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POPULAR ELECTRONICS

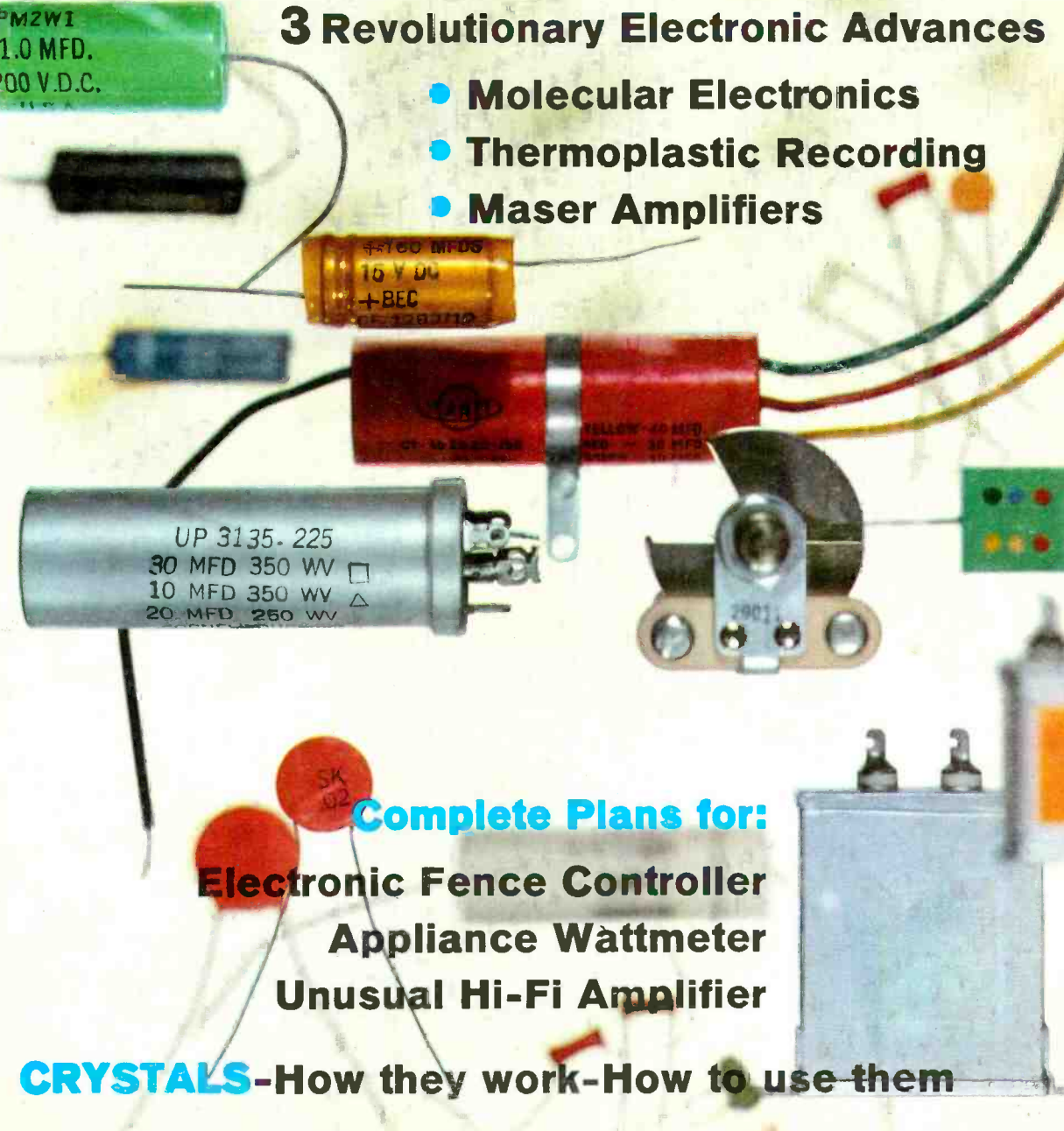
APRIL
1960

35
CENTS

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- Thermoplastic Recording
- Maser Amplifiers



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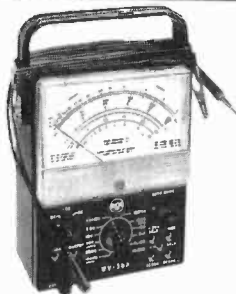
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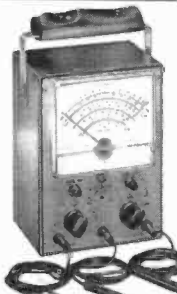
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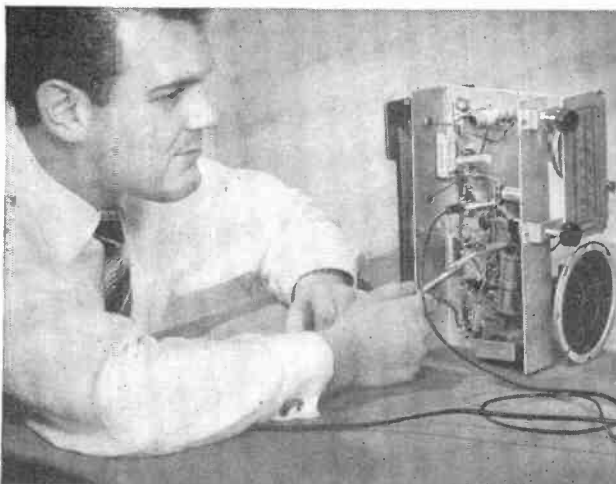
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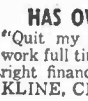
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NUMBER 4



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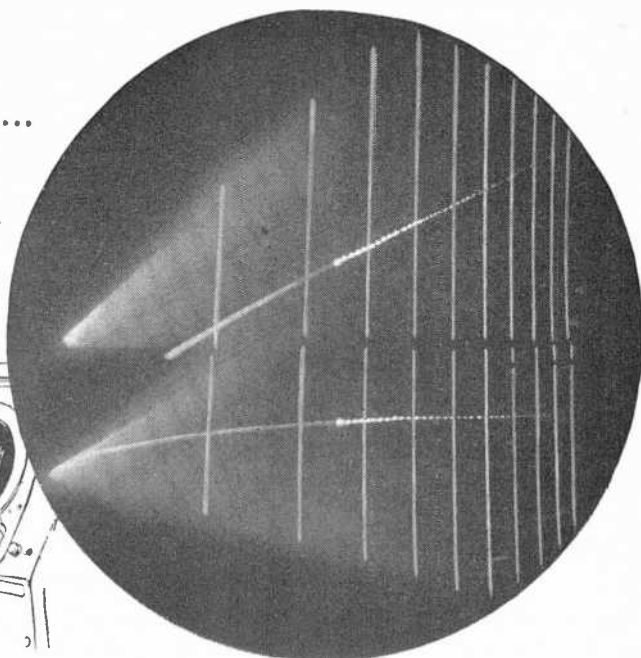
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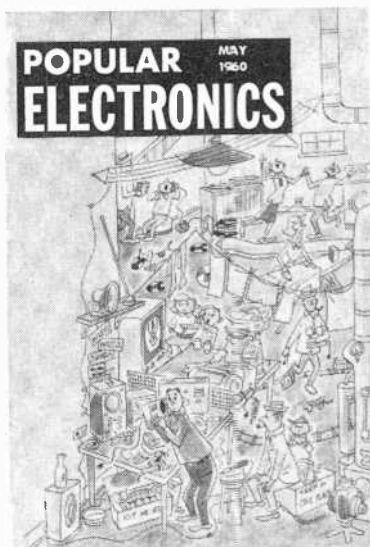
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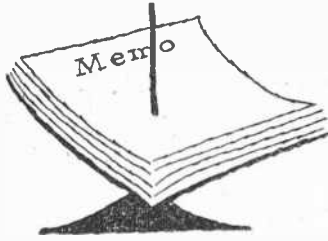
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Notes from the Editor

DYNAMIC FIELD. With each passing month, it becomes more and more evident that electronics is an amazingly dynamic field. Announcements of new inventions and discoveries are being made at an ever-increasing rate. All of these developments will have far-reaching effects on the electronic industry and on our everyday lives. Some of them would have been almost inconceivable ten years ago. For example, the concept of molecular electronics (see page 89) could come only after extensive research and experimentation in the field of solid-state physics. The maser, too, (page 41) is based on lengthy work in the same field.

In some cases, scientific discoveries are important to electronics. Recent exploration of the upper atmosphere, for instance, has revealed that there is a radio "pipeline" about 5000 feet above the South Atlantic Ocean which could dependably carry radio and TV signals between South America and Africa. At least three other radio ducts are known to exist. These "pipelines" will probably be put into commercial use within ten years. Since the ducts can handle a very broad transmission band, they offer a means of achieving world-wide TV hookups, and thus are an alternate to the communications satellite system discussed in last month's issue.

Another revolutionary advancement announced recently is thermo-plastic recording (see page 53). Although this system is still in the developmental stage, its design simplicity suggests that here at last is a video recorder suitable for home use.

Just stop a minute and think how electronics will be affecting your life in 10 or 15 years. Barring a nuclear war, you'll sit in your living room and watch TV from all over the world. If you want to preserve a program, you will record it on your video recorder. If you want to see a TV program while you're out on a fishing trip, you will take along your molecular electronic pocket TV set. And you'll be able to call your wife from hundreds of miles away with your personal radio-telephone.

NEW STEREO TAPE SYSTEM. The persistent rumors about a new stereo tape cartridge system from CBS Laboratories are apparently true. No public announcement has been made yet, but CBS is expected to unveil a tape cartridge player soon that can change tape cartridges like a record changer changes records. The system uses special 1/8" tape manufactured by Minnesota Mining and Manufacturing Co. (Scotch tape) and operates at a speed of only 1-7/8 inches per second. We'll just have to wait to see (and hear) how the system works. Offhand, it seems that the slow speed will limit the frequency response, but maybe CBS will manage to pull a rabbit out of its hat.

Oliver Read

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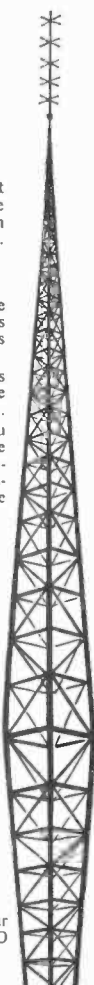
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Harold W. Johnson, 5070 Hermosa Ave., Los Angeles, Calif.	1st	15
Arthur W. Hardy, 66 Dresser Ave., Great Barrington, Mass.	1st	12
Ralph Frederick Beisner, 2126 Grand, Joplin, Mo.	1st	12
N. B. Mills, II, 110 So. Race St., Statesville, N. C.	1st	12
Dean A. Darling, 403 S. Chase Ave., Columbus 4, Ohio	1st	12
Paul D. Bernard, 408 First Ave., N. E., Watertown, S. D.	1st	18
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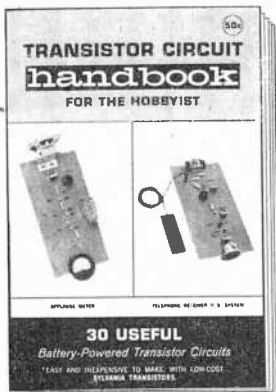
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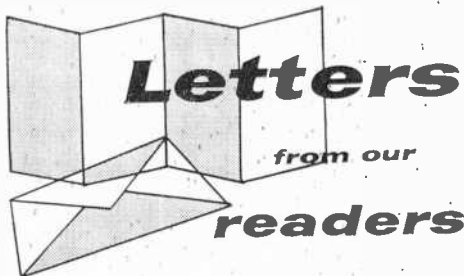
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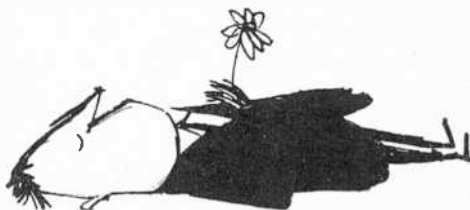
■ I have found that making a few revisions in the circuit of the "Pocket Regenerative Receiver" (August, 1959) can convert it into a radio which requires no antenna or ground. First, you replace the standard transistor antenna coil with a tapped, variable transistor antenna coil and increase the number of turns on the coil to 25 or 30. Then you substitute a G.E. 2N169A transistor for the 2N85 and replace the 9-volt battery with an Eveready AA 1½-volt penlight cell.

I constructed the unit in a 1½" x 1¾" x 2½" pill box. The current drain is 2 μa., and I have had very good results on locals in the Baltimore area.

ROBERT BARD
 Baltimore, Md.

Avoiding Mercury Vapor

■ I enjoy your publication greatly, but feel that I should draw your attention to the suggestion by Bob Coulter in the January *Tips and Techniques* that mercury be used to lower the melting point of solder. Since mercury vapor is a deadly poison and the heat of a soldering iron is more than suffi-



cient to vaporize mercury used in this manner, I recommend that this technique be avoided at all times. Solders with lower melting points are commercially available, and the slight premium paid for them is well worth the convenience they provide.

J. E. SCHLAJKER
 New York, N. Y.

Our thanks go to Reader Schlaikjer and to many others for setting us straight on the dangers of this technique. We second the suggestion that the user purchase commercially available solder which has the desired melting point.

Ham vs. Hi-Fi

■ I note from time to time that your ham readers seem to want more ham articles and less hi-fi, and your hi-fi fans want less ham material and more hi-fi. Personally, I think you publish a very good balance of material.

In many cases, so-called "hi-fi" articles can profitably be read by hams. For example, you ran an article some time ago about an audio notch

loyd B. Arkell

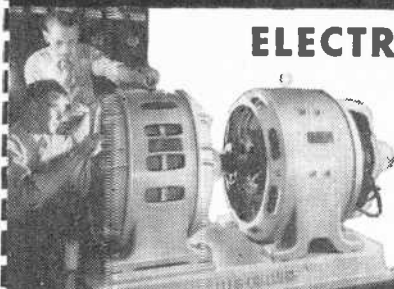
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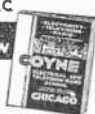
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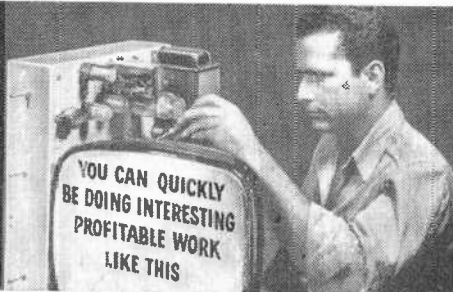


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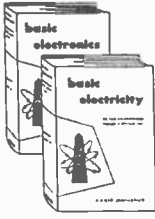
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Letters

(Continued from page 10)

filter for reducing turntable rumble; I found this item excellent for getting rid of heterodyne interference and even static on my ham receiver.

Yours is about the only magazine left with good how-to-build articles. Keep it that way.

C. E. HOOVER, WØKWKY
 Ames, Iowa

Calling All "BC'ers"

■ For about a year now, I have been logging stations on my broadcast-band receiver, and in that time I have managed to receive over 200 stations from 32 states and 4 Canadian provinces, along with stations from Mexico and Cuba. I have been able to interest a couple of my friends in this hobby to the point where they are just as enthusiastic about "BC'ing" as I am. But there doesn't seem to be any organization for "BC'ers," perhaps because the short-wave clubs feel that there isn't a large enough interest in this branch of radio to do anything about it.

I assure you that once a person gets interested in this hobby, he's hooked for good. I get more of a thrill listening to some station in Denver than I do listening to the Australian Broadcasting Corporation's morning broadcast. And I'm sure that there must be at least a couple of thousand other people who agree with me and wish there were some organization solely for those who find pleasure in BC logging.

Other P.E. readers who are interested in logging and making reports to AM stations are hereby requested to drop me a line, telling me about their logging activities and including suggestions on how to get such a club started.

J. D. LEITCH
 8 Skipton Rd.
 Box 1004, R.R. 3
 Ottawa, Ont., Canada

A Computerman Comments

■ The story of Jim Stewart ("Meet the Man Who Out-Thinks Univac," December, 1959) is a familiar one to me and to my co-workers. We use slightly different titles here, and work for another major computer manufacturer, but we have much in common. Although it is true that Jim's job of "roving trouble-shooter" is a unique one, his hours and methods are familiar to us all. We use the same "logic and educated guesswork."

I was gratified to see your article explaining our job; so many people are unaware of this type of work, its qualifications, satisfactions, and headaches. I was happy, also, to see the fact brought out that men without a college degree can still qualify for a rewarding, challenging, and dignified field in electronics.

JOHN W. BOUDREAU
 Customer Engineer
 IBM Corporation
 Sierra Vista, Arizona

Hi-Fi Modulators

■ Being a charter subscriber to **POPULAR ELECTRONICS**, I feel I am entitled to a comment once in a while. I am by no means an engineer, but I do make my living in electronics. Experimenting and construction are my basic hobbies.

Each month I read Herb Brier's column (*Across*

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Letters

(Continued from page 12)

the Ham Bands) and I think he does a nice job for the beginners (and old-timers, too). But since there are so many beginners who are looking to his articles for guidance, I thought a word or two about the following subject would be in order.

In the January issue, Mr. Brier brings up the possibility of using a hi-fi amplifier to modulate a transmitter. In an emergency, yes. But for continued use on the ham bands, no, no, no! With the crowded conditions that exist on the bands, we definitely have no place for hi-fi modulators. On the contrary, let's eliminate them completely.

Let's use the bare minimum of frequency response in the speech amplifiers and modulators, thereby concentrating power more closely around the carrier. Don't spread your modulation power for 15 kc. on both sides of the carrier, occupying a total of 30 kc., when you can get by nicely on one-fifth that amount of bandwidth, do it with less modulation power, and make it more pleasant for us all.

JAMES L. LANTERMAN, W5UJN
Ardmore, Okla.

Stabistor Correction

■ In the article entitled "The Stabistor Diode," which appeared in your January issue, the maximum current ratings for the SG-22 and SM-72 stabistors were transposed. The correct maximum current rating for the SG-22 is 150 milliamperes; the SM-72 is rated at 2000 ma.

R. J. SHAUGHNESSY
Stoneham, Mass.

CB Calling Frequency

■ In your December issue, Tom Kneitel made the suggestion in his *On the Citizens Band* column that one CB channel be set aside to be monitored by both CB'ers and SWL's. As Tom pointed out, this would be a big help to motorists looking for overnight accommodations in a strange town and to those who experience mechanical trouble along



the way. I've talked to a number of people about it and everyone thinks very highly of the idea.

I'm looking forward to more articles on Citizens Band subjects. I would especially like to see something on improving the efficiency of mobile antennas.

JOE E. BROOKS, 8WØ853
Jackson, Miss.

See this month's *On the Citizens Band* for additional info on CB calling frequency. Tom Kneitel promises to go into the subject of mobile antennas in a future column.

-30-

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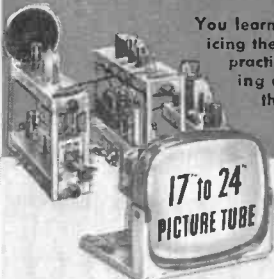
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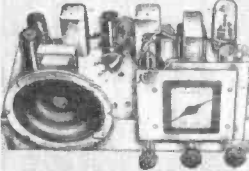
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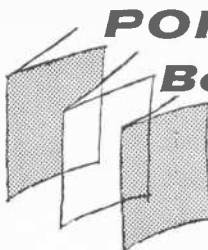


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"FUNDAMENTALS OF ELECTRICITY,"
Fourth Edition, by K. C. Graham. Published by the American Technical Society, 848 East 58th St., Chicago 37, Ill. 342 pages. \$4.75.

An ideal book for the non-technical person who would like to learn about electricity and electronics, this volume is written and organized clearly and logically. The author manages to communicate a great deal of information very easily.

Starting with atoms and electrons, the book covers d.c. circuits, a.c. circuits, magnetism and electromagnetism, electric and electromagnetic generators, electric motors, transformers and rectifiers, and electric waves. The material is clear and to the point, with review questions appearing at the end of each chapter.

Highly recommended as a basic introduction to electricity and electronics.

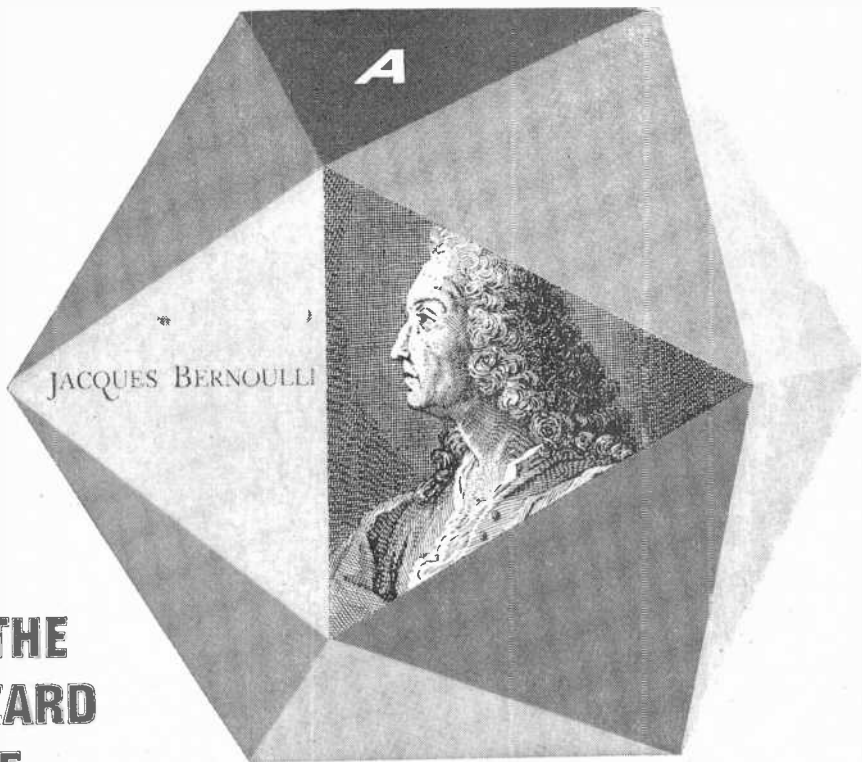


"FUNDAMENTALS OF ELECTRONICS"
by E. Norman Lurch. Published by John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 631 pages. \$8.25.

By coincidence, this book picks up where the preceding one leaves off. Even more interesting, it has the same good qualities: excellent organization and clear writing. The two books together provide a solid grounding in electronics.

This big (631 pages) and comprehensive volume assumes that the reader has a knowledge of basic electrical theory, including a.c. circuits and d.c. circuits. It begins with two-element electron devices (including vacuum tubes and semiconductors), and then works its way step by step to various types of amplifiers, oscillators, etc. The incorporation of transistors into the mainstream of electronic devices (instead of putting them in a separate section) is a somewhat new, but very logical, technique. Thus, the reader learns about vacuum tubes and transistors at the same time

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probability that you or any other subscriber will be busy is 1 in 20, the same as the probability that side “A” of an icosahedron will be on top. The odds against 15 or more of you talking at once are again about 100 to 1. Thus it would be extravagant for the Bell System to supply your group with 150 trunk circuits when 15 are sufficient for good service.

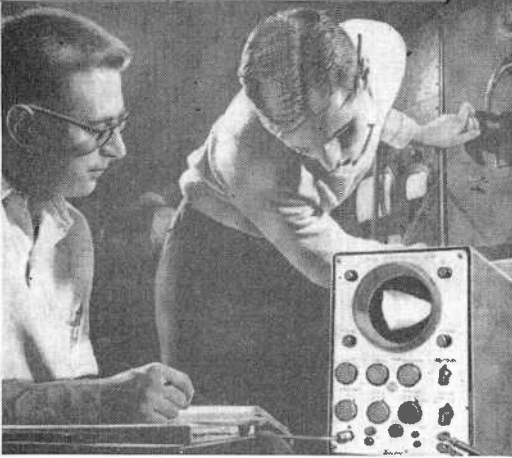
Telephone engineers discovered at the turn of the century that telephone users obey Bernoulli’s formula. At Bell Telephone Laboratories, mathematicians have developed the mathematics of probability into a tool of great economic value. All over the Bell System, the mathematical approach helps provide the finest telephone service using the least possible equipment. The achievements of these mathematicians again illustrate how Bell Labs works to improve your telephone service.



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(Continued from page 16)

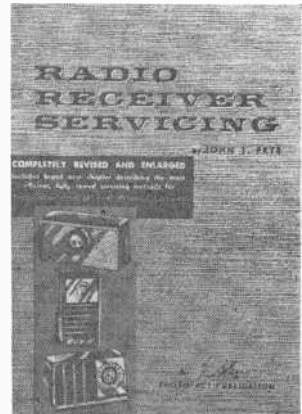
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"RADIO RECEIVER SERVICING" by John T. Frye. Second Edition. Published by Howard W. Sams & Co., Inc., 2201 East 46th St., Indianapolis 5, Ind. 222 pages. Soft cover. \$2.95.

As most readers of POPULAR ELECTRONICS will realize, John T. Frye, the author of this book, also writes our monthly “Carl and Jerry” series. From these and other articles, Mr. Frye has gained a well-deserved reputation as being a writer who knows what he is talking about. This book, a revised and enlarged version of an earlier book on



radio servicing, is the result of author Frye's long years of experience in the field. Probably the most practical, useful, and best-written volume yet to appear on servicing radio receivers, it is rather long—over 220 pages of smallish type without any unnecessary illustrations—and very complete. It is a pleasure to read, and anyone whose hobby or profession is radio servicing will want to have a copy.



"MASTER RECEIVING-PICTURE TUBE SUBSTITUTION GUIDE BOOK" by H. A. Middleton. Published by John F. Rider Publisher, Inc., 116 West 14th St., New York 11, N. Y. 343 pages. \$7.45.

With the stream of new tube types continuing to pour out of the tube factories at an increasing rate, a tube substitution book



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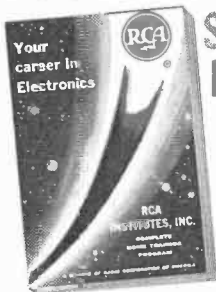
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Bookshelf (Continued from page 18)

is always a good investment for a service technician or electronic experimenter. This is one of the most complete ones yet to appear. It lists over 5100 receiving tube substitutions and 825 picture tube substitutions, with American equivalents for 320 European tubes also given. If any circuit changes are required for substitution of a tube, they are fully outlined. If the circuit changes necessitate changing the tube socket, a diagram of the socket is provided.

Recommended as a valuable aid to servicing and building electronic equipment.



"ENCYCLOPEDIA OF ELECTRONICS AND NUCLEAR ENGINEERING" by Robert I. Sarbacher. Published by Prentice-Hall, Inc., Englewood Cliffs, N. J. 1426 pages. \$35.00.

This enormous book is obviously not intended for the casual reader, but for engineers, technical writers, libraries, and schools. With over 14,000 entries and 1400 illustrations, it seems to be quite complete

and up to date. The definitions and explanations are very clear, and higher mathematics is called upon only when necessary.

Recommended as an invaluable reference book for people with serious interest in these fields.

Miscellaneous Literature

Designed for the first-class Citizens Bander, a handy reference guide to the most commonly used "10" series of signals is available from Vocaline Company of America, 10 Coulter St., Old Saybrook, Conn. The guide is free for the asking, but the company requests that you include your call letters to authenticate usage.

The mysteries of stereo high-fidelity are explained in an attractive 36-page booklet offered by Allied Radio, 100 N. Western Ave., Chicago 80, Ill. Intended for the beginner in stereo, it was prepared under the direction of Edward Tatnall Canby. "This Is Stereo High-Fidelity" is a good introduction to the subject and is available for 25 cents. Stock number is 37K387. -30-

3 Great New Kits for Stereo
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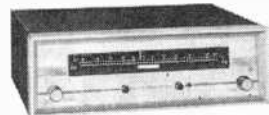
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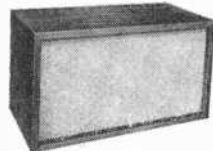
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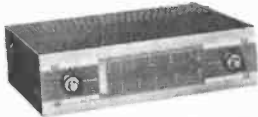
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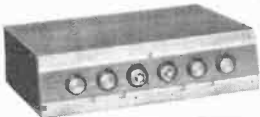
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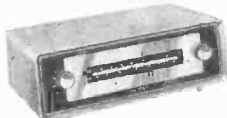
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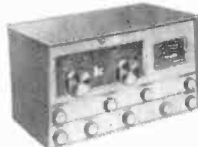
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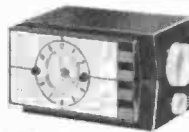
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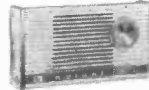
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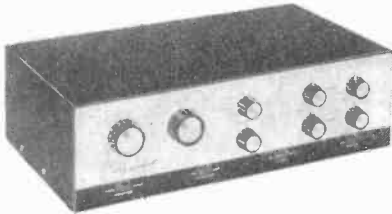
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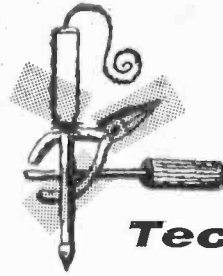
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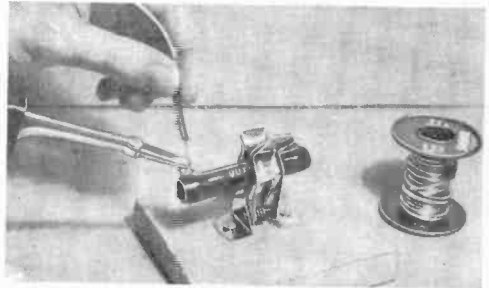
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Tips and Techniques

BROOM-CLIP "VISE"

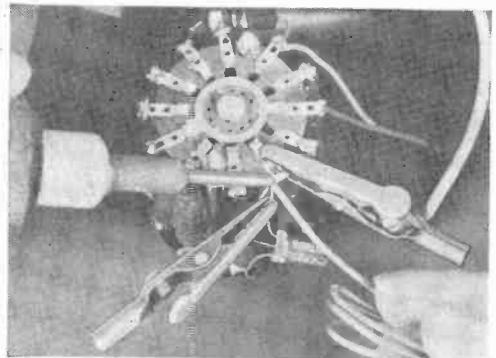
Fasten down a broom clip like the one shown to a scrap piece of wood. It will come in handy for holding wires or parts



while you solder them. A broom-clip "vise" will hold almost any size part securely as you apply the solder.—*Charles Lang, San Francisco, Calif.*

COPPER CLIPS ABSORB HEAT

Solid copper alligator clips make efficient heat sinks to protect heat-sensitive components while soldering. You'll insure rapid heat conduction if you remove the teeth



with a file to keep the contact points clean and bright.—*Myron Bookwalter, Spokane, Wash.*

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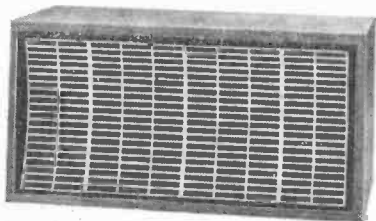
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CO tube tester kit #2625K ABSOLUTELY FREE when you purchase \$10.00 worth of receiving tubes from TELTRON within 60 days. Tube tester may be purchased outright for \$34.95 PREPAID. Send for FREE list on EICO test eqpt. & Hi-Fi Compts.

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0Z4	.45	6AL5	.43	6DE6	.43	12BE6	.46
183GT	.52	6AN8	.59	6DG6	.50	12BH7	.61
1R5	.51	6AQ5	.64	6DQ6	.89	12BQ6	.63
1S5	.43	6A55	.52	6H6	.47	12BY7	.65
1T3	.43	6AU6GT	.50	6J6	.49	12CR6	.63
1U4	.51	6AU6	.60	6K6GT	.39	12CU6	.63
1X2	.43	6AW6	.43	6SA	.54	12D8B	.59
2AF4	.62	6AV6	.50	6SC7	.45	12KS	.44
2BN4	.55	6AW8	.37	6SA7	.41	12SQ7	.45
3AU6	.43	6AX4GT	.50	6SC7	.45	12SN7GT	.56
3BC5	.58	6BA6	.56	6SK7	.45	12SQ7	.38
3BN6	.90	6BA8	.48	6SN7GT	.60	12V6GT	.43
3BZ6	.45	6BC5	.49	6SQ7	.38	12L6GT	.43
3C6	.51	6BC8	.59	6T8	.71	12WG6T	.43
3D7E	.48	6BF6	.46	6U8	.71	12W6GT	.68
3V4	.51	6BG6	.48	6V6GT	.76	19A4	.68
4B0A	.69	6BG6G	.51	6W4GT	.43	19B6G	.60
4B0C	.59	6BJ6	.51	6X4	.37	25BQ6GT	1.48
4C86	.61	6BK5	.51	6X8	.75	25C6G	1.19
5AW6	.54	6BK7	.78	7AU7	.53	10DE7	.79
5AN8	.59	6BL7GT	.78	8C7	.53	12A8B	.49
5AT8	.54	6BN6	.90	8M7	.53	12AF6	.44
5AV8	.64	6BQ6	.83	9U6	.42	12AT7	.37
5BK	.54	6BR7	.45	10E7	.79	12E6	.44
5J6	.68	6BS7	.85	11A6	.49	12F6	.44
5L6	.61	6BY5G	.75	12AF6	.44	12G6	.48
5U4	.59	6BZ6	.45	12B7E	.37	12H6	.48
5U4G	.45	6C4	.95	12AT7	.37	12I6	.48
5U4B	.48	6C6	.51	12AUG	.43	12J6	.48
5V4	.59	6C8	1.63	12AU6	.58	12K6	.48
5X8	.55	6CF6	.45	12AV6	.58	12L6	.48
6AF4	1.02	6CG6	.44	12AV7	.73	12M6	.48
6AC7	.65	6CH8	.54	12AX4GT	.60	12N6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12O6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12P6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12Q6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12R6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12S6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12T6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12U6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12V6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12W6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12X6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12Y6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12Z6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12AA6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12AB6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12AC6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12AD6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12AE6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12AF6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12AG6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12AH6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12AJ6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12AK6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12AL6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12AM6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12AN6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12AO6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12AP6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12AQ6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12AR6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12AS6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12AT6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12AU6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12AV6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12AW6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12AX6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12AY6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12AZ6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12BA6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12BB6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12BC6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12BD6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12BE6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12BF6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12BG6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12BH6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12BI6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12BJ6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12BK6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12BL6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12BM6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12BN6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12BO6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12BP6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12BQ6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12BR6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12BS6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12BT6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12BU6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12BV6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12BW6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12BX6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12BY6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12BZ6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12CA6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12CB6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12CC6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12CD6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12CE6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12CF6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12CG6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12CH6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12CI6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12CJ6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12CK6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12CL6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12CM6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12CN6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12CO6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12CP6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12CQ6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12CR6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12CS6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12CT6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12CU6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12CV6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12CW6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12CX6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12CY6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12CZ6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12DA6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12DB6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12DC6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12DD6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12DE6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12DF6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12DG6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12DH6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12DI6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12DJ6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12DK6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12DL6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12DM6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12DN6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12DO6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12DP6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12DQ6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12DR6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12DS6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12DT6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12DU6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12DV6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12DW6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12DX6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12DY6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12DZ6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12EA6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12EB6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12EC6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12ED6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12EE6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60	12EF6	.48
6AC7	.65	6C8	.44	12AX4GT	.60	12EG6	.48
6AF4	1.02	6C8	.44	12AX4GT	.60		

**biggest
sound**
you ever heard from
a bookshelf speaker
AUDAX CA-60
only
\$59.95 9"x10½"x18"



Among many individuals, there is a need to minimize on the space to be devoted to a component stereo system. A rash of "bookshelf" types have appeared in an attempt to meet this need. In practice, however, they seem neither fish nor fowl...either too large for compactly spaced bookshelves or too small for use as free-standing units.

The AUDAX CA-60 is a true bookshelf speaker system, measuring only 9" high by 10½" deep by 18" wide. It houses a 6" woofer and separate tweeter in a ducted-slot enclosure constructed of ¾" thick wood, finished in oiled, hand-rubbed of a walnut on four sides. The grille is shaped in an attractive parabolic contour, giving the unit a character which blends with a variety of surroundings.

A real powerhouse...handles 20 watts in integrated program material! Hear it at your dealer's.

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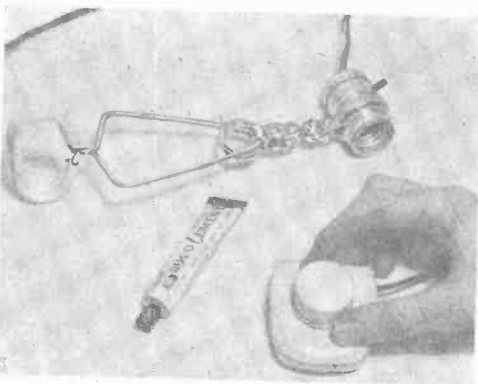
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Atlas Radio Corp., 50 Wingold Ave., Toronto, Can.

Tips

(Continued from page 22)

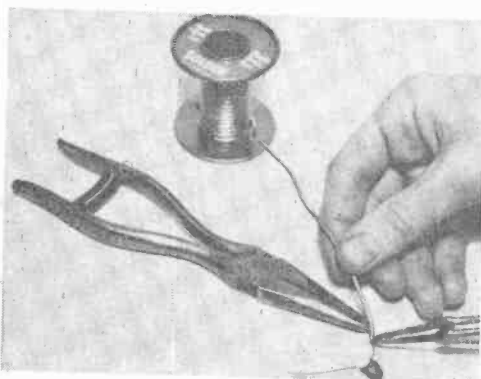
the mike to a chair or other convenient object. First remove the light-socket assembly from the clamp. Cement a round bottle cap—the metal cap from an Aerosol spray



can works perfectly—to the back of the mike with a plastic cement such as Duco. Then attach the clamp to the bottle cap. This stand gives you a much better chance of accurate sound pickup and leaves your hands free, too.—James Clifford, Detroit, Mich.

SPRING GIVES PLIERS POWER

Hook a coil spring between the handles of a pair of pliers and you have a handy vise for holding small radio parts while solder-



ing. You can also use the spring-operated pliers as a heat shunt by clamping them onto the wire lead between the part and the soldering iron.—Joseph Carroll, Brooklyn, N. Y.

EASY MINIATURE TUBE REMOVAL

Removing miniature tubes from crowded chassis can be speeded up by installing a

(Continued on page 28)

Always say you saw it in—POPULAR ELECTRONICS

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PROGRESSIVE RADIO

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 - ★ SIGNAL TRACER
 - ★ SIGNAL INJECTOR
 - ★ CODE OSCILLATOR
 - ★ No Knowledge of Radio Necessary
 - ★ No Additional Parts or Tools Needed

Unconditional Money-Back Guarantee

It is understood and agreed that should the Progressive Radio "Edu-Kit" be returned to Progressive "Edu-Kits" Inc. for any reason whatever, the purchase price will be refunded in full, without quibble or question, and without delay.

The high recognition which Progressive "Edu-Kits" Inc. has earned through its many years of service to the public is due to its unconditional insistence upon the maintenance of perfect engineering, the highest instructional standards and 100% adherence to its Unconditional Money-Back Guarantee. As a result, we do not have a single dissatisfied customer throughout the entire world.

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

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

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

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

You will receive training for the Novice, Technician and General Classes of F.C.C. Radio Amateur Licenses. You will build 16 Receiver, Transmitter, Code Oscillator, Signal Tracer and Signal Injector circuits, and learn how to operate them. You will receive an excellent background for television, Hi-Fi and Electronics.

Absolutely no previous knowledge of radio or science is required. The "Edu-Kit" is the product of many years of teaching and engineering experience. The "Edu-Kit" will provide you with a basic education in Electronics and Radio, worth many times the complete price of \$22.95. The Signal Tracer alone is worth more than the price of the entire Kit.

THE KIT FOR EVERYONE

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

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

PROGRESSIVE TEACHING METHOD

The Progressive Radio "Edu-Kit" is the foremost educational radio kit in the world, and is universally accepted as the standard in the field of electronics training.

"Edu-Kit" uses the modern educational principle of "Learn by Doing." Therefore you construct, learn schematics, study theory, practice trouble-shooting—all in a closely integrated program designed to provide an easily-learned thorough and interesting background in radio. You begin by examining the various radio parts of the "Edu-Kit." You then learn the function, theory and wiring of these parts. Then you build a simple radio. With this first set you will enjoy listening to regular broadcast stations, learn theory, practice testing and trouble-shooting. Then you build a more advanced radio, learn more advanced theory and techniques. Gradually, in a progressive manner, and at your own rate, you will find yourself constructing more advanced multi-tube radio circuits, and doing work like a professional Radio Technician.

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

THE "EDU-KIT" IS COMPLETE

You will receive all parts and instructions necessary to build 16 different radio and electronics circuits, each guaranteed to operate. Our Kits contain tubes, tube sockets, variable electrolytic mica, ceramic and paper dielectric condensers, resistors, tie strips, coils, hardware, tubing, punched metal chassis, Instruction Manuals, hookup wire, solder, etc.

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

FREE EXTRAS

• SET OF TOOLS

- SOLDERING IRON
- ELECTRONICS TESTER
- PLIERS-CUTTERS
- ALIGNMENT TOOL
- WRENCH SET
- VALUABLE DISCOUNT CARD
- CERTIFICATE OF MERIT
- TROUBLESHOOTING MANUAL
- HIGH FIDELITY GUIDE • QUIZZES
- TELEVISION BOOK • RADIO
- TROUBLESHOOTING 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.

J. Statatilis, 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."

FROM OUR MAIL BAG

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 Troubleshooting Tester that comes with the Kit is really swell, and finds the trouble, if there is any to be found."

PRINTED CIRCUITRY

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

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

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

ORDER DIRECT FROM AD—RECEIVE FREE BONUS RESISTOR AND CONDENSER KITS WORTH \$7

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LA-250A
COMPLETELY WIRED
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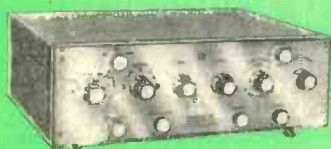
50 WATT INTEGRATED STEREO AMPLIFIER KIT

- RESPONSE 15-40,000 CPS \pm 0.5 DB (at normal listening level)
- UNIQUE "BLEND" CONTROL • PREMIUM EL86 OUTPUT TUBES
- 50 WATTS MONAURAL—25 WATTS EACH STEREO CHANNEL • CLUTCH-OPERATED VOLUME CONTROL • SEPARATE BASS & TREBLE CONTROLS

A completely new stereo high fidelity amplifier with a high quality of reproduction, remarkable versatility and new distinctive styling. Full range of controls include a unique "blend" control for continuously variable channel separation—from full monoaural to full stereo, 4-position Selector, Mode, Loudness and Phasing switches plus outputs for 4, 8 or 16 ohm speakers. Harmonic distortion less than 0.25%, IM distortion less than 0.5%. Hum and Noise 74 db below full output. Assembly is simple—no special skills or tools required. Complete with deluxe cabinet and legs, all parts, tubes and detailed instruction manual. Shpg. wt., 26 lbs.

KT-250AWX Stereo Amplifier Kit 5.00 Down Net 74.50
LA-250AWX Stereo Amplifier, wired & tested 5.00 Down Net 99.50

KT-600 IN KIT FORM
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LA-600
COMPLETELY WIRED
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PROFESSIONAL STEREO CONTROL CENTER KIT

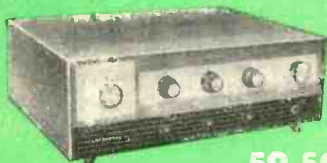
- RESPONSE 5-40,000 CPS \pm 1 DB • UNIQUE STEREO & MONAURAL CONTROL FEATURES • PRECISE "NULL" BALANCING SYSTEM • CONCENTRIC INPUT LEVEL CONTROLS

A truly professional stereo preamplifier and master audio control center—solves every stereo/monaural control problem. Features unique Bridge Control for variable cross-channel feed for elimination of exaggerated channel separation effects—plus controlled 3rd channel output. Has all-concentric controls—including clutch-operated Volume Balance control. Provides complete and advanced facilities for accepting, controlling and providing undistorted gain for any and all program sources. Sensitivity 2.2 mv for 1 volt out (low level inputs). Dual low impedance "plate follower" outputs 1500 ohms. Response 5-40,000 cps \pm 1 db. Less than .03% IM distortion. Less than .1% harmonic distortion. Hum and noise 80 db below 2 volts (high level inputs). Uses 7 new 7025 low-noise dual triodes. Size: 14"x4 1/2"x10 1/2". Shpg. wt., 16 lbs. Complete with all parts, tubes, deluxe cabinet and detailed instruction manual.

