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# ELECTRONICS ILLUSTRATED

A FAWCETT PUBLICATION

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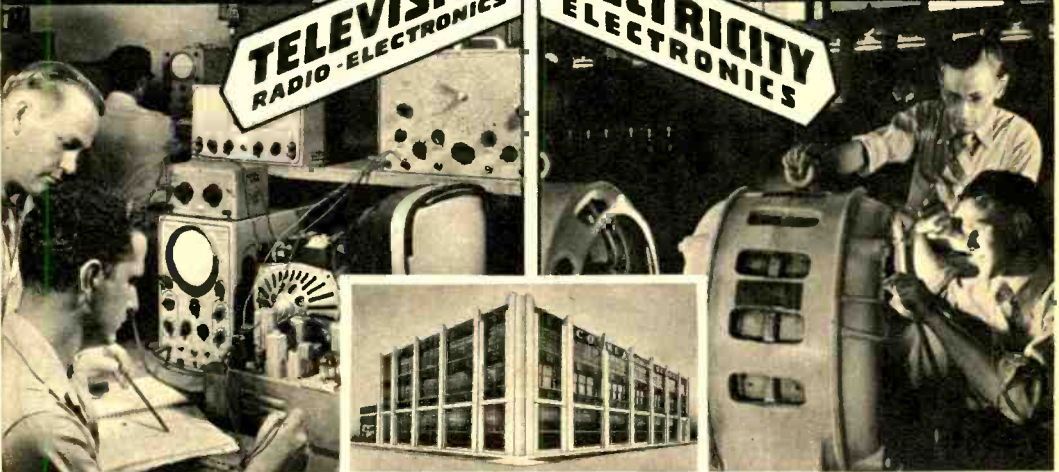
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# A Message From the Editor

**O**UR COVER, as befits the season, deals with underwater exploration using an electronic metal detector. The author of our story is Elgin Ciampi, well known skin diver, treasure hunter and photographer. Gene, who is 34, does most of his explorations in the crystal-clear waters off the Bahama Islands and if he's come up with any fabulous treasures he's not talking about them. Co-author of the book "Underwater Guide to Marine Life," he is currently working on another which will be published soon. He's traveled around the world, is a member of the Explorers Club and has been diving for 15 years. Some of his underwater film adventures have been shown on the "Bold Journey" television show and Gene himself has appeared on the "Tonight" program. He is even now on an archeological expedition. Be sure to read his story about



electronic treasure hunting underwater starting on page 27.

We've got some exciting news for you about a series starting in our next issue. Milt Kiver, highly respected authority on electronic servicing test instruments and well known author and teacher in electronics, will tell you how to use meters. This will be a down-to-earth, practical series including information on how to use the most basic as well as advanced instruments and will eventually include signal generators. Milt knows more than almost anyone on what people need to know when confronted with a meter — how to read the scales, how to adjust the various knobs, where to make the most important measurement. If you now own



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a meter or ever intend to buy one, this series is for you. Starting next month, August, in *EI*.

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Incidentally, we plan to bring you a complete report on the Russian fair held in this country recently, we're sure you will be interested in some of the unusual items they displayed.

In our June issue we featured the new Class D Citizens band for two-way radio. Our next issue will contain construction plans for a small converter which you can affix to your broadcast radio for receiving Citizens band radio.

If you've listened to stereo hi-fi through the winter, I'm sure you are loath to leave it in the spring and summer. Our August issue will have an extensive article on how to rig up a stereo hi-fi system for your patio, backyard, garden, etc.

Most people, at one time or another, look at the little used-up starters that come out of their fluorescent fixtures and wonder if there isn't something they can do with them. They contain a little neon tube and capacitor, nicely packaged. It's a pity to discard them. Actually, there are lots of things you can do with them as you will learn in the article "Fun With Fluorescent Starters."

Of course we will also have the Electronic Brain, Hi-Fi Clinic, ABC's of Electronics, explaining pentodes, and our other regular features. Hoping to see you next month . . .

*Charles Tupper*



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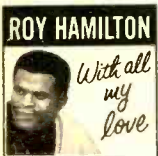
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


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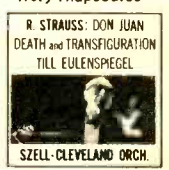
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30. A "must" for any record library



10. Be My Love, Where or When, etc.



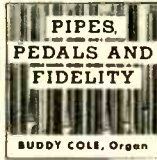
37. Lovely "musical portrait of nature"



12. Let's Dance, Jubilee, 7 more



11. Berlioz' most popular work



22. Organist Cole plays 11 hit tunes



17. Rain, Blidin' My Time, 10 more



29. High-spirited, gay symphonies



20. Come to Me, Long Ago, 10 more



3. Didn't It Rain, God Is Real, etc.



39. Also: Sylvia, Coppelia, etc.



33. 11 beautiful, immortal melodies



18. Two electrifying tone poems



45. Tico-Tico, Brazil, 10 others



36. The ballet that "rocked the world"



28. Brahms' most beloved symphony



44. 12 songs from famous movies



31. Solitude, Autumn Leaves, etc.



16. Two colorful, exciting scores

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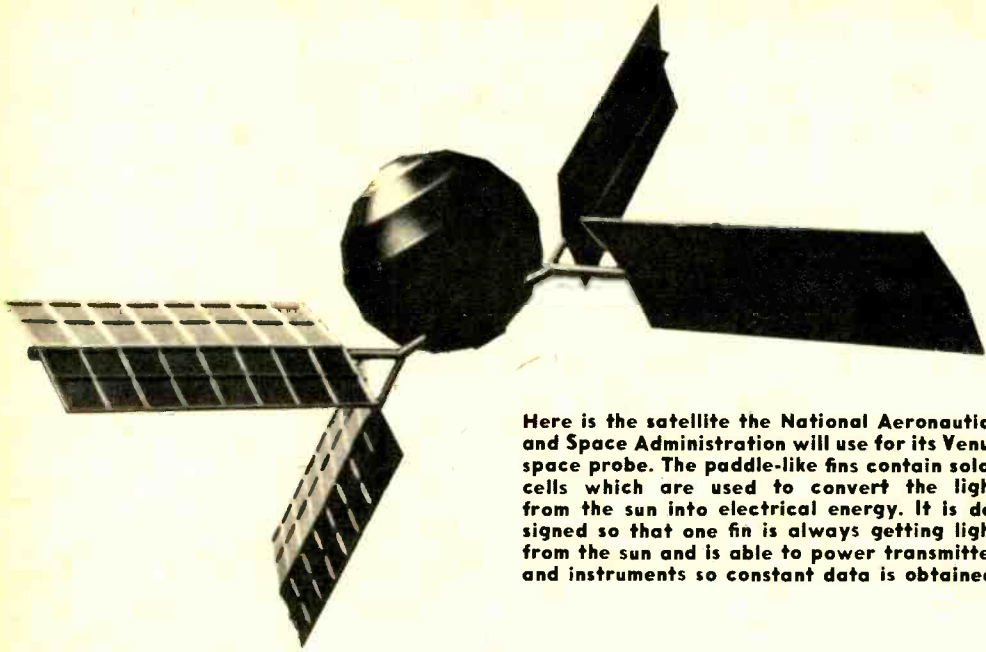
CIRCLE 6  
NUMBERS:

- 1 22
- 2 24
- 3 25
- 5 27
- 6 28
- 7 29
- 8 30
- 9 31
- 10 33
- 11 36
- 12 37
- 13 39
- 15 40
- 16 41
- 17 42
- 18 44
- 19 45
- 20 49
- 21 50

F-87

### COUPON NOW

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Here is the satellite the National Aeronautics and Space Administration will use for its Venus space probe. The paddle-like fins contain solar cells which are used to convert the light from the sun into electrical energy. It is designed so that one fin is always getting light from the sun and is able to power transmitter and instruments so constant data is obtained.

## Electronics in the News

This month the US will display many of its products at the American National Exhibition in Moscow. One of the highlights will be a display of the latest American television receivers. The Russian words appearing on the RCA set here say "see yourself on TV" and the Russians will be able to do just that.





