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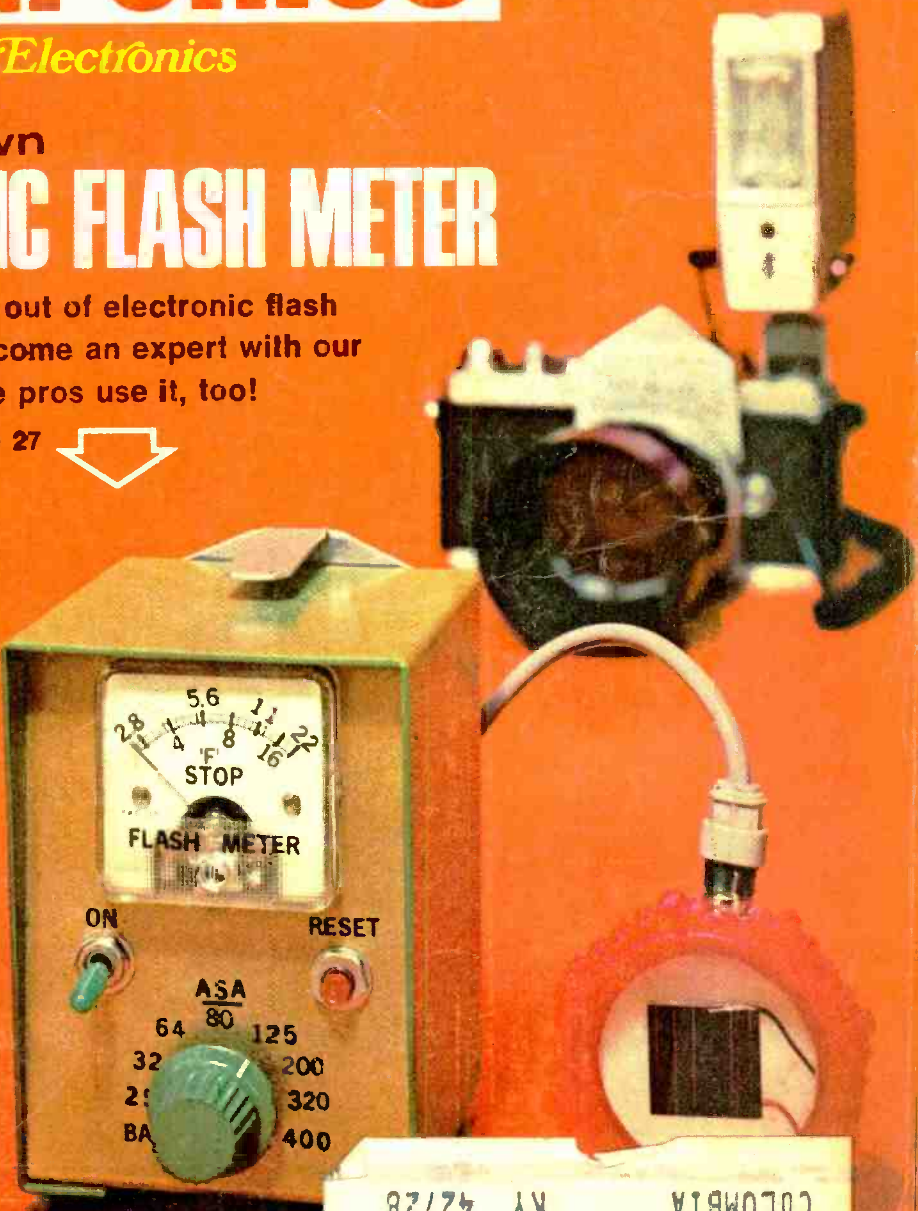

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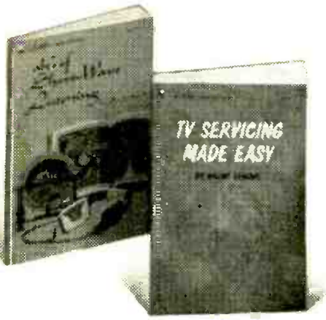

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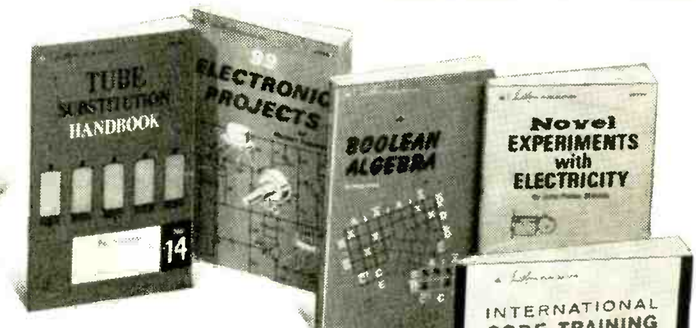

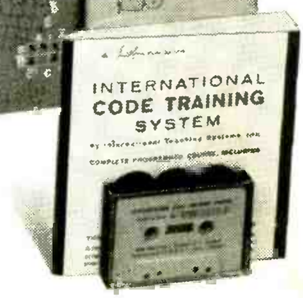

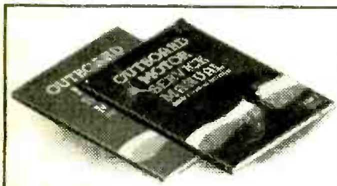

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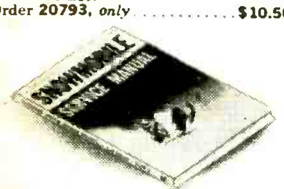

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CIRCLE NO. 2 ON PAGE 17

• July/August 1971 • Vol. 11 No. 3

e/e elementary Electronics

Dedicated to America's Electronics Hobbyists

☆ Cover Highlights

AUTHORS IN THIS ISSUE

Helen K. Branson, Len Buckwalter, K1ODH, James Busse, Steve Daniels, WB2GIF, Charles Green, W6FFQ, Jack Herman, Don Jensen, Francois Markette, Jack Schmidt, Dick Strippel, and the ELEMENTARY ELECTRONICS' editorial staff.

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CIRCLE NO. 4 ON PAGE 17

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July/August 1971 Vol. 11/No. 3
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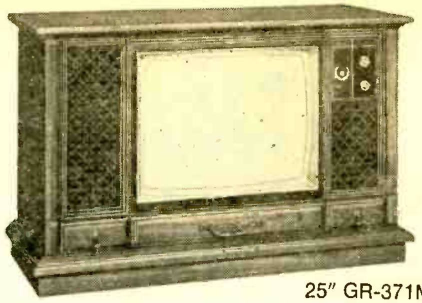
CIRCLE NO. 5 ON PAGE 17

23″ GR-370



25″ GR-371MX

20″ GR-270

18″ GR-269

14″ GR-169

There's a Heathkit® solid-state color TV to fit every size and budget need. Think about it.

Consider the choice. Heath offers five different solid-state color TV's in easy-to-assemble kit form, from the portable 14″ GR-169 to the largest screen in the industry, the 25″ GR-371MX. All offer Heath's famous modular plug-in circuit board design that makes assembly easier. Only two tubes (picture and high voltage rectifier). And Heathkit color TV's are the only sets available at any price that can be serviced by the owner, without special test equipment or years of training. The famous Heath manual, combined with the special volt-ohm meter supplied, enables you to perform every adjustment required. And each set includes the No-charge 90-day Warranty Service on solid-state modules and 2 year picture tube warranty. Here's the rundown on the Heath series of solid-state color TV's. Think them over, you'll find one just right for your own size and budget requirements.

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23″ GR-370. Actually the GR-371MX with a smaller picture tube. Features a premium quality bonded face, etched-glass 23″ screen . . . 295 sq. in. of viewing enjoyment. Includes the same standard high performance features as the 371MX above, except the Matrix picture tube is a low cost option.

Kit GR-370 (less cabinet) 127 lbs. **$539.95***

Kit GR-370MX, as above with Matrix picture tube **$549.95***

20″ GR-270. In reality, the feature-packed GR-371MX with standard 20″ bonded-face, etched-glass picture tube providing 227 sq. in. of colorful TV viewing. See the GR-371MX above for all the other standard features. Easily your best buy in a medium size solid-state color TV, and ideal screen size for smaller living rooms.

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18″ GR-269 . . . the Heathkit "compact" color TV. Has the same highly sophisticated modular solid-state circuitry as the GR-371MX, but modified to accept the popular 180 sq. in. color picture tube. Features AFT, "Instant On", 3-stage IF, MOSFET VHF tuner, switch-controlled degaussing . . . all standard.

Kit GR-269, (less cabinet), 100 lbs. **$399.95***

14″ GR-169 delivers console performance with portable convenience. Here's the GR-371MX modular circuitry modified slightly to accept a 14″ diagonal picture tube. Features MOSFET VHF tuner, 3-stage IF, switch-controlled degaussing, complete up-front secondary controls, built-in VHF & UHF antennas. Handsome portable cabinet included.

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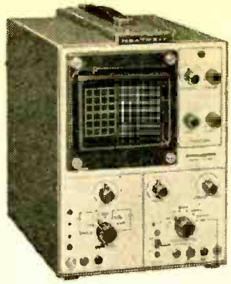

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CIRCLE NO. 6 ON PAGE 17

DX central reporting

A world of SWL info!

BY DON JENSEN

What's in store for the DXer in the coming months and years? The answer is easy—higher powered stations. More and more broadcasters are opting for potent new transmitters as the "KiloWatt War" heats up.

From the SWL's standpoint, this power race is a two-edged sword. The proliferation of hundred and multi-hundred kilowatt stations will make already noisy and crowded shortwave bands even more of a bedlam. But it may also mean that many DXers will be adding new stations and new countries to their logbooks when these high powered transmitters go on the air.

One of the world's most popular stations, Radio Nederland, which already has a relay station on Bonaire in the West Indies, is building another on Madagascar. From this Indian Ocean island just east of Africa, programs produced in Holland will be relayed to Asia, the Mid-East and Africa by a pair of 300,000 Watt transmitters.

This station will begin testing in October. One frequency to watch for this one will be 17,810 kHz.

This year, too, Israel will activate the first of two 300 kW shortwave stations, according to Arie Hauslich, station director. This should give Israel an overseas service to match its arch rival, Egypt.

Portugal's largest private broadcaster, Radio Clube Portugues, which has been absent from shortwave for a couple of years, is expected to return to the air with a 100 kW station in 1971. In the past this was a rare European logging; soon it should be in everyone's log.

Looking a little further down the road, another international broadcaster that favors the relay station approach, Germany's Deutsche Welle, will construct facilities on the island of Malta. Don't look for this one until about 1973, though.

Reception from the Dark Continent is changing, too, as more of the emerging African nations are installing new transmitters. Malawi

(Continued on page 12)

CIRCLE NO. 8 ON PAGE 11

DX Central Reporting

(Continued from page 10)

and Gabon are two that have gone this route already.

You can find the Malawi Broadcasting Corporation's signal on 3,380 kHz., and Radiodiffusion Television Gabonaise on 4,777 kHz. during the late evening hours.

DXers have been turned on by reports out of Swaziland that the government of this tiny African country and the well-known missionary organization, Trans-World Radio have reached an agreement on the construction of broadcasting facilities. It is reliably reported that TWR will begin this year to build a new station near the Swazi capital of Mbabane.

And watch, too, for interesting shortwave developments in another African nation, Uganda.

Finally, though still in the rumor stage, there are reports that shortwave outlets, though probably not of the high power variety, are in the works in such remote corners of the world as the Kingdom of Bhutan and the Faroe Islands.

Tip Topper. Take one of Africa's rarest stations, tack a few hours onto its daily broadcast schedule, and what do you have? This month's tip topper, that's what!

Radio Gambia, located at Bathurst, capital of Gambia, a wedge-like enclave on Africa's West Coast, began shortwave broadcasting back in 1962. For over eight years it was one of the rarest catches from Africa. It's problem was its schedule. It signed off too early and few North American DXers were able to hear it, since rarely does the 60-meter band "open" before the station left the air at 2030 GMT. Adding to the problem, a stronger Angolan station occupied the same frequency and time.

Recently, though, Radio Gambia added a "morning" transmission to its schedule. And though still plagued by QRM (interference), propagational conditions are more favorable and quite a few listeners are reporting it now.

Try for Radio Gambia at sign on time, 0630 GMT. Preceding the opening announcements, which are in English, you'll hear the station's unusual tuning signal played on the cora, a native instrument. After the announcements, the program swings right into Islamic chanting of the sort you'd expect to hear from a North African or Middle Eastern broadcaster.

Bandsweep. Frequencies in kHz, all times GMT: **1540**—East Coasters may find their first foreign medium wave catch, other than Canada, Mexico or Cuba, in ZNS1, the *Voice of the Bahamas*, just after local sunset . . . . . **4,035**—Obtaining station data through the Bamboo Curtain is ultra tough, but it is generally believed that the Chinese speaking station noted around 1100 is located at Lhasa, Tibet . . . . . **5,060**—QSL collectors attention! Aden, or the People's Republic of Southern Yemen as it's known these days, has finally begun to answer SWL reports. Look for it on the air around

0400 . . . . . 6,045—*La Voz del Baru* is believed to be the only Panamanian shortwaver now active. Not an easy catch, but try early in the morning, say around 1030, and see what you hear . . . . . **9,660**—Here's one for the inexperienced listener looking for a Venezuelan logging. *Radio Rumbos* is easy to identify, despite its all-Spanish programming, during much of the evening . . . . . **11,910**—ETLF, *Radio Voice of the Gospel* in Addis Ababa, Ethiopia, is doing nicely, thank you, around 2000. Programming is in English . . . . . **11,950**—And not far away on the dial is another religious station, ELWA, Monrovia, Liberia. Its gospel broadcasts are audible around 0615 . . . . . **15,165**—Though *Radio Denmark* dropped its English language service some time ago, you can still catch a quicky station identification in our lingo at 1230.

(Credits: Larry Magne, Pennsylvania; Dan Ferguson, Florida; Duane Gettings, Ohio; Ira Wagner, N.Y.; Dan Romanchik, Michigan; National Radio Club, Box 99, Cambridge, Massachusetts; North American SW Association, Box 989, Altoona, Pennsylvania)

Backtalk. Paul Gunn, an Aurora, Ill., reader, asks, *"Have you any information on a station in Lithuania? I've heard it on about 9.8 MHz, at 2245. The city was announced, but I couldn't understand it."*

What you heard, Paul, was Radio Vilnius. This program, in English and Lithuanian, is recorded in Lithuania and is broadcast twice a week, Fridays and Sundays at 2230 GMT, by various Russian transmitters. The broadcast you heard on 9,800 kHz was from a station at Kazan, USSR.

One of the hottest spots for real DX these days is the 60-meter band, the frequencies around 5 MHz. Members of the North American Short Wave Association recently received a listing of 60-meter band stations compiled by loggings editor, Dan Ferguson. Now, according to Dan, this useful log has been made available to non-members. You can get a copy for one buck, by writing Dan at P.O. Box 8443, Coral Gables, Fla.

Canadian Graham Fleck of Victoria, B.C., sends a list of some of his recent loggings, including Radio Japan. Graham reports hearing the Tokyo station on 9,505 kHz at 1700 GMT, on 9,670 kHz at 1430 GMT, and on 11,705 kHz at 2300 GMT.

Morrie Goldman tells of a mysterious station he heard on about 8,995 kHz several days before the launching of the Apollo 14 moon shot. Around 0500 he logged the single sideband signal, in Russian. The Chicago listener said the transmission consisted of a series of repeated words.

A spy station? Signals from one of those Red trawlers that prowl our coasts, and not just for

(Continued on page 100)

stamp shack

Philatronics Today!

BY ERNEST A. KEHR

●● It may come as a distinct surprise to Americans, but little Belgium is the only nation in the world that offers its citizens completely automatic telephone service to any part of the world. The astonishing fact was marked by the release of a multi-colored 1½-franc stamp that was released on Jan. 18. Designed by Ets. J. Malvaux, it simply shows a handset telephone against a background of concentric lines spreading from it to the stamp's borders to symbolize limitless communications facilities.

● With some 10 million inhabitants, Belgium is one of the most densely populated countries on earth, and because of their extremely high level of education and business acumen, it's not at all surprising that demands for telephones has risen from 350,000 to 1.3 million in the last twenty-five years.

● Direct dialing service was initiated in 1922, and within two years, extended to other city central offices. By 1930, when a distinct tele-

phone administration was established, Belgium had dialing service in operation in 23 cities and four domestic networks which required no human operators to make inter-urban calls.

● Like telephone companies in other lands, Belgium's government-operated facilities found itself overwhelmed with service demands following World War II. Local calls reached the billion mark; there are upwards of 250 million interurban calls and more than 40 million international calls annually. That's enough to tax any equipment.

● The invention and development of automated, electronically controlled telephone equipment was seen as the only solution and as soon as it was made available, Belgium appropriated vast sums to purchase the machinery. By February, 1967 interurban service was completely automatic. Belgians could pick up any telephone in the land (including public pay stations) and reach any other telephone in Belgium without calling upon operator assistance.

● Automatization is so complete that pay station telephones will complete a call just as soon as the correct number of coins are deposited: even making the distinction between day, night and holiday rates, and indicating when overtime fees must be dropped into the slots—all without a human ever having to be necessary!

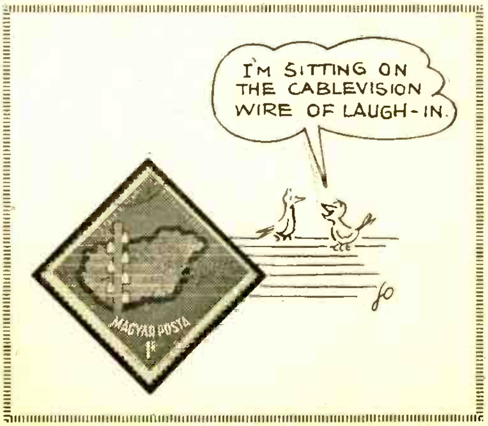
● Following the domestic automatization, Belgium's telephone service was linked with other European networks through the European Conference of Posts and Telecommunications. On Oct. 8, 1970, work was completed on the international facilities, and today any Belgian telephone can automatically complete a long-distance call to any place on earth that has telephones, whether it be next-door Holland or Honshu, half a world away.

●● Skipping from telephones to another form of rapid communications, Portugal commemorated, on Nov. 21, last year, the first submarine cable which linked it a century ago to England, with four multi-color stamps.

● Two of the stamps, designed by Duarte Nuno Simoes, (1 and 2½ escudo) show the "Secanderia" laying the under-water cable, while the other two (2.80 and 4 escudo) show a close-up of the heavily insulated cable circuits. On the day of issue Portugal also distributed special first-day envelopes imprinted with a pictorial design showing a cable end, the rugged coast at Carcavelos, near Lisbon, where the first Portuguese terminal was built and put into operation on June 8, 1870.

● Within two years after the first trans-Atlantic cable was finally laid for successful transmission of messages between the United States and Britain, John Pender, an English textile mag-

(Continued on page 16)



(Continued from page 14)

nate, established the British India Submarine Telegraph Company, Ltd., to lay a cable from Bombay to Suez. The Anglo-American Telegraph Company had already linked Alexandria to Malta.

Work began on the manufacture of the complicated, reinforced and insulated wire. By Nov. 1869—just weeks after construction of the Suez Canal was completed by Ferdinand de Lesseps—the "Great Eastern" and "Chiltern" left Portland with some 2,600 miles of cable for the job of laying it between Bombay and Suez, via Aden. The "Hibernia" and "William Cory" left later, sailing to Aden. Subsequently, the four ships dropped their cargo to the ocean floor at different points, but simultaneously. At the same time, the Suez to Alexandria link was put down on Egyptian soil. When that work was done, messages could be sent all the way to Malta. It now remained for the Malta-Britain link to be finished. On May 14, 1870, the ships, "Scanderia," "Edinburgh" and "Hibernia" laid the last 3,300 miles of cable, using Carcavelos as a base between Gibraltar and England. The final splice here was made on June 8.

● Although this cable has been subjected to more than a century of wear and tear under the oceans and have been supplemented by much more modern and sophisticated submarine wiring, maintenance of it since 1870, has kept it in good working order. Since then Portugal has established its own cable links to territories in Africa; the land has been connected with existing cable networks of other nations so today there is no spot on earth which has such facilities is beyond the reach of Portuguese citizens.

● **What's New?** In response to our contest offered a few months ago, several dozen readers wrote letters telling why they would like to own one of the H. E. Harris Company "Stateman" albums, probably the best of publications to properly house postage stamps of the world. The letters came from all parts of the country; from collectors of all ages—nine to 77! All were interesting and worthy so the final selection became particularly difficult and required considerable deliberation. Winner of the album is Yin L. Shih of Howard Beach, N.Y. As was promised, each person who also submitted a stamped, self-addressed envelope with his letter received an assorment of foreign postage stamps.

Something new in stamp collecting is a service offered by the Martin Stamp Company. Worldwide collectors often specialize in some areas, but never the entire world—just too costly. Thus, many pages in their worldwide albums are blank—lean at best. Now, each month, the worldwide collector can receive a packet of stamps from a single country from some remote area of the world. Month after month, his collection will begin to perk up as blank portions of his album are filled quickly. Get the complete details by writing to the Martin Stamp Company, P.O. Box 122C, Brooklyn NY 11223. Do it today!

Collectors living near, or planning to be in New York next winter, will do well to mark their calendar as one of the most outstanding stamp shows of all time will be held at the Waldorf-Astoria Hotel from Nov. 26 to Dec. 1. Intended to commemorate the 75th anniversary of the Collectors Club, one of the world's two most distinguished philatelic organizations, it will include examples of all the "aristocrats" of stampdom which are owned by members. Among the treasures are the unique British Guiana one-cent of 1856, which was sold last year for $280,000; the Post Office Mauritius cover, which brought $380,000 at auction a little while earlier, a block of the United States air-mail stamps with inverted center and similar priceless gems. ■

ELEMENTARY ELECTRONICS

READER SERVICE PAGE

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

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

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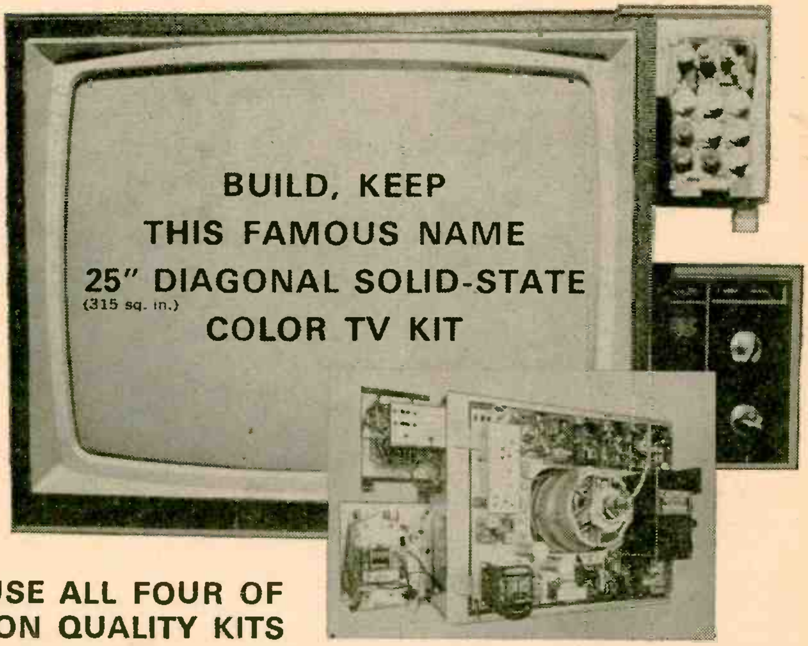

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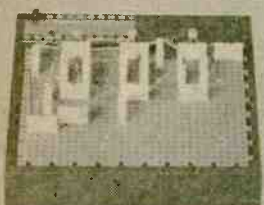

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YOU'LL BE READY FOR COLOR TV . . . B&W AND MOST HOME ENTERTAINMENT ELECTRONICS DEVICES

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

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

Why Color TV pays better.

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

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

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

EXCLUSIVE ELECTRO-LAB® IS YOURS TO KEEP, USE

This unique at-home laboratory comes to you in 16 shipments and includes a remarkably instructive ***design console.*** You can rapidly "breadboard" a great variety of circuits without soldering. The ***Oscilloscope*** offers 3-way jacks to handle test leads, wires, plugs. Images on screen are bright, sharp. Your ***Transistorized Meter*** is fully portable, features a sensitive, 4-inch, jewel-bearing d'Arsonval meter movement. It registers the slightest power surge or lag on a large, easily read dial.

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Note: TV picture is simulated.

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CIRCLE NO. 12 ON PAGE 17

BOOKMARK
BY BOOKWORM

If you're active in electronics it's a sure bet you've built some of Herb Friedman's projects. In his thousands of published articles he's always tried to use components the experimenter can get without too much difficulty. In *99 Electronic Projects* he's packed in a wide assortment of inexpensive projects, most of which can be built right out of the junk box or for less than $10. The book contains sixteen project groups, from audio amplifiers, to remote controls, to test equipment; well, you name it and it's in the book.

Whether your interests lie in Ham radio, CB, auto repair, photography, audio or just general experimentation, you'll find several projects to

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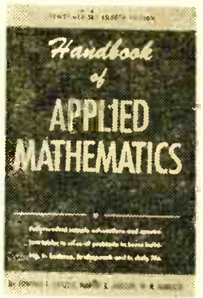
Circle No. 38
on Page 17

whet your interest. If you're not an experienced electronic hobbyist, building these projects will introduce you to many of the new solid-state devices such as solar cells, silicon controlled rectifiers, triacs, zener diodes and, of course, the transistor.

Unlike other project "cookbooks" with components dating back to the stone age, *99 Electronic Projects* uses the latest solid-state devices, which are readily available from your local distributor or the major mail order houses. You'll not find a single 2N107 project that indicates a five to ten-year-old project. Also, you're not left hanging in the air about such things as heat sinks, wiring techniques, crystal types or calibration. Herb's anticipated most of your problems and every project contains all the oddball information you'll need to get it working right. He's even included an introduction on how to save a buck when buying components. Don't expect commercial-grade performance from most of the projects; just a lot of fun and useful devices like a professional type home burglar alarm. Published by Howard W. Sams & Co., Inc.

A How-To Math Book. Beginning with a broad review of basic mathematics, arithmetic, algebra, geometry, trigonometry, and calculus, *The Handbook of Applied Mathematics* covers in full the methods and calculations in building construction and mathematical shop work, together with the techniques and methods of pro-



Hard cover
1119 pages
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Circle No. 39
on Page 17

cedure. It also includes the most widely used calculations in business mathematics. Among the new features of the *Fourth Edition* are discussions of the recent advances in building construction, including double pane and triple pane glass for picture windows, plate glass for windows and shower stalls; new methods of building block construction; new insulating materials especially foamed plastic; the new hubless soil pipe; and the new methods of electrical wiring with flexible conductors. The section on Electronics has been fully revised to include transistors and their circuits as they are used in the new types of radio sets, television sets (both black-and-white and color), and high fidelity and stereophonic music systems. The new treatment of business calculations includes the latest data on income and withholding taxes, automobile insurance, and an entirely new chapter on Accounting for Small Businesses. Published by Van Nostrand Company, Inc.

Hush Puppies of Ham Radio. The great expense to which many radio amateurs have gone to operate Ham radio stations has brought considerable criticism to the art. Now, a formerly unpopular Ham operation, QRP, has become one of the fastest growing trends largely because it means a return to "home brewing", and economical operation. *Solid-State QRP Projects* by Edward M. Noll, W3FQJ encourage this activity which already has sprouted into a world-wide chain of clubs and networks. The topics covered here are, for the most part, QRP projects—another way of saying amateur operations with very, very, little power. The units covered have power ratings from less than 100 milliwatts up to about 20 watts. A variety of solid-state oscillators, both crystal-controlled

(Continued on page 97)

LITERATURE LIBRARY

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

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

3. Custom *Alarms* reveals how inexpensive professional alarms can really be. Install one yourself. Circle 3 for exclusive catalog.

4. Get it now! *John Meshna, Jr.'s* new 96-page catalog is jam packed with surplus buys.

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

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

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

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

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

10. It's just off the press—*Lafayette's* all-new 1971 illustrated catalog packed with CB gear, hi-fi components, test equipment, tools, ham rigs, and more—get your free copy!