KT-600 WX Stereo Preamplifier Kit 5.00 Down Net 79.50
LA-600 WX Stereo Preamplifier, wired and tested 5.00 Down Net 134.50

KT-236A
IN KIT FORM

NEW!



59.50

36-WATT INTEGRATED STEREO AMPLIFIER KIT

- 36-WATTS MONAURALLY—18 WATTS PER CHANNEL • FREQUENCY RESPONSE 15-30,000 CPS \pm 1 DB • UNIQUE "BLEND" CONTROL • CONCENTRIC CLUTCH-OPERATED VOLUME CONTROL • DUAL CONCENTRIC BASS AND TREBLE CONTROLS • 4-EL84 TUBES IN PUSH PULL

This exciting new amplifier kit combines dual preamplifiers and dual 18 watt power amplifiers in one compact chassis. Instant selection from monophonic to stereophonic is provided by the turn of a switch. An amazing new "Blend" control gives continuously variable channel separation from full monophonic to full stereo. The concentric clutch-operated volume control offers independent or simultaneous level adjustments of both channels. Dual concentric bass and treble controls furnish 4 independent tonal adjustments. Harmonic distortion less than 0.15% at normal listening level. 1.M distortion is less than .3%. Hum and noise 70 db below rated output. Complete with cage, legs and detailed instructions. Shpg. wt., 24 lbs.

KT-236AWX Stereo Amplifier Kit 5.00 Down Net 59.50

KT-500 IN KIT FORM
74.50



LT-50
COMPLETELY WIRED
124.50

FM-AM STEREO TUNER KIT

- 11 Tubes (4 dual-purpose) + Tuning Eye + Selenium rectifier provide 17 tube performance • Multiplex Output for new Stereo FM • Armstrong Circuit with Dual Limiters and Foster-Seelye Discriminator • Extreme Sensitivity and Wide Frequency Response.

A precision engineered, highly stable tuner—perfect for lifelike stereo FM-AM broadcast reception, FM reception and/or AM reception. Features separate tuning and volume controls for AM and FM. Magic eye on AM and FM, plus automatic frequency control on FM for accurate tuning—stations are "locked" in. Other deluxe features include cathode follower outputs and 5-position Function Selector. Efficient, broadband circuitry on AM with built-in antenna. FM section features include 2 microvolts sensitivity for 30 db quieting, frequency response 20-20,000 cps \pm 1/2 db and full 200 KC bandwidth. Two printed circuit boards make wiring simple—even for such a complex unit. Complete kit includes all parts, deluxe cabinet and detailed instruction manual. Size is 13 1/4"W x 10 1/2"D x 4 1/2"H. wt., 22 lbs.

KT-500WX FM-AM Stereo Tuner Kit 5.00 Down Net 74.50
LT-50 WX Same as above, wired & tested 5.00 Down Net 124.50

KT-310 IN KIT FORM
47.50



LA-310
COMPLETELY WIRED
72.50

STEREO / MONAURAL POWER AMPLIFIER KIT

- 36 WATT STEREO AMPLIFIER—18 WATTS EACH CHANNEL • EMPLOYS 4 PREMIUM-TYPE 7189 TUBES • 2 PRINTED CIRCUIT BOARDS FOR SIMPLIFIED WIRING • FREQUENCY RESPONSE 20-40,000 CPS \pm 1/2 DB AT 18 WATTS • LESS THAN 1% HARMONIC OR IM DISTORTION

A superb basic stereo amplifier in easy-to-build kit form. Unit may be used with a stereo preamplifier to provide two 18 watt stereo channels or, at the flick of a switch, as a fine 36 watt monaural amplifier. Controls include 2 input volume controls, Channel Reverse switch and Monoaural-Stereo switch. Dual outputs for 4, 8, 16 or 32 ohm speakers. Input sensitivity .45 volts per channel for full output. Tubes are 2-6ANB, 4-7189, GZ-34 rectifier. Size: 10-9/16" d x 5 1/2" h x 13 1/4" w. Complete kit with cage, all parts, tubes and detailed instruction manual. wt., 22 lbs.

KT-310 WX Stereo Power Amplifier Kit 2.00 Down Net 47.50
LA-310 WX Stereo Power Amplifier, wired and tested 5.00 Down Net 72.50

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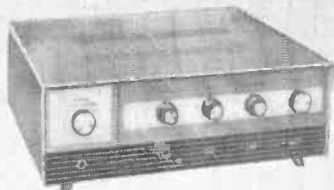
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NEW! Lafayette 50 Watt Complete Stereo Phono System



LAFAYETTE LA-250A



WOOD BASE

GARRARD
RC121/11

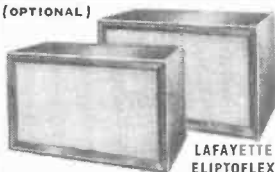


NEW GE
VR-227



LAFAYETTE
SK-58

(OPTIONAL)



LAFAYETTE
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FINISHED ON 4-SIDES

COMPONENTS

LAFAYETTE LA-250A 50-WATT AMPLIFIER	99.50
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GARRARD RC 121/11 STEREO CHANGER	41.65
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2- LAFAYETTE SK-58 FAMOUS FREE EDGE	59.00
12" COAXIAL SPEAKERS @ 29.50	59.00

REGULAR CATALOG PRICE ~~229.95~~

COMPLETE STEREO SYSTEM

184.50

You Save
44.05

YOUR GUARANTEED BEST STEREO SYSTEM BUY!

This superb system will add a new dimension in living to your home with all the excitement and realism of a live concert. The new Lafayette LA-250A, 50-watt stereo amplifier (25 watts each channel) forms the heart of this outstanding stereo hi-fi phonograph music system—the features, versatility and advanced circuitry of this unit are second to none. Also included is the famous Garrard RC121/11 intermix 4-speed automatic record changer with full manual or automatic operation supplied with your choice of stereo cartridges—the new GE VR-22 (.7 Mil) diamond stereo cartridge, Pickering 371-7D (.7 Mil) diamond stereo cartridge, Shure M7D (.7 Mil) diamond stereo cartridge or the new Electro-Voice 31 MD7 (.7 Mil) diamond stereo cartridge. Supplied with the Lafayette wood base cut for the RC121 in your choice of finishes. These outstanding components are coupled with the 2 famous free edge Lafayette SK-58 12" Coaxial speakers with built-in crossover network and brilliance level control. System supplied with plugs, cables and simple instructions. Shpg. wt., 67 lbs.

HF-670WX Hi-Fi STEREO PHONO SYSTEM with choice of cartridge and mahogany, walnut or blond changer base (please specify)..... 5.00 Down Net 184.50

HF-671WX Same as HF-670, but with 2 Laf Eliofoflex Series Bookshelf Enclosures (please specify finish). Shpg. wt., 143 lbs..... 10.00 Down Net 247.50

HF-675WX Stereo AM-FM-Phono System. Same as HF-670 but including the Lafayette LT-50 stereo tuner. Shpg. wt., 85 lbs. 10.00 Down Net 299.50

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39th
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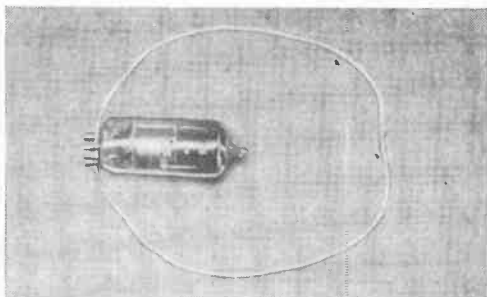


Name.....
Address.....
City..... State.....

Tips

(Continued from page 24)

simple tube puller beneath each tube before placing the tube in its socket. Tie an eight-inch piece of strong nylon thread into a circle and pass the loop under the base of



the tube. Plug the tube into its socket with the loop in place, and fasten the other end of the loop to an i.f. transformer or any other handy spot with a piece of tape. A gentle tug on the free end of the loop will quickly remove the tube.—*Ronald S. Newbower, Gloversville, N. Y.*

COAT-HANGER HANDLE FOR VOM

Why chance dropping a handle-less VOM or multimeter when you can give the instrument a wire handle in a few minutes'



time? Take a wire coat hanger, straighten it out, clip about 12" from it, and bend the 12" length into a handle that will fit into two small holes carefully drilled in either side of your meter's case.—*John A. Comstock, Wellsboro, Pa.*

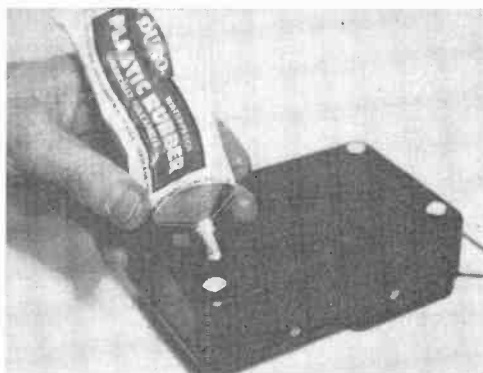
INEXPENSIVE LIGHTNING ARRESTER

An old automobile spark plug can be turned into a simple and effective lightning arrester for your receiving antenna. To make the arrester, solder a piece of heavy wire (No. 12 or 14) to the threaded barrel of the plug and connect the wire to the

antenna lead. Solder a second wire to the post of the plug on the porcelain and run this wire to a good ground. Incidentally, a six-foot pipe driven into the earth often makes a better electrical ground than the water-pipe system. Corroded pipe joints may form high-resistance paths—and lightning charges follow paths of least resistance.—*Kent A. Mitchell, Hagerstown, Md.*

SHOCK-ABSORBING METER FEET

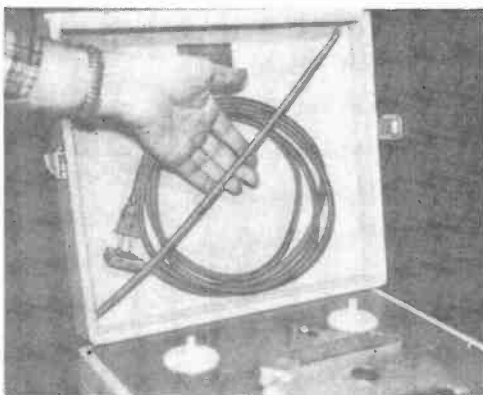
If your volt-ohm-milliammeter doesn't already have resilient rubber feet to help absorb mechanical shocks, you can add



some made of Duro plastic rubber. Three layers of the liquid rubber are usually sufficient; remember to allow plenty of drying time between applications.—*Charles Lang, San Francisco, Calif.*

SPRING HOLDS POWER CORD

If your tape recorder has a detachable power cord, a screen-door spring screw



fastened to the inside of the recorder's lid makes for neat cord storage. Just coil up the cord and store it behind the spring.—*Jerome Cunningham, Chicago, Ill.* —30—

NEW! LAFAYETTE HE-15 CITIZENS BAND 11 METER SUPERHETERODYNE TRANSCEIVER



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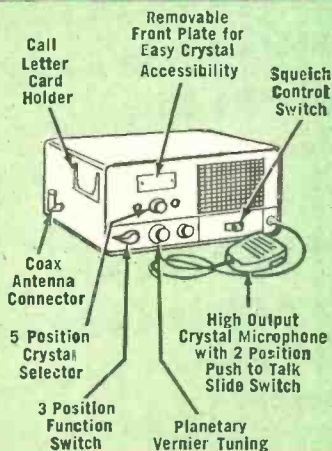
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- Planetary Vernier Tuning: Controls Include 3 position function switch (transmit, receive, plus transmit with spring return) and squelch noise limiter control switch.
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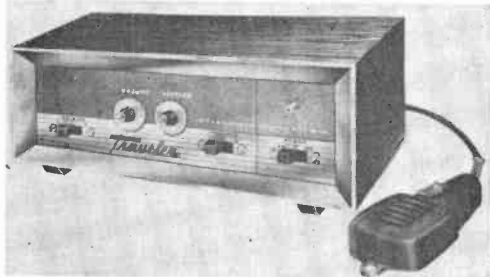
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NEW products

TRANSISTORIZED CB TRANSCEIVER

The introduction of the "Traveler," an all-transistor transceiver for use on the Citizens Band, has been announced by *International Crystal Mfg. Co., Inc.*, 18 North Lee, Oklahoma City, Okla. Weighing less



than five pounds and requiring no a.c. power supply, the unit is ideal for portable applications. The 12-transistor circuit in-

cludes a noise limiter and squelch, and two crystal-controlled receiving and transmitting channels. The "Traveler" can be operated from standard dry cells, rechargeable batteries, or from 117 volts a.c. (with accessory power supply).

STEREO MICROPHONE

A dual-element microphone for use in making stereo recordings has recently been announced by

North American Philips Co., Inc., High Fidelity Products Div., 230 Duffy Ave., Hicksville, Long Island, N. Y. The Norelco EL-3752/01 microphone employs the moving-coil



principle and has dual cardioid pickup patterns. Sensitivity is high, with the output only 50 db down at 1 volt, at an input pressure of 1μbar/cm². The output impedance is 25,000 ohms. Price, including 16' of shield-

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SPECIAL NOTE TO DEALERS: for information on ordering your supply of records, contact Ziff-Davis Publishing Company, Direct Sales Division, One Park Avenue, New York 16, N. Y.

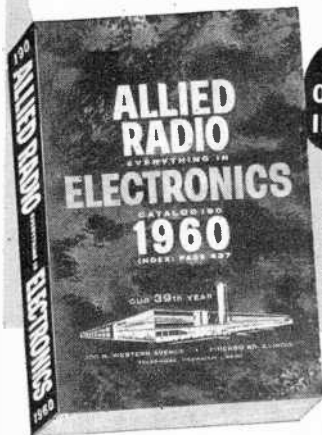
Here are some of the questions this record will answer for you!

- ✓ *How good is my stylus? Is it worn? Will it damage my records?*
- ✓ *What about my stereo cartridge? Does it have enough vertical compliance so that it won't ruin my expensive stereo records?*
- ✓ *Is my turntable running at the right speed? Is it free of rumble, wow, and flutter?*
- ✓ *What sort of standing waves do I get in my listening room?*
- ✓ *Are my speakers hooked up correctly? Are they phased properly, and is the correct speaker connected to the right stereo channel?*
- ✓ *How perfectly is my system equalized?*
- ✓ *What about separation? Is it adequate?*

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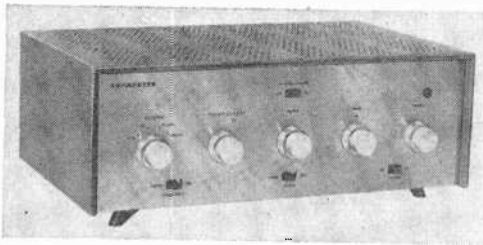
products

(Continued from page 30)

ed cable and a three-conductor telephone plug, \$39.50.

STEREO AMPLIFIER

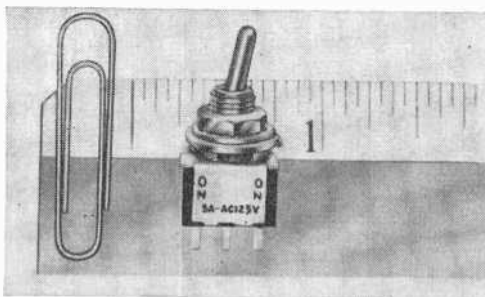
Introduced by *Lafayette Radio*, 165-08 Liberty Ave., Jamaica 33, N. Y., the Model LA-235 stereo amplifier delivers 17½ watts per channel in stereo operation or 35 watts in mono use. Frequency response is from



20 to 20,000 cps ±1 db at normal listening levels. Distortion at full output is less than 1% harmonic and less than 2% IM. The LA-235 features five sets of inputs, 8- and 16-ohm speaker outputs, and a blend control to provide continuously variable channel separation. Price, \$69.95.

SUBMINIATURE SWITCH

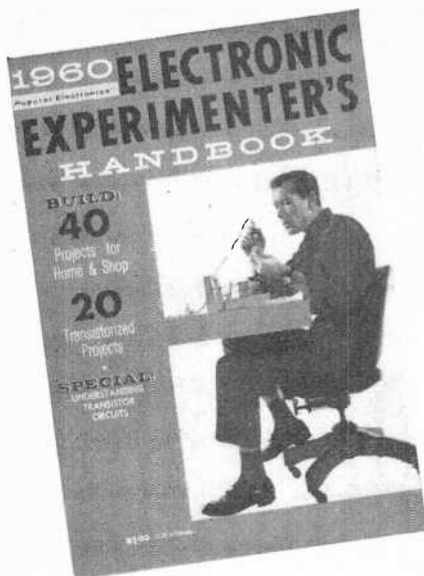
Development of a high-current subminiature toggle switch has been announced by *ALCO Electronic Products, Inc.*, 3 Wolcott



Ave., Lawrence, Mass. Measuring only ½" x ¾" x ¼", it is rated at 5 amperes at 115 volts a.c.; voltage breakdown is 1000 volts a.c. Price: s.p.d.t. model, \$1.65; d.p.d.t. model, \$2.15.

TRANSISTOR STEREO AMPLIFIER

Twenty-five watts output per channel is obtainable with the all-transistor stereo amplifier announced by *Transis-Tronics (TEC), Inc.*, 1650 21st St., Santa Monica, Calif. The Model S-25 has separate treble



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- Cascode RF Unit
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- Nifty Novice 15 Meter Transmitter
- Trans-6 Super-Regenerative Receiver

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- Stereo Tape Transistor Preamp
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- Stereocomplex

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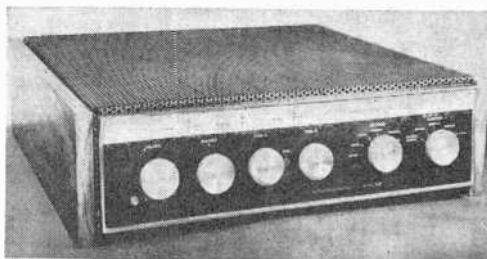


88-06 Van Wyck Expressway Richmond Hill 18, N. Y.

products

(Continued from page 32)

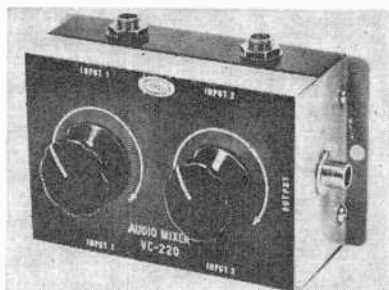
and bass controls for each channel, seven sets of inputs, and a phase reversal switch. Frequency response is from 20 to 20,000 cps



±1 db at 25 watts. This unit can also be employed as a 50-watt mono amplifier and can be operated from either 117 volts a.c. or 12 volts d.c.

AUDIO MIXER

Input and output impedances of 500,000 ohms are provided by the Model VC-220 two-channel audio mixer available from Olson Radio Corp., 260 South Forge St.,



Akron, Ohio. The input jacks accommodate either standard ¼" phone plugs or RCA-type phono pin plugs. The output terminates in an RCA-type phono pin jack. Size, 4" x 2½" x 1½". Price, \$3.00.

STEREO RECEIVER

The Madison Fielding Model 440 single-chassis stereo tuner-amplifier, introduced

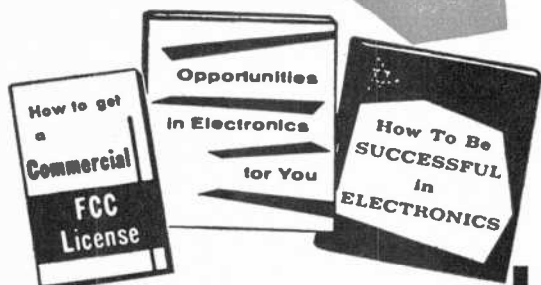


by Crosby Electronics Corp., Syosset, N. Y., comprises a stereo AM-FM tuner and two

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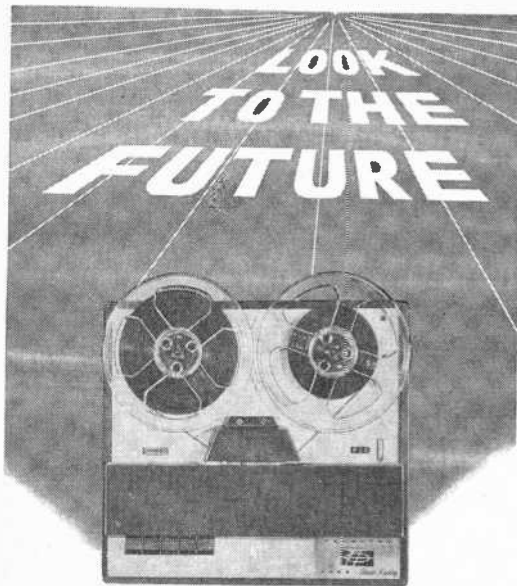
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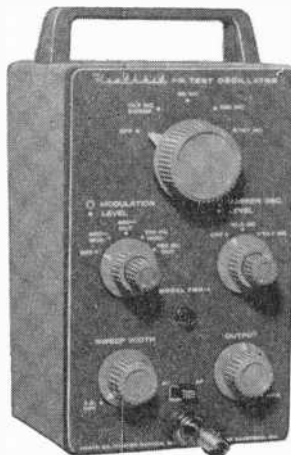
products

(Continued from page 34)

20-watt amplifiers. Sensitivity on FM is 2 microvolts for 20 db quieting; AM sensitivity is 80 microvolts per meter. Each amplifier section provides full output with less than 1% harmonic distortion, and the input facilities accommodate all standard stereo program sources. Price, \$325.00.

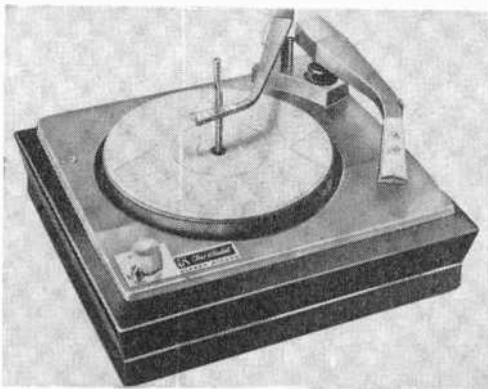
FM TEST OSCILLATOR KIT

A new kit-built oscillator designed specifically for use with FM receivers is available from the *Heath Company*, Benton Harbor, Mich. Model FMO-1 features fixed-frequency outputs at 90, 100, and 107 mc., a 10.7-mc. sweep oscillator with variable sweep width from 200 kc. to over 1 mc., a 10.7-mc. crystal marker, a 10-mc. calibrating crystal and a switched 400-cycle signal for radio-frequency modulation.



STEREO RECORD CHANGER

Designed for use with both monophonic and stereo records, the Model GS-400 record



changer announced by *Glaser-Steers Corp.*, 155 Oraton St., Newark 4, N. J., automatically changes records intermixed in

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—	1A2Z	.62	—	4B27	.96	—	6B07	.94	—	6K6	.58	—	12AZ7	.66	—	12U7	.62
—	1B3GT	.79	—	4D8B	.59	—	6B08	.87	—	854	.48	—	12B4	.63	—	12V6GT	.53
—	1DMS	.55	—	4C55	.61	—	6B06	.51	—	6SA7GT	.76	—	12BA6	.50	—	12W6	.69
—	1G3	.73	—	4D6E	.62	—	6B06	.55	—	6SK7GT	.74	—	12BD6	.50	—	12X4	.38
—	1J3	.73	—	4DK6	.60	—	6B06	.44	—	6SL7	.80	—	12BE6	.53	—	17AX4	.67
—	1K3	.73	—	4D76	.55	—	6B06	1.66	—	6SN7	.65	—	12BF6	.44	—	17BQ6	1.09
—	1L6	1.05	—	5AM8	.79	—	6B08	.65	—	6SQ7	.73	—	12BH7	.73	—	17C5	.58
—	1L6A	.69	—	5AN8	.86	—	6B08	.87	—	6T4	.99	—	12BK5	.70	—	17CA5	.62
—	1L6C	.79	—	5A05	.52	—	6B06	.62	—	6T8	.80	—	12BL6	.56	—	17D4	.69
—	1LNS	.59	—	5AT8	.80	—	6BK5	.80	—	6U8	.78	—	12B06	1.06	—	17D6	1.06
—	1R5	.62	—	5BK7A	.82	—	6B07	.85	—	6V6GT	.54	—	12BY7	.74	—	17L6	.58
—	1S5	.51	—	5B27	.97	—	6BL7	1.00	—	6W4	.57	—	12BZ7	.75	—	17W6	.70
—	1T4	.58	—	5BR8	.79	—	6BN4	.57	—	6W6	.69	—	12C5	.56	—	19AU4	.83
—	1U4	.57	—	5C08	.76	—	6BN6	.74	—	6X4	.39	—	12CA5	.59	—	19BG6	1.39
—	1U5	.50	—	5C18	.76	—	6BQ5	.65	—	6X5GT	.53	—	12CN5	.56	—	19T8	.80
—	1X2B	.82	—	5E48	.80	—	6B06GT	1.05	—	6X8	.77	—	12CR6	.54	—	21X6	1.49
—	2AF4	.96	—	5E08	.80	—	6B07	.95	—	7AU7	.61	—	12CU5	.58	—	25AU4	.87
—	2BN4	.60	—	5I6	.68	—	6BR8	.78	—	7A8	.68	—	12CU6	1.06	—	25BQ6	1.11
—	2C15	.71	—	5T8	.81	—	6B58	.90	—	7B6	.69	—	12CX6	.54	—	25C5	.53
—	3AL5	.42	—	5U4	.60	—	6B08	.70	—	7Y4	.69	—	12DB5	.69	—	25CA5	.59
—	3AU6	.51	—	5U8	.81	—	6B06	.54	—	8AU8	.83	—	12DE8	.75	—	25C06	1.44
—	3AV6	.41	—	5V6	.56	—	6B26	.54	—	8AW8	.93	—	12DL8	.85	—	25CUG	1.11
—	3BA8	.51	—	5X8	.78	—	6B27	.97	—	8B05	.60	—	12DM7	.67	—	25DN6	1.42
—	3BC5	.54	—	5Y3	.46	—	6C4	.43	—	8C07	.62	—	12DM6	1.04	—	25EH5	.55
—	3BE6	.52	—	6AB4	.46	—	6CB6	.54	—	8CM7	.68	—	12DS7	.79	—	25L6	.57
—	3BN4	.63	—	6AC7	.96	—	6CD6	1.42	—	8CN7	.97	—	12DZ6	.56	—	25W4	.68
—	3BM6	.76	—	6AF3	.73	—	6CF6	.64	—	8CX8	.93	—	12EL6	.50	—	25Z6	.66
—	3BU8	.78	—	6AF4	.97	—	6CG7	.60	—	8EB8	.94	—	12EG6	.54	—	35C5	.51
—	3BY6	.55	—	6AG5	.65	—	6CG8	.77	—	10D47	.71	—	12EK6	.56	—	35L6	.57
—	3BZ6	.55	—	6AH5	.99	—	6CM7	.66	—	11CY7	.75	—	12EZ6	.53	—	35W4	.52
—	3CB6	.54	—	6AK5	.95	—	6CN7	.65	—	12A4	.60	—	12F5	.66	—	35Z5GT	.60
—	3CF8	.60	—	6AL5	.47	—	6CR6	.51	—	12AB5	.55	—	12F8	.66	—	50B5	.60
—	3CS6	.52	—	6AM8	.78	—	6CS6	.57	—	12AC6	.49	—	12FM6	.45	—	50C5	.53
—	3CY5	.71	—	6AN4	.95	—	6C05	.58	—	12A06	.57	—	12K5	.65	—	50DC4	.37
—	3DE6	.62	—	6AM8	.85	—	6CU6	1.08	—	12AE6	.43	—	12SA7M	.86	—	50EH5	.55
—	3DK6	.60	—	6AQ5	.50	—	6CY5	.70	—	12AF3	.73	—	12SK7GT	.74	—	50L6	.61
—	3DT6	.50	—	6AR5	.55	—	6CY7	.71	—	12AF6	.49	—	12SN7	.67	—	117Z3	.61
—	305	.80	—	6AS5	.60	—	6D4A	.68	—	12AJ6	.46	—			—		
—	354	.61	—	6AT6	.43	—	6D6	.69	—	12AL5	.45	—			—		
—	3V4	.58	—	6AT8	.79	—	6DE6	.58	—	12AL8	.95	—			—		
—	4AU6	.54	—	6AU4	.82	—	6D06	.59	—	12A05	.52	—			—		
—	4BA6	.51	—	6AU6	.50	—	6D06	1.10	—	12AT6	.43	—			—		
—	4BC5	.56	—	6AU7	.61	—	6D75	.76	—	12AT7	.76	—			—		
—	4BC8	.96	—	6AU8	.87	—	6D76	.53	—	12AU6	.50	—			—		
—	4BE6	.54	—	6AV6	.40	—	6EU8	.79	—	12AU7	.60	—			—		
—	4BN6	.75	—	6AW8	.89	—	6EAB	.79	—	12AV5	.97	—			—		
—	4BQ7	.96	—	6AX4	.65	—	6EB8	.94	—	12AV6	.41	—			—		
—	4BS8	.98	—	6AX7	.84	—	6EGT	.58	—	12AV7	.75	—			—		
—	4BU8	.71	—	6BA6	.49	—	6J5GT	.51	—	12AX4	.67	—			—		

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products

(Continued from page 36)

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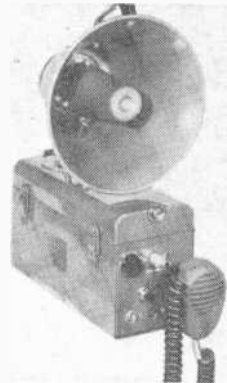
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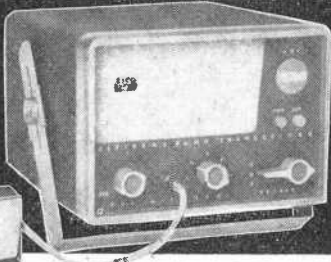
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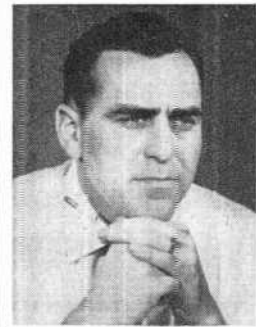
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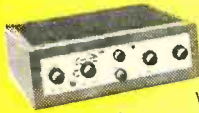
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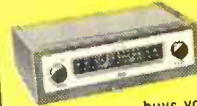
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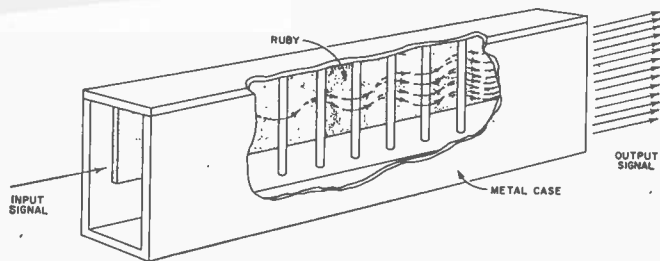
Maser-operated
radic telescope at the
Naval Research Labora-
tory has a range of more
than seven billion light years.

see next page 





Disassembled maser is shown at left; scientist R. W. DeGrasse of Bell Laboratories holds in his right hand the strip of synthetic ruby which provides the amplification. The cutaway view of a maser (below) shows how the input signal weaves in and out of the row of pins next to the strip of ruby; each time the signal goes around a pin, additional energy is radiated, resulting in increased amplification.



ON FEBRUARY 10th of last year, eight scientists gathered at MIT's famous Lincoln Laboratory near Boston. They carefully checked over the powerful research radar installed there, then angled its huge dish antenna sharply into the afternoon sky. At exactly 2:21 p.m., a pulse shot out from the antenna in the direction of the planet Venus. Just under five minutes later, an echo so faint as to be hardly recognizable came back to earth. Man had made his first direct contact with the planets.

The scientific breakthrough that made it possible for an electronic signal to complete the 55-million-mile round trip from Earth to Venus was the invention of the "maser." This amplifying device effectively makes radar sets up to 100 times more sensitive than they were before, vastly extending their range. The world's first true "atomic amplifier," the maser owes its amazing sensitivity to the fact that it actually harnesses the tremendous internal energy of the electron's spin.

The "solid-state maser," to give it its full name, is an odd but deceptively simple-looking gadget. Its heart is a strip of synthetic jewel which is suspended in a tank

of liquid helium and maintained at the almost unbelievable temperature of nearly 460°F below zero! Add a few lengths of waveguide—electronic plumbing to direct the radio waves in and out—and you've got the whole assembly.

While the maser's most publicized triumphs to date have been associated with radar, its accomplishments have by no means been limited to this field.

Searching Space. Columbia University's Dr. Charles H. Townes, who invented the maser, and scientists at the Naval Research Laboratory near Washington have built a maser-operated 50-foot radio telescope which has a range three and one half times as great as the best light telescopes—over seven billion light years! This has opened up for exploration a total volume of space about 40 times greater than that seen by the 200-inch Mount Palomar telescope and earlier radio telescopes.

The great sensitivity of the new 50-foot "space eye" is already enabling astronomers to learn something about the surface of Venus for the first time. This has been perhaps the most mysterious of all the planets because it is eternally obscured by

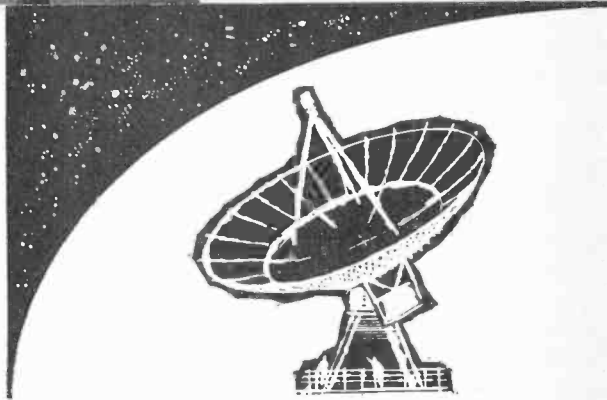


Three Bell Labs scientists, Harold Seidel, H. E. D. Scovil, and George Feher, are shown here with one of their brain-children, an early solid-state maser.

thick clouds. But the maser telescope can pick up its feeble surface radiation easily, and astronomers now know far more about it than ever before. They have recently learned, for example, that the surface of Venus is a sizzling 585°F—far too hot for the existence of life as we know it.

But this is just the beginning. Dr. Frank D. Drake of the National Astronomy Observatory at Green Bank, West Virginia, predicts that within about a year a radio telescope with three times the range of the 50-foot unit at the Naval Research Laboratory and ten times the range of earlier radio telescopes will allow scientists to “see” the actual surface of Venus and to determine for the first time its speed of rotation—that is, the length of its days.

This new instrument is already under construction at the West Virginia observatory site. Its gigantic dish antenna will be 600 feet in diameter; two football fields would fit end to end across its span. Not only will it “see” nearby planets more clearly, but its tremendous sensitivity will enable it to probe 30 to 40 times as much space as can now be explored with the 50-foot telescope. Its range may extend as far as 20 billion light years! Astronomers think they will even be able to observe the “edge of space,” where radiation emitted at the time of the formation of the universe may perhaps be detected or where space may actually be seen to curve.

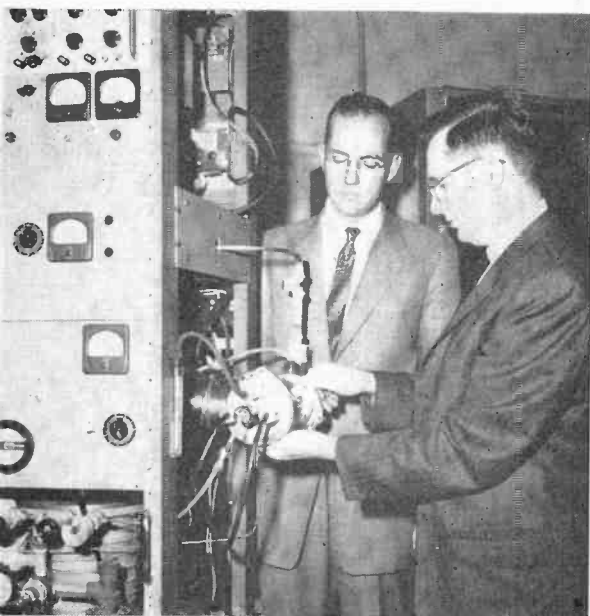


“Such observations,” says Dr. Townes, “will quite possibly indicate whether present ideas of an expanding universe are correct, as well as providing a means of checking other cosmological theories.”

One of the maser’s most obvious applications is in the field of satellite communications. Since tons of fuel must be burned for every pound of satellite put into orbit, scientists use every conceivable trick to design the lightest possible equipment for space probes. With maser amplifiers one hundred times as sensitive as older types in ground listening posts, smaller and lighter transmitters can be installed in satellites. Smaller transmitters also use lighter batteries, saving more weight.

Thermal Noise. The maser—this weird piece of frigid hardware—is able to perform its many tricks because its unique principle of operation virtually eliminates that old bug-a-boo, thermal noise.

Why is this so important? Let’s take a



The inventor of the maser, Dr. Charles H. Townes (above left), of Columbia University, and J. P. Cedarholm of IBM inspect a gas maser clock which is used in scientific research.

look at the maser's use in radar and find out. Figure 1 shows a radarscope with an echo from a nearby airplane. The echo is strong and clear. But notice the wiggly lines along the bottom of the scope. Radar operators call this irregular pattern "grass." Engineers call it thermal noise.

If there were no thermal noise, the scope trace with the same echo would look like Fig. 2. Here, the transmitter pulse and the echo is unchanged; the only difference is that there is now no "grass," or thermal noise. It makes little difference whether or not the thermal noise is there, as long as we get a strong echo from a nearby target.

But what about that echo from Venus? By the time a signal travels 55 million miles, there isn't much of it left. On a maser radarscope, the trace would look like Fig. 3. Without the maser, it would look like Fig. 4. Where is the echo? Completely blanked out by thermal noise.

How does the maser do away with thermal noise? To answer this question, let's quickly review the cause of thermal noise.

If you could look inside the tubes and wires of your hi-fi set, for example, you would see streams of electrons rushing

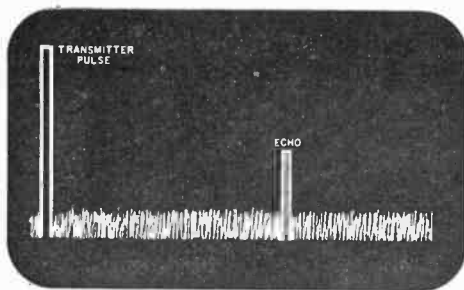


Fig. 1. Radarscope picture of pulse and echo, with thermal noise along bottom of the trace.

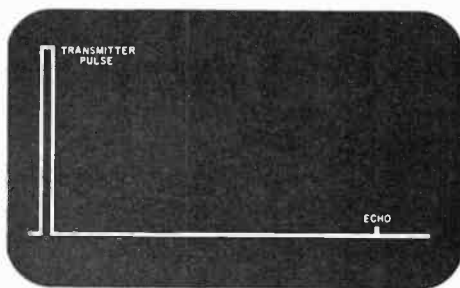


Fig. 3. Maser-operated radar has no thermal noise, allowing very weak echo to be received.

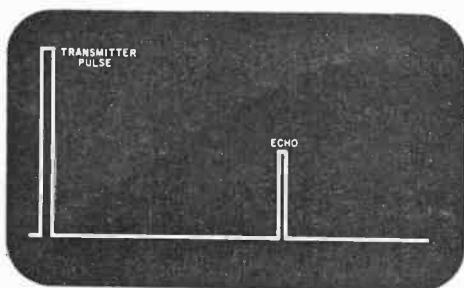


Fig. 2. Radarscope picture of same pulse and echo, but without any thermal noise or "grass."

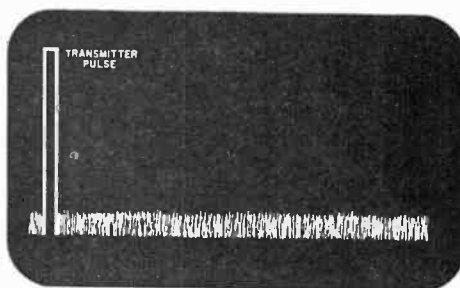
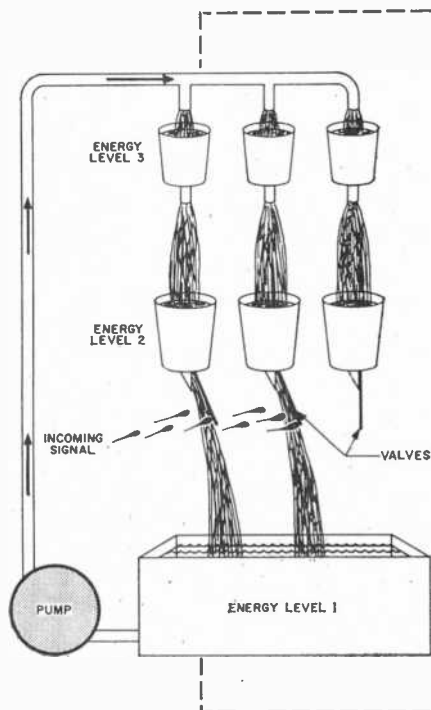


Fig. 4. On conventional radar, thermal noise completely swamps out echoes of low amplitudes.

along in orderly groups. This flow of electrons is the "signal" that eventually comes out of the speaker as music or speech. But here and there a few electrons, stirred up by the heat present in any circuit, scamper around aimlessly. This random movement generates a small but measurable current of its own, which comes out as noise. It is called thermal noise, or thermal agitation, since it is caused by heat: the more heat, the more noise.

You can actually hear thermal noise on



your hi-fi amplifier, just as you can see it on a radarscope. With no signal applied to your hi-fi set, turn up the volume control and put your ear next to the speaker. The hissing sound you hear is thermal noise greatly amplified. Although such noise is rarely objectionable in hi-fi amplifiers, it seriously limits the range of radar, as we have seen.

Since the maser does not depend on electron flow, there is little random noise created. And even the few stray electrons that would normally wander about are much less likely to do so when the maser is dipped in a chilling bath of liquid helium. At temperatures close to absolute zero (-473°F), random electron movement be-

(Continued on page 122)

HOW THE MASER WORKS

The heart of the solid-state maser is a strip of semiconductor material—usually synthetic ruby—placed in a resonant chamber into which are piped the signal to be amplified and the so-called "pump" signal.

Scientists tell us that materials such as synthetic ruby contain electrons spinning at different rates, or to be more accurate, at different "energy levels." Under normal conditions, most electrons are at the lowest energy level, which is called "Energy Level 1." Fewer electrons are at Energy Level 2, and still fewer at Energy Level 3. When an electron "falls" from a high level to a lower one, it gets rid of its excess energy by radiating that energy in the form of microwave signals.

To illustrate how the maser works, a mechanical analogy can be used. This analogy describes the operation of the "3-level maser," the most common type.

Let us represent Energy Level 1 by a tank of water. Energy Level 2 by a row of buckets suspended above the tank, and Energy Level 3 by a still higher row of buckets. Valves in the bottom of the buckets on Energy Level 3 are arranged so that they automatically keep the buckets on Energy Level 2 full.

