By The Publishers of
MECHANIX ILLUSTRATED

Let E's Hi-Fi Expert Select the Best Stereo for You • See page 27

ELECTRONICS ILLUSTRATED

25c
OCTOBER

STARTLE YOUR FRIENDS WITH A TESLA COIL

How To:

Install a 2-way Radio In Your Car

Build a 1-transistor Radio

Report on a new $43 2-way radio kit

ELECTRONICS ILLUSTRATED

OCTOBER, 1959 Vol. 2, No. 10

A FAWCETT PUBLICATION

CONTENTS

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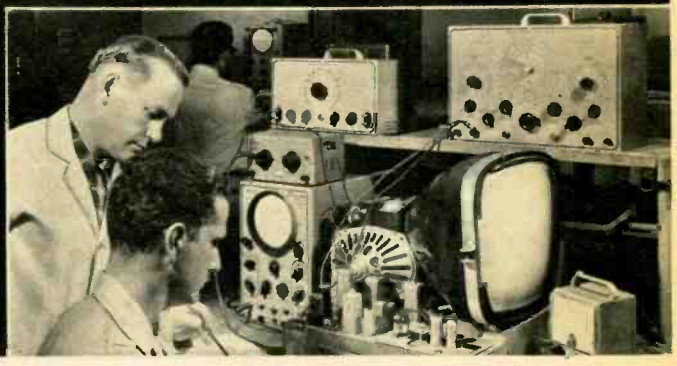
AM-FM and Auto Radios Transistors—Printed

Circuits—Test Equipment

(Right — Instructor helping students check the wiring and trace circuits of television receivers.)



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A Message From the Editor

LAST year we ran a series of articles on how to build a safe model missile. Our primary interest, of course, is electronics and our intention was to help any of our readers who wanted to learn more about and experiment with electronic telemetering and control devices used in rocketry. We discovered that we could not go right into the subject because there was not enough published material available on how to build a safe rocket, so we gave the plans and outlined the safety rules to use in building and firing a rocket. Unfortunately, this rocket was too small to instrument successfully and we decided to develop a larger rocket that could be instrumented electronically. We haven't reported our progress in this project to you before because like all carefully designed projects there were many tentative steps taken and many changes made. Now, however, we can not only report to you that such a rocket is in readiness, but show you a picture of it. This two-stage, four-foot rocket was built for us by a young amateur rocketeer, and will already have been test fired by the time you read this. A future issue of *Electronics Illustrated* will contain complete plans for this rocket, the "Condor 1" as well as information on how to build the electronic equipment to put into it.

I have in the past asked you what you would like us to cover and build for future articles. Your letters have been very helpful and I appreciate your response. Now, I'd like to ask your opinions on regular columns. You have noticed that we have very few. We'd rather report on new ideas, new build-it-yourself projects and new fields in our snappy style with lots of large pictures and not waste valuable space on columns which very often are routine and repetitive. However, there are certain topics which lend themselves to column type coverage. If you feel that there is some subject on which you would like us to run a regular column every month, please tell us.

Among the many interesting articles in this issue is one on the electronics industry in Japan. The information for this article was gathered by Mr. Ray Popkin Clurman, U. S. electronic engineer and manufacturer of industrial and broadcast equipment during a recent visit to electronic plants in Japan. You are now and will be seeing more and more Japanese electronic products:

radios, tape recorders, TVs, etc. Here's the story on how they are made and their quality controlled.

The article on the tesla coil in this issue is in response to letters from our readers for such a device. This one has been designed and built for us by Harvey Pollack, a name that you will recognize as standing for practical construction projects. I warn you, if you build this tesla coil you'll let yourself in for many hours of fun and magic.

We have long resisted the pressure to go into the consumer rating business. We feel that we do not have the extensive laboratory and personnel necessary for such a program both to be of honest use to our readers and fair to the manufacturer. As you know, we assemble kits and report regularly (two in every *EI* issue) on how well they go together and perform. In the last few months we set up a laboratory to check on one specific product—hi-fi stereo records. We've put a great deal of time and special equipment into this program and we think we've come up with some valid and startling information. How good are these records technically? How long will they stand up? How should you play them to get the most out of them? A full report on this subject will be in our November issue.

Maintaining our promise to keep you up to date on the new unlicensed two-way radio Citizens Band, next month we will have a report on mobile and fixed antennas available and how to install them. You can't get the most out of the low powered two-way radio unless you have an efficient antenna installation. We'll show you what types to use where. Be sure to be with us.

Charles Tuttle

Electronics Illustrated

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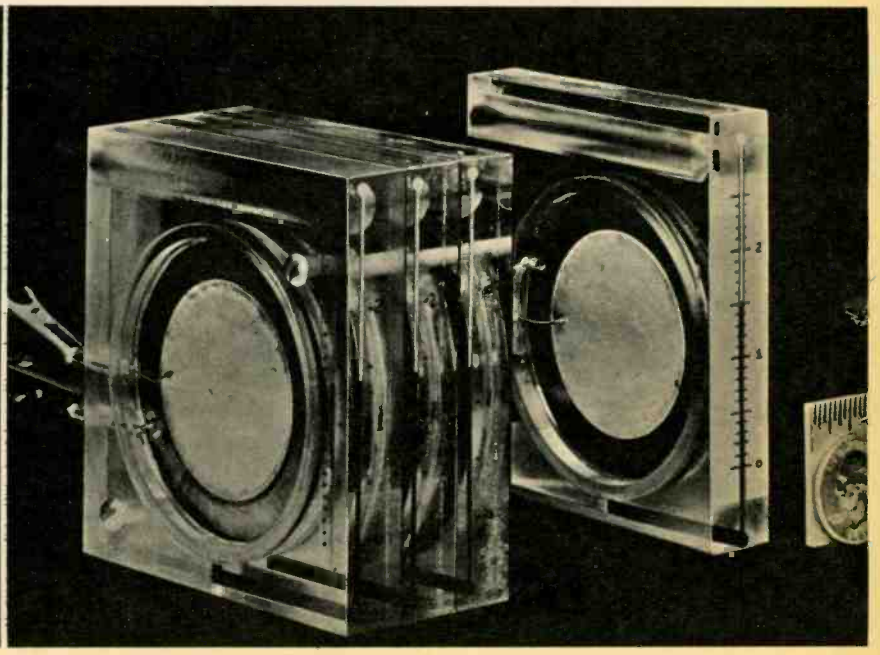
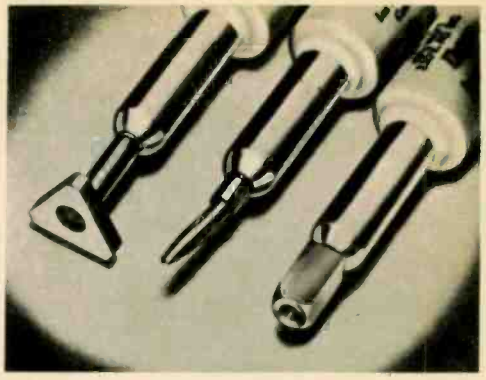
Electronics in the News

An atomic clock which neither gains nor loses one second in a *thousand* years will be put into orbit in the not too distant future to check Einstein's theory of relativity. The theory says that a clock running in a different gravitational field above the Earth would run faster than a clock on the ground. A stream of ammonia molecules generates a highly stable signal whose frequency acts as an escapement for time keeping. Hughes Aircraft is working on the project.

Here is a new type of voltmeter using no moving parts. Each plastic wafer contains two metal sheets to which ceramic discs are bonded. When electric potential is applied, the ceramic contracts, cupping the metal disc and forcing the colored fluid between these discs to rise in a tube at meter front, indicating voltage. Meter is ¾" wide.

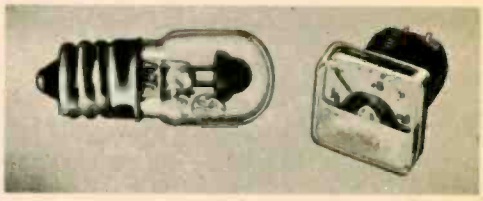


. . . News



Ungar Electric Tool Company has expanded its line of de-soldering tools with the addition of three new tiplets especially designed for printed circuit work. These screw into the end of the Ungar low voltage soldering irons. The triangle tiplet melts solder simultaneously from electrolytic capacitor leads which are in a triangular pattern. The offset slotted tiplet straightens leads and tube tabs, melts and removes excess solder on wire connections and the cube shape melts solder and removes center pins of tube sockets. These tiplets perform multiple operations and cut rework time. All inquiries pertaining to these tiplets should be addressed to Ungar Electric Tools, Inc., 4101 Redwood Ave., Los Angeles 66, California.

—o—



Another product has been added to the growing list of miniature and subminiature equipment for the home builder. Alco Electronics has introduced a new VU and S meter in addition to the ½" panel meter that measures both voltage and current (shown above). The face of the S-10 is ⅝" x ⅝" x ½". It is available in 4 ranges. Priced at $3.95 from Alco, 3 Wolcott Ave., Lawrence, Mass.

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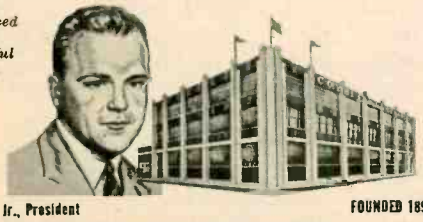

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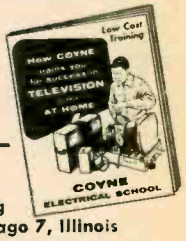

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. . . News

Weathers Industries has announced the latest thing in bookshelf speakers—a "book" speaker. Two models are now available; the Harmony speaker and the Hideaway bass. A combination of two Harmony and one bass speakers will effect three channel stereo reproduction. Recently shown at hi-fi shows, these new type speakers excited much interest. Price for the Harmony is $29.75—Hideaway bass $69.50. Complete specifications available from Weathers Industries, Barrington, New Jersey.

—o—

With the introduction of a new "sandwich" recording tape by Minnesota Mining and Manufacturing Co., oxide rub-off on recording heads, one of the biggest problems in data processing, has been virtually eliminated according to the company. A protective 50 micro-inch plastic layer shields the iron oxide coating on the tape from direct contact with recording heads. The tape runs through the computer recording heads as a smooth surface rather than one composed of exposed abrasive particles, thus greatly reducing the possibility of recording error. Tape is currently used by Minnesota Mutual Life Ins. Co.

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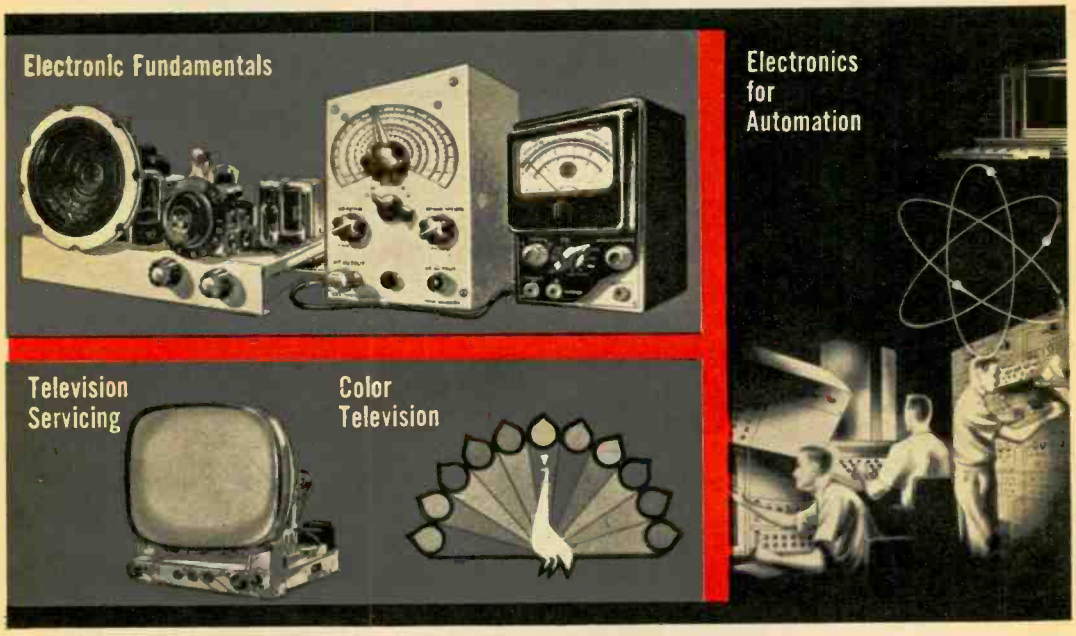

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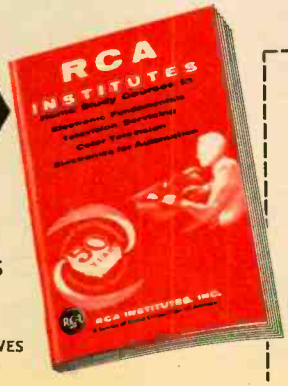

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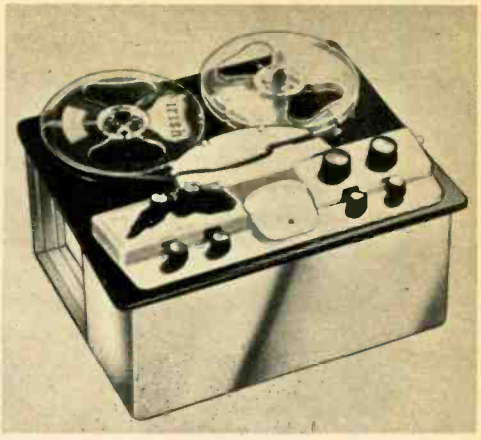
. . . News



Two new tape recorder kits using both 3¾ and 7½ ips speeds have been made available by the Heath Company of Benton Harbor, Michigan. The TR-1C has monophonic record and playback while the TR-1D provides the same with the added feature of stereo playback. The mechanical assembly, with fast forward and rewind is completely assembled and adjusted, only the tape amplifier must be built. Two inputs are provided. In the TR-1D, a separate playback channel with cathode follower output is provided for each stereo track.

Separate record and playback heads and amplifiers allow monitoring from tape while recording and a built-in sound level meter indicates proper recording level. Instant starting and stopping of tape is achieved with a pause control. Kit includes counter for cueing and editing. The possibility of accidental erasing is minimized by a safety interlock switch on record. The TR-1C is priced at $159.95 and the TR-1D at $169.95.

—o—

Westinghouse has developed a "strainer" that will filter out images of storms and heavy clouds that now clutter the radar scope in bad weather. This permits the all-weather jet interceptor pilots to see their target more clearly, and increases radar range between five and ten times the present maximum in storms.

. . . News

Dynaco, Inc. has announced production of their new Dynakit Mark IV 40 watt amplifier. It features the Dynaco A-470 output transformer and offers wide band low distortion performance for stereo or monophonic use. The kit includes a pre-wired printed circuit board, step-by-step instructions and pictorial diagrams. Construction time is about 3 hours. Dynaco guarantees the Mark IV for 1 year. The complete unit is 5″ x 14″ x 6½″ and is finished in a nickel and charcoal brown vinyl coated cover. Available in prewired ($79.98) or semi-assembled kit form ($59.95) from Dynaco, 618 N. 41 St., Phila., Pa.

—o—

Atlas Sound has introduced a new decorator-type loudspeaker—the DU-12. Speaker may be turned to face any direction and Atlas says it is "tailored" to reproduce speech without the reverberations often associated with this type of speaker. All wiring is concealed. Complete specifications available from Atlas, 1449 39th Street, Brooklyn 18, N. Y. $21.00.

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9. The right to use RTS Seal of Approval, and the RTS Credo.
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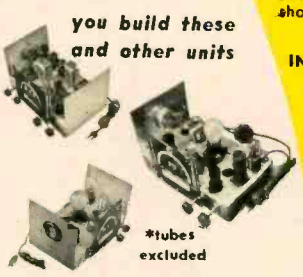
you build these and other units



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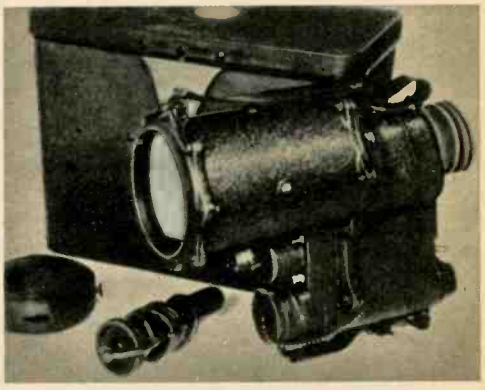
. . . News

A six transistor portable radio kit has been announced by EICO. The RA-6 features a built-in Ferrite loop antenna, pre-aligned RF and IF transformers, a 4″ x 6″ oval PM speaker, and a high impedance earphone jack. Building is made simpler with the plug-in transistor sockets and pre-aligned transformers, no test instruments or alignment are required. Radio is housed in a simulated tan leather carrying case with retractable handle. Available as kit—$29.95—or factory wired and tested—$49.95—from EICO, 33-00 Northern Blvd., Long Island City 1, N.Y.

—o—



In a recent issue (July '59) of *EI* you read about an infrared "Snooperscope" that can "see" in the dark. It was originally developed for US Navy signalling and reconnaissance in complete darkness, but is now available to the general public for $39.50. The scope is used by plant guards and police for the detection of night prowlers and thieves without being observed. Complete specs available from Edmund Scientific Co., Barrington, N. J.

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

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

You will learn the basic principles of radio. You will construct, study and work with RF and AF amplifiers and oscillators, detectors, rectifiers, 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, Progressive Dynamic Radio & Electronics Tester and the accompanying instructional material.

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

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

THE KIT FOR EVERYONE

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

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

PROGRESSIVE TEACHING METHOD

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

You begin by examining the various radio parts of the "Edu-Kit." You then learn the function, theory and wiring of these parts. Then you build a simple radio. With this first set you will enjoy listening to regular broadcast stations, learn theory, practice testing and trouble-shooting. Then you build a more advanced radio, 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 chassis, special tube sockets, hardware and instructions. You also receive a useful set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio & Electronics Tester. The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator, in addition to F.C.C.-type Questions and Answers for Radio Amateur License training. You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector, 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 TROUBLE-SHOOTING BOOK
- MEMBERSHIP IN RADIO-TV CLUB: CONSULTATION SERVICE • FCC AMATEUR LICENSE TRAINING
- PRINTED CIRCUITRY

SERVICING LESSONS

You will learn trouble-shooting and servicing in a progressive manner. You will practice repairs on the sets that you construct. You will learn symptoms and causes of troubles 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. Stataitis, of 25 Poplar Pl., Waterbury, Conn., writes: "I have repaired several sets for my friends, and made money. The "Edu-Kit" paid for itself. I was ready to spend $240 for a Course, but I found your ad and sent for your Kit."

FROM OUR MAIL BAG

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

Robert L. Shuh, 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."

UNCONDITIONAL MONEY-BACK GUARANTEE

The Progressive Radio "Edu-Kit" has been sold to many thousands of individuals, schools and organizations, public and private, throughout the world. It is recognized internationally as the ideal radio course.

By popular demand, the Progressive Radio "Edu-Kit" is now available in Spanish as well as English.

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.

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.
☐ Send me FREE additional information describing "Edu-Kit."

Name .....

Address .....

.....

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world's easiest-to-build kits

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BEST...by Design!

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BUILD THE BEST

Y-774 Deluxe 40-Watt Stereo Amplifier (with Center Channel) **$79.50**
only $5 down

R-100 Amateur Communications Receiver (Hi-gain, with built-in Q-Multiplier) . . **$104.50**
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Y-713 Citizen's Band Transceiver . **$39.95**
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only *knight-kits* have "CONVENIENCE ENGINEERING" for easiest building...no previous electronic experience needed

Exclusive in Knights-Kits, "convenience engineering" means special attention to every detail: resistors are carded and numbered for easy selection...all parts and hardware are packaged in clear plastic bags for easy identification...wire is precut, stripped, tinned and color-coded to save time... special printed circuitry is used to eliminate complex wiring...all parts are top premium quality...you get everything—even the solder! Finally, Knight-Kit instructions are clear as crystal; step-by-step procedure and wall-sized picture diagrams make assembly a marvel of simplicity. Your final reward is proud enjoyment of the superior performance designed into your Knight-Kit.

SEE THEM HERE

AMATEUR KITS
50-Watt Transmitter
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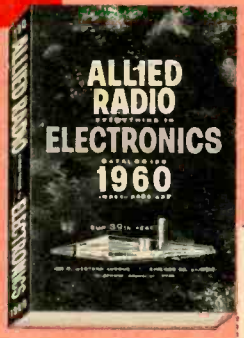
100 kc Crystal Calibrator
RF "Z" Bridge
Code Practice Oscillator



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1960 ALLIED CATALOG

Write for the 1960 ALLIED Catalog featuring the complete KNIGHT-KIT line—see the big news in electronic kits—get this leading Buying Guide for everything in Electronics. Send for your FREE copy.

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Pioneers in the development of the world's finest electronic kits

our 39th year

THE WORLD'S LARGEST ELECTRONIC SUPPLY HOUSE

. . .News

A new ceramic cardioid microphone, model 729, selling for $24.50 is being produced by Electro-Voice, Inc., Buchanan, Mich. This new microphone is designed for public address, call and paging systems, amateur radio, home recorders and general communications. It is dead from the rear making it suitable for amateur radio VOX operation and single sideband.

—o—

When the 2000 mile an hour Air Force B-70 Valkyrie bomber, now in the blueprint stage at North American Aviation finally takes to the air, it will carry an electronic shield to protect it from enemy attack. This defensive system will make use of electromagnetic and other techniques to make it difficult if not impossible for enemy aircraft or missiles to successfully attack the B-70. At the same time, the B-70's defense will involve electronic counter-measures that will delay, confuse and distort enemy intelligence. Westinghouse has been selected to develop this system.

—o—

Have trouble memorizing mathematic formulas? A new plastic covered card made by the Redi-Reference Card Co. should solve your problems. The 3″x5″ card gives formulas from algebra, geometry and trigonometry, including definitions; special right triangles; law of sines, cosines, and tangents; tables of three place logarithms of numbers and functions of angles. Single card is priced at 50c, 3 cards—$1. Cards are available from Redi-Reference Card Co., 35 Corchaug Avenue, Port Washington, New York.

Do you WISH you were EMPLOYED in ELECTRONICS?

F.C.C. LICENSE—THE KEY TO BETTER JOBS

An F.C.C. *commercial* (not amateur) license is your ticket to higher pay and more interesting employment. This license is Federal Government evidence of your qualifications in electronics. Employers are eager to hire *licensed* technicians.

WHICH LICENSE FOR WHICH JOB?

The THIRD CLASS radiotelephone license is of value primarily in that it qualifies you to take the second class examination. The scope of authority covered by a third class license is extremely limited.

The SECOND CLASS radiotelephone license qualifies you to install, maintain and operate most all radiotelephone equipment except commercial broadcast station equipment.

The FIRST CLASS radio telephone license qualifies you to install, maintain and operate every type of radiotelephone equipment (except amateur) including all radio and television stations in the United States, its territories and possessions. This is the highest class of radiotelephone license available.

GRANTHAM TRAINING PREPARES YOU

The Grantham course covers the required subject matter completely. Even though it is planned primarily to lead directly to a first class FCC license, it does this by TEACHING you electronics. Some of the subjects covered in detail are: Basic Electricity for Beginners, Basic Mathematics, Ohm's and Kirchhoff's Laws, Alternating Current, Frequency and Wavelength, Inductance, Capacitance, Impedance, Resonance, Vacuum Tubes, Transistors, Basic Principles of Amplification, Classes of Amplifiers, Oscillators, Power Supplies, AM Transmitters and Receivers, FM Transmitters and Receivers, Antennas and Transmission Lines, Measuring Instruments, FCC Rules and Regulations, and extensive theory and mathematical calculations associated with all the above subjects explained simply and in detail.

OUR GUARANTEE

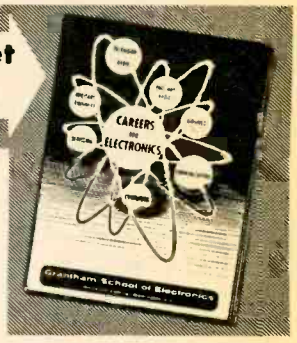
If you should fail the F. C. C. exam after finishing our course, we guarantee to give additional training at NO ADDITIONAL COST. Read details in our free booklet.

Get
Your First Class Commercial
F.C.C. LICENSE
QUICKLY!

CORRESPONDENCE OR RESIDENCE CLASSES

Grantham School of Electronics *specializes* in F.C.C. license preparation. Correspondence training is conducted from Hollywood, Seattle, Kansas City and Washington; also, resident DAY and EVENING classes are held in all four cities. Either way, by correspondence or in resident classes, we train you quickly and well.

This booklet FREE!



This free booklet gives details of our training and explains what an F.C.C. license can do for your future.

HERE'S PROOF...

that Grantham students prepare for F.C.C. examinations in a minimum of time. Here is a list of a few of our recent graduates, the class of license they got, and how long it took them:

	License	Weeks
Robert J. Conley, 129 W. 46th St., New York 36, N. Y.	1st	14
W. R. Smith, 1335 E. 8th St., Long Beach, Calif.	1st	12
Howard E. Martz, 301 S. Penn. St., Fairmount, Ind.	1st	24
John W. Dempsey, Box 55, Rising Sun, Md.	1st	12
Donald H. Ford, Hyannis RD, Barnstable, Mass.	1st	12
Richard J. Falk, 2303 Helman St., Bremerton, Wash.	1st	22
Denson D. McNully, 1117 N. Houston St., Amarillo, Texas	1st	9
James D. Heugh, 400 S. Church St., East Troy, Wisc.	1st	12
Odie B. Perry, Jr., Rt. #3, Zebulon, N. C.	1st	12
Milton C. Gee, Rt. #1, Washington, N. J.	1st	11

Grantham School of Electronics

Hollywood Division	1505 N. Western Ave. Hollywood 27, Calif. (Phone: HO 7-7727)
Seattle Division	408 Marion Street Seattle 4, Wash. (Phone: MA 2-7227)
Kansas City Division	3123 Gillham Road Kansas City 9, Mo. (Phone: JE 1-6320)
Washington Division	821-19th Street, N. W. Washington 6, D. C. (Phone: ST 3-3614)

MAIL COUPON TO SCHOOL NEAREST YOU

(Mail in envelope or paste on postal card)

To: GRANTHAM SCHOOL OF ELECTRONICS

1505 N. Western Hollywood • 408 Marion Seattle • 3123 Gillham Rd. Kansas City • 821-19th, NW Washington

Gentlemen:

Please send me your free booklet telling how I can get my commercial F.C.C. license quickly. I understand there is no obligation and no salesman will call.

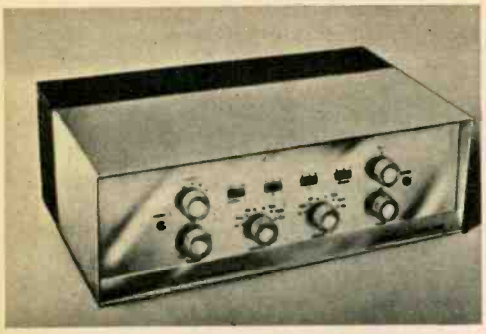
Name_____ Age____

Address_____

City_____ State____

I am interested in: ☐ Home Study, ☐ Resident Classes 98-R

. . . News



A new stereo control center using dual 14-watt amplifiers has been announced by Arkay. A switch will convert the two 14-watt amplifiers, to one using 28 watts for monaural use. The versatile amp pre-amp kit features reverse stereo switch for interchanging channels; a balance control; gain control for adjusting both channels simultaneously; step-by-step instructions. The CS-28 is available in kit form for $64.95 or factory wired and tested for $99.95 from Arkay, Inc., 88-06 Van Wyck Expressway, Richmond Hill 18, New York.

—o—

New Bulletins and Catalogs. . . .

"A Study of the Unique Influence of Space-Automation Technology on the Present-Day Environment with Special Attention to its Implications for the Behavioral Sciences" is the "terse" title of a booklet containing a collection of cartoons illustrating the effect of electronics on life today. Audio Devices, 444 Madison Ave., N. Y.

The uses of vacuum tubes and transistors in high-fidelity applications is discussed in a bulletin by CBS-Electronics. "Tubes and Transistors in Hi-Fi" available free from Parker St., Newburyport, Mass.

