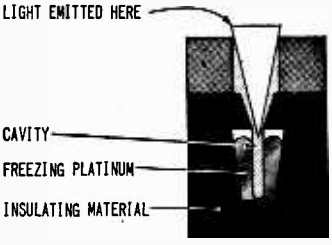
DERIVING THE SIX BASE UNITS OF



TIME (second)



ELECTRIC CURRENT (ampere)



LUMINOUS INTENSITY (candela)

MASS (kilogram)

saturated absorption, in methane vapor, of radiation from a 3.39 micron helium-neon laser. We won't try to unravel this bit of scientific jargon now since the laser method has yet to be accepted as a new standard.

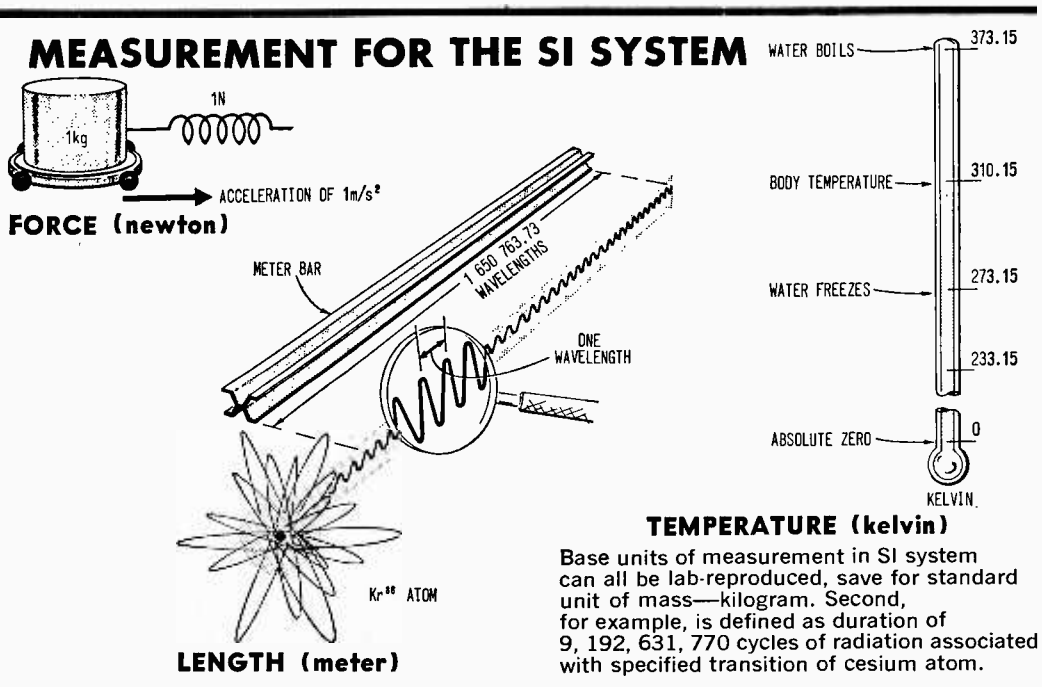
Why even consider its use? Because the present krypton standard is accurate to only one part in one hundred million whereas the laser technique promises to be nearly 1000 times as reproducible!

Mass and Force. The *kilogram* is the standard SI unit of mass. Significantly, it is the only base unit still defined by an artifact—a cylinder of platinum-iridium alloy kept at Paris. A duplicate of the standard is in the custody of the National Bureau of Standards in Washington, D.C.

a downward acceleration of about 9.8 meters per second per second.

Work versus Power. The words *work, energy,* and *power* are often confused and used interchangeably, hence incorrectly, in colloquial speech. Work and energy are synonymous, and the SI unit for either work or energy *of any kind* is the *joule* (J). At one time the joule was used mainly to express electrical energy; physical energy or work was expressed in other units such as the foot-pound.

In the SI system, the joule becomes a more generally applicable unit of work or energy. One joule of energy or work is obtained when a force of one newton is applied over a distance of one meter.



Base units of measurement in SI system can all be lab-reproduced, save for standard unit of mass—kilogram. Second, for example, is defined as duration of 9, 192, 631, 770 cycles of radiation associated with specified transition of cesium atom.

Force is closely allied to the concept of mass. The SI unit of force is the *newton* (N). A force of one newton, when applied for one second, will give a speed of one meter per second to a one kilogram mass, or an acceleration of one meter per second per second. That is a rather round-about way of defining force, but it seems to be the best that the experts have cooked up so far. Perhaps it will help to know that one newton is approximately equivalent to two-tenths of a pound of force.

Weight is the force exerted on an object by the influence of gravity which gives mass

Power refers to the speed of doing work. The SI unit of power of any kind is the *watt* (W). One watt of power is represented by one joule of work or energy acting over a time period of one second. To calculate the amount of power, simply divide the total work or energy in joules by the time in seconds.

Time Change. Throughout the ages man has devised many ingenious devices for the measurement of time. It wasn't until the 17th century that time was defined in terms of the mean solar day, the time of the average rotation of the earth on its axis. The

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mean solar second is 1/86,400 part of a mean solar day.

Such a system is adequate for timing ordinary human activities, like getting to work or school on time. Thing is, scientific activities require something far more accurate. A move in the right direction was made in 1956 with establishment of the ephemeris time system. This system is based on the revolution of the earth around the sun as measured in terms of the tropical year of 1900. A tropical year is the time it takes the earth to make one revolution around the sun. The ephemeris second is 1/31,556,-925.9747 part of a tropical year.

Even this definition is less than satisfactory. A lengthy series of astronomic measurements must be made to obtain current values for the mean solar second that can be compared with the ephemeris second.

In 1964, scientists once again re-defined the second, this time in terms of the transition between two specific energy levels in the element cesium-133. Thus, the second—like the meter—is now defined in terms of a quantum transition.

Cesium-133, a naturally occurring isotope, vaporizes when heated. Using appropriate equipment, this vapor is passed through tubes to produce a cesium beam. When this beam is energized, the cesium electrons move to higher spin energy levels. Subsequent spin transition to lower energy levels releases energy in very precise frequency increments amounting to 9,192,631,770 Hz per second. In other words, one ephemeris second is the time needed to generate this number of reasonating cycles.

By using the cesium atom as a frequency standard, it is now possible to make so-called atomic clocks having truly incredible accuracies. Some such clocks will accumulate an error of only one second over a period of 1600 years!

The SI unit for speed is the *meter per* second (m/s), which is approximately three feet per second. Acceleration is the rate of change of speed. The SI unit for acceleration is the *meter per second per second* (m/s^2).

Temperature. The SI temperature standard is based on the Kelvin scale which uses "absolute zero" as a designation of the coldest possible conditions. Incidentally, absolute zero is no longer defined as that temperature at which all molecular motion ceases, as it once was. By means of statistical and quantum mechanics it has been proved that the molecules of a substance, at absolute zero, still have a finite amount of kinetic energy known as the zero-point energy.

Anyway, zero on the Kelvin scale is as cold as you can get. This corresponds to minus 459.67° on the Fahrenheit scale. On the Kelvin scale water freezes at 273.15° and boils at 373.15°. One big advantage of the Kelvin scale is that it eliminates the need to use minus values. In other words, just as the 24-hour clock does away with such anachronisms as a.m. and p.m., the Kelvin scale records all temperatures in one way only—positive.

The experimentally determinable temperature of 273.16°K is called the *triple point* because at this temperature water exists in its three phases—liquid, solid, and vapor. Note that the triple point is one hundredth of a degree warmer than the freezing point, and corresponds to approximately 32.02°F and to 0.1° on the Celsius (Centigrade) scale.

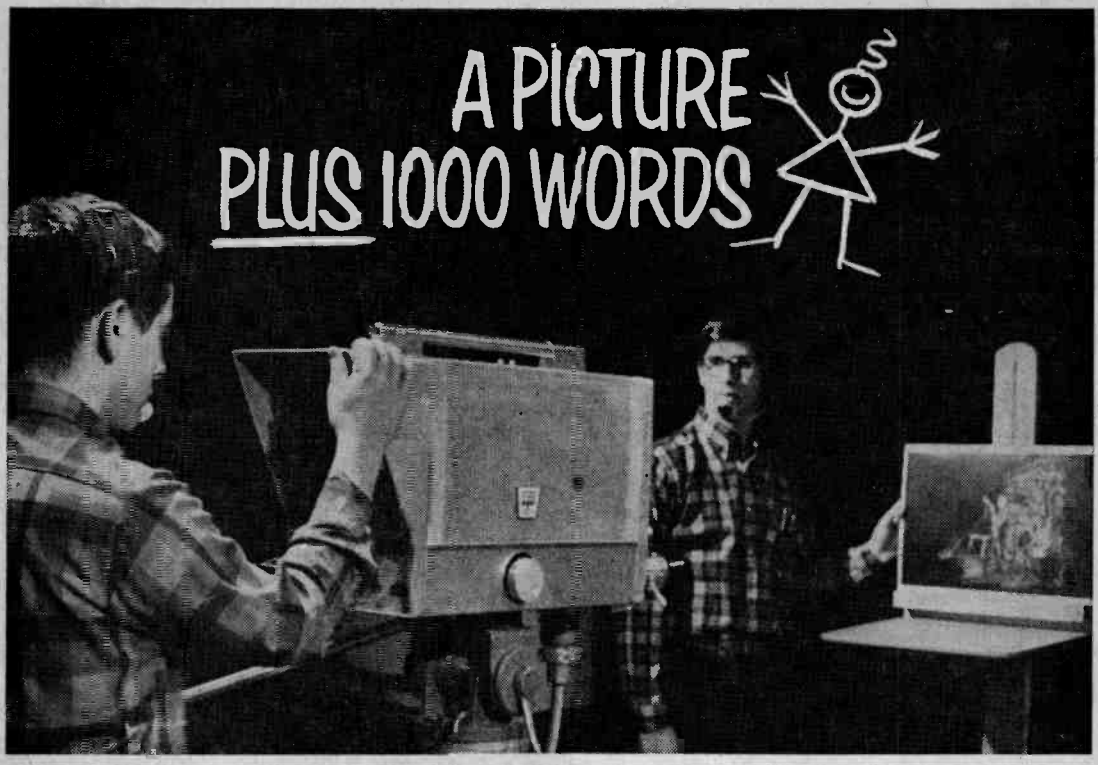
This fixed point temperature is defined in terms of a triple point cell which is an evacuated glass cylinder filled with water. When the cell is cooled until a mantle of ice forms around the reentrant well, the temperature at the interface of solid, liquid, and vapor is 273.16°K or 0.01°C. Thermometers to be calibrated are placed in the reentrant well.

Electrical Standards. In the past, the international *ampere* was defined as that current which would deposit 0.001118 grams of metallic silver each second in an electrolysis reaction. The SI ampere (A) is now defined in terms of *newtons of force*: "One ampere is the magnitude of electric current that, when flowing through each of two infinitely long parallel wires separated by one meter in empty (free) space, results in a magnetic force between the two wires of $2x10^{-7}$ newton for each meter of wire length."

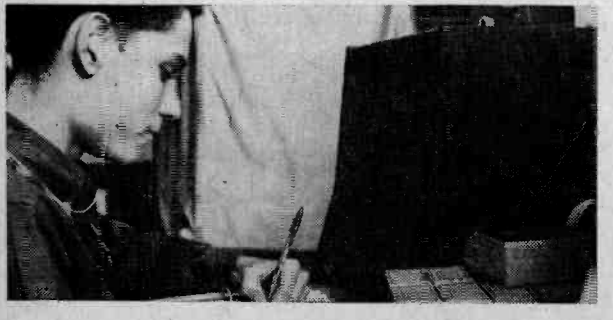
If that is too much for one gulp, digest it slowly this way. Send an electric current along two very long parallel wires set one meter apart. When the current flows, a magnetic field is set up between the two wires. When the current is so adjusted that the force of the magnetic field is exactly

(Continued on page 97)

A PICTURE PLUS 1000 WORDS



Video tape (above, top) and computer center (immediately above) at Evanston High.



Microfilm reader is yet another audio-visual tool at beck and call of Evanston's students.

Traditional school libraries are rapidly becoming a thing of the past. Reason is that they're being replaced by resource centers—basic factors in the new electronic revolution in education and focal points of the multi-media teaching technique. The very phrase *resource center* tells a great deal about what goes on in these space-age learning laboratories. Unique examples exist at Evanston Township High School in Illinois (see our photos), where Dr. Lloyd Michael presides over more than 4500 students and a physical plant that will have cost more than $15 million when it's completed.

Since Evanston is divided into four separate schools, four attractively equipped and arranged centers have been set up. They are geared specifically to English, social studies, foreign languages, and math.

Evanston's resource centers are on the second floor of each wing of the four-school complex and each center occupies almost an entire floor. Outside walls are lined with books on every appropriate subject. The student can confer with his teacher with the proper information close at hand, or he can study at one of the tables in the center, using the area as a library. Written materials are supplemented by audio tapes, video tapes, film, filmstrips, and slides. *(turn page)*

A PICTURE PLUS

Above, machines check out books at Evanston's library, and computers automatically record their withdrawal. Right, audio-visual rooms accommodate two students, can be used for listening to tapes or records, viewing filmstrips, or just plain gabbing.

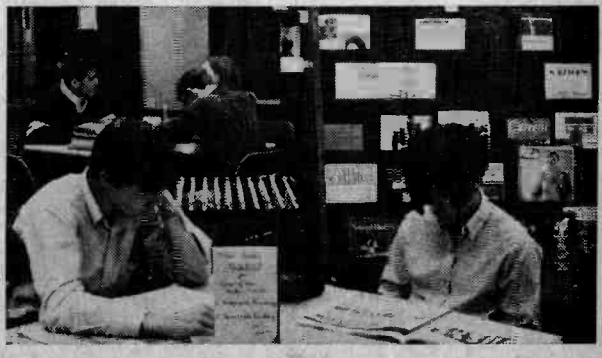
Evanston faculty members feel that a substantial number of students who would not be successful if they relied on books alone actually become involved when exposed to the modern hardware and airy atmosphere of the resource centers.

"Kids cut their educational teeth learning from TV," says Dr. Ben Israel, an electronic evaluation specialist for the New York City Board of Education. "That's why today's educators are adopting the Madison Avenue approach to learning."

Resource centers are especially helpful to above-average students who possess a strong desire to work on their own. Yet the centers have also been highly regarded by students on the academic fringes. "The teachers don't have to beat me over the head anymore," says one boy who admits that the excitement of electronic education is probably keeping him in school.

As resource centers eventually spread throughout the country, the day will come when a pupil in Indianapolis, say, making a study of FDR and the New Deal, will be able to slide into his carrel, dial a number, and quickly get all the information he needs to complete his project. Who says it don't rain in Indianapolis in the summertime? ■

Variety of special audio-visual aids is available at central desk of Evanston's resource center (above). Below, daily papers and some 40 magazines make for good reading.



WHITE'S RADIO LOG

An up-to-date Directory of North American AM, FM, and TV Stations, including special sections on World-Wide Shortwave Stations and Emergency Stations for Selected Areas

WHITE'S RADIO LOG CONTENTS FOR 1969*

* If you save six consecutive issues of Radio-TV Experimenter and Science and Electronics, you will have a complete White's Radio Log. If you have missed an issue, you may be able to get a copy by writing directly to the publisher stating which issue you wish and enclosing $1.00 for each issue.

U. S. FM Stations by States

WHITE'S RADIO LOG

Location	C.L.	MHz
ALABAMA		
Abbeville	WARI-FM	94.3
Albertville	WQSB	105.1
Alexander City	WRFS-FM	106.1
Andalusia	WNBX	98.1
Anniston	WHMA-FM	100.5
Athens	WJOF	104.3
	WATM-FM	104.1
Auburn	WFRI	97.7
Bay Minette	WWSM	105.5
Birmingham	WAPI-FM	99.5
	WBRC-FM	106.9
	WCRT-FM	96.5
	WDJC	93.7
	WENN-FM	107.7
	WVSU-FM	91.1
Carrollton	WRAG-FM	94.1
Clanton	WKLF-FM	97.7
Cullman	WFMH-FM	101.1
	WKLN	92.1
Decatur	WDRM	102.1
	WRSA	96.9
Dothan	WOOF-FM	99.7
	WTVY-FM	95.5
Enterprise	WIRB-FM	96.9
Fairhope	WABF-FM	92.1
Florence	WQLT	107.3
Gadsden	WLJM	103.7
Guntersville	WTWX	95.9
Hamilton	WERH-FM	92.1
Homewood	WJLN	104.7
Huntsville	WAHR	99.1
	WNDA	92.9
Jackson	WHOD-FM	104.9
Mobile	WKRG-FM	99.9
	WMFC-FM	98.5
	WLPR	96.1
Montgomery	WFMI	98.9
	WAJM	103.3
	WHHY-FM	101.9
Muscle Shoals	WLAY-FM	105.5
Oneonta	WKLD	97.7
Ozark	WOAB	104.9
Roanoke	WELR-FM	95.3
Scottsboro	WCNA-FM	98.3
Selma	WTUN	100.1
	WTQX-FM	100.9
Sylacauga	WMLS-FM	98.3
Tuscumbia	WVNA	100.3
Tuscaloosa	WTBO-FM	95.7
	WACT-FM	105.5
ALASKA		
Anchorage	KNIK	105.5
	KAMU	102.1
	KHAR-FM	103.9
	KYAK-FM	101.3
College	KUAC	104.7
ARIZONA		
Flagstaff	KAFF-FM	92.9
Globe	KWJB-FM	100.3
Mesa	KBUZ-FM	104.7
	KMND-FM	93.3
Phoenix	KRFM	95.5
	KFCA	91.5
	KJTH	101.3
	KMEO-FM	96.9
	KOOL-FM	94.5
	KNIX-FM	102.5
	KOY-FM	92.5
	KTAR-FM	98.7
	KYEW	93.3
	KHEP-FM	101.5
Scottsdale	KDOT-FM	100.7
Show Low	KVWM	93.5
Tempe	KUPD-FM	97.9
Tucson	KFMM	99.5
	KCEE-FM	96.1
	KVOA-FM	93.7
ARKANSAS		
Benton	KOOM	107.1
Blytheville	KLCN-FM	96.1
Brinkley	KBRI-FM	102.3
Camden	KWEH	97.1
Conway	KASC	91.5
	KVEE-FM	105.1
Crossett	KAGH-FM	104.9
Dardanelle	KCAB-FM	102.3
El Dorado	KRIL	99.3
	KELD-FM	103.1
Fayetteville	KFAV	92.1
	KNWA	103.9
Ft. Smith	KFPW-FM	94.9
	KMAG	99.1
	KTCS-FM	99.9
Harrison	KHOZ-FM	102.9
Hot Springs	KBHS-FM	96.7
	KGUS	97.5
Jacksonville	KGMR-FM	100.3
Jonesboro	KBTM-FM	101.9
	KASU	91.9
Little Rock	KARK	103.7
	KAAY-FM	98.5
	KMMK	94.1
	KMYO-FM	95.7
Magnolia	KFMV	107.9
Mammoth Springs	KAMS	103.9
Mena	KENA-FM	101.7
Monticello	KHBM-FM	93.5
Newport	KNBY-FM	105.5
Osceola	KOSE-FM	98.1
Pine Bluff	KOTN-FM	92.3
Pochontas	KPOC-FM	103.9
Siloam Springs	KUOA-FM	105.7
Springdale	KSPR-FM	104.9
Texarkana	KADO	107.1
Wynne	KWYN-FM	92.7
CALIFORNIA		
Alameda	KJAZ	92.7
Anaheim	KEZR-FM	95.9
Angwin	KANG	89.9
Apple Valley	KAVR-FM	102.3
Arcata	KHSC	90.5
Atherton	KPEN	101.3
Auburn	KAFI	101.1
Avalon	KBIG	104.3
Bakersfield	KERN-FM	94.1
	KBBY	107.9
	KGFM	101.5
	KIFM	96.5
Berkeley	KPFA	94.1
	KALX	90.7
	KPFB	89.3
	KPAT-FM	102.9
Bijou	KHUR	99.9
Bishop	KIBS-FM	100.7
Carlsbad	KARL-FM	95.1
Cathedral City	KWXY-FM	103.1
Chico	KEQR	107.7
	KCHO	91.1
Claremont	KSPC	88.7
Coachella	KCHV-FM	93.7
Concord	KVHS	91.1
Davis	KDVS	91.5
Delano	KDNO	98.5
El Cajon	KECR	93.3
El Centro	KNEU	98.5
Escondido	KOWN—FM	92.1
Eureka	KINS-FM	96.3
Fremont	KFMR	104.9
Fresno	KARM-FM	101.9
	KFIG	94.5
	KFRE-FM	93.7
	KMJ-FM	97.9
	KXQR	102.7
Garden Grove	KTBT	94.3
Gilroy	KPER-FM	94.3
Glendale	KFMU	97.1
	KUTE	101.9
Hayward	KTUX	101.7
Hemet	KHSJ-FM	105.5
Indio	KINI	98.3
Inglewood	KTYM-FM	103.9
La Canada	KUNF	88.9
La Sierra	KSDA	89.7
Livermore	KYTE	101.7
Lodi	KCVR-FM	97.7
Lompoc	KLOM-FM	92.7
Long Beach	KJLH	102.3
	KLON	88.1
	KNOB	97.9
Los Altos	KPGM	97.7
	KPSR	91.5
	KFJC	88.7
Los Angeles	KABC-FM	95.5
	KBBI	107.5
	KBCA	105.1
	KCBH	98.7
	KFAC-FM	92.3
	KFOX-FM	100.3
	KGBS-FM	97.1
	KHJ	101.1
	KMET	94.7
	KMLA	100.3
	KNX-FM	93.1
	KOST	103.5
	KPFK	90.7
	KPOL-FM	93.9
	KRHM	102.7
	KRKD-FM	96.3
	KUSC	91.5
	KWST	105.9
	KXLU	88.9
	KHOF	99.5
Los Angeles-Avalon		
	KBIG-FM	104.3
Los Banos	KLBS-FM	95.9
Los Gatos	KLGS	95.3
Marysville	KRFD	99.9
Mendocino	KMFB-FM	92.7
Merced	KAMB	101.5
Modesto	KBEE-FM	103.3
	KTRB-FM	104.1
	KDHS	90.5
Mojave	KDOL-FM	97.7
Monterey	KWAY	96.9
Newport Beach	KOCM	103.1
Northridge	KEDC-FM	88.5
Oakland	KAFE	98.1
Oceanside	KUDE	102.1
Ontario	KSOM-FM	93.5
Oxnard	KPMJ	104.7
Pacific Grove	KOCN	104.9
Palm Springs	KGEC	104.7
Pasadena	KPCS	89.3
	KPPC-FM	106.7
Redding	KEWB	104.3
Redondo Beach	KKOP	93.5
Redlands	KCAL-FM	96.7
	KUOR-FM	89.1
Ridgecrest	KLOA-FM	105.5
Riverside	KBBL	99.1
	KACE-FM	92.7
	KDUO	97.5
Riverside	KUCR	88.1
Roseville	KPDP-FM	93.5
Sacramento	KCTC	96.1
	KERS	90.7
	KFBK-FM	92.5
	KEBR	100.5
	KHIQ	105.1
	KJML	106.5
	KRAK-FM	92.9
	KSFM	96.9
	KXOA-FM	107.9
	KZAP	98.5
Salinas	KSBW-FM	102.5
	KRSA-FM	100.7
	KERR	103.9
San Bernardino	KVCR	91.9
	KFMW	99.9
	KEBS	89.5
	KRCS	95.1
San Diego	KOGO-FM	94.1
	KBKB	101.5
	KEBS	89.5
	KFMB-FM	100.7
	KFMX	96.5
	KITT	105.3
	KDIG	98.1
	KLRO	94.9
	KPRI	106.5
	KSDS	88.3
	KBBW	102.9
	KSDO-FM	103.7
	KSEA	97.3
San Fernando	KVFM	94.3
San Francisco	KALW	91.7
	KBRG	103.3
	KCBS-FM	98.9
	KDFC	102.1
	KEAR	97.3
	KFOG	104.5
	KFMS	106.1
	KGO-FM	103.7
	KIOI	101.3
	KNBR-FM	99.7
	KMPX	106.9
	KOIT	93.3
	KQED-FM	88.5
	KRON-FM	96.5
	KSAN	94.9
	KCMA	90.3
	KBRG	103.3
	KABL-FM	98.1
	KKHI-FM	95.7
San Jose	KSJO-FM	92.3
	KBAY	100.3
	KRPM	98.5
	KSJS	90.7
	KPLX	106.5
San Luis Obispo	KATY-FM	96.1
	KCPR	91.3
	KSBY-FM	93.3
San Mateo	KCSM	90.9
	KVEZ	107.7
San Rafael	KTIM	100.9
Santa Ana	KWIZ-FM	96.7
	KYMS	106.3
Santa Barbara	KCSB-FM	91.5
	KDB-FM	93.7
	KMUZ	103.3
	KTMS	97.5
Santa Clara	KSCU	90.1
	KREP	105.7
Santa Cruz	KSCO-FM	99.1
Santa Maria	KXFM	99.1
	KSMA-FM	102.5
Santa Monica	KCRW	89.9
	KSRF	103.1
Sierra Madre	KMAX	107.1
Stanford	KZSU	90.1
Stockton	KUOP	91.3
	KJAX	99.3
	KWG-FM	105.7
Tahoe Valley	KTHO-FM	103.1
Thousand Oaks	KNJO	92.7
Torrance	KNHS	89.7
Tracy	KSRT	100.9
Tulare	KBOS	94.9
Turlock	KOSO	93.1
Twenty-Nine Palms		
	KDHI-FM	95.7
Ukiah	KUKI-FM	93.5
	KLIL	94.3
Vacaville	KVFS	95.3
Ventura-Oxnard	KVEN-FM	100.7
Visalia	KONG-FM	92.9
Walnut Creek	KDFM	92.1
West Covina	KBOB	98.3
Woodland	KRBT	102.5
COLORADO		
Boulder	KRNW	97.3
Colorado Springs	KRCC	91.5
	KKFM	96.5
	KSHS	90.5
	KVOR-FM	92.9
	KPIK-FM	94.3
	KRDO-FM	95.1
	KRYT-FM	101.9
Cortez	KZFM	94.1
Denver	KADX	105.1
	KFML-FM	98.5
	KLIR-FM	100.3
	KLZ-FM	106.7
	KMYR	95.7
	KDEN-FM	99.5
	KOA-FM	103.5
	KOSI-FM	101.1
	KBPI	105.9
Ft. Collins	KCSU-FM	90.9
	KFMF	93.9
Ft. Morgan	KFTM-FM	101.7
Grand Junction	KREX-FM	92.3
Greeley	KCBL-FM	91.3
	KGRE	92.3
Gunnison	KWSB-FM	91.9
Lakewood	KJAE	107.5
Longmount	KLMO-FM	104.3
Loveland	KLOV-FM	102.3
Manitou Springs	KCMS-FM	102.7
Morrison	KWBI	91.1
Pueblo	KVMN	98.9
Rocky Ford	KAVI-FM	95.9
CONNECTICUT		
Bridgeport	WJZZ	99.9
	WPKN	89.5
Brookfield	WGHF	95.1
Danbury	WLAD-FM	98.3
Fairfield	WSHU	91.1
Groton	WSUB-FM	105.5
Hamden	WKCI	101.3
Hartford	WHCN	105.9
	WDRC-FM	102.9
	WCCC-FM	106.9
	WLAE	93.7
	WRTC-FM	89.3
	WTIC-FM	96.5
Meriden	WBMI	95.7
Middletown	WESU	88.1
	WIHS	104.9
New Britain	WRCH-FM	100.5
New Haven	WNHC-FM	99.1
	WYBC-FM	94.3
New London	WTYD	100.9
Norwalk	WDRN	95.9
Norwich	WICH-FM	97.7
Stamford	WSTC-FM	96.7
Storrs	WHUS	91.7
Wallingford	WWEB-FM	90.1
Waterbury	WATR-FM	92.5
	WWCO-FM	104.1
W. Hartford	WWUH	91.3
Westport	WMMM	107.9
DELAWARE		
Dover	WDOV-FM	94.7
Georgetown	WSEA	93.5
Wilmington	WDEL-FM	93.7
	WJBR	99.5
D. C.		
Washington	WASH	97.1
	WAMU-FM	88.5
	WETA-FM	90.9
	WFAN-FM	100.3
	WGAY	99.5
	WGMS-FM	103.5
	WGTB	90.1
	WMAL-FM	107.3
	WMOD	98.7