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

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

13. Take it off (insulation, that is) neatly and quickly with *Xcelite* Wire Stripper-Cutters. Discover three models, adjustable for all commonly used solid and stranded wires.

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

15. Here's a free 20-page booklet that tells you how to improve your TV pic and a do-it-yourself approach to installing a Master Antenna TV (MATV) system. *Mosley Electronics* will wing it your way.

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

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

18. *Heath's* new 1971 full-color catalog is a shopper's dream. Its 116 pages are chock full of gadgets and goodies everyone would want to own.

19. Get two free books—"How to Get a Commercial FCC License" and "How to Succeed in Electronics"—from *Cleveland Institute of Electronics.*

20. *National Schools* will help you learn all about color TV as you assemble their 25-in. color TV kit.

21. Bone up on CB with the latest Sams books. Titles range from "ABC's of CB Radio" to "99 Ways to Improve your CB Radio."

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

23. For success in communications, broadcasting and electronics, get First Class FCC license. *Grantham School of Electronics* will show you how.

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

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34. Pep-up your CB rig's performance with *Turner's* M+2 mobile microphone.

35. CBers, *Midland* has come up with a neat colorful brochure on their line. Before you buy, check on *Midland*.

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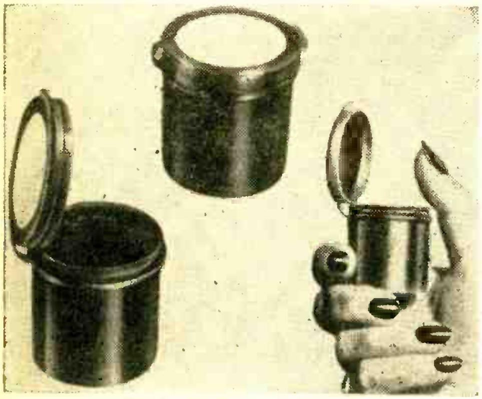
Hey, look me over

Showcase of New Products

Keeps Its Lid On

Poly-Cons, the protective containers with convenient flip-open and snap-shut hinged lids are air-tight, moisture-proof, unbreakable and chemically inert. These unique containers are made in 7/8-in. x 1 1/2-in. (1/2



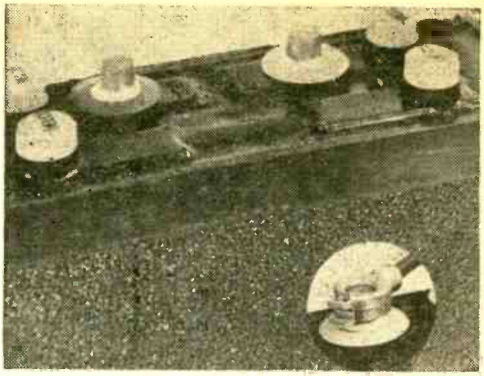
Richard Mfg. Poly-Cons

oz.), 1 1/2-in. x 1 1/2-in. (1 oz.) and 1 1/2-in. x 2-in (2 oz.) sizes and in a wide variety of bright, attractive colors plus semi-transparent. Blank labels are recessed into their tops for identification marking. Poly-Cons are valuable around the home, farm, trailer, and in workshops for the hobbyist. They will safely house such items as photo film and accessories, model parts, paints and glazes, electronic components. The manufacturer will send a representative bag of twelve Poly-Cons in assorted sizes and colors for $1.00 to cover postage and handling. Write: Richard Manufacturing Company, Box 2041, Van Nuys, Calif., 91404.

Circle No. 32 on Page 17

Cuts Crust

Automobile battery life can now be increased by as much as 50 per cent, thanks to a unique new vinyl battery accessory, Battery Savers. They fit all standard automotive and truck-type battery posts and are guaranteed to prevent corrosion formation or buildup if installed as directed. In-



David's Battery Savers

stallation is simple, fast, and can be performed by anyone. Secret of the new device is its vinyl honeycomb core construction which suspends standard motor oil and provides a continuous flow of anti-corrosive lubrication by capillary action to the area between the cable clamp and the battery post where it is needed most. Price is $1.00 per set, postpaid, from Louis David, Elkhart Lake, Wisconsin 53020.

Circle No. 33 on Page 17

Tuner Cartridge

Two new cartridge tuners for automotive stereo tape players have been introduced by GC Electronics as part of its Audiotex line. They are an AM-FM tuner and an FM multiplex stereo tuner. Both are designed to slip into the cartridge loading slot of all automotive 4- and 8-track tape cartridge players. The AM-FM tuner, model number 30-3075, is powered by an internal 9-volt transistor-radio battery. It slides into the cartridge slot, after being connected to the car's external radio antenna. A special antenna adapter connector is provided with the unit which can be left in the car's antenna line permanently. A slide switch on top of the unit selects AM or FM modes. This tuner is priced at $45.00. The FM stereo multiplex tuner, model number 30-

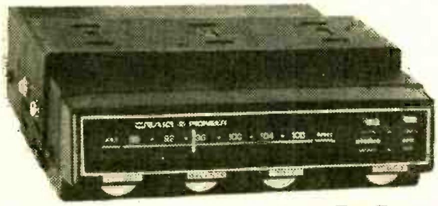
GC 30-3075 Cartridge Tuner

3076, is physically similar to the AM-FM unit. It has a "Stereo/Mono" mode selector switch for optimum operation, as well as a stereo beacon indicator light that flashes on when a stereo station is being received. A special switch on the bottom of the tuner adjusts input circuitry for nearby and distant FM stations. This unit is priced at $54.00.

Circle No. 34 on Page 17

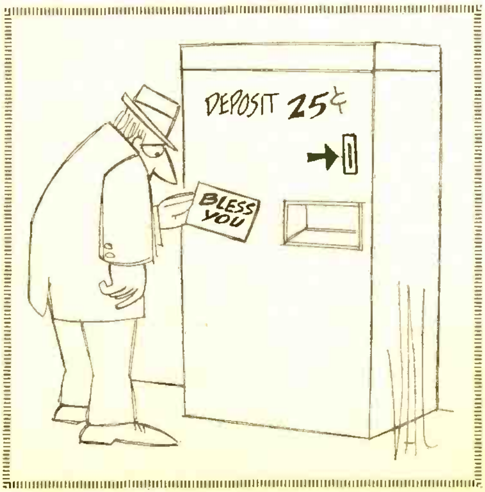
Road Runner

Craig Corporation's new model 1901 Mobile FM Stereo Receiver features an FET (field effect transistor) pre-selector to prevent overload and cross modulation, ceramic filters to maintain exact alignment of IF stages and switchable automatic frequency control for convenient and precise tuning, combined with drift-free reception. A "stereo-mono" switch locks the receiver in monaural condition when stereo reception is excessively noisy. Stereo lamp indicates presence of a stereo broadcast. Unit is furnished with a multi purpose mounting bracket for quick and easy installation under lip of the dash or on the floor or console of any car, truck or boat with 12 volt negative ground electrical system. Suggested list price is $109.95. ■

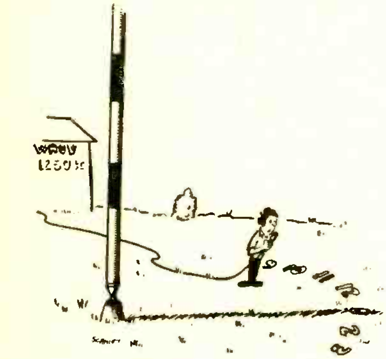


Craig FM Receiver

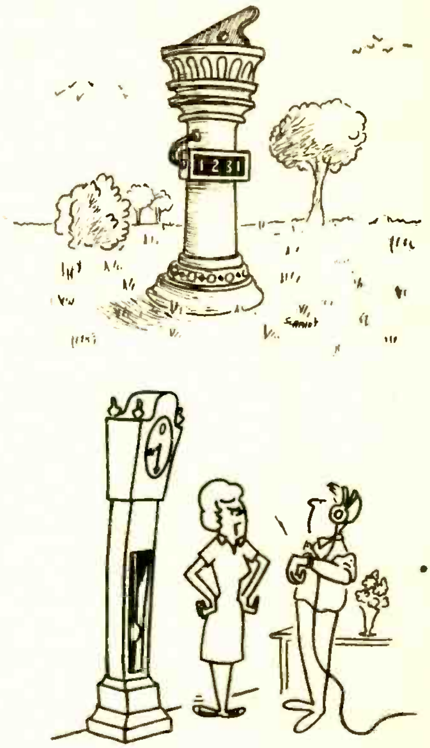
Circle No. 35 on Page 17



by Jack Schmidt



"The time is now . . ."



"Yeah, but it's a lot older than WWV."

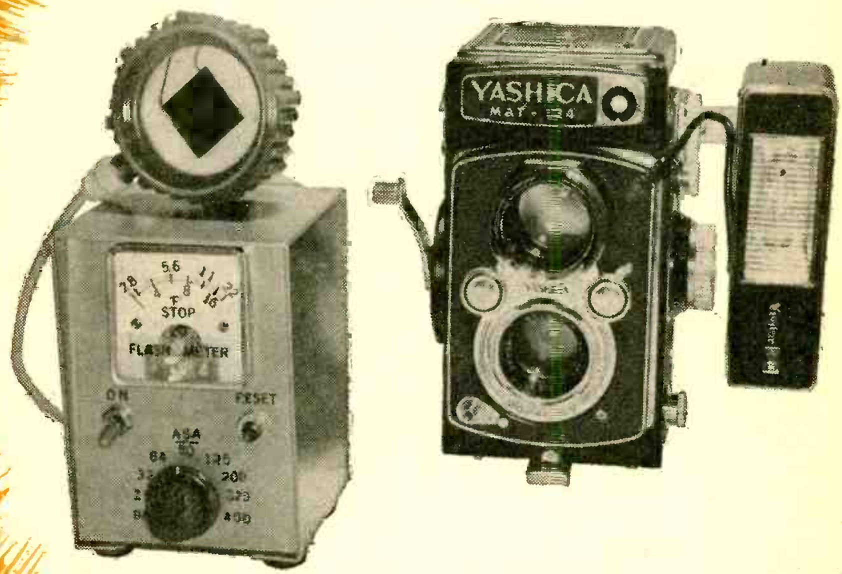
"It's sign-off time, Harry!"

"Remember, honey, right at 8 o'clock you press the doorbell button!"

"Okay, okay . . . after we hear your watch hum, then what?"

elementary Electronics JULY-AUG 1971

FLASH MASTER



Our meter stops strobe photography's F-stop fumble

by Charles Green, W6FFQ

Electronic flash units, or strobes, as they are called, are blinking their way into the equipment carry-alls of amateur and pro shutterbugs alike. And, for pretty good reason, too. Low in cost, these compact strobes bring the advantages of professional electronic flash gear to John Q. Hypo. Having made obsolete the conventional you-have-to-slobber-the-end-first flash bulb, an electronic flash's light quality is so close to daylight that it's the perfect Jill for all the Jacks whose cameras are always loaded with daylight rated color film.

But, you can't go strobing yourself into a silver halide eternity, though. Problem with modern electronic flash doojobbies is that you still need to revert back to old fashioned methods to determine your camera F-stop lens setting. Many a pro develops calloused shoulders hefting his assortment of tape measures, guide estimates, and a whole host of literature give-aways needed each time he goes on a shooting spree with his electronic flash. Worse yet, pity our poor photog busily poring over his not so easily understood tables and guides, all the while missing that one-in-a-lifetime shot he so arduously prepared himself for!

Slaying The F-Stop Dragon. Saint George made short shrift of the mythical Dragon the same way our *Flash Master* takes the fumble out of F-stop calculation. Our electronic meter will give you F-stop readings faster than any published table can. All without the problem of measuring the distance between film plane and subject. And *Flash Master* "remembers" the F-stop needed in the particular scene you want to capture, too! Just trigger the electronic flash before you take your picture with *Flash Master* at the subject. Our *FM* will indicate the required F-stop you have to set your camera's lens opening to. Exposure bracketing is now a thing of your past!

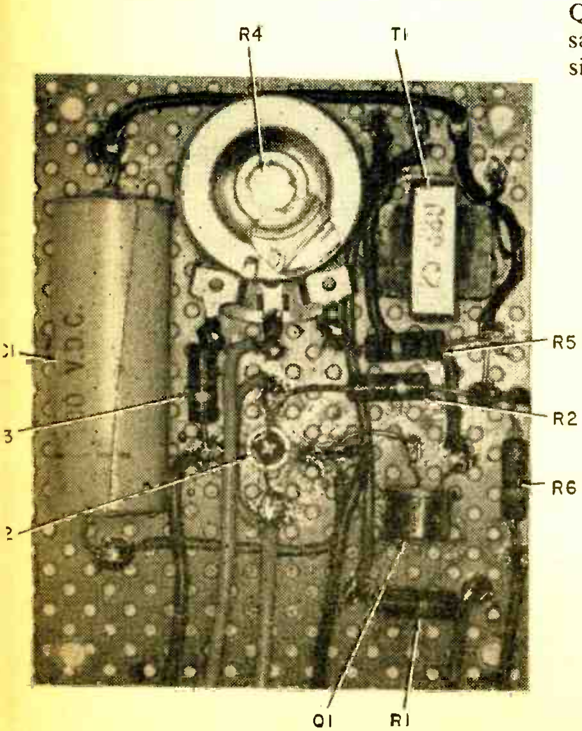
Take a peek at *Flash Master's* schematic; you'll see our electronic flash meter uses a silicon photo cell and an IGFET (Insulated Gate Field Effect Transistor) in a novel and easily-duplicated circuit. *Flash Master's* ASA ranges are switch selected for performance repeatability. And, the DC power requirements are supplied by a C-size flashlight battery.

Our *FM* is housed in a compact aluminum cabinet with the silicon photo cell in a probe housing. One of *Flash Master's* advantages over conventional photo light reading devices is that it doesn't respond to incident light. Not only can it be left on for long periods without constant re-zeroing before actual use, but our *Flash Master* only responds to *electronic* strobe light, making its readings accurate either indoors or out of the studio. And the flash meter's circuit draws less than 1 mA from the self-contained battery, assuring the photographer long battery life.

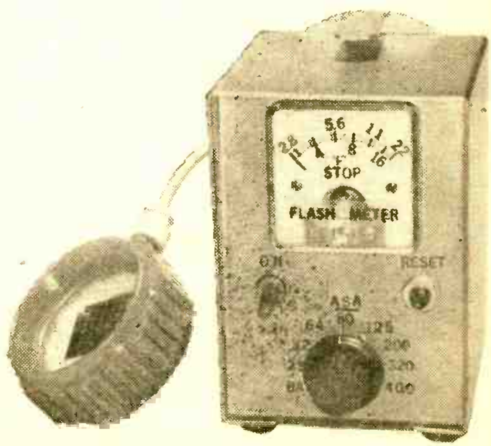
Flashing Performance. When a brief burst from an electronic flash unit is sensed by the photocell Z1, a pulse is generated and fed via resistor R1 to the 3.2-ohm winding of transformer T1 (an ordinary audio output transformer connected "backwards"). The pulse voltage is stepped up to a higher value in T1's 500-ohm secondary winding. This stepped-up pulse is rectified by transistor Q1, rigged a la diode. The "diode" is really formed by the collector to base junction of Q1. Referring to our schematic, you'll see that no connection is made to Q1's emitter; snip off this lead close to Q1's case.

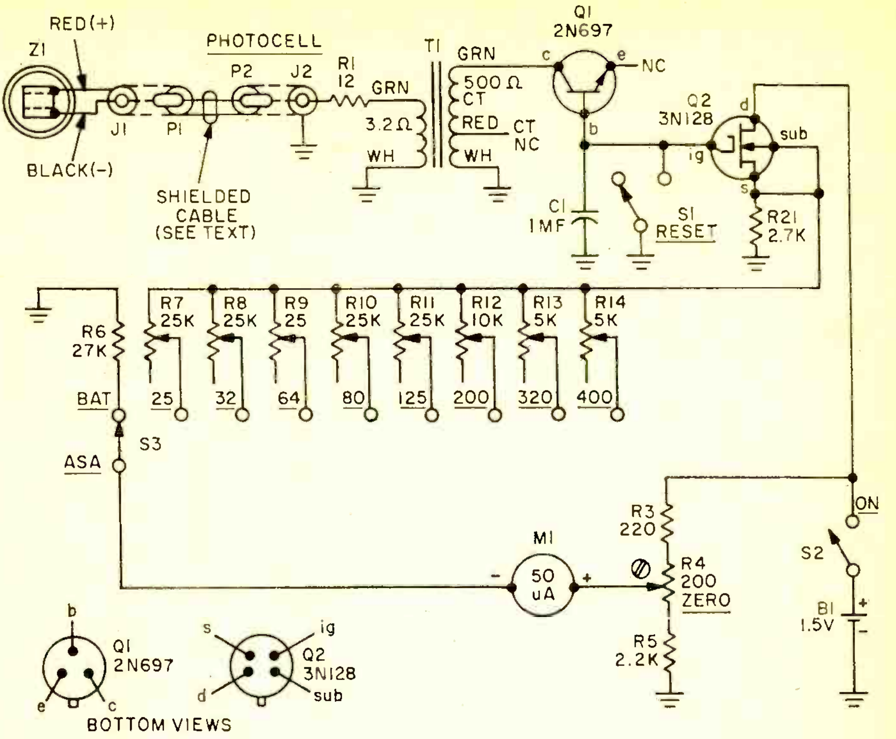
The voltage output of Q1 charges capacitor C1 to a value dependent upon the amplitude of the electrical pulse (which is determined by the light flash intensity). Capacitor C1's voltage charge controls direct current flowing through the insulated gate of field effect transistor Q2 which is wired into a basic super-high-input-impedance voltmeter circuit. Finally, voltage across C1 is read on milliammeter M1, calibrated in F-stops to read directly.

The electrical charge of C1 will be held until the very high internal resistances of Q1 ad Q2—measured in terms of thousands of megohms—and the dielectric resistance of C1 itself, drains the charge off



Perf board, with all of Flash Master's components except pots R7-R14 (mounted on separate perf board), is housed in pro-style cabinet, below.





PARTS LIST FOR FLASH MASTER

B1—1.5 volt C-size battery (Eveready 1035 or equiv.)
C1—1 uF, 100 volt min. rating, Mylar capacitor (see text)
J1, J2—Phone jacks (single hole mounting type)
M1—50 uA panel meter (Lafayette 99F50494 or equiv.)
P1, P2—Phono plugs (part of 6-inch shielded cable—see text)
Q1—2N697 silicon NPN transistor (RCA)
Q2—3N128 Insulated gate field effect transistor (RCA)
R1—12-ohms, ½-watt, fixed resistor
R2—2,700-ohms, ½-watt, fixed resistor
R3—220-ohms, ½-watt, fixed resistor
R4—200-ohms, linear potentiometer (with slotted shaft)
R5—2,200-ohms, ½-watt, fixed resistor
R6—27,000-ohms, ½-watt, fixed resistor
R7, R8, R9, R10, R11—25,000-ohms, miniature trim pot (from Radio Shack 271-201 Trim Pot Assortment)
R12—10,000-ohms, miniature trim pot
R13, R14—5,000-ohms, miniature trim pot
S1—SPDT, miniature pushbutton switch (Calectro E2-141 or equiv.)
S2—SPDT, miniature toggle switch (Radio Shack 275-326 or equiv.)
T1—Output transformer: 500-ohm center-tapped primary; 3.2-ohm secondary. Turns ratio 12.5 to 1 (Midland 25-620 or equiv.)
Z1—Silicon photo cell, approximate output .5 Volt @ 25 mA (Calectro J4-800 or equiv.)
1—Aluminum cabinet 4-inches high x 2¾-inches wide x 2¾-inches deep (LMB 2754-N or equiv.)
1—plastic flashlight lamp housing (see text)

Misc.—perf board and push-in clips, battery holder for B1, sheet aluminum for photo cell housing, 3/16-in. spacers, hookup wire, sheet foam rubber, decals, solder, etc.

the capacitor. C1's electrical charge will normally last long enough for you to take your reading on M1 minutes after your strobe light has flashed. After you take the reading, depress switch S1, discharging C1 and resetting M1 for the next light flash.

Potentiometers R7 to R14 are adjusted for specific sensitivities of M1 and are selected by switch S3 for the eight most popular ASA ranges. Resistor R6 is connected in series with M1 with S3 thrown into the *Bat* position to form a simple voltage divider. Purpose is to provide the photog with some means of checking B1's health. And lastly, switch S2 controls the DC power from B1 to *Flash Master's* circuit.

Flash Master's Bright Boardwork. Most of our *FM*'s components are mounted on a 2½ x 3-inch perf board installed on the rear of the 2¾ x 2¾ x 4-inches high aluminum cabinet. Component placement is not critical; any size perf board and cabinet can be used. Trim pots R7 to R14 are mounted on another perf board measuring 2½ x 2-inches. It's installed on the rear terminals of M1. *Flash Master's* remaining components are mounted on the box front panel and bottom section.

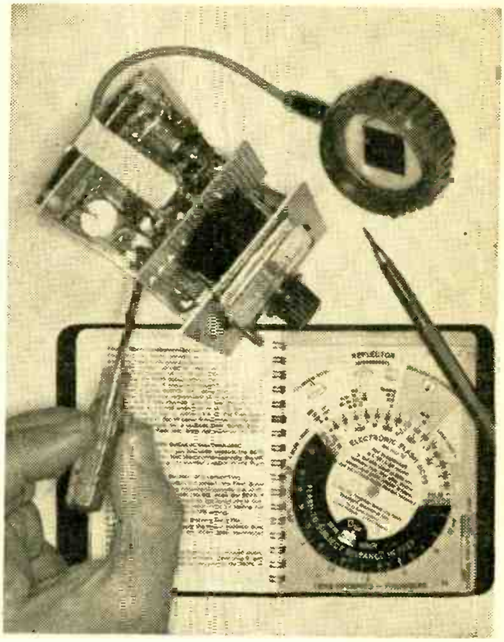
Begin construction by cutting the 2½ x 3-inch perf board to size, and mounting the components with flea clips as shown in our photos and schematic. Use caution when mounting the insulated gate field effect transistor Q2. To prevent damage to Q2, do not remove the shorting wire that the manufacturer has wrapped around the transistor leads (at the body base) until you've wired all of *Flash Master's* circuits.

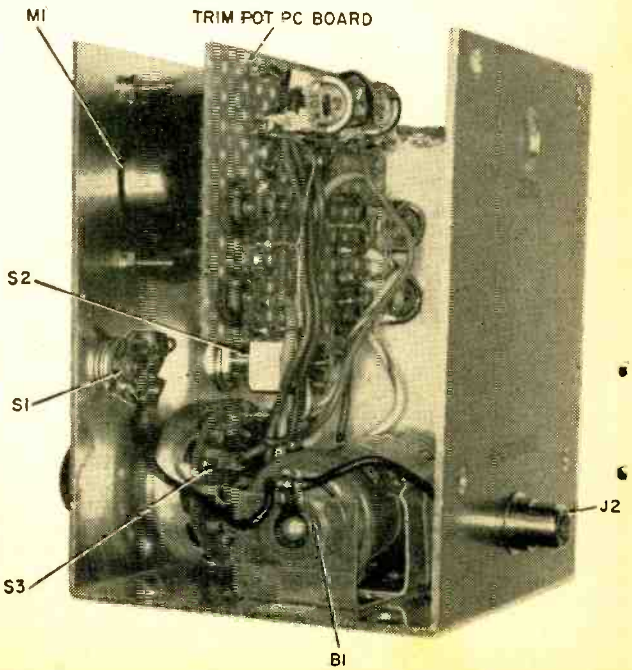
Transformer T1 is mounted by bending its mounting lugs through holes in the perf board. Then drill a hole in for potentiometer R4 (zero adjust) near the top of the perf board holding *FM*'s circuit. Mount and wire the remaining perf board components as in our schematic.

Lay out and mount meter M1 and the remaining front panel components as shown in our photos. Temporarily position the 2½ x 3-inch component board on the rear panel and locate the hole for adjusting R4 zero-adjust potentiometer. Also locate the mounting holes for RCA-type phono jack J2, and B1's battery holder on the bottom of the box. After you've mounted the circuit perf board on the rear panel with 3/16-inch spacers, slap J2, the battery holder, M1, and the remaining controls onto the front panel.

Cut a 2½ x 2-inch perf board section for all trim pots. The author attached this perf board to M1's meter terminals. But it can

(Continued on page 100)





Trim pot perf board is mounted on rear of meter via M1's lead hardware. Prewire trim pot perfboard first, wire it to S3 next; then mount both units in place. Calibrating Flash Master only requires strobe with known BCPS rating plus Kodak's Master Photoguide AR-21, available at most photo shops. Calibrate Flash Master for incident light.

THE COMING OF CLASS E CB

Imagine 80 channels, 25 watts, FM reception, 60-foot high antennas, and plans to separate the boys from the businessmen!

by Jack Herman

CB radio will have 80 more channels when the FCC adopts new rules proposed by the Electronic Industries Association. In addition to 23 Class D channels in the congested 27-MHz (11-meter) band and 8 paired Class A channels in the 460-MHz band, there would be 80 new channels in the 220-MHz band.

The EIA has proposed that the 220-222

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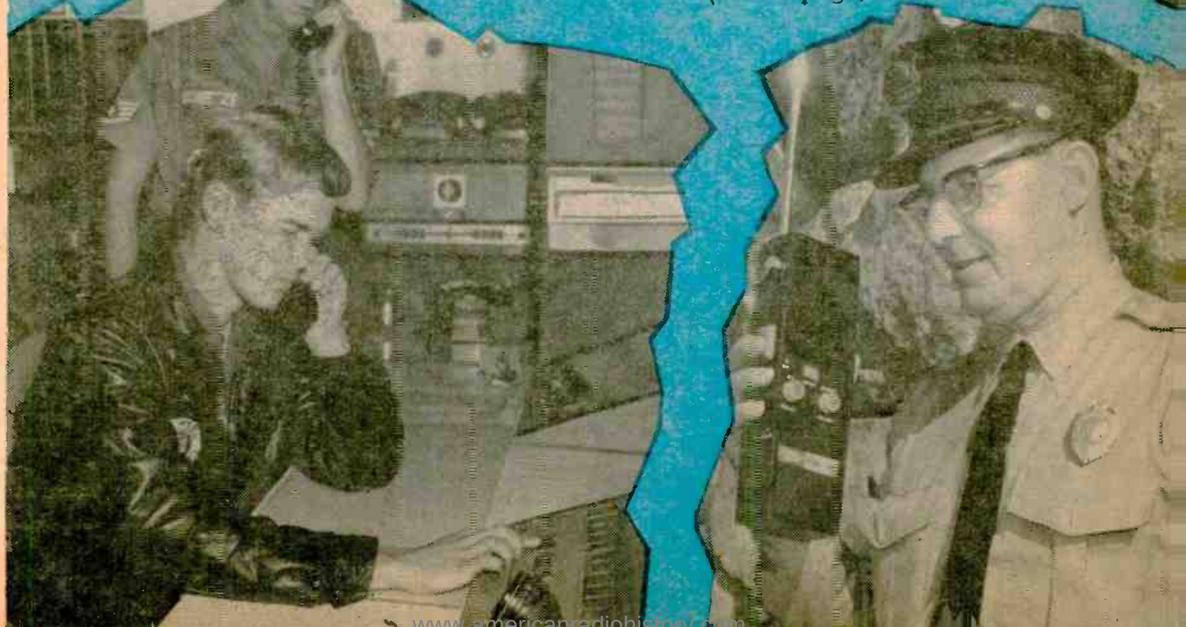


MHz portion of the 220-225 MHz ham band be re-allocated to the Citizens Radio Service for use by a new class of CB station designated Class E.

It is highly probable that the petition will be acted upon favorably because of the backing of the powerful EIA and because there is expected to be little or no opposition. The very few hams who operate in this band would still have 3 MHz of space available.

Differences—Class D and Class E. They're quite different. The Class D CB channels are within the old 11-meter ham band. This band is available to industrial, scientific and medical (ISM) devices which can knock out the entire band with impunity. The Class D channels are available on the basis of "no protection" against ISM interference. No wonder the hams gave up the band without a struggle.

Either AM or SSB is permitted on Class D channels whereas only FM would be permitted on Class E channels.