A step-by-step method for selecting specific rectifiers for circuit applications is available in a 24-page brochure illustrated with work sheets, charts, graphs and nomographs. Free from General Electric, Semiconductor Products Dept., Syracuse, N. Y.

Accredited by the National Home Study Council

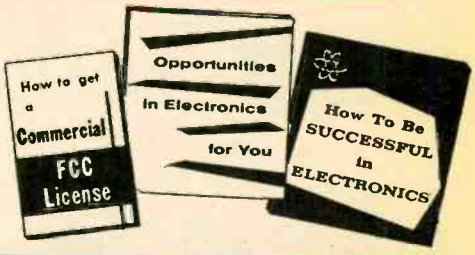
good training doesn't cost . . . it pays!

How To Get an FCC License (Commercial)

Get Your FCC License Quickly

We Guarantee to train you until you receive Your FCC License

Get all 3 FREE



We guarantee

to train you until you receive

Your FCC License

—or your money back

The Master Course in Electronics will provide you with the mental tools of the electronics technician and prepare you for a First Class FCC License (Commercial) with a radar endorsement. When you successfully complete the Master Course, if you fail to pass the FCC examination, you will receive a full refund of all tuition payments.

Cleveland Institute training results in job offers like these:

Radio Operators

TWA has opportunities for radio operators with a 2nd class license or better. Must be able to type at least 35 wpm. Free transportation for self and family. Vacation and many other benefits.

Electronic Technicians

Goodyear Aircraft Corp. has openings for electronic technicians, to work as assistants to engineers on developmental electronics projects such as missile systems, radar, antennas and analog computers.

And our trainees get good jobs

"Investment in training really pays off"

"I am now employed by the Western Electric Company as an electronic tester. My status as a student of Cleveland Institute was an important factor in my being employed. Knowledge gained through the course has proved amazingly helpful and affords me a feeling of complete confidence." T. E. Spence, Greensboro, N. C.

Cleveland Institute of Electronics

4900 Euclid Ave. Desk EI-13 Cleveland 3, Ohio

Cleveland Institute of Electronics

Desk EI-13 4900 Euclid Ave., Cleveland 3, Ohio

Please send Free Booklets prepared to help me get ahead in Electronics. I have had training or experience in Electronics as indicated below:

- ☐ Military
- ☐ Broadcasting
- ☐ Radio-TV Servicing
- ☐ Home Experimenting
- ☐ Manufacturing
- ☐ Telephone Company
- ☐ Amateur Radio
- ☐ Other_____

In what kind of work are you now engaged? _____

In what branch of Electronics are you interested? _____

Name_____ Age_____

Address_____

City_____ Zone_____ State_____

EI-13

◀ See Page 24 for EICO'S BEST BUYS in "HAM" GEAR and TRANSISTOR RADIOS.

the EI

Convert to Stereo

questionnaire

IF you have a monophonic hi-fi system now you have probably been thinking about how to convert to stereo. Not everyone needs nor desires stereo, but when well done it does bring an extra dimension to music that can be startling, and converting your present system to play stereo music sources (records, tapes, etc.) need not be expensive. Yes, there is a confusing variety of components: stereo adapters, special speakers, amplifiers, cartridges, etc., and trying to determine which is best for you can be difficult. But, if your present system is taken into account and your particular needs are analyzed, you will find that may be only two or so methods of converting to stereo hi-fi are best for you. This, ELECTRONICS ILLUSTRATED will do for you! Fill out the questionnaire on this and the following pages completely. Draw a diagram of the layout of the room in which you will play your stereo system (follow our example) and mail this questionnaire to us. By return mail you will receive our recommendations to guide you when you convert to stereo. When you tell us how much you desire to spend please be realistic, we cannot recommend a stereo conversion that will cost you $50 and be hi-fi. Also, if you would like some hi-fi component kit recommendations be sure to tell us of your previous kit assembling experience. If you have no hi-fi now, we will design some complete systems for you.

Your Hi-Fi Room:

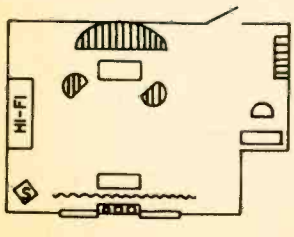
length_____ width_____ height_____

type of flooring:_____

total wall area covered by drapes:_____

Draw Your Room Layout (looking down at room)

example:



fill in:

Name _____

Address _____

_____

_____

I Now Have the Following Hi-Fi Equipment:

_____

_____

_____

_____

I Want to:

play stereo records ☐

play stereo tapes ☐

record stereo tapes ☐

receive AM-FM stereo broadcasts ☐

receive FM multiplex stereo broadcasts ☐

I Listen:

loud ☐ intently ☐ for background ☐

to classics ☐ to jazz ☐ to pops ☐

to semiclassics ☐

I Prefer:

large size speaker enclosures ☐

small size speaker enclosures ☐

I Would Like to Assemble From Kits For:

most components ☐

some components ☐

I have already assembled some kits ☐

I Don't want to Spend More Than $ _____

I Want to Convert To Stereo: all at once ☐ in stages ☐

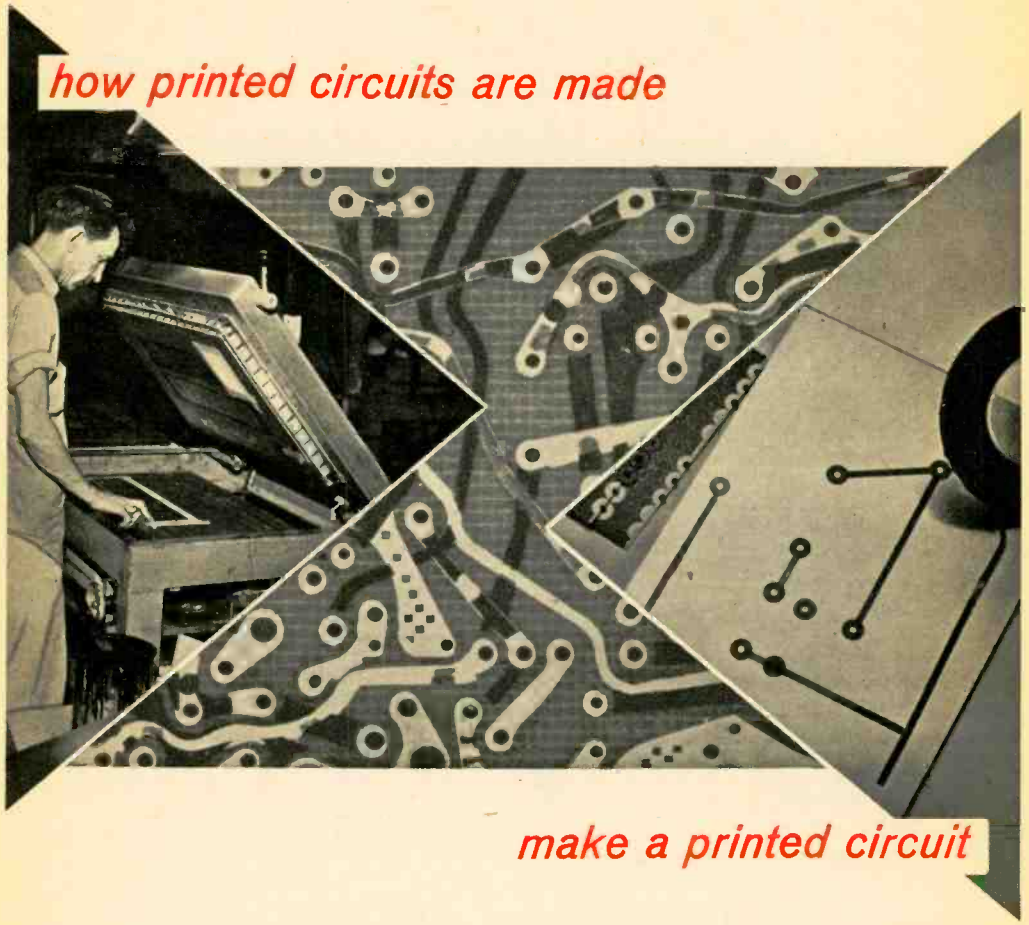
Fill out completely and mail with self-addressed stamped envelope to:

ELECTRONICS ILLUSTRATED, Dept. Q1

67 West 44th Street, New York 36, New York

Printed Circuit Primer

A Special *Electronics Illustrated* Staff Report....



ETCHED, embossed, engraved, plated—these are all terms that have come to be associated with one of the truly revolutionary developments in electronics, the printed circuit. Why revolutionary? Because the printed circuit technique represents a most convenient method of mass producing uniform and reliable electronic circuits. Making a printed circuit is literally a "boiling down" process—connecting a number of components in proper sequence without a mess of wiring that looks like a hopelessly tangled dish of spaghetti.

A printed circuit may be small with few connecting links (such as the one inside your TV tuner); or it may be a complex computer plug-in card bearing many transistors, tubes, resistors, etc. Large or small, simple or complex, many manufacturers find it far less expensive to mount those tubes, et al., on a printed board than it would be to have a long line of patient, sharp-eyed

Insulating base materials may vary from paper base phenolic laminates to shock and heat resistant Fiberglas. Copper foil (other metals may be used) is bonded to one or both sides of base with tough adhesive. All raw materials are put through heat, humidity, pressure tests, above. Left, *EI* staffer looks over uncut base stock with Photocircuits' G. Maisch (right).

How Printed Circuits Are Made

women hand-wiring each connection. The home hobbyist is fast finding out that he, too, can make good use of printed circuits (see page 33).

Recently, *ELECTRONICS ILLUSTRATED* visited the world's largest factory devoted to making printed boards—Photocircuits Corp., Glen Cove, N. Y. This company has turned out over 20,000 *different* printed circuit designs for all types of electronic devices ranging from radio receivers to airborne computers. The photos on these pages show some of the more important steps in the mass production of one of electronics' most discussed items.

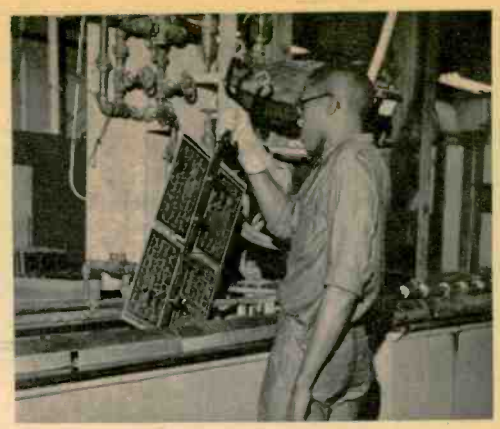
Precision is the watchword in making the master layout drawing. Tolerances must be held to within 0.001". The instrument being used by Pat Clohessy is a Swiss-made "coordinatograph" which microscopically can locate the center of each hole.

An exact-size photo is taken of drawing above. Negative is placed in a special "step and repeat" camera which reproduces circuit several times on a glass plate. Plate then becomes negative to impose image on a fine mesh stainless steel screen.

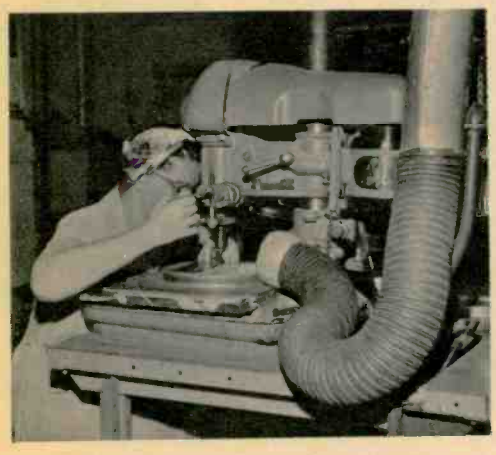
Photos by Mike Bonvino

Screen is inserted in silk screen, then lowered over blank board of base material. Resist compound, resembling blue paint, is squeegee'd through screen onto base material, leaving pattern of circuit outlined in acid resist. Girls with paint brushes touch up any rough spots on board.

Resist-coated boards then go to big tanks of etching solution where excess foil is removed.



Series of baths remove foreign material that may be clinging to boards, deters corrosion.



Once individual boards are die-cut from common board, holes are drilled in proper places.

Complete circuit can be assembled at factory. Hand and dip soldering techniques are used.

Odd shapes and sizes of printed circuit boards attest to their wide use and versatility.

At left, each circuit is tested for continuity both before and after the soldering operation.

Speaker acts as a mike in the preamp built to show printed wiring techniques.

Make A Printed Circuit

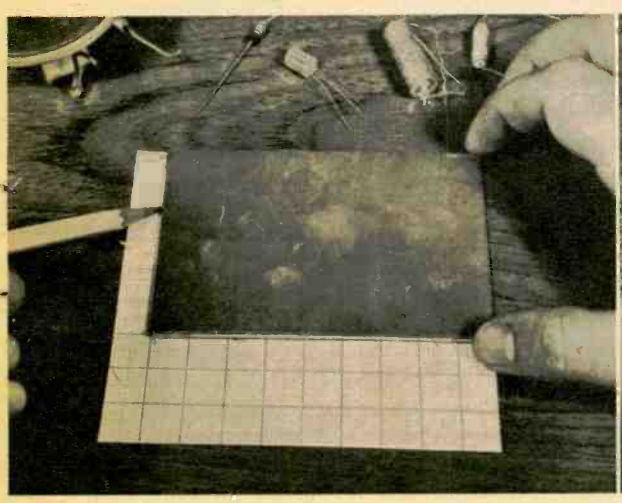
By Len Buckwalter
Associate Editor

Convert a speaker into a dynamic mike. The printed board can be made with readily available materials.

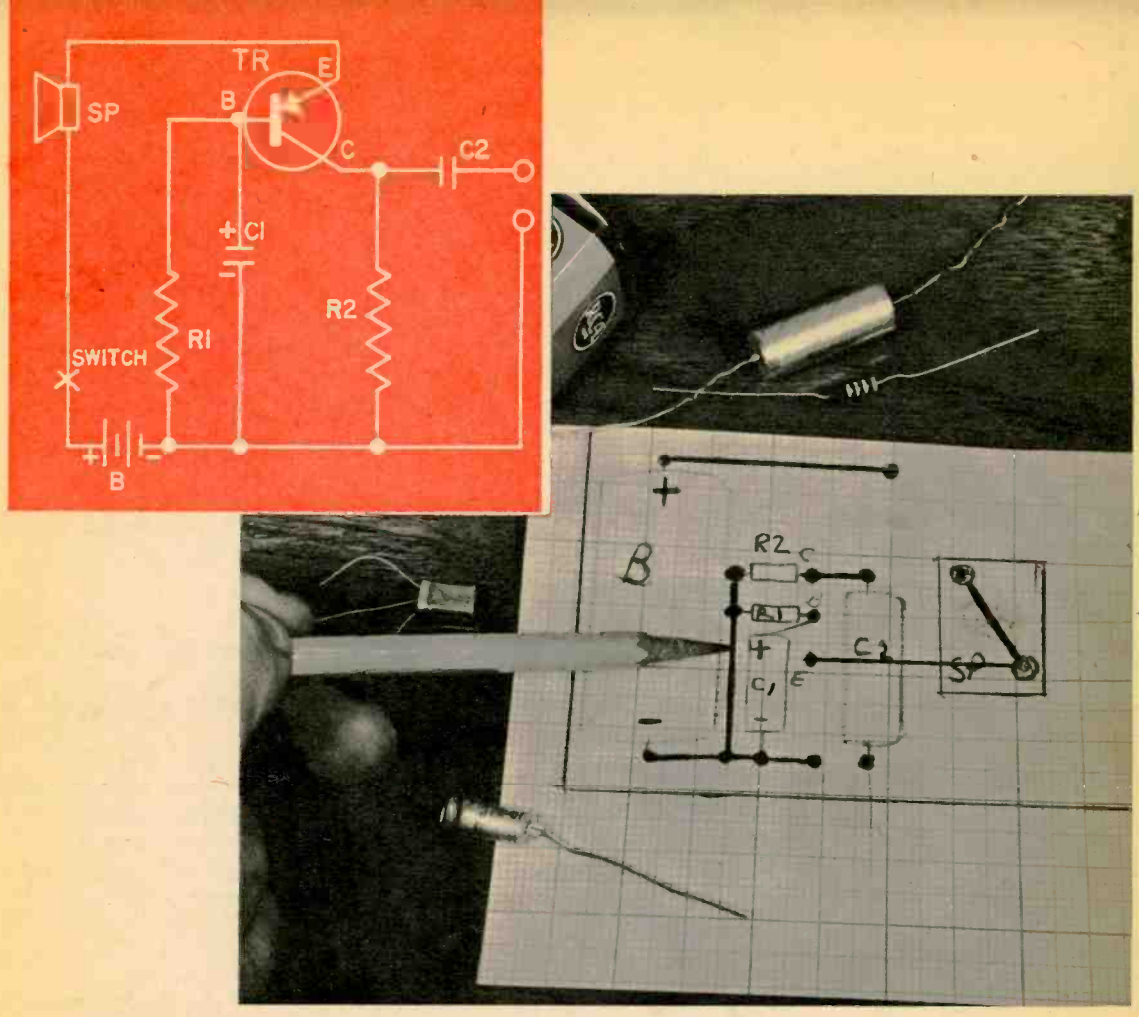
COMPLETE kits and components enable the home hobbyist to fabricate his own printed circuits on a kitchen table. Kits begin at $3.75 and contain basic materials to produce simple circuits. As items are used, they may be replenished on an individual basis. Switches, sockets and coil forms, specially designed to plug into printed boards are also appearing in the catalogs of electronic distributors.

The process is simple. The circuit design is applied to a copper clad phenolic board with a substance called resist. Submerge

Outline of copper clad phenolic board, large enough to hold parts, is drawn on graph paper.



Paper will serve as a work sheet to determine parts location. Dot marks point for wire hole.



Guided by the schematic, upper left, parts are outlined in exact mounting position. Only heavy black lines and dots will appear on foil pattern.

PARTS LIST

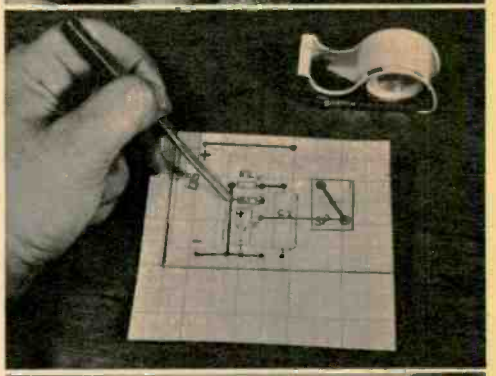
R1—390,000 ohm ½ watt resistor
R2—33,000 ohm ½ watt resistor
C1—8 mfd 6 volt miniature electrolytic capacitor
C2—.47 mfd paper capacitor 200 volt
SP—Speaker 2½", 10 ohm voice coil (approx.)
TR—CK722 transistor
B—6 volt battery (RCA VSO68)
Misc.—Printed circuit materials available from Lafayette Radio, Allied Radio and other electronic parts distributors. SPST normally-open pushbutton switch (if desired) may be inserted at point "X" in schematic

the board in an etching solution and the copper foil not protected by the resist will be eaten away. Ferric chloride, a relatively harmless chemical is used as the etchant. After the reaction is finished, the resist is removed, leaving a copper foil pattern of the circuit. The complete procedure, step-by-step, is shown in the photos.

Planning is important. Changes in wiring are difficult once the board is etched. The layout should avoid crossing over of conductors since this would necessitate jumper wires soldered from one foil section to another. In the more complex circuits, foil on both sides of the board is used to avoid crossovers and permit the mounting of many components. Double clad boards are also important for miniaturization.

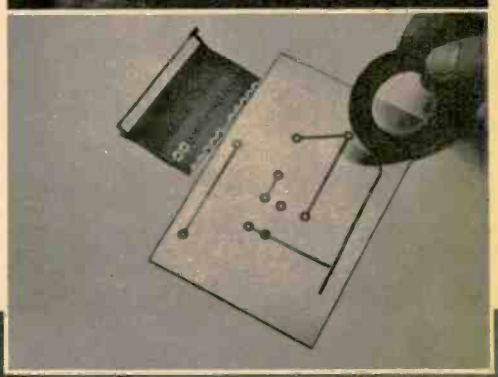
Resist may be applied in several ways. Tape and precut dots are used here, but pen and resist ink is suitable, though not as neat. A ball-point pen with resist ink has appeared on the market. In the tape method, firm pressure

Dirt is removed from copper foil side of board by rubbing with steel wool for proper application of resist and etchant.

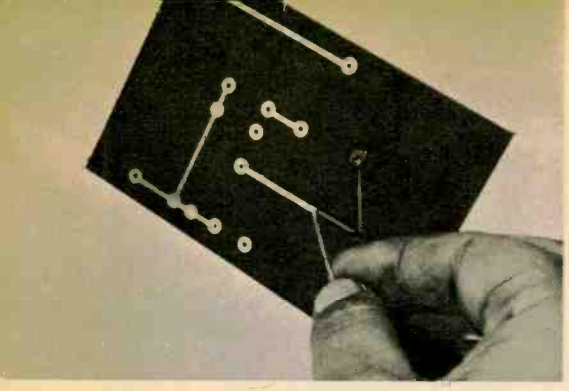


Graph paper is taped to board and circuit transferred by carbon paper. Center punch marks location of drill holes.

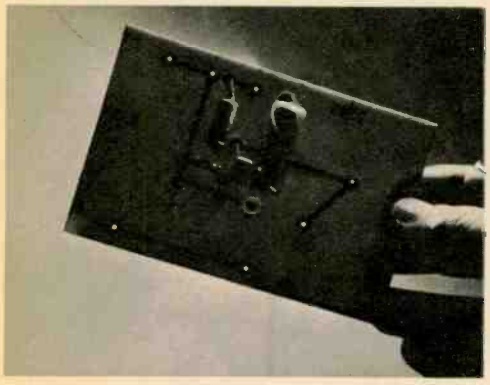
Tape resist is applied to circuit pattern. Dots, available on a precut sheet, are pressed firmly onto the punch marks.



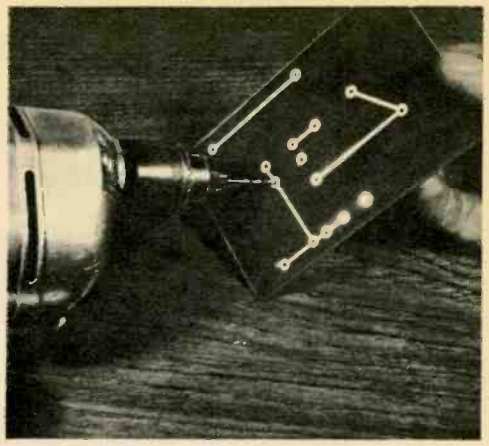
Board is examined after etching 15 to 20 minutes. Solution should cover board by ¼ inch depth and tray rocked gently.



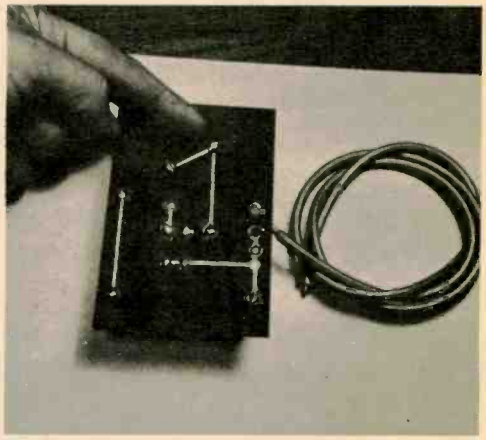
Board is washed in water and resist tape peeled off. Copper foil pattern is revealed.



Small parts are mounted and soldered. Strong light behind board makes both sides visible.



A #52 drill bit is used to make holes for insertion of component leads through board.



Finger points to screw used to hold speaker to board. It requires a slightly larger hole.

Battery is held to board, at left, by wires soldered to its terminals and holes in board.

with a cloth is used to secure the adhesive backing to the board.

The board must be clean for two reasons; so the resist adheres to the foil, and to permit the etchant to attack the unwanted copper. Steel wool will do the job.

Etching solution may be purchased in powdered or liquid form. The powdered version is prepared by mixing with water. Ordinary rubbing alcohol will remove stains on fingers if they come in contact with the solution. Etching takes about fifteen or twenty minutes, its progress checked periodically by removing the board with plastic tongs or an insulated wire tied around the board.

Preparation of the board is completed by washing in water and drilling holes

[*Continued on page* 92]

Our IGY satellite-orbitings were more numerous and perhaps more valuable scientifically than those of the Russians. But the VHF signals from our space vehicles could not be picked up as conveniently as those from Soviet transmitters using globe-circling short-wave bands. Below: Author's QSL on Sputnik I, and letter he received concerning Lunik.

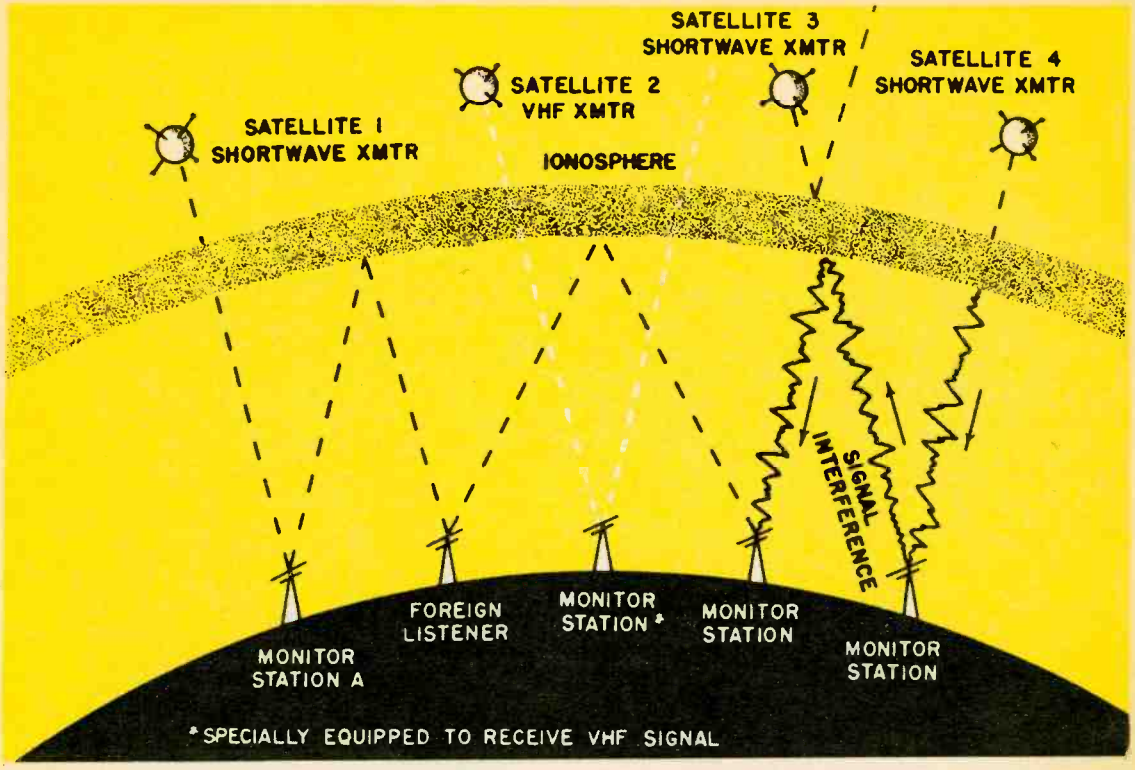
are we losing prestige in the

Race To Space

By C. M. Stanbury II

FOR practical purposes, the real bread-and-butter conquest of space probably won't begin for another 10 years or more. Yet the space programs in the United States and Russia are desperate and immediate efforts. Why?

If it were merely a matter of developing weapons, you can bet there wouldn't be half the publicity. The real and very vital issue is *prestige*. Democracy or communism—which system can take man the farther faster? Outer space certainly isn't the only test, but it is the most dramatic and clear-cut one. And right now



VHF is more reliable than short wave, but short wave reaches more listeners. SW signals from satellite 1 pass through ionosphere and skip between it and the earth many times. They are heard not only by monitor stations, but also by almost anyone with an SW receiver. One drawback: direction finder receiving a second or third "hop" signal will give false satellite position. VHF signals from satellite 2 travel reliably in line of sight to monitor, but reflected signals go right back into space. SW is subject to ionospheric disturbances while VHF transmissions are not. Signals from satellite 3 did not even penetrate ionosphere and those from satellite 4 are garbled.

the free world is losing the ball game—*and not because we lack technology!*

As we go to press, Russia has successfully launched three satellites and one space probe. The United States has countered with two space probes and six satellites. But hits don't necessarily win ball games and these figures aren't winning the space race. They convince the average American. So what? He was already sold!