Location	C.L.	MHz
	WRC-FM	93.9
	WTOP-FM	96.3
	WWDC-FM	101.1

FLORIDA

Atlantic Beach	WKTZ-FM	96.1
	WAQB-FM	104.9
Belle Glade	WSWN-FM	93.5
Blountstown	WRTV	102.3
Boca Ratan	WWOG	99.9
Boynton Beach	WHRS	91.7
Bradenton	WBRD-FM	103.3
Clear Water	WTAN-FM	95.7
	WQXM	97.9
Cocoa	WEZY-FM	99.3
Cocoa Beach	WCKS	101.1
	WKPE-FM	104.1
Coral Gables	WYOR	105.1
	WVUM	90.5
Crestview	WAAZ-FM	104.9
Daytona Beach	WNDB-FM	94.5
	WMFJ-FM	101.9
De Funiak Springs		
	WZEP-FM	103.1
DeLand	WOOO-FM	105.9
Ft. Lauderdale	WFTL-FM	100.7
	WIXX-FM	105.9
	WMJR	100.7
	WSRF-FM	103.5
Ft. Meyers	WINK-FM	96.9
	WMYR-FM	101.9
Ft. Pierce	WARN-FM	98.7
	WOVV	95.5
Ft. Walton Beach		
	WFTW-FM	99.3
Gainesville	WRUF-FM	103.7
Hialeah	WHMS	92.1
Immokalee	WCOF-FM	95.9
Jacksonville	WJAX-FM	95.1
	WQIK-FM	99.1
	WRLJ	96.9
	WIVY-FM	92.5
	WKTZ-FM	96.1
Key West	WFYN-FM	92.5
Lake City	WTLD-FM	94.3
Lakeland	WVFM	94.1
Maitland	WTLN-FM	95.3
Marianna	WTOT-FM	100.9
Melbourne	WYRL	102.3
Miami	WKAT	93.1
	WGBS-FM	96.3
	WGOS-FM	93.9
	WIOD-FM	97.3
	WTHS-FM	91.7
	WEDR	99.1
	WWPB	101.5
Miami Beach	WOCN-FM	94.9
Milton	WXBM-FM	102.3
Mt. Dora	WHIY-FM	107.7
Naples	WNFM	94.5
Ocala	WMOP-FM	93.7
Okeechobee	WLMC	103.1
Orlando	WDBO-FM	92.3
	WHOO-FM	96.5
	WKIS-FM	100.3
	WORJ-FM	107.7
	WWQS	105.1
Palm Beach	WWOS-FM	97.9
	WPBA-FM	107.1
Panama City	WMAI-FM	107.9
	WPAP-FM	92.5
Pensacola	WPEX-FM	94.1
	WCOA-FM	102.7
	WONF	101.5
Plantation Key	WPLC	100.3
Quincy	WCNH-FM	101.7
St. Augustine	WFOY-FM	97.7
St. Petersburg	WGNB	101.5
	WTCX	99.5
	WWBA-FM	107.3
Sarasota	WSAF-FM	102.5
	WSPB-FM	106.3
Sebring	WANZ	105.5
Stuart	WMCF	92.7
Tallahassee	WANM	104.1
	WFSU-FM	91.5
	WBGM-FM	98.9
	WOMA	94.9
Tampa	WDAE-FM	100.7
	WFLA-FM	93.3
	WPKM	104.7
	WUSF	89.7
Titusville	WRMF-FM	98.3
West Palm Beach		
	WEAT-FM	98.3
	WPBF	107.9
Winter Haven	WXKL	97.5
Winter Park	WPRK	91.5
	WLOQ	103.1

GEORGIA

Albany	WGPC-FM	104.5
	WJIZ	96.3
Americus	WDEC-FM	94.3
Athens	WGAU-FM	95.5
	WDOL-FM	104.7
Atlanta	WABE	90.1
	WPLO-FM	103.3
	WGKA-FM	92.9
	WKLS	96.1
	WREK	91.1
	WSB-FM	98.5
	WLTA-FM	99.7
Auburn	WFRI	97.7
Augusta	WAUG-FM	105.7
	WBBQ-FM	104.3
	WGUS-FM	102.3
	WZZW	103.1
Bainbridge	WMGR-FM	97.3
Brunswick	WGIG-FM	100.7
	WYNR-FM	101.5
Canton	WCHK-FM	105.5
Carrollton	WBTR-FM	92.1
Cochran	KVMG-FM	96.7
Columbus	WRBL-FM	102.9
	WGBA-FM	107.3
	WWRH	104.9
Cordele	WMJM-FM	98.3
Cornelia	WCON-FM	99.3
Decatur	WAVO-FM	94.9
Dublin	WXLI-FM	92.7
Gainesville	WDUN-FM	103.9
	WWQT	97.1
Griffin	WKEU-FM	97.7
Hawkinsville	WCEH-FM	103.9
Jackson	WJGA-FM	92.1
Jesup	WLOP-FM	105.5
Lagrange	WLAG-FM	104.1
Macon	WDEN-FM	105.3
	WMAZ-FM	99.1
Manchester	WFDR-FM	93.3
Marietta	WBIE-FM	101.5
Milledgeville	WMVG-FM	102.3
Moultrie	WMTM-FM	93.9
Newnan	WCOH-FM	96.7
Perry	WPGA-FM	100.9
Rome	WRGA-FM	102.3
	WROM-FM	97.7
Rossville	WRIP-FM	105.5
Savannah	WTOC-FM	94.1
	WEAS-FM	93.1
	WXLM	97.3
Smyrna	WQXI-FM	94.1
Statesboro	WMCD	100.1
Swainsboro	WJAT-FM	98.3
Toccoa	WLET-FM	106.1
Vidalia	WVOP-FM	97.7
Valdosta	WGOV-FM	92.9
Warner Robins	WRBN-FM	101.7
W. Point	WCJM	100.9

HAWAII

Honolulu	KAIM-FM	95.5
	KFOA	94.7
	KGMB-FM	93.1
	KHVH-FM	93.9
	KPOI-FM	97.5
	KUOH	90.5

IDAHO

Boise	KBOI-FM	97.9
	KBBK-FM	92.3
Caldwell	KBGN-FM	94.1
Idaho Falls	KID-FM	96.1
	KGVM-FM	99.1
Jerome	KFMA	92.7
Lewiston	KOZE-FM	96.7
Moscow	KUID	91.7
	KUOI-FM	89.3
Nampa	KCRH	91.5
Pocatello	KBGL	88.7

ILLINOIS

Alton	WOKZ-FM	100.3
Anna	WRAJ-FM	92.7
Arlington Heights	WEXI	92.7
Aurora	WKKD-FM	95.9
	WAUR	107.9
Bloomington	WBNQ	101.5
Canton	WBYS-FM	98.5
Carbondale	WSIU	91.9
	WCIL-FM	101.5
Carmi	WROY-FM	97.3
Centralia	WILY-FM	95.3
Champaign	WDWS-FM	97.5
	WLRW-FM	94.5
Charleston	WEIC-FM	92.1
Chicago	WBBM-FM	96.3
	WBEZ	91.5
	WHPK-FM	88.3
	WLS-FM	94.7
	WDHF	95.5
	WEBH	93.9
	WEFM	99.5
	WFDM	97.9
	WFMF	100.3
	WNUS-FM	107.5
	WFMT	98.7
	WKFM	103.5
	WMAQ-FM	101.1
	WMBI-FM	90.1
	WNIB	97.1
	WXRT	93.1
	WJJD-FM	104.3
Columbia	WCBW	104.9
Crete	WTAS	102.3
Danville	WDAN-FM	102.1
	WIAI	99.1
Decatur	WSOY-FM	102.9
DeKalb	WNIU	89.5
	WLBK-FM	92.5
Dixon	WIXN-FM	101.7
Downers Grove	WDGC-FM	88.3
Dundee	WVFV	103.9
E. St. Louis	WMRY	101.1
Effingham	WCRA-FM	95.7
	WELG	103.9
	WRMN-FM	94.3
Elgin	WEPS	88.1
	WRMN-FM	94.3
Elmhurst	WRSE-FM	88.7
Elmwood Park	WXFM	105.9
Evanston	WEAW	105.1
	WNUR	88.7
Fairfield	WFIW-FM	104.9
Flossmoor	WHFH	88.5
Freeport	WELL-FM	98.5
Galesburg	WYKC-FM	88.1
	WGIL-FM	94.9
Glen Ellyn	WELF	107.1
Granite City	WGNU-FM	106.5
Greenville	WGRN	89.3
Harrisburg	WEBQ-FM	99.9
Highland Park	WEEF-FM	103.1
Jacksonville	WLDS-FM	100.5
	WAJP	93.5
Jerseyville	WJBM-FM	104.1
Joliet	WJOL-FM	96.7
Kankakee	WKAK-FM	99.9
	WKOC	88.3
Kewanee	WKEI-FM	92.1
LaGrange	WLTL	88.1
Lansing	WLNR-FM	106.3
LaSalle	WLPO-FM	99.3
Lawrenceville	WAKO-FM	103.1
Lincoln	WLCC	88.7
Litchfield	WSMI-FM	106.1
Loves Park	WLUV-FM	96.7
Macomb	WWKS	91.3
	WKAI-FM	100.1
Mattoon	WLBH-FM	96.9
Mendota	WGLC-FM	100.9
Moline	WMDR	96.9
Monmouth	WVPC-FM	97.7
Morris	WRMI-FM	104.7
Morrison	WMHS	91.5
Mt. Carmel	WSAB	94.9
	WVMC-FM	101.1
Mt. Vernon	WMIX-FM	94.1
Naperville	WONC	89.1
Normal	WGLT	91.7
Oak Park	WOPA-FM	102.7
Olney	WSEI-FM	92.9
Ottawa	WOLI	98.3
Paris	WPRS-FM	98.3
Park Forest	WRHS	88.1
Park Ridge	WMTH	88.5
Pekin	WSIV-FM	95.3
Peoria	WMBD-FM	93.3
	WIVC	106.9
Pittsfield	WBBA-FM	97.7
Pontiac	WPOK-FM	103.1
Quincy	WGEM-FM	105.1
	WTAD-FM	99.5
	WTAY-FM	100.7
Robinson	WROK-FM	97.5
Rockford	WHBF-FM	98.9
Rock Island	WVIK	90.9
	WRSV	101.9
Skokie	WRWC	103.1
S. Beloit	WTAX-FM	103.7
Springfield	WFMB	104.5
	WVEM	101.9
Sterling	WJVM	94.3
Streator	WIZZ-FM	97.7
Taylorville	WGGM	95.0
	WTIM-FM	92.7
Tuscola	WITT	93.5
Urbana	WILL-FM	90.9
	WPGU	107.1
	WTWC	103.9
Waukegan	WEFA	102.3
Wheaton	WETN-FM	88.1
Winnebago	WRVI	95.3
Winnetka	WNTH	88.1
Woodstock	WSTK	105.5

INDIANA

Angola	WJCC	100.1
Auburn	WIFF-FM	105.5
Bloomington	WFIU	103.7
	WTTV-FM	92.3
Bluffton	WCRD	100.1
Boonville	WBNL-FM	107.1
Columbia City	WFDT	106.3
Columbus	WCSI-FM	98.3
Connersville	WCNB-FM	100.3
Crawfordsville	WNDY	106.3
Decatur	WADM-FM	92.7
Elkhart	WCMR-FM	104.7
	WFIM	100.7
	WXAX	104.7
Elwood	WBMP	101.7
Evansville	WIKY-FM	104.1
	WEVC	91.5
	WPSR	90.7
	WVHI	105.3
Fort Wayne	WPTH	95.1
	WKJG-FM	97.3
Franklin	WFCI	89.3
	WIFN	95.9
Frankfort	WILO-FM	99.7
Gary	WGVE	88.1
Goshen	WGCS	91.1
Greencastle	WGRE	91.7
	WXTA	94.3
Greenfield	WSMJ	99.5
Greensburg	WTRE-FM	107.3
Hammond	WYCA	92.3
Hartford City	WHCI	91.9
	WWHC	104.9
Huntington	WVSH	91.9
	WHLT-FM	103.1
Indianapolis	WAJC	104.5
	WBDG	90.9
	WICR	88.7
	WFBM-FM	94.7
	WFMS	95.5
	WGEE-FM	103.3
	WIAN	90.1
	WIFE-FM	107.9
	WNAP	93.1
	WTLC	105.7
Jasper	WITZ-FM	104.7
Kendallville	WAWK-FM	93.3
Kokomo	WFKO	100.5
	WKMO	93.5
Lafayette	WASK-FM	105.3
	WAZY-FM	96.7
La Porte	WLOI-FM	96.7
Lebanon	WNON	100.9
Logansport	WSAL-FM	102.3
Madison	WORX-FM	96.7
Marion	WMRI-FM	106.9
	WBST	90.7
Martinsville	WCBK-FM	102.3
Michigan City	WMCB-FM	95.9
Monticello	WVTL	95.3
Muncie	WMUN	104.1
	WWHI	91.5
New Albany	WNAS	88.1
New Castle	WCTW-FM	102.5
	WYSN	91.1
N. Manchester	WBKE-FM	89.5
North Vernon	WOCH-FM	106.1
Peru	WARU-FM	98.3
Plainfield	WJMK	98.3
Plymouth	WTCA-FM	94.3
Princeton	WRAY-FM	98.1
Richmond	WGLM	96.1
	WECI	91.5
	WKBV-FM	101.3
Rochester	WROI	92.1
Salem	WSLM-FM	98.9
Scottsburg	WMPI	100.9
Seymour	WJOD	93.7
Shelbyville	WSVL-FM	97.1
South Bend	WETL	91.9
	WHME	103.1
	WNDU-FM	92.9
	WRBR	103.9
	WSBT-FM	101.5
Terre Haute	WTHI-FM	99.9
	WBOW-FM	107.5
	WPFR	102.7
	WVTS	100.7
	WISU	89.7
Wabash	WKUZ	95.9
Warsaw	WRSW-FM	107.3
Washington	WFML	106.5
West Lafayette	WBAA-FM	99.1
W. Terre Haute	WWVR	105.5
Valparaiso	WAKE-FM	105.5
	WVUR	89.5
Vincennes	WAOV-FM	96.7
Winchester	WIUC	98.3

IOWA

Ames	KASI-FM	107.1
	WOI-FM	90.1
	KLFM	104.1
Atlantic	KJAN-FM	103.7
Boone	KFGQ-FM	99.3
Burlington	KBUR-FM	107.3
Carroll	KCIM-FM	93.7
Cedar Falls	KTCF	88.1
Cedar Rapids	KHAK-FM	98.1
	KCOE-FM	90.5
	WMT-FM	98.5
	KRIT	96.9
Clarion	KROS-FM	96.1
Clinton	KRCB-FM	98.5
Council Bluffs	KSIB-FM	101.7
Creston	WOC-FM	103.7
Davenport	KALA	90.1
	KWNT-FM	106.5
Denison	KDSN-FM	107.1
Des Moines	KDPS	88.1
	KDMI-FM	97.3
	WHO-FM	100.3
	KFMG	94.9
	KRNT-FM	102.5
	KWDM	93.3
Dubuque	WDBQ-FM	105.3
	KFMD	92.9
Ft. Dodge	KWMT-FM	94.5
Grinnell	KDIC	107.1
Iowa City	KSUI	91.7
	KXIC-FM	100.7
Iowa Falls	KIFG-FM	95.3
LeMars	KLEM-FM	99.5
Maquoketa	KMAQ-FM	95.3
Marshalltown	KFJB-FM	101.1
Mason City	KLSS	106.1

WHITE'S

RADIO LOG

Location	C.L.	MHz
Mt. Vernon	KRNL-FM	89.7
Muscatine	KWPC-FM	99.7
Newton	KCOB-FM	95.9
Oskaloosa	KBOE-FM	104.9
Pella	KCUI	89.1
Sioux Center	KDCR	91.3
Sioux City	KDVR	97.9
	KTFC	103.3
Spencer	KICD-FM	107.7
Storm Lake	KAYL-FM	101.5
Waterloo	KNWS-FM	101.9
	KWWL-FM	107.9
	KXEL-FM	105.7
Waukon	KNEI-FM	103.9
Waverly	KWAR	89.1

KANSAS

Abilene	KABI-FM	98.3
Baldwin	KNBU	88.9
Dodge City	KGNO-FM	95.5
Emporia	KSTE	88.7
	KVOE-FM	104.9
Garden City	KUPK-FM	97.3
Hutchinson	KSKU	102.1
Independence	KIND-FM	101.7
Junction City	KJCK-FM	94.5
Kansas City	KCJC-FM	98.1
	KCKN-FM	94.1
Larned	KANS-FM	96.7
Lawrence	KANU	91.5
	KLWN-FM	105.9
Leavenworth	KCLO-FM	98.9
Liberal	KJRL	99.3
Manhattan	KSDB-FM	88.1
Newton	KJRG-FM	92.3
Ottawa	KTJO-FM	88.1
	KOFO-FM	95.7
Parsons	KPPS-FM	91.1
Pratt	KWNS-FM	93.1
Russell	KRSL-FM	95.9
Salina	KAFM	99.9
Scott City	KFLA-FM	94.5
Topeka	KTOP	100.3
	KEWI-FM	107.7
	WIBW-FM	97.3
Wichita	KFH-FM	100.3
	KARD	107.3
	KEYN-FM	103.7
	KQTY	101.3
	KMUW	89.1
Winfield	KSWC	88.3