Of the 23 Class D channels, only seven may be lawfully used for intercommunication between units of different licensees (general communications). One channel is reserved for emergency communications, and 15 are for communications between units of the same station.

Under the EIA proposal for Class E stations, there would be *50* channels for intercommunication between units of different licensees (inter-station), *29* for communications between units of the same station (intra-station) and *one* emergency channel. Power limit on 57 of the channels would be *25 watts*. On the other 23 channels the power limit would be *one watt*.

Where the Band Is. The proposed Class E band is in the VHF portion of the radio spectrum. Fig. 1 shows that the band is 4 MHz above TV Channel 13, and 46 MHz above the 150-174 MHz public safety/industrial/and transportation/marine band. It's a good part of the radio spectrum—it's free of skip and much more immune to noise than the 27-MHz band. And it's not as much affected by absorption as the Class A UHF citizens band in the 460-470 MHz portion of the radio spectrum.

Advantages of FM. The main reason for lower noise is the location of the band in the radio spectrum. FM, as used in FM broadcasting, minimizes noise because of the noise improvement capability of "wideband FM." Class E stations would use "narrowband FM" which takes some advantage of FM noise improvement—but it's not much better than AM and is inferior to SSB.

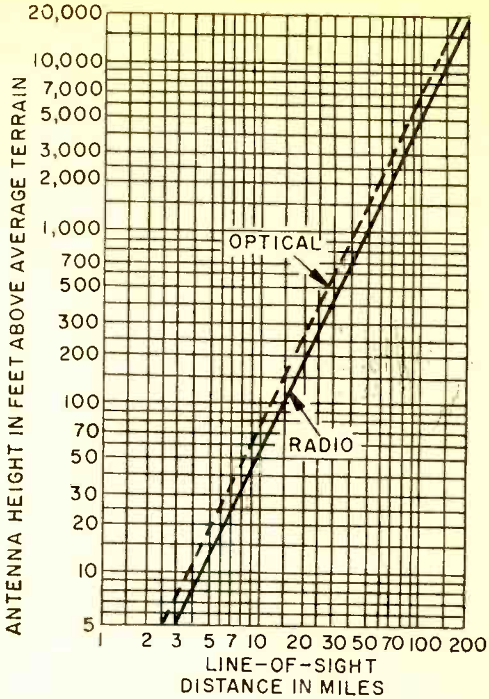


Figure 2. As antenna height increases, radio signal spans greater line-of-sight distance.

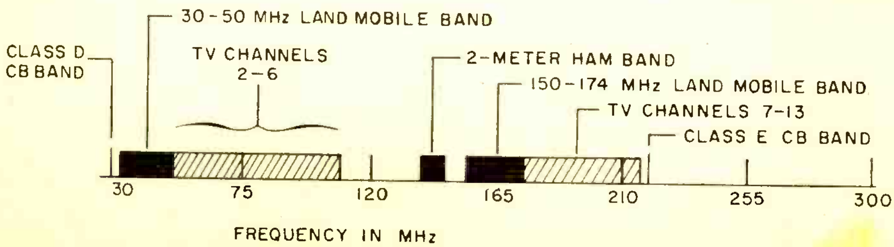


Figure 1. Class E CBers won't be bothered as much QRN or skip as Class D CBers.

So why not use SSB? The answer is simple: it would cost considerably more. All things considered, FM is the best choice with AM a close second choice.

The big advantage of narrowband FM over AM is the FM "capture effect." On the Class D citizens band (27 MHz), you can hear more than one AM station at a time, plus heterodyne beats (whistles caused by one signal heterodyning with others). But, with a true FM receiver, you will hear only the strongest signal. The receiver "captures" the strongest signal and blocks out weaker signals.

Communicating Range. Don't expect to talk more than 100 miles unless your base station is on top of Twin Peaks, Mount Diablo, Mount Washington or some other high point! Reliable range is somewhat greater than line-of-sight. Fig. 2 shows the "radio horizon" range. But, the signals are usually "reflected" by solid objects beyond that distance and into closer-in areas that would be "dead spots" for 27-MHz signals.

Class D v. Class E Comparison Table

	Class D	Class E
Power limit	5 watts	25 watts*
Modulation	AM or SSB	FM
Antenna height limit	20 feet	60 feet
Channel allocations:		
Inter-station	7	28
Inter-station calling (only)**	0	3
Intra-station	15	19
Intra-station calling (only)	0	1
Business (only)	0	9
In-plant (only)	0	5
Marine (only)	0	5
Public service (only)	0	14
Emergency	1	1
Total channels	23	80

* On all except 23 of the Class E channels which are limited to 1 watt.
** Unofficially Class D Channel 11 is widely used.

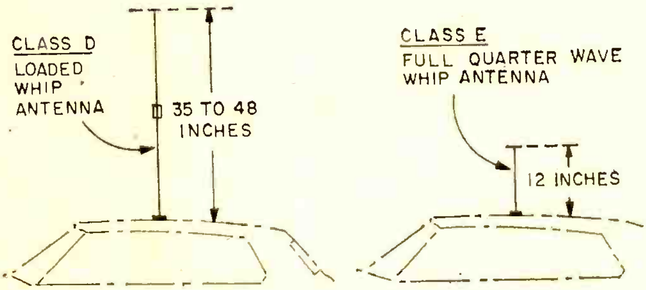


Figure 3. Class E CB will be boon for those who take their rigs with their wheels. Not only is Class E antenna shorter than Class D antenna, it's also easier to install. Better VSWR between transceiver final, antenna is another plus for Class E—no loading coil's needed.

Antenna "height" is not a good term. (The proposed new rules would allow antenna height to be 20 feet above an existing structure or 60 feet above ground, whichever is higher.) "Effective antenna elevation" is much more meaningful. For example, an antenna 60 feet above a 1000-foot hill is 1060 feet above the valley floor below. From a 1000-foot hill you can see much farther than when standing in the valley below or in flat country. Fig. 2 tells you why.

Antenna Size. Here's the big advantage of Class E over Class D. A full quarter-wave whip antenna is only 12 inches long. On the Class D (27-MHz) band, a quarter-wave whip is nine feet long. Even a loaded whip is about four feet long. Fig. 4 shows the big difference.

Mobile Beam. There are 27-MHz band mobile beams which work well. But, the two whips should be approximately nine feet apart. In the 220-MHz band, they need to be only approximately one foot apart. Long ago, the New Jersey Turnpike police cars were equipped with a pair of 18-inch whip antennas spaced about 18 inches apart. By means of a switch, as shown in Fig. 4, either whip can be the antenna and the other a reflector. This makes it possible to improve communication in either the forward or reverse direction. Imagine what CBers would come up with!

Base Beam. Because of the short wavelength, high-gain beam antennas can be about one-fifth of the size of a 27-MHz band antenna array for the same gain. And, if you have the space, you can build (or buy) a beam with much more gain.

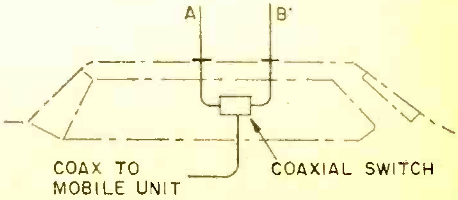


Figure 4. Coax switch routes RF energy to antenna A or B, depending upon vehicle direction.

e/e COMING OF CLASS E CB

Two-Frequency Operation. Class D (27-MHz) CB stations employ single-frequency simplex operation wherein both inter-communicating stations alternately transmit and receive on the *same* frequency. Class E stations would use the single-frequency simplex mode and/or two-frequency simplex, as shown in Fig. 5. The base station transmits on frequency 1 (f1) and receives on frequency 2 (f2). Mobile units transmit to a base station on f2 and receive from a base station on f1. This technique permits more systems to operate on the same pair of frequencies with less interference and in closer proximity to each other.

Equipment Differences. Ever since 1958, CB equipment manufacturers have demonstrated that they could develop and build amazingly good AM gear and sophisticated SSB transceivers—at a low price. On the other hand, commercial land mobile FM radio equipment has been much higher in price. Not that it costs more to build FM equipment, but because the number of units manufactured is smaller—the principles of mass production were difficult to apply.

An AM transmitter requires a high-power modulator, but in an FM transmitter, low-level modulation is applied at the output of the oscillator, as shown in Fig. 6, by a single tube or transistor. Or, the oscillator itself can be frequency-modulated by a varactor diode (varicap), as shown in Fig. 7.

More stages are required, however, but they shouldn't cost much. For example, to transmit on 220.800 MHz (Channel 33),

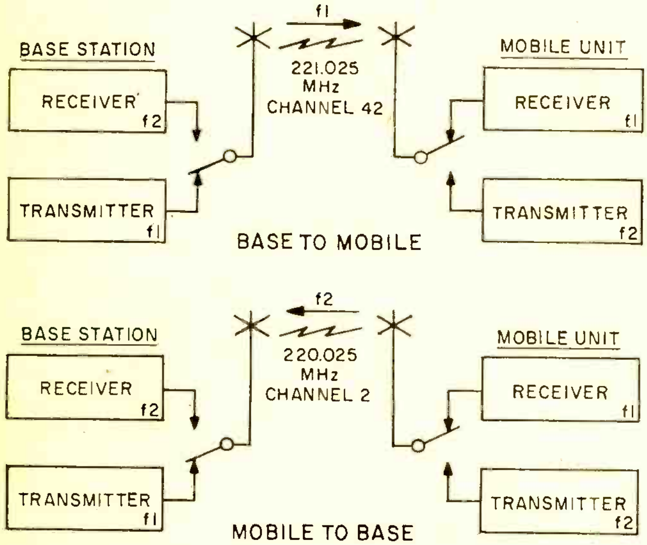


Figure 5. Base station operator transmits to mobile unit on one of 80 different channels allocated to Class E Citizens Band. Mobile operator responds to base station on another channel, as our figure to left, shows. Greater transmit-receive flexibility is one of Class E's advantages over Class D's restriction (two stations may occupy only one frequency at same time).

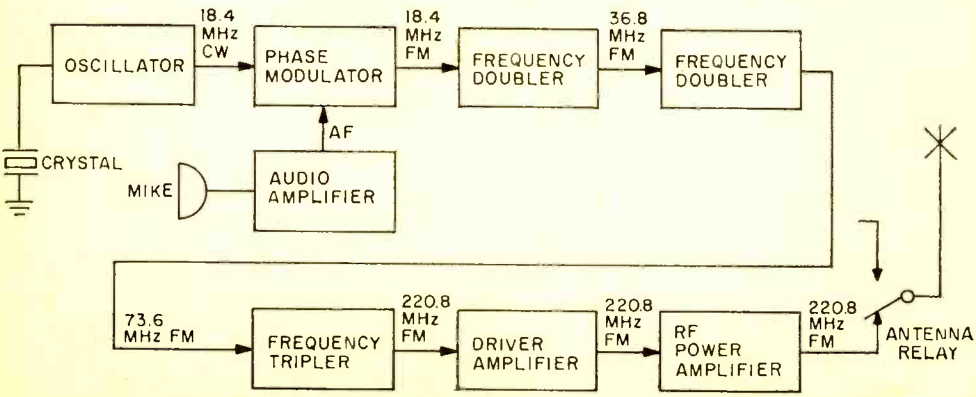


Figure 6. Original oscillator signal is multiplied 12 times in FMed Class E rig.

PROPOSED CLASS E CHANNEL ALLOCATIONS

CH.	FREQ. (MHz)	CODE	CH.	FREQ. (MHz)	CODE	CH.	FREQ. (MHz)	CODE	CH.	FREQ. (MHz)	CODE
1	220.000	MS	21	220.500	MC	41	221.000	G	61	221.500	S1
2	220.025	MS	22	220.525	MD	42	221.025	G	62	221.525	S1
3	220.050	MS	23	229.559	MD	43	221.050	G	63	221.550	S1
4	220.075	MS	24	220.575	MD	44	221.075	G	64	221.575	S1
5	220.100	MS	25	220.600	MD	45	221.100	MC	65	221.600	S1
6	220.125	MS	26	220.625	MD	46	221.125	B	66	221.625	IP1
7	220.150	MS	27	220.650	MD	47	221.150	B	67	221.650	IP1
8	220.175	MS	28	220.675	MD	48	221.175	B	68	221.675	IP1
9	220.200	E	29	220.700	MD	49	221.200	B	69	221.700	IP1
10	220.225	MS	30	220.725	MD	50	221.225	B	70	221.725	IP1
11	220.250	MC	31	220.750	MD	51	221.250	B	71	221.750	TC1
12	220.275	TA	32	220.775	MD	52	221.275	B	72	221.775	TC1
13	220.300	TA	33	220.800	MD	53	221.300	B	73	221.800	TC1
14	220.325	WA	34	220.825	MD	54	221.325	B	74	221.825	TC1
15	220.350	TA	35	220.850	MD	55	221.350	SC	75	221.850	TC1
16	220.375	MD	36	220.875	G	56	221.375	M	76	221.875	RC1
17	220.400	MD	37	220.900	G	57	221.400	M	77	221.900	RC1
18	220.425	MD	38	220.925	G	58	221.425	M1	78	221.925	RC1
19	220.450	MD	39	220.950	G	59	221.450	M1	79	221.950	RC1
20	220.475	MD	40	220.975	G	60	221.475	M1	80	221.975	RC1

B = business only. CH = channel. E = emergency. Freq. = frequency. G = general use. IP1 = in-plant (1-watt). M = marine. M1 = marine (1-watt). MC = general calling (mobile only). MD = General use (mobile only). MS = intra-station (mobile only). RC1 = road condition information (1-watt). S1 = intra-station (1-watt). SC = intra-station calling. TA = traffic advisory. TC1 = traffic control (1-watt). WA = weather advisory.

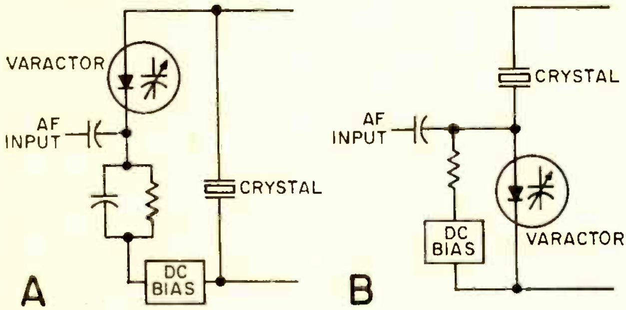


Figure 7. Figures A, B shows how varactor diode directly FMs oscillator. Junction capacitance of diode is varied by AF input in series with DC bias. Whether diode is in parallel (as in A), or series (as in B) with crystal, varying capacitance directly changes output frequency of crystal in oscillator.

the transmitter oscillator could employ an 18.4-MHz crystal followed by the phase modulator, two frequency doublers and a frequency tripler to produce a 220.8-MHz output signal 18.4 x 2 x 2 x 3 = 220.8). A frequency multiplier (doubler, tripler, etc.) is simply a Class C amplifier stage or varactor stage.

An FM receiver can be exactly the same as an AM receiver. It will demodulate AM signals and narrowband FM signals (because of slope detection). But, far better is a true FM receiver employing IF limiter stages plus a discriminator, ratio detector or gated beam detector for demodulating FM signals. There is a little more cost here for limiters and an FM detector, but not much more.

What to expect. Watch the market to be flooded with all kinds of Class E transceivers—base, mobile and portables. Some will employ true FM circuitry. The cheapies will undoubtedly employ an AM receiver circuit capable of demodulating FM. The former type is what to consider—forget the latter type unless you're strapped for funds.

As many will recall, the earliest Class D rigs were operable on only one channel. Some had tunable receivers so all 23 channels could be tuned in, but transmission was limited to one channel. Later, multi-channel transceivers became available which employed crystal control of both the transmitter and receiver. And, more recently, came the 23-channel transceiver which employs a frequency synthesizer and is factory-equipped with crystals for operation on all

(Continued on page 97)

The quietest doctor on the staff of a California health clinic is the one who sits in a little room by himself all day interviewing patients....

The Doctor's a Computer

A patient puzzles over one of the questions asked by Medical History Taker at interview.

The computer is remarkable in its responses as it encourages the patient to answer questions.

What's the doctor's most boring task in any medical examination? Certainly not the bill! It's finding out a patient's past history. Usually he delegates this chore to his nurse.

A computer has now been developed that does the job quicker and better. It's in operation at the Alta Bates Hospital in Berkeley, California, where it forms part of a massive health screening clinic. The interview with the computer is the first of many stages in the 90-minute "total screening" operation. This "screening procedure" is part of a gradual worldwide switch in emphasis from therapeutic to preventive medicine. The computer questionnaire is called the "Medical History Taker." It works very simply. A patient enters a small room where he confronts a display screen fitted with a row of buttons. He is alone—"Complete privacy is essential," points out Dr. David Singman, medical director of the East Bay Health Screening Center, a division of Alta Bates. "Many of the questions it is necessary to ask patients are of a confidential nature and truthful answers are essential to the diagnostic procedure."

Discovered by hams almost three decades ago, it's a new bag for today's CBers!

By Len Buckwalter, KBA4480

Ask almost anyone in Citizens Radio what the maximum transmitter power is and he'll say, "Five watts." And the number of CB channels assigned by the FCC, as everyone knows, is 23. Yet, an increasing number of manufacturers are talking about transmitter power well over 5-watts and rigs that communicate on *46* channels! Is this a case for the Better Business Bureau? Not at all since there's truth in all these claims. The reason is a special method of transmitting and receiving known as SSB, or single sideband. Nearly a dozen CB manufacturers now offer rigs that fall in the sideband category.

Sideband is so efficient and powerful that military services adopted it decades ago for long-distance voice transmission. The American Radio Relay League says that hams started using it back in 1933, and today it's the major mode for phone (voice) operation. Many hams, in fact, slyly ridicule regular AM as *Ancient Modulation*. Telephone companies have used sideband for point-to-point radio for years and recent FCC regulations say that everyone on the 2-3 MHz marine band must switch to sideband within a few years. Citizens Banders got into sideband about eight years ago, and recently the number of CB sideband sets has multiplied in the marketplace, with an ever-increasing variety of interesting features being offered.

If sideband's so good, why doesn't the FCC make it the rule of realm? There are good reasons that delay a complete changeover from regular AM to sideband. For one, sideband is more complex than regular AM and is priced higher. A sideband receiver must be extremely stable for good reception. It requires extra circuitry and controls, like a speech "clarifier," since sideband is more critical to tune. Also, a sideband signal is not compatible; on a standard receiver it sounds like a dyspeptic Donald Duck. But the benefits of sideband for many operators could ultimately outweigh its shortcomings simply on an ability to double the number of channels that can be assigned a given band. There's also the sideband signal's excellent ability to penetrate interference.

Conventional AM. To grasp the mysteries of sideband, begin with regular AM. Sideband, in fact, is a form of Amplitude Modulation, but with major electronic surgery. Many students of radio have been brought up on the basic picture of AM shown in Fig. 1. It shows a radio carrier produced by an oscillating crystal, then amplified in a final radio-frequency stage of a transmitter. As the name implies, the carrier bears the voice or intelligence over long distances. (It takes carrier frequencies far higher than audio to create electromagnetic fields that leave the antenna.) Note that an audio signal from the mike (after amplification) is joined to the carrier in the final RF stage. Since audio is delivered as a varying voltage to the tube plate, voice frequencies apparently control the amplitude, or strength, of the emerging carrier. This creates the classic AM signal—one where the carrier pulsates in exact step with audio.

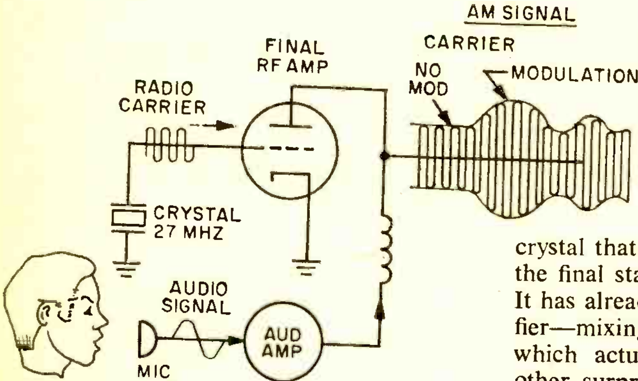


Fig. 1. This is how AM works. The carrier wave, generated by a fixed-frequency crystal oscillator, has its amplitude modulated by the audio signal. The modulated carrier is transmitted at crystal frequency.

Missing Links. But that's only part of the picture. A closer look at an AM signal would reveal that it actually consists of *three*, not one, basic components. The reason is that audio within the final stage is actually *mixing* with the carrier. Assume, for example, that audio is a tone of 1 kHz (which may also be written as .001 MHz) and this intelligence is modulated onto the 27-MHz CB radio carrier. As shown in Fig. 2, audio and radio mix in the final amplifier and three distinct signals go to the antenna:

Upper sideband—The audio tone and carrier *add* (1 kHz + 27 MHz) and create 27.001 MHz, the upper sideband;

Lower sideband—The tone and carrier also *subtract* (1 kHz – 27 MHz) and create 26.999 MHz, the lower sideband;

Carrier—The third product is the RF carrier, which emerges *without* a trace of modulation on 27 MHz.

Thus a CB rig's output is actually a three-part affair. The surprise, in terms of a conventional textbook picture of an AM signal, is the carrier. It actually emerges with no modulation and is as steady as the crystal that produced it. And once it leaves the final stage it serves no further purpose. It has already done its job in the RF amplifier—mixing with audio to create sidebands, which actually bear the modulation. Another surprise is that *one* sideband is also useless. Since uppers and lowers are mirror images of each other—and carry identical audio—one can be cast aside without losing a syllable. (That's why conventional AM, the sideband supporters say, transmits a lot of air pollution.)

Puckered-Out Power. To heap another indignity on old-time AM, let's see how much power it wastes. As shown in Fig. 3, if a CB transmitter is putting out 3 watts of RF power, then two watts fall to the carrier. The remaining watt then divides between the two sidebands. Thus, fully two-thirds of the transmitter RF power is lost.

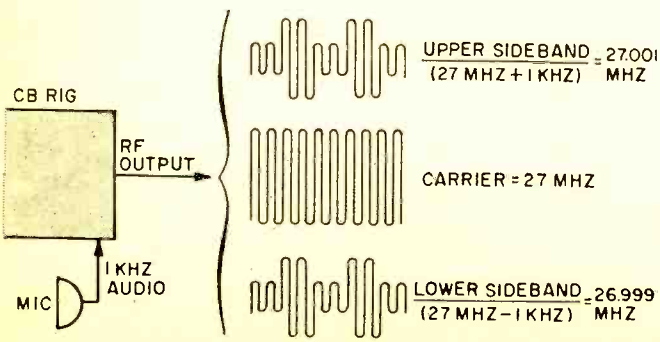


Fig. 2. When analyzed, the AM signal is found to be a combination of an unmodulated carrier plus sidebands. The sideband frequencies are equal to the carrier frequency plus and minus the audio frequency.

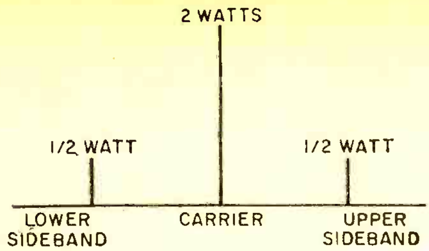


Fig. 3 The power distribution in an AM signal shows how much is wasted in the sidebands.

When the duplicate sidebands arrive at the receiver, they add their voltages so there's no power loss here. But even though both sidebands can be ultimately used in receiving, there's still a major disadvantage in transmitting upper and lower, as shown in a moment.

Suppressing the Villains. Now take the array of signals and let's repackage them in far more efficient fashion. As shown in Fig. 4, the same three RF watts have been completely jammed into the upper sideband. The carrier is now considered *supressed*, its energy poured into the upper sideband. Similarly, the lower sideband is suppressed and its energy also shifted to the upper sideband. Now, every bit of RF wattage is serving the cause; to send maximum voice power without violating FCC power restrictions. Before seeing how this three-into-one package is created, note another important benefit in Fig. 4. The signal—now single sideband—is far narrower than the original. It's about 3 kHz wide instead of 6 or more kHz. This is behind the claim that sideband takes 23 channels and doubles them to 46. It's possible for two independent sideband stations to operate on the same assigned channel; one selects the lower sideband as the other transmits on the upper position. Since they're several kHz apart, there's no

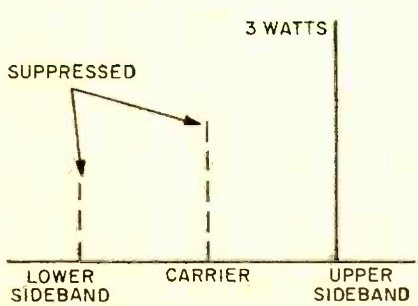


Fig. 4 One sideband receives all the power once used by suppressed carrier and other sideband.

mutual interference. What's more, these stations will not produce those annoying heterodynes usually heard on a busy band. Sideband stations transmit no carriers to create this type of interference.

Because of its efficiency, it's generally stated that single sideband will have about 8 times the effectiveness of an equivalent AM signal—and occupy half the bandwidth. Before seeing how the receiver is adapted for SSB reception, consider the basic transmitter circuits that create the sideband signal.

Signal Splitting. A popular circuit for producing sideband is the "filter" method. It begins by suppressing the carrier in the *balanced modulator* stage shown in Fig. 5.

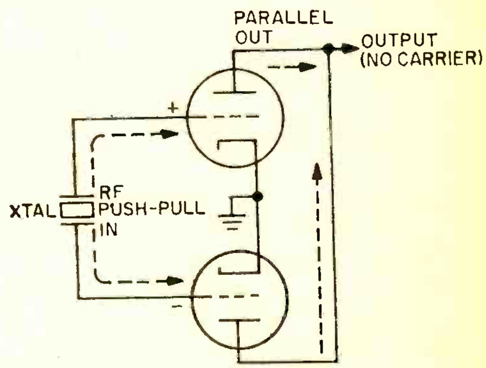
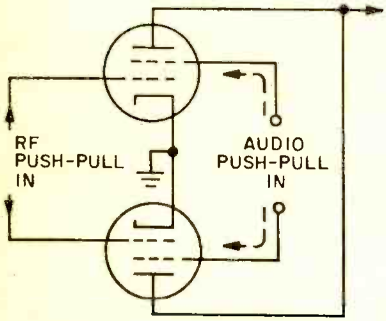


Fig. 5 This balanced modulator suppresses the RF carrier by cancellation in the load.

Although there are various ways to construct the circuit, the idea is to take the carrier, which alternates between plus and minus, then rearrange it to cancel itself out. Note in Fig. 5 that a crystal is generating the RF carrier and feeding it to the grids of a pair of triode tubes. The key action is that the signal is applied in *push-pull* (one grid is driven positive while the other is driven negative), much like push-pull audio in a hi-fi amplifier. But the big difference is at the output connection. In conventional push-pull, the load is split so signals *add* in the output. In the balanced modulator, though, tubes are connected in *parallel*. The net effect is that each tube contributes a signal of opposite polarity—and the result is cancellation in the load. So push-pull in, and parallel out, phases out the carrier.

Add Audio. Now to introduce the voice intelligence. Let's modify the balanced modulator by adding a screen grid, which is a convenient point for introducing audio.

Tracing the action in Fig. 6: when no audio occurs, there is no RF output because of the phasing-out process just described. But start to speak and audio is applied to the screen grids. The tubes are now unbalanced at an audio rate. Unbalance occurs as audio drives one screen more positive than the other, and unequal tube currents result. Now the RF signal sees an "unbalanced" modulator. This means the RF signal can no longer cancel itself completely in the output, so some carrier signal appears. That carrier, however, flows exactly in step with the voice, or rate of unbalance. The total effect is the appearance of the two RF sidebands—and a suppressed carrier.



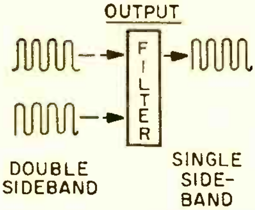


Fig. 6 The audio signal causes a double sideband to appear in the output. The filter then removes one of the sidebands.

Filters. There remains another major step. We want single, not double, sideband, so one sideband is passed through an extremely sharp filter with very high attenuation on the undesired sideband. One example is the Collins unit in Fig. 7, an electromechanical device which resonates very sharply on a single frequency (the desired sideband) and rejects the unwanted signal. Fig. 8 shows the actual circuitry.