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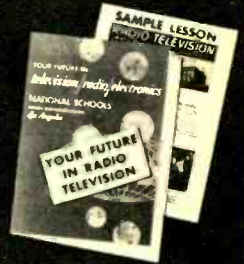
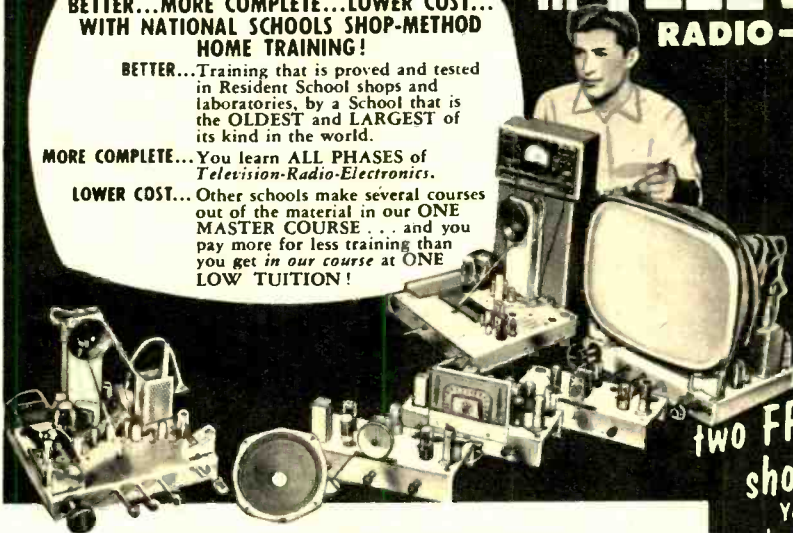
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...News



A new VTVM featuring one all-purpose probe that will do the work of four probes has been introduced by Century Electronics Co. The rotating head can be set to function as either a DC, AC, Lo-Cap or RF probe. The VT-1 is self-powered and completely portable.

As a DC voltmeter it will measure DC down to 1.5 volts full scale with minimum circuit loading and give readings of scale divisions as low as .025 volts. It will measure low AGC and oscillator bias voltages from .1 volts to 1500 volts. Zero center is provided for all balancing measurements such as discriminator, hi-fi amplifier balancing, etc.

As an AC voltmeter, the VT-1 will measure peak-to-peak as low as 3 volts of any wave form including TV sync, deflection voltages, video, etc. Scale divisions are down to .1 volt; measures RMS at 1/20th the circuit loading of a VOM. Price is \$58.50 for the fully wired and calibrated unit from 111 Roosevelt Ave., Mineola, N.Y.

A new 22" x 28" 2-color wall chart showing diagrams of the basic electronic schematic symbols is available to teachers from EICO, 33-00 Northern Blvd., Long Island City, N.Y. Free chart sent on request.

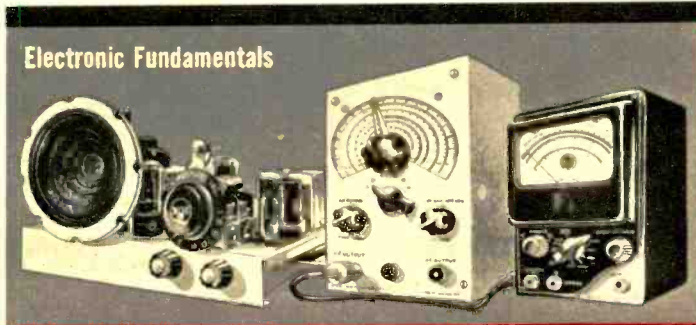




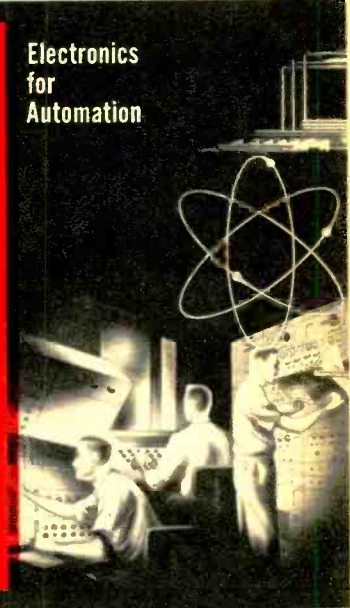
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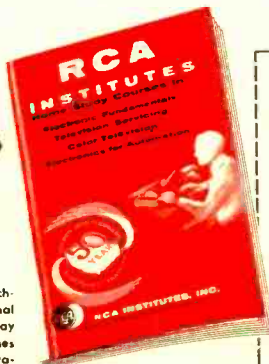


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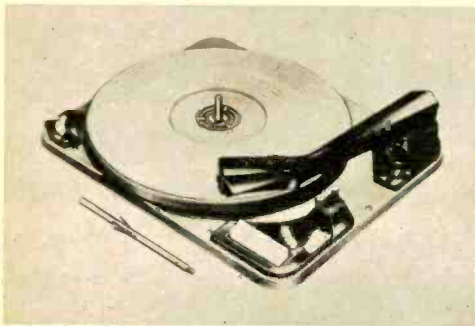
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United Audio Products of 202-4 E. 19th St., N.Y.C., announced the new United Audio Dual-1006 combination stereo turntable-record changer. This 4speed unit uses a rigid equipoise suspension which reduces vertical rumble. The tone arm has a double set of direct acting ball bearings for both vertical and lateral axes for light action. The changer works with 5" to 12" records. \$69.95 Net.



A new type of ultrasensitive Geiger counter for measuring minute amounts of radiation is now being marketed by Amperex Electronic Corp., Hicksville, L.I. These tubes measure beta radiation. Usually, to eliminate background count, the beta detector tube is surrounded by as many as 30 guard tubes. Lead shielding is used to reduce other radiation. With the Amperex system, the beta detector or tube, type 18515, fits into the cup-shaped anode of the ring-shaped guard tube, type 18517.

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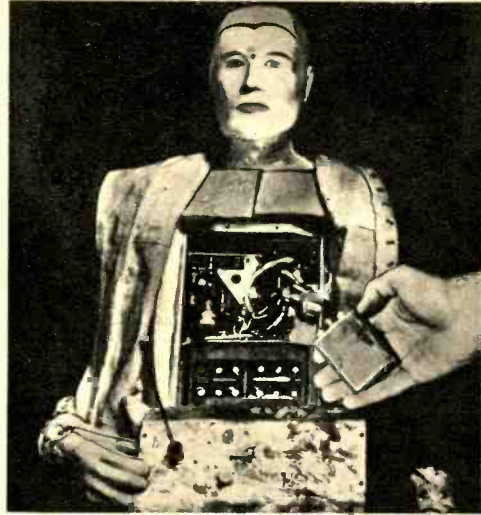
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## ...News



This is Hurricane Sam, the electronics-filled dummy who has helped the Air Force develop supersonic flight escapes. He is 6 feet tall, weighs 180 lbs., and is called an anthropomorphic dummy, meaning human in form. Beneath his sponge-rubber skin are delicate strain gauges, accelerometers and a telemetering transmitter to measure and transmit stresses and strains as he races toward a precipice at 1,500 miles per hour and catapults into it, drifting by parachute 1,500 feet to the canyon floor. This equipment is powered by Yardney "Silvercel" batteries which are rugged and up to six times lighter and five times smaller than ordinary batteries.

Thermoelectric refrigeration, based on direct conversion of heat to electric power, is likely to become a significant part of power demand. Practical thermoelectric refrigeration devices have been built and tested, said Dr. John Kelly of Westinghouse Research Labs. Equivalent in performance to present refrigerators, these new devices have the advantages of silence, becoming cold faster, and they are adaptable to almost any size or shape of task. Heat pumps, devices for heating and cooling, based on the thermoelectric principle are not too far in the future.



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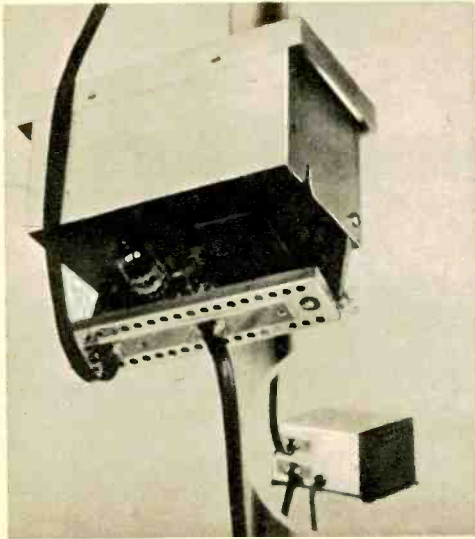
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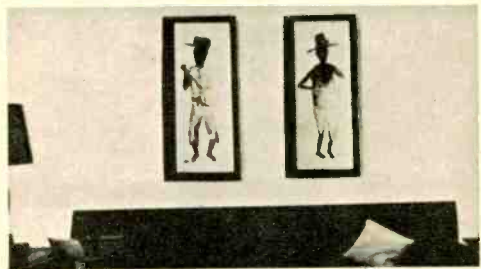
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## ...News



Blonder-Tongue Labs has manufactured a new antenna-mounted booster to improve the picture and sound of your TV set under weak-signal condi-

tions. The AB-2 features all-channel VHF circuitry, an aluminum weather-proof case, remote operation up to 600 feet from the TV receiver and 300 ohm "no-strip" terminal connections. Booster and control box—\$54.95.