Turning the coin over, it's a pretty safe bet that Russia has juggled the facts and convinced Ivan that his own country is white-washing Western competition. And there isn't very much we can do about this. What's at stake? Those nations and their peoples who are neither communist nor solidly in the western camp—the hundreds of millions in Africa, India and Southeast Asia, and those of our allies who lack confidence in Western achievement.

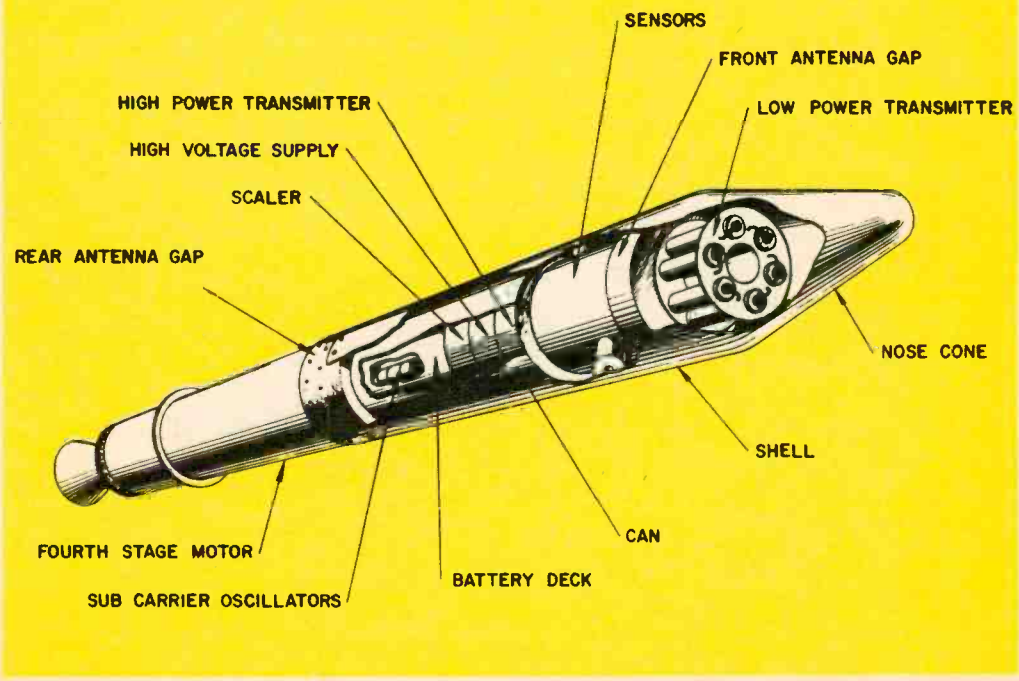
If these people in foreign lands could actually hear a satellite or lunar rocket —not a rebroadcast—they would have something fairly tangible to hang their belief and admiration upon. If they happen to be interested enough to request confirmation of the signals and receive an attractive QSL in return, then so much the better. This is exactly the kind of "tangible" proof the Russians are providing.

All Russian space vehicles have transmitted on short wave around 20 mc. All successful U. S. space vehicles have sent back tracking and telemetering signals via the higher frequency

[*Continued on page* 100]

Left, U.S. "talking" satellite is ready to be launched, but few heard VHF signal. Bottom of page, diagram of Explorer IV radio set-up.

Author monitors gear that picked up Sputnik I and Lunik. Hammerlund ham set feeds signal to GE aero receiver for further amplification.



In complete installation, rig is firmly mounted under the dashboard. Once channel, squelch and volume are adjusted, only mike button is used to switch from receive to send.

how to install

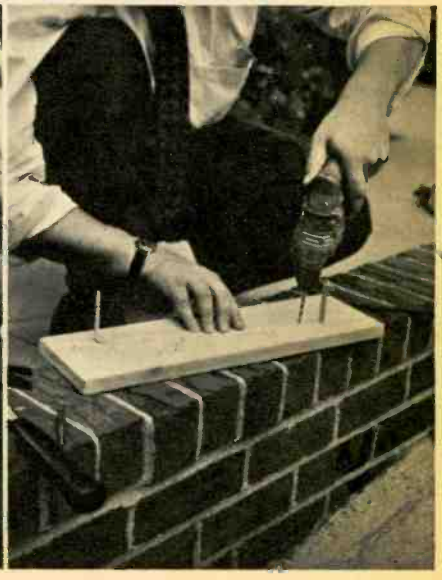
A 2-Way Radio in Your Car

Follow this simplified installation for a Citizens Radio. It permits easy removal when necessary.

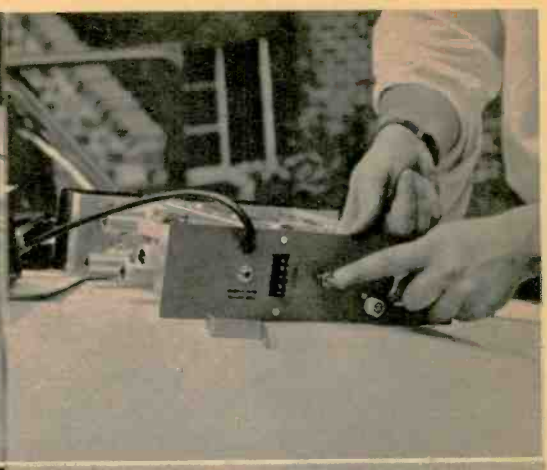
Carrying handle on front part of set will be used for mounting. Text describes substitutes.

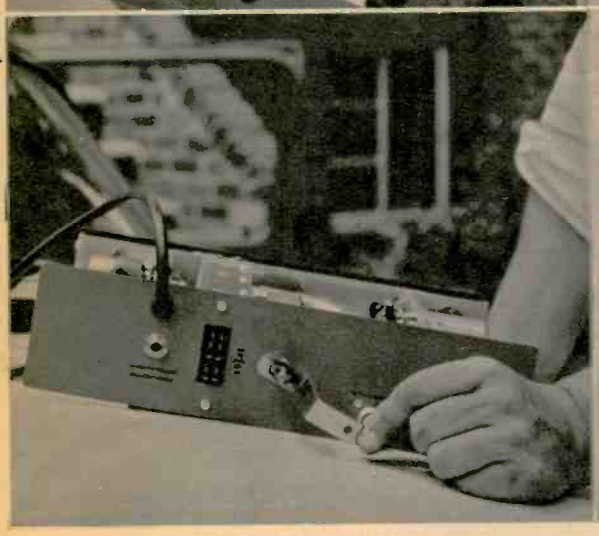
Using the set itself as a template, find a clear spot under center of dash or glove compartment.

Carrying handle (or other metal strip serving as a bracket) is drilled near both ends.



Photos by Mike Bonvino





At upper left, holes to match bracket are drilled in underlip of dash. Be careful not to drill into wiring behind dash.

Radio is removed from its case to permit fastening a long nut and bolt at rear. Carefully drill a hole if not provided.

Rear bracket is a metal strip bent into a Z-shape. Fingers hold end that mounts to firewall, wing nut holds other end.

DUE to variation in dashboard arrangement from one car to the next, each mobile radio creates its own installation problem. With this in mind, *EI* set out to find one method that would apply in the greatest amount of cases. In the system finally devised, several desirable features are included. Among them are the use of simple tools and techniques, accessibility of operating controls, and a minimum amount of interference to passenger's legs.

An important provision is to be able to remove the radio from its mounting quickly. This can be done in moments by simply loosening three screws. Most Citizens Radio sets are capable of both battery and house current operation, thus, easy removal takes advantage of this flexibility.

The unit illustrated in the photos is the Globe CB-100, a three-channel superhet receiver and five watt transmitter. The form factor of its case, low and wide, lends itself well to mobile installation. However, most Citizens Radio equipment is compact enough to permit a similar mounting arrangement.

Note how the carrying handle is used to secure the forward part of the radio to the dashboard. If your set has none, a good substitute is some sheet metal strapping which can be fastened to the 2-way rig. Another possibility is small right-angle brackets.

Several kinds of antennas are available, the simplest clip-on type is shown here. Greater range is possible with a longer (¼-wave) whip, but installation is somewhat more involved. To avoid cutting holes in the car's rear deck, it can be clamped onto the rear bumper.

Total installation time of the complete rig ran about three hours.

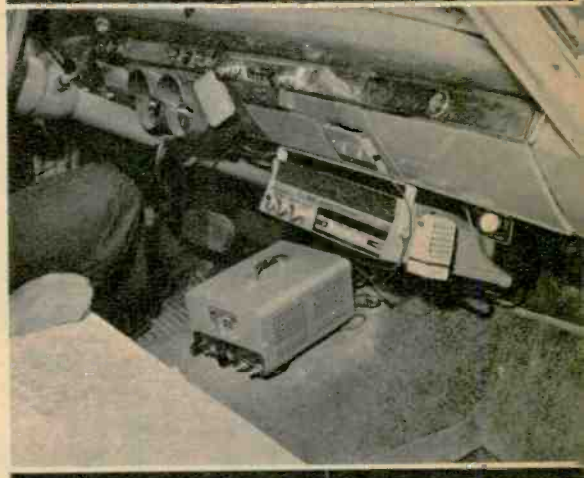
Installation of the system may be prolonged by tracking down sources of noise that interfere with reception. Sharp pulses of sound that vary with the speed of the car's engine are often reduced through use of resistor spark

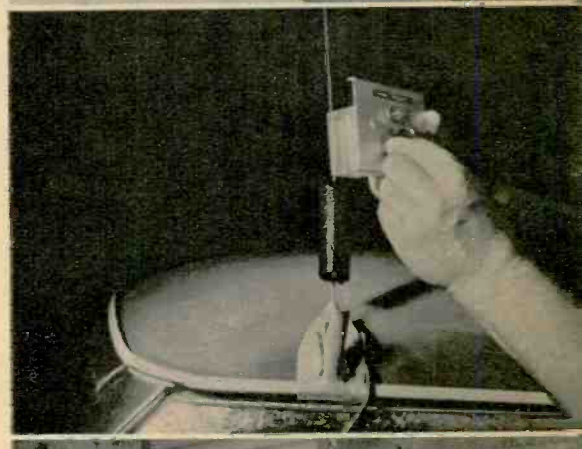
At lower left, rear bracket is attached to firewall with self-tapping screw after the correct-size hole is drilled.

At upper left, the front bracket screws are being tightened. Radio is secured to rear bracket by wing nut.

Clip-on type antenna is shown above. Pressure clamp at lower end engages the car's rain gutter.

plugs. A vibrating muffler or exhaust pipe may generate noise, too. This is remedied by bonding it to the chassis through a length of braided ground strap. The whine of the car's generator heard in the speaker can be minimized by capacitors designed for this purpose. Also, auto supply stores often carry powder that may be squirted into inner tubes to prevent static charges from forming.





Antenna is mounted and the coaxial cable fed through the window, then plugged into radio. This mounting method permits easy removal.

At top right, power is secured by plugging into cigar lighter. For permanent installations a hot terminal on ignition switch may be used.

The inverter (on floor) changes 6 volts DC to 117 VAC. It is needed for units that operate only on the newer 12 volt systems and 117 VAC.

Tune-up is important for best performance. A power indicator (wavemeter) is held near the antenna while the set's trimmers are adjusted.

Home installation. Range is limited with indoor whip shown, but may be increased with an antenna mounted outside on top of roof.

if it's Made In Japan is it good?

By J. R. Popkin-Clurman
President, Telechrome Mfg. Corp.

After three trips to the Far East, American expert gives his views on the boom in Japan electronics.

Author, with Japanese manufacturers, handles chopsticks like native.

Huge television set factory in Japan turns out 17" TV, mostly for Japanese local markets, but author believes country has a future in low-cost color TV.

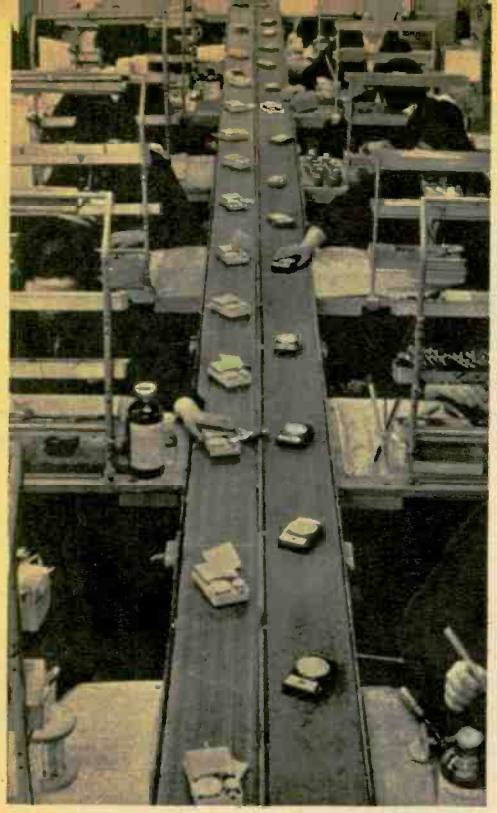
I HAVE made three extended tours of the Japanese electronics industry in the past two years. These visits have taught me to respect what is one of the most vigorous and rapidly growing electronics industries outside of the United States.

The hard-working Japanese, with their comparatively low labor costs, *could* make any electronic device as well as we can. But the big qualifying factor is the materials available in Japan. Frankly, some are not as good as American materials and as a result some Japanese components, although often satisfactory, are generally not as good as corresponding American parts. The difference is not noticeable in transistor radios, which are subject

While these girls at Sony transistor plant perform electronic quality control tests. . .

. . . other women, with their hands in special chambers, execute hermetic sealing process.

Typical of Japanese products that have been designed to capture the consumer market in transistorized radios is the first AM-FM portable. It contains 15 transistors and operates on flashlight batteries. List price is $150.



Pocket transistor radios are being mass produced on assembly lines. Low-cost labor and semi-automation help keep prices down.

Tiny Kowa tape recorder, shown beside 10-pack of cigarettes, runs at 3¾ ips and has 3 transistors. It will retail here for about $80.

Unit at right is medical electronics preamp. Most Japanese instruments, even those for local use in Japan, are labeled in English.

to rigid industry-wide inspection standards. Indeed, these Japanese-set standards certainly help to account for the transistor radio's great success in this country. The quality is there, alongside favorable prices.

However, in fine electronic instruments the highest quality materials must be used. Therefore, it did not come as too much of a surprise to me to see American-made test equipment, scopes, etc., in many Japanese plants and laboratories, even though they cost much more than locally made instruments.

The quality of American instruments and the enormous prestige of our own electronics industry have produced some curious practices in Japan. Nearly all Japanese instruments carry dial titles and indications in English, although few are exported—so far.

Many Americans scorn the Japanese as copy cats. Actually, there's good reason for copying. When you copy a successful radio or other appliance, there's not as much risk as there would be of a new design. Don't forget that nearly all American manufacturers "borrow" good ideas and circuit features from each other. They'd be fools not to.

I've discovered that the Japanese generally improve on the equipment whose basic circuits they copy. For instance, I saw some video tape recorders in Japan that beat the American originals in performance.

In addition, the Japanese have invented some original electronic devices that are almost unknown in America. One company, Taiko Electric, makes a burglar and fire alarm that connects to

[*Continued on page* 92]

General Davis, who designed and built fascinating and educational war game, gets set to launch an air attack on an enemy target. The meters indicate offense potential of each side.

Electronic War Game

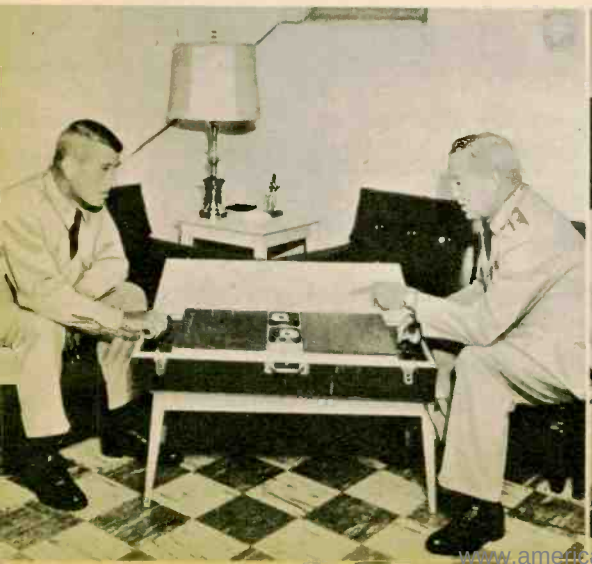
A two-star Air Force general designed this compact unit to bring home the dynamics of modern warfare.

HOW does air power and industry figure in the dynamics of modern warfare? How can they be used to lay the enemy low before he can do the same to you?

Major General L. I. Davis, USAF, attached to the Air Research and Development Command in Washington, turned to his extensive knowledge of electronics to come up with a unique, entertaining and educational game that dynamically brings home the touchy and complex situations of war waged from the air.

Each side of the game board is assumed to be an industrial nation with as much war-making [*Continued on page* 109]

The general takes on Col. William Clough in a "quick" war. Note game's "suitcase" housing.



M/Sgt. Dick Kidder gets peek at complex circuitry. Electronics is the general's hobby.

Only earphone lead emerges from small plastic case, there is no ground or antenna lead.

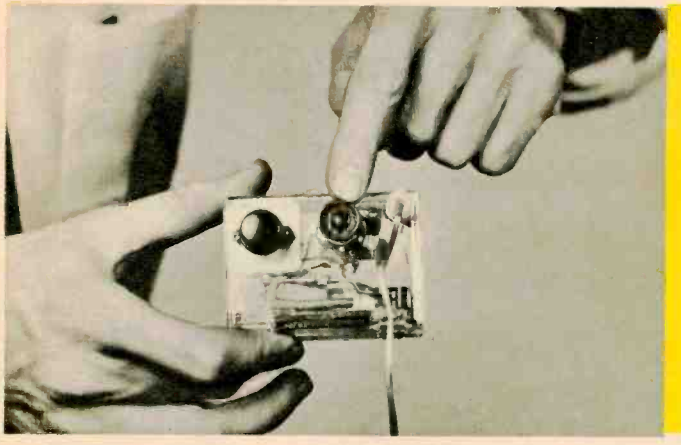
Photos by Mike Bonvino

no antenna needed with this

1-Transistor AM Radio

By Herb Cohen

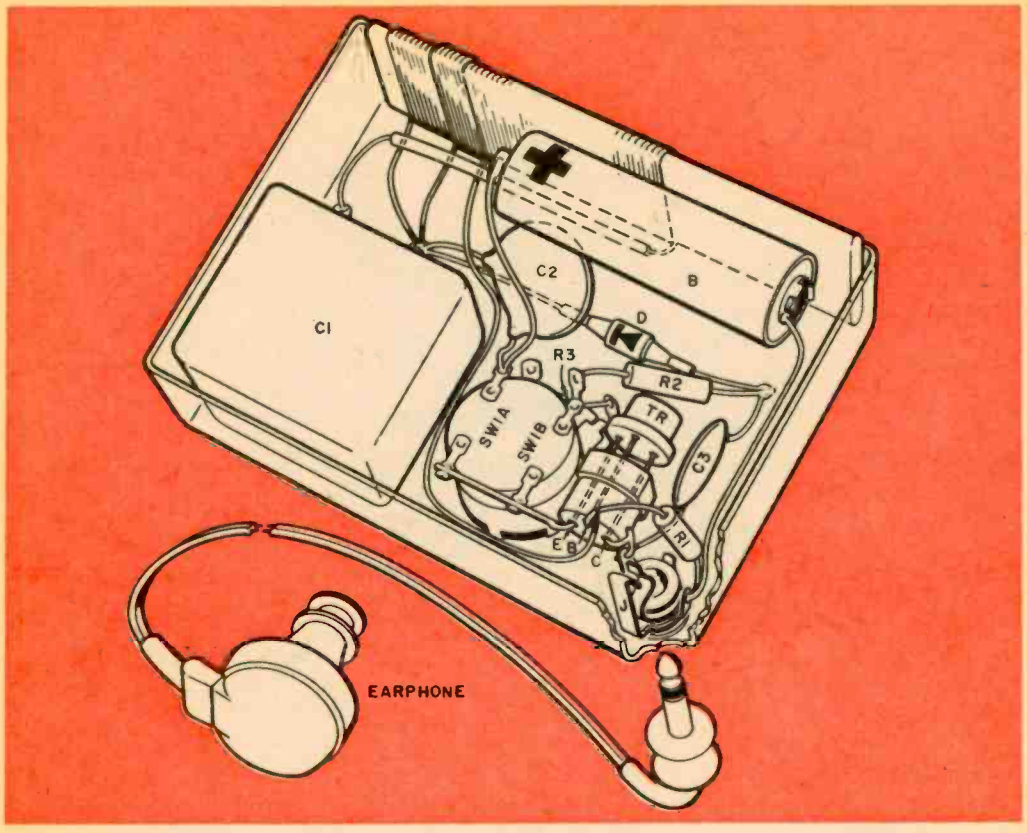
Build this sensitive reflex receiver. Its simple design requires the minimum amount of components.



Finger points to the sensitivity control. Stations are tuned in with the knob at left.

HERE is an AM radio that has literally been stripped down to bare essentials. Its performance nevertheless is surprising! The secret of its high sensitivity is the reflex-type circuit used. The transistor is made to amplify *both* radio and audio frequencies simultaneously. A diode (D) feeds detected audio back to the transistor for amplification.

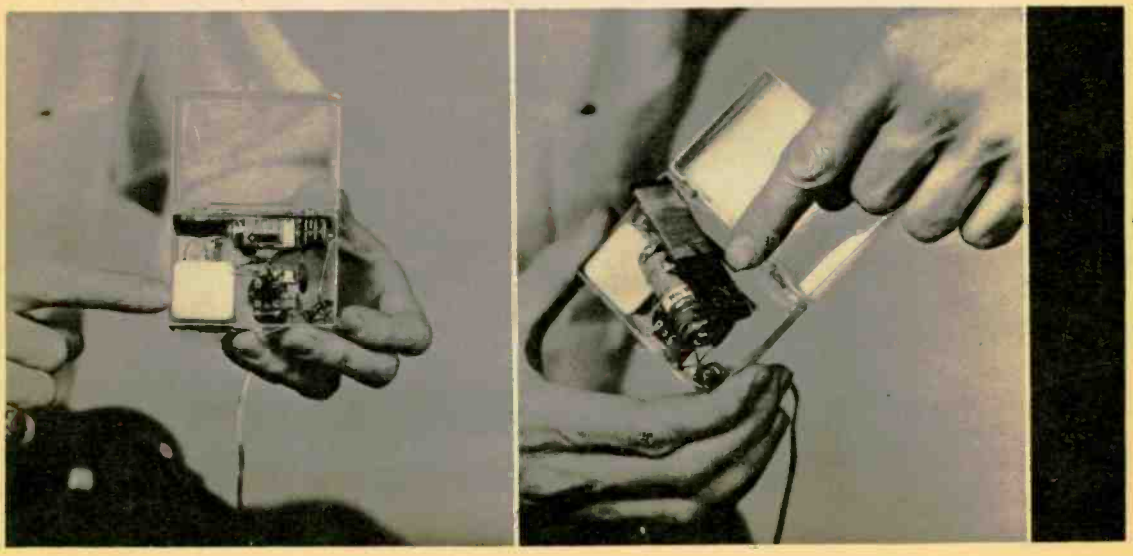
The entire radio is housed in a plastic case. Holes for mounting the earphone jack, variable capacitor and volume control are made by touching a hot soldering iron to the plastic for just a moment. Once a small hole is melted through, take a round file and gently file it to the correct size for each of the above parts.



During construction, observe battery polarity and transistor connections shown in wiring guide.

Tuning capacitor, pointed out, is supplied with its own plastic case for protection.

Before loopstick is glued in place, turns from one end are removed to adjust tuning range.



The antenna coil suggested in the parts list must be modified before mounting it permanently in the case. After the unit is wired, tune to the AM station occupying the highest frequency in your area (around 1500 to 1600 kc). Remove turns from the antenna coil until this station is heard when the tuning capacitor is almost at the end of its travel clockwise. The lowest station will then be received with the capacitor turned to the other end of its travel (maximum capacity). While adjusting the tuning range in this manner, remove just a turn or two at a time, then check the range.

If the ferrite core of the coil is too large for the case snap off the excess length with a cutters. It was found convenient to glue the antenna coil in place.

The battery is then glued to the antenna coil, and battery leads soldered on. This procedure makes the battery somewhat difficult to replace but current drain is very low and a battery change will not be frequent. This was considered worth the saving in space afforded by this method of mounting.

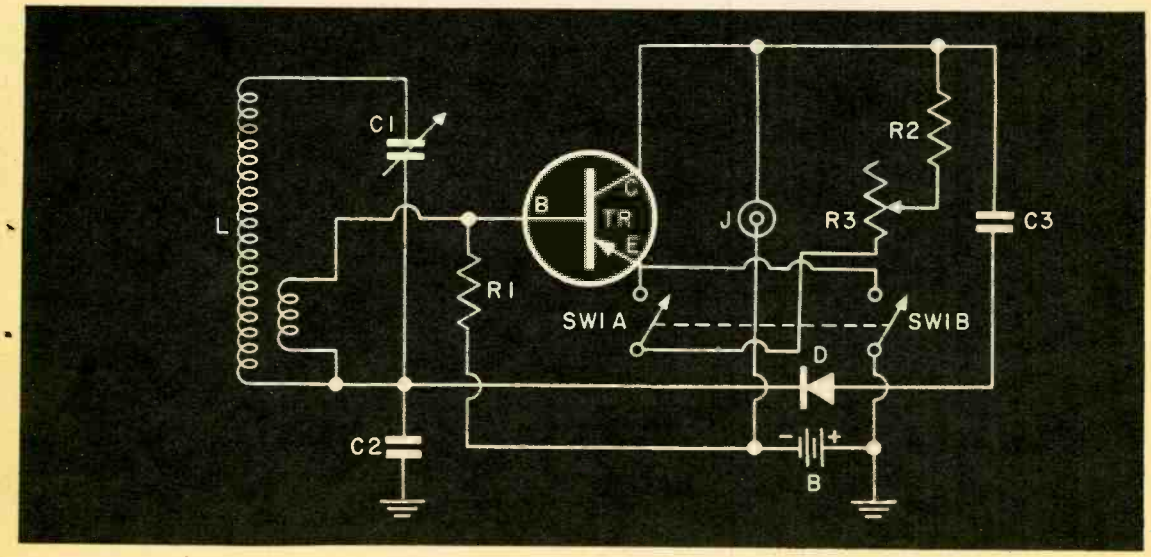
The completed radio should work if the values given are used, but maximum sensitivity is possible if the following procedure is followed. Substitute a 2 megohm potentiometer for the 180,000 ohm resistor, R1. A milliammeter is wired in series with the collector of the transistor. Adjust the potentiometer until the collector current reads approximately 1 milliampere. Have a station tuned in while doing this since the most sensitive point may be a little more or less than 1 milliampere. Measure the resistance of the potentiometer and solder in a fixed resistor of this value.

Just a word on the transistor. The author found that any transistor of the type between 2N604 to 2N608 may be used. However, the 2N608 recommended is the least expensive unit.

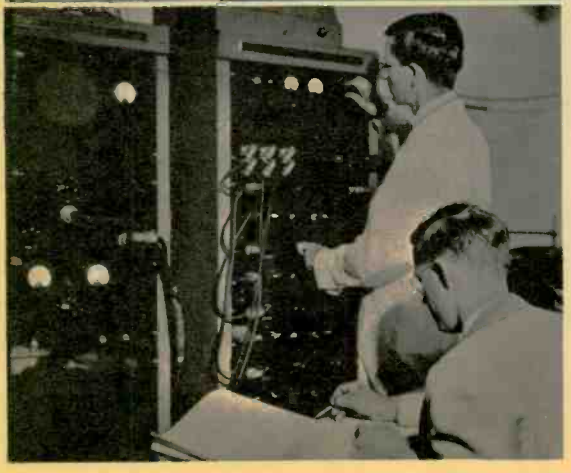
PARTS LIST

C1—Variable capacitor 365 mmfd (Lafayette MS-274)
C2—.01 mfd disc ceramic capacitor 25 volt or higher
C3—.005 mfd disc ceramic capacitor 25 volts or higher
R1—180,000 ohm ½ watt resistor
R2—2,700 ohm ½ watt resistor
R3—1000 ohm potentiometer with DPDT switch for SW1A,SW1B
L—Transistor antenna coil (Meissner 14-9005)
D—1N34 crystal diode
TR—2N608 transistor (General Transistor 2N608 available from Hudson Radio, 48 W 48th St., New York, N. Y. at $3.75)
J—Jack to match earphone
Earphone—3,000 ohm dynamic type
B—9 volt battery (RCA VS309)
Case—1"x2"x2⅞" plastic

In schematic, R3 is sensitivity control, adjusted for best reception of the station tuned in.