KENTUCKY

Albany	WANY-FM	106.3
Ashland	WCMI-FM	93.7
Beattyville	WLJC	102.3
Benton	WCBL-FM	102.3
Bowling Green	WLBJ-FM	96.7
Campbellsville	WTCO-FM	103.9
Carrollton	WVCM	100.1
Central City	WNES-FM	101.9
Columbia	WAIN-FM	93.5
Corbin	WCTT-FM	107.1
	WYGO-FM	99.3
	WCYN-FM	102.3
Cythiana	WHIR-FM	107.1
Danville	WQXE	106.3
Elizabethtown	WHKK	100.9
Erlanger	WABD-FM	107.9
Ft. Campbell	WSAC-FM	105.5
Ft. Knox	WKYW	104.9
Frankfort	WFUL-FM	104.9
Fulton	WRVG	90.1
Georgetown	WGGC	95.1
Glasgow	WGOH-FM	102.3
Grayson	WKIC-FM	101.1
Hazard	WSON-FM	99.5
Henderson	WHOP-FM	98.7
Hopkinsville	WKOF	100.3
Jamestown	WJRS-FM	103.1
Leitchfield	WMTL-FM	104.9
Lexington	WBKY	91.3
	WLAP-FM	94.5
	WLEX-FM	98.1
	WVLK-FM	92.9
Louisville	WFPK	91.9
	WFPL	89.3
	WHAS-FM	97.5
	WKLO-FM	99.7
	WKRX	106.9
	WLRS	102.3
Madisonville	WFMW-FM	93.9
	WNGO-FM	94.7
Manfordville	WLOC-FM	102.3
Manchester	WWXL-FM	103.1
Maysville	WFTM-FM	95.9
Monticello	WFLW-FM	101.7
Morehead	WMOR-FM	92.1
	WMKY-FM	91.1
Morganfield	WMSK-FM	95.3
Mt. Sterling	WMST-FM	105.5
Murray	WAWW	103.7
Owensboro	WOMI-FM	92.5
	WVJS-FM	96.1
Paducah	WPAD-FM	96.9
	WKYX-FM	93.3
Paintsville	WSIP-FM	100.1
Paris	WPDE-FM	96.7
Pikeville	WPKE-FM	92.1
Prestonburg	WDOC-FM	95.5
	WPRT-FM	105.5
Richmond	WEKU-FM	88.9
Russellville	WRUS-FM	101.1
St. Mathews	WSTM	103.1
Scottsville	WLCK-FM	99.3
Somerset	WSEK	96.7
	WSCC	90.7
Stanford	WRSL-FM	95.9
Whitesburg	WTCW-FM	104.9

LOUISIANA

Alexandria	KALB-FM	96.9
	KDBS-FM	100.3
Ames	KLFM	104.1
Baton Rouge	WJBO-FM	102.5
	WAFB-FM	98.1
	WQXY-FM	100.7
	WYNK-FM	101.5
DeRidder	KDLA-FM	101.7
Golden Meadow	KLEB-FM	94.3
Hammond	WTGI	103.3
Houma	KCIL	107.1
	KHOM	104.1
Jennings	KJEF-FM	92.7
Jonesboro	KTOC-FM	104.9
Lafayette	KRVS-FM	88.3
	KPEL-FM	99.9
	KSMB	94.5
Lake Charles	KPLC-FM	99.5
	KIKS-FM	96.1
La Place	WCKW	92.3
Monroe	KMLB-FM	104.1
	KNOE-FM	101.9
	KREB	106.1
Morgan City	KMRC-FM	96.7
Mt. Vernon	KRNL-FM	105.3
Natchitoches	KNOC-FM	97.7
New Iberia	KNIR-FM	99.1
New Orleans	WBEH	89.3
	WDSU-FM	93.3
	WJMR-FM	97.1
	WRNO	99.5
	WWOM-FM	98.5
	WWMT	95.7
Opelousas	KSLO-FM	107.1
Ruston	KRUS-FM	107.1
Shreveport	KRMD-FM	101.1
	KBCL-FM	96.5
	KEEL-FM	93.7
	KWKH-FM	94.5
Thibodaux	KTIB-FM	106.3
Ville Platte	KVPI-FM	93.5
W. Monroe	KYEA	98.3
Winnfield	KVCL-FM	92.1
Winnsboro	KCRF-FM	95.9

MAINE

Augusta	WFAU-FM	101.3
Bangor	WABI-FM	97.1
	WMEH-FM	90.9
Brunswick	WBOR	91.1
	WCME-FM	98.9
Caribou	WFST-FM	97.7
Ellsworth	WDEA-FM	95.7
Lewiston	WCOU-FM	93.9
	WRJR	91.5
Orono	WMEB-FM	91.9
Portland	WLOB-FM	97.9
	WPOR-FM	101.9
	WGAN-FM	102.9
Rockland	WRKD-FM	93.5
Waterville	WTVL-FM	98.3

MARYLAND

Annapolis	WNAV-FM	99.1
	WXTC	107.9
	WAQE-FM	101.9
Baltimore	WBJC	91.5
	WCAO-FM	102.7
	WFMM-FM	98.1
	WRBS	95.1
	WBAL-FM	97.9
	WITH-FM	104.3
	WMAR-FM	106.5
	WSID-FM	92.3
	WTOW-FM	101.9
Bethesda	WJMD	94.7
	WHFS	102.3
Bradbury Heights	WPGC	95.5
Cambridge	WCEM-FM	106.3
Catonsville	WBMD-FM	105.7
Cumberland	WCUM-FM	102.9
	WKGO	106.1
Frederick	WFMD-FM	99.9
Frostburg	WFRB-FM	105.3
Glen Burnie	WISZ-FM	95.9
Hagerstown	WJEJ-FM	104.7
	WARK-FM	106.9
Halfway	WHAG-FM	96.7
Havre de Grace	WASA-FM	103.7
Oakland	WBUZ	95.5
	WMSG-FM	92.1
Salisbury	WBOC-FM	104.7
	WICO-FM	94.3
Tacoma Park	WGTS-FM	91.9
Waldorf	WSMD-FM	104.1
Westminster	WTTR-FM	100.7

MASSACHUSETTS

Amherst	WAMF	88.1
	WFCR	88.5
	WMUA	91.1
Andover	WPAA	91.7
Boston	WBUR	90.9
	WBCN	104.1
	WBZ-FM	106.7
	WCOP-FM	100.7
	WEEI-FM	103.3
	WERS	88.9
	WHDH-FM	94.5
	WJIB	96.9
	WROR	98.5
Brockton	WBET-FM	97.7
Brookline	WBOS-FM	92.9
Cambridge	WGBH-FM	89.7
	WHRB-FM	95.3
	WTBS	88.1
Fitchburg	WFMP	104.5
Framingham	WKOX-FM	105.7
Gloucester	WVCA-FM	104.9
Greenfield	WHAI-FM	98.3
Haverhill	WHAV-FM	92.5
Hyannis	WCOD-FM	106.1
Lawrence	WCCM-FM	93.7
Lowell	WLLH-FM	99.5
	WLTI	91.5
Lynn	WLWN-FM	101.7
Medford	WHIL-FM	107.9
New Bedford	WBSM-FM	97.3
	WNBH-FM	98.1
N. Adams	WMNB-FM	100.1
Northampton	WHMP-FM	99.3
Pittsfield	WQRB	105.5
	WBRK-FM	101.7
Plymouth	WPLM-FM	99.1
Southbridge	WESO-FM	100.1
S. Hadley	WMHC	88.5
Springfield	WHYN-FM	93.1
	WAIC	91.9
	WCRX	102.1
	WSCB	88.9
	WMAS-FM	94.7
	WRLM	93.3
Taunton	WBRS	91.7
Waltham	WCRB-FM	102.5
W. Yarmouth	WOCB-FM	94.9
Williamstown	WCFM	91.3
Winchester	WHSR-FM	91.9
Worcester	WAAF	107.3
	WSRS	96.1

MICHIGAN

Adrian	WLEN	103.9
	WVAC	88.1
Alma	WFYC-FM	104.9
Alpena	WHSB	107.7
	WATZ-FM	93.5
Ann Arbor	WUOM	91.7
	WOIA-FM	102.9
	WPAG-FM	107.1
Bad Axe	WLEW-FM	92.1
Battle Creek	WKFR-FM	103.3
Bay City	WBCM-FM	96.1
	WNEM-FM	102.5
Benton Hrbr.	WHFB-FM	99.9
Big Rapids	WBRN-FM	100.9
Birmingham	WHFI	94.7
Charlotte	WCER-FM	92.7
Cheboygan	WCBY-FM	105.1
Clare	WCRM-FM	95.3
Coldwater	WANG-FM	98.3
Dearborn	WKNR-FM	100.3
Detroit	WDET-FM	101.9
	WBFG	98.7
	WCHD	105.9
	WABX	99.5
	WDTR	90.9
	WGPM	107.5
	WJBK-FM	93.1
	WMUZ	103.5
	WGPR	97.9
	WJR-FM	96.3
	WOMC-FM	104.3
	WQRS-FM	105.1
	WRMK-FM	98.7
	WWJ-FM	97.1
	WWWW	106.7
	WXYZ-FM	101.1
	WCAR-FM	92.3
E. Lansing	WKAR-FM	90.5
	WITL-FM	100.7
	WSWM	99.1
	WVIC-FM	95.7
Flint	WFBE	95.1
	WGMZ-FM	107.9
	WMRP-FM	105.5
Grand Rapids	WFUR-FM	102.9
	WJFM	93.7
	WLAV-FM	96.9
	WYON	101.3
	WOOD-FM	105.7 (s)
	WVGR	104.1
	WXTO-FM	97.9
	WZZM-FM	95.7
Greenville	WPLB-FM	107.3
Hancock	WMPL-FM	93.5
Hastings	WBCH-FM	100.1
Highland Pk.	WHPR	88.1
Holland	WJBL-FM	94.5
	WHTC-FM	96.1
	WGGL-FM	91.1
Houghton	WJGS	98.5
Houghton Lake	WIAA	88.3
Interlochen	WBBC	94.1
Jackson	WKHM-FM	106.1
Kalamazoo	WMUK	102.1
	WSEO-FM	106.5
Lansing	WJIM-FM	97.5
	WILS-FM	101.7
Lapeer	WTHM-FM	103.1
Marquette	WNMR	90.1
	WDMJ-FM	95.7
Marshall	WALM-FM	96.7
Midland	WQDC-FM	99.7
Monroe	WVMO	98.3
Mount Clemens	WBRB-FM	102.7
Mount Pleasant	WCMU	90.1
	WCEN-FM	94.5
Muskegon	WFFM	106.9
Niles	WNIL-FM	95.3
Oak Park	WLDM	95.5
Owosso	WOAP-FM	103.9
Petoskey	WJML	98.9
	WMBN-FM	96.7
Port Huron	WHLS-FM	107.1
Royal Oak	WOAK	89.3
	WOMC	104.3
Saginaw	WSAM-FM	98.1
	WSBM	106.3
	WWWS	107.1
St. Johns	WRBJ-FM	92.1
St. Joseph	WSJM-FM	107.1
Sandusky	WMIC-FM	97.7
Southfield	WSHJ	88.3
Spring Arbor	WSAE	89.3
Sturgis	WSTR-FM	103.1
Traverse City	WLDR-FM	101.9
	WCCW-FM	92.1
	WTCM-FM	103.5
Waterford	WTSD	88.1
Warren	WPHS	91.5
Ypsilanti	WEMU	88.1

MINNESOTA

Alexandria	KXRA-FM	92.7
Austin	KAUS-FM	99.9
Anoka	KTWN	107.9
Blue Earth	KBEW-FM	100.9
Brainerd	KLIZ-FM	95.9
Breckenridge	KKWB	101.7
Collegeville	KSJR-FM	90.1
Duluth	WDIO-FM	94.9
Faribault	KDHL-FM	95.9
Fergus Falls	KBRF-FM	103.3
Fosston	KEHG-FM	107.1
Golden Valley	KQRS-FM	92.5
Hibbing	WMFG-FM	106.3
Hutchinson	KDUZ-FM	107.1
Litchfield	KLFD-FM	95.3
Mankato	KMSO	90.5
	KEYC-FM	99.1
	KYSM-FM	103.5
Marshall	KMHL-FM	100.1
Minneapolis-St. Paul		
	KTIS-FM	98.5
	WLOL-FM	99.5
	KNOF	95.3
	KTCR-FM	97.1
	WPBC-FM	101.3
	WAYL	93.7
	WCTS-FM	100.3
Moorhead	KVOX-FM	99.9
	KCCM-FM	91.1
	KQWB-FM	98.7
New Brighton	KSJN-FM	91.1
New Ulm	KNUJ-FM	93.1
Northfield	WCAL-FM	89.3
Owatonna	KRFO-FM	104.9
Park Rapids	WPRM-FM	103.7
Pipestone	KKLP	98.7
Red Wing	KCUE-FM	105.5
Richfield	WPBC-FM	101.3
Rochester	KROC-FM	106.9
	KNCV	101.7
	KNXR	97.5
	KOLM-FM	96.7
St. Cloud	KFAM-FM	104.7
	WJON-FM	101.7
	KVSC	88.5
St. Louis Park	KRSI-FM	104.1
St. Paul	KEEY	102.1
	KSTP-FM	94.5
St. Peter	KRBI-FM	105.5
Wadena	KKWS	105.9
Wilmar	KWLM-FM	102.5
	KWOA-FM	95.1

MISSISSIPPI

Biloxi	WBIL	106.3
Cleveland	WDSK-FM	92.7

Location	C.L.	MHz
Columbia	WFFF-FM	96.7
Columbus	WMBC-FM	103.1
Corinth	WKCU-FM	94.3
	WWTX	95.3
Forest	WQST	92.5
Greenville	WGVM-FM	100.7
Greenwood	WSWG	99.1
Gulfport	WROA-FM	107.1
Hattiesburg	WHSY-FM	104.5
	WFOR-FM	103.7
Houston	WCPC-FM	93.3
Indianola	WNLA-FM	105.5
Jackson	WJDX-FM	102.9
	KFXM	95.5
	WJMI	99.7
	WSLI-FM	96.3
	WWHO	94.7
Kosciusko	WKOZ-FM	105.1
Laurel	WNSL-FM	100.3
Louisville	WLSM-FM	107.1
Magee	WSJC-FM	107.5
McComb	WCCA	105.7
Meridian	WMMI	88.1
	WOKK-FM	97.1
Moss Point	WCIS-FM	104.9
Natchez	WQNZ	95.1
New Albany	WNAU-FM	103.5
Oxford	WOOR	97.5
Pascagoula	WPMP-FM	99.1
Poplarville	WRPM-FM	107.9
Pontotoc	WSEL-FM	96.7
Starkville	WSMU-FM	106.3
Tupelo	WELO-FM	98.5
Vicksburg	WQMV	98.7
Yazoo City	WJNS-FM	92.1

MISSOURI

Aurora	KSWM-FM	100.1
Bolivar	KLTB	106.3
Buffalo	KBFL	90.3
Cape Girardeau	KZYM-FM	102.9
Carrollton	KAOL-FM	101.1
Clayton	KFUO-FM	99.1
	KHRU	88.1
Columbia	KWWC-FM	90.5
	KBIA-FM	91.3
	KTGR-FM	96.7
Crestwood	KSHE	94.7
El Dorado Springs	KESM-FM	101.7
Hannibal	KGRC	92.9
Houston	KBTC-FM	99.3
Joplin	WMBH-FM	96.1
	KOBC	91.1
	KSYN	92.5
Kansas City	KFMU	94.9
	KBEY	104.3
	KTSR	90.1
	WDAF-FM	102.1
	KCAR-FM	89.3
	KMBR-FM	99.7
	KPRS-FM	103.5
	KXTR	96.5
	KWKI	93.3
Kennett	KBOA-FM	98.9
Kirksville	KRXL	103.5
Marshall	KMFL-FM	102.9
	KNOX	91.7
Mexico	KWWR-FM	95.7
Moberly	KRES	104.7
	KMTS	90.1
Osage Beach	KRMS-FM	93.5
Point Lookout	KSOZ	88.1
Poplar Bluff	KWOC-FM	94.5
Rolla	KCLU-FM	94.3
	KMSM	88.5
St. Charles	KCLC	89.9
Ste. Genevieve	KSGM-FM	105.7
St. Joseph	KUSN-FM	105.1
St. Louis	KCFM	93.7
	KACO	107.7
	KADI	96.5
	WIL-FM	92.3
	KMOX-FM	103.3
	KNDA	102.5
	KRCH	98.1
	KSLH	91.5
	KRFD	106.9
Sedalia	KSIS-FM	92.1
Springfield	KTTS-FM	94.7
	KTXR	101.5
	KWFC	97.3
	KWTO-FM	98.7
	KLPW-FM	101.9
Waynesville	KFBD-FM	97.7
	KJPW-FM	102.3
West Plains	KWPM-FM	93.9

MONTANA

Belgrade	KGVW-FM	96.7
Billings	KURL-FM	97.1
Bozeman	KGLT	90.1
Great Falls	KOPR-FM	106.3
Hamilton	KLYQ-FM	95.9
Missoula	KUFM	88.1
Plentywood	KPWD	100.1

NEBRASKA

Aurora	KROA	103.1
Beatrice	KWBE-FM	92.9
Columbus	KJSK-FM	101.1
Hastings	KICS-FM	93.5
Kearney	KOVF-FM	91.3
Kearney-Holdrege	KRNY-FM	98.9
Lexington	KRUN-FM	93.1
Lincoln	KFMQ	95.3
	KLIN-FM	107.3
	KUCV	91.3
	KWHG	102.7
Omaha	KFAB-FM	99.9
	KGBI-FM	100.7
	KIOS-FM	90.9
	KOIL-FM	96.1
	KOZN	94.1
	WOW-FM	92.3
Scottsbluff	KNEW-FM	94.1
York	KAWL-FM	104.9

NEVADA

Carson City	KRWL-FM	97.3
Fallon	KVLV-FM	99.3
Las Vegas	KORK-FM	97.1
	KRGN	101.9
	KLUC-FM	98.5
	KULA	92.3
Reno	KNEV	95.5
	KUNR	88.1
	KSRN	104.5

NEW HAMPSHIRE

Berlin	WMOU-FM	103.7
Claremont	WTSV-FM	106.1
Conway	WBNC-FM	93.5
Durham	WUNH	90.3
Exeter	WPEA	90.1
Laconia	WLNH-FM	98.3
Keene	WKNE-FM	103.7
Manchester	WKBR-FM	95.7
	WGIR-FM	101.1
Mt. Washington	WMTW-FM	94.9
Nashua	WOTW-FM	106.3
Portsmouth	WPFM	100.3

NEW JERSEY

Asbury Park	WJLK-FM	94.3
	WHTG-FM	105.5
Atlantic City	WFPG-FM	96.9
	WMGM	103.7
	WRNJ	95.1
Bridgeton	WSNJ-FM	107.7
Camden	WKDN-FM	106.9
Cape May	WRIO-FM	99.7
Dover	WDHA-FM	105.5
E. Orange	WFMU	91.1
Eatontown	WHTG-FM	106.3
Franklin	WLVP	102.3
Franklin Lakes	WRRH	88.7
Glassboro	WGLS-FM	89.7
Hackettstown	WNTI	91.9
Hanover	WHPH	90.3
Long Branch	WRLB	107.1
Millville	WMVB-FM	97.3
Newark	WHBI	105.9
	WFME	94.7
	WVNJ-FM	100.3
	WBGO	88.3
New Brunswk.	WCTC-FM	98.3
Newton	WIXL-FM	103.7
Paterson	WPAT-FM	93.1
Point Pleasant	WADB	95.9
Princeton	WPRB	103.3
Red Bank	WFHA-FM	106.3
South Orange	WSOU	89.5
Toms River	WOBM	92.7
Trenton	WBJH	101.5
	WCHR	94.5
	WTOA	97.5
	WTSR	89.7
Wildwood	WCMC-FM	100.7
Zarephath	WAWZ-FM	99.1

NEW MEXICO

Alamogordo	KXXI	94.3
Albuquerque	KANW	89.1
	KBNM	99.5
	KDEF-FM	94.1
	KRST	92.3
	KHFM	96.3
	KOAT-FM	100.3
	KOB-FM	93.3
	KUNM	90.1
Artesia	KSVP-FM	92.9
Carlsbad	KCNM	92.1
Clovis	KTQM-FM	99.9
	KMTY-FM	99.1
Hobbs	KHOB-FM	95.7
Los Alamos	KRSN-FM	98.5
Las Cruces	KGRD-FM	103.9
Las Vegas	KEDP	91.1
Lovington	KLEA-FM	101.7
Portales	KENW-FM	88.9
Roswell	KBIM-FM	94.9
Santa Fe	KAFE-FM	97.3
	KSNM	95.5
Taos	KKIT-FM	99.3
Tucumcari	KTNM-FM	92.7
University Park	KRWG	91.7

NEW YORK

Albany	WAMC	90.3
	WDKC	106.5
	WHRL	103.1
	WROW-FM	95.5
Auburn	WMBO-FM	106.9
Babylon	WTFM	103.5
	WBAB-FM	102.3
Binghamton	WNBF-FM	98.1
	WHRW	90.5
	WKOP-FM	99.1
Baldwinsville	WSEN-FM	92.1
Brooklyn	WNYE	91.5
Brookville	WCWP	88.1
Buffalo	WBEN-FM	102.5
	WADV	106.5
	WDCX	99.5
	WBFO	88.7
	WBUF	93.3
	WEBR	94.5
	WGR-FM	96.9
	WWOL-FM	104.1
	WYSL-FM	103.3
	WBNY-FM	96.1
Canton	WSLU	96.7
Central Square	WCSQ	89.3
Cherry Valley	WJIV	101.9
Clinton	WHCL-FM	88.7
Corning	WCLI-FM	106.1
Cortland	WKRT-FM	99.9
Depew	WBLK-FM	93.7
DeRuyter	WOIV	105.1
Dundee	WFLR-FM	95.9
Elmira	WECW	88.1
	WEHH-FM	94.3
	WENY-FM	92.7
Endicott	WENE-FM	105.5
Floral Park	WSHS	90.3
Garden City	WLIR	92.7
Geneseo	WGSU	89.3
Glen Falls	WWSC-FM	95.9
	WXQL	107.1
Gouverneur	WIGS-FM	92.7
Hempstead	WHLI-FM	98.3
	WVHC	88.7
Hornell	WHHO-FM	105.3
Hudson	WHUC-FM	93.5
Ithaca	WHCU-FM	97.3
	WICB	91.7
	WEIV	103.7
	WVBR-FM	93.5
Jamestown	WJTN-FM	93.3
	WKSN-FM	101.7
Johnstown	WIZR-FM	104.9
Kenmore	WYSL-FM	103.3
Kingston	WGHQ-FM	94.3
	WNDN	97.7
Lake Ronkonkoma	WSHR	89.7
Lake Success	WTFM	103.5
Liberty	WVOS-FM	95.9
Loudonville	WVCR-FM	89.1
Middletown	WALL-FM	92.7
Mt. Kisco	WRNW	107.1
	WVIP-FM	106.3
Newburgh	WFMN	103.1
New Rochelle	WVOX-FM	98.5
New York	WABC-FM	95.5
	WBAI	99.5
	WCBS-FM	101.1
	WEVD-FM	97.9
	WFUV	90.7
	WHOM-FM	92.3
	WKCR-FM	89.9
	WLIB-FM	107.5
	WNCN	104.3
	WNEW-FM	102.7
	WNBC-FM	97.1
	WNYC-FM	93.9
	WNYE	91.5
	WOR-FM	98.7
	WPIX-FM	101.9
	WQXR-FM	96.3
	WRFM	105.1
	WRVR	106.7
Niagara Falls	WHLD-FM	98.5
Norwich	WCHN-FM	93.9
Olean	WHDL-FM	95.7
Oswego	WOSE	104.9
	WRVO	89.9
Plattsburg	WEAV-FM	99.9
Patchogue	WALK-FM	97.5(s)
	WPAC-FM	106.1
	WLNA-FM	100.7
Potsdam	WTSC-FM	91.1
	WPDM-FM	99.3
Poughkeepsie	WSPK	104.7
	WEOK-FM	101.5
Riverhead	WHRF-FM	103.9
Rochester	WHFM	98.9
	WBFB	92.5
	WCMF	96.5
	WIRQ	90.9
	WNYR-FM	101.3
	WROC-FM	97.9
	WRUR-FM	90.1
	WVOR	100.5
Sag Harbor	WLNG-GM	92.1
Saratoga Springs	WKAJ-FM	102.3
Schenectady	WGFM	99.5
Seneca Falls	WSEF-FM	99.3
Smithtown	WGSM	94.3
South Bristol	WMIV	95.1
Springville	WSPE	88.1
Syracuse	WAER	88.1
	WDDS-FM	93.1
	WONO	107.9
	WSYR-FM	94.5
Troy	WFLY	92.3
	WRPI	91.5
Utica	WRUN-FM	105.7
	WIBQ-FM	94.9
	WOUR	96.9
Wethersfield Township	WBIV	107.7
White Plains	WFAS-FM	103.9