Each bucket on Energy Level 2 has a sensitive valve on its bottom which can be opened by the slightest touch. The system also has a pump which pumps water from the tank, keeping the buckets on Energy Level 3 full, which in turn keeps the buckets on Energy Level 2 full.

The maser is now ready to operate. Tiny drops of water shooting into the system from the outside will hit the valves on the bottom of the buckets on Energy Level 2, releasing large amounts of water. These small drops of water represent small incoming signals, which in actual masers cause the electrons on Energy Level 2 to drop to Energy Level 1, and thereby radiate their excess energy. The amount of energy they radiate is far more than the amount needed to trigger them. Therefore, a small signal coming into the maser is amplified into a large one.

Because of complex technical considerations, it is easier in practice to "pump" electrons up to Energy Level 3 and let them drift down to Energy Level 2 than to pump them directly to Energy Level 2. The "pump" used in an actual maser is an oscillator operating at a frequency higher than the signal frequency to be amplified. In practice, the cavity in which the maser is placed must be resonant at the signal and pump frequencies.

The gas maser is a "2-level maser," which operates on a slightly different but similar principle. The word "maser" stands for "Microwave Amplification by Stimulated Emission of Radiation."

New Integrated Stereo Amplifier Kit

The PACO SA-40 is tailor-made
for the stereo enthusiast

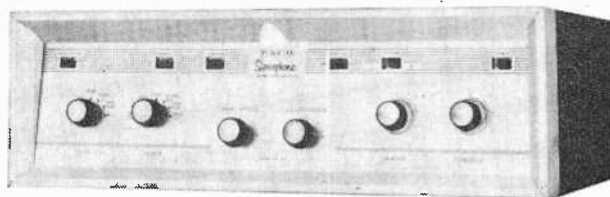


AMONG other things, stereo has brought us back to the integrated amplifier system—preamplifier, amplifier, and power supply all in one compact chassis. One of the neatest integrated stereo systems on the market today is the PACO SA-40 kit (PACO Electronics, Inc., 70-31 84th St., Glendale 27, L. I., N. Y.). The unit incorporates two 20-watt amplifiers, a separate preamplifier for each, and a common power supply. At its price of \$79.95 (\$129.95, factory-wired), the SA-40 is a good buy.

Features. Versatility is one of the unit's outstanding features and seems to have been foremost in the minds of its designers. With the number of inputs available—fourteen in all—you can connect virtually anything to the completed amplifier. An *Input Selector* chooses between auxiliary inputs 1 and 2, phono inputs 1 and 2, tape head, and microphone. A *Mode Switch* selects type of operation—stereo, stereo-reverse, monophonic, or separate-channel—and also provides for balancing the loudspeaker systems used. *Balance, Loudness, Bass, Treble, Equalization, Rumble, Speaker System Selection*, and a separate *On-Off Switch* make up the remaining operating controls.

A *Parallel-Separate* switch on top of the chassis determines whether the two power amplifiers operate separately or in parallel. With the power amplifiers operating in parallel—and thus supplying a combined output of 40 watts—an auxiliary external power amplifier can be connected to the left preamp section to drive the other channel.

Each power amplifier incorporates 25 db



of inverse feedback around its voltage amplifier, phase inverter, and output stages, as well as the output transformer itself, cutting hum and distortion by nearly 20 times. Equalization networks for both tape and phono are also of the inverse-feedback type. Large capacitors (100 μ f.) make power supply regulation good, an important feature in view of the use of fixed bias on the output tubes.

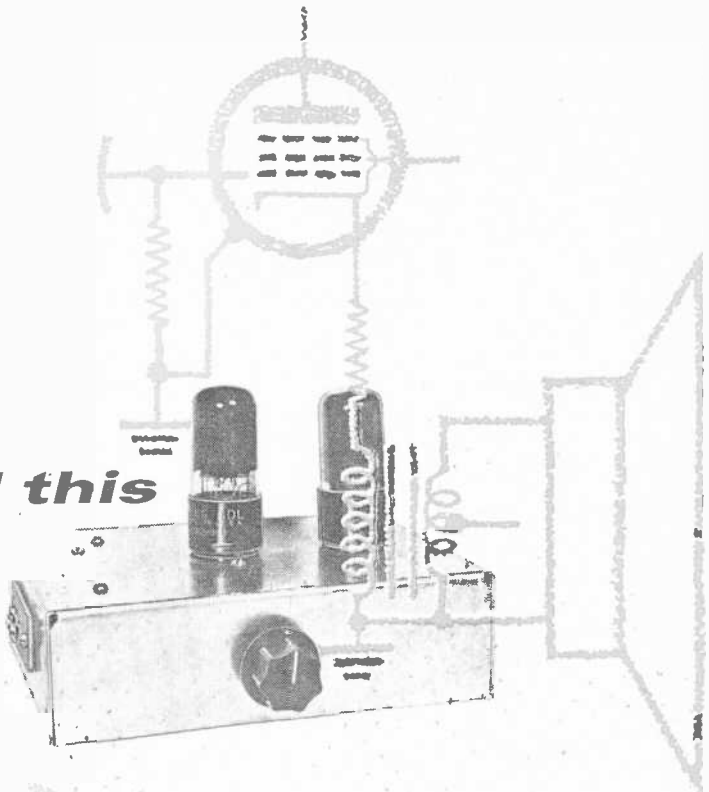
Mechanically, two a.c. outlets (one switched, one unswitched) at the rear of the chassis will supply power to the associated equipment. Provision is also made at the rear of the chassis for connecting the amplifier chassis to a waterpipe ground—one of the most foolproof ways of reducing hum to an imperceptible level.

Comment. It would be wrong to look upon the SA-40 as a construction kit for the experienced kit builder. The instruction manual is thorough and has been carefully worked out to guide the newcomer to kit building. And while the project is extensive—you can count on at least 20 hours of construction time—it isn't difficult.

The completed SA-40 offers nearly all that could be asked for in an integrated stereo system—neatness, compactness and versatility.

-30-

Build this



Unusual AMPLIFIER

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HERE'S an unusual amplifier that should appeal to the hi-fi experimenter. It's unusual because the output is taken from the cathode and not from the plate of the output tube as you would expect. A similar circuit appears quite often in hi-fi preamplifiers where you probably know it as the cathode follower.

This amplifier was designed to work from a high output cartridge or tuner. You'll need about .1 volt or more to drive the unit to its full output which is in the region of 1 watt. For a simple stereo system, two of these units would be ideal.

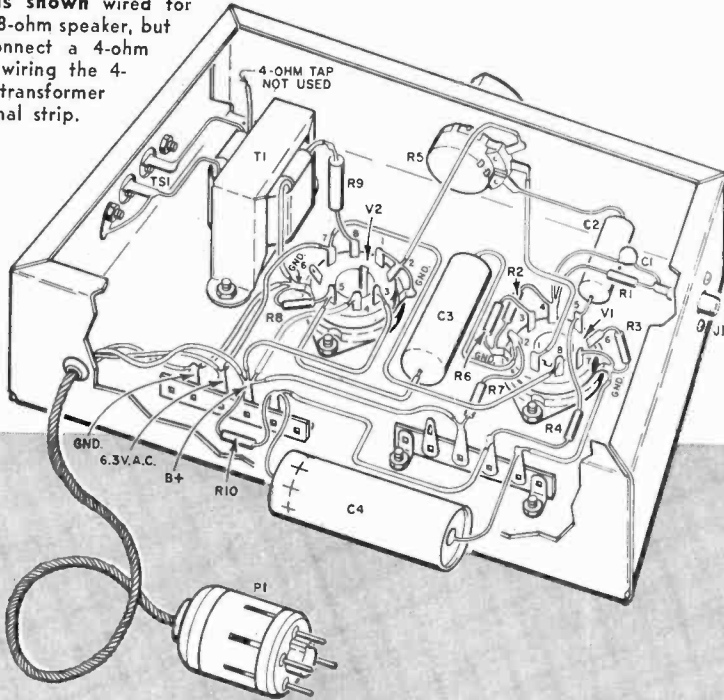
The author built his model on a 5" x 7" x 2" chassis he had on hand, and the power supply was built on a separate chassis of the same size. (If you wish, you can build both on a single larger chassis with no ill effects.) Although the circuitry is noncritical, all grid leads should

By

JAMES ROMELFANGER

April, 1960

Amplifier is shown wired for use with an 8-ohm speaker, but you can connect a 4-ohm speaker by wiring the 4-ohm tap on transformer T1 to terminal strip.



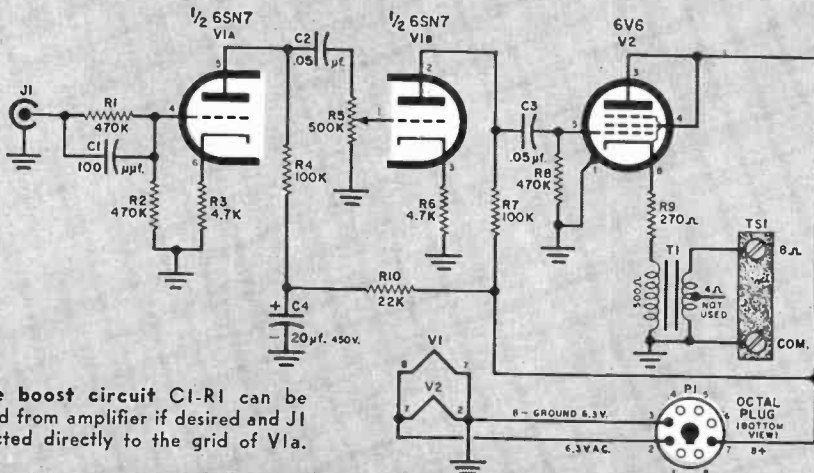
HOW IT WORKS

Audio signals from a crystal or ceramic phono cartridge are applied to triode V1a through simple treble-boost circuit C1-R1. Amplified signals are taken from the plate of this triode and fed to volume control R5. The desired portion of the audio is tapped off R5 and applied to the grid of triode V1b where it is again amplified, and finally applied to V2's control grid. The signal is then taken from the cathode of V2 and coupled to the speaker through output transformer T1. Resistor R9 biases V2 in normal fashion.

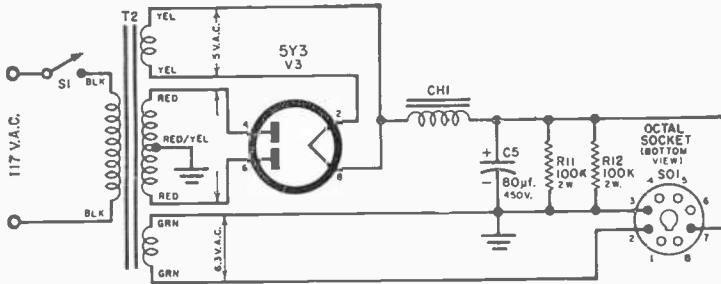
The power supply is a standard full-wave rectifier with a choke-input filter consisting of C4 and C5. Paralleled resistors R11 and R12 operate as a bleeder and as a discharge path for capacitor C5.

be kept short and away from leads carrying a.c. power and heater current. It's generally best to wire the heater and power leads first, and then proceed with the rest of the wiring.

A cable is used to interconnect the two chassis, with an octal plug and socket serving as cable connectors. Mount the socket—but not the plug—on the power supply chassis. If the plug were on the power supply, you would be liable to get a bad shock at the plug pins with the supply turned on. If you want a smaller unit, you can sub-



Treble boost circuit C1-R1 can be omitted from amplifier if desired and J1 connected directly to the grid of V1a.



Choke-input filter in power supply lowers B+ to proper voltage for V2. Capacitor C5 must be large since it filters output of supply and also serves as audio bypass for V2.

PARTS LIST

- C1—100- μ f. disc ceramic capacitor
- C2, C3—.05- μ f., 600-volt capacitor
- C4—20- μ f., 450-volt electrolytic capacitor
- C5—80- μ f., 450-volt electrolytic capacitor
- CHI—15-henry, 75-ma. filter choke (Stancor C1002 or equivalent)
- J1—RCA-type phono jack
- P1—Octal plug
- R1, R2, R8—470,000 ohms All resistors
- R3, R6—4700 ohms 1/2 watt unless
- R4, R7—100,000 ohms otherwise noted
- R5—500,000-ohm potentiometer
- R9—270 ohms, 2 watts
- R10—22,000 ohms
- R11, R12—100,000 ohms, 2 watts
- S1—S.p.s.t. toggle switch
- SO1—Octal socket
- T1—Line-to-voice-coil transformer, 500-ohm primary to 4- and 8-ohm secondary (Stancor A8101 or equivalent)
- T2—Power transformer, 117-volt primary, secondaries 650 volts CT at 70 ma., 5.0 volts at 3 amps, and 6.3 volts at 3.5 amps (Knight 62G042 or equivalent)
- TS1—Two-terminal screw-type terminal strip
- V1—6SN7 tube (see text)
- V2—6V6 tube (see text)
- Misc. hardware, chassis, tube sockets, tie points, wire, etc.

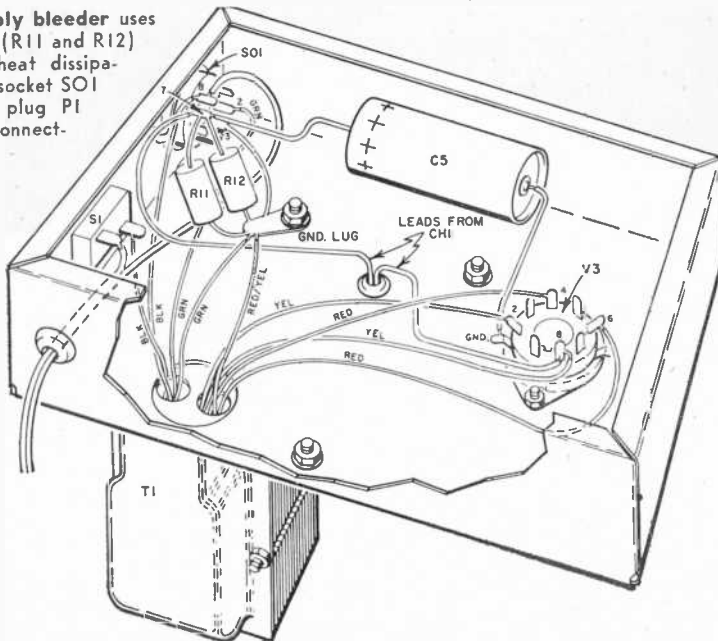
stitute a 12AU7 for the 6SN7 tube (V1) and a 6AQ5 for the 6V6 tube (V2). No circuit changes would be necessary.

Transformer T1 is not a standard output transformer. It is a line-to-voice-coil unit with a primary impedance of 500 ohms and a 4- and 8-ohm secondary.

A simple boost circuit, C1-R1, equalizes the phono cartridge output. These parts can be eliminated if no boost is required and J1 can be connected directly to the grid of V1a.

—30—

Power-supply bleeder uses two resistors (R11 and R12) for better heat dissipation. Octal socket SO1 mates with plug P1 on the interconnecting cable.



Transistorized Electronic Fence Controller

Inexpensive unit keeps animals in, pests out!

By R. L. WINKLEPLECK

AN ELECTRONIC fence controller, or "charger," is a useful device for keeping animals either in or out of an enclosed area. It supplies a pulsed high-voltage output to a length of bare fence wire and thus delivers an annoying jolt to any animal that touches it. And, in addition to being ideal for keeping livestock within desired boundaries, the fence controller can also be connected to such things as garbage cans—to prevent dogs or pranksters from knocking them over.

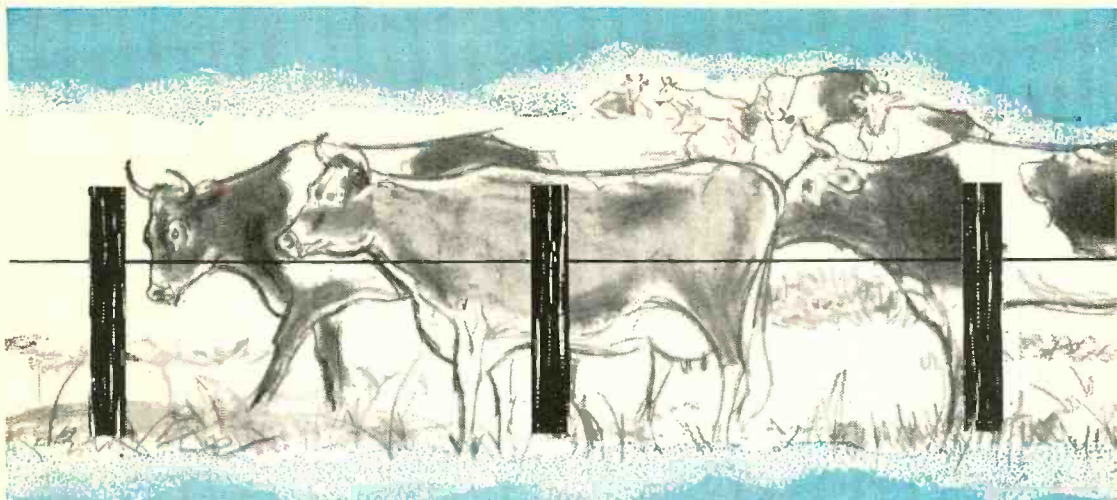
No moving parts are used in the transistorized fence controller described here. There is nothing to wear out except the battery, and—thanks to the circuit's high efficiency—battery replacement should be infrequent. The controller complies fully with safety regulations; it will give a stinging shock, but it can cause no serious harm to anyone coming in contact with the charged wire.

You can build the unit, ready for action, for just a shade over ten dollars.

Construction. The fence controller fits in a 3" x 5" x 7" Minibox. First, assemble the transistor circuitry on a 2" x 5" perforated phenolic circuit board. Then wire the components point-to-point, using solder lugs or "flea" clips where necessary. Attach completely wired phenolic circuit board to the mounting bracket on the spark coil



Output of controller is fed to a bare wire fence. With the controller connected, animals touching the wire will receive a harmless shock.



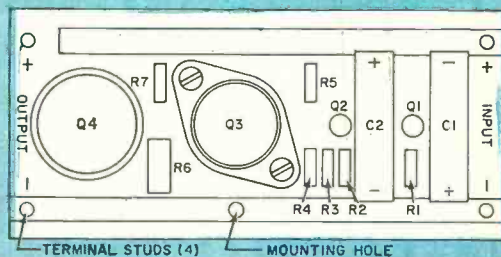
or to any other convenient point. Spark coil *T1* may be a 6- or 12-volt model depending on the voltage of the battery you decide to use.

Connect the high-voltage output of *T1* to the stand-off insulator on the top of the box with auto ignition wire. Battery and ground connections are made to the three binding posts on the bottom of the box. As a final touch, fasten a bracket to the box so that you can mount it on a fence post.

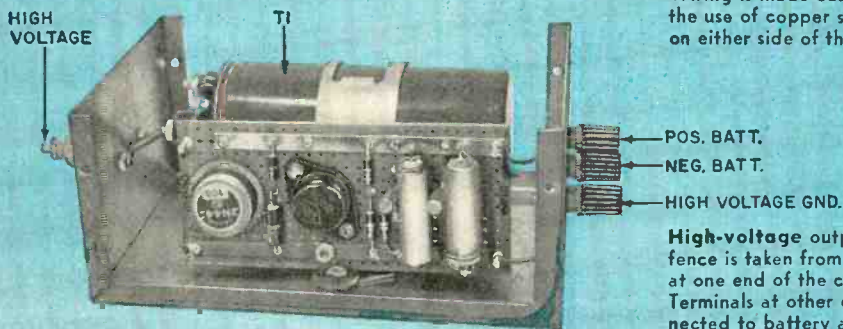
Test the finished controller by connecting a 6- or 12-volt "hot-shot" or storage battery to the positive and negative binding posts, being sure to observe polarity. Check for a spark between the stand-off insulator and the ground binding post by scratching a well-insulated wire between these terminals. Don't use bare wire or you may be knocked off your feet.

After the unit is checked out, spray the circuit board and the outside of the box with an insulating spray lacquer to guard against dirt and moisture.

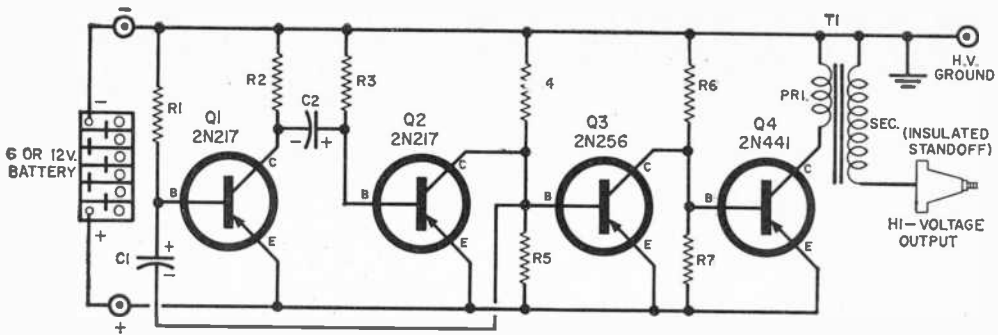
Operation. String single- or double-stranded bare wire around the area to be enclosed. Use insulators



Most components are mounted on phenolic board. Wiring is made easier through the use of copper strips on either side of the board.



High-voltage output to fence is taken from a terminal at one end of the charger. Terminals at other end are connected to battery and ground.



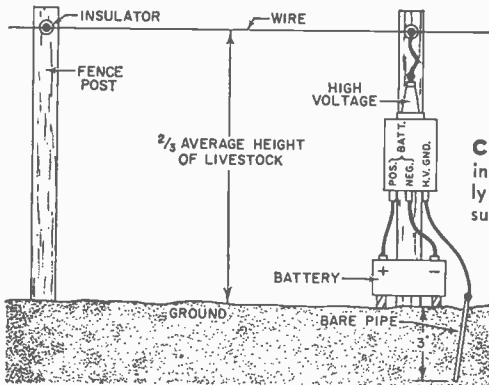
PARTS LIST

- B1—6- or 12-volt storage battery (see text)
 - C1—20- μ f., 50-volt electrolytic capacitor
 - C2—100- μ f., 50-volt electrolytic capacitor
 - Q1, Q2—2N217 transistor (RCA)
 - Q3—2N256 power transistor (CBS)
 - Q4—2N441 high-power transistor (Delco)
 - R1—100,000 ohms
 - R2—2200 ohms
 - R3—82,000 ohms
 - R4, R5—220 ohms
 - R6—82-ohm, 1-watt resistor
 - R7—82 ohms
 - T1—6- or 12-volt automobile ignition coil (see text)
 - 1—3" x 5" x 7" Minibox (or equivalent)
 - 1—2" x 5" perforated phenolic circuit board
- All resistors $\frac{1}{2}$ watt unless otherwise noted

Transistors Q1 and Q2 operate as a multivibrator, Q3 and Q4 as common-emitter amplifiers. Capacitor C1 is feedback capacitor in multivibrator circuit.

(ceramic or plastic) to fasten the wire to the fence posts; the wire should be at a level roughly two-thirds the average height of the livestock. Then mount the controller on a fence post, preferably in a spot where it will be well protected from the weather.

Connect the controller's stand-off terminal to any convenient point along the wire; auto ignition wire is best for this purpose if the wire is very long. The controller's ground terminal is connected to a pipe or rod driven at least three feet into



Connect the completed charger to an insulated fence. Check fence carefully before connecting the battery to insure that there are no paths to ground.

HOW IT WORKS

Transistors Q1 and Q2 are connected in a multivibrator circuit which oscillates due to feedback from the collector of Q2 to the base of Q1. Transistors Q3 and Q4 are common-emitter amplifiers. In oscillation, Q1 and Q2 conduct alternately. When Q1 conducts, it biases Q2 to cutoff. With Q2 thus cut off, Q3 conducts, and cuts off Q4. When Q2 conducts, it biases Q3 to cutoff, which allows Q4 to conduct.

Since the output of the multivibrator is non-symmetrical, Q4 is cut off for a longer time than it conducts. Transistor Q4 therefore acts as an automatic switch to trigger the spark coil. The charger's "off" time is determined primarily by the time constant of C2-R3, its "on" time by C1-R1. With the values shown, Q4 is cut off for nearly a second and then conducts heavily for a fraction of a second.

the ground. When the battery is connected, the fence will immediately become "alive."

Use a lightning arrester to prevent damage to the controller. Connect the arrester between the porcelain stand-off insulator and ground. The gap on the arrester should be wide enough (about $\frac{1}{4}$ ") to keep the normal output of the controller from jumping the gap.

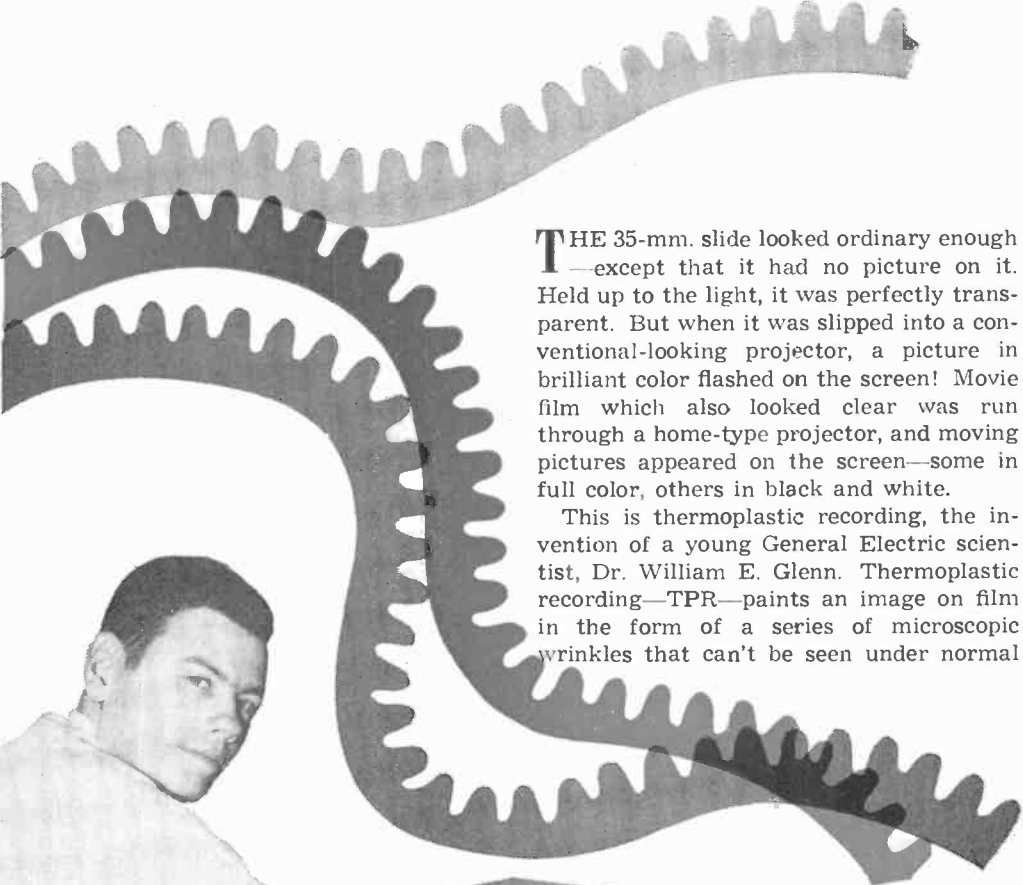
To turn off the controller, disconnect either battery lead. Animals soon learn to respect and to avoid a charged fence; once they have been shocked they will often be wary of it for weeks after the power is disconnected.

To keep the neighbor's dog from knocking over your garbage can, just set the can on insulating blocks and connect the controller to it as described above.

Dr. Glenn's Magic Wrinkles

By ROBERT REMINGTON

*Young GE scientist devises new ultra-wide-band recording system
for use in video recording, data storage, missile guidance, etc.*



THE 35-mm. slide looked ordinary enough—except that it had no picture on it. Held up to the light, it was perfectly transparent. But when it was slipped into a conventional-looking projector, a picture in brilliant color flashed on the screen! Movie film which also looked clear was run through a home-type projector, and moving pictures appeared on the screen—some in full color, others in black and white.

This is thermoplastic recording, the invention of a young General Electric scientist, Dr. William E. Glenn. Thermoplastic recording—TPR—paints an image on film in the form of a series of microscopic wrinkles that can't be seen under normal



Inventor of thermoplastic recording, Dr. William E. Glenn, is shown at left.

Surface modulation of recording film is basis for thermoplastic recording.

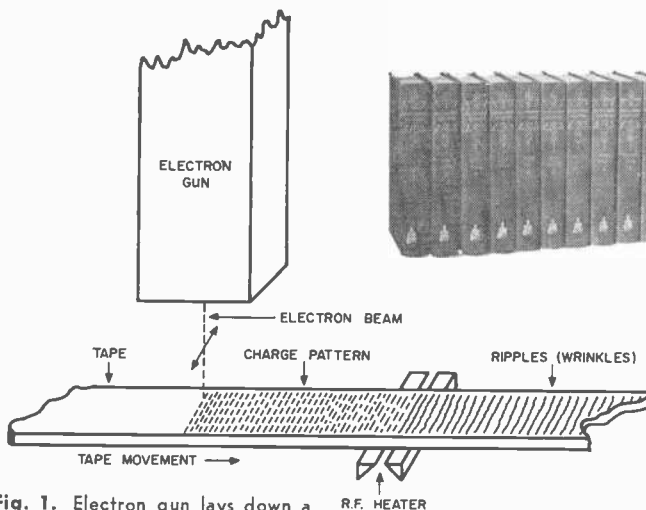


Fig. 1. Electron gun lays down a pattern of electrons similar to those which produce a TV picture.

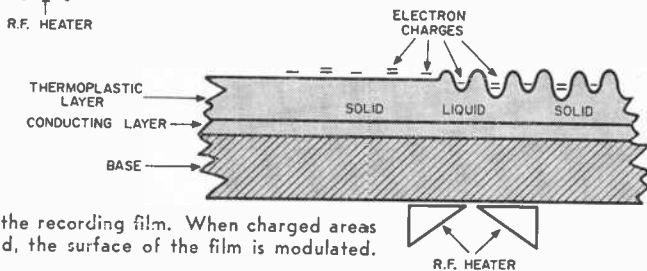


Fig. 2. Side view of the recording film. When charged areas of the film are heated, the surface of the film is modulated.

Thermoplastic recording techniques would allow an entire set of the Encyclopedia Britannica to be recorded on the tiny reel of film Dr. Glenn holds in his hand.

conditions. But they break up beams of light projected through them into black and white or brilliantly colored pictures.

New Concept. TPR is the first completely new principle in recording to come along since magnetic tape, and it seems destined to make an even bigger splash. The reason: thermoplastic recording combines most of the advantages of tape and film recording with a number of its own.

Here are some of TPR's most important features:

- It can record anything that can be represented by an electrical signal: TV pictures; sound; computer, radar, or sonar images.
- Both recording and playback are instantaneous.
- It provides an image that can be viewed optically or projected on a screen, but it needs no chemical processing.
- Recordings can be used, erased, and re-used, again and again.
- Duplicate recordings can be reproduced by stamping, like phonograph records—a much faster and cheaper process than tape re-recording.

- TPR has fantastic bandwidth capabilities (up to 50 megacycles) and resolution. It can cram a staggering amount of information into a small space.

For example, television pictures can be recorded on a tape one-tenth of an inch wide which moves at the astonishingly slow speed of only five inches per second. A half-hour TV program can be put on a reel that would fit in your vest pocket.

At the system's present degree of refinement, the contents of the entire *Encyclopedia Britannica* could be recorded on a reel only a few inches in diameter, at a rate of one volume per minute. Dr. Glenn says that eventually it should be possible to store the same amount of information on a reel the size of a spool of thread.

By using a binary digit system, recorded information can be compressed even more. Since up to forty million "bits" of information can be put on each square inch of film, the contents of a dozen full-length novels could be recorded on one square inch of film, in binary form.

The ability to store vast amounts of in-

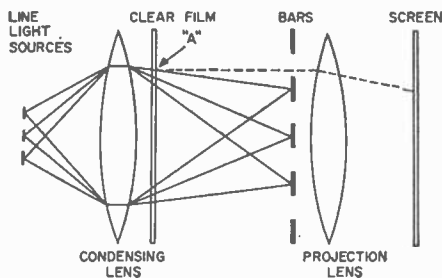
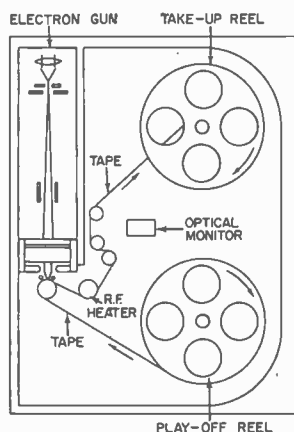


Fig. 3. Video recordings are reproduced through a modified slide or movie projector. No modulation of the film's surface results in no light reaching the screen. A surface ripple, however, such as that at point "A," will diffract the light between the bars, allowing light to reach the screen.



Dr. Glenn tests his prototype thermoplastic recorder. He estimates that he could halve its size by rebuilding it. Diagram of the TPR recorder is at left.

formation is becoming more and more important in this age of rapid scientific progress. Many research and development projects, for instance, are hampered because truly comprehensive collections of reference material are available in only a few major libraries.

With TPR, it will be possible to store all of the information in New York's famous Engineering Societies Library—one of the nation's finest collections of technical and scientific information—in a cabinet the size of an ordinary office desk. Techniques used in present-day computers would make it possible to locate any piece of stored information within a few seconds. Consequently, every company or university could have a relatively inexpensive, readily accessible source of information of the sort now available in only a few places in the world.

Preserving the Wrinkles. Dr. Glenn got the idea for thermoplastic recording while working on a refinement for the Eidophor TV projection machine (see *POPULAR ELECTRONICS*, May 1959). It occurred to him that if there were some way to catch

and "freeze" the wrinkles that made up the picture, such a system would have tremendous advantages over conventional recording methods. Thermoplastic recording grew out of this concept.

In TPR, an electron beam sweeps back and forth across a recording film, laying down a pattern of electrons proportional to the signal being recorded. In principle, this is exactly the way an electron beam creates an image on a TV picture tube. (See Fig. 1).

The recording film is composed of three layers. Over a relatively thick base (approximately as thick as a movie film) is a much thinner strip of an electrically conducting plastic; above this is the thermoplastic layer which has a low melting point. (See Fig. 2).

As the tape moves past the electron beam where it collects the electron pattern, it crosses an electronic heater which induces a current flow in the middle layer. This heats the top thermoplastic layer above its melting point. While the thermoplastic is

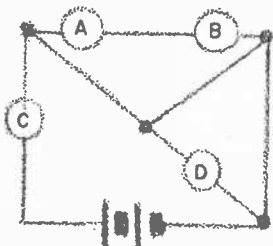
(Continued on page 132)

Find the brightest bulb

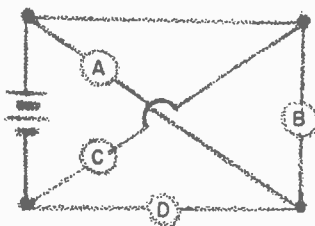


In each of the circuits below, all of the bulbs have the same voltage and wattage rating. In every circuit, however, ONE of the bulbs lights brighter than the rest. Which one is it?

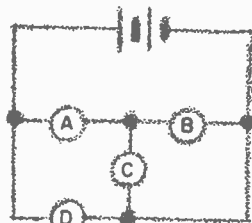
By ROBERT P. BALIN



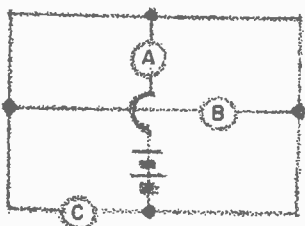
1 (C)



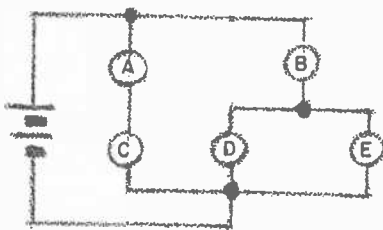
2 (C)



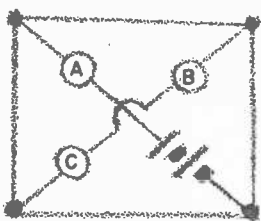
3 (D)



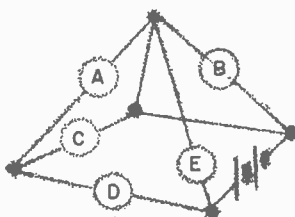
4 (A)



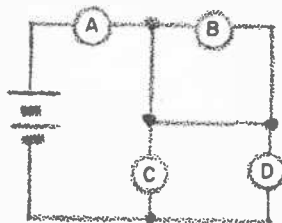
5 (B)



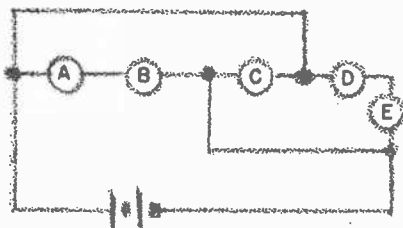
6 (A)



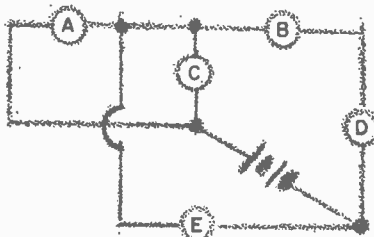
7 (E)



8 (A)



9 (C)



10 (E)

Answers on page 120



Transistor Topics

By LOU GARNER

EACH MONTH, more and more transistorized consumer products are developed as replacements for vacuum-tube designs. In view of this trend, a radio kit recently introduced by the Heath Company

room, den, "rec" room, bedroom, or office. With no dangling cord to plug in, the set can be placed anywhere rather than near an electrical outlet.

Basically a six-transistor superhet using *p-n-p* types in the common-emitter arrangement, the TCR-1 boasts a number of circuit innovations as well as several interesting operating features. It tunes the AM broadcast band from 535 to 1620 kc. and has a standard 455-kc. i.f. Its audio amplifier can deliver a maximum of 300 mw. to its 4" x 6" loudspeaker, more than ample for good room volume. Radio battery life is from 100 to 500 hours, depending on whether standard penlight or mercury cells are used. A separate battery powers the clock; operat-

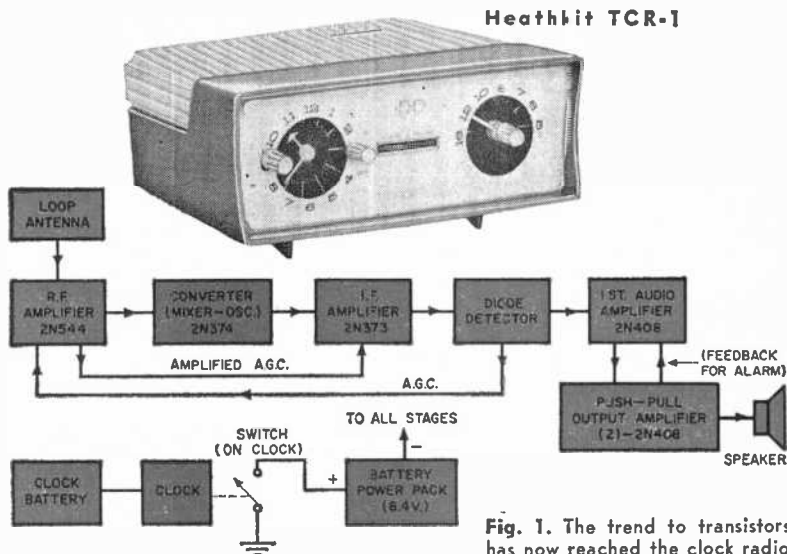


Fig. 1. The trend to transistors has now reached the clock radio with this all-transistor circuit by Heath. One battery powers the radio, another powers the clock.

(Benton Harbor, Mich.) takes on special significance. Dubbed "Your Cue," Heath's TCR-1 is frankly designed as a transistorized *table-model clock radio*. If desired, the set can be converted into an attractive "portable" by fitting it in an optional leather carrying case.

Battery-operated, and hence completely shock-proof, the TCR-1 is as at home in the kitchen or bathroom as it is in the living

ing life is approximately four months, using a mercury cell.

Referring to the block diagram of Fig. 1, the set features a high-gain built-in loop antenna and a tuned r.f. amplifier ahead of its converter stage. This is in contrast to the more common practice of having the

antenna coupled directly to the converter, and it insures better image rejection and overall sensitivity.

Although a single i.f. stage is employed, adequate selectivity is assured by the use of a double-tuned i.f. transformer. The d.c. component of the detected i.f. signal is coupled back to the r.f. amplifier for automatic gain control (a.g.c.); the r.f. stage amplifies the a.g.c. voltage which is then applied to the i.f. stage.

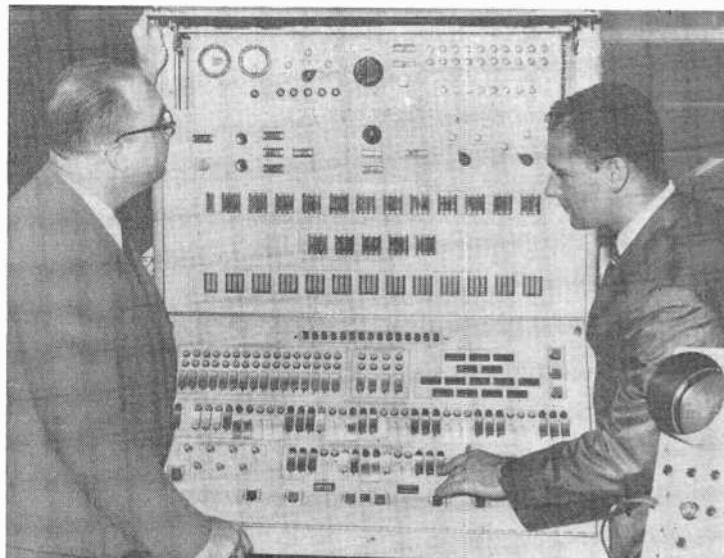
The audio signal from the detector is applied through the receiver's volume control

and waken to either music or an alarm. In addition, an earphone jack is provided for personal listening.

From the builder's viewpoint, the TCR-1 is fairly easy to assemble. A conventional chassis and point-to-point wiring techniques are used. The instruction manual furnished is clear and well illustrated with pictorial diagrams.

"MOBIDIC." In the field of computer design, too, the transistor has virtually supplanted the vacuum tube. Few—if any—computers in current manufacture or in the

Transistorized computer console, the "MOBIDIC," is already under production at Sylvania for the U. S. Army Signal Corps.



to an audio amplifier which, in turn, drives a push-pull output stage. The power amplifier is operated Class B to insure minimum battery drain at low volume levels. A special feedback network permits the entire audio amplifier to function as a tone generator, supplying a pleasant "alarm" signal.

The TCR-1's clock-actuated switch allows the user to choose any of several modes of operation, depending on individual preferences. The set can be used as a conventional radio whenever desired. At night, a special "Lull-to-Sleep" control will turn it off automatically after a playing time of up to 60 minutes. The clock can be set to turn the receiver on automatically, supplying either an alarm tone or a radio program. Used in the bedroom, the TCR-1 permits the listener to go to sleep with music

design stage use tubes. Most use transistors, diodes, and other solid-state amplifying and control devices.

One of the most versatile of military computers is Sylvania's transistorized "MOBIDIC" (Mobile Digital Computer)—pronounced, naturally, "Moby Dick." This computer is used extensively by the army for routine business calculations as well as for such battlefield work as logistics, combat surveillance, tactical operations, scientific and analytic computation, map compilation, and determining artillery target assignment.

Readers' Circuits. The circuits in Fig. 2 were submitted by readers from opposite ends of the continent. John Gottcent of 173 Warwick St., Brooklyn 7, N. Y., sent in the circuit given in Fig. 2(A), while the one shown in Fig. 2(B) is the work of Larry

Gorney, K6EBX, of 1536 E. Ave., Q-11, Palmdale, Calif.