The minstrel boys shown in the above wall mounted pictures are merely facades for two hi-fi speakers. Decrosonic Sound Systems have a 12 watt capacity and 8 ohm impedance. Available in 12" x 30" size (\$49.95) and 23" x 28" size (\$69.95). Shaw-White, 333 N. Michigan Ave., Chicago, Ill.



# BUILD 16 RADIO

## CIRCUITS AT HOME

with the New 1959  
PROGRESSIVE RADIO "EDU-KIT"®

### A Practical Home Radio Course

- Now Includes**
- ★ 12 RECEIVERS
  - ★ TRANSMITTER
  - ★ SIGNAL TRACER
  - ★ SIGNAL INJECTOR
  - ★ CODE OSCILLATOR
  - ★ No Knowledge of Radio Necessary
  - ★ No Additional Parts or Tools Needed
  - ★ EXCELLENT BACKGROUND FOR TV
  - ★ School Inquiries Invited
  - ★ SOLD IN 79 COUNTRIES

only  
**\$22.95**



Reg. U.S.  
Pat. Off.

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

The "Edu-Kit" offers you an outstanding PRACTICAL HOME RADIO COURSE at a rock-bottom price. Our Kit is designed to train Radio & Electronics Technicians, making use of the most modern method of home training—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 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 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 worthwhile 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.

### 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.

### 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. Stakatis, 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

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

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

### 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 postage.
- Send me FREE additional information describing "Edu-Kit."

Name .....

Address .....

### PROGRESSIVE "EDU-KITS" INC.

1186 Broadway, Dept. 513AE, Hewlett, N. Y.

## ONE CENT SALE

**BUY ONE AT OUR REGULAR LOW PRICE AND GET THE SECOND FOR ONLY 1¢ MORE**

**CITIZENS BAND TRANSMITTER** (27 MC) chassis complete with crystal. \$9.99 ea. two for \$10.00.

**TRANSMITTER** similar to above but with 5 watt RF stage instead of 1 watt. \$12.49 ea. two for \$12.50.

**CITIZENS BAND RECEIVER** chassis tunable through all 22 channels. Complete with audio amplifier. \$9.99 ea. two for \$10.00.

**AMATEUR BAND TRANSCEIVER** (144-148 MC) chassis with dual VHF triodes for walkie-talkie radiophone. \$9.99 ea. two for \$10.00.

**MICROPHONE** High output 200 ohm carbon with terminal lugs. \$1.49 ea. two for \$1.50.

**COILED CORD** 4 conductor 11" telephone cord. Extends to over 4 ft. .99 ea. two for \$1.00.

**KIT OF PARTS** for AM-FM VHF radio receiver. Tunable from 80-200 mc. which includes U. S. satellite frequencies. \$6.99 ea. two for \$7.00.

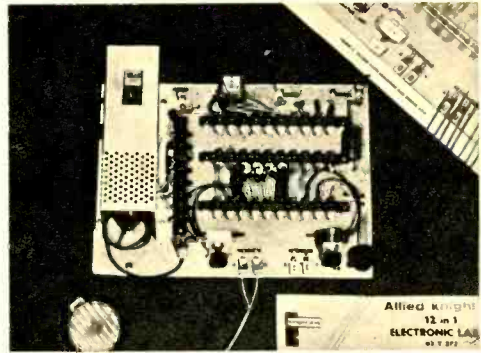
**SUPER SPECIAL:** 25 watt, 30 to 40 mc. crystal controlled FM radiophone mobile transmitter with 8 tubes and dynamotor power supply. Orig. cost over \$300.00. Can be converted to Citizens Band. Used good condition \$24.99 ea. two for \$25.00 F.O.B. Hollis, N. Y.

**LIMITED QUANTITY—NO LITERATURE OR CATALOG**

Remit in full. Include sufficient postage. No C.O.D.'s.

**VANGUARD ELECTRONIC LABS.** Box 12-EL7, Hollis 23, N. Y.

## ...News



Allied Radio has announced the new Knight-Kit 12-In-1 Electronic Lab Kit. The kit includes a low-voltage 12K5 tube, carbon microphone and building parts for any of 12 circuits. An audio amplifier, AM radio, wireless broadcaster, code practice oscillator and other projects may be built using the one kit. As a safety feature, no voltage on the kit board exceeds 25 volts and the power supply is shielded. All parts are permanently soldered in place. Circuits can be made and changed by just moving the jumper wires to different points on the terminal strips. An instruction manual including pictorial diagrams and the operational theory for each hookup is included. Stock number 83 Y 272 is \$14.95. 100 N. Western Avenue, Chicago, Illinois.



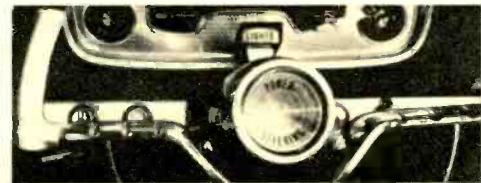
### GERMAN AUTOMATIC

6-SHOT REPEATER—22 CAL.

German Automatic, latest model 6 shot repeater, 22 caliber self ejecting clip, precision made by the finest West German Gunsmiths. Wonderful for sporting events, theatrical performances, would-be attackers, etc. 4" long, perfectly balanced. (Not available to residents of California.) Comes for \$6.95 ppd. from

### BEST VALUES

Department K-282, 403 Market St., Newark, N. J.



Electronic Light-Minder guards against parking your car and absently leaving the lights on. As soon as the engine is shut off, Light-Minder lights up indicating that either dims, parking or bright lights are on. Available in either 6 or 12-volt models, it may be installed in cars or trucks. Unit is made by the Unitron Corporation, Dade City, Florida and sells for \$5.00.



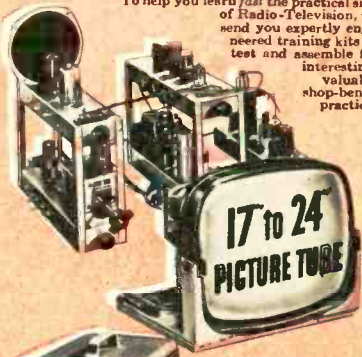
**WE'RE MAKING IT EASIER THAN EVER TO BECOME A WELL PAID  
RADIO-TELEVISION SERVICE TECHNICIAN**

**NOW - Just \$6 Starts You Training in  
RADIO-TELEVISION**

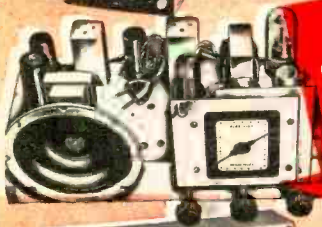
**the SPRAYBERRY "Learn-by-Doing" Way...**

**25 BIG, COMPLETE KITS  
of PARTS & EQUIPMENT**

To help you learn *(at the practical side of Radio-Television, we send you expertly engineered training kits to test and assemble for interesting, valuable shop-bench practice!)*



- The new Sprayberry Training Television Receiver, built and tested in 5 sections.
- Now offered... this fine modern oscilloscope.
- You build this powerful two-band superheterodyne radio receiver.



**Big New CATALOG AND Sample Lesson FREE!**



You build the new Sprayberry tester—a complete 18-range Volt-Ohm-Milliammeter test meter.

\*\*\* This great industry is begging for trained men... to step into good paying jobs or a profitable business of their own! Our new plan opens the doors of Radio-Television wide to every ambitious man who is ready to act at once!

Men by the thousands... trained Radio-Television Service Technicians... are needed at once! Perhaps you've thought about entering this interesting, top paying field, but lack of ready money held you back. Now—just \$6 enrolls you for America's finest, most up to date home study training in Radio-Television! Unbelievable? No, the explanation is simple! We believe Radio-Television *must* have the additional men it needs as quickly as possible. We are willing to do our part by making Sprayberry Training available for less money down and on easier terms than ever before. This is your big opportunity to get the training you need... to step into a fine job or your own Radio-Television Service Business.

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Only a limited number of students may be accepted on this liberal and unusual basis. We urge you to act at once... mail the coupon below and get complete details plus our big new catalog and an actual sample lesson—all free. No obligation... no salesman will bother you.

