

SPECIAL HI-FI STEREO ISSUE

POPULAR

**OCTOBER
1959**

ELECTRONICS

**35
CENTS**


HI-FI • HAM RADIO • SWL • TEST GEAR



**Special
Reports on:**

- Acoustical Tile
- Tone Arm Kits

Build a

- Super Stereo Amplifier 
- Stereo Speaker System
- Pocket Marine Receiver
- Novice Band Receiver

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on page 49**



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18108 WINDWARD
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“TD”



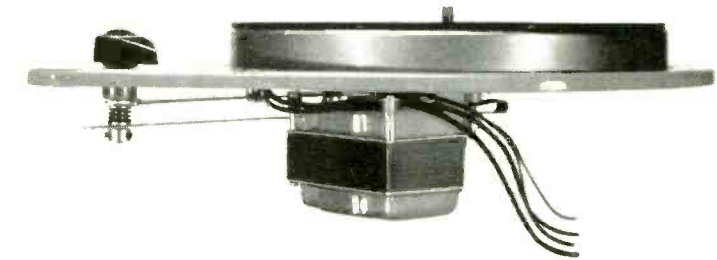
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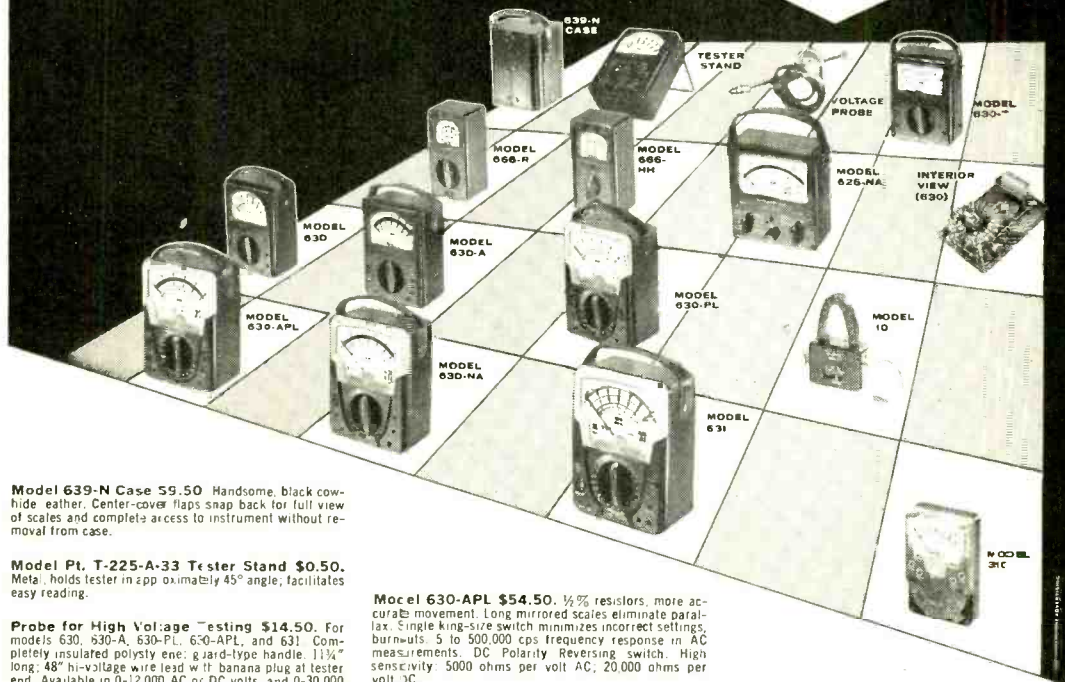
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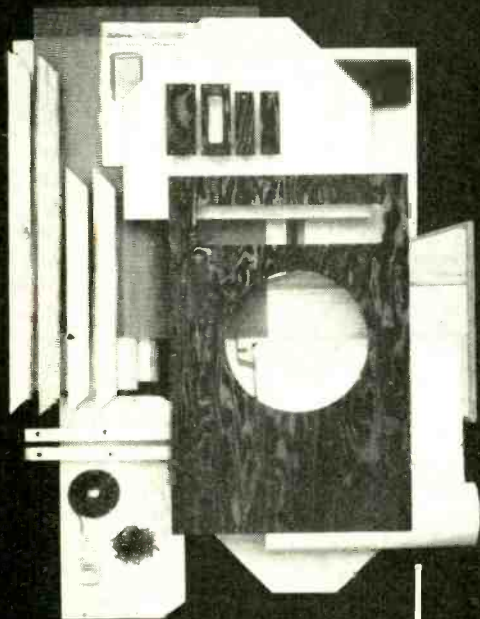
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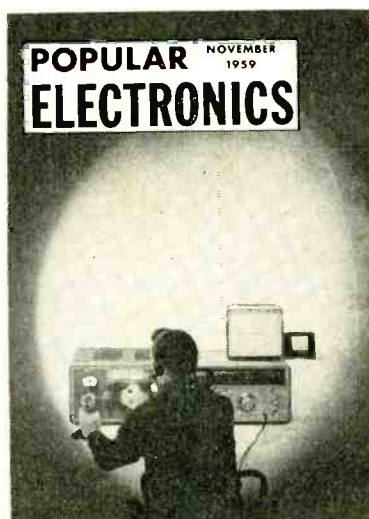
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This month's cover photo by Bruce Pendleton

COMING NEXT MONTH



(ON SALE OCTOBER 22)

Are your QSL's few and far between? The November cover story, "Orient Your Beam Antenna," will give you the facts on planning your antenna installation to pick up those rare foreign stations.

Other articles will take you on various behind-the-scenes tours: to Cape Canaveral to check on telemetering techniques; to New Mexico to get the fascinating facts behind the electronic diving rod that points out water hundreds of feet beneath the earth's surface; and to the realm of the ultra-small with the amazing electron microscope.

In addition to the regular hi-fi, ham, and test instrument features, you'll find some interesting construction items—including the "Supersonic Squawker," a transistorized noise generator.

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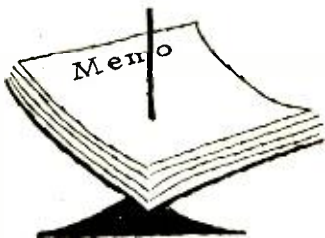
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Notes from the Editor

CITIZENS BAND. From the avalanche of reader mail we've received concerning the Citizens Band, it's apparent that this service has really captured the public's imagination. While it's gratifying to see this warm reception, at the same time, serious problems are making themselves evident. The most pressing difficulty concerns the increasing number of traffic jams on the limited number of channels available. This problem can be solved only by the operators. We would like to propose two basic rules which we think will help relieve congestion.

RULE NO. 1. If you don't have a message to send, stay off the air. The Citizens Band is not a second-class ham band. It was organized to allow private citizens to make short-range radio communications for personal or business use. The word "personal" does not mean that the Citizens Band is to be used for entertainment purposes. It means that if you have a personal message to communicate, go ahead, but do not tie up valuable channel space talking about the weather. Obviously, CQ'ing is also out. And DX'ing for the sake of DX'ing is a needless waste of channel space.

All this isn't to say that the Citizens Band shouldn't be fun to use. It's a real challenge to squeeze the last drop of efficiency out of a low-powered device — but not at the expense of others. Use the Citizens Band as efficiently as you can, but don't make it a hobby.

RULE NO. 2. Keep it short. With only a limited number of channels available, it's obvious that demand for channel space is going to outrun supply. Complete your message and then get off the air. Ten other guys may be waiting on you. If you want to chew the rag with somebody, use the telephone.

If the Citizens Band is grossly misused, the FCC conceivably could decide to wash its hands of Citizens Radio altogether and kill the whole business. It is imperative that each operator use the service in the spirit for which it was intended and forget about finding legalistic loopholes in the regulations. If this is done, Citizens Radio will continue to be a valuable adjunct to other systems of communication.

COLUMN TITLE CHANGE. At our suggestion, Herb Brier is reshaping his monthly column, "Among the Novice Hams," to cover a wider range of amateur radio material. It is now called "Across the Ham Bands," and we feel that this change will be popular with hams of all classes. Each column will contain plenty of useful information both for Novices and for more advanced operators.

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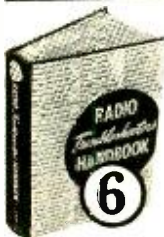
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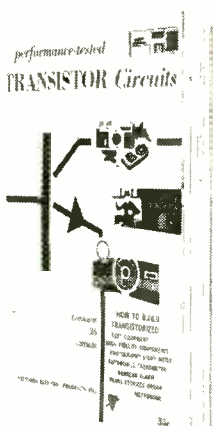
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Letters

from our

readers

Transistor Circuits

■ Thanks very much for your fine article on "Understanding Transistor Circuits" in the August issue. I am a transistor experimenter and before I read this article I really learned very little about transistor theory because everything was either over my head or else it didn't say enough. How about more transistor construction projects?

HAL CARLSON
Park Ridge, Ill.

We have quite a few transistor projects in the works, Hal. Just keep reading!

Battery "Sweat Box"

■ I noticed in the August "Tips and Techniques" column that Jerome Cunningham advises putting portable radio batteries in plastic bags to prevent them from leaking onto the radio. I tried this a long time ago and found that temperatures often reached 135° to 140° in this type of "sweat box." I would rather take the chance that a leaky bat-



tery might damage the radio than replace the battery every week because it had been damaged by too much heat. A plastic bag heats up very quickly and retains its heat for a long time. This combination can put an end to a battery about as fast as anything I know of.

In the same issue is a "Tubeless and Transistorless Code Practice Oscillator." Ha! What do you call the neon tube?

KIM BORISKIN, K2MGS
Brooklyn, N. Y.

We usually call it a neon lamp, but in this case we slipped up.

CB Rag-Chewers

■ Your article in the August issue on how to fill out a Citizens Band application was very fine, except for one point that struck me as a little laugh-

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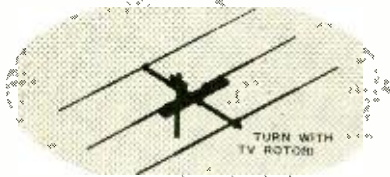
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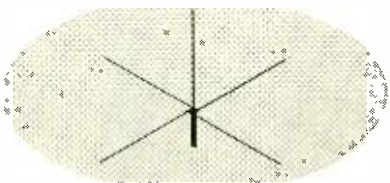
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Letters

(Continued from page 12)

able, that the Citizens Band "is *not* a no-exam ham service and is *not* meant to be used by 'rag-chewer' clubs or would-be DX artists." That is exactly how it is being used out here in the majority of cases.

Actually, I see nothing in the FCC regulations that prohibits such use. In fact, I rather imagine the FCC had the foresight to realize that 23 channels in the vicinity of 10 meters which were available to private citizens would be put to use by would-be hams who had never bothered to get a ticket.

SHALER HANISCH
Pasadena, Calif.

See editorial comments on page 8.

Electronics Against Cancer

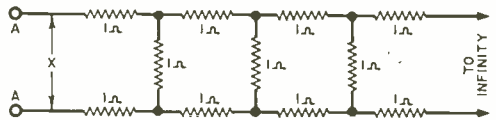
■ My family and I read your article entitled "Electronics Against Cancer" in the August issue, and I would like to thank you for this valuable and interesting feature. The best way to defeat "hush-hush" diseases like cancer, mental illness, etc., is to get them out into the open and discuss them. In the same way a child fears the dark, we fear anything we do not understand or are ignorant about. We may not understand cancer, but articles such as yours at least help us to know our enemy and thereby partially reduce the near-hysterical reaction that many people have at the mention of cancer.

IRVING GOLDSTEIN
New York, N. Y.

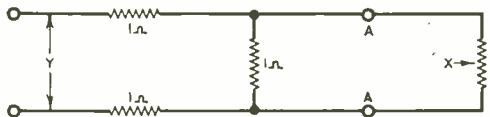
Stickler Proof

■ I am writing with regard to the "Stickler" No. 1 in the July 1959 issue. While this problem can certainly be solved by repetitive methods, there is at least one much simpler way to solve it.

We are given an infinite network of one-ohm resistors connected as shown:



and we are to find the resistance X . The solution to this problem can easily be found by adding another section to the network:



where X is the resistance of the infinite network and Y is the resistance of the same network with the addition of an identical section.

From the rules for series and parallel resistors, we see that the resistance of the new network is:

$$Y = 1 + \frac{1 \times X}{1 + X} + 1$$

But, since the section we have added is just one more added to an infinitely long chain of identical

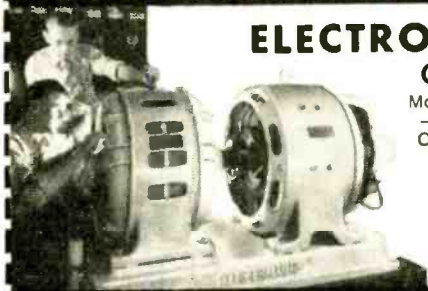
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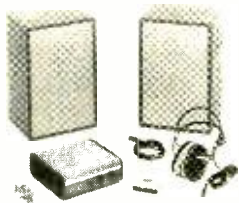
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Letters

(Continued from page 14)

sections, the resistance at Y must be the same as the resistance at X (a-a), or:

$$X = Y$$

Therefore, the solution is:

$$X = 2 + \frac{1 \times X}{1 + X}$$

$$X(1 + X) = 2(1 + X) + X$$

$$X^2 - 2X - 2 = 0$$

$$X = 1 \pm \frac{1}{2} \sqrt{12} = 1 \pm \sqrt{3}$$

$$= 1 \pm 1.73 = 2.73$$

We can neglect the negative answer because we know that all the parts of the circuit have positive resistances.

GEORGE E. BEINE
Rochester, N. Y.

For 2¢ Plain

■ I've recently noticed the better quality of your articles and have re-subscribed to POPULAR ELECTRONICS. I would like to cast my vote for such articles as: "Trouble-Shoot Your Projects," "How to Fix Auto Radios," and "Customize Your Kits." Your kit reviews are also a big help to me in deciding what to buy. I would like to see more articles like those named here and a little less on hi-fi.

Well, that's my 2¢ worth. Keep up the good work.

LANNY MARCUS, K6PQL
Los Angeles, Calif.

Well, all you hi-fi'ers, what do you say about this?

Ground Resistance Measurements

■ Allow me to correct Saunder Harris on his method of measuring ground resistance in the August "After Class." A megohmmeter generally reads one megohm or higher, and if this is the lowest his ground readings have been, I hope he hasn't put too much faith in his grounds for protection.

I think he should have specified a Kelvin bridge or a low-range ohmmeter such as the Simpson 362 or Industrial Instruments LRO-1. Even a standard ohmmeter would give a better indication of ground resistance than a megohmmeter.

ROBERT B. FRANKE, W3YNC
Oley, Pa.

"Stereoplex" Feedback

■ I recently completed the "Stereoplex" amplifier described in your April issue. Congratulations on a fine construction project. However, when I used the recommended feedback resistors, my amplifier oscillated violently. The removal of the feedback resistors altogether resulted in quite good performance. I have found through experimentation that 10,000-ohm feedback resistors provide excellent performance.

GEORGE E. MOCK
Indianapolis, Ind.

Oscillation in the "Stereoplex" can be caused either by the parts layout or by the variation between tubes. Should oscillation occur, higher values are recommended for R9 and R18, the feedback resistors.

-30-

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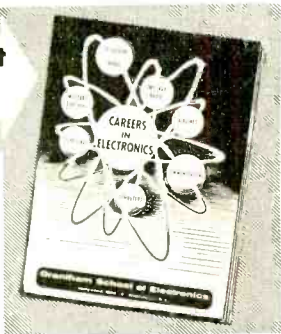
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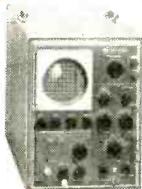
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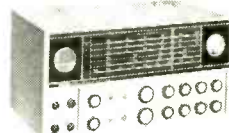
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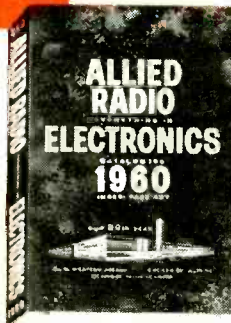
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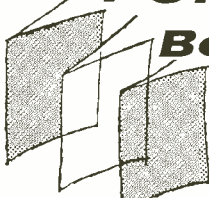
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"BASICS OF MISSILE GUIDANCE AND SPACE TECHNIQUES" by Marvin Hobbs. Published by John F. Rider Publisher, Inc., 116 West 14th St., New York 11, N. Y. Total pages: 301. Two volumes with soft cover binding, \$3.90 each; two volumes in single cloth binding, \$9.00.

Here is the fascinating story of the many types of electronic and mechanical systems being used in our space exploration program. Coverage includes: principles of control and guidance, satellite theory and practice, telemetry, space navigation, etc. The style is not only authoritative but also unusually readable. Frequent use of large-sized pictorial diagrams makes the rather complex and intrinsically difficult subjects surprisingly easy to understand. If you're

at all interested in the problems raised by our attempted conquest of outer space, you'll find these volumes extremely interesting and maybe even exciting.



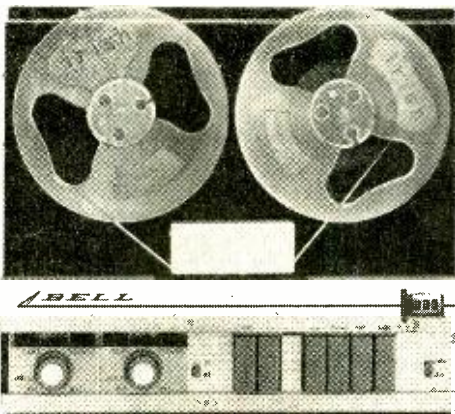
"TELEVISION SERVICING" by Alex Levy and Murray Frankel. Published by McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y. 534 pages. Hard cover. \$7.75.

Designed for both laboratory and shop, this authoritative text gives practical, step-by-step procedures in the servicing of television receivers. It is recommended for the practicing television serviceman who wants to brush up on his knowledge of the subject, and also for the beginner who wants an easy-to-understand text. A chapter on home servicing includes a fully illustrated "trouble" index, showing photographs of the various distortions on the TV screen.



"STEREO—HOW IT WORKS" by Herman Burstein. Published by Gernsback Library,

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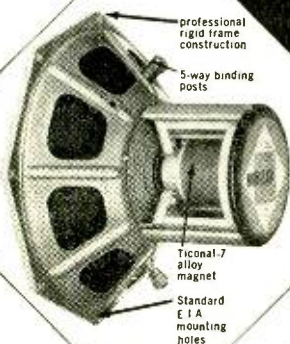
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Bookshelf

(Continued from page 20)

Inc., 154 West 14th St., New York 11, N. Y. 224 pages. Soft cover, \$2.90; hard cover, \$5.00.

Considering how fast things are moving in the field of stereo, this book is amazingly up to date. For instance, the author covers the Crosby FM multiplex system, the Bell-Becker "time-delay" stereo system, four-track stereo tape, and the RCA tape cartridge—all of which are relatively new. Also included are descriptions of the Minter stereo record system, the CBS system, the Westrex system, etc.

By assuming that the reader has a degree of familiarity with monophonic hi-fi equipment, Mr. Burstein avoids wasting time and space answering such questions as "What is an amplifier?" "What is a tuner?" etc. This factor, coupled with the author's expert knowledge of the field and his ability to explain things clearly, makes this probably the best book yet to appear on the subject of stereo, especially for those who want to do more than just "scratch the surface."



"THE PURSUIT OF THE ATOM" by Werner Braunbek. Published by Emerson Books, Inc., 251 West 19th St., New York 11, N. Y. 250 pages. \$3.95.

This book covers the history of atomic research during the last 60 years. Dr. Braunbek traces the growth of our knowledge of the atom by explaining and relating the contributions made by many scientists in many countries. As bit by bit each new discovery "falls into place," the reader shares the excitement of the pioneer nuclear scientists. This interesting and illuminating book should provide several evenings of enjoyable and instructive reading.



"RAPID RADIO REPAIR" by G. Warren Heath. Published by Gernsback Library, Inc., 154 West 14th St., New York 11, N. Y. 224 pages. Hard cover, \$4.60; soft cover, \$2.90.

The old adage "Time is money" is particularly true when applied to radio repair. Since the cost of radios has been brought down to such a low level due to mass production techniques, the average customer

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Bookshelf (Continued from page 22)

is reluctant to invest more than four or five dollars in a repair when he can buy a new radio for so little. Consequently, the only way the service technician can keep his customers happy and still make a profit for himself is to keep his charges down by completing his repairs with a minimum of wasted time. This book is an alphabetical aid for diagnosing and repairing modern radios with the greatest possible efficiency. Although the average technician will find that it covers a lot of familiar ground, the number of time-saving hints it contains should make it well worth its cover price.



"THE AUDIO CYCLOPEDIA" by Howard W. Tremaine. Published by Howard W. Sams and Co., Inc., 2201 East 46th St., Indianapolis 6, Ind. 1280 pages. \$19.95.

Containing 26 sections, this massive volume covers every imaginable aspect of the audio art. Over 3400 answers to questions relating to audio are found in its 1280 pages. The index alone occupies 54 pages. A par-

tial listing of subjects would include: basic principles of sound, methods of recording and reproduction, magnetic and optical film recording, test equipment, installation techniques, general information charts and tables, etc. *The Audio Cyclo-pedia* should prove invaluable to engineers, serious audiophiles, recordists, service technicians, students, etc.

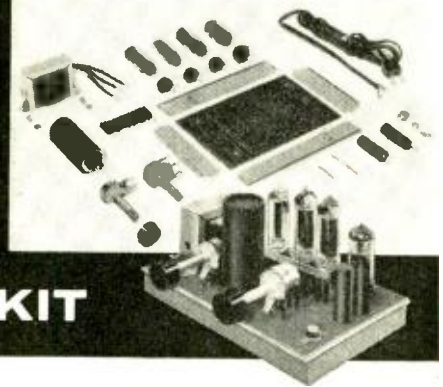
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path. Corrective steering orders are computed and transmitted automatically to the missile. The ground station monitors the progress of the flight continuously and obtains immediate evaluation of mission success. And since the principal control equipment is kept on the ground, expendable hardware in the missile itself is minimized.

This guidance system is a product of the Bell Laboratories-Western Electric development-production team. It is in production at Western Electric for the first operational squadrons of the Titan intercontinental ballistic missile.

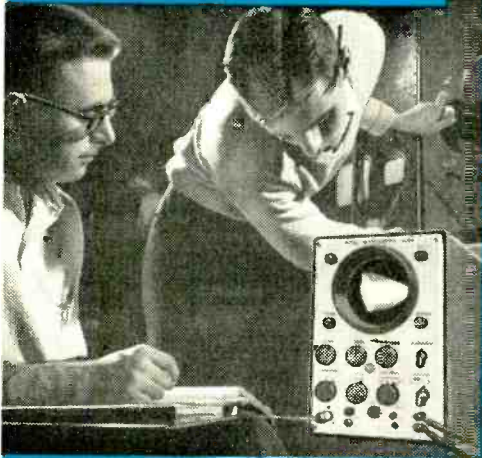
Bell Labs scientists and engineers developed the world's most versatile telephone network and much of our nation's radar. They have constantly pioneered in missile systems. From their storehouse of knowledge and experience comes this new achievement in missile guidance.

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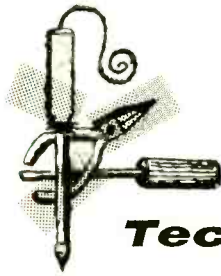


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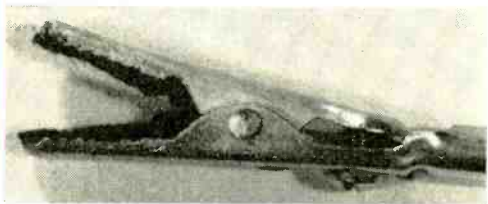
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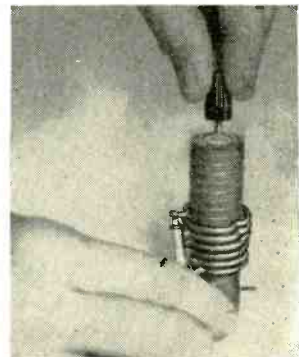
A very handy and inexpensive heat sink can be made from an ordinary small alligator clip by fastening a small piece of felt to each jaw with a spot of waterproof glue. In use, the felt is saturated with water and the clip is attached to the lead wire between



the soldering point and a heat-sensitive component. The water evaporating from the felt does a near-perfect cooling job.—
R. L. Winklepleck, Baltimore, Md.

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SPEED CHANGE

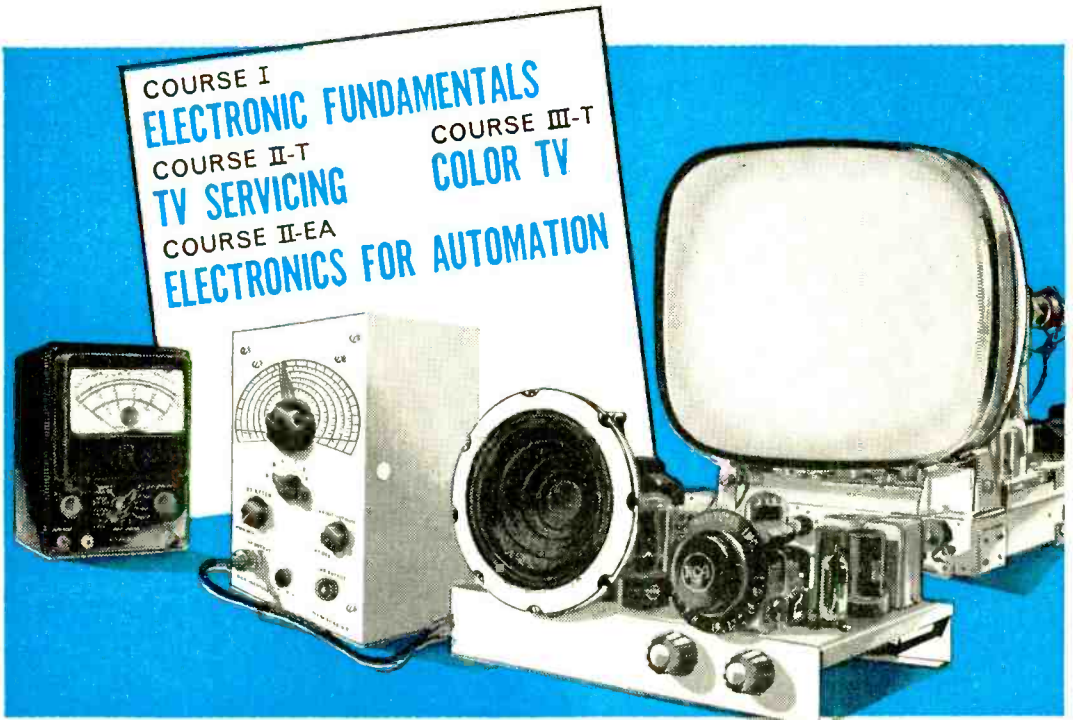
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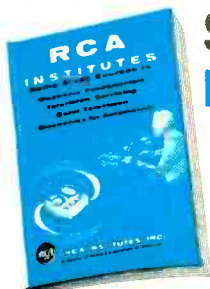
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(Continued from page 26)

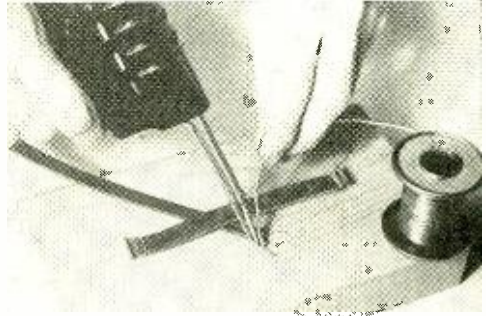
motor, thus varying its speed. This should be tried only with 2-pole motors, as better motors will overheat or stall.—*Hart Weber, Red Bank, N. J.*

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while you solder them. This type of watchband can be used for a variety of clamping jobs.—*John A. Comstock, Wellsboro, Pa.*

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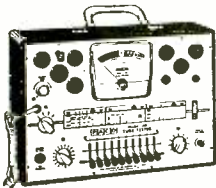
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Dependable, modern, lever operated portable tube checker for all up-to-date tubes. Available accessories adapt the

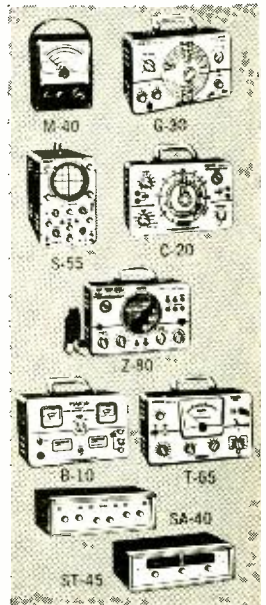
T-60 for picture tubes, including the new 110° deflection tubes. Kit Net Price: \$38.75 Factory Wired: \$54.50

Model	Description	Net Price	
		Kit	Wired
B-10	Battery Eliminator	\$41.95	\$49.50
C-20	Res-Cap-Ratio Bridge	\$20.95	\$31.50
G-30	RF Signal Generator	\$28.50	\$39.95
M-40	High Sensitivity V-O-M	\$31.50	\$37.50
S-55	Wideband 5" Oscilloscope	\$87.50	\$139.50
T-65	Transistor and Crystal Diode Tester	\$39.95	\$59.50
Z-80	RF-AF Signal Tracer	\$29.50	\$42.50
SA-40	40 Watt Stereo Preamp Amplifier	\$79.95	\$129.95
ST-45	AM/FM Stereo Tuner	COMING SOON!	

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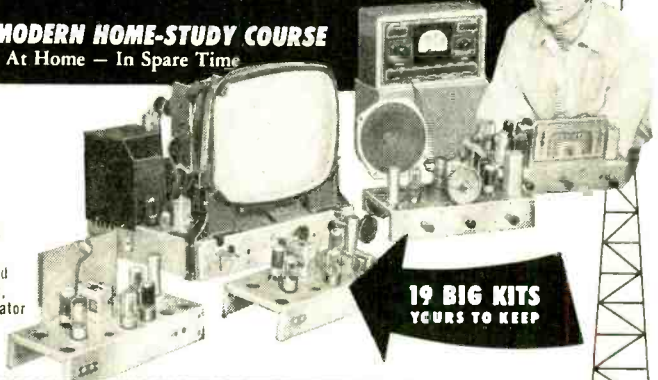
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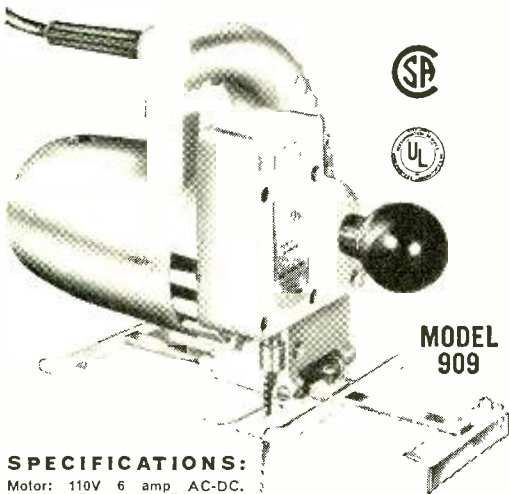
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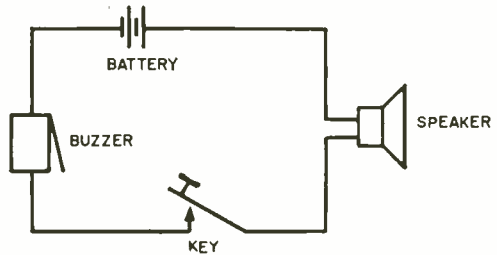
Tips

(Continued from page 28)

stalled, one should paint the screws with Insl-X, a plastic tool-handle dip of high insulating quality. It will act as a protective sheath that can easily be peeled off when necessary.—*Jerome A. Cunningham, Chicago, Ill.*

INCREASE CODE PRACTICE VOLUME

When the volume level of a code practice buzzer is not loud enough, try connecting a permanent magnet type loudspeaker in series with the buzzer and the battery as shown in the diagram. This will increase



the volume to a point where a whole class of code students will be able to follow the code.—*Howard S. Pyle, W7OE, Mercer Island, Wash.*

WARM THAT SPRAY CAN!

If you want your spray-on can of service chemicals to go further and apply easier, set the can in a pan of warm (not hot) water before using. This will make the chemical less viscous and it will spray much easier. *DON'T* overheat the can or heat it with a direct flame, for it may explode.—*John A. Comstock, Wellsboro, Pa.*

READING FADED TUBE LETTERING

When the type numbers of radio and TV tubes are obliterated to the point where they can't be read, try viewing them *through* the tube from the opposite side in a strong light. The numbers and letters are usually legible when observed in this manner provided that the interior of the tube isn't coated.—*Peter Barna, Wilmington, Calif.*

—30—

Please Note

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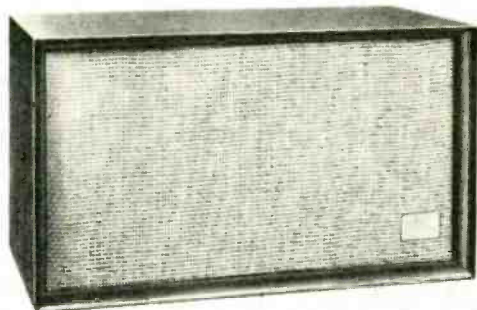
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NEW products

COMPACT SPEAKER SYSTEM

The Esquire 200, recently announced by *Electro-Voice, Inc.*, Buchanan, Mich., is the latest addition to its line of ultra-compact

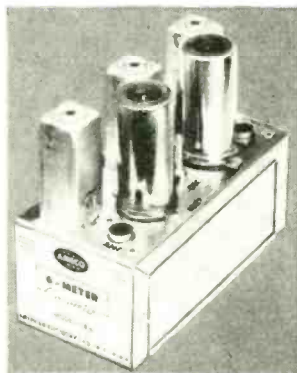


speaker systems. Drivers are a 12" long-throw woofer, an 8" mid-range speaker, and

a tweeter for the high frequencies. The manufacturer states that this system is ideal for use in pairs for stereophonic reproduction. Available in several hand-rubbed hardwood veneers.

SIX-METER CONVERTER

Features of the AMECO Model CB-6W six-meter converter include a 6BZ7 cascode r.f. amplifier and a 6U8A mixer-oscillator. Output frequency is crystal-controlled—any output frequency may be attained by changing the crystal and the tap on the output coil. Gain is 20 db with a noise figure better than 4 db. Power requirements: 117 volts d.c. at 16 ma.; 6.3 volts a.c. at .85 ampere. A separate power sup-



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TYPE	PRICE	TYPE	PRICE
0A2	.60	5J29	.50
0A3	.70	750TL	32.00
0A4	.75	807	1.00
0B2	.45	813	1.00
0B3	.65	815	1.70
0C3	.50	829B	7.00
003	.40	832	3.00
2C44	.75	832A	5.50
2021	.55	843	.30
2E24	1.95	866A	1.05
2E26	1.95	872A	1.65
4X150A	8.50	884	.80
5R4GY	1.00	885	.75
C6J	6.50	954	.20
6D4	1.50	955	.30
6X4W	1.00	957	.30
100TH	6.75	2050	.90
HF200	9.00	2051	.75
218	8.00	5751	.90
250TH	17.00	5814A	.75
250TL	17.00	5879	.90
304TL	35.00	6080	2.75
313C	1.25	6082	3.75
450TH	40.00	6146	2.45
450TL	40.00	8020	.75

0A2	5X8	6BH6	6SF5	7Z4	19BG6G
0A7GT	5Y3GT	6B86	6SF7	12A8	19J6
1B3GT	5Y4G	6BK5	6SJ7	12A8	19T8
1H4G	6A7	6BK7	6SK7	12A8	24A
1H5GT	6A8	6BL7GT	6SL7GT	12A7	25AV5
1L4	6A84	6BN6	6SN7GT	12A6	25BQ6
1L6	6AC7	6BQ6GT	6SQ7	12A7	25DN6
1NSGT	6AF4	6BQ7	6SS7	12AV7	25L6GT
1Q5GT	6AG5	6B7	6T4	12AV6	25W4GT
1R5	6AG7	6B2E	6T8	12AX4GT	25Z
1S5	6AH4GT	6B27	6U8	12AX	25Z6
1T4	6AH6	6C1	6V6	12A27	25Z6
1U4	6AK5	6C6	6W4GT	12A7	25Z6
1U5	6AL5	6C6	6W6GT	12A8	35A5
1V2	6AL7	6C86	6X5	12BA7	35B5
1X2	6AN8	6CDB6	6X8	12BE6	35C5
2A3	6A8	6CDB6	6Y6	12BF6	35L6GT
2AF4	6AQ5	6CF6	7A/XXL	12BH7	35W4
2BC5	6AQ8	6CG7	7A5	12BQ6	35Y4
38N6	6AQ7GT	6CL6	7A6	12BR7	35Z5GT
38Z6	6ARS	6CM6	7A7	12BY7	37
3C86	6AS3	6CM7	7A8	12CA5	39/44
3CF6	6AT6	6CN7	7B4	12C7	42
3CS6	6AT8	6CS6	7B5	12K7	43
3LF4	6AU4GT	6CDB6	7B6	12L6	45
3Q4	6AU5GT	6DE6	7B7	12Q7	50A5
3S4	6AU6	6DQ6	7B8	12SA7	50B5
3V4	6AV8	6E6	7B9	12SG7	50CS
4BQ7A	6AVSGT	6H6	7C4	12S7	50L6GT
4BZ7	6AV6	6J4	7C5	12SK7	50K6
5AS8	6AW8	6J5	7C6	12SN7GT	56
5AT8	6AX4GT	6J7	7C7	12SQ7	57
5AV8	6AX5GT	6K6GT	7C8	12TG7	58
5AW4	6BR	6K7	7E6	12W6GT	71A
5EK7	6B86	6K8	7E7	12X4	75
5J6	6BC5	6L7	7E7	12Z3	76
5T8	6BC8	6N7	7F7	14A7	77
5U4G	6BD6	6Q7	7F8	14B7	78
5U8	6BE6	6Q7	7H7	14C7	80
5V4G	6BF5	6S4	7N7	14D7	80
5V6GT	6BF5	6S4	7Q7	14E7	80
	6BG6	6SA7	7X7	14F7	80
		6SC7	7Y4	14G7	80
			XXFM	19	34/6Z4
				19AU4GT	117Z3
					117Z6

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products

(Continued from page 32)

ply, Model PS-1, is also available. Price for the converter is \$27.50 wired, and \$19.95 in kit form. (American Electronics Co., 1203-05 Bryant Ave., New York 59, N. Y.)

ITALIAN RECORD CHANGER

Manufactured in Italy, the Lesa CD2/21 automatic record changer has recently been made available on the American market. The CD2/21 is a four-speed machine which



automatically intermixes records of all standard sizes. Special features are an extra-heavy turntable, four-pole motor, and an automatic click suppressor. Both stereo or monophonic cartridges are accommodated. For further information, write Lesa's American sales representative, *Electrophono and Parts Corp.*, 530 Canal St., New York, N. Y.

TUBE CADDY-PAL

Hickok has recently introduced a combination tube-transistor tester and sensitive

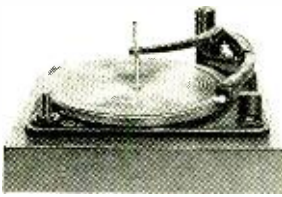


VTVM designed to fit any popular tube caddy. The tube tester section performs

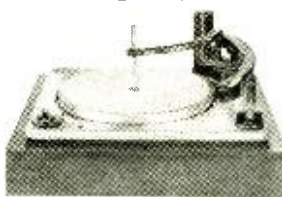
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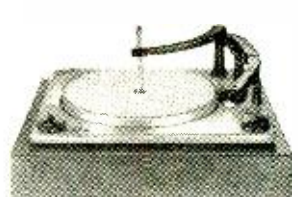
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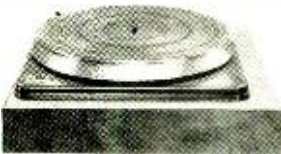
The Constellation, Model TC-99—\$59.50



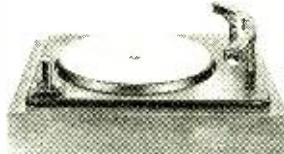
The Continental II, Model TSC-840—\$49.50



The Coronation II, Model TSC-740—\$42.50
 *The Conquest II, Model TSC-640—\$38.50



Transcription Turntable, Model 4TR-200—\$49.50



Manual Player, Model TP-59—\$29.95



Every Collaro stereo record player is built with typical British attention to every detail. They are precision engineered and rigidly tested to give truly professional performance and the ultimate in operating convenience. Here are some of the important features that make Collaro the logical choice for stereo or monophonic records. • Performance specifications exceed NARTB standards for wow, flutter and rumble with actual performance test reports accompanying each model TC 99 • Extra-heavy, die-cast, non magnetic turntables (weighing up to 8 1/2 lbs) —with actual performance test reports accompanying each model TC 99 • Extra-heavy, die-cast, non magnetic turntables (weighing up to 8 1/2 lbs) —with actual performance test reports accompanying each model TC 99 • Shilded four-pole motors are precision balanced, screened with triple interleaved shields to provide extra 25 db reduction in magnetic hum pick up • Detachable five terminal plug-in head shells (on TC-99, TSC-840, TSC-740, TP-59) provide two completely independent circuits, guaranteeing ultimate in noise reduction circuitry. • Transcription-type stereo tonearms are spring-damped and dynamically counterbalanced to permit the last record on a stack to be played with virtually the same low stylus pressure as the first. • All units are handsomely styled, available with optional walnut, blond and mahogany finished bases or unfinished utility base. There's a 4-speed Collaro stereo record player for every need and budget! Prices slightly higher in the West. For free catalog on the Collaro line, write to: Rockbar Corporation, Dept PE-10 Mamaroneck, N. Y. (*Not shown. Similar in appearance to The Coronation.)



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products

(Continued from page 34)

critical "fringe" tests of gas, grid emission, contact potential, leakage and shorts, while the transistor test section tests all standard transistors.

Model 820 measures volts in four ranges, from 1.5 to 750 volts. Three resistance ranges cover 1 ohm to 100 megohms. Price, \$99.55. (Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland 8, Ohio.)

STEREO MULTIPLEX ADAPTER

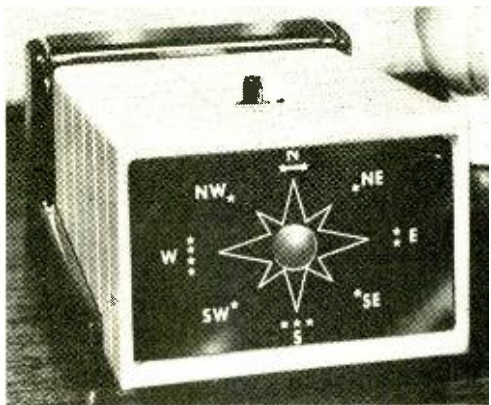
An FM multiplex adapter announced by Fisher Radio Corp., 21-21 44th Drive, Long Island City 1, N. Y., makes possible the re-



ception of FM stereo broadcasts produced with the Crosby multiplex system. The MPX-10 can be connected to any FM tuner equipped with a multiplex output. Price, \$79.50. Cabinet, \$12.95 extra.

ANTENNA ROTATOR

Claimed to be the first 45° flasher rotator in the industry, the "Electric Eye Tenn-A-Liner," Model 9523, has just been an-



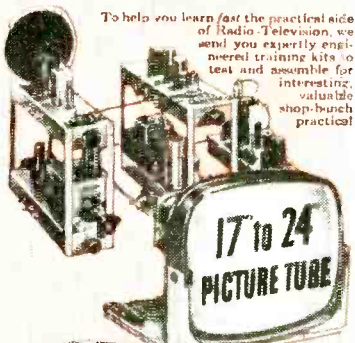
nounced by Channel Master Corp., of Ellenville, N. Y. As the antenna is rotated, the "electric eye" indicator signals in the following way: one steady flash signifies that

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products

(Continued from page 36)

the antenna is facing north; two flashes, east; three flashes, south; and four flashes, west. The rotator has high torque and can turn the heaviest fringe-area antennas. List price, \$33.95.