Twin beds are a must for couple, above. Wife tosses right out from under covers while her hubby sleeps like a log. Note electrode taped to sole of her foot and wires into panel above headboard.



Technician checks voltages before this couple retires for the night. Electrodes attached to skin do not interfere with subjects' movements, provide continuous record of various physiological factors.

Night after night, sleep data is gathered and recorded electronically at the sleep laboratories in New Jersey. From thousands of graphs, Sleep Research Foundation draws its conclusions about sleep.

Photos by Efield of Three Lions

new fields for electronics

Wired For Sleep

DID you know that your dreams, good or bad, do not interfere with your sleep? (Unless, of course, they are so bad that they frighten you awake.) That is one conclusion the Sleep Research Foundation has come up with in their electronic effort to learn what makes people sleep, how they sleep, and why they don't sleep (if they don't).

Volunteers get paid $8 a night to sleep five nights a week for six weeks at the U. S. Testing Company's labs in Hoboken, N. J. Before retiring for the night, each subject is helped into an electronic "harness" consisting of various devices to measure their nocturnal brain waves, skin temperature, pulse rate and blood pressure.

Electrodes on the head detect the minute electrical currents generated by the brain. These currents are transmitted to the complex electroencephalograph, a machine which amplifies and charts brain waves on graph paper. Unusually strong brain wave activity might indicate that the sleeper was in the middle of a bad dream, or had fallen asleep [*Continued on page* 109]

In the morning, volunteer sleepers are asked detailed questions about how they slept and what they dreamed. Their comments are then compared with electronic readings of their nocturnal blood pressure, pulse rate, etc. At right, the brain wave chart from the electroencephalograph is explained to the couple.

Cover Feature

Vertical tube is secondary of Tesla coil. Wire ring on top discharges high voltage and lights fluorescent bulb. Actually, bulb lights at several feet.

A Tesla Coil

By Harvey Pollack

Demonstrate high voltage principles with this unit; corona discharge, ionizing gas tubes and lightning.

FEW electrical phenomena are as startling as the hissing blue corona discharge from a Tesla coil. When bystanders see an unconnected fluorescent lamp held in your hand light up brightly, their astonishment knows no bounds. These, and other tricks such as a steel wool St. Elmo's fire and artificial lightning to a hand held screwdriver, make this high-efficiency Tesla coil a fascinating and educational project.

Invented by Nikola Tesla about 1886, the device that bears his name is really a transformer operating under rather special circumstances. Instead of using 60 cycle alternating current, the primary winding is supplied high-frequency AC (in this model about 300,000 cycles per second). The primary has relatively few

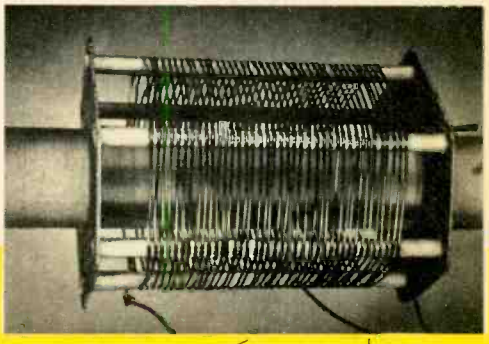
turns of heavy wire. Coaxial with the primary is a secondary coil containing many, many turns of fine wire. Thus, to start with, the arrangement constitutes a step-up transformer with a large secondary-to-primary turns ratio. But this in itself cannot produce the startling effects mentioned earlier. For proper operation the secondary coil must be so constructed that it will resonate with its own distributed capacitance and the stray capacitance of the circuit at the primary frequency. When this happens, the voltages developed across the secondary winding become truly phenomenal.

Among the features that make this Tesla coil construction unique are: (1) a sliding primary coil makes up for winding errors by tuning the system to resonance without the need for a secondary capacitor. When correctly positioned, the primary induces enough voltage in the secondary to produce *four-inch corona sparks.* (2) once a Tesla coil is built, there is always a transportation and storage problem due to the long secondary coil. In this model, both the secondary and primary coils are demountable; the secondary is actually a plug-in coil, while the primary leads are connected to the oscillator circuit via color-coded banana plugs and jacks. So—take it apart in seconds to transport it to the place it is to be demonstrated, or to store it on an ordinary, shallow shelf.

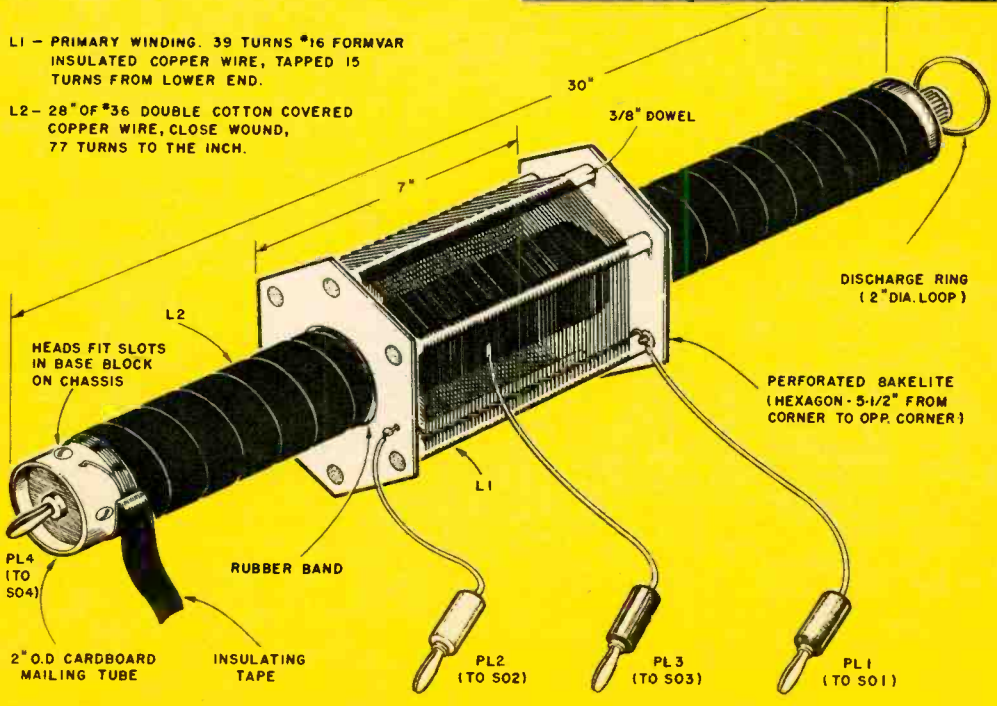
The first step in construction is preparing the secondary coil.

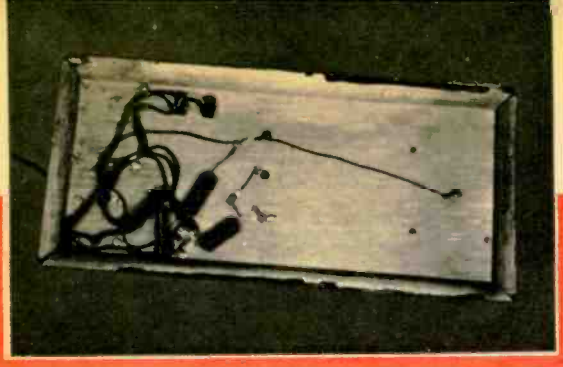
A cardboard mailing tube 2 inches in

"Squirrel cage" primary is made of dowel sticks and hexagons at each end. It is able to slide on secondary for tuning purposes.

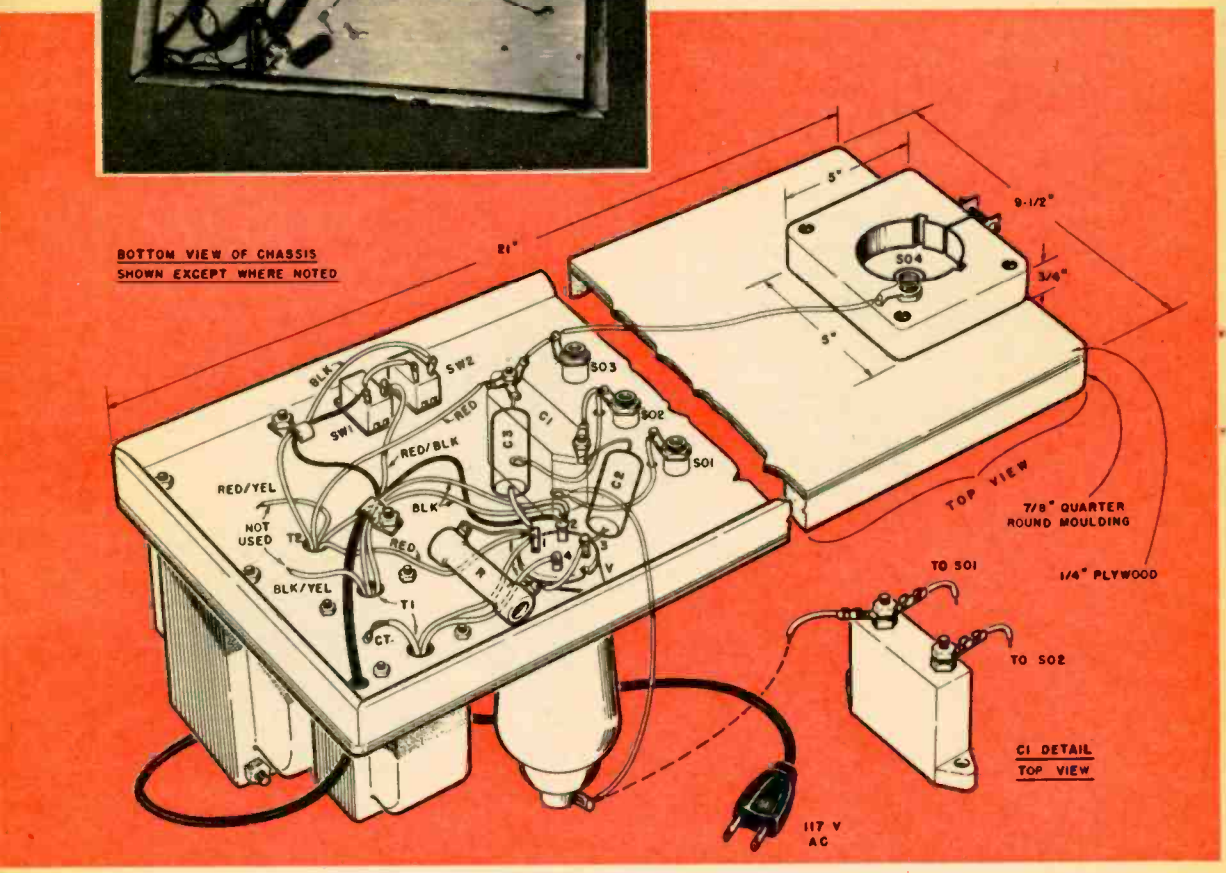


Construction details for primary and secondary coils. Rubber band on long secondary, just below cage, holds primary in place.





Underside view of wood chassis reveals simple layout. Tape exposed or unused leads.



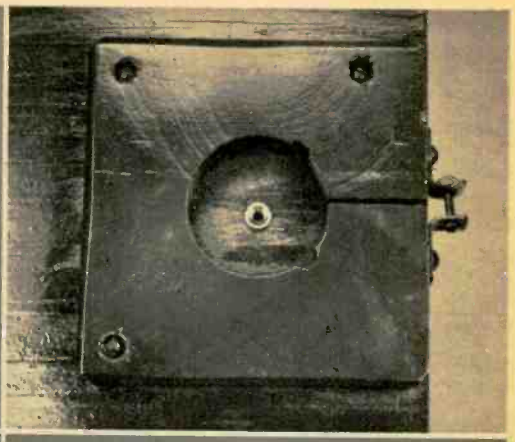
Left half of wiring guide shows underside of chassis. Right half is a top view with detail of SO4. Note that C1 has been moved down for clarity.

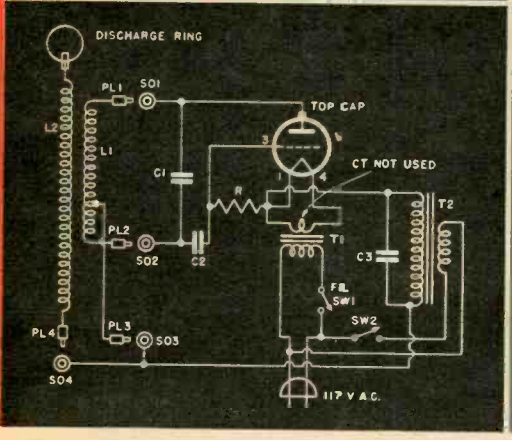
outside diameter and 30 inches long is suitable as a secondary coil form. (Bakelite tubing was used in the model because of its greater rigidity, but cardboard is just as good.) Prepare the mailing tube by giving it at least two coats of spar varnish, letting it dry 24 hours between coats. Obtain a 2 lb. roll of #36 double-cotton covered copper wire and, starting 1 inch from either end, start the secondary coil of close-wound turns. #36 d.c.c. wire gives you 77 turns per inch and you have 28 inches to wind all told making a total of 2156 turns (a little over 1100 feet or 1/5 of a mile of wire). There's no need to count the turns; merely close-wind the full 28 inch stretch. Unless you use a lathe for the purpose, you had better count on several sittings to complete the winding. Keep a heavy rubber band handy to hold the final turns in place at the end of each sitting.

When the winding is complete, apply several coats of shellac or varnish to hold the turns firmly seated on the coil form. Cut two plugs of ½ or ¾ inch stock to fit in the ends of the coil form; drill each plug in its exact center, one hole to take a standard banana plug and the other for a top binding post. Pass the ends of the secondary winding through two fine holes at each extreme and solder the ends to the banana plug

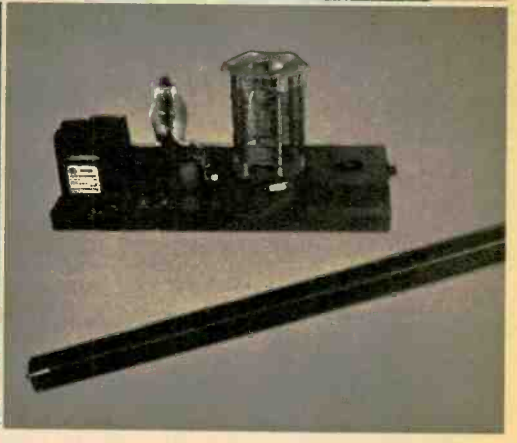
Bottom of secondary has banana plug that inserts into socket visible in photo at right.

Retaining block for secondary, SO4 at center. Slot and clamp at right adjust for tension.





Schematic. Circuit is a simple oscillator, feedback occurs from plate to grid through L1.



The completed Tesla coil is easily stored or transported by unplugging the secondary coil.

and binding post, respectively. The secondary coil is now finished.

The primary coil can be started between varnish coats on the secondary. Cut 6 pieces of ⅜ inch wood dowels, each piece 7 inches long. Using a broad saw blade or the edge of a file, cut 40 shallow notches in each dowel along its length. Start the first notch 1 inch from one end, space the notches ⅛ inch apart so that 40 notches will occupy 5 inches all told.

Next, cut two hexagons of either 3 ply, ¼ inch pine or fir, (5½ inches from corner to opposite corner) or using ordinary tin shears, cut the hexagons from

[*Continued on page* 102]

PARTS LIST

C1—.0015 mfd 3,000 volt capacitor (Solar type XS)
C2—.0005 mfd 10,000 volts paper tubular capacitor
C3—.005 mfd 6,000 volt paper capacitor
R—2,500 ohm 10 watt wirewound resistor
V—811A tube with 4-pin socket and plate cap
T1—Filament transformer, primary 6.3 volts at 4 amps, center tap not used (Stancor P-4019)
T2—Plate transformer, 117 volt primary, 750-0-750 at 265 ma, center tap not used (Stancor PC-8304)
SW1,SW2—SPST toggle switches
L1,L2—See text
PL1-3,SO1-3—Insulated banana plugs and sockets in three different colors
PL4,SO4—Uninsulated banana plug and socket for secondary connection
Misc.—AC line cord and plug, wood base of 3 ply wood ¼" thick 21"x9½", wood strips or molding for chassis apron, 5"x5"x¾" wood block for secondary retainer, two small steel brackets for retainer clamping screw, forty-five inches of ⅜" wood dowel, one mailing or Bakelite tube 30" long by 2" diameter, two hexagons of wood or perforated Bakelite for primary cage, one binding post for top of secondary coil.

Signal Generators

what they are, what they do—

By Norman Eisenberg

THE old saying "Whatever goes up must come down," applied to electronic equipment translates something like "Whatever goes in must come out." In other words, equipment is designed to produce given results (output) for a given signal (input). Sometimes the output isn't what it should be, and that situation usually involves the use of test instruments. But just as important are special instruments that control the input to the equipment. These are usually called signal generators.

What a signal generator does, basically, is to feed "pure and simple" signals (unmodulated) as well as "complex and impure" signals (modulated), to a TV or radio set, or other electronic component. These test signals, in effect, tell the set to put-up-

RF GENERATORS: The general purpose radio-frequency generator is the most common input device, feeding controlled signals to receivers, etc.

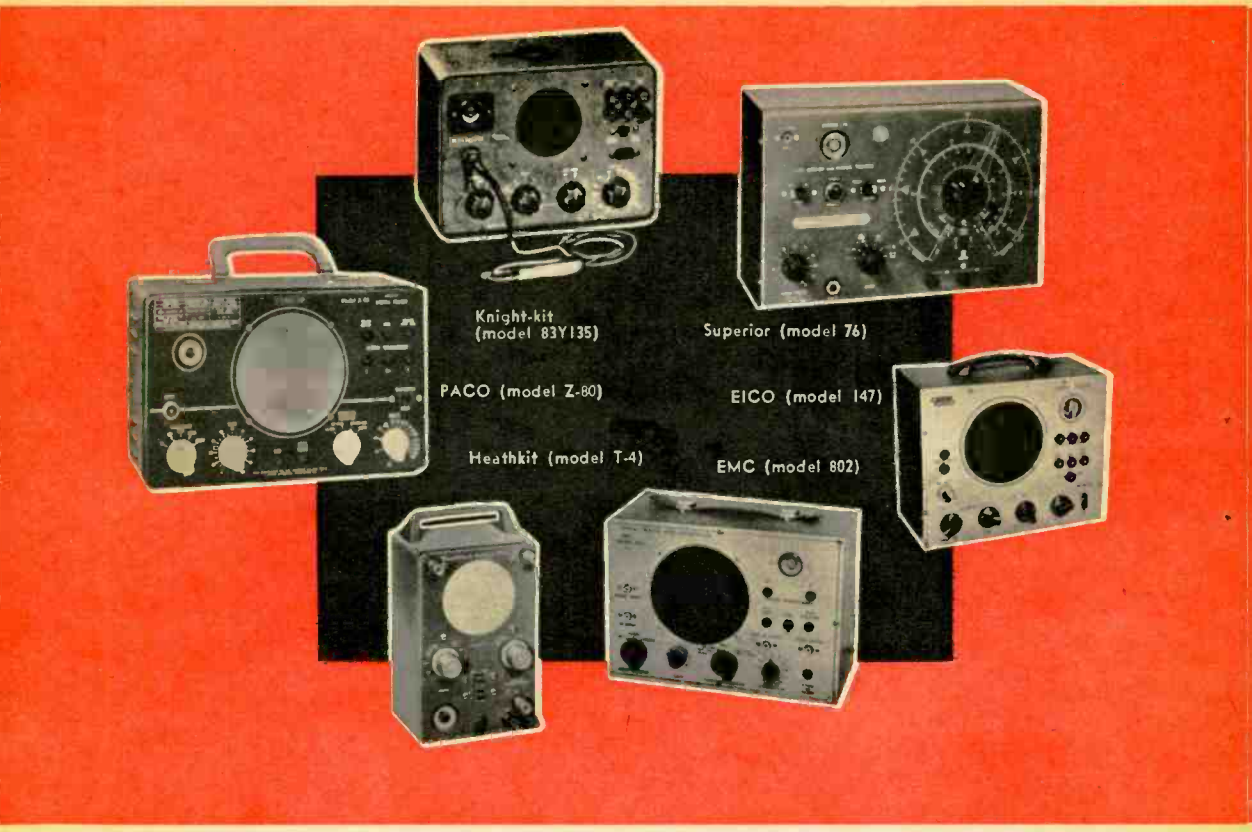
AUDIO GENERATORS: This category includes units that cover entire range of audio frequencies, and those that generate sine- and square-waveforms.

or-shut-up. Since test signals are deliberately predetermined and mathematically planned, you know exactly what (and how much) goes in, and you can better judge what comes out.

The "general purpose" RF signal generator is perhaps the most common input device. It produces a radio-frequency signal that can be varied in amplitude and frequency. The generated signals range from the lowest RF likely to be used in radios, transmitters, etc., and extend to the megacycle region. Some stop below 100 mc; others hit 400 mc.

The kind of signal produced by the RF signal generator may be varied to suit the requirements of the equipment tested. It can produce a pure carrier wave or an audio-modulated signal. The RF can be varied as needed and fed to the receiver. By reading the output results on a meter or oscilloscope, you can determine the receiver's ability to do its job.

There are several good reasons why a regular broadcast signal is unsuited for the job of testing a receiver. For one thing, a broadcast signal of the needed frequency may not be available. Further, the noise level in a signal is hard to assess unless the signal has been generated with equipment of known capability. Finally, the modulation characteristics and strength of a broad-



SIGNAL TRACERS: With one of these handy instruments you can probe around inside a circuit, checking the output at any stage along the way.

cast signal are uncontrollable by the tester at the receiving end and consequently are not the most reliable guide to the important qualities of selectivity, sensitivity, and detection ability.

In alignment work, the signal generator is indispensable. Alignment of a superheterodyne receiver, for example, involves adjusting each of several tuned stages to provide a given band-pass for specific intermediate frequencies (IF). If the IF itself is outside the normal broadcast band there is no way to get that frequency except with a signal generator. What's more, as alignment progresses, the set becomes increasingly sensitive. This means that the test signal must be reduced progressively in amplitude to avoid overloading succeeding stages and the condition known as "false alignment."

The main difference between "general purpose" signal generators is in the number of frequencies they provide. Signal generators in kit form can cost as little as $20. Knight-kit 83Y145 and Heathkit SG-8, both sell for under $20 and furnish five pre-tuned signals generally useful in aligning AM broadcast receivers. EICO also makes an RF signal generator kit (No. 324) for $26.95 that has six fundamental ranges up to 145 mc. Lafayette distributes a 6-range wired unit for $22.50. Prices for more advanced units with wider frequency ranges vary depending on the over-all coverage as well as the degree of precision and stability. As in other types of electronic gear, such factors as shielding, accuracy of dials, convenience of use, quality of components, and so on are all reflected in the price-tag.

The "middle-priced" ($34-$60) type of signal generator is characterized by

HOW TO BUY A SIGNAL GENERATOR

DO YOU NEED AN AUDIO OR RADIO FREQUENCY GENERATOR?

Audio Frequency For

- Hi-fi amplifiers and preamplifiers
- Public address systems
- Audio section of radio and TV sets

Radio Frequency For

- AM, FM, TV sets
- Communications receivers
- R/C equipment

WHAT FREQUENCY RANGES REQUIRED?

Audio

- 20-100 kc sine waves.
- Square waves (useful for frequency response measured with an oscilloscope).

RF

- Approx. 100 kc to over 100 mc for AM, FM, communications sets—to 216 mc for TV sets.

TYPES OF MODULATION ON RF GENERATORS

- Should have 400 cycle tone modulation for aligning AM sets.
- Should have provision for external modulation (useful for frequency response tests; must be applied in conjunction with an audio generator).
- Frequency modulation (sweep) is essential for FM and TV alignment. There are special TV-FM sweep generator units.

ACCURACY

- Calibrating crystals correct dial error.
- Marker crystals are needed for FM, TV alignment.
- Low backlash on dial drive lessens calibration error.

PRICE

- Higher cost units usually have higher accuracy and broader frequency coverage; for service shop or lab work.
- Low-cost equipment useful to hobbyists, students, and kit-builders.

several frequency bands, with modulation provisions, pre-tuned coils, and a controllable output on the order of 100,000 microvolts.

Somewhat different from the RF signal generator is the audio generator, which produces a fairly pure signal and feeds it to the unit being tested. Any distortion introduced by the tested equipment will then show up on a VTVM. The VTVM can be helpful in estimating the gain from stage to stage; it also can indicate an amplifier's sensitivity, its uniformity of gain, and its linearity of frequency response. A scope would also reveal spurious oscillations and other malfunction symptoms.

A special type of audio generator is the square-wave generator. A "square-wave" contains a fundamental frequency together with a number of odd-order harmonics. The presence of these harmonics changes the sine-wave shape, "filling it out" so that it has very steep (vertical) sides and a squared-off top and bottom. To pass a square-wave test, an amplifier must have a response that is 20 times below and above the fundamental frequency. Thus, if a square wave whose fundamental frequency was 1,000 cycles is fed to an amplifier, and the amplifier is passing that square-wave, then it is known at once that the amplifier has a response from 50 to 20,000 cycles.

While the square-wave generator has undeniable value in providing a quick picture of an amplifier's response, it does not provide the means for specific analysis. It should never be purchased without an accompanying sine-wave generator, which is slower, but more thorough. Indeed, most manufacturers incorporate both generators in a single unit. In kit form they sell for about $60; somewhat higher for wired models.

An instrument that isn't quite an "indicating" or an "input" device, but use-

[*Continued on page* 93]

E I assembles

A Citizen's Radio Kit

For car, boat or home use, here is the inexpensive Heath CB-1 kit. Assembly is fast; results are good.

Identifying decals, supplied with kit, are afixed in spaces to right of speaker grill.

The kit includes a nut starter at lower right. Package at left contains most small parts.

THE Heath Company's CB-1 is among the first of the Citizen's Band radios to appear on the market in kit form. Designed for use on the exam-free Class D band, it provides moderate range communication for home, mobile or marine use.

The transmitter, according to FCC regulation, is under five watts input power and its frequency crystal-controlled. The receiver is tunable over the 23 channels assigned to this band. Good receiver sensitivity is achieved through use of a superregenerative circuit.

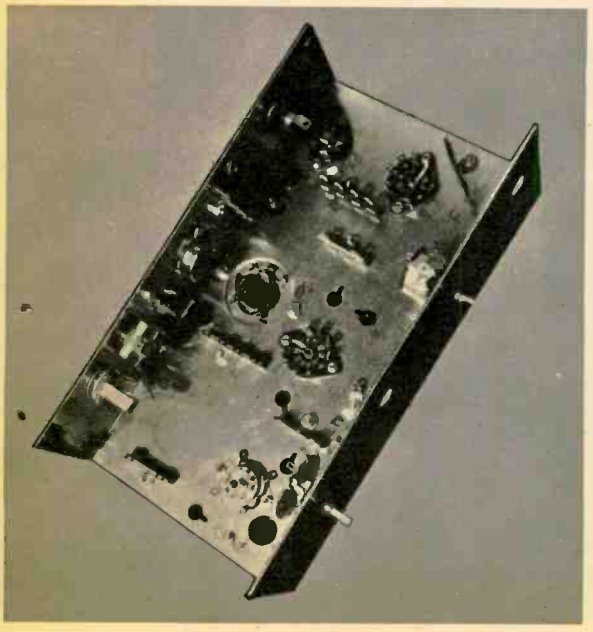
Construction of the kit demands care on the part of the builder. The routing of wires, especially to the various coils, must follow the instruction manual closely. Otherwise, small losses will accumulate and reduce the rig's efficiency.