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Under world-famous 27-year old Sprayberry Plan, you learn entirely at home in spare time. You keep on with your present job and income. You train as fast or as slowly as you wish. You get valuable kits of parts and equipment for priceless shop-bench practice. And everything you receive, lessons and equipment alike, is all yours to keep.

**LET US PROVE HOW EASILY YOU CAN LEARN!**

Radio-Television needs YOU! And Sprayberry is ready to train you on better, easier terms, that any ambitious man can afford. *Just \$6 starts you!* Mail coupon today... let the facts speak for themselves. You have everything to gain. Let us prove the kind of opportunity in store for you!

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**Mail This Coupon Now—No Salesman Will Call**

**Sprayberry Academy of Radio-Television**  
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Please rush all information on your ALL-NEW Radio-Television Training Plan. I understand this does not obligate me and that no salesman will call upon me. Include New Catalog and Sample Lesson FREE.

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CITY..... ZONE..... STATE.....





## 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 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.

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

### 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<sup>50</sup>

### 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.

## Superior's New Model TV-50A GENOMETER

# 7 Signal Generators in One!

- ✓ R.F. Signal Generator for A.M.
- ✓ Bar Generator
- ✓ R.F. Signal Generator for F.M.
- ✓ Cross Hatch Generator
- ✓ Audio Frequency Generator
- ✓ Color Dot Pattern Generator
- ✓ Marker Generator

This versatile All-Inclusive GENERATOR Provides ALL the Outputs for Servicing:

A.M. Radio • F.M. Radio • Amplifiers • Black and White TV Color TV



**Model TV-50A GENOMETER . . .**  
Total Price \$47.50—Terms: \$11.50 after 10 day trial, then \$6.00 monthly for 6 months.

**R. F. SIGNAL GENERATOR:** The Model TV-50A Genometer provides complete coverage for A.M. and F.M. alignment. Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

**VARIABLE AUDIO FREQUENCY GENERATOR:** In addition to a fixed 400 cycle sine-wave audio, the Model TV-50A Genometer provides a variable 300 cycle to 20,000 cycle peaked wave audio signal.

**BAR GENERATOR:** The Model TV-50A projects an actual Bar Pattern on any TV Receiver Screen. Patterns will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars.

**CROSS HATCH GENERATOR:** The Model TV-50A Genometer will project a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shifting, horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

**DOT PATTERN GENERATOR (FOR COLOR TV)** Although you will be able to use most of your regular standard equipment for servicing Color TV, the one addition which is a "must" is a Dot Pattern Generator. The Dot Pattern projected on any color TV Receiver tube by the Model TV-50A will enable you to adjust for proper color convergence.

**MARKER GENERATOR:** The Model TV-50A includes all the most frequently needed marker points. The following markers are provided: 189 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc., (3579 Kc. is the color burst frequency).

The Model TV-50A comes absolutely complete with shielded leads and operating instructions. Only

# \$47<sup>50</sup>

**EXAMINE BEFORE YOU BUY!**  
**USE APPROVAL FORM ON NEXT PAGE**



# Superior's New Model 70 UTILITY TESTER® FOR REPAIRING ALL ELECTRICAL APPLIANCES and AUTOMOBILE CIRCUITS



Model 70—UTILITY TESTER  
Total Price...\$15.85 —  
Terms: \$3.85 after 10 day  
trial, then \$4.00 monthly for  
3 months, if satisfactory.  
Otherwise return, no ex-  
planation necessary.

## As an electrical trouble shooter the Model 70:

- Will test Toasters, Irons, Broilers, Heating Pads, Clocks, Fans, Vacuum Cleaners, Refrigerators, Lamps, Fluorescents, Switches, Thermostats, etc.
- Measures A.C. and D.C. Voltages, A.C. and D.C. Current, Resistances, Leakages, etc.
- Will measure current consumption while the appliance under test is in operation.
- Incorporates a sensitive direct-reading resistance range which will measure all resistances commonly used in electrical appliances, motors, etc.
- Leakage detecting circuit will indicate continuity from zero ohms to 5 megohms (5,000,000 ohms).

## As an Automotive Tester the Model 70 will test:

- Both 6 Volt and 12 Volt Storage-Batteries • Generators • Starters • Distributors
- Ignition Coils • Regulators • Relays • Circuit Breakers • Cigarette Lighters • Stop Lights • Condensers • Directional Signal Systems • All Lamps and Bulbs • Fuses
- Heating Systems • Horns • Also will locate poor grounds, breaks in wiring, poor connections, etc.



**INCLUDED FREE** This 64-page book—practically a condensed course in electricity. Learn by doing.

Just read the following partial list of contents: What is electricity? • Simplified version of Ohms Law • What is wattage? • Simplified wattage charts • How to measure voltage, current, resistance and leakage • How to test all electrical appliances and motors using a simplified trouble-shooting technique. • How to trace trouble in the electrical circuits and parts in automobiles and trucks.

Model 70 comes complete with 64 page book and test leads

**\$15.85**  
Only

# Superior's New Model TW-11 STANDARD PROFESSIONAL TUBE TESTER



Model TW-11 — TUBE TESTER ...  
Total Price \$47.50—Terms: \$11.50  
after 10 day trial then \$6.00 per  
month for 6 months.

- Tests all tubes, including 4, 5, 6, 7, Octal, Lock-In, Hearing Aid, Thyatron, Miniatures, Sub-miniatures, Novals, Sub-minars, Proximity fuse types, etc.
- Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TW-11 as any of the pins may be placed in the neutral position when necessary.

• The Model TW-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.

• Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large easy-to-read type.

• NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

## EXTRAORDINARY FEATURE

SEPARATE SCALE FOR LOW-CURRENT TUBES. Previously, on emission type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current

tubes has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

The Model TW-11 operates on 105-130 Volt 60 Cycle A.C. Comes housed in a beautiful hand-rubbed cabinet complete with portable cover.

**\$47.50**

# SHIPPED ON APPROVAL NO MONEY WITH ORDER — NO C. O. D.

Try any of the instruments on this or the facing page for 10 days before you buy. If completely satisfied **then** send down payment and pay balance as indicated on coupon. **No Interest or Finance Charges Added!** If not completely satisfied return unit to us, no explanation necessary.

### MOSS ELECTRONIC, INC.

Dept. D-613 3849 Tenth Ave., New York 34, N. Y.

Please send me the units checked on approval. If completely satisfied I will pay on the terms specified with no interest or finance charges added. Otherwise, I will return after a 10 day trial positively cancelling all further obligation.

Name .....

Address .....

City ..... Zone ..... State .....

All prices net, F.O.B., N. Y. C.

Model 70 ..... Total Price \$42.50  
\$12.50 within 10 days. Balance \$6.00  
monthly for 5 months.

Model TV-50A ..... Total Price \$47.50  
\$11.50 within 10 days. Balance \$6.00  
monthly for 6 months.

Model 70 ..... Total Price \$15.85  
\$3.85 within 10 days. Balance \$4.00  
monthly for 3 months.

Model TW-11 ..... Total Price \$47.50  
\$11.50 within 10 days. Balance \$6.00  
monthly for 6 months.

The specs are the proof... now your  
BEST BUY in  
ham gear is

**EICO®**



New

**90-WATT CW TRANSMITTER . . #720**  
KIT \$79.95      WIRED \$119.95

Conservative, highly efficient design plus stability, safety, and excellent parts quality. 80 thru 40, 20, 15, 11, 10 meters (popular operating bands) with one knob band-switching. 6146 final amplifier for full "clean" 90 W input, protected by clamper tube. 6CL6 Colpitts oscillator, 6AQ5 clamper, 6AQ5 buffer-multiplier, GZ34 rectifier. "Novice limit" calibration on meter keeps novice inside FCC-required 75W limit. No shock hazard at key. Wide range, hi-efficiency pi-network matches antennas 50-1000 ohms, minimizes harmonics. EXT plate mod. terminals for AM phone modulation with 65W input. Excellent as basic exciter to drive a power amplifier stage to max. allowable input of 1KW. Very effective TVI suppression. Ingenious new "low silhouette" design for complete shielding and "living room" attractiveness. Conservatively rated parts, copper-plated chassis, ceramic switch insulation. 5" H, 15" W, 9½" D.