GENERAL-PURPOSE MIKE

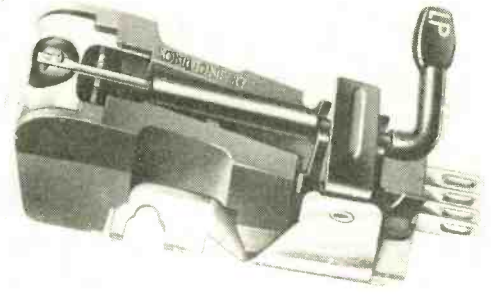
American Microphone Mfg. Co., 412 South Wyman St., Rockford, Ill., is producing a new microphone, the Model D-10, which is equally useful in public address, paging systems, amateur work, and home recording. Frequency response is from 50 to 11,000 cps. Output impedance is 50 ohms and output level -57 db. List price, \$29.50. A similar high-impedance unit, Model D-10T,



has an output impedance of 40,000 ohms, an output level of -55 db, and is priced at \$33.00.

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Sonotone Corp., Elmsford, N. Y., has released its new Model 8TA ceramic stereo



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-30-

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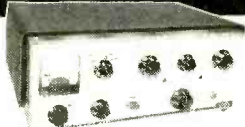
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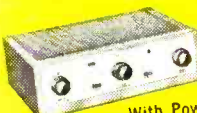


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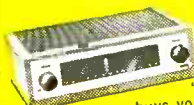
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See Page 38 for EICO'S BEST BUYS in "HAM" GEAR and TRANSISTOR RADIOS.

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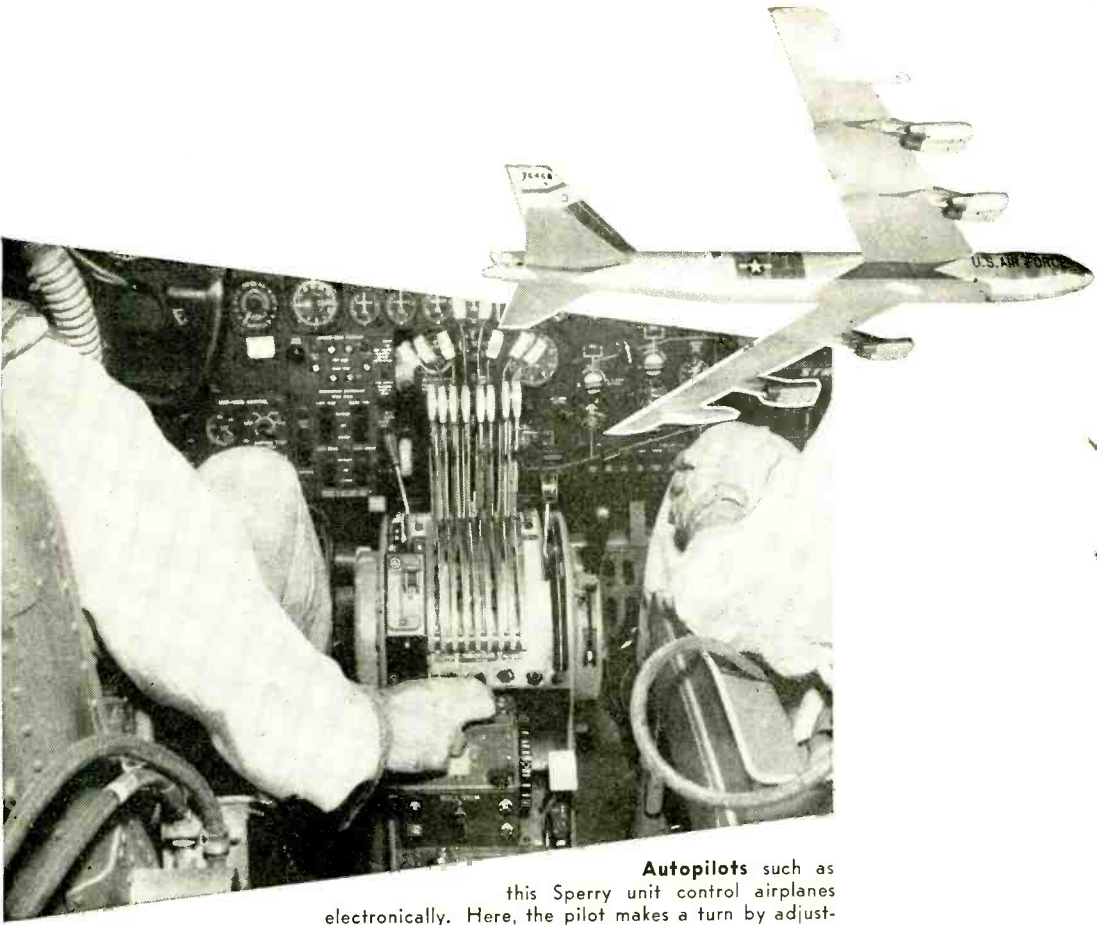
avionics systems

are already in use today

ON A CLEAR August day in 1910, a be-goggled boot-shod aviator named James McCurdy guided a kite-like Curtiss biplane through the air over Sheepshead Bay, New York. Aloft with him was a crudely packaged collection of coils, capacitors, and wires. As he piloted his craft over the bay, McCurdy tapped away on a telegraph key. On the ground nearby an associate listened intently to a radio receiver, transcribing the crackling dit-dahs into:

Horton: Another chapter in aerial achievement is recorded in the sending of a wireless message from an airplane. McCurdy.

Thus it was that James McCurdy became the father of avionics—aviation electronics. Although he certainly guessed the significance of his achievement,



Autopilots such as this Sperry unit control airplanes electronically. Here, the pilot makes a turn by adjusting a knob on the autopilot instead of using manual controls. Regular controls can override the autopilot if an emergency situation should occur.

McCurdy probably never dreamed that the next half century would see electronic gadgetry become almost as important to a plane as its rudder.

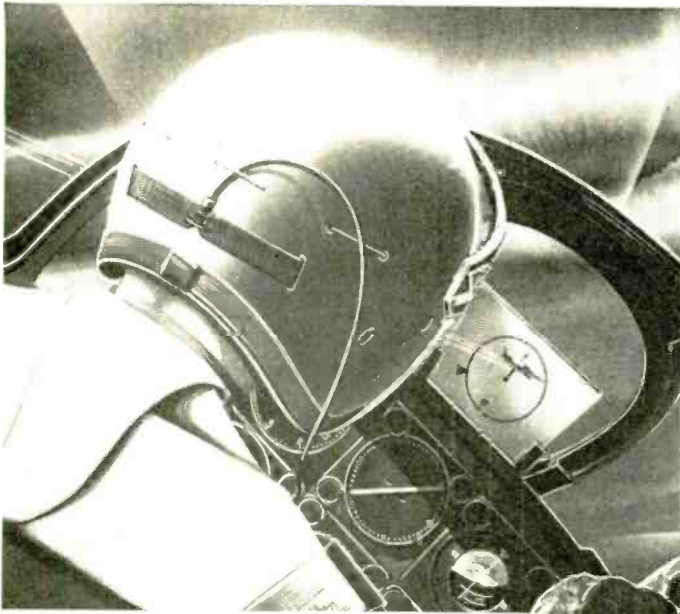
Today electronic systems not only provide a pilot with a means of keeping in contact with airports and other planes. They show him his course. They warn of bad weather ahead. They enable him to make a perfect landing in complete darkness. They take over so much of the flying job that, in some cases, the pilot just goes along for the ride.

Just how far and how fast aviation electronics has come along is suggested by comparing today's aircraft with the flying machines of World War II. The Norden bombsight of wartime days weighed 50

pounds, cost \$8000; today's radar-computer bombsights weigh 2000 pounds, cost \$250,000. A typical World War II fighter had 1545 feet of wiring; a jet fighter today carries 23,000 feet of wire. The modern fighter has nine electronic communications systems, three times as many as a World War II job.

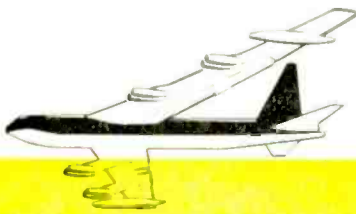
Electronics Takes Flight. Electronics played handmaiden to many of aviation's greatest achievements. As we all know, Lindbergh made the first non-stop solo crossing of the Atlantic in 1927. But few people remember that, in 1919, six Navy airmen flew a NC-4 flying boat over the big pond. All the while they kept in touch with the fleet via wireless telegraph.

In 1933, Sperry Gyroscope Co. teamed



Optical gunsight in F-104 Starfighter, part of General Electric fire-control system, helps pilot aim and fire. It tells him when target is within range, when to fire, and when the plane has come dangerously close to the target.

Simplified model of the electro-mechanical linkage used in the B-58's adaptive control system. Designed by Bendix Aviation, this system prevents the pilot from oversteering the plane.



up with Wiley Post to startle the world with a new super-gadget, the automatic pilot. Post soloed around the world in his "Winnie Mae," enjoying cat naps while the autopilot watched the store. When he fell deeply asleep, a wrench tied to his wrist would fall out of his hand, literally yanking him back to wakefulness.

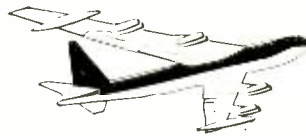
As the Thirties rolled by, avionics started making life a lot safer for the average flyer. A pilot who lost his way had little to fear with a radio direction finder aboard. All he had to do was tune it until he got a local radio station, take a bearing, and fol-

low the broadcast right to its home town.

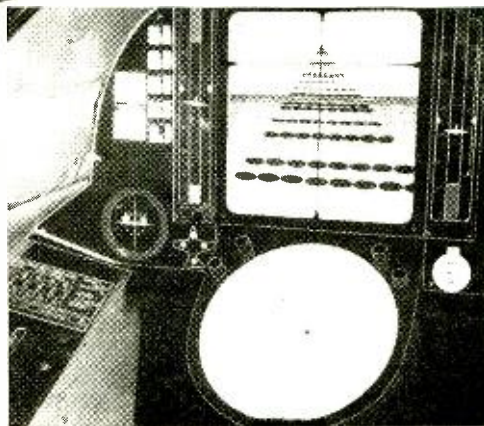
The radio altimeter was another life saver. With one of these electronic gadgets, a pilot didn't have to worry about finding himself skimming treetops while staring at an air-pressure device which gave him an altitude reading of 5000 feet. The radio altimeter avoided the problems inherent in barometric altitude devices by bouncing a beam off the ground and electronically measuring how long it took to come back;



Moving map above pinpoints location of helicopter in Bendix-Decca navigating system. Stylus receives signals from ground transmitters and interprets them into course line. The speed of the map moving on rollers matches the speed of the helicopter.



TV-like displays like that below will take the place of cluttered instrument panels in aircraft of the future. The necessary information is generated by a small computer. (Official U. S. Navy photograph)



this time difference was then converted into an accurate altitude reading.

When the second World War came along, both aviation and electronics got a big boost. Radar and other devices were introduced which have become an important part of the flying scene. Take the Norden bombsight, for instance.

As a Norden-equipped B-17 got set to start its bomb run, the navigator would call out on the interphone: "Give me second station." With the usual "Roger," the pilot would then flip a switch on the autopilot and sit back. The bombardier, hunched over his sight, would twist a dial first one way and then the other, making the plane change course as if it were a huge gun he was sighting. Then bombs away, and the pilot would take over again.

Remote Control Pilots. The Norden system was one of the first practical remote control link-ups with an autopilot. Some of the systems we have today are even more awe-inspiring. The SAGE (Semi-Automatic Ground Environment) air defense system, for example, picks up approaching planes on its radar and tells which way they are going and at what speed. But that isn't all. Through a radio link-up with the autopilots of our fighter planes, SAGE can actually fly the planes automatically to the "intercept" point.

A similar system has been devised to

give carrier-based naval pilots an electronic assist during landings at sea. Today's naval aviator need only get into his carrier's traffic pattern, and his troubles are over. Radar on the flight deck keeps him under watch and a radio-controlled autopilot jockeys the plane around for him. If a sudden gust of wind or a rough sea throws off the approach, the plane gets an electronic wave-off. All the pilot has to do is cut his switches once he's safely on the deck.

Electronic Fire Control. Few things are more important in a warplane than the ability to aim and fire with precision. During World War II, when high-speed planes would get out of range before the gunners could figure out where to point their weapons, it became obvious that electronic help was necessary. Such help was provided by the building of electronic calculators and servo systems right into the gunsight system. With this arrangement, if the flyer could recognize what was coming at him

(Continued on page 130)

Build a Novice Band Receiver

Two-tube regen circuit features wide bandspread

on 80, 40 and 15 meters

HERE IS a receiver which uses only two tubes, requires no alignment, yet will give the average low-priced superhet a run for its money in Novice band c.w. reception. And it has an important advantage usually found only in expensive communication receivers: the Novice bands are spread over a large portion of the main tuning dial for easy tuning. For example, the 80-meter c.w. band occupies almost half the total dial space on the main tuning dial, a big aid to the beginner in finding the band and tuning in stations.

Two octal base tubes are used in the receiver. The 6SN7 and the 6V6 are readily available types, with tube sockets large enough so that soldering is easy. Likewise, layout is "wide open" for ease of wiring. Coil winding is no problem as coils are

available "ready made" (although they have to be modified slightly).

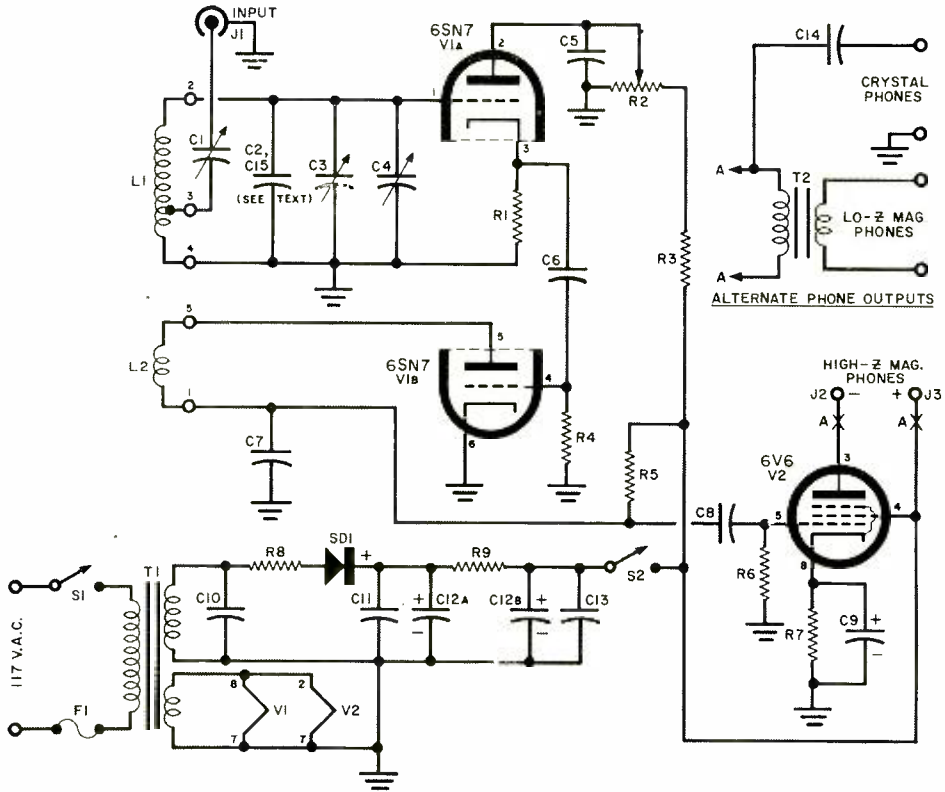
Construction. Drill and cut the chassis and front panel following the layout shown in the illustrations. Notice that the tubes and coils are located close to the front panel to keep tuning leads short and to provide shielding from hand-capacity effects. The power supply is at the rear of the chassis.

The coils are the heart of the receiver, so prepare them with care. One plug-in coil (L_1 , L_2) is used for each of the three Novice bands. In order to achieve high "C," each coil is used on a *lower* frequency than that for which it is marked when it comes from the factory. For example, the coil used to tune the 80-meter band is a 40-meter B&W, 25-watt "Baby" inductor, the type ordinarily used in small transmitters. A similar B&W 20-meter coil is used for receiving the 40-meter band, and a 10-meter coil for 15 meters.

There are several coil modifications to be made. On both the original 40-meter and 20-meter coils, a 100- μ f. silver mica capacitor is soldered *across* the total coil winding. As shown on the coil socket diagram, this capacitor is connected to pins "2" and "4." On the original 10-meter coil, no capacitor is used; however, the center tap on the coil is moved over and resoldered so that it is approximately $1\frac{1}{8}$ turns from



By
JOHN STOCKTON



Phones used with receiver can be crystal, low-impedance or high-impedance type. If output circuit for crystal or low-Z phones is employed, transformer T2 should be mounted away from tuning coils.

PARTS LIST

- | | |
|---|--|
| C1—3-30 μ f. mica trimmer capacitor | R2 100,000-ohm, 2-watt potentiometer (Ohmite CU1041 or equivalent) |
| C2, C15—100- μ f. silver mica shunt capacitor (one used to modify 40-meter coil for 80 meters, the other to modify 20-meter coil for 40 meters) | R3—47,000-ohm, 2-watt resistor |
| C3—100- μ f. variable capacitor | R4—1.5-megohm, 1/2-watt resistor |
| C4—15- μ f. variable capacitor | R5, R6—470,000-ohm, 1-watt resistor |
| C5—0.5- μ f. (or higher), 200-volt capacitor | R7—2500-ohm, 2-watt resistor |
| C6—250- μ f. mica capacitor | R8—47-ohm, 1-watt resistor |
| C7—100- μ f. mica capacitor | R9—1000-ohm, 2-watt resistor |
| C8—.01- μ f., 400-volt capacitor | S1, S2 S.p.s.t. toggle switch |
| C9—20- μ f., 25-volt electrolytic capacitor | SD1—Silicon diode, 50 ma. or higher |
| C10—.005- μ f., 600-volt paper capacitor | T1—Power transformer; secondaries, 125 volts, 50 ma.; 6.3-volt, 2-amp. filament winding (Merit P-3045 or equivalent) |
| C11, C13—.01- μ f., 600-volt capacitor | T2—6V6 output transformer, single plate-to-voice coil (see schematic diagram) |
| C12a/C12b—Dual 30- μ f., 150-volt electrolytic capacitor | V1—6SN7 tube |
| C14—.01- μ f., 600-volt capacitor (used with crystal headphones) | V2—6V6 tube |
| F1—1-amp. fuse and holder | 1—2" x 8" x 10" chassis |
| J1—Antenna jack | 1—8" x 11" aluminum front panel |
| J2, J3—Pin tip jacks | Misc. hardware, grommet, terminal lugs, five-prong ceramic coil socket, octal tube sockets (two—one ceramic) |
| L1, L2—See text | |
| R1—4700-ohm, 1-watt resistor | |

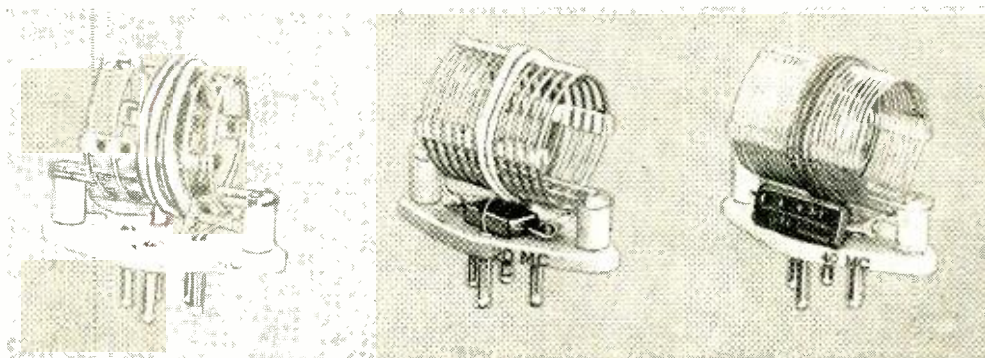
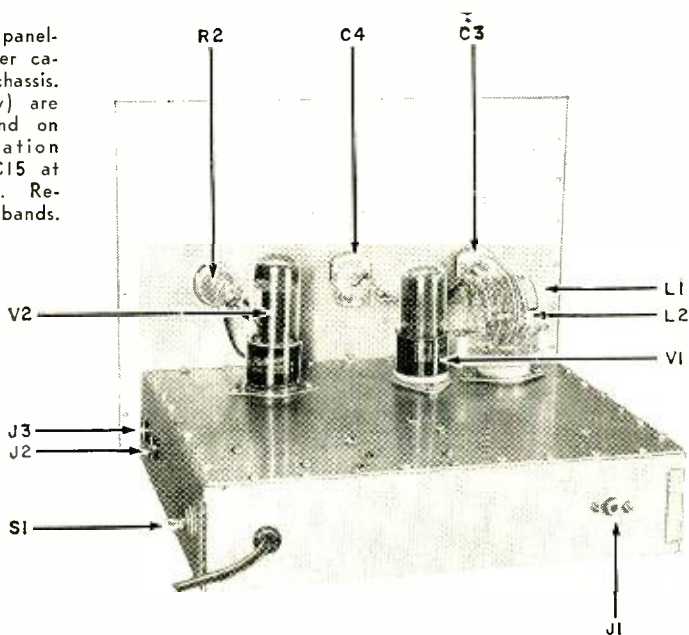
the pin 4 end of the coil (closer to "ground" to reduce antenna coupling).

Once the above modifications are completed, the next step is to add tickler windings. This is very easy to do, except that care is needed to avoid the possibility of

improper polarization of windings. Start out by looking at the bottom of the modified 40-meter coil, with the pins facing you.

As shown on the socket diagram, this tickler winding starts with unused pin 1. Solder one end of a piece of hookup wire in

All receiver controls are panel-mounted except antenna trimmer capacitor C1, located under the chassis. Tuning coils (see photos below) are modified for specific ham band on which each is used; note location of shunt capacitors C2 and C15 at base of 80- and 40-meter coils. Re-label coils for new operating bands.



this pin. Then make three turns around the center of the coil and solder the remaining free end of the wire into unused pin 5. It is important that this winding, like the winding already on the coil, be in a clockwise direction.

The tickler for the modified 10-meter coil should also have three turns, while the tickler on the modified 20-meter coil should be wound with two turns.

Testing and Adjustments. Before applying power, it is a good idea to "polarize" high-impedance magnetic headphones by making certain that the B-plus lead of the phones goes to the B-plus in the set. One pin on most magnetic headphones has this lead identified by a colored stripe (usually red). Low-impedance magnetic headphones or crystal headphones must *not* be placed in the plate circuit of the 6V6. See the

schematic diagram for circuits used with various headphones.

There are two power switches. The "stand-by" switch (S2) on the front panel is used to shut off the receiver when you are transmitting. At the side of the chassis is the main power switch (S1).

In testing the set, first connect the antenna and ground. The antenna can be a single wire, preferably 60' or longer, erected as high as possible. While the set will work on an indoor antenna run around the room, much better results can be expected from a good outdoor antenna, for example, your transmitting antenna. Any type of convenient jack or terminal can be used for the antenna connector (J1). The chassis should be grounded to a cold water pipe or other good ground.

(Continued on page 126)



**LOOK
and LISTEN
with a
Sunglasses
Radio**

IF YOU THINK you've seen everything, stop a minute and take a look at this! It's a three-transistor radio built into a pair of sunglasses. And it really works!

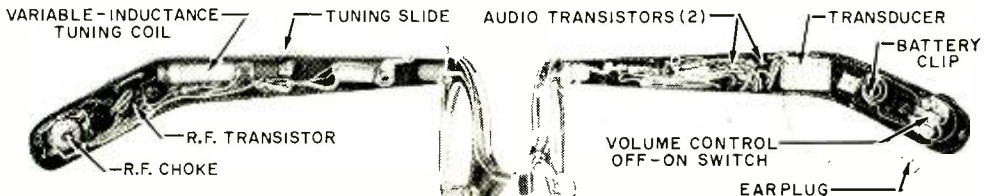
The electronic components are fitted into the arms of the sunglasses. The left arm contains the r.f. circuitry—including an r.f. transistor, a diode, and a sliding-core variable inductor which is used to tune in the stations. All the audio circuitry is housed in the right arm; the audio components include two transistors, a transducer, and a combination volume control and on-off switch. A flexible plastic tube connects the transducer to the plug which fits into the right ear.

In the New York area, six local stations were picked up clearly with this radio, and the sensitivity seemed to be quite good over the entire broadcast band. Due to the low number of tuned circuits, selectivity was not particularly good, and some stations spilled over onto their next-door neighbors; in areas where fewer stations are on adjacent channels, however, the selectivity should be quite adequate. The audio response is peaked to some extent in the mid-range, but the audio quality is surprisingly good.

Powering the radio is a thumbnail-sized mercury cell battery. This 1.3-volt midget is estimated to run the receiver for about 160 hours of continuous operation. Replacement batteries (Mallory RM625 or equivalent) are available from most radio parts stores for 35 cents each.

Everything considered, the sunglasses radio packs an amazing wallop. Marketed by Lafayette Radio, this Japanese import is priced at \$24.50.

-30-



▲ **Major components** of the sunglasses radio are pointed out above. A total of three transistors is used.



◀ **"Swing-up" cover** for the battery compartment makes the tiny mercury cell battery easily accessible.

Build a



By
HARRY KOLBE

SUPER STEREO AMPLIFIER

Each output of this two-channel simplex amplifier delivers 50 watts effective power at low distortion

HOW would you like to build us a super-de luxe stereo simplex amplifier?" the editors of POPULAR ELECTRONICS asked me. "Sure," I said. After all, I had already built a 10-watt job (the "Stereoplex," described in the April 1959 issue) and a souped-up one should be a snap—or so I thought.

My first step was the design of a top-notch mono amplifier. A Dynaco A-431 output transformer was chosen for use in the popular "screen-tapped" output circuit, as this transformer will deliver at least 60 watts of power at low distortion when it is fed by 6550's, KT88's or EL34's.

Circuit Considerations. The mono section of the amplifier is a variation of the excellent Mullard 520 circuit. The input stage uses an RCA 5879 low-noise pentode, with *R6*, *R8*, and *R10* forming a voltage divider which supplies the correct bias and screen voltages. An 1800-ohm resistor (*R12*) in series with a 100- μ f. capacitor (*C1*) is connected across the plate load resistor to minimize high-frequency phase shift and to increase stability.

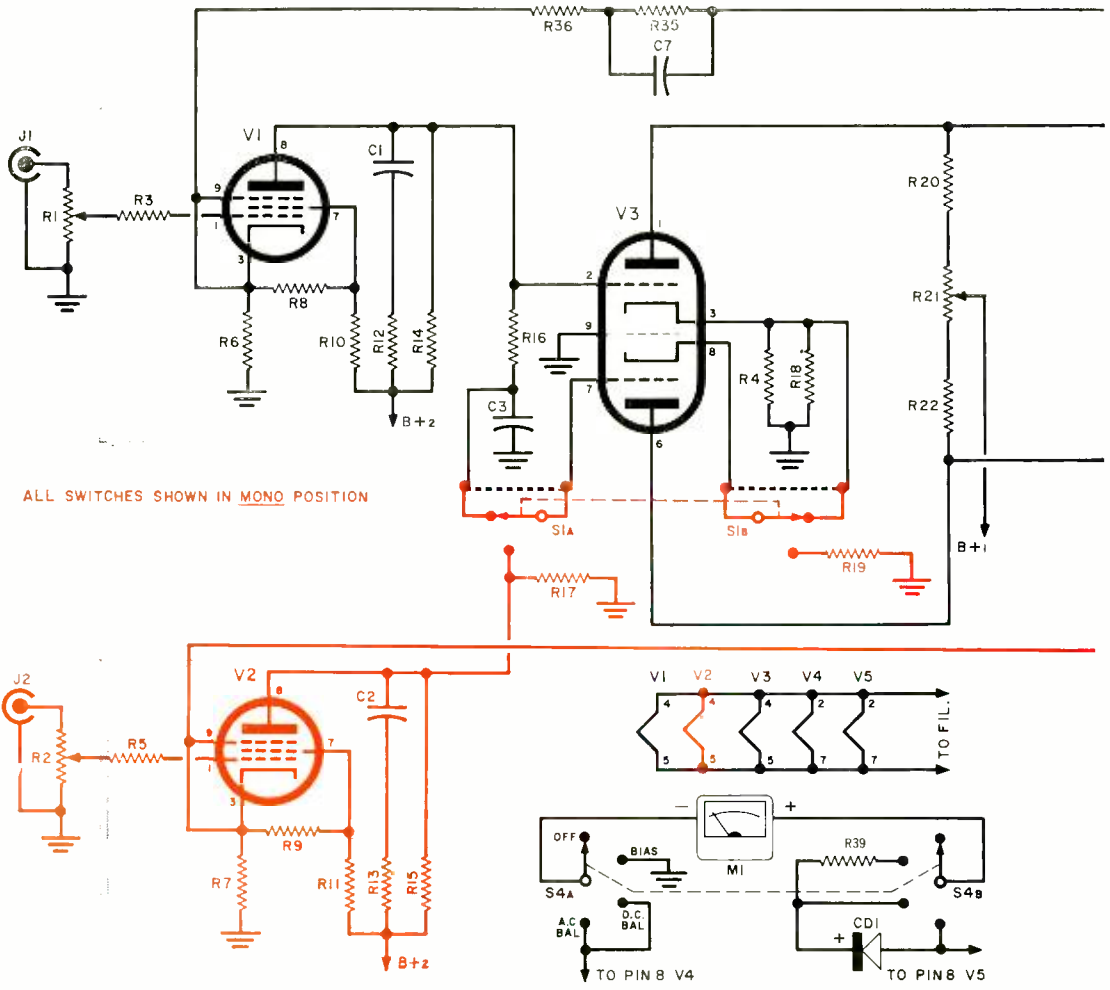
In the phase inverter circuit, I used the cathode-coupled or "long-tailed pair" con-

figuration. This circuit was chosen because it provides exceptionally well-balanced, low-distortion output in mono use and, in addition, it can be switched to function as two straight triode amplifiers for simplex operation.

Power Supply. Silicon diode rectifiers were used in a voltage-doubler power supply. This type of rectifier has several advantages over vacuum-tube rectifiers: (1) small size, (2) low voltage drop—resulting in excellent voltage regulation under vary-

•••••
• The Super Stereo Amplifier should not be
• your first—or even your second—construction
• project. It is expensive and complex, and
• should be attempted only by one who has
• more-than-average experience and knowledge
• of electronic construction techniques. The
• theory of simplex operation was discussed fully
• in the April issue of POPULAR ELECTRONICS.
• Component placement is uncritical except
• for the usual precaution of keeping input and
• output circuits away from each other. In gen-
• eral, the author's layout should be followed.
• Chassis punching dimensions will depend upon
• the specific components used.
•••••

—THE EDITORS



Sections of amplifier diagram enclosed in shaded lines are individual Vector socket assemblies. Color portions show optional simplexing circuitry; if this is omitted, make connections shown by dashed lines. Bias adjustment is made with R28 *without* depressing S3. Set a.c. balance with switches in Mono position and a test tone going through amplifier. Depress S3 and adjust R21 for minimum meter deflection. R24 similarly sets d.c. balance, but without input signal.

ing current demand, (3) cool operation, and (4) extremely long life.

Several different power transformers can be used. Two models of RCA replacement transformers (#78893 and #79971) are currently available from Barry Electronics Corp. (512 Broadway, New York 12, N. Y.) at a cost of only \$4.50 each. Either of these transformers is satisfactory. Alternately, the more expensive Triad R-93A is also stocked by most large dealers.

The transformers and output tubes are protected by fuses in both the power line and the B+ circuit. In addition, an Amper-

ite thermal delay tube allows the tubes to warm up for ten seconds before the B+ voltage hits them.

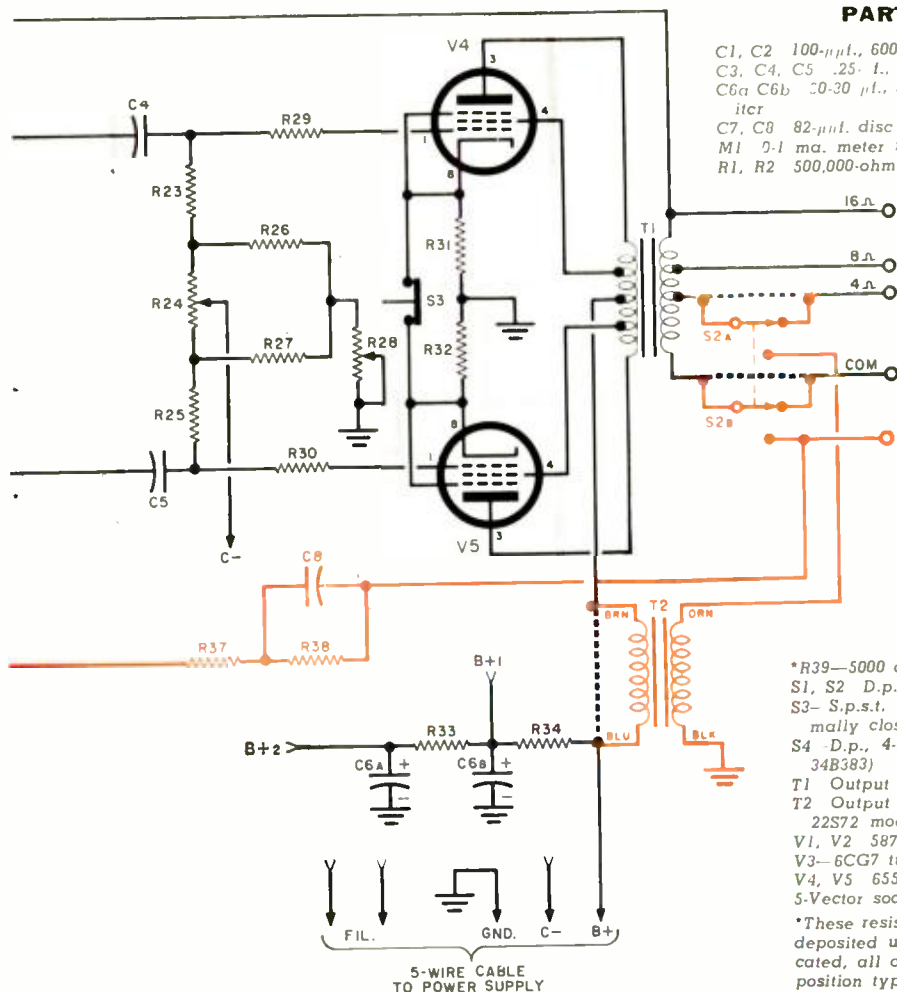
Since this was supposed to be a perfectionist's amplifier, I couldn't resist building in a meter circuit to allow adjustment of the bias as well as the a.c. and d.c. balance. This circuit is, of course, optional.

To keep noise to a minimum, one-watt low-noise resistors were used in the input stages and feedback loop, and high-quality standard carbons were employed in the rest of the circuit (unless otherwise specified). The investment in quality resistors paid off,

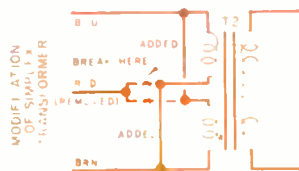
PARTS LIST

- C1, C2 100- μ l., 600-volt disc capacitor
 C3, C4, C5 .25- μ l., 600-volt capacitor
 C6a, C6b 20-30 μ l., 500-volt electrolytic capacitor
 C7, C8 82- μ l. disc ceramic capacitor
 M1 0-1 ma. meter movement
 R1, R2 500,000-ohm potentiometer
 R3, R5, R29, R30—10,000 ohms, 1/2 watt
 R4, R18 36,000 ohms
 *R6, R7 750 ohms
 *R8, R9, R35, R38—3000 ohms
 *R10, R11—120,000 ohms
 *R12, R13 18,000 ohms
 *R14, R15 180,000 ohms
 R16, R17—1.5 megohms
 R19 18,000 ohms
 R20 22,000 ohms
 R21, R24—10,000-ohm, 2-watt potentiometer
 R22—27,000 ohms
 *R23, R25 100,000 ohms
 R26, R27—10,000 ohms
 R28—20,000-ohm, 2-watt potentiometer
 R31, R32—24 ohms, 2 watts, 1%
 R33—68,000 ohms
 R34—15,000 ohms, 10 watts, wire-wound
 *R36, R37 3000 ohms

- *R39—5000 ohms
 S1, S2 D.p.d.t. toggle switch
 S3—S.p.s.t. push-button switch (normally closed)
 S4—D.p., 4-pos lever switch (Mallory 34B383)
 T1 Output transformer (Dynaco A-431)
 T2 Output transformer (Thordarson 22S72 modified as per schematic)
 V1, V2 5879 tube (RCA)
 V3—6CG7 tube
 V4, V5 6550's, KT88's, or EL34's
 5-Vector sockets; 2 octal, 3 noval
 *These resistors are 1%, 1-watt carbon-deposited units. Unless otherwise indicated, all others are 10%, 2-watt composition types.



Tube	Power at Clipping Point	Input Sensitivity for Full Output	IM at 60 watts 4:1 60/7000 cps	Recommended Bias (as read by M1) Mono Stereo
6550	72 watts	0.87 volts	0.85%	1.82 v. 2.5 v.
KT88	72 watts	0.88 volts	0.9 %	1.65 v. 2.2 v.
EL34	68 watts	0.75 volts	0.5 %	1.45 v. 2.0 v.



since the combined hum and noise figure was 92 db below maximum output.

Converted, But Clipped. So far, so good. I had a fine monophonic amplifier. Now, I thought, conversion to simplex operation would be a cinch—just add another input stage, a second transformer, and switching to convert the phase inverter into two voltage amplifiers.

So I did—and you should have seen the

scope trace! The positive peak of the sine wave was lovely—but the negative peak was completely clipped!

For those who may not be familiar with the theory of simplex operation, let's examine a few of its basic truths. The stereo signal picked up from a stereo disc is composed of a *sum* signal (which contains the major power component) and a *difference* signal (the stereophonic information). In a

simplex amplifier, the sum signal is amplified in push-pull throughout while the difference signal is amplified in parallel.

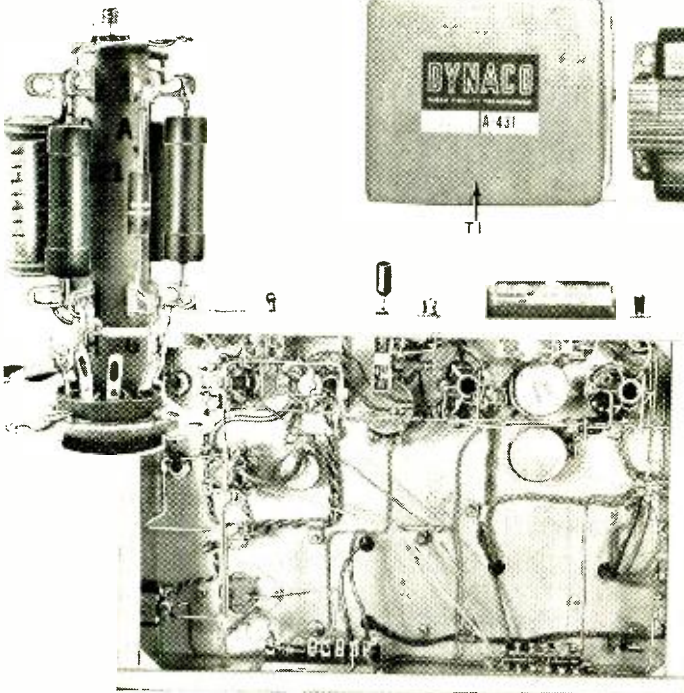
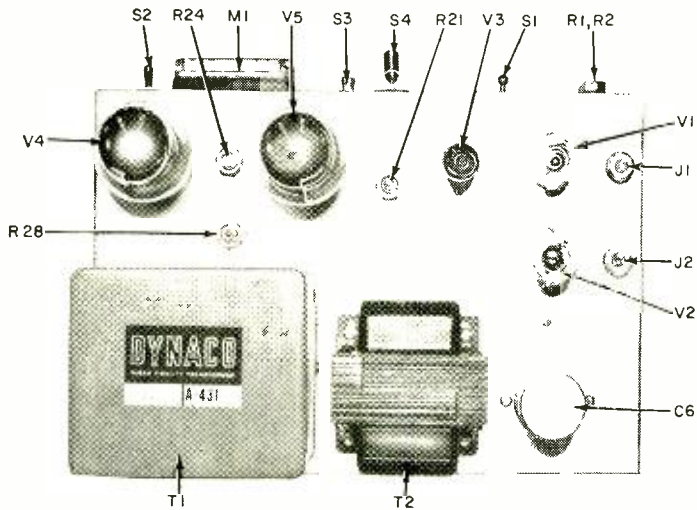
Now back to the problem at hand. Not only was the parallel (difference) signal badly clipped on one side, but to add to my troubles, the hum level had gone up.

At this point I remembered that the monophonic amplifier was running in Class AB1. This means that the tube was biased way down on its operating curve. A large positive peak could be handled, but the negative peak would drive the tube into cutoff and hence would be clipped. In push-pull operation, this would make no difference because the positive peak would be handled by one output tube and the negative by the other. However, when we drive both tubes in parallel, the tubes swing together on the positive peak *and* on the negative—which causes clipping.

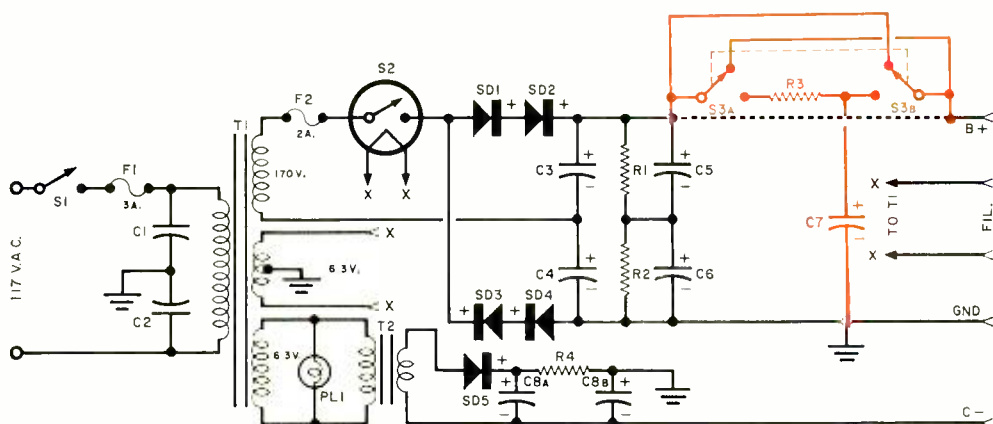
In terms of my amplifier, the only solution was to bring the operating point closer to Class A operation. This could easily be done by lowering the bias on the output tubes. However, lower bias would mean that the tubes would draw excessive current unless the plate voltage was also lowered. Obviously, a redesign of the power supply was called for. Sure enough, adding an extra stage of RC filtering simultaneously dropped the hum level and the B+ voltage. Switch S3 allows bypassing the extra network for mono operation.

Transformer Troubles. After making the necessary circuit changes and readjusting the bias, I again hooked up the scope and signal generator only to be rewarded by a very low powered and badly distorted waveform. Several weary hours later I was forced to the conclusion that my troubles were caused by my simplex transformer.

Component placement shown in top chassis view of the stereo amplifier (right) should be followed for best results.



Turret socket type of construction employed is shown in bottom view of completed chassis.



Power transformer T1 shown in schematic diagram of power supply is RCA type with dual filament windings. Triad model has single winding.