At first glance, the two circuits appear similar. Both employ a diode and two transistors; both are designed for operation on a 3-volt battery, both tune the AM broadcast band; both use modified direct-coupling between stages; both require an external antenna for optimum performance; both employ standard magnetic earphones and, finally, both can be assembled using standard commercial components. But with all these similarities, the two circuits are nonetheless very different in operation.

Referring, first, to Fig. 2(A), we see that John's receiver consists of a conventional LC tuned circuit followed by a two-stage RC-coupled audio amplifier which uses *p-n-p* transistors in the common-emitter arrangement. Coil *L1* is a standard ferrite loopstick antenna coil (such as Lafayette No. MS-11), *C1* a common 365- μf . tuning capacitor, and *R1* a familiar 1-megohm volume control with s.p.s.t. switch (*S1*). Capacitors *C2* and *C3* are 0.5- μf . and 0.01- μf . units, respectively; 200-volt paper tubulars may be used. Any of several diodes can be employed—the popular 1N34 or, if you prefer, a 1N48, 1N68, or CK705. Transistors *Q1* and *Q2* are both G.E. Type 2N107's. The 3-volt battery, *B1*, is made up of a pair of penlight cells connected in series.

In operation, signals picked up by the antenna are selected by tuned circuit *L1-C1* and applied to the diode detector. From here, the detected audio signal is amplified by *Q1* and coupled through *R1* and *C2* to *Q2*. Additional amplification is supplied by the second stage, with *Q2*'s output driving the pair of magnetic earphones. Capacitor *C3* serves as a high-frequency bypass across the 'phones.

Note that no effort has been made to supply a separate source of bias current for *Q1*'s collector. This current is obtained through *Q2*'s base-collector resistance; hence, *Q2*'s leakage resistance will play an important part in overall circuit operation. In some cases, it may be necessary to interchange *Q1* and *Q2* (identical types are used) or to try different *p-n-p* types for

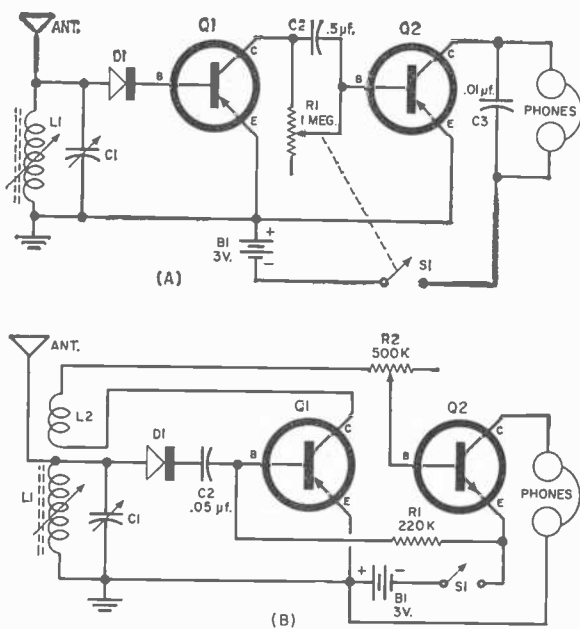


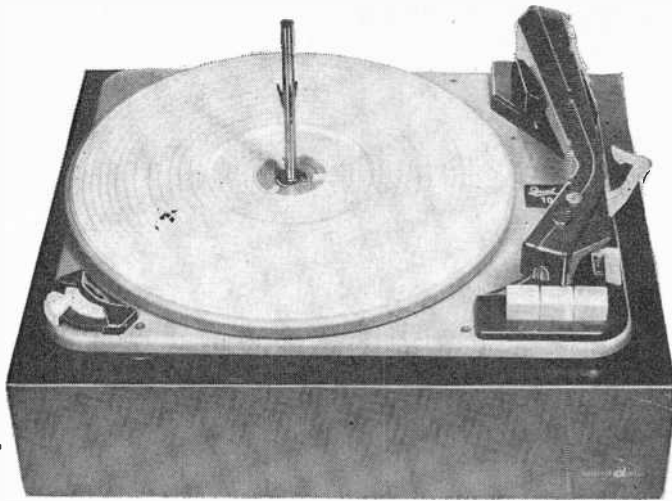
Fig. 2. Diodes serve as detectors in the transistorized receiver circuits submitted by readers John Gottcent and Larry Gorney. Note use of regeneration in Larry's circuit (B.)

Q2 until best performance is attained.

Larry's circuit, in contrast, takes advantage of the complementary characteristics of *p-n-p* and *n-p-n* types of transistors to achieve direct-coupling between stages. Referring to Fig. 2(B), *Q1* is a popular *p-n-p* type (Raytheon's CK722), while *Q2* is Sylvania's familiar *n-p-n* type, the 2N35.

As in the first circuit, *L1* is a ferrite loopstick antenna coil and *C1* a standard 365- μf . tuning capacitor. *L2* is an "extra" winding added to *L1* and consists of 10 to 15 turns of 22- to 28-gauge enamel wire wound on *L1*'s form about $\frac{1}{4}$ " from the coil itself. Larry used a type 1N34A diode, but other general-purpose units will work as well. Capacitor *C2* is a 0.05- μf . paper or ceramic capacitor; working voltage is not critical. Resistor *R1* is a 220,000-ohm, $\frac{1}{2}$ -watt carbon resistor, and *R2* a common 500,000-ohm potentiometer. Any s.p.s.t. switch can be used for *S1*—toggle, slide, rotary, or push-button. As before, the 3-volt battery, *B1*, may be made up of a pair of penlight cells connected in series.

In operation, r.f. signals picked up by the antenna system are selected by tuned circuit *L1-C1*, detected by the diode, and coupled through *C2* to common-emitter amplifier *Q1*. Enough r.f. "spills" through (Continued on page 118)



STEREO-MONO Record Changer

Dual-1006 tracks at two grams, features built-in stylus pressure gauge

THE Dual-1006 is a four-speed stereo record changer that has few equals on the market today. It is one of just two or three record changers whose performance can be compared with that of separate tone arms and turntables. In terms of operation and reliability, the Dual-1006 leaves little to be desired.

The excellent performance of this West German unit results from several factors. First of all, a high-quality four-pole motor is used which has little vibration and noise. In fact, the motor is so quiet that the listener practically has to wrap his ear around it to hear it. And, in contrast to most changers, touching the base plate while the motor is running reveals only a barely detectable vibration.

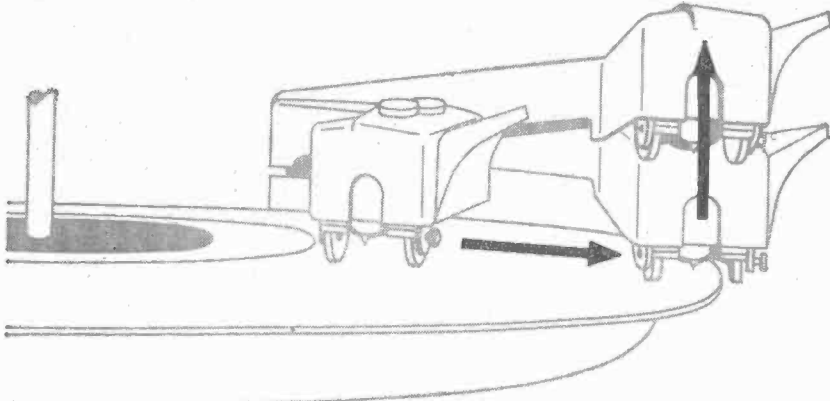
A somewhat more elaborate idler-wheel system than is customary couples the motor to the turntable. While most changers employ only a single idler wheel, the Dual-1006 uses two idler wheels arranged in series. This provides an extra stage of me-

chanical filtering and helps prevent motor vibrations from reaching the turntable.

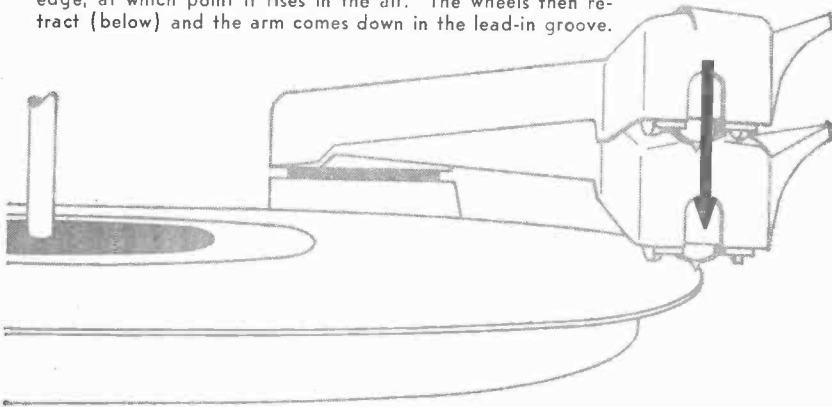
Problems of wow and flutter are largely overcome by the use of a heavy (for record changers) turntable which weighs 3½ pounds. An even heavier turntable weighing 5¼ pounds is an optional accessory for extra-fussy listeners.

This changer has a number of other features that are quite unusual. For instance, the design of the tone arm is such that the Dual-1006 will track with stylus pressures as low as two grams. Incidentally, the unit has a built-in stylus pressure gauge calibrated from 2 to 10 grams.

Perhaps the most unusual aspect of the unit's operation is its system for intermixing records of different sizes. After a record is dropped, the arm swings to the inside of the record. Then it skates across the surface of the record on a pair of tiny wheels until it reaches the edge of the record. At this point, it rises in the air, the little wheels retract into the cartridge shell,



Record-indexing sequence of the Dual-1006. After record is dropped, arm swings to center of record (above). It then skates on tiny wheels across the record until it reaches the edge, at which point it rises in the air. The wheels then retract (below) and the arm comes down in the lead-in groove.

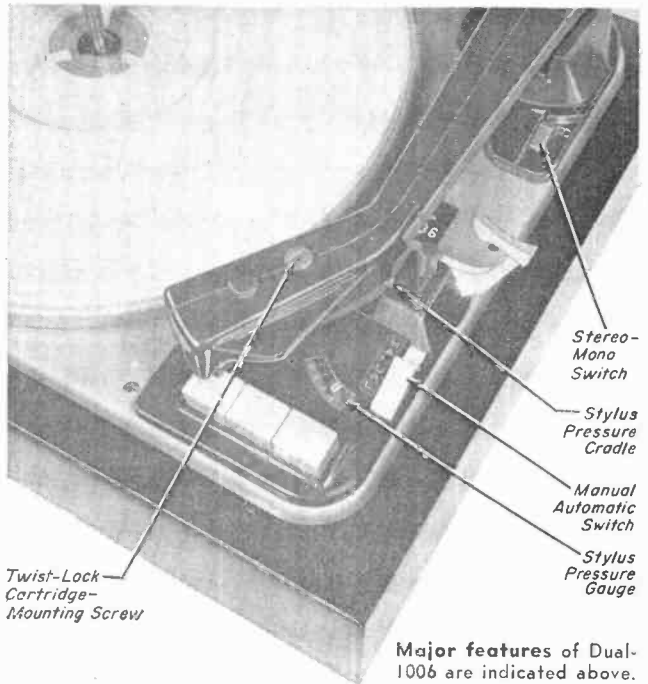


and the arm comes down in the lead-in groove. This operation is diagramed above. The user will probably be unnerved the first time he sees the arm scoot across one of his most treasured records, but the process is harmless.

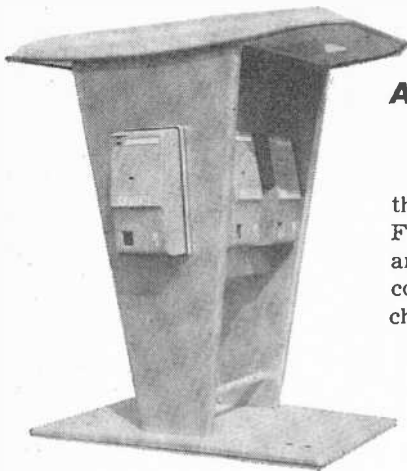
Records can be played manually as well as automatically. A separate manual spindle is included as standard equipment with the unit.

The Dual-1006 seems to be soundly designed and constructed, and it should provide years of eminently satisfactory service. It is imported and distributed by United Audio Products, 12 West 18th St., New York 11, New York.

-30-



Major features of Dual-1006 are indicated above.

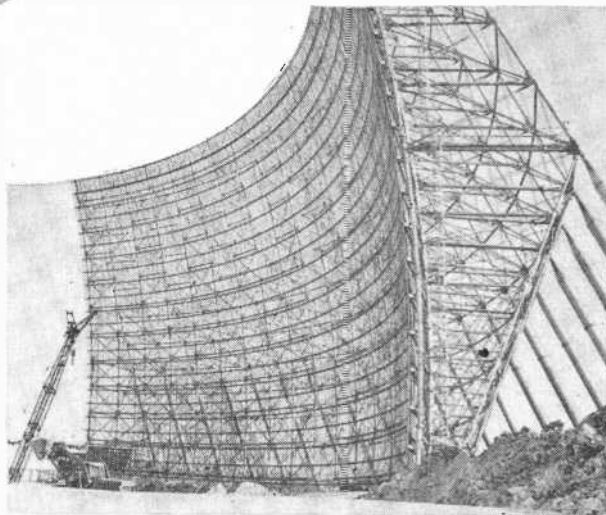


AUTOMATIC POST OFFICE

Electronically controlled miniature post offices like this one are being installed in busy areas throughout France. Each consists of a telephone booth, a mailbox, and a stamping machine which automatically puts the correct postage on a letter and returns the proper change to the customer. (Authenticated News)

GIANT ANTENNA REFLECTOR

This huge antenna reflector, an integral part of the BMEWS missile-warning system, is shown under construction in the Arctic. Built by the D. S. Kennedy Co. under a General Electric subcontract, the structure measures 165' high and 400' long and can withstand a 6" coating of ice in winds up to 185 mph. The BMEWS system is being built at a total cost of about a billion dollars and is expected to provide a 15-minute warning in case of a missile attack on the North American continent.



SOUND TRUCK

A completely self-contained mobile audio system is available from Sound Triumph Co., 8145 Keystone, Skokie, Ill. Its transistorized amplifying equipment operates directly from the truck's 12-volt battery and has an output of 160 watts. There is a continuous-play tape cartridge deck, a four-speed record player, and a wireless microphone. Cost, including truck, is under \$5,000.



INSIDE the Hi-Fi

Tape Recorder

FEW INVENTIONS have had as profound an effect on their fields as the tape recorder has had on communications. Tape recording changed the radio industry, just as it is now changing television. It revolutionized the recording industry and indirectly laid the foundation for the development of high fidelity in the home.

Tape has provided every man with a simple means of recording the events around him which can be expressed in sound. In millions of homes, the tape recorder has taken its place alongside the camera as an instrument of artistic expression as well as a means of providing entertainment and a record of family life.

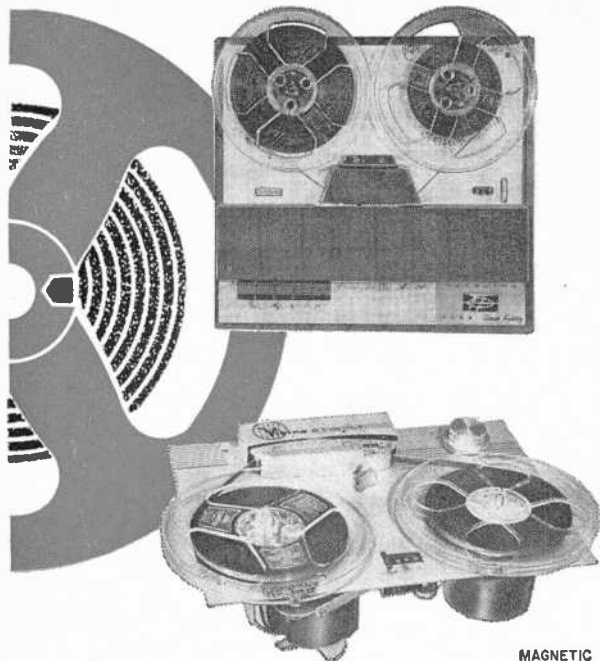
The Recording Process. Tape recording is extremely simple in theory. The recording head of a tape recorder is a nearly circular electromagnet with a very small gap. The electromagnet consists of a coil wound over a laminated core; electric cur-

By **JOSEPH MARSHALL**

rents through the coil cause magnetic fields to build up across the gap. The recording tape consists of a thin film of billions of iron-oxide particles on a plastic base, held in place by a bonding agent.

Suppose we pull the tape across the gap of the recording head at a speed of 30 inches per second while we energize the magnet with an alternating current of 60 cycles per second. Each half-cycle of the signal will produce a magnetic field across the head gap. This, in turn, will cause the iron-oxide particles on the tape to arrange themselves lengthwise on the tape, becoming miniature bar magnets.

Negative half-cycles of the input signal

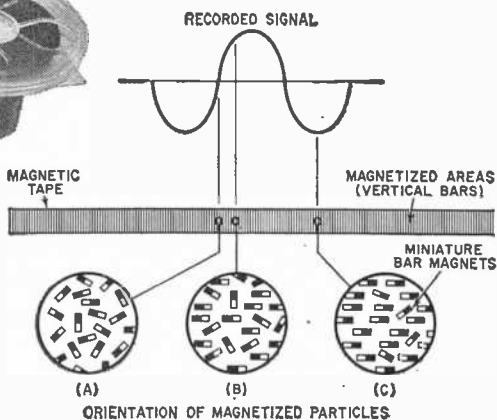


A tape deck is the simplest type of tape-playing equipment. The Telectro 800 (upper left) and the Viking 85 (lower left) are suitable for reproducing four-track tapes through a separate stereo system. Matching electronic units are available which enable the user to make mono or stereo recordings in the home.

will produce magnets which have north poles at, let's say, their right ends, and positive half-cycles will produce magnets with north poles at their left ends. If we record the negative and positive half-cycles of a 60-cps signal on a length of tape moving past the recording head at the speed of 30" per second, a 30" length of tape would have 120 areas of magnetic concentration, or vertical bars.

Because the particles are fixed to the base, the pattern will remain on the tape indefinitely. Now suppose we run this same tape through the tape machine again, but this time without energizing the electro-magnet. As the magnetized areas on the tape pass by the gap, they will produce fluctuating magnetic fields across the gap which, in turn, will induce small currents in the coils of the head's winding. These currents are replicas of the original signal, but much weaker in strength. We could, if we wished, use the same head for both record and playback, but the more professional machines generally use two or more separate heads, each designed for a specific purpose.

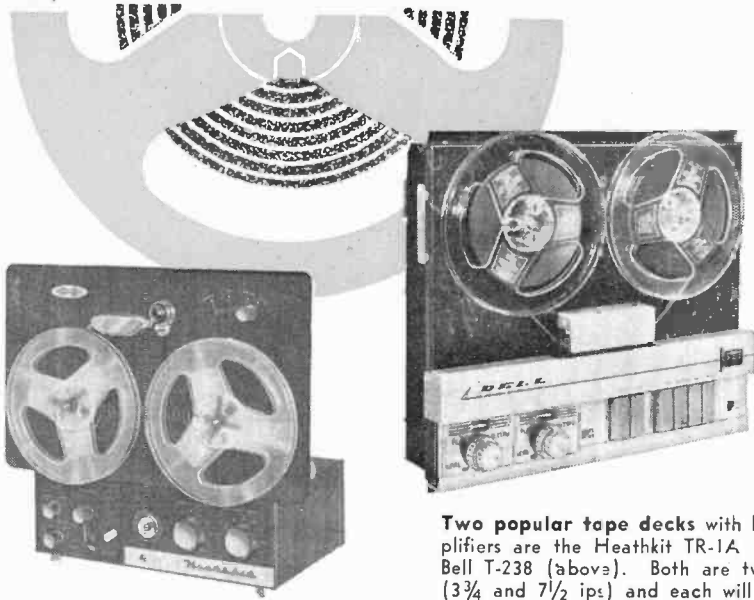
Frequency and Tape Speeds. If we think about this process a bit, two things will become apparent. First, the lower the frequency of the signal that energizes the recording head, the wider the magnetized



Magnetization of the tape varies with the recorded signal. At (A), the signal is at zero and thus the iron-oxide particles are oriented at random. As the signal's positive peak is approached (B), the particles align themselves sideways like miniature bar magnets. On the negative half-cycle (C), the magnets face the opposite direction.

areas, or bars; and the higher the frequency, the narrower the bars. This is obvious because at 60 cycles, for example, each half-cycle would magnetize the tape for 1/120 of a second. Traveling at a speed of 30 ips, about .25 inch of tape would pass over the gap in 1/120 of a second, and thus each bar would be about 1/4" wide. But at 600 cycles, the magnetizing field would last only 1/1200 of a second. Only .025 inch of tape would pass over the gap in that time, and hence each bar would be .025" wide. At 6000 cycles, the field would last only 1/12,000 of a second, and the bars would be only .0025" wide.

It also follows that the slower the tape



Two popular tape decks with built-in preamplifiers are the Heathkit TR-1A (left) and the Bell T-238 (above). Both are two-speed units ($3\frac{3}{4}$ and $7\frac{1}{2}$ ips) and each will take 7" reels.

travels across the recording head's gap, the narrower the bars will be at any given frequency. For example, at 15 ips, the 60-cycle bars would be $\frac{1}{8}$ " wide. At $7\frac{1}{2}$ ips, they would be only $\frac{1}{16}$ " wide.

The important concept to be drawn from these data is that at the higher frequencies the individual magnets on the tape become shorter and shorter, and thus tend to cancel each other—particularly at the slower tape speeds. This means that a reduction in tape speed reduces the high-frequency response of a recorder—assuming that the width of the head gap remains the same.

Rising Response. The other thing that becomes apparent is this: if we use energizing signals of the same amplitude in recording, a 60-cycle signal will produce less output in playback than that produced by a 600-cycle signal and much less than that produced by a 6000-cycle signal. How come? Well, remember that the voltage output of any generator is determined by the total number of magnetic lines of force

which are cut by a magnetic field (and vice versa).

Since the magnetic fields of high frequency signals cross the recording head's gap more rapidly than do those of low-frequency signals, in playback, the 6000-cycle bars will produce stronger signals in the playback head than the 60-cycle bars. This



"Built-in" construction is typified by the Norelco EL 3536 (upper right) and the Tandberg Model 5 (right). Designed for portability, these units also offer three speeds, self-contained playback amplifiers, and a built-in speaker for one channel.



means that a signal recorded at a constant level will nevertheless play back with a 6-db-per-octave boost as the frequency increases.

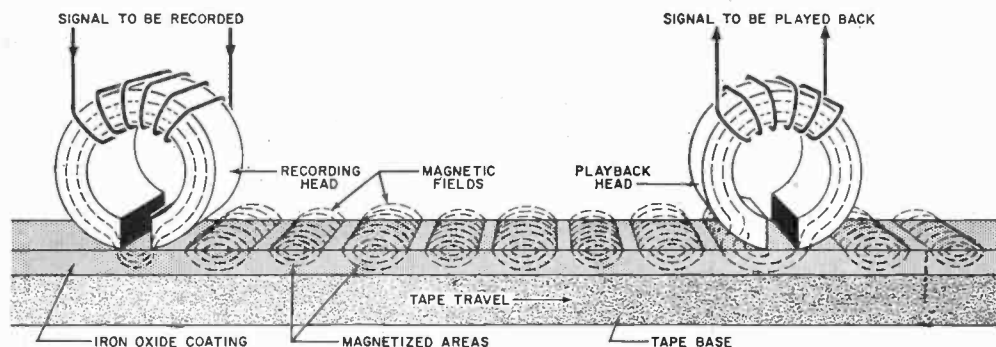
The rising response continues to about 3000 cycles, at which point losses in the playback head cause the high-frequency response to drop off. As you might expect, this characteristic of a rising response and subsequent drop-off necessitates special equalization circuits for proper playback. They will be discussed in a future article in this series.

Playing Times. The German tape recorders brought to this country after the war operated at 30 inches per second. It is

For less critical purposes (voice, dictation, etc.), high-frequency response can be sacrificed, and still lower speeds have come into use— $3\frac{3}{4}$ ips, $1\frac{1}{8}$ ips, and even $\frac{1}{4}$ ips.

There are two other approaches to extending the playing time at a given speed. One way is to make the tape thinner, so that more of it can be put on a reel of a given size. We currently have two types of long-play tapes—one that permits 1800 feet of tape to be put on a 7" reel (extending the playing time by 50%), and a super-thin one that allows 2400 feet to go on a 7" reel (doubling the playing time).

The other way to extend playing time in-



Basic recording process is shown above. The recording head magnetizes alternating areas on the tape in accordance with the input signal. The magnetic fields of these areas then induce currents in the playback head, resulting in an output voltage.

easy to get good high-frequency response at this speed; however, a 1200' roll of tape will give only $7\frac{1}{2}$ minutes playing time at 30 ips. The initial solution to this problem was to reduce the speed to 15 ips. The gap of the playback head had to be narrowed, but it was still not difficult to get response to 15,000 or even 20,000 cycles. Using a 10" reel with 2400 feet of tape yielded 30 minutes' playing time, a convenient length for both broadcasting and recording.

Even so, the 15-ips speed provided only 15 minutes' playing time on the 7" tape reel used by most home recordists. The next step, therefore, was to halve the speed again to $7\frac{1}{2}$ ips. By employing improved heads with narrower gaps, it was possible to get a response to 15,000 cycles at this speed in the best tape recorders, and to 10,000 cycles in recorders for non-professional uses. The 7" reel, together with the $7\frac{1}{2}$ -ips speed, allowed 30 minutes of recording time.

involves recording on less than the full width of the tape. By making the recording and playback heads only half the width of the tape, it is possible to record two separate tracks on the same tape. One track can be recorded on the upper half of the tape, the tape reels reversed, and a second track recorded on the lower half of the tape. In this way, the program available on a given length of tape can be doubled once again. Using the two-track system, a 7" reel of tape can give one hour's recording time at $7\frac{1}{2}$ ips.

Two-track recorders made stereophonic tape recordings possible by recording two tracks at the same time and in the same direction. By 1955 or so, stereo tape recorders became available and most recording companies began to issue stereo versions of their recordings on two-track tape. Stereo tapes boomed until 1958 when the stereo disc arrived and placed stereo tapes

(Continued on page 124)

The



CAPACITOR

What it is

What it does

How it works

The capacitor was invented in 1745 by experimenters who were looking for a way to "condense" and store that newly discovered curiosity, electricity. Although many of their ideas were wrong, they came very close to doing what they set out to do! Today's modern capacitor comes in thousands of different sizes, shapes, and colors. It is of vital importance in the operation of everything from the family car to guided missiles; yet it does exactly the same thing and works on the same principle as its remote ancestor discovered in a laboratory at the University of Leyden over two centuries ago.

By KEN GILMORE

Storing the Charge

- What Is a Capacitor?

A great bolt of lightning crashes to earth with an ear-splitting clap of thunder. This is perhaps the most dramatic demonstration of capacitance at work.

A guided missile streaks into the heavens on a column of flame. Without capacitors doing hundreds of different jobs in its guidance, control, and firing systems, it would never leave the ground.

Your radio and television sets bristle with capacitors used in dozens of different ways. Radio and TV broadcasting stations use thousands of them.

Neither your electric refrigerator nor your car would start without capacitors; your fluorescent lights would remain dark.

Capacitors set off photographers' flash bulbs, help deliver electric power efficiently to your home, automatically start water fountains and open doors as you approach them.

What is this strange phenomenon of capacitance that surrounds us on every hand? How does it work? What causes it? What does it do?

The answer sounds almost too simple. A capacitor is a device that can store an electrical charge. Because of this seemingly modest accomplishment, it can perform an astonishing variety of jobs and is one of the most important of our electrical and electronic servants.

Capacitive Operation

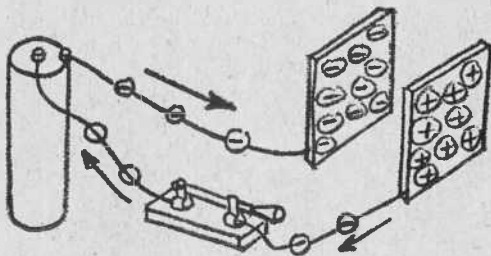
- How a Capacitor Works

Did you ever walk across a carpet on a cool, dry day and feel a spark jump from your fingers to the door knob as you reached to open the door? Whether you knew it or not, your body was one part of a charged capacitor; the walls of the room—including the door and the door knob—were the other part. You built up the electrical charge by walking across the rug. The friction between your

shoes and the rug deposited excess electrons on your body, each one helping to build up a higher and higher *negative* charge. Simultaneously, a *positive* charge of exactly the same strength was accumulating on the walls.

When you got close to the door, the capacitor was discharged. The excess electrons in your body leaped across space between your fingers and the door knob to neutralize the charge.

The capacitor formed by your body and the room is very different from the ones used in radio, but it works in exactly the same way. A radio capacitor is usually made of two or more metal plates, parallel to each other, but not touching. They are charged, not by rubbing them across a carpet (it could be done that way, but there is a better method), but by connecting them to a battery with a switch as shown in the diagram below.

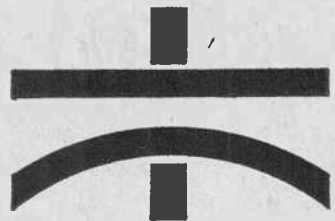


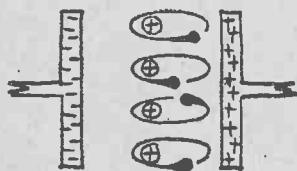
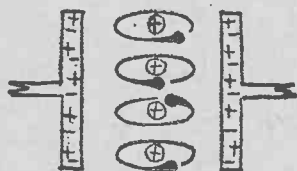
Charging the Capacitor

With the switch open, there is no charge across the plates. When the switch is closed, the battery's positive terminal begins to attract free electrons from the plate connected to it, while at the same time the negative terminal starts to force large numbers of excess electrons *into* the plate connected to it. More and more electrons pile up on the plate, making it continuously more difficult for the battery to force any more on to it. Thus, one plate takes on a negative charge, the other a positive charge.

Soon, the battery has moved all the electrons it can. The flow stops; the capacitor is fully charged. If it were now disconnected and the voltage across it measured, by a very high impedance meter, it would equal the battery voltage.

The capacitor actually stores the energy in its *dielectric*, that is, in the insulating material between the metal plates. The dielectric can be air or any other insulator.





Practical capacitors are manufactured with dozens of different kinds of dielectrics.

This theoretical view shows how the charge is stored. In an uncharged capacitor, the number of free electrons in either plate is the same. The electrons in the molecules of the dielectric can be seen orbiting around their nuclei.

When a charge is applied, the picture changes. The negative plate now has all of the free electrons. Since it is a basic law of electricity that like charges repel each other, and unlike charges attract, the orbiting electrons in the dielectric are repelled by the negative plate and attracted by the positive one. They move as far toward the positive plate as they can, which stretches the molecules of the dielectric out of shape. These misshapen molecules are like springs under tension: they try to pop back to their normal shape.

As long as the charging voltage is applied, they can do nothing. But if a conducting path is supplied between the two plates, the dielectric molecules will snap back, pushing the excess electrons out of the negative plate, and discharging the capacitor.

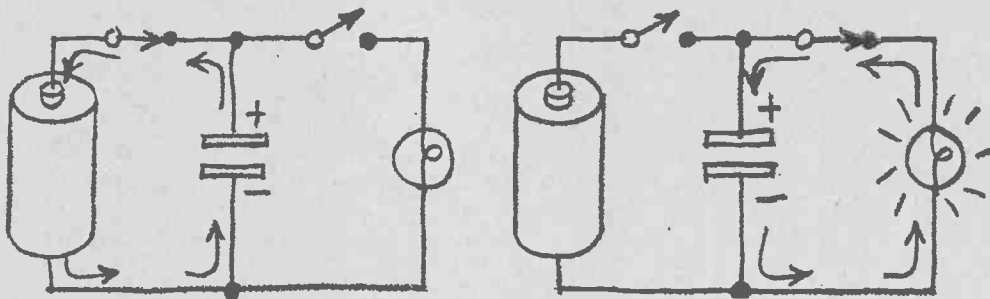
The voltage storing ability of a capacitor is called *capacitance*. You may sometimes hear it called *capacity*, but *capacitance* is grammatically correct.

Firing a Flash Bulb

Of what practical use is a capacitor's ability to store a charge? Photographers use it in one of the simplest and most obvious ways. In one type of flash gun, they charge a capacitor, then connect a flash bulb across its charged plates. All the electrons stored on the negative side try to rush to the positive plate at one time, through the flash bulb. This surge of current fires the bulb. (See the circuits at the top of the next page.)

Why not connect the battery directly to the bulb? This could be done if a large enough battery were used. Such a heavy-duty battery could deliver enough current to fire the flash bulb. But a far lighter, more compact unit weighing only a few ounces can be made to do the same job with the help of a capacitor.

A battery capable of putting out only a trickle



of current—far less than would be required to set off the bulb—can be used. Over a period of time, the trickle builds up a powerful charge across the capacitor, in the same way that a tiny stream of water can eventually fill a large tank. When the capacitor is fully charged, it can deliver a surge of current even more powerful than the heavy battery, and thus easily fire the flash bulb.

Positive and Negative

A great deal has been said about “positive” and “negative” charges. But did you ever stop to think why one pole of a battery is called positive and the other negative? It’s all a mistake, really, because the one we call negative is actually positive, and the one we call positive is..... But maybe we should start from the beginning.

Old Ben Franklin made the original mistake. Nobody knew for sure in which direction current flowed. So Franklin guessed. He named one pole positive, the other negative, based on the reasoning that current went *from* the positive pole, which he visualized as having an excess of current, *to* the negative pole, which had a shortage.

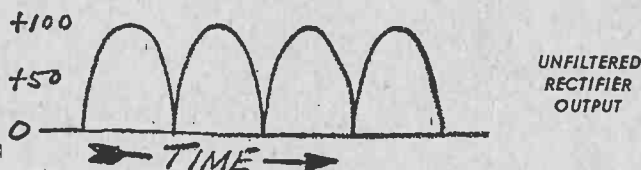
He had a fifty-fifty chance of guessing right, but luck was against him. Many years later it was established that current actually flows in the other direction. By that time, positive and negative terminology was firmly established and it was decided that no change would be made.

Whether the labels are right or wrong, polarity is an important consideration in many capacitor circuits. For example, the electrolytic capacitors used in power supplies will be ruined if they are connected with the wrong polarity.

Capacitors in Power Supplies

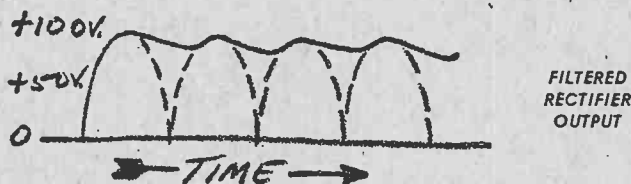
Capacitive "filters" are frequently used in power supplies to smooth out the pulsating d.c. output from an a.c. rectifier circuit, thus allowing 117-volt house current to be converted into direct current.

Without a capacitive filter, a power supply produces pulsating direct current. The current flows in only one direction, but not steadily. A picture of pulsating d.c. from a full-wave power supply looks like this:



But radio and TV receivers need a source of *pure* d.c. that rises to a certain voltage level and *stays* there.

A capacitor connected across the power supply gives just this effect. As the voltage rises to maximum, the capacitor becomes charged. When the power supply voltage falls to zero again, the capac-



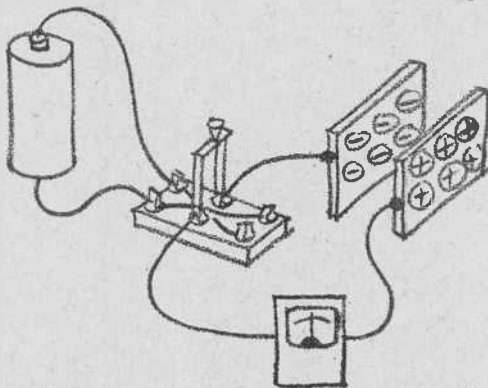
itor begins to discharge, and helps keep the voltage near its maximum level until the following power supply surge, which charges the capacitor again for the next cycle.

You may notice that the voltage does not remain exactly at the maximum level during the capacitor discharge. But if circuit components of the proper values are selected, it stays close enough so that the difference is unimportant.

It is easy to tell when the filter capacitor (or capacitors) in your radio are going bad. As the capacitor starts to fall down on the job, the *ripple* gets bigger and bigger. Soon it begins to affect the operation of the whole set, and you hear a loud hum. As it gets worse, speech and music become distorted or garbled; then a heavy hum is about all you can hear.

The two examples of capacitor use mentioned so far—photo flash and filter—deal with d.c. voltages and currents. But a capacitor's function in a.c. circuits is perhaps even more important. To understand how it works, let's take a look at the two plates and battery setup again. Only, this time, they are connected by a double-pole, double-throw switch, that is, a switch that can quickly reverse the polarity of the charging current applied to the capacitor.

Applications in A.C. Circuits



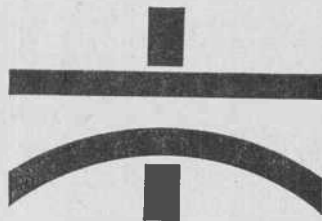
With the switch thrown to the left, the capacitor charges. Open the switch, and the capacitor retains its charge.

The switch is now thrown to the right. This connects the capacitor to the battery again, but with the polarity reversed; the negative plate is now connected to the positive battery terminal and vice versa.

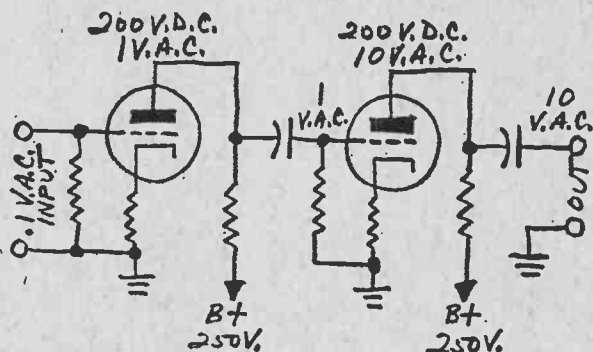
The electrons quickly flow through the battery from the negative plate to the positive one, discharging the capacitor. It then charges again, but this time with opposite polarity. The ammeter shown connected in series with one plate will indicate current flow during this process.

With the switch to the left, the meter will show a current flowing while the capacitor is charging. When the switch is reversed, the meter indicates a current in the *opposite* direction while the capacitor discharges its old charge and takes on the new one. If the switch is thrown back and forth fast enough, the meter will show current flowing at all times—first in one direction, then the other.

Thus, it is clear that even though direct current cannot flow in a capacitor circuit (except during a brief charging period), alternating current can be made to flow continuously by alternately charg-



ing and discharging the capacitor. To put it another way, a capacitor "blocks" d.c., but "passes" alternating current. This ability is put to work in countless ways. Here, for example, is a simplified amplifier circuit that demonstrates the effect.



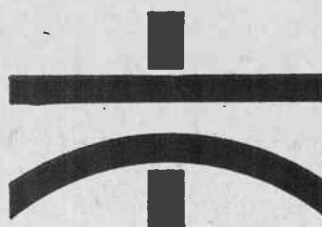
The signal is introduced into the tube's grid circuit, is amplified, and leaves through the plate circuit. For the tube to work, the plate must be kept at a high positive voltage—say 200 volts—while the grid must be slightly negative.

Since electron tubes usually operate with a high positive voltage on the plates and a low negative voltage on the grid, the problem obviously arises: how can the tubes be coupled together plate-to-grid without disturbing their respective d.c. operating levels?

The capacitor is made to order for this job. Since the signal to be amplified is a.c., it will pass through a capacitor easily, while the d.c. operating voltage will be blocked.

A capacitor used in this way is called a *coupling or blocking capacitor*. Either name is correct.

A capacitor's ability to pass a.c. while blocking d.c. is also useful in another kind of hookup. For example, signals frequently appear where they aren't wanted. A capacitor can "short" such an unwanted signal to ground while leaving the circuit's d.c. voltage unaffected. This is called "bypassing."



Versatility Unlimited

- Values, Types, Uses of Capacitors

The capacitor was invented back in October, 1745, by Dean E. G. von Kleist of the Kammin Cathedral in Pomerania. A few months later—in January, 1746—Pieter von Musschenbroek, a professor at the University of Leyden, made the same discovery all over again. Somehow, Musschenbroek got the credit, and early capacitors were called Leyden jars after his university. You may have seen one around a physics laboratory; they're still used at times to demonstrate the principle of capacitance.

The Leyden jar is simply a bottle with about three-quarters of both the inside and outside surfaces covered with metal foil. The two pieces of foil are insulated from each other by the glass dielectric. A brass rod goes through a stopper and makes contact with the inside foil.

Early experimenters used a jar because they were looking for a way to "condense" and store electricity. Since they thought of electricity as a fluid, they figured a jar would be just the thing to hold it. The name *condenser*, which is still frequently used instead of *capacitor*, comes from these early attempts to condense electricity.

Musschenbroek and his associates discovered that if they touched the brass rod of the Leyden jar to an "electric machine" (they had a crude

electrostatic generator), the jar retained a charge. You could get a shock by holding the outer foil with one hand and touching the rod with the other.

Since they couldn't think of much to do with the Leyden jar except stand around and shock each other, they didn't have any need for an accurate system of measuring the stored charge, or the capacitance, of the jar.

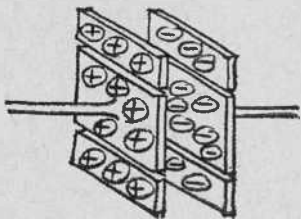
As the science of electricity progressed, it became obvious that a system of measurement was needed. So a basic unit of capacitance was decided on. It was named the *farad*, after Michael Faraday, one of the great electrical pioneers.

A farad represents a specific amount of "storing power" or capacitance. In actual use, the farad turned out to be far too large a unit, so practical capacitors are usually rated in *microfarads* (mf.)—one millionth of a farad, and in *micromicrofarads* (mmf.)—one millionth of a microfarad. (According to one system of notation, a "μ" is substituted for "m" in the abbreviation. Thus, "mf." becomes "μf." and "mmf." becomes "μμf." The meaning in either case is the same.) To put it another way:

1 mf. (or μf.) = .000 001 farads

1 mmf. (or μμf.) = .000 000 000 001 farads

Capacitor Variables



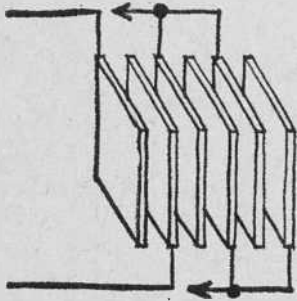
The capacitance of any capacitor is determined by four factors. Let's take a look at each one.

1. *Size of plates.* Large plates can hold a greater charge (more electrons) than small plates.

2. *Separation of plates.* The closer together the plates are (without touching), the greater the charge they can store.

3. *Number of plates.* The more plates, the greater the capacitance.

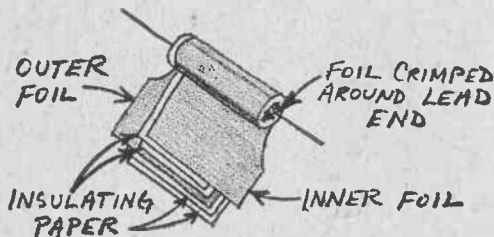
4. *Dielectric constant.* Every different dielectric material has its own dielectric constant. Air has an arbitrarily assigned constant of 1. Mica has a constant of about 7. This means that mica will store about seven times the charge that air can handle, with all other factors the same. Paper has a dielectric constant of about 5, and some types of ceramic over 1000! Different substances have different constants because each molecule has a different "natural elasticity," which allows some to store vastly



greater amounts of energy than others (see page 70). Among frequently used dielectrics are plastics of various kinds, air, mica, and paper.