**NEW UNIVERSAL MODULATOR-DRIVER #730**

KIT \$49.95      WIRED \$79.95      Cover E-5 \$4.50

Superb, truly versatile modulator at low cost. Can deliver 50 W of undistorted audio signal for phone operation, more than sufficient to modulate 100% EICO #720 CW Transmitter or any transmitter whose RF amplifier has plate input power of up to 100W. Multi-match output xmt matches most loads between 500-10,000 ohms. Unique over-modulation indicator permits easy monitoring, no need for plate meter. Lo-level speech clipping & filtering with peak speech freq. range circuitry. Low distortion feedback circuit, premium quality audio power pentodes, indirectly heated rectifier filament. Balance & bias adj. controls. Inputs for xtal or dynamic mikes, phone patch, etc. Excellent deluxe driver for high-power class B modulation. ECC83/12AX7 speech amp., 6AL5 speech clipper, 6AN8 amp. driver, 2-EL34/6CA7 power output, 6W4 over-mod. indicator, GZ34 rect. Finest quality, conservatively rated parts, copper-plated chassis. 6" H, 14" W, 8" D.

**NEW GRID DIP METER . . . . . #710**

KIT \$29.95      WIRED \$49.95 including complete set of coils for full band coverage.

Exceptionally versatile. Basically a VFO with micro-ammeter in grid; determines freq. of other osc. or tuned circuits; sens. control & phone jack facilitate "zero beat" listening. Excellent absorption wave meter. Ham uses: retuning & neutralizing amplifiers, power indication, locating parasitic osc., antenna adj., correcting TVI, debugging with xmitter power off, determining C.L.Q. Servicing uses: alignment of filters, IF's, as sig. or marker gen. Easy to hold & thumb-tune with 1 hand. Continuous 400 kc-250 mc coverage in 7 ranges, pre-wound 0.5% accurate coils. 500 ua meter movement. 6AF4(A) or 614 Colpitts osc. Xmtf-operated sel. rect. 2½" H, 2¼" W, 6¼" L. Satin deep-etched aluminum panel; grey wrinkle steel case.



**NOW IN STOCK!** Compare & take them home—RIGHT "off the shelf"—from 2000 neighborhood EICO dealers. For free catalog, mail coupon to EICO ad 2 pages forward. In the West, add 5%. Over 1 MILLION EICO instruments in use throughout the world.

33-00 Northern Blvd.,      Copr. © 1958,  
Long Island City 1, N.Y.      Electronic Instr.  
Co., Inc.

See EICO's other ad on page 26

## ... News

### New Booklets and Catalogs. . . . .

A new magazine containing information on application of ultrasonics has been published by Acoustica Associates. "Ultrasonings" is available free from 26 Windsor Avenue, Mineola, L. I.

"Now You Can Enjoy Hi-Fi and Stereo, Too!" is a new booklet by Blonder-Tongue, 9 Alling St., Newark, N. J. It is designed to answer your stereo and hi-fi questions.

The CBS-Hytron Technician's Handbook for 1959 contains up-to-the-minute information on electron tubes and semi-conductors. Features data on transistors, crystal diodes, receiving, picture and special tubes. May be obtained from CBS-Hytron distributors.

International Rectifier Corp. has a new catalog "Selenium Photovoltaic Cells," describing a line of self-generating photocells. It includes information about cell structure and operation, performance characteristics and applications. For free copy, request bulletin PC-649A, El Segundo, Calif.

An illustrated bulletin describing Kin Tel's closed-circuit television equipment is available from Cohu Electronics, 5725 Kearny Villa Rd., San Diego, Calif.

A new panel and flashlight lamp chart is available, free, from parts stores.

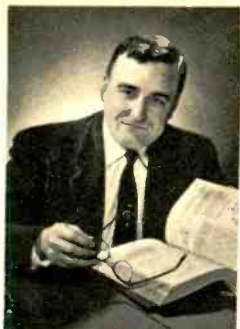
National Company's line of amateur and short-wave receivers is described in catalog RC-100, available from radio stores.

Seco test equipment and service aids are described in folder listing specifications and prices. Available free from Seco, 5015 Penn Ave., So. Minneapolis, Minnesota.

"Most-Often-Needed 1959 Radio Diagrams and Servicing Information" covering portable, clock radio, transistor sets, and other home radios is available for \$2.50 from Supreme Publications, 1760 Balsam Road, Highland Park, Ill.

Reprints of the article, "60 Watt Amplifier With a Silicon Rectifier Power Supply" are now available for the asking. It contains information on a simple circuit using silicon rectifiers for home construction. Triad Transformer Corp., 4055 Redwood Ave., Venice, Calif. ●

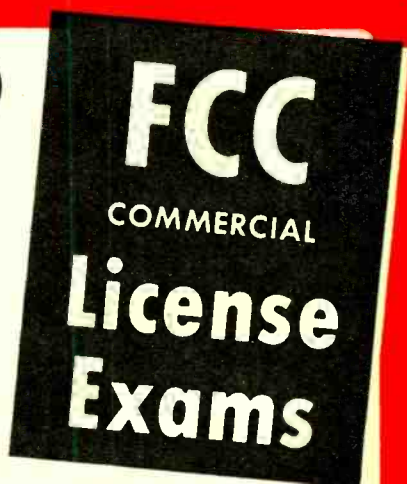
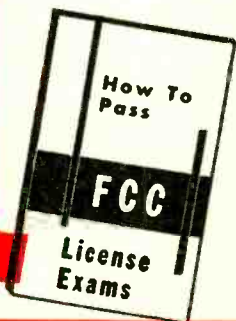




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# How To Pass

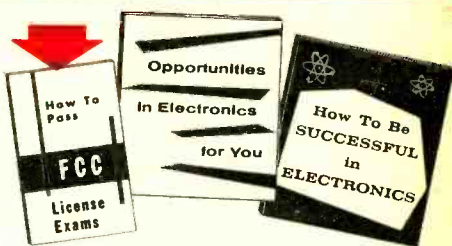


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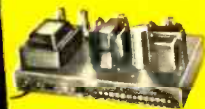
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See Page 24 for EICO's BEST BUYS in "HAM" GEAR.





## Cover Feature

Author chips coral from cannon he discovered in 15' of water behind Walkers Cay in the Bahamas. It was marked "1702."

# *hunting sunken treasure with* Underwater Metal Detectors

By **Elgin Ciampi** Member, Explorers Club

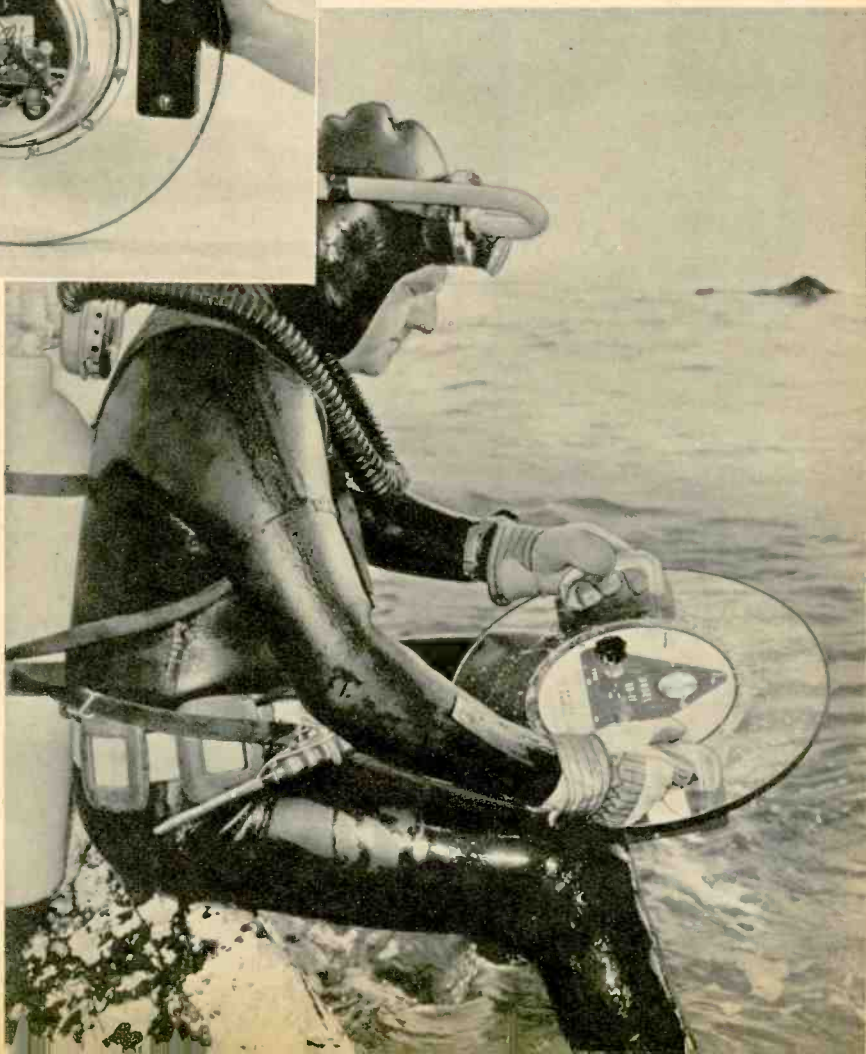
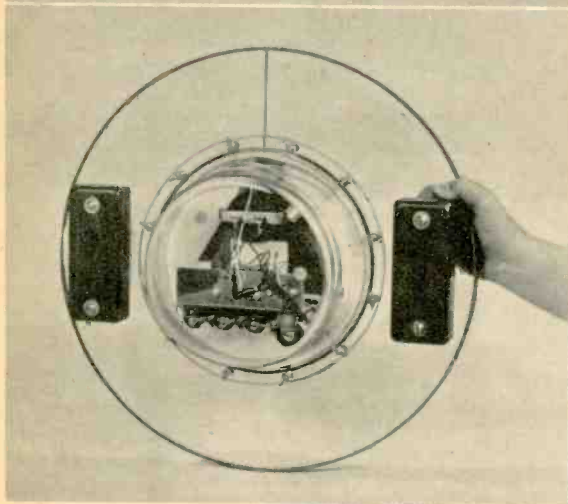
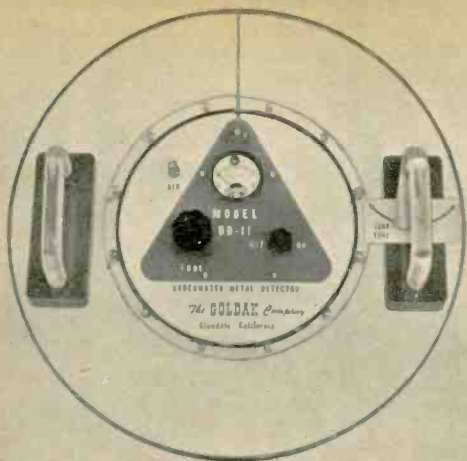
**Ancient fortunes, new thrills are within reach of skin divers who take electronics below the surface.**