PARTS LIST

- C1, C2— $.03\text{-}\mu\text{f.}$, 600-volt capacitor
 C3, C4, C5, C6— $150\text{-}\mu\text{f.}$, 300-volt electrolytic capacitor
 C7— $50\text{-}\mu\text{f.}$, 500-volt tubular electrolytic capacitor
 C8a/C8b— $50\text{-}50\ \mu\text{f.}$, 150-volt electrolytic capacitor
 F1—3-amp. fuse (and holder)
 F2—2-amp. fuse (and holder)
 PL1—6.3-volt pilot lamp assembly
 R1, R2—100,000-ohm, 2-watt resistor
 R3—500-ohm, 50-watt wire-wound resistor
 R4—10,000-ohm, 1-watt resistor
 S1—S.p.s.t. toggle switch
 S2—10-second time delay relay tube (Amperite 6N010)
 S3—D.p.d.t. toggle switch
 SD1, SD2, SD3, SD4, SD5—Silicon diodes (Audio Devices Type 40E5)
 T1—Power transformer; 117-volt primary; 170-volt and 6.3-volt secondary
 T2—Filament transformer, 117-volt primary; 6.3-volt, 1-amp. secondary
- All electrolytic capacitors are can types with cardboard insulating tubes unless otherwise indicated.*

Experiments with several output transformers of varying impedances proved that there was a critical impedance match (4:1 ratio) between the primaries of T1 and T2. And to add to the problem, it seems that the secondary matching between the two transformers was also critical and must be about 4:1. I now searched through the catalogs for a suitable transformer—one with a primary impedance of 1100 ohms, a secondary of 4 ohms and which was capable of carrying 60 d.c. watts. There was no such animal.

Since a compromise was in order, I modified a Thordarson 22S72 audio output transformer. In its original state this transformer has a 3000-ohm center-tap primary with a multi-tap secondary and is capable of carrying about 30 watts. By paralleling both halves of the primary, I would get a primary impedance of 750 ohms and a current-carrying capacity of 60 watts. The impedance ratio was not perfect, but static

tests indicated that both the parallel and push-pull channels worked properly.

Success! Now it was time to give the amplifier an initial listening test. After carefully reversing the polarity of one set of leads from my Shure M3D stereo cartridge (see "Stereo Simplexing Simplified," April 1959), I turned everything on. Ah, sweet stereo—it sounded great!

At this point, the amplifier was given a final instrument check and it proved capable of 50 watts effective output on each channel at only 0.6% IM distortion.

And so ends the stereo simplex saga. It's up to the builder whether he wants to construct the mono amplifier (either with or without the extras) or add the simplexing circuits and turn it into a stereo amplifier. Of course, if you're a real fanatic like my wife says I am, you'll want to build two 70-watt mono jobs—one for each channel.

Hmm, let's see, now, where did I put that soldering iron?

Test Instruments

The Oscilloscope



Part 2

Horizontal Sweep Circuits

By **LARRY KLEIN**
Technical Editor

LAST MONTH we investigated the inner workings of the cathode-ray tube. We found that the neck of the tube contains a device called an *electron gun*. This gun emits a stream of particles which passes through an obstacle course of bending, focusing and accelerating elements on its way toward the phosphor-coated face of the CRT. If everything's okay, we see a pinpoint of light on the CRT face where the beam hits.

But now that we have the spot on the face of the CRT, how do we go about getting it to produce meaningful waveforms? Remember that last month we found two sets of deflection plates in the CRT. One pair swings the beam right and left—the other pair swings the beam up and down. (See Fig. 1.) If we want to refer to the movements in a more formal way, we speak of the X-axis and the Y-axis.

On the Axis. If you remember your geometry, you know that the terms X-axis and Y-axis are drawn from graph plotting. Basically, graphs show changes that occur over a period of time—such as business

changes over a year, temperature changes over a week, or voltage changes over a fraction of a second.

Long before the CRT was developed, there were instruments called *oscillographs* which were capable of drawing a trace on a photographic plate or a smoked drum. But these were all mechanical devices (like meter movements) and could respond only to simple waveforms in a limited band of frequencies. Since the dot on the face of the cathode-ray tube is inertialess, it has no difficulty in flashing from one side of the CRT face to the other thousands of times a second.

Let's investigate what this means in terms of what is seen on the scope face. The instant we apply an a.c. signal to the horizontal plates high enough in voltage and frequency, the spot appears to turn into a thin horizontal line. Appearances are deceiving, however, because the spot is still the same size—it is being driven back and forth too fast for the eye to follow.

The a.c. signal voltage with its rapid alternation between positive and negative

is responsible for the shuttling action. Some scopes which have provision for slowing down the sweep rate will let you see the spot in its travels—it looks like a miniature comet, complete with tail.

Sine and Saw. While the a.c. sine-wave input will serve to demonstrate how the deflection plates work, another type of waveform must be applied to the horizontal plates before meaningful traces can be obtained.

Assume that we want to view the waveform at the secondary of a 60-cycle fila-

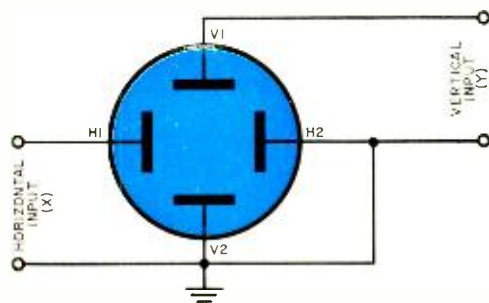


Fig. 1. Hookup of vertical and horizontal deflection plates. Signal voltage inputs only are shown; in actual practice positioning circuits are present.

ment transformer. We connect the 6.3-volt leads across the vertical input terminals of the scope and, as before, we see a thin line—but this time in the vertical plane. In $1/60$ of a second the spot moves from the center of the tube face, up to the top, back down past the center to the bottom, and then up again to the center.

Now here's where the tricky part comes in. Assume that a signal voltage with a special characteristic is applied to the horizontal plates. The signal voltage we have in mind linearly increases for $1/60$ of a second, drops down to zero and starts to build up again. This is known as a saw-tooth wave; Fig. 2 shows its sweeping action.

With the saw-tooth voltage applied to the horizontal plates and a 60-cycle sine wave applied to the vertical, the electron beam will swing in a direction that is the resultant of the two deflections. Referring to Fig. 3, we see that while the sine-wave voltage (applied to the vertical plates) is swinging positive and moving the spot upward, the saw-tooth voltage is moving the spot from left to right.

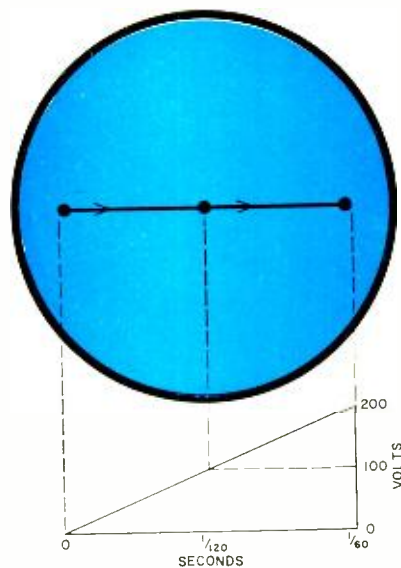
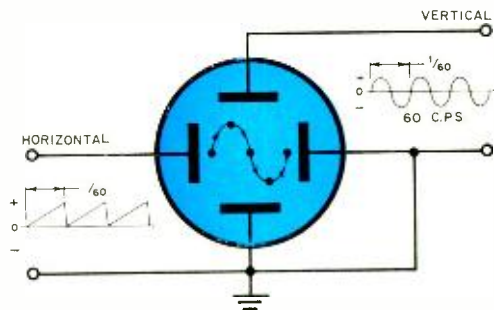


Fig. 2. A saw-tooth waveform applied to the horizontal plates will move the spot linearly (with respect to time) across the face of the tube.

Fig. 3. Frequency ratio between the vertical and horizontal input signals determines the number of cycles viewed on the tube screen.



After $1/240$ of a second, the sine-wave voltage will hit its positive peak and start going negative, but the saw-tooth voltage will continue to carry the spot evenly across the tube face. When the cycle is carried to its completion, we see a single sine wave "written" on the tube face.

If the saw-tooth voltage were set for a frequency of 30 cps instead of 60 cps, then two complete cycles of the sine-wave pattern would appear.

Sweepers—Hard and Soft. Now that we've determined that a saw-tooth voltage

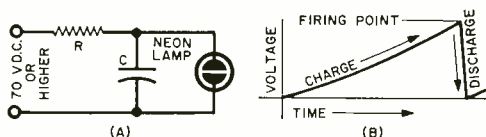


Fig. 4. Relaxation oscillator in which charging rate of capacitor is determined by the RC time constant, neon breakdown voltage and applied voltage.

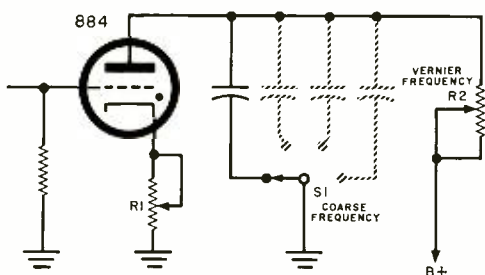


Fig. 5. In typical gas tube sweeper, the coarse sweep frequency is set by S1. Pot R2 adjusts the fine frequency by changing the plate voltage. Output is taken from plate.

but when extreme linearity was required at sweep frequencies up to 200 kc., the scope designers were forced to turn to the vacuum or "hard" tube multivibrator sweep generator (Fig. 6).

Simply explained, a multivibrator consists of two tubes, usually identical, connected so that the output of one feeds the input of the other. The developed signal (usually a square wave) is used to charge and discharge a capacitor which provides the saw-tooth waveform. Sweep frequency is determined by the charging time of the capacitors selected by the *coarse frequency* switch. A variable resistor shunting the capacitor provides vernier adjustment.

There is a large variety of multivibrator

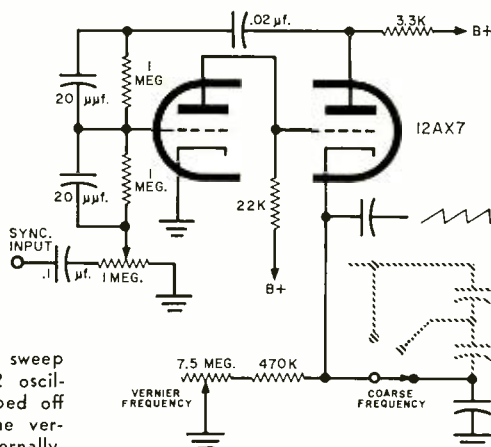


Fig. 6. Partial schematic of the sweep generator of the Heath OM-2 oscilloscope. The sync input is tapped off a high-level signal point in the vertical amplifier or applied externally.

is what we need, let's see how we go about generating it.

If the waveshape of Fig. 2 seems familiar, it's probably because it reminds you of the charging curve of a capacitor or the output waveform of a relaxation oscillator like that shown in Fig. 4. In fact, some of the earlier, inexpensive scopes did use a neon lamp sweep generator. The ordinary neon lamp was soon replaced by a souped-up big brother designed especially for oscilloscope sweep circuits, the 884 gas thyratron tube. Figure 5 shows the circuit of the gas or "soft" sweep generator.

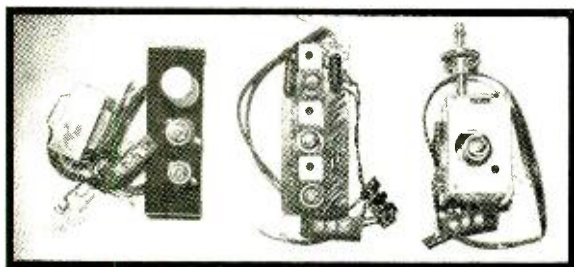
The specialized gas tube was doomed for the junk box, too, as more and more stringent demands were made on the sweep circuits. A top sweep frequency of 30 kc. was fine when the highest frequency the scope amplifiers could work at was about 500 kc.;

circuits found in current equipment, but basically they operate on the principle just described.

Sweep Accessories. As you may have noticed, you never find the sweep circuit of the modern oscilloscope stripped to the bare essentials as we've shown it here. Almost every scope will have an *external sync.* jack and a switch that will connect an external or an internal synchronization signal to the input grid of the sweep tube. This enables the sweep to "lock in" and steadies the trace on the scope screen.

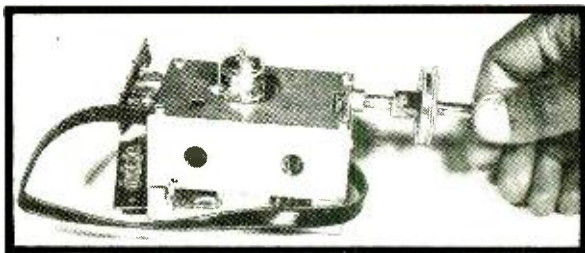
You'll usually find a *sync. amplitude* control on the scope's front panel which controls the amount of sync signal applied to the sweep tube. Set this control with a light touch, because too much sync applied to the sweep tube grid will drive it into

(Continued on page 136)

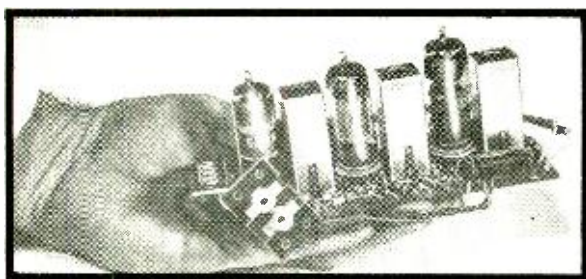


Factory-wired sections of the new Precise tuner kit are shown at left. Below is the r.f. unit.

“MAKE kits easier to build and the consumer will beat a path to your door.” This might well be the motto of most manufacturers in the electronic kit field. In the last few years, electronic kits have become easier and easier to put together through the use of printed circuits, and in some cases, pre-wired sections. This trend toward “quick and easy” kits now seems to have been brought to its logical end by a



New Design Speeds Kit Assembly

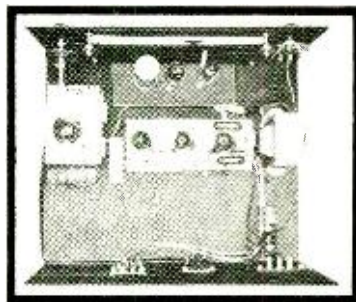


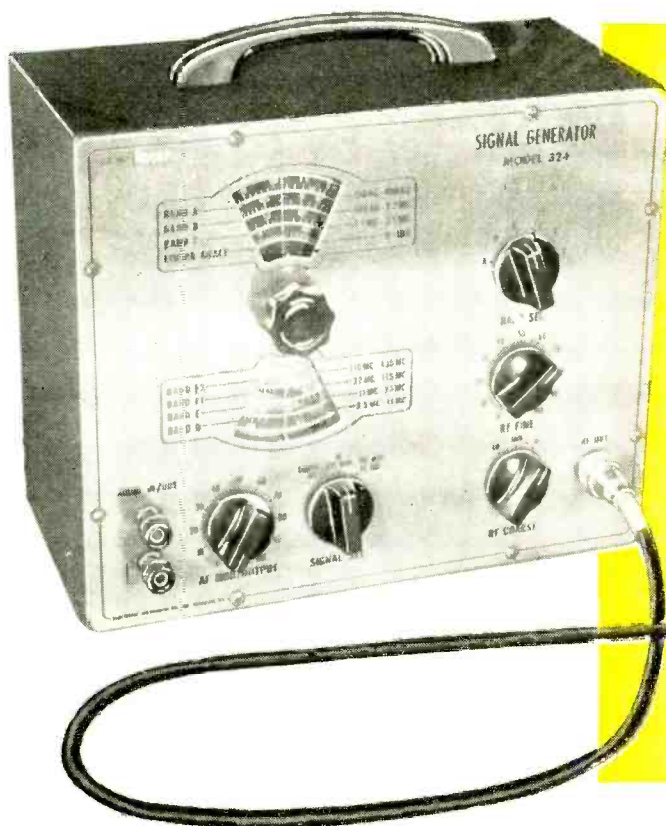
new concept in kit design from the laboratories of Precise Development Corporation.

The new Precise kits feature a type of “unitized” construction which allows the constructor to put them together with only a screwdriver. Each section of each kit is preassembled and tested at the factory. No lead-cutting and no soldering is necessary. All the builder has to do is mount the sections on the pre-punched chassis, make the electrical connections from one section to another, and, presto, the kit is finished!

An FM tuner kit is the first of a complete line of Precise kits to use the “unitized” principle. The circuitry of this tuner is divided into three “building blocks”—the r.f. section, the i.f. section, and the power supply—which can be installed on the chassis and interconnected in about 30 minutes. Although the final design has not been completed yet, the finished circuit will include an r.f.-oscillator-mixer stage, two i.f. stages, one limiter, and a Foster-Seeley discriminator. Preliminary tests of a pre-production model indicate that this tuner should be a winner.

I.F. strip (above) features two amplifiers and a limiter. At right is top view of completed tuner.





By
RUFUS P. TURNER

Use Your R.F. Signal Generator as a Grid Dip Meter

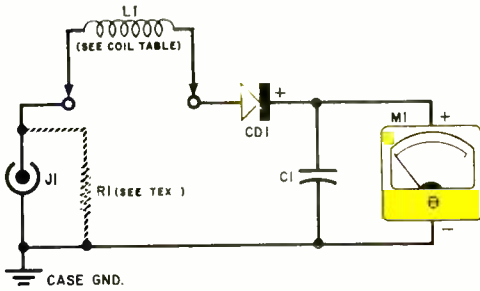
Inexpensive probe measures r.f. resonant circuits

IF YOU own an r.f. signal generator, you can attach this simple probe to it and have a useful grid dip meter. Even an inexpensive generator has a reasonably accurate frequency calibration and its dial is large enough to permit closer settings and better readings than most grid dip meters.

The probe is connected to the r.f. output jack of the generator through a flexible cable. This will not disturb the internal circuitry of the generator in any way and no direct connections need be made to a tuned circuit under test. Although the

probe contains the dip meter and usual coupling coil, all tuning is done with the generator. The resonant frequency is read directly from the generator dial. Only three small plug-in coils are needed to cover the frequency spectrum from 100 kc. to 200 mc.

While the dip probe idea is not new, the unit shown here is much smaller and more compact than similar adapters described previously. Being less than six cubic inches in size, it can be handled more easily than most grid dip oscillators. Its high sensitivity enables it to operate with very little



L1 COIL TABLE	
COIL A	100KC TO 6MC - 145 TURNS #32 ENAMELED WIRE CLOSE-WOUND
COIL B	5 TO 40MC - 18 TURNS #22 ENAMELED WIRE CLOSE-WOUND
COIL C	35 TO 200MC - 3 TURNS #22 ENAMELED WIRE CLOSE-WOUND

(ALL COILS WOUND ON $\frac{3}{4}$ " DIAMETER COIL FORMS)

Only two pins are required for dip meter coil socket. Jack J1 should match plug on signal generator interconnecting cable.

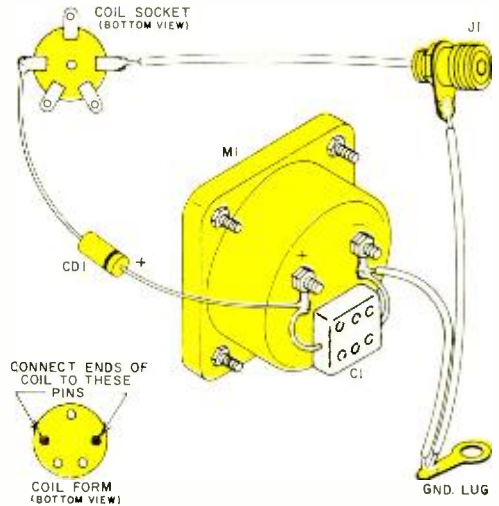
r.f. energy from the signal generator, and it requires no batteries or power supply.

Construction. The probe is built in a $2\frac{5}{16}$ " x $2\frac{1}{8}$ " x $1\frac{3}{4}$ " aluminum chassis box. Mount the miniature 0-50 d.c. microammeter (M1) in a $1\frac{1}{2}$ " hole in the top of this box. The coil socket is mounted in the nose end, and the output cable jack J1 in the rear end. Fasten the pigtailed of bypass capacitor C1 directly to the meter terminal screws. The pigtailed of diode CD1 are connected directly between the coil socket and the positive terminal of the meter.

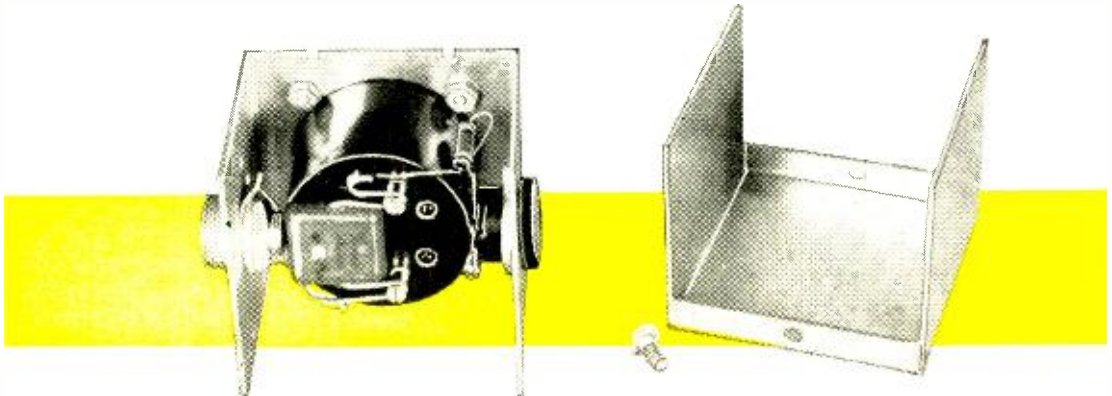
You can make the patch cable by fastening a mating plug on each end of a 3' length of RG 59/U coaxial cable. This cable

PARTS LIST

- C1—0.002- μ f. mica capacitor
- CD1—Germanium diode (Raytheon CK705 or equivalent)
- J1—Chassis mounting jack (Amphenol 75-MCIM or equivalent)
- L1—Plug-in coil (see schematic diagram)
- M1— $1\frac{1}{2}$ " 0-50 d.c. microammeter (Lafayette Type TM-200 or equivalent)
- R1—See text
 - 1— $2\frac{5}{16}$ " x $2\frac{1}{8}$ " x $1\frac{3}{4}$ " aluminum chassis box
 - 2—Cable connectors (Amphenol 75-MCIF or equivalent)
 - 1—3' length of RG 59/U coaxial cable
 - 3— $\frac{3}{4}$ "-diameter plug-in coil forms (Amphenol 24-6H or equivalent)
 - 1—Coil socket (Amphenol 78S56 or equivalent)



The ground lug shown can be eliminated by using the shield lug on J1 for the common ground.



All components are mounted in one half of the small aluminum chassis box. Keep the leads as short as possible.

is quite flexible and allows complete freedom in handling the probe. If your signal generator is not equipped with an output jack but has binding posts, the plug may be omitted from one end of the cable.

Wiring of the probe is simple and straightforward. Be careful, however, to observe the correct polarity of the meter

HOW IT WORKS

Radio-frequency energy from the signal generator is fed into the circuit through Amphenol input jack *J1*. The plug-in coupling coil, *L1*, is connected in series with *J1*, germanium diode (*CD1*), and the miniature 0-50 d.c. microammeter. Capacitor *C1* serves as an r.f. bypass for the meter.

Full-scale deflection of the meter is obtained at most frequencies with an r.f. voltage of only 0.05 volt r.m.s.; this signal strength is available with almost all signal generators and test oscillators. When coil *L1* is held near the coil of the tuned circuit under test, and the signal generator is tuned to the resonant frequency of that circuit, a sharp dip will be obtained due to absorption of r.f. energy from probe coil.

and diode; otherwise backward deflection of the meter will occur.

Only three coils are required to cover the complete frequency range between 100 kc. and 200 mc. These coils are wound on $\frac{3}{4}$ "-diameter plug-in coil forms, according to the winding instructions given on the schematic diagram. Coil A (100 kc. to 6 mc.) fills the entire form. Wind coil B (5 to 40 mc.) and coil C (35 to 200 mc.), which are much shorter, near the top ends of their forms to permit close coupling to a circuit under test. Each coil is close-wound, i.e., no space is left between turns.

Most signal generators have resistive output—a resistor connected internally across the r.f. output terminals. Occasionally, however, a generator has a blocking capacitor in its output lead. If such is the case with your generator, the probe circuit will have no d.c. return path and the meter will not deflect. To correct this trouble, simply connect a $\frac{1}{2}$ -watt resistor (*R1*) hav-

ing any value between 100 and 270 ohms across the input jack (*J1*) inside the probe.

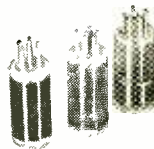
Operation. After you are sure the wiring is correct, connect the probe to the signal generator, plug a coil into the probe, and set the output attenuator of the generator to zero. Switch on the power to the generator and allow a five-minute warm-up period.

Set meter to full scale by very slowly advancing the generator output attenuator. Couple the probe coil to the tuned circuit under test by holding it close to the coil in the tuned circuit. Then carefully tune the generator over the tuning range of the selected probe coil, watching for a sharp dip of the meter. If a dip is not obtained, change the probe coil and repeat the tuning.

If at any time during the tuning the deflection of the meter slowly increases or decreases, it may be restored to full scale by readjustment of the generator output attenuator. Note that the sharpest dip and the most accurate measurement are obtained with minimum coupling between the probe coil and the circuit under test. Back off the probe until the dip is just discernible and read the resonant frequency from the signal generator tuning dial.

Since there is a slight tendency toward response at harmonic frequencies, it is best to tune the generator starting from the highest frequency in any coil range and progressing downward. For convenience, a label can be attached to each coil showing its frequency limits. Use only fundamental frequencies of the signal generator; do *not* use the harmonics generated on the highest frequency bands.

-30-



About the size of a cigarette pack, the dip meter probe, together with its interconnecting cable, takes up little room on your workbench.

VARIABLE TRANSISTOR POWER SOURCE



Miniature a.c.-operated supply

replaces dry cells

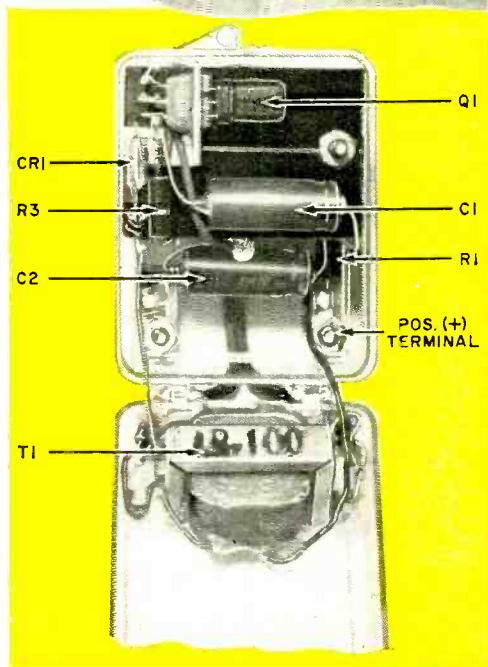
By **FRANK H. TOOKER**

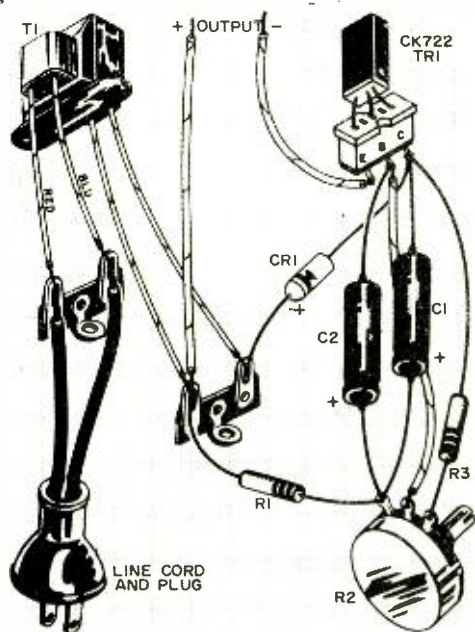
HERE IS a transistor power supply that's truly subminiature in size, yet features adjustable d.c. output from near zero to six volts. Excellent filtering (less than 0.5% ripple) and up to 5 ma. output current make this is a fine unit for experimental transistor setups.

Since relatively few parts are employed in this unit, and all of them are miniature, the entire supply can be assembled easily in a small plastic box ($1\frac{3}{8}$ " x $2\frac{1}{8}$ " x 1").

Construction. A good-quality household plastic cement should be used to mount transformer *T1* in the plastic box. Clamp the transformer in place and allow 12 hours

Major components are mounted on a strip of $1\frac{1}{16}$ " x $1\frac{1}{8}$ " x $\frac{1}{16}$ " Bakelite immediately below the potentiometer; secure strip to top of box with two 4-40 x 1" screws. Remaining components are mounted in positions shown, point-to-point, by their leads.





PARTS LIST

- C1, C2—30- μ f., 15-volt miniature electrolytic capacitor
- CR1—Type 1N295 germanium crystal rectifier (Raytheon)
- Q1—CK722 transistor
- R1—0.68-ohm, $\frac{1}{2}$ -watt resistor
- R2—Miniature 5000-ohm wire-wound potentiometer
- R3—2200-ohm, $\frac{1}{2}$ -watt resistor
- T1—Transistor audio transformer (Argonne AR-100)
- 1—Transistor socket for Q1
- 2—Miniature Fahnestock clips
- 1—Miniature knob for $\frac{1}{4}$ " shaft
- 1— $1\frac{5}{8}$ " x $2\frac{1}{8}$ " x 1" plastic box (or larger)
- Misc. hardware, Bakelite strip, thin aluminum for transistor socket L-bracket, solder lugs, etc.

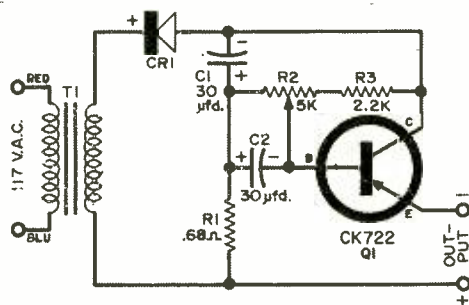
for the cement to harden. The leads should be precut to size and stripped before T1 is mounted.

If desired, the CK722 transistor can be wired directly into the circuit without using a transistor socket. Be extremely careful in soldering the transistor leads. With your long-nose pliers serving as a heat sink, clamp each lead with the pliers between the transistor and the soldering point.

The use of spaghetti and plastic tape will insulate any wiring that may short out. It is also important to mark the positive Fahnestock clip with a dab of red fingernail lacquer to prevent error in hookup.

How It Operates. Transistor Q1 is connected as an emitter follower, similar to a vacuum-tube cathode follower. Moderately filtered d.c. from rectifier CR1 and capaci-

In constructing the transistor power source, observe polarity of the capacitors and diode. Note that R1 has a resistance only slightly greater than $\frac{1}{2}$ ohm; the value of this resistor is quite critical. Solder lugs can be left out to conserve space in the miniature box. The power-on switch has been left out for the same reason.



tor C1 is applied to Q1's collector. Well-filtered d.c. is taken from the emitter.

Variable base voltage from the arm of potentiometer R2 controls the output voltage at the emitter between zero and 6 volts d.c. The current output at any voltage should be limited to 5 ma. to protect Q1.

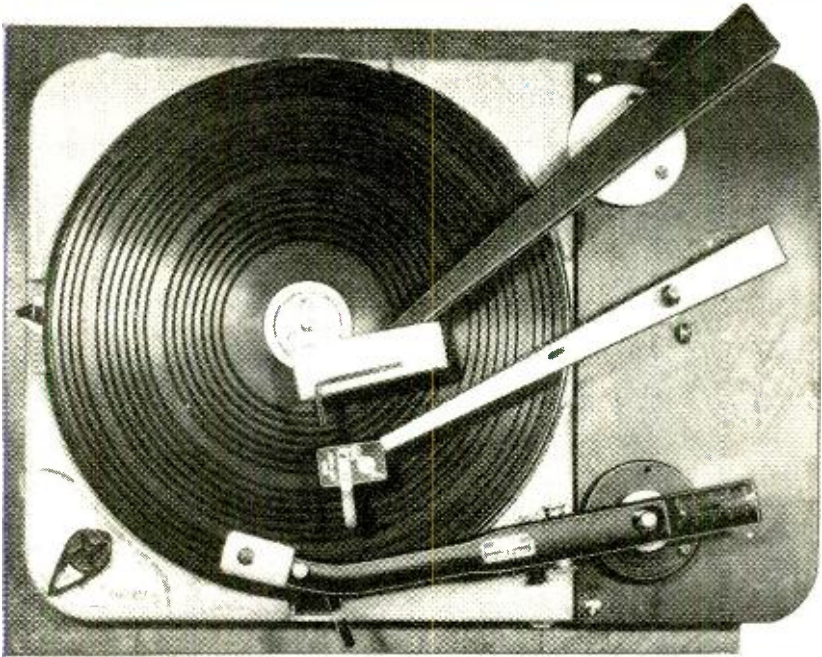
The ripple filtering results from the action of C1 in removing the a.c. component from the output voltage of CR1. A small ripple voltage, which appears across R1 as a result of the ripple current flowing through C1, is applied to the base via capacitor C2 and cancels an additional portion of the hum.

Using the Supply. Whenever you're testing a new circuit, take full advantage of the variable output feature of this unit by turning the voltage control down to zero before plugging in the power cord. Connect a 0-5 milliammeter in series with the output of the unit, and advance the output control slowly while watching the meter. A short or any malfunctioning of the circuit under test can then be spotted easily.

With its very long life, this little power supply is actually less expensive to use than batteries.

STEREO

TONE ARM



KITS

POPULAR ELECTRONICS

takes a close look at the first three designs available

THE DEMANDS of stereo reproduction have focused new interest on the problems of high-fidelity tone-arm design. Once considered only the humble vehicle that carried the cartridge from the outer to the inner groove, the stereo tone arm has achieved new prominence as one of the components that can make the difference between good sound and bad.

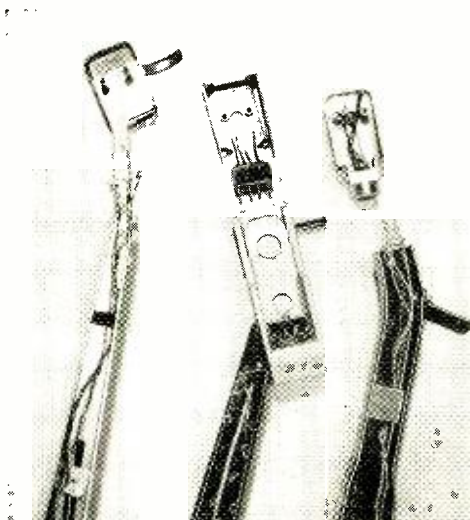
A Tricky Business. The traditional headache of the tone-arm designers, and the one most familiar to the hi-fi fan is "tracking." When the pickup is tangent to the arc formed by the record groove, we have perfect tracking. But, considering the geometry of the path that the arm must travel, the achievement of minimum tracking error (and distortion) is a tricky business.

Resonance is the second big problem of

the tone-arm designer. We are all aware of the hectic interplay of forces at the tip of the stereo stylus. The well-bred tone arm must not react to the frenzy down at its business end but must conduct itself calmly and aloofly through the most fortissimo passages. Any tendency to sympathetic vibration must be suppressed—the arm must *not* "get into the act."

In addition to the questions of tracking and resonance, the tone-arm critic also wants to know how drag-free the bearings are, how easy the arm is to handle (if it tends to fly out of one's hands), is it simple to mount, will it accommodate a variety of cartridges, is it trouble-free, and, last but not least, is it attractive?

All of these questions are answerable by consultation at a hi-fi showroom or by examination of the manufacturer's litera-



Cartridge mounting provisions for the three kit tone arms now available. Components arm (left) provides clips for direct connection to cartridge terminals; Gray arm (center) makes use of convenient plug-in cartridge slides; and Audax arm (right) employs cotter pins to plug into shell.

neered for the plug-in Audax cartridge, this tone arm features needle point bearings for movement in both the vertical and lateral planes. The bearings for both planes are part of one pivot assembly; the lateral pivot is factory-assembled, the two vertical pivot points are set by the builder. Setting the vertical pivots can be a little tricky, but you'll know when you have it right by the "feel" of the arm.

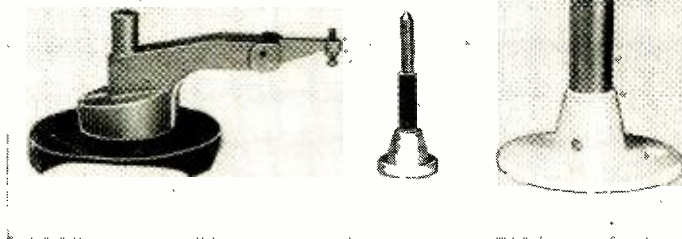
A calibrated counterweight set at the top rear of the arm can adjust the stylus force of any current cartridge, and it eliminates the need for springs. A detachable shell houses the cartridge.

We didn't like: the use of cardboard pads for height adjustment; the fact that the Audax shell would not conveniently fit several of the physically longer stereo cartridges.

We did like: the very clear assembly and mounting instructions; the locking-type arm rest and conveniently large finger lift.

The Components Arm. Physically the lightest and most delicate of the three, the Components arm uses a combination of

The three types of pivot assemblies used in the tone-arm kits. From left to right are the Audax, the Components, and the Gray.



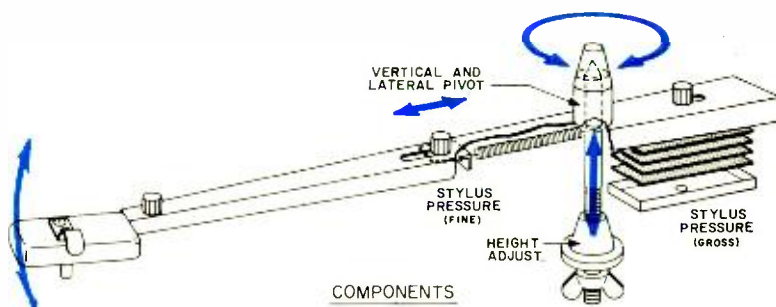
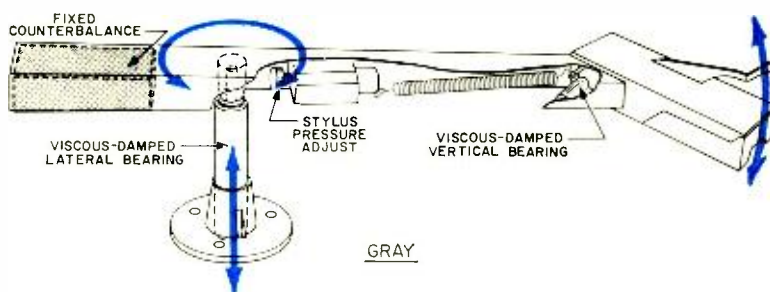
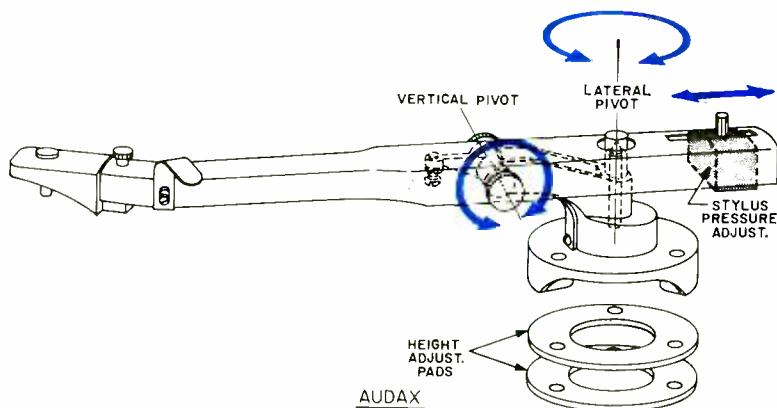
ture. But, with the introduction of tone-arm kits, two more vital questions have joined the others. How easy is the tone arm to put together and how does it compare with factory-assembled models?

At the time of this writing there are three tone-arm kits available. Alphabetically, they are the Audax, Components and Gray kits. Curious as to how these build-it-yourself arms were put together, POPULAR ELECTRONICS obtained and assembled one of each. Here's what we found.

The Audax Arm. Of the three kits tested, the Audax is both the first available and the least expensive. Originally engi-

spring loading and a single needle bearing pivot for both vertical and lateral movement. Gross counterbalance is obtained by adding or removing lead weights from the rear of the arm. A spring arrangement that can be set from the topside of the arm permits fine stylus pressure adjustment when the arm is in playing position. The thin, main pivot assembly allows simple adjustment for optimum tracking angle.

Instead of the $\frac{3}{16}$ " single-hole mounting, the builder may cut a 1" slot of equal width and adjust the tracking angle of the arm while playing one of the special test discs available from the Components Cor-



poration. Assembly instructions consisted of one large sheet with a detailed exploded view and step-by-step instructions; no particular difficulties were experienced.

We didn't like: the spring/spindle setup which would disassemble when the arm was lifted from the spindle; the difficulty in force-fitting the pivot bearing to the tone arm proper.

We did like: the simplicity of design and use of solderless and screw-terminal connectors.

The Gray Arm. Famous from the earliest days of high fidelity for its broadcast-studio and viscous-damped tone arms, Gray

has a factory-assembled stereo arm available which was modified only slightly when it was turned into a kit. So the Gray kit is necessarily a fairly complex device. The parts list includes 49 separate items, a number of which bear somewhat confusing nomenclature; Gray plans to clarify the instructions in later printings.

A sealed and preassembled viscous-damped "cartridge" contains the bearings for the lateral arm movement. The vertical ball-bearing pivot is far forward and has a "limp wrist" action. Stylus pressure is controlled by a spring arrangement, but Gray

(Continued on page 135)

ATOMIC CLOCK TO CHECK EINSTEIN

*There once was a Miss Fanny Bright
Whose speed was much greater than light
She set out one day
(In a relative way)
And arrived the previous night*

ACCORDING to Einstein's theory of relativity, if you were to travel in space for 20 years at the speed of light (186,000 miles per second), you would return to find the earth millions of years older. In the topsy-turvy world of relativity, where space and time merge into one and the same thing, the average person tends to be incredulous about the whole thing. But you can't argue about the existence of atomic bombs—which were developed according to Einstein's "theories." And now a most critical check of the *special* and *general* relativity theories is being planned.

Dr. Harold Lyons, head of Hughes Aircraft's atomic physics department, is supervising the design of a 30-pound atomic "clock" which will be rocketed into space to "keep time" as it orbits around the earth through varying intensities of the earth's gravitational field. More accurate

than any other time device in existence, the atomic clock will lose or gain less than one second in a thousand years. It bears no resemblance to an ordinary clock—having no arms or face—and in truth is more oscillator than clock. It looks something like a foot-long electron tube.

Before being launched, the atomic clock will be synchronized with a similar clock on the ground. Then, as it orbits through space at 18,000 miles per hour, it will generate an alternating current at a frequency of 24 billion cycles per second. For purposes of measurement, this extremely high frequency will be converted to a frequency more convenient for use with earth-based laboratory instruments. This information will then be radioed to earth and the time on the orbiting clock will be compared with the time on the earth clock.

It is expected that the satellite clock will run slow in comparison with the ground clock as it passes through orbits below 2000 miles because, according to the *special* theory of relativity, motional effects should predominate below that altitude. Above 2000 miles, the clock should run fast in order to bear out the *general* theory of relativity; at higher altitudes, the effects of the earth's gravity will be less.