This signal processing is done at very low-level stages in the transmitter and it wins sideband's great power efficiency. By eliminating carrier and sideband early in the circuit, these unwanted components never reach later stages for amplification. Only the desired sideband is boosted in the final tube or transistor and all the wattage goes into talk power.

Fig. 7 This is the type of filter used to remove the unwanted sideband from the output signal.

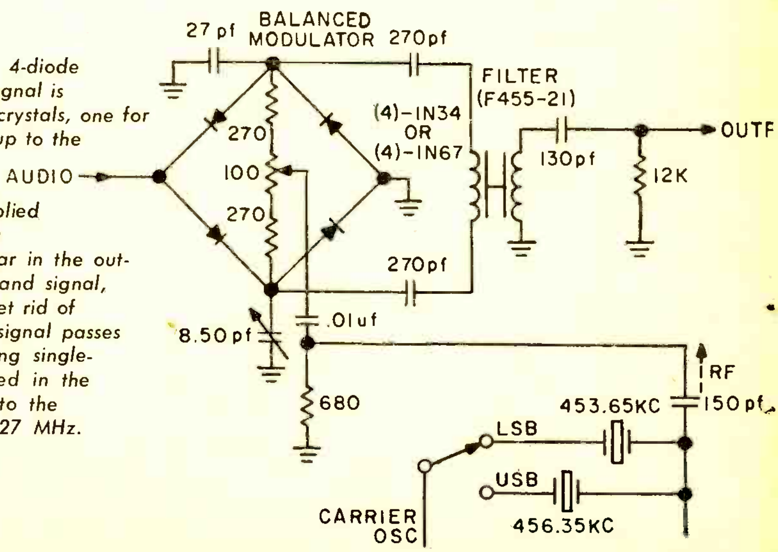


Fig. 8. Filtering circuit uses a 4-diode balanced modulator. The RF signal is generated by one of the two crystals, one for each sideband. The RF is fed up to the center of the modulator, and phasing of the signal cancels the RF. But when audio is applied to the modulator, the resulting imbalance allows RF to appear in the output. This RF is a double-sideband signal, minus the steady carrier. To get rid of one sideband, the composite signal passes through the filter. The resulting single-sideband signal is heterodyned in the transmitter's later stages, up to the final operating frequency of 27 MHz.

Receivers. A conventional receiver picks up sideband as sheer gobbledegook. The reason is that the carrier is missing. The detection process in any receiver is exactly the opposite of modulation back in the transmitter, even for conventional AM signals. Recall that the carrier originally mixed with audio to produce sidebands. The identical mixing must be repeated in the receiver to convert the sideband back to audio. Since no carrier is supplied with an SSB signal, the receiver must "reinsert" it for sideband detection. This is easily done by switching on the receiver BFO (beat-frequency oscillator), the same type used to make code signals audible. The receiver, therefore, supplies a "local" RF carrier to beat, or heterodyne, against the incoming sideband. The mixture of the two recovers the original audio frequency. It is far more efficient for the receiver to supply a carrier of a few milliwatts than to use the powerful, but wasteful, carrier sent with a regular AM signal.

One reason why sideband is more difficult to tune than a standard signal is because of that local carrier. The receiver must supply an extremely accurate frequency so sideband and local carrier mix to create the original frequency. This is never a problem in regular AM because you're always receiving the original carrier (that one that produced the sidebands) and frequency error can't occur. But the SSB receiver must be very accurately tuned. Unless you're within less than 100 Hz (cycles) of the correct frequency, speech is inverted or unintelligible. Fine control over the local frequency is done with the "clarifier" knob adjusted by the operator.

Another special quality in receiving sideband is selectivity. To fully exploit the system's ability to reject interference and noise, a receiver must narrow its response to signals of about 3 kHz in width. This is the approximate width of one sideband, and, broader response by the receiver admits unnecessary noise and adjacent-channel interference. Such sharp selectivity in the receiver is usually obtained by crystal or mechanical filters.

Commercial Circuits. How the Tram Company achieves sideband operation in its Titan III is shown in Fig. 9. Note that a knob (Receiver Mode Switch) on the front panel allows the operator to choose upper or lower sideband on any channel, as well as regular AM for transmitting to CBers not equipped for sideband reception. Fig. 10 is a block diagram of the same rig's transmitting arrangement for CB Channel 11. As shown, the carrier is generated at about 6 MHz, then balanced out. The crystal filter

Fig. 9. Single-sideband transceiver by Tram gives choice of either sideband on any channel.

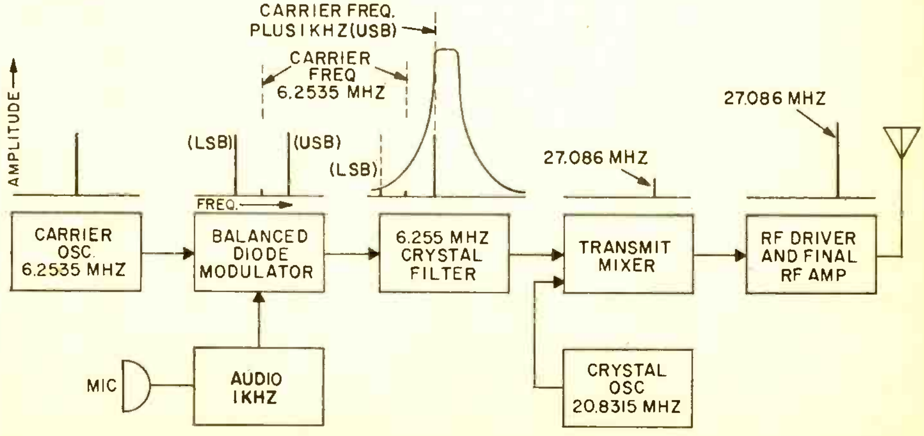


Fig. 10. Here's how a channel-11 upper-sideband signal is generated in Tram's Titan III transceiver.

chops away either sideband, and the final transmitting frequency is obtained by mixing the sideband up to 27 MHz. The reason for all these steps is that a sideband is easier to generate and filter at relatively low frequency of 6 MHz, then boosted to the final value by further mixing.

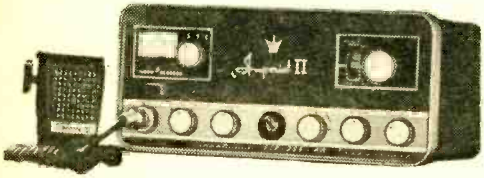


Fig. 11—The Regency Imperial II double-sideband transceiver operates on 117 VAC or 12 VDC.

The Regency Imperial II (Fig. 11) is actually a *double* sideband set, an intermediate type of operation. The carrier is suppressed, but both sidebands are transmitted. This produces a broader signal, but one that gains some of the power once assigned to the carrier. Double sideband sacrifices the 46-channel transmitting feature of single sideband, but the audio signal will have more talk power than a conventional AM circuit. Still, the design is "old hat" and not as good as SSB rigs. The double sideband signal can be received on sets fitted for single sideband reception. The Regency circuit can also transmit conventional AM for compatibility.

Mark Products Sidewinder-46 is a single sideband transceiver (Fig. 12) that uses a crystal lattice filter to slice away the undesired sideband. The carrier is suppressed by more than 40 dB, which means it's about one-ten thousandths of what a conventional

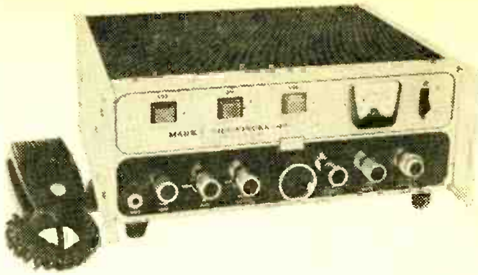


Fig. 12—Mark Products Sidewinder-46 single-sideband transceiver uses a crystal lattice filter.

carrier strength would be. The alternate (unwanted) sideband is suppressed by about the same amount. A close look at the front panel of this rig reveals it has an "RF Gain" control, usually missing from a regular set. This is provided since the conventional circuit has an automatic gain control (AGC) to prevent the receiver front end from overloading. Since an AGC circuit operates by sensing the strength of the incoming carrier, it's not practical in sideband (which has no carrier). Thus an RF gain control is provided so the operator can manually reduce receiver gain to prevent

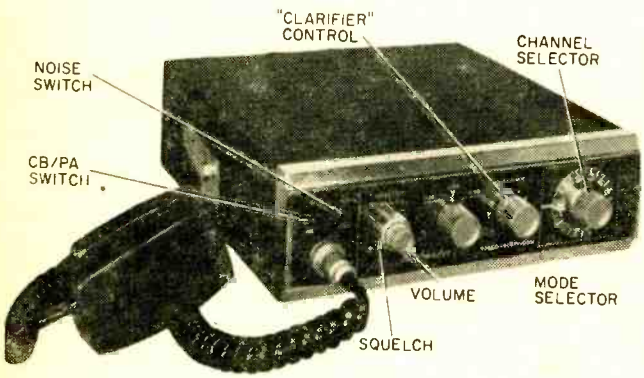


Fig. 13. SBE Sidebander by Linear Systems has a lamp that lights when AM is transmitted and which brightens as the operator speaks. The "Clarifier" control provides fine tuning for speech. The mode selector has three settings, one for AM, and the other two for the upper and lower sidebands.

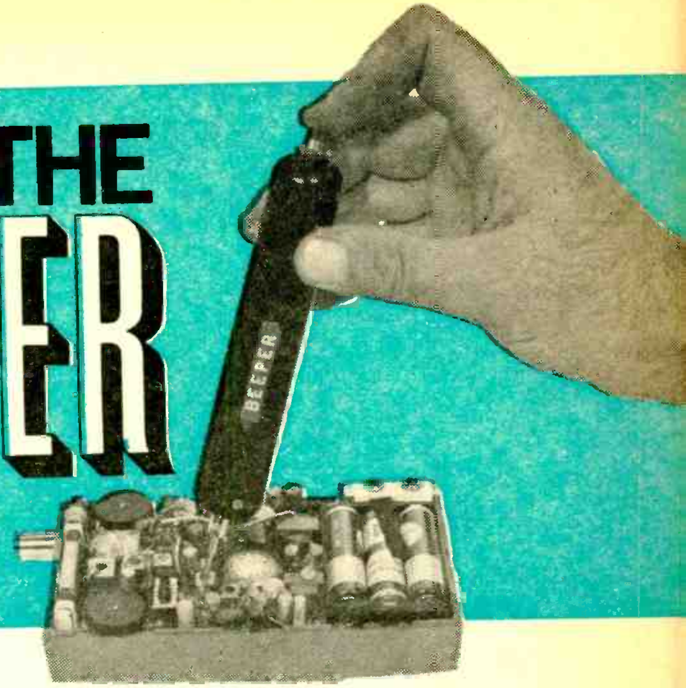
overload.

Another item peculiar to sideband because a carrier-less operation is the rating of the final power amplifier. In a regular CB set, output wattage is easily figured by measuring the voltage and current in the final transmitter stage, then multiplying the two figures for a rating in watts. Sideband, however, produces an RF signal that's varying at an audio rate, so the method of measurement is different. It's done by using the peak value of signal as a reference. The power rating, therefore, is always greater than the customary five watts. It's always understood, though, that sideband measure-

(Continued on page 97)

by Francois Markette

THE BEEPER



Doctor your gear with a pocket-sized injection of signal

One of the easiest ways to troubleshoot a defective amplifier or radio is with a signal injector. Here's a device that generates, simultaneously, AF and RF signals. You feed the injected signal into the stage closest to the speaker, and then work back towards the input or antenna. At the point where you can no longer ram a signal through the equipment, you've found the defective stage. Then you proceed with standard volt-ohm measurements to determine which component is disabling the stage.

A simple, easy-to-use signal injector, dubbed *Beeper*, costs about $6, exclusive of the battery and power switch. *Beeper* is a simple blocking oscillator, like the garden variety found in early TV receiver vertical oscillators. The fundamental frequency of this oscillator type is in the audio range, but since the output waveform is so distorted, it's output voltage contains harmonics well up into the RF spectrum.

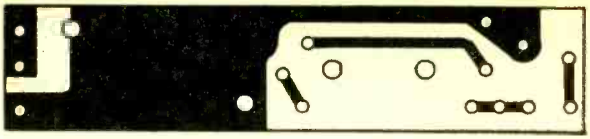
Fact is, *Beeper's* output extends from approximately 1kHz to the top of the standard AM Broadcast Band. Our little tube shaped injector's ideal for servicing tube or transistorized radios.

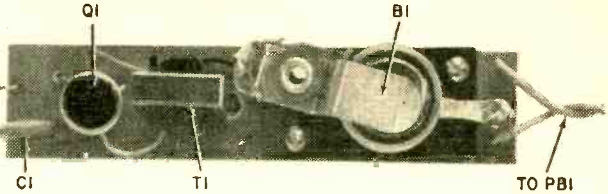
In the model shown, a mercury cell supplies power rather than a flashlight-size battery. Seems the small batteries, such as the AA and N size, which would fit into the probe, are highly prone to leakage which would destroy the components. A mercury cell will last several years without leaking, so it's the author's choice and is, therefore, suggested. In the model shown, a standard mercury cell holder is used. Reason is, you want to avoid soldering leads directly to the mercury cell, which could destroy the cell.

Except for battery B1 and push-button switch PB1, all component values are critical and *no* substitutions should be made. Push-button switch PB1 can be any nor-

Check out Beeper for shorts, other wiring errors, before slipping unit into its case.

e/e THE BEEPER





Top Right—Full-size foil outline for Beeper's printed circuit board. Right—Topside view of printed circuit board showing location of components. Hold board with foil pattern as shown; flip over for correct parts placement.

mally open (NO) type you have lying around. The probe handle is supplied pre-drilled with a 13/32-in. hole for a standard ⅜"PB switch. But, by using a ⅜-in. grommet to fill the hole, a miniature type ⅜-in. PB switch can be used. If you prefer, an on-off miniature switch can be substituted to avoid having to hold the switch down when using our *Beeper*.

Construction. The *Beeper* is assembled on a ⅝-in. x 3-in. printed circuit board for which a template is supplied. To make the PC board, cut a piece of copper-clad board (any type) to the specified dimensions and clean the copper surface thoroughly with a coarse household cleanser; then rinse the board and dry.

Place a piece of carbon paper, carbon side towards the copper foil, on the board and tape the board under the supplied template, or a copy of the template. Using a sharp instrument, indent the copper at the indicated component mounting holes by forcing the point of the instrument through the template into the copper. Then, using a ball-point pen, trace the foil outlines.

Remove the PC board, and using a resist pen, or a brush dipped in resist, fill in the outlined areas of foil to be protected. Let the resist dry for a few minutes and then immerse the board under at least ¼-in. of etchant.

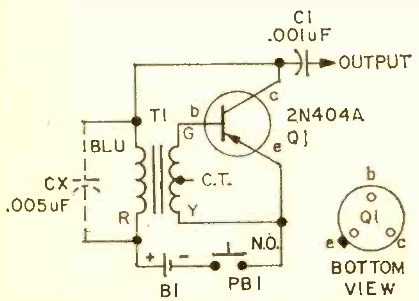
Etch for about 45 minutes, agitating the board frequently. Then check to see if all undesired copper is removed. If it isn't, re-immerse the board for 5 minute intervals until every trace of the undesired copper has been etched away.

Rinse the board thoroughly under running water and then drill the component mounting holes, which are indicated in the copper foil by the indents.

The holes for the mercury cell holder requires a #39 bit for #2 or #3 screws. The holes for transformer T1's mounting tabs use a #27 bit. The remaining component holes are made with a #57, #58 or #59 bit.

Install transformer T1 first. Note that the secondary is center-tapped. The center-tapped lead is not used; cut it off at the transformer. Though we have given the color codes for T1's leads in the schematic, note that manufacturers do change their color codes, so double-check the particular transformer you use before installation. Re-

(Continued on page 98)



If Beeper doesn't oscillate, reverse T1's secondary leads. Or, add Cx (see text).

PARTS LIST FOR THE BEEPER

B1—Mercury cell, Mallory type RM625 or PX-13
C1—.001 uF, 500 VDC disc capacitor
Cx—.005 uF, 25 VDC capacitor, see text
PB1—Push-button switch, see text
Q1—Transistor, 2N404A
T1—10000 ohm primary, 2000 ohm C.T. secondary sub-miniature transistor transformer. (Custom Electronics 442-3390).
1—Keystone type 117 mercury cell holder
1—Keystone test probe kit
A kit containing all the above components except B1 and PB1 is available for $5.85 plus 75¢ postage and handling from the Electronic Hobby Shop, Box 587, Brooklyn, N. Y. 11202. Outside U. S. shipments add $1 extra.

e/e checks out an excellent AUDIO-COLOR ORGAN

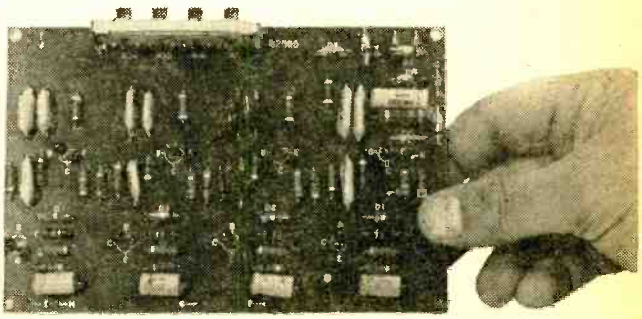
EICO's latest contender in the audiophile's fight for sight is an honest-to-gosh heavyweight

Just imagine the pleasure we could get from music if we could hear, see, touch and smell the melodies! It would be total interaction between the senses and pleasure. Unfortunately, technology hasn't yet made it possible to immerse all our senses in sound, but with EICO's Model 3450 Audio-Color Organ you will be able to both hear and "see" the music.

The EICO Color Organ is a four-channel lighting device that translates the music into blends of four different colors, with the blending and intensity determined by the frequency and dynamic range of the music. In a typical installation, the color organ is connected across the hi-fi amplifier's output and it does not interfere with the normal speaker feed. The organ's sensitivity control is then adjusted so the lowest-level music passages barely cause the organ lamps to light. The crescendos will cause the lamps to light to full brilliance. The frequency spectrum of the music determines which lamps will light. The bass frequencies cause predominatly blue light, the lower midrange is red, the upper midrange is green, and the high frequencies are amber. Since music consists of many frequencies and overtones, the four color channels are ever-blending.

The color organ measures 30 in. high x 15 in. wide x 11 in. deep. It is finished in Danish walnut (vinyl on pressed wood). Unlike some other color organs, the EICO has complete full-wave, high-voltage lamp circuits for high brilliance effects, as well as a full-dispersion screen (rather than a semi-opaque screen on which the lights seem to stand in one position). In the EICO color organ the colors blend and flow across the entire screen.

How it works. The Color Organ's input is through a bridging transformer that connects directly across the hi-fi amplifier's output. This provides electrical isolation be-



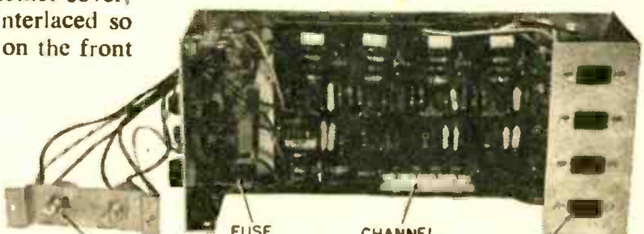
Printed circuit board holds most of EICO's Model 3450 Color Organ kit components. Board has anti-run protective coating applied to it; this assures that even neophyte hobbyist won't be able to ruin board from too much heat. Potentiometer strip, seen at top of board, is for individual color-channel sensitivity adjustments. They're set once, then forgotten.

tween the amplifier and the color organ. The signal output from the bridging transformer's secondary winding is then fed to four active filters—one each for the bass, lower midrange, upper midrange and high frequencies. Each filter output is then amplified, fed to a level control and then to an SCR (Silicon Controlled Rectifier). Each rectified controls a string of eight lamps of the same color. Since the lamps are fed from the power line through a full-wave bridge rectifier, each SCR can fire its lamps on both halves of the powerline cycle, thereby providing double the brilliance of the more common SCR lamp control.

Building the kit. With the exception of the SCRs and power outlets for the lamp strings, all electronic circuits are assembled on a printed-circuit board. The board is in turn mounted on a metal bracket which also serves as the heat-sinks for the SCRs.

The lamp assemblies are supplied prewired with molded plugs and sockets. Each string is mounted on the rear cabinet cover, with the different color lamps interlaced so that there is no fixed color area on the front screen. the lamps blend together, providing moving color across the entire screen.

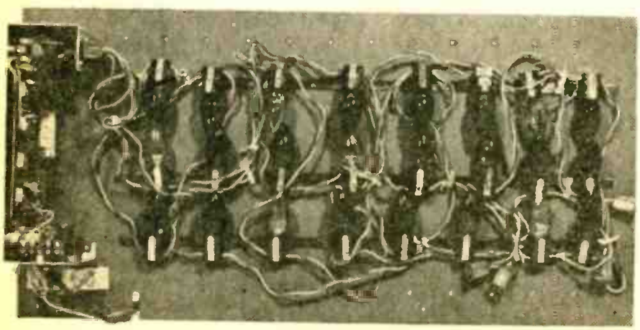
Rear panel of EICO Model 3450 Color Organ. One corner of cabinet back cover has user-adjustable Color Balance, Input Sensitivity controls. AC power switch is part of Input Sensitivity control. Both controls appear to have same effect. Each channel has its own screwdriver-adjusted control.



Assembled pc board is installed on combination chassis/heat sink. Silicon Controlled Rectifiers, power outlets, even input circuit are fastened to this double-duty chassis.

Set up. Since the energy varies at different frequencies, depending to a large degree on the type of music and the instruments being used, and because the intensity of the colored lamps differs from color to color. the user must establish a basic gain setting for each of the four color channels so that there is no predominant color shade, unless a predominant shade is desired. The

(Continued on page 102)



Here's how EICO Color Organ's rear panel looks before it is installed into simulated walnut case. Note that four sets of lamps are interlaced into three rows so that colored effects are spread evenly from side to side, top to bottom.

For the best DX of all

BE YOUR OWN BAND PICKER

All it takes is a globe, a hunk of string, and a little homework

By Dick Strippel

Tonight—in the comfort and privacy of your own home—how would you like to predict the best band for hearing or working South Africa at 8:00 p.m. on May 15, 1972? And without using a Ouija board or astrology tables?

After you read this article, the procedure will become a simple matter of wrestling for a few minutes with a piece of string, a dime-store world globe, and some basic propagation data.

During World War II, many riddles of long-range radio communications were unraveled. And in the years that followed, quite accurate means of forecasting paths and frequencies were developed. Material available from the Government Printing Office in Washington, D.C., will enable you to dig deeper into this fascinating branch of electronics later on if you choose.

While these engineering methods are more accurate than the one we're about to present, we can take advantage of one big plus factor. We're not interested in exact frequencies worked out to the tolerances of a gnat's eyebrow. As hams or SWLs, we're limited to specific bands. And if we can predict good reception conditions for these bands, we're as good as we need to be.

How We Do It. On the next two pages you'll see tables and charts. At first glance, they look like bingo cards. In reality, they're the basis of our calculations.

First off, Fig. 1 is a chart of Optimum Traffic Frequencies (OTF) by month, over the next several years, derived from long-range sunspot data and averaged out to the nearest ham or SWL band. Critical tolerance forecasting requires the user to go through several steps involving the selected path, before figuring the OTF.

Next, Fig. 2 shows Lowest Usable High Frequencies month-by-month over the same period. To put it simply, it's possible to receive signals on the bands that lie *above* the LUHF and *below* the OTF.

If you haven't drowned in the alphabet soup yet, let's go on!

In Fig. 3 you'll find a graphic presentation of the hour-by-hour factors by which

e/e BAND PICKER

the basic monthly OTF and LUHF figures must be multiplied. Fig. 4 provides an additional corrective factor for seasonal variations in noise level at the receiving point, and applies only to LUHF.

Problem. To show how we manipulate all this information, let's work out our previously given example. (Don't forget the world globe and piece of string as you sharpen your pencil.) The details will come later.

Say we're located at DX Central in New York City and we want to hear Johannesburg at 8:00 p.m. on May 15, 1972.

- Stretch the piece of string tightly across the face of the world globe between New York and Johannesburg. Using the scale of miles on your globe, mark the string at a point 1250 miles from New York toward Johannesburg, and at a second point 1250 miles from Johannesburg toward New York.
- Determine the sun time at these points, using a 24-hour clock. Allow 15 degrees of *displacement* (longitude) for one hour. And don't forget to take Daylight Saving Time into account, if applicable.
- In our example, local time at the point 1250 miles from New York will be 8:00 p.m., or 20:00 hours, minus one hour for Daylight Saving Time, minus an additional hour for 15 degrees displacement, or *18:00 hours*. Local *standard* time at Johannesburg is six hours ahead of New York, or 13:00 hours; 1250 miles downline it will be *14:00.*
- From Fig. 1, we find that the basic OTF for May (between April-June) of 1972 is 11 MHz.
- From Fig. 2, we find that the basic LUHF for that date is 7 MHz.
- Multiply these frequencies by the factors found in Fig. 3.

Time	OTF	LUHF
18:00 hours	11 x 0.7=7.7 MHz	7 x 0.4=2.8 MHz
14:00 hours	11 x 1.0= 11 MHz	7 x 1.0= 7 MHz

- The *lower* OTF (7.7 MHz) will prevail over the route, while the *higher* LUHF (7 MHz) will define the lower limit. (These figures can be rounded off to the nearest SWL or ham band and still retain their accuracy.) We can now add the Seasonal Noise Corrector, if any, from Fig. 4. In this case the corrector for 7.7 MHz, when it is spring at the receiver's location, is zero—no change.

Solution. At 8:00 p.m. on May 15, 1972, the "best" band for hearing or working South Africa would be 40/41 meters, which is the band opposite the 7-MHz frequency in Fig. 5, the Band Relationships table. Since the OTF is somewhat higher, SWLs could also search for South African stations on 39 meters.

Reviewing, here are the steps to compute a prediction:

1. Stretch a string between receiver and transmitter points on the globe. This gives you the great-circle path between these points and shows how the signal will travel.
2. Determine *local* time at points 1250 miles up and down the signal path from its terminals.
3. Find basic OTF and LUHF from Figs. 1 and 2, then apply the hour-by-hour correction in Fig. 3.
4. Apply the Seasonal Noise Correction factor from Fig. 4.
5. Over the selected route, at the time desired, the *lower* OTF and the *higher* LUHF will determine the frequency range in which communication will be propagated. When the LUHF is higher than the OTF, communication is impossible.

Another Example. Take the winter date of Feb. 15, 1974, for noon only. From Fig. 1, the OTF is 7 MHz. The hourly correction from Fig. 3 for noon is zero, so the OTF remains at 7 MHz. From Fig. 2, the LUHF is 6 MHz. The hourly correction is again zero, so the LUHF remains at 6 MHz. But the Seasonal Noise Corrector for 6 MHz in winter is -2, so the LUHF is moved two bands lower, to 4 MHz, or 75/80 meters.

How Propagation Works. A brief review of radio propagation theory will help explain what we've been doing.

DX signals travel from transmitter to receiver by a *sky wave* which travels in a straight line, heading out toward space, until it meets a layer of ionized gasses strong enough to bend it back to the Earth's surface. For communications purposes, we can assume a fixed position for this layer (the E-layer, or lowest reflecting layer) to be about 60 miles high and about 1250 miles downline from the transmitter. In practice, depending upon the strength of the reflecting layer land the frequency of the signal, the first returning waves from the ionosphere

USE THESE AIDS TO PICK YOUR BEST DX BAND

YEAR 19-	71	72	73	74	75	76	77	78
JAN-MAR	18	11	9	7	9	15	18	21
APR-JUN	15	11	9	7	11	15	18	26
JUL-SEP	15	11	7	9	11	15	21	26
OCT-DEC	15	9	7	9	11	18	21	26

Fig. 1—Basic Optimum Traffic Freqs (OTF).