**E**XPERTS say that one-fourth of all the gold and silver ever mined lies at the bottom of the sea—most of it lost in the long-submerged, coral-encrusted wrecks of Spanish galleons, men-o-war and pirate raiders. Treasure ships as far back as the 16th Century were known to carry gold and silver valued on today's market at between \$2-million to \$10-million. Some of these ships went down in very deep water and their treasure is lost forever. But many wrecks lie in shallow water (10-30' deep), well within the range of the aqualung diver.

Salvaging old wrecks once required a large boat, an experi-



Comparatively inexpensive at \$187, this metal detector, made by Goldak Co., Glendale, Calif., is battery-operated, compact and above all, waterproofed. It consists of a detection loop, transistorized oscillator-amplifier, and the indicating circuit. As the loop is brought near metals, an apparent change in frequency occurs which produces a change in meter reading. The clear plastic construction is not affected by salt water and has minimum buoyancy. The 18" diameter main disc carries the detection loop around its outer perimeter. Center section is shielded by a clear plastic "hat." The top face contains the main tuning control, fine tuning control, on-off switch, meter, pilot light and air valve for pressurizing. Detailed circuit operation is described in text. Below, diver in rubberized cold-water suit, will have no trouble taking the instrument below as weights are attached to underside of handles. If released underwater, detector will rise slowly to surface. Red triangle on white background makes unit easy to find.







**Fish-inhabited wreck, with its coral-encrusted ribs and ballast, is examined by curious diver.**

enced diving team and expensive equipment, and more often than not, the expense did not justify the gamble. Today, however, a skin diver needs only a small outboard, an aqualung, and simple hand tools. And with the help of an underwater electronic metal detector, he can have more than his share of treasure-hunting luck.

It is not very difficult to find a sunken wooden ship, especially in the Bahamas, near Caribbean islands, and along the East Coast of the United States. These areas boast many old pirate coves and hundreds of wrecks have been discovered accidentally by skin divers. Historical records of wrecks and sea battles are good clues. Submerged reefs in areas where there was once heavy shipping, are also good bets. Using the above methods, I personally have searched over 15 interesting sunken ships.

The common picture of a wreck has the ship mostly intact, heeled over on its side, with tattered sails in the rigging and chests full of golden doubloons spilling out of the hull. This is hardly an accurate picture. The wood almost



**Roscoe Thompson (right) and pal with home-made detector, turned up 72-lb. silver ingot.**

always has been eaten by teredo worms. All that remains is cannon, ballast rock, iron, brass work, pottery and, of course, the gold and silver.

All this is generally covered by a layer of coral and limestone many inches thick, and skin divers have a tendency to swim over fortunes without even knowing they're over a wreck. Here's where the electronic metal detector comes in handy. Most of the wrecks that have been found have never been fully explored despite the fact that many skin divers have been down to them. Once a wreck is located, a careful check will show objects with man-made lines visible through the coral crust. With an underwater metal detector, hundreds of innocent looking coral clumps can be investigated with a minimum of effort, for it is in this coral, and under sand, that valuables hide.

Much could be written regarding the theory of metal detection, but briefly there are four ways it can be done underwater: 1. acoustical; 2. magnetic; 3. electrical and 4. electromagnetic. The acoustical method (sonar, for instance) generates sound waves and times their travel from ship to ocean floor and back.



Man-made lines of cannon are an easily recognizable sign of wreck to skin diver. Here an aqualung diver hitches a ride to the surface.



After 200 years of silence, author retrieved ship's bell from sunken English man-o-war. It now summons dinner guests on Walkers Cay.

The response, displayed on a cathode ray tube, shows the contour of the bottom. A large metal object would show up as a deviation. The big disadvantage is that almost any useless object on the bottom also shows up as a deviation.

Magnetic detection systems are very costly. They measure the earth's magnetic field and a metal object distorts the field. Interpretation is very difficult. This is also true of electric methods. The latter involves the placing of electrodes in the water at varying potentials and distances from each other. A certain amount of ionization takes place as the system is moved over metal objects, but detection is very uncertain in salt water.

The method used by most portable underwater metal detectors, such as the Goldak Company's model UD-11, is the electromagnetic method. This particular model sells for only about \$187. More specifically, it uses a beat frequency oscillator with a single loop, the frequency of which is adjustable by an external control. The other oscillator is operated at a fixed frequency, in this case 100 kc. When the two oscillators are at exactly the same frequency they "beat" and no tone is produced (if phones are used). The meter reads zero. If you set the variable oscillator so that the frequency difference is about 300 cycles, the resulting tone will be heard on the phones or appear as a reading on the meter.

As metal approaches the instrument,

it alters the electromagnetic field of the fixed oscillator, in effect changing the frequency. The operator hears a different tone or sees a deflection on the meter's needle and knows that he has encountered metal.

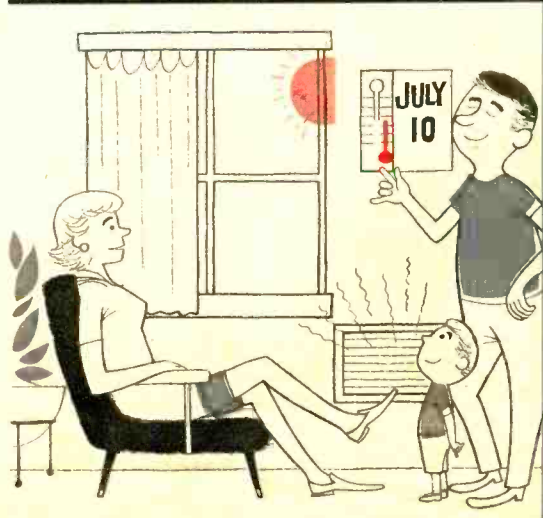
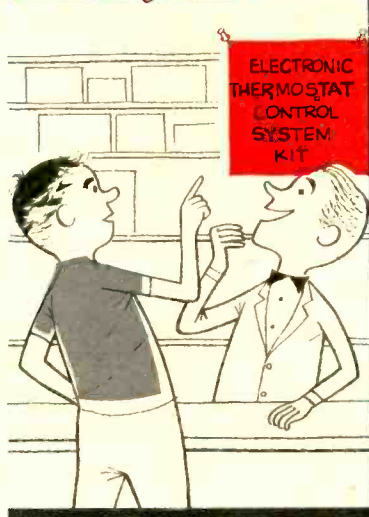
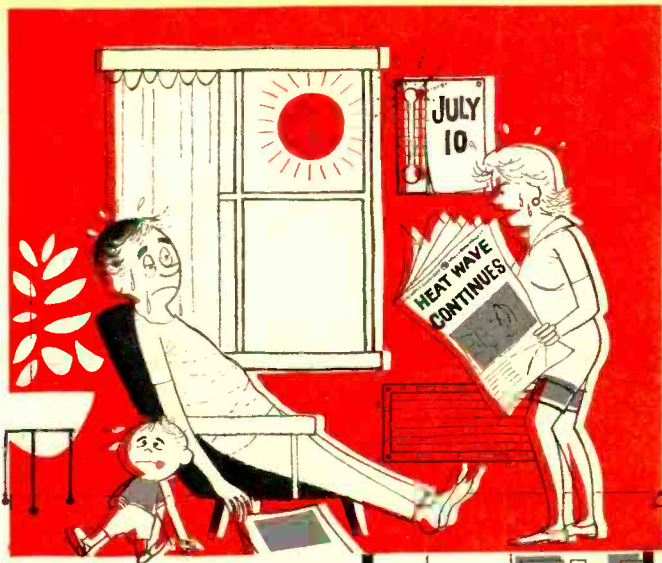
In water, this detection method is easiest to control. The range is somewhat limited, but for its purpose, adequate. The loop around the outside of the UD-11 is the antenna for the fixed oscillator. Its field extends a maximum distance of 10'.