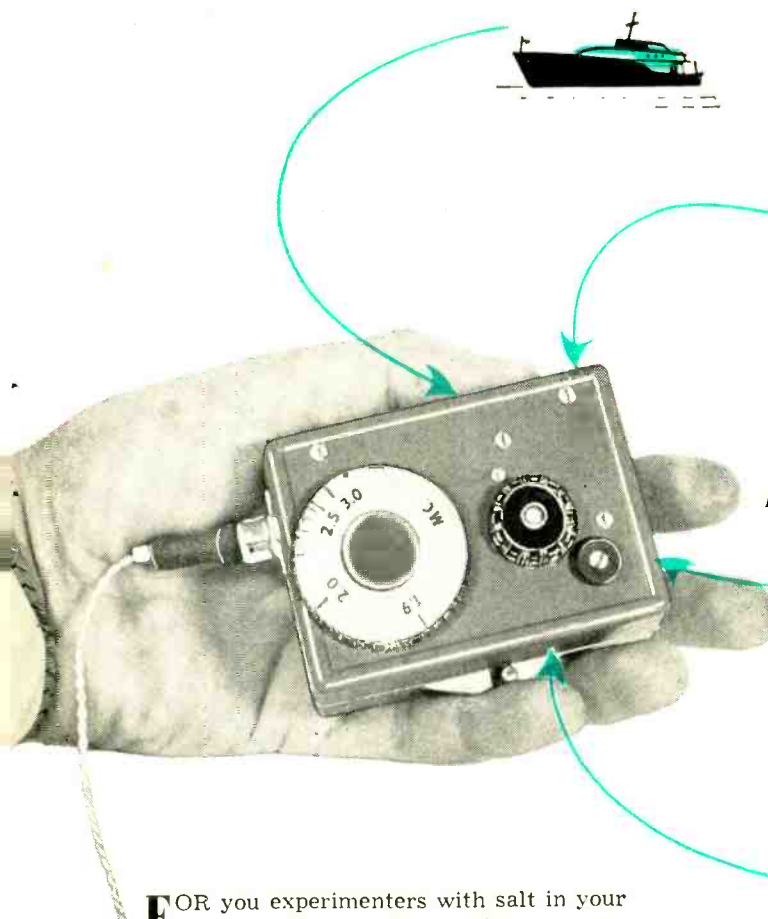
Since the effects of motion and gravity are opposite, as the satellite goes through the 2000-mile point, they should cancel out and the two clocks should agree. Thus both the *special* and *general* relativity theories will be checked.

The importance of the experiment was pointed out by Dr. Lyons, who stated, "Any experiment that puts the general theory of relativity on a firmer physical basis would spur much significant work in the space and nuclear ages." With an actual clock-launching probably only several years off, the entire scientific world eagerly awaits the results.

-30-



Dr. Harold Lyons examines the tubular heart of the atomic clock which will be rocketed into space to test Einstein's two theories of relativity.



Pocket Marine Receiver



**Monitor the marine
communications band with this
three-transistor midget**

FOR you experimenters with salt in your veins, here's a pocket receiver to cover the 2.0 to 3.0 mc. marine communications band. And if you happen to be a "landlubber," this three-transistor regen job can easily be converted into a good broadcast receiver.

A small plastic case serves to house the receiver, with the detector and battery in one cover and the audio section in the other. Besides keeping the antenna away from large metal parts and arranging the various components for minimum crowding, there is nothing critical about the layout.

Locate all mounting hole positions and punch carefully with a sharp-pointed scribe. Drilling should be done very slowly to avoid chipping the plastic. The holes for the tuning capacitor shaft and phone jack (J1) are carefully enlarged with a tapered reamer or a jeweler's file. The large hole for the volume control knob is made the same way.

Before mounting the tuning capacitor, cut the shaft off to a convenient length; but don't make it too short.

The earphone jack shown (J1) is an RCA

**By
J. E. PUGH, Jr.**

PARTS LIST

- B1—1.5-volt battery (Burgess Type 7) and bracket
 C1—50- μ f. silver mica capacitor
 C2—10-365 μ f. miniature tuning capacitor (Lafayette MS-274 or equivalent)
 C3—8-60 μ f. miniature trimmer capacitor (El Menco 404 or equivalent)
 C4—.05- μ f. miniature capacitor
 C5, C6—2.0- μ f., 6-volt electrolytic capacitor
 J1—Phone jack
 L1—Ferrite loop antenna (Miller 2004, modified as stated in text)
 Q1—2N274 transistor
 Q2, Q3—2N406 transistor
 R1—1200 ohms
 R2, R4—1800 ohms
 R3—12,000 ohms
 R5—10,000-ohm miniature volume control with s.p.s.t. switch (Lafayette VC-43 or equivalent)
 R6, R9—220,000 ohms
 R7—22 ohms
 R8—4700 ohms
 S1—S.p.s.t. switch (part of R5)
 T1—20,000 to 1000 ohm interstage transformer (Argonne AR-104 or equivalent)
 Phones—High-impedance magnetic type (Trimm, 24,000 ohms, or Lafayette MS-260)
 I—2 $\frac{7}{8}$ " x 2" x 1" plastic box
 I—Tuning dial to fit C2
 I— $\frac{3}{8}$ " o.d. x 5/32" i.d. shouldered fiber washer
 Misc. screws, washers, nuts, wire, rosin-core solder

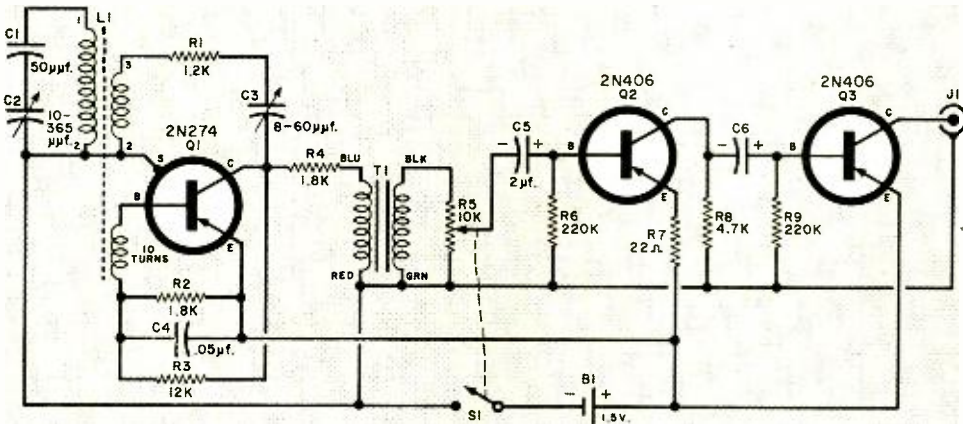
the other components) can be assembled on the plastic terminal strip before being mounted in the case. Most of the detector can also be preassembled.

The antenna (L1) is a flat ferrite loop that fits in the case nicely. It is modified by carefully removing all of the original winding between terminals 1 and 2 and then re-winding 48 turns of the same wire spread evenly over 1 $\frac{5}{16}$ ". The section between terminals 2 and 3 remains untouched.

Now wind 10 turns of #30 or #32 wire over the section between terminals 2 and 3, and fasten everything down securely with a

HOW IT WORKS

This simple regenerative detector, which tunes over the 2.0 to 3.0 mc. marine communications band, is compensated for nearly constant regeneration by R1 and R4. Chance of over-driving the detector by strong local signals is minimized by a small amount of automatic gain control. Transformer T1 gives good coupling between Q1 and Q2 with minimum loss of signal strength. High-impedance magnetic headphones load the output stage properly for maximum output.



type phono jack, but it could be one of the miniature phone jacks. A thin strip of plastic is mounted on the solder lug of J1 for use as a tie strip for the audio amplifier section.

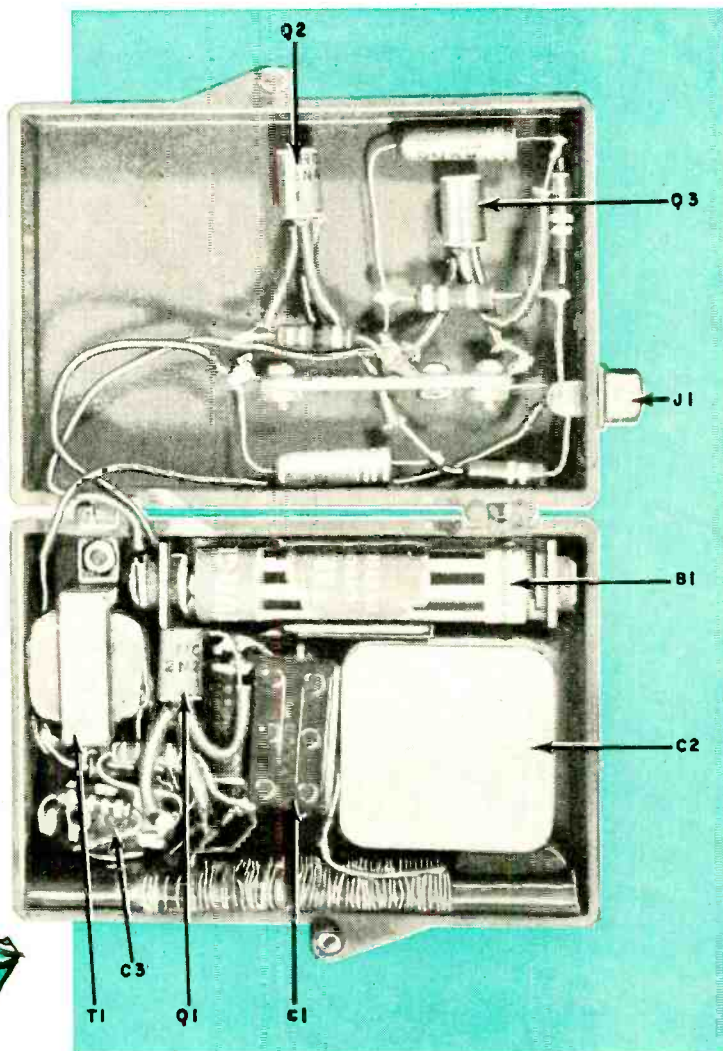
In cases where the outside noise level is high (the usual case in most motorboats), ordinary padded headphones will be best, as both ears will be covered and used. Otherwise one of the small single earphones will be suitable.

Most of the wiring should be done outside the case to avoid melting the plastic with your soldering iron. For example, the entire audio amplifier section (Q2, Q3 and

thin coat of coil dope or wax. When you are soldering this added 10-turn winding into the circuit, reverse the two leads if regeneration is not obtained.

The original antenna winding is litz wire and the ends are pretinned. Where the leads need to be shortened, the ends must be cleaned and carefully retinned. The easiest way is to remove the cotton covering and dip the wire in solder paste. Heat thoroughly with the soldering iron, using plenty of solder and paste. This will remove the enamel very effectively and tin the wire ends. After tinning, wash all traces of the paste off with alcohol to prevent corrosion.

The receiver's detector stage, battery and interstage transformer are mounted in one cover of plastic case (bottom) and the amplifier stages in the other cover.



(For any soldering other than this tinning operation, never use solder paste. Always use a good grade of rosin-core solder.)

If you want to build the receiver for the broadcast band, simply wind the 10 turns on the antenna as above but leave the original windings untouched. Eliminate capacitor *C1* and that's all there is to it, except for possibly changing *R4* for best regeneration balance.

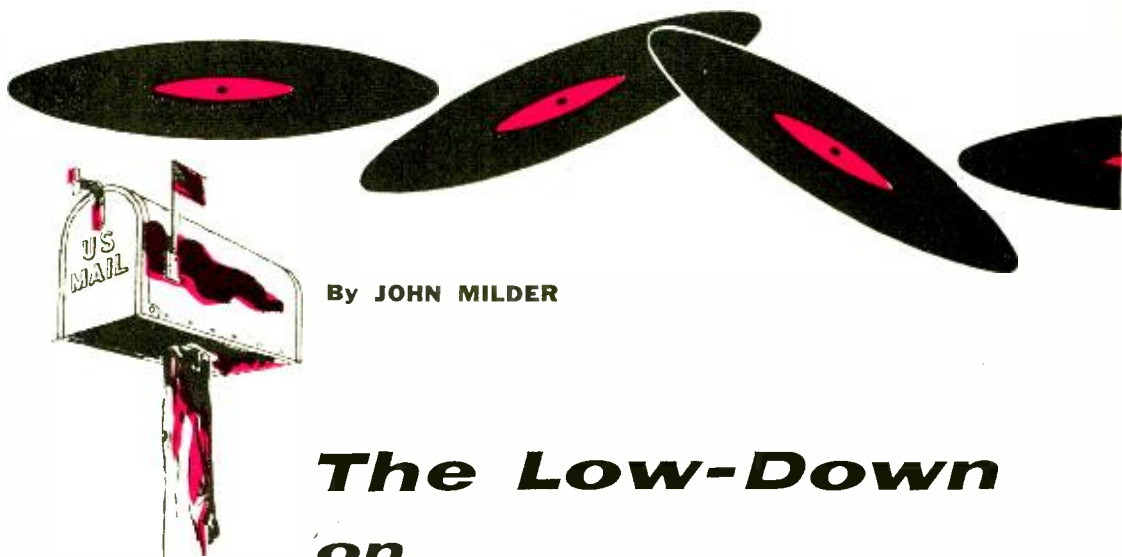
The antenna is held in the case with small rolls of rubber tape placed between it and the case and the tuning capacitor. Adjust the tension by adding more turns to each roll of tape.

Mount regeneration capacitor *C3* in the case by removing its adjustment screw and inserting it through a hole provided in the

case. A small flat washer is placed between the screw head and the plastic case to reduce friction. Put a drop of light machine oil between the screw head and the washer and another on the screw threads. After *C3* is fastened into position, a small, snug-fitting shouldered fiber washer cemented to the screw head serves as a knob.

Calibration and adjustment of the tuning dial is accomplished by covering the original BC band markings with white tape and using an r.f. signal generator (2 to 3 mc. range) to establish the new scale markings. Keep the regeneration control of the receiver just below the oscillation point for the greatest accuracy.

Include any special frequencies that you
(Continued on page 141)



By JOHN MILDER

The Low-Down on **RECORD CLUBS**

Have you considered joining a record club?

Here's what you should know before you do!

THOUGH it may not have occurred to you, that hi-fi rig in your living room is a bit like the car parked outside your house. It needs fuel to keep going. For most of us, hi-fi "fuel" means records—as many as we can afford.

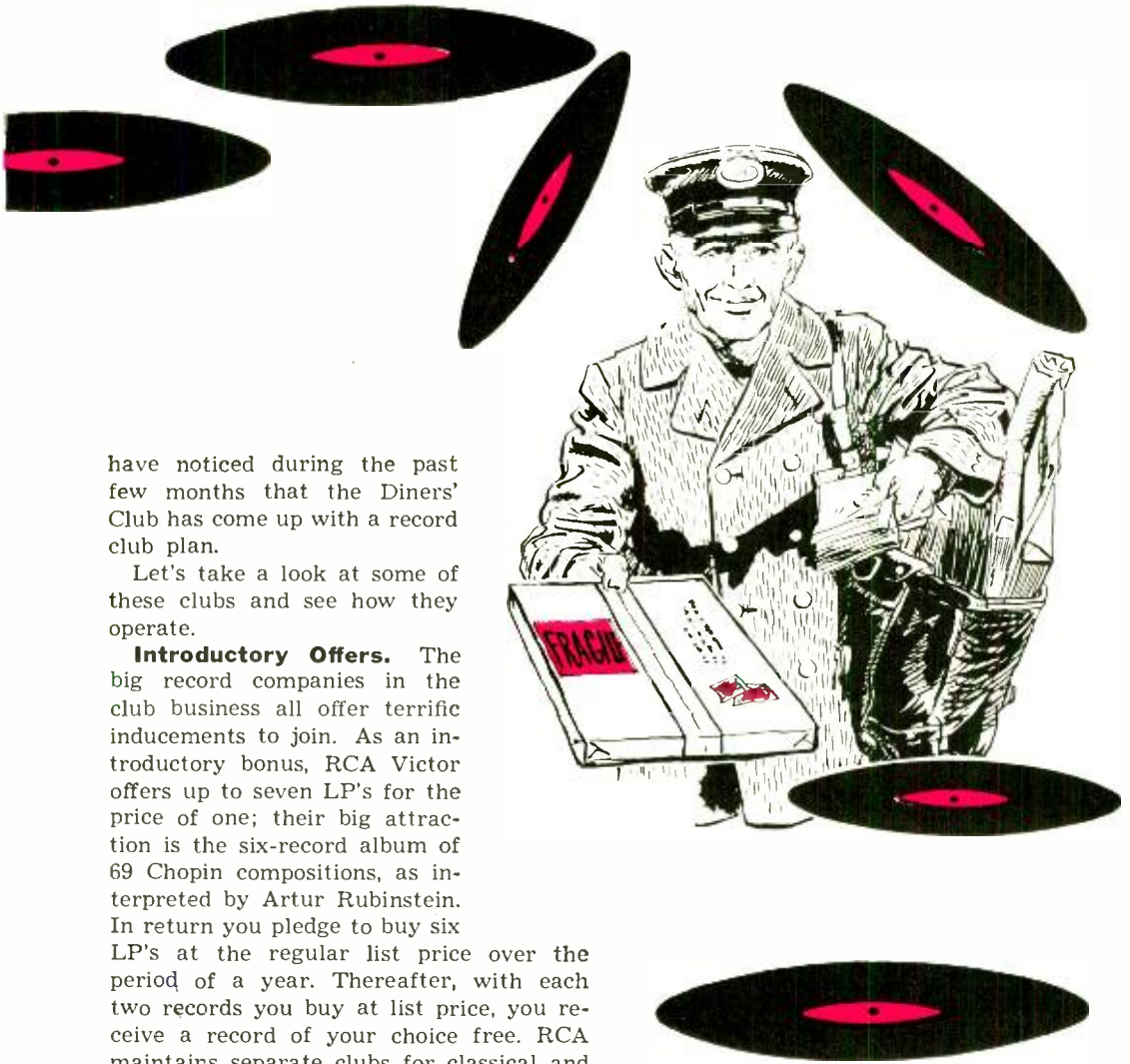
The record-fancier who lives in a big city usually has few problems. Many of the big record discount stores engage in hot and heavy competition for customers, cutting each other's prices to the bone, especially in slack seasons, and maintaining a large enough selection to satisfy almost any customer's tastes.

Outside the big cities, though, things are different. The average record store in a medium-sized town or a suburb can't keep a wide enough selection of records to satisfy everyone, particularly now that hi-fi has been at work broadening our musical interests. Also, the store owner doesn't have the tremendous volume of business that would justify his giving juicy discounts. Consequently, the audiophile who can't

make trips to a metropolis sometimes has a bit of trouble keeping his rig fueled up with records.

Clubs Are Born. This supply situation hasn't pleased record makers any more than it has the listener. The big record companies have tried every imaginable gimmick to keep their products within easy reach of the average customer, but have not achieved the kind of results they want. With the staggering number of record releases every month—particularly now that stereo is on the scene—the struggle for shelf space in stores is fierce, and nobody really wins the battle.

In the past few years, however, some of the record companies have started a flanking movement. They are approaching the customer directly by way of record clubs. If you've been noticing the record club advertisements of companies like Columbia, Capitol, and RCA Victor, chances are you've wondered whether they're as good a deal as they seem to be. You may also



have noticed during the past few months that the Diners' Club has come up with a record club plan.

Let's take a look at some of these clubs and see how they operate.

Introductory Offers. The big record companies in the club business all offer terrific inducements to join. As an introductory bonus, RCA Victor offers up to seven LP's for the price of one; their big attraction is the six-record album of 69 Chopin compositions, as interpreted by Artur Rubinstein. In return you pledge to buy six LP's at the regular list price over the period of a year. Thereafter, with each two records you buy at list price, you receive a record of your choice free. RCA maintains separate clubs for classical and pop material; so if you're after mixed fare, you have to join each independently.

Columbia splits its club into six divisions, with separate memberships for classical, listening and dancing, jazz, show tunes, stereo classical, and stereo popular. On joining, the new member receives six records for the price of one and promises to buy five records during the next year. Once the initial requirement is out of the way, every third record is free. Included with Columbia's listings are records from its subsidiary, Epic.

Capitol slices the pie three ways. Show tunes, pops and dance music are placed in the same division, with separate groupings for classical music and jazz. Again, you receive a special record bonus for joining the club, for which you agree to buy six records

at list price during the year. Thereafter every third record is free, as with the other big clubs.

Recently the Diners' Club made its entrance on the record club scene. It offers about the same savings as the other companies and operates with the same bonus system, but it draws its releases from a number of the best-known smaller labels such as Vanguard and Westminster. To be eligible for record benefits, you must join the Diners' Club itself (at a yearly membership fee of \$5.00). Currently, in addition to receiving five free stereo or mono records, you may also select up to 22 records at 50% off the list price at the time you

(Continued on page 143)



**POPULAR
ELECTRONICS**

Builds a

Transistorized Bias and Power Supply

EICO Model 1020 provides 0-30 volts output

TRANSISTOR EXPERIMENTERS had just about become resigned to sprawling battery packs and strings of resistors crawling across the workbench when test power supplies specially designed for transistor applications made their appearance. One of the latest of these specialized units, the Model 1020 (EICO, 33-00 Northern Blvd., Long Island City 1, N. Y.), is not only designed for transistor applications but is itself transistorized.

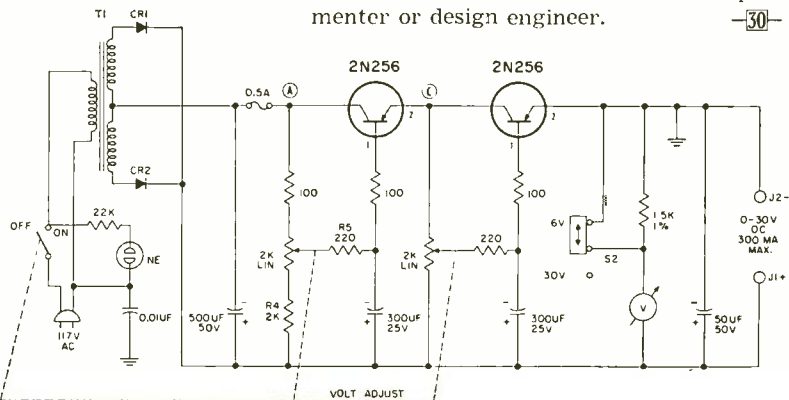
The Circuit. Two *p-n-p* power transistors are in series across the output of a full-wave silicon diode rectifier circuit. The 2N256's are connected in a grounded collector circuit with the collector-base bias voltage for each power transistor controlled by a dual potentiometer. Bias variation affects the emitter current, which in turn determines the output voltage.

The transistors do *not* respond to power supply ripple in their collector circuit. This, plus heavy

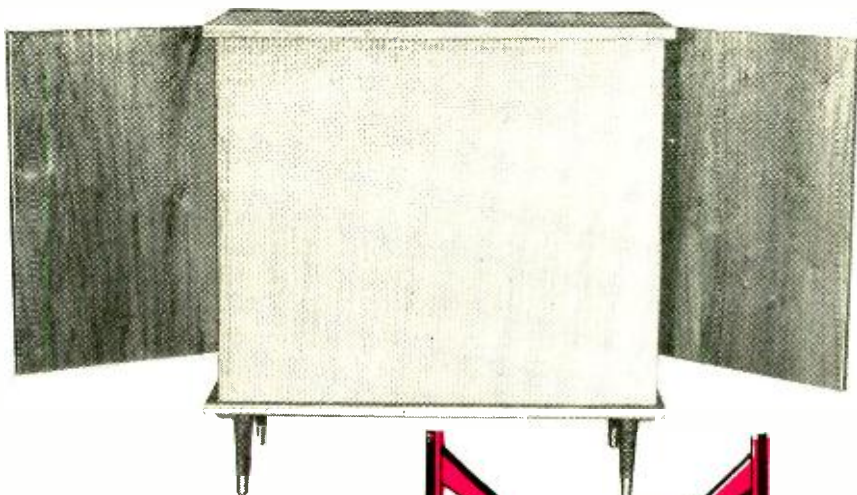
filtering, results in an extremely good ripple factor.

Putting It Together. As with most compact transistor equipment, you may strain a pinkie trying to thread a nut in a tight corner, but you should experience no major difficulties. Make sure to check the binding post and power transistor mountings for shorts to chassis. Also, recheck your wiring to the terminal strips; these are prime areas for possible errors.

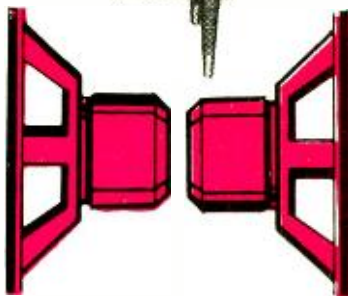
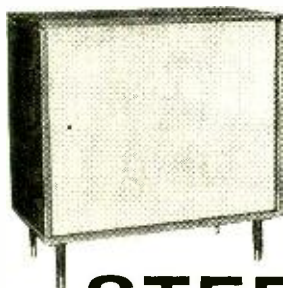
The power supply operated perfectly from the moment it was switched on. EICO's construction manual leaves few opportunities for the constructor to go wrong. All in all, the Model 1020 represents a fine investment for the transistor experimenter or design engineer.



-30-



By **DAVE GORDON**



Building the **STEREOFLECTOR** **ENCLOSURE**

Winged stereo speaker system is adjustable for room location

THE MEN who design rocket ships and satellites aren't the only ones concerned with problems of space. The stereophile, too, must worry about space—or the lack of it. Setting up a stereo system involves not only making room for the speakers, but also finding the optimum position for them without causing chaos in the living room decor.

The "Stereoflector" may be the answer to your stereo space problems. It's a single-cabinet stereo speaker system which uses adjustable acoustical reflectors to distribute the sound to suit any taste in any listening room. The acoustical-reflector idea is already employed in commercial systems by University and Bozak, but the "Stereoflector" has an advantage in that reflectors may be installed either at the rear of the enclosure (to reflect the sound directly into the room) or at the front (to bounce the sound off one or more walls).

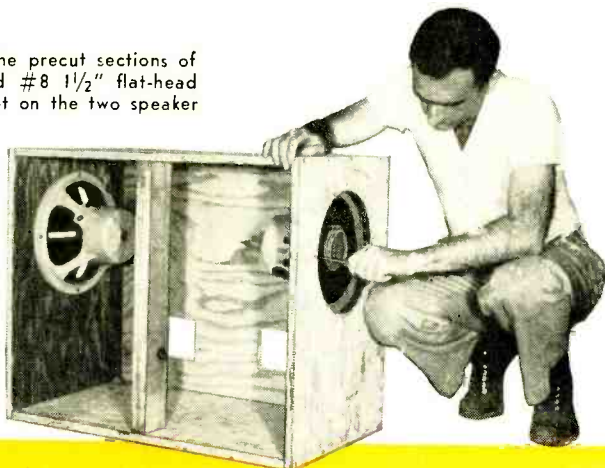
Smooth response down to about 30 cps is possible with the "Stereoflector." An adaptation of the bass reflex principle, the enclosure semi-

couples two tuned compartments to each other through an Ozite screen. Bass resonance peaks are damped out by friction-loading the dual ports with burlap.

Two of the new Audax A120X speakers were used in the "Stercolector" with excellent results. Other speakers with fundamental resonance points between 35 and 45 cps should also perform well. "Coaxial" type speakers are recommended since some of the high-frequency output is absorbed by the reflectors.

Phase the speakers by connecting the leads in parallel temporarily and touching a flashlight battery across them. Connect the leads so that both speaker cones move in or out simultaneously at the moment of contact. Mark the leads going to the positive pole of the battery and connect them to the proper impedance-matching taps in the amplifier; the other two leads connect to "common."

1 Butt joints are used in assembling the precut sections of the basic cabinet. Wood glue and #8 1½" flat-head wood screws are used throughout except on the two speaker panels, which are mounted with screws only. The back panel 2" x 4" brace shown is installed with its narrow edge flush with the rear edge of the top and bottom panels. Wood screws and glue are used at each end to hold the brace in position. Although not shown, a front panel brace of the same dimensions may also be installed. The two Audax speakers are mounted with 1½" bolts and nuts.



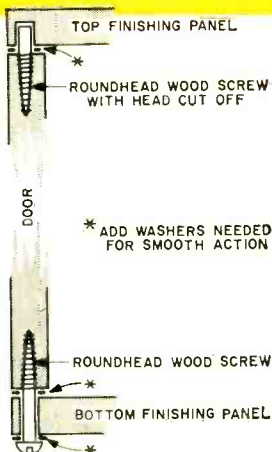
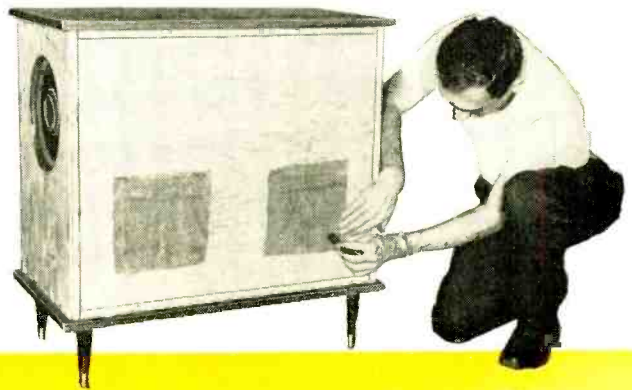
2 A layer of Ozite is installed across the center of the cabinet reaching from top to bottom, thus separating the cabinet into two loosely coupled compartments. About 1½" of fiberglass or other acoustical damping material should be stapled loosely to the walls of each compartment. Avoid covering the ports. Two "pillows" of fiberglass are stapled to the back panel spaced to avoid the rear panel brace. Separate zip-cord cables are connected to each speaker and lead out through small holes drilled in the enclosure's back panel.



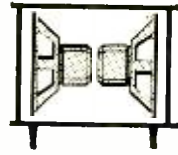
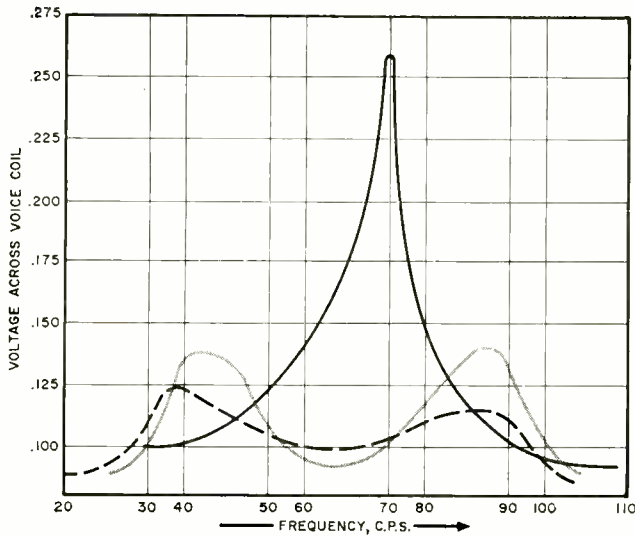


3 After back panel is glued and screwed into place (against rear brace and rear edges of panels), seal all possible points of air leakage with wood putty. Mount bottom finishing panel on legs to suit your decor. Drill both the top and bottom finishing panels for the pivot screws for the reflector doors before attaching panels permanently. The completed cabinet rests on the bottom panel and may be glued or screwed or held in place by its own weight. Space the panels to be flush at the rear and to allow about an inch of overhang at front and sides.

4 One layer of ordinary burlap is stapled tightly over each of the ports to provide "friction loading" of the speakers. See the graph on the next page for effect of adding burlap. If more "resonant" bass is desired, omit the burlap strip.

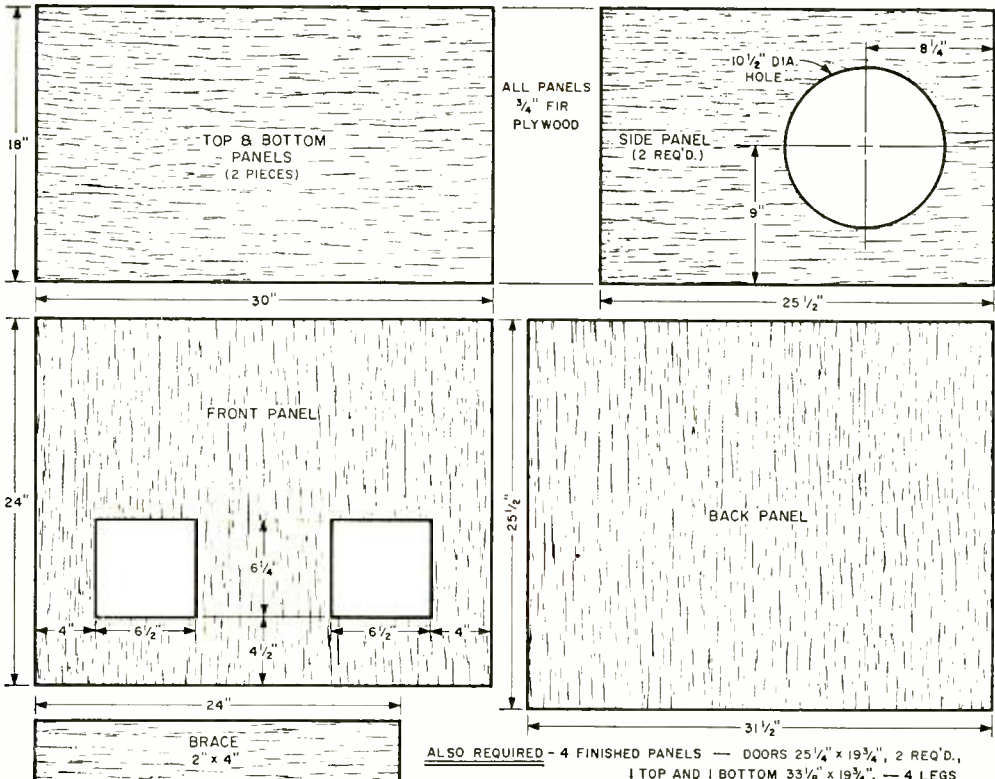


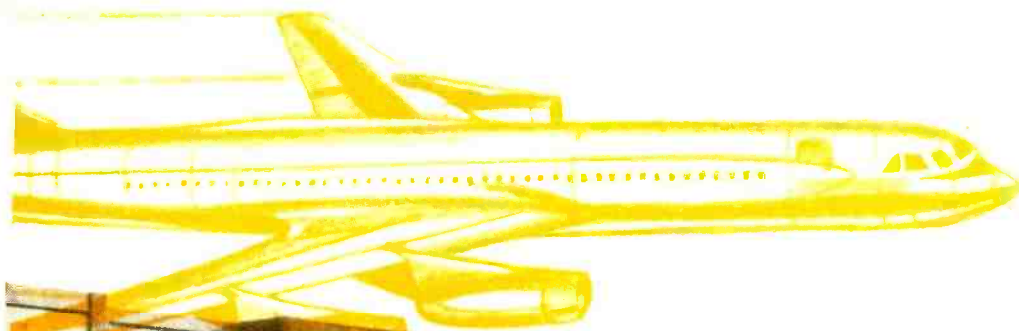
5 Reflector doors should be fitted before Mellotone grille cloth is stapled into place. Pivot screw holes are drilled in the finishing panels $\frac{3}{8}$ " in from the rear and sides. To allow doors to swing freely, it may be necessary to bevel their inside rear edges. When closed, the front edges of the reflector doors should line up with the front edges of the top and bottom finishing panels. Brass washers can be used to space the doors between the top and bottom finishing panels. During operation, the reflector doors should be adjusted to provide the stereo directionality and "focus" desired. Room acoustics and personal taste determine optimum setting.



6 Impedance curves of the two speakers connected in parallel. Free-air resonance of the speakers is about 40 cycles; however, installation in sealed cabinet causes the resonant peak to move up to about 70 cycles (solid line). The dual ports tune the cabinet properly, as shown by the two peaks of approximately equal amplitude (grey line). The final curve (dashed line) results from stapling burlap over each port.

All plywood panels can be precut before construction is started. Builder has choice of wood for finishing panels.





ARINC-Miami Station



ARINC Unheralded Voice of the Airlines

*A behind-the-scenes giant radio network
that keeps the airliners flying*

By TOM KNEITEL

HAVE YOU ever heard of "ARINC"? This is the abbreviation, and nickname, for one of the most unusual corporations we've ever come across. Their official monicker is Aeronautical Radio, Inc., and they employ some 400 persons, all needed to service their hundreds of customers.

As a matter of fact, if you've ever flown on an airliner in the United States, you owe a tip of your fedora to good ol' ARINC.

But alas, in 30 years, they have never sent a salesman around to drum up business, never employed a press agent to publicize the organization, and, as you may have imagined by now, never made a dime.

Just What Is ARINC? And why does it stay in business under these seemingly unbusinesslike conditions? Well, ARINC is a communications company, specializing in the aeronautical mobile and fixed serv-

ices. It's principally owned and used by the major U. S. airlines, but it services many non-owners also, including military and foreign flag interests.

The ARINC stations, and there seem to be more of them than a filter cigarette has filter traps, maintain contact with aircraft and with other ground stations, re-laying data on weather, landing and take-off, flight plans, airport gate assignments, and other messages relating to the safety of aircraft.

But don't think that they just sit around and rag-chew with planes. They also do research in the field of reliability of electronic tubes, equipment, and systems. ARINC serves its member companies as a technical meeting center, advising them of service requirements, equipment characteristics, and standard performance requirements.

To cover all of ARINC's operations in detail, we'd have to eliminate the margins on this page, so let's select only one function and take a backstage look at it. Flipping through their station directory (77 pages thick), we stop at the Miami, Florida, station.

A Typical Station. Miami is a communication man's paradise. It is well staffed and operated with plenty of savvy. The "shack" is a neat-looking one-story building at 5931 N.W. 36th Street, just a wavelength from Miami's busy International Airport.

The heart of the ARINC-Miami Station (code name: MIAXA) ground-to-air 'phone section is the spiffy looking control point, with six operating positions. The station is also in high-speed c.w. contact with other ground stations in Nassau, Cuba, and Brazil. And talk about radioteletype . . . they've got 124 machines clattering away with messages to the Caribbean area and to Central and South America.

This beehive buzzes 24 hours a day, using 4500 transmitting and receiving tubes, 118 receivers, and 22 transmitters (most of them multi-channel). The fantastic array of equipment spans "Kilocycleville" from one end of town to the other (2848 kc., c.w., to 131 mc).

MIAXA's 'phone channels are: 2952, 2966, 3105, 3432.5, 4668.5, 5506.5, 5566.5, 5589, 5619, 6537, 8837, 8871, 10,021, 13,294.5 and 13,344.5 kilocycles and 126.9, 127.3, 130.8 and 131 megacycles. The station can be easily heard on any of these frequencies throughout the entire North American continent.

It has often been heard in Europe and South America with good level. Their 'phone handle is "Miami."

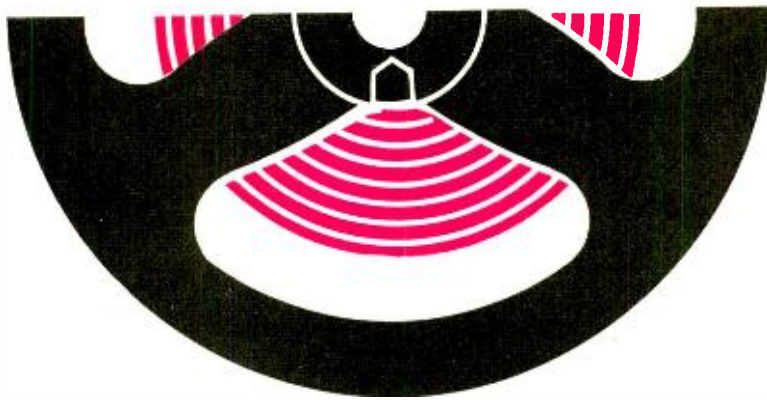
Because of their varied operating frequencies, an intricate series of antennas is required. To provide elbow room for the "antenna farm," a site was selected out in the sticks. And that happens to be the perfect description of the antenna farm, sticks sticking on top of sticks, out in the sticks. The sticks in this case are telephone poles, and there seem to be billions of them, stuck into the ground, into each other, into everything. Draped between the poles, looking like a giant spider's nightmare, are miles of antenna wires. Keeping these antennas humming are 1-, 3-, and 5-kw. Collins and Wilcox rigs.

The receivers are also out in the country, at a different location from the transmitters, and they have their own antenna farm. There is a single-channel crystal-controlled receiver for each receiving frequency in use. Generally, non-directional antennas are used for voice and c.w. work, with rhombics on the teletype channels.

Separate Networks. Now that you have an idea of the setup at this one ARINC station, bear in mind that MIAXA is a part of numerous networks. Each network uses different groups, or families, of frequencies covering certain areas and flight routes. Some airlines provide their own extensive communications system, into which MIAXA is connected. Although ARINC holds the licenses for the U. S. airline radio stations, very often a station is staffed by personnel employed by the airline that the station normally contacts.

As far as the DX'er is concerned, ARINC stations have always been cooperative in providing information about themselves, and QSL'ing with such courtesy that you almost hate yourself for not writing to them sooner. Reception reports for ARINC stations should be addressed to: Supervisor of Radio Communications, name of airline the station was heard working, city, state. You can send a prepared reply card, but chances are that even if you don't you'll get a QSL, via letter.

Think of ARINC as a nation-wide chain of stations, each one as elaborate as MIAXA, all dedicated to making air transportation safer and more enjoyable, and you'll have a picture of this organization: the champion behind-the-scenes outfit of all time.



STEREO TAPE IS BACK—TO STAY!

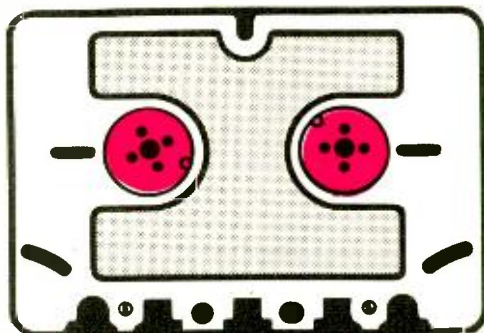
Four-track systems give stereo tape a new lease on life

THINGS are happening faster than ever in the audio world. Just a few months ago it looked as if stereo tape were going the way of silent films, and the average audiophile could spend his time more profitably looking for old Edison cylinders than trying to locate worthwhile stereo tapes—especially ones he could afford. With a first-round wallop that made Ingo Johansson's right look like a love tap, stereo records had floored stereo tape, and it seemed as if it were down for the count.

But stereo tape is suddenly back on its feet, and it has a new one-two punch: four-track reel-to-reel tapes and tape cartridges. Right now the battle between tapes and discs is beginning to look like a toss-up, and no matter which one the consumer bets on, he himself will be the real winner.

Tape Cartridges. Part of the big news is the availability of stereo tape cartridges and the machines to play them on. Here at last is the answer for those who have shied away from tape because it's been

By **ERNEST JOHN**



hard to handle. If you haven't had a chance to see the cartridge system in action, here's how it works.

The prerecorded tape comes packed and specially wound inside a tough plastic case, or cartridge. After the cartridge is slipped onto the player, you just press the start button and you're in business. Total elapsed time—about five seconds! There's no threading to do, and no loose ends of tape can find their way off the reel onto the floor. The cartridge itself is foolproof and childproof; about the only way to do any damage to the music locked inside is to take a blowtorch to it.

The tape cartridge system is a standout in other ways. At the end of the first "side" of the tape, the machine stops automatically. You flip the cartridge over and, at the touch of a button, the second side is all ready to go. To skip one side, you press the fast-forward button and flip the cartridge over after the automatic stop. When you're finished for the evening, you shove the cartridges in the nearest bookcase—or any place other than on a hot radiator.

What about the tape that's in the cartridges? Well, in comparison with the old two-track stereo tapes that were played back at $7\frac{1}{2}$ inches per second, the tape cartridge system enables four times as much music to be put on a given length of tape. This is possible since the number of tracks has been doubled and the tape speed has been reduced to $3\frac{3}{4}$ ips. The net result of these doubling-up tactics has been to give the four-track $3\frac{3}{4}$ -ips tape cartridge slightly more playing time than an average stereo record.

Radio Corporation of America plans to have 65 prerecorded stereo tape cartridges on the market by Christmas, and other companies such as Mercury, Bel Canto, and Omegatape are also planning to get into the tape cartridge swim. Prices now run between \$4.95 and \$9.95, and they may eventually come down to the price range of stereo records.

Cartridge Players. If you've followed the development of the tape cartridge, you'll recall that in the last two years RCA has had its troubles with the cartridge player. Every time they figured that all the "bugs" were out, it seemed a new one popped up. Now it appears that all the while Bell Sound was quietly working on its own player (which would also handle the RCA tape cartridges).

The situation at the present time is that RCA, the moving force behind the whole tape cartridge business, has only one machine on the market while Bell has no less than *six* different models. Other manufacturers such as Viking, Pentron, and VM will probably be offering their models shortly. Let's take a quick look at the machines now available, the RCA and the Bell units.