Take care, too, while soldering wires to terminal lugs. Several lugs support up to three and four wires which are crimped on, then soldered. It has been the author's experience to discover that one lead, in what appears to be a perfect solder joint, is actually loose. An effective remedy is to shine a bright light on the joint and jiggle each wire to discover if solder has flowed down properly. Check this if your completed model is wired correctly but operates intermittently.

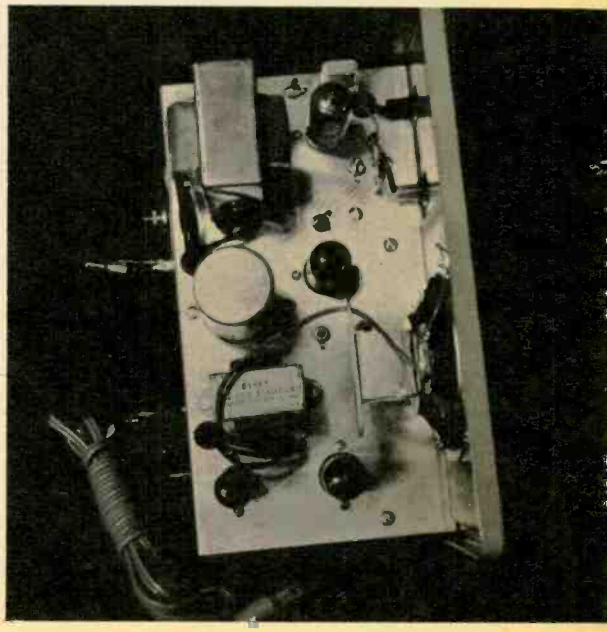
Thick wire leads on large resistors tend to be brittle. They can break off if bent at sharp right angles to the body of the resistor. Allow an eighth-inch before bending. This applies to other parts with heavy leads made of solid wire.

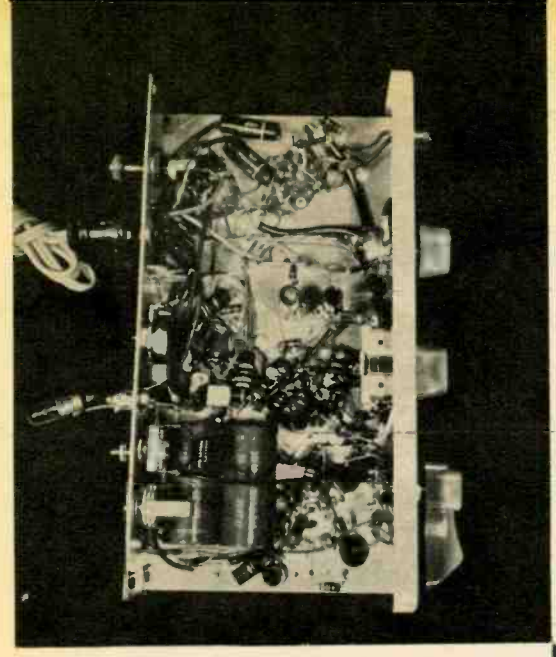
Following thirteen hours of construction time, the set was tuned up. A dummy load consisting of pilot lamp and plug is inserted into the antenna jack and viewed for maximum brilliance on the bulb while adjustments are made. A radiating antenna

Underside of chassis prior to wiring. Part numbers are pencilled in for easy location.

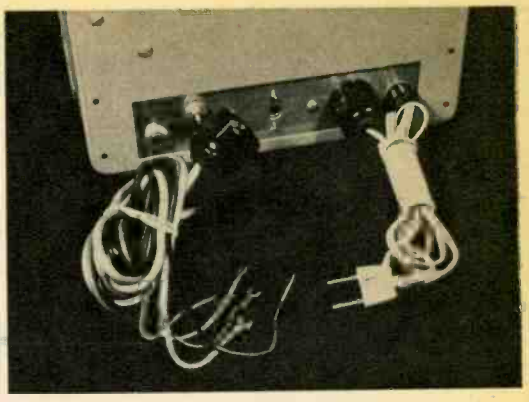


Topside view of chassis with the front panel attached. Power transformer is at upper edge.



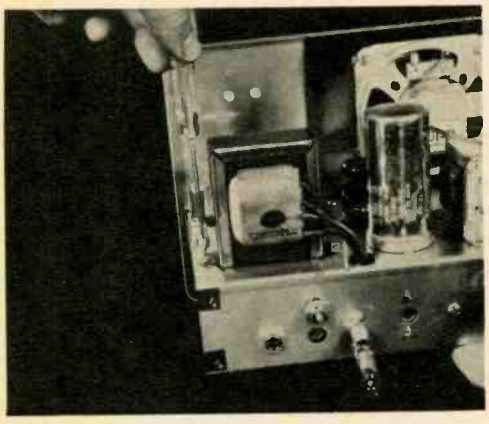


Underchassis view of completed model. Wiring must follow physical layout detailed in manual.



117 volt AC cord is plugged in at right. Other cord is wired for 6 or 12VDC, but must be used with vibrator power supply.

Above, power of the transmitter is measured. Milliammeter clips to jack at rear of unit.



Left, dummy load in lower right of photo is observed for glow as oscillator coil is tuned.

must not be connected until the station license is secured. The necessary forms are included with the kit.

Antennas must be purchased separately and are available for mobile or fixed-station use. The dummy load serves only to indicate if the transmitter is operating properly. When the antenna is used in its place, the tuning will change. The use of some type of external indicator for antenna tune-up is strongly advised. A simple power indicator is described in the June, 1959 issue of *EI* for use by authorized persons.

The unit was tested in an extremely difficult area covering a radius of one mile. Though signals were obstructed most of the time, communication was solid at a half-mile, becoming spotty at one mile. The range of one to ten miles claimed by Heath should easily be possible under reasonably clear-path conditions.

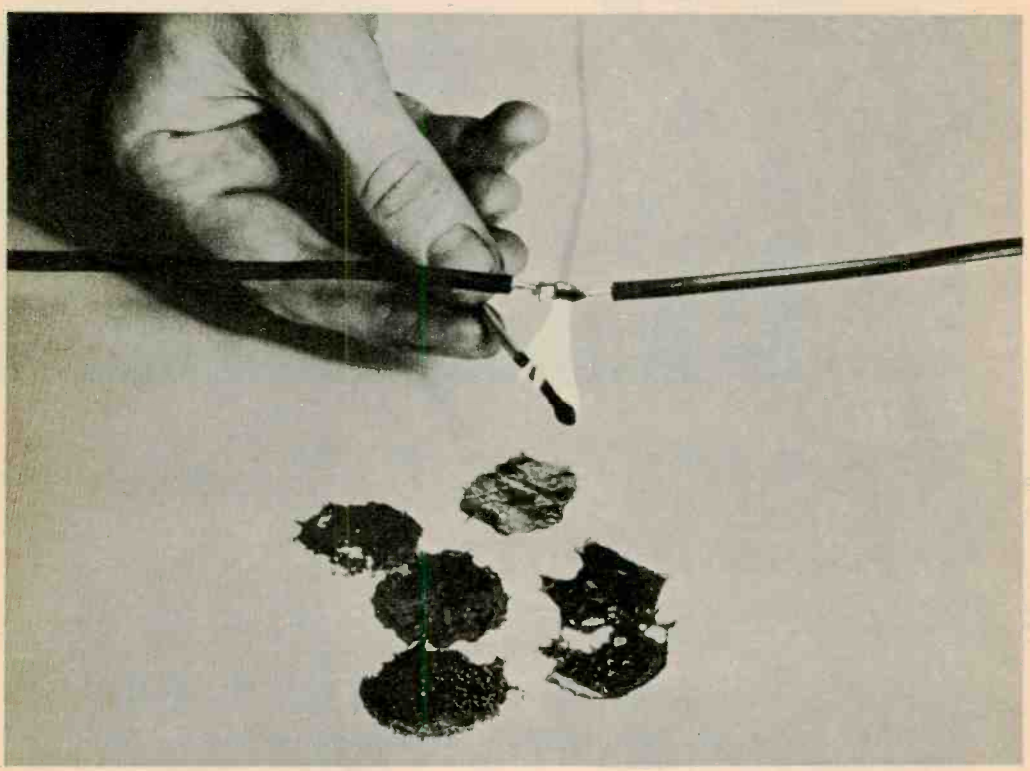
At $42.95, *EI* rates the Heathkit CB-1 a Good Buy.

Watch for a report on Citizen's Band antennas to appear in the next issue of *EI*. It explains how to choose one of the basic types; ¼-wave, base loaded, beam, or ground plane.

Try These

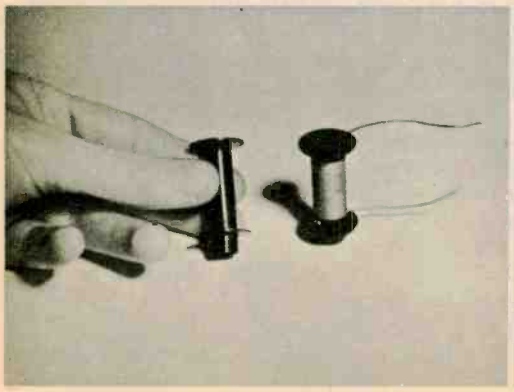
Save Those Drops Of Solder

Ever shake a soldering iron and have excess solder splatter on the floor? Save the drops for soldering wires where there's no power. Wrap around, melt with a match.



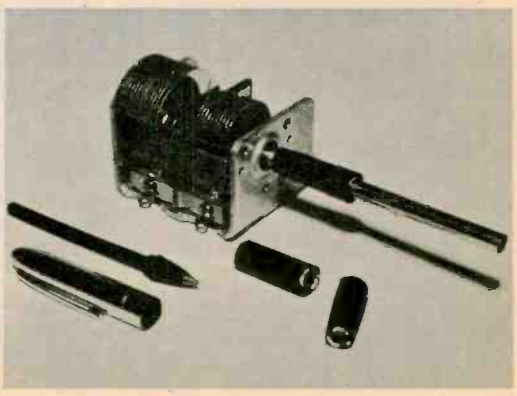
Coil Forms

Save spools used for 35mm film. They serve as excellent low-loss coil forms.



Plastic Couplers

Several shaft couplings may be cut from the plastic barrel of a ballpoint pen.



Along the unit's front panel are clock timer and AC switches. Below, author flips switch to power the desired piece of hi-fi equipment.

Timer for Your Hi-Fi System

By Donald Schroeder

Record programs while away from home! This unit also provides central AC outlets for all equipment.

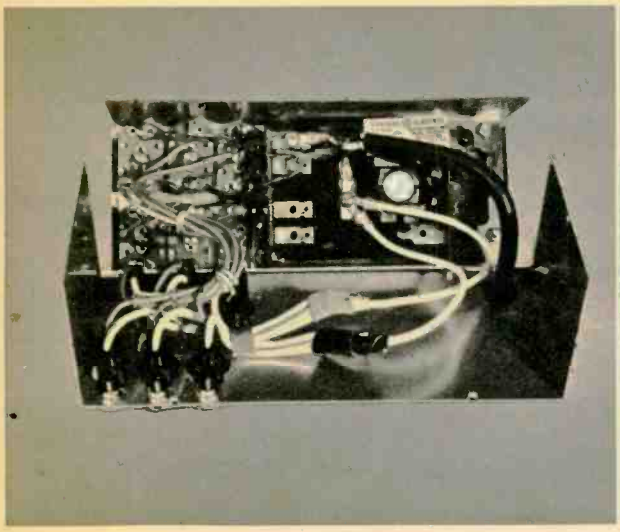
IF YOUR high fidelity system includes more than an amplifier and turntable you probably have a maze of cables and scattered power switches. While most amplifiers on the market today come equipped with an auxiliary power outlet on the back panel, this is not adequate for an assortment of tuners, turntable and tape recorder. The unit described here greatly relieves the power problem. It requires only one plug at the wall outlet. It combines all power control on one convenient panel.

The main advantage of this system is that it offers clock control for recording "off-the-air" when you are not at home to catch that favorite radio program, as well as the alarm clock possibility from your choice of program source.

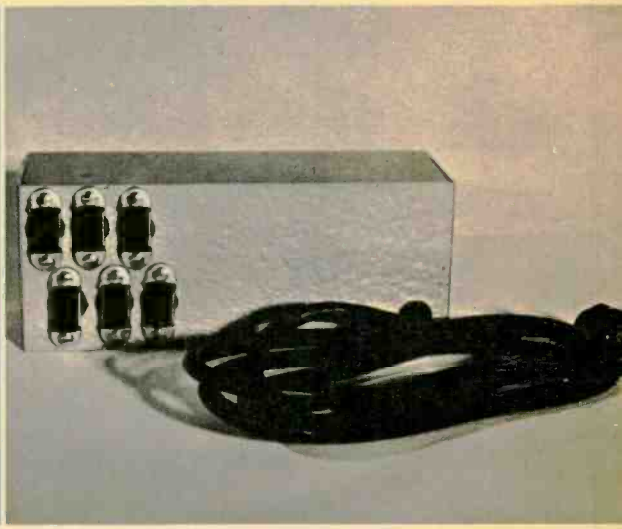
The unit can easily be assembled for less than ten dollars. None of the parts is critical and the layout could be changed to suit the individual builder. Some of the layout was dictated by component size, the clock causing some problems on the back panel.

There are many good clock timers on the market but care should be exercised in buying one that offers a selection in the

Interior view shows careful layout. Rear of switches is at upper left, clock is at upper right, receptacles on panel at lower left.



Six AC receptacles at the rear are positioned to match their switches on the front panel. Heavy power cord is used to supply AC power.



turn-off time. (See unit in Parts List).

Since most of these clocks are designed for timing dinner on a stove, it is the turn-off time that is set and the turn-on time is subtracted from this, depending upon how long the program "cooks." The switches shown are single pole double throw toggles to allow direct switching to the line or through the clock.

All holes can be drilled and reamed except those for the clock face and the outlets. The large hole for the clock was drilled with many small holes around the circumference, the insert broken out, and a smooth edge filed. The rectangular holes at the back were cut with a socket punch and filed until the receptacles fit. A simpler alternative here would be use of the type receptacle sold in dime stores that mounts on the surface.

Wire leads should be left long enough to permit opening the box if necessary. They can easily be looped out of the way for closing. While care should always be taken with line wiring, there is little danger of shorting because one side of the line runs directly to the receptacles and all other wiring is done with the same side of the line. If connections are too close to the metal box, strips of black plastic insulating tape can be run in the box in the possible short areas.

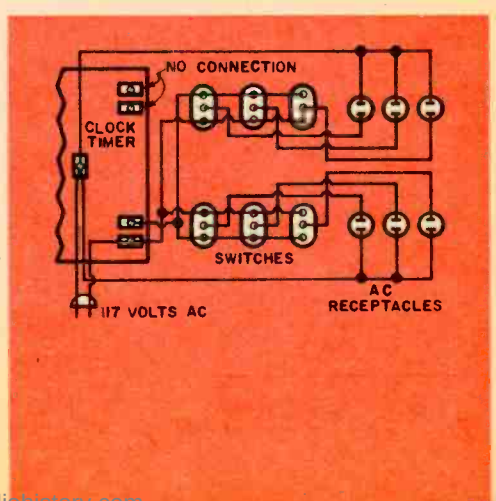
The whole unit can be dressed up considerably with white decals. Both the Audio and the Numeral sets were used.

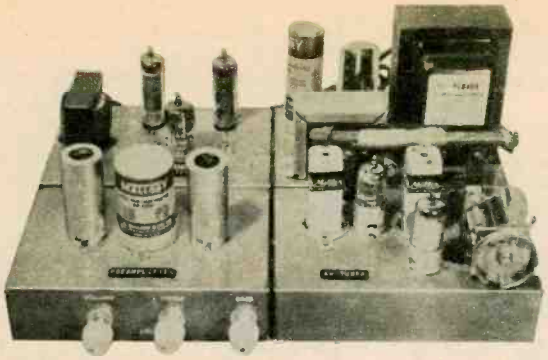
[*Continued on page* 109]

PARTS LIST

- 6 Single pole double throw toggle switches
- 6 Chassis mount AC receptacles
- 1 Clock timer, GE Telechron (Burstein Applebee 37A418)
- 1 Aluminum case 6¼"x3½"x2⅛" (LMB #138)

Wire the parts according to this diagram.





Complete project plugs together. Two rear units are amplifier at left, and power supply. In front is preamp, left, and AM tuner on the right.

the E I

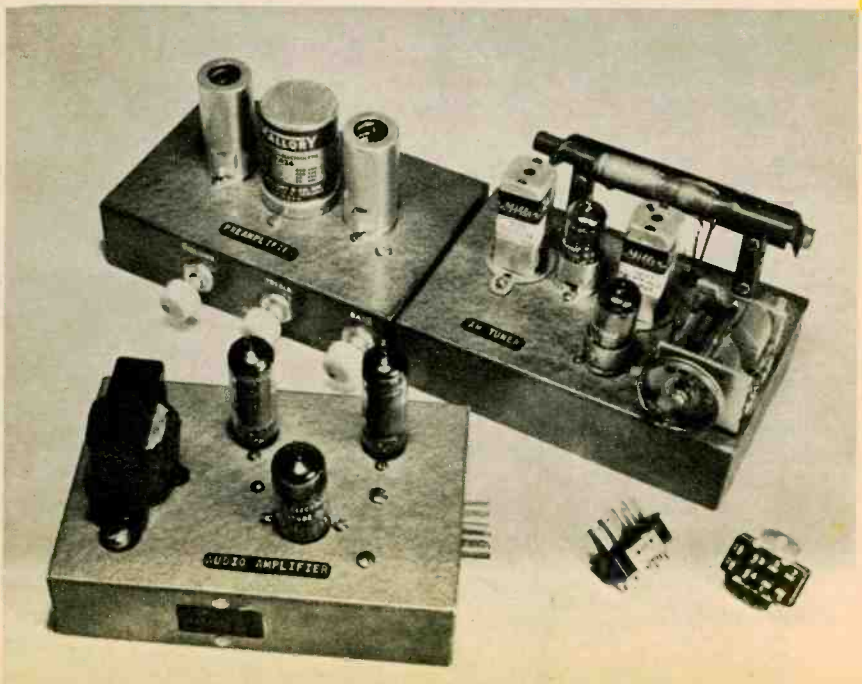
Build-it Course-2

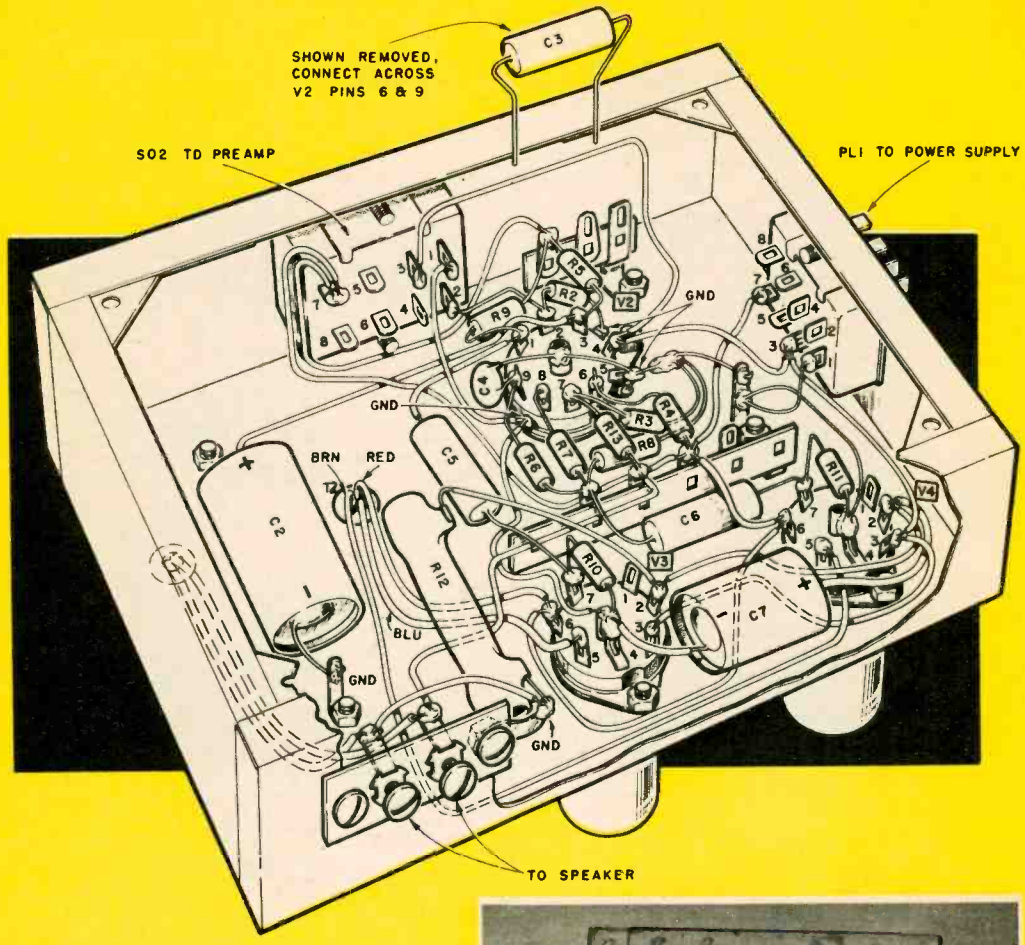
The second plug-in unit described in this theory and practice series is a basic audio amplifier.

COMBINING theory with practice, this series continues with a basic audio amplifier. Plug it into the power supply described last month and you'll have a general purpose unit useful for a variety of applications. It will amplify signals from a tuner or preamplifier, both to be discussed in future articles.

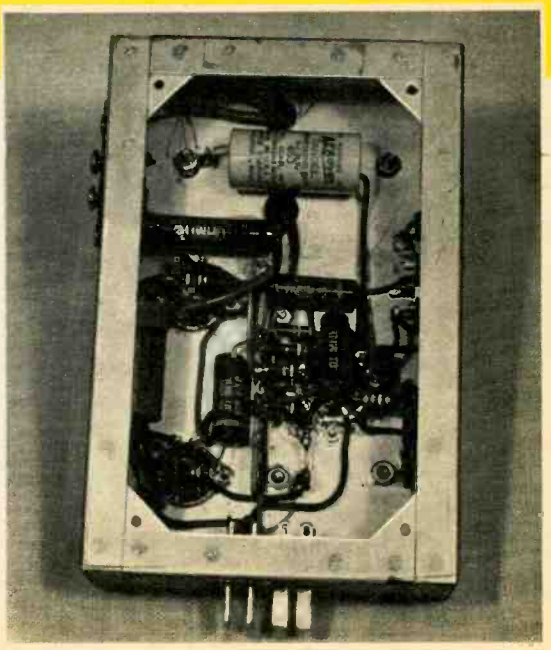
The design of the amplifier is conventional. It utilizes a voltage

The audio amplifier is unplugged from two of the other units (power supply not shown). To the right are Cinch-Jones plugs, used in all of the projects.





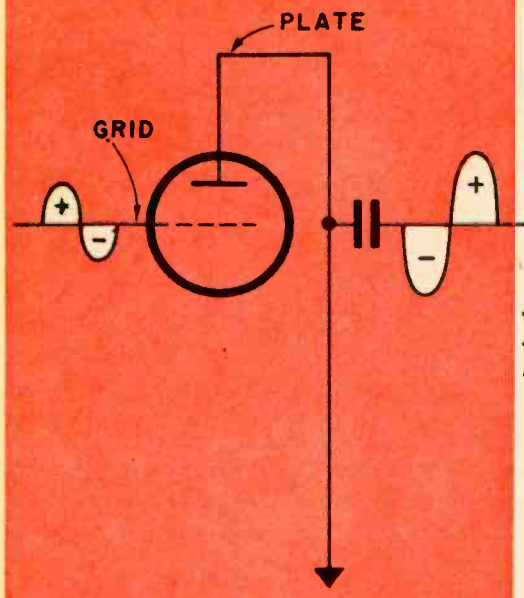
Wiring guide for building amplifier. Note C3 at top, shown removed from chassis. Use lockwashers under ground lugs.



Underside view of completed amplifier. Plug at bottom is PL1, connects to power supply to pick up operating voltages.

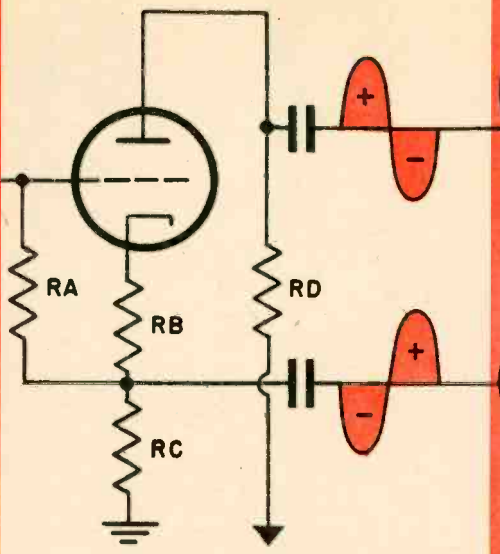
HOW THE AMPLIFIER WORKS

VOLTAGE AMPLIFIER



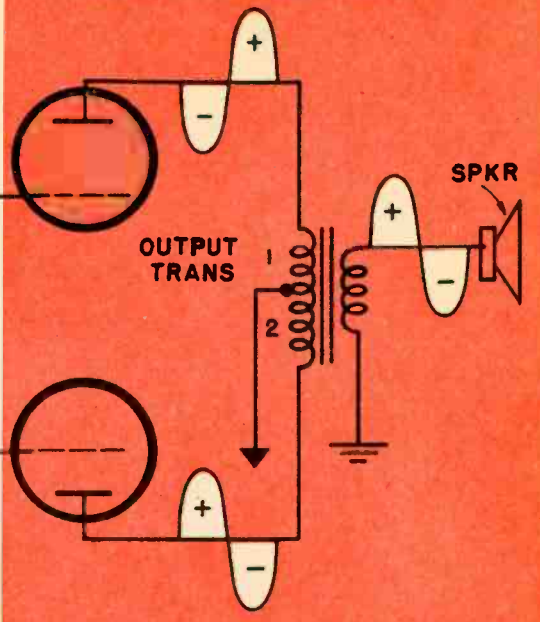
First stage of the amplifier receives the input signal from the source, usually a tuner or preamplifier. The positive and negative alternations are impressed on the grid and control the stream of electrons to the plate where amplification takes place. In the actual circuit this voltage amplifier is the pentode section of the 6U8 tube (V2A). Note that the wave form in the plate circuit is an identical reproduction of the input wave form, varying in just one respect—amplitude. If any irregularity appeared in the plate circuit the result would be distortion. An amplifier of this type is operating in a linear manner, one of the important requirements for hi-fi.

PHASE INVERTER



The phase inverter is the second half of the 6U8 tube, the triode section. Its job is to split the signal before it is fed to the push-pull output stage. This is accomplished by putting half the tube load in the cathode circuit (RC) and the other half in the plate circuit (RD). Equal currents flow through RC and RD but are opposite in phase where the two coupling capacitors are connected. Phase reversal occurs in a tube as its grid goes more negative, for example, causing less plate current to flow. The voltage across the plate load will then increase in a positive direction. RA is grid resistor, RB for bias.

PUSH - PULL OUTPUT



Note how the signal is fed to the grids of the push-pull tubes. As the upper grid goes negative, the lower is driven positive. The amplified currents flow in sections 1 and 2 of the primary of the output transformer and return through the center-tap connection. The two current flows are equal and opposite in polarity causing the top of the transformer to become positive and the lower end to become negative. The net effect is that they add in the secondary winding to produce an output power double that of one tube. As mentioned in the text, hum and even-order harmonics are canceled out due to their unbalanced currents and thus do not appear in the output.

amplifier, phase inverter and push-pull output stage to drive a speaker. The quality of sound is surprisingly good considering its simple, low-cost components. No attempt was made to attain rigid hi-fi standards. A "utility" amplifier of this type, however, is capable of pleasing reproduction of voice or music.

Prime purpose of the amplifier is to receive about one volt of signal at its input and produce large amounts of current for operation of the speaker. Output power is in the vicinity of six watts.