YEAR 19-	71	72	73	74	75	76	77	78
JAN-MAR	9	9	7	6	7	9	11	11
APR-JUN	9	7	6	6	7	9	11	15
JUL-SEP	9	7	6	6	7	9	11	15
OCT-DEC	9	7	6	7	9	9	11	15

Fig. 2—Basic Lowest Usable High Freqs (LUHF).

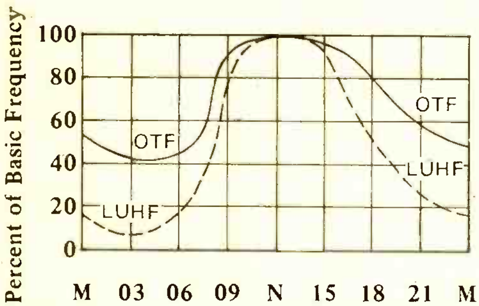


Fig. 3—Hourly OTF/LUHF Variation.

Check the text thoroughly before you use these tables and graph.

	FREQUENCY 3-7	7-12	12-UP
WINTER	−2	−1	0
SPRING/FALL	+1	0	−1
SUMMER	+2	0	−2

— sign = Number of bands lower
+ sign = Number of bands higher

Fig. 4—Seasonal Noise Corrector, applied to LUHF only.

MHz	3	4	5	6	7	9	12	15	18	22	26
METERS	90	80 75	60	49	41 40	39	25	20 19	16	15 13	11

Fig. 5—Relationship of Frequencies to Bands

may strike the Earth as close as several hundred miles from the transmitter.

The reflective ability of the ionosphere depends upon ultraviolet radiation from the sun. The strength of this radiation follows the number of sunspots, and both vary quite predictably over an 11-year cycle.

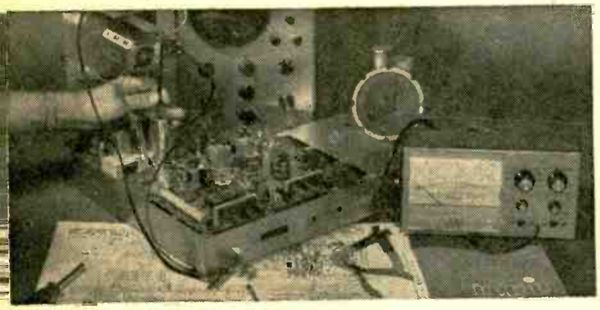
Unfortunately, ultraviolet radiation from the sun also causes the formation of a signal-absorbing layer of ionization (the D-layer), closer to the Earth than the E-layer. Signals must be sufficiently high in frequency or power to pass through the D-layer before they can be bounced back by the E-layer or the even higher F-layers.

Seasonal Considerations. In addition to D-layer absorption, lower-frequency signals run afoul of noise, both man-made and atmospheric. Since thunderstorms are more prevalent in the summer (and tropics) atmospheric noise varies with the seasons.

Generally, during the listener's winter season, reception is better on the higher-frequency bands (15, 17, 21 and 25 MHz) and when it is daylight at both the transmitter and receiver locations. During evening and night hours, reception is better on the lower bands (up through 11 MHz), becoming particularly good in the winter. When both transmitter and receiver are located in the same hemisphere, summer DX is especially good on the higher bands.

Further Details. If you're interested in how to predict openings more accurately, material available from the Environmental Sciences Service Administration (ESSA) will help. Write the U.S. Government Printing Office, Washington, D.C. 20401, and ask for the prices on the Central Radio Propagation Laboratory (CRPL) publications. ■

...first and only school to include training equipment designed from chassis up for your education



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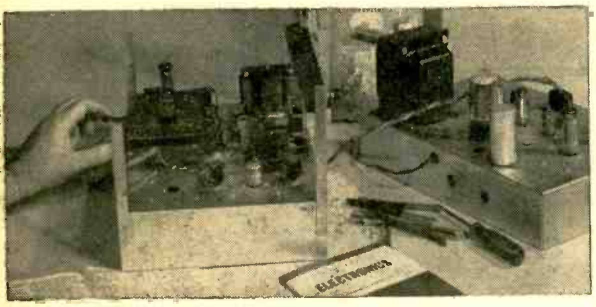

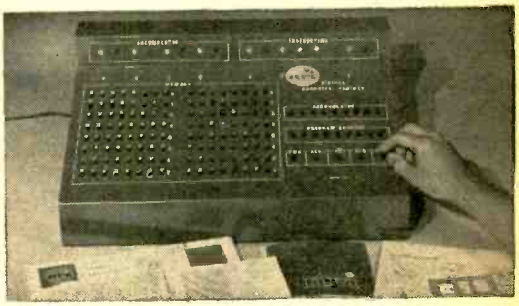

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CIRCLE NO. 13 ON PAGE 17

e/e etymology

How about a word with us?

QUANTUM

▲ Classical languages contain lots of raw material for possible use in shaping new words. This is one of the primary sources to which a scientist turns when a new phenomenon is found for which there is no name. Until comparatively recent times, it was actually considered bad taste (or lack of knowledge) to get the stuff with which to shape new labels from any other source.

Physicist Max Karl Ernst Ludwig Planck was rather mild-mannered in spite of his formidable name and his tremendous intellect. So when he developed a radical new theory about the nature of radiation he turned to Latin to name the minute particle he had never seen, but which his theory required.

From Latin for "how much," Planck coined the term *quantum*. He used it to indicate the hypothetical "unit of radiation" that helps to explain behavior of radiant energy.

First publicly presented to the Berlin Physical Society in the late autumn of 1900, the *quantum theory* is a milestone in the progress of modern science. According to it a quantum ("how much"?) is a packet of energy equal to hv, where h is *Planck's constant* and v is the frequency of the radiation.

HILAC

▲ Proliferation of research and discovery in our times has led to a boom in formation of acronyms—words completely artificial in nature, having no roots in any language, and shaped by putting together initial letters of complicated descriptive terms.

So many acronyms have been formed and so many have proved usable that formal names of programs and systems are often chosen so that acronyms will take the form of familiar words. That was the case with the **D**ispersed **E**arly **W**arning radar system set up across North America at about the 70th parallel. Here the name was chosen so that the acronym drawn from it would be **DEW**.

No such strategy was used in early talk about a sophisticated accelerator at the University of California. Scientists simply called it what it seemed to be: heavy-ion linear accelerator.

That was fine, so long as only a handful of persons made occasional references to this elaborate equipment. As it became more and more prominent, and increasing numbers of persons couldn't avoid referring to it, the inevitable happened. The cumbersome name was in common speech dropped in favor of its acronym.

That is how the accelerator that last May produced element #105 (with 105 protons and 155 neutrons) came to be known as *hilac*. It would be harder to produce a clumsier word by trying to do so—but the hilac looms so large in atomic physics that its name is sure to find a permanent place in speech.

GHOST

▲ Developers of a constant-level balloon that could be put into the stratosphere with a pay load of instruments couldn't think of a simple name. They realized that whatever label attached to it was likely to be condensed into an acronym.

So they deliberately juggled words until they came up with Global Horizontal Sounding Technique balloon. Now almost universally designated by the artificial-but-realistic word formed from initial letters, the *ghost* balloon has played a big part in advancing space technology and changing plans for a worldwide system of weather balloons.

Launched from Christchurch, New Zealand, in 1966, the first ghost circled the Southern Hemisphere eight times, stayed aloft for 102 days. Another ghost launched in September, 1967, remained in action more than four times as long and made 35 trips around the world. A typical ghost carries about $3,000 worth of instruments—most of which are never recovered—and doesn't function well in the troposphere (the lower six miles of the atmosphere).

NEWTON

▲ Thousands of surnames of theorists and discoverers have attached to phenomena with which they worked. Many of these "names that have become words" are highly technical. Some survived only a few years, and then dropped out of use. In several cases, otherwise little-known persons are commemorated by universally used terms.

Sir Isaac Newton is often labelled "the greatest scientist who ever lived." But the only common word shaped from his name is modern in origin and seldom used. Increasing use of high-level energy required a name for a big unit in the meter-kilogram-second system. So *newton* was adopted as shorthand for 100,000 dynes—unit of force required to accelerate a mass of one kilogram one meter per second. ■

Optacon

Electronic touch-and-tell eyes for the unsighted.

by Helen K. Branson

You probably never stop to think how easily you look at a printed page, a chart, or a label, and take in a dozen words at a glance. Only a blind person can truly understand the inconvenience of not being able to read print. I wish I had a nickel for every can I've opened, thinking it contained one thing, and getting another. It would be worth much more than a nickel to me for every time I've lost dollars just because I had to wait to have something important read to me, and so missed a publisher's deadline, because nobody was available to help me.

All this promises to be remedied within the next year and a half, according to Dr. James Bliss, of Stanford University's Palo Alto, California Research Institute's Bio-Information Systems Lab. For it was Dr. Bliss' lab which designed and brought the Optacon into existence after 6 years of research.

The electronic device, battery operated, and about the size of the casette tape recorder, weighs about 6 pounds. And Optacon's development, which will allow blind persons to read everything from banner headlines to the smallest newsprint by touch vibration, cost $600,000—not much by today's medical research standards. The device, which has been displayed recently, is still experimental, and will not be available commercially for at least another year and a half.

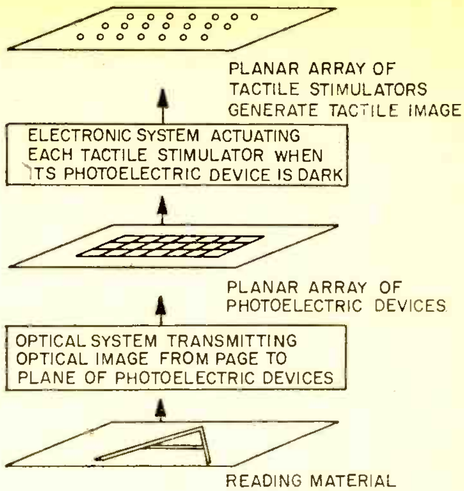
Six of the instruments have been put together at a cost of $5,000 each. They're being field-tested by blind students, professional persons with serious visual handicaps, and other blind workers. One is on public display at the Palace of Arts and Sciences in San Francisco, where blind persons not directly associated with the research project will be given an opportunity to try out the machine.

Actually, it takes several months of training to learn the tactile skill required to interpret the vibrations well enough to read 60 words per minute of ordinary printed materials. Field tests show that an Optacon-aided blind person "reading" text material is slower than most experienced braille readers. But braille materials are very limited, and many blind find it difficult to learn to read the braille characters with speed and facility—especially those who have read ink print into adolescence or longer.

Books, newspapers, typewritten letters, labels on cans and bottles, and denominations of paper money can be read by holding the scanner in one hand, and interpreting the vibrations of the Optacon with the other.

Photoelectric sensors in the scanner pick up the shapes of individual letters and convert them into electric impulses which travel through a cord in the read-out unit. The impulses cause a total of 144 fine wires to vibrate selectively in the form of the letter or combination of letters being scanned.

The blind person puts a finger into a groove, and the wires vibrate against the fingertip. The letter felt by the finger can be blown up 5 times its size by a zoom lens on the scanner, and a controllable size-doubling device in the simulator. Larger letters such as headlines can be traced.



When unsighted person places his fingers upon Optacon's "reading" surface, he's sensing sets of vibrating pins that are actuated by photoelectric-driven IC circuits.

Dr. Bliss feels that the speed with which the blind person reads is emotional, not physical, the reader can move the scanner as fast as he desires. However, some blind people disagree with this assumption, saying that the ability of the finger to interpret the vibrations of the wire is also a limiting factor. A good braille reader can go much faster than 60 words per minute, but, the limitations of braille make the possibility of using a scanner much more practical.

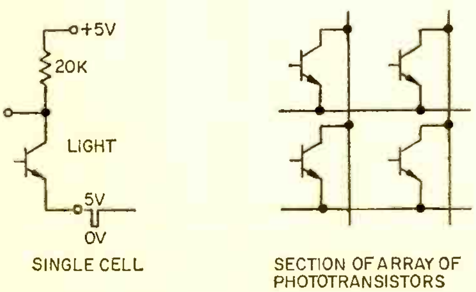
Candy Linvill is a blind tester for the Stanford project. Candy, seen in the photograph on page 57, has had about 300 hours of practice on 5 different machines. She reads about half of her braille speed currently, and she says that her Optacon speed is increasing all the time. Candy, a freshman at Stanford, uses the Optacon as her sole means of study for a course she is taking in Conversational French. She is assigned the same material as all other students in the class. Although she reads more slowly than her sighted companions, she feels that the system is far superior to braille in many ways.

How Optacon Sees. The main principle of the Optacon is the generation of a dynamically magnified tactile image which is a facsimile of the ink characters being viewed by an optical system. The tactile image is generated by a rectangular array of vibratory pins which can be made to vibrate selectively, individually or in groups. Integrated circuits, and piezelectric vibrators are the essential new components of the Optacon. Special integrated circuits have been invented and developed for Optacon by graduate students, as well as faculty and research staff at the Stanford Graduate School and the Stanford Research Institute.

The optical system includes a rectangular group of photo cells on which the ink print characters to be "read" are focused. The reader rests his finger on the sensing plate which brings the vibrations of the pins to a focus that can be interpreted through perforations in the plate. Once the research project had established several years ago that blind persons could "read" the vibrations, the problems of constructing photo sensitive arrays and the electronics control and switching circuits required to generate tactile images from ordinary printed material were solved.

Actually, the array of photo transistors to which the image of reading materials is conducted is not necessarily new. This version of Optacon has only 12 rows of photo transistors. The reading rates of this model were low because the image was not clearly transmittable to the reader; the problem was mainly in the distinction of letters.

Dr. Bliss studied this aspect of the situation carefully. He decided that at least 24 rows would be required for facile reading of all capital and lower case letters. The use of plastic fibers to conduct the images from the reading materials to the array of vibrators gave a partial solution to the problem. Dr. Bliss and others realized, however, that faster reading rates could only come about when integrated-circuit technology was brought into play.



Schematic of single photoelectric cell (left) which is the basic unit of phototransistor array (right) housed within the scanning retina of the Optacon.

The Eyes of Optacon Revealed. The silicon retina of Optacon consists of an array of 6 by 24 photo transistors on a single chip of silicon 100 by 160 mils in area. Also, a multiplex circuit which has 6 channels of communication is necessary.

A guiding device which keeps the scanner roughly in line with the lines on the printed page is utilized so that the reader will not scramble the material. Small bulbs in the reading head illuminate the portion of the page to be focused on by the 100 by 160 mils silicon retina of the reading head.

Six channels of output signals are fed from the reading head through the thin wire cable to the electronic control circuit, which is housed in the small flat box under the reading plane. Signals are processed in this box. They gate on and off a 200-Hz source to appropriate piezo-electric reeds. This is what presents the tactile image to the left index finger of the reader.

In parallel, a corresponding signal is fed to the array of neon lamps in the box on which a large lighted image for the sighted research observer is presented. This image would not be necessary for practical use of the device outside of the laboratory. It is necessary in the research field, of course, so that progress of reading tests can be followed.

The small, light reading head is one of the chief advantages of the Stanford scanner. Moving it easily over the page is one factor which makes the device more practical than other systems. The silicon retina has made this possible.

As already mentioned, this retina consists of an array of 4 transistors in a rectangle on a single silicon chip. These are operated in the charge-storage mode. The essential features of the operation are shown on this page. At the left is shown a series circuit consisting of a photo transistor with its base floating, a 20,000 ohm load resistor which is connected to a 5 volt power supply, and the emitter terminal which periodically is brought from 5 volts, where it usually rests, to 0 volt. At the time of the pulse of 0 volt on the emitter of the circuit, a current flows through the phototransistor.

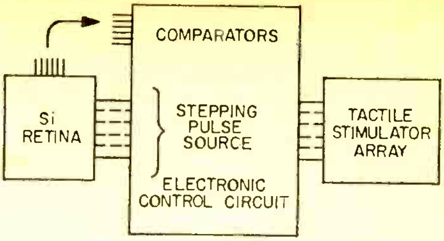
In the present reading aid, the frequency of the pulsating 5 volt emitter voltage is 200 Hz. In the silicon retina, an array of 6 columns of 24 phototransistors each is on a single silicon chip. In any given column, all of the phototransistors have a common collector, and the common terminal is terminated in a single load resistance. All of the emitters in a given row share the common emitter terminal. Only one of the emitter rows at a time is subjected to a negative-going emitter pulse. Successive rows are integrated in turn, and the voltage appearing at the load resistor for the column then gives in sequence the indication of lightness or darkness of the individual phototransistors over the preceding sample period.

If you could draw a photomicrographic schematic of Optacon's silicon retina, the individual phototransistor bases would be seen as dark rectangles 5 by 10 mils in dimension. Horizontal step lines represent the aluminum leads connected to each row of the emitters, which are small rectangular dots 1 mil square. Alternate rows of emitters are connected to bonding pads of aluminum on opposite sides of the silicon chip. Six of the aluminum areas at the top and bottom of the slide are the terminals for the collectors of the respective columns. At opposite corners of the chip are leads connected to the corners of aluminum pads fastened to the silicon substrate. Simple, isn't it?

The Electronic Control Circuits. The functional operation of the electronic control circuits coupling the silicon retina to the tactile stimulator ray is illustrated at top of page. The silicon retina is provided with a stepping-pulse source which delivers successive negative-going pulses to the rows of the silicon retina, one at a time. The output pulses from each of the columns of collectors are supplied over 6 channels to the electronic circuits where they are applied to comparator circuits which determine whether a given element of the silicon retina has been lighted or not.

The electronic control circuit provides 200-Hz squarewave voltages to the piezoelectric reeds whose corresponding phototransistors have been dark.

The most recent version of the tactile stimulator has 6 columns of 24 rows of pins. Each is connected to a cantilever-mounted piezoelectric reed. The piezoelectric reeds



Working much like the human nerve system, Optacon "sees" printed characters with its silicon retina, and integrates the scanned information into a signal which controls the Tactile Stimulator Array.

are made of lead zirconate and lead titinate and are manufactured by the Clevite Corporation. They are surprisingly small, compact and efficient motors. The arrangement of the vibratory pins has a mounting with 100 mil spacing between columns of pins that are spaced in 50 mil series.

This size permits the tip of the finger to be placed in the grooved space on the plastic cover of the stimulator and there receive a tactile image of the letter being viewed by the optical reading head.

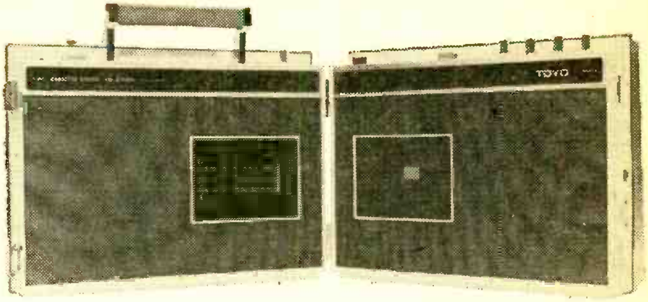
The combination of the integrated circuits in the silicon retina, and the control (or controlled) circuits with piezoelectric vibratory reeds for tactile stimulation makes up a very practical system.

A somewhat smaller reading aid using the same principles is being tested. It requires only 1½ watts of continuous power; 1 watt of this is required for illumination. This makes it possible to power this Optacon by rechargeable batteries.

Actually, the Optacon is in an intermediate stage of development. The machines tested by Candy Linvill have each been progressively more utilitarian, and it is expected that before actual production begins in about a year and a half, the machine will be improved even more. "If some of the ideas for improving the Optacon are successful, Dr. Bliss said, "reading performance equal or exceeding that of braille should result, and the cost of production should decrease." If the Optacon proves to be as practical as Stanford researchers predict, it should, indeed, be an example of how modern technology can be used to mitigate human problems. ■

e/e checks out an excellent PORTABLE MUSIC CENTER

You can take it with you—Toyo's new portable has an AM/FM-stereo radio in the left half and a cassette recorder in the right half. Pick it up and go!



☐ Here's a complete music center for the hi-fi enthusiast on the go, the college student with not much room for a full-size stereo rig, and just about anyone who wants to tuck a music center into a corner of the bedroom or playroom. It's the Toyo CRH-506 portable cassette recorder and AM/FM-stereo radio, housed in a travel case no larger than carry-on airplane luggage.

The Toyo radio measures 11″H x 12¾″ W x 6¾″ D. Weight is 13 lb. The case consists of two half-cases with lift-off hinges. Each case-half contains a 5″ speaker and part of the total electronics. The left half also contains the power supply and the AM/FM-stereo tuner while the right half contains the cassette recorder and power amplifiers.

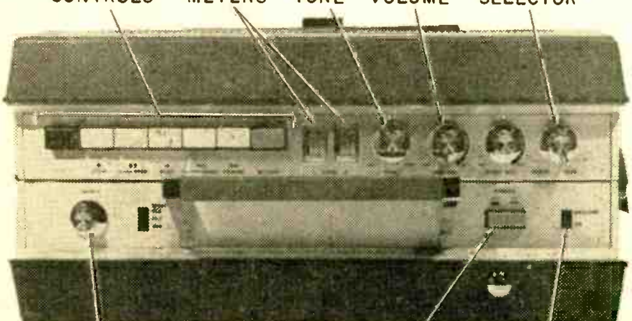
Most features found on standard stereo compacts are found on the Toyo, such as an FM-stereo beacon and dual VU recording meters. Controls include tuning, tone, volume right, volume left, and tape/radio selector. There are switches for power, AC/battery, and AM/FM/FM-stereo modes.

The cassette recorder uses piano-key controls for eject, stop, instant stop, play, fast forward, rewind and record interlock. The recorder can record either from the supplied microphones or from any amplifier sound source. A monitor switch allows speaker monitoring of the radio inputs while recording.

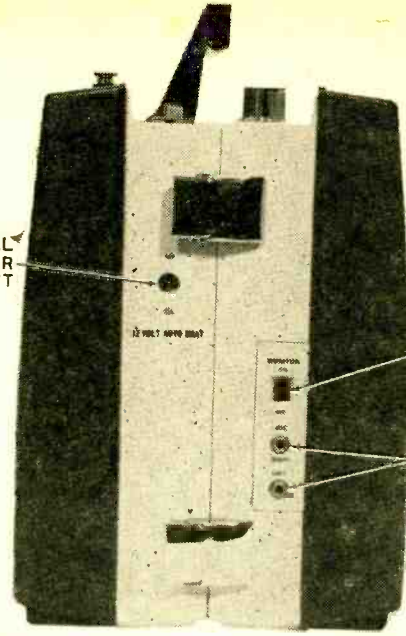
The unit is powered by 117 VAC, from internal D batteries, or an external 12 VDC source. The batteries, power cord and a 6′ speaker cord are housed in a storage compartment in the rear of the left case. A similar storage compartment in the rear of the right case houses the microphones.

A telescopic whip antenna is provided for FM reception, and a rod antenna for AM.

Performance. Because the unit is basically a radio, and because there are no



With the sections folded and locked, the CRH-506 becomes a portable music center no larger than an airline travel case. All operating controls are mounted on top of the case. The top half, as shown, contains the amplifier and its operating controls. The bottom half contains the tuners, power supply and their controls.



The right case half of the Toyo CRH-506 has the recorder monitor switch and microphone input on the side. The left half has an external 12 VDC power input jack.

standard input and output connections, the Toyo CRH-506 could not be measured for performance to the usual hi-fi standards. Instead, we compared its relative performance against better quality radios and portable cassette recorders.

First off, the sound quality is very good, noticeably better than so-called stereo record players or "compacts" in the $100 price range. Also, the maximum low distortion power output is considerably more than better quality players and radios; this unit has no difficulty producing ear-straining volume levels in smaller rooms.

The single hi-cut tone control works the same as others of its type, either attenuating the highs to produce a "mellowed" sound, or restoring the highs for "brilliance."

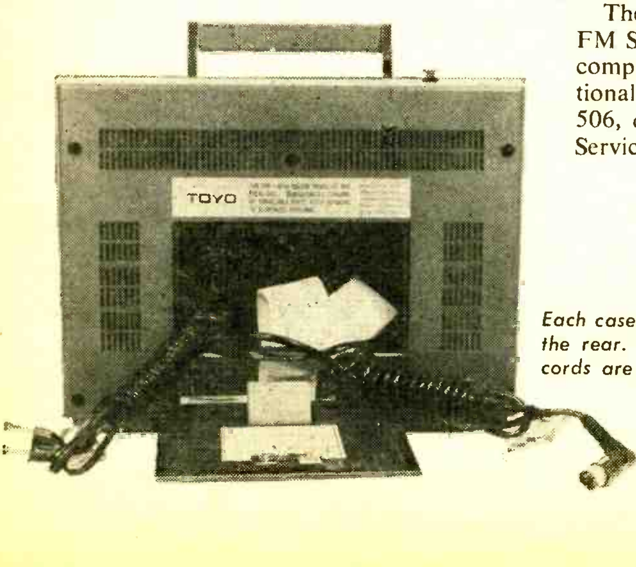
The FM radio, through its whip antenna, was about as sensitive as a $50 FM radio and delivers good performance in urban and surburban areas—it is not a fringe-area receiver. Separation as judged by listening was about average for a good-quality FM radio. AM performance similarly equaled a good-quality radio.

The cassette recorder performance easily matched any but strictly hi-fi cassette recorders. Wow and flutter was 0.32% with a ±3 dB, 50 to 8000-Hz response.

In short, the all-round performance was very attractive.

Summing up. While not a hi-fi system in the true sense of the term, the Toyo CRH-506 is an excellent choice as a portable or "vacation" music system, and is certainly recommended for college students and playroom use.

The Toyo CRH-506 Cassette AM/FM Stereo Radio is priced at $149.95 complete with microphones. For additional information on the Toyo CRH-506, circle number 37 on the Reader Service Coupon on page 17. ■



Each case has a storage compartment in the rear. The power and speaker connecting cords are stored in the rear of the left case. The right case has a similar compartment for the microphones that come with the music center.

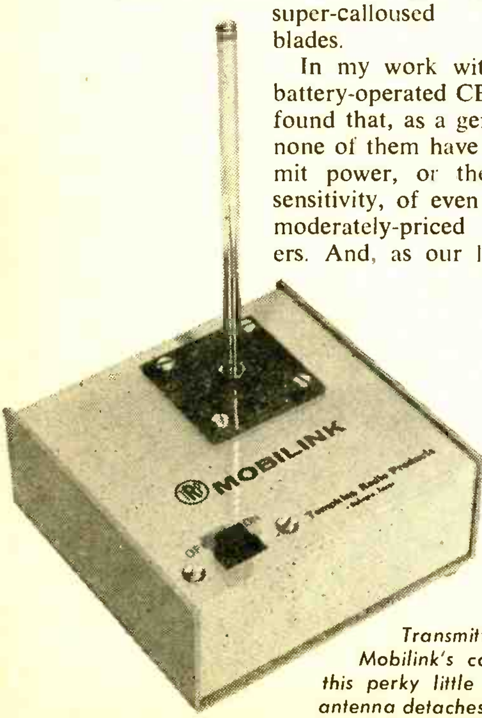
KATHI'S CB CAROUSEL

By *Kathi Martin, KAIØ614*

I've got a riddle for the active CBer.

How do you fellow-CBers keep yourselves in contact with the messages ("Hurry, Kathi, it's a *real* crisis. You don't have a minute to wait!!") that somehow manage to spew forth just as you amble away from your parked car. Especially, when the destination is that long awaited snack at the local diner. Certainly, nobody in his right mind would unbolt his rig from the dashboard, and strong-arm it into the restaurant. And, if you think that the answer to my riddle lies under the guise of a portable CB transceiver, just try a tug-of-war with one of these "mobile" beauties. You know—the kind that are conveniently" carried from the shoulder. I guarantee you'll soon be begging your local druggist for his entire stock of skin softener as your brand new baby Brunhilde muscles ripple under both super-calloused shoulder-blades.

In my work with various battery-operated CB rigs, I've found that, as a general rule, none of them have the transmit power, or the receiver sensitivity, of even the more moderately-priced transceivers. And, as our lab almost always confirms, those mini-rigs doctored to deliver decent performance suffer badly from Dying Battery-itis after but a few chit-chats on the Band.



Transmitter half of Mobilink's contained in this perky little box. Whip antenna detaches from base.

Crystal-controlled ten transistor receiver is Mobilink system's other half.