Here are some of the more common types of capacitors, classified according to dielectric material.

Paper capacitors are made of long strips of aluminum foil, wrapped tightly in a roll, separated by a paper dielectric. To make the paper a better insulator (to prevent breakdown of the capacitor when high voltage is applied to its plates), it is usually impregnated with oil, wax, or plastic.



Plastic capacitors are similar, but use thin sheets of plastic—Mylar and others—as a dielectric. They have the same uses and are about the same size as paper capacitors.

Metallized paper capacitors are another variation of the same basic type. Instead of strips of aluminum foil, this capacitor's plates are microscopically thin layers of metal deposited by an evaporation technique on the dielectric paper. Because the plates are so thin, the capacitor can be rolled into a very much smaller package than a standard capacitor of the same capacitance.

All of these variations of the paper capacitor are widely used in coupling, bypass, and tone control circuits. They are usually tubular, and range in capacitance from about 250 $\mu\text{f.}$ to 1.0 $\mu\text{f.}$ or more. They have voltage ratings up to about 1600 volts—that is, they can withstand 1600 volts without the voltage breaking through the dielectric and destroying the capacitor. Most used, however, are capacitors in the 400-600 volt range.

Minor differences exist between the various types. Plastic capacitors can be built more easily to withstand higher voltages. Metallized ones, as

Types of Capacitors

mentioned earlier, are smaller, and they cost more. With these exceptions, the three types are generally interchangeable.

The printed band around one end of these tubular capacitors tells you which lead is connected to the outer layer of foil. In general, the lead so marked should be connected to the "low" side of the circuit. To put it another way, connect it to ground if possible, or to the side of the circuit electrically closest to ground potential. The band does not indicate the *polarity* of the connections. When a capacitor is used this way, the outer layer of foil serves as an *electrostatic shield*, so that the capacitor's operation will not be affected by other stray fields within the circuit.

Oil capacitors also use a layer of paper as a dielectric; the paper is impregnated with a special type of oil that gives it both a high capacitance and a high voltage rating. They are usually used as high-voltage power supply filters. Capacitance varies from 1.0 $\mu\text{f.}$ to 20.0 $\mu\text{f.}$ or more.

Oil capacitors are usually sealed in a heavy can, and may have a rating of 1000 volts or more.

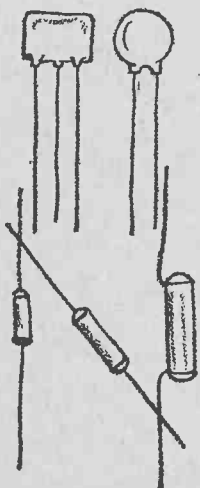
Mica capacitors are made of a number of flat strips of metal (tin, copper, aluminum, etc.) separated by sheets of mica. Alternate plates are hooked together, and the whole assembly is molded into a block of plastic or ceramic material.

They range in capacitance from about 10 $\mu\text{f.}$ to .01 $\mu\text{f.}$ Mica is an unusually good insulator, so capacitors with a mica dielectric can be built with ratings up to 5000 volts or more, and are used in high-voltage transmitting circuits.

Ceramic capacitors, a newer type, use sheets of ceramic as a dielectric. The plates are normally vapor-deposited silver. A ceramic capacitor generally has only two plates—one on either side of a ceramic disc, or one on the outer and one on the inner surface of a ceramic tube.

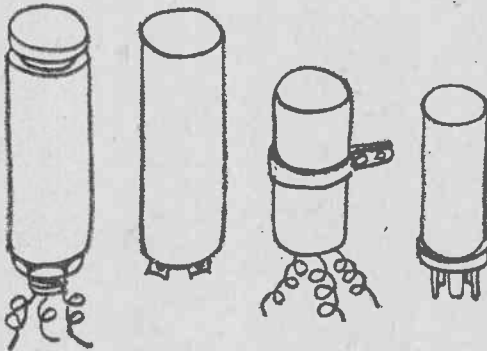
Since ceramic has a very high dielectric constant, up to 1200, relatively large values of capacitance can be obtained with small capacitors. Also, the insulation quality of ceramic is excellent, so these units can easily be designed to operate at several thousand volts. They are widely used in television, military and satellite communications equipment, and other critical circuits.

Advanced manufacturing techniques have



brought the cost of ceramics down to about the same range as paper. They have one disadvantage: they are not as readily available in the larger common values.

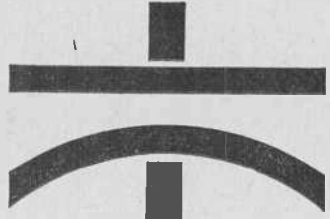
Electrolytic capacitors pack the largest amount of capacitance into the smallest space. They come in sizes up to several *thousand* microfarads, with working voltages up to about 600 volts. The cans an inch or more in diameter and four to six inches long that are mounted on top of almost every radio and TV chassis are electrolytic capacitors. They are usually used as power supply filters.



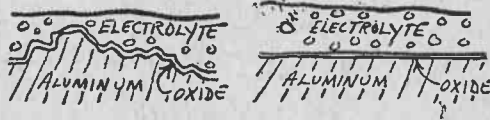
Electrolytics have extremely high capacitance values because the dielectric is only a few millionths of an inch thick. The capacitor is manufactured by dipping an aluminum sheet into an electrolytic solution, and setting up a current flow from the solution to the aluminum. The action of the current builds up a layer of oxide on the plate. When the layer is completely formed, the aluminum is ready to become the positive plate of a capacitor. The dielectric—the oxide coating—is already in place. The unit is sealed in a can filled with a conducting liquid which becomes the negative plate of the completed capacitor.

This is a description of the so-called “wet” electrolytic. There is also a “dry” electrolytic. The only difference is that the “wet” uses an actual solution, while the “dry” has a saturated layer of gauze between the plates. In actual use, the wets have almost disappeared, because dries are more convenient to manufacture, store, and use.

Electrolytics, like most other components, are getting smaller and smaller in this age of miniaturization. A recently developed type—the etched aluminum electrolyte—packs even greater capaci-



tance into a smaller volume by using a plate that has been roughened by chemical etching. A greatly magnified cross section of the etched aluminum would compare with the usual polished surface like this:



Obviously, the etched plate has a far greater surface area exposed to the electrolyte, and consequently has greater capacitance. The etched aluminum capacitor is now on the market, but is considerably more expensive than the ordinary electrolytic. Its extra cost is, of course, well worth the difference in such diverse applications as hearing aids and missiles, where weight and size are very important.

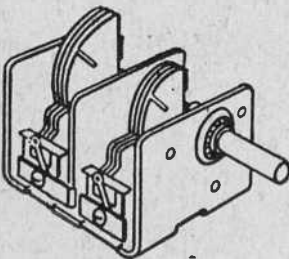
Electrolytics have several disadvantages. One is that leakage current is larger than for any other type. The other is that the electrolytic has a positive and a negative terminal. Therefore it cannot be used where the polarity changes (in a.c. circuits, for example). Great care must be taken to see that it is properly connected. Even a few seconds exposure to the wrong polarity voltage can ruin an electrolytic, or even cause it to explode.

Variable air capacitors are used in every radio for tuning in different stations.

One of the sets of plates is fixed to the frame, and is called the *stator*. The other set, which moves, is called the *rotor*. Naturally, as in all capacitors, the two sets of plates are close together but do not touch. Capacitance is varied by changing the amount the plates mesh. (There are fixed air capacitors, but they are rare.)

Variable air capacitors come in sizes from a fraction of a $\mu\mu\text{f.}$ to 1200 $\mu\mu\text{f.}$ or more. Those used in low-voltage receiving circuits may have 10 to 30 plates separated by less than a hundredth of an inch. Large transmitting types can have 80 to 100 plates, separated by a half inch or more.

Variable air capacitors are frequently *ganged*. This means that several independent capacitors are arranged along one shaft so that they rotate together. In this way, several circuits can be tuned simultaneously.



Although we have only mentioned fixed mica, paper, oil, ceramic, and plastic capacitors, there are variable capacitors which use some of these dielectrics, too. But most variable capacitors have air as the dielectric. The one common exception to this is the small mica "trimmer" capacitor found in most radio receivers. These units, with a capacitance of only a few $\mu\text{f.}$, are adjustable with a screwdriver. They are used in making minor adjustments in circuits where the amount of capacitance is critical. The local oscillator in a superheterodyne receiver, for example, is tuned to an exact frequency with a mica trimmer.

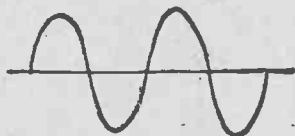
Only the principal types of capacitors have been listed so far. There are many others: vacuum, glass, vitreous-enamel, polystyrene, tantalum, Milinex, and even one with the jaw-breaking name of polytetrafluorethlene. Each has its own advantage and special uses. And some, like tantalum, are becoming more popular.

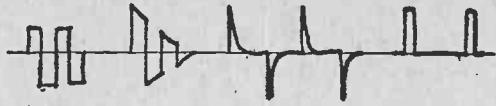
The many ways mentioned so far in which capacitors are used hardly scratches the surface of the jobs to which this versatile component is suited. Every radio, television, or communications transmitter or receiver, for example, must operate on a certain predetermined frequency. The signal sent out by the transmitter must oscillate, or vibrate, at a precise rate—so many times a second. Receivers must be tuned to this exact frequency to pick up the signal. Capacitors play an important part in circuits which determine operating frequency. Vary the capacitance, and the frequency changes. When you tune your radio, you are adjusting the capacitance of the tuning circuits.

Another important duty of the capacitor is waveshaping. The most common waveshape is the sine wave,

The electrical power that comes into our homes is in this form; this is also the shape of an ordinary oscillator's output. But for certain uses—radar, television, telemetering, to name only a few—waveforms of many shapes must be produced.

Willing Workhorse





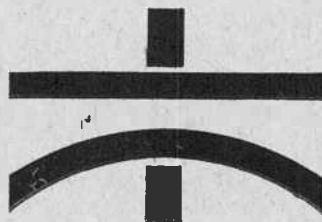
These and thousands of other waveshapes can be formed by hooking capacitors together in different combinations with other components.

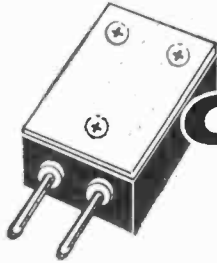
Heavenly Charges

Oh, yes, one more thing. What does capacitance have to do with lightning? In stormy weather, air currents rise swiftly. Particles of water vapor in clouds are swept past other stationary particles, and a charge accumulates by friction, just as it does when shoes rub across a carpet. The charge on the clouds, small at first, builds up rapidly. At the same time, a similar—but opposite—charge builds up on the ground under the cloud. As the cloud races across the sky, the charge moves along the ground with it—it can be measured with the proper equipment.

Higher and higher builds the charge, as more particles of water vapor rush by, each adding to the charge. First, it can be measured in volts, then millions, next trillions of volts from cloud to earth. Finally, the giant capacitor—the cloud forming one plate, the earth the other—“breaks down.” The charge arcs over the insulating dielectric (air) and a blinding flash lights up the heavens. The mammoth capacitor discharges in a brilliant flash of lightning.

Capacitance—the simple ability of two bodies to store an electrical charge—is thus responsible for one of our most useful electrical components, and at the same time, for one of nature’s most spectacular displays.





CRYSTALS

Nearly everyone in electronics makes use of crystals every day—here's why these rock-like plates play such an important role in keeping the world in tune

By **JIM KYLE**, K5JKX/6

AN amateur radio operator, an airline pilot, a police radio dispatcher, a broadcast-station announcer . . . sound like a hodge-podge of job holders? Maybe so, but they have at least one thing in common. All make daily use of the peculiar properties of quartz crystals—thin, glass-like plates that keep the world in tune.

Crystals are found in almost all commercial and ham radio equipment, but few of their users know how they work. Before we examine the details of crystal operation, let's take time out to define our terms. There are three important words involved: *resonance*, *damping*, and *piezoelectricity*.

Resonance means the frequency at which an object will vibrate most easily. Every object has a resonant frequency. Musical instruments—the piano, for instance—are based on this principle. When you strike a key, a hammer hits the piano string, which then vibrates at its resonant note.

Damping means the suppression of an object's tendency to vibrate. The more highly damped an object is, the less readily it will vibrate. In the piano, for example, stepping on the loud pedal removes the damping from the strings. Stepping on the soft pedal damps the vibrations even more than usual.

Finally, *piezoelectricity* is a property shared by several substances. It means that the substance generates a small voltage

across its opposite sides if it is stretched or squeezed. In addition, applying a voltage to opposite sides of a piezoelectric material will deform the substance as long as the voltage is present.

How a Crystal Works. Let's assume that we have a crystal of some piezoelectric substance, and a means of making electrical contact to its opposite sides. Since the crystal has mass, it will have a resonant frequency. If it's jarred—mechanically excited—it will vibrate at that frequency. And if the crystal's damping is light, it will continue to vibrate at its resonant frequency for some time.

But remember that our crystal is piezoelectric. By definition, this means that it will develop a voltage across its opposite sides whenever it's stretched or squeezed. The electrical contacts we've connected to those sides will allow us to utilize that voltage.

If the crystal's size is such that the resonant frequency falls within the r.f. spectrum—and this is ordinarily the case—we have a generator of r.f. energy. But our generator must be jarred to be put into operation, and it will operate only until the vibrations die out. For it to be of use to us, we must make our crystal operate continuously.

The addition of a special vacuum-tube or transistor circuit to amplify a portion of

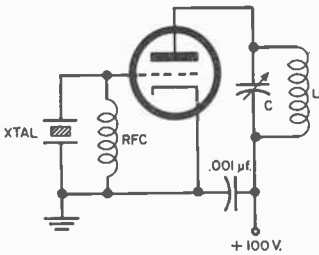


Fig. 1. In a typical oscillator circuit, turning the oscillator on develops a voltage between its cathode and grid, and this voltage shocks the crystal into vibration at its resonant frequency. The vibration in turn develops an alternating voltage across the crystal terminals, which is amplified by the tube. The LC circuit is tuned near the crystal frequency and presents a high impedance in the tube's plate circuit. Consequently, a portion of the amplified voltage is fed back to the crystal and maintains oscillation.

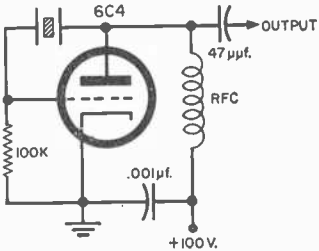


Fig. 2. Pierce oscillator operates at almost any frequency, but uses only fundamental frequency of the crystal. Plate voltage should be as low as possible.

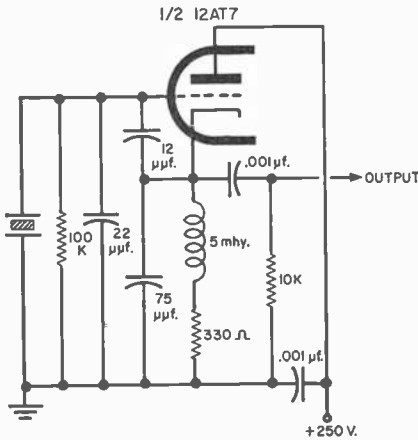


Fig. 3. Colpitts oscillator gives good output on harmonic as well as fundamental frequencies if LC circuit is substituted for the 10,000-ohm resistor.

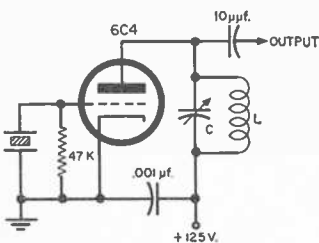


Fig. 4. Overtone oscillator will provide output up to 60 mc. with crystals ground for third-harmonic operation. LC circuit must be tuned to output frequency.

the crystal's developed voltage and then feed it back to the crystal will keep the crystal operating indefinitely. Such a circuit is called an oscillator and is used to "jar" the crystal electrically at the proper instant to keep its vibrations going. Before looking at several types of oscillator circuits, let's consider the reason for using a crystal at all.

Why Use Crystals? Since oscillators can be built without using a crystal—the ordinary superheterodyne radio receiver and the ham's VFO are good examples — the question arises, "Why bother with crystals?"

Actually, a crystal has only one major advantage over a well-built variable oscillator—stability. A crystal's resonant frequency is determined primarily by its physical size. This means that the frequency of a crystal is relatively unaffected by outside influences.

There are, however, two outside influences which can change a crystal's frequency. One is widely known, the other almost ignored.

The first enemy of crystal stability is heat. Like any substance, a crystal will change in size slightly as it heats or cools—and its frequency is determined mainly by its size. Thus, changes in temperature will be reflected as a drift in frequency.

The effect can be serious. In commercial applications, a crystal is usually kept in a tiny oven, thermostat-regulated to maintain an even temperature. Amateur and experimenters' crystals, in contrast, are designed to remain at a fixed frequency under reasonable temperature variations. But overloading the crystal in an effort to extract the last measure of power from the circuit can push its temperature into the "unreasonable" region.

Even more serious than the heating problem—and far less widely known—is the matter of shunt capacitance. In an ideal situation, the crystal will “see” no load at all across its terminals. But such a circuit is impossible in practice, since the crystal must feed an oscillator in order to operate. And, with the oscillator connected, some capacitance is unavoidable.

This capacitance acts as a load on the crystal, slowing down its rate of vibration and thus lowering its resonant frequency slightly. Depending upon the capacitance in the circuit, a crystal will produce higher or lower frequencies than that specified. Since this effect cannot be avoided, crystal manufacturers assume a standard value of shunt capacitance and build their crystals to give specified frequency when working into that load. For most amateur crystals, the design value is 32 $\mu\mu\text{f}$.

Since manufacturers can't be expected to know the capacitance involved, most of them refuse to guarantee extremely close accuracy unless they can calibrate the crystal in the actual circuit to be used.

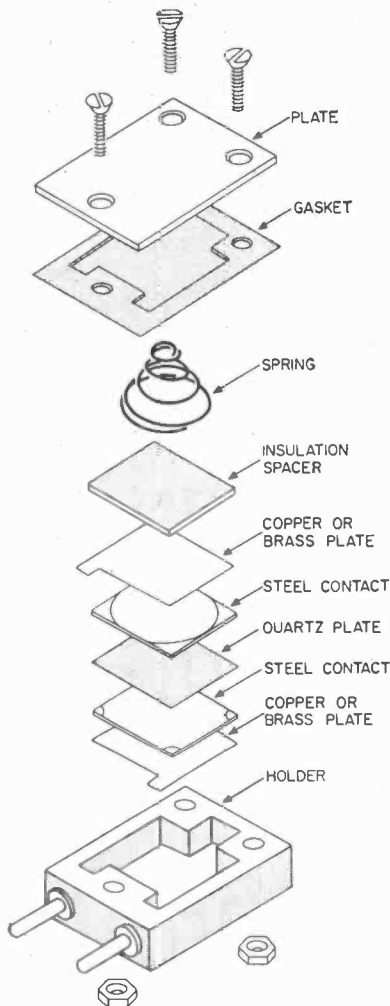
Oscillator Circuits. There are a number of circuits that can be used as oscillators. All have two things in common—a means of amplifying the crystal's output, and a way of feeding some of that output back to keep the crystal oscillating. A typical oscillator circuit (Fig. 1) makes use of the tube's grid-cathode voltage to place the crystal in operation. Because the crystal is in the grid circuit, the tube amplifies its output.

Some oscillator circuits are designed to give output only at the fundamental frequency of the crystal—the frequency of the crystal itself. Others are built to provide the fundamental and integral multiples of the fundamental frequency as well. Such multiples are known as harmonics and have frequencies of two, three, four, or more times the fundamental frequency.

Still a third variety of crystal oscillator is the “overtone” circuit. A major difference between it and a harmonic oscillator is that the overtone circuit produces only one output frequency—the third, fifth, or other *odd* harmonic. A harmonic oscillator, in contrast, produces the entire gamut—the fundamental, the desired frequency, and other harmonics, too.

The Pierce circuit shown in Fig. 2 is typical of a fundamental-frequency oscilla-

(Continued on page 128)



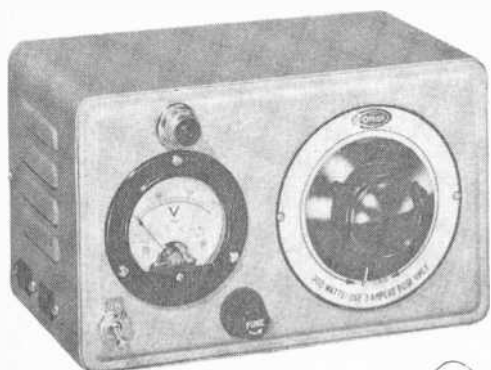
Structurally, the piezoelectric crystal used in radio transmitters consists of a thin plate of Brazilian quartz about 1/2" square. There is a contact on either side, and the entire unit is enclosed in a container for protection. The contacts are held in position against the crystal by spring pressure, or, sometimes, they are plated onto the surface of the quartz. Each contact is then connected to one of the base pins.

Variable A.C. Supply

*Inexpensive Olson Radio T-266 kit
places line voltage control at your fingertips*

VARIABLE a.c. voltage supplies have helped put more than one kit or construction project on the road to proper functioning. What's more, they can be a valuable aid in radio-TV trouble-shooting.

The T-266 supply kit shown here is available from Olson Radio Corp., 260 S. Forge St., Akron 8, Ohio, for only \$15.95. An evening's work should complete it, with plenty of time left over for equipment testing. The supply uses an autotransformer to vary its output between 0 and 150 volts. It is fused for safety and has a built-in volt-



meter connected across its output.

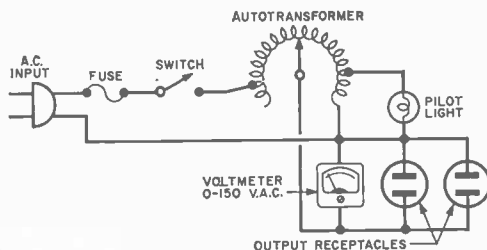
In use, the variable supply is plugged into an a.c. line, and the equipment is plugged into the variable supply. With the equipment connected in this manner, the on-off switch on the supply will also turn the equipment on and off. And, once connected, you have an a.c. supply that stands ready to vary its output over a 150-volt range at a twist of the control knob.

The T-266 has two a.c. outlets to permit powering two pieces of equipment at the same time. Both outlets supply the same voltage, since the two are in parallel. Total current capacity is 300 watts, so the drain imposed by the equipment under test shouldn't exceed this amount.

A variety of testing operations is pos-

sible. By adjusting the supply voltage to a receiver, for example, pin-pointing defective resistors and capacitors is often a matter of turning a knob. So, too, is detecting a defective oscillator or making circuit voltage checks under the specified a.c. input voltage. You can also use the supply for checking induction motors.

This handy supply has a function other than servicing and testing. If you've ever hooked an a.c. voltmeter across your a.c. line, you may have watched the voltage variations with interest. And if you haven't run a check or two on the a.c. line voltage in your area, you may be in for a surprise. You can't blame the power companies, since most of them do the best they can. The simple fact is that varying line loads result



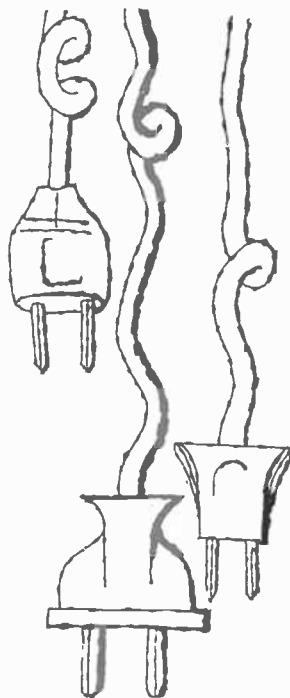
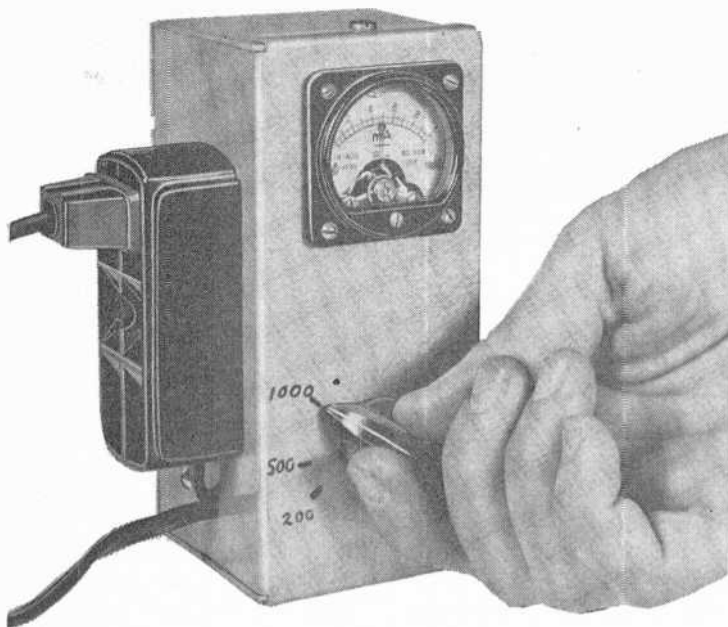
in varying line voltages; in some areas, it's not unusual for line voltages to waver from a low of 105 to a high of

125 volts during a single 24-hour period. For these reasons, your line voltage is probably not the 117 volts engineers assume for equipment design purposes. But feeding equipment with an honest 117 volts is a simple matter with this variable a.c. supply. Again, voltage control is simply a matter of a twist of the knob.

The T-266 kit as supplied was complete in every respect. Instructions were easy to follow. The completed supply is compact (measuring 8" x 4 3/8" x 4 1/2"), and, with its grey finish and balanced panel layout, attractive. The T-266 would seem a desirable adjunct to the experimenter's or serviceman's test bench.

-30-

POPULAR ELECTRONICS



Build your own

Miniature tester spots troubles in home appliances

By FORREST H. FRANTZ, SR.

CHECKING on appliance power consumption from time to time is a wise precautionary measure. With a wattmeter, power-consumption trouble-shooting is a snap.

The wattmeter described here can be constructed in a few hours at a cost of only five to ten dollars. A rheostat-type range control permits calibration of the unit with full scale readings of 200, 500, and 1000 watts.

The entire unit was built in a 5" x 2½" x 2½" aluminum box with a wall-mounting three-way outlet attached to the side of the box. Resistor *R1* was made from a length of Nichrome heater-element wire cut to correct length for a resistance of one ohm. The precise resistance can be measured with a Wheatstone bridge or the lowest ohms scale on a VTVM. If it's more convenient to buy a 1-ohm, 10-watt, wire-wound resistor, you can use a commercial unit instead of making your own.

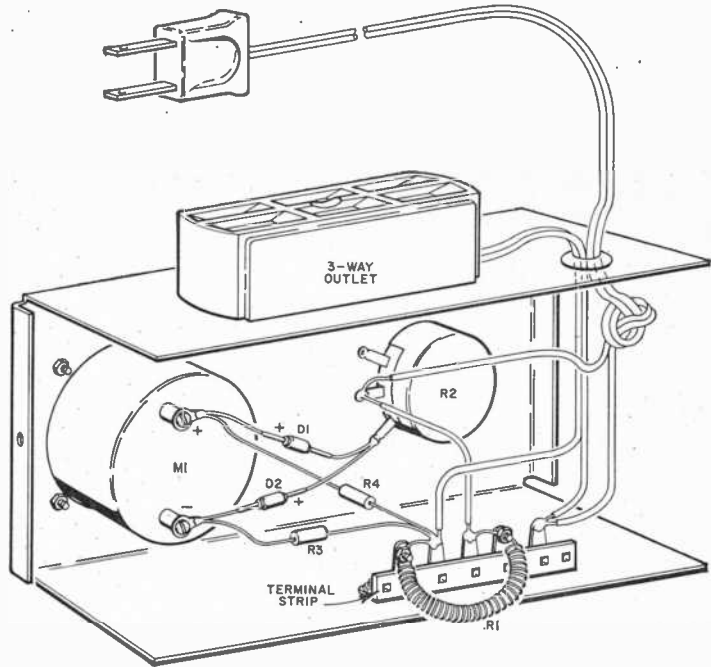
Testing and Calibration. To test the wattmeter, turn potentiometer *R2* to its approximate mid-point. Plug the wattmeter into an a.c. outlet, and plug a lamp containing a 100-watt bulb into the outlet on the wattmeter. Turn the lamp on and rotate *R2* until the meter reads 0.5 ma. Place a mark opposite the knob pointer on the metal box. Label this mark "200," since this is the calibration point for the 200-watt scale.

Now rotate *R2* until the meter reads 0.2. Mark this point

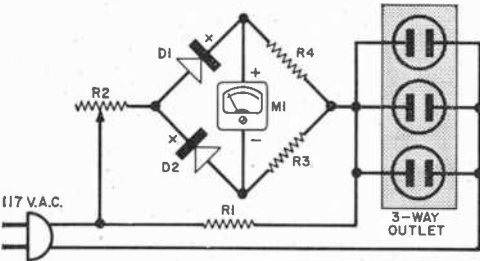
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PARTS LIST

- D1, D2—1N54A diode
- M1—Miniature 0-1 ma. meter (Lafayette TM-400 or equiv.)
- R1—1-ohm, 10-watt resistor (see text)
- R2—10,000-ohm, wire-wound potentiometer (Clarostat series 43 or equivalent)
- R3, R4—1000-ohm, 1/2-watt resistor
- 1—5" x 2 1/4" x 2 1/4" aluminum box (Bud CU-2104A or equivalent)
- 1—5-lug terminal strip (Cinch-Jones 2005 or equivalent)
- 1—Line cord and plug
- 1—Wall-mounting three-way outlet
- 1—Pointer knob
- Misc. screws, washers, nuts, wire, rosin-core solder



Watch polarity of both meter and diodes when wiring wattmeter. Resistor R1 can be made from Nichrome wire or purchased from a supply house.



HOW IT WORKS

Meter *M1* is a 0-1 d.c. milliammeter. Diodes *D1* and *D2* with resistors *R3* and *R4* form a rectifier bridge that converts the a.c. at the bridge input to d.c. for the meter. Potentiometer *R2* is connected in series with the bridge circuit input. These components form an a.c. voltmeter that measures the a.c. voltage drop across *R1*.

Deflection of the meter is directly proportional to the power consumption for a given setting of *R2*. With *R2* adjusted to a low value, the meter will be deflected full scale for relatively low power consumption. As power consumption increases, the voltage drop across *R1* increases. Therefore, *R2* is set to a higher resistance value for testing appliances with higher current drains.

The meter reading in each case (between 0 and 1) multiplied by the range setting (200, 500, or 1000) is the power consumption for the appliance being tested.

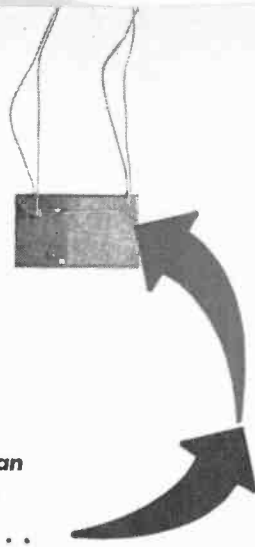
on the case opposite the pointer and label it "500"—the 500-watt range.

Next, plug a 300-watt load (a 300-watt 3-way lamp is ideal) into the meter receptacle in addition to the 100-watt bulb already connected, and adjust *R2* until the meter reads 0.4. Mark the case as before and label this range "1000."

This completes calibration and you're ready to make measurements. But before you begin, here's a note of caution: the Nichrome resistor (*R1*) tends to heat on loads over 500 watts. Therefore, don't leave loads of 500 to 1000 watts connected to the wattmeter for more than a few seconds at a time.

Operation. To check appliance power consumption, simply plug the wattmeter cord into an a.c. outlet and plug the appliance into the receptacle on the wattmeter. As with any meter, it's a good idea to set the range control at maximum and then decrease the range if necessary.

There's probably something wrong with the appliance if the wattmeter indicates 25% or more power consumption above the appliance rating. A short or leakage path is the most common fault. And if the appliance consumes only 75% or less of its rated power, or if the readings are erratic, it's likely that there's a poor connection within the appliance.



A five-watt audio amplifier less than the size of a dime and a two-stage video amplifier much smaller still . . . these are among the first products of an exciting new era, the age of . . .

Molecular Electronics

AT a press conference in Washington recently, a demonstrator connected an ordinary phonograph to a pair of tiny wafers that fitted easily into the palm of his hand. Then he hooked two leads from the wafers to a 15" loudspeaker. When he flipped a switch, music filled the room.

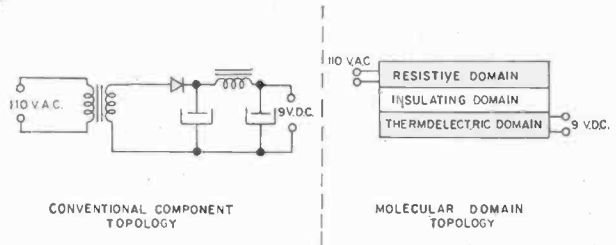
The two little discs that did the man-sized job of amplifying the weak signal from the record player into a hefty five watts of power are striking examples of some of the first triumphs of "molecular electronics," a startling new design concept that promises to revolutionize the entire electronics industry.

Molecular electronics is not just a new advance in miniaturization. It is a radically different approach to electronic design that provides amplifiers, oscillators, and other complete, operating electronic circuits

**By
J. K. LOCKE**



Five full watts of audio power can be obtained from the molecular electronic amplifier at left. In actual use, the tiny unit is installed in a heat sink (black casing in lower photo). Smaller unit in demonstrator's hand is a preamplifier. The amplifying system has an overall response from 0 to 20,000 cps.



Comparison of molecular electronic power converter with conventional circuit. In the molecular circuit, one block of material does the entire job of rectification and filtering. Heat produced by passage of 110-volt alternating current through the resistive domain (top layer) is transferred by the electrically insulating center layer to the bottom layer, which is composed of a thermoelectric material.

without tubes, transistors, resistors, or capacitors.

Although molecular electronics is hardly out of the laboratory, it is already clear that equipment using its principles will be far smaller, lighter, more reliable, and ultimately cheaper than anything available today. One example will illustrate its advantages.

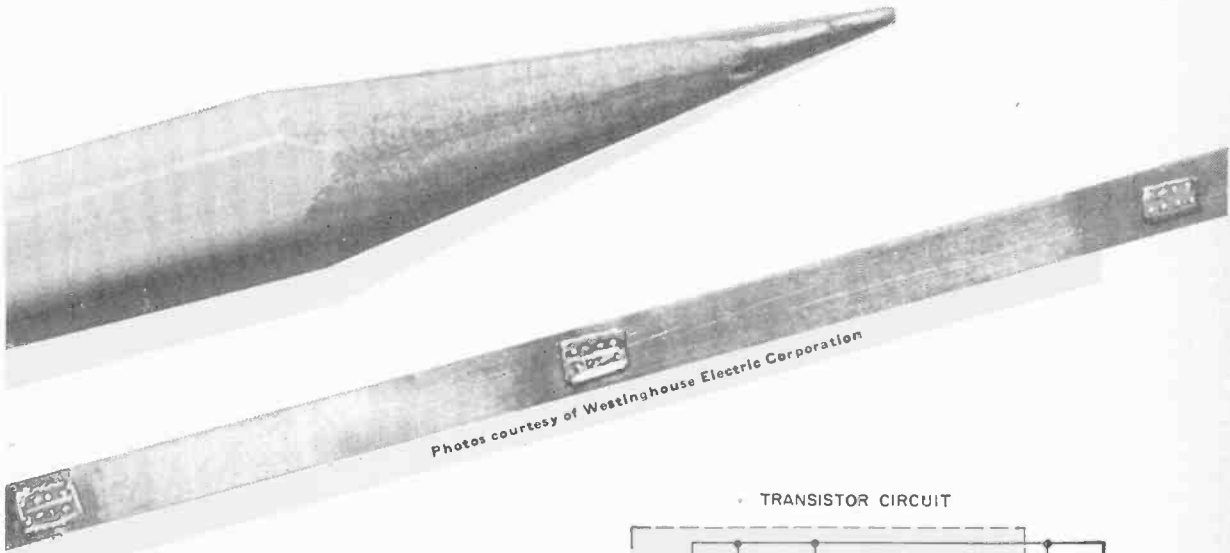
A transistorized i.f. stage for a TV set can be built today to fit into a match box. But molecular electronics has made possible the production of a device that contains *two* such stages and is only a fraction of the size of a single transistor! (See photo on page 89). And the molecular electronic unit operates on only a fraction of a volt—much less than the power required for transistors.

As far as complexity is concerned, a transistorized circuit has perhaps a dozen components and 35 soldered connections, while a comparable molecular electronic circuit only has about two parts and four connections.

Integrated Circuitry. The concept of molecular electronics was developed during the search for better ways to miniaturize electronic equipment. While great strides had been made in designing smaller and smaller individual components, it was obvious that far greater miniaturization and reliability could be achieved if all the necessary electronic properties could somehow be built into a single, solid block of semiconductor material.

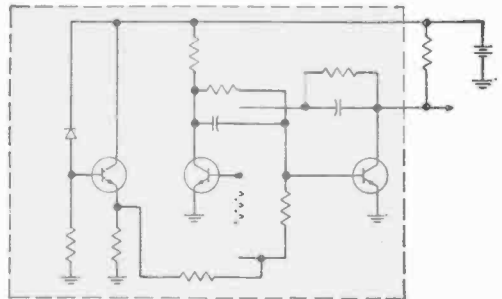
As solid-state physicists gained better understanding of the structure of materials and the flow of electrical charges in them, it became possible to design simple "function blocks" containing, for example, both capacitance and resistance. Later, *n*- and *p*-type materials were added to produce amplification as they do in transistors and tunnel diodes. Finally, scientists were able to produce single bits of material that would function as complete electronic circuits.

The various electrical properties such as resistance, capacitance, and amplification



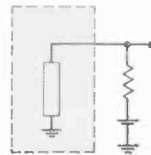
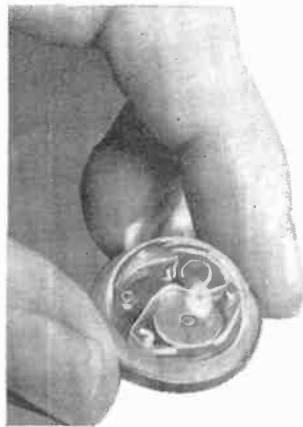
Multiple-junction systems attached to the dendritic ribbon above are complete multivibrator circuits smaller than the point of a pencil. These are some of the first molecular electronic circuits to be produced by entirely automatic machinery. Engineers hope that complete amplifiers, radios, and other more complex circuits will soon be produced automatically.

TRANSISTOR CIRCUIT



MOLECULAR ELECTRONIC CIRCUIT

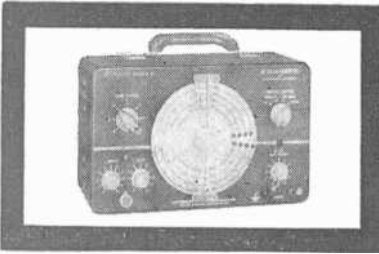
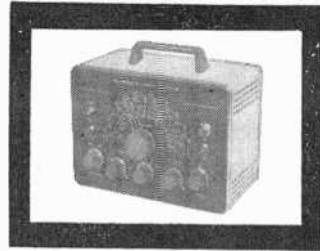
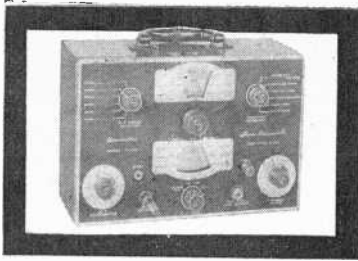
are not localized in any one spot in these function blocks. They are, instead, distributed *throughout* the material. Molecular function blocks—even those as complex-looking as the five-watt audio amplifier with its concentric rings (shown on page 90)—are not put together from a number of different parts. Instead, they are cut from a single tiny chunk of semiconductor material. The block is then etched, alloyed and treated until the desired results are obtained.



Molecular electronics greatly simplifies circuitry. A conventional transistorized circuit for a light telemetry subsystem is shown in upper diagram above, with the equivalent molecular electronic circuit below it. Fewer components and fewer soldered connections will increase reliability of equipment. Unit in photo is the actual molecular electronic telemetry subsystem.

Automatic Production. Engineers are working on the design of machines that will turn out completed circuits automatically. Although only the simplest circuits are now produced by automatic machines, great strides have been made. For example, a method of drawing ribbons of semiconductor
(Continued on page 116)

Test Instruments



the Signal Generator

Part 1

JUST what is a signal generator? Technically, any collection of wires, tubes, resistors, and other assorted electronic gadgetry hooked together to produce an electrical signal could bear this title. But, as it's commonly known, a signal generator is an electronic instrument producing an amplitude-modulated r.f. sine wave for test purposes. To avoid confusion, special-purpose instruments—sweep generators, color-bar generators, audio generators, markers, and so on—are known by their special names, although they, too, are technically signal generators.

Let's take a close look at the standard r.f. signal generator to see how it works.

What It Is and How It Works

By G. H. HARRISON

Figure 1 shows the block diagram of a typical instrument. An r.f. oscillator produces the basic signal. A tuning section (part of the oscillator circuit) allows us to vary the output over a wide range of frequencies. A self-contained a.f. oscillator supplies an a.f. signal to modulate the r.f. signal produced by the r.f. oscillator. A mixer-buffer tube combines the r.f. and a.f. signals and isolates the r.f. oscillator from its load. And, finally, an attenuator circuit controls the output signal level to suit the job at hand.

R.F. Oscillator. Since the key to any generator is its oscillator, let's take a moment to discuss what an oscillator is and what it does. Simply stated, an oscillator is an amplifier with enough positive feedback to set up self-sustaining oscillations. In Fig. 2, the familiar Colpitts oscillator circuit, tuned circuit $L1-C1-C2$, is tuned to the desired frequency of oscillation. For

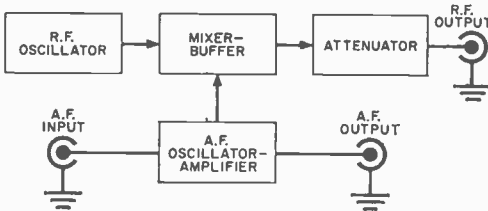


Fig. 1. Signal generator design varies, but a typical unit includes these functions. The a.f. input jack permits alternate source of modulation.

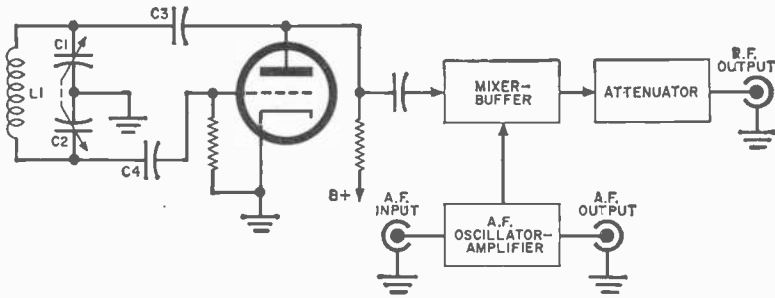


Fig. 2. Colpitts oscillator circuit is often used in signal generators. Capacitor $C3$ provides feedback from plate to grid.

feedback purposes, both grid and plate are connected to opposite ends of the tuned circuit through capacitors $C3$ and $C4$.

The amplified voltage from the plate circuit is fed back to the top of coil $L1$ in phase with the voltage already in the circuit. Because the two voltages are in phase, each complements the other. The increased voltage at the top end of $L1$ is reflected as an increased voltage at the opposite end,

as shown which would tune from, say, 100 to 290 kc. But by substituting another coil in place of $L1$, the same circuit could be made to tune from 280 to 1000 kc. A third coil could extend the range still further, and so on. Figure 3 shows such a circuit as used in the Heath LG-1 signal generator.