The cannon and ballast rocks are the best identifying marks of an underwater wreck. When a ship hit a reef, it seldom sank on the spot. More likely it bounced along the reef, spilling out its insides along the way until it landed on the bottom. It was common practice during the days of the Spanish Main for captains to hide their gold and silver under a layer or two of ballast rock in the bilges to protect it from raiding parties. Experienced divers have learned that much in the way of valuables sifted down under the tons of ballast rock when a ship struck a reef. To remove these tons of rocks is quite a task.

The metal detector is a real time saver and very important to the skin diver whose time underwater is limited by his short air supply, weather, and water temperature. A skin diver using the detector in a systematic search of a wreck

[Continued on page 100]







# How To Learn Code

By Len Buckwalter, W2GKI

Associate Editor

**For the would-be "ham" there are many training aids, records and tapes to help him master code.**

Aside from disc-recorded courses, there is Tape-code. Two hours practice fit on tape at 3¾ ips, 2 tracks. Student may listen with speaker or headset.



July 1950 Electronics Illustrated





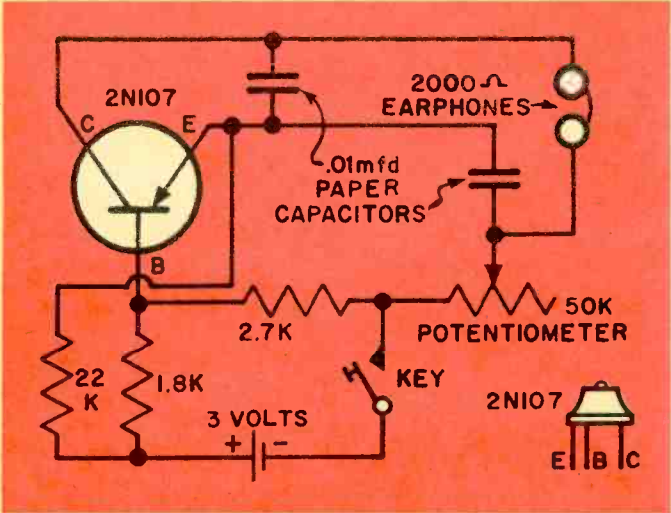
Side by side, young and old learn code and theory at 14-week Novice course offered by Allied Radio in Chicago. Over 100 students signed up for session.

**P**ERHAPS the greatest obstacle to getting a ham license is the code. It needn't be. You could team up with a friend and organize a two-man code class, but often it is inconvenient to meet regularly, and for a long enough period of time. However, this is about the most inexpensive approach and will certainly get you on your way. The necessary equipment includes a key, earphones, and a tone oscillator. There's a diagram for an oscillator you can build included in this article.

The alternative is a code course available on tape, disc, or keying machine. One of their chief advantages is perfectly spaced "dits and dahs" transmitted at the proper speeds.

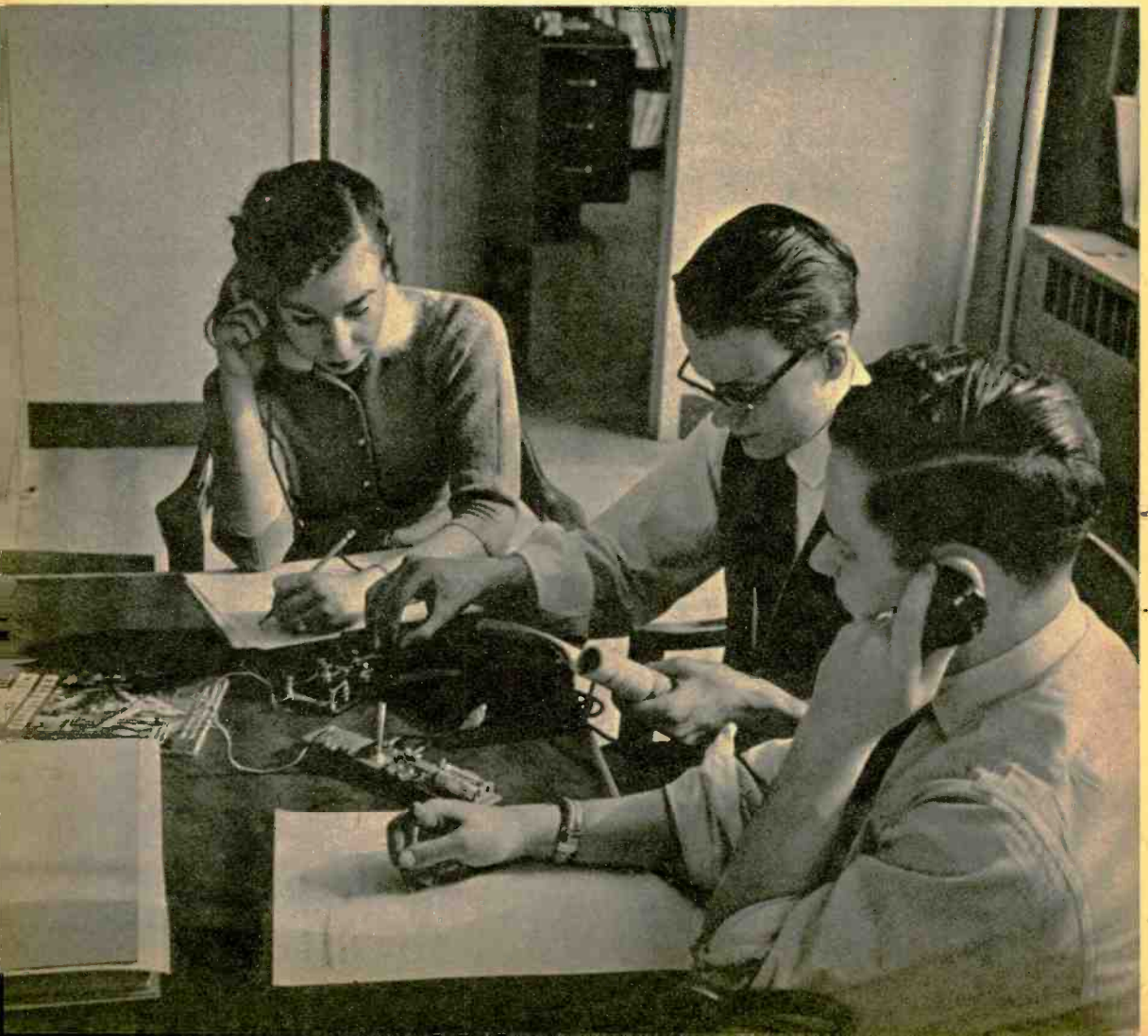
Experts agree that the real key to acquiring the code is *practice*. Repetition of the characters in time will enable you to respond with a reflex-type of action—no thinking involved. For this reason, memorizing the number of dits and dahs in a given letter is a hindrance. It adds an extra step. Each letter should be heard as a whole. As you read this sentence you see words, not separate letters.

Another pitfall is learning in alphabetical order. The result will be a *visual* memory, rather than an aural one. It's for this reason that the terms "dit and dah" are used rather than "dot and dash." The former words suggest the sound rather than



Extremely simple, inexpensive code practice oscillator may be built from this schematic. Will drive several earphones.

Oscillator, built on a piece of perforated board, is seen lying on table next to key. It is ideal for small groups.