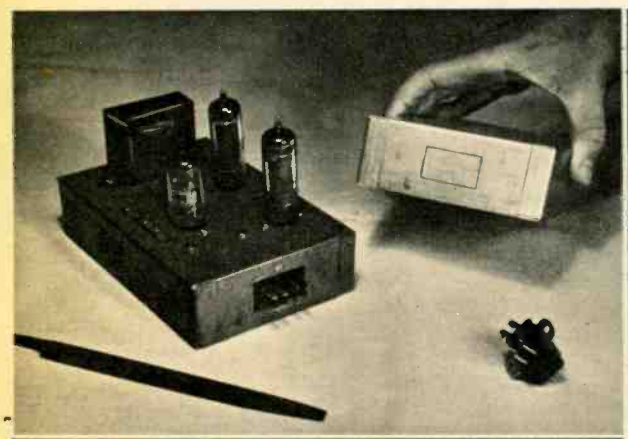
Several aspects of the design reduce distortion which interferes with the amplifier's ability to faithfully reproduce signals fed into it. A foremost consideration here is class of amplifier service. From the four major categories, A, AB, B and C, class A is selected. The others increasingly sacrifice fidelity for efficiency. In relatively low power devices we are not too concerned with inefficiency since the cost of power is not a factor and fidelity is important.

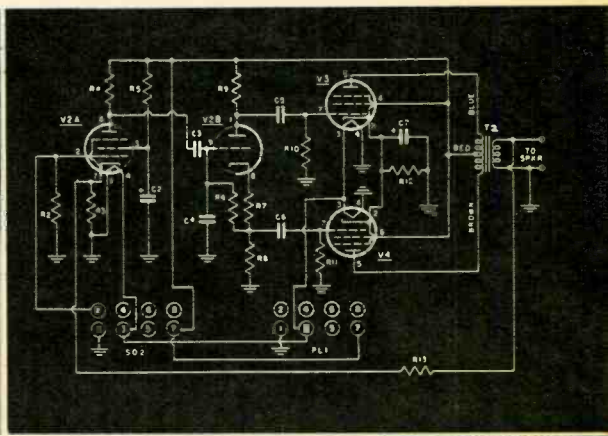
In class A operation, current in the tube's plate circuit flows during all voltage variations on the control grid. This has been graphically explained in *EI*'s recent series titled *"ABC's of Electronics."* Ideally, the only change in

[*Continued on page* 106]

PARTS LIST

(Part numbers continue from last month's power supply project)
R2,R6,R10,R11—470,000 ohm (all resistors ½ watt unless otherwise noted)
R3—470 ohm resistor
R4—100,000 ohm resistor
R5—330,000 ohm resistor
R7—390 ohm resistor
R8,R9—10,000 ohm 1 watt resistor 5 percent tolerance
R12—250 ohm 10 watt resistor
R13—4,700 ohm resistor
C2—4 mfd electrolytic capacitor 450 volts
C3,C5,C6—.01 mfd paper capacitor 400 volts
C4—500 mmfd disc ceramic capacitor 400 volts
C7—20 mfd electrolytic capacitor 50 volts
V2—6U8 tube
V3,V4—6AQ5 tube
T2—Audio output transformer 10,000 ohm center-tapped to 3.2 ohm voice coil (Triad S-15X or equiv.)
PL1—8-pin chassis mount plug (Cinch-Jones P308AB)
SO2—8-pin chassis mount socket (Cinch-Jones S308AB)
Chassis—4"x6"x1½" aluminum (Premier ACH-436)
Misc.—3-lug terminal strip (1 lug grounded), 4-lug terminal strip, 9-pin tube socket with four ground lugs and center post, two 7-pin tube sockets with center post, 2-lug speaker terminal strip, rubber grommets





Hole for socket or plug is made by drilling a series of holes on pencilled outline of part.

Pin numbers on SO2 and PL1, bottom of schematic, correspond to numbering on parts.

A 3.2 ohm speaker connects to output of the amplifier appearing at rear terminal strip.

Wide-angle lens captures a street of the "Old West" as cast and production crew get set to shoot a scene. At far right is well-equipped sound truck.

on location with "Cheyenne"

How Audio Rides with Your TV Western Hero

THOSE TV westerns take a heap o' recording and a heap o' audio knowhow. While the big heroes, such as "Cheyenne's" Clint Walker, tangle with badmen up and down mountains, get into occasional fist fights, gun fights, etc., some 20-odd technicians are doing the same thing off camera. Rough country and loud gunshots don't necessarily mix with sensitive mikes and delicate electronic gear—not to mention trying to keep a man on horseback within range of the microphone.

Electronics Illustrated recently went out on location with star Clint Walker of the popular western, "Cheyenne." The episode, to be seen on ABC television this Fall, is called "Reprieve." Walker masquerades as an outlaw, joins a rough-tough gang at their mountain hideout and makes a bold attempt to discourage a young fellow from following in his bad-dad's footsteps.

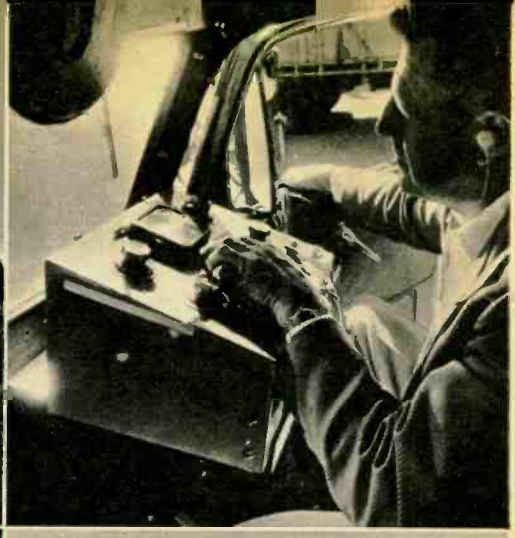
Sound simple? In order to film this show Warner Brothers

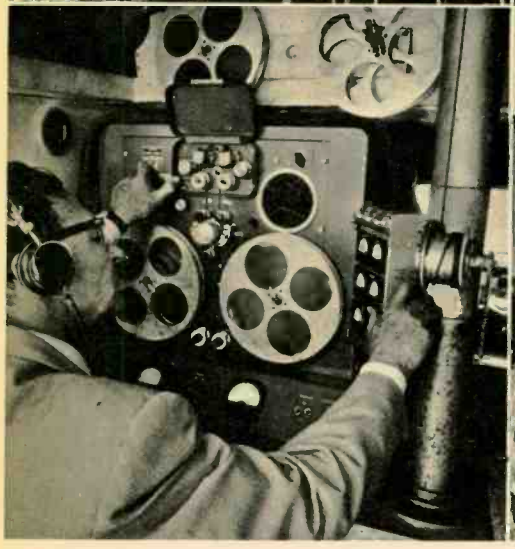
Photos by
John R. Hamilton—GLOBE

Ready to roll, hero has gun drawn and scowl on his face. Note mike cable coming out of left pants leg of other gunslinger.

Star Clint Walker adjusts lavaliere mike to be tucked under shirt. Voice goes in here and. . .

. . . comes out here. RCA dynamic mikes are adjusted so as not to distort loud gunshots.





Top left: Mike is set against sky. Preamps at base of boom help offset noise pickup in lines.

Top right: Out of the sun, engineer monitors sound with mixer case, VU meter before him.

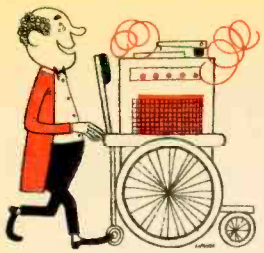
Lower left: Inside truck, 1000′ of magnetic recording film is run through recording case.

After hard day's ride, hero tosses gun to aide. Crewmen, meanwhile, stow gear, coil cables.

had to call on one of eight four-wheel-drive sound trucks. These trucks, built from surplus weapons carriers, contain all the instruments necessary to record as much as 6,000 feet of film (magnetic recording film, *not* tape) each day. And the cast and crew work six days a week.

Aside from a mile of cable, power generators, microphones, preamps and mixers, there is the 17½ mm magnetic film sound recorder, a device worth some $8,000 all by itself. It records at 45′ per minute, half the camera speed. Yet this is fully satisfactory from an audio standpoint, and it saves magnetic film.

The two major portable units in the sound truck are the mixer case and the recording case. Together they contain all the basic operational components of the sound system, except the batteries, microphones and microphone amplifiers. The mixer case has three "mic" inputs, a monitor amplifier, an auxiliary monitor output, a telephone subset, VU metering circuits, and an "A" and "B" voltmeter. The recorder case is fitted with equalizers, bias oscillator, monitoring circuits, "B" dynamotor, filters.



Hi-Fi Clinic

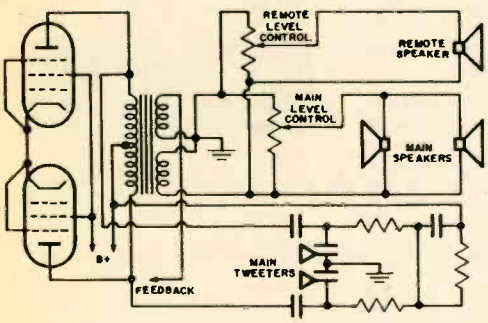
Send in your questions on hi-fi, the clinic answers each one by mail. If of general interest, they will appear in this column.

Remote Speaker Controls

My phonograph uses a pair of electrostatic speakers and two cone woofers. To this I've added a remote loudspeaker and equipped it and the main woofers with level controls as shown in the diagram.

I wanted to keep the hi-fi set in the living room at low volume while listening to the remote speaker but find that the main system simply becomes thin and lacking in bass when I turn down its control. Even with both level controls turned all the way up, I still get some loss of bass from the main system. Why does this happen?

Howard S. Caton, Jr., Dixon, Ill.



Because of the location of the tweeters *ahead* of the amplifier's output connections, their level will not be affected by controls inserted between the amplifier's output and the cone speakers. Thus, controlling the cone speakers will reduce their volume but leave the tweeters operating at full volume resulting in loss of bass. The slight loss of bass when the controls are full up results from insertion loss, due to the control's minimum resistance.

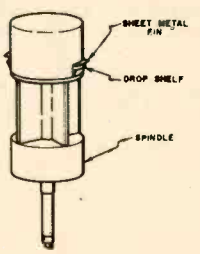
One answer is the use of an extremely efficient speaker system at the remote location and to equip this speaker only with a level control, eliminating the control from the main speakers. Then, with the remote speaker control set full up, its volume would be considerably higher than that of the main system. By turning down the remote speaker's control, you could equalize their volumes or shut off the remote speaker.

If you wish to shut off the main speakers these would have to be equipped with a switch to disconnect them and their tweeters simultaneously.

Non-Changing Changer

My Garrard RC-88/4 normally works fine, but occasionally slows down and stops during the change cycle. Also, when I put a full stack of 45 rpm records onto the special spindle, it often fails to drop the next record properly. Any suggestions?

Harold Hayden, Agana, Guam



Slowing or stalling during the change cycle may usually be corrected by cleaning the rubber idler tire and pulley and drum surfaces it contacts with gasoline. Check, too, for binding in lever arms and cams under the motor board.

Failure of 45 rpm discs to drop may be caused by a bent sheet metal arresting fin. It should lie horizontally, and the distance between it and the drop shelf beneath it should be very slightly less than the thickest part of a 45 rpm disc (the label area). If either fin appears displaced, *gently* bend it into position. (See diagram.)

1. Making the paper mix for the speaker cones. This mix consists of water, wool fiber and pulp in carefully controlled proportions and is beaten to desired consistency in special mill. 2. The wire-screen form on which the mix for the cone will be deposited is inserted onto a frame below the cylinders in a tank.

6. The wet cones, still on the wire-screen forms, are placed in a thermostatically controlled drier for a slow curing process.

How a Loudspeaker is Made

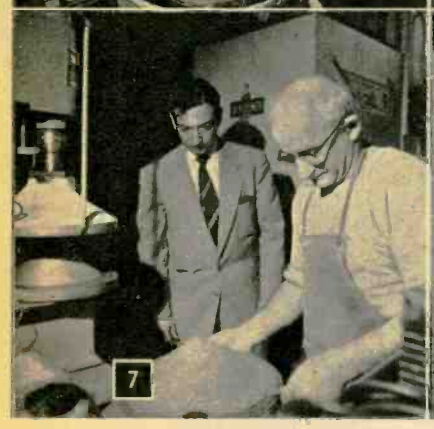
From making the paper to placing in an enclosure, *EI* takes you on a tour of a hi-fi speaker plant.

BOZAK is a high fidelity loudspeaker that stands for uncompromised high standards; it is also the name of the engineer who designed and produces it and is so attentive to every detail in its manufacture that his little plant in small-town Norwalk, Connecticut makes more of the parts that go into a loudspeaker than most other producers. With this thought in mind, *EI's* camera visited the Bozak plant to record for its readers the steps in the making of a quality speaker. We were shown how the wool and pulp composition which constitutes the cone is made and poured into the mold—the exact composition and varying thickness of the cone is specially designed to prevent breakup and resonances within the audible range and give best music reproduction. The speaker we followed along the production line was the 12″ woofer which was later combined with twin 3″ cone tweeters to make a full range system.

3. The mix is poured into unequally spaced cylinders onto cone form.

4. Cylinders are raised and cone on its form is removed from the tank.

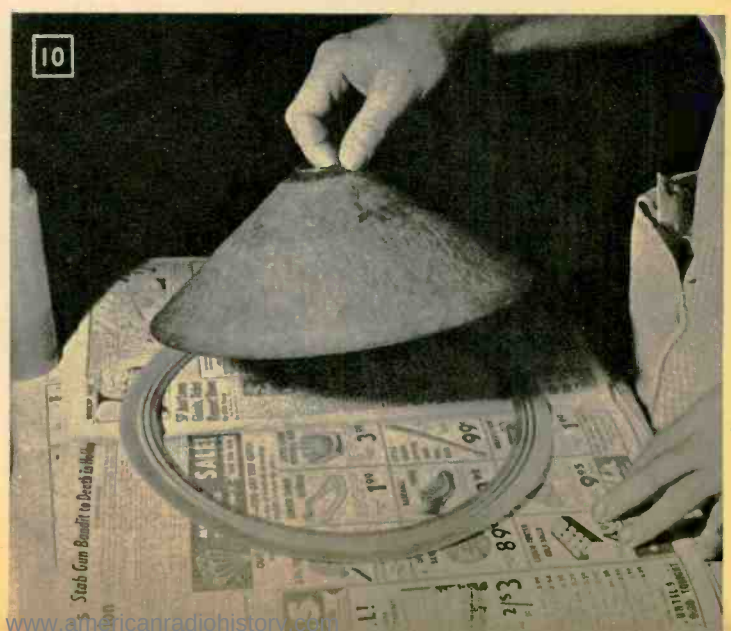
5. Wet cone is inspected on light table for pin holes or other defects.



7. Dried cone is peeled off form. Paper at apex is thicker than at rim.

8. Cone is shaped and flattened for greater strength in this press.

9. Die cutting press then cuts the cone to correct size; forms center hole.



10. The finished cone is cemented to a corrugated rim of special cloth-like material for greater compliance at low frequencies.

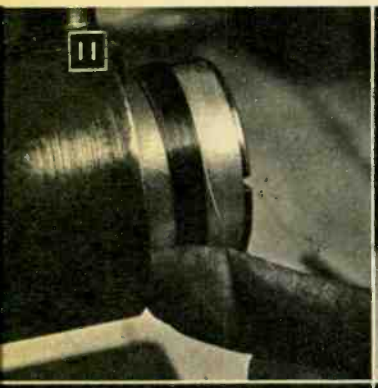
All photos by Simon Nathan

October, 1959

11. The copper ribbon of the voice coil is wound on small aluminum form.

12. The coil is cemented to the apex of the cone. Knurled knob is removed.

13. Various parts of speaker magnet are assembled prior to magnetization.



14. Magnet assembly is placed between poles of electromagnet and charged.

15. Speaker cone and coil are positioned in frame which now holds magnet.

16. Each speaker is tested with signal generator for its audio reproduction.

17. After tweeters are added to the large woofer, the entire assembly is ready to go into a finished enclosure designed for it. Note the crossover network on cabinet bottom.

Phono jacks carry signals in and out of the converter. Supply voltages connect at right.

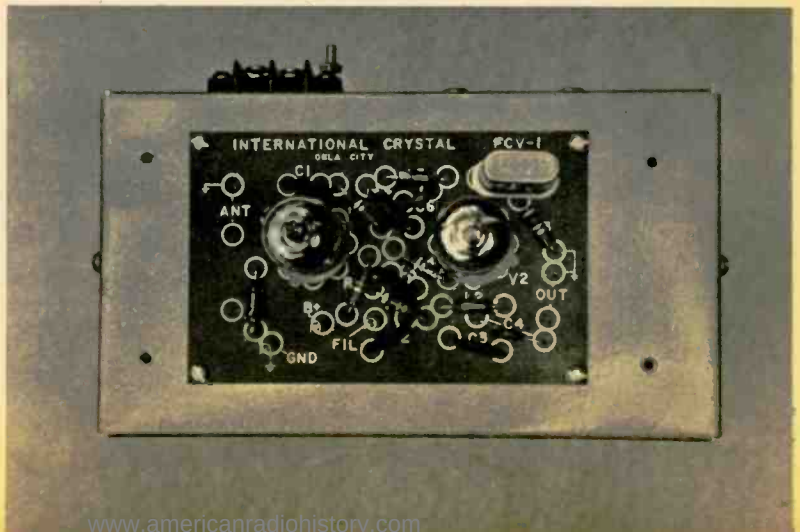
A Six Meter Rig For Your Car 2

By Don A. Smith, W3UZN

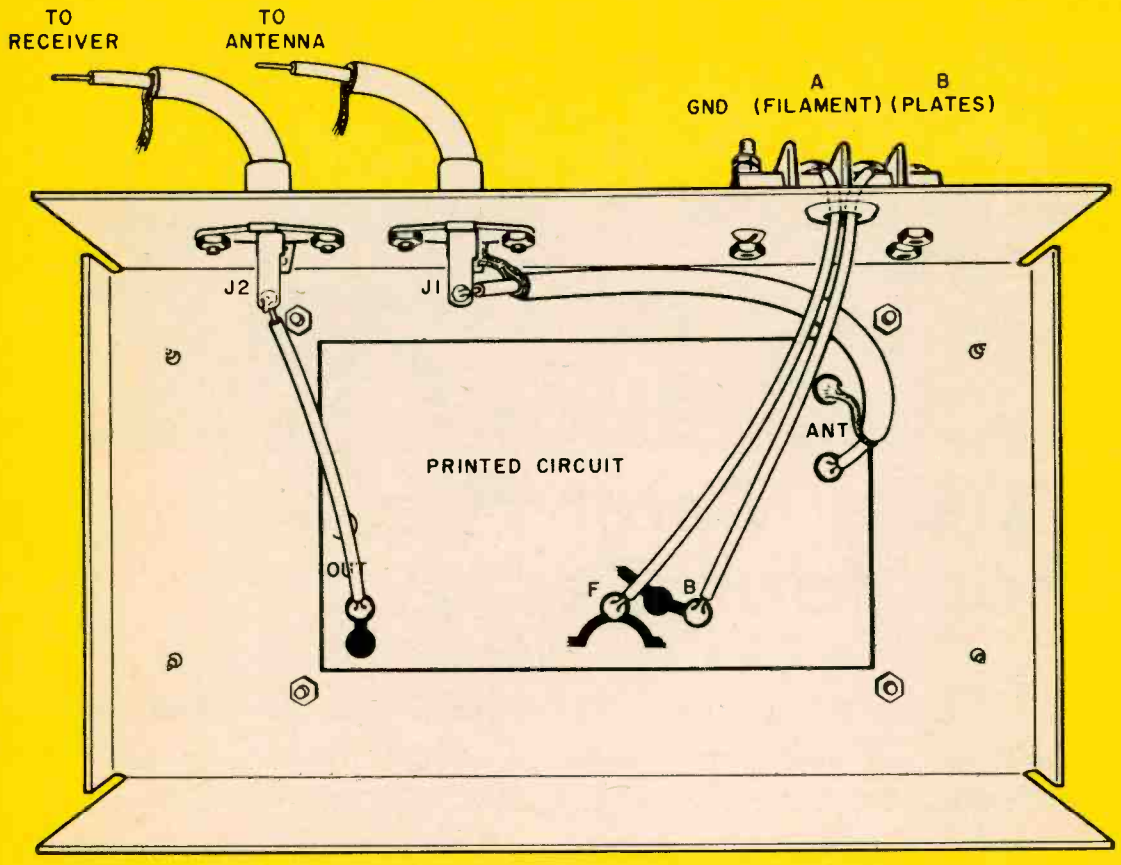
A companion to the transmitter described last month, this converter works through auto radio.

THE heart of the 6 meter converter is a printed circuit kit, which comes complete with printed board, all resistors, capacitors and pre-wound coils. Thus, it eliminates alignment, coil winding and the problem of critical wiring. The two necessary jacks are also furnished. The unit is built on an LMB box to match the transmitter described last month. You can construct the converter for under $20.00 if everything is purchased new.

A 6AK5 is used as a broad-band RF amplifier and one half of a 6J6 for the mixer and one half as a crystal controlled oscillator. If you are going to use the converter with an auto receiver, order a 49.4 mc crystal with the kit so that the output of the converter



Top view of easily assembled printed board reveals most components. Crystal is at upper right on the board.



Follow this simple wiring guide for interconnections. Avoid excess heat on board while soldering.

will be in the broadcast band. The author wanted a converter which was free from "bugs" so the beginning amateur could duplicate his results without any problem. The printed circuit board is one of the major factors in eliminating these "bugs." Wire lengths and placement at these frequencies can be a major problem.

The cutout in the chassis should be made first. Simply drill a series of small holes around a pencil outline. Make the cutout about ¼" smaller than the printed circuit board. Notice that the board has a band of metal foil around its outside edge. This is ground, so when you mount the board contact is made with the metal chassis.

After you have drilled the small holes, the center will come out of the chassis. Take a flat file, and smooth the edges. The printed circuit board is set in the cutout and centered. Mark the location of the four mounting holes and drill them.

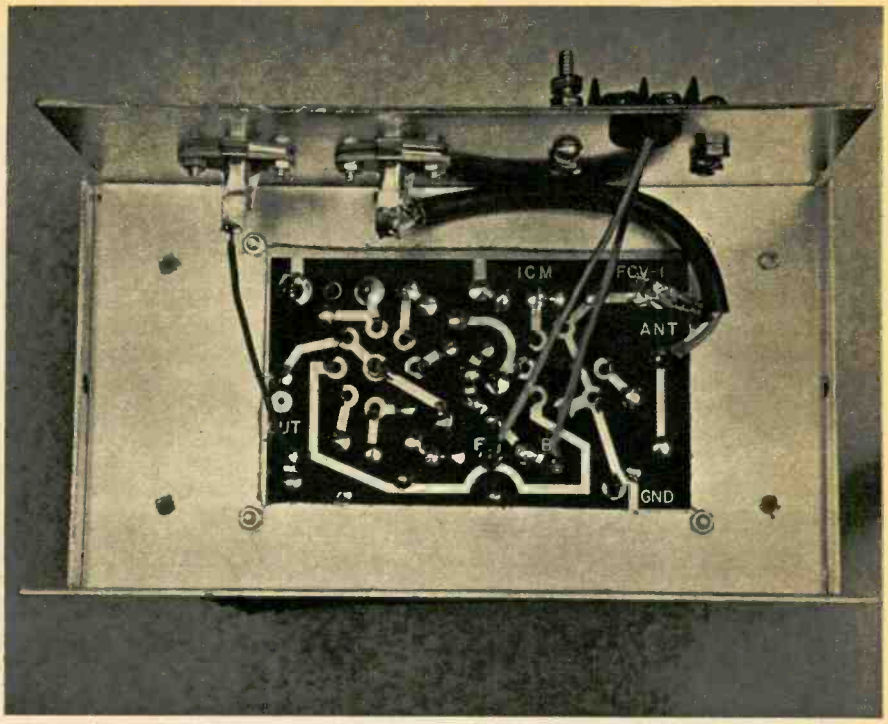
Mark and drill the holes for the two jacks and the terminal strip. Mount these parts. It is a good idea to use a rubber grommet in the hole where the wires run from the printed circuit board to the terminal strip. Now mount the parts on the printed circuit board and solder them.

When the wiring of the printed circuit

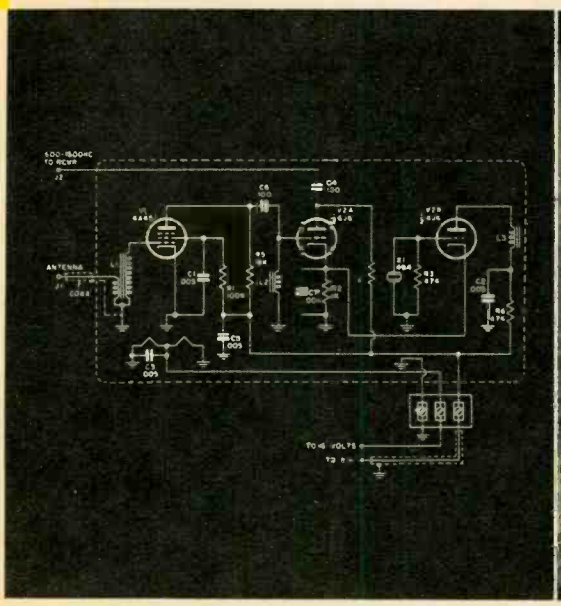
[*Continued on page* 101]

PARTS LIST

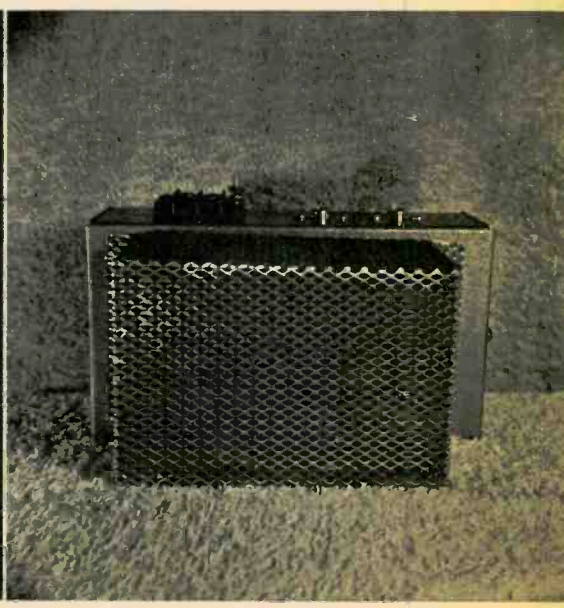
Printed board—FCV-1 6 meter converter kit, available from International Crystal Mfg. Co., 18 North Lee, Oklahoma City, Oklahoma.
Chassis—LMB aluminum case # 138, 6¼x3½x2⅛"
Barrier strip—Cinch-Jones barrier strip, two-terminal.



Underside of chassis and printed board. Note how foil on edges of board contacts the edges of cutout in metal chassis. This establishes a common ground connection.



Schematic of printed board is shown within dotted lines and indicates ports in the kit.



Top view of converter. Protective aluminum cage can be built or ordered with the kit.

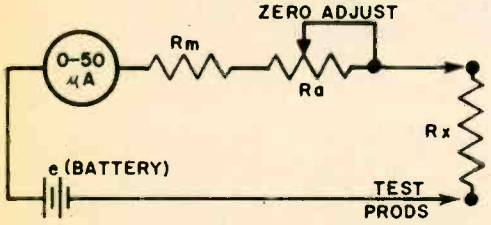
The Electronic Brain

Send in any questions on electronics. All queries will be answered either in this column or by mail.

Ohmmeter Circuit

Will you provide me with a circuit that will enable me to build an ohmmeter using a 0-50 microampere meter movement? A maximum resistance reading of 1 megohm would be satisfactory.

Edwin Cole, Wethersfield, Conn.



A 0-50 microampere meter can be made up into an excellent ohmmeter by connecting it in the simple circuit shown.

We are providing you with a general circuit so that you can establish any range you wish. The applicable equation is:

$$R_x = \frac{eR_m}{E} - R_m$$

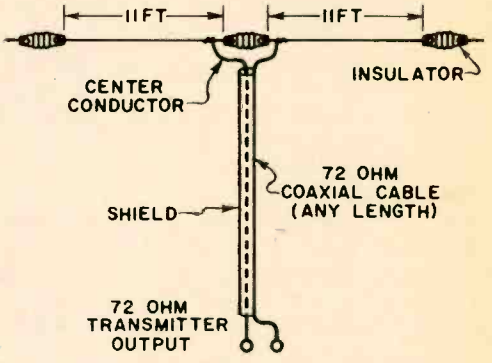
where R_x is the resistance to be measured, e is the battery voltage, R_m is the resistance added in series with the meter to make it a high-resistance voltmeter, and R_a is a zero adjust potentiometer. E is the meter reading with R_x connected.