One final detail: $C3$ in Fig. 3 is a trimmer capacitor for calibrating the dial. Once set, it needn't be changed again unless parts

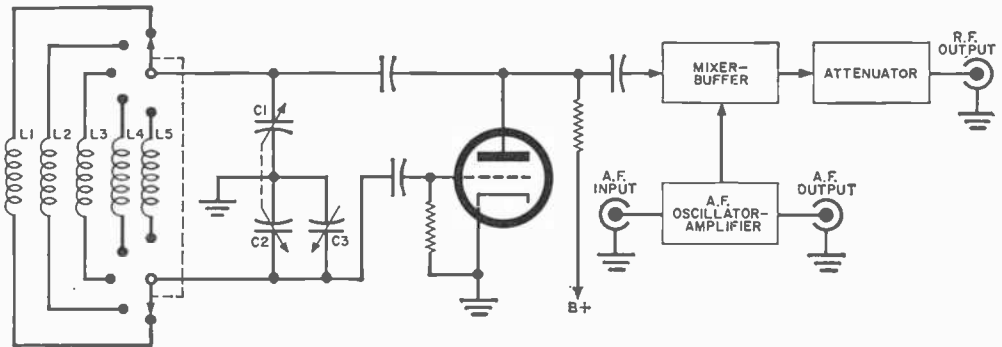


Fig. 3. Switched coils in Heath LG-1 unit provide a wide range of output frequencies. Again, a Colpitts oscillator is used.

which, you'll remember, is connected to the grid. This results in an increased grid input voltage which, since the tube is an amplifier, brings about an even greater signal at the plate. Obviously, our feedback is positive, and, when the amount of feedback becomes large enough, oscillation will occur at a frequency determined by the values of $L1$, $C1$, and $C2$.

Usually, a somewhat more complicated circuit than that shown in Fig. 2 is used in order to cover a wider frequency range. For example, an oscillator could be built

are replaced, or aging causes frequency drift.

A.F. Oscillator. An r.f. oscillator as discussed above is all that is needed for many jobs. But its usefulness can be greatly increased by adding two more circuits—the audio oscillator and the mixer-buffer stage already mentioned.

A simplified diagram of the audio oscillator in the EICO Model 324 r.f. generator appears in Fig. 4. The values $L1$, $C1$, and $C2$ were chosen so that the oscillator would operate at about 400 cps. The a.f. output

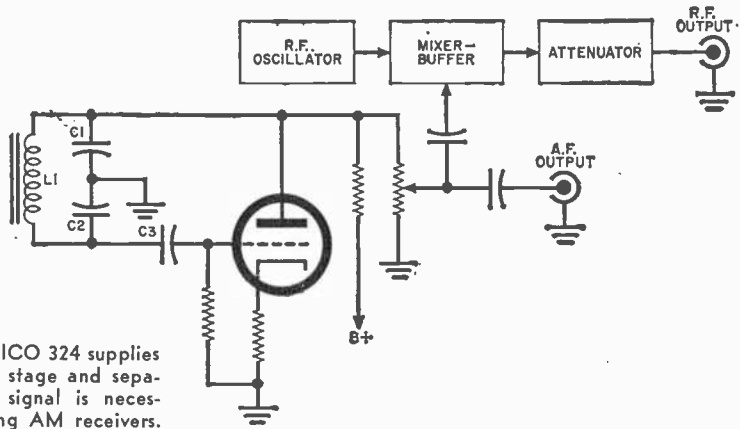


Fig. 4. Audio oscillator in EICO 324 supplies signal to both mixer-buffer stage and separate output jack. Audio signal is necessary for testing and aligning AM receivers.

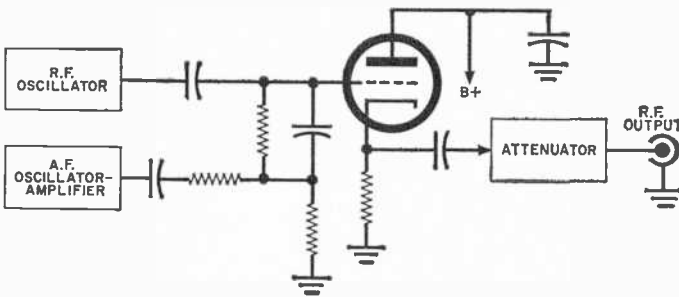


Fig. 5. Mixer-buffer stage in Knight generator combines output of r.f. and a.f. oscillators and serves to isolate the r.f. oscillator from its load.

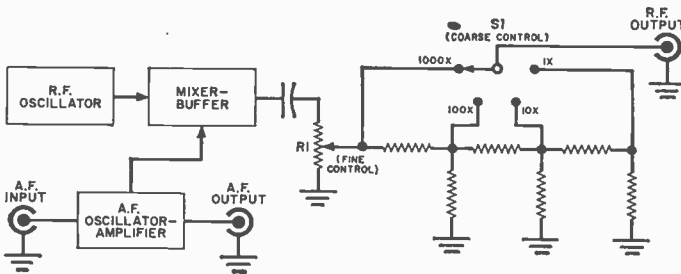


Fig. 6. Attenuator in EICO 315 generator is typical. Potentiometer R1 provides fine control; four-position switch S1 furnishes coarse control.

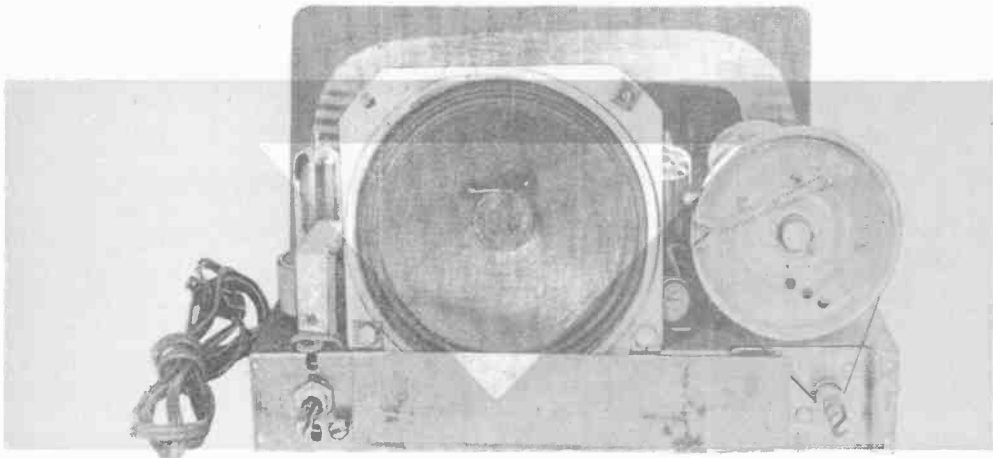
is connected to the mixer-buffer and an a.f. "out" jack on the front panel. This dual connection enables the 400-cps signal to serve two purposes. It can be taken directly from the front panel for trouble-shooting a hi-fi amplifier or the audio stage of a radio. And, since it is also used to modulate the r.f. output of the main oscillator (in the same way that voice and music signals modulate broadcast-station signals), it equips the signal generator with a modulated r.f. signal for aligning and trouble-shooting AM receivers.

Mixer-Buffer. The circuit used to combine the separate r.f. and a.f. signals in a signal generator is known as a mixer-buffer

stage. (See Fig. 5 for the mixer-buffer stage used in the Knight R. F. Signal Generator.) This circuit acts somewhat like a funnel: two separate signals are "poured" in, and one well-mixed signal—a combination of the two—comes out.

As you might guess from its name, the mixer-buffer stage does more than mix r.f. and a.f. As a "buffer," it also serves to isolate the r.f. oscillator electrically from its load (radio, amplifier, or other device under test). Such a stage is necessary because an oscillator is really a rather delicate circuit. An oscillator can be "detuned"—tuned away from its operating frequency—very

(Continued on page 119)



How to Convert a Radio to an AM Tuner

*Simple rewiring job plus low-cost transformer
adapts standard a. c.-d. c. radio
for use with your hi-fi system*

By **DAVE GORDON**

CHANCES ARE that you have an old a.c.-d.c. radio around somewhere that's doing nothing but gathering dust. Here's how to turn that old five-tuber into an AM tuner you can play through your hi-fi system.

Basically, the conversion consists of installing an isolation transformer to prevent shock hazards and removing the radio's present audio circuitry. While the results may not be precisely hi-fi, in most cases you'll be surprised at the quality attained. The complete conversion can be made for about three dollars.

The particular model converted by the author had a tube line-up consisting of a 12BE6, a 12BA6, a 12AT6, a 50C5, and a 35W4. However, radios using 12SA7, 12SK7, 12SQ7, 50L6, and 35Z5 tubes can be handled in a similar manner.

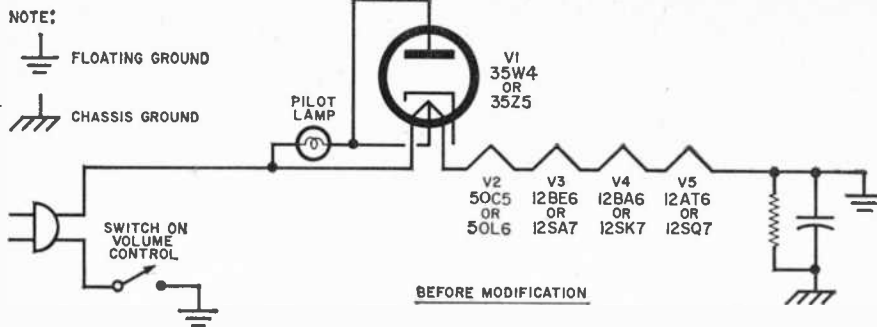
Begin the conversion by removing the set's speaker, output transformer, and 50C5 or 50L6 output tube. Then install the isola-

tion transformer (Lafayette TR-91, supplied with line cord), 125-ohm, 10-watt resistor, and an audio cable as shown on the schematics. When mounting the transformer, be certain to locate it away from any filter capacitor since it runs quite hot.

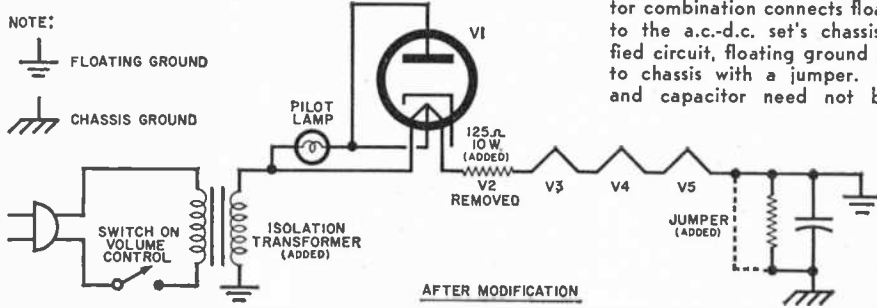
Before rewiring the set, disconnect all leads to the on-off switch on the rear of the volume control. Connect the primary of the isolation transformer to the on-off switch terminals as shown; you will have to cut into the transformer's line cord to make this connection. In wiring the isolation transformer primary, do not ground either of the switch terminals or you will defeat the purpose of the transformer and allow a shock hazard to exist.

Connect one of the transformer's two secondary leads to the chassis. The other lead is connected to the rectifier tube (35W4 or 35Z5).

Locate the 125-ohm resistor on top of the chassis since it will also get hot in opera-



Before modification, a resistor-capacitor combination connects floating ground to the a.c.-d.c. set's chassis. In modified circuit, floating ground is connected to chassis with a jumper. The resistor and capacitor need not be removed.



tion. Run two insulated leads from this resistor through any convenient hole in the chassis and connect them to the heater terminals on the socket of the 50C5 or the 50L6.

At least one jumper should be connected between floating ground and the chassis to reduce hum. The jumper can be connected at the proper volume control lug or between the 12AT6 or 12SQ7 heater and the chassis, as shown in the diagrams, or two jumpers can be used. Choose whichever connection results in the least hum.

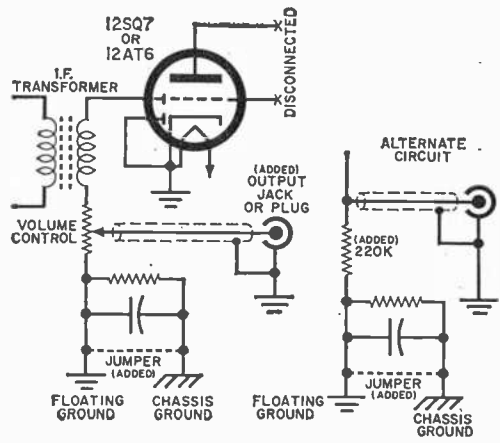
To complete the conversion, connect a 3' or 4' length of shielded output cable to the set's volume control as shown; disconnect the lead already connected to the center lug of the volume control, but do not disturb any of the other leads. If you want to use the volume control on your hi-fi set instead of the one on the receiver, you can connect the output cable to a 220,000-ohm, 1-watt fixed resistor instead. This alternate connection is shown at right.

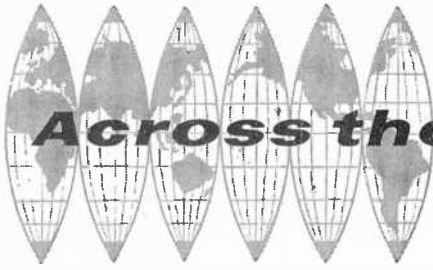
Modified detector circuit shows added output cable and jack or plug, with a jumper connected between floating ground lug on the volume control and the chassis. One or both jumpers must be connected; use the combination which gives the best results.

The output cable should be terminated in a standard RCA phone plug or any other suitable plug. Listening tests made by the author against a commercial AM tuner revealed that the length of shielded output cable used caused no detectable roll-off of the tuner's treble response.

The converted set can be put back in its original cabinet. Or, you can mount it in a new cabinet and add a vernier tuning dial. But whether you do it plain or fancy, a small investment in time and money will pay off with a fine-sounding and fine-performing AM tuner.

-30-





Across the Ham Bands

By
HERB S. BRIER
W9EGQ

HANDLING MESSAGES BY HAM RADIO

THE OTHER DAY a local ham called me on the telephone and said, "Herb, I just received a radiogram from a ham in the W5 call area and I delivered it by telephone. The woman asked me to take a reply, but what do I do with it?"

"Put it in standard amateur message form, report into a traffic net, and start it on its way. Or give it to me, and I'll take care of it," I replied.

"Well, Herb, the woman was so tickled to get the message—it was from her son—that it made me feel good to deliver it. So, if you don't mind, I'd like to finish the job by handling the reply myself, if you'll brief me on how to do it."

Message Forms. This is the way many hams get their introduction to the message-handling phase of ham radio. Besides being fun and a public service, it is the best possible training for supplying emergency

communications in any disaster that disrupts normal communications channels. Consequently, all hams should know at least the rudiments of message-handling.

The following is a sample message in standard message form: *Nr. 1 W9EGQ 12 Gary Ind. 530 pm March 15. Miss June Jones, Women's Residence, Northeastern College, Rockford, Ill. Phone Wo-12345. I will arrive at 400 pm Saturday. Have your dancing shoes ready. Tom.*

The message is divided into four parts: preamble, address, text, and signature. The



Ham of the Month

Our Ham of the Month for April is James "Stu" Craig, W3DBZ, 7406 Dorcass St., Philadelphia 11, Pa. Stu is 22 years old and got his start five years ago at a demonstration of ham radio in a high school "open house."

Before he left the demonstration Stu had decided to become a ham. Two weeks later, he was copying the code at 8 wpm on an old broadcast receiver with a short-wave band. Within a month, WN3DBZ was born!

Stu's first station consisted of a converted ARC-5 "surplus" transmitter and a used National NC-57 receiver. Although he made many contacts as a Novice, he kept studying, and two months later passed his General Class examination.

Besides his intense interest in ham radio, Stu keeps bees! He started this hobby in junior high school, with the encouragement of his English teacher, and he soon had four hives. As his reputation spread, Stu would often be called on by the police, the humane society, and others to remove swarms of bees from public places. This little chore is especially interesting when the friendly bees sometimes turn out to be hornets, yellow jackets, or wasps!

If you live around Philadelphia, listen to "Jimmie Craig's Saturday Nite Dance Time" on Radio WJMJ. Yep. That's our boy, W3DBZ. And when he isn't hamming, raising bees, or MC'ing his radio program, you'll find Stu working at the General Atronics Corp. research laboratory. He is also a part-time radio engineer at WJMJ. The rest of the time he just loafs.

last three items are self-explanatory and are the responsibility of the person sending the message, but you prepare the preamble. It consists of your message number, starting with number one; your call letters; the "check" or number of words in the text of the message; place of origin; and the time and date the message is filed. The preamble is transmitted unchanged by all hams who handle the message.

Some hams omit the check, although it provides a simple way to tell if words have



Tim Hiteman, K8LCV, Parma Heights, Ohio.

been added or omitted in the text in handling a message under unfavorable conditions.

When punctuation is included in the text of the message, it should be spelled out, comma, period, etc., and counted in the check. Some operators use "X" or "x-ray" as a substitute for other punctuation.

Relay to Destination. Some messages are transmitted directly to their destinations over long distances. However, most of them are relayed from station to station in traffic nets until they are delivered. There are literally hundreds of these ham traffic nets. Most of them operate in the c.w. and phone sections of the 3.5- to 4-mc. ham band in the late afternoon and early evening hours, although there are some on all ham bands from 160 through 2 meters.

If you have a message to send, the easiest way to get it on its way is to tune across the ham bands until you hear a net handling messages. Listen to it for a few minutes to find out the call letters of the net control station (n.c.s.) and how the net is operated. Then call the n.c.s. and report your traffic.

Suppose, for example, you are K9OVC,

have a message for Los Angeles, and hear Bob, W9JOZ, calling "CQ QIN" on 3656 kc., the Indiana c.w. net frequency. You would call "W9JOZ DE K9OVC K." Bob would reply "K9OVC DE W9JOZ QRU? K." You would send "QTC 1 Los Angeles." Bob would then probably reply "R QRX," and, in a few minutes, he would tell you to whom to send your message.

If you have only an occasional message to send, it doesn't make much difference which traffic net you report into. All organized traffic nets are interconnected. Therefore, once your message gets into the system, it is routed to its destination.

If you want to become a regular traffic man, you can join your own state c.w. or phone net. If you don't know its operating schedule or frequency, write or—better yet—send a message to the American Radio Relay League, Inc., 38 La Salle Road, West Hartford, Conn., and request a copy of the latest ARRL net directory, which lists all the registered ham traffic nets in the United States and Canada. Also, ask for a copy of the special "QN" signals used on most c.w. nets in addition to the regular Q signals.

Remember when you report into a net that the net control station is "boss" during net sessions. In exchange for handling your traffic, the net will expect you to accept for delivery by mail, telephone, or in person, any messages whose destinations are close to your station. Also, the FCC requires that you keep on file for one year all messages which you handle by ham radio.

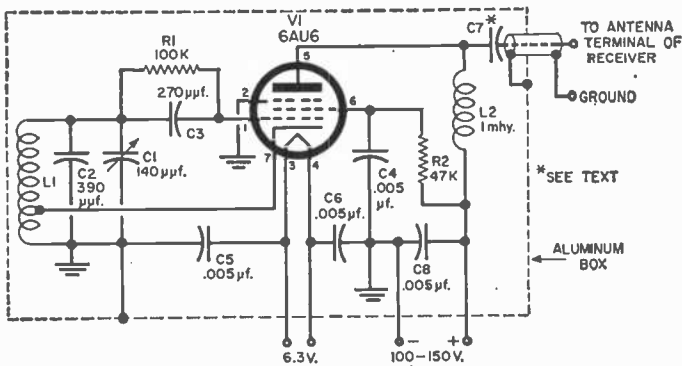
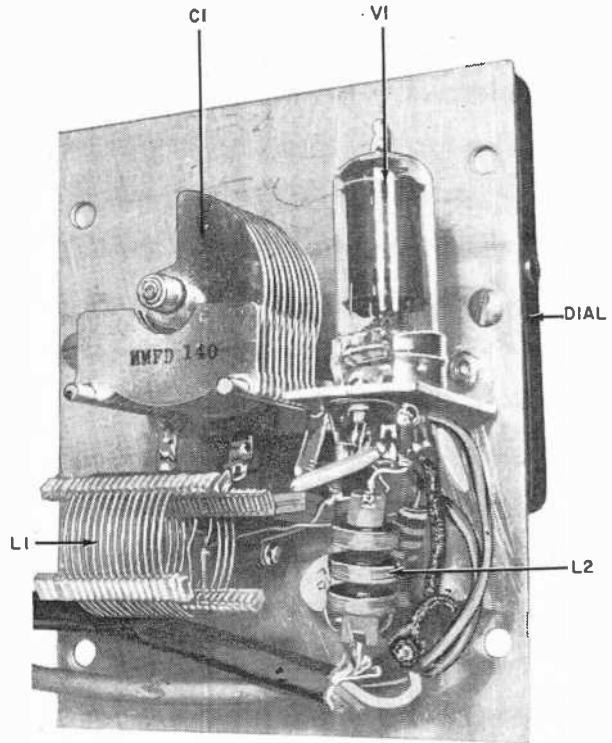
Restrictions. In the United States and its possessions, there are no restrictions on the messages you may handle, as long as they are not obscene and you receive no compensation for handling them. However, international regulations forbid the handling of third-party communications of any kind with foreign countries, whether by messages, "phone patches," or other means, unless special agreements have been negotiated between the governments involved.

Such agreements are in effect between the United States and Canada, Chile, Costa Rica, Cuba, Ecuador, Liberia, Mexico, Nicaragua, Panama, Peru, and Venezuela.* With these countries, we may exchange unimportant messages that would not ordinarily be sent by commercial communica-

* On January 6, 1960, the United States and Haiti signed an agreement in Port au Prince permitting the exchange of third-party communications between the two countries via ham radio. The agreement went into effect February 5.

PARTS LIST

- C1—140- μ f. midget variable capacitor (Bud 1856 or equivalent)
 C2—390- μ f. silver-mica capacitor
 C3—270- μ f. mica capacitor
 C4, C5, C6, C8—0.005- μ f. disc ceramic capacitor
 C7—"Gimmick" capacitor or 1.2- to 10- μ f. variable capacitor (Cardwell PL-6000 or equivalent—see text)
 L1—13 turns of #20 wire, 1" dia., spaced 1/16" between turns, tapped four turns from grounded end (part of B & W 3015 Miniductor)
 L2—1-mh. r.f. choke
 R1—100,000-ohm, 1/2-watt resistor
 R2—47,000-ohm, 1/2-watt resistor
 V1—6AU6 tube
 1—3" x 4" x 5" aluminum box
 1—Vernier dial (Millen 10039 or equivalent—see text)



Simple tuner for single-sideband reception is actually an electron-coupled oscillator which restores the suppressed carrier. It can be operated from a small power supply or the power can be taken from the receiver's accessory socket.

tion channels. Also, we can handle emergency messages with them during failures of commercial channels.

In addition, it is often possible to send messages to and from U. S. military personnel with A.P.O. or F.P.O. addresses. They are routed overseas via the Military Affiliate Radio System (MARS) outside the ham bands.

SINGLE-SIDEBAND TUNER

You can improve the reception of those monkey-chatter single-sideband suppressed-carrier (SSB) signals on your ham receiver by using the simple tuner shown here. It will work on all ham bands up to 29.7 mc.

and operates by restoring the suppressed carrier before the signal enters the receiver. Thus, the SSB signal can be tuned in the receiver like a conventional AM signal.

The one-tube electron-coupled oscillator in the tuner operates in the range between 3.5 and 4.0 mc. with strong harmonics up to 30 mc. Little power is required by the tube and only one connection to the receiver antenna is necessary.

The complete tuner is built into a two-panel 3" x 4" x 5" aluminum box with all components mounted on one panel. Connect coax cable such as RG-59/U between "gimmick" capacitor C7 and receiver antenna.

(Continued on page 126)



Short-Wave Report

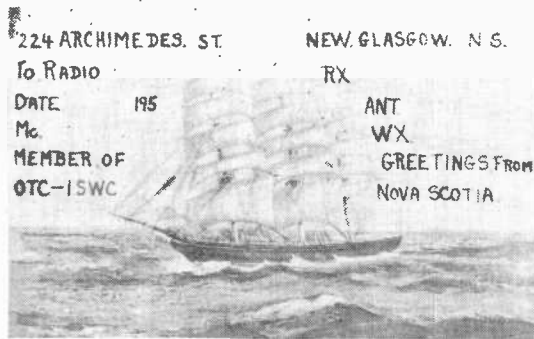
By **HANK BENNETT**
W2PNA/WPE2FT

AN INCREASING NUMBER of inaccurate reports have been received recently by the Far East Network (Japan). According to Mr. Henry Yaskal, Directorate of Engineering for the FEN, reports have also been received for stations which are out of existence. In a letter to your Short-Wave Editor, Mr. Yaskal said, in part:

"We receive reports from short-wave listeners and radio amateurs of many countries. They have a genuine interest in radio and take great pains to be accurate. We consider their reports to be of great value

and are happy to send them our QSL Cards. It would be unfair to them if we also sent cards to those people forwarding unverifiable or down-right dishonest reports."

A second letter from Mr. Yaskal was accompanied by an original report that had been sent to him by one of our POP'tronics Monitors. The report listed the day and time that the station was "heard" and gave program data. But a check into the station log for that particular day indicated that the program "heard" was, in fact, scheduled for another day of the week. Further, the



Fred K. Baines, of New Glasgow, Nova Scotia, sends out reports on the attractive photographic-type SWL card above. Fred is shown at left with his Hallicrafters receiver and some of the QSL cards in his collection.



log showed that the station was *actually off the air on that one day for antenna maintenance*. Further investigation proved conclusively that the Monitor making the report had copied the program information from a previous listing in this column, added a "date" to the report and sent it in.
(Continued on page 135)

THE
INTERNATIONAL



Traveler



It's COMPACT!
It's PORTABLE!
It's TRANSISTORIZED!

A completely new, truly portable, all transistor Transceiver for the Citizens Radio Service. Weighs less than five pounds.

Small but mighty . . . The Traveler packs 12 transistors and a walloping big signal! The perfect communicator in the home, the office, as well as outdoors. Inconspicuous atop the desk. Adjust the special shoulder strap, and it becomes your companion in the field.

Three types of power supplies. (1) Rechargeable battery, complete with charger. (2) Standard dry cell. (3) 115 VAC.

Due to extremely efficient design, the International Traveler provides greater output than any other Citizens transistor transmitter currently on the market.

Special High Frequency transistors are utilized in the transmitter. The receiver's dual conversion superhetrodyne RF circuits use special High Frequency transistors. Provides microvolt sensitivity.

Other features: Noise limiter and squelch, two channel crystal controlled transmitter, two channel crystal controlled receiver.



Your choice . . . Portable case with mobile mounting bracket adjustable shoulder strap, complete with whip antenna and microphone . . . or if you prefer, a beautiful "hand rubbed" wood case* complete with microphone.

Available soon at your International dealer or write for details.

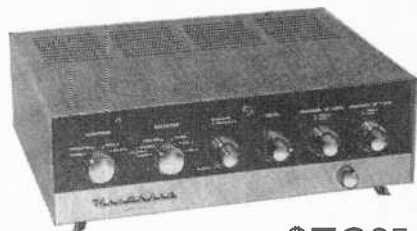
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FROM HEATH... ■■■

14 NEW KITS



AA-50 \$79⁹⁵

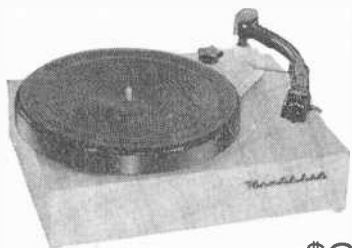
HI-FI RATED 25/25 WATT STEREO AMPLIFIER-PREAMPLIFIER KIT

A complete 25/25 watt stereo power and control center (50 watts mono) . . . 5 switch-selected inputs for each channel . . . new mixed center speaker output . . . stereo reverse and balance controls . . . special channel separation control . . . separate tone controls for each channel with ganged volume controls . . . all of these deluxe features in a single, compact and handsomely styled unit! Five inputs for each 25 watt channel are provided: stereo channel for magnetic phono cartridge (RIAA equalized); tape head input; three high level auxiliary inputs for tuners, TV, etc. There is also an input for monophonic magnetic phono cartridge, so switched that monophonic records can be played through either or both amplifiers. The automatically mixed center speaker output lets you fill in the "hole-in-the-middle" found in some stereo recordings, or add extra monophonic speakers in other locations. Nearly all of the components are mounted on three circuit boards, simplifying assembly and minimizing possibility of wiring errors. 30 lbs.

New Heathkit Stereo Hi-Fi Components . . .

plus Exciting New Kits for the Ham, Technician,

Boating Fan and Hobbyist



AD-10
\$33⁹⁵

MANUAL STEREO RECORD PLAYER KIT

Made by famous Garrard of England, the AD-10 is a compact 4-speed player designed to provide trouble-free performance with low rumble, flutter and wow figures. "Plug-in" cartridge feature. Rubber matted heavy turntable is shock-mounted, and idler wheels retract when turned off to prevent flat spots. Powered by a line-filtered, four-pole induction motor at 16, 33 $\frac{1}{2}$, 45 and 78 rpm. Supplied with Sonotone STA4-SD ceramic stereo turn-over cartridge with .7 mil diamond and 3 mil sapphire styli. Mechanism and vinyl covered mounting base preassembled, arm pre-wired; just attach audio and power cables, install cartridge and mount on base. With 12" record on table, requires approximately 15" W. x 13" D. x 6" H. Color styled in cocoa brown and beige. 10 lbs.



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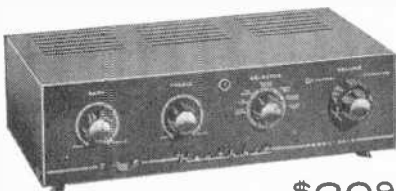
AA-20 \$34⁹⁵



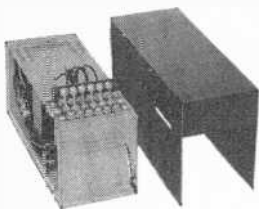
AA-30 \$45⁹⁵



SA-2 \$54⁹⁵



SA-3 \$29⁹⁵



AN-10 \$19⁹⁵

ECONOMY STEREO PREAMPLIFIER KIT

Although these two new Heathkit models are designed as companion pieces, either one can be used with your present stereo system. The preamplifier (AA-20) features 4 inputs in each stereo channel and gives you a choice of 6 functions. It will accommodate a magnetic phonograph (RIAA equalized), a crystal or ceramic phonograph, and two auxiliary sources (AM-FM tuners, TV, tape recorders, etc.) and is completely self-powered. The six-position function selector switch gives you instant selection of "Amplifier A" or "Amplifier B" for single channel monophonic; "Monophonic A" or "Monophonic B" for dual channel monophonic using both amplifiers and either preamplifier; "Stereo" and "Stereo Reverse". 8 lbs.

HI-FI RATED 14/14 WATT BASIC STEREO AMPLIFIER KIT

Two 14-watt high fidelity amplifiers, one for each stereo channel, are packaged in the single, compact, handsomely styled amplifier (AA-30). Suitable for use with any stereo preamplifier or with a pair of monophonic preamplifiers, it features individual amplifier gain controls and speaker phase reversal switch. Output terminals accommodate 4, 8 and 16 ohm speakers. 21 lbs.

HI-FI RATED 14/14 WATT STEREO AMPLIFIER KIT

A tremendous dollar value in the medium power class, this top-quality stereo amplifier-preamplifier combination delivers full 14 watts per stereo channel (28 watts monophonic) to drive your stereo system with ease, while versatile controls give you fingertip command of its every function. In addition to "stereo" and "stereo reverse" functions, the SA-2 provides for complete monophonic operation. Inputs on each stereo channel accommodate "magnetic phono" (RIAA equalized), "crystal phono", "tuner" and high level auxiliary input for tape recorder, TV, etc. Other features include a speaker phase-reversal switch, clutched volume controls, ganged tone controls, filament balance controls, and two AC outlets to accommodate accessory equipment. Handsomely styled in black with inlaid gold design. 23 lbs.

UTILITY RATED 3/3 WATT STEREO AMPLIFIER KIT

Your least expensive route to stereo, the SA-3 delivers 3 watts per stereo channel (6 watts monophonic), adequate for average living-room listening. The high level preamplifier has two separate inputs for each channel and is designed for use with ceramic or crystal cartridge record players, tuners, tape recorders, etc. Featured are ganged bass and treble tone controls, clutched volume controls, channel reversing switch, speaker phase reversal switch and mono-stereo function selector switch. Attractively styled with satin-black cabinet. 13 lbs.

MIXED LOWS STEREO CROSSOVER NETWORK KIT

The AN-10 makes it possible for you to convert to stereo or improve your present stereo system by using just one bass "woofer"; saves buying a second bass speaker, permits using more economical "wing" speakers, improves the bass response of any stereo system. Delivers the non-direction bass frequencies of both channels below 250 cps to a single woofer and passes the higher frequency stereo channels to a pair of wing speakers. Rated at 25 watts per channel. Matches 8 or 16 ohm woofers, 8 ohm high frequency speakers, or Heathkit SS-1-2-3 speaker systems. 10 lbs.

TURN PAGE FOR MORE HIGH QUALITY DO-IT-YOURSELF KITS

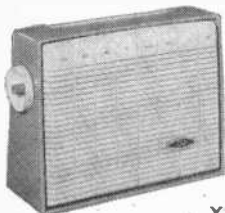


HEATHKIT® GIVES YOU MORE IN THESE TEN WAYS:

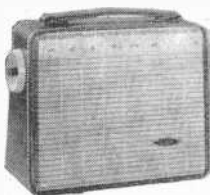
- 1. Building a Heathkit is easy**—Check-by-step instruction manuals make it virtually impossible for you to fail.
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GC-1
\$99⁹⁵
\$10.00 dn., \$9.00 mo.



XR-2P
\$29⁹⁵
(6 lbs.)



XR-2L
\$34⁹⁵
(7 lbs.)

TEN-TRANSISTOR "MOHICAN" GENERAL COVERAGE RECEIVER KIT (GC-1)

An excellent portable or fixed station receiver. Many firsts in receiver design, ten transistor circuit, flashlight battery power supply and new ceramic IF transfilters. The amazing miniature transfilters used in the GC-1 replace transformer, inductive and capacitive elements used in conventional circuits for shaping bandpass; offer superior time and temperature stability, never need alignment, provide excellent selectivity. Telescoping 54" whip antenna, tuning meter, fly-wheel tuning and large slide-rule dial also featured. Covers 550 kc to 30 mc in five bands. Electrical bandspread on five additional bands cover amateur frequencies from 80 through 10 meters. Operates up to 400 hours on 8 standard size "C" batteries. Sensitivity: 10 uv, broadcast band; 2 uv, amateur bands, for 10 db signal-to-noise ratio. Selectivity: 3 kc wide at 6 db down. Measures 6½" x 12" x 10". 20 lbs.

HEATHKIT XP-2. Plug-in power supply for 110 VAC operation of GC-1. 2 lbs. \$9.95



HD-19
\$34⁹⁵



HD-20
\$14⁹⁵

6-TRANSISTOR PORTABLE RADIO KIT (XR-2 Series)

Unsurpassed quality and styling are combined in these handsome sets to provide you with superb and dependable portable entertainment wherever you are—wherever you go! Choose the gleaming, two-tone molded plastic model or the handsome simulated leather-and-plastic combination—both feature a gracefully curved grille in smart beige plastic. The XR-2P complements the handsome grille with a mocha colored case of high-impact plastic, while the XR-2L encases the beige grille in suntan color Sur-U-Lon simulated leather. Vernier tuning control gives you smooth, precise station selection. Six Texas Instrument transistors are used for quality performance and long life; a large 4" x 6" PM speaker with heavy magnet provides "big set" richness of tone. Ready to play after simple assembly—transformers prealigned. Six flashlight batteries used for power (500—1,000 hrs.) (Batteries not included).



HW-19 (10 meter)
HW-29 (6 meter)

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New! One switch operation

"HYBRID" PHONE PATCH KIT (HD-19)

Transfer calls from ham rig to telephone by flipping a single switch! Allows voice control (VOX) or manual operation. VU meter monitors output to 600 ohm line and serves as null depth indicator. Separate receiver and transmitter gain controls. Provides better than 30 db isolation between receive and transmit circuits. All leads filtered to minimize RF feedback. Matches receivers with 3 to 16 ohms impedance. 4 lbs.

NEW 100 KC CRYSTAL CALIBRATOR KIT (HD-20)

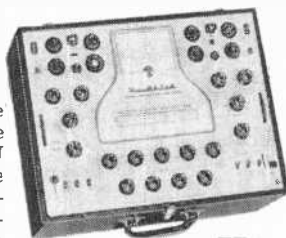
This versatile ham aid provides marker frequencies every 100 kc between 100 kc and 54 mc. Use to align all types of communications equipment. Features transistor circuit dependability, battery power portability, and crystal control accuracy. .005% crystal supplied. 1 lb.

Two brand new models

HEATHKIT 10 & 6 METER TRANSCEIVERS

Complete ham facilities at low cost! Ideal for beginning and veteran hams for local net operations. Transmitter and receiver are combined in one easy-to-use instrument. Features neat, modern styling, press-to-talk transmit/receive switch, built-in AC power supply, variable receiver tuning, variable gain control, and amplifier metering jack. Operates mobile using vibrator power supply. Microphone and two power cables included. Handsomely styled in two-tone mocha and beige. Less crystal.

VIBRATOR POWER SUPPLIES: VP-1-6 (6 volt), VP-1-12 (12 volt). 4 lbs. Kit; \$8.95 each. Wired; \$12.95 each.



TT-1
\$134.95
\$13.50 dn., \$12.00 mo.

MUTUAL CONDUCTANCE TUBE TESTER (TT-1)

The impressive list of its features make this tube tester a fine value. Tests Gm (amplifiers) from 0-24,000 micromhos, Emission, Leakage, Grid current ($\frac{1}{4}$ microampere sensitivity), Voltage regulators (built-in variable DC power supply), Low power Thyatron and Eye tubes. Features 300, 450, and 600 ma constant current heater supplies, life test, Hybrid tube test, built-in switch operated calibration circuit. Large easy-to-read meter, and constant tension free-rolling roll chart mechanism. Individual selector switches allow testing any tube type, regardless of basepin connections, protecting against obsolescence. Assembly simplified by 7 wiring harnesses and transformer terminal board. Assembly skill of technician or higher recommended, time 40 hours average. Black leatherette case with white trim, nylon feet, removable top. 27 lbs.



EDUCATIONAL KIT (EK-1)

Teaches, as you build, the basic "yardsticks" of electronics—opens up fascinating areas of study for youngsters and adults alike. The combination kit and text-workbook gives you a practical demonstration of the principles of voltage, current and resistance; the theory and construction of direct current series and parallel circuits, voltmeter, ammeter and ohmmeter circuits and the application of ohms law to these circuits. The completed meter is used to verify ohms law and the maximum power transfer theorem, one of the most important theorems in electronics. The finished kit, a practical volt-ohm-milliammeter, may be used in a variety of applications. Procedures for checking home appliances and automobile circuits included with the kit. The EK-1 will serve as a prerequisite to following Heathkit Educational kits. Get started NOW in this new and exciting series of "learn-by-doing" educational kits. 4 lbs.



EK-1
\$19.95

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Carl and Jerry

By
JOHN T. FRYE
W9EGV

El Torero Electronico

AS CARL STEPPED through the open door of the electronic laboratory he shared with his pal, Jerry, in the basement of the latter's home, his ears were assailed by a loud, piercing, unwavering tone. It was coming from a hi-fi speaker in one corner of the room, and Jerry was crouched over some electronic equipment directly in front of the speaker.

"What are you doing?" Carl shouted. "This is no day to be messing around in

doors. Spring is busting out all over out there. And shut off that blasted noise!"

Obediently Jerry reached out and shut off the sine-wave generator connected to the input of the hi-fi amplifier.

"I'm experimenting with converting sound energy into electrical energy," he explained. "Look at this sound level chart that appeared in the February 1959 issue of *Electronics World* and at this one prepared by Bell Telephone Laboratories. See: the audio power in peak sounds from a seventy-five piece orchestra is .65 watts. The sound of an ordinary airplane at eighteen feet is better than 20 db, or 100 times more powerful; so it must put out close to 6500 watts of sound. Think how much more sound power is put out by one of those six-engine jets at the air base. When they take off, you can't hear yourself think."

"So-o-o-o?"

"So if I can work out a really efficient way of changing part of this wasted noise into electrical energy, it can be charging batteries and taking some of the load off the plane's generating plant."

"How're you starting out?"

"I'm trying to find the most efficient de-

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1A7GT	3A5	5V8	6AU6GT	6BN6	6C06	6SF7	7B6	12A85	12CN5	21A8	56
1B3GT	JALS	5V4G	6AU5GT	6B06GT	6D6	6SG7	7B7	12A05	12D4	2526GT	57
1C6	38C5	5V6GT	6AU6	6B07	6D66	6SH7	7B8	12A16	12F5	26	58
1C7	38N6	5X8	6AU8	6BR8	6DG6GT	6S17	7C4	12A17	12K7	27	71A
1F4	38Z6	5Y3	6AV5GT	6B58	6D06	6SK7	7C5	12A06	12L6	35	75
1F5	3C86	6A6	6AV6	6BY5G	6F5	6S17	7C6	12A07	12Q7	35A5	76
1G4	3Q4	6AB4	6AW8	6BZ6	6F6	6S07	7C7	12AV6	12S47	35B5	77
1H5GT	354	6AC7	6AX4GT	6BZ7	6H6	6SR7	7E5	12AV7	12S17	35C5	78
1L4	3V4	6AF4	6AX5GT	6C4	6J4	6T4	7E6	12AKGT	12SK7	35W4	80
1L6	4B07A	6AG5	6B7	6C86	6J5	6UR	7E7	12AK7	12SN7GT	35Z5	84/624
1NSGT	4B58	6AHGT	6BA6	6CD6G	6J6	6V6GT	7F7	12A27	12S07	36	11723
1RS	4BZ7	6AM6	6BC5	6CF6	6J7	6W6GT	7F8	12B4	12V6GT	38	
1S5	4C86	6AK5	6BC8	6CG7	6K6GT	6X4	7G7	12BA6	12W6GT	39/44	
1T4	5AM8	6AL5	6BD6	6CH8	6K7	6X5GT	7M7	12BA7	12X4	41	
1U4	5AN8	6AN8	6BE6	6CL6	6N7	6X8	7M8	12BD6	14A7/12B7		
1U5	5AT8	6AN8	6BF5	6CM6	6O7	6X6G	7O7	12BE6	14B6	42	
1V2	5AV8	6AQ5	6BG6G	6CM7	654	7A4/XXL	757	12BF6	14O7	43	
1X2	5AZ6	6AQ6	6BH6	6CN7	657	7A5	7X6	12BH7	19	45	
2AF4	5BR8	6AQ7	6BJ6	6C08	658GT	7A6	7X7	12BQ6	19AU4GT	50A5	
2BN4	5J6	6AR5	6BK5	6CB6	65A7	7A7	7Y4	12BR7	19EG6G	50B5	

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vice for translating sound into electricity without worrying about the actual efficiency percentage of the device. Measuring actual sound power is real tricky even when you have elaborate sound-measuring equipment and a sound-deadened room. By measuring the voltage developed across the eight-ohm voice coil of this speaker by my 1000-cycle tone, I'm setting the electrical power fed into the speaker at exactly one watt. I figure the speaker has an efficiency of between five and ten per cent; so I estimate that the sound power output is only around one-fifteenth of a watt or thereabouts.

"This transducer I'm trying first is a sound-powered phone. As you can see, it's mounted exactly a foot away from the speaker and directly in front of it. These sound-powered phones are designed to be transducers of sound into electrical energy and electrical energy into sound. When two of the units are connected together, sound striking the diaphragm of either moves an attached coil in a strong magnetic field, producing currents in the coil. These induced currents travel along the connecting



wires and flow through the coil of the other unit, causing it to vibrate its diaphragm and produce sound again. Notice that all the power used—and you can carry on conversations up to twelve miles with a pair of these phones—is produced by sound waves.