The RCA cartridge player-recorder is a compact item, with its own built-in three-speaker system to handle one stereo channel and a speaker output jack for the second channel. All the tape transport controls are push-button affairs, and there's a volume control, tone control, "magic eye" recording level meter, and a selector switch for changing tracks and choosing the method of operation. The machine lists for \$299.95, including two microphones.

Bell's line starts off with a playback-only job for \$129.95. The only controls in sight on this svelte little beauty are an on-off switch and one operating lever which you set at *neutral*, *play*, or *fast*. No speakers and no preamps are included, just two outputs to connect to the tape-head inputs of your stereo rig.

As you go on up the Bell line, things get fancier. The next model has dual preamps, and it's still strictly for playback. Then you hit the models that record as well as play. There's a choice of portables and table models, with attractions like twin VU meters, transistor recording preamps, three sets of inputs, and separate level controls for each channel—plus the other standard facilities. The top of the line goes for \$299.95 without speakers.

Four-Track $7\frac{1}{2}$ -ips Tape. In all the excitement over cartridge tapes and players, let's not gloss over the other part of stereo tape's new one-two punch, four-track reel-to-reel tapes. From any angle, four tracks mean twice as much music on a reel or in a cartridge. And for those stereophiles who sniff indignantly at the idea of $3\frac{3}{4}$ -ips tapes, the new four-track $7\frac{1}{2}$ -ips stereo tapes on standard reels provide the answer. Though they cost roughly the same as older two-track tapes, they hold twice as much music.

While the four-track system is still in the medium-fi category at $3\frac{3}{4}$ ips, the fidelity of four-track tape at $7\frac{1}{2}$ ips is high enough to satisfy the most critical pair of calibrated ears. And since the two stereo



stereo discs and also against each other.

With the tape cartridge manufacturers eyeing a mass market for their product, it seems likely that the cartridges will be standardized at 3¾ ips, since the lower speed will mean more music on the same amount of tape and allow the cartridges to be priced as low as records. Cartridge machines are already available on about the same price scale as record-playing

◀ The RCA tape cartridge and cartridge player are now available. Prerecorded four-track stereo cartridges cost from \$4.95 to \$9.95. Player is \$299.95.

This Bell tape cartridge machine sells for \$199.95. More elaborate models which cost up to \$299.95 are also available.



channels are always spaced apart by the other two channels, there's actually less chance of crosstalk. The only trouble with four-track reel-to-reel tape is that which afflicts any reel-to-reel system: it's awkward to handle.

The prospect of a good catalog of four-track reel-to-reel stereo tapes is promising. Ampex has just formed a new division to handle commercial four-track releases for all companies. The idea is to encourage the various companies to go ahead full speed and get those new reels into the hands of consumers. A total of 500 selections from 12 companies should be in the stores by the end of the year. Prices will be from \$6.95 to \$8.95, with playing times from 30 minutes to about an hour.

Four-track tapes can be played on any machine with the proper facilities and almost all tape machines are available with four-track facilities these days. Most older stereo recorders can be converted to four-track operation by installing the necessary playback heads. The conversion would not obsolete present collections of two-track tapes since they can be played on four-track systems.

Tapes vs. Discs. It's quite evident that four-track tapes, in one form or another, are going to give stereo discs a run for their money. Let's take a look at the way the two new tape systems stack up against

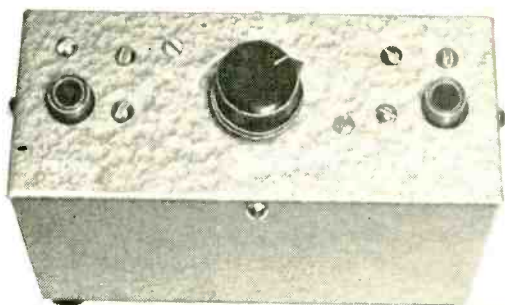
equipment, and more of them are coming.

In quality, discs receive the nod over cartridges—though the situation could change if some breakthrough in tape manufacture should come. The major appeals of both, however, are price and convenience.

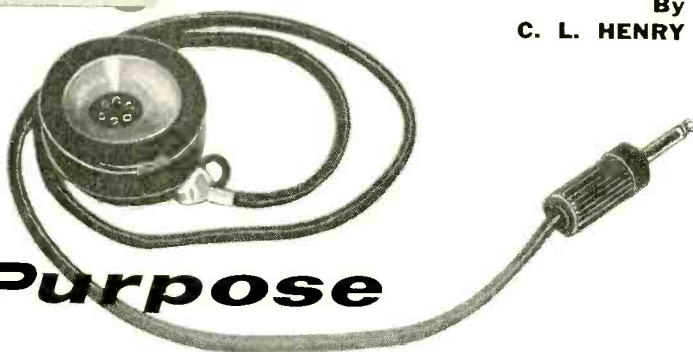
In terms of traditional hi-fi virtues like frequency response, low distortion and noise, and dynamic range, four-track 7½-ips reel-to-reel tape appears to be superior to the cartridge and disc systems. Although cartridges and discs will undoubtedly be improved to the point where they will be on a quality level with present-day four-track 7½-ips tape, comparable advances in quality will also be made by the reel-to-reel system. This means that 7½-ips four-track tape will be the only choice for the quality-conscious stereophile, regardless of its extra cost and awkwardness in handling.

As indicated earlier, the winner in this three-way battle which is shaping up will be *you*. Between records, cartridges, and reels, you're going to find more good listening than ever before.

—30—



By
C. L. HENRY



Multi-Purpose Transistor Amplifier

HAVE you ever tried to find a short in a cable by the "cut and try" method and finished with no cable at all? Could you use a vibration analyzer, a preamplifier, a monitor amplifier, etc? If so, this general-purpose transistorized amplifier may be just what you need for your tool kit.

With the addition of accessory probes, this pocket unit will do all the above jobs—and more! A probe using an iron-core coil will enable you to locate shorted wires in any size cable. And a crystal-diode probe can be used for tracing signals in all r.f., i.f. and a.f. circuits.

Operated from a long-lived battery, the amplifier is independent of power lines, and is built in a small case which is convenient to carry and use. Since the total cost of constructing this unit is less than \$15.00, it is a project well worth considering.

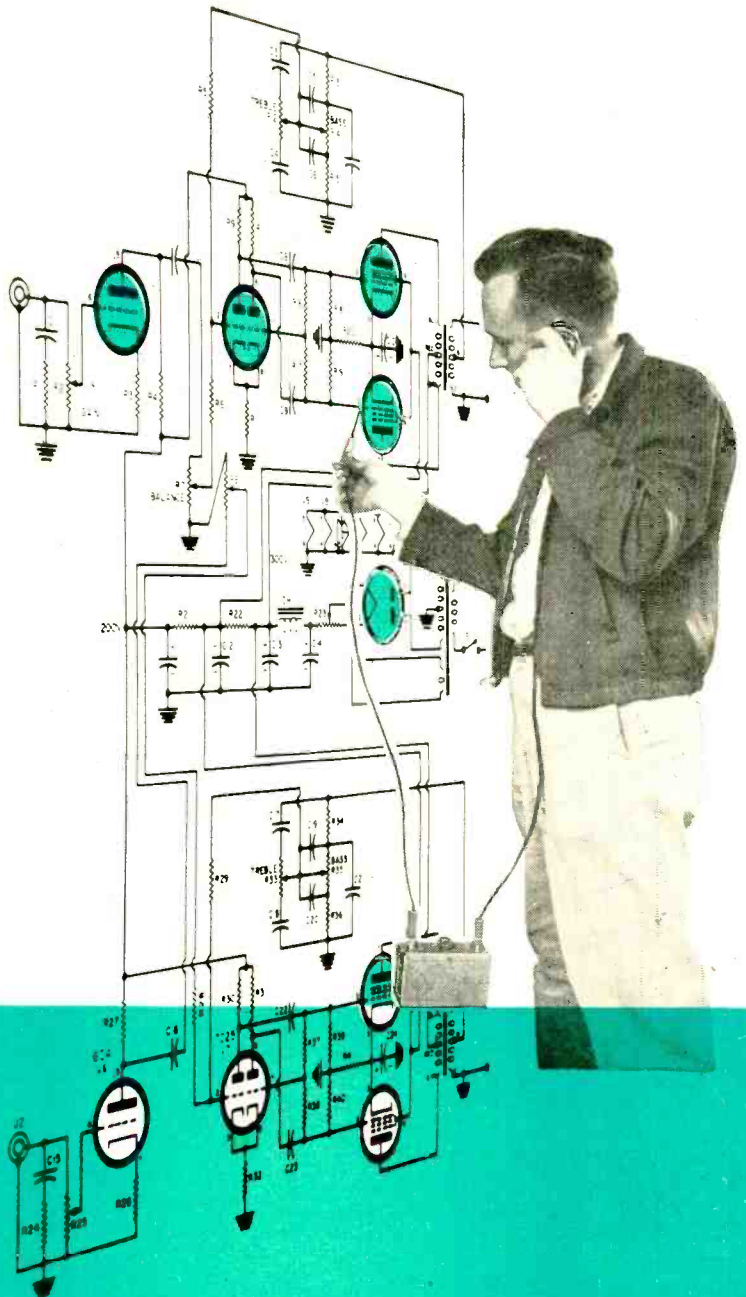
Mount all circuit components, with the exception of the jacks, gain control, and battery, on a small piece of perforated phenolic board. Flea-type lugs can be inserted in the holes to simplify the wiring.

The board assembly is mounted on the front panel of a 3¼" x 5¼" x 2" box. Jacks *J1* and *J2* are of the long frame telephone type; they cost more initially, but will give longer trouble-free service.

Optimum values of *R1* and *R₂* are determined experimentally. These resistors, after selection for maximum stage gain, will fall between 10,000 and 20,000 ohms. Make sure that a maximum of 5 ma. flows in each stage. If everything works out as it should, total gain should be close to 60 db with the gain control at maximum. Transistor *Q2* can be driven to overload with 10 millivolts of signal at *J1*.

The battery and spring mounting clip

...for the
trouble-shooter
and the
experimenter

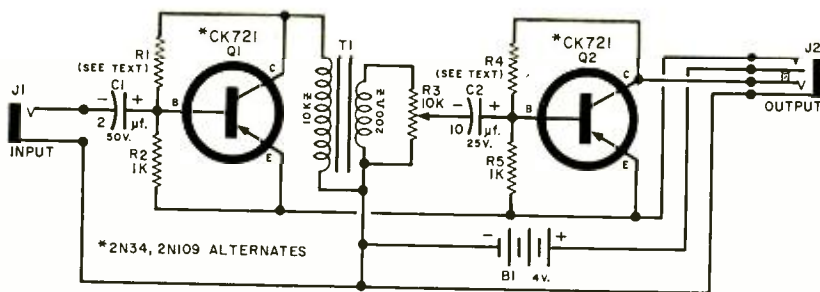


are mounted on the bottom of the box and the amplifier's power leads are soldered directly to the battery since frequent replacements will not be needed. When all soldering is complete, the wires can be laced. The component board is mounted between jacks *J1* and *J2*, with two 1½" long 6-32 machine screws and bolts arranged as stand-offs.

Next, the front panel should be fastened in place and decals applied. Rubber feet

and a shoulder strap can be installed if desired.

Applications for this gadget are plentiful. Possibly the most useful accessory is a pickup coil constructed by winding 500 or more turns of thin wire on a laminated iron core. (An old transformer or choke



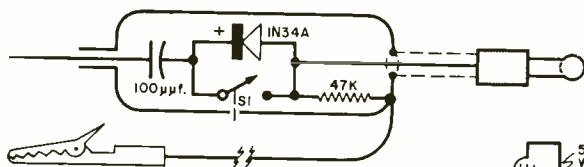
PARTS LIST

- B1—4.0-volt mercury battery (Eveready type E-233 or equivalent)
- C1—2- μ f., low-voltage electrolytic capacitor
- C2—10- μ f., low-voltage electrolytic capacitor
- J1—Telephone type jack, (Switchcraft type MT-331 or equivalent)
- J2—Telephone type jack, (Switchcraft type MT-333 or equivalent)
- Q1, Q2—2N109, 2N34 or CK721 transistor
- R1—See text
- R2—1000-ohm, $\frac{1}{2}$ -watt carbon resistor
- R3—10,000-ohm potentiometer
- R4—See text
- R5—1000-ohm, $\frac{1}{2}$ -watt carbon resistor
- T1—Interstage transformer, 10,000-ohm primary to 200-ohm secondary (Stancor TA-34 or equivalent)
- 1—3 $\frac{1}{4}$ " x 5 $\frac{1}{4}$ " x 2" steel box (ICA 3797 or equivalent)
- 1—Small perforated phenolic board

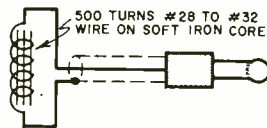
Select transistors that will provide the greatest gain for the amplifier. You can either solder the transistors in place or use sockets for convenience of replacement and testing, as you wish.

will provide the laminations.) The coil is insulated with tape and connected to a 4' cable which is terminated in a telephone plug.

In use, the pickup coil is held close to the point to be monitored. With it, you can trace trouble in an audio amplifier by picking up the signal at the transformers. You can also monitor a telephone and follow



Two probes for the amplifier: the one above, for a.f. and r.f. signal tracing, is built in a small shielded container; the induction probe at right has an unshielded winding. A similar a.f.-r.f. probe is described in greater detail in the July '59 issue.



the signal in any equipment using transformer coupling.

To find the exact location of a short in a cable, connect an audio oscillator to ends of the shorted pair in the cable. Move the pickup coil along the cable, starting at the oscillator end. The short will be found near the point where the signal stops.

Another handy accessory is a signal-tracing probe. Using this probe, trouble may be traced in a radio receiver, and the defect easily found. The probe is constructed in a shielded can as shown.

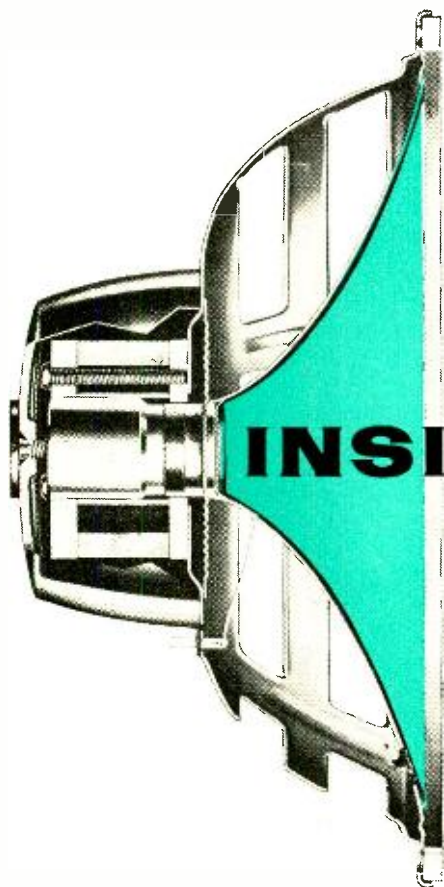
A vibration pickup may be constructed using a crystal phonograph cartridge. And with a little thought, you will probably be able to find many other uses for this truly versatile transistor amplifier.

HOW IT WORKS

This utility amplifier has two stages, each a common emitter type. The input goes directly to the base of the first CK721, through a 2- μ f. electrolytic capacitor. Base bias is determined by a voltage divider (R1 and R2) connected from the collector to the emitter. Transistor Q1 amplifies the signal 40 times and the collector output feeds the primary of T1, the secondary of which is connected to the gain control, R3. The second stage is identical to the first, except that the output of the CK721 goes to a high-impedance headphone instead of to a transformer.

When the induction pickup-coil probe is used, it intercepts the magnetic lines of force surrounding a coil or wire carrying an alternating current. In the r.f. probe, the applied signal is coupled to the diode which demodulates the signal and applies it across the 47,000-ohm load resistor. The output voltage obtained from either probe is applied to the amplifier.

By
JOSEPH MARSHALL



INSIDE the HI-FI Loudspeaker

IF WE had to single out one element of a hi-fi system as being the most important, we would doubtless select the loudspeaker.

We can appreciate the difficult job the loudspeaker has to perform if we recall that the various types of musical instruments generate sound in different ways. The string instruments produce sound by vibrating a string, the brasses by forcing air through a specially shaped aperture and the woodwinds by vibrating a reed coupled to a wood or metal pipe, the percussion instruments by striking a taut diaphragm or pieces of metal, wood, glass, etc.

Each of these sound-generating methods imparts a special character to the produced sound. The loudspeaker, on the other hand, can generate sound in only one very simple way—by moving a “piston” back and forth in the air. And yet, through this single means of generation, it is expected to duplicate not only the sounds produced by the various instruments individually, but also the sounds of all of them playing simultaneously!

Practical Air Pump. A loudspeaker is nothing more than an air pump which alternately



**Speaker design is
a tricky—sometimes
personal—process.
Here are some of
the considerations
involved**

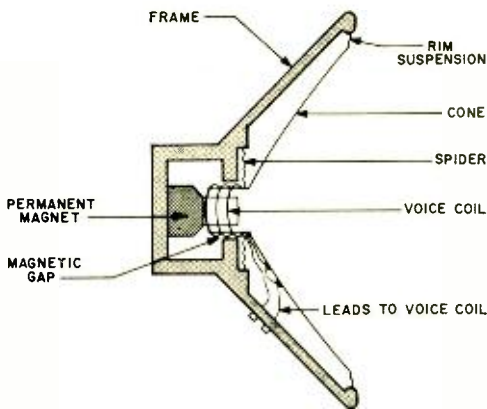


Fig. 1. Cross section of typical permanent magnet loudspeaker. Magnetic assembly is the "motor," and the cone is the "piston" which moves the air.

pushes and pulls the air in front of it and behind it. This back-and-forward motion of the loudspeaker cone produces compressions and rarefactions of the air, creating variations of air pressure which we perceive as sound.

To make a practical loudspeaker, we need a "piston" to contact the air and some kind of "motor" to drive it back and forth. Several types of motors have been developed but almost all current speakers use either the "dynamic" or the "electrostatic" principle.

The theory of the dynamic motor is quite simple. If we slip a few coils of wire over a rod-shaped magnet and then pass an alternating current through the wire, the alternating magnetic field around the coil interacting with the steady magnetic field of the magnet will cause the coil to move back and forth. Thus, we have what might be called a "push-pull" electric motor, to distinguish it from the rotary motors used in fans, sewing machines, etc.

If we attach this motor to a suitable piston to push the air, we will have our loudspeaker. In practice, the a.c. is supplied to the speaker voice coil by the output of an audio amplifier.

Springs and Resonances. The cross section of a typical dynamic loudspeaker is shown in Fig. 1. A device called a "spider" suspends and positions the voice coil in the proper relationship to the magnetic field for optimum response. Obviously there must be some "give" to this suspension for the voice coil to move back and forth freely. But a big cone is too heavy to be

held in place by the spider alone. Therefore, it is necessary to suspend the cone at its outer edge. Obviously, this suspension must also be quite flexible; it is frequently composed of a compliant material such as soft leather, cloth, or foam rubber.

Thus we see that the cone is suspended on two sets of circular "springs," the spider and the rim suspension. These springs complicate matters because power must be wasted in compressing and expanding them as the voice coil goes back and forth. On the other hand, the springs provide a necessary "restoring force" to keep the voice coil centered not only coaxially over the magnet, but also laterally in the middle of the magnetic field.

But the advantages of this restoring force come only at a high price. Whenever a system of springs is introduced into a device, mechanical resonances are the unavoidable consequences. These resonances, as we shall see, produce some problems which are difficult to overcome.

Design Compromises. A loudspeaker, therefore, has the following individual elements: the magnet and its gap, the voice coil, the cone, and the suspension. Each of these elements has an effect on performance and all interact with one another.

For example, the bigger the cone, the more air it can move with a given push or pull. This would seem to indicate that speakers should be designed with very large cones. But as the cone is made bigger and heavier, more power is required to drive it, and the suspension system's restoring force must be made stronger. If the cone is designed to move back and forth over a greater distance, and thus move more air, the magnetic gap must be deeper and the suspension be made both more compliant and more linear.

By increasing the effective magnetic field, the speaker can be made more efficient. But should the available field be concentrated in a shallow gap or a deep one? A deep gap permits longer voice coil travel but decreases the magnetic force at any given point. A shallow gap concentrates the force, but limits the distance the voice coil can travel and still remain within the magnetic gap.

In order for the voice coil to move easily, it should be as light as possible. But if the coil winding wire is small, the electrical resistance goes up and power is used up in heating the coil instead of driving the mo-

tor. If a larger coil is used, thereby decreasing resistance, its weight goes up, making it more difficult to drive.

In other words, there is no one "right" way to design a loudspeaker. Even if the designer were free to produce a "cost-no-object" speaker (which he usually is not), it is obvious that compromises must be made at almost every step of the way. There is no such thing as a "best" loudspeaker design.

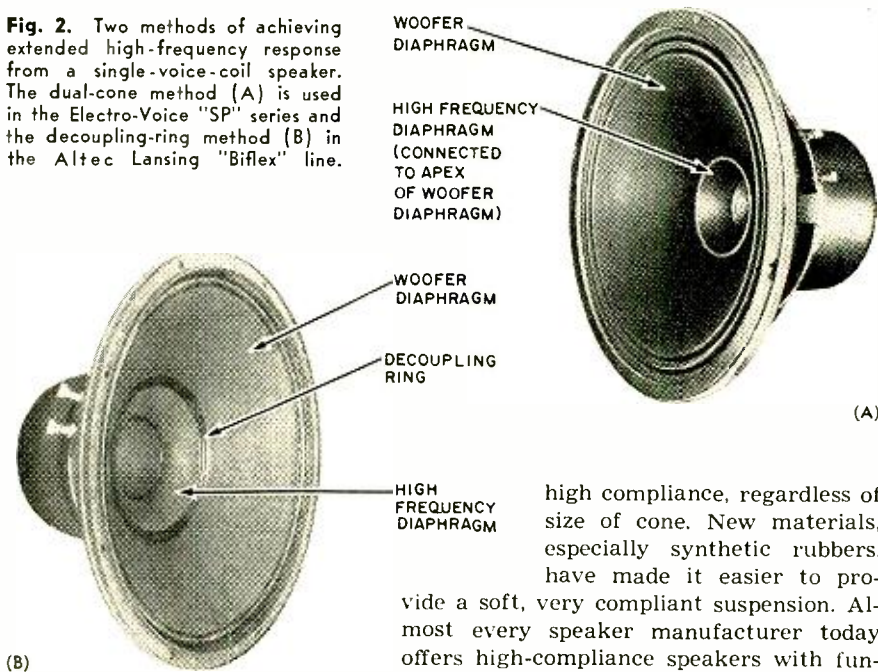
A speaker designer must have not only

to extend the bass response, we must lower the resonant point.

There have been two schools of thought on how to push resonance down in frequency. One school favored making the cone large and relatively heavy. The other school preferred a smaller cone in a more compliant suspension. Until recently American manufacturers in general favored the big cone, while the British favored the small cone in a compliant suspension.

The trend today is toward speakers of

Fig. 2. Two methods of achieving extended high-frequency response from a single-voice-coil speaker. The dual-cone method (A) is used in the Electro-Voice "SP" series and the decoupling-ring method (B) in the Altec Lansing "Biflex" line.



a lot of engineering know-how but also a good ear. And since the final test of a loudspeaker is how it sounds, the designer's personal taste will invariably have a lot to do with the way his speakers are put together.

Lowering the Resonance. We have mentioned that the system of springs which suspends the cone causes the speaker to resonate at certain frequencies. Very little energy is required to produce sound at the resonant frequency. Below resonance, however, the large cone excursions require a suspension system with uniform compliance, or distortion will be generated. A speaker isn't very effective below its resonant frequency, and therefore, if we want

high compliance, regardless of size of cone. New materials, especially synthetic rubbers, have made it easier to provide a soft, very compliant suspension. Almost every speaker manufacturer today offers high-compliance speakers with fundamental resonance points in the neighborhood of 20 cycles.

Extending the Highs. It is very difficult for a single-cone speaker to cover the entire audio range, especially the high frequencies, satisfactorily. Two simple ways to extend the high-frequency response of a single-cone speaker are shown in Fig. 2.

One method is to add a smaller cone to the same voice coil, inside the big cone, as in Fig. 2(A). Another way is to divide the main cone into two cones, joined by a flexible decoupling ring. At bass frequencies both cones operate as a single piston, but at high frequencies only the inner half vibrates. See Fig. 2(B).

Still another approach is to use separate speakers for the high and low frequencies. An independent tweeter can be mounted on the frame of the woofer, may be part of

the woofer magnet assembly, or can be mounted separately.

Damping. The ideal speaker would reproduce the sound fed into it and then stop dead. Unfortunately, since a speaker cone has inertia, it will tend to keep going even after its driving signal stops.

In a piano we can damp the vibrations of

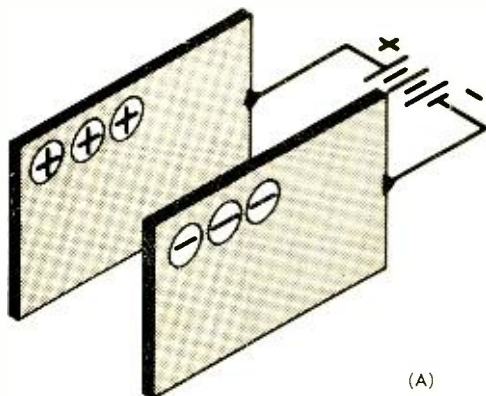
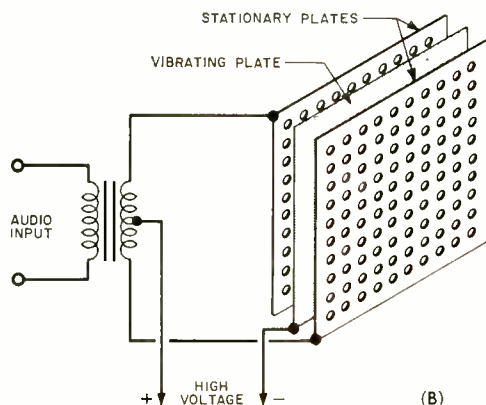


Fig. 3. The fundamental principle of electrostatic speaker operation is shown in (A). When the plates have a like charge, they will move toward each other; when they have unlike charges, they will repel each other. In (B) is a typical hookup for a practical electrostatic speaker.



the wires by pressing the "soft" pedal. This moves a felt pad against the wire, absorbing energy and thus stopping the vibration. We can damp a loudspeaker in a comparable way by a combination of several factors.

- *Mechanical damping* is provided by the suspension system at frequencies other than the resonant frequency.
- *Magnetic damping* is provided by the

magnetic field. Magnetic damping also works together with electrical damping; and the greater the magnetic field, the higher the damping potential.

- *Electrical damping* is provided by the amplifier which drives the speaker. If the voice coil of a speaker is externally shorted, its movement will generate a voltage which opposes the magnetic field and therefore damps the voice coil. Although the nominal output impedance of an amplifier may be rated at 8 ohms, its effective resistance may be 1 ohm or even less. The lower it is, the more the voice coil sees a shorted condition and the higher the damping voltage its movement generates. The combination of a low amplifier output resistance and high magnetic flux can produce a high degree of damping.

- *Acoustic damping* is provided by the air into which the speaker works. Free air offers very little resistance, but air enclosed in a box offers considerable resistance to cone movement and therefore damps the speaker. The smaller the enclosure, the greater the load the air offers and the higher the damping.

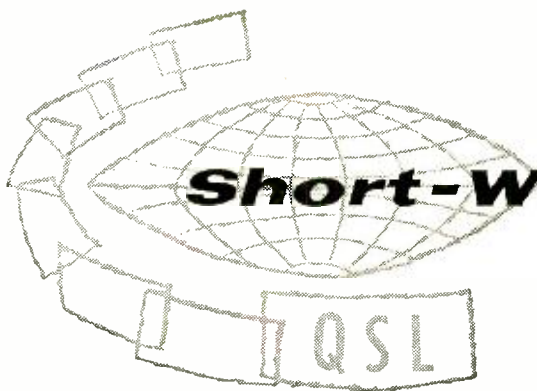
By using a combination of these various methods we can achieve any amount of damping we want. The damping ought to be at least enough to smooth down the resonant peak of the speaker. But here again the question of taste arises.

Some people like a highly damped system which immediately stops producing sound the moment excitation ceases. Others prefer a little "hangover" because it produces a more resonant and more "live" sound. Many amplifiers provide damping controls to permit the adjustment of the damping to optimum—or to suit the preference of the listener.

Efficiency and Quality. All other things being equal, an efficient speaker is preferable to an inefficient speaker because it can be driven with less power. But it's easy to be misled here. While a resonant speaker is far more efficient than a non-resonant one, it may be less faithful to the original sound. Also, a highly damped speaker, although it has improved transient response, is less efficient than an undamped speaker.

So we see that it's very difficult to equate efficiency with quality. Some of the finest systems are very inefficient; some are very efficient. There is no necessary correlation.

(Continued on page 142)



Short-Wave Report

By HANK BENNETT
W2PNA/WPE2FT

SINCE Ray Linnville started DX'ing two years ago, he has logged 17 countries on the short-wave broadcast bands. Ray is one of the younger P.E. reporters (16), a student, and lives at 1106 East Tunis Street, Pensacola, Florida. His Short-Wave Monitor call letters are WPE4LR.

Ray began DX'ing with the assistance of two local radio amateurs, K4RSD and K4TPU. Six of the countries he has logged on the broadcast bands have been verified. On the amateur bands, Ray has verifications from nearly 300 stations. His best verification came from a low-powered Italian station.

The mainstay of the Linnville listening post is a Hallicrafters S-38E receiver. Ray also owns a Globe Scout 50-watt transmitter. The antenna currently in use is a doublet cut to the 21-mc. band; he plans to install a long-wire shortly.

Ray's best DX'ing is done on the 31-

meter band (9000 to 10,000 kc.). His favorite stations are *Radio Switzerland* and the BBC, the former for musical programs and helpful tips to the DX'er, and the latter for their highly informative newscasts.

Now a member of the American Radio Relay League and the Pensacola Amateur Radio Club, Ray also intends to join the Newark News Radio Club. His other hobbies include photography and sports.

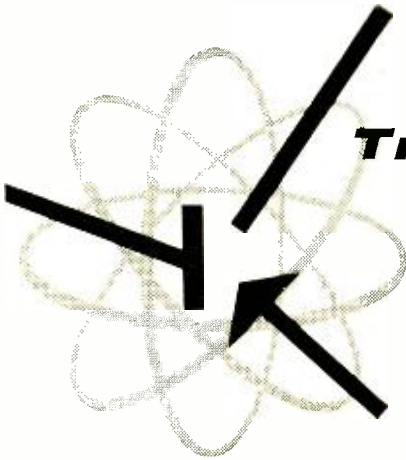
Ray would like to see a periodic listing of SWL Card Swappers as well as more articles on antennas in the pages of P.E. (Try the one on page 97 for size, Ray.) He also would like to see this "featured DX'er" section continued on a monthly basis. Would you? If you have any suggestions as to whom you would like us to interview, let us know. We will be happy to hear from you.

(Continued on page 150)

Ray Linnville, WPE4LR, at his listening post in Pensacola, Fla. Ray's Hallicrafters S-38E receiver (at left in photo) is also used on the ham bands with his Globe Scout 50-watt transmitter (shown at the right of the receiver).



Transistor Topics



By **LOU GARNER**

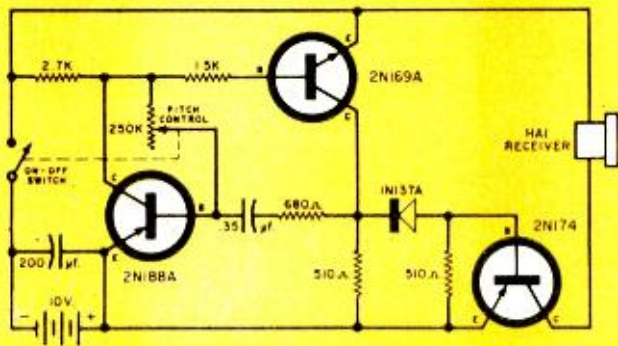
ON A long-term basis, the transistor's importance may be measured by its direct contribution to mankind's health and welfare rather than by the extent of its

a convenient three-transistor *electronic larynx*.

This new miniature unit produces audio signal pulses which can be fed into the throat from the outside and serve as a substitute for the sound vibrations normally produced by the vocal cords. The vibrations can then be turned into intelligible speech by normal use of the throat muscles, tongue, mouth, teeth and lips. Experienced operators can achieve a sentence intelligibility of better than 97%.

A schematic diagram of the Bell unit is shown in Fig. 1. Basically, the device consists of a *p-n-p/n-p-n* complementary relaxation oscillator with a pulse rate of be-

Fig. 1. Transistorized artificial larynx developed by Bell Telephone Laboratories. The entire unit is housed in a 1 $\frac{3}{4}$ "-diameter by 3 $\frac{1}{4}$ "-long package.



application to entertainment, communication, and warfare. In earlier columns we discussed some of the transistor's applications in medical research and instrumentation. The first large-scale commercial use of the transistor, of course, was in hearing aids. Today, all commercial hearing aids are transistorized.

And just as there are hundreds of thousands of individuals whose hearing has been impaired by accident or disease, so are there many people who have lost their voices through larynx removal or vocal-cord paralysis. To help these individuals, Bell Laboratories has recently developed

tween 100 and 400 per second, depending on the adjustment of the *pitch* control. The relaxation oscillator, in turn, is coupled through a diode to a single-ended common-emitter power amplifier driving a modified telephone receiver cartridge (*HA1*) as an output transducer. Operating power is supplied by a pair of 5.2-volt mercury batteries connected in series to supply 10.4 volts, but can be obtained from an a.c. power pack for home or office use.

The entire unit, including the output transducer and battery power pack as well as the electronic circuitry, is housed in a cylindrical package about 1 $\frac{3}{4}$ " in diameter

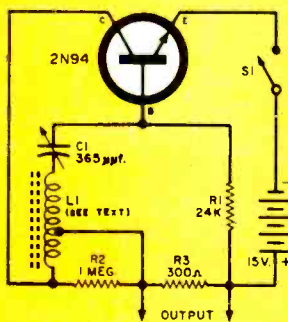


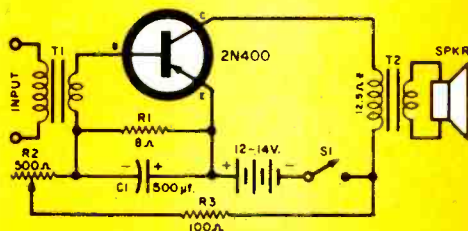
Fig. 2. This r.f. oscillator circuit, submitted by reader Joe Frankel, has many potential applications.

made to the junction of $L1$ and $C1$, with the power switch $S1$ replaced with a standard hand-key.

An $n-p-n$ transistor in the common-emitter configuration is used as a modified Hartley oscillator, with its frequency of oscillation determined by a series-resonant circuit $L1-C1$. Base bias is furnished through $R1$ and collector bias current through $R3$ and part of $L1$; $R2$ serves as a fixed load across $L1$'s tapped section and helps improve circuit stability. The output signal is obtained across $R3$, thus minimizing frequency shift due to loading.

You can assemble a similar unit on a standard metal chassis or on one of the perforated Bakelite boards so popular with

Fig. 3. Gene Richardson's "booster" amplifier will deliver up to six watts.



by $3\frac{1}{4}$ " long. The instrument's on-off switch and *pitch* control are ganged to a single finger-operated lever.

In using the electronic larynx, the operator presses the output transducer against the side of his throat, a little under the chin, and actuates the control switch with one finger. Men adjust the pulse rate from about 100 to 200 pps to change voice inflection; women generally use a frequency range from 200 to 400 pps.

As this is written, the Bell electronic larynx is still a developmental device, and is not yet in commercial production. Chances are that production units will be available in not too many months, however.

Readers' Circuits. Submitted by reader Joseph E. Frankel (Suite 8, 13309 Buckeye Rd., Cleveland, Ohio), the simple r.f. oscillator circuit in Fig. 2 has a number of potential applications in experimental work. It can be used as a test oscillator, BFO, or, if calibrated, as a signal generator. If it is equipped with a short antenna, it can serve as a low-power c.w. transmitter; here, the antenna connection could be

experimenters. $L1$ is a ferrite loopstick (Type AA-50, Shields Electronics, Chicago, Ill.) and $C1$ is a standard 365- μf . variable capacitor. A 22.5-volt battery can be employed if a 40,000-ohm resistor is used for $R1$ and 500 ohms for $R3$. Other r.f. $n-p-n$ transistors can take the place of the 2N94, but you may have to experiment with bias resistor values to obtain best performance.

A single-ended power amplifier stage delivering up to 6 watts, the circuit shown in Fig. 3 was sent in by reader Gene Richardson (310 East Mason, Alexandria, Va.). He suggests using this circuit as a "booster" amplifier for a personal-portable receiver or, if combined with a standard preamplifier, in p.a. or phonograph applications. All parts are standard and readily available through most distributors.

A $p-n-p$ power transistor is employed as a common-emitter Class A transformer-coupled amplifier. Base bias is supplied by voltage divider $R1-R2-R3$, with $R1$ bypassed by $C1$. A 12- to 14-volt power supply battery is controlled by a standard s.p.s.t. toggle or slide switch ($S1$). $R1$ and

$R3$ are 1-watt resistors, $R2$ a 2-watt rheostat or carbon potentiometer. $C1$ is rated at 500 μ f., 15 volts. Transformer $T1$ should be chosen to match the signal source to a 10-ohm load (a small tube output transformer will serve here . . . or, if you prefer, use an Argonne Type AR-114). Transformer $T2$ is a power output transformer matching 12.5 ohms to the loudspeaker's voice coil impedance (this could be a "universal" transformer, such as the Lafayette Type TR-94).

Gene suggests that the amplifier be assembled on a small metal chassis which will serve as a "heat sink" for the transistor. You can use a Bendix Type 210 6500 mounting kit to mount the transistor and to insulate it from the chassis. Operating power can be supplied from any heavy-duty 12- to 14-volt battery . . . an auto storage battery would be excellent, as would a 12-volt "hot shot" or lantern battery.

After assembly, set $R2$ to its maximum resistance. Open the collector lead and insert an 0.5 ampere meter in series. Next, with the power turned on, but with no signal applied, adjust $R2$ for a current reading of 1.25 amperes. Afterwards, the meter is removed and the collector recon-

until satisfactory performance is obtained. Surprisingly, this "cut and try" method is not confined to gadgeteers, but is often employed by advanced design engineers, for transistor tolerances are such that mathematical design techniques seldom result in final values.

To aid in this work, several manufacturers have introduced "transistor breadboards." Essentially, these are made up of one or more transistor sockets, variable resistors, various capacitors, and one or more power supplies. They range in price from under \$80 to nearly a thousand dollars, depending on features.

The least costly of the available units is Sprague's Model LF-1 "Transimulator," distributed through most parts outlets. Larger—and more expensive—units are manufactured by National Electronic Laboratories, Inc. ("Transistor Circuit Synthesizer"), 1713 Kalorama Rd., N.W., Washington, D. C., and by Abrams Instrument Corporation ("Transistor Breadboard" Model TB-1), 606 E. Shiawassee St., Lansing, Mich.

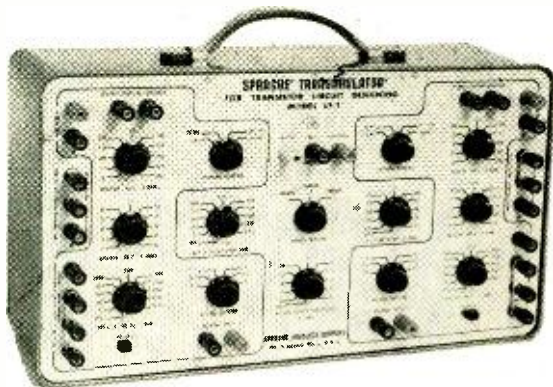
New Literature. A number of semiconductor manufacturers have recently published booklets, brochures, or folders containing data of value to transistor experimenters, technicians, and engineers. Here's a quick "round-up."

General Electric Company (Semiconductor Products Dept., Syracuse, N. Y.) has published a 24-page brochure entitled "Designing with GE VAC-U-SEL Component Rectifiers." Work sheets, charts, graphs and nomographs are included. Copies of this brochure, GE No. EGG-344, are available free on letterhead requests from engineers and technicians.

Bendix Red Bank (Semiconductor Products Div., 201 Westwood Ave., Long Branch, N. J.) is offering a four-page folder featuring 20 practical transistor circuits. Included are circuits for intercoms, megaphones, light flashers, preamps, phono amplifiers, and power supplies. All parts values are given. Copies of this folder, "An Application Note on Transistor Circuits I," are free on request.

Radio Corporation of America (Semiconductor Products—Distributor Sales, Har-

(Continued on page 140)



Complete "breadboard" setups for experimenters, such as Sprague's Model LF-1 "Transimulator" shown here, are now becoming available commercially. See text for more details.

nected to $T2$. For longer battery life, $R2$ can be adjusted for a lower current (0.5 ampere, for example), but power output will be reduced proportionately.

Transistor Breadboards. Many home experimenters like to work out new circuits, and their "design" technique often consists of wiring the experimental circuit, then adjusting various component values

You can improve the listening quality of your hi-fi system, especially stereo, with acoustical tile. How this new component helps make hi-fi sound better, and how you can install it in your home, will be described in this, and future articles.

By ANDREW LORANT

ACOUSTICAL TILE— *a New Hi-Fi Component*

THE manufacturers of hi-fi equipment have been able to provide many methods of controlling sound—bass and treble tone controls, filters, loudness compensating controls, and so on. But all of these exert their effects on the sound *before* it is produced. To provide complete control of sound, we need some way of regulating the sound *after* it is produced. This we can do only by altering the acoustical properties of the listening room.

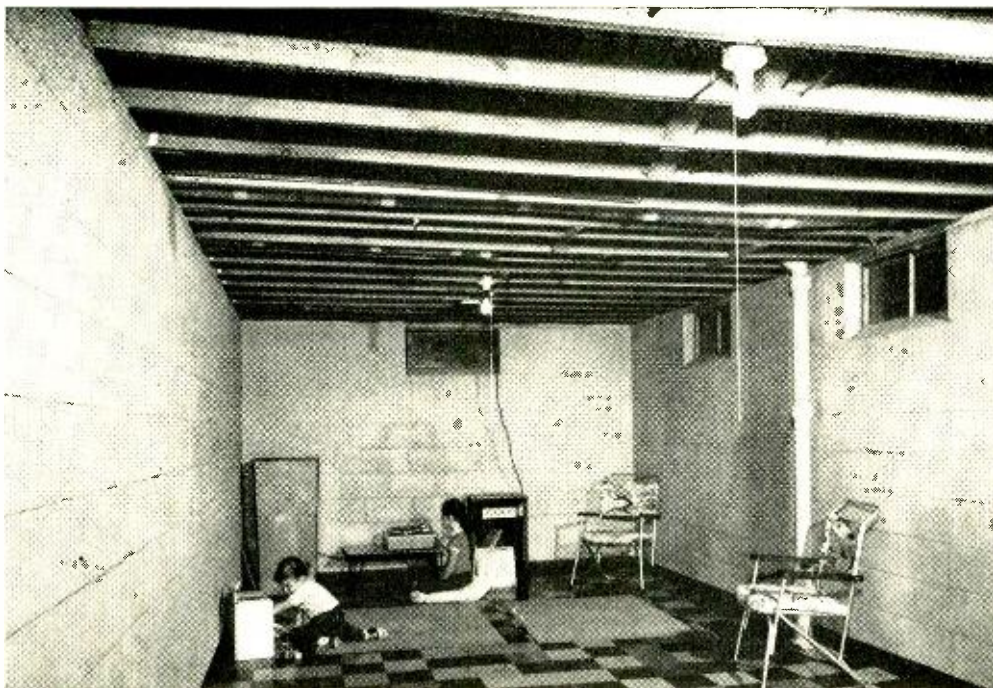
One way to achieve acoustical control is by putting sound-absorbent furnishings—chairs, rugs, drapes, etc.—in the room. Obviously, this method is limited in flexibility by practical factors; after all, only just so many overstuffed chairs can be fitted into any given room.