Suppose you wanted to use a 3 volt battery (2 dry cells in series). Since the 0-50 microampere movement is a 20,000 ohm-per-volt type, you would need 60,000 ohms in series with the meter so that it would read full scale when the test prods were shorted. Using a 50,000 ohm resistor in series with a 25,000 ohm potentiometer would then enable you to adjust for zero if the battery is a bit off rating. The ohmmeter could then be calibrated for various unknown resistances by using the equation or by substituting known values for R_x.

Ham Antenna

Can you provide me with constructional details for a 15-meter amateur transmitting antenna?

Ed Crow, Pittsburgh, Pa.



There are many different types of antennas and feeder systems suitable for use on the 15-meter amateur band. For the beginner—and we assume that you are just beginning since your letter mentions that you are building a 25 watt transmitter—few antennas are as simple, yet as satisfactory in performance, as the untuned, coaxially fed, half-wave dipole. This system is shown in the diagram.

A horizontal dipole has its greatest directivity broadside to the wire. Thus, if you are more interested in east and west communication, run your antenna north and south; similarly, good directivity to the north and south is obtained by orienting the half-wave dipole on an east-west line. This is not to say that you will not be able to work other directions beside the preferred ones; it merely means that your antenna will have the greatest gain in the directions indicated.

The dimensions given in the diagram have been selected for the center of the 15-meter band. An untuned antenna such as this should be coupled to the "cold" end of the output tank coil via a two-turn loop of stiff wire.

Volume Controls, RF Insulation

(1) *We have had considerable trouble with replacement volume controls recently. Even those of good manufacture tend to become noisy after short periods. Can something of a preventive nature be done about this?*

(2) *On page 85 of the April issue of* EI, *a suggestion for using discarded ballpoint pen cases as bushings appeared. Can a portion of such a case be used in building home-made neutralizing capacitors for a transmitter?*
James Fleetwood, Rockwell City, Iowa

(1) The carbon composition used in potentiometers tends to powder with age, especially if dust is present to act as an abrasive when the resistor is put into service. An excellent precaution that many servicemen use before installing doubtful units is to clean and lubricate the control with special combination solvent-oils such as General Cement Type 65-16 "Control Kleener"

(2) This would be a risky procedure at best. Not many ballpoint pens are fabricated of RF insulating materials such as the polyethelenes and polystyrenes. In any case, it would be highly advisable to give a sample of the plastic an RF breakdown test by connecting a short section of it directly across the tuning capacitor or tank coil of a medium power transmitter (100 watts or so). Using clip leads, you might keep shortening the length of the plastic test strip until leakage becomes evident in the form of arcing or bubbling of the plastic. This will give you a reliable estimate of the RF resistance and breakdown characteristics of the material.

Interference From TV Set

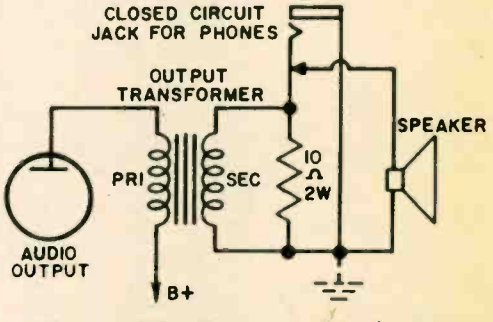
My television receiver produces a whistling noise in all the radios in my house making it difficult to record radio programs on tape when the TV set is on. Can you help me cure this?
Michael Lacanski, Peoria, Ill.

The whistling noise you hear is due to the horizontal sweep oscillator in your television receiver. When a TV set is poorly shielded, the 15,750 cps oscillation radiates through the air for short distances and is picked up by your receiver. Very often, too, some of the 15,750 cps signal reaches your radio through the AC lines that are common to both the radio and the TV set. As you mention in your letter, however, you can hear this whistle on your car radio and a portable radio that have no connection with the lines. Thus, your trouble is obviously due to radiation.

There is only one way to cure this difficulty properly. You will have to shield your television receiver thoroughly by building up a copper or aluminum screening case *all around it.* This means that the bottom and top of the receiver must be enclosed in the screening material as well as all four sides. When the enclosure is complete, run as short a lead as possible from the screen to a GOOD ground such as a cold water pipe or a six foot length of ½ inch pipe driven into the ground.

Adding Headphones

I should like a circuit that would permit me to connect my headphones to my all-wave receiver. The speaker should not operate when the headphones are working.
W. J. Windham, Chicago, Illinois



The modifications consist of opening one lead going from the voice coil of the speaker to the secondary of the output transformer. If one lead in your receiver is grounded, break the *ungrounded* one and add the phone jack and a 10 ohm, 2 watt carbon resistor. The phone jack may be mounted on the panel.

When the phones are plugged in, the speaker circuit opens automatically. At the same time, the secondary of the output transformer is made to work into the 10 ohm resistor.

Fig. 1. Note the ZERO ADJ. knob on this VTVM. This is used to equalize the current flow through both tubes of the bridge circuit so that the meter reads zero when there is no input voltage across the probe and alligator ground clip.

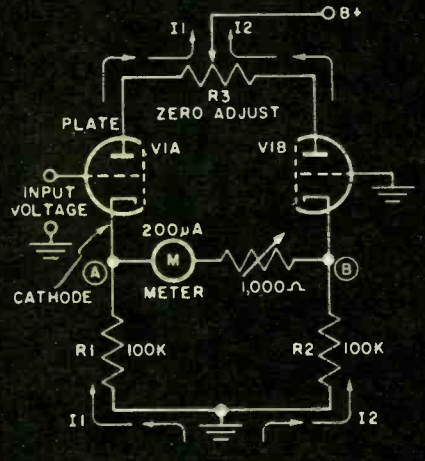


Fig. 2. The basic bridge circuit of a VTVM. Note the individual current flow through each section of the dual triode used here.

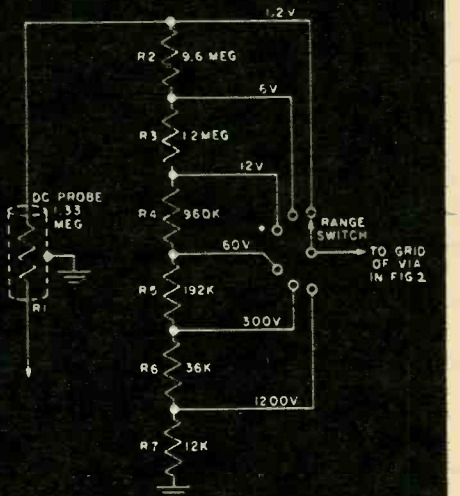


Fig. 3. The voltage divider network in the input section of the VTVM allows the meter to select six voltage ranges.

Milt Kiver on

How to Use Meters–3

How the vacuum tube voltmeter (VTVM) works, how to use it and why it is more accurate than VOM's.

THE vacuum-tube voltmeter or VTVM employs a vacuum tube amplifier internally to provide the instrument with a very high input impedance and a sensitivity that exceeds that of a VOM.

The basic circuit which is employed most widely in vacuum-tube voltmeters is the balanced bridge shown in Fig. 2. Here, two triodes are utilized, with the input voltage applied to the grid of one tube, V1A, while the grid of the second triode, V1B, is permanently connected to ground.

Let us assume that the grid of V1A is also grounded, this representing a condition of zero input voltage. The current for V1A will flow from cathode to plate of this tube, through R3 until the center arm is reached and then to B+ of the power supply. In the power supply, the current flows to ground and then up

Fig. 4. This VTVM has a zero center scale for convenience. The DC probe in front has high resistance, reduces losses in leads.

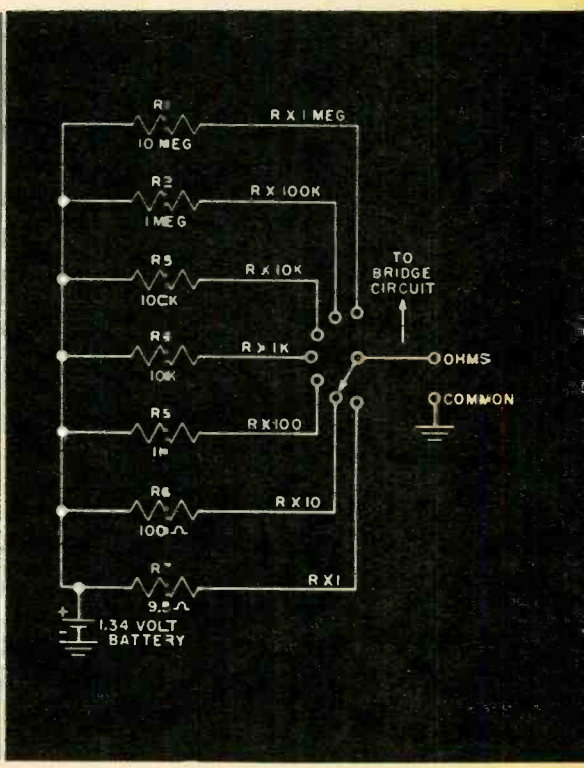
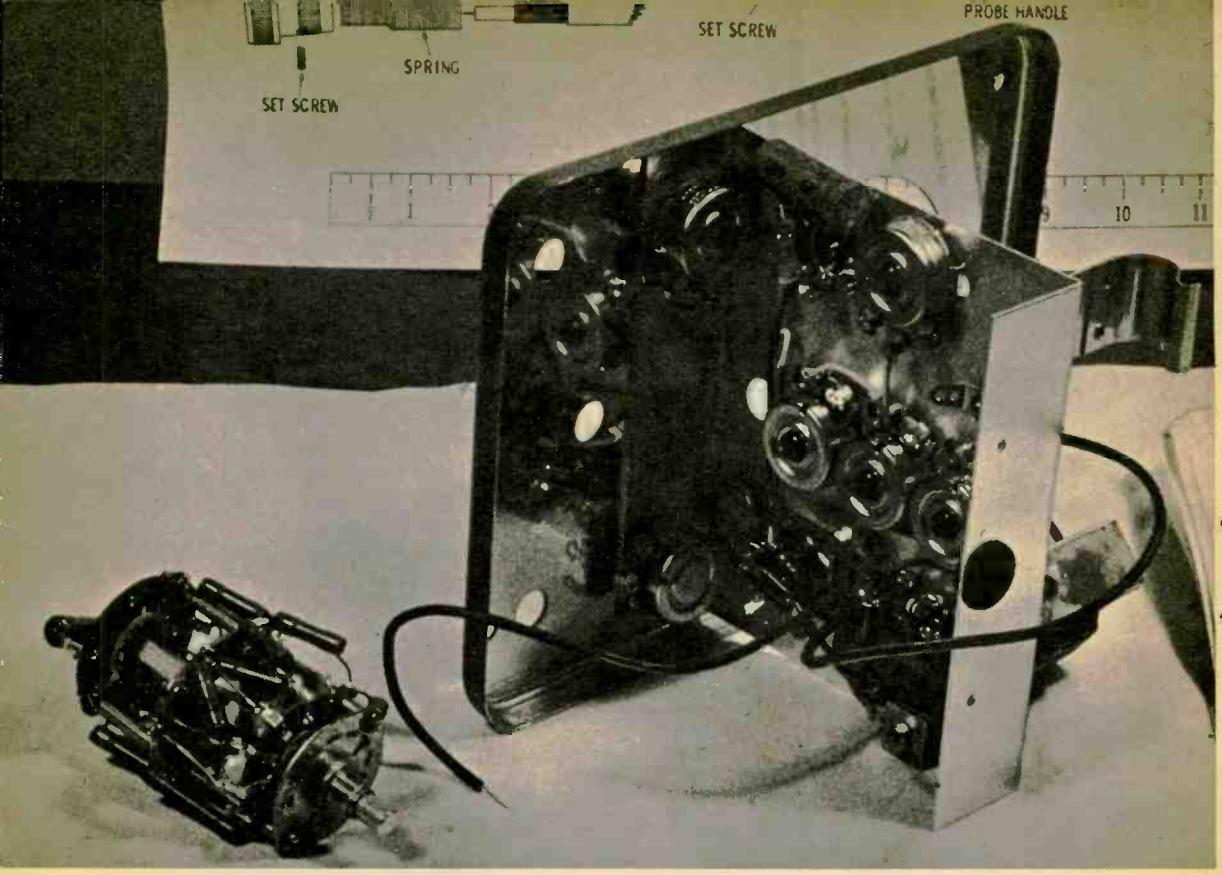


Fig. 5. The resistor network for ohmmeter section is identified by multiplier. Meter reading times multiplier gives resistance in ohms.



Interior view of VTVM with range selector switch out. Note how precision resistors are mounted.

through R1 to the cathode of V1A. The flow of this current, I1, through R1 causes point A to become positive with respect to ground.

V1B develops its own current, I2 in Fig. 2, and this current flows from the cathode of this tube to plate, then through R3 to the center arm, and from here to B+ of the power supply. I2 travels through the power supply to ground and then up through R2 to the cathode of V1B. As before, the flow of current through R2 causes point B to become positive with respect to ground.

Now, both points A and B are positive and if V1A and V1B were identical, both points would possess exactly similar positive potentials. In this case, meter M would have the same positive pressure applied to both its terminals and consequently it would read zero.

However, such ideal conditions are never quite realized and one point will be slightly more positive than the other. This will cause the meter needle to deflect. To "zero the meter" and thus bring both branches of the circuit into balance, variable resistor R3 is adjusted. Through this variation, the currents through V1A and V1B can be manipulated until points A and B possess the same positive potentials. At this point the meter needle will be at zero.

R3 is the knob on the front panel of a VTVM which is labeled "Zero Adjust." See Fig. 1.

To employ the bridge circuit to measure voltages, assume that a small positive voltage is applied to the grid of V1A. This will increase the current flowing in this tube and cause point A to become more positive. This will force the needle of meter M to deflect up scale, away from the zero mark. For a greater positive voltage, a greater meter deflection will be obtained; for a smaller positive voltage, the deflection will be less. Thus, the meter scale can be calibrated directly in volts.

If a negative voltage is applied to the

grid of V1A, point A will become less positive and the meter needle will deflect in the opposite direction, or to the left. Since in most instruments the zero position is already as far to the left as the pointer normally goes, applying a negative voltage to the VTVM would drive the needle off scale. To have the needle move up scale for negative voltages, either the leads can be reversed or a switch can be incorporated which does this internally.

Thus, most VTVM's, like the one in Fig. 1, have a +DC VOLTS position of the FUNCTION switch and a —DC VOLTS position.

The zero adjustment should be checked whenever the range is changed. A number of VTVM's (like the one in Fig. 4) contain provision for positioning the needle at the center of the scale when no voltage is being applied to the instrument. Internally, this is accomplished by unbalancing the bridge until point A (Fig. 2) is made sufficiently positive to deflect the needle to the center of the scale. If negative voltages are now applied to the unit, the needle will swing to the left of center by an amount proportional to the voltage. Positive voltages will swing the meter needle to the right of center.

To measure a variety or range of voltages with a VTVM, a voltage divider circuit is placed across the input to the meter, as shown in Fig. 3. The probe itself, which makes contact with the voltage to be measured, contains a resistance of 1.33 megohms. This is then followed by resistors R2-R7 and if all the resistance values are added up, a total of 13.33 megohms is obtained. This input resistance remains unchanged no matter what the voltage to be measured.

Notice in Fig. 3 that as the voltage to be measured rises, the grid of V1A (of Fig. 2) is moved lower and lower on the voltage divider chain. Thus, we insert more and more resistance between the voltage and V1A and this prevents too much voltage being applied to the grid.

[*Continued on page* 93]

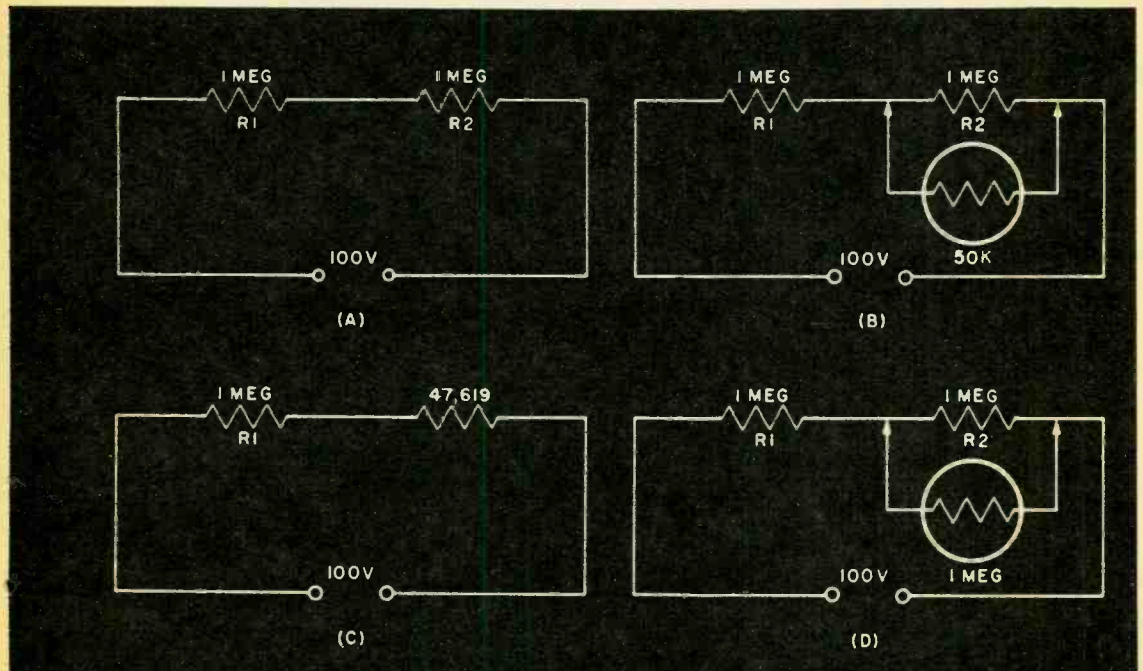


Fig. 6. Paralleling 1 megohm with low resistance meter makes reading inaccurate, see text.

E I kit report

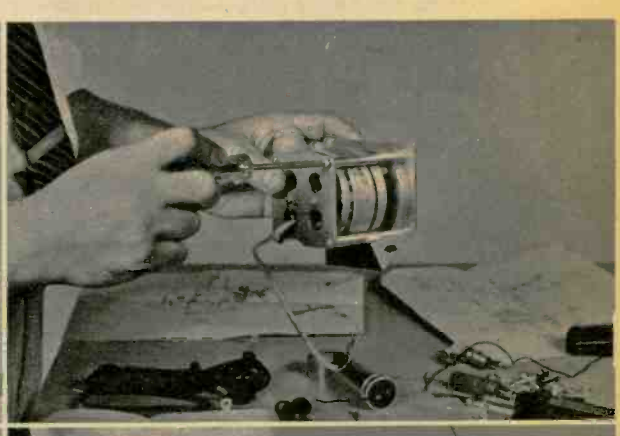
Gray Turntable HSK-33

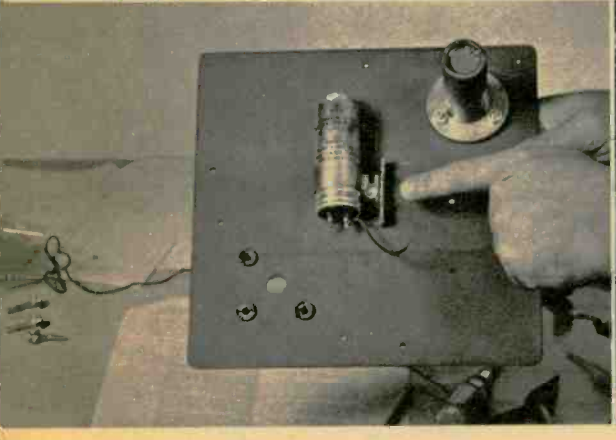
Stereo demands no vertical movement. That's why this platter is belt-driven from hysteresis motor.

THIS 33⅓ rpm hi-fi turntable kit can be bought from Gray Manufacturing Co., 16 Arbor St., Hartford 1, Conn., for $49.50. Price does not include pre-cut base kit ($14.95). Platter is driven by stretch-limited belt to reduce rumble, but the adjustment of this belt on motor shaft is a bit tricky. Assembly time: about one-half hour, after checking instructions, parts and getting organized.

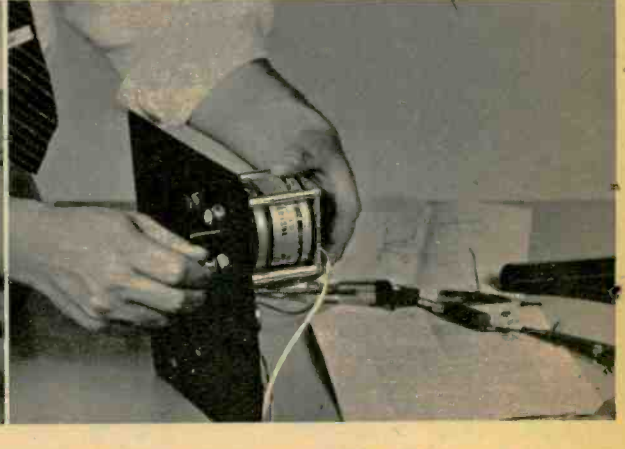
1. Parts are few and easy to identify. First step is to read instruction booklet carefully.

2. Gather all necessary tools. You'll need a Phillips screw driver to mount motor plate.





3. Capacitor and terminal strip are set with single screw. Note platter shaft bearing.

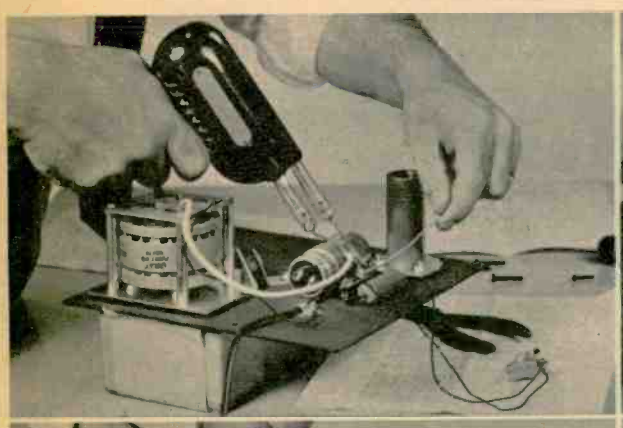


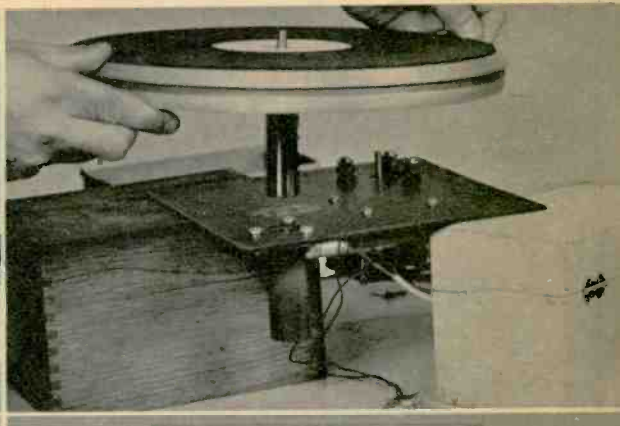
4. Motor is mounted temporarily with screws and shock mounts. Screws are adjusted later.

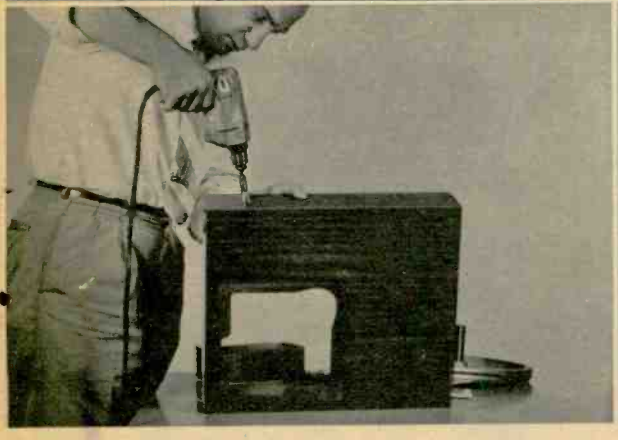
All set to receive tone arm, Gray turntable is completely assembled and mounted on base veneered with Formica. Gray SAK-12 tone arm kit is designed for both stereo and monophonic cartridges. It is $23.95.

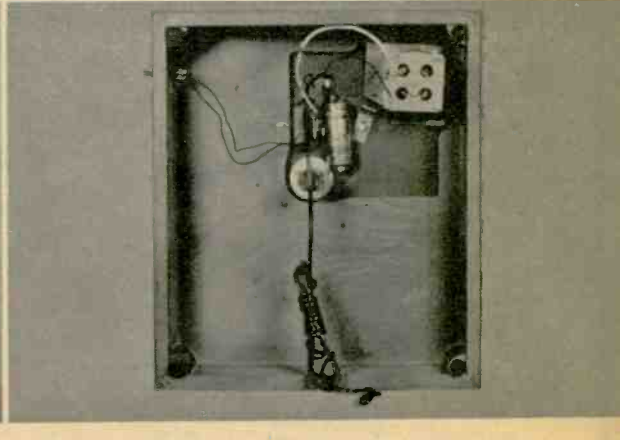
5. Solder joints are few. Switch leads must be long enough to reach base mounting position.

6. Bearing, motor should not rest on bench. Pieces of 2x4, file boxes make good supports.









7. Choose convenient spot, drill hole for on-off switch. Electric drill is best for Formica.

8. Here is uncluttered underside of completed turntable. Tone arm has not yet been mounted.

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 mfd.
- 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 mfd.
- Quality of all electrolytic condensers (the ability to hold a charge)
- High resistance leakage up to 300 megohms
- New or unknown condensers . . . transformer, socket, component and wiring leakage capacity

OUTSTANDING FEATURES

- Ultra-sensitive 2 tube drift-free circuitry
- Multi-color direct scale readings for both quality and value . . . in-circuit or out-of-circuit
- Simultaneous readings of circuit capacity and circuit resistance
- Built-in hi-leakage indicator sensitive to over 300 megohms
- Cannot damage circuit components
- Electronic eye balance indicator for even greater accuracy
- Isolated power line

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	$69.85

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

$34.50 Net

SIZE: W–6″ H–7″ D–3¼″

IN-CIRCUIT RECTIFIER TESTER

Model SRT-1

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

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

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

SIZE: W–6″ H–7″ D–3¼″

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

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 current gain, leakage, opens, shorts, cut-off current ● Checks all diodes for forward to reverse current gain ● All tests can be made even if manufacturers' rated gain is not available ● Less than half a minute required for tests of either transistors or diodes ● Large 3″ meter is extremely sensitive yet rugged . . . with multi-color scales designed for quick easy readings ● Power is supplied by an easy to replace 6-volt battery — current drain so small, service life almost equal to shelf life. Battery cannot be drained due to accidental shorting of test leads ● Cannot burn-out its own meter or damage transistor or diode under test ● Long test leads and insulated test clips enable tests without entirely removing transistor from circuit ● Test leads are identified by E.I.A. color code so that connection to the correct terminal is assured ● Comes complete with replaceable transistor set-up chart that fits into a special rear compartment.

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

SIZE: W–6″ H–7″ D–3¼″

IMPORTANT FEATURE: The TT-2 cannot become obsolete as the circuitry is engineered to enable you to 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

CENTURY

INSTRUMENTS ARE ALL GUARANTEED FOR ONE FULL YEAR

All CENTURY instruments are so brilliantly engineered and so durably constructed of top quality components that all carry an ironclad guarantee against defective parts and workmanship for one full year.

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 V-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

❶ DC Probe ❷ AC-Ohms Probe ❸ Lo-Cap Probe ❹ 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.

SIZE: W-7⅞" H-9" D-4¼"

FUNCTIONS

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

AC VOLTMETER . . . True Peak-to-Peak measurements as low as 3 volts of any wave form including TV sync, deflection voltages, video pulses, distortion in hi-fi amplifiers, AGC and color TV gating pulses . . . Scale divisions are easily read down to .1 volts . . . Measures RMS at 1/20th the circuit loading of a V.O.M. . . . Unlike most other V.T.V.M.'s there is no loss in accuracy on the lowest AC range.