NORTH CAROLINA

Ahoskie	WRCS-FM	99.3
Albemarle	WABZ-FM	100.9
Asheboro	WGWR-FM	92.3
Asheville	WLOS-FM	104.3
Bridgeton	WVWB-FM	97.7
Black Mountain	WMIT	106.9
Burgaw	WPGF-FM	99.9
Burlington-Graham	WBAG-FM	93.9
	WBBB-FM	101.1
Chapel Hill	WUNC	91.5
Charlotte	WBT-FM	107.9
	WRNA	95.1
	WSOC-FM	103.7
	WYFM	104.7
Clingman's Pk.	WMIT	106.9
Clinton	WRRZ-FM	107.1
Concord	WEGO-FM	97.9
Durham	WDNC-FM	105.1
	WSRC-FM	107.1
Elkin	WIFM-FM	100.9
Fayetteville	WQSM	98.1
Forest City	WBBO-FM	93.3
	WAGY-FM	105.3
Franklin	WFSC-FM	96.7
Gastonia	WGNC-FM	101.9
Goldsboro	WEQR	96.9
Greensboro	WMDE	98.7
	WQMG-FM	97.1
	WUAG	89.9
Greenville	WNCT-FM	107.7
Grifton	WITN-FM	93.3
Henderson	WHNC-FM	92.5
	WHKP-FM	102.5
Hendersonville	WHKP-FM	102.5
Hickory	WHKY-FM	102.9
	WXRC	95.7
High Point	WHPE-FM	95.5
	WMFR-FM	99.5
	WNOS-FM	100.3
Jacksonville	WRCM	92.1
	WXQB-FM	105.5
Kannapolis	WRKB-FM	99.7
Kinston	WRNS	95.1
Laurinburg	WSTS	96.5
Leaksville	WEAF	94.5
Lexington	WBUY-FM	94.3
Lumberton	WTSB-FM	95.7
	WJSK	102.3
North Wilkesboro	WKBC-FM	97.3
Raleigh	WKIX-FM	96.1
	WKNC-FM	88.1
	WPTF-FM	94.7
	WRAL-FM	101.5
	WSHA	88.9
Reidsville	WWMO-FM	102.1
Rocky Mount	WEED-FM	92.1
	WFMA	100.7
Rochester	WVOR	92.5
Roxboro	WRXO-FM	96.7
Salisbury	WSTP-FM	106.5
Sanford	WWGP-FM	105.5
Shelby	WOHS-FM	96.1
Statesville	WFMX	105.7
Tabor City	WTAB-FM	104.9
Tarboro	WCPS-FM	104.3
Thomasville	WTNC-FM	98.3
Washington	WITN-FM	93.3
Williamston	WIAM	103.7
Wilmington	WPRV	98.9
	WFOG	102.7
	WHSL-FM	97.3
Wilson	WVOT-FM	106.1
Winston-Salem	WAAA-FM	107.5
	WFDD-FM	88.5
	WEPL	93.1
	WSJS-FM	104.1

NORTH DAKOTA

Bismarck	KFYR-FM	92.9
	KBMR-FM	94.5
Devils Lake	KDLR-FM	96.7
Fargo	KFNW-FM	97.9
	WDAY-FM	93.7
	KDSU	91.9
Grand Forks	KVBC	94.7
Jamestown	KSJM	93.3
	KKND	95.5
Minot	KCJB-FM	97.1

OHIO

Akron	WAKR-FM	97.5
	WAPS	89.1
	WAUP	88.1

WHITE'S RADIO LOG

Location	C.L.	MHz
	WCUE-FM	96.5
Alliance	WFAH-FM	101.7
Archbold	WHFD	95.9
Ashland	WNCO-FM	101.3
	WRDL	88.1
Ashtabula	WREO-FM	97.1
Athens	WOUB-FM	91.3
	WATH-FM	105.5
Bellaire	WOMP-FM	100.5
Berea	WBWC	88.3
Bowling Green	WAWR-FM	93.5
	WBGU	88.1
Bryan	WWMS-FM	100.7
Bucyrus	WBCO-FM	92.7
Cambridge	WILE-FM	96.7
Canton	WHBC-FM	94.1
	WNYN-FM	106.9
	WTOF	98.1
Cedarville	WCDR-FM	90.1
Celina	WMER-FM	94.3
	WCSM-FM	96.7
Chillicothe	WBEX-FM	98.3
Cincinnati	WAEF	98.5
	WCPO-FM	105.1
	WEBN-FM	102.7
	WAKW	93.3
	WGUC	90.9
	WKRC-FM	101.9
	WZIP-FM	92.5
Circleville	WNRE	104.9
Cleveland	WBOE	90.3
	WCRF-FM	103.3
	WCLV	95.5
	WDOK	102.1
	WERE-FM	98.5
	WGAR-FM	99.5
	WCJW	104.1
	WKYC-FM	105.7
	WMMS	100.7
	WNOB	107.9
	WRUW-FM	91.1
	WXEN	106.5
	WZAK	93.1
Cleveland Hts.	WCUY-FM	92.3
Columbus	WCBE	90.5
	WBNS-FM	97.1
	WBUK	96.3
	WCOL-FM	92.3
	WMNI-FM	99.7
	WNCI	97.9
	WOSU-FM	89.7
	WSPO	94.7
	WFIZ	105.5
Conneaut	WTNS-FM	99.3
Coshocton	WHIO-FM	99.1
Dayton	WONE-FM	104.7
	WDAO	107.7
DeGraff	WDEQ-FM	91.1
Delaware	WSLN	88.7
Dover	WJER-FM	101.7
E. Liverpool	WRTS	104.3
Eaton	WCTM	92.9
Elyria	WBEA	107.3
Fairfield	WCNW-FM	94.9
Findlay	WFIN-FM	94.9
Fostoria	WFOB	96.7
Fremont	WFRO-FM	99.1
Gallipolis	WJEH-FM	101.5
Granville	WDUB	90.9
Greenville	WDRK-FM	106.5
Hamilton	WQMS	96.7
	WHOH	103.5
Hillsboro	WSRW-FM	106.7
Holland	WPDS-FM	102.3
Kent	WKSU	89.7
	WKNT-FM	100.1
Kenton	WKTN-FM	98.3
Kettering	WVUD-FM	99.9
Lancaster	WHOK-FM	95.5
Lima	WIMA-FM	102.1
	WTGN	97.7
Logan	WLGN-FM	98.3
London	WLNO	106.3
Mansfield	WVNO	106.1
	WCLW-FM	105.3
Marietta	WCMO	89.3
	WMOA-FM	94.3
Marion	WMRN-FM	106.9
Medina	WDBN	94.9
Miamisburg	WFCJ	98.9
Middletown	WPFB-FM	105.9
Mt. Vernon	WMVO-FM	93.7
New Concord	WMCO	90.7
Newark	WCLT-FM	100.3
New Philadelphia	WNPQ	95.5
Norwalk	WLKR-FM	95.3
Oberlin	WOBC	88.7
Oxford	WMUB	88.5
	WOXR	97.7
Piqua	WPTW-FM	95.7
Port Clinton	WRWR-FM	94.5
Portsmouth	WPAY-FM	104.1
	WNXT-FM	99.3
Salem	WSOM-FM	105.1
Sandusky	WLEC-FM	102.7
Sidney	WMVR-FM	105.5
Springfield	WBLY-FM	103.9
	WEEC-FM	100.7
	WUSO	89.1
Steubenville	WSTV-FM	103.5
Struthers	WKTL	90.7
Sylvania	WGLN	105.5
Tiffin	WTTF-FM	103.7
Toledo	WSPD-FM	101.5
	WCWA-FM	104.7
	WKLR	99.9
	WMHE	92.5
Urbana	WCOM-FM	101.7
Van Wert	WERT-FM	98.9
Wapakoneta	WERM	92.1
Washington Court House	WCHO-FM	105.5
Westerville	WOBN	91.5
	WBBY	103.9
Wilberforce	WCSU-FM	88.9
Wooster	WWST-FM	104.5
	WCWS	91.9
Worthington-Columbus	WRFD-FM	97.9
Xenia	WHBM-FM	103.9
	WBZI	95.3
Yellow Springs	WYSO	91.5
Youngstown	WKBN-FM	98.9
	WBBW-FM	99.3
	WRED	101.1
Zanesville	WHIZ-FM	102.5

OKLAHOMA

Bethany	KNBQ	104.9
Chickasha	KNDR	105.5
Durant	KSEO-FM	107.3
Edmond	KWHB	97.7
	KCSC	90.1
Enid	KCRC-FM	96.9
Eufaula	KCES	102.3
Henryetta	KHEN-FM	99.5
Lawton	KLAW	101.5
McAlester	KNED-FM	101.3
Midwest City	KTEA-FM	92.5
Muskogee	KMMM-FM	106.9
Nowata	KNFB	94.3
Oklahoma City	KOKH	88.9
	KEBC	94.7
	KIOO	100.5
	KJEM-FM	102.7
	KOCY-FM	96.1
	KOFM	104.1
	KFNB	101.9
Ponca City	KLOR-FM	99.3
Poteau	KLCO-FM	98.3
Shawnee	KBGC	89.9
Stillwater	KOSU-FM	91.7
	KSPI-FM	93.9
	KVRO	105.5
Tahlequah	KTLQ-FM	101.7
Tulsa	KWGS	90.5
	KRMG-FM	95.5
	KMOD	97.5
	KOGM-FM	92.9
	KORU	103.3
	KRAV	96.5
Weatherford	KCCE	95.3

OREGON

Aguadilla	WIVA-FM	100.5
Albany	KWIL-FM	107.9
Ashland	KSOR	90.1
Corvallis	KFLY-FM	101.5
	KBVR	90.1
Dalles City	KCIV	104.5
Eugene	KRVM	91.9
	KORE-FM	93.1
	KFMY	97.9
	KLCC	90.3
	KPNW-FM	99.1
	KWAX	91.1
	KBMC	94.5
	KZEL-FM	96.1
Grants Pass	KGPO	96.9
Medford	KBOY-FM	95.3
Oretech	KTEC	88.3
Portland	KBOO	90.7
	KINK	101.9
	KJIB	99.5
	KLIQ-FM	92.3
	KOAP	91.5
	KOIN-FM	101.1
	KPDQ-FM	93.7
	KPFM	97.1
	KPOK	98.5
	KQFM	100.3
	KRRC	89.3
	KXL-FM	95.5

PENNSYLVANIA

Allentown	WFMZ	100.7
	WAEB-FM	104.1
	WMUH	89.7
Altoona	WVAM-FM	100.1
	WFBG-FM	98.1
Beaver Falls	WBVP-FM	106.7
	WGEV	88.3
Bedford	WAKM	100.9
Bellwood	WHGM	103.9
Bethlehem	WGPA-FM	95.1
Bloomsburg	WHLM-FM	106.5
Boyertown	WBYC-FM	107.5
Braddock	WLOA-FM	96.9
Butler	WBUT-FM	97.7
Carbondale	WODL-FM	94.3
Carlisle	WHYL-FM	102.3
Chambersburg	WCHA-FM	95.1 (s)
Charleroi	WESA-FM	98.3
Clearfield	WCPA-FM	93.5
Danville	WPGM-FM	96.7
DuBois	WCED-FM	102.1
Easton	WEST-FM	96.1
	WJRH	90.5
	WEEX-FM	99.9
Ebensburg	WEND-FM	99.1
Elizabethtown	WMSH-FM	106.7
Ellwood City, Pa.	WFEM	92.1
Erie	WWYN-FM	99.9
	WWGO-FM	103.7
Gettysburg	WGET-FM	107.7
Greencastle	WKSL	94.3
Greensburg	WOKU-FM	107.1
Greenville	WGRP-FM	107.1
Grove City	WEDA-FM	95.1
	WSAJ-FM	89.5
Harrisburg	WHP-FM	97.3
	WMSP	94.9
	WSFM	99.3
	WTPA-FM	104.1
Havertown	WHHS	89.3
Hazleton	WAZL-FM	97.9
Huntingdon	WHUN-FM	106.3
Indiana	WQMU	103.1
	WIUP-FM	91.3
Jenkintown	WIBF-FM	103.9
Johnstown	WARD-FM	92.1
	WJAC-FM	95.5
Lancaster	WGAL-FM	101.3
	WDAC	94.5
	WLAN-FM	96.9
Lebanon	WLBR-FM	100.1
Lewisburg	WVBU-FM	90.5
Lewiston	WMRF-FM	95.9
Lock Haven	WBPZ-FM	92.1
Mansfield	WNTE	89.5
Martinsburg	WJSM-FM	92.7
Meadville	WARC	90.3
	WMGW-FM	100.3
Media	WXUR-FM	100.3
Milton	WMLP-FM	100.9
Montrose	WPEL-FM	96.5
New Kensington-Tarentum	WYDD	100.7
New Wilmington	WKPS	88.9
North East	WHYP-FM	100.9
Oil City	WDJR	98.5
Palmyre	WRLC	92.1
Philadelphia	WCAU-FM	98.1
	WPBS-FM	105.3
	WDAS-FM	105.3
	WRCP-FM	104.5
	WFIL-FM	102.1
	WDVR	101.1
	WFLN	95.7
	WUHY-FM	90.9
	WIFI	92.5
	WIBG-FM	94.1
	WMMR	93.3
	WPEN-FM	102.9
	WPWT	91.7
	WQAL	106.1
	WRTI-FM	90.1
	WWDB	96.5
	WXPN	88.9
Pittsburgh	KDKA-FM	92.9
	WAMO	105.5
	WEEP-FM	107.9
	WTAE-FM	96.1
	KQV-FM	102.5
	WDUQ	91.5
	WJAS-FM	99.7
	WKJF	93.7
	WPIT-FM	101.5
	WWSW-FM	94.5
	WYDD	104.7
Pottsville	WPPA-FM	101.9
Reading	WRFY-FM	102.5
	WXAC	91.3
Red Lion	WGCB-FM	96.1
Ridgeway	WKBI-FM	94.3
Scranton	WGBI-FM	101.3
	WEJL-FM	107.1
	WUSV	88.9
	WWDL-FM	104.9
Selinsgrove	WQSU	91.5
Sharon	WPIC-FM	102.9
Somerset	WVSC-FM	97.7
South Williamsport	WMPT-FM	99.3
State College	WMAJ-FM	103.1
	WDFM	91.1
	WQWK	96.7
Stroudsburg	WVPO-FM	93.5
Sunbury	WKOK-FM	94.1
Tamaqua	WSVB	105.5
Telford	WBMR	89.7
Towanda	WTTC-FM	95.3
Tyrone	WGMR-FM	102.3
Union City	WBVB	106.3
Uniontown	WPQR-FM	98.5
University Park	WDFM	91.1
Warren	WRRN	92.3
Washington	WJPA-FM	95.3
Waynesboro	WAYZ-FM	101.5
Wellsboro	WGCR-FM	97.7
Wilkes-Barre	WBRE-FM	98.5
	WRKC	88.5
	WYZZ	92.9
Williamsport	WLYC-FM	105.1
	WRAK-FM	100.3
York	WNOW-FM	105.7
	WSBA-FM	103.3
York-Hanover	WYCR	98.5

RHODE ISLAND

Kingston	WRIU	91.1
Providence	WPJB-FM	105.1
	WBRU	95.5
	WDOM	91.3
	WICE-FM	107.7
	WHIM-FM	94.1
	WLKW-FM	101.5
	WPRO-FM	92.3
Westerly	WERI-FM	103.7
Woonsocket	WWON-FM	106.3

SOUTH CAROLINA

Aiken	WLOW-FM	95.9
	WAKN-FM	99.3
Anderson	WCAC	101.1
	WANS-FM	107.3
Bamberg	WWBD-FM	92.7
Barnwell	WBAW-FM	101.7
Batesburg	WBLR-FM	92.1
Beaufort	WBEU-FM	98.7
Charleston	WCSC-FM	96.9
	WTMA-FM	95.1
	WSBF-FM	89.3
Clemson	WCOS-FM	97.9
Columbia	WNOK-FM	104.7
	WUSC-FM	89.9
Conway	WLAT-FM	104.1
Darlington	WDAR-FM	105.5
Dillon	WDSC-FM	92.9
Due West	WARP	91.7
Easley	WELP-FM	103.9
Florence	WSTN	103.1
Greenville	WESC-FM	92.5
	WFBC-FM	93.7
	WMUU-FM	94.5
Greenwood	WCRS-FM	96.7
Kingstree	WDKD-FM	100.1
Lancaster	WLCM-FM	107.1
Laurens-Clinton	WLBG-FM	100.5
Myrtle Beach	WMYB-FM	92.1
N. Charleston	WKTM	102.5
Orangeburg	WDIX-FM	106.7
Rock Hill	WRHI-FM	98.3
Seneca	WBFM	98.1
Spartanburg	WSPA-FM	98.9
Sumter	WFIG-FM	101.3
Walterboro	WALD-FM	100.9

SOUTH DAKOTA

Brookings	KBRK-FM	101.7
	KESD	88.3
Hot Springs	KOBH-FM	96.7
Madison	KJAM-FM	103.1
Rapid City	WVSR	97.9
Sioux Falls	KELO-FM	92.5
	KCHF-FM	93.5
	KNWC-FM	96.5
	KSOO-FM	97.3
Vermillion	KUSD-FM	89.9
	KVRF	102.3
Watertown	KDLO-FM	95.3
	KWAT-FM	96.1

TENNESSEE

Bristol	WOPI-FM	96.9
Brownsville	WBHT-FM	95.3
Chattanooga	WDOD-FM	96.5
	WDYN	89.7
	WLOM	106.5
	WDEF-FM	92.3
	WVMS	88.9
Cleveland	WCLE-FM	100.7
Clinton	WYSH-FM	104.9
Collegedale	WSMC	90.7
Columbia	WYFY-FM	101.7
Cookeville	WHUB-FM	98.3
	WPTN-FM	94.3
Covington	WKBL-FM	93.5
Crossville	WAEW-FM	99.3
Dickson	WDKN-FM	102.3
Dyersburg	WTRO-FM	100.1
Elizabethton	WLSN	99.3
Erwin	WXIS	103.9
Franklin	WFLT-FM	100.1
Gallatin	WFMG	104.5
Greeneville	WOFM	94.9
Henderson	WFHC-FM	91.5
Humboldt	WIRJ-FM	102.3
Jackson	WTJS-FM	104.1
Jamestown	WDEB-FM	100.1
Johnson City	WJCW-FM	101.5
Kingsport	WKPT-FM	98.5

Location	C.L.	MHz
Knoxville	WBIR-FM	93.5
	WEZK	97.5
	WIVK-FM	107.7
	WKCS	91.1
	WUOT	91.9
Lawrenceburg	WDXE-FM	95.9
Lebanon	WFMQ	91.3
Lenoir City	WLIL-FM	93.5
Lewisberg	WJJM-FM	94.3
Lexington	WDXL-FM	99.3
Livingston	WLIV-FM	95.9
Manchester	WMSR-FM	99.7
Marshall	KMHL-FM	100.1
Martin	WCMT-FM	101.7
McKenzie	WKTA	106.9
McMinnville	WHNR	103.9
Memphis	WMC-FM	99.7
	WCBC	91.1
	WHBQ-FM	105.9
	KLYX	101.1
	WMPS-FM	97.1
	WREC-FM	102.7
	WTCV	104.5
Milan	WKBJ-FM	92.3
Morristown	WMTN-FM	95.9
Murfreesboro	WMTS-FM	96.3
	WMOT	89.5
Nashville	WLAC-FM	105.9
	WKDA-FM	103.3
	WPLN	90.3
	WNAZ-FM	88.9
	WSET	92.9
	WSIX-FM	97.9
	WSM-FM	95.5
	WATO-FM	94.3
Oak Ridge	WATO-FM	94.3
Oneida	WBNT-FM	105.5
Paris	WTPR-FM	105.5
Savannah	WORM-FM	101.9
Sevierville	WSEV-FM	102.1
Sparta	WSMT-FM	105.5
Springfield	WDBL-FM	94.3
Sweetwater	WDEH-FM	95.3
Tullahoma	WJIG-FM	93.3