Enjoyment of hi-fi—especially stereo—can usually be improved by installing acoustical tile in the listening area.

A simpler method involves the use of acoustical tile. This material is particularly good because, in addition to its sound-controlling properties, acoustical tile is easy to install, flexible in installation, and is available in a variety of decorator patterns. Cost is surprisingly low and the results, from an acoustical standpoint, are well worth while.

How does a sound-absorbent material like acoustical tile work? Well, imagine



Measurements have been made to determine the practical effects of installing acoustical tile. Above is the test room before it received acoustical treatment. The many hard surfaces in this room made the enjoyment of music very difficult.

that you are in a room with four hard walls and a volley of ping-pong balls, rather than sound waves, is being propelled from your speaker system. The ping-pong balls will bounce merrily back and forth from wall to wall. Now, while the original balls are still bouncing around, if a second volley of balls were to be "shot" out of the speaker, all the balls would mix together and it would be impossible to distinguish one group from the other.

This, in effect, is what happens to sound when it is reflected from hard-surfaced walls, ceilings and floors. The direct wave of sound from the speakers mixes together with the reflected sound. By the time the music reaches your ears, it has been so colored by room acoustics that no amount of knob-twisting can make it sound realistic.

Now consider what happens when sound-absorbent materials are added to the room. When sound hits them, it stops bouncing around like so many ping-pong balls. But you can go overboard using these mate-

rials; unless you are careful, too much sound absorption will create a "dull" or "hollow" effect.

It's plain to see, therefore, that acoustical problems cannot be solved by merely adding sound-absorbent materials indiscriminately. The acoustic surroundings must be *controlled*. And this is where acoustical tile comes to the rescue.

By installing acoustical tile on the ceiling and then applying varying amounts of tile on the walls, any degree of sound absorption can be attained. Because of its extreme flexibility of installation, acoustical tile offers infinite opportunities for the design of a listening room which will suit any listening taste.

In addition to its importance as a sound-controlling factor, acoustical tile is useful in cutting down unwanted sounds. If, for example, you wish to listen to hi-fi in the basement while the rest of the family is watching TV upstairs, acoustical tile on the ceiling will help prevent sound transmission from one room to another.



Treatment of test room with acoustical tile results in better room acoustics and better looks, too.

Since the introduction of stereo, the acoustical treatment of the listening room has become even more important than with monophonic hi-fi systems. Ideally speaking, each ear should receive sound from only one of the stereo speakers. The left speaker, for example, should make its strongest impression on the left ear, and sound from the right speaker should be concentrated on the right ear.

For acoustical treatment in a stereo room, therefore, you may find it advisable to put acoustical tile part way down the walls along each speaker enclosure. This will help prevent sounds from the speakers from getting bounced over to the wrong side of the room.

Obviously, then, the treatment of a room with acoustical tile involves not only the amount of tile used, but also where it is



Professional sound-measuring instruments were necessary to obtain data on the results of installing various amounts of acoustical tile.

placed. By carefully studying the many scholarly books that have been written about acoustics, you can find out how much sound-absorbent material is optimum for a room with a given volume of air; but it's more difficult to get some practical guid-

ance that tells where and how to install it.

Accordingly, a test room has been set up to make the necessary measurements and evaluations. Since measurements under as wide a variation of conditions as possible were desired, a basement room with concrete walls, rubber tile flooring, and open beam ceiling was chosen. By erecting "dummy" walls, false ceilings, etc., a number of different conditions could be simulated without too much difficulty.

The preliminary results of these tests (which are presented in the section below) indicate that the application of acoustical tile has undoubtedly improved the acoustics of the test room, but since the study is necessarily detailed, the conclusive report on the measurements will be presented next month rather than in this issue. In the meantime, you might start checking into the advisability of installing acoustical tile in *your* listening room. -50-

DOES ACOUSTICAL TILE REALLY MAKE A DIFFERENCE?

What does acoustical tile add to the enjoyment of a stereo system? To find the answer, a series of tests was undertaken during the installation of acoustical tile in a typical listening area.

Stereo Acoustics. To obtain the greatest stereo effect, the left ear should receive the sound from the left speaker, the right ear from the right speaker. This situation, however, can be only partially realized because each ear also hears the "other" speaker.

Our hearing mechanism is able to pinpoint a sound source because of a difference in *time* and *level*. Since the path from the left speaker to the right ear is longer than from

the left speaker to the left ear, as indicated by the solid lines in Fig. 1, a sound emanating from the left speaker reaches the right ear an instant later than the left ear. Also, the sound level at the right ear will be less than at the left ear.

In a "hard" room, sound also reaches the ears through reflection from walls, ceiling, and floor. One possible reflected path is shown by the dashed lines in Fig. 1. These reflected sounds not only upset the ear's "timing" mechanism, but they also tend to equalize the level on both ears. As a result, the ability to pinpoint the sound source is reduced.

In order to be able to locate the sound source easily, the reflected sound must be minimized. This is accomplished by the application of acoustical tile.

Measurements. To measure the effects of acoustical tile, the left and right ears were simulated by a sound level meter. With the left speaker providing a sound source, it was possible to measure the sound levels at the left and right "ears." The results are represented in Fig. 2 and Fig. 3.

Without acoustical tile, the difference between the sound levels at the left and right ears is negligible beyond six feet from the speaker (see Fig. 2). In the treated room, however, the difference between sound levels at the left and right "ears" is significant up to 15 feet from the speaker (see Fig. 3). More results will be given next month.

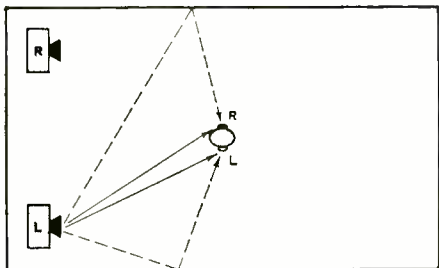


Fig. 1. The solid lines indicate direct sound paths; the dashed lines show some possible paths for reflected sound.

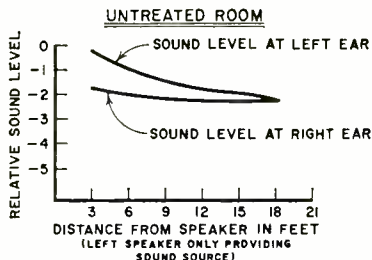


Fig. 2. Untreated room shows negligible differences in sound levels at left and right "ears" beyond 6 feet from speaker.

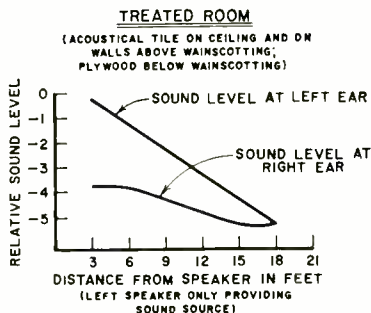
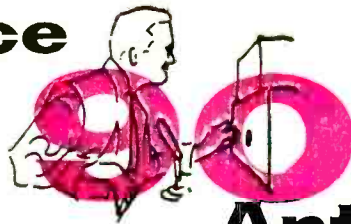
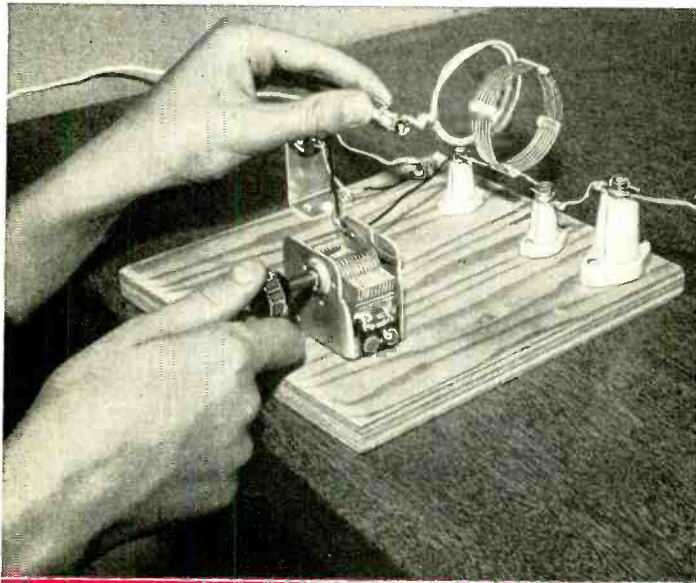


Fig. 3. After treatment with acoustical tile, test room shows improved stereo separation up to 15 feet from speaker.

The Novice



Antenna



**Simple tuner makes
long-wire antenna
effective on
40 and 80 meters**

MANY a Novice ham has difficulty in "getting out"—and nine times out of ten the trouble lies in failure to put power into the antenna. Fifteen watts of power actually *in* the antenna will put out a reliable signal on the Novice bands.

Transferring power from transmitter to antenna can be tricky business, and this is particularly true when you try to feed most ordinary long-wire antennas with the typical pi network stage of a transmitter. In many cases, the antenna represents a high-impedance load—and feeding it from the low-impedance output of the transmitter makes for a big waste of precious power.

This problem is neatly sidestepped with the "Novice 90" antenna, which is designed to be end-fed with a low-impedance line. Thus, the antenna is very simple to erect and, even more important, you can adjust resonant length right in the operating room. The adjustment is easily made using a 10-cent flashlight bulb which shows you the point of maximum antenna current.

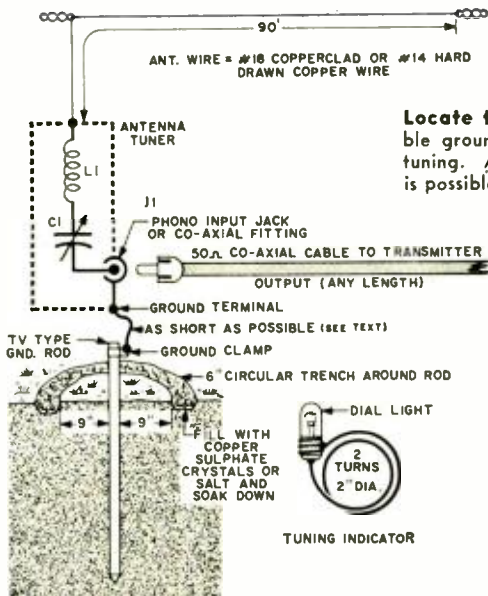
By JAY STANLEY

This current is the power being soaked up by the antenna.

Construction. The "heart" of the antenna is a simple tuner, consisting of a TRF-type single-gang tuning capacitor (*C1*) and coil *L1*. These parts are mounted on a convenient board as shown in the diagram. Stand-off insulators support the coil and the antenna terminal.

Variable capacitor *C1* and the Fahnestock clip for the ground connection are mounted directly on the board. The RCA phono input jack *J1* (a regular coax connector could be used instead) is mounted on a small metal angle bracket screwed to the board. Jack *J1* connects to the coaxial cable jumper which runs to your transmitter output terminal.

The coil for the antenna tuner consists



Locate the antenna tuner for the shortest possible ground wire while maintaining accessibility for tuning. A remote waterproofed tuner installation is possible but this would make tuning more difficult.

is rock salt. Ordinary table salt will work well also, but of course is more expensive. Dump in the chemicals, soak down the area with a garden hose, and you will have a ground far more efficient than the usual water pipe ground. The latter should be used only as a last resort and cannot be expected to work as well.

In a typical station layout, the antenna tuner should be mounted alongside a window sill. The ground should be just outside the window, close to the house. The antenna tuner can be connected to the transmitter by any convenient length of 50- or 52-ohm (approximately) coaxial cable.

Antenna Tune-Up. First, attach a two-turn loop of wire to a No. 44 dial light bulb or a bulb from a two-cell flashlight. The loop and the bulb provide an indicator for antenna current. Then, connect the coaxial cable from the transmitter to the antenna tuner. Set the capacitor on the antenna tuner approximately one-half "open."

Next, set your transmitter for 80 meters, and tune it following the manufacturer's instructions. Load up the transmitter final by adjusting the antenna loading and plate tuning capacitors in the transmitter. Now, couple the pickup loop and bulb (as shown in the photograph) to the antenna coil, and adjust antenna tuning capacitor *C1* for maximum brightness. When you find this point, you have the antenna at resonance and it is taking maximum power.

On 40 meters the adjustment is quite similar, although the resonance point is usually very broad, as shown by the tuning loop indicator. On this band, set the antenna tuner capacitor to as high a capacity as possible (plates almost closed) where the tuning indicator is at maximum brilliance.

The last step is to adjust the transmitter tuning for proper load as indicated by the milliammeter in the final of the transmitter. Don't make any big changes in the antenna resonance adjustment already achieved, but check for maximum brilliance of the bulb.

PARTS LIST

- C1*—350- μ f. (or larger) midget TRF single-gang variable capacitor
- J1*—RCA type phono jack (or suitable coaxial cable connector)
- L1*—Six turns of B & W 2"-diameter Type 3900 coil stock
- 3—Stand-off insulators
- 1—Baseboard
- 1—Fahnestock clip

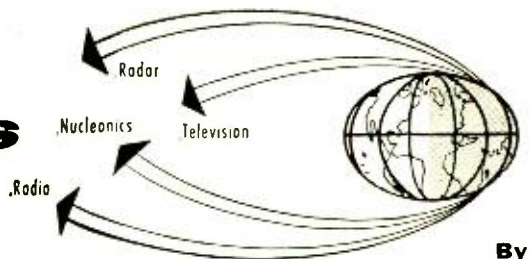
of six turns of No. 14 wire approximately 2" in diameter. Turns are spaced approximately $\frac{1}{8}$ " apart. Wind the coil yourself or cut some turns from a piece of B & W 2"-diameter No. 14 wire coil stock (Type 3900).

The antenna itself is a 90' "L"-shaped length of wire. How much is horizontal and how much is vertical is not particularly important: for example, 30' up to 60' out is ideal. However, other combinations, such as 40' up and 50' out, will work as well.

For best results, keep the ground lead under 10' in length, the shorter the better. If it must be longer, subtract the length of the ground lead *over* 10' from the antenna length in feet. For example, if the ground lead is 14', make the antenna 86' instead of 90'.

You can build an efficient ground as shown in the diagram. Use a standard TV ground rod (the longer the better) and then improve the conducting characteristics by chemically treating the ground nearby. Copper sulphate crystals are excellent, as

After Class



By
FORREST H. FRANTZ, SR.

TRANSDUCERS

Part 1—Voltage Generators

ONCE a nation gets a satellite orbiting, the propulsion and steering teams of scientists relax, loosen their neckties, and perhaps go out for a short beer. The main burden now falls on the shoulders of the telemetering team. These are the people the satellite "talks" to with quavering beeps and chirps, transmitting the latest news from outer space. The electronic sense organs that enable Sputniks and Vanguards to "perceive" the universe about them belong in the main to a group of electronic devices called *transducers*.

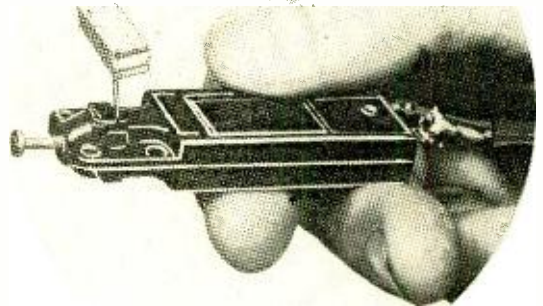
While the word may not mean very much to the casual reader, the technician understands a transducer to be a device that takes mechanical, heat, light or sound energy in one "end" and puts out electrical energy from the other. You'll find transducers used to convert speed, direction, acceleration, mechanical force, strain, temperature, radiated energy, light intensity and numerous other quantities into a voltage or change in resistance, capacitance, or inductance. Generally speaking, a transducer converts signals from one form into another.

Transducers are grouped in two general classifications: (1) voltage-generating transducers; and (2) parameter-changing transducers.

The voltage-generating types of transducers may be further classified as: (a) magnetoelectric (such as the headphone, dynamic microphone, and loudspeaker); (b) piezoelectric (e.g., the crystal phonograph pickup and microphone, the quartz crystal in an oscillator); (c) thermoelectric (e.g., the thermocouple ammeter); and (d) miscellaneous types (in-

cluding photoelectric cells and tubes, electrochemical transducers, etc.).

Magnetoelectric devices operate on the principle that the generated voltage is proportional to the velocity of a wire moving through a magnetic field. Thus, if a small generator is turned slowly, the output voltage is low. If the generator is



Standard crystal pickup serves as a vibration sensing element when small wooden block is attached to short length of wire fitted into the stylus chuck. Unit may have to be shielded to avoid picking up 60-cycle hum.

turned more rapidly, the output voltage is increased. If the generator is geared to the wheel of a bicycle—or the shaft is held against the tire, and the output of the generator is connected to a meter, the meter may be calibrated in miles per hour, and

the total result is a bicycle speedometer.

This principle is widely used in measuring air and fluid flow and the speed of motors and engines in industry. The simple tachometer described in the April '59 issue is an example of magnetolectricity in action.

The permanent magnet dynamic loudspeaker is another commonly used transducer. Here, however, a varying current passing through a coil of wire in a strong magnetic field is used to move a stiff paper cone. The cone in turn imparts the velocity to the air in front of it, resulting in the production of audible sound waves. If a PM loudspeaker is connected through a matching transformer to the input of an

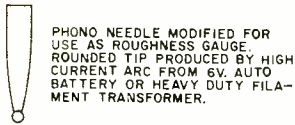


Fig. 1.

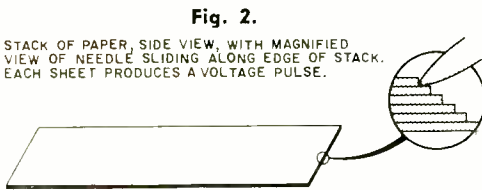


Fig. 2.

amplifier, it may be used as a microphone. The ability to function as either an input or an output signal device holds true for most voltage-generating transducers.

Piezoelectric devices operate on the principle that when a mechanical stress is applied a voltage output results. Conversely, if a voltage is applied to a crystal, the internal stresses in the crystal change to produce an expansion or contraction of the crystal.

Everyone is familiar with the crystal or ceramic phonograph pickup cartridge which has an output proportional to the mechanical vibration picked up from the record groove by the mechanically coupled needle. The phono pickup cartridge may be utilized as a vibration pickup by providing a coupling like that shown in the photo. Or by modifying a needle as shown in Fig. 1, the pickup may also be used as a surface roughness gauge. If the roughness gauge is held against a surface with uniform pres-

sure and moved at a uniform speed, the output voltage will be proportional to the roughness of the surface.

A crystal phono cartridge may even be used to count sheets of paper, and it does it fast! If a stack of paper is pushed out of shape so that it presents a parallelogram profile (see Fig. 2), and the needle of a phono cartridge is passed along the sloped end of the pile, each "step" passed produces a voltage pulse. If these pulses are fed into an electronic counter, the number of sheets in the stack can be counted in no time flat.

A thermoelectric transducer produces a voltage when heated which is proportional to the temperature. A more common name for a thermoelectric transducer is "thermocouple." The thermocouple is formed by joining two dissimilar metals.

The most common use for the thermocouple is temperature measurement. However, it can also be used to measure r.f. current in conjunction with a d.c. voltmeter.

Advantages of using thermocouples for temperature measurements are that they can operate at extreme temperatures, are very accurate, and permit remote reading of temperatures or automatic control of processes with suitable auxiliary equipment.

The "miscellaneous" category of voltage-generating transducers takes in a vast multitude of devices (far too many to cover here) that do not fit into the other three categories. The most familiar one is the photoelectric cell.

There are two types of photoelectric cells: the photovoltaic type such as the selenium and germanium cells, and the photoemissive type which is normally encased in a glass tube. The most common applications for such light-sensitive devices are in counter pickups, burglar alarms, annunciators, and smoke detectors. Other applications are color-matching, automatic light control and heat radiation measurement.

You may also have heard of the electrochemical transducer which the chemist uses to measure ion concentration in solutions. In this case, the transducer is a glass electrode that produces an output voltage proportional to the ion concentration which is measured with a high-input-resistance VTVM.

Next month we'll discuss the various parameter-changing transducers. —30—



Across the Ham Bands

By
HERB S. BRIER
W9EGQ

KEYING WITH A "BUG"

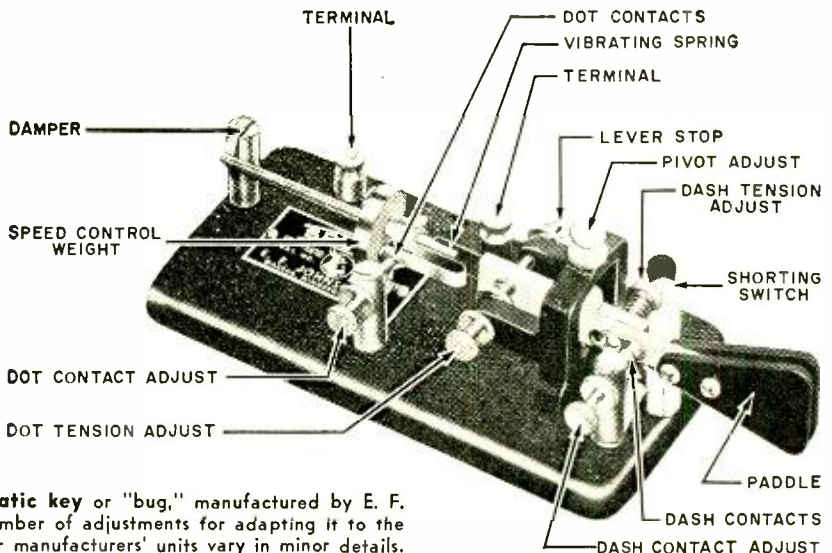
IN SKILLED HANDS, a semi-automatic or "bug" key does for the code operator what an outboard motor on his boat does for a fisherman. The motor doesn't make the angler a better fisherman—it can even scare the fish away if used improperly. In the same way, a semi-automatic key can be a monster in disguise if it is not used properly. Or it can save you a lot of unnecessary work. If you compare the effortless manner in which a skilled operator sends on a semi-automatic key with your own sending on a conventional "straight" key, you will undoubtedly want a "bug" key of your own.

How the Bug Works. The semi-automatic key performs its labor-saving function by making dots automatically when its control paddle is pushed to the right. The dots are formed through the vibration of a weighted, flat spring. This vibration causes the dot contacts to make and break

at a speed determined by the number and position of the weights on the speed-control shaft. Dashes are made manually in the normal manner by pushing the paddle to the left.

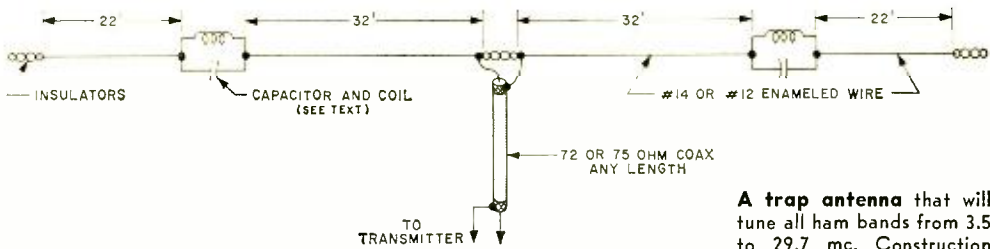
When the weights are removed entirely from the key, the spring vibrates so rapidly that it makes a buzzing sound. This is supposed to be the origin of the term "bug." Whether it is the true explanation or not, the Vibroplex Company has used the picture of a bug as a trade-mark on their semi-automatic keys for over 50 years.

Novice visitors to my shack jump at the opportunity to send on my bug. Of course, they quickly discover that sending on it is not as easy as it looks. Their A's come out as U's or V's, and their D's and B's sound like 6's. The truth is that a bug doesn't work well below 10 wpm. Sure, you can slow one down to a walk by hanging enough extra weights on it. But the bug



This semi-automatic key or "bug," manufactured by E. F. Johnson, has a number of adjustments for adapting it to the user's "fist." Other manufacturers' units vary in minor details.

October, 1959



A trap antenna that will tune all ham bands from 3.5 to 29.7 mc. Construction details for the tuned traps are given on page 144.

is harder to send on at low speeds than a straight key.

Adjustments. When you take your bug out of its case, a few adjustments will probably be required.

The top and bottom pivots should center the control arm so that both dot and dash contacts meet squarely. Loosen the pivots enough to allow the arm to move freely but not so much as to allow any appreciable vertical motion in it. See that the right-hand stop just lets the end of the weight bar touch the damper at the rear of the bug without bending the flat dot spring when the control arm is at rest.

Set the left-hand stop to permit the control arm to swing about $3/32$ " when its paddle is pushed to the right. Then, set the fixed dash contact to permit the paddle to move about the same distance to the left in making a dash. Also, adjust the tension springs so that the contacts will open immediately upon the release of pressure on the control paddle. Too much tension may make your sending jerky and cause the bug to skitter all over the table in operation, even though it does weigh five pounds. Too little tension will result in sloppy spacing, especially between dashes.

Good "bug" technique is demonstrated by Gary Harwell, WV6ALL.



To adjust the dot contact, place the bug on the table, slow it down to a reasonable speed, and connect it to an audio oscillator. Then adjust the fixed contact so that pushing the paddle to the right produces a string of 10 to 12 dots before the vibrating contact comes to rest against the fixed one and produces a steady note from the oscillator.

The dot contact is not adjusted correctly if holding the paddle to the right produces a long string of dots that finally tapers off into nothingness. Such an adjustment produces dots that are too light to cut through the static, interference, and other noises on the air.

The minimum dot speed of the usual bug is about 15 wpm. This is a bit fast to start with and for regular use in the Novice bands. However, it is a simple matter to slow the speed down to about 10 wpm by pushing the weights out to the end of the control shaft and wrapping a few turns of solder tightly around them.

Using Your Bug. Place the bug on the operating table in the position most comfortable for you, leaving plenty of room for your forearm to rest on the table. Grasp the paddle lightly between your thumb and forefinger, and use a slightly rolling motion of your wrist to manipulate the paddle. Some operators don't touch the paddle except when they are actually making a dot or dash.

As with most things connected with the code, the one way to master a bug is by practice and more practice. Nevertheless, after an hour or so of practice with an audio oscillator, you will be tempted to put it on the air. Go ahead. You might do surprisingly well for a transmission or two. But if you have an initial failure, don't worry about it. Just go back to the oscillator for some more practice.

(Continued on page 144)



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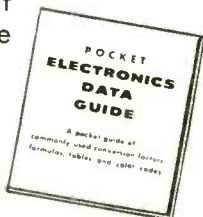
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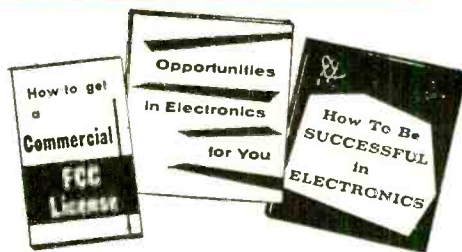
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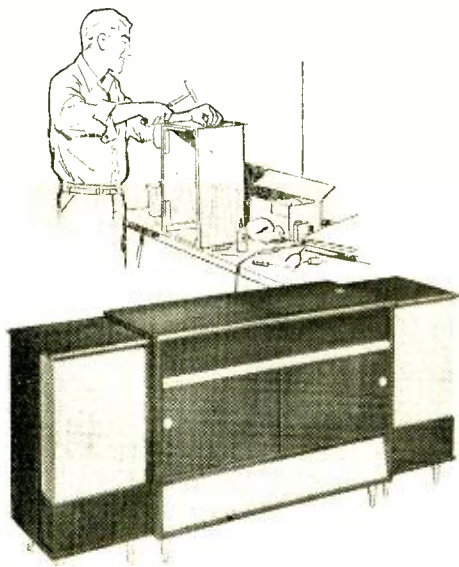
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HEATHKIT FM-3A **\$26⁹⁵**

HIGH FIDELITY FM TUNER KIT

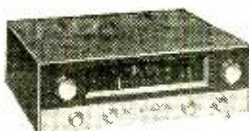
The thrills of FM entertainment are yours at budget cost with this handsomely styled tuner. Featuring broad-banded circuits for full fidelity and better than 10 microvolt sensitivity for 20 db of quieting, the FM-3A pulls in stations with clarity and full volume. Shpg. Wt. 8 lbs.



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HEATHKIT PT-1
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**MONAURAL-STEREO
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**MONAURAL-STEREO (two channel mixer)
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Control your entire stereo system with this 2-channel preamplifier. A remote balance control with 20' of cable allows balancing the stereo system from listening position. Shpg. Wt. 15 lbs.



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HEATH COMPANY
Benton Harbor, Mich.

A Subsidiary of Daystrom, Inc.



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Features 150 watt phone input and 180 watt CW input. Provision for single-sideband transmission using the SB-10 External Adapter. Shpg. Wt. 110 lbs.



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MOBILE POWER SUPPLY KIT

Furnishes all power required to operate both MT-1 Transmitter and MR-1 Receiver from 12-14 volt battery. Delivers full 120 watts continuously or 150 watts intermittently. Kit includes 12' battery cable, tap-in studs for battery posts, power plug and 15' connecting cable. Shpg. Wt. 8 lbs.

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HEATHKIT MR-1
\$119⁹⁵

"COMANCHE" MOBILE HAM RECEIVER KIT

Handsome styling, rugged construction, top quality components and economy are all wrapped up in the "Comanche". It is an 8-tube superheterodyne receiver operating AM, CW and SSB on the 80, 40, 20, 15 and 10 meter amateur bands. Operates from 12 volt car battery through the MP-1 Mobile Power Supply. Can be converted in minutes to a fixed station unit by using an AC power supply. Shpg. Wt. 19 lbs.

MOBILE ACCESSORIES

Quality 5" PM speaker in rugged steel case with mounting brackets. Heathkit AK-7. \$5.95. Shpg. Wt. 4 lbs.

Mobile base mount holds both transmitter and receiver. Universal floor mounting bracket. Heathkit AK-6. \$4.95. Shpg. Wt. 5 lbs.



HEATHKIT MT-1
\$99⁹⁵

"CHEYENNE" MOBILE HAM TRANSMITTER KIT

The fun and convenience of mobile operation are yours with the compact and efficient "Cheyenne" Transmitter. Featuring high power with minimum battery drain, the unit provides up to 90 watts phone input and covers 80, 40, 20, 15 and 10 meters. Featured are a built-in VFO, modulator, 4 RF stages with a 6146 final amplifier pi network (coaxial) output coupling. The "Cheyenne" is designed as a companion to the "Comanche" receiver and is powered by the MP-1 Power Supply. Shpg. Wt. 19 lbs.



HEATHKIT VHF-1
\$159⁹⁵

"SENECA" VHF HAM TRANSMITTER KIT

General, technician or novice class hams wishing to extend transmission into the VHF region will find the "Seneca" ideal. A completely self-contained 6 and 2 meter transmitter, the VHF-1 features up to 120 watts input on phone and 140 watts input on CW in the 6 meter band. Included are controlled carrier phone operation, built-in VFO for both 6 and 2 meters, and four switch-selected crystal positions. Shpg. Wt. 56 lbs.



HEATHKIT V7-A
\$25⁹⁵

ETCHED CIRCUIT VTVM KIT

World's largest selling VTVM, the V7-A measures AC voltage (RMS), AC voltage (Peak-to-peak), DC voltage and resistance. Features 7 AC (RMS) and DC voltage ranges of 0-1.5, 5, 15, 50, 150, 500 and 1500. In addition there are 7 peak-to-peak AC ranges of 0-4, 14, 40, 140, 400, 1400 and 4000. Seven ohmmeter ranges are provided. Battery and test leads are included with kit. Shpg. Wt. 7 lbs.



HEATHKIT TC-3
\$39⁹⁵

TUBE CHECKER KIT

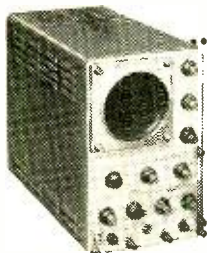
An invaluable aid to servicemen, the TC-3 tests for open, short, leakage, heater continuity and quality of all tube types commonly encountered in radio and TV servicing. Checks 4, 5, 6 and 7-pin large, 7 and 9-pin miniature, 7-pin sub-miniature, octal and loctal tubes and pilot lamps. A blank socket provides for future tube types. Shpg. Wt. 12 lbs.



Model 355.

TV PICTURE TUBE TEST ADAPTER

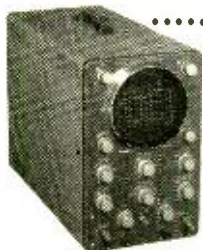
For use with TC-3 or earlier model TC-2. Includes 12-pin TV tube socket, 4' cable. Octal connector and data. No. 355. Shpg. Wt. 1 lb. \$4.50.



HEATHKIT OP-1
\$179⁹⁵

"PROFESSIONAL" 5" DC OSCILLOSCOPE KIT

Offering complete versatility, the OP-1 features DC coupled amplifiers and also DC coupled CR tube unblanking. Triggered sweep circuit operates on internal or external signals and may be either AC or DC coupled. Transformer operated power supply has silicon diode rectifiers. Shpg. Wt. 34 lbs.



HEATHKIT OM-3
\$39⁹⁵

"GENERAL PURPOSE" 5" OSCILLOSCOPE

Ideal in servicing as well as routine laboratory work, the OM-3 features wide vertical amplifier frequency response, extended sweep generator operation and improved stability. Vertical response is within ± 3 db from 4 CPS to 1.2 mc. Sweep range covers 20 CPS to over 150 kc. Shpg. Wt. 22 lbs.



HEATHKIT T-4
\$19⁹⁵

VISUAL-AURAL SIGNAL TRACER KIT

Doubling as a utility amplifier, test speaker, or substitution transformer, the T-4 represents an outstanding buy. Traces RF, IF and audio signals in AM, FM and transistor-type radios. Shpg. Wt. 5 lbs.



HEATHKIT SG-8
\$19⁵⁰

RF SIGNAL GENERATOR KIT

Aligns RF, IF and tuned circuits of all kinds. Provides extended frequency coverage in five bands from 160 kc to 110 mc on fundamentals and up to 220 mc on calibrated harmonics of the fundamental frequencies. Shpg. Wt. 8 lbs.



HEATHKIT CT-1
\$7⁹⁵

IN-CIRCUIT CAPACI-TESTER KIT

Check capacitors for "open" or "short" right in the circuit. Detects open capacitors from 50 mmf up and checks shorted capacitors up to 20 mfd. Checks all bypass, blocking and coupling capacitors of the paper, mica and ceramic types. Shpg. Wt. 5 lbs.



HEATHKIT TO-1
\$16⁹⁵

TEST OSCILLATOR KIT

Provides fast and accurate selection of test frequencies most used by servicemen in repairing and aligning modern broadcast receivers. Five fixed-tuned frequencies are quickly selected for trouble-shooting. Shpg. Wt. 4 lbs.

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HEATHKIT US-1
\$750

12" UTILITY SPEAKER

This high quality auxiliary speaker offers many possibilities in audio, radio and TV work and will handle up to 12 watts with a frequency response from 50 to 9,000 CPS \pm 5 db. Speaker impedance is 8 ohms and employs a 6.8 ounce magnet. Shpg. Wt. 7 lbs.



Fun for the whole family

HEATHKIT XR-1P
\$29⁹⁵

6 TRANSISTOR PORTABLE RADIO KIT

This easy-to-build portable radio offers fun and enjoyment for the whole family. Features 6 transistors, large 4" x 6" PM speaker for "big-set" tone quality, and built-in rod-type antenna. Uses standard size "D" flashlight cells for extremely long battery life (between 500 and 1,000 hours). The modern molded plastic case with pull-out carrying handle is two-tone blue with gold inlay and measures 9" L. x 7" H. x 3 3/4" D. Shpg. Wt. 6 lbs.



HEATHKIT BR-2
\$18⁹⁵
(less cabinet)

BROADCAST BAND RADIO KIT

Fun to build, and a fine receiver for your home. Covers complete broadcast band from 550 to 1600 kc. Built-in 5 1/2" PM speaker and rod-type antenna. Transformer operated power supply. Excellent sensitivity and selectivity. Shpg. Wt. 10 lbs.

Cabinet optional extra: No. 91-9A. Shpg. Wt. 5 lbs. \$4.95.

Complete Engine "Tune-Up" Facilities!

ELECTRONIC IGNITION ANALYZER KIT (IA-1A)



Just clip the two test leads to operating engine (400 to 5,000 RPM) and check condition of coil, condenser, points, plugs and wiring. Shows either primary or secondary circuit patterns, parade or superimposed secondary patterns. Shpg. Wt. 20 lbs.

MODIFICATION KIT for IA-1 Models: Provides switch selection of primary and secondary circuit patterns, or, choice of parade and superimposed secondary patterns. Shpg. Wt. 2 lbs.
Heathkit MK-6.....\$4.95

HEATHKIT AK-1
\$9⁹⁵



MICROPHONE ACCESSORY KIT

Useful in countless applications, this kit consists of a rugged high fidelity crystal mike and three holders; a mike stand adapter, a lavalier neck-band and desk stand. An 8' cable with phone plug is included. Shpg. Wt. 1 lb.

HEATHKIT IA-1A
\$59⁹⁵



Let your boy learn radio

HEATHKIT CR-1
\$7⁹⁵

CRYSTAL RADIO KIT

Any youngster interested in radio or electronics will enjoy building and using this fine little crystal receiver. Frequency coverage is from 540 to 1600 kc. A sealed germanium diode is used for detection —no critical "cats whisker" adjustment. Headphones included. Measures 6" L. x 3" W. x 2 1/8" D. Shpg. Wt. 3 lbs.



check engine RPM

HEATHKIT TI-1
\$25⁹⁵

ELECTRONIC TACHOMETER KIT

Easy-to-build and simple to install. Operates directly from the spark impulse of any 2 or 4 cycle engine with any number of cylinders. Operates on 6, 8, 12, 24 or 32 volt DC systems and is completely transistorized. The easy-to-read indicator shows RPM from 500 to 6,000. A calibration control is also provided. Shpg. Wt. 4 lbs.



HEATHKIT TK-1
\$9⁹⁵

COMPLETE TOOL SET

This handy tool kit provides all the basic tools required for building any Heathkit. Includes pliers, diagonal sidecutters, screwdrivers, and soldering iron with holder. Pliers and sidecutters are equipped with insulated rubber handles that provide protection from electrical shock. All of the tools are of top quality case hardened steel for rugged duty and long life. Shpg. Wt. 3 lbs.



HEATHKIT DF-2
\$69⁹⁵

2-BAND TRANSISTOR RADIO DIRECTION FINDER KIT

Economically powered by 6 standard flashlight cells, the DF-2 provides you with a completely portable 6-transistor standard and beacon band receiver of unusual quality and performance. Covers the beacon band from 200 to 400 kc and broadcast band from 540 to 1620 kc. A tuning dial light is provided for night operation. Large 4" x 6" speaker provides superb tone reproduction. Shpg. Wt. 9 lbs.

HEATHKIT PC-1
\$24⁹⁵



12 VOLT POWER CONVERTER KIT

Household electricity right on your boat or in your automobile is yours with this 12-volt power converter kit. Operate your radio, electric razor, lights, etc., directly from your 12-volt boat or car battery. Power rating is 125 watts continuously and 175 to 200 watts intermittently. Note: not recommended for record players, tape decks, power tools or radio transmitters. Shpg. Wt. 8 lbs.



HEATHKIT MC-1
\$39⁹⁵

MARINE CONVERTER KIT

Charge your 6 or 12 volt batteries at dockside even while your boat's electrical system is in use. Provides up to 20 amperes continuously for charging 6-volt batteries or 10 amperes continuously for charging 12-volt batteries, regardless of type. Charging current is continuously monitored by a 25 ampere meter. Shpg. Wt. 16 lbs.

MARINE BATTERY CHARGE INDICATOR KIT

See at a glance the exact percentage of charge in your boat batteries. Checks from 1 to 8 storage batteries instantly. Operates on 6, 8, 12 or 32 volt systems. Note: for mounting on non-ferrous metals or wood only. Shpg. Wt. 3 lbs.



HEATHKIT CI-1
\$16⁹⁵



HEATHKIT FD-1-6
(6 volt)
FD-1-12
(12 volt)
\$35⁹⁵ each

FUEL VAPOR DETECTOR KIT

Protecting against fire and explosion on your boat, the FD-1 indicates the presence of explosive fumes and shows immediately if it is safe to start the engine. The kit is complete including spare detector unit. Shpg. Wt. 4 lbs.


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Carl and Jerry

By **JOHN T. FRYE**
 W9EGV

Out of the Shadow

IT WAS Saturday morning, and Carl and Jerry were lying flat on their backs on Jerry's brown-tinged front lawn watching the fluffy white clouds moving across the deep blue sky overhead. School had been going almost four weeks; but summer, hot and dry, still lingered in the Midwest.

"Hey, Jer," Carl drawled lazily, "how fast do you suppose those clouds are moving?"

"Oh, I dunno," Jerry answered. "That breeze must be blowing 20 miles an hour here on the ground, and it's probably doing better than that up there . . . I'd guess maybe 25 miles an hour."

"What say we measure the cloud speed?" Carl suggested as he raised himself on one elbow and deliberately sprinkled a few blades of grass on his chum's upturned face. "It's something to do, and our science teacher says we ought to make precise personal observations and measurements whenever we have a chance."

"Okay, but how'll we go about it?"

"Well, I thought we could use our trans-

CLASS "D" CITIZEN BAND CRYSTALS



3rd Overtone—Hermetically Sealed .005% tolerance—Meet F C C requirements. 1/2" pin spacing—.050 pin diameters. (.093 pins available, add 15c per crystal.)

\$2.95 EACH

22 CHANNELS
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The following Class "D" Citizen Band frequencies in stock (frequencies listed in megacycles): 26.945, 26.975, 26.985, 27.005, 27.015, 27.025, 27.035, 27.055, 27.065, 27.075, 27.085, 27.105, 27.115, 27.125, 27.135, 27.155, 27.165, 27.175, 27.185, 27.205, 27.215, 27.225.

RADIO CONTROL CRYSTALS in HCG/U HOLDERS—SIX FREQUENCIES

In stock for immediate delivery (frequencies listed in megacycles): tolerance .005%, 1/2" pin spacing, .050 pin diameter. (.093 pins available, add 15c per crystal.) Specify frequency desired.

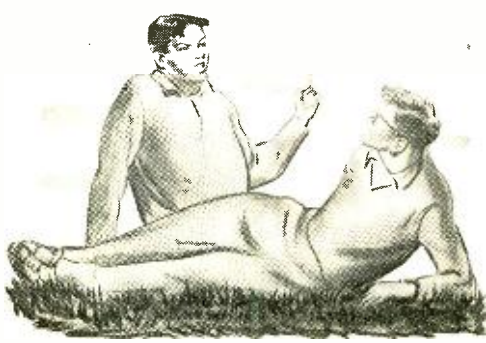
26.995, 27.045, 27.095, 27.145, 27.195, 27.255 **\$2.95 EACH**

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1C7	3Q4	6AW4GT	6BE6	6CQ8	65T7	7C4	12AV7	12V6GT	43
1F4	3S4	6AH6	6BF5	6CR6	65G7	7C5	12AX4GT	12W6GT	45
1F5	3V4	6AK5	6BG6G	6C56	65H7	7C6	12AX7	12X4	50A5
1G4	4BQ7A	6AL5	6BH6	6CU5	65J7	7C7	12A27	14A7/12B7	50B5
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1I4	4B7	6AN8	6BK5	6D6	65L7	7E6	12BA6	14O7	50L6
1I6	4CB6	6A05	6BK7	6DE6	65Q7	7E7	12B7A7	19	56
1NSGT	5AR6	6A06	6BL7GT	6DG6GT	65R7	7F7	12BD6	19AU4GT	57
1R5	5AN8	6A07	6BN6	6DQ6	674	7F8	12BE6	19B6GG	58
1S5	5AT8	6AR5	6BQ6GT	6F5	6UB	7G7	12BF6	1916	71A
1S5	5AV8	6A55	6BQ7	6F6	6V6GT	7H7	12BH7	1918	75
1U4	5A24	6AT6	6BR8	6H6	6W6GT	7N7	12BQ6	24A	76
1U5	5BR8	6AU4GT	6BS8	6J4	6X4	7O7	12BR7	2526GT	77
1V2	5J6	6AU5GT	6BY5G	6J5	6XS7	757	12BY7	26	78
1X2	5R4	6AU6	6R26	6J6	6X8	7X6	12CA5	27	80
2AF4	5U4	6AU8	6R27	6J7	6Y6G	7X7	12CN5	35	84/624
2BN4	5U8	6AV5GT	6C4	6K6GT	7A4/XXL	7Y4	12D4	35A5	117Z3
2CY5	5V4G	6AV6	6CB6	6K7	7A5	7Z4	12E5	35B5	
3A4	5V6GT	6AW8	6CD6G	6N7	7A6	12A8	12K7	35C5	
3A5	5X8	6AX4GT	6CF6	6O7	7A7	12A85	12L6	35W4	
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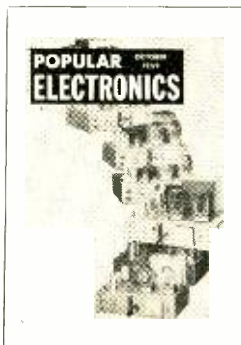
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ceivers. We can station ourselves a mile apart in line with the way the clouds are traveling. When a cloud shadow passes over the first fellow, he can give a signal; and then the other fellow can see how long it takes the shadow to reach him."