**Instructograph is a punched tape, mechanical keyer, available on a rental or purchase plan.**

written-out dot and dash marks. The system used by the Signal Corps in training high speed operators is to teach groups of letters associated by their similarity. For example, E,I,S,H, and the number 5 all are comprised of dits. T,M,O, and zero are varying numbers of dahs. This continues with A,U,V, and 4, which have one dah followed by different amounts of dits.

Within the learning process, most beginners experience "plateaus." Progress does not increase smoothly. You might be stuck on three words per minute, then suddenly jump to double this speed. These plateaus are broken only by continued practice. Space your sessions to avoid overtiring.

Before describing the various code courses, here are some suggestions for learning with an oscillator and a friend. First, group all the letters and numbers according to their similarity. In addition to the ones already mentioned there are N,D,B, and 6. Continue on with these groupings until all letters and numbers are accounted for. Rather than reproduce the groups here, it is suggested that the student do it himself to get some idea of how the code is structured.



**Flashcards supplement the Rider code records. On rear of "R" card is dit and dah equivalent.**

Once this is done, start with the simplest group. The "teacher" says "E" and sends a dit. The student then writes it down. Once the letter is known, the teacher should just send the code character without uttering the name of the letter. Continue this, adding letters, repeating more often the ones that are consistently written incorrectly.

Letters that are missed by the student, as he is receiving, should be ignored. Otherwise several successive letters will also be missed. As skill increases there will be fewer "holes" in the copy. Learning code is not a process of thinking—it is one of conditioning.

Progress at the higher speeds occurs if the code is transmitted at a rate just beyond the capability of the student. If clear text is being sent, as opposed to code groups, try not to anticipate the ending of the word since you will err a good deal of the time. Finally, before taking an examination for a license, be able to take solid copy at a rate that is a few words faster than the actual test (5 wpm for Novice, 13 wpm for General). This will compensate for nervousness you might experience during the exam.

*[Continued on page 96]*

# how to install A TV Antenna

**Restore the missing quality to your TV picture with a properly selected, installed, and oriented antenna.**

**S**NOWY pictures, washed-out detail—ghosts? Chances are that a good antenna will restore the missing quality to your TV picture. A well-planned installation will also minimize the slanted lines of co-channel interference, fading, and the brilliant white flashes caused by broken connections.

Think of an antenna as an extension of the set. It reaches up to intercept signals radiated by the TV station. The principles involved are just as delicate and balanced as any component within an actual TV chassis. It must snare a few millionths of a volt and induce them down the lead-in wire to the set.

Installation begins right here, on the ground. Mentally, fly a crow to the TV broadcast station (avoid the downtown studios which may be miles away from the site). Mark off the line in miles; 20-50-75-150. Find yourself on this line to determine if you are in a primary, secondary, fringe, or deep fringe area. This is helpful, especially when confronted with a baffling array of antenna types to choose from. Each antenna fits into one of these fairly basic groups, to be described.

But first, a look into how the signal behaves. If you were able (like the broadcast consulting engineers) to fly around in an airplane and observe the readings of a field strength meter, you could plot out beautiful circular patterns showing how the signal weakens with distance. But, back on earth all sorts of difficulties appear. The first is obstruction. In the VHF (very high frequency) region, where channels 2 through 13 are situated, physical blocking by man-made or natural structures reduces

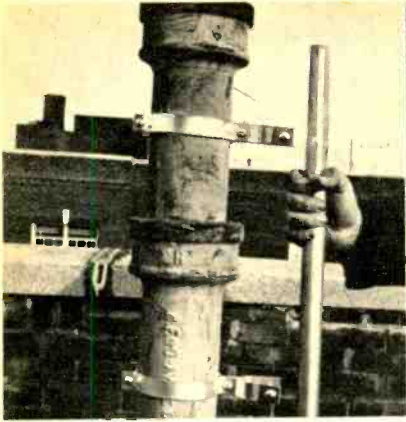
**Typical antenna package. When removed, the elements are snapped in place.**

**Holes in brick can be made by a star drill, rotated after each hammer blow.**

**Brackets are held to brick by screwing lag bolts into lead shields placed in holes.**



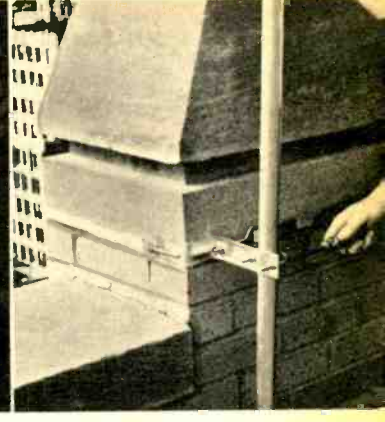




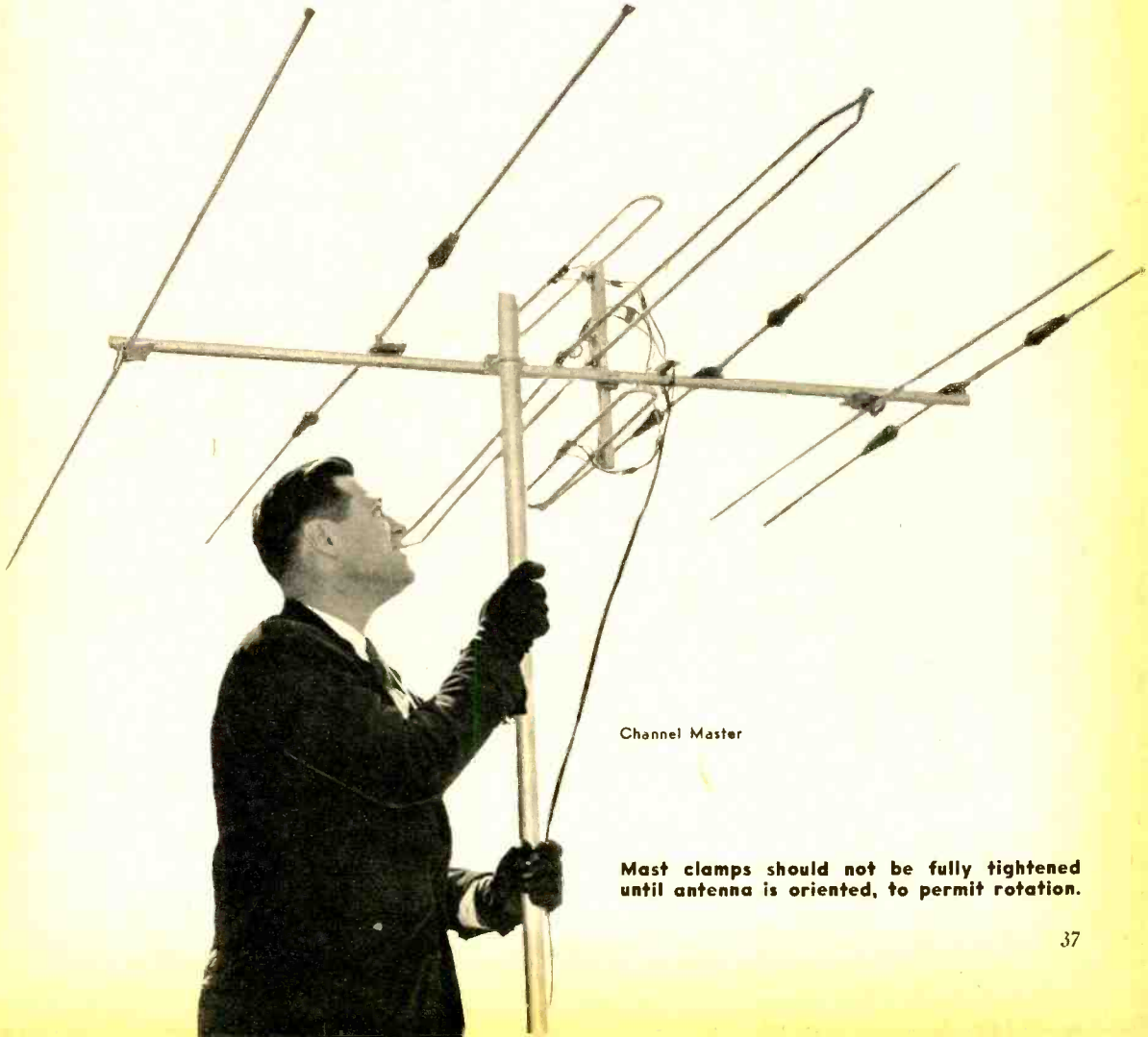
**Vent-mount brackets are easily installed on a pipe, standard size is 4-inch.**



**Brackets for chimney mount come with two metal straps usually 10 or 12 feet long.**