What's the active CBer, who can't always crook his ear toward that sensitive mobile (or base) rig, to do? Portable rigs *do* work very well for short-range CBing. But, the answer for the Citizens Bander who has to monitor his rig away from car or home lies with a better idea from Refugio, Texas!

Thanks to the Lone Star crowd down at *Tompkins Radio Products*, they've solved this CB dilemma with a device known as *Mobilink*. You can monitor your CB rig from as far as ¼ mile away with their add-on goody! With a *Mobilink* working for you, taking a coffee break in the local diner and still keeping tabs on your mobile CB rig becomes a simple matter, indeed. Or, you can go out to work around the house and still monitor on the base rig for a "family" call. *Mobilink's* the best way I can think of listening for your Channel 9 distress calls, too. With a *Mobilink*, CB is no further away than your shirt pocket.

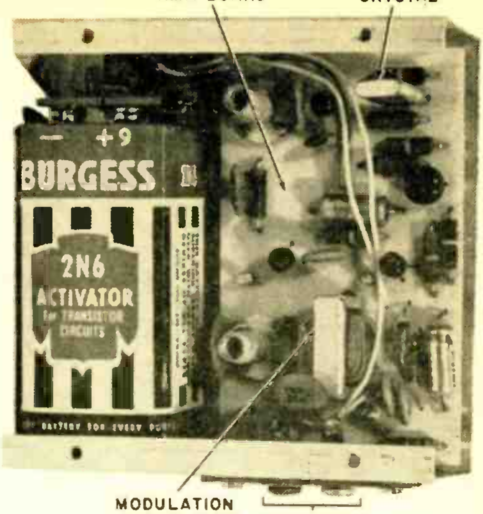
Pocket-sized Messenger Service. A *Mobilink* system consists of a small signaltriggered transmitter and a pocket-size receiver. The handsize transmitter boasts a 75 mW RF signal. It is voice actuated by the regular CB receiver; and has a built-in telescopic antenna like the collapsable jobs supplied with normal CB walkie-talkies. A two-wire audio cable connects the audio input to the CB transceiver's speaker, or directly to your rig's External Speaker jack.

With no signal being received, a special circuit keeps the *Mobilink* transmitter inactive. Whenever an audio signal is received at your rig, the transmitter is activated by the received audio, which re-transmits the original message over another CB channel. A small *Mobilink* receiver in the operator's pocket—no larger than a transistor radio—receives the re-broadcast signal. Now you can enjoy full-time, unattended, monitoring of your CB transceiver!

Both *Mobilink* transmitter and receiver are crystal controlled. The crystals plug-in; any CB frequency can be used for re-broadcasts. Simply select a channel infrequently used by the local CBers.

It's What Inside that Counts. After I opened *Mobilink's* cabinet, I counted four transistors, a modulation transformer, and a handful of resistors and capacitors. Two transistors form the heart of a two-stage transmitter, simply consisting of an oscillator and a power amplifier. The modulation transformer receives its signal directly from the CB rig's audio output transformer. Both remaining transistors work as a voice-actuated switch, turning the oscillator stage on or off. When no audio reaches the modulation transformer, the transistor switch is "open," and the oscillator is inoperative. No signal is transmitted—it's like squelch in reverse! Audio fed from your rig "trips" the transistor switch, which, in turn, turns on the oscillator and the received signal is re-broadcast by *Mobilink*. It's a simple arrangement but in our tests *Mobilink* worked very well.

The receiver appears to be an ordinary transistorized radio, modified with the standard AM front end removed, and a crystal-controlled, CB front end substituted. It is a very small radio—measuring merely 4¼ x2¾ x 1½-inches—and will easily slip into a shirt or jacket pocket. The supplied antenna is the small telescopic type such as found on small CB walkie-talkies.



Innards of Mobilink transmitter. Circuitry's simple but unit worked well under field testing.

Testing . . . 1 . . . 2 . . . 3. First, I tried the *Mobilink* system with the transmitter placed on the seat of my car. The effective range for receiving really solid copy dropped down to about 200 feet. Then after moving *Mobilink's* transmitter onto the car's dash, I tried the test again. This increased *Mobilink's* useful range to about 400 feet.

With the transmitter placed outside the car and on its fender, solid-copy range was about ⅛ mile, with received signal starting to peter out into the noise beyond this distance. So far, so good.

When I broke out my expensive CB walkie-talkie, and used this as the *Mobilink* receiver, the solid-copy range increased to a quarter of a mile.

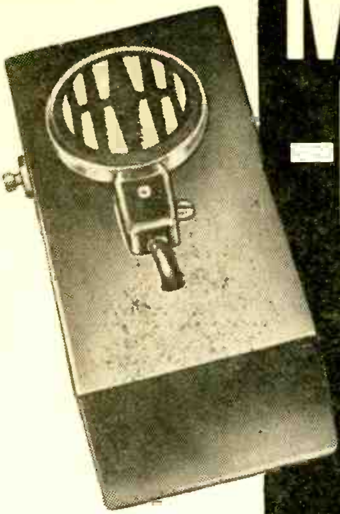
The transmitter's received signal was very clear and triggering was essentially instantaneous—the first word wasn't "lost" as the transmitter turned itself on.

Performance was the same on all forms of transmission (such as AM, sideband and tone-controlled squelch) because the *Mobilink* functions on the audio output fed to the speaker of your rig.

Some Last Thoughts. *Mobilink's* an important accessory for the CBer on the go. The *Mobilink* transmitter is priced at $44.95, and the receiver sells for $24.95. Prices include antennas, crystals and batteries. For additional information circle number 36 on the Reader Service page 17. ■

MAGIC-MIKE

Use it with any FM set connected to your PA! No mike line needed!



by Steve Daniels
WB2GIF

When the FCC opened the FM band to permit legal use of low-powered transmitters for wireless microphones, telemetering and for measurement, they opened a Pandoras Box for many an experimenter. Within the short space of time after the FCC relaxed their regulations, there was a flood of flea-power devices on the market. Some were good, some bad, but most had one basic inherent problem. Body capacity affected the tuning of the device, which, in turn, affected its usefullness.

No doubt about it. For a speaker or performer to be completely free of a fixed position—dictated mostly by the best location for a floor microphone in a PA system—is probably the dream of all would-be orators and very-off-Broadway thespians. So, as soon as the new wireless microphones were introduced, there was a rush to try them out.

It didn't take long before it was discovered that this ideal device was not so ideal. Problem was, when tuned up on the bench, the little devils worked perfectly. But, after the bench tune-up, when concealed in the clothing of a voluptuous young chick, or, for that matter, an uninteresting looking gentleman, the tuning was off.

Just by walking or breathing, the signal quality, as well as its output level changed, and so at times there was poor sound. Or, no sound at all! This is very disturbing for any performer whose roller-coaster voice levels causes the audience to loose a tomato/egg barrage!

Simple Magic. Our *Magic-Mike* certainly solves the tuning problem and so ultimately solves the major drawback of this equipment. You may well ask what makes *Magic-Mike* so different, especially when we note that a commercially-produced transistorized oscillator is used to generate the signal? Secret is, we added an FET (Field Effect Transistor) buffer stage to the output of the commercial unit. That isolated the tuned elements of the oscillator from the antenna and thereby eliminated the problem of body capacity disturbing the tuning of the oscillator. This buffer stage is comprised of components R1, C1, C2, L2 and Q1. These are wired as an RF amplifier. Transistor Q1 is an *n* channel FET operating in a positive ground circuit which may appear to be a bit unusual.

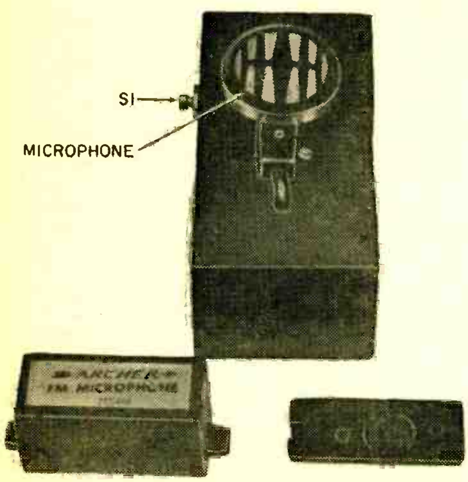
Microphone Making. Sure, you could wind coils and assemble transistors, resistors and capacitors together into a basic oscillator. But if you're like us—a little on the lazy side—it's much simpler, and cheaper, to buy a commercially-built unit to start your project. We used an Archer model 277-205 FM Wireless Microphone. It's available through *Allied Radio Shack* sales outlets. The module's easier to work with if you use just the printed circuit board without the housing.

Start your module mashery by prying off the bottom plate of the Archer module and removing the printed circuit board with its components from the housing. We mounted this circuit board, along with a ¾ X 1⅜-in. piece of perfboard (on which the buffer stage components are mounted) and the battery, microphone element and power switch into a 4 X 2⅛ X 1⅝-in. bakelite utility case supplied with aluminum cover panel.

Drill mounting holes for the switch, the microphone, the antenna, the circuit board, and the battery clamp in the plastic utility case. You can see the arrangement we used in the photos. The layout isn't critical; however, we suggest you use the basic arrangement shown in the photos to simplify the construction project.

The crystal lapel microphone was fitted with a metal spring clip that can be bent to pass through a hole in the bakelite face of the utility cabinet. The clip's then crimped to hold the microphone in position. A scrap of aluminum was pressed into service as a battery clamp, holding it tightly inside the case.

The perfboard is mounted on two 6-32 machine screws with ¼-in. spacers raising it off the surface of the case. The printed-circuit board is suspended from the perfboard by soldering a stiff solid wire lead and capacitors C1 and C2 to circuit connecting points between them.



Heart of our Magic-Mike is FM wireless mike module shown with its cover on. We removed pc board from case to make easier assembly.

Buffer Stage Assembly. Drill mounting holes in the perfboard to match the spacing of the mounting bolt holes you drilled in the plastic case. Mount three push-in pins on the free end of the perfboard for mounting and making connections to the FET (Q1). Resistor R1 is mounted between the pins that connect to the *gate (g)* and *source (s)* pins of Q1.

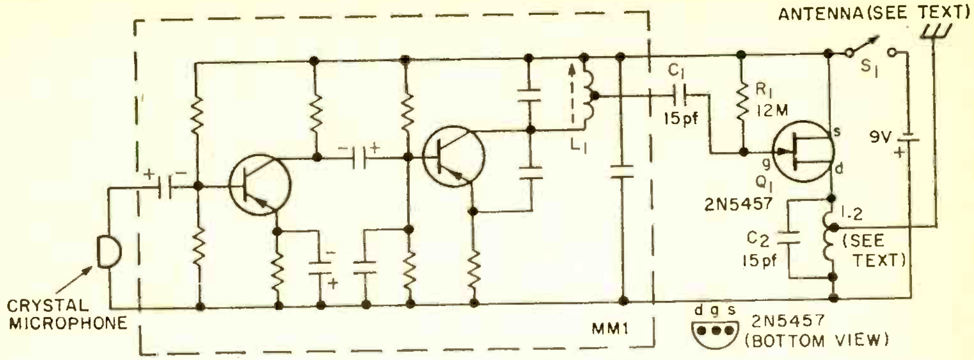
Next comes coil L2, which is made by winding 3 ½ turns of #22 bare copper wire on a 3/16-in. diameter. Use a 3/16 in. diameter dowel rod to form the coil. After it's wound, spread it out and solder the antenna lead to the center turn. When these operations have been completed remove the dowel rod and discard it. After winding the coil the turns should be spread apart so that total length of the coil is 5/16-in.

Solder coil L2 directly to the leads of capacitor C2 and cut off any excess coil lead wire. One end of C2 is connected to the *drain (d)* of Q1, and the other end is soldered to the 9V plus terminal on the printed circuit board that connects to the center tap of the coil (L1) on this circuit board. Except for the minus battery lead which is run from one side of the power switch to the *source (s)* terminal of Q1, the buffer stage is now finished.

The only other connections required to complete the project are your microphone and the plus battery leads. The shielded microphone cable supplied is cut to a length of about 2-in. Skin back the shielding about ½-in. Then connect the center lead of this cable to the proper tab on the Wireless Mike module printed circuit board. The shield of the mic cable is soldered to the ground bus at this same end of the pc board.

The 9V battery connector is soldered to the assembly so that the red wire (plus lead) is connected to the tab on the printed circuit board where you connected C2. The black lead (minus lead) is soldered to one side of the power switch.

Now that the hard (?) work has been completed, there's little left to do. Fasten the perfboard assembly and printed circuit board to the case. Then mount S1 into the hole you drilled for it, insert the battery and you're ready to test *Magic-Mike*.



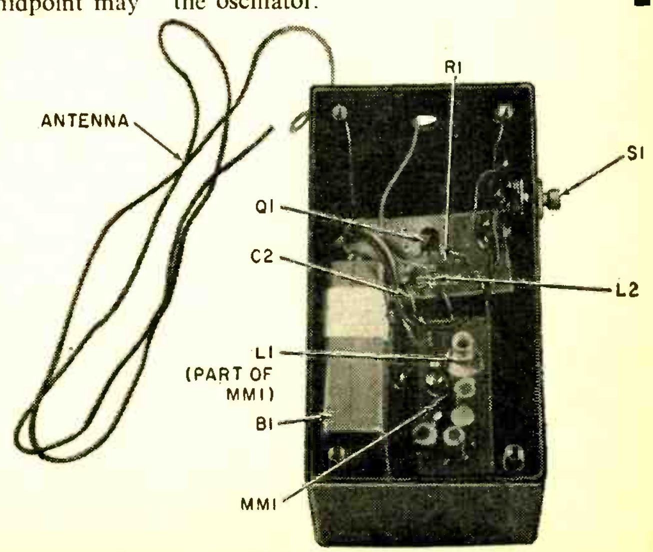
PARTS LIST FOR MAGIC-MIKE

B1—9V Battery (Eveready 216 or equiv.)
C1, C2—15 pF, 1000V ceramic disc capacitor (Lafayette 32F01514 or equiv.)
L2—3½ turns #22 bare copper wire (see text)
MM1—FM wireless microphone module (Allied Radio Shack 277-205 or equiv. —see text)
Q1—*n* channel FET, Motorola MPF103 or HEP 801 or 2N5457
R1—12,000,000-ohm, ½-watt carbon resistor
1—4 X 2⅛ X 1⅝-in. plastic mini utility box with aluminum panel (Lafayette 99F80780 or equiv.)
1—Battery connector (Allied Radio Shack 270B325 or equiv.)
1—Crystal lapel microphone (Allied Radio Shack 33B100 or equiv.)

Misc. Wire, solder, bolts, nuts, spacers, perfboard, push-in terminals, aluminum strip for battery clamp, etc.

One thing not mentioned—the antenna discussed above—is soldered to the center tap of coil L2. It should be made from a piece of #22 stranded wire about 18-in. long. You might try points other than the exact physical center of coil L2 as the final connection point for the antenna. A spot a little ahead or perhaps behind the midpoint may produce a better signal.

So okay, already, how does a smart operator like you groove on *Magic-Mike?* Just follow the instructions that come with the Archer module! We haven't changed the module's basic how-it-works principles. All we've done is to provide a means of eliminating one of the principle drawbacks inherent in all of these units. Namely, the problem of a chick's body capacity broadly detuning the oscillator. ■



It's easier to follow our layout although circuit isn't critical. If you want to make it small enough to hide in performer's clothes go ahead and try it. The case we used may be a little too deep.

newscan

Electronics in the News!

Look Out Below

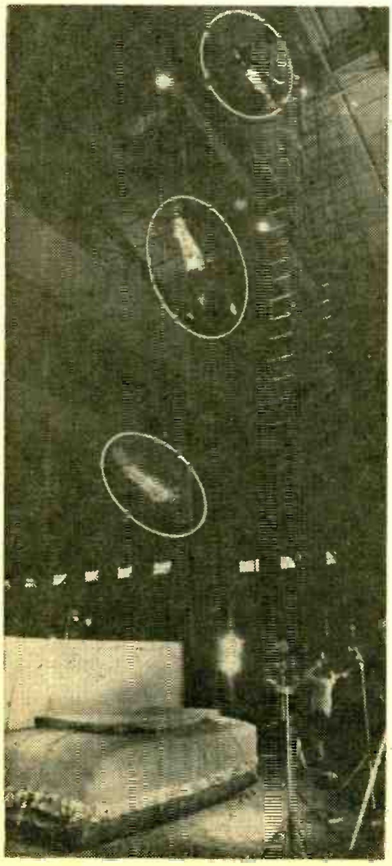
A series of dives by a circus performer from heights up to 57 feet has helped General Motors researchers study impact forces similar to those experienced in automobile crashes. The high dives were performed by stunt-man Ross Collins, under contract to GM Research Laboratories, from a 60-foot tower. Carrying instruments that recorded the severity of his impact, Mr. Collins slammed repeatedly into a 3-foot thick foam rubber pad at speeds up to 40 miles per hour. The new data provided by the tests is considered to be a valuable contribution to a body of biomechanics information which they have been collecting for some 15 years, and which has led to progressively increasing the crashworthiness of automobiles.

The Martian-like appearance of circus performer Ross Collins comes from instrumentation and telemetry he carried in high dives of up to 57 feet for GM safety research. Accelerometers on his head and chest recorded his rapid deceleration. Around his waist are the telemetry units which transmitted this data to scientific monitoring equipment manned by biomechanics specialists.

In his dives, Mr. Collins experienced a measured chest impact of 48 g's of deceleration, higher than was previously considered to be a "safe" level. The "g" is a measurement of the severity of the jolt, and 48 g's means that the forces experienced by Mr. Collins were equivalent to 48 times his own weight of 189 pounds. In dives from 57 feet, Mr. Collins is stopped from a 40 miles per hour impact in a space of about two feet. His landing platform is made up of foam rubber, similar to that used to cushion the landings of pole-vaulters.

The dives he performed for GM are identical to those Mr. Collins makes routinely as part of his act at the Circus-Circus, a Las Vegas casino with in-residence circus acts.

Mr. Collins, a stunt man for 23 of his 40 years, is an accomplished aquatic high-diver. He holds the world's highest diving record: 132 feet into 8 feet of water, set at the 1954 championships in Panama City. In his dives onto the pad, he begins in the swan position, then rolls to land on his back. Important stresses within the chest and head, particularly those



A 57-foot jump for science by circus performer Ross Collins helps GM safety researchers study the effects of high speed impacts. This multiple-image photograph shows Collins heading for a cushion of foam-rubber strips three feet thick.

on the critical lower regions of the brain, are similar from a biomechanial standpoint whether the impact is from the front or back.

Rock Diary

The moon's Ocean of Storms, explored by the Apollo 12 astronauts in 1969, has been wracked by at least four cataclysmic events during the past 70 million years. This discovery, based upon a sophisticated analysis of cosmic ray tracks in lunar materials, was reported by scientists from the General Electric Research Development Center, who examined some rocks.

One lunar sample, known as Rock 12017, provided numerous clues to the natural forces that have repeatedly stirred the dry surface of the Ocean of Storms. Rock 12017 is a gray stone about 1.5 inches in diameter. By interpreting the cosmic ray tracks stored in the rock, the GE scientists have deduced that, about 70 million years ago, it was jarred from a lower depth to within the top few feet of the moon's surface layers. Then, about 1.7 million years ago, the rock appeared on the surface of the moon, where it remained in position for roughly the next 700,000 years. At that point, a natural force caused the rock to flop over. Finally, some 9,000 years ago, the rock was splattered with molten glass.

The GE researchers suspect that the impact of meteoroids against the moon was responsible for this repeated churning of the dry surface of the Ocean of Storms. A meteoroid collision also could melt and splatter lunar material for long distances, accounting for the "young" glassy coating on Rock 12017.

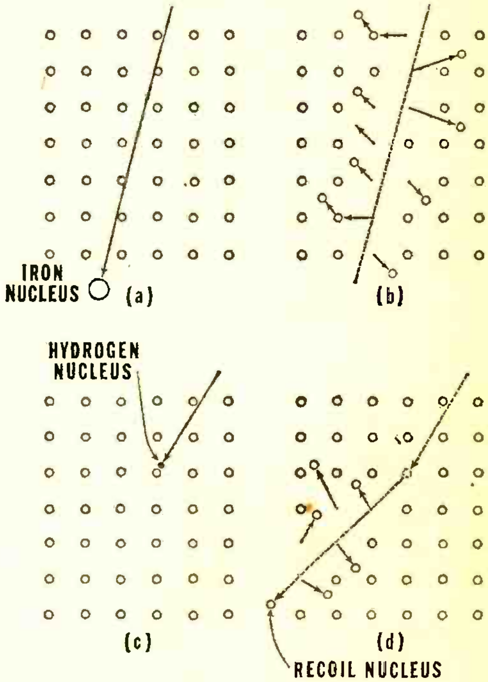
The scientists have examined Rock 12017 and other lunar specimens with a new technique for detecting the tracks left by cosmic rays —charged particles that bombard the moon and earth ceaselessly from outer space.

Some types of cosmic rays are spewed out by the sun, while others are generated by unknown sources in outer space. Among the cosmic rays striking the moon are the nuclei of iron atoms, which leave distinctive tracks in surface rocks. An average iron nucleus penetrates only two or three inches of rock.

Other types of cosmic rays, on the other hand, can penetrate several feet of solid rock. Among these are the nuclei of hydrogen atoms, which themselves are not massive enough to leave tracks. However, as a hydrogen nucleus moves through a rock, it sometimes collides with and alters a heavier nucleus belonging to one of the rock's constituent atoms. If this happens, the heavier nucleus recoils, and leaves a short track in the rock.

The cosmic ray bombardment of the moon is believed to have remained constant over hundreds of millions of years. Thus, by counting the tracks of iron nuclei, the GE scientists can determine how much time a rock spent on the moon's surface.

Further, by performing calibration experiments with man-made "cosmic rays" generated by an accelerator at Princeton University, the GE scientists have determined the number and nature of "recoil tracks" that should be created in rocks near the moon's surface over certain

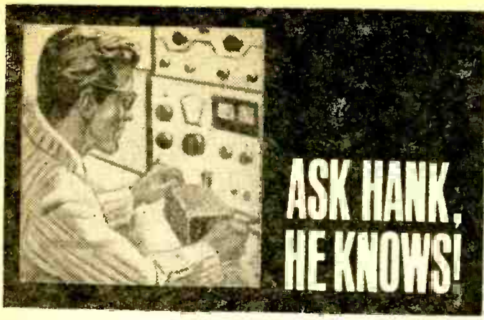


Cosmic rays have riddled moon rocks with tracks of damage. As one type of cosmic ray passes through a rock (a), it ionizes adjacent atoms, thereby giving them an electrical charge. Because like charges repel, the atoms move apart (b), creating a track that can be observed with an electron microscope. This track can be etched out chemically and enlarged for study with an optical microscope. An average iron nucleus penetrates only two or three inches of rock. Other types of cosmic rays, such as the nucleus of a hydrogen atom, can penetrate several feet of solid rock. Although a hydrogen nucleus is not massive enough to leave a track, it sometimes collides with and alters a heavier nucleus (c) belonging to one of the rock's constituent atoms. If this happens, the resulting nucleus recoils, and leaves a short track (d) in the rock.

amounts of time. This information permits them to calculate how long a sample was buried within a few feet of the surface—and, by comparison with other measurements, at which depths.

Once a rock reaches the surface of the

(Continued on page 99)



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

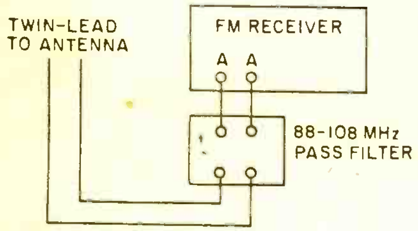
Hank Scott, Workshop Editor
ELEMENTARY ELECTRONICS
229 Park Avenue South
New York NY 10003

Interference on FM

I recently purchased an FM-stereo receiver. I have been getting some pretty bad interference on the lower part of the FM band from short-wave stations. One station on 91.5 MHz is ruined by WWV. Another on 95.5 MHz is drowned out nightly by Radio Havana. I have tried special antennas for FM and FM-stereo but the interference continues. What would you suggest that I do?

—A.F., New Kensington, Pa.

The best advice is "trade it in for a better receiver." The fact that you can hear WWV at



91.5 MHz seems incredible. Your receiver's front end must be poorly designed. Try a band-pass filter (Finco 3007 or equal) in series with the antenna as shown in the diagram.

FBI Frequency

On what frequency do FBI mobile radio systems operate?

—O.R., San Rafael, Calif.

None of your business.

Portable as Amplifier?

I would like to use a portable transistor radio as an electric guitar amplifier. Would it be possible to install a jack on the radio?

—J.D., Southgate, Mich.

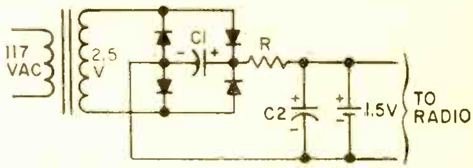
You wouldn't be happy with the results. In the first place, the gain of the audio section of a typical transistor radio is not great enough. Neither is the audio power output.

Power Supply for Battery Radio

I want to know how I can build a power supply for a battery-pack radio that requires 90 volts DC and 1.5 volts DC. I have built a power supply to replace the 90-volt battery to operate the receiver. However, I was unable to get the 1.5 volts for the tube filament. Can you help me with this problem?

—C.F.B., Green Bay, Newfoundland.

Stay with the 1.5-volt battery. A hum-free 1.5-volt rectifier power supply would be costly. But



you can keep the 1.5-volt battery charged by floating it across the charger whose circuit is shown in the diagram. Try different values for R until the current measured at X with the receiver on is zero. Then, the charger will furnish the current and the battery will last its shelf life and act as a filter and voltage stabilizer. The diodes can be International Rectifier type 8D4 or equal and C1 and C2 can be 6000-uF, 6-volt electrolytics.

No Distortion with Speaker

I hooked up a jack on my radio for recording. But if I have the speaker on while recording, can it cause distortion? If it does, can you tell how to record with the speaker on and no distortion?

—C.C., North Salem, N.Y.

If you're recording radio programs, leaving the speaker on should not cause distortion.

Separating the Stations

I have a 4-band regenerative SW receiver with good sensitivity, but poor signal separation. I thought it might be a good idea to get a superhet receiver for better separation. However, I have been told that it isn't wise to move up to a more expensive receiver. This gave me doubts. Could you please straighten me out. I just want to listen to one thing at a time.

—K.C., Somers, Conn.

A good superhet with a selectivity filter or Q-multiplier is better. A regen receiver depends upon feedback to improve the selectivity of one tuned circuit. In a superhet you have several tuned circuits. ■

e/e's all NEW BASIC COURSE in ELECTRICITY & ELECTRONICS *

PART 11
UNDERSTANDING RLC CIRCUITS

What You Will Learn. You will now learn how to combine both reactive effects (inductive and capacitive) with and without resistance. A number of important special circuits, called tuned circuits, depend on the RLC combination. You will learn how to calculate their effects in circuits having inputs of various frequencies. After you have finished this part, you will know a general rule about phase and power in AC circuits. You will be able to analyze the effects of RLC circuits on pulse inputs in terms of frequency response, and how to use a universal time-constant chart.

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

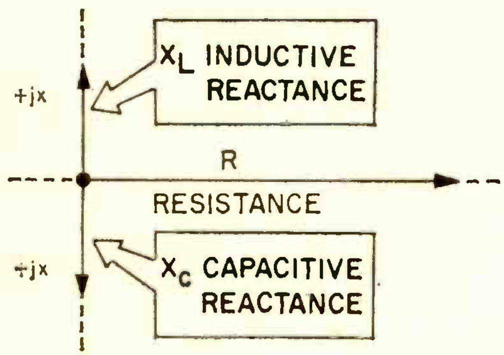
e/e Basic Course

RLC IMPEDANCE

When vector diagrams are used to find the impedance and phase angle (as in the previous parts), +jX is always drawn upward, while −jX is always drawn downward. This leads to the idea that inductance and capacitance provide opposite reactions.

What happens if a circuit contains both inductance and capacitance in series? The two reactances cannot be just arithmetically added to find the total reactance. +jX and −jX tend to offset each other, and the total effect is their difference.