"Aw, that's too simple," Jerry objected. "We could do that with the telephone. Remember we're electronic technicians. Let's see now; the clouds are moving southwest to northeast. That's perfect. How about this: remember when that geodetic survey crew went through here last summer and put that marker along the road that goes up over Bear Mountain and said it was precisely three miles airline from the marker to Jeff's fire tower?"

"Yes, I'm not a complete idiot, you know."

"I keep forgetting. Suppose we hook a photocell unit to one of our high-frequency transmitters so that as long as sunshine is on the cell the transmitter is turned off, but whenever a shadow passes over the cell it switches on the transmitter and keeps it turned on until the shadow passes. We'll set this light-controlled transmitter right at that marker; then we'll go on up the mountain and have a nice visit with our friend Jeff, the fire warden.

"While we're visiting," Jerry continued, "we can listen on our high-frequency receiver for the transmitter down at the marker and use our stop watch to clock the speed of several clouds. We'll take the average for the cloud speed and compare that with Jeff's wind-gauge there at the tower to get an idea of how fast clouds travel compared with the wind at ground level."

"When anyone asks you for a slice of bread, they get a whole bakery," Carl observed as he stood up and brushed the grass from the seat of his trousers; "but I'll buy the idea. You get the electronic gear together, and I'll coax Mom into fixing us some sandwiches."

CARL AND JERRY were men of action, and within the hour they pulled their bicycles off to the side of the little-traveled dirt road leading up Bear Mountain and started looking for the geodetic survey marker.

"Here it is," Jerry soon called as he stood in the center of a small clearing. "You cut a stake about six feet long to mount the
(Continued on page 116)

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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 and study with RF and AF amplifiers and oscillators, detectors, rectifiers, test 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, and the 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 a future, you will find the "Edu-Kit" a worth-while investment. Many thousands of individuals of all

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

PROGRESSIVE TEACHING METHOD

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

You begin by examining the various radio parts of the "Edu-Kit." You then learn the function, theory and wiring of these parts. Then you build a simple radio. With this first set you will enjoy listening to regular broadcast stations, learn theory, practice testing and trouble-shooting. Then you build a more advanced radio, 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 and soldering on metal chassis, plus the new method of radio construction known as "Printed Circuitry." These circuits operate on your regular AC or DC house current.

THE "EDU-KIT" IS COMPLETE

You will receive all parts and instructions necessary to build 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, hook-up wire, solder, etc.

In addition, you receive Printed Circuit Materials, including Printed Circuit Materials, 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 our Dynamic Radio and Electronics Tester for Radio Amateur License training. You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector, a High Fidelity Guide and a Quiz Book. You receive Membership in Radio-TV Club, Free Consultation Service, Certificate of Merit and Discount Privileges. You receive all parts, tools, instructions, etc. Everything is yours to keep.

FREE EXTRAS

SET OF TOOLS

- SOLDERING IRON
- ELECTRONICS TESTER
- PLIERS-CUTTERS
- ALIGNMENT TOOL
- WRENCH SET
- VALUABLE DISCOUNT CARD
- CERTIFICATE OF MERIT
- TESTER INSTRUCTION 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. Statistis, of 25 Poplar Pl., Waterbury, Conn., writes: "I have repaired several sets for my neighbors 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. 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

- Send "Edu-Kit" postpaid. I enclose full payment of \$22.95.
- Send "Edu-Kit" C.O.D. I will pay \$22.95 plus postage.
- Rush me FREE descriptive literature concerning "Edu-Kit."

Name

Address

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Progressive Building, Dept. 561D, 1184-86 Broadway, Hewlett, N. Y.

Lafayette Superior Quality Hi-Fi Kits

50 WATT INTEGRATED STEREO AMPLIFIER



KT-250
IN KIT FORM
64.50

LA-250
COMPLETELY
WIRED
89.50

- RESPONSE 17-21,000 CPS \pm 1 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 monaural 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 1%. 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-250 Stereo Amplifier Kit 6.45 down Net **64.50**
LA-250 Stereo Amplifier, wired & tested—8.95 down
Net **89.50**

PROFESSIONAL STEREO CONTROL CENTER



KT-600
IN KIT FORM
79.50

LA-600
COMPLETELY
WIRED
134.50

- 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" x 4 1/2" x 10 1/2". Shpg. wt., 16 lbs. Complete with all parts, tubes, deluxe cabinet and detailed instruction manual.

KT-600 Stereo Preamp Kit—7.95 Down Net **79.50**
LA-600 Stereo Preamp Kit, wired and tested—13.45 Down
Net **134.50**

Outstanding Design — Incomparable Performance

STEREO/MONAURAL POWER AMPLIFIER KIT



KT-310
IN KIT FORM
47.50

LA-310
COMPLETELY
WIRED
72.50

- 36 WATT STEREO AMPLIFIER—18 WATTS EACH CHANNEL
- EMPLOYS 4 PREMIUM-TYPE 7189 TUBES
- 2 PRINTED CIRCUIT BOARDS FOR SIMPLIFIED WIRING
- RESPONSE BETTER THAN 35-30,000 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 Monaural-Stereo switch. Dual outputs for 4, 8, 16 or 32 ohm speakers. Input sensitivity .45 volts per channel for full output. Tubes are 2-6AN8, 4-7189, GZ-34 rectifier. Size 10.9/16" d x 5 1/4" h x 13 1/4" w. Complete kit with cage, all parts, tubes and detailed instruction manual. Shpg. wt., 22 lbs.

KT-310 Stereo Power Amplifier Kit—4.75 Down Net **47.50**
LA-310 Stereo Power Amplifier, wired and tested—6.95 Down
Net **72.50**

FM-AM STEREO TUNER KIT



KT-500
IN KIT FORM
74.50

LT-50
COMPLETELY
WIRED
124.50

- 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-Seeley Discriminator
- Extreme Sensitivity and Wide Frequency Response.

A precision engineered, highly stable tuner—perfect for life-like stereo FM-AM broadcast reception, FM reception and/or AM reception. Feature separate tuning and volume controls for AM and FM. Magic eye on AM and FM, plus automatic frequency control of 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 1/2" W x 10 1/2" D x 4 1/2" H. Shpg. wt., 22 lbs.

KT-500 FM-AM Stereo Tuner Kit—7.45 Down Net **74.50**
LT-50 Same as above, wired & tested—12.45 Down
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4 SPEED CHANGER
WITH BRAND NEW
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HYSTERISIS TURNTABLE**
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20,000
OHM
PER VOLT
MULTIMETER**
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8" DUAXIAL SPEAKER**
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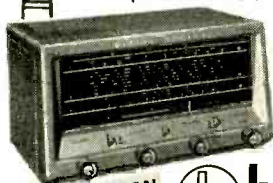
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receiver
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3 short wave bands plus standard broadcast. Built-in speaker, headset output.



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You should! The winged horse symbolizes the world's leading publisher of special-interest magazines... and the hexagon stands for the organization that *proves* this leadership beyond a shadow of a doubt.

The publisher, of course, is Ziff-Davis—who brings you **POPULAR ELECTRONICS** each month. Along with Ziff-Davis' six other leading special-interest monthlies, **POPULAR ELECTRONICS** is the established circulation leader in its field.

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transmitter on. We want it up high enough so that leaves can't blow over the photocell or rabbits cast a shadow on it. None of the trees are close enough to cast a shadow on it until nearly sundown."

"Okay," Carl said, sliding his hatchet from its belt holster; "but have you noticed how dry everything is here? Listen how the leaves and twigs snap and crack with every step I take. They're dry as gunpowder. I'll bet Jeff's really keeping a sharp eye out for forest fires."

The long stake was driven right beside the marker, and the little battery-powered transmitter with its photocell control was mounted on top of it. The sensitivity of the photocell unit was adjusted so that the transmitter came on the instant the shadow of Jerry's hand fell on the cell.

Satisfied with the installation, the boys got back on their bicycles, shifted them into low gear, and started the long, hard, dusty pull up the mountain. They stopped several times to rest and to do justice to Carl's mother's sandwiches; but finally they rode into the clearing at the base of the steel tower that rose high up into the sky above.

"Hi, boys," a deep voice greeted them warmly. Jeff, the fire warden, stood up from where he had been sitting on a bench at the base of the tower. At the same time a couple of squirrels and a half-grown raccoon he had been feeding scampered off into the brush. Jeff was a tall, powerful, broad-shouldered man with twinkling blue eyes set deep in a pleasant face tanned and wrinkled by wind and sun. His curly hair was jet black except for a touch of gray.

"I just came down to have lunch with my friends and to welcome you," he remarked. "I've been watching you coming up the mountain for a long time, but I couldn't

(Continued on page 120)





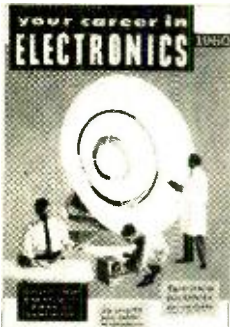
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SHIPPED ON APPROVAL

an IN-CIRCUIT CONDENSER TESTER THAT *DOES THE WHOLE JOB!*

IN-CIRCUIT CONDENSER TESTER Model CT-1

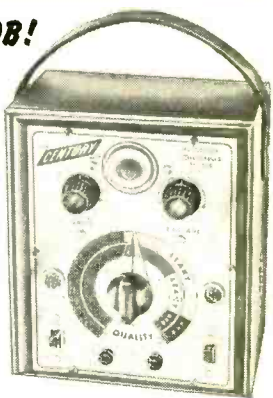
The CT-1 actually steps in and takes over where all other in-circuit condensers fail. The ingenious application of a dual bridge principle gives the CT-1 a tremendous range of operation . . . and makes it an absolute "must" for every serviceman.

in-circuit checks:

- ✓ Quality of over 80% of all condensers even with circuit shunt resistance. . . (This includes leakage, shorts, opens, intermittents)
- ✓ Value of all condensers from 200 mmfd. to .5 mf.
- ✓ Quality of all electrolytic condensers (the ability to hold a charge)
- ✓ Transformer, socket and wiring leakage capacity

out-of-circuit checks:

- ✓ Quality of 100% of all condensers . . . (This includes leakage, shorts, opens and intermittents)
- ✓ Value of all condensers from 50 mmfd. to .5 mf.
- ✓ 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

WHY THE CT-1 SURPASSES ALL OTHERS IN THE FIELD

INSTRUMENT	IN-CIRCUIT PERFORMANCE					PRICE
	Leakage	Value	Open	Short	Electrolytics	
CENTURY CT-1	Yes	Yes	Yes	Yes	Yes	\$34.50
Advertised Instrument A	Yes	No	No	Yes	No	\$79.95
Advertised Instrument B	No	No	Yes	Yes	No	\$92.50
Advertised Instrument C	No	No	Yes	Yes	No	\$34.50
Advertised Instrument D	Yes	No	No	No	No	\$44.95
Advertised Instrument E	No	Yes	No	No	No	\$69.95

Model CT-1 — housed in sturdy hammetone finish steel case complete with test leads . . . only

\$34.50 Net

SIZE: W-6" H-7" D-3 1/4"

IN-CIRCUIT RECTIFIER TESTER Model SRT-1

Checks all power rectifiers in-circuit whether SELENIUM, GERMANIUM, SILICON, etc.



Model SRT-1—housed in sturdy hammettone finish steel case complete with test leads **\$29.50** Net

With the growing trend towards compactness, portability and low price, TV manufacturers are resorting more and more to producing series-string TV sets employing selenium, germanium or silicon power rectifiers. Now the need for an in-circuit rectifier tester is greater than ever.

THE SRT-1 CHECKS ALL POWER RECTIFIERS IN-CIRCUIT AND OUT-OF-CIRCUIT WITH 100% EFFECTIVENESS FOR:

- ✓ Quality
- ✓ Fading
- ✓ Shorts
- ✓ Opens
- ✓ Arcing
- ✓ Life Expectancy

SIZE: W-6" H-7" D-3 1/4"

SPECIFICATIONS

- Checks all types of power rectifiers rated from 10 ma. to 500 ma. (selenium, germanium, silicon, etc.) both in-circuit or out-of-circuit.
- Will not blow fuses even when connected to a dead short.
- Large 3" highly accurate multi-color meter . . . sensitive yet rugged.
- Separate meter scales for in-circuit and out-of-circuit tests.
- Cannot damage or over heat rectifier being tested.

SIMPLE TO OPERATE

Just clip SRT-1 test leads across rectifier under test right in the circuit without disconnecting rectifier from circuit. Press test switch and get an instant indication on the easy-to-read three-color meter scales. . . .

TRANSISTOR TESTER Model TT-2

AN INEXPENSIVE QUALITY INSTRUMENT DESIGNED FOR ACCURATE AND DEPENDABLE TESTS OF ALL TRANSISTORS AND DIODES QUICKLY AND ACCURATELY



Model TT-2 — housed in sturdy hammettone finish steel case complete with test leads **\$24.50** Net

Every day more and more manufacturers are using transistors in home portable and car radios . . . in hearing aids, intercoms, amplifiers, industrial devices, etc. Since transistors can develop excessive leakage, poor gain, shorts or opens, the need for TRANSISTOR TESTER is great.

SPECIFICATIONS

- Checks all transistors, including car radio, power output, triode, tetrode and unijunction types for cut-off current
- Checks all diodes for forward to reverse current gain
- All testers' rated gain is not available
- Less than half a minute required for yet rugged . . . with multi-color scales designed for quick easy reading
- Power is supplied by an easy to replace 6-volt battery — current drain due to accidental shorting of test leads
- Cannot burn-out its own meter
- Leads enable tests without entirely removing transistor from circuit
- Test terminal is assured
- Comes complete with replaceable transistor set-up chart that fits into a special rear compartment.

SIZE: W-6" H-7" D-3 1/4"

IMPORTANT FEATURE: The TT-2 cannot become obsolete as you check all new type transistors as they are introduced. New listings will be furnished periodically at no cost.

EASY TO BUY IF SATISFIED
see order form on facing page

FOR 10 DAY FREE TRIAL

Convince yourself at no risk that CENTURY instruments are indispensable in your every day work. Send for instruments of your choice without obligation... try them for 10 days before your buy... only then, when satisfied, pay in easy-to-buy monthly installments — without any financing or carrying charges added.

NEW Battery Operated Peak-to-Peak VACUUM TUBE VOLT METER Model VT-1

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

- ① DC Probe ② AC-Ohms Probe ③ Lo-Cap Probe ④ RF Probe

The VT-1 is a tremendous achievement in test equipment. With its unique MULTI-PROBE it will do all the jobs a V.T.V.M. should do without the expense of buying additional probes. 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 do any one of many time-saving jobs. A special holder on side of case keeps MULTI-PROBE firmly in place ready for use.

FUNCTIONS

DC VOLT METER . . . 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 AC and oscillator bias voltages from 1 volt 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.

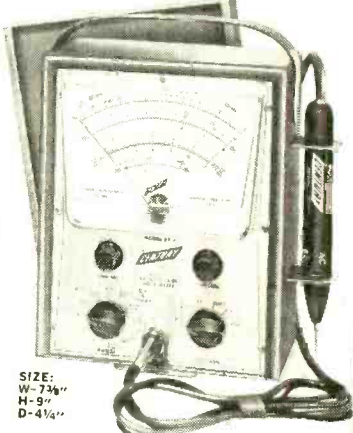
AC VOLT METER . . . True Peak-to-Peak measurements of any wave form including TV sync, deflection voltages, video pulses, audio in hi-fi amplifiers, AC and color TV gating pulses. . . Scale divisions are AC easily read down to 1 volt. . . Measures RMS at 1/20th the circuit loading of a V.O.M. . . Unlike other low V.T.V.M.'s there is no loss in accuracy on the lowest AC range.

ELECTRONIC OHM METER . . . Measures from 0 to 1000 megohms. . . Scale divisions are easily read down to 2 ohms. . . Will measure resistance values high resistance leakage in electrolytic and bypass condensers.

RF and LO-CAP MEASUREMENTS . . . With these extra VT-1 functions you can measure as sync and ACQ pulses, diving saw tooth voltages, color TV gating pulses, mixer output levels, I.F. stage-by-stage gain and detector inputs.

OUTSTANDING FEATURES

- Completely portable — self powered with long life batteries — permits use everywhere
- New advanced drain • Large 6" 100-microampere meter, many times more sensitive than meters used in most V.T.V.M.'s
- Laboratory accuracy performance — 2% of full scale easy-to-read 4-scale meter
- No heat operation assures rigidity stability and accuracy
- Immune to power line compensated attenuator — a feature found only in costly laboratory instruments
- Meter completely isolated — practically burn-out proof
- Hand-crafted circuitry eliminates the service headaches of printed circuitry
- 15% resistors used for permanent accuracy
- Separate ground return for hi-fi and RF measurement
- Microphone type co-axial connector
- Matching cover protects instrument face — snaps on and off instantly.



SIZE: W-7 3/4" H-9" D-4 1/4"

SPECIFICATIONS

- DC Volts — 0 to 1.5/16/30/150/300/600/1500 volts
- AC Volts (RMS and Peak-to-Peak) — 0 to 3/12/60/300/1200 volts
- Ohms — 0 to a billion ohms, 10 ohms center scale — Rx1/10/100/1K/10K/100K/1M
- RF — Peak reading demodulator supplied for use on all AC ranges
- Zero Center — available on all DC volt ranges with zero at mid-scale
- Decibels — from -10 db to +10/22/36/50/62 based on the Dbm unit: 0Db = 1mV
- Impedance — 11 megohms DC, 1 megohm AC, 10 megohms Lo-Cap
- Input Capacity — 130 mmfd. RMS, 250 mmfd. Peak-to-Peak, 25 mmfd. Lo-Cap

Model VT-1 — fully wired and calibrated, housed in handsome hammertone finish steel case, complete with MULTI-PROBE, and thorough instruction manual covering all the applications in detail. **\$58.50** Net

FAST-CHECK TUBE TESTER Model FC-2

Simply set two controls . . . insert tube . . . and press quality button to test any of over 700 tube types completely, accurately . . . IN JUST SECONDS!

Over 20,000 servicemen are now using the FAST-CHECK in their every day work and are cutting by selling more tubes with very little effort. See for yourself at no risk why so many servicemen chose the FAST-CHECK above all other tube testers.

PICTURE TUBE TEST ADAPTER INCLUDED WITH FAST-CHECK

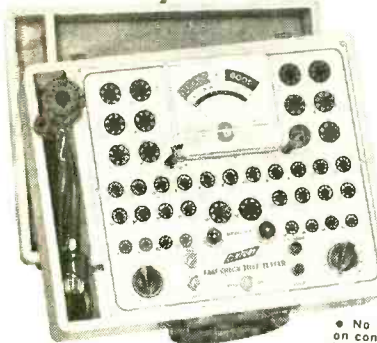
Enables you to check all picture tubes (including the new short-neck 110 degree type) for cathode emission, shorts and life expectancy. . . also to rejuvenate weak picture tubes.

RANGE OF OPERATION

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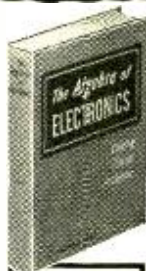
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quite make out through the telescope if those were tuna-fish or ham-salad sandwiches. Come on up to the cabin with me. I don't want to be away long with everything dry as tinder like it is. Did you meet anyone on the way up?"

"Only some crazy galoots driving too fast that forced us into the ditch," Carl answered as the boys followed the warden up the steps that zigzagged up the tower. "And the sandwiches were tuna fish."

"I thought so," Jeff growled. "But I'm really glad those drunks are out of the woods. They went off and left their campfire smouldering, and I had to go put it out. That's a criminal thing to do when the woods are like this."

When they reached the cabin atop the tower, Carl and Jeff were breathing only a little deeper than normal; but Jerry was puffing like a steam engine as he leaned up against the cabin wall.

"It gets your wind when you're not used to it," Jeff consoled him. "Gosh, I'm glad to see you boys. I was hoping you would get up to see me before we closed down for the season. You see," he added sadly, "it looks like this will be my last season up here."

"Why?" the boys chorused with deep concern.

"Well, the department has a new head who thinks every man over forty-five spends all his time dozing in a rocking chair and couldn't see across the clearing if he were awake," Jeff said with a rather drawn grin. "He wants to get rid of us old codgers and put new 'alert, keen-eyed young men' in our place."

Jeff stopped talking while he swung the telescope through a slow, careful arc. "Dog-gone it!" he suddenly exploded. "If I thought my eyes were failing or that age was keeping me from doing my job, I'd ask to be retired; but I know that's not so. What's more, it's going to take another man a long time to learn what I have learned in fifteen years, about what looks normal and what doesn't out there on Bear Mountain—and I'm still learning," he added.

THE BOYS were embarrassed. They wanted very much to say something consoling, something that would ease Jeff's deep hurt, but they couldn't think of anything to say. In an effort to take his mind off the painful subject, they started ex-

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plaining about their attempt to measure cloud speed.

The high-frequency receiver was turned on, but not a sound could be heard from the transmitter, and it seemed as if none would be heard for a while. There wasn't a cloud in the sky. However, Jeff's instruments showed that the wind was still blowing strongly from where they had left the transmitter, and he told them his weather reports indicated that high scattered clouds should be coming in before long.

Suddenly the telephone rang. It was the local supervisor at the base station advising all tower stations that the head of the department was making a surprise inspection tour and was expected momentarily. The supervisor requested all wardens to be especially alert and businesslike.

"A lot of good it will do," Jeff said bitterly. "We're not men to him. We're just numbers on a card—"

He was interrupted by the sudden sound of an audio tone coming from the little speaker of the high-frequency receiver. It quickly ceased and then came on again. Fascinated, the boys listened as the transmitter kept kicking on and off erratically. Each time it stayed on a little longer.

"Do you suppose something's gone wrong with your equipment?" Jeff asked as he scanned the cloudless sky.

"That's always a possibility, but I doubt it," Jerry answered. "That circuit is very dependable. I think something is cutting off the sunlight from the cell. "It sounds as though little bits of clouds were drifting over it."

As Jeff heard this, he swung the big telescope and brought it to bear on the spot where the boys had left the transmitter. He looked long and searchingly and then reached for the telephone: "Reporting a




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small fire just starting along the Bear Mountain Road a few yards southwest of the survey marker," he said carefully and distinctly.

"That's smoke drifting over your photocell," he whispered to the boys while he held his hand over the telephone transmitter. "I can just make it out through the telescope."

Holding their breath, the boys listened to the flurry of conversation as other watch stations were alerted and asked to check on the reported fire. Suddenly a crisp voice snapped out of the receiver:

"Bear Mountain Station, this is Adams, the department head. Are you *sure* you see a fire? None of the other stations can see it."

"I'm sure, sir," Jeff said with quiet conviction. "The strong wind is holding the smoke down close to the ground."

"Very well. We'll get in the helicopter and take a look. Stand by."

IN ONLY MINUTES the boys could see the whirlybird hover over the spot at which Jeff's telescope was aimed; then it settled down below the tops of the trees. The tone that had been coming from the speaker of the high-frequency receiver almost continuously began cutting on and off again and then stopped completely. The helicopter popped into view and sailed off toward the base station. Once more the telephone jangled. Jeff held the receiver away from his head so that the boys could listen.

"Bear Mountain, this is Adams again. I want to congratulate you on your keen eyesight and alertness. That fire, undoubtedly set by a cigarette tossed from a car, was just starting. We put it out easily with hand extinguishers, but if you hadn't spotted it when you did, we undoubtedly would have had a nasty forest fire on our hands at this point."

"Thank you, sir," Jeff said; "but I feel I should tell you—"

"Never mind telling me anything. You've shown me. Instead, let me tell you something. As you possibly know, I've been considering a policy of replacing men your age with younger men. After what I've seen here this afternoon, I'm dropping that policy. My younger men couldn't even see the fire after you had spotted it. I'm convinced that experience such as you have must not be wasted. I hope you'll be watching for



us up on Bear Mountain for a long, long time. That's all."

"Thank you again, sir; I'll be here as long as you need me," Jeff said with a happy grin as he hung up the receiver.

"Those drunks managed to set a fire in spite of everything," he said to the boys; "but thanks to your handy-dandy little cloud-and-smoke watcher, it did no damage. If that little gadget hadn't tipped us off, the fire would have been going great guns by the time the smoke rose high enough above the trees to be noticed. I'm sure much obliged to you two boys. Looks like you're going to have to put up with me here on Bear Mountain for a while."

"That sure will be awful," Carl said with a broad grin; "but I guess we'll just have to bear it—no pun intended. Right now, though, I think we'd better head for home unless we want to try riding down that rough road in the dark. After all, we've still got to stop and pick up our little transmitter."

AS the boys started coasting down the mountain, Carl suddenly said: "Hey, we never did measure cloud speed, did we?"

"Nope," Jerry answered as he looked back over his shoulder at the tower silhouetted against the sky and waved to Jeff who was leaning out of the open window of the cabin. "This was a better day for getting rid of clouds, real, smoke, or otherwise, than it was for measuring them; but I'm satisfied."

"So am I," Carl said contentedly. —30—

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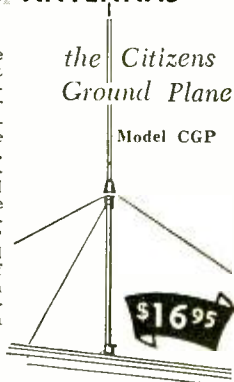
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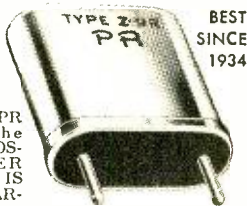
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Novice Band Receiver

(Continued from page 47)

For evening tests, plug in the 80-meter coil (15 meters is good in daylight hours), and switch on the a.c. and B-plus. As a starting point, set antenna trimmer $C1$ to approximately one-half capacity. Advance the regeneration control ($R2$) approximately half way, and turn band-setting capacitor $C3$ until you hear the 80-meter amateur phone stations. Then tune band-spread capacitor $C4$ with the main tuning dial. The 80-meter Novice band will be found at a slightly lower frequency (capacitors more "closed").

With a little experimenting, you will be able to set $C3$ for the best coverage on the main tuning dial. On the original model of the set, the same setting of $C3$ would "hold" for all three Novice bands, so, once set, it could be left alone. Only minor adjustments should be needed when you are shifting bands.

Operation. Now advance regeneration control $R2$ to the point where the set just breaks into oscillation. This is the best operating condition for receiving c.w. stations. For phone reception, the control should be backed off until any whistling stops.

Should the set refuse to oscillate, the most probable cause would be that the tickler windings were not properly polarized. Reverse the connections of the tickler windings to the coil pins, and try again.

The antenna trimmer capacitor ($C1$) should be adjusted for the best reception on the 21-mc. band. If desired, $C1$ can be replaced by a knob-operated variable capacitor which will let you trim the antenna for best reception on each of the three bands.

-50-

HOW IT WORKS

This circuit is essentially a regenerative detector followed by one stage of audio. A high "C" and high "Q" tuned circuit is used to increase the stability of the detector stage. Triode $V1a$ is connected to the tuned circuit and is operated as an r.f. amplifier with a cathode-follower output. The r.f. from $V1a$ is detected by triode $V1b$ which also operates as a feedback or regeneration stage. Since the detector does not load the tuned circuit, improved selectivity and sensitivity result.

The audio output stage, $V2$, is heavily biased to keep plate current down and to avoid any damage to series-operated magnetic headphones. The power supply is a conventional half-wave rectifier. Small capacitors across the high-voltage winding of $T1$ and across the filter capacitors eliminate tunable hum and line noise.

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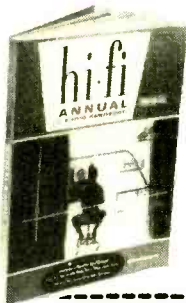
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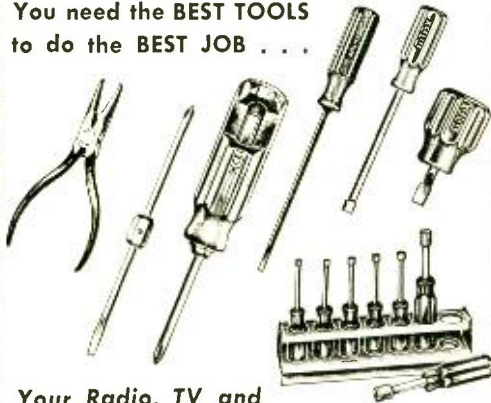
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128

TWO-METER BAND OPENED TO TECHNICIANS

THE Federal Communications Commission has made a rule change which now permits Technician Class amateurs to operate between 145 and 147 megacycles in the two-meter band. Many arguments were presented to the Commission, both for and against the rule change, each of which was evaluated before the change was made. Some of the pros and cons are given below.

Pros:

- The two-meter band would act as a stepping stone between the communication techniques used in the h.f. region and those used in the u.h.f. region. It would offer the less experienced amateurs an easier transition to the higher v.h.f. and the u.h.f. frequencies than the present jump from 6 meters to 1¼ meters.
- Civil defense activities would be accelerated inasmuch as this would be the best band for civil defense work open to all amateurs.
- The rule change would provide a common meeting ground where Novice and Technician licensees could communicate with each other.
- Such a rule change would relieve an economic hardship now imposed upon Novice licensees who progress to the Technician Class.
- The proposed amendment would greatly assist those Technicians living in TV Channel 2 areas by providing a v.h.f. band much less likely to interfere with TV reception.
- There is no reason to single out one band in the v.h.f. spectrum and deny Technicians the right to operate in it.

Cons:

- The Technician Class license was established in order to promote experimentation in the higher portion of the spectrum, and to permit the study of propagation characteristics and the development of equipment and communication techniques by persons not interested in the routine exchange of communications. The experience gained since the 50 - 54 mc. band was made available to Technicians indicates that little experimentation is conducted in that band by Technicians and that the predominant use of the band by this class of amateur operator is for rag-chewing. The

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same situation would probably result in the 144 - 148 mc. band because a great majority would use it for purposes other than experimentation.

- As has happened in the 50 - 54 mc. band, this rule change would tend to reduce further the number of Technicians who will increase their code speed to 13 words per minute and qualify as General Class licensees.
- In a number of the larger metropolitan areas, the two-meter band is already well occupied. Permitting Technicians to operate in the band may well overload it in those areas.

Conclusions:

Frequencies in the 144-148 mc. range have been demonstrated to be very useful and reliable for communication purposes over distances up to and somewhat beyond line of sight. Furthermore, long-range interference is seldom a serious problem at these frequencies. Consequently, the band could provide means for carrying on necessary civil defense and emergency communications over short- and medium-range distances, and use of the frequencies may be duplicated in relatively closely spaced areas without mutual interference. Further, Technicians are the only amateurs who presently have no access to the 144 - 148 mc. band. Making this band available to Technicians would provide one area of the spectrum in which all amateurs could intercommunicate on one band, and the only area in which Technicians and Novices could intercommunicate.

The rule change would permit experimentation by Technicians in the two-meter band and thereby increase the potential for the advancement of general knowledge of this portion of the spectrum.

Even though Technicians are not eligible for R.A.C.E.S. station licenses, permitting them to operate their amateur stations in the two-meter band would result in there being in use more equipment capable of operation in that band.

The Commission concluded that, to attain a more even distribution of occupancy of the v.h.f. amateur bands, increase participation of amateurs in civil defense activities, and still retain some of the incentive for Technicians to gain General Class privileges, *part* of the band under discussion should be made available to Technicians.

-30-

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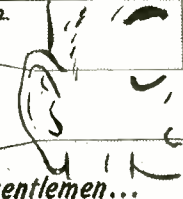
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Airborne Electronics

(Continued from page 44)

and could remember its wing span, he adjusted a knob and cut loose as soon as his sight was filled. The electronic fire-control system would then "lead" the target for him automatically.

But a modern jet pilot doesn't get a good enough look to tell him what kind of planes the enemy is flying. And there isn't time for him to fiddle with knobs. These problems are being solved by even more elaborate fire-control systems. For instance, all the skipper of an F-104 Starfighter has to do is line up the target in an optical sight and keep it centered as he closes in. His General Electric fire-control system does the rest. It tells him when to fire and when to break off his pass to avoid hitting the resultant debris.

Power Steering. The terrific speeds of the jet age, not to mention its altitudes, have introduced problems even more basic than fire control.

Picture the boss of a supersonic ship that has left the sound barrier far behind. He decides to make a slight turn and moves his stick and rudder pedals accordingly. That is, he *tries* to move them. Air resistance against his control surfaces is so great that he might as well try to budge a concrete foundation. To help solve this problem, the booster control system was developed. It does somewhat the same job as your car's power steering; it makes up for the pilot's physical limitations in handling the controls.

But sometimes even a booster system isn't enough. Let's consider the case of the B-58 "Hustler," one of the latest strategic bombers. This baby cruises at Mach 2, twice the speed of sound, and performs more like a missile than an airplane.

Suppose a B-58 commander, flying at 25,000 feet, makes a turn at 500 miles an hour. To do this, let's say he has to move his control surfaces about 20 degrees. Then he gives her the works, streaks to 80,000 feet, and ups his speed to 1000 miles an hour. If he decides to make another turn and moves his controls 20 degrees again, he will find himself being thrown all over the sky. At the greatly increased speed and altered air flow conditions, gentler movement of the controls is necessary.

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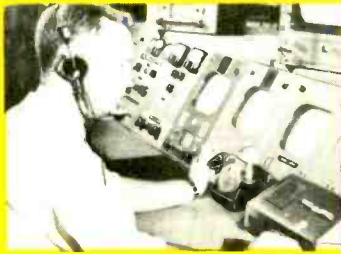
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Navigation Systems. Let's look for a moment at what electronics has done for aerial navigation. Since 1929, pilots have been guided by ground-originated radio beacons, and these systems have become more complex and versatile in the intervening years. But newer electronic hardware has made pilots virtually independent of help from the ground.

Doppler radar is one big example (see May, 1959, POPULAR ELECTRONICS). It measures true ground speed in terms of Doppler shift. If a plane beams a given

radio frequency at the ground ahead, the echo comes back as a somewhat higher frequency. The greater the speed of the plane, the higher the frequency of the echo. Doppler radar also tells which way the plane is actually going, instead of which way it happens to be pointing.

Inertial guidance systems tell the pilot much the same sort of thing. These systems are based on accelerometers, which show changes in speed or course by measuring changes in velocity.

For commercial use, though, navigation equipment that works with ground-based transmitters is still used most often. With this type of system, the pilot gets his information from a compass-like indicator or an audio signal. But some new twists have been added lately.

For example, the new Bendix-Decca system features a built-in road map. The pilot's course is literally drawn on a map as it unwinds on rollers. The speed of the map is geared to the aircraft's speed, and local radio transmitters control the pen.

The Sky's Not the Limit. If these gimmicks seem like they're right out of Buck Rogers, what can the future possibly

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- ✓ Three-gang (1300 mmfd) loading capacitor provides continuous adjustment 10-80 Meters plus harmonic and TVI-suppression. Separate capacitor ganged to loading capacitor tunes output link for 6 Meters.
- ✓ Unnecessary to remove transmitter from cabinet to adjust link when changing frequency on 6 Meters; link tuned from front panel.
- ✓ Built-in power supply. High quality choke input for best regulation.
- ✓ Novel 3-color diagrams simplify kit construction.

A new concept in transmitter design, the Globe Scout Deluxe incorporates a host of features making it the most outstanding and exciting low-cost AM transmitter available. The newly designed cabinet features the modern "low look" which is so popular today. The attractive panel is etched aluminum, trimmed with black. Styling and appearance blends with any surroundings, making the unit at home in living-room, den or office. New RF circuitry provides greater output and efficiency. Six meter output greater than that of any comparable transmitter on the market today. Extensive TVI precautions have been taken, including separate shielding of final amplifier and meter. Convenient rotary switches used throughout; no unsightly toggle or slide switches to mar appearance. Functional design of the meter face extends the length of scale for easier reading. Kit contains all parts, tubes, pre-punched chassis and detailed construction manual. Compact cabinet: 15 1/4 x 6 1/4 x 11 1/4". Shipping weight: 35 lbs.



bring? For one thing, electronic equipment will be more tightly integrated with the plane as a whole. Partial integration is already here. A Navy F4H-1 fighter, for instance, carries a Collins Radio package that combines radio communications, navigation, friend-or-foe identification and interphone in one compact unit.

As infrared devices are perfected, even radar will be challenged. Infrared equipment makes pictures from the heat patterns given off by natural and man-made objects. Because no transmitter is needed, it consumes less power than radar and never reveals its presence to a radar-hunting receiver.

We can also expect instrument displays to be greatly simplified. Picture-like presentations will replace the mass of dials now confronting a pilot. As servomechanisms are used to a greater extent, the control stick will probably become little more than a handle mounted on a panel in front of the pilot.

And this tells just part of the story. With the coming of space navigation, the sky is no longer the limit—it's only the beginning!

-30-

Stereo Tone Arm Kits

(Continued from page 65)

has eliminated the bounciness normally associated with springs by including a damping element in the spring.

We didn't like: the number of small components not adequately identified for the novice; omission of mounting provisions for the monophonic dual-stylus General Electric cartridges.

We did like: the extreme ease of cartridge replacement and the sturdy appearance of the arm.

Testing. After assembly, the three arms were test-mounted on the Thorens Model TD 124 transcription turntable, chosen because of its fine quality and flexible arm-mounting provisions. The Shure M3D stereo cartridge was mounted in each of the arms for the listening tests.

Test records with steady and swept test tones were played and viewed on a sensitive oscilloscope. No distortion due to tone-arm drag, bearing problems or resonances were noted in any of the tests. Within the individual tone arm's price range, each can be considered a good buy.

-30-

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Test Instruments

(Continued from page 56)

non-linearity and distort the trace. It's best to use minimum sync voltage and stabilize the trace with the *frequency vernier* control.

Some of the latest scopes have incorporated an automatic sync circuit. This serves both to amplify and to limit the sync signal, thus sparing the technician the job of readjusting the sync control for every change of input signal.

A more common sweep circuit accessory is the retrace blanking amplifier. The need for such an item arises from a problem in the saw-tooth waveform. Since it's impossible for the saw-tooth generating capacitor to discharge instantaneously, a certain amount of time must elapse from the start of the discharge until it hits "zero voltage."

Instead of the voltage falling off a cliff, it rolls down a slope and drags the spot back across the CRT face as it goes. The situation isn't too bad, though, because the discharge "fall time" is a lot shorter than the rise time. Older scopes without retrace blanking will show a portion of the retrace signal elongated and dim behind the main signal.

Blanking of the retrace is achieved by tapping off a signal of the proper phase from the sweep generator and applying it to the cathode or grid of the CRT, thus lowering the intensity of the screen at the instant of retrace.

Scopes designed for special applications will have special sweep circuits. Some scopes have sweeps that are "triggered" by the incoming signal; this allows the scope to present a fairly steady picture of signals whose repetition rate is not constant. There are also ultra-expensive laboratory scopes with very slow sweeps; these scopes usually have long-persistence CRT's that let you see an electrical event which may take a second or more to reach completion.

In general, the most complicated portion of the oscilloscope circuit is the sweep section (or as it is known more formally—the linear time-base generator). Once you've gotten that under your belt, the rest of the CRT oscilloscope is a snap.

Next month we are going to deal with all the rest of the scope circuitry, and look into such items as vertical input attenuators, peaking coils and d.c. coupling in the scope's amplifiers.

—30—



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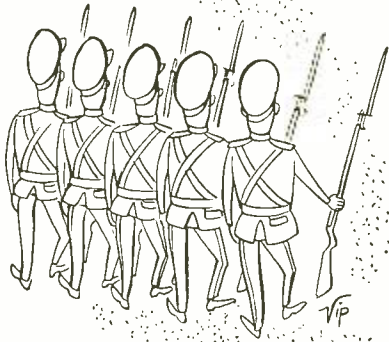
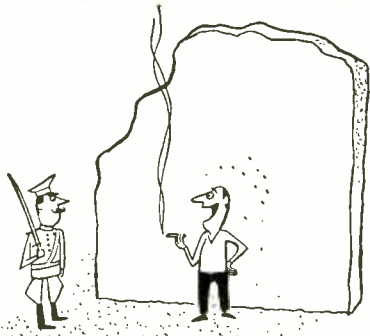
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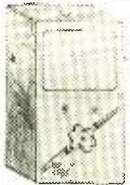
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On the Citizens Band



By **TOM KNEITEL**, 2W1965

CITIZENS RADIO is no longer a baby, and a quick look over the band will prove it to you. Funny though, in some areas certain Class D channels are so popular that everybody but Grandma operates on one frequency, forsaking the other 22 channels. Nobody really knows why this happens, not even the boys who are piled into the frequency like sardines.

The other day we actually asked one of these fellows why he doesn't use one of the many clear channels available. His reply was, "Sorry, can't read you through the noise on the frequency!"

Before you choose your frequency, you'd be wise to find out which are the "traffic snarl" channels in your area, so you can avoid them like the plague.

A number of inquiries have been received asking for advice on converting ham rigs for CB use. Our advice is "forget it."

First, very few commercially designed ham transmitters have a 5-watt input to the final, and it's tricky to keep the transmitter operating at the full 5 watts allowed by the FCC without exceeding this limit. Don't think that you can get away with chiseling a few extra watts; besides asking for trouble from the FCC, it really isn't cricket, at least not the kind of cricket that Jack Armstrong, Hoppy, or Perry Mason would have anything to do with.

Secondly, the .005% frequency tolerance we have to live with is as tight as a size 14 collar on King Farouk. It didn't mean too much if you drifted around within the limits of a ham band, but that kind of jazz doesn't go so well on CB. Many ham rigs just weren't designed with CB in mind. If you still feel that conversion is worth a fling, though, good luck to you!

It seems as though many CB'ers tire of waiting for their licenses to come through and have occasionally (and also illegally) taken to the airlines minus call letters. You can often hear things like "Max call-

ing Charlie" coming out of your receiver.

Well, ol' Uncle Sam is busy watching you, Max, and if you don't watch your step, you'll get an antenna-full of trouble from the FCC, who, we understand, is listening with eager ears on all 23 channels.

We got a look at the Globe "Citizens Broadcaster" recently, and also had a chance to see it in action. One unit was in a car and the other was in a one-story building. We were in the mobile unit, driving around looking for potential "dead" spots to see how much guts the set had.

The unit is designed to look as slick as an oiled eel, and frankly we figured that because it looked so "pretty" it must be a sissy. The laugh was on us because the Globe came through the inquisition like a trooper.

We went down alleys, under tunnels, behind tall buildings, and didn't suffer more than a slight fading now and then (not enough to disrupt the contact). The Globe is as reliable as Liberace's smile, and we take our Stetson off to it. It isn't often that a nice-looking piece of electronic equipment lives up to its appearance.