"Any other transducers I use, such as

Floyd Darknell

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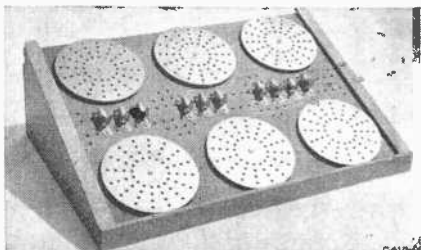
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Be careful before you answer. GENIAC the first electrical brain construction kit is equipped to play tic-tac-toe, cipher and encipher codes, convert from binary to decimal, reason (in syllogisms) as well as add, subtract, multiply and divide. Specific problems in a variety of fields—actuarial, policy claim settlement, physics, etc.—can be set up and solved with the components. Connections are solderless and are completely explained with templates in the manual. This covers 125 circuits and shows how new ones can be designed. You will find building and using GENIAC a wonderful experience: one kit user wrote us: "this kit has opened up a new world of thinking to me." You actually see how computing, problem solving, and game play (tic-tac-toe, nim, etc.) can be analyzed with Boolean Algebra and the algebraic solutions, transformed directly into circuit diagrams. You create from over 400 specially designed and manufactured components a machine that solves problems faster than you can express them.

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I enclose \$..... in full payment.

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- ASTATIC CERAMIC MICROPHONE
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- 3 MODELS—6 Volt—12 Volt—110 Volt

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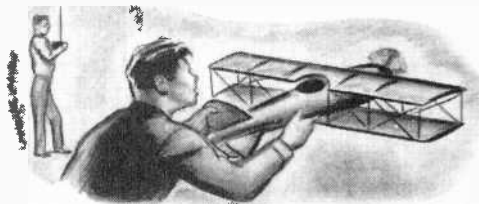
CHICAGO 41, ILL.

sound-powered units working on a slightly different variable-reluctance principle, speakers, crystal units, etc., will be mounted in the same position as this moving-coil unit. They will be subjected to the same dynes per cm² of sound power as long as I keep one watt of 1000-cycle tone feeding into the speaker. This will allow me to compare relative efficiencies by simply taking into account the pickup area of my transducer and noting the electrical power developed across a resistive load. Of course, impedances between the transducer and the load must be carefully matched to develop maximum power. That's what I'm doing now."

"Sounds like a real neat idea, but let's save it for a rainy day," Carl suggested. "Come along and help me try out my brand-new radio-controlled plane. The thermometer is up to 75 out there, and the buds are bursting like popcorn."

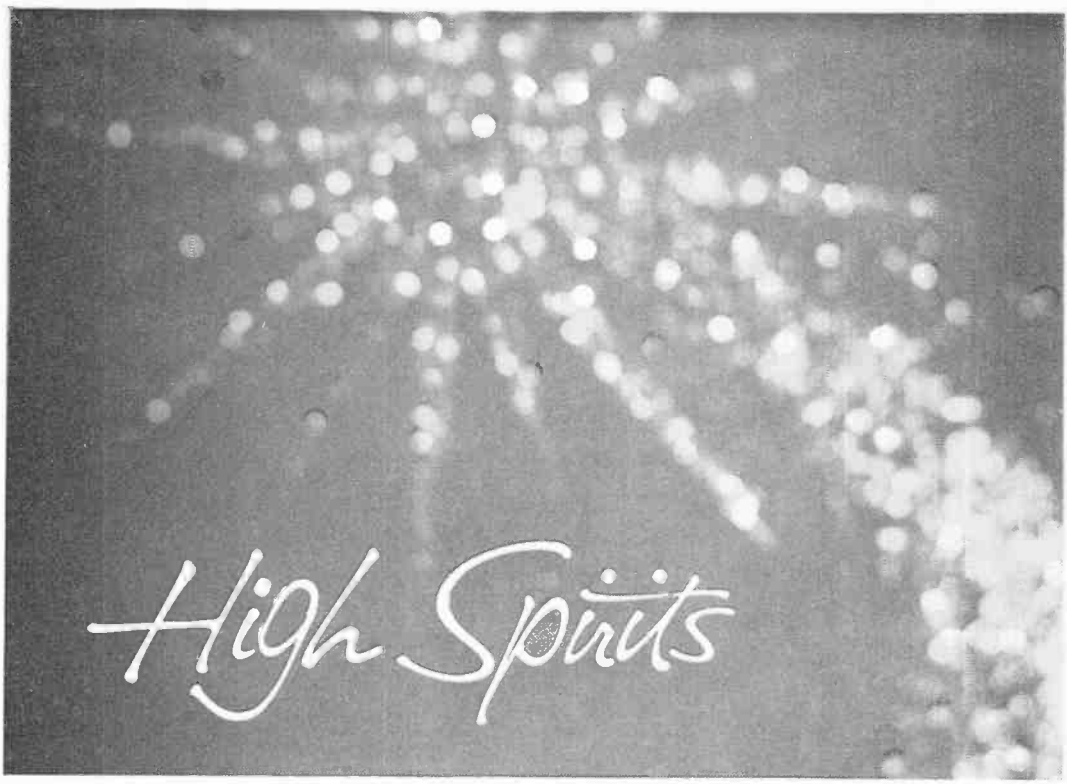
JERRY NEEDED little urging, and a half hour later the boys were parking their bicycles along a narrow dirt road running alongside a large pasture with a single tree growing in the center of it.

Carl's plane was not a sleek modern aircraft. Instead, it was a sturdy old-fashioned biplane model of the sort he had seen crop-dusters using in the South. The large wing area permitted it to stay in the air at slow speed, and an oversize engine gave it lots of power for hedge-hopping tactics. Carl had spent a great deal of time—and no



little money—designing the most responsive and complete remote control possible for maximum maneuverability. It was his intention to fit a smoke emitter in the plane and give a realistic demonstration of dusting procedures at a model airplane meeting coming up in a couple of months.

Carl handled the controls, and Jerry hand-launched the plane. Right from the start it performed beautifully. Carl first sent it high above the pasture to test it out; but when he saw how quickly and smoothly



High Spirits

A happy reel of spirited classics

... available in a special Audiotape bonus package

DETAILS OF THE PROGRAM

"High Spirits" includes these bright selections:

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- Strauss.....from Fledermaus Waltz
- Beethoven...from Symphony No. 1 in C
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- Berlioz.....Rakoczy March

DETAILS OF THE OFFER

This exciting recording is available in a special bonus package at all Audiotape dealers. The package contains one 7-inch reel of Audiotape (on 1½-mil acetate base) and the valuable "High Spirits" program (professionally recorded on standard Audiotape). For the entire package, you pay only the price of two boxes of Audiotape, plus \$1. And you have your choice of the half-hour two-track stereo program or the full-hour monaural or four-track stereo versions. Don't wait. See your Audiotape dealer now.

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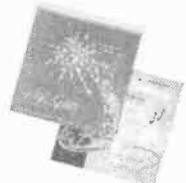
The makers of Audiotape have not gone into the music business. They are simply using this reel to allow Audiotape to "speak for itself."

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Model VT-10
LINE OPERATED

Model VT-1
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WITH LARGE EASY-TO-READ 6" METER
featuring the sensational new
MULTI-PROBE (Patent Pending)

No extra probes to buy! The versatile
MULTI-PROBE does the work of 4 probes

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③ Lo-Cap Probe ④ RF Probe

No longer do you have to cart around a maze of entangled cables, lose time alternating cables or hunting for a misplaced probe. With just a twist of the MULTI-PROBE tip you can set it to function as either a DC Probe, AC-Ohms Probe, Lo-Cap Probe or RF Probe.

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Ideal for use on the test bench. Designed to run cool even under continuous operation... Line isolated.

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Completely portable... Invaluable wherever line connection is undesirable or unavailable... Unique circuitry assures low battery drain.

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DC VOLTMETER... Will measure D.C. down to 1.5 volts full scale with minimum circuit loading, and give accurate readings of scale divisions as low as .025 volts... Will measure low AGC and oscillator bias voltages from .1 volts or less up to 1500 volts with consistent laboratory accuracy on all ranges... Zero center provided for all balancing measurements such as discriminator, ratio detector alignment and hi-fi amplifier balancing.

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RF and LO-CAP MEASUREMENTS... With these extra VT-1 functions you can measure voltages in extremely high-impedance circuits such as sync and AGC pulses, driving saw tooth voltages, color TV gating pulses, mixer output levels, I.F. stage-by-stage gain and detector inputs.



Model VT-10
\$58.50
Net

TERMS: \$14.50 within 10 days. Balance \$11 monthly for 4 months.

Model VT-1
\$58.50
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TERMS: \$14.50 within 10 days. Balance \$11 monthly for 4 months.

FEATURES OF VT-1 and VT-10

- New advanced pentode amplifier circuit
- Large 6" 100-microampere meter, many times more sensitive than meters used in most V.T.V.M.'s
- Simplified multi-color easy-to-read 4-scale meter
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SPECIFICATIONS OF VT-1 and VT-10

- DC Volts — 0 to 1.5/6/30/150/300/600/1500 volts
- AC Volts (RMS and Peak-to-Peak) — 0 to 3/12/60/300/1200 volts
- Ohms — to a billion ohms, 10 ohms center scale — RX1/10/100/1K/10K/100K/1M
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Model CT-1 IN-CIRCUIT CONDENSER TESTER

Here is an IN-CIRCUIT CONDENSER that DOES THE WHOLE JOB! The CT-1 actually steps in and takes over where all other in-circuit condensers fail. The ingenious application of a dual bridge principle gives the CT-1 a tremendous range of operation... and makes it an absolute 'must' for every serviceman.

in-circuit checks:

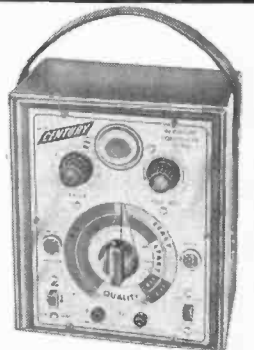
- ✓ Quality of condensers even with circuit shunt resistance... (This includes leakage, shorts, opens, intermittents)
- ✓ Value of all condensers from 200 mmfd. to .5 mfd.
- ✓ Quality of all electrolytic condensers (the ability to hold a charge)
- ✓ Transformer, socket and wiring leakage capacity

out-of-circuit checks:

- ✓ Quality of condensers... (This includes leakage, shorts, opens and intermittents)
- ✓ Value of all condensers from 50 mmfd. to .5 mfd.
- ✓ Quality of all electrolytic condensers (the ability to hold a charge)
- ✓ High resistance leakage up to 300 megohms
- ✓ New or unknown condensers... transformer, socket, component and wiring leakage capacity

OUTSTANDING FEATURES

- Ultra-sensitive 2 tube drift-free circuitry
- Multi-color direct scale readings for both quality and value... In-circuit or out-of-circuit
- Simultaneous readings of circuit capacity and circuit resistance
- Built-in hi-leakage indicator sensitive to over 300 megohms
- Cannot damage circuit components
- Electronic eye balance indicator for even greater accuracy
- Isolated power line
- Deep brushed long lasting etched aluminum panel
- Housed in sturdy gray hammerfone finish steel case... comes complete with test leads

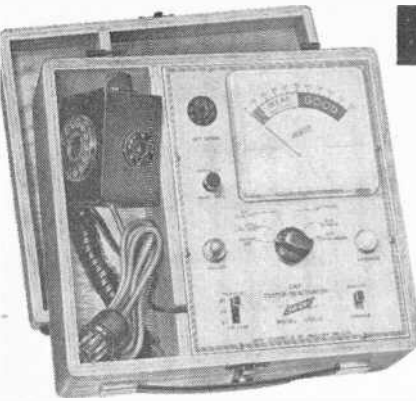


Model CT-1
\$34.50
Net

TERMS: \$9.50 within 10 days. Balance \$5 monthly for 5 months.

10 DAY FREE TRIAL ON CENTURY INSTRUMENTS OF YOUR CHOICE

See for yourself at no risk why thousands of servicemen all over the country selected CENTURY test equipment above all others. Send for instruments of your choice without obligation... try them for 10 days before you buy... only then, if satisfied, pay in easy-to-buy monthly installments — without any financing or carrying charges added.



Model CRT-2 CRT TESTER-REACTIVATOR

TESTS, REPAIRS and REACTIVATES

- ALL BLACK AND WHITE PICTURE TUBES (including 110° tubes) ... from 8" to 30", whether 12 pin base, 8 pin base, 14 pin base ... and the very latest 7 pin base.
- ALL COLOR PICTURE TUBES ... Each of the red, green and blue color guns is handled separately.

CHECK THESE EXCLUSIVE FEATURES

- ✓ THE MULTI-HEAD (Patent Pending) ... A SINGLE PLUG IN CABLE AND UNIQUE TEST HEAD — A tremendous advance over the maze of cables and adapters generally found with other testers.
- ✓ WATCH IT REACTIVATE THE PICTURE TUBE — You actually see and control the reactivation directly on the meter as it takes place. This allows you for the first time to properly control the reactivation voltage and eliminates the danger of stripping the cathode of the oxide coating. It also enables you to see whether the build-up is lasting.
- ✓ CONTROLLED "SHOT" WITH HIGHER VOLTAGE FOR BETTER REACTIVATION — Stronger than any found in other testers — high enough to really do the job — yet controlled to avoid damage to the picture tube.
- ✓ UNIQUE HIGH VOLTAGE PULSE CIRCUIT — Will burn out inter-element shorts and weld open circuits with complete safety to the picture tube.

Housed in hand-rubbed oak carrying case — complete with MULTI-HEAD

Model CRT-2
\$57.50 Net
 TERMS: \$13.50 within 10 days. Balance \$311 monthly for 4 months.

THE CRT-2 DOES ALL THIS RIGHT IN THE CARTON, OUT OF THE CARTON OR IN THE SET

- | | |
|------------|---|
| TEST | <ul style="list-style-type: none"> • For quality of every black and white and color picture tube, employing the time proven dynamic cathode emission test principle. • For inter-element shorts and leakage up to one megohm. Separate short test provided for each element in the picture tube. • For life expectancy. |
| REPAIR | <ul style="list-style-type: none"> • Will clear inter-element shorts and leakage. • Will weld open elements. |
| REACTIVATE | <ul style="list-style-type: none"> • The "SHOT" (high voltage controlled pulse) method of reactivation provided by the CRT-2 will restore picture tube to new life in instances where it was not possible before. The high voltage is applied without danger of stripping the cathode as you always have perfect control of the high voltage pulse. • The "BOOST" method of reactivation also provided by the CRT-2 is used effectively on tubes with a superficially good picture but with poor emission and short life expectancy. It will also improve definition, contrast and focus greatly and add longer life to the picture tube. |

- ✓ VISUAL LIFE TEST — Enables both you and your customer to see the life-expectancy of any picture tube right on the meter ... helps eliminate resistance to picture tube replacement when necessary.
- ✓ SPECIAL LOW SCREEN VOLTAGE TUBES — Will handle new type picture tubes with special low voltage of approximately 50 volts.
- ✓ SEPARATE FILAMENT VOLTAGES — including the very latest 2.35 volt and 8.4 volt types as well as the older 6.3 volt types.
- ✓ NEW '5F' PICTURE TUBES — Accommodates the different base pin connections of this new type picture tube.



Model FC-2 FAST-CHECK TUBE TESTER

Simply set two controls ... insert tube ... and press quality button to test any of over 900 tube types completely, accurately ... IN JUST SECONDS!

The FAST-CHECK enables you to cut servicing time way down, eliminate unprofitable call-backs and increase your dollar earnings by selling more tubes with very little effort on your part. You make every call pay extra dividends by merely showing your customer the actual condition and life expectancy of the tube. The extra tubes you will sell each day will pay for the FAST-CHECK in a very short time.

PICTURE TUBE TEST ADAPTER INCLUDED WITH FAST-CHECK
 Enables you to check all picture tubes (including the new short-neck 110 degree type) for cathode emission, shorts and life expectancy ... also to rejuvenate weak picture tubes.

- #### RANGE OF OPERATION
- ✓ Checks quality of over 900 tube types, employing the time proven dynamic cathode emission test. This covers more than 99% of all tubes in use today, including the newest series-string TV tubes, auto 12 plate-volt tubes, OZ4s, magic eye tubes, gas regulators, special purpose hi-fi tubes and even foreign tubes.
 - ✓ Checks for inter-element shorts and leakage.
 - ✓ Checks for gas content.
 - ✓ Checks for life-expectancy.

SPECIFICATIONS

- No time consuming multiple switching ... only two settings are required instead of banks of switches on conventional testers
- No annoying roll chart checking ... tube chart listing over 900 tube types is located inside cover. New listings are added without costly roll chart replacement
- Checks each section of multi-section tubes and if only one section is defective the tube will read "Bad" on the meter scale
- 41 phosphor bronze beryllium tube sockets never need replacement
- 7-pin and 9-pin straighteners mounted on panel
- Large 4 1/2" D'Arsonval type meter is the most sensitive available, yet rugged — fully protected against accidental burn-out
- Special scale on meter for low current tubes
- Compensation for line voltage variation
- 12 filament positions
- Separate gas and short jewel indicators
- Line isolated — no shock hazards
- Deep brushed long lasting etched aluminum panel.

NOTE: The Fast-Check positively cannot become obsolete ... circuitry is engineered to accommodate all future tube types as they come out. New tube listings are furnished periodically at no cost.

Housed in hand-rubbed oak carrying case complete with CRT ADAPTER

Model FC-2
\$69.50 Net
 TERMS: \$14.50 within 10 days. Balance \$111 monthly for 5 months.

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- Model VT-10 Vacuum Tube Volt Meter \$58.50 \$14.50 within 10 days. Balance \$111 monthly for 4 months.
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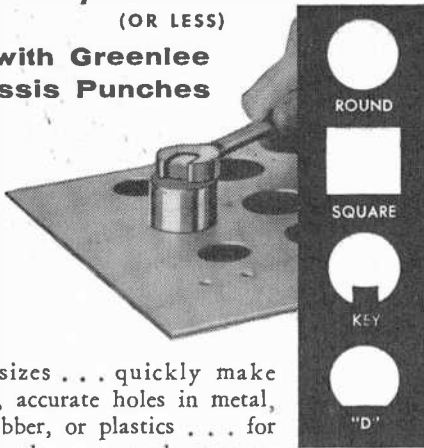
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TRANSMITTER provides choice of two channels for interference-free transmission. Unit comes equipped with crystal for one channel operation. Hand-held microphone with push-to-talk button is included.

The **RECEIVER** is tunable across the band for maximum flexibility. Features: Double conversion, super-heterodyne design, adjustable squelch, noise limiter, illuminated slide rule dial, AVC, and crystal controlled first oscillator.

Available in two Models—Model CB-27 for use on 115V 60 cy AC, and Model CBM-27 for 12V DC. \$124.95

Regency Division, I.D.E.A., Inc.

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it answered every electronic command, he brought it down until it was skimming only a few feet above the fresh green sod.

"What a sweet-flying job!" he chortled happily. "Watch this, old buddy; watch me put it in a tight circle around that tree."

The little plane lifted easily to the top of the tree and went into a tight banked left turn. At this moment there was a terrific rumbling roar right in the boys' ears, and Carl was so startled that he dropped the control box. Standing in front of the boys, with only the fence between, was a red-



eyed black bull emitting a low earth-shaking bellow through his flared nostrils.

"Wow!" Jerry exclaimed shakily; "what a beast! I'm sure glad that fence is there. He must have sneaked up on us while we were watching the plane."

"Where is the plane?" Carl asked as he snatched up the control box and anxiously scanned the empty sky. "Oh, oh!" he groaned. "There it is in the tree."

Sure enough, the little plane was resting in the upper branches of the tree with its motor still snarling away. Carl cut the motor off with the control box, and the two boys tried to drive the huge animal away by shouting at him and waving their arms. But this only seemed to add to the bull's ill temper. Finally they went down the road a short distance and hid in the side-ditch.

The bull eventually calmed down and wandered over to the far side of the pas-

Always say you saw it in—POPULAR ELECTRONICS

ture. Stealthily Carl and Jerry crawled under the barbed wire and quietly approached the tree. They were almost to it when the beast spotted them. Its tail went up into the air, and it came in a lumbering run straight for them.

The tree was a lot closer than the fence, and both boys started to climb it simultaneously. Since the trunk was only about a foot in diameter, this caused some confusion. They made it up to the branches, though, and as they sat there, breathing hard and staring down at the bellowing animal below, Jerry said bitterly:

"You and your superior muscles! What's the big idea of climbing over the top of me? If there's one thing I can't stand, it's a show-off!"

"I didn't mean to climb over the top of you; I had help from the bull," Carl explained, tenderly rubbing the area of his hip pocket. "I was having a little trouble climbing, though, with you standing on my face. I'm going up to get the plane. You keep Ferdinand entertained."

IN A FEW MINUTES Carl had inched his way back down to Jerry's level with the

plane in his hands. "Not hurt a bit!" he gloated. "When I dropped the control box, the plane must have pulled up in a stall and then pancaked into the tree. We're lucky."

"Oh, we're lucky, all right!" Jerry exclaimed sarcastically. "We have a choice: we can either sit up here in this tree and freeze to death tonight or we can let that bull make *shish kebab* out of us on his horns."

"It's not that bad—I hope," Carl comforted. "We'll get out of this some way. He'll get tired after a while and wander away. Let's be quiet and see if he doesn't forget us."

The boys remained absolutely still for half an hour, but the bull did not calm down. He circled around and around the tree, pawing the earth and throwing great clods of soft turf up over his back while slobbers ran from his bellowing mouth.

"Gee, what a grouch!" Carl finally exclaimed as he looked anxiously at the sun touching the horizon. "I never realized what 'bull-headed' really meant until now. He's not going to cool off. We've got to think of something else."

"You might jump out of the tree and

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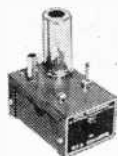
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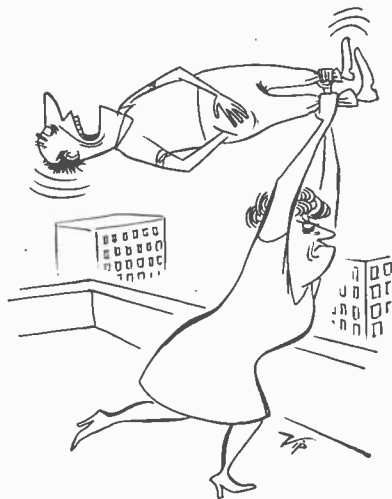
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sprint for the fence," Jerry suggested. "You're pretty fast and may be able to outrun him. While he's chasing you, I'll carry the plane to the fence on the other side of the pasture."

Before Carl could answer, the bull thrust a sharp pointed horn into the trunk of the tree and ripped off a great slab of bark.

"Let's think of another idea," Carl said as he tightened his grip on the quaking limbs. "What we really need is a toreador to coax him away from us."

"That's it!" Jerry exclaimed: "an electronic toreador! You got any red cloth about you?"

"I don't think so," Carl answered; "but if you think I'm going to get down there and wave a red flag in front of that couple of tons of pure cussedness, you've got another think coming."

"That lining of your jacket is red silk," Jerry observed. "Take my pocket knife and cut out a chunk a couple of feet square."

"Mom will kill me if I do."

"Would your mother rather have a whole jacket or a son with a whole hide? Get with it while I unravel a sock to get a piece of strong thread. We'll fasten the piece of red cloth to the plane with about ten feet of thread. Then we'll make the plane drag the cloth back and forth in front of Ferdinand. If we're lucky, we may be able to coax him away from the tree long enough for us to reach the fence."

Carl butchered a large square of cloth from the jacket lining and fastened it with the thread to the plane at a point where the drag would have a minimum effect on the plane's maneuverability. Then Jerry inched out on a limb until he could launch the plane in the clear. The motor was started and, at a word from Carl, Jerry gave the little plane a strong push. For an anxious moment it swooped down until the piece of cloth brushed the grass, but then it started climbing and sailed around the pasture easily.

Carl worked the control box expertly, and the little plane came back toward the tree carrying the bright red cloth about three feet above the ground. The animal turned his great head toward the sound of the purring motor and spied the approaching red cloth. With a bellow of anger, he charged it.

The plane went into a steep climb and carried the cloth out of reach; then it wheeled about and came back and actually

dragged the bright fabric over the back of the startled bull. As it flipped off his horns in front of his eyes, he charged fiercely after it. Carl throttled the motor down until the plane was almost stalling and flew a zigzag course that kept the red cloth tantalizingly in front of the animal's nose



until he was led into a far corner of the pasture; then both boys leaped to the ground and ran for the closest fence.

Carl, as he ran, still kept an eye on the little plane and used the control box to keep it flying. The bull was so engrossed with his new "enemy" that he did not notice the boys' escape at all. When they were safely across the fence, Carl brought the little plane sailing to them. He handed the control box to Jerry and had him put the plane into a tight circle while he caught the dangling piece of red cloth and broke the thread; then he took over and brought the plane in for a smooth landing on the narrow dirt road.

"WELL," Jerry observed, getting astride his bicycle; "that's that, and we'd better be getting home or we'll miss supper."

"Yeah," Carl agreed as he shot a malevolent look at the snorting bull, once more just on the other side of the fence; "and I just hope we have beefsteak!"

-30-

April, 1960

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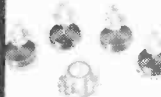


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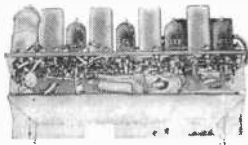
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Molecular Electronics

(Continued from page 91)

tor material called "dendrites" directly from the molten mass has already been perfected. These ribbons are of exact size and thickness, with optically perfect surfaces. They are practically ready for use as they emerge from the furnace, and there are virtually no rejects.

By contrast, semiconductors are normally made in the form of ingots which must be x-rayed, oriented, sawed, lapped, etched, and polished before they are ready to use. In addition, this "old" method results in a high percentage of rejects.

A dendritic ribbon to which tiny multiple-function systems have been automatically attached is shown on page 91: Here a series of multivibrators has been created directly on the dendrite. The individual circuits need only be clipped apart and leads attached. Soon, complete amplifier circuits will be produced the same way. The dendrite ribbon will be snipped into different lengths to give amplifiers of different gains—the longer the strip, the greater the amplification!

Eventually, engineers hope to "grow" complex electronic equipment—complete receivers, for example—automatically and continuously from a pool of semiconductor material. These receivers are still far in the future, but they would be unbelievably cheap and trouble-free by today's standards. Because of the low power consumption of molecular electronic function blocks, a single battery would last for years.

Military Significance. As might be expected, the first application for molecular electronics will be in the military and space fields. The savings to be realized in weight, size, and power consumption are of paramount importance here.

Of even greater significance is the tremendously improved reliability that can be achieved through the use of these amazing devices. To see why, consider the example of a giant rocket designed for hurling our satellites into orbit.

The rocket's electronic "innards" are made up of 20 or 30 thousand separate parts and perhaps 75 thousand connections. If just one of these parts or connections fails, we suffer another missile failure. With molecular electronic equipment, only one-tenth to one-twentieth the number of parts and connections is needed. Consequently,

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there is much less chance that a part or connection will go bad under strain, and the promise is that missile firings will be far more successful than ever before.

Molecular electronic units for military use are now being developed by Westinghouse under a U.S. Air Force contract. Although it takes time to design and test circuits, set up production lines, and train personnel, the first of these units will be going into action within about three years.

Consumer Use. It is hard to say when molecular electronic products will be available for the consumer market. But it is a certainty that such devices will be on sale some day. Because they will be produced by continuous, automatic, low-cost production methods, their price is bound to become so low that conventional tube and transistor circuits—with their separate resistors, capacitors, inductances, and complex soldered connections—will be on the way out, except possibly for highly specialized uses.

Molecular electronic devices will open up exciting new fields with their combination of high performance, small size, and low cost. For example, the wrist radio—a *la* Dick Tracy—will become commonplace. The personal telephone—a tiny gadget to strap on your wrist or carry in your pocket—will become possible. With it, you will be able to call anybody in the world who is similarly equipped.

A flat-screen TV set that hangs on your wall like a picture will become a reality. Rapid advances in electroluminescence have already come close to making practical a screen only a fraction of an inch thick. Molecular electronics will make it possible to pack the rest of the TV circuitry into a hollow corner of the frame!

There are endless speculations possible on the changes molecular electronics will bring—the probable developments in communications already mentioned are only a few. But who can say what revolutions in medicine, industry, business, government, and other phases of human endeavor will come about?

As with most truly revolutionary advances, molecular electronics will bring about profound changes impossible to predict. We'll be looking forward to them eagerly, however. For certainly, molecular electronics, whatever its contributions, will help shape a better and more exciting world for us all.

-30-



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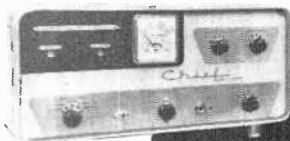
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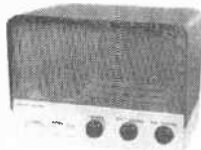
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Transistor Topics

(Continued from page 59)

the detector and $Q1$ to permit feedback winding $L2$ to provide regeneration, increasing circuit gain and improving selectivity. Transistor $Q1$'s base bias is furnished through $R1$. The amplified audio signal is applied through regeneration-volume control $R2$ to $Q2$ which, like $Q1$, is connected as a common-emitter amplifier. Finally, $Q2$'s output drives the magnetic earphones.

Either of these circuits can be assembled on a conventional chassis or on a Bakelite or fiber mounting board. Follow good wiring practice, keeping the signal leads short and direct and observing all d.c. polarities. Don't install batteries or turn the circuit on until you have double-checked all connections for wiring errors and accidental shorts.

Both circuits give optimum performance when used with moderate-length (25' to 100') external antennas; a ground connection is optional. In strong signal areas, a shorter antenna may give satisfactory results. Moderate-impedance (500- to 2000-ohm) magnetic earphones should be used. In the second circuit—Fig. 2(B)—try interchanging $L2$'s connections, as in any regenerative circuit, using the connection which gives maximum gain.

Product News. With the Citizens Band "booming," Radio Manufacturing Engineers, Inc. (RME), Washington, Ill., has introduced a fully transistorized, hand-held transceiver for use in the Class D Citizens Band. This compact instrument, about the size of the familiar "Walkie-Talkie," incorporates seven transistors and one diode.

Webster Electric Company (1900 Clark St., Racine, Wis.), manufacturer of "Teletalk" intercoms and "Ekotape" recorders, has introduced a line of transistorized d.c. to d.c. power converters. A typical unit, Type 2D12, has an input rating of 12.6 volts at 3 amp. and can supply 250 volts d.c. at up to 100 ma.

Lafayette Radio (165-08 Liberty Ave., Jamaica 33, N. Y.) has issued the second edition of its popular Semi-Conductor Directory. This useful publication, supplied free on request, has been expanded to 36 pages and lists the latest in diodes, rectifiers, and transistors.

That's it for now, fellows—we'll be back next month with more news.

Lou

Test Instruments

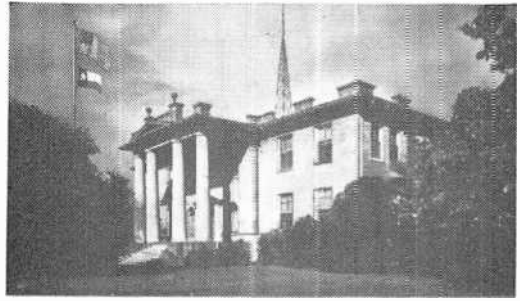
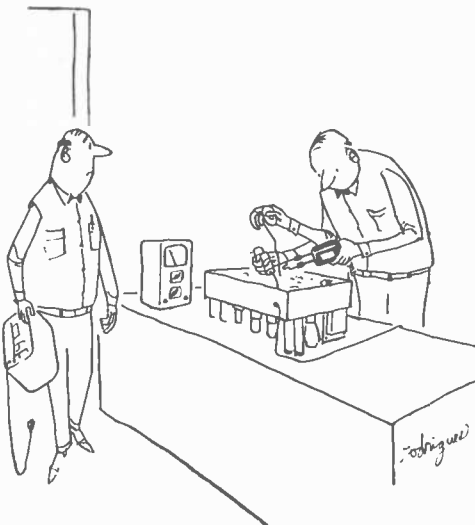
(Continued from page 94)

easily by being coupled too closely to its load. If the coupling is too tight, it may actually stop oscillating. A regenerative receiver, for example, will sometimes refuse to oscillate when it isn't optimally coupled to its antenna. For this reason, too, almost every transmitter has a buffer stage between its oscillator and power amplifier.

The buffer eliminates this loading effect by isolating the oscillator and its load from each other. By carefully selecting the capacitors and other components that couple the oscillator and buffer together, the designer can make certain that the oscillator is relatively independent of its load.

The designer of the Knight circuit in Fig. 5 chose a cathode-follower stage as a buffer to minimize loading effects further. As you probably know, a cathode follower delivers its output signal from its cathode rather than its plate. This results in a very low output impedance, which further minimizes stray capacitance effects.

Attenuator. The final circuit in any r.f. signal generator is the attenuator. This circuit is very much like a faucet on a water pipe: its job is to supply any amount of "juice" from a trickle to a torrent. It does this by varying the output voltage from zero to the maximum voltage the generator can produce. For many uses, exact output voltage control isn't necessary. But in some cases—measuring receiver gain is one—the attenuator must be capable of controlling



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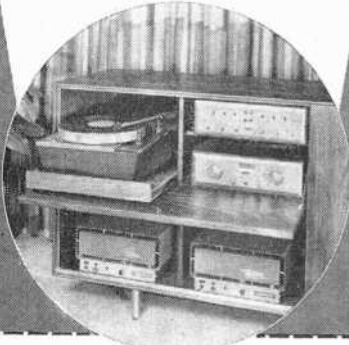
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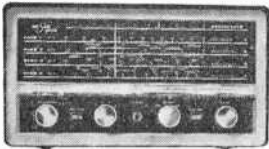


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(the output very precisely and indicating its level accurately.

Figure 6 shows the attenuator circuit of the EICO Model 315. Switch *S1* is the "coarse" or "multiplier" control which selects the general range of output levels. Potentiometer *R1* is the "fine" control which allows continuously variable output voltage within the selected range. The resistance values for the "coarse" control have been chosen so that the output of switch position 2 is about 10 times as large as position 1, output of position 3 is 10 times as large as position 2, etc.

Some signal generators have considerably more complex attenuator circuits. Expensive laboratory instruments designed for high precision work, for example, have attenuators which include sensitive meters. They indicate the output level far more accurately than is needed for ordinary service or experimental work. Such attenuators are also designed to minimize stray capacitance effects, improve the linearity of the output over the entire range, and keep the output impedance constant throughout the entire frequency and output level ranges.

At the other extreme, very inexpensive instruments may have only a single variable resistor for an attenuator. While such control is not very precise, it does allow the output to be varied and is adequate for most everyday purposes. Naturally, r.f. and a.f. sections, mixers, and other features also vary widely from one instrument to another.

Prices on signal generators run from under \$20 (kits) to as high as about \$150 (fully wired). Your choice will depend on just what you want the instrument to do.

Next month: details on the most common use of the standard r.f. signal generator—aligning a receiver.

-30-

CIRCUIT	ANSWER
1	(C)
2	(C)
3	(D)
4	(A)
5	(B)
6	(A)
7	(E)
8	(A)
9	(C)
10	(E)

Answers to "brightest bulb" problems on page 56.

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The Amazing Maser

(Continued from page 45)

comes virtually non-existent. A radar echo from Venus, minute signals from a star six billion light years away, or a feeble message from a satellite with a small, lightweight transmitter can come right in without competing with amplifier noise.

Spinning Electrons. When Dr. Townes invented the maser in 1954, he was not looking for a new type of amplifier. In the process of using radio waves to study the structure of gas molecules, he discovered that the energy of the spinning electrons in the gas could be tapped under certain conditions, and that it would give off microwave radiation similar to radar waves. Eventually he found a way to make the electrons radiate large amounts of energy when stimulated by small amounts, a reaction similar in some ways to a vacuum tube's action in controlling a large current flow with a small signal. Thus, a new amplifier working on an entirely new principle was born.

Dr. Townes' first instrument was a "gas maser," as opposed to the solid-state maser mentioned earlier. One of its first applications was in the world's most accurate atomic clock. Because the energy radiated by the maser's electron spin vibrates at an extremely constant rate, he was able to build a clock regulated by these vibrations that was accurate to within one second in a hundred years! With similar clocks, scientists are now measuring the rotation of the earth so accurately that soon we will know if it is actually slowing down, as many think.

The gas maser has also been used to confirm Einstein's theory of relativity concerning the velocity of light. Earlier attempts had been hampered by the lack of a timing device of sufficient accuracy. The maser clock enabled scientists to prove conclusively that the theory was correct.

Although the gas maser operated perfectly in atomic clocks and a few other devices, it was not a particularly efficient amplifier, so investigators began looking around for other materials to which the principle of the maser could be applied. A team of Bell Telephone Laboratories scientists, headed by Dr. H. E. D. Scovil, constructed a series of successful designs which used semiconductor solids, some of them similar to those used in transistors. So far,

synthetic ruby has proved to be one of the more effective materials, and many of today's atomic amplifiers are made of this material.

Future Applications. The maser seems likely to be cast in a starring role when National Aeronautics and Space Administration and Bell Telephone scientists try to transmit high-frequency signals from coast to coast and across the Atlantic by bouncing them off satellites. (See "Communications Satellites—Key to World-Wide TV," POPULAR ELECTRONICS, March, 1960.) Specially designed maser amplifiers and powerful antennas are now under construction at Bell Labs in New Jersey. And when world-wide TV becomes a reality, the maser will play an important part.

If the space probe scheduled to be fired into orbit around Venus this year is successful, scientists on earth will listen to its cryptic messages with maser receivers. And, of course, masers will be on hand when man himself takes the big step into space and wants to communicate over vast distances back to his home planet.

New uses, some based on startlingly original concepts, are proposed regularly. For

example, work has begun on the development of masers operating at frequencies so high that they are actually visible light. Techniques for generating infrared and visible light rays and for transmitting them like radio waves—although still far in the future—may open up entirely new applications for the maser.

Are masers likely to show up in our home TV and radio receivers? Well, there are some tremendous technical problems that have to be solved first. For example, the earth gives off feeble radiations which can jam the super-sensitive maser. Maser devices that have been successful so far overcome this problem by using sharply directional antennas pointed up and away from the earth's radiation. Consequently, maser-operated home television receivers seem unlikely until the day comes when our TV stations broadcast from satellites.

Although at this time we can only guess where future developments may lead, we can be sure that the maser and its applications will grow increasingly valuable—both here on earth and in the empty vastness of space when man leaves his planet to explore the stars.

-30-

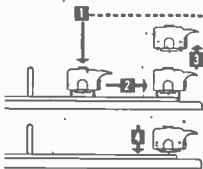
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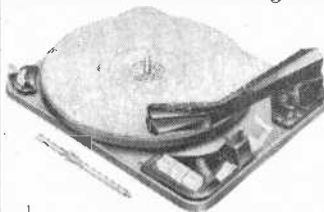
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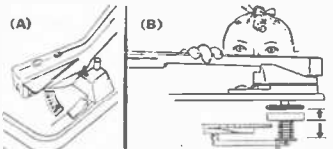
CONSTANT SPEED CHANGE-CYCLE — independent auxiliary transmission is used only for cycling. Thus change action is fast at all speeds.

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PERFECT TRACKING — double set of ball-bearings in each axis provides perfect arm motion — lateral and vertical — so vital for stereo tracking.

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Inside the Tape Recorder

(Continued from page 66)

at a price disadvantage. Tape answered back, though, with new heads that allowed four tracks to be placed side by side on a single tape. However, even four-track stereo tape usually costs more per minute of playing time than does a stereo disc, but many audiophiles feel that the results so far as quality is concerned are worth the difference in price.

Types of Recorders. For semi-professional and home use, tape recorders are available in either two-track or four-track models. Present stereo tape recordings are four-track recordings. The older two-track stereo tapes, as well as all monophonic tapes, can also be played back on the four-track tape machines. Hence, four-track machines are preferred by those who want to reproduce commercial stereo and monophonic tapes, since such machines can handle all present and past types of commercial tapes (except the long-obsolete stereo tapes for "staggered-head" machines).

The simplest types of tape machines are the tape *decks* which permit tape *playback* only and have no facilities for recording. They are inexpensive and are used with preamplifiers which equalize and amplify the signal as it comes from the heads of the deck. Decks are available in either two- or four-track types.

Most people, however, like to be able to make recordings as well as play back commercial tapes. Hence, they want a machine that permits recording as well as playback. These machines, too, can be separated into general types: those that permit only monophonic recording and those that permit both monophonic and stereo recording. The ones which permit four-track stereo or monophonic recordings are, of course, the most versatile—and the most expensive.

Tape recorders and decks usually offer a choice of at least two speeds—and sometimes three speeds. Semi-professional and home machines generally offer 7½-ips and 3¾-ips and sometimes 1⅞-ips speeds. Since it is likely that 3¾-ips tapes will eventually be available in prerecorded reels, a machine that has both 7½-ips and 3¾-ips speeds is a prudent buy. Furthermore, the 3¾-ips speed is an economical speed for home recording, and the quality is good enough for voice and acceptable for some musical re-

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cording. As a rule, the 1 $\frac{7}{8}$ -ips speed is suitable only for voice work.

Home-type recorders usually take 7" or smaller reels only. Semi-professional types also accommodate 10 $\frac{1}{2}$ " reels, which hold twice as much tape as 7" reels and give twice the recording and playback time. The semi-professional machines are more complicated, more versatile, yield higher performance, and cost a great deal more than home types—usually well above \$300 in monophonic versions, and above \$400 in stereo versions. They offer better frequency response, less wow and flutter, usually take 10 $\frac{1}{2}$ " reels, permit more exact editing of the tape, and are more precisely and sturdily built.

During the past year, tape cartridges have been introduced which require no threading and can be slipped on a suitable player as easily as a disc recording is put on a turntable. These cartridges, however, come only in the 3 $\frac{3}{4}$ -ips speed and are four-track types. They can only be used on special tape-cartridge recorders which cannot play the four-track 7 $\frac{1}{2}$ -ips reel-to-reel stereo tapes issued by other record manufacturers. The quality of the tape cartridges is slightly inferior to that of the 7 $\frac{1}{2}$ -ips tapes because of the slower speed.

Manufacturers have a very wide choice of features and facilities which they can incorporate into a tape recorder. Consequently, there are dozens of different types of recorders available, and the buyer is free to choose the one that best fits both his needs and his purse.

Next month we will continue our discussion by examining in detail the basic mechanical systems of modern-day magnetic tape recorders.

-30-



"Here you are, Mr. Hi-Fi . . . electric bill!"

April, 1960

SHORT CUT TO TELEVISION REPAIRS

No. 1

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Across the Ham Bands

(Continued from page 99)

tenna terminal. Capacitor *C7* is formed by twisting two lengths of insulated wire together for an inch or so. For more control, use a midget 1.2- to 10- μ f. variable capacitor for *C7* such as the Cardwell PL-6000. For best operation, it may be necessary to cut off a portion of the capacitor's plates to lower the minimum capacity. Insulate *C7* from the aluminum box, and connect its shaft to a small front panel knob with an insulated flexible coupling.

A midget vernier dial (not visible in the photo) is desirable for precise tuning of capacitor *C1*. If you don't want to invest in a vernier dial, use as large a knob as you have on hand.

Power the tuner with a separate power supply or "rob" the power from your transformer-operated (a.c.) receiver. You'll need 6.3 volts a.c. at 0.3 ampere and a few milliamps of B+ at 150 volts.

In operation, switch the receiver BFO off and tune in the desired sideband signal on the receiver for maximum output. Adjust tuning capacitor *C1* until the signal becomes intelligible. Coupling capacitor *C7* should also be adjusted for best performance on each signal.