TEXAS

Abernathy	KWGO-FM	99.5
Abilene	KACC-FM	91.1
	KFMN	99.3
	KWKC-FM	105.1
Amarillo	KGNC-FM	93.1
	KDJW-FM	94.1
Austin	KHFI-FM	98.3
	KASE	100.7
	KMFA	89.5
	KOKE-FM	95.5
	KTBC-FM	93.7
	KUT-FM	90.7
Beaumont	KHCB-FM	105.7
	KAYD-FM	97.5
	KBPO	94.1
	KTRM-FM	95.1
	KJET-FM	107.7
Big Spring	KFNE	95.3
Brenham	KWHI-FM	106.3
Brownwood	KFRN-FM	99.3
Bryan	KORA-FM	98.3
Clear Lake City	KMSC	102.1
Cleburne	KFAD	94.9
College Station	WTAW-FM	92.1
Conroe	KNRQ	106.9
	KNRO-FM	106.5
Corpus Christi	KZFM	95.5
	KIOU	96.5
	KSIX-FM	93.9
Dalhart	KXIT-FM	94.3
Dallas	KIXL-FM	104.5
	KEIR	102.9
	KNUS	98.7
	KRLD-FM	92.5
	WFAA-FM	97.9
	WRR-FM	101.1
	KVTT	91.7
	KXXK	105.3
	KBOX-FM	100.3
Del Rio	KDLK-FM	94.3
Denison-Sherman	KDSX-FM	101.7
Denton	KDNT-FM	106.1
DiBoll	KSPL-FM	95.5
Dumas	KDDD-FM	95.3
El Campo	KULP-FM	96.9
El Paso	KTEP	88.5
	KPAK	94.7
	KTSM-FM	99.9
Ft. Worth	WBAP-FM	96.3
	KBUY-FM	93.9
	KCWM	99.5
	KFJZ-FM	97.1
	KFWT-FM	102.1
	KNOK-FM	107.5
	KTCU-FM	89.1
Gainesville	KGAF-FM	94.5
Galveston	KGBC-FM	106.5
Harlingen	KELT	94.5
Henderson	KGRI-FM	100.1
Hereford	KPAN-FM	106.3
Highland Park-Dallas	KVIL-FM	103.7
Hillsboro	KHBR-FM	102.3
Houston	KHCB-FM	105.7
	KIKK-FM	95.7
	KILT-FM	100.3
	KFMK	97.9
	KODA-FM	99.1
	KLEF	94.5
	KQUE	102.9
	KRBE	104.1
	KXYZ-FM	96.5
	KTRH-FM	101.1
	KUHF	91.3
	KBNO	93.7
Humboldt	WIRJ-FM	102.3
Huntsville	KSAM-FM	101.7
Jacksonville	KEBE-FM	106.5
Jasper	KTXJ-FM	102.3
Killeen	KLEN-FM	93.3
Lake Jackson	KLJT	107.3
Lamesa	KELE	100.3
Longview	KLUE-FM	105.7
Lubbock	KSEL-FM	93.7
	KBFM	96.3
	KLBK-FM	94.5
	KTXT-FM	91.9
Marshall	KMHT-FM	97.3
McAllen	KQXX	98.5
McKinney	KAWB	95.3
Midland	KNFM	92.3
Mt. Pleasant	KIMP-FM	100.7
Muleshoe	KMUL-FM	103.1
Nacogdoches	KSFA-FM	92.1
	KEFM	103.3
New Braunfels	KNBT	92.1
Odessa	KQIP	96.7
	KOCV	91.3
	KOYL-FM	97.9
Paris	KPLT-FM	99.3
Pasadena	KLVL-FM	92.5
Plainview	KHBL	88.1
Port Arthur	KFMP	93.3
	KPAC-FM	98.5
Robstown	KROB-FM	99.9
Rosenberg	KFRD-FM	104.9
San Angelo	KWLW	93.9
	KSJT	97.5
San Antonio	KISS	99.5
	KBER-FM	100.3
	KEEZ	97.3
	KAKI-FM	98.1
	KITY	92.9
	KMFM	96.1
	KWFR-FM	94.5
	KCOR-FM	101.9
	KITE-FM	104.5
	KSYM-FM	90.3
Sherman	KSHN	96.7
Sinton	KTOD-FM	101.3
	KCTA-FM	103.3
Spearman	KBMF-FM	98.3
Stephenville	KWWM	98.3
Temple	KYLE-FM	104.9
Terrell Hills	KBUC-FM	106.3
Texarkana	KTAL-FM	97.9
	KOSY-FM	102.5
Tyler	KZAK-FM	93.1
	KNUE	101.5
Victoria	KTXN-FM	95.1
Waco	KEFC	95.5
	KWTX-FM	97.5
	KWBU	89.9
Wichita Falls	KLUR	99.9
	KNTO	95.1

UTAH

Cedar City	KCDR-FM	88.1
Ephraim	KEPH	88.9
Logan	KUSU-FM	91.5
Ogden	KBOC	101.9
	KWCR-FM	88.1
Provo	KBYU-FM	88.9
	KFMC	96.1
Salt Lake City	KCPX-FM	98.7
	KQMU	94.1
	KRSP-FM	103.5
	KSL-FM	100.3
	KSOP-FM	104.3
	KUER	90.1
	KWHO-FM	93.3
	KWIC	97.1
Spanish Fork	KONI-FM	106.3

VERMONT

Burlington	WJOY-FM	98.9
	WRUV	90.1
	WVNY	92.9
Middlebury	WRMC-FM	91.7
Northfield	WNUB-FM	89.1
White River Junction	WNHV-FM	95.3

VIRGINIA

Abingdon	WBBI-FM	92.7
Arlington	WAVA-FM	105.1
Ashland	WIVE-FM	100.1
Blocksburg	WVVV	104.9
	WUVT-FM	90.7
Charlottesville	WINA-FM	95.3
	WTJU	91.3
Chesapeake	WFOS	90.5
Chester	WDYL	92.1
Covington	WKEY-FM	100.9
Crewe	WSVS-FM	104.7
Danville	WBTM-FM	103.3
Farmville	WFLO-FM	95.7
Fredericksburg	WFVA-FM	101.5
	WFLS-FM	93.3
Gretna	WMNA-FM	103.3
Grundy	WNRG-FM	97.7
Hampton	WVEC-FM	101.3
	WHOV	88.3
Harrisonburg	WEMC	91.7
	WSVA-FM	100.7
	WLUR	91.5
Lynchburg	WWOD-FM	100.1
	WDMS-FM	101.7
	WEZR	106.7
Manassas	WMEV-FM	93.9
Marion	WOLD-FM	102.3
	WMVA-FM	96.3
Martinsville	WGH-FM	97.3
Newport News	WMTI	91.5
Norfolk	WCMS-FM	100.5
	WNOR-FM	98.7
	WRVC	102.5
	WTAR-FM	95.7
	WTID-FM	104.5
	WXRI	105.3
	WYFI-FM	99.7
Norton	WNVA-FM	106.3
Petersburg	WSSV-FM	99.3
	WSML	95.3
Portsmouth	WAVY-FM	96.9
Pulaski	WPUV-FM	107.1
Radford	WRAD-FM	101.7
Richmond	WTVR-FM	98.1
	WRFK	91.1
	WRVA-FM	94.5
	WRNL-FM	102.1
Roanoke	WDBJ-FM	94.9
	WLRJ	92.3
	WROV-FM	103.7
	WSLS-FM	99.1
Salem	WJLM	93.5
South Boston	WHLF-FM	97.5
South Hill	WJWS-FM	105.5
Staunton	WSGM	93.5
Suffolk	WXYW	92.9
Tappahannock	WRAR-FM	105.5
Tazewell	WTZE-FM	100.1
Warrenton	WEER-FM	107.7
Warsaw	WNNT-FM	100.9
Williamsburg	WCWM	89.1
	WRCI	96.5
Winchester	WRFL	92.5
	WEFG	102.5
Woodbridge	WXRA	105.9
Yorktown	WYCS	91.5

WASHINGTON

Bellevue	KFKF-FM	92.5
Bellingham	KGMI-FM	92.9
	KERI	104.3
Bremerton	KBRO-FM	106.9
Centralia	KELA-FM	102.9
Cheney	KEWC-FM	89.1
College Place	KGTS	91.3
Edmonds	KBIQ	105.3
Ellensburg	KCWS-FM	91.5
Eugene	KBMC	104.5
Hoquiam	KGHO-FM	103.9
Longview	KLYK	105.5
Lynden	KLYN-FM	106.5
Moses Lake	KWIQ-FM	100.3
Opportunity	KZUN-FM	96.1
Prosser	KACA	101.7
Pullman	KPUL-FM	104.9
Richland	KCYS	102.7
Seattle	KING-FM	98.1
	KBBX	98.9
	KBLE-FM	93.3
	KETO-FM	101.5
	KIRO-FM	100.7
	KISW	99.9
	KLSN	96.5
	KOL-FM	94.1
	KRAB	107.7
	KTW-FM	102.5
	KUOW	94.9
	KIXI-FM	95.7
Spokane	KREM-FM	92.9
	KCFA-FM	107.9
	KDNC-FM	93.7
	KTWD	105.7
	KXLY-FM	99.9
	KHQ-FM	98.1
	KUDY-FM	98.9
Tacoma	KCPS	90.9
	KLAY-FM	106.1
	KPLU	88.5
	KTNT-FM	97.3
	KTOY	91.7
	KTAC-FM	103.9
Wenatchee	KPQ-FM	102.1
Yakima	KNDX	104.1
	KIT-FM	94.5

WEST VIRGINIA

Beckley	WBKW	99.5
Berkeley Springs	WSCF-FM	93.5
Bethany	WVBC	88.1
Bluefield	WHIS-FM	104.5
Buckhannon	WVWC	88.9
Charleston	WKAZ-FM	97.5
	WCHS-FM	96.1
	WKNA	98.5
	WTIO	102.7
	WVAF	99.9
	WZFM	98.3
Charlestown	WKEE-FM	100.5
Huntington	WMUL	88.1
	WVQM	103.3
Logan	WVOW-FM	101.9
Martinsburg	WEPM-FM	97.5
Morgantown	WAJR-FM	101.9
Oak Hill	WOAY-FM	94.1
Parkersburg	WTAP-FM	103.1
	WCEF-FM	99.3
St. Albans	WKLC-FM	105.1
Welch	WOVE	106.3
Wheeling	WKWK-FM	97.3
	WWVA-FM	98.7
	WTRF-FM	107.5

WISCONSIN

Appleton	WLFM	91.1
	WAPL-FM	105.7
Beaver Dam	WBEV-FM	95.3
Beloit	WBCR-FM	88.1
Chilton	WHKW	89.5
Chippewa Falls	WCFW	105.5
Colfax	WHWC	88.3
Delafield	WHAD	90.7
Dodgeville	WDMP-FM	107.1
Eau Claire	WIAL	94.1
	WBIZ-FM	100.7
	WEAU-FM	104.5
Fond du Lac	WFON	107.1
Fort Atkinson	WFAW	107.3
Green Bay	WBAY-FM	101.1
	WDUZ-FM	98.3
Greenfield Twp.	WWCF	94.9
Hayward	WRLS-FM	92.1
Highland	WHHI	91.3
Highland Twp.	WHSA	89.9
Janesville	WCLO-FM	99.9
Kaukauna	WVLE	104.9
Kenosha	WAXO	96.9
	WLIP	95.1
La Crosse	WHLA	90.3
	WWLA	93.3
Madison	WHA-FM	88.7
	WIBA-FM	101.5
	WISM-FM	98.1
	WMFM	104.1(a)
	WRVB-FM	102.5
Manitowoc	WKUB	92.1
Marinette	WHMD	91.5
Marshfield	WDLB-FM	106.5
Medford	WGIM-FM	99.3
Menomonee	WZMF	98.3
	WDMW	92.1
	WVSS	89.5
Merrill	WLIN	100.7
	WXMT-FM	93.5
Milwaukee	WFMR	96.5
	WMIL-FM	95.7
	WISN-FM	97.3
	WRIT-FM	102.9
	WAWA-FM	102.1
	WQFM	98.3
	WTMJ	94.5
	WBON	107.7
	WEMP-FM	99.1
	WUWM	89.7
Monroe	WEKZ-FM	95.7
Neenah	WNAM-FM	99.3
Neillsville	WCCN-FM	107.5
New London	WLIH-FM	95.5
New Richmond	WIXK-FM	107.1
Oconto	WOCO-FM	107.1
Oshkosh	WMKC	96.7
	WRST-FM	88.1
	WOSH-FM	103.9
Park Falls	WNBI-FM	98.3
Platteville	WSUP	90.5
	WSWW-FM	99.3
Portage	WPDR-FM	100.1
Port Washington	WGLB-FM	100.1
Racine	WRJN-FM	100.7
	WFNY	92.1
Rhinelander	WOBT-FM	107.9
Rice Lake	WJMC-FM	96.3
Richland Center	WRCO-FM	100.9
Ripon	WCWC-FM	95.9
River Falls	WRVF	106.3
	WRFW	88.7
Rudsburg	WRDB-FM	104.9
Sauk City	WVLR	96.7
Shawano	WTCH-FM	100.1
Sparta	WCOW-FM	97.1
Stevens Point	WSPT-FM	97.9
	WSUS	89.9
Sturgeon Bay	WDOR-FM	95.9
Superior	WWJC-FM	105.1
	WSSU	91.3
Suring	WRVM	102.7
Tomah	WTMB-FM	98.9
Two Rivers	WQTC-FM	102.3
Viroqua	WGBM	102.3
Watertown	WTTN-FM	104.7
Waukesha	WAUK-FM	106.1
Waupaca	WDUX-FM	92.7
Wausau	WRIG-FM	101.9
	WHRM	91.9
	WSAU-FM	95.5

Location	C.L.	MHz
Wauwatosa	WTOS	103.7
West Bend	WBKV-FM	92.5
Whitewater	WSUW	91.7
Wisc. Rapids	WWRW	103.3
WYOMING		
Casper	KAWY	94.5
Cheyenne	KVWO-FM	106.3
	KFBC-FM	97.9
Laramie	KUWR	91.5
GUAM		
Agana	KUAM-FM	93.9
PUERTO RICO		
Arecibo	WCMN-FM	107.3
	WNIK-FM	107.3
Aguadilla	WABA-FM	100.3
Bayamon	WRSJ-FM	100.7
Caguas	WVJP-FM	103.3
Camuy	WCHQ	102.9
Carolina	WVOZ-FM	107.7
Corozal	WORO	92.5
Fajardo	WMDD-FM	94.7
Guayama	WXRF-FM	96.5
Mayaguez	WKJB-FM	99.1
	WORA-FM	97.5
	WOYE-FM	94.1
Ponce	WLEO-FM	101.9
	WPAB-FM	93.3
San German	WRPC	95.1
San Juan	WIPR-FM	91.3
	WIAC-FM	102.3
	WITA-FM	107.7
	WKVM-FM	105.7
	WKYN-FM	99.9
VIRGIN ISLANDS		
Charlotte Amalie	WBNB-FM	97.9
	WESP	101.1
Christiansted	WIVI-FM	99.5

Canadian AM Stations by Location

Location	C.L.	kHz
Abbotsford, B.C.	CFVR	1240
Ajax, Ont.	CHOO	1390
Alma, Que.	CFGT	1270
Altona, Man.	CFAM	950
Amherst, N.S.	CKDH	900
Amos, Que.	CHAD	1340
Antigonish, N.S.	CJFX	580
Barrie, Ont.	CKBB	950
Bathurst, N.B.	CKBC	1360
Belleville, Ont.	CJBQ	800
Blind River, Ont.	CJNR	730
Brampton, Ont.	CHIC	790
Brandon, Man.	CKX	1150
Brantford, Ont.	CKPC	1380
Bridgewater, N.S.	CKBW	1000
Brockville, Ont.	CFJR	1450
Burns Lake, B.C.	CFLD	1400
Cabano, Que.	CJAF	1240
Calgary, Alta.	CBR	1010
	CFAC	960
	CFCN	1060
	CHQR	810
	CKXL	1140
Callander, Ont.	CFCH	600
Cambell River, B.C.	CFWB	1490
Campbellton, N.B.	CKNB	950
Camrose, Alta.	CFCW	790
Causapscal, Que.	CJBM	1450
Charlottetown, P.E.I.	CFCY	630
Chatham, Ont.	CFCO	630
Chicoutimi, Que.	CBJ	1580
	CJMT	1420
Chilliwack, B.C.	CHWK	1270
Churchill, Man.	CHFC	1230
Cobourg, Ont.	CHUC	1450
Collingwood, Ont.	CKCB	1400
Corner Brook, Nfld.	CBY	990
	CFCB	570
Cornwall, Ont.	CFML	1110
	CJSS	1220
Courtenay, B.C.	CFCP	1440
Cranbrook, B.C.	CKEK	570
Creston, B.C.	CFKC	1340
Dartmouth, N.S.	CFDR	790
Dauphin, Man.	CKDM	730
Dawson Creek, B.C.	CJDC	1350
Dolbeau, Que.	CHVD	1230
Drumheller, Alta.	CJDV	910
Drummondville, Que.	CHRD	1480
Dryden, Ont.	CKDR	900
Duncan, B.C.	CKAY	1500
Edmonton, Alta.	CBX	740
	CFRN	1260
	CHED	630
	CHFA	680
	CHQT	1110
	CJCA	930
	CKUA	580
Edmundston, N.B.	CJEM	570
Elliott Lake, Ont.	CKNR	1340
Estevan, Sask.	CJSL	1280
Flin Flon, Man.	CFAR	590
Fort Frances, Ont.	CFOB	800
Ft. Nelson, B.C.	CFNL	590
Fort Simpson, N.W.T.	CFMR	1490
Fort St. John, B.C.	CKNL	560
Fort William, Ont.	CJLX	800
Fredericton, N.B.	CBZ	970
	CFNB	550
Galt, Ont.	CFTJ	1110
Gander, Nfld.	CBG	1450
Goose Bay, Nfld.	CFGB	1340
Granby, Que.	CHEF	1450
Grande Prairie, Alta.	CFGP	1050
Grand Bank, Nfld.	CJOX	710
Grand Falls, Nfld.	CBT	540
	CKCM	620
	CJCN	680
Gravelbourg, Sask.	CFRG	710
	CFGR	1230
Guelph, Ont.	CJOY	1460
Halifax, N.S.	CBH	860
	CHNS	960
	CJCH	920
Hamilton, Ont.	CHAM	1280
	CHML	900
	CKOC	1150
Hauterive, Que.	CHLC	580
Hearst, Ont.	CFLH	1340
Huntsville, Ont.	CKAR	630
Hull, Que.	CKCH	970
Inuvik, N.W.T.	CHAK	860
Joliette, Que.	CJLM	1350
Jonquiere, Que.	CKRS	590
Kamloops, B.C.	CFJC	910
Kapuskasing, Ont.	CFLK	1230
	CKAP	580
Kelowna, B.C.	CKOV	630
Kenora, Ont	CJRL	1220
Kentville, N.S.	CKEN	1350
Kingston, Ont.	CFRC	1490
	CKLC	1380
	CKWS	960
Kirkland Lake, Ont.	CJKL	560
Kitchener, Ont.	CHYM	1490
	CKKW	1320
Kitimat, B.C.	CKTK	1230
Lac Megantic, Que.	CKFL	1340
Langley, B.C.	CJJC	850
La Pocatiere, Que.	CHGB	1310
La Sarre, Que.	CKLS	1240
La Tuque, Que.	CFLM	1240
Leamington, Ont.	CHIR	730
	CHYR	710
Lethbridge, Alta.	CHEC	1090
	CJOC	1220
Levis, Que.	CFLS	1240
Lindsay, Ont.	CKLY	910
Lloydminster, Alta.	CKSA	1080
London, Ont.	CFPL	980
	CJOE	1290
	CKSL	1410
Marystown, Nfld.	CHCM	560
Matane, Que.	CKBL	1250
Medicine Hat, Alta.	CHAT	1270
Melfort, Sask.	CJVR	1420
Middleton, N.S.	CKAD	1490
Midland, Ont.	CKMP	1230
Moncton, B.C.	CBA	1070
	CBAF	1300
	CKCW	1220
Mont Laurier, Que.	CKML	610
Montmagny, Que.	CKBM	1490
Montreal, Que.	CBF	690
	CBM	940
	CFCF	600
	CFMB	1410
	CJAD	800
	CJMS	1280
	CKAC	730
	CKLM	1570
	CKGM	980
Moose Jaw, Sask.	CHAB	800
Nanaimo, B.C.	CHUB	1570
Nelson, B.C.	CKKC	1390
New Carlisle, Que.	CHNC	610
Newcastle, N.B.	CKMR	790
New Glasgow, N.S.	CKEC	1320
New Liskeard, Ont.	CJTT	1230
New Westminster, B.C.	CKNW	980
Niagara Falls, Ont.	CJRN	1800
North Battleford, Sask.	CJNB	1050
North Vancouver, B.C.	CKLG	730
Oakville, Ont.	CHWO	1250
Orillia, Ont.	CFOR	1570
Oshawa, Ont.	CKLB	1350
Osoyoos, B.C.	CKOO	1240
Ottawa, Ont.	CBO	910
	CBOF	1250
	CFRA	580
	CJRC	1150
	CKOY	1310
	CKPM	1440
Owen Sound, Ont.	CFOS	560
Parry Sound, Ont.	CKAR-1	1340
Peace River, Alta.	CKYL	610
Pembroke, Ont.	CHOV	1350
Penticton, B.C.	CKOK	800
Peterborough, Ont.	CHEX	980
	CKPT	1420
Pointe Claire, Que.	CFOX	1470
Portage La Prairie, Man.	CFRY	920
Port Alberni, B.C.	CJAV	1240
Port Arthur, Ont.	CFPA	1230
	CKPR	580
Powell River, B.C.	CHQB	1280
Prince Albert, Sask.	CKBI	900
Prince George, B.C.	CKPG	550
Prince Rupert, B.C.	CFPR	860
	CHTK	560
Quebec, Que.	CBV	980
	CHRC	800
	CJLR	1060
	CKCV	1280
Quesnel, B.C.	CKCQ	570
Red Deer, Alta.	CKRD	850
Regina, Sask.	CBK	540
	CJME	1300
	CKCK	620
	CKRM	980
Revelstoke, B.C.	CKCR	1340
Richmond Hill, Ont.	CFGM	1310
Rimouski, Que.	CJBR	900
Riviere du Loup, Que.	CHRT	1450
	CJFP	1400
Roberval, Que.	CHRL	910
Rosetown, Sask.	CKKR	1330
Rouyn, Que.	CKRN	1400
Ste. Agathe des Monts, Que.	CJSA	1230
St. Anne-des-Monts, Que.	CKGN	1340
St. Boniface, Man.	CKSB	1050
St. Catharines, Ont.	CHSC	1220
	CKTB	610
St. Hyacinthe, Que.	CKBS	1240
St. Eleuthere, Que.	CHRT	1450
St. Jean, Que.	CHRS	1090
St. Jerome, Que.	CKJL	900
Saint John, N.B.	CBD	1110
	CFBC	930
	CHSJ	1150
St. John's, Nfld.	CBN	640
	CJON	930
	VOAR	1230
	VOCM	590
	VOWR	800
St. Thomas, Ont.	CHLO	680
Salmon Arm, B.C.	CKXR	580
Sarnia, Ont.	CHOK	1070
	CKJD	1250
Saskatoon, Sask.	CFNS	1170
	CFQC	600
	CKOM	1250
Sault Ste. Marie, Ont.	CJIC	1050
	CKCY	920
Schefferville, Que.	CBDR	1230
Sept-Iles, Que.	CKCN	560
Shaunavon, Sask.	CJSN	1490
Shawinigan, Que.	CKSM	1220
Sherbrooke, Que.	CHLT	630
	CJRS	1510
	CKTS	900
Simcoe, Ont.	CFRS	1540
Smiths Falls, Ont.	CJET	630
Smithers, B.C.	CFBV	1230
Sorel, Que.	CJSO	1320
Stratford, Ont.	CJCS	1240
Steinbach, Man.	CHSM	1250
Stephenville, Nfld.	CFSX	910
Sudbury, Ont.	CFBR	550
	CHNO	900
	CKSD	790
Summerside, P.E.I.	CJRW	1240
Swift Current, Sask.	CKSW	1400
Sydney, N.S.	CBI	1140
	CHER	920
	CJCB	1270
Terrace, B.C.	CFTK	590
Thetford Mines, Que.	CKLD	1230
Thompson, Man.	CHTM	610
Tillsonburg, Ont.	CKOT	1510
Timmins, Ont.	CFCL	620
	CKGB	680
Toronto, Ont.	CBL	740
	CFRB	1010
	CHFI	680
	CHIN	1540
	CHUM	1050
	CJBC	860
	CKEY	590
	CKFH	1430
Trail, B.C.	CJAT	610
Trois-Rivières, Que.	CHLN	550
	CJTR	1150
Truro, N.S.	CKCL	600
Val d'Or, Que.	CKVD	800
Valleyfield, Que.	CFLV	1370
Vancouver, B.C.	CBU	690
	CFUN	1410
	CHQM	1320
	CJOR	600
	CKLG	730
	CKWX	1130
Verdun, Que.	CKVL	850
Vernon, B.C.	CJIB	940
Victoria, B.C.	CFAX	1070
	CJVI	900
	CKDA	1220
Victoriaville, Que.	CFDA	1380
Ville Marie, Que.	CKVM	710
Ville St. Georges, Que.	CKRB	1460
Ville Vanier, Que.	CFOM	1340
Wawa, Ont.	CJWA	1240
Welland, Ont.	CHOW	1470
Weyburn, Sask.	CFSL	1190
Whitehorse, Y.T.	CFWH	570
Williams Lake, B.C.	CKWL	1240
Windsor, N.S.	CFAB	1450
Windsor, Ont.	CBE	1550
	CKLW	800
	CKWW	580
Wingham, Ont.	CKNX	920
Winnipeg, Man.	CBW	990
	CFRW	1470
	CJOB	680
	CKRC	630
	CKY	580
Woodstock, N.B.	CJCJ	920
Woodstock, Ont.	CKOX	1340
Yarmouth, N.S.	CJLS	1340
Yellowknife, N.W.T.	CFYK	1340
Yorkton, Sask.	CJGX	940