Very satisfactory results have been achieved by Burt Cheesman, 8WØ148, of Compton, Ark., with a ground plane antenna. Burt also uses a rotary beam and a center-fed half-wave dipole on his roof. He regularly hears CB'ers in Chicago, Detroit, Dallas, Buffalo, New York City, and even Miami. Who could ask for anything more?

There is some concern on the part of city department dwellers about not being able to put an antenna on the roof. In the interests of CB we tried a "hidden antenna" and can report good news.

We mounted a small "junior size" mobile mount on the window sill, running a short length of coax between it and the transceiver. We grounded the shielded side of the coax to the metal frame of the casement window (an air conditioner cabinet or copper window screen will do) and screwed a 96" whip into the mount. Presto! An instant ground plane!

If you have no place to attach a ground, forget it and substitute a 102" whip for the 96-incher. The beauty of the whole thing is that when you are not on the air you simply unscrew the whip from the mount and bring it inside the house.

We're closing our CB log for the time being; but if and when anything hot pops up, we'll be talking to you again. -30-

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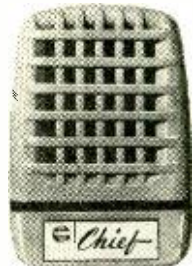
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Transistor Topics

(Continued from page 92)

erson, N. J.) has issued a 16-page booklet featuring a number of practical circuits designed around the 2N307 power transistor. All the circuits were chosen for special appeal to hobbyists and experimenters. See your local RCA distributor for a copy.

Sylvania Electric Products, Inc. (100 Sylvan Rd., Woburn, Mass.) has issued the second edition of their 20-page "Transistor Characteristics and Interchangeability Guide." Price is 10 cents a copy.

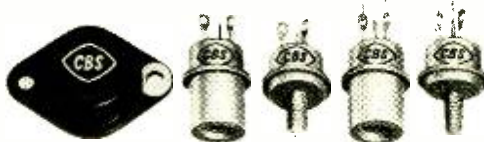
Product News. From CBS Electronics, (Semiconductor Div., Danvers, Mass.) comes news of a line of *n-p-n* power transistors to complement its well-known *p-n-p* units, offering the circuit designer a variety of types for complementary-symmetry applications.

The popularity of the "controlled rectifier" is growing by leaps and bounds. General Electric has just announced price reductions in its entire line ranging from 25% on the 16-ampere, 200-volt unit, to 14% on the 10-ampere, 300-volt model. Both International Rectifier Corporation (1521 East Grand Ave., El Segundo, Calif.) and Transistron Electronic Corporation (Wakefield, Mass.) are now producing silicon controlled rectifiers in a variety of types and sizes. One of Transistron's new units can handle 10 kilowatts of power.

Philco has started production of a transistorized portable TV receiver. Weighing only 15 pounds, this unit employs 21 transistors and 14 diodes and provides a viewing area of 80 square inches. It is powered with rechargeable dry cells, but can be operated on a 117-volt a.c. line. We'll try to get more details on this exciting item.

Good news for hams! Pacific Semiconductors, Inc. (Culver City, Calif.) is de-

CBS Electronics' new line
of *n-p-n* power transistors.



veloping an r.f. power transistor capable of 5 watts dissipation at up to 50 mc. This unit should find wide application in Citizens Band, marine, and mobile transmitters.

Smaller than a candy "Life-Saver," a printed-circuit amplifier just introduced by Centralab (900 East Keefe Ave., Milwaukee 1, Wis.), uses four transistors and can deliver a gain of from 73 to 78 db with a 1000-ohm load. Physically, the unit measures 0.531" in diameter by 0.288" in height, and weighs only $\frac{1}{16}$ ounce. For details, write direct to Centralab.

That covers the transistor picture for now. See you next month . . .

Lou



Pocket Marine Receiver

(Continued from page 69)

want but be sure to mark the international calling and distress frequency at 2.182 mc.

If desired, the tuning range can be widened by increasing $C1$ slightly and spreading the end windings on $L1$ slightly. To narrow the range, decrease $C1$ and compress the $L1$ windings.

After the correct tuning range is obtained, check that regeneration is balanced on both ends of the tuning range. It will normally rise near the center of the band and drop off slightly on the ends. If the high end drops off too much, increase $R4$; decrease it if the regeneration at the high end is greater than at the low end.

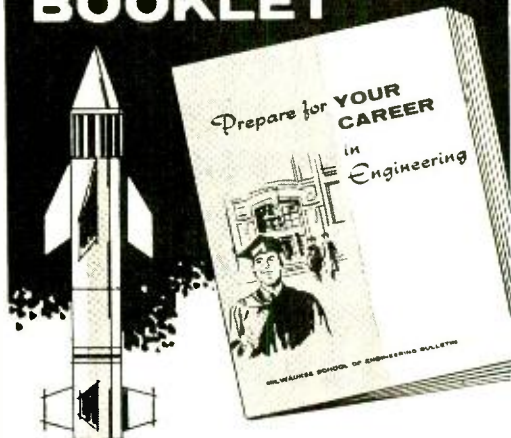
Both phone and code stations can be heard on the marine communications band, the c.w. stations being received with the regeneration control turned up to the oscillation point.

In most cases the reception range will be good, but not great, because most marine transmitters have fairly low power and low antennas. However, where the transmitter power is high, very good results can be obtained. For example, at night WWV at 2.5 mc. is easily received at a distance of 1000 miles.

If the receiver is built for the broadcast band, its sensitivity will be about the same as that of any other regenerator. Its chief advantage lies in its being usable with a minimum of regeneration adjustment. So far as local broadcasts are concerned, the regeneration control should need no adjustment for good reception over the entire band.

-30-

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Inside the Hi-Fi Loudspeaker

(Continued from page 88)

However, inefficient speakers do require high-power amplifiers.

Electrostatics. In the last few years the supremacy of the moving-coil permanent-magnet loudspeaker has been challenged by the electrostatic speaker. The design fundamentals of the latter have been known for a long time, but it is only recently that the electrostatic speaker has become available commercially. Its principle of operation is simple. See Fig. 3(A).

Suppose we have two light plates of metal and arrange them with their surfaces parallel but separated by a small gap. If we apply a high voltage to these plates, they will become charged. If both plates have a like charge, they will tend to repel each other; if they have unlike charges, they will attract each other. If we then vary the charge on the plates at an alternating audio rate, the plates will move back and forth and move the air to produce sound.

Most practical electrostatic speakers use three plates in the push-pull arrangement

as shown in Fig. 3(B). The two outer plates are stationary and perforated to permit air to move through them. The inner plate is charged with a high voltage. When an audio voltage is fed to the outer plates, the audio signal will vary the charge on the middle plate and it will vibrate as a sound-generating piston.

Theoretically, the piston could be made very large and only a little motion would be needed to produce low frequencies. In practice, it is difficult to produce a large plate which has the necessary low mass to vibrate freely when driven by low audio voltages. Also, the vibrating plate cannot just "float." It must be suspended, and this brings about resonance problems. Most electrostatics marketed to date have been for high-frequency operation only, but several full-range models are also available.

One of the most attractive features of the electrostatics is that they do not require critically designed enclosures for operation. Dynamic speakers, however, must be mounted in suitable enclosures for best results. Next month, we will consider this sometimes "baffling" question of speaker baffles or enclosures.

-30-



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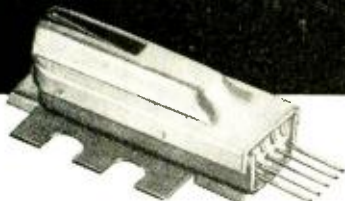
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C-501-D—Diamond	\$17.50
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Low-Down on Record Clubs

(Continued from page 71)

join. Then you must buy six records in the next year. Charges for records are combined with any other Diners' Club bills you may accumulate.

How the Clubs Work. Each of the clubs sends out a monthly magazine which discusses the record selected for the month and advises you of the alternate selections available. You may reject any monthly selection, choosing to take an alternate or no record at all for that month, as long as you buy enough records during the year to satisfy the membership requirement. The monthly selections are almost always brand-new releases, and the alternate lists offer a fairly wide choice of both new and old records.

All the big clubs offer approximately the same economy. In effect, you save about 40 to 45% over list price during the first year and approximately 33% thereafter. This kind of saving compares very favorably with the discount prices offered in the hot and heavy competition between big record stores in the larger cities. Most of the clubs add a "shipping and handling" charge to each order, however, which generally runs in the neighborhood of 35 cents per record.

The only drawback is a minor one, and it's much the same with all the clubs. As in any mail-order business, mistakes can happen now and then, and the club member has to be willing to get off a letter to straighten things out. He must also be ready to get in his rejection slips for records he doesn't want. By the way, the percentage of defective records is low, and replacement of defectives is usually made quickly.

Which Club to Choose? Picking a club is pretty tough. Each has its own appeal, and it's not easy to choose one over another. There's Columbia with Brubeck and Bernstein, RCA Victor with Toscanini, Rubinstein, and Belafonte's folk songs, Capitol with Sinatra and Steinberg, and the Diners' Club with over 20 companies represented.

If you usually buy ten or more records a year, joining two clubs might be the answer; the savings on records would make this a feasible proposition. Whatever your decision, however, your rig is likely to "run smoother" for it.

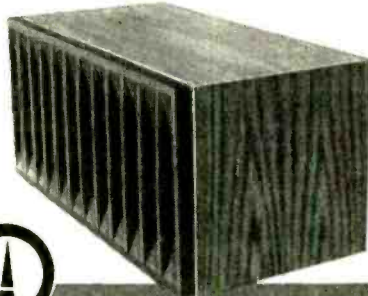
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Across the Ham Bands

(Continued from page 102)

As you become more skilled with your bug, you will probably want to modify some of the adjustments you made earlier, especially the dot adjustments. However, these vary from transmitter to transmitter. For example, a set of dot adjustments correct for a transmitter with "hard" keying will produce dots that run together at high speeds on a transmitter with "soft" keying or on one with a slight keying chirp. You will have to listen to the transmitter signal on your receiver with the receiving antenna removed and the antenna terminals shorted together while making the adjustments.

If you catch a visitor touching anything but the paddle after you have your bug adjusted exactly to your liking, you will know why old-timers get so upset about anybody adjusting their bugs for them.

All-Band Trap Antenna

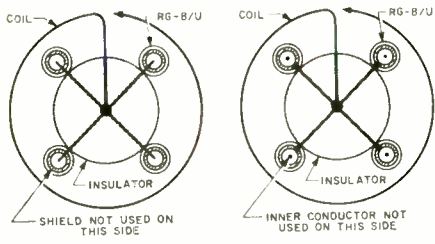
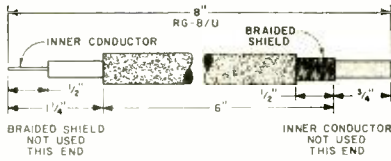
A popular antenna for all the amateur bands between 3.5 and 29.7 mc. is the "trap" doublet sketched on page 102. This simple antenna is efficient, yet inexpensive.

For each trap, cut four 8" lengths of RG-8/U cable to make the capacitors. Remove the vinyl coating and the shield braid for 1¼" on one end and ¾" on the other end of each length of coax, leaving exactly six inches of the braid and vinyl undisturbed. Then bare ½" of the inner conductor at the 1¼" end. Also bare a small patch of the shield braid on the ¾" end. Next, tape the four lengths to a tubular antenna insulator (E. F. Johnson #136-107 or equivalent).

Connect the exposed inner conductors together with an 8" length of #12 jumper wire at the 1¼" end. Then join the shields together with a 6" length of #12 jumper wire by tinning the exposed patches of braid on the ¾" end and soldering the wire to them. Leave an extra six inches of jumper wire at each end as illustrated for later connections.

For each coil, cut a 14-turn length from a B&W #3905-1 or an Illumitronics #2006T 2½"-diameter bulk coil. Unwind one turn from each end, leaving a 12-turn coil of #12 wire, 2½" in diameter and 2" long. Center the coil around the insulator and coax capacitor, and connect its ends across the capacitor. The coil is supported by its leads.

If a grid dip meter is available, use it



Traps for "all-band" antenna. Ceramic insulators and plastic tape are a must for high Q and low loss.

to place each trap on approximately 7175 kc. Reduce the number of turns in the coils a quarter turn at a time if the traps resonate below 7150 kc. Add turns if they resonate above 7200 kc. If a grid dip meter is not available, the traps will work well provided that the above instructions are followed carefully.

Spray the finished traps with several coats of acrylic lacquer and connect them in the antenna as shown.

News and Views

Bob Femrite, KNØSG, (14), Howard Lake, Minn., likes to rag-chew on 80 meters. In 53 days he worked 35 states, including California and Alaska, using a borrowed 50-watter which the owner has just reclaimed. Bob is now converting a surplus ART-13 transmitter. He receives on a Knight Ocean Hopper feeding a 4-watt audio amplifier. . . . **Dennis "Abe" Abraham, WA2BSX**, 156 East Fourth St., Clinton, N. J., used to hate code, but now that he has pushed his speed up to 20 wpm, he thinks it is the "most." His goal is a 35-wpm certificate. Abe has worked 29 states and Quebec as a Novice using a Heathkit DX-100B transmitter at 72 watts and a Hallicrafters SX-99 receiver. . . . New 1/4-meter DX record! On June 22, **W6NLZ** and **KH6UK** established a 47-minute contact between Hawaii and California on 222 mc. They also hold the two-meter DX record for this 2540-mile path.

Jack Purdum, KN8MGT, 224 West Homestead, Medina, Ohio, noticed a sudden decrease in the number of his contacts; so he took down his antenna and found its connections all cor-

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roded. After resoldering them, his results improved to their previous level. Jack uses a Heathkit DX-40 transmitter running 75 watts and receives on a Hallicrafters S-40 with an added Q-Multiplier. He has made about 200 contacts in 21 states on 40 meters. . . . **Gary R. Harwell, WV6ALL**, (15), 650 Chimalus Drive, Palo Alto, Calif., was a Novice for a full year, and his "General" should have arrived by now. His DX-40 transmitter, Hallicrafters S-85 receiver, plus Q-Multiplier, and simple antennas



Ham of the Month

Lana Murphy, KN9PQO, (17), Route 2, Box 82, Martinsville, Ind., hopes to possess a General Class license by the time you read this. Having graduated from the Martinsville High School last spring as a Science-Math-English major with a straight "A" average, she is now studying Aeronautical Engineering at Purdue University on a four-year Exceptional Achievement Scholarship. Lana also won the Bausch and Lomb Award for Exceptional Achievements in Science and has been a member of the National Honor Society for two years. She is a past president of the Martinsville High School Science Club, and last year was Secretary/Treasurer of the school radio club, also winning its achievement award. As KN9PQO, Lana has worked 10 states on 80 meters, using a Heathkit DX-20 to feed a doublet antenna. She has recently begun to work 40 meters also.

accounted for 30 states and Japan in about six months on 40 and 15 meters. Then, he received a high-gain, three-element, 15-meter beam for Christmas and knocked off another 10 states, many Canadians, and DX like Australia and New Zealand.

Bob Saltzman, WA2BWC/WV2BWC, (13), 1 Vista Drive, Great Neck, N. Y., rates the fact that his 11-year-old brother, Rick, has received his license—WV2EXY—as his biggest thrill in amateur radio. Bob has worked 44 states and 20 countries in five continents using a Globe Scout 680-A transmitter and a National NC-109 receiver. His "beam antenna" is a 65' piece of wire. In spite of his DX record, 80 meters is Bob's favorite. . . . **Joseph Curry, KN3ICO**, 7211 Oak Ave., Philadelphia 26, Pa., likes to build ham equipment, especially transmitters. He uses both a home-built,



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George Thomas Walczyk, WV2FCC, 108-22 Inwood St., Jamaica 35, N. Y., has no trouble with fellows forgetting his call letters. Look at them! George started with an Ameco AC-1 transmitter running 15 watts and now has a WRL Globe Chief 90A running 75 watts. He radiates with a 67' antenna, and he receives on a Hallicrafters S-38E. In 31 days, he has made 52 contacts in 11 states on 80 and 40 meters. George will help prospective hams get their licenses from the "other" FCC. . . .

Paul "Ed" Carpenter, KN8OFQ, (17), Rt. 1, Box 335, Watson, W. Va., started on the air with a 50-watt, home-built transmitter. He now has both a Heathkit DX-20 and a Knight 50-watter, and he receives on a Hallicrafters S-53. In two and a half months on 40 meters, his record is 22 states worked.

Need code practice? **Adolph F. Elster, W2FSL**, 53 Commercial Ave., Avenel, N. J., has been transmitting code practice for years on the following schedule: Saturdays, Sundays, and holidays, 0730 to 0800, local time, at approximately 8 wpm; Mondays, Wednesdays, Thursdays and Fridays, 1800 to 1830, local time, at approximately 15 wpm. Frequency: 3675 kc. Call letters: **K2IBC** (Avenel Radio Club). Local prospective hams are given personal assistance.

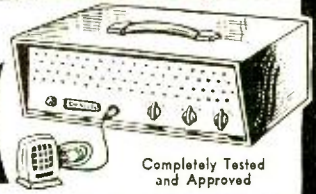
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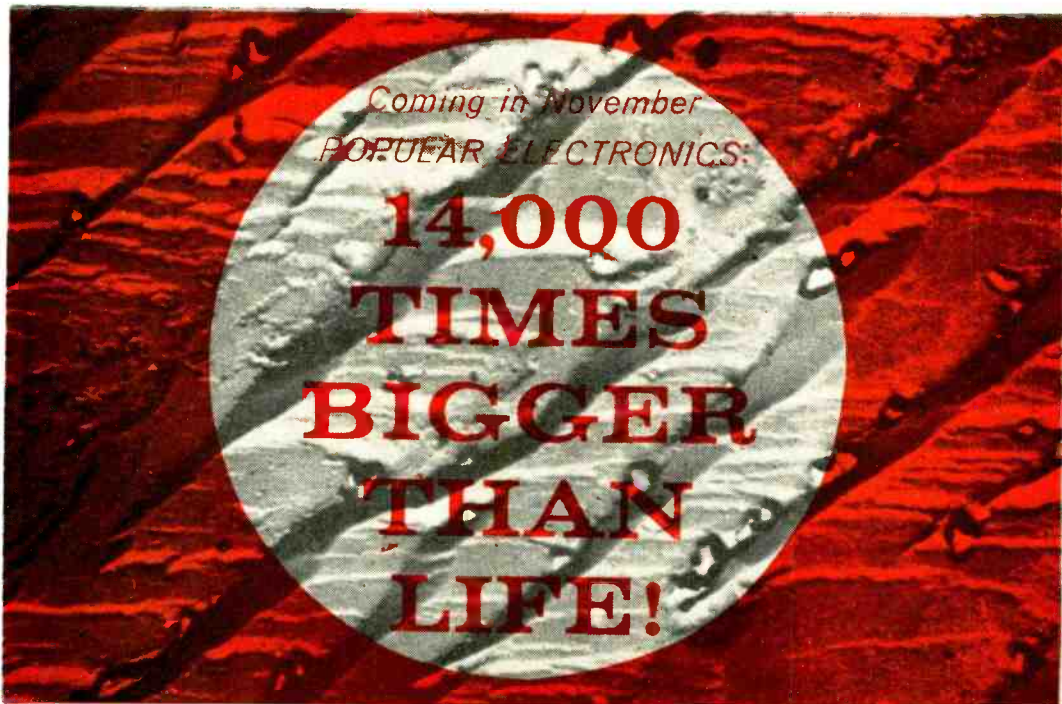


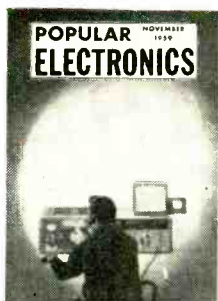
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Short-Wave Monitor Registration

Working with the throttle wide open, Tom Kneitel, WPE2AB, Director of Monitor Station Registration, had just about caught up with the backlog of registration forms when he ran out of certificates. Don't despair if the mailman hasn't delivered yours; he will, shortly. If you haven't registered yet, fill out the form below and mail to: Monitor Registration, POPULAR ELECTRONICS, One Park Ave., New York 16, N. Y. Please include ten cents to help cover cost of mailing and processing your certificate.

(Please Print)

Name

Address City State

Receiver Make Model

 Make Model

Principal SW Bands Monitored Number of QSL Cards Received

Type of Antenna Used

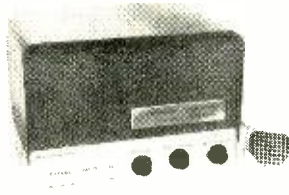
Signature Date

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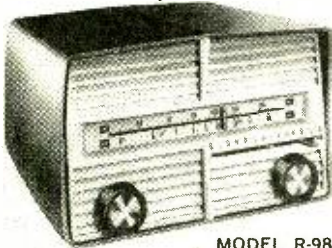
ADDRESS: _____

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Short-Wave Report

(Continued from page 89)

The following is a resume of current station reports. All times shown are Eastern Standard and the 24-hour system is used. Please bear in mind that at time of compilation all reports are correct. Stations often change frequency and/or schedule with little or no advance notice. Please send all reports to: Hank Bennett, Short-Wave Editor, P. O. Box 254, Haddonfield, N. J., in time for them to arrive by the tenth of each month.

Albania—R. Tirana verified with a letter stating that they broadcast daily on 7850 and 7157 kc. at 1630-1700 in English. However, no mention was made of the 6900-kc. outlet. (WPE2UN)

Argentina—LRA33, R. Nacional, Buenos Aires, 15,345 kc., carries Eng. at 1800-1900. Spanish from 1900 to 2000/close. On Mondays a new Eng. program entitled "Argentina, Legend and Reality" is presented. (WPE4FY, WPE9K4, DC)

The 9690-kc. channel carries Eng. at 2200-2300. Reports go to: Radio Difusora Argentina, Palacio del Correo, Sarmiento 151, Buenos Aires. (WPE9MV)

Australia—A few revisions have been made in R. Australia's schedule. Broadcasts in Eng. are currently scheduled as follows: to South Asia at 1714-1830 on 15,210 kc., at 1714-0415 on 21,540 kc., at 1815-0230 on 17,840 kc., at 1915-1930 and 0129-0445 on 15,160 kc., at 0459-1230 on 9580 kc., at 0800-0830 and 0930-1230 on 11,740 and 7220 kc., and at 0830-1000 on 11,760 kc.; to the North Pacific and East Asian areas at 1559-1800 on 15,240 kc., at 0244-0700 on 11,760 kc., and at 0459-0900 on 15,160 kc.; to the Mid-Pacific Islands at 1500-1700 on 15,315 kc., and at 0129-0445 on 11,810 kc. (WPE9DN, WS)

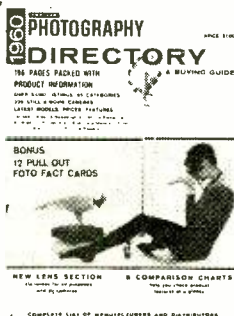
Austria—At time of this report, Vienna was testing on 5985 kc. at 0800-1200 with anmets in German, French, English, Italian, and Spanish at 0800; then a Home Service relay until 1200. (DXRA)

Belgian Congo—Another station testing is R. Bukavu, Costermansville, 4808 kc., daily at 1030-1400 (Saturdays from 0700) with 10 kw. This one is expected to change frequency



The listening post of John Cox, Belton, S. C.

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soon. Reports should be sent to Mr. H. DeSy, Director, *Radio Bukavu*, B. P. 1100, Costermansville. (DXRA)

Brazil—A new station (previously thought to be *R. Rural*) is *R. Marajuaba*, Belem, 15,245 kc. They have been noted testing at 1100-1600 with Brazilian music and three Portuguese anmts per hour. (WPE9KM, GF)

Ceylon—The schedule for the Commercial Service of *R. Ceylon* reads: in the National Service at 0630-1200 (news at 1015) on 5020 kc. daily, and at 2330-0230 on 7240 kc. (Sundays and public holidays); to Asia at 0745-1130 on 9520 kc. (news at 0800) and 2030-2230

MONITOR CERTIFICATES

Applications for Short-Wave Monitor registration certificates and call letters are pouring in thick and fast. If you haven't written for yours yet, you'll find an official application form on page 149 of this issue. Make sure you include a dime. This project will be of most value to SWL's when everyone is registered.

on 15,265 kc. (news at 2100); to Ceylon at 0230-0430 on 6075 kc. (0230-0630 on 7240 kc. on Saturdays and Sundays), at 0730-1230 on 4870 kc. (news at 0800) and at 2030-2330 on 7240 kc. (news at 2100); to S. E. Asia at 0415-0545 on 17,820 kc. (news at 0430). All xmsns are in English. (CP)

Colombia—HJFK, *La Voz de Amiga*, 6010 kc., is noted from 2243 to past 2300. The IS is four gongs. Location is said to be Caldas. (WPE0JJ)

Ecuador—A new outlet is *R. Rembarde*, Quito, 6100 kc., 500 watts. This has been noted evenings. (WPE9KM)

England—The latest schedule from London for North, Central, and South America reads: to N.A. (USA, Canada, Mexico, and British Honduras) at 0700-0715 on 15,300 kc. and at 0915-1315 on 17,810 kc. (special programs); in the General Overseas Service (USA, Canada, Mexico) at 1615-1845 on 17,715 kc., 1615-2200 on 15,310 kc., 1800-2000 on 11,780 kc., and at 2100-2200 on 9825 kc.; to the West Indies, Central and South America (North of the Amazon, including Peru) at 1500-1815 and 1845-1915 on 21,550 kc., 1615-1815 and 1845-2200 on 17,810 kc., 1800-1815 and 1845-2200 on 15,070 kc., and at 2100-2200 on 11,750 kc.; to South America (South of the Amazon, excluding Peru) at 1500-1915 on 17,870 kc., 1615-2200 on 15,360 kc., 1700-2200 on 12,040 kc., and 1800-2200 on 9825 kc.; to South Georgia at 1700-1945 (until 1915 Sundays) on 12,095 kc.; and to the West Indies at 1815-1845 on 21,550, 17,810, and 15,070 kc. There is also a special broadcast in the General Overseas Service at 1945-2200 on 15,420 kc. and it is heard well. (WPE3NB, WPE9DN)

Ghana—*R. Ghana*, Accra, has news from London at 0100-0115 followed by a program of music, interviews, and local news. This is on 9640 kc.; other channels are 4915 and 3366 kc. (WPE2TK, WPE2UN)

Greece—*R. Athens*, 15,345 and 17,778 kc., operates in French at 1215-1230, Eng. at 1230-

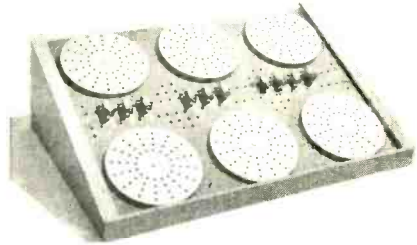
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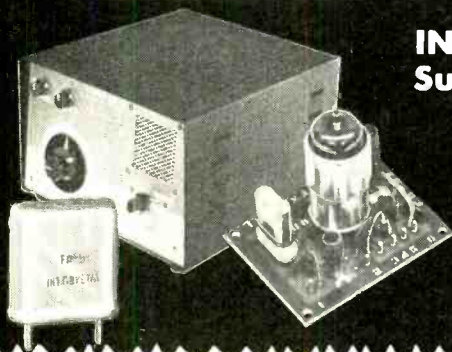
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India—All-India Radio, Delhi, is noted on 15,185 kc. at 1815 s/on after IS; on 15,170 kc. from 1500 to 1545/close with native music and Eng. anmts; on 15,270 kc. at 0725-0800 in language with Eng. ID at 0730; and on 15,350 kc. (not listed) at 0550-0559 with music. (WPE4FY, WPE9KM, GF)

Japan—Here is the latest schedule from R. Japan, Tokyo (all xmsns listed have Eng. as well as other languages): to South Asia at 1000-1130 on 11,965 and 15,325 kc.; to Middle East at 1145-1345 on 11,705 and 15,325 kc.; to Europe at 0230-0330 on 17,855 and 21,620 kc. and at 1400-1600 on 11,705, 21,620, 11,965, and 9525 kc.; to N.A. at 1930-2030 on 17,855 and 21,620 kc.; to N.A. and Hawaii at 0000-0200 on 17,855, 15,325, and 15,235 kc.; to Australia and New Zealand at 0430-0530 on 11,940 and 15,235 kc.; to Asia at 0545-0745 on 11,705 and 9525 kc.; to Indonesia and the Philippines at 0630-0800 on 17,855 and 15,325 kc.; to S.E. Asia at 0800-1100 on 11,705 and 15,235 kc.; and in the General Asian Service at 2000-2030, 2200-2300,

DXplorers Radio Club

In response to letters from a number of readers, the DXplorers Radio Association wishes to announce that it is a closed club with membership strictly by invitation from a Club Officer. This group is made up of a small number of highly skilled DX'ers who recently formed their own Club Constitution. There are no dues charged. News is passed from member to member through the medium of a constantly circulating news-letter rather than an official club bulletin. Your Short-Wave Editor is not a member of this group; the information that is credited to DXRA is sent to us by an officer of the group.

0030-0130, 0500-0530, and 0700-0930 on 15,135 and 11,800 kc. (WPE2AEP, WPE2DM, WPE4FY, WPE4ON, WPE5AG, WPE6EZ, WPE7AT, WPE8MS, JW)

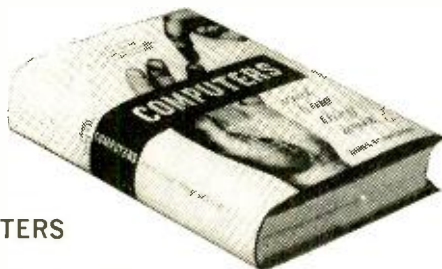
Kenya—A station tuned on 6171 kc. at 1200 with frequent mention of Nyeri is believed to be ZHW24, Nairobi. (WPE1AK)

Malaya—The BBC Far Eastern Station, Singapore, can be tuned on 9725 kc. at 0500-0615 beamed to Indonesia with BBC news at 0600, and on 17,755 kc. with news and sports at 0700-0730. In response to queries, this station does verify if reports are sent to P.O. Box 434, Singapore, Malaya, % Mr. R. J. Keir, Resident Engineer. (WPE4OA, WPE4ON, WPE6EZ)

Mexico—XEWX, Mexico City, has returned to 15,160 kc. and is noted at 0855-0900 and around 1625 with music and commercials in

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Spanish. The signal has been "cleaned up" and the distortion which plagued them for weeks has disappeared. (WPE9KM, GF)

Morocco—Radio Inter-Africa (also known as IBRA Radio) sends a multi-colored QSL written in three languages. They are on the air daily at 1200-1715 in Danish, Dutch, French, Finnish, German, Greek, Hungarian, Italian, Japanese, Russian, Spanish, Swedish, and Ukrainian, and at 1715-1800 with music

SHORT-WAVE ABBREVIATIONS

anmt	Announcement	N.A.	North America
BBC	British B/C Corp.	QSL	Verification
Eng.	English	R.	Radio
ID	Identification	~/on	Sign-on time
IS	Interval signal	~/off	Sign-off time
kc	Kilocycles	xmsn	Transmission
kW.	Kilowatts	xmtr	Transmitter

and anmts in French and Eng. on 11,505 and 14,858 kc. Reports go to: 9 Rue de Russe, Tangier, Morocco. (WPE1KR)

According to a Tunis news bulletin, the Moroccan premier signed a royal decree on May 27 fixing December 31, 1959, as the deadline for the termination of operations by privately owned stations at Tangier. After that date the only legal broadcaster in the kingdom will be *Radiodiffusion Nationale Marocaine*. Specifically cited was *Radio Africa-Maghrib*, but presumably Gospel broadcasters, as well as the *Voice of America*, will be affected. Quoting the Moroccan daily "At-Tahrir," the Middle East News Agency reports that the Moroccan authorities recently discovered a clandestine transmitter operating from Tangier with programs intended for Moroccan Jews. MENA adds that the existence of this clandestine station was among the reasons which prompted the Moroccan authorities to close all foreign-operated stations in the country by the end of the year. (ZC4PE1A)

Netherlands—Hilversum carries Eng. at 0400-0440 to Australia and New Zealand on 25,610, 21,480, and 17,775 kc.; to Africa and India at 1045-1125 on 21,480 kc. (Africa) and on 17,775, 15,220, and 6020 kc. (Europe); at 1615-1655 to N.A. and Europe on 17,775, 15,220, 11,730, and 6020 kc.; and at 2130-2210 to N.A. on 11,730, 9590, and 6025 kc. The *Happy Station* Program to N.A. is aired Sundays at 2100-2230 on the same channels as the N.A. xmsn. (WPE2DM, WPE4QM, WPE4QQ, WPE7AT, EM, R. Nederland)

R. Nederland will have a new QSL card shortly, thus eliminating the long-used tulip design. Available, free of charge, is an illustrated calendar and a booklet on short-wave antennas. (WPE8HS, JC)

Norway—A partial reading of *Radio Norway's* schedule indicates that they broadcast as follows: at 0600-0715 to Japan, Far East, New Zealand, and Australia on 11,735, 15,175, 17,825, and 21,670 kc.; at 0130-0235 and 0800-0915 to Central Europe on 6130, 9610, 11,735, and 17,825 kc.; and at 2000-2115 to North and Central America on 6130, 9610, 11,735, and 15,175 kc. (JW)

Panama—HOLA, R. *Atlantico*, 9505 kc., has an Eng. program at 2100-2200 featuring many commercials. Another Eng. segment is from 1745 to 1800. Reports go to Apt. 444, Colon, Republic of Panama. (WPE4KB, FC, DW)

Peru—OAX2G, R. *Cajamarca*, Cajamarca, has been found on 4770 kc. from 2340 to 2359 s/off with fair signals. (WPE0JJ)

Portuguese India (Goa)—R. Goa is now off the air for a xmtr change. They plan to be back on soon with higher power according to the R. *Australia* DX program. (WPE4OA)

Sudan—R. *Omdurman* has an Eng. program daily at 1100-1130 on 5039 kc. (20 kw.), 9612 kc. (7.5 kw.), and 11,855 kc. (20 kw.). Reports go to the Ministry of Information and Labour,

SHORT-WAVE CONTRIBUTORS

Jack Rouse (WPE1AK), Wallingford, Conn.
 Alan Roth (WPE1BY), Bridgeport, Conn.
 Jim Monahan (WPE1GU), East Haven, Conn.
 Mirville Burns (WPE1KR), Morrisville, Vt.
 Richard Flam (WPE2EP), Beltsore, N. Y.
 Richard McCurdy (WPE2DM), Harrison, N. Y.
 Robert Salamack (WPE2TK), Amsterdam, N. Y.
 Dominic Lorenzini (WPE2LN), Landisville, N. J.
 John Wilson (WPE3NB), Wilmington, Del.
 Ronald Biron (WPE3BI), Miramar, Fla.
 Jim Maynard (WPE3FY), Lexington, Ky.
 Glenn Cuthrell (WPE4KB), Maxton, N. C.
 Jimmy Boockholdt (WPE4OA), Eutaw, Ala.
 John Cordrey (WPE4ON), St. Petersburg, Fla.
 Peter Forell (WPE4QM), Fort Lauderdale, Fla.
 Don Peterson (WPE4QQ), Sanford, Fla.
 William Bing (WPE5AG), New Orleans, La.
 J. Art Russell (WPE6EZ), San Diego, Calif.
 Don W. Beebe (WPE7AT), Seattle, Wash.
 Dan Watts (WPE8HS), Greenwich, Ohio
 Mike Kander (WPE8MS), Dayton, Ohio
 J. P. Arendt (WPE9DN), Aurora, Ill.
 A. R. Niblack (WPE9KM), Vincennes, Ind.
 Ron Kozor (WPE9MY), Fort Wayne, Ind.
 John Beaver (WPE0AE), Pueblo, Colo.
 Gerry Dexter (WPE0JJ), Waterloo, Iowa
 Middle Eastern Correspondent (ZC4PEIA)
 Donald Chester (DC), Woodlawn, Tenn.
 Fred Colley, Jr. (FC), West Palm Beach, Fla.
 Jack Carr (JC), Cincinnati, Ohio
 Grady Ferguson (GF), Charlotte, N. C.
 George Henley (GH), Watford, England
 Ed Macdonald (EM), Malvern, Pa.
 Chandra Pereira (CP), Quilon, South India
 Ward Stewart (WS), Des Moines, Iowa
 Dan Wilt (DW), Barberton, Ohio
 John Walter (JW), Coos Bay, Oregon
 DXplorers Radio Association (DXRA)
 Radio Nederland

Sudan Broadcasting Service, P.O. Box 522, Khartoum, Sudan. (WPE8MS, GH)

Tanganyika—Dar-es-Salaam was noted signing weakly at 2340 on 5050 kc. This station is very difficult to tune. (WPE1GU)

As of last June, all transmissions were to continue past 1315 to close-down time. This means that the 4846-kc. outlet would parallel the 5050-kc. transmission throughout the afternoon. (ZC4PEIA)

Turkey—R. *Ankara* has replaced the 15,160-kc. outlet with 9743 kc. at 1500-1545. From 1545 to 1600 it is dual to 7285 kc. English is carried from 1600 to 1645 on both channels. (WPE2AEP)

United Arab Republic—Damascus has Eng. news on 15,165 kc. at 1015-1030. Another newscast is given from 1515 but fade-out prevented good reception of this station. (WPE2UN, WPE0AE)

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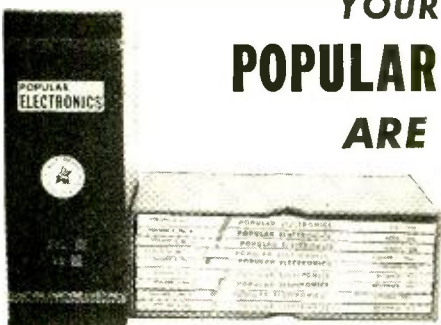
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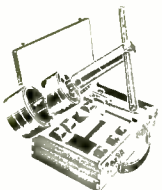
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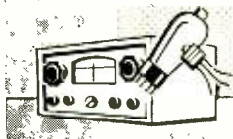
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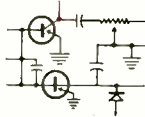
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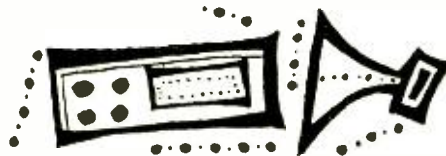
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MODEL 83

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From 50 degree to 110 degree types
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ALL COLOR TUBES

Test ALL picture tubes—in the carton—out of the carton—in the set!

but lacking in proper definition, contrast and focus. To test for such malfunction, you simply press the rej. switch of Model 83. If the tube is weakening, the meter reading will indicate the condition. ● Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83 applies a selective low voltage uniformly to assure increased life with no danger of cathode damage.

Housed in handsome portable Saddle Stitched Texon case—complete with sockets for all black and white tubes and all color tubes. Only

\$38⁵⁰

Model 83—C.R.T. Tube Tester
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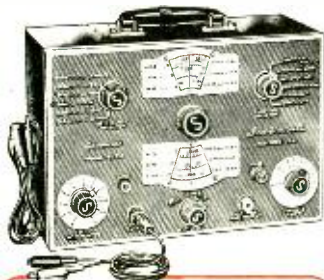
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- ✓ Bar Generator
- ✓ Cross Hatch Generator
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- ✓ Marker Generator

This versatile All-Inclusive GENERATOR Provides ALL the Outputs for Servicing:

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Model TV-50A GENOMETER
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BAR GENERATOR: The Model TV-50A projects an actual Bar Pattern on any TV Receiver Screen. Patterns will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars.

CROSS HATCH GENERATOR: The Model TV-50A Genometer will project a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shifting, horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

DOT PATTERN GENERATOR (FOR COLOR TV): Although you will be able to use most of your regular standard equipment for servicing Color TV, the one addition which is a "must" is a Dot Pattern Generator. The Dot Pattern projected on any color TV Receiver tube by the Model TV-50A will enable you to adjust for proper color convergence.

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The Model TV-50A comes absolutely complete with shielded leads and operating instructions. Only

\$47⁵⁰

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TEST ANY TUBE IN 10 SECONDS FLAT!

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Model 82A comes housed in handsome, portable, Saddle-Stitched Texon case. Only.... **\$36.50 Net**



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 TW-11

- Tests all tubes, including 4, 5, 6, 7, Octal, Lockin, Hearing Aid, Thyatron, Miniatures, Sub-miniatures, Novals, Subminars, Proximity Fuse Types, etc.
- Uses the new self-cleaning Lever Action Switches for individual element testing. All elements are numbered according to pin-number in the RMA base numbering system. Model TW-11 does not use combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.
- Free-moving built-in roll chart provides complete data for all tubes. Printed in large easy-to-read type.

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New
Model 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL-VIEW METER

Compare it to any peak-to-peak V. T. V. M. made by any other manufacturer at any price!

- Extra large meter scale enables us to print all calibrations in large easy-to-read type.
- Employs a 12AU7 as D. C. amplifier and two 9006's as peak-to-peak voltage rectifiers to assure maximum stability. • Meter is virtually burn-out proof. The sensitive 400

micro-ampere meter is isolated from the measuring circuit by a balanced push-pull amplifier. • Uses selected 1% zero temperature coefficient resistors as multipliers. This assures unchanging accurate readings on all ranges.

SPECIFICATIONS

AS A DC VOLTMETER:—The Model 77 is indispensable in Hi-Fi Amplifier servicing and a must for Black and White and color TV Receiver servicing where circuit loading cannot be tolerated.

AS AN ELECTRONIC OHMMETER: Because of its wide range of measurement leaky capacitors show up glaringly. Because of its sensitivity and low loading, Intermittents are easily found, isolated and repaired.

AS AN AC VOLTMETER: Measures RMS values if sine wave, and peak-to-peak value if complex wave. Pedestal voltages that determine the "black" level in TV receivers are easily read.

- DC VOLTS—0 to 3/15/75/150/300/750/1,500 volts at 11 megohms input resistance.
- AC VOLTS (RMS)—0 to 3/15/75/150/300/750/1,500 volts. • AC VOLTS (Peak to Peak)—0 to 8/40/200/400/800/2,000 volts.
- ELECTRONIC OHMMETER—0 to 1,000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms. • DECIBELS: -10 db to +18 db. +10 db to +38 db, +30 db to +58 db. All based on 0 db = .006 watts (6 mw) into a 300 ohm line (1.73V). • ZERO CENTER METER—For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.



Model 77—VACUUM TUBE VOLTMETER. Total Price. . . \$42.50
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Comes complete with operating instructions, probe leads, and streamlined carrying case. Operates on 110-120 volt 60 cycle. Only

\$42.50

SUPERIOR'S
NEW MODEL 79

SUPER-METER

WITH NEW 6" FULL-VIEW METER

A Combination VOLT-OHM MILLIAMMETER Plus CAPACITY, REACTANCE, INDUCTANCE & DECIBEL MEASUREMENTS Also Tests SELENIUM & SILICON RECTIFIERS, SILICON & GERMANIUM DIODES

The model 79 represents 20 years of continuous experience in the design and production of SUPER-METERS, an exclusive SICO development. It includes not only every circuit improvement perfected in 20 years of specialization but, in addition includes those services which are "musts" for properly servicing the ever-increasing number of new components used in all phases of today's electronic pro-

duction. For example with the Model 79 SUPER-METER you can measure the quality of selenium and silicon rectifiers and all types of diodes — components which have come into common use only within the past five years, and because this latest SUPER-METER necessarily required extra meter scale. SICO used its new full-view 6-inch meter.

SPECIFICATIONS:

- D.C. VOLTS: 0 to 7.5 15 75/150 750 1,500. • A.C. VOLTS: 0 to 15/30/150 300 1,500 3,000. • D.C. CURRENT: 0 to 1.5 15 150 Ma. 0 to 1.5 15 Amperes. • RESISTANCE: 0 to 1,000/100,000 Ohms. 0 to 10 Megohms. • CAPACITY: .001 to 1 Mfd., 1 to 50 Mfd. • REACTANCE: 50 to 2,500 Ohms, 2,500 Ohms to 2.5 Megohms. • INDUCTANCE: .15 to 7 Henries, 7 to 7,000 Henries. • DECIBELS: -6 to +18, +14 to +38, +34 to +58. The following components are all tested for QUALITY at appropriate test po-

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