INDUCTIVE AND CAPACITIVE REACTANCE VECTORS OPPOSE



This difference is in the direction of the greater of the two reactances. So, if a circuit contains a capacitor, the reactance of which is −j50 ohms, and an inductor, the reactance of which is +j100 ohms, the net result is equivalent to an inductive reactance of +j50 ohms.

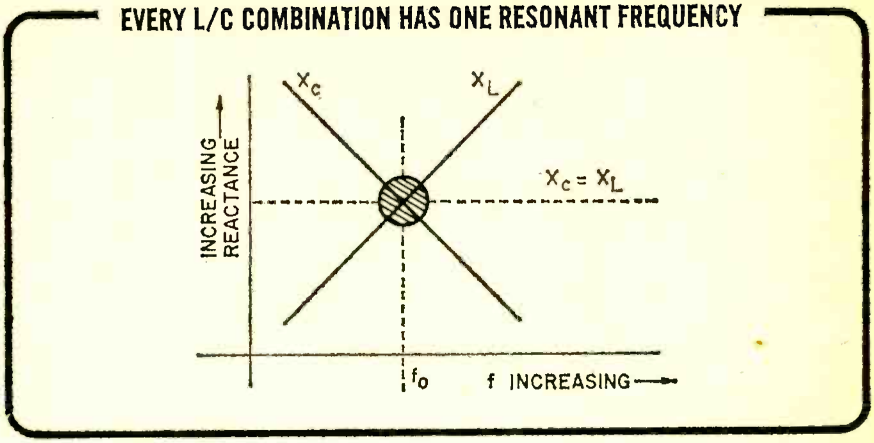
If a resistor is connected in series with an LC circuit, the impedance of the circuit will simply be the resultant reactance (whether inductive or capacitive) in series with the resistor.

A series circuit containing L and C behaves either as a capacitor or as an inductor, whichever of the two components has the greater reactance at the operating frequency.

RESONANCE

A special case arises when the capacitive reactance and the inductive reactance are equal. When this condition exists, the reactances cancel each other and the circuit appears to be purely resistive. This can happen at only one frequency, however, for each particular set of inductive and capacitive values. At a low frequency, the inductive reactance is low and the capacitive reactance is high. The circuit, therefore, behaves as a capacitance. If the frequency of the applied voltage is gradually increased, the inductive reactance will gradually increase and the capacitive reactance will gradually decrease. At some point the two reactances become equal, and thus cancel. This point is called the **resonant frequency** of the circuit. If the frequency is increased further, the inductive reactance becomes greater than the capacitive reactance, and the circuit will behave as an inductor.

Every L and C combination has one, and only one, resonant frequency. It is the frequency at which the inductive and capacitive reactances are equal.



Q1. Capacitance and inductance both store energy. Capacitance stores energy in a(an) -------- field. Inductance stores energy in a(an) -------- field.

Q2. How do capacitance and inductance affect a DC input?

Q3. What are the formulas for finding capacitive and inductive reactances?

Q4. How does an increase in the frequency of the input affect capacitive reactance? Inductive reactance?

Q5. Capacitive impedance is expressed in component form as R — jX. Inductive impedance is expressed as ———.

Q6. What is the total reactance of a circuit that has an X_L of 100 ohms and an X_C of 25 ohms? Is the total reactance capacitive or inductive?

Q7. The condition existing when capacitive reactance is equal to inductive reactance is known as ----------.

Q8. Any circuit containing inductance and capacitance has only one -------- frequency.

Your Answers Should Be:

A1. Capacitance stores energy in an **electric** field. Inductance stores energy in a **magnetic** field.

A2. **Capacitance blocks DC. Inductance offers no opposition to D.C.**

A3. $X_C = \frac{1}{2\pi fC}$; $X_L = 2\pi fL$

A4. An increase in frequency results in a **decreased capacitive reactance**, and an **increased inductive reactance.**

A5. Inductive impedance is expressed as **R + jX.**

A6. **75 ohms of inductive reactance.**

A7. The condition existing when capacitive reactance is equal to inductive reactance is known as **resonance.**

A8. Any circuit containing inductance and capacitance has only one **resonant** frequency.

Resonant Frequency Calculation

The resonant frequency (f_o) formula is derived as follows:

$$2\pi f_o L = \frac{1}{2\pi f_o C}$$

Multiplying by f_o,

$$2\pi f_o^2 L = \frac{1}{2\pi C}$$

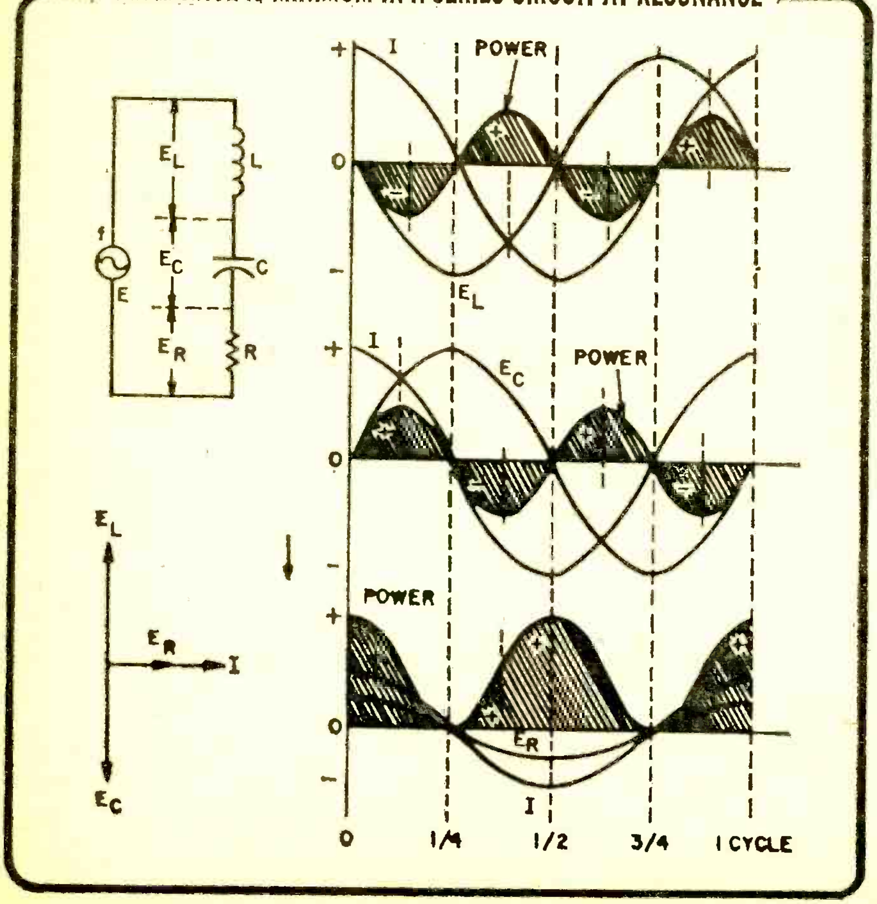
Dividing by $2\pi L$,

$$f_o^2 = \frac{1}{4\pi^2 LC}$$

Taking the square root of both sides,

$$f_o = \frac{1}{2\pi\sqrt{LC}}$$

IMPEDANCE IS MINIMUM IN A SERIES CIRCUIT AT RESONANCE



Now see what actually happens in a series resonant circuit. Current I, which is in phase with the applied AC voltage, flows through all three components—L, C, and R. During the first quarter cycle (of each sine wave) the inductance is returning energy **to** the circuit and the capacitance is taking energy **from** the circuit at the same rate.

During the second quarter cycle, the situation is reversed—the capacitor is returning energy, and the inductor is taking it out. This sequence occurs during each cycle.

The voltage across the capacitance is equal and opposite to the voltage across the coil at all times, and the two cancel. One voltage (E_C) is 90° behind the current and the other voltage (E_L) is 90° ahead. No power is consumed in the L and C elements—only the resistor consumes power.

Q9. What is the resonant frequency of a circuit containing 2 henrys in series with 2 mfd?

Q10. If a 100-ohm resistor is placed in series with the two components of Question 9, what happens to the resonant frequency of the circuit.

Your Answers Should Be:

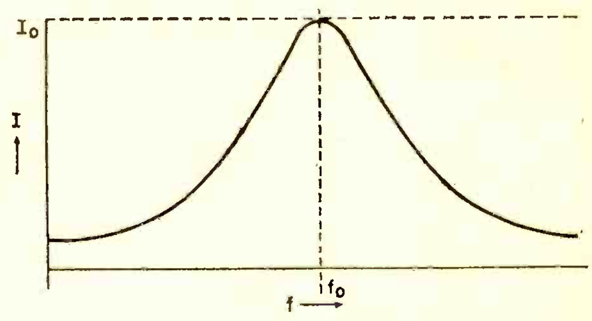
A9. $f_0 = \dfrac{1}{6.28 \times \sqrt{2 \times 0.000002}} =$ **79.6 Hz**

A10. If a 100-ohm resistor is placed in series with the two components of Question 9, the resonant frequency of the circuit will **remain the same.**

Q of a Resonant Circuit

At resonance, the voltage across the capacitor and across the inductor is greater than at any other frequency. The effective current in the circuit is also higher at the resonant frequency than it is below or above resonance.

SERIES-CIRCUIT CURRENT IS MAXIMUM AT RESONANT FREQUENCY

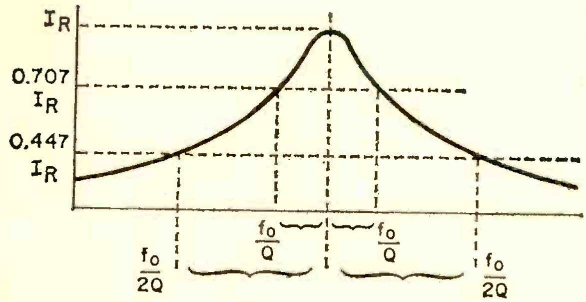


The quality of a resonant circuit can be measured by the **Q** factor. Q is the ratio of the energy stored in the capacitor and inductor divided by the energy dissipated in the resistor.

The amount of reactive opposition to current flow at a given frequency is not effected by the Q of the circuit. The resistive opposition, however, does vary according to the Q. This means that the shape of the resonance curve depends on this factor. If the frequency is changed from f_0 to a frequency where the reactance is low, and if the Q is high (resistance is only a few ohms), the total impedance will be halved. If the Q is low (resistance is high), the total impedance will be increased by only a small amount, and the current decrease will be very small.

The Q determines the exact shape of the resonance curve of a circuit. For example, if the resonant frequency is multiplied by $\frac{1}{Q}$, and the frequency of the input is changed from the resonant frequency by this amount, the current will be 0.707 times the resonant current. If the frequency is changed by $\frac{1}{2Q}$ times the resonant frequency, the current will be 0.447 times the resonant current.

CIRCUIT Q DETERMINES THE SHAPE OF THE RESONANCE CURVE

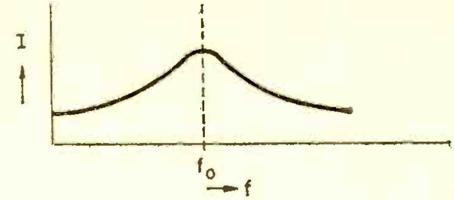


Q11. Both the capacitor and the inductor in a resonant circuit store energy. Do both store energy at the same time?
Q12. Do they both store the same maximum amount of energy?
Q13. At what frequency would you measure the Q of a circuit?
Q14. What is the Q of a circuit whose resonant frequency is 1,000 Hz, inductance is 0.5 henry, and resistance is 10 ohms?
Q15. If two resonant circuits are identical except that one has a greater R (and therefore a lower Q) than the other, which one will pass a greater effective current at a given voltage?
Q16. Draw a curve representing current for various frequencies in a low-Q, series resonant circuit.

Your Answers Should Be:

A11. No. The inductor stores energy when the capacitor is releasing it, and vice versa.
A12. Yes. When maximum energy is stored in the inductor, the capacitor has stored no energy.
A13. At its **resonant frequency.**
A14. $Q = \frac{X_L}{R} = \frac{2\pi fL}{R} = \frac{3{,}140}{10} = \mathbf{314}$

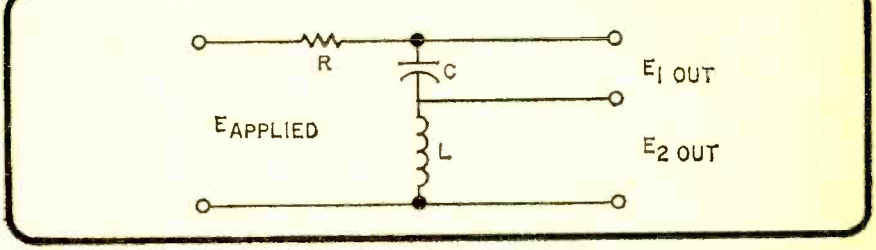
A15. The one with the higher Q will pass the greater current.
A16. Your curve should look something like this:



APPLICATIONS OF RLC CIRCUITS

Frequency-selective properties of series resonant circuits are useful in applications where it is desired to pass one particular frequency with more ease than others. The circuit can act as a filter.

A BANDPASS FILTER CONSISTS OF L AND C COMPONENTS



If the voltage across either L or C is used for the output, the voltage will be much greater for signals having the resonant frequency than for signals above or below this frequency. Such a circuit is called a **bandpass filter.**

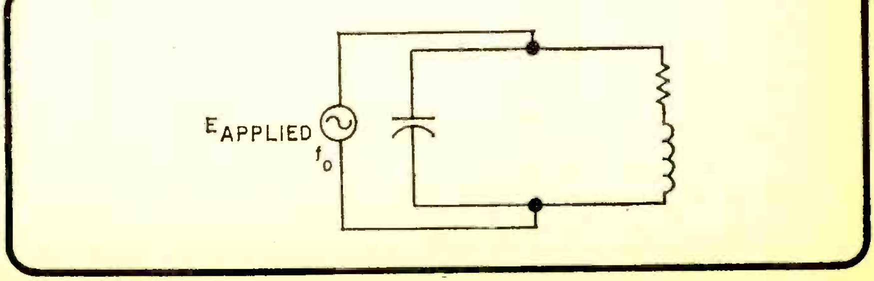
The width of the bandpass depends on the circuit Q—the higher the Q, the sharper the resonance curve, and the narrower the bandpass.

In a radio-frequency circuit a high-Q tuned circuit can be used to select the desired station and reject all others. In a power supply, a circuit using fairly large L and C values may be used to reject undesired frequencies.

PARALLEL RESONANT CIRCUITS

A parallel resonant circuit is made up of inductance and each of the two branches shows reactance. The capacitive losses are usually associated with the coil rather than with the capacitor, the resistance is usually shown as being in series with the inductance.

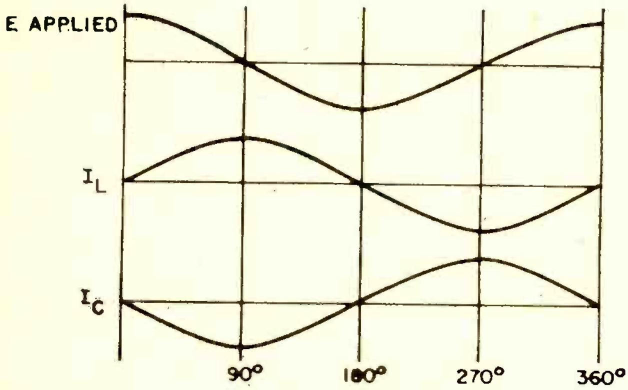
INDUCTANCES IN PARALLEL-RESONANT CIRCUITS HAVE DC RESISTANCE



Q17. What is the phase relationship between the applied voltage and the output voltage across the capacitor in the bandpass filter circuit on page 81?
Q18. What is the phase relationship between the applied voltage and the output voltage across the inductor?
Q19. What is the phase relationship between the applied voltage and the current through the circuit?
Q20. Analyze what will happen in the parallel-resonant circuit on page 81. Assume that R is negligible. What effect will C have on the phase of the current through the C branch?
Q21. What effect will L have on the phase of the current through the L branch?
Q22. Draw a sketch of the applied voltage sine wave and then of the inductive and capacitive currents to show their phase relationships.

Your Answers Should Be:

A17. Output voltage across the capacitor lags the applied voltage by 90°.
A18. Output voltage across the inductor leads the applied voltage by 90°.
A19. Current is in phase with the applied voltage.
A20. In the C branch, current will lead the applied voltage by 90°.
A21. In the L branch, current will lag the applied voltage by 90° (if R is negligible).
A22. Your sketch should look like this:



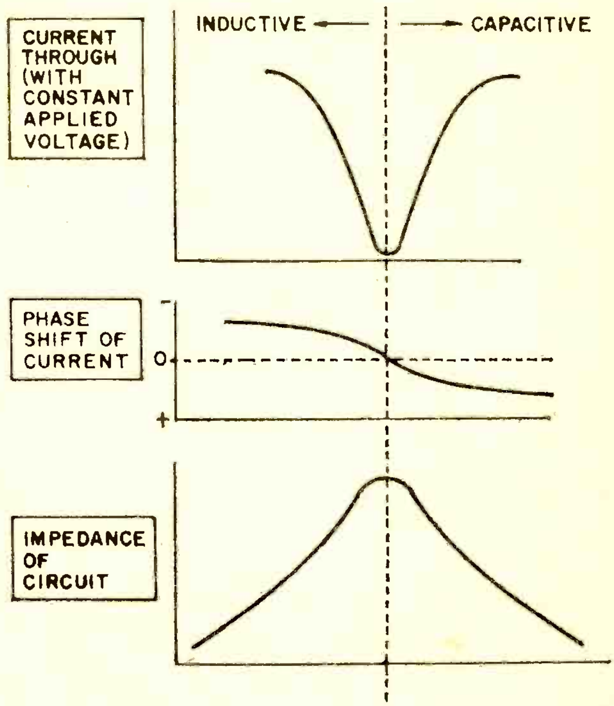
Parallel RLC Circuits

When an AC voltage is applied to a parallel RLC circuit, each of the two branches shows reactance. The capacitive reactance in the capacitor branch is high at low frequencies, and decreases as the frequency increases. Similarly, the inductive reactance of the inductor branch is low at low frequencies, and increases as the frequency increases.

The capacitor has a high reactance and the inductor a low reactance at frequencies below resonance. Consequently, most of the current flows through the inductive branch and lags the applied voltage. Similarly, if the frequency is above resonance, most of the current will flow in the capacitive branch and will lead the applied voltage.

At some particular frequency the two reactances in a parallel resonant circuit are exactly equal. Since there is an AC voltage applied across each branch, both kinds of current are present—an inductive current in the inductive branch and a capacitive current in the capacitive branch. At resonance the two currents are equal.

CURRENT, PHASE SHIFT, AND IMPEDANCE IN A PARALLEL CIRCUIT



But, because one of the currents **leads** the applied voltage by 90°, and the other **lags** the voltage by 90°, the two currents are 180° out of phase with each other. This means that they cancel (add up to zero).

The applied voltage was kept constant as the frequency was varied. Since current is minimum through the circuit at resonance, a parallel circuit has a higher impedance at the resonant frequency than at any other.

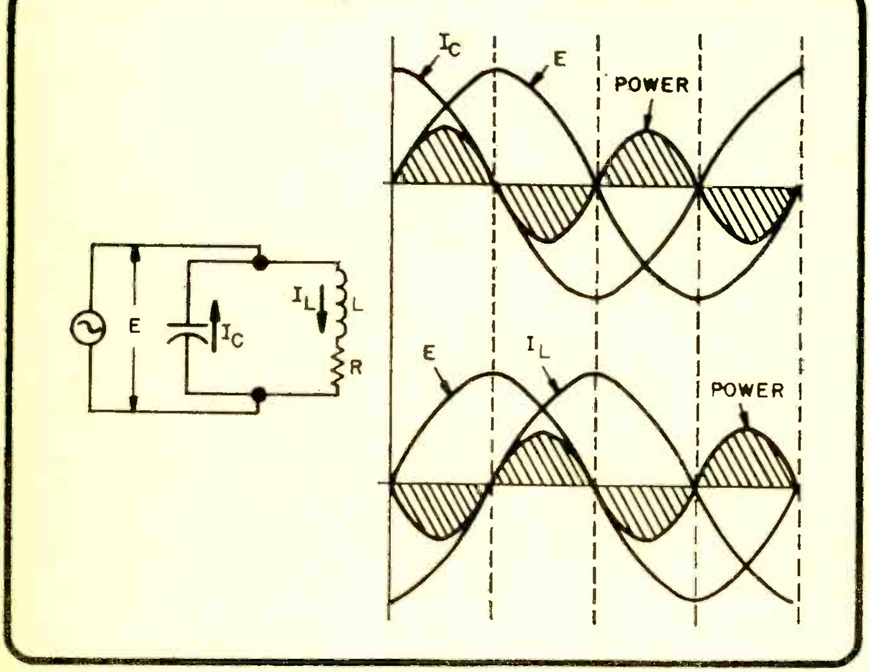
Now, let's look at what happens inside the loop formed by the inductance and capacitance.

The two large currents—inductive and capacitive—still flow, but only inside the loop. Energy alternately flows from capacitor to inductor and back again, twice each cycle. The capacitor alternately charges and discharges, first in one direction and then in the other. The inductive magnetic field alternately builds up and collapses, changing polarity twice each cycle. But this flow back and forth is contained in the loop, and none appears in the external circuit. The outside circuit only has to replenish the energy lost in any resistance the inductor has, and this constitutes the entire external current.

The Q of the circuit, just as in the series resonant circuit, is the inductive reactance at resonance divided by the resistance of the inductor ($\frac{X_L}{R}$). In a parallel resonant circuit the loop current flowing between inductor and capacitor is Q times the external (resistive) current.

A parallel resonant circuit is, in a way, the opposite of a series resonant circuit. A series circuit has low impedance at resonance (maximum current); a parallel circuit has high impedance (minimum current). The total impedance will be greater as X_L and X_C become greater relative to resistance. It will decrease as R increases and draws more current. The impedance of a parallel circuit at its resonant frequency can be found by this formula:

CURRENT, VOLTAGE, AND POWER IN PARALLEL-RESONANT CIRCUIT



$$Z_0 = \frac{X_L X_C}{R}$$

If you use the formulas for X_L and X_C, you can also develop another formula.

$$X_L\,X_C = 2\pi fL \times \frac{1}{2\pi fC} = \frac{2\pi fL}{2\pi fC} = \frac{L}{C}$$

Substituting in the above impedance formula,

$$Z_0 = \frac{X_L X_C}{R} = \frac{L}{CR}$$

Another useful formula can be developed if you notice that X_L R is the Q of the circuit. This means that the impedance at resonance is simply X_C (or X_L since they are equal) times the Q of the circuit.

$$Z_0 = X_L Q = 2\pi fLQ$$

The impedance curve for a parallel resonant circuit is the same shape as the current curve for a series resonant circuit. Its shape depends on the Q of the circuit in the same way.

Parallel tuned circuits are used in receivers, transmitters, and similar equipment. For instance, the superheterodyne radio receiver has parallel tuned circuits in its IF amplifiers. Their function is to select certain frequencies and reject others.

Q23. What is the impedance at resonance of a parallel resonant circuit consisting of a 1-henry inductor with 1 ohm of DC resistance, and a 1-mfd capacitor?

Q24. If the resonant frequency of a circuit is 1,000 Hz, L is 1 henry, and the Q of the circuit is 80, what is the impedance of the circuit at resonance?

Your Answers Should Be:

A23. $Z_0 = \frac{L}{CR} = \frac{1}{0.000001 \times 1} =$ **1 megohm**

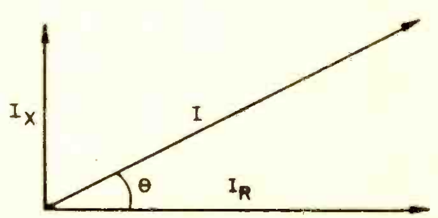
A24. $Z_0 = 2\pi fLQ = 6.28 \times 1{,}000 \times 1 \times 80 =$ **502,400 ohms**

POWER IN RLC CIRCUITS

To calculate the power dissipated in a circuit containing only resistance, either $P = I^2R$ or $P = EI$ can be used. Either will yield the same result. However, $P = EI$ applies only to resistive circuits (circuits in which the voltage and current are in phase).

In a parallel circuit that contains resistance and either capacitance or inductance, $P = EI$ gives the **apparent power.** This, however, is not the true power—apparent power is always larger. The reason is that the overall current in a reactive circuit is not in phase with the voltage. The total current is actually the vector sum of the resistive current (which is in phase with voltage) and the reactive current (which leads or lags by 90°). To use $P = EI$, multiply the voltage by only that portion of the current that is in phase—the resistive current. In order to calculate the true consumed power, the resistive and reactive currents must be taken separately.

TOTAL AMPS IS VECTOR SUM OF REACTIVE AND RESISTIVE CURRENT



The overall current is the vector sum of the reactive current and the resistive current. This overall current leads or lags the applied voltage by an angle θ.

The true power dissipated in a circuit is found by multiplying the apparent power by $\cos\theta$.

$$\frac{EI\cos\theta}{EI} = \cos\theta$$

(Continued on page 90)

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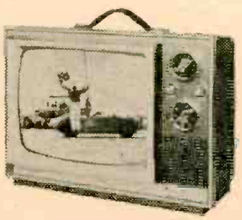

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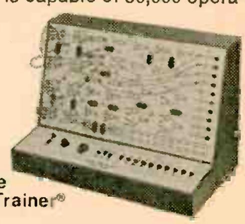

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(Continued from page 85)

True power divided by apparent power equals cos θ and is called the **power factor** of the circuit. There are several things to consider about power factor. The more reactance there is in a circuit (compared to the resistance present), the more out of phase the current will be with the voltage, and the smaller the power factor will be.

It is possible to represent the total current flowing as two separate component currents at right angles to each other. The resistive current produces power (does the work). The reactive current merely flows in and out of the capacitance or inductance as it charges and discharges, but it does no work.

Even though the reactive current produces no power in the circuit, the wires must be large enough to carry it. Power lines are designed to carry the total current, not just the resistive component.

A low power factor sometimes leads to problems. For example, when a plant that uses induction motors draws a large reactive current (has a low power factor), equipment must be provided to supply it with more current than it actually consumes. The large inductive component can be canceled in such cases by placing large capacitors in series with the load. The capacitors draw reactive current 180° out of phase with the inductive current, and thus the capacitors cancel the inductive component. This is called "power factor improvement" and can save considerable money in large power installations.

Q25. Is a high or a low power factor desirable in electrical circuits used to transmit power?
Q26. How can inductive reactance be canceled to increase the power factor in an inductive circuit?

Your Answers Should Be:
A25. A high power factor.
A26. Inductive reactance can be canceled by **capacitive reactance.**

PULSES IN RLC CIRCUITS

Pulses are a special type of AC voltage, even though they often have a DC voltage component as well. Radar systems are based on pulses of RF energy reflected from targets. Digital computers, counters, and other data-processing circuits employ pulses. Pulses are also used in telemetry and remote control to switch circuits on and off. Trains of pulses are used to transmit information between satellites, spaceships, and the earth.

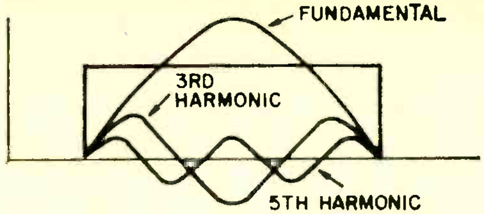
All these applications create a need for circuits that can generate, amplify, send, receive, count, recognize, and/or process pulses. Because pulses are composed of a combination of many sine-wave frequencies, pulse-handling circuits have very severe requirements placed on them.

Frequency Response

All pulse waveforms are made up of a combination of sine waves.

The lowest frequency contained in a train of rectangular pulses is called the **fundamental frequency.** This frequency has a period equal to that of the square wave. All the other frequencies contained in the square wave are **harmonics**, or multiples, of the fundamental frequency. In the case of a square or rectangular wave, only the **odd harmonics** are included. (The next higher

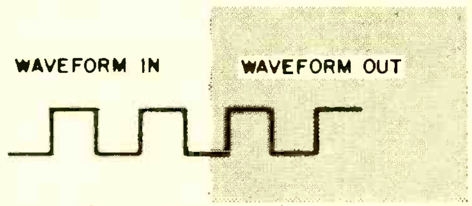
A SQUARE WAVE IS COMPOSED OF ODD-ORDER HARMONICS



frequency is three times the fundamental (the third harmonic), then five times the fundamental (the fifth harmonic), etc.). A perfectly square waveform contains an infinite number of odd harmonics.