Canadian FM Stations by Location

Location	C.L.	MHz
Belleville, Ont.	CJBQ-FM	97.1
Brampton, Ont.	CHIC-FM	102.1
Brandon, Man.	CKX-FM	96.1
Brantford, Ont.	CKPC-FM	92.1
Calgary, Alta.	CHFM-FM	95.9
Clearwater, B.C.	CFFM-FM-2	92.7
Clinton, B.C.	CFFM-FM-4	106.5
Cornwall, Ont.	CJSS-FM	104.5
Edmonton, Alta.	CFRN-FM	100.3
	CJCA-FM	99.5
	CKUA-FM	98.1
Halifax, N.S.	CHNS-FM	96.1
Hamilton, Ont.	CKDS-FM	95.3
Kamloops, B.C.	CFFM-FM	98.3
Kelowna, B.C.	CJOV-FM	104.7
Kentville, N.S.	CKWM-FM	97.7
Kingston, Ont.	CFRC-FM	91.9
	CKLC-FM	98.3
	CKWS-FM	96.3
Kitchener, Ont.	CFCA-FM	105.3
	CHYM-FM	96.7
La Pocatiere, Que.	CHGB-FM	102.9
Laval, Que.	CFGL-FM	105.7
Lethbridge, Alta.	CHEC-FM	100.9
London, Ont.	CFPL-FM	95.9
Maniwaki, Que.	CBFL-FM	98.9
Merritt, B.C.	CFFM-FM-3	103.9
Montreal, Que.	CBF-FM	95.1
	CBM-FM	100.7

Location	C.L.	MHz
	CFQR-FM	92.5
	CJFM-FM	95.9
	CJMS-FM	94.3
	CKGM-FM	97.7
Mount Timothy, B.C.	CFFM-FM-5	99.7
North Bay, Ont.	CKAT-FM	93.7
Oshawa, Ont.	CKQS-FM	94.9
Ottawa, Ont.	CBO-FM	103.9
	CFMO-FM	93.9
Penticton, B.C.	CKOK-FM	97.1
Peterborough, Ont.	CHEX-FM	101.5
Port Arthur, Ont.	CKPR-FM	94.3
Quebec, Que.	CHRC-FM	98.1
Red Deer, Alta.	CKRD-FM	98.9
Regina, Sask.	CFMQ-FM	92.1
Richibucto, N.B.	CBHM-FM	98.5
Rimouski, Que.	CJBR-FM	101.5
Saint John, N.B.	CFBC-FM	98.9
Saskatoon, Sask.	CFMC-FM	103.9
	CJUS-FM	89.7
Sault Ste. Marie, Ont.	CJIC-FM	100.5
	CKCY-FM	104.3
Savona, B.C.	CFFM-FM-1	101.9
Sherbrooke, Que.	CHLT-FM	102.7
Smith Falls, Ont.	CJET-FM	101.1
St. Catharines, Ont.	CHSC-FM	105.7
	CKTB-FM	97.7
Sudbury, Ont.	CKSO-FM	92.7
Sydney, N.S.	CJCB-FM	94.9
Tillsonburg, Ont.	CKOT-FM	100.5
Timmins, Ont.	CKGB-FM	94.5
Toronto, Ont.	CBL-FM	94.1
	CHFI-FM	98.1
	CHIN-FM	100.7
	CHUM-FM	104.5
	CJRT-FM	91.1
	CKFM-FM	99.9
Trail, B.C.	CJAT-FM	106.7
Truro, N.S.	CKCL-FM	100.9
Vancouver, B.C.	CBU-FM	105.7
	CBUF-FM	97.7
	CHQM-FM	103.5
	CKLG-FM	99.3
Verdun, Que.	CKVL-FM	96.9
Victoria, B.C.	CFMS-FM	98.5
Windsor, Ont.	CKLW-FM	93.9
	CKWW-FM	88.7
Winnipeg, Man.	CBW-FM	98.3
	CFRW-FM	94.3
	CJOB-FM	97.5
	CKY-FM	92.1

A THANK YOU NOTE FROM THE EDITORS

Thank you! The Editors of SCIENCE AND ELECTRONICS would like to thank all readers who offered information on station changes, additions and deletions during the past few months. Though many of the letters overlapped, each aided us considerably in the task of making *White's Radio Log* as current as possible at press time. If we left your name out, please for give us!

John R. Anderson, Burlington, Iowa
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Atwood Shupp, Easton, Pa.
John Simpson, Crawfordsville, Ind.
Sheldon Swartz, Sharon, Mass.
R. C. Wheeler, Walla Walla, Wash.

White's World-Wide Shortwave Stations

Continuing with our rundown of some of the bare basics of how to succeed in SWLing without really trying, let's take a brisk look at methods of sending signal strength reports. Mind you, a report of signal strength isn't 100% of a reception report (we discussed the other things in the previous edition), but it's the one thing which really makes the whole thing useful to the broadcaster who hears from you. He makes use of your report by seeing how his signal is getting into your area and can then decide on his future schedules and frequencies.

Saying in your report, "Your signal was readable," or even "strong" is simply not enough to be of any use. There are too many other factors. In fact, at one time broadcasters demanded that listeners use the old "RST" system of reporting. This indicated Strength, Readability, Tone. Eventually this system was found to be insufficient for many broadcasters faced with today's many spectrum problems. A new system was devised which has become the standard for reception reports; it's a snap to use, it tells the whole story, and we suggest that you incorporate it into all of your reception reports. It's known as the SINPO system and it tells about *Signal strength, Interference, Noise, Propagation disturbances* (fading), and *Overall merit*. Each signal is evaluated for these individual characteristics and then given a number rating for each of them. The numbers range

QSA Signal strength		QRM Interference		QRN atmospheric Noise		QSB Propagation disturbance		QRK Overall merit	
5	excellent	5	NIL	5	NIL	5	NIL	5	excellent
4	good	4	slight	4	slight	4	slight	4	good
3	fair	3	moderate	3	moderate	3	moderate	3	fair
2	poor	2	severe	2	severe	2	severe	2	poor
1	barely audible	1	extreme	1	extreme	1	extreme	1	unusable

WORLD-WIDE SHORTWAVE STATIONS

from 1 to 5, with 5 being the best possible rating and 1 being the lowest. You would then send out your reception reports with signal ratings which might read SINPO 55555 (which is the best possible rating and would only be awarded to a station whose signal was peeling the paint off your walls). A report of SINPO 34332 would mean that the strength was only fair to begin with, but because of moderate interference and static, combined with moderate fading, the overall merit of the signal was poor.

You should be able to send out top notch reports with this system on the very first few tries. We are furnishing you with a complete guide to using the SINPO system—good DX!

kHz	Call	Name	Location
2360	TGBA	R. Maya	Huehuetenango, Guat.
2430	YVPM	E. Radiofonicas	Caracas, Venez.
2470	YVNI	R. Carora	Carora, Venez.
2510	HLK50	V. Free Korea	Seoul, S. Korea

90-Meter Band—3200 to 3400 kHz

3204	—	Nigerian BC	Ibadan, Nigeria
3230	VRH8	Fiji BC	Suva, Fiji Is.
3241	YDR3	RRI	Ambon, Indonesia
3255	ELBC	Liberian BC	Monrovia, Liberia
3265	HCMZ6	V. Dorado	Dorado, Ecuador
3284	VRM9	Fiji BC	Suva, Fiji Is.
3295	YDY2	RRI	Samarinda, Indonesia
3310	—	R. Clube de Mozambique	Quelimane, Mozamb.
3325	ZYJ2I	R. Borborema	Campina Grande, Brazil
3335	ZYR59	V. do Serato	Pres. Prudente, Brazil
3346	—	Lusaka Calling	Lusaka, Zambia
3360	—	R. Peking	Peking, China
3375	VUD	All India R.	Gauhati, India
3380	—	R. Mali	Bamako, Mali
3390	—	R. Peking	Peking, China
3448	—	RRI	Purwokerto, Indonesia
3815	HCPZ1	R. Rumichaca	Tulcan, Ecuador
3910	CR4AC	R. Barlavento	Cape Verde Is.
3945	JOZ4	Nihon Tampa Hoso	Tokyo, Japan
3970	—	R. Buea	Buea, Cameroon
3980	—	Nigerian BC	Enugu, Nigeria
3995	—	RAI	Rome, Italy
4040	—	R. Erevan	Erevan, USSR
4265	DAM	(time signals)	Elmshorn, Germany
4500	VNG	Austral. BC	Lyndhurst, Australia
4665	—	R. Baku	Baku, USSR

60-Meter Band—4750 to 5060 kHz

4756	VRH4	R. Fiji	Suva, Fiji Is.
4762	OCX4W	R. Inca	Lima, Peru
4770	YVQE	R. Bolivar	Bolivar, Venez.
4784	TIRHB2	R. Popular	San Jose, C.R.
4790	OAX5X	R. Nazca	Lima, Peru
4800	VUD	All India R.	Hyderbad, India
4810	—	VTVN	DaNang, S. Vietnam
4820	HCRT6	R. Paz y Bien	Ambato, Ecuador
4825	OAZ6Z	R. Moquegua	Moquegua, Peru
4840	—	R. Botswana	Gaberones, Botswana
4850	V3USE	Mauritius BC	Forest Side, Maurit.
4855	OCX7E	R. Pt. Maldonado	Pt. Maldonado, Peru
4870	HCGM7	R. Rio Amazonas	Macuma, Ecuador
4880	HCWE1	R. Nac. Espejo	Quito, Ecuador
4890	YVKB	R. Venezuela	Caracas, Venezuela
4895	ZYN22	R. Cultura	Bahia, Brazil
4907	—	R. Cambodia	Phnom-Penh, Cambodia
4915	—	R. Accra	Accra, Ghana
4920	YVKR	R. Caracas	Caracas, Venez.
4934	OAX5Q	R. Concejo Prov.	Abancay, Peru
4940	OAZ4R	R. San Juan	San Juan, Peru
4950	HCAV3	R. Luz y Vida	Quito, Ecuador
4955	OAX5S	R. Amauta	Huanta, Peru
4967	—	R. Kuwait	Kuwait
4975	OCX4H	R. del Pacifico	Lima, Peru
4985	CP75	R. Cruz del Sur	La Paz, Bolivia
4995	ZYX2	R. Brasil Central	Goiania, Brazil
5000	WWV	(time signals)	Boulder, Colo.
5005	OAX2S	R. Jaen	Jaen, Peru

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kHz	Call	Name	Location
5020	—	R. Niger	Niamey, Niger
5025	ZYX30	R. Aquidauana	Aquidauana, Brazil
5033	CR6RW	R. C. de Cabinda	Cabinda, Angola
5040	YVQH	R. Maturin	Maturin, Venez.
5055	CP87	R. San Rafael	San Rafael, Bolivia
5070	TGMS	T. Nacional	Mazatenango, Guat.
5170	—		Fukien, China
5500	—	R. Peking	Peking, China
5850	—	R. Peking	Peking, China
5920	—	R. Tashkent	Tashkent, USSR

49-Meter Band—5950 to 6200 kHz

5954	TIQ	R. Casino	San Jose, C.R.
5955	CP60	R. Pio Decimo Segundo	La Paz, Bolivia
5960	BEP23	Police BC	Taipei, Taiwan
5965	HCGE5	R. Mundial	Quito, Ecuador
5975	CP44	R. Nacional	LaPaz, Bolivia
5980	BED30	BC of China	Taipei, Taiwan
5985	—	R. Hanoi	Hanoi, N. Vietnam
5993	—	R. Mdandaka	Mdandaka, Congo
6000	OEI20	R. Osterreich	Vienna, Austria
6005	CFCW	—	Montreal, Que.
6010	YSS	R. Nacional	San Salvador, El Salvador
6020	4VEB	R. Caraibes	Pt.-au-Prince, Haiti
6025	CSA52	R. Nacional	Lisbon, Portugal
6030	CFVP	—	Calgary, Alta.
6040	—	V. America	Munich, W. Germany
6045	OCY4H	R. Santa Rosa	Lima, Peru
6055	—	R. Kuwait	Kuwait
6060	LRA3I	R. Nacional	Buenos Aires, Argentina
6070	—	R. Sofia	Sofia, Bulgaria
	OAX4S	R. Onda Popular	Lima, Peru
6075	CXA3	R. Ariel	Montevideo, Uruguay
6080	4VHW	R. Haiti	Pt.-au-Prince, Haiti
6090	ZAA	R. Tirana	Tirana, Albania
6095	ZYB7	R. de Sao Paulo	Sao Paulo, Brazil
6105	—	R. Prague	Prague, Czech.
6110	HRXW	R. Comayaguela	Tegucigalpa, Honduras
6115	—	R. C. de Mozambique	Lourenco Marques, Mozamb.
6120	DZF4	Call of Orient	Manila, Phil.
6125	PRG9	R. Nac de Sao Paulo	Sao Paulo, Brazil
6130	CHNX	—	Halifax, N.S.
6135	OCX4M	R. Pasco	Pasco, Peru
6145	HRXE	R. Mil Treinta	Juticalpa, Hond.
6155	ZAA	R. Tirana	Tirana, Albania
6165	—	Swiss BC	Berne, Switz.
6170	8FK35	RRI	Padang, Indonesia
6175	—	Nigerian BC	Kaduna, Nigeria
6185	LLI	R. Norway	Oslo, Norway
6190	VUD	All India R.	Delhi, India
6198	OAX1B	R. Sudamericana	Lima, Peru
6225	—	R. Peking	Peking, China
6325	—	R. Peking	Peking, China
6430	—	R. Peking	Peking, China
6620	—	R. Peking	Peking, China
6850	—	Pathfinders Station	Warsaw, Poland
7055	—	R. Peking	Peking, China

41-Meter Band—7100 to 7300 kHz

7100	—	R. Budapest	Budapest, Hungary

kHz	Call	Name	Location
7105	—	R. Nepal	Kathmandu, Nepal
7115	—	R. Peking	Peking, China
7125	—	V. de Revolucion	Conakry, Guinea
7135	—	R. Monte Carlo	Monte Carlo, Monaco
7145	—	R. Malaysia	Sarawak
7155	HVJ	Vatican Radio	Vatican City
7160	—	Austr. BC	Darwin, Australia
7170	—	R. Algiers	Algiers, Algeria
7180	—	R. Liberty	Spain
7190	—	R. Columbo	Columbo, Ceylon
7200	ZAA	R. Tirana	Tirana, Albania
7210	PCJ	R. Nederland	Hilversum, Netherlands
7220	—	R. Liberty	Munich, Germany
7230	CR6RM	R. Cl. de Mocamedes	Mocamedes, Angola
7235	—	RAI	Rome, Italy
7240	—	R. Peking	Peking, China
7250	—	R. Singapura	Singapore
7260	—	Gorovit Minsk	Minsk, USSR
7270	—	R. RSA	Johannesburg, S. Afr.
7280	—	BBC	London, England
7290	DMQ7	Deutsche Welle	Cologne, W. Germany
7295	—	R. Athena	Athens, Greece
7305	—	R. Novosibirsk	Novosibirsk, USSR
7335	CHU	(time signals)	Ottawa, Ont.
7440	—	R. Peking	Peking, China
7620	—	R. Peking	Peking, China
7947	—	R. Peking	Peking, China
8400	—	R. Peking	Peking, China
8638	DAM	(time signals)	Elmshorn, Germany
9277	NPG	(time signals)	San Francisco, Calif.
9457	—	R. Peking	Peking, China

31-Meter Band—9500 to 9775 kHz

9500	—	R. Berlin Int'l	Berlin, E. Germany
9510	—	BBC	London, England
9515	—	R. Malaysia	Malaysia
9525	—	BBC	London, England
9530	—	V. America	Wooferton, Engl.
9535	—	Swiss BC	Berne, Switz.
9545	DMQ9	Deutsche Welle	Cologne, W. Germany
9550	—	R. Warsaw	Warsaw, Poland
9555	—	BBC	London, England
9565	—	R. Moscow	Moscow, USSR
9570	—	BBC	Tebrau, Malaysia
9575	VUB	All India R.	Bombay, India
9585	—	R-TV Francaise	Paris, France
9590	—	Swiss BC	Berne, Switz.
9595	—	Trans World R.	Monte Carlo, Monaco
9600	XEYU	Universidad Nac.	Mexico City, Mex.
9610	—	R. Addis Ababa	Addis Ababa, Ethiopia
9615	TIRICA	V. de la Victor	San Jose, C.R.
9620	ZYR97	R. Nova de Julio	Sao Paulo, Brazil
9630	—	R. Nacional	Lisbon, Portugal
9640	DMQ9	Deutsche Welle	Cologne, W. Germany
9645	TIFC	Faro del Caribe	San Jose, C.R.
9655	DMQ9	Deutsche Welle	Cologne, W. Germany
9660	BED42	BC of China	Taipei, Taiwan
9675	—	R. Japan	Tokyo, Japan
9685	—	R. Erevan	Erevan, USSR
9690	—	R. Peking	Peking, China
9700	—	R. Sofia	Sofia, Bulgaria
9710	—	RAI	Rome, Italy
9720	—	Swiss BC	Berne, Switz.
9725	—	BBC	Tebrau, Malaysia
9735	—	V. America	Dixon, Calif.
9745	—	R. Mali	Bamako, Mali
9752	—	R. Suriname	Surinam
9760	—	R. Hanoi	Hanoi, N. Vietnam
9770	OEI47	R. Osterreich	Vienna, Austria
9800	—	R. Peking	Peking, China
9905	—	Gorovit Khabarovsk	Khabarovsk, USSR
10000	WWVH	(time signals)	Honolulu, Hawaii
10530	—	Gorovit Alma Ata	Alma Ata, USSR
11505	—	R. Peking	Peking, China
11680	—	BBC	London, England

25-Meter Band—11700 to 11975 kHz

11700	TGQB	R. Quezaltenango	Quezaltenango, Guat.
11710	—	R. Brazzaville	Brazzaville, Congo
11720	—	BBC	Limassol, Cyprus
11730	ETLF	R. V. Gospel	Addis Ababa, Eth.
11735	CXA7	R. Oriental	Montevideo, Uruguay
11745	—	R. Berlin Int'l	Berlin, E. Germany
11755	VUD	All India R.	Delhi, India
11760	—	R. Habana	Havana, Cuba
11775	—	Swiss BC	Berne, Switzerland
11785	DMQ11	Deutsche Welle	Cologne, W. Germany
11790	WNYW	R. New York W/W	New York, N.Y.
11800	PCJ	R. Nederland	Hilversum, Netherlands
11805	—	V. America	Manila, Phil.
11815	—	R. Free Europe	Lisbon, Portugal
11820	—	R. Abidjan	Abidjan, Ivory Coast
11830	—	V. America	Dixon, Calif.
11845	VUD	All India R.	Delhi, India
11855	ETLF	R. V. Gospel	Addis Ababa, Eth.
11860	—	BBC	Ascension I.
11866	—	R. Lubumbashi	Lubumbashi, Congo
11875	—	R. Japan	Tokyo, Japan
11880	VLH11	R. Australia	Melbourne, Australia
11890	DZE9	Call of Orient	Manila, Phil.
11900	CXA10	SODRE	Montevideo, Uruguay
11910	VUD	All India R.	Delhi, India
11915	HCJB	V. de los Andes	Quito, Ecuador
11925	—	BBC	London, England
11935	—	R. Nacional	Lisbon, Portugal
11945	DMQ11	Deutsche Welle	Cologne, W. Germany
11955	—	R. Warsaw	Warsaw, Poland
11965	—	R. Japan	Tokyo, Japan
11975	ELWA	R. ELWA	Monrovia, Liberia
12005	—	R. Peking	Peking, China
12060	—	R. Peking	Peking, China
13555	GIC33	(time signals)	Hailsham, England
15000	LOL	(time signals)	Buenos Aires, Arg.
15095	—	R. Peking	Peking, China

19-Meter Band—15100 to 15450 kHz

15115	—	Australian BC	Darwin, Austr.
15130	ETLF	R. V. Gospel	Addis Ababa, Eth.
15135	PRB23	R. Panamericana	Sao Paulo, Brazil
15150	—	R. Kuwait	Kuwait
15160	—	R. Budapest	Budapest, Hungary
15165	ZYN7	Cera R. Clube	Fortaleza, Brazil
15180	—	Gorovit Sverdlovsk	Sverdlovsk, USSR
15195	—	V. America	Tangiers, Morocco
15210	—	V. America	Manila, Phil.
15225	—	R. Bucharest	Bucharest, Rumania
15236	—	R. Peking	Peking, China
15250	—	R. Bucharest	Bucharest, Rumania
15260	—	BBC	London, England
15270	CXA18	SODRE	Montevideo, Uruguay
15285	—	V. America	Colombo, Ceylon
15300	DZH9	Call of Orient	Manila, Phil.
15310	—	V. Revolucion	Conakry, Guinea
15320	—	R. Australia	Melbourne, Australia
15335	VUM	All India R.	Madras, India
15345	BED49	BC of China	Taipei, Taiwan
15360	—	V. America	Monrovia, Liberia
15370	ZYC9	R. Tupi	Rio de Janeiro, Brazil
15385	—	Gorovit Gorki	Gorki, USSR
15400	—	V. America	Greenville, N.C.
15410	—	V. America	Greenville, N.C.
15425	ETLF	R. V. Gospel	Addis Ababa, Eth.
15435	DMQ15	Deutsche Welle	Cologne, W. Germany
15445	—	V. America	Monrovia, Liberia
15520	—	R. Pyongyang	Pyongyang, N. Korea
17194	PPR	(time signals)	Rio de Janeiro, Brazil

16-Meter Band—17700 to 17900 kHz

17705	VUD	All India R.	Delhi, India
17720	—	R. Tunis	Tunis, Tunisia
17745	—	BBC	London, England
17755	—	V. America	Manila, Phil.
17770	—	RAI	Rome, Italy
17775	—	V. America	Monrovia, Liberia
17775	—	R. Moscow	Moscow, USSR
17795	—	R. Budapest	Budapest, Hungary
17805	—	R. Free Europe	Lisbon, Portugal
17805	—	R. RSA	Johannesburg, U. S. Africa
17815	—	RAI	Rome, Italy
17820	—	V. America relay	Poro, Phil.
17845	—	R. Prague	Prague, Czech.
17855	HCJB	V. Andes	Quito, Ecuador

13-Meter Band—21450 to 21750 kHz

21450	—	R. Prague	Prague, Czech.
21455	—	V. Nigeria	Lagos, Nigeria
21470	—	BBC	London, England
21580	—	R-TV Francaise	Paris, France
	—	V. Nigeria	Lagos, Nigeria
21500	—	R. Brazzaville	Brazzaville, Congo
21535	—	R. RSA	Johannesburg, S. Afr.
21540	HER	Swiss BC	Berne, Switz.
25610	—	R. Nederland	Hilversum, Neth.
25650	—	BBC	London, England
25730	LLL	R. Norway	Oslo, Norway
25790	—	R. RSA	Johannesburg, S. Afr.
25900	LLA	R. Norway	Oslo, Norway

White's Emergency Radio Station Listings for the Boston Area

☐ RADIO-TV EXPERIMENTER and SCIENCE AND ELECTRONICS furnishes this exclusive listing of emergency radio stations as an aid to our many readers now engaged in the fascinating and rapidly growing hobby of monitoring emergency radio communications. We have and will be publishing similar lists devoted to different metropolitan areas in forthcoming issues so that you'll be able to accumulate a sizable array of this difficult-to-obtain data. Refer to the index on page 81 for our 1969 program.