ELECTRONIC OHMETER . . . Measures from 0 to 1000 megohms . . . Scale divisions are easily read down to .2 ohms . . . Will measure resistance values from .2 ohms to one billion ohms . . . Will detect high resistance leakage in electrolytic and by-pass condensers.

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

OUTSTANDING FEATURES

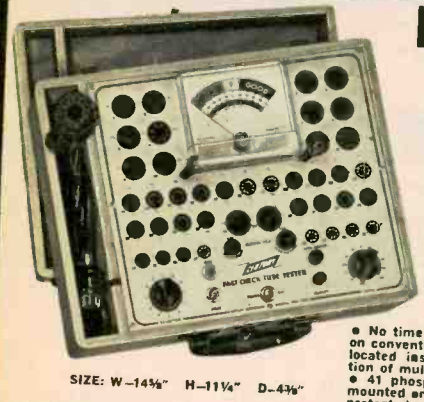
- Completely portable — self powered with long life batteries — permits use everywhere
- New advanced pentode amplifier circuit assures amazingly low battery drain
- Large 6" 100-microampere meter, many times more sensitive than meters used in most V.T.V.M.'s
- Laboratory accuracy performance — 2% of full scale on DC, 5% of full scale on AC
- Simplified multi-color easy-to-read 4-scale meter
- No heat operation assures rigid stability and accuracy
- Immune to power line fluctuations
- Amplifier rectifier circuit with frequency compensated attenator — 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
- 1% resistors used for permanent accuracy
- Separate RF ground return for low-loss RF measurement
- Microphone type co-axial connector
- Matching cover protects instrument face — snaps on and off instantly.

SPECIFICATIONS

- DC Volts — 0 to 1.5/6/30/150/300/600/1500 volts
- AC Volts (RMS and Peak-to-Peak) — 0 to 3/12/60/300/1200 volts
- Ohms — 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 DC 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-1MW in 600 ohms
- 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

CENTURY'S extremely low prices are made possible because you are buying direct from the manufacturer.



SIZE: W—14⅜" H—11¼" D—4⅜"

Model FC-2 — housed in hand-rubbed oak carrying case complete with CRT adapter **$69.50** 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 servicing time way down, eliminating unprofitable call-backs and increasing their dollar earnings 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

- Checks quality of over 700 tubes types, employing the time proven dynamic cathode emission test. This covers more than 99% of all tubes in use today, including the newest series-string TV tubes, auto 12 plate-volt tubes. OZ4s, magic eye tubes, gas regulators, special purpose hi-fi tubes and even foreign tubes.
- Checks for inter-element shorts and leakage.
- Checks for gas content.
- Checks for life-expectancy.

SPECIFICATIONS

- No time consuming multiple switching . . . only two settings are required instead of banks of switches on conventional testers
- No annoying roll chart checking . . . tube chart listing over 700 tube types is located inside cover. New listings are added without costly roll chart replacement
- Checks each section of multi-section tubes and if only one section is defective the tube will read "Bad" on the meter scale
- 41 phosphor bronze beryllium tube sockets never need replacement
- 7-pin and 9-pin straighteners mounted on panel
- Large 4½" D'Arsonval type meter is the most sensitive available, yet rugged — fully protected against accidental burn-out
- Special scale on meter for low current tubes
- Compensation for line voltage variation
- 12 filament positions
- Separate gas and short jewel indicators
- Line isolated — no shock hazards
- Long lasting etched aluminum panel.

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

CONVENIENT TIME PAYMENT PLAN — NO FINANCING CHARGES

CENTURY ELECTRONICS CO., INC.

CHECK INSTRUMENTS DESIRED

- ☐ **Model CT-1 In-Circuit Condenser Tester** **$34.50**
  $9.50 within 10 days. Balance $5 monthly for 5 months.
- ☐ **Model SRT-1 In-Circuit Rectifier Tester** **$29.50**
  $4.50 within 10 days. Balance $5 monthly for 5 months.
- ☐ **Model TT-2 Transistor Tester** **$24.50**
  $4.50 within 10 days. Balance $5 monthly for 4 months.
- ☐ **Model VT-1 Battery Vacuum Tube Volt Meter** **$58.50**
  $14.50 within 10 days. Balance $11 monthly for 4 months.
- ☐ **Model FC-2 Fast-Check Tube Tester** **$69.50**
  $14.50 within 10 days. Balance $11 monthly for 5 months.

Prices Net F.O.B. Mineola, N. Y.

111 Roosevelt Avenue, Dept. 410, Mineola, New York

Please rush the instruments checked for a 10 day free trial. If satisfied I agree to pay the down payment within 10 days and the monthly installments as shown. If not completely satisfied I will return the instruments within 10 days and there is no further obligation. It is understood there will be NO INTEREST or FINANCING charges added.

Name ..... Please print clearly

Address .....

City ..... State .....

Made In Japan

Continued from page 46

the telephone. If a burglar enters the guarded premises, the machine automatically—and silently—dials the police and repeats over and over again a recorded message including the address of the place. In case of fire, the machine calls the fire department. It only costs $261 in Japan.

What would happen if the Japanese started shipping color TV sets to this country? My knowledge of the American electronics industry and my tours of Japan have convinced me that if the prices of color TV receivers drop to a level at which the great mass of American families will rush to buy them, the sets will be imported from Japan.

Using the difference in price between American transistor radios and the Japanese models that are taking over the market as a guide, high-quality Japanese color consoles might be sold in the United States as low as $250. This is just one-half the suggested list price for the most inexpensive color set made by RCA.

General Electric has recently announced that color TV is going no place at present. But Admiral has gone back into the manufacture of color sets. There seems to be some confusion. Does the American consumer want color TV or doesn't he? I think he would want it —if the price were right.

I urged my many Japanese friends, as well as those government officials concerned, to standardize on a 21″ color picture tube. My argument was that the only way for color TV to become a paying proposition in Japan was through heavy exports of the same sets to America. At present they have agreed on a 17″ tube, which is more than adequate for the small Japanese equivalent of our living room.

However, I believe that the Japanese electronics industry will go to a 21″ color set within the next year or so, since that is the only size that can sell a color set in the U. S. The increase in picture size would take little effort since it doesn't cost very much more to make a 21″ color set than a 17-incher. Incidentally, the pictures on the Japanese TV sets I have watched are excellent.

There's a lot of grumbling in the American electronics industry about Japanese imports, although many American manufacturers are buying Japanese transistors, tubes and parts to incorporate in their own finished products. Some Americans are calling for protective tariffs against Japanese electronic goods in an effort to tax them right out of the American market. I think that would be a costly mistake.

First of all, it would mean loss of the substantial Japanese market for American instruments and high-grade components. More important, the Japanese are our good friends and staunch allies. Let's keep them that way by competing only with new ideas and automatic production, instead of through tariffs or quotas. In this competition some American companies may lose a few rounds because the Japanese have undoubtedly appealed to the American consumer with the one thing the consumer understands best—low prices. But I am convinced that these imports will only stimulate, not ruin, the American electronics industry.

Make A Printed Circuit

Continued from page 36

for component leads. It is cleaned with steel wool once again to provide a shiny copper surface that takes solder easily.

Final assembly is similar to the construction of a kit with printed boards. Parts are pushed through the holes, their leads bent, clipped and soldered to the board. Don't apply too much heat or the foil will lift from the board. Excess solder flux can be dissolved away with alcohol. If desired, the circuit may be protected with lacquer or acrylic spray.

Among the printed circuit kits on the market are units by Techniques Inc., and Kepro. Both are distributed by the large electronic mail order houses, who also supply accessories and individual items such as etchant, resist and copper clad boards.

Signal Generators

Continued from page 61

ful to the hobbyist and technician is the "signal tracer." Basically, it is an amplifier that feeds its own built-in speaker. In some models, visual indicators such as magic-eye tubes, are provided. The tracer enables you to explore, stage by stage, through a set and serves as a substitute for the portion of the set following any given point to which it is connected by means of a probe. Kits cost about $20, wired models a bit under $40.

Sweep generators, used for aligning TV sets, hi-fi tuners, are handy all-purpose units.

How To Use Meters

Continued from page 87

AC voltages are measured by a VTVM by first rectifying the AC voltage to DC and then measuring this DC voltage in the same way as any other DC voltage.

The ohmmeter section of a VTVM is shown in Fig. 5. The small battery (a 1.34 volt unit) is used to supply the potential. This potential, when applied to the grid of V1A, is sufficient to cause full scale deflection of the meter. A variable front panel control, marked "Ohms Adj," permits the operator to accurately position the meter needle so that it stops directly over the final right-hand marking of the "Ohm" scale. In Fig. 2, this adjustment is the 1000 ohm variable resistor in series with the meter. This control is adjusted with no resistor connected between the OHMS and the COMMON terminals of the meter and with the leads from these terminals not touching. The needle position at the other end of the scale (i.e., zero) should also be checked with the meter leads shorting together. The "Zero Adjust" knob is used this time to bring the needle directly over the zero line.

When the resistance under test is connected between the COMMON and OHMS test leads, a voltage divider circuit is produced consisting of the 1.34 volt battery in series with one of the standard resistors R1 to R7 and the resistor under test. The voltage across the unknown resistor is proportional to its resistance. This voltage is applied to the grid of V1A of the bridge circuit and it produces a meter deflection proportional to the unknown resistance.

When the ohmmeter is not in use, the meter needle remains at the extreme right-hand side of the scale at the "INF." mark. This is opposite to its resting position when in use on other scales, such as volts or milliamperes.

VTVM's also come with an RF probe, which is essentially a rectifier and is designed to first rectify high frequency signals and then measure their value. High voltage probes are also available

Superior's 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!

Model 77—VACUUM TUBE VOLTMETER . . . Total Price $42.50 — Terms: $12.50 after 10 day trial, then $6.00 monthly for 5 months.

- Model 77 completely wired and calibrated with accessories (including probe, test leads and portable carrying case) sells for only $42.50.
- Model 77 employs a sensitive six inch meter. Extra large meter scale enables us to print all calibrations in large easy-to-read type.
- Model 77 uses new improved SICO printed circuitry.
- Model 77 employs a 12AU7 as D.C. amplifier and two 9006's as peak-to-peak voltage rectifiers to assure maximum stability.
- Model 77 uses a selenium-rectified power supply resulting in less heat and thus reducing possibility of damage or value changes of delicate components.
- Model 77 meter is virtually burn-out proof. The sensitive 400 microampere meter is isolated from the measuring circuit by a balanced push-pull amplifier.
- Model 77 uses selected 1% zero temperature coefficient resistors as multipliers. This assures unchanging accurate readings on all ranges.

Specifications

• **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 500 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.

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.

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 TV-50A **GENOMETER**

7 Signal Generators in One!

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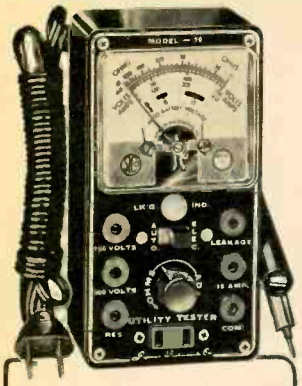

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and these are designed to enable the instrument to measure voltages as high as 50,000 volts or more. These probes are similar to the DC probe shown in Fig. 3 except that their internal resistor (or series of resistors) is high enough to reduce the high voltages being measured to levels that the regular voltage divider network can handle.

Why VTVM's Give More Accurate Voltage Readings

Mention has been made of the fact that the internal input resistance of a VTVM is far higher than the input resistance of a VOM. This is a particularly desirable feature because the higher the input resistance of the meter, the less *loading* effect it is likely to have on any circuit where measurements are to be made.

As an illustration of the effect that a voltmeter can have on the voltages in a circuit being measured, consider the simple circuit shown in Fig. 6A. Here, 100 volts are being applied to two 1 megohm resistors, R1 and R2. Now, if we were to measure the voltage across either of these resistances, 50 volts should be indicated; however, let us take three meters with three different input impedances and see what the actual reading does become. We will use a 1,000 ohms-per-volt VOM, a 20,000 ohms-per-volt VOM, and a VTVM with an input impedance of 15 megohms.

Starting with the 1,000 ohms-per-volt VOM, this should be turned to its 50V scale (in anticipation of the voltage to be measured). On this scale, the VOM has an input impedance of 50 $\times$ 1,000 or 50,000 ohms. Therefore, let us represent this 1,000 ohms-per-volt VOM by a 50,000-ohm resistor connected across R2. See Fig. 6B. Now, if we place 50,000 ohms across 1 megohm, the total resistance of the combination is given by the formula:

$$\frac{R1 \times R2}{R1 + R2} \text{ OR } \frac{(1{,}000{,}000) \times (50{,}000)}{1{,}000{,}000 + 50{,}000}$$

Using this formula, we find that the parallel resistance of R2 and the 50,000 ohm resistance presented by the VOM is 47,619 ohms. Thus, the circuit now appears as shown in Fig. 6C. The 100 volts will now distribute itself so that R1 receives close to 95 volts, while only 5 volts will appear across the parallel combination of R2 and the VOM. Since only 5 volts is applied across the meter, that is all it will indicate.

Now, let us replace the 1,000 ohms-per-volt VOM by a 20,000 ohms-per-volt VOM. Again, let us assume 50 volts across R2 and assume the VOM is set to this range. The meter input impedance will be 50 $\times$ 20,000 ohms or one megohm. The circuit now appears as shown in Fig. 6D, with the VOM represented by a 1 megohm resistor in parallel with R2.

The combined resistance of R2 and the VOM now becomes 500,000 ohms, again obtained by using the formula given. Hence the circuit consists of R1 (one megohm) and 500,000 ohms from the parallel combinations of R2 and the VOM. With this setup, the 100 volts will distribute itself so that 66⅔ volts appear across R1 and 33⅓ volts appear across the meter and would be so indicated. While this is still considerably below the 50 volts that actually do appear across R2 in the absence of the meter, it is still a lot closer to 50 volts than the value indicated when a 1,000 ohms-per-volt VOM is employed for the measurement.

Finally, let us place a VTVM, with an input resistance of 15 megohms, across R2. The parallel combination of 1 megohm from R2 and 15 megohms from the VTVM will leave the total impedance presented by this combination fairly close to 1 megohm. Consequently, the circuit will be relatively undisturbed and the VTVM will record the 50 volts appearing across R2.

By this simple illustration, we can see what a profound effect a voltmeter will have on the circuit if its impedance is close to the impedance of the circuit where the voltage is being measured. It is important to keep this limitation in mind whenever a VOM or VTVM is used. VOM's can provide correct readings in low resistance circuits or in high resistance circuits when the voltage to be measured is similarly very high. VTVM's will give accurate readings in high or low resistance circuits.

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Continued from page 38

VHF. As a result, many thousands of persons throughout the world have been able to hear the satellites launched from the USSR, while only a mere handful with special equipment have been able to listen to their American counterparts.

Short wave is reflected back to earth by the ionosphere and because there is little absorption of short-wave frequencies, signals often can be heard clear around the globe. On the other hand, VHF signals do not "hop" between earth and ionosphere. Reception is usually limited to line of sight. In other words, the signal from the satellite transmitting VHF goes directly to the monitoring station.

The Russians have even gone so far as to verify reception of their sputniks and lunik. I personally have received an attractive QSL card from the Russians for my report on Sputnik I. Thousands of other short-wave listeners around the world have received the same. It reads:

> To Mr. C. M. Stanbury, observer of the Soviet sputniks, the first artificial earth satellites in the world. Thank you for your reports. The information is of scientific value and will be used in the processing of material in accordance with the program of the International Geophysical Year. We hope to receive further reports of observations from you in the future.
>
> The U.S.S.R. Committee on the International Geophysical Year

The conservative tone of this QSL gives it greater propaganda impact. And the repeated allusion to the International Geophysical Year makes it sound as if the Russians were *really* trying to cooperate with that distinguished worldwide scientific effort.

However, the fact that the Russians did not use an IGY recommended frequency (around 108 mc), and the fact that they did not see fit to announce the satellite launching until after Sputnik I was in orbit, points to *non-cooperation* rather than cooperation.

Taking the Russians' invitation to submit further observation reports at face value, I hurried to my receiver upon hearing the announcement of the launching of a Russian lunar rocket, now called Lunik. At about 2253 GMT on January 3rd of this year, I tuned to 19.995 mc. About 5 kc below WWV I heard what sounded like a 300 cycle modulated continuous wave. The next day I heard the same signal, but weaker.

I wrote to the Academy of Sciences in Moscow and received a reply dated February 6, 1959. It was signed by the Academy's scientific secretary. That letter is reproduced on these pages. Translation reveals that the Russians confirmed my first report, but expressed doubt about my second report since the lunar rocket no longer was a lunar rocket, but rather a cosmic one heading into orbit around the sun.

Why are we using VHF? For some excellent technical reasons. From the start, our space program, now directed by the National Aeronautics and Space Agency, has been a scientific data-gathering endeavor, not a propaganda effort. VHF is far less subject to interference than short wave and therefore a more reliable means of transmitting data. With short wave there is the danger of the ionosphere, under certain conditions, completely blocking the signals off from the earth. Also, short wave's multihop reception could result in ambiguous tracking reports making the satellite appear at a point in the heavens far removed from its actual position.

From a data-gathering standpoint, VHF telemetering and tracking are technically superior and the United States should continue using VHF. However, how about also installing a simple, inexpensive short-wave transmitter in at least one satellite and possibly one space probe? Power could be provided by small, but long lasting batteries. Sputnik I, the most widely heard of all the space vehicles, used only one watt and yet its signals frequently bounced around the globe.

Such a short-wave transmitter in an American satellite may be operated exclusively for foreign listeners and amateur monitors, or it could be used to transmit scientific information. Of course, a repeater tape loop bearing a voice message would be highly effective as a propaganda gimmick, although

higher power and a more complicated transmitter would be required.

Signals from a space probe would, of course, have to span much greater distances than those from an orbiting satellite. Again, small lightweight batteries could be used, but with higher power compensated by shorter life, say two or three days. The additional cost of such a project would be small beside the millions of dollars spent on the Voice of America every year. The cost of mailing a QSL card by the government would also be small, yet would certainly pay off in added prestige for America.

EDITOR'S NOTE: An official spokesman for the National Aeronautics and Space Agency (NASA) in Washington has informed us just as we go to press that Explorer VI will be carrying 20, 40 and 60 mc transmitters—a departure from previous satellite communications. Space and weight problems in earlier launchings precluded inclusion of such a complete communications package, but more powerful rockets, such as Juno II, now permit heavier payloads. Also it has been pointed out that a 20 mc transmitter had been installed in an early Explorer satellite which, unfortunately, failed to enter orbit.

We have also been informed that NASA does *not* plan to QSL satellite reports. They want to keep our space program on a high, scientific level and will continue to rely on the government-sponsored Minitrack network for tracking reports. However, *Electronics Illustrated* has learned that NASA certainly would welcome tape recordings of satellite signals taken off the air by short-wave listeners and radio amateurs, if these recordings are accompanied by complete reception information.

A Six Meter Rig

Continued from page 81

board is complete, mount it on the chassis (from the top), and secure with the four nuts and bolts supplied. Then connect the input jack to the "ANT" connection on the bottom of the printed circuit board, using a short piece of shielded cable, such as RG-58/U coaxial cable. The connection from the output jack to the "OUT" connection on the bottom of the printed circuit board can be an ordinary piece of wire, but make it as short as possible. Connect a lead from "B+" connection on the bottom of the printed circuit board to a connection on the barrier strip. Do the same for the filament lead.

The converter is now ready for installation in the car. When you tune your auto receiver from 600 kc to 1600 kc, you will actually be tuning 50 to 51 megacycles. As an example, when your radio dial is at 980 kc you will be tuned to 50.38 mc. The unit may be installed in the trunk with the transmitter, under the dash, or even in the glove compartment, as the unit is quite small. The location will depend on the space available in your particular car. Keep in mind, however, that you will connect the output of the unit to your auto radio antenna input.

Use shielded cable for the B+ lead from the transmitter, to minimize possible pickup of ignition and other noise. The "A" lead for the filaments may be connected to any spot where six volts DC is readily available in the radio.

Use a piece of coax, or other shielded cable from the output jack on the converter chassis to the jack on your receiver that the broadcast antenna plugs into. You will have to unplug the auto antenna lead from your receiver. Put a regular auto antenna type plug on the cable from the converter and simply plug it into your auto receiver.

As described last month in the transmitter section, the B+ voltage from the auto receiver which connects to the push-to-talk relay in the transmitter, is connected through the relay, back to the auto receiver when the "mike" switch is not depressed. Connect the B+ lead from your converter to this same terminal on the barrier strip. This way, the converter will have B+ when the receiver has it, and will not when the mike switch is depressed. Be sure that you do not connect this B+ lead from the converter to the B+ lead *from* the receiver. Otherwise you will have B+ to the converter when transmitting and not when receiving. You must connect it to the terminal on the transmitter barrier strip which goes BACK to the receiver from the relay.

A Tesla Coil

Continued from page 57

thin perforated Bakelite as was done in this model. Place the hexagons atop one another and drill a ⅜ inch hole near each corner through each of the pieces. This will assure accurate alignment of the pairs of holes. While in this position, cut a 2⅛ inch diameter hole in each end plate to form the openings through which the secondary will pass. Finally, slip the dowels into the pairs of holes in the end plates flush with the surfaces and glue in place with a fast-drying cement. This makes up the "squirrel cage" form for the primary coil.

The primary is wound by fitting #16 Formvar enamelled wire into the dowel grooves and pulling tight around each turn, for a total of 39 turns. The ends of the coil may be wound once around the terminal dowel stick and crimped tightly in place.

Counting up from either end of the primary, scrape the Formvar or enamel insulation clean from the 15th turn. After scraping both ends of the winding, solder 20 inch lengths of flexible wire to each end and to the tap at the 15th turn. This wire should have good insulation such as the vinyl material used on modern hookup wire. Connect a colored, insulated banana plug to the free end of each of the wires; use three different colors to match the banana jacks that will later be located on the oscillator chassis. The primary coil is now finished.

To protect the thin insulation of the secondary turns, cover the entire winding with one layer of a good grade of vinyl tape. This not only makes for long life but also for trim appearance. After the coils are in place and the leads plugged into their matching jacks, throw the filament switch on. The 811A tube filament should light. Turn the filament off. Using a 12 inch wood ruler or any scrap wood *at least this long*, place it under the bottom end plate of the primary and slide the coil up on the secondary until its top end plate is about ⅓ of the way from the upper end of the secondary. Turn on the filament for at

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least 10 seconds, then turn on the high-voltage switch. FROM THIS POINT ON, KEEP AWAY FROM THE COILS AND THE VACUUM TUBE. YOU ARE DEALING WITH 1500 VOLTS FROM THE TRANSFORMER AND MUST EXERCISE EXTREME CARE TO AVOID SHOCK.

You may or may not get corona discharge from the wire ring in the upper binding post at this time (see photographs) since the secondary may not be in resonance. Let the primary slip slowly down the secondary column while you observe the ring. At a well-defined point along the column, corona sparks should begin to shoot from the ring. Note the position of the primary for maximum corona, TURN OFF THE PLATE SWITCH THEN THE FILAMENT SWITCH, and then mark the correct position of the primary coil with a bit of crayon on the vinyl tape. A heavy rubber band around this portion of the secondary will serve to hold the primary in place during use.

The Tesla coil is used principally as a demonstration of high-tension electricity. The corona discharge is fascinating to watch, especially in a dark room. Bring a long fluorescent tube, held in your hand, about two feet from the secondary and it will light brightly as if by magic; it will continue to glow up to four feet from the coil.

Stand three feet from the coil with a neon lamp in your mouth. You'll look like a human dynamo, because the lamp will glow brightly without connections.

Hold an insulated screwdriver in your hand and bring the blade within inches of the discharge ring. Sparks will leap to metal, but you will feel nothing.

Lay a piece of medium steel wool about the size of a golf ball on the discharge ring. When power is applied, you will see a startling display of St. Elmo's fire coming from the many strands.

Make a five-pointed star of aluminum foil and connect it to the discharge ring (vertically). Watch the streamers from the points and its spectacular effect.

If you can borrow some Geissler tubes filled with gases such as neon, helium, argon, mercury vapor, etc., hold one end of each of these in your hand in a fan-

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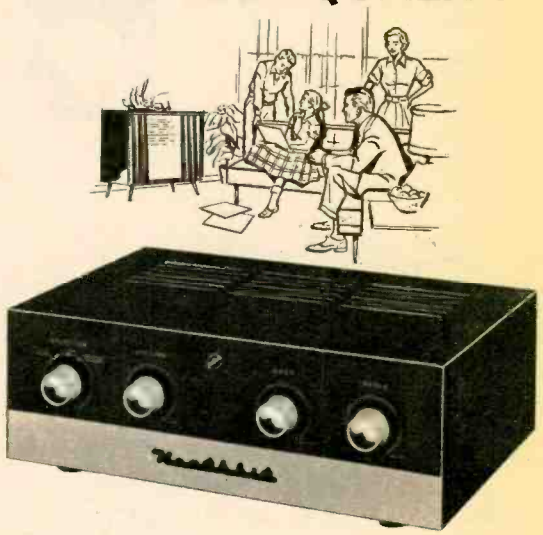

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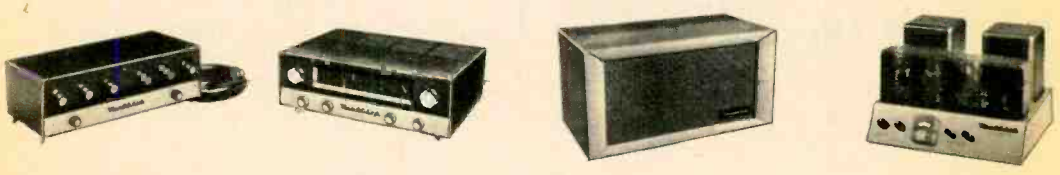

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like arrangement. The display of colors will be startling, when they are brought near the discharge ring.

Carefully remove the secondary and, while it is still coaxial with the primary, lay the whole assembly on its side on a wood table top. Connect a length of wire to the banana plug at one end and another length to the binding post and form a 6 or 7 inch spark gap. (Some retuning by shifting the primary winding may be necessary since the secondary is now removed from ground.) REMEMBER THAT ADJUSTMENTS MUST BE MADE WITH BOTH SWITCHES OFF!

Build-It Course

Continued from page 71

wave form from input to output of a given tube in this application is in amplitude, or strength.

Another reduction in distortion is accomplished by *inverse feedback*. Small irregularities appear in the output if the tube does not perfectly amplify all parts of the signal wave form. It is possible to cancel out these irregularities by tapping off a small portion of the output voltage and feeding it back to an earlier stage in the amplifier. It is important that the feedback voltage be of opposite polarity to the point it is applied to. Examine the practical schematic diagram that shows all parts of the complete amplifier. At the lower right is R13, the feedback resistor. It taps voltage from the secondary of the output transformer and brings it to pin 7 of the first amplifier tube V2A. The feedback voltage, being opposite in polarity, cancels that part of the wave that carries distortion. Although the process of feedback reduces the overall gain of the amplifier, a desired effect is achieved.

Push-pull is also a distortion-reducing feature. Instead of selecting one large power tube in the output circuit, two smaller ones are used. At a given instant, the applied signal causes one tube grid to go negative, the other relatively positive. Thus the output currents complement each other, as one tube's current rises and the other falls. This con-

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In launching attacks, there is a time delay (the time it takes to charge a capacitor) before the attack actually reaches the target. This is indicated by the rate of flashing of a neon bulb. Depending on the rate of attack, the target may have a chance to marshall a defense. The interception of a strike is handled in this manner: The grid of a thyratron tube is driven, through resistors, by the plate of a cathode-coupled multivibrator. The cathode is adjusted to the proper level by a potentiometer. A negative pulse from the multivibrator drives the grid negative and prevents the negative pulse on the cathode from firing the thyratron. The negative grid signal thus becomes an interception of the strike.

The progress of the "war" is presented to the players mainly through neon bulbs. When a target capacitor, for instance, is charged to the "destroyed" point, a neon bulb glows. When the bulb flashes rapidly, the offense is at a high level. When the striking force is low, the bulb barely flashes at all. Meters are provided to indicate the level of each side's offensive potential and the game is usually decided when one side is below 10% of its offensive potential.

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