To pass or amplify a square wave without distortion, a circuit must be able to pass all the frequencies contained in the wave. In practice, an infinitely high frequency response is not electrically possible, nor is it necessary. All circuits have some frequency-sensitive characteristics due to such factors as stray capacitance, the inability of vacuum tubes or transistors to amplify signals above certain limits, etc. All of these frequency-sensitive characteristics result in distortion of the square wave.

RESPONSE IS SAME TO ALL FREQUENCIES ABOVE FUNDAMENTAL



Q27. In a pulse circuit, inductance opposes a change in - - - - - - - .
Q28. In a pulse circuit, capacitance opposes a change in - - - - - - - .
Q29. What sine-wave frequency contributes most of the amplitude of the flat-top, or straight-line, portion of a square wave?
Q30. What sine-wave frequencies are responsible for the steep leading and trailing edges of a square wave?

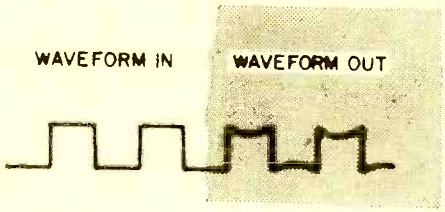
Your Answers Should Be:

A27. In a pulse circuit, inductance opposes a change in **current.**
A28. In a pulse circuit, capacitance opposes a change in **voltage.**
A29. The **fundamental** frequency.
A30. The **higher** harmonic frequencies.

Pulse Circuit Applications

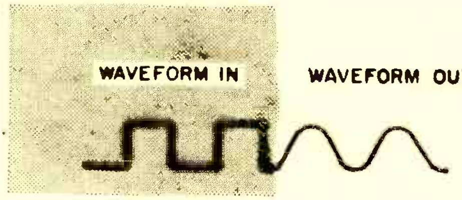
If a circuit has poor low-frequency response, there will be a visible sag in the level portion of the output waveform.

POOR CIRCUIT LOW-FREQUENCY RESPONSE



If the circuit has good low-frequency response but poor high-frequency response, the corners of the output waveform will be rounded off.

POOR CIRCUIT HIGH-FREQUENCY RESPONSE

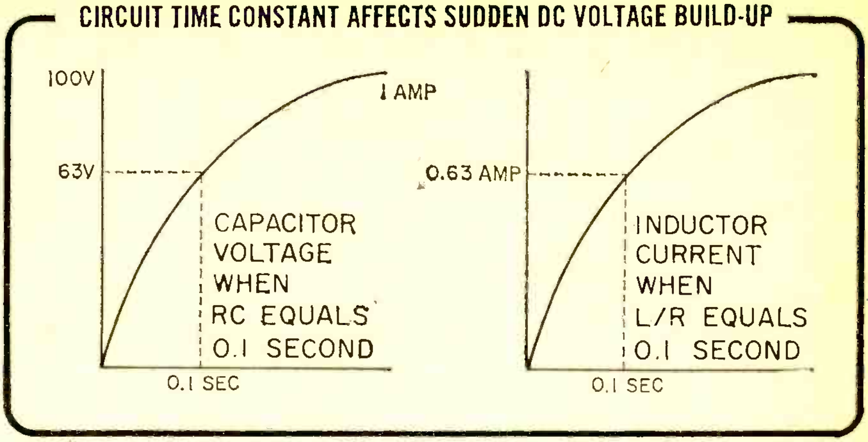


The application of the pulse determines whether a particular circuit is good enough or not. In a telegraph system, it may only be necessary to detect the presence or absence of pulses with no concern as to their exact shape.

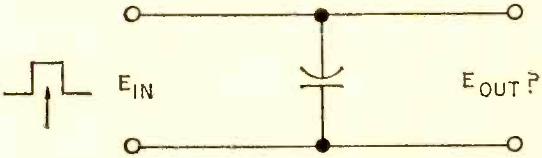
But if precise location of the start of a pulse is necessary (as in a precision radar, or a timing circuit), then the high-frequency response of the circuit is extremely critical.

TIME CONSTANTS

LR and RC time constants indicate how quickly current or voltage builds up when a sudden increase in DC voltage (such as a square wave) is applied to a particular combination of L and R or C and R. One time constant is the time required for voltage (or current, depending on the circuit) to reach 63% of its peak value. The percentage of the peak value can be calculated for any elapsed time if the time constant of the circuit is known. The curves for the voltage increase across a capacitor, or the current increase through an inductor, are exactly the same if the time constants of the two circuits are the same.



Q31. If a square wave is applied to the circuit below, the capacitor will tend to bypass what frequencies? What frequencies will be emphasized in the voltage across the capacitor? How will this affect the shape of the output waveform?

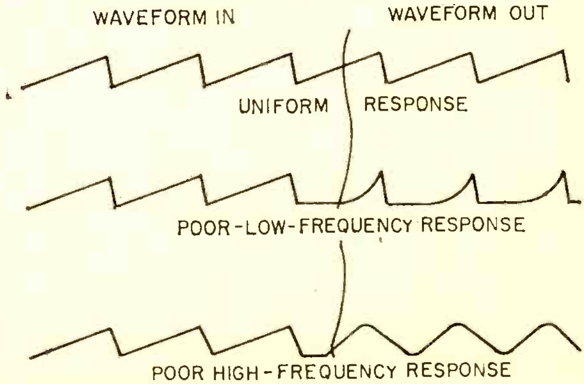


Q32. Sketch how you think a sawtooth wave should be affected by a circuit with a poor low-frequency response. With a poor high-frequency response.

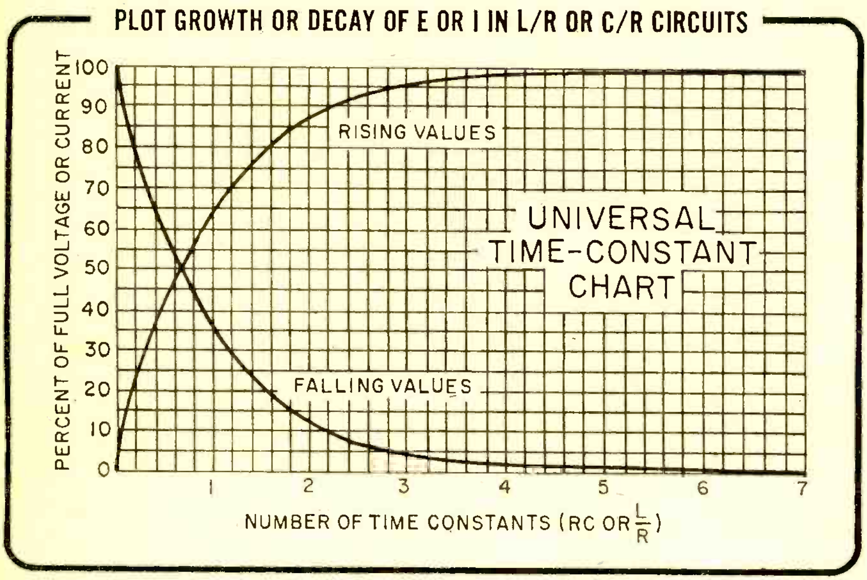
Your Answers Should Be:

A31. The capacitor will tend to **bypass** the **high frequencies** and **emphasize** the **low frequencies** in the output voltage. This will tend to **round off the steep edges** of the waveform.

A32. The response to a sawtooth is very similar to that of the square wave.

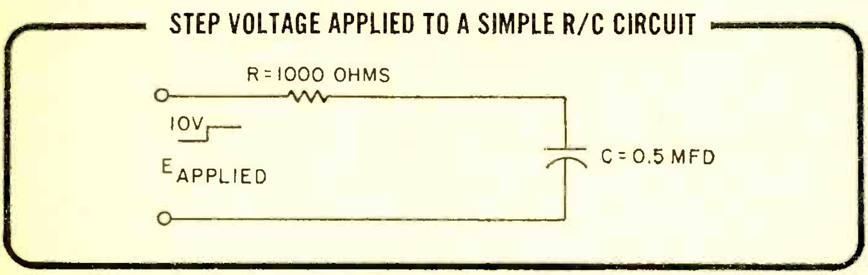


Poor low-frequency response produces a **sag** in the **sloped portions** of the wave, while poor high-frequency response **rounds off** the **sharp corners** of the wave.



A **universal time-constant chart** can be used to calculate the growth and decay of voltage and currents in any RL or RC circuit to which a sudden step voltage is applied. All you have to know is the final voltage and current, and the time constant of the circuit.

Calculate the voltage across the capacitor and the current in the following circuit:



The time constant is:
$RC = 1{,}000 \times 0.5 \times 10^{-6} = 0.5 \times 10^{-3} = 0.5$ millisecond

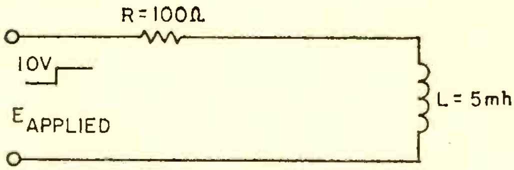
When the 10 volts is first applied, the current will be $E/R = \frac{10}{1{,}000} = 0.01$ ampere. Using the time constant and the falling curve in the chart, it can be seen that at the end of one time constant 0.5 millisec), the current is about 37% of its full value ($0.37 \times 0.01 = 0.0037$ ampere). At the end of two time constants (1 millisecond), current will be 13% ($0.13 \times 0.01 = 1.3$ milliamperes). At the end of three time constants, current will be 5% ($0.5 \times 0.01 = 0.5$ milliampere), and so on.

The voltage across the capacitor can be determined in a similar manner. When the switch is first closed, E_C is zero. This voltage gradually increases to the value of the power supply, or 10 volts. At the end of one time constant (0.5 millisec) E_C will be 63% of maximum (6.3 volts). At the end of two time constants 1 millisec) E_C will be 87% of maximum (8.7 volts), etc.

The same charts can be used when the voltage is suddenly removed (the switch is opened). In this case, E_C decays according to the falling curve.

Q33. Use the universal time-constant chart to describe in detail what happens when a step voltage of 10 volts is applied across a 100-ohm resistance in series with a 5-millihenry inductance.

Your Answers Should Be:
A33.



Time constant $= \frac{L}{R} = \frac{0.005}{100} =$ 50 microseconds.

(1) Current through R and I is zero to start with, and increases to $\frac{E}{R} = \frac{10}{100} =$ 0.1 ampere eventually. Use the rising curve.

(2) Voltage across L is 10 volts initially, and drops to zero eventually. Use the falling curve.

(3) Voltage across R is zero at first, and rises to 10 volts eventuall. Use the rising curve.

Time in sec	No. of time constants	I amps	E_L volts	E_R volts
0	0	0	10.0	0
0.25	0.5	0.038	6.2	3.8
0.35	0.7	0.050	5.0	5.0
0.50	1.0	0.063	3.7	6.3
1.00	2.0	0.087	1.3	8.7
1.50	3.0	0.095	0.5	9.5
2.00	4.0	0.098	0.2	9.8
2.50	5.0	0.099	0.1	9.9
3.00	6.0	0.0995	0.05	9.99
		0.100	0	10.00

Remember that a universal time-constant chart can only be used with step voltages or square waves.

e/e Basic Course

WHAT YOU HAVE LEARNED

1. Equal amounts of capacitive and inductive reactance cancel each other when they are combined in series. If inductive reactance is greater than capacitive reactance, the total circuit will behave as though it had only an inductive reactance equal to the difference between the two reactances. If capacitive reactance is greater, the circuit will be capacitive.
2. For any series RLC circuit there is one frequency at which the two reactances are exactly equal. This is called the resonant frequency. This frequency can be found by setting the formulas for inductive and capacitive reactance equal to each other:

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

3. Maximum current will flow in a series RLC circuit at the resonant frequency, and this current will decrease at higher or lower frequencies.
4. A parallel RLC circuit has maximum impedance at its resonant frequency, and much lower impedance at higher or lower frequencies.
5. The Q of a resonant circuit is the amount of reactance of either kind, divided by the resistance. $Q = \frac{R}{X_L} = \frac{R}{X_C}$ The Q of a resonant circuit determines how quickly current or impedance decreases as the frequency is changed from the resonant frequency. High Q means a very sharp drop, low Q means a slower decrease.
6. Formulas $\frac{L}{CR} = Z_0$, $X_L Q = Z_0$, and $2\pi f L Q = Z_0$ give the impedance of a parallel resonant circuit at its resonant frequency.
7. $P = EI \cos \theta$ is a power formula that can be used to find true power in any kind of RLC circuit. $\cos \theta$ is the cosine of the phase angle between the reactive and resistive vectors, and is called the power factor. $I \cos \theta$ represents the resistive portion of the overall current.
8. The straight-line (flat-top) portions of pulses are determined by the low-frequency, sine-wave components and the steep edges are determined by the high-frequency components.
9. RLC circuits that tend to filter out low frequencies cause the straight-line portions of pulse waveforms to sag, while those that filter out high frequencies cause the steep edges to be rounded off.
10. A universal time-constant chart can be used to analyze the response of either an RL or an RC circuit to a step voltage.

NEXT ISSUE: Part 12—Understanding the Transformer

This series is based on material appearing in Vol. 2 of the 5-volume set, BASIC ELECTRICITY/ELECTRONICS, published by Howard W. Sams & Co., Inc. @ $19.95. For information on the complete set, write the publisher at 4300 West 62nd St., Indianapolis, Ind. 46268.

Bookmark

Continued from page 22

and VFO, are explained. Multi-stage CW transmitters can be constructed using the included data, permitting a bit more power and additional versatility. Both AM and sideband circuits are presented. The emphasis is on solid state. Bipolar transistors, field-effect transistors and integrated circuits (ICs) are the main characters in *Solid State QRP Projects*. No extensive knowledge of electronics is required but a good deal of operating skill must be developed to utilize the equipment efficiently. The

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Circle No. 40 on Page 17

serious experimenter will find in this book many hours of pure enjoyment. Published by Editors and Engineers, a Division of Howard W. Sams & Co., Inc. ■

Single Sideband

Continued from page 44

ments refer only to instants of peak power. The letters "P.E.P." (peak envelope power) qualify the rating. The Sidewinder, for example, is specified at 3.5 watts AM, but 8 watts P.E.P. sideband. This is equivalent to more than a doubling in power, though, since voice power in sideband is about eight times more potent because so little power is wasted in the carrier.

The SBE Sidebander by Linear Systems illustrated in Fig. 13 is a compact sideband rig. Note a front panel knob marked "Clarifier" to fine-tune speech. The mode selector chooses upper or lower sideband in each channel. Pick the wrong one and speech will be detected backwards and sound like gibberish. A red output lamp on this set glows when AM is being transmitted and brightens as the operator speaks. It will flash rapidly during sideband transmission, however, because there's no carrier to keep it illuminated between words. The Mode Selector picks AM, USB or LSB.

So the next time you hear a signal on the air that sounds like the Martians have landed in Grovers Corners, N.J., attribute it to single sideband. It's taken a long time to catch on in CB, probably because CBers like to talk to other operators and sideband isn't compatible. Everyone has to have the same receiving capability. But the powerful boost of sideband, its narrower bandwidth and ability to cut through noise and interference should guarantee it a position among conventional AM sets. ■

Class E CB

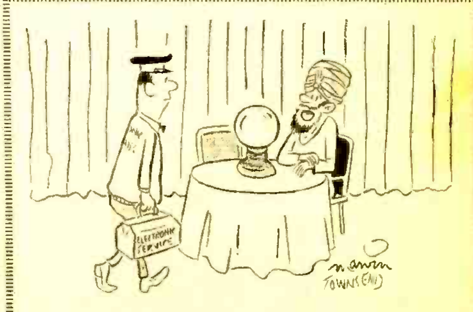
Continued from page 35

23 channels.

For the new citizens band, it would be possible to build transceivers operable on all 80 channels. However, it is highly probable that such rigs won't become available because of cost and technical design problems. There will be multi-channel transceivers as well as single-channel units.

It won't be long after the new rules are adopted before Class E gear will be available. Those manufacturers who already produce 150-174 MHz band commercial mobile radio equipment will be able to modify them quickly for 220-MHz band operation.

What's available. It will not be feasible to modify Class D gear for the 220-MHz band, nor to use a frequency converter with a Class D rig, because FM must be used instead of AM or SSB. It will, however, be feasible to use a converter and an AM BCB



"I can't get any ghosts."

(Continued from previous page)
or SWL receiver for receiving 220-MHz band FM signals, depending upon slope detection for demodulating FM.

As soon as the FCC okays Class E CB, if new equipment is not available, you won't have to wait to get on the air.

You will be able to buy modified second-hand mobile units and base station equipment previously used (by police, etc.) on 150-174 MHz band frequencies. This equipment should work well, if properly modified. Be sure the seller "certifies" that it performs as required by FCC technical standards. How much? About $88 and up!

How soon? It's impossible to predict when the FCC will act. Before new rules are adopted, it is customary for the FCC to ask for, and review, comments from the public. In this case, quicker than usual action should be forthcoming because affirmative action will help alleviate Class D channel congestion and put a stop to badgering of the FCC by CB groups demanding legalization of hobby-type operations on Class D channels. Meanwhile, start saving scraps of wire about one foot long—they're potential Class E antennas! ■

Beeper

Continued from page 46

gardless of the color codes, the secondary is center-tapped, and the leads on both sides of the center-tap are the secondary leads.

Orient the PC board horizontally so that you face the top of the board (copper foil is underneath) with the holes for the mercury cell holder to the right. The extreme right side of the board has three component holes—one for the holder connection and two for the switch.) Hold T1 so you face the top of the transformer with the center-tap lead on top. Then push T1's mounting tabs into their respective holes.

Using a screwdriver or long nose pliers, fold the tabs over so that T1 is secured to the board. Then install T1's leads, C1, Q1 and the battery holder in that order. If the holder is supplied with the "solder lug" off to one side, carefully bend it in so the lug cuts through the center of the holder's insulating block.

Note carefully the construction of the holder. When the cell is installed, the positive terminal seats into the holder. The solder lug is the positive terminal. The heavy spring clamp that secures the cell is the negative terminal. Make certain the holder is installed so that the heavy spring clamp faces T1 while the solder lug faces the end of the PC board.

Capacitor Cx, a 0.005 uF disc ceramic unit, is not used or installed at this time. It is needed to compensate for possible variations in the transistor or transformer, and its use, depending on the checkout, might not be required.

Solder a 1½-in. stranded twist pair to switch PB1; then connect the free ends to the appropriate PC board terminals. Solder a 1½-in. bare solid wire to the output PC terminal.

Checkout. Using an amplifier, tape recorder, or any other audio device, check out the *Beeper* by touching the output wire to the amplifier input. You should hear a tone of approximately 1 kHz. If you get a deep *growl*, connect capacitor Cx across T1's *primary* terminals on the *under-side* of the board—the foil side. (Tack solder Cx's leads to the foil.)

Using the BEEPER. Since the peak output of the *Beeper* is 2V—a voltage that can damage some transistors—always try to inject the signal without directly touching a transistor lead. Bring the probe tip *near* the appropriate transistor lead until the signal is heard in the speaker. If this "capacity" coupling does not inject the signal, you can then bring the probe tip in contact with the transistor lead. Tubed circuits aren't critical in this respect and the tube pins can be touched directly with the probe tip.

In RF circuits, such as a superhet radio's IF amplifier, *Beeper's* signal can often be injected by simply placing the probe tip near an IF can or connecting wire.

If you work primarily with tube circuits, or any high-impedance-type circuit, and find that touching the probe tip to a low-level amplifier grid causes excess hum in the amplifier, install a ground lead for the *Beeper* by soldering a short flexible wire to Q1's emitter PC tab. Drill a small hole in the probe body, bring the wire through the hole and install an alligator clip to the free end. The ground lead has not been made part of the basic *Beeper* since accidental contact of the ground lead when working on solid-state gear will disable the *Beeper*. ■

NewScan
(Continued from page 73)

moon, it is relatively easy to determine whether is has remained in one position on the surface or has been turned over. If the rock is not disturbed, cosmic ray tracks will build up only at its top surface. However, if the rock has been turned over, cosmic ray tracks will be found in both the bottom and top of the rock—as was the case with Rock 12017.

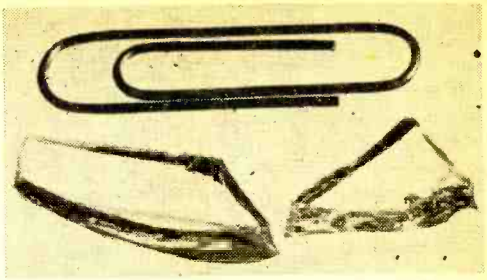
Moon Glass

A chunk of glass that spent 31 months on the moon aboard the Surveyor III spacecraft has revealed new clues to the rate at which lunar rocks are undergoing erosion. The clues, discovered by scientists at the General Electric Research and Development Center, take the form of cosmic ray tracks in a glass filter housed inside the Surveyor's TV camera. The TV camera was removed from the spacecraft by the Apollo 12 astronauts on their mission to the Ocean of Storms in 1969, and returned to the earth.

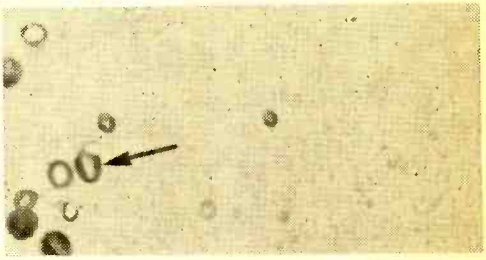
Measurements of the density and depth of the cosmic ray tracks in the chunk of glass have enabled GE scientists to calculate that particles from space are wearing away the moon's rocks at a rate of about one layer of atoms per year. At this rate, it would take 60 million years to wear away one half inch of rock. Unlike the earth, the moon has no winds or surface water to erode its rocks. However, the moon also lacks an atmosphere and a magnetic field—two factors that help to shield the earth against bombardment by various types of particles. Destructive particles that constantly rain down upon the moon's surface include meteoroids (ranging in size from specks of sand to extremely large chunks of rock), the solar wind (charged particles that stream out from the sun), and cosmic rays.

Cosmic rays are energetic charged particles, that bombard the moon from all directions in space. Studies have demonstrated that as such a charged particle passes through a glass on the surface of the moon for an extended period of time will register cosmic ray tracks.

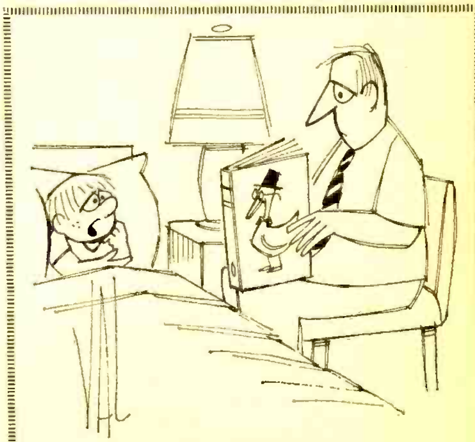
In their original state, cosmic ray tracks are extremely tiny (less than a millionth of an inch wide), and can be observed only with extremely powerful electron microscopes. However, GE scientists have learned how to etch out such tracks and enlarge them for study with optical microscopes. After etching fragments of the glass filter, the GE scientists counted the number of cosmic ray tracks and measured the depths to which various types of cosmic rays had penetrated. This provided them with information about the density and energy spectrum of the cosmic radiation over the fixed period of time.



Fragments from a chunk of glass (top) that spent 31 months on the moon have revealed new clues to the rate at which lunar rocks are undergoing erosion. By studying cosmic ray tracks (arrow bottom) that accumulated in glass during its stay on the moon, GE scientists have calculated that particles from space are wearing away the moon's rocks at a rate of about one layer of atoms per year. At this rate, it would take 60 million years to wear away one half inch of rock.



In addition, the scientists etched various samples collected by the astronauts, and made similar measurements on the cosmic ray tracks revealed in lunar minerals. By comparing the variations of track density with depth in the glass filter fragments to the variations of track density with depth in the lunar rock samples, the scientists were able to calculate the rate at which erosion exposes new rock surface on the moon. This rate turned out to be approximately one atomic layer per year. ■



"After a day of violence on TV this stuff is kind of dull!"

DX Central Reporting

Continued from page 13

halibut? Who knows what gives on the bands?

Are you looking for a DX club to join? Every serious listener should consider joining one or more of these organizations. To help you, DX Central will spotlight the major hobby clubs in this and subsequent columns.

The American SWL Club was founded back in 1959, and is presently headquartered on the west coast. In its monthly bulletins you'll find current information on shortwave broadcast stations, their schedules and where they're being heard. The ASWLC bulletins also have plenty of information on obtaining those QSL cards, data on the non-broadcast type utility stations, and a top-flight propagation column.

If you're interested, use the handy form on this page. Remember, though, send it directly to the club, not to DX Central Reporting. ■

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Flash Master

Continued from page 30

also be mounted with small bracket or long screws attached to the front panel on either side of M1. Mount and wire *FM*'s ASA trim pots R14 to the perf board, before installing it into the flash meter. Incidentally, you can mount your trim pots on both sides of the pc board for easier wiring, instead of on the rear side as in our unit. Last step's installing a C-size 1½ volt battery into its holder.

Flash Master's Big Red Eye. We mounted the photo cell made from a red plastic lamp housing cannibalized from an inexpensive flashlight. Jack J1 fits into a hole in the lamp housing's side. Photo cell Z1 is held against the ex-flashlight's glass or plastic faceplate by a section of foam rubber. Finally, after you've soldered Z1's leads to J1 cut a section of sheet aluminum and press-fit it into the lamp bottom.

A plastic strap was also mounted on the aluminum section to fit an aluminum bracket. Install it on the *Flash Master's* case as shown in the photos. If you don't need this feature, it can be left out of your model. Only problem is that the photo cell housing would have to be hand-held while you're working with *Flash Master*.

Normally, a short shielded lead (approximately 6-inches long) connects the probe assembly to J2. But longer pickup probe lead lengths can be used as well. After you've made sure that your wiring chores are completed—and correct—set S2 to its off position. Then depress the reset button (that's S1), and remove Q2's shorting strap while keeping S1 depressed.

BCPS and Tape Measure, too. To calibrate *Flash Master*, you need an electronic strobe unit with a known guide number BCPS rating (Beam-Candlepower-Seconds). Also, scout up a tape measure and a flash exposure distance guide (similar to the one in Eastman Kodak's Master Photoguide AR-21 Manual). You'll find the Photoguide available in most photo stores.

Make sure that M1's pointer is at zero; if not, adjust the meter's mechanical zero until the pointer sits on the goose egg. Set the ASA switch (S3) to bat, turn S2 on, and observe that the pointer of M1 swings nearly full scale. Mark the M1 scale at this point to indicate a fresh battery's voltage reading. Next, set the ASA switch to the position that is connected to R14 (full clockwise position), depress S1, and electrically "zero" M1 by adjusting R4. If M1 cannot be adjusted to zero, change the resistance value of R3 or R5. Set S2 to its off position.

We calibrated our flash meter for the eight most popular ASA film ratings. If you desire, the meter can be calibrated for other ASA values to fit your special needs (up to ASA 400). All you need is a large room, or long hallway, to properly calibrate the flash meter. Set your *Flash Master* on a window ledge or table at one end of the room or hallway and position the photo cell toward you. Attach one end of the tape measure near the photocell and extend the other end outward.

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This demand for licensed operators and service technicians will be boosted again in the next 5 years by the mushrooming of UHF television. To the 500 or so VHF television stations now in operation, several times that many UHF stations may be added by the licensing of UHF channels and the sale of 10 million all-channel sets per year.

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- 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."

UNCONDITIONAL MONEY-BACK GUARANTEE

Please rush my expanded "Edu-Kit" to me, as indicated below:

Check one box to indicate choice of model

- ☐ Deluxe Model $31.95
- ☐ New Expanded Model $34.95 (Same as Deluxe Model Plus Television Servicing Course)

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 ....

PROGRESSIVE "EDU-KITS" INC.

1189 Broadway, Dept. 547DJ, Hewlett, N. Y. 11557

PRINTED CIRCUITRY

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

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

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

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