If you desire to obtain similar lists from other areas in the United States that have not or will not be published in this magazine in 1969, then we suggest you write to Communications Research Bureau, Box 56, Commack, N. Y. 11725. They may have a list of emergency radio services that covers your locality. Include a stamped, self-addressed envelope with your request.

Station	Police	Fire
BOSTON POLICE DEPT.		
KCA860	158.97	KCF751 453.35
KCC768-84	39.02	KGR364 453.20
KCC918	39.02	KGR365 453.40
KCD937	39.02	KGR366 453.30
KCF712	39.02	
BOSTON FIRE DEPT.		
KCA591	33.74 153.89	154.22
KJS733-5	33.74 153.89	
KJW560	33.74 153.89	
MUNICIPAL DEPARTMENTS		
Abington	KBE498	155.73	KCD823	33.90
Acton	KC8875	155.01	mobiles	45.60
Amesbury			KCV354	154.07
			KCV354	154.145
Andover	KCB262	39.10	KCF313	33.66
			KCF313	154.07
			KJD876	33.66
Arlington			KCR311	154.22
Ashburnham			KCB404	33.70
			KCB404	33.82
Ashland	KCE327	155.79	KCF945	46.46
Auburn	KCB970	155.55	K8T465	33.62
			KCN817	33.62
Avon	KCI271	155.73	KCD727	46.14
Ayer	KCF802	39.42	KAQ921	46.14
Bedford	KCF442	158.73	KBT205	33.66
			KBT205	154.34
Bellingham	KCE915	39.42	KEP595	33.54
Belmont	KAX786	155.655	KCD849	154.13
	KCA969	155.655	KCD849	154.22
	KCA969	158.97		
Berlin	mobiles	37.10		
Beverly	KCA875	45.58	KAY259	154.07
	KCA875	158.97		
Billerica	KCB490	155.13	KCF312	33.66
Blackstone	KCI228	155.79	KGT480	33.62
Bolton			KBA887	33.70
Boxford	mobiles	44.74	KCH315	154.07
Boylston	KFV420	37.10	KCF337	33.70
Braintree	KCA780	155.49	KCC352	46.14
	KCA780	158.97		
Brockton	KCB421	155.685	KCA403	154.31
	KCB421	155.73		
Brookline	KCA975	39.94	KCF364	33.78
			KCF364	154.22
			KCF366-70	33.78
Burlington	KCA953	155.13	KAX310	154.34
Cambridge			KCB290	33.94
			KCB290	154.22
			KCB290	154.355
Canton	KCB417	155.73	KCB746	33.50
Carlisle	KEM669	155.01	KCF311	33.66
Charlton	KCB296	155.07	KCD975	33.62
Chelmsford	KCF493	155.67	KCF310	33.66
Chelsea	KCA343	45.10	KDD985	154.22
			KDD985	154.325
Clinton	KCA896	37.10	KCH246	33.70
			KCH246	154.31
Cohasset	KCA446	155.07	KCH618	154.19
Concord	KCA685	155.01	KCD596	46.50
Deedham	KJU853	39.08		
	KCA957	155.61		
Dover	KCG758	155.31	KCA303	33.50
Dracut	mobiles	155.67	KCB745	33.66
	mobiles	155.85	KCB745	154.44
Dudley	KCC416	155.43	KCH427	33.62
Dunstable	mobiles	39.42	KCF309	33.66
			KJS918	33.66
Duxbury	KCA707	39.22	KCA351	33.90
E. Boxford	KJD278	45.14		
E. Bridgewater	KCC354	155.73	KCC350	33.90
			KBW838	153.98
E. Douglas			KAY985	33.62
Easton	KCF692	155.73	mobiles	33.50
Essex			KCI370	155.82
Everett	KCA634	155.595	KCH424	154.31
	KCA634	158.97		
Fitchburg	KCA852	155.61	KCB764	154.25
Foxboro	KCA855	155.37	KCF297	33.50
Framingham	KCA458	39.52	KCC457	33.98
Franklin	KCA462	39.42	KCY582	33.50
			KCY582	33.54
Gardner	KCB401	155.73	KCA395	33.70
			KCB308	154.13
			KCD690	154.01
			KCD690	154.07
			KCF979	154.13
Georgetown	KFN667	155.01		
Gloucester	KCA632	155.55	KDV782-3	154.16
	KCA632	158.97	KDV820	154.16
			KDQ249	154.07
			KDQ249	154.16
			KJE242	same
Groton	KCA850	39.42	KAP589	46.14
Groveland	KAW496	155.01	KCF251	154.01
			KCF251	154.07
Hamilton	KDE633	158.97		
Hanover	KAY875	155.73	KCH519	33.56
			KCH519	33.90
Hanson	KCF898	155.73	KCD453	33.90
Harvard	KFI514	159.09	KCD582	33.70
			KFS979	33.70
Haverhill	KCA865	155.01	KCA434	154.01
Hingham	KCA987	155.07	KCA638	154.19
Holbrook	KCC756	155.49	KCC742	46.14
			KCF402	46.14
Holden			KCC705	33.70
Holliston	KCE221	39.42	KCE745	46.46
Hopedale			KCG489	33.62
Hopkinton	KJD275	39.42	KCE204	46.46
Hubbardston			KCB364	33.70
Hudson	KCA952	155.13	KCI278	33.98
			KCI278	46.42
Hull	KCA956	155.07	KCB458	154.19
Ipswitch	KCA926	45.90	KBA346	154.07
	KCA926	158.97		
Kingston	KCH720	39.22	KCB479	33.90
Lancaster	KCF779	37.10	KEM722	33.70
Lawrence	KCA382	155.37	KAR981	153.95
			KJG925	154.025
Leicester	K8G762	45.18	KCD904	33.62
			KDU288	33.62
Leominster	KAQ389	45.66	KCB360	33.70
	KCA684	45.66	KCE365	33.70
Lexington	KJE225	155.535		
	KJE225	158.97		
Littleton			KDG722	33.66
Lowell	KCA861	155.67	KCF947	33.66
			KCF947	154.01
Lunenburg	KCH343	155.76	KAX916	33.70
Lynn	KCA702	45.46	KCC886	154.415
	KCA702	158.97		
Lynnfield Ctr.	KCB224	39.10		
Malden	KCA854	156.21	KCH732	154.25
	KCA854	158.97		
Manchester	KCA850	158.73	KCX954	154.07
	KCA850	158.97		
Mansfield	KCA888	39.54	KCA328	33.50
Marblehead	KCA728	156.33	KCH550	154.07
			KCH550	154.37

Station		Police		Fire
Marlboro	KCB300	39.10		
	KCB300	158.97		
Marshfield	KCA251	39.22	KCC359	33.90
	KCA251	158.97	KCF246	33.90
Maynard	KCA313	155.01	KCD309	46.50
Medfield	KCD812	39.98	KCV350	33.50
			KCV350	33.54
Medford	KCA877	45.70	KCI223	46.26
	KCA877	158.97	KCI223	154.22
Medway			mobiles	33.50
			mobiles	33.54
Melrose	KCB285	39.90	KDD961	46.06
			KDD961	154.22
Mendon	KCH317	155.79	KBG300	33.62
			KCE448	33.62
Merrimac	KCC497	39.82	KBX936	154.01
			KBX936	154.07
			KJF783	154.01
Methuen	KCA995	37.30	KCI237	154.01
			KCI237	154.07
Middletown	mobiles	44.74	KCD782	46.06
	mobiles	44.90	KCD782	154.07
Milford	KCB617	155.79	KCE417	46.46
Millis	KCD797	39.42	KDE245	33.50
			KDE245	33.54
Millville	KCG564	39.98	KGR326	33.62
Nahant	KCC943	155.55	KCE459-60	154.37
			KJF873	154.07
Natick	KCA457	39.32	KCB768	33.98
	KCA457	39.42	KCB768	154.205
Needham	KCA915	155.31	KCH520	153.95
	KGT439	155.31	KCH520	154.22
			KGT437	same
Newbury	mobiles	39.82	KCN852-3	154.07
			KCN852-3	154.145
Newburyport			KCY638	same
Newton	KCA692	45.78	KCE632	33.82
	KCA692	158.97	KCE632	154.22
Norfolk	KCD475	39.42	KCN689	33.50
	KCD475	39.98	KCN689	33.54
N. Andover	KCB630	158.79	KCB542	33.54
	KCB630	158.97	KCB542	154.07
Northboro	KCD548	155.79	KCZ931	33.62
Northbridge	KCA918	39.98		
N. Easton			KCG574	33.50
N. Reading	KCC370	39.10	KCF308	33.66
Norwell	KCG961	155.73	KCG933	33.90
Norwood	KCA863	39.98	KDG816	33.50
			KDG816	33.54
Paxton			KDN599	33.70
Peabody	KCA338	45.18	KCC847	46.46
	KCA338	45.18	KCC847	154.07
Pembroke	KCE998	39.22	KAD874	33.68
			KAD874	33.90
			KAS874	same
			KCH961	33.90
Pepperell	KDZ480	39.42	KDB386	33.66
Plainville	KCH621	39.42	KCE798	33.50
	KCH621	39.54	KCE798	33.54
			KCE798	46.18
Princeton	KCA881	44.74	KCD399	33.70
			KCN575	33.70
Quincy	KCA848	158.97	KGW679	153.95
	KCA848	159.15		
Randolph	KCZ482	45.50	KCE474	46.14
Reading	KCA844	45.98	KCF818	33.66
	KCA844	158.97	KCF818	46.06
			KCN708	33.66
Revere	KCA821	45.34	KDR728	154.175
	KCA821	158.97	KDR728	154.22
Rockland	KCD811	155.73	KCD427	33.78
			KCD427	33.90
Rockport	KCA872	155.25		
Rowley	KGX946	39.82	KDC289	154.07
			KDC289	154.145
Rutland	KCF353	37.22	KCH585	33.70
Salem	KCA226	46.02	KCH507	46.42
	KCA226	158.97	KCH507	154.07
Salisbury	KCA571	39.82		
	KCA571	158.97		
Saugus	KCB907	155.31	KDN542	154.07
			KDN542	154.37
Scituate	KCB621	155.07	KCB949	154.19
			KFG552	154.19
Sharon	KCA389	155.37	KCF980	33.50
Sherborn	KBM662	39.42		
Shirley	KCF350	39.42	KAX906	46.14
Shrewsbury	KGB227	39.42	KBC893	33.62
Somerville	KCA907	39.82	KDR298	33.86
			KDR298	154.22

WHITE'S EMERGENCY RADIO STATIONS

Station	Police		Fire	
S. Ashburnham			KCF249	33.70
			KCF249	33.82
Southboro	KBR639	39.10	KCE864	46.42
Southbridge			KBG787	33.62
			KBG787	154.145
S. Easton			KGG574	33.50
Spencer	mobiles	44.74	KCF772	33.62
Sterling	KJW623	37.10	KCE537	33.70
Stoneham	KCA837	45.22	KBZ954	46.06
Stoughton	KCA214	155.73	KCA629	33.50
			KCA629	46.14
Stow	KJN740	155.01	mobiles	46.50
	KJN740	155.13		
Sudbury	KCG677	39.42	KCA583	33.98
			KCS999	33.98
Sutton	KDS617	39.98	KDF582	33.62
Swampscott	KCA973	154.74	KCB724	154.07
	KCA973	158.97	KCB724	154.37
Tewksbury	KBS945	155.13		
	KBS945	155.85		
	KBS945	158.97		
Topsfield	mobiles	44.74	KCE922	154.07
	mobiles	44.90	KJL701	154.07
Townsend	mobiles	39.42	KCE553	33.70
Tyngsboro	KFF222	155.13	KCF314	33.66
Upton	KCC462	39.98	KEM634	33.62
Uxbridge	KCC462	39.98	KCF918	33.62
Wakefield	KCA845	39.46	KCC215	46.06
Walpole	KCA864	39.98	KCF375	33.50
			KCF375	33.54
Waltham	KCB361	154.43	KCD489	154.13
	KCB361	158.97	KJJ403	154.22
Watertown	KCB537	45.62	KCY613	46.22
			KCY613	154.22
Wayland	KCL471	39.42	KCE987	33.98
			KCG258	33.98
Webster	KCA315	156.21	KBL404	33.62
Wenham	mobiles	155.94		
Wellesley	KGB455	39.42	KCE403	33.98
			KCE403	46.10
			KCE403	154.22
W. Acton			KCD310	46.50
Westboro	KCC380	39.42	KAU327	33.62
W. Boylston	KCE761	37.10	KCH239	33.70
W. Bridgewater	KCD819	155.73	KCD820	33.44
			KCD820	33.90
Westford	KCE644	155.67	KCF315	33.66
	KCE644	155.85		
W. Groton			KAP590	46.14
Westminster	KCG832	155.73	KCD658	33.70
Weston	KCA857	37.30		
	KCA857	158.97		
W. Wareham			KCA639	33.90
Westwood	KCA908	39.98	KCF389	33.50
	KCE353	39.98	KCF389	33.54
			KCR898	same
Weymouth			KCA302	154.19
Whitsinville			KBQ744	33.62
Whitman	KCA874	155.73	KCB715	33.90
Wilmington	KCC421	155.13	KBR364	154.34
Winthrop			KGP681	154.22
Woburn	KCA922	39.10	KCH684	46.38
			KFF323	46.38
Worcester	KCA968	45.54	KCA706	33.86
Wrentham	KCD546	39.42	KCH794	33.50

COUNTY AGENCIES

(Other than those stations listed here, county police and fire agencies do not operate any radio units within the territory covered in this bulletin.)

Essex County Fire Dept.	mobiles		154.07
Middlesex Co. Police			
Billerica	KDZ445	45.94	
Concord	KFN561	45.90	
Plymouth Co. Police			
Hanson	KCH949	155.73	
Worcester Co. Fire Dept.			
Fitchburg	KCH677	33.70	

STATE AGENCIES

MASS. STATE POLICE

Andover	KCA884/KCB930	44.74	
Boston	KCA992	39.58	158.97
	KCD302	44.74	158.97
Bridgewater	KCC852	44.74	
	KGY246	158.97	
Canton	KCG819	158.97	
Clinton	KCB867	39.58	
Dartmouth	KCB916	44.74	
E. Boston	KCB980	44.74	
Foxboro	KCB927	44.74	
Framingham	KCC516	39.58	
	KCC204/KCE755	44.74	
Grafton	KCB921/KFI593	44.74	
Hadley	KCI422	158.97	
Holden	KCE226	44.74	
Leominster	KCB919	44.74	
Middleboro	KCC203	44.74	158.97
Milton	KCA880	44.74	
	KCA992	39.58	158.97
Newton	KCF886	44.74	
Norwell	KCB917	44.74	
Princeton	KCA881	44.74	
	KJK777	39.76	
Southboro	KCB869	39.58	
Stoneham	KJH269	39.60	
Tewksbury	KCC853	44.74	
Topsfield	KCB929/KDZ500	44.74	
W. Concord	KCB928	44.74	
Westboro	KCC851	44.74	

MASS. PORT AUTHORITY

Charlestown	KCB218	155.19	

MASS. CORRECTIONAL INSTITUTIONS

Bridgewater	KGY426	45.46	
Framingham	KCO324	45.46	
Norfolk	KCF292	45.46	
Walpole	KBF510	45.46	

DEPT. OF HEALTH, FOOD & DRUG DIV.

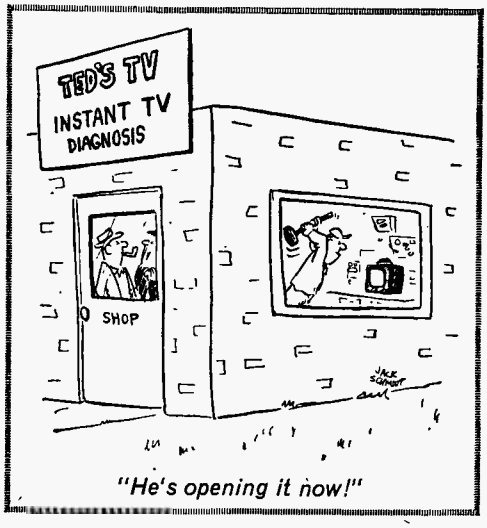
Amherst	KCF710	37.14	
Boston	KCF711	37.14	
Marshfield	KCF817	37.14	37.34

MASS. TURNPIKE POLICE

Auburn	KCE940	156.03	
Boston	KFD587	156.03	
	KFD586	159.03	
Charlton	KCE952	159.03	
Framingham	KCE938/KCE957	156.03	
Millbury	KCE939	156.03	
Newton	KFD588/KFT239	156.03	
Westboro	KCE951	159.03	
Weston	KCE937/KFB938	156.03	
	KCE950	159.03	

DEPT. OF NATURAL RESOURCES NETWORKS

31.34 31.38 31.46



"He's opening it now!"

Ham Traffic

Continued from page 73

will have more ham privileges than those of us who haven't yet qualified for an Extra Class ticket—which makes me wonder just whose country this is, anyhow?

I'm all in favor of incentive licensing—but I think it should apply equally to United States citizens *and* to foreign visitors. We now have a licensing system which makes us *earn* our privileges—and that's the way it should be. But the incentive regulations should apply to *everyone*.

What's a Field Day? The X-Mitter, club paper published by the Penn Wireless Association, reports one of the club's members visited in England a while back and showed hams there some photos of Field Day operations in the United States.

The "G-land" hams were surprised at the "plush setup" and fine equipment shown in the photos. It seems the British hams also have a Field Day contest, but it's a much more modest effort, in some ways, than ours. For example, the maximum power input permitted is 10 watts! This is rigidly enforced, with government inspectors visiting the Field Day sites and measuring the power input to the rigs.

Also, the British hams spend a lot more time planning and preparing for their Field Day. Their efforts include building efficient portable antennas and modifying rigs for low power operation.

These steps could be evidence of characteristic British softspoken, almost timid, attitudes. But they also could indicate the British have a better grasp of what Field Day is all about. For those of us who have forgotten, the whole idea is to demonstrate our ability to operate under makeshift conditions, out in the boondocks away from commercial facilities. If we ever have to provide emergency communications following a storm, fire, explosion, flood, or enemy action, we might have to work under some pretty primitive conditions . . . and quite possibly with low power because nothing else might be available. Good advance planning and experience in working through interference with a low power rig would really pay off.

What's Really Up There? While hams looking for DX may rejoice at sudden new activity in the ionosphere, pilots flying at high altitudes may be quite upset—literally —about the same thing.

It seems that some scientists have discovered that clear air turbulence, commonly called "CAT," which has nearly wrecked more than one high-flying jet, may somehow be related to intense ionization in the lower ionosphere, called "Sporadic-E."

Scientists from Utah State University made the discovery during measurements of a patch of Sporadic-E near the Great Salt Lake. They found that severe air turbulence was occurring in the same area as the Sporadic-E activity.

So, the next time you find a sudden band opening, you may wonder if some high-flying pilot is having a rough time of it up there as the blue yonder suddenly becomes very wild, indeed. ■

Hot-wire Ammeter

Continued from page 54

it. It is much easier to position the Datak characters this way.

AC Operation Experiment. The Hot-Wire Ammeter will indicate AC current as well as DC current. You can experiment with its AC operation by measuring the AC current drawn by lamp bulbs connected to the AC line.

Make an experiment board with three surface mounting lamp sockets fastened to a wood base and connected in parallel as in the schematic drawing. The Hot-Wire Ammeter is connected in series with one side of the lamp sockets and one side of the AC line cord. The other side of the line cord is connected to the open paralleled lamp socket connections.

You can experiment with the Hot-Wire Ammeter by connecting the lamps as shown in the AC Calibration Guide Table and measuring their current drain. The table is based on a nominal line voltage of 117 volts. Your hot-wire ammeter should read currents as tabulated in guide below. ■

AC CALIBRATION GUIDE TABLE

Approx. AC Current (Amps)	Lamps Connected (Watts)	Calculated value (Watts)
0.5	60	(57.5)
1	100 and 15	(115)
1.25	100 and 40	(143.75)
1.5	100 and 75	(172.5)
1.75	100 and 100	(200.25)
2	100, 100, and 25	(230)

Magnets and Life

Continued from page 38

Using magnetic fields of 20,000 to 70,000 gauss, researchers found no change in breathing rate. But there was a decrease in the heart rate, plus major changes in electrocardiogram patterns. At field strength of 100,000 gauss operation of the heart (which generates strong electrical currents) is seriously affected. It is conceivable that with strong enough magnetic fields one could cause heartbeat to cease altogether, in a functionally similar way as the magnetic damping used on balances and other devices.

Contributing Factors. No single factor or process can account for the varied effects of magnetic fields upon living things.

Some energy transfers are believed to be on the molecular level. Electrons, protons, and neutrons have magnetic poles and join magnetically to form the elements. Many join in such fashion that individual fields or "moments" cancel one another out. But at least 25 elements have atoms with unpaired electrons; magnetism of such atoms is not canceled by anti-ferromagnetic coupling to other electrons. As a result, many molecules including such atoms have their own magnetic moments and may be attracted or repelled by a stronger field of force.

Cells, in turn, probably react as ordered electrical systems. Effects of cell walls are supplemented by electrical qualities of fluids within them.