News and Views

Steve Russell, KN8NHC, 715 Dwillard Drive, Kalamazoo, Mich., probably has the "N" knocked out of his call letters by now. As a Novice, he worked 38 countries in five continents and 46 states, 43 confirmed, in 900 contacts. A Heathkit DX-40 running 75 watts, feeding separate antennas for 80, 40, and 15 meters, and a 22-year-old SX-16 receiver did the trick. Steve has a 25-wpm code certificate and is glad to help prospective hams. . . . **Roger Warren, K9UHH**, 8715 Guilford Ave., Indianapolis, Ind., was formerly **K3EWM**. In three months with his new call, he has worked 46 states and 30 countries in the six continents using a modified DX-40 and VF-1 VFO. Roger also has three antennas: a Hy-Gain 14-AV vertical on the roof, a 2-element 15-meter beam, and a 150' wire fed through an antenna tuner which was described in *Across the Ham Bands*. Oh, yes, he got a Hallicrafters SX-101 receiver for Christmas. . . . **Mark Rowland, KN5TST**, 1717 East 31st St., N. Little Rock, Ark., operates on 15 and 40 meters. His Heathkit DX-35 and Hallicrafters S-85 receiver have accounted for 650 contacts in 48 states—he needs Montana and Nevada—and all continents except Europe. This record was compiled with two 15-meter antennas eight feet high and a 40-meter dipole. By now, he should have a 3-element 15-meter beam in operation. Mark likes to re-work hams who

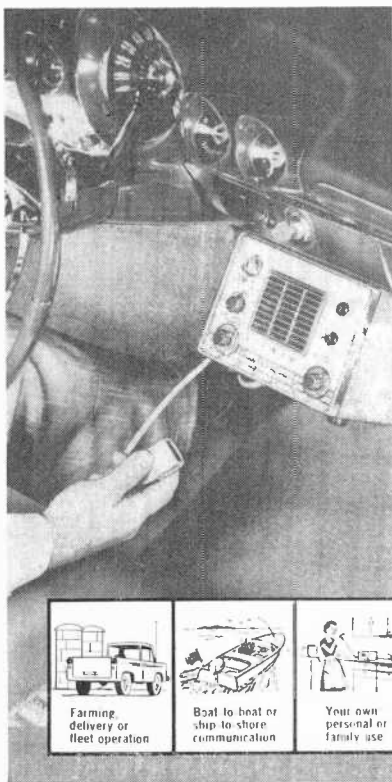
promise to QSL, then don't, to find out why.

Mike Swink, 8009 Beverly, Prairie Village 15, Kansas, worked all continents—85 countries—and WAS on phone in Dallas, Texas, where he operated as **K5HWY**. His tools were a Globe Champ transmitter, a National NC-173 receiver aided by an RME DB-23 preselector and separate ground-plane antennas, plus a home-brew 10-meter beam. Now he is starting all over again as **KØVVR**. . . . **Jim Zientara**, **K9MAN**, 1850 Lake Ave., Whiting, Ind., is a lucky ham. He admits he has practically no electrical noise at his location! He must have lots of room, too, because he has four antennas and is planning on a 20-meter beam and a vertical for 80 and 160 meters. He receives on a Hallicrafters SX-101A and transmits on a Heathkit DX-100. You can usually find him either handling traffic on 160 or 75-meter phone or chasing DX on 20-meter c.w. . . . **Joe Hauptly**, **K3CNN**, 2205 West Market St., Pottsville, Pa., calls attention to the typographical error in the January *Across the Ham Bands* which made the General Class code test speed 12 wpm instead of the correct 13 wpm. Joe uses a Heathkit DX-20 to drive a Globe LA-1 amplifier to about 175 watts on 20-meter c.w. He uses the DX-20 "barefoot" on 40 meters, and receives on a Hallicrafters SX-43. His record is 41 states and "some" DX. Joe offers to schedule anyone needing Pennsylvania, "if anyone needs Pennsylvania." And he would like to schedule Hawaii. "But who wouldn't?" he asks.

Bob Wilhelm, **WA2AYI**, 239 Third Ave., Garwood, N. J., Membership Chairman EASN, invites you to report into the Eastern Area Slow Speed Net, which meets daily at 1800 EST on 3748 kc. Normal speed is 10 to 15 wpm, but they slow down for Novices. The net teaches traffic-handling procedures, and members receive the semi-monthly bulletin "QNC." Write to Bob for more details. . . . **Dale Cochrane**, **K4YBS**, 1830 Patton Dr., Eastpoint, Ga., uses a Heathkit DX-100B transmitter and a Hammarlund HQ-129X receiver, a trap dipole antenna, and a 2-element 15-meter beam. He worked 18 countries as a Novice and now has 42 countries. He needs Hawaii and Vermont for WAS. . . . **Earl Spencer**, **K4FQU**, 1413 Davis Drive, Ft. Myers, Fla., was a Novice for eight months and worked 45 states and nine countries with a Johnson Adventurer transmitter feeding a 40-meter dipole. His receiver is an Allied Knight R-100. Since getting his General as a Christmas present, Earl has built a screen modulator for his Adventurer transmitter and uses it to drive a Globe LA-1 linear amplifier, giving him about 70 watts output on phone. . . . **Bill Berry**, **K6UNS**, 1660 Chatsworth Blvd., San Diego 7, Calif., says he was the last Novice in California to receive a "KN" before the FCC started issuing "WV6" calls.

That uses up our space. See you all next month. As always, keep your letters, pictures, "Ham of the Month," and construction ideas coming. 73,

Herb, W9EGQ



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Crystals

(Continued from page 85)

tor. It operates at the crystal's fundamental frequency, without tuning or other adjustments.

One of the most popular harmonic-oscillator circuits is shown in Fig. 3. This is the Colpitts or "grid-plate" circuit. As shown, it produces useful power output up to the fourth harmonic of the crystal's fundamental frequency, if an LC circuit in the output is tuned to the desired output frequency.

There are many types of overtone oscillator circuits. The one shown in Fig. 4 is recommended by International Crystal engineers for use with their overtone crystals in the 15-60 mc. range.

All three of these circuits are stable. Crystal heating—if operating voltages are kept within the limits shown—poses no problem. If you keep in mind that a crystal is intended to control frequency and not to produce power, you'll have no trouble. Keep power input to the oscillator as low as possible, and let other stages of the equipment provide power output.

In both the Pierce and Colpitts circuits,

shunt capacitance affects the crystal's operating frequency. Values shown for the Colpitts circuit result in about 32 $\mu\mu\text{f}$. across the crystal. In either circuit, a small variable capacitor can be connected in parallel with the crystal to adjust the output frequency slightly.

Since the overtone circuit operates differently, additional capacitance across its crystal will have little effect on frequency. If the capacitance is excessive, though, it may keep the oscillator from functioning.

Controlling the frequency of a radio transmitter is but one application of the quartz crystal. Although it operates in a completely different way, a crystal is electrically the same as an extremely efficient LC (or "tank") circuit. For this reason, a crystal can replace a tank circuit in any low-power installation.

But the major use of quartz crystals today is in transmitter frequency control. Here, they provide precision channels at low cost and enable efficient use of the limited radio spectrum. In fact, these rock-like plates make radio as we know it possible. Their purpose? Keeping the world in tune!

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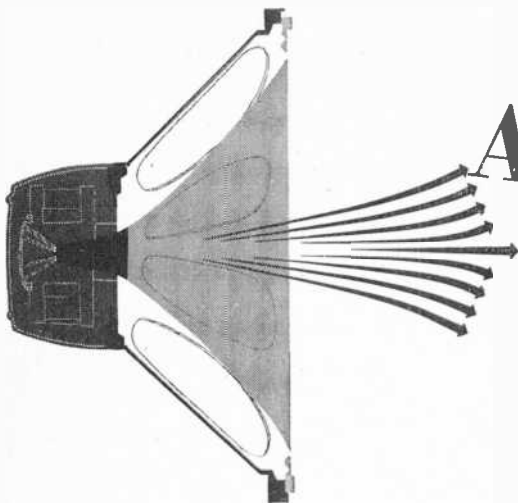
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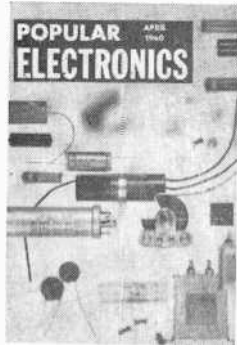
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On the Citizens Band



By **TOM KNEITEL**, 2W1965

MANY STATIONS have adopted the APCO "10" signals, that is, the code developed by the Associated Police Communication Officers, Inc. Use of the "10" code saves transmission time and will very often enable you to get your message through some pretty rough noise. Here are some of the commonly used "10" signals.

- 10-1 Receiving poorly
- 10-2 Receiving well
- 10-3 Stop transmitting
- 10-4 O.K.—acknowledged
- 10-5 Relay message
- 10-6 Busy
- 10-7 Leaving the air
- 10-8 In service
- 10-9 Repeat message
- 10-10 Transmission completed—subject to call
- 10-11 Speak slower
- 10-12 Visitors present
- 10-13 Advise weather/road conditions
- 10-18 Complete assignment quickly
- 10-19 Return to station
- 10-20 What is your location?
- 10-21 Call me by telephone
- 10-23 Stand by
- 10-24 Trouble at station
- 10-25 Can you contact _____?
- 10-30 Does not conform to rules and regulations
- 10-33 I have an emergency message
- 10-36 Correct time
- 10-65 Await message
- 10-92 Your transmission's poor
- 10-98 Assignment completed
- 10-99 Cannot read you
- 10-101 (Unofficial) Switch to Channel No. _____

Copies of this list should be at your base station and in all mobile units. You, too, can sound like "Highway Patrol!"

The long-awaited "Executive" unit is finally available from International Crystal, and it's as versatile as you could want a CB set to be. It has three transmit channels, and a dual-conversion superhet receiver with two crystal-fixed positions. The receiver is fully tunable across all 23 CB channels.

The "Exec" is decked out in a fancy bronze-colored cabinet with gold and red trim. But the external features are just the "plus" of the unit; "it's what's in back that counts." And what's in the back really does count. In fact, you can almost knock a horse over with the signal.

We ran a test with Bill Edwards, 2W4096, and made a solid contact for a good 10-mile haul. This was within New

York City, being blocked by an adjacent 16-story steel-frame building and using only a mobile whip at street level. Just think, if we fed the "Exec" into a "dual ground plane," we could probably raise Saturn (oops—no DX'ing on CB).

By the way, "Exec's" are sold *only* through dealers and are *not* available directly from International Crystal.

Speaking of dual g.p.'s, many of you have written asking for information on this antenna, which seems to be gaining popularity by the minute. It's a nine-element monster; a vertical radiator sticks up on top, four "drooping" radials surround the vertical radiator at its base, and four horizontal radials are a quarter-wave below the "drooping" radials. The antenna has a low angle of radiation and will add 3 db to your signal. Essco makes it.

Just for the record, you are *not* allowed to "pull-out and plug-in" crystals to change frequencies. You *must* have a properly filled-in Transmitter Identification Card (FCC Form 452-C) attached to each CB transmitter. And you should *not* try to soup up your rig by substituting "hot shot" audio tubes, capacitors, and other gizmos.

And *never, never* let an unqualified person poke around your rig's innards for any purpose whatsoever. A ham is *not* qualified to tune a CB transmitter. Neither is a TV serviceman. Nor is Uncle Elbert who might be a whiz at finding water with a bent twig, and can fix a TV set better than "any of those service guys." Fooling around with your unit cancels the manufacturer's warranty.

Last month's news-flash about the unofficial selection of two CB channels (9 and 13) for marine use was probably welcome news for the many sportsmen who have wanted to stick a rig aboard the ol' "Nellie Belle" but didn't know which channels to utilize. Choosing the two channels was no easy task. For one reason or another, just about every one of the 23 CB channels was a problem child—1 was too low, 11 was too jammed, 23 was loaded with R/C, 8 was too crowded in Podunk, and so on.

The main thing is—let's all cooperate and get the most out of these two channels by using them properly. This also holds true for land stations utilizing Channel 9, which is now the unofficial national CB calling channel.

-30-

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Dr. Glenn's Magic Wrinkles

(Continued from page 55)

in a liquid state, the charged areas are electrostatically attracted to the base, wrinkling the surface. A few thousandths of a second later, the tape cools, re-hardens, and the wrinkles are "frozen" into a permanent pattern. (For re-use, the tape is heated again, and normal surface tension smooths out the wrinkles.)

Reproduction. "Playback" is through any conventional slide projector or movie projector which has undergone a simple modification. The playback system is shown in Fig. 3. If the film has no wrinkles and thus is perfectly flat, the line light sources and bars are arranged so that they exactly cancel each other. No light gets through to the screen.

But a single ripple on the film, as at point "A," will diffract the top beam (shown in the diagram by the dashed line). This beam will then miss the bars and shine on the screen. Therefore, a single ripple will appear as a single line of light across the screen. And a series of ripples arranged in a pattern to form a picture will diffract the beams in such a way that they project a replica of the ripple pattern on the screen.

The color projector operates on a similar, but more complex, principle. The ripples here are designed to break the beams into a color spectrum in the same way a prism turns a beam of sunlight into many hues. A system of bars screens out all the unwanted colors.

Compact and Simple. TPR equipment promises to be significantly smaller and simpler than any recording device that can even begin to approach its capabilities. The prototype machine constructed by Dr. Glenn is built into a standard relay rack 6' tall and 18" wide. But this is an experimental machine. According to Dr. Glenn, simply rebuilding the same machine in more compact form would reduce it to about one-half its present size. Or, to put it another way, it would be smaller than many of today's studio-type sound tape recorders. Further development will no doubt reduce the size still more. And although General Electric won't predict future price tags for TPR equipment, there is every indication that it should cost far less than today's complex video recorders.

What might reductions in size and price bring about? First, of course, every TV

station would be able to afford TPR equipment. Every university, industry, advertising agency, or organization that now uses movie film would consider changing to this more convenient—and perhaps cheaper—form of recording images. Howard A. Chinn, chief engineer of CBS Television, predicts that even movies may someday switch to TPR. Using this system, a director would handle entire productions from a central console, watching all scenes from several camera angles and editing the film as he goes.

As a possibility for the more remote future, a portable TPR system might be designed making use of a vidicon or similar lightweight camera, with a complete recorder so compact that it could be carried by the operator! The volume-storage capabilities of the machine would make it possible to record hours of material in one "take."

Tremendous Potential. Defense planners are excited about the possibilities of TPR in a number of fields. For example, satellites used to record Signal Corps messages from one ground station and play them back thousands of miles away would

be able to handle far more information with TPR—video signals, for instance.

Missile guidance by "map-matching" techniques is another possible use for TPR. In this system, a "movie" of the path a missile is supposed to follow is played back by TPR inside the missile during its flight. At the same time, an optical system scans the earth below and the stars above. An electronic "brain" compares the pictures from the tape and the optical system. If there is any difference, it acts to bring the missile back to the correct flight path as indicated by the tape.

TPR will extend the range and reliability of radar by a method known as "optical correlation." Briefly, both the outgoing signal and the returning echoes are recorded, then compared for similar characteristics. Sometimes when returning signals are very weak, true echoes cannot be separated from background noise. With optical correlation, they are easily identified.

Large-screen displays of radar, sonar, and infrared signals will become possible. At present, when large numbers of people want to view these images simultaneously, they must use either hand-plotted boards or

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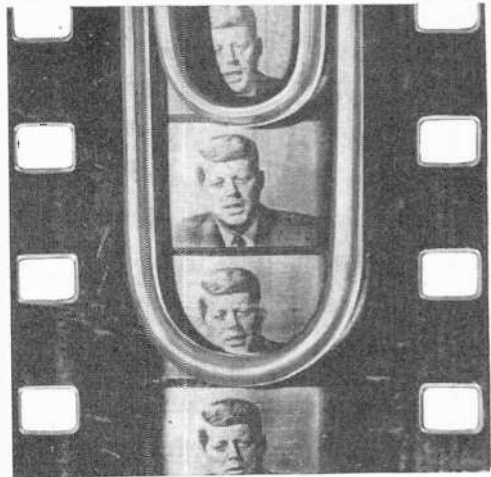
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photographic enlargements. Either method involves delay. But with TPR, a recording of a radarscope can be made and the playback projected on a large screen a fraction of a second later.

With military TPR going into action within a year and commercial versions likely to appear shortly afterwards, the typical consumer wants to know when thermoplastic recording will be available for home and hobby use. Not any time soon, to be



Each frame of a thermoplastic recording is less than a quarter of an inch wide and fits inside a paper clip. This photo was obtained by lighting the film from an angle, making it possible to view the film's surface modulation, or wrinkle pattern.

sure. As with any new system that works on an entirely different principle, a great deal of refinement and simplification must take place before it becomes practical.

For instance, even though video recording has been around for several years, home video tape recorders are not available. Undoubtedly the same thing will be true of TPR. Even so, it seems to be better suited for the consumer market, since it will probably be cheaper and simpler than magnetic tape video recording.

You may not have your own personal TPR machine for a few years, but you will soon begin to feel the effects of this new medium. As it plays back the television programs you watch, records the information you need on the job, and helps defend our country, Dr. Glenn's thermoplastic recording, with its "magic wrinkles," will play an important part in the life of our nation.

Short-Wave Report

(Continued from page 100)

hoping to receive, in return, a verification from the station.

We cannot condone this method of sending reports to stations. It is, to put it mildly, an act of bad faith on the part of the Monitor. The report serves no purpose whatever to the station receiving it and can only result in the SWL hobby acquiring a bad reputation. As we have pointed out before, reports to stations must be accurate. They must be based only on *actual listening time*. And they should also include certain other items which will help stations to know, without doubt, that you actually heard them. Our Verification Leaflet lists suggested methods for preparing reports.*

Incidentally, upon receiving Mr. Yaskal's second letter, we immediately contacted the Monitor in question, whom we knew only as being one of our newer members. In return we received his assurance that the report had been sent in haste and without due consideration of the possible consequences and, further, that such a report would never again be sent.

SWL News. Did you get your copy of the 1960 *World Radio Handbook* yet? It's available for \$2.70. The summer supplement can be obtained at a later date for \$1.00. The WRH Bulletin is available (via airmail) for \$1.50 for three months or \$5.65 for one year, and the booklet entitled "How To Listen To The World" is priced at \$1.00. All orders should go to Gilfer Associates, P. O. Box 239, Grand Central Station, New York 17, N. Y., and *not* to Your Editor or to POPULAR ELECTRONICS.

We've received many replies to our query in the January column regarding the full name of Mr. Lord and his sailing ship. Phillips Lord was the name and the schooner was the "Seth Parker," operating on 8840 kc. with the call letters KNRA.

A new publication in the SWL-FM-TV field is "DXing Horizons," published monthly by Robert B. Cooper, Jr., 820 Tully Rd., Modesto, Calif. Its Short-Wave Editor is Ken Boord, 948 Stewartstown Rd., Morgantown, W. Va., and its FM Editor is Bruce Elving, 920 Laramie St., Manhattan, Kan-

* The Verification Leaflet, as well as other leaflets listing clubs, publications, time zone conversion, and reporting codes can be obtained from your Short-Wave Editor. Please send your request to P. O. Box 254, Haddonfield, N. J., enclosing a postage stamp to help defray postal expenses.

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sas. The TV column is currently being handled by staff members of the magazine.

The Universal Radio DX Club has announced the appointment of C. M. Stanbury, II, Box 218, Crystal Beach, Ontario, as Eastern Short-Wave Editor. Mr. Stanbury is known to many as an expert in the commercial and utility station category, especially in the 2000- to 4000-kc. range.

Current Station Reports

The following is a resumé of the current reports. At time of compilation all reports are accurate. Stations often change frequency and/or schedule with little or no advance notice. All times shown are Eastern Standard and the 24-hour system is used. Please send your reports to P.O. Box 254, Haddonfield, N. J., in time to reach your Short-Wave Editor by the eighth of each month.

Afghanistan—Kabul has been noted on 9575 kc. from 0800 s/on to 0830 s/off with native musical numbers and vocals and ID's in several languages including English. Reports go to: Technical Department, *Radio Kabul*, Kabul. (WPE4BC, WPE9KM)

Bechuanaland—A very rarely heard station is Mafeking on 5900 kc. It was heard recently from 0605 to 0628 with English news. Further checks are being made. (CS)

Brazil—A new station is *R. Roquete Pinto*, Av. Almirante Barosso 81, Rio de Janeiro, 9515 kc. Reported opening at 0600. The exact schedule is requested. (WRH)

Bulgaria—Sofia, 9700 kc., has Eng. to N.A. at 2000-2030 and 2300-2330 with a “Mailbag” period on Thursdays and Sundays and a DX program on the first Friday of each month. A daily concert is aired from 1800 to 1830. Another Eng. period is noted at 1430. Reports go to: English Language Broadcast, *Radio Sofia*, Bulgaria, (WPE4BEI, WPE8RE, WPE9DN, WPE0EW)

China—Yunnan has moved from 9992 to 10,034 kc. Fair at 0740 with native language program, it fades rapidly by 0800. (WPE3NF)

Colombia—HJKF, *La Voz de Bogota*, Bogotá, 5960 kc., has “Sunday Evening Show” in Eng. and Spanish on Sundays at 2100-2230. A new station is *R. El Sol*, Cali, 6118 kc., noted at 2300 with music and commercials. (WPE9KM)

Czechoslovakia—Prague operates to N.A. and the Near East at 1930-2000 on 9550, 11,745, and 11,840 kc., at 2200-2300 on 9550 and 11,745 kc., at 0000-0030 on 9665 and 11,840 kc., and at 0330-0430 on 11,840, 15,185, and 21,450 kc. The 7340-kc. outlet was used for several weeks recently. A program for SWL's is broadcast on the first and third Thursdays of the month at 1930 and 0000 and on the first and third Fridays at 2200 and 0330. (WPE1GO, WPE1-HA, WPE1YI, WPE2AFK, WPE2BDU, WPE2-BVP, WPE3AWB, WPE4AMC, WPE4BC, WPE4BEI, WPE4EC, WPE5AG, WPE6EZ, WPE7QN, WPE8HF, WPE0CT, WPE0OI, VEIPE2U)

Denmark—Copenhagen operates to N.A. daily in Eng. on 9520 kc. at 2030-2130 and 2200-2300. (WPE8AGL)

Ecuador—“Caribbean Call,” a feature of

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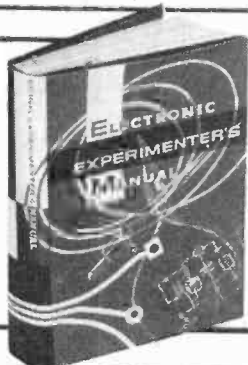
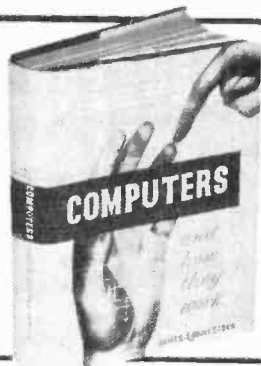
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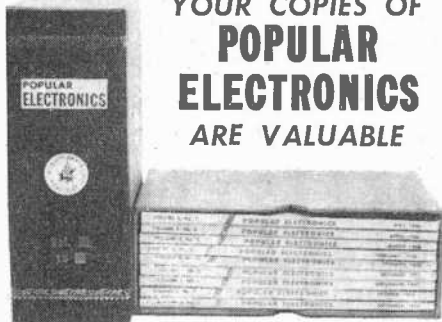
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HCJB, Quito, is now being beamed to Europe on 17,890 kc. as well as to the Americas on 15,115 kc. at 1830-1900. This xmsn is broadcast daily except Mondays. (WPE111, FD)

Formosa—The Voice of Free China, Taipei, has English to N.A. and Hawaii at 2030-2045 over BED58, 17,755 kc., dual to 7230, 11,815,

African Station Report

At the end of World War II, in 1945, there were only four independent states in Africa: Egypt, Liberia, Ethiopia, and South Africa. Now the ever-growing rolls of freedom have expanded to include Morocco, Tunisia, Guinea, Ghana, Sudan, and Cameroon. Added to these are the French Autonomous (self-governing) Republics of Malagasy (Madagascar), Gabon, Congo, Central African Republic, Chad, Niger, Dahomey, Ivory Coast, Voltaic Republic, Senegal, Mauretania, and the Comoro Islands. Slated for independence in 1960 are Togoland (April 27), Somalia (July 1), and Nigeria (Oct. 1). The following is a list of some of the African stations which have been heard recently; the numbers in bold face are the frequencies in kilocycles.

3322—CR7BW, Lourenco Marques, Mozambique, was noted from 1632 to 1702 s/off with pop dance music, dual to 4840 kc.

4815—Ouagadougou, Upper Volta, logged from 1620 to 1631 s/off with pop music and French announcements.

4855—VQ7LO, Nairobi, Kenya, heard with 1500/closing; not dual to 4885 kc.

4875—Cotonou, Dahomey, which moved here from 4870 kc., closes at 1600; also noted s/on at 0030 but not too strong.

4955—R. Mali, Dakar, French West Africa, has moved to this spot and is strong at 0307/closing.

4981—UFAC, Elizabethville, Belgian Congo, now closes Saturdays at 1600 with a march number; audible from 1530 with instrumental dance music and French anmts. Elizabethville is also tuned on 5951 kc. (a move from 5933 kc.) at 1450 with native vocals.

5040—Libreville, Gabon, 5040 kc., is audible some days from 1530, mostly with native music. Closing seems to be 1600 weekdays, 1700 Saturdays.

5045—Lome, Togo, has moved from 5036 kc., and is good at 0105 and 1600 in French.

6608—Benghazi, Libya, normally s/off at 1615, may run longer on holidays.

This special report was compiled by Charles Sutton. (CS) and George Cox (WPE3NF).

and 15,345 kc. English is also scheduled at 0505-0550 on the same channels. The 9575-kc. channel has been dropped. An Eng. xmsn to the West Coast is aired at 0030-0130 on 11,925 and 15,258 kc. (WPE1BM, WPE4AHA, WPE4BC, WPE6CW, WPE0EH, AB)

Germany—Deutsche Welle, Cologne, operates to N.A. at 1830-2145 (Eng. at 1930-1950)

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on 11,795 and 9640 kc., and at 2200-0115 (Eng. at 2300-2320) on 11,945 and 11,795 kc. A xmsn to the Near East with ID's in several languages, including Eng., is noted at 0930-1240 on 17,875 kc. (*WPE1BY, WPE1HA, WPE4MM, WPE8ANI, WPE0ADY, VE2PE1H, VE7PE2Y*)

According to QSL Card, *Bayerischer Rundfunk (Bavarian Radio)* is on 6085 kc. at 2330-0350 and 0430-1900 on Mondays, Wednesdays, and Fridays, at 2300-1900 Tuesdays, Thursdays, and Saturdays, and at 0000-1900 Sundays. (*WPE1BM*)

SDR, Muhlacker, 6030 kc., is noted at 0120-0145 with violin recital, at 0145-0200 with a piano recital. German news follows, then more classical music. (*MM*)

Ghana—Accra carries Eng. at 1630-1715 on 4915 kc. and at 0100-0115 on 3366 kc. Careful tuning is a "must" on both channels. (*WPE3-FZ, WPE8BCW*)

Goa—R. Goa is scheduled at 2030-0430 and 0600-1230 with Eng. at 0130-0330 and 0930-1030 on 4850 and 9610 kc. A new 50-kw. xmtr may be in operation by the time you read this; watch for it in the 49-, 41-, and 16-meter bands. (*WPE1BY, WRH*)

Haiti—R. Lumiere, 4VO, Aux Cayes, is now operating on 6093 kc., dual to 3322 kc., at 0650-2130 on Sundays and at 0530-0800 and 1700-2130 Monday through Saturday, with best reception at 0530-0700 and 2000-2130. Another new outlet is 4VAB, R. Caribe, Port-au-Prince, 6025 kc., noted with good signal at 0635 with music and 0645 with news. (*WPE2LH*)

4VRW, R. Haiti, Port-au-Prince, has been

SHORT-WAVE ABBREVIATIONS

anmt—Announcements	N.A.—North America(n)
Eng.—English	R.—Radio
ID—Identification	s/off—Sign-off
IS—Interval signal	s/on—Sign-on
kc.—Kilocycles	xmsn—Transmission
kw.—Kilowatts	xmtr—Transmitter

noted irregularly on Sundays on 10,150 kc. with French music at 1730-1800. (*CS*)

4VEH, Cap Haitian, has Eng. at 0445-0600, 0800-1000, 1500-1715 (Sunday), at 2000-2200 (Saturday, Sunday, Monday) and at 2200-2300 (Sunday, Monday) on 9770 and 6000 kc. (*WPE1KR, WPE9AGB, DC*)

Hungary—Budapest is scheduled currently at 1900-2000 and 2200-2330 on 11,910 and 9833 kc. to N.A., and at 0700-0800 on 21,685 kc. to Australia/New Zealand. (*PG*)

India—Delhi has Eng. at 1445-1545 on 17,790, 15,105, 11,710, and 9590 kc. and Eng. and Burmese at 1930-1950 on 15,280 and 11,895 kc. (*WPE9DN*)

All-India Radio's Hyderabad outlet on 4988 kc. has been tuned at 0743 with native language news and at 0745 with native music. (*WPE3NF*)

Indonesia—Djakarta was found on 9595 kc. (*YDF6*) at 0930-1010 with music and frequent ID's. They are asking for reports. (*WPE4BC*)

Iran—R. Teheran may now be operating 24 hours daily on 3780, 7288, and 9680 kc. The 9659-kc. channel will also be in use from 1515

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1T4	6A8	6C8	6S7	12B4G	26
1U4	6A8	6C9	6S7	12B6A	35A5
1U5	6A8	6C9	6S7	12B6B	35B5
1V2	6A8	6C9	6S7	12B6C	35C5
1X2	6A8	6C9	6S7	12B6E	35L6GT
2A3	6A8	6C9	6S7	12B7	35M4
2A4	6A8	6C9	6S7	12B7	35N4
3BC5	6A8	6C9	6S7	12B7	35P4
3BN6	6A8	6C9	6S7	12B7	39/44
3BZ6	6A8	6C9	6S7	12B7	42
3CB6	6A8	6C9	6S7	12B7	43
3CF6	6A8	6C9	6S7	12B7	44
3CS6	6A8	6C9	6S7	12B7	45
3LF4	6A8	6C9	6S7	12B7	46
3Q4	6A8	6C9	6S7	12B7	47
3S4	6A8	6C9	6S7	12B7	48
3V4	6A8	6C9	6S7	12B7	49
4B7A	6A8	6C9	6S7	12B7	50A5
4B7	6A8	6C9	6S7	12B7	50B5
5A8	6A8	6C9	6S7	12B7	50C5
5A8	6A8	6C9	6S7	12B7	50L6GT
5A8	6A8	6C9	6S7	12B7	50M6
5A8	6A8	6C9	6S7	12B7	50N6
5A8	6A8	6C9	6S7	12B7	50O6
5A8	6A8	6C9	6S7	12B7	50P6
5A8	6A8	6C9	6S7	12B7	50Q6
5A8	6A8	6C9	6S7	12B7	50R6
5A8	6A8	6C9	6S7	12B7	50S6
5A8	6A8	6C9	6S7	12B7	50T6
5A8	6A8	6C9	6S7	12B7	50U6
5A8	6A8	6C9	6S7	12B7	50V6
5A8	6A8	6C9	6S7	12B7	50W6
5A8	6A8	6C9	6S7	12B7	50X6
5A8	6A8	6C9	6S7	12B7	50Y6
5A8	6A8	6C9	6S7	12B7	50Z6
5A8	6A8	6C9	6S7	12B7	51A6
5A8	6A8	6C9	6S7	12B7	51B6
5A8	6A8	6C9	6S7	12B7	51C6
5A8	6A8	6C9	6S7	12B7	51D6
5A8	6A8	6C9	6S7	12B7	51E6
5A8	6A8	6C9	6S7	12B7	51F6
5A8	6A8	6C9	6S7	12B7	51G6
5A8	6A8	6C9	6S7	12B7	51H6
5A8	6A8	6C9	6S7	12B7	51I6
5A8	6A8	6C9	6S7	12B7	51J6
5A8	6A8	6C9	6S7	12B7	51K6
5A8	6A8	6C9	6S7	12B7	51L6
5A8	6A8	6C9	6S7	12B7	51M6
5A8	6A8	6C9	6S7	12B7	51N6
5A8	6A8	6C9	6S7	12B7	51O6
5A8	6A8	6C9	6S7	12B7	51P6
5A8	6A8	6C9	6S7	12B7	51Q6
5A8	6A8	6C9	6S7	12B7	51R6
5A8	6A8	6C9	6S7	12B7	51S6
5A8	6A8	6C9	6S7	12B7	51T6
5A8	6A8	6C9	6S7	12B7	51U6
5A8	6A8	6C9	6S7	12B7	51V6
5A8	6A8	6C9	6S7	12B7	51W6
5A8	6A8	6C9	6S7	12B7	51X6
5A8	6A8	6C9	6S7	12B7	51Y6
5A8	6A8	6C9	6S7	12B7	51Z6
5A8	6A8	6C9	6S7	12B7	52A6
5A8	6A8	6C9	6S7	12B7	52B6
5A8	6A8	6C9	6S7	12B7	52C6
5A8	6A8	6C9	6S7	12B7	52D6
5A8	6A8	6C9	6S7	12B7	52E6
5A8	6A8	6C9	6S7	12B7	52F6
5A8	6A8	6C9	6S7	12B7	52G6
5A8	6A8	6C9	6S7	12B7	52H6
5A8	6A8	6C9	6S7	12B7	52I6
5A8	6A8	6C9	6S7	12B7	52J6
5A8	6A8	6C9	6S7	12B7	52K6
5A8	6A8	6C9	6S7	12B7	52L6
5A8	6A8	6C9	6S7	12B7	52M6
5A8	6A8	6C9	6S7	12B7	52N6
5A8	6A8	6C9	6S7	12B7	52O6
5A8	6A8	6C9	6S7	12B7	52P6
5A8	6A8	6C9	6S7	12B7	52Q6
5A8	6A8	6C9	6S7	12B7	52R6
5A8	6A8	6C9	6S7	12B7	52S6
5A8	6A8	6C9	6S7	12B7	52T6
5A8	6A8	6C9	6S7	12B7	52U6
5A8	6A8	6C9	6S7	12B7	52V6
5A8	6A8	6C9	6S7	12B7	52W6
5A8	6A8	6C9	6S7	12B7	52X6
5A8	6A8	6C9	6S7	12B7	52Y6
5A8	6A8	6C9	6S7	12B7	52Z6
5A8	6A8	6C9	6S7	12B7	53A6
5A8	6A8	6C9	6S7	12B7	53B6
5A8	6A8	6C9	6S7	12B7	53C6
5A8	6A8	6C9	6S7	12B7	53D6
5A8	6A8	6C9	6S7	12B7	53E6
5A8	6A8	6C9	6S7	12B7	53F6
5A8	6A8	6C9	6S7	12B7	53G6
5A8	6A8	6C9	6S7	12B7	53H6
5A8	6A8	6C9	6S7	12B7	53I6
5A8	6A8	6C9	6S7	12B7	53J6
5A8	6A8	6C9	6S7	12B7	53K6
5A8	6A8	6C9	6S7	12B7	53L6
5A8	6A8	6C9	6S7	12B7	53M6
5A8	6A8	6C9	6S7	12B7	53N6
5A8	6A8	6C9	6S7	12B7	53O6
5A8	6A8	6C9	6S7	12B7	53P6
5A8	6A8	6C9	6S7	12B7	53Q6
5A8	6A8	6C9	6S7	12B7	53R6
5A8	6A8	6C9	6S7	12B7	53S6
5A8	6A8	6C9	6S7	12B7	53T6
5A8	6A8	6C9	6S7	12B7	53U6
5A8	6A8	6C9	6S7	12B7	53V6
5A8	6A8	6C9	6S7	12B7	53W6
5A8	6A8	6C9	6S7	12B7	53X6
5A8	6A8	6C9	6S7	12B7	53Y6
5A8	6A8	6C9	6S7	12B7	53Z6
5A8	6A8	6C9	6S7	12B7	54A6
5A8	6A8	6C9	6S7	12B7	54B6
5A8	6A8	6C9	6S7	12B7	54C6
5A8	6A8	6C9	6S7	12B7	54D6
5A8	6A8	6C9	6S7	12B7	54E6
5A8	6A8	6C9	6S7	12B7	54F6
5A8	6A8	6C9	6S7	12B7	54G6
5A8	6A8	6C9	6S7	12B7	54H6
5A8	6A8	6C9	6S7	12B7	54I6
5A8	6A8	6C9	6S7	12B7	54J6
5A8	6A8	6C9	6S7	12B7	54K6
5A8	6A8	6C9	6S7	12B7	54L6
5A8	6A8	6C9	6S7	12B7	54M6
5A8	6A8	6C9	6S7	12B7	54N6
5A8	6A8	6C9	6S7	12B7	54O6
5A8	6A8	6C9	6S7	12B7	54P6
5A8	6A8	6C9	6S7	12B7	54Q6
5A8	6A8	6C9	6S7	12B7	54R6
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5A8	6A8	6C9	6S7	12B7	54T6
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5A8	6A8	6C9	6S7	12B7	54W6
5A8	6A8	6C9	6S7	12B7	54X6
5A8	6A8	6C9	6S7	12B7	54Y6
5A8	6A8	6C9	6S7	12B7	54Z6
5A8	6A8	6C9	6S7	12B7	55A6
5A8	6A8	6C9	6S7	12B7	55B6
5A8	6A8	6C9	6S7	12B7	55C6
5A8	6A8	6C9	6S7	12B7	55D6
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5A8					



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Italy—Rome has Eng. to S. Africa at 1030-1055 on 21,560 kc. and to N.A. at 1930-1950 and 2205-2225 on 9575 and 11,900 kc. French to N.A. is given at 1950. The bird call noted in the IS is that of a nightingale. (WPE2BTI, WPE5OP, WPE9AGB, WPE0VQ, AB, DC)

Jordan—Hashemite Broadcasting Service, Amman, is now operating on 6020 kc. from

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World Radio Handbook (WRH)

1500 to 1705 s/off with Mid-East and Western music and anmts in Arabic and English. Reports on this new 100-kw. xmtr go to Box 909, Amman, Jordan. (WPE1BD, WPE1BM, WPE1BY, EC, SS)

Martinique—Fort-de-France was logged on

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3315 kc. at 1700 with a drama, dance music from 1730, all French. The 5995-kc. outlet is noted from 1725 to 2100 s/off. (WPE1BM, WPE3NF, WPE4BC)

Nepal—R. Nepal has been noted on 7100 kc. from 0725 to 0750 s/off with music. No English. A new 10-kw. xmtr is expected to go into operation shortly. (WPE1BY, CS)

Netherlands—Hilversum has Eng. to N.A. and Europe at 1615-1705 on 15,220 and 11,730 kc. (also on 6020 kc. to Europe only) and to Eastern N.A. at 2030-2120 (Sundays at 2100-2230) on 9590 and 6025 kc. A DX program is aired on Mondays. (WPE3AKL, WPE4BE1, WPE5GQ, WPE8AGL, WPE9AVB, WPE9DN, WPE0WM)

Nicaragua—The station reported by many on 6026 kc. is—according to some sources—YNX, Managua. Noted evenings, the ID seems to be *La Menara Vanari*. (WPE1BY, WPE3DS, WPE9KM)

Peru—R. La Cronica was logged at 2030 on 9530 kc. This channel is actually listed as one of Tacna's outlets. (WPE9KM)

Pitcairn Island—Station VR6AC, 14,135 kc., broadcasts a daily religious program in Eng. at 0500-0530. This frequency replaces 12,110 kc., formerly used. Has anyone heard this program? (WRH)

Poland—Warsaw operates to N.A. at 0630-0700 and 0730-0830 on 15,120, 15,275, and 17,800 kc., and at 1930-2030 and 2130-2230 on 15,275, 11,815, and 7315 kc. A "Mailbag" program is broadcast Mondays at 1930. (WPE2PA, WPE5AG, WPE8RE, WPE9BR, WPE0IC, WPE0LN, VE3PE5F)

Solomon Islands—VQO2, Honiara (Box 115), now operates Mondays, Fridays, and Satur-

days at 0300-0530 (to 0540 Tuesdays, Wednesdays, Thursdays; at 0400-0530 Sundays). Tune for it on 5960 kc. (WPE1BD, WPE3AKL)

South Korea—Seoul operates as follows: to N.A. at 2330-0000 on 17,745 and 15,410 kc.; to Hawaii at 0130-0200 on 15,255 kc.; in General Overseas Service at 0430-0500 on 6035 and 9640 kc.; and to S. E. Asia at 0800-0830 on 9640 and 15,410 kc. This schedule is for the Eng. programs only. (WPE2BFB, WPE6ARE)

The Ministry of Communications, Republic of Korea, Seoul, Korea, has provided us with the following short-wave schedule: HLK5 to Southeast Asia on 9640 kc. at 9000-1000; HLK6 to Hawaii and Europe on 11,925 kc. at 1100-1200; HLK8 to U.S.A., Hawaii, and Southeast Asia on 15,410 kc. at 0030-0130, 0230-0330 and 9000-1000; HLK9 to Europe on 17,835 kc. at 0200-0230. Address QSL cards to the Director of Telecommunications. (Ed.)

Tunisia—R. Tunis, 6125 kc., apparently with new 100-kw. xmtr, is scheduled at 0030-0330, 0600-0800, and 1130-1715. It is being noted in some areas from 1355 with chanting. Some sources list the schedule as being all French; however, Arabic seems to be the language used widely on the 1130-1715 xmsn. (WPE1BY, WPE1HY, WPE3NF, WPE4BC, WPE0AE)

Turkey—Ankara is currently operating at 1815-1900 to N.A. on 9515 kc. The 15,160-kc. channel is not in use. (WPE4BC, WPE0AE)

Vietnam—Hanoi is strong on 7009 kc. at 0742 in a native language xmsn. There is heavy amateur interference at times. (WPE3NF)

Utility—Standard frequency station OMA, Prague, is operating 24 hours daily on 2500 kc. On each quarter hour the call OMA is given 10 times in Morse code. (WHR) -30-

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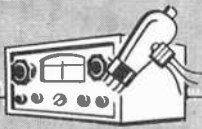
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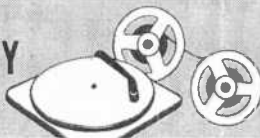
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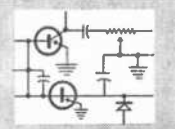
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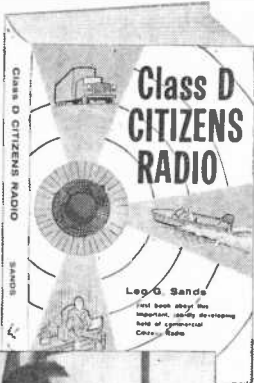
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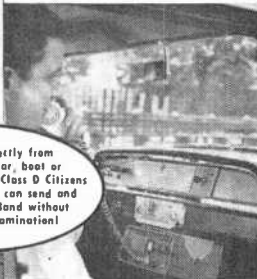
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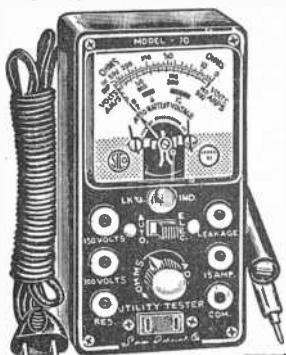
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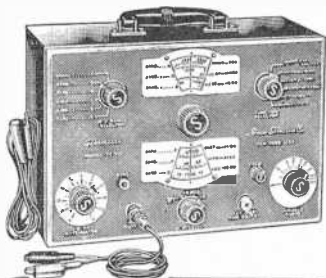
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SPECIFICATIONS:

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