In 1888, the Austrian botanist Friedrich Reinitzer observed phenomena characterizing substances that soon came to be called liquid crystals. After 1930, interest in these compounds waned and has been revived only recently.

A liquid crystal has mechanical properties resembling those of ordinary liquids, with the optical properties of crystals and the electrical properties of semi conductors. Several major types are usually distinguished. Some are foamy, or smectic; others are threadlike, or nematic. And compounds that include cholesterol form a great number of cholesteric crystals (though cholesterol itself is not a liquid crystal). A schematic representation of these major types, prepared by the Liquid Crystal Institute at Kent State University (Ohio), shows molecules of ordinary liquids to be randomly arrayed. However, it also shows those of liquid crystals to be all in alignment with one another.

Liquid crystals, which abound in living organisms and make up much of the grey matter of the human brain, are remarkably sensitive to electromagnetic radiation. Enzymes and hormones rich in liquid crystals have dielectric properties that cause them to react strongly when they are placed in magnetic fields.

Finally, the bodies of many creatures (including man) are known to have elaborate DC electrical systems. A strong magnetic field may have the effect of inducing flow of current throughout a biological system or branches of it.

This influence is the most likely explanation for "seeing" a fluctuating electromagnetic field, "hearing" radar, or "experiencing internal short circuits" during electromagnetic storms. Induced currents influence sensory systems of birds, fishes, even snails. Orientation, navigation, and seasonal migration of many creatures is believed to be greatly influenced by the geomagnetic field.

Yves A. Rocard of the University of Paris even suggests that particularly sensitive persons may function as diviners, (dowsers) accurately locating underground streams of water as a result of instinctive reactions to induced currents. When water filters through porous media, currents are produced through electrofiltration and concentration effects. Given a medium with high conductivity, there exists at the surface a small magnetic anomaly. This anomaly, thinks Rocard, is capable of causing a dowser to sense differences in the current induced in his body.

The Future? Biomagnetism has left the era of superstition and moved into the age of science. Many forms of cancer may be described as due to uncontrolled cell division—and magnetic fields have already been shown to influence this process. Growing knowledge about Earth's magnetic field, solar flares that produce magnetic storms on our planet, and the intricacies of the human body's electrical systems may lead to important discoveries about hysteria, suicide, and insanity.

For all their intriguing achievements, the pioneers in biomagnetism have probed only a few aspects of a relationship that becomes more complex and more important the more it is examined. Within a few decades or generations, the tools of the electronic era are likely to find vital and unexpected new uses in man's age-old quest for understanding and mastery of magnetism. ■

Modern Metrics

Continued from page 78

0.0000002 newton, one ampere is flowing through the wire.

It is obviously impossible to set up experimental equipment having parallel wires that are infinitely long. In practical standardization applications, coils of wires rather than straight wires are used, and the two wires are separated only a few centimeters. Such an instrument is called a current balance.

The definitions of other electrical units are derived from the ampere. For example, the SI *volt* (V) is the electromotive force that produces one watt of power from one ampere of current:

$$1V = \frac{1W}{1A}$$

Formerly, the volt was defined in terms of resistance, one volt being that electromotive force which would produce a current of one ampere when steadily applied to a conductor having a resistance of one ohm.

The SI unit of electrical resistance, the *ohm,* is still defined in the classical way as that resistance of a circuit in which a potential difference of one volt produces a current of one ampere:

$$1\ Ohm = \frac{1V}{1A}$$

For all practical purposes, the actual values of the volt, ampere, and ohm remain close to what they have always been, though the definitions have been changed in some cases. And yet small changes are at times required as the techniques of measurement are improved.

For example, early in 1969, the value of the U.S. volt was changed in order to bring the volt's value into international agreement. The magnitude of change was very small, about ten parts per million, making the old-fashioned volt equivalent to about 1.000010 new volts. This correction was required because of improved accuracy of measurement. The change is of significance only to those who must make extremely precise voltage measurements, so don't begin to doubt your VTVM!

Let There be Light. For a long time the unit of luminous intensity was the "candle" which was originally defined as the light intensity produced by the burning of a candle of specific chemical composition. Later, the international standard consisted of a group of carbon-filament lamps kept at the Bureau of Standards.

In 1948 the International Commission on Illumination introduced a new standard of luminous intensity called the *candela.* The SI candela (cd) is now defined as the luminous intensity of 1/600,000 of a square meter of a radiating cavity at the temperature of freezing platinum (2042°K).

The device used to create light of unit luminous intensity consists of a cylindrical tube made of a refractory material such as fused thoria which has a very high melting point. The tube is surrounded by pure platinum. When the platinum is heated to its normal melting point, the light emitted from the widened open end of the thoria provides light of standard unit intensity.

The candela agrees with the original "candle" within tenths of one percent; the difference is so small as to be of significance in only the most exacting of light measurements.

The SI unit of light flux is the *lumen* (lm). The latest definition: "A light source having an intensity of one candela in all directions radiates a light flux of 4 pi lumens." A typical 100-watt light bulb emits about 1700 lumens.

Many of the new SI definitions are admittedly harder to understand than were the older definitions most of us had become accustomed to. For example, it is a lot easier to think about two scratches on a bar of metal, one meter apart, than to visualize 1,650,763.73 wavelengths of a krypton-86 spectral line.

Even so, there are compensations. One of the beauties of the metric system, for example, is its prefixes: tera (10^{12}), giga (10^{9}), mega (10^{6}), kilo (10^{3}), hecto (10^{2}), deka (10^{1}), pico (10^{-12}), nano (10^{-9}), micro (10^{-6}), milli (10^{-3}), centi (10^{-2}), and deci (10^{-1}). In terms of the meter, this means that a kilometer is 1000 meters, a millimeter is 0.001 meter, a micrometer is 0.000001 meter, and so on.

So bear this happy thought in mind if you start brooding about the complexities of modern measurement: if you are never called upon to build a king-size Ark, at least you won't have to pick wood slivers out of your elbow while measuring the deck planks. ■

[Design Solid-State Circuits]

Continued from page 58

member that Ic is about the same as IE. Therefore,

$$R4 = \frac{\textit{Battery Voltage} - \textit{Collector Voltage}}{\text{Ic}}$$

$$= \frac{9V - 5.8V}{.1\ mA} = 3200\ ohms$$

And what about C2? Since we have been talking in terms of an audio amplifier, the value of C2 must be such that it can bypass the low end of the audio spectrum with ease. A good rule of thumb is to make sure that the capacitive reactance (Xc) is less than 5% of R1 at 20 Hz. Since R1 here is 2700 ohms, Xc should be less than 135 ohms at 20 Hz.

If calculating the capacitive reactance is too tedious, try a reactance chart (there's one in Allied's great little *Electronics Data Handbook,* another in the back of the *Radio Amateur's Handbook*). In our case C2 should be greater than 50 *u*F, and preferably 100 *u*F. Its working voltage should be double the voltage across R1, so 6 volts should do nicely.

If we make C1 and C3 100 *u*F at 10 volts, we have a nice little preamp with a voltage gain of approximately 150.

The Wrap-Up. Now let's sum up the guidelines for designing our circuit:

1. Choose a collector supply voltage (Vcc) that is lower than the breakdown voltage of the transistor.

2. Select the value of the base voltage (VB). Don't forget that $V_B - V_{BE} = V_{RE}$, and that the larger the VRE the less the collector swing.

3. Select the value of IE you want. (An IE of about 1 mA is generally a good bet.)

4. Select the value of voltage divider current. As a rule of thumb, about 10% of the IE will do.

Now the Formulas:

1. Emitter Resistor $= \dfrac{V_B - V_{BE}}{I_E}$

2. Total Divider Resistance $= \dfrac{\text{Collector Supply Voltage (Vcc)}}{\text{Divider Current}}$

3. R2 $= \dfrac{\text{Divider Current}}{V_B}$

4. R3 $= \dfrac{V_{CC} - V_B}{\text{Divider Current}}$

5. Collector Resistor $= \dfrac{V_{CC} - V_{RE}}{\dfrac{2}{I_E}}$

And that does it—you're on your own! Next time you need another stage of gain for a preamp or an intercom, try designing it yourself. What you end up with may not be quite the equivalent of a $100.00 preamp, but who cares? After all, the satisfaction of being your own engineer is worth a few hundred smackers—and then some! ■

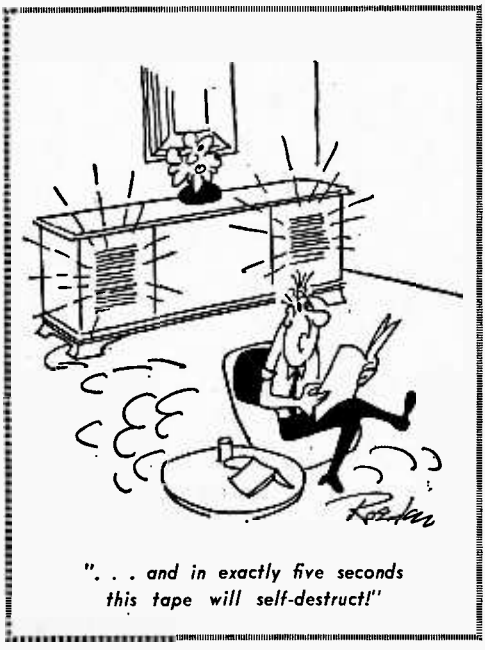
[Famous Patents]

Continued from page 63

sources for the future. More and more, scientists are focusing their attention on another application of the *Edison Effect*—the *thermionic generator.* This device converts heat to electricity by "boiling" off electrons from a heated cathode.

Since the turn of the century the Patent Office has granted hundreds of thousands of electronics patents. But the first, unrecognized at the time, even by the inventor himself, was Edison's 1884 patent on an "Electrical Indicator." ■

Copies of Edison's Electrical Indicator patent are available for fifty cents each from the U.S. Patent Office, Washington, D.C. 20231. In ordering, give the number of the patent—No. 307,031.



". . . and in exactly five seconds this tape will self-destruct!"

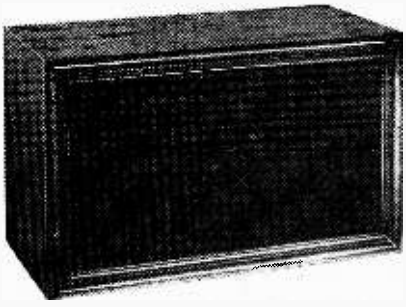
[New Products]

Continued from page 21

music power, less than 1% harmonic distortion. Response: 20-25,000 Hz with 40 dB separation. Loudness, AFC, stereo-mono, tape monitor controls. Front-panel selection switch for additional remote speakers. The tuner has stereo indicator light and tuning meter and better than 3-μV sensitivity with over 30 dB stereo separation. There's a 300-ohm FM antenna and built-in ferrite loop for AM. The Garrard turntable has a 4-pole shaded induction motor with Pickering magnetic cartridge and diamond stylus. Automatic cutoff turns off all power on last record. Model 35-160 sells for $259.95, and you can get more info from Claricon, 663 Dowd Ave., Elizabeth, N.J. 07201.

Top of the Line

The *dernier cri* (that's "the last word") in a speaker kit is the AS-48 from the Heath Company. Its damped reflex, tube-ported 8-ohm



Heathkit AS-48 Bookshelf Speaker System

system uses a 14-in. woofer with a 11½-lb. magnet assembly and a 4-in. edgewound topper ribbon voice coil in conjunction with a 2-in. piston-type direct radiator tweeter to handle up to 50 watts of program material. Quality clue—these speakers are custom-made for Heath by JBL (James B. Lansing Sound). And they make it easy for you by building the 2000-Hz crossover network and wiring the high-frequency level control prior to installation. Both speakers as well as the crossover and level controls are mounted from the front of the one-piece cabinet. The cabinet is finished in Mediterranean pecan and has a removable front grille. Price of the AS-48 is $169.95; for full specs, drop a line to the Heath Co., Dept. 19, Benton Harbor, Mich. 49022.

23 Channels by Messenger

Latest in the E.F. Johnson line of Citizens two-way radios is the Messenger 123, featuring full 23-channel operation at new low prices. Power input to the final amplifier is the maximum 5 watts for FCC type acceptance. The 123's receiver has 0.4-μV sensitivity with sharp

E.F. Johnson Messenger 123 Transceiver

filtered 7-kHz selectivity. There's a noise limiter, and the all solid-state circuitry is fully temperature-compensated to operate from −22°F to +140°F. Other features: variable squelch control, automatic volume control, a meter that monitors incoming signal strength and transmitter output power. For under-the-dash snugness, the Messenger 123 measures 2½ x 6⅜ x 8¾ in., weighs only 5 lb. Price is $169.95. For more information write to the E. F. Johnson Co., 299 10th Ave. S.W., Waseca, Minn. 56093.

Looking for a Left-Handed Monkey Wrench?

This 24-page catalog of hard-to-find tools could be a big help with your construction projects. All kinds of tools are available from the Brookstone Co.; for instance, electronic pliers, sensitive drillers, precision tools, unusual solders, miniature files, rifflers, endless hacksaw, etc. These all have detailed descriptions and applications and are only available by mail. For the jam-packed catalog, send 25¢ to Brookstone Co., 96R River Rd., Worthington, Mass. 01098.

Brookstone "Hard-To-Find Tools" Catalog

Transceiver Mit Pluses

The new Galaxy GT-550 is a 5-band single-sideband transceiver designed for either mobile or fixed station use by amateur radio operators. Compact (11¼ x 12⅜ x 6-in.), lightweight (17 lb.), yet it has 550 watts SSB power, 360 watts CW. The GT-550 is priced at $449. Accessory-wise, you can have the LA amplifier for $495, the RF console at $69, the remote VFO at $75, and the speaker console at $19.95. Other optional accessories are: AC power supply, mobile power supply, phone patch, CW filter, VOX accessory, calibrator, mobile mounting bracket, floor-board adapter. For a free brochure on the complete line write to Galaxy Electronics, 10 S. 34th St., Council Bluffs, Iowa 51501. ■

Ready for Rescue

Continued from page 47

ambulances to a woman thrown through the windshield of her car and to a boy whose clothing was flaming in gasoline, apprehended three burglars, prevented extensive damage and loss of life in three fires, and helped recapture five escaped convicts. Significantly, drivers are to report only what they see: they are not to take any action or get involved in trying to capture criminals.

Cooperating organizations include the U.S. Coast Guard, regional Civil Defense units, state Civil Air Patrol wings, military police, utilities, railroads, and disaster-coordinating centers. Typical calls by observant drivers include highway accidents, gang fights, burglaries, medical emergencies, and fires. As a matter of policy, every type of critical situation is recorded in the logs of CRW dispatchers.

In an effort to roll back the tide of crime and lawlessness and relieve the burden of law-enforcement officers, Motorola has gone on record as being ready to help every U.S. city inaugurate and maintain a Community Radio Watch program. Interested civic officials, trade associations, and service clubs can get full information about this program by dropping a line to Community Radio Watch, 1301 E. Algonquin Rd., Schaumburg, Ill. 60172. ■

Positive Feedback

Continued from page 10

The color and brightness are much like those of a flame, whose light is due to glowing particles of finely divided carbon, or soot.

An experiment was performed to see if a ball of carbon and air with an initial temperature of 18,000° Fahrenheit (roughly the final temperature of an ordinary lightning stroke) would behave like ball lightning. Major questions were how the ball would keep from rising like a hot-air balloon, or cooling off too quickly. It was found that when enough heavy soot particles are formed, the ball did not rise and heat generated by soot formation slowed down the rate of cooling. But it also turned out that the glow would be too dim to see. However, it was supposed that possible burning or other phenomena occurring at the surface of the ball might make it considerably brighter for the eye to see.

The Westinghouse study showed that many kinds of finely divided particles could have the same effect as soot. But it ruled out plain balls of hot air, or hot air mixed with traces of metal vapor.

The scientists speculated that there may be several causes of ball lightning. Several years ago a scientist investigated the possibility that ball lightning is caused by electric current flowing between clouds and ground, but this did not explain the many cases of ball lightning entering houses and other enclosures. Many ideas have been proposed about what ball lightning is, but few have been thought through to the extent of making detailed numerical calculations to find out if the ideas are sound. We can expect many more scientific "guesses" before we eventually learn the truth. Till then, do what this Editor would do if he saw a bouncing orange ball—*scram!* ■

Stamp Shack

Continued from page 13

stamps whose designs are related to all phases of telecommunications will find two available services extremely helpful.

● The one is "Topical Time," a monthly journal of the American Topical Association, which lists all such stamps as they are announced or issued, and often includes pertinent information about them.

A sample copy of the magazine and subscription form are available from Jerry Husak, Editor, 3306 N. 50th St., Milwaukee, Wisc. 53216.

● The second are album pages produced by the Washington Press, Maplewood, N.J. 07040. As there are no printed albums available for such specialty collections, it becomes necessary to mount and annotate one's own. The "White Ace" pages, which are among the best in the field, are blank except for a border design to enable owners to exercise their individuality. They are punched to fit standard 3-ring binders.

● H. E. Harris & Co., Boston has released the Second 1969 Edition of the *Harris Collector's Guide-Catalog*. This newly revised booklet is compact and easy-to-use, with 64 pages and nearly 800 clear identifying illustrations. The catalog contains complete listings of United States postage stamps plus specialties at up-to-date prices, reflecting an extremely active market. It also has a section for "Americana" stamps—foreign stamp issues which commemorate outstanding events and persons in American history. Copies of the Second 1969 Edition of the *Harris Collector's Guide-Catalog* are now available for only 10¢ from H. E. Harris & Co., Dept. W, Boston, Mass. 02117. ■

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Harry Remmert on the job. An Electronics Technician with a promising future, he tells his own story on these pages.

By Harry Remmert

AFTER SEVEN YEARS in my present position, I was made painfully aware of the fact that I had gotten just about all the on-the-job training available. When I asked my supervisor for an increase in pay, he said, "In what way are you a more valuable employee now than when you received your last raise?" Fortunately, I did receive the raise that time, but I realized that my pay was approaching the maximum for a person with my limited training.

Education was the obvious answer, but I had enrolled in three different night school courses over the years and had not completed any of them. I'd be tired, or want to do something else on class night, and would miss so many classes that I'd fall behind, lose interest, and drop out.

The Advantages of Home Study

Therefore, it was easy to decide that home study was the answer for someone like me, who doesn't want to be tied down. With home study there is no schedule. I am the boss, and I set the pace. There is no cramming for exams because I decide when I am ready, and only then do I take the exam. I never miss a point in the lecture because it is right there in print for as many re-readings as I find necessary. If I feel tired, stay late at work, or just feel lazy, I can skip school for a night or two and never fall behind. The total absence of all pressure helps me to learn more than I'd be able to grasp if I were just cramming it in to meet an exam deadline schedule. For me, these points give home study courses an overwhelming advantage over scheduled classroom instruction.

Having decided on home study, why did I choose CIE? I had catalogs from six different schools offering home study courses. The CIE catalog arrived in less than one week (four days before I received any of the other catalogs). This indicated (correctly) that from CIE I could expect fast service on grades, questions, etc. I eliminated those schools which were slow in sending catalogs.

FCC License Warranty Important

The First Class FCC Warranty* was also an attractive point. I had seen "Q" and "A" manuals for the FCC exams,

*CIE backs its FCC License-preparation courses with this famous Warranty: graduates must be able to pass the applicable FCC License exam or their tuition will be refunded in full.

and the material had always seemed just a little beyond my grasp. Score another point for CIE.

Another thing is that CIE offered a complete package: FCC License and technical school diploma. Completion time was reasonably short, and I could attain something definite without dragging it out over an interminable number of years. Here I eliminated those schools which gave college credits instead of graduation diplomas. I work in the R and D department of a large company and it's been my observation that technical school graduates generally hold better positions than men with a few college credits. A college degree is one thing, but I'm 32 years old, and 10 or 15 years of part-time college just isn't for me. No, I wanted to *graduate* in a year or two, not just *start*.

If a school offers both resident and correspondence training, it's my feeling that the correspondence men are sort of on the outside of things. Because I wanted to be a full-fledged student instead of just a tagalong, CIE's exclusively home study program naturally attracted me.

Then, too, it's the men who know their theory who are moving ahead where I work. They can read schematics and understand circuit operation. I want to be a good theory man.

From the foregoing, you can see I did not select CIE in any haphazard fashion. I knew what I was looking for, and only CIE had all the things I wanted.

Two Pay Raises in Less Than a Year

Only eleven months after I enrolled with CIE, I passed the FCC exams for First Class Radiotelephone License with Radar Endorsement. I had a pay increase even before I got my license and *another* only ten months later. I'm getting to be known as a theory man around work, instead of one of the screwdriver mechanics.

These are the tangible results. But just as important are the things I've learned. I am smarter now than I had ever thought I would be. It feels good to know that I know what I know now. Schematics that used to confuse me completely are now easy for me to read and interpret. Yes, it is nice to be smarter, and that's probably the most satisfying result of my CIE experience.

Praise for Student Service

In closing, I'd like to get in a compliment for Mr. Chet Martin, who has faithfully seen to it that my supervisor knows I'm studying. I think Mr. Martin's monthly reports to my supervisor and generally flattering commentary have been in large part responsible for my pay increases. Mr. Martin has given me much more student service than "the contract calls for," and I certainly owe him a sincere debt of gratitude.

And finally, there is Mr. Tom Duffy, my instructor. I don't believe I've ever had the individual attention in any classroom that I've received from Mr. Duffy. He is clear, authoritative, and spared no time or effort to answer my every question. In Mr. Duffy, I've received everything I could have expected from a full-time private tutor.

I'm very, very satisfied with the whole CIE experience. Every penny I spent for my course was returned many times over, both in increased wages and in personal satisfaction.

Perhaps you too, like Harry Remmert, have realized that to get ahead in Electronics today, you need to know much more than the "screwdriver mechanics." They're limited to "thinking with their hands"...learning by taking things apart and putting them back together...soldering connections, testing circuits, and replacing components. Understandably, their pay is limited—and their future, too.

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

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

THE KIT FOR EVERYONE

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

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

PROGRESSIVE TEACHING METHOD

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

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

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

THE "EDU-KIT" IS COMPLETE

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

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

Progressive "Edu-Kits" Inc., 1186 Broadway, Dept. 555NN, Hewlett, N. Y. 11557

FREE EXTRAS

• SET OF TOOLS

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

SERVICING LESSONS

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

FROM OUR MAIL BAG

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

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

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

PRINTED CIRCUITRY

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

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

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

UNCONDITIONAL MONEY-BACK GUARANTEE

Please rush my Progressive Radio "Edu-Kit" to me, as indicated below:
Check one box to indicate choice of model

- ☐ Regular model $26.95.
- ☐ Deluxe model $31.95 (same as regular model except with superior parts and tools plus valuable Radio & TV Tube Checker).

Check one box to indicate manner of payment

- ☐ I enclose full payment. Ship "Edu-Kit" post paid.
- ☐ I enclose $5 deposit. Ship "Edu-Kit" C.O.D. for balance plus postage.
- ☐ Send me FREE additional information describing "Edu-Kit."

Name .....

Address .....

City & State ..... Zip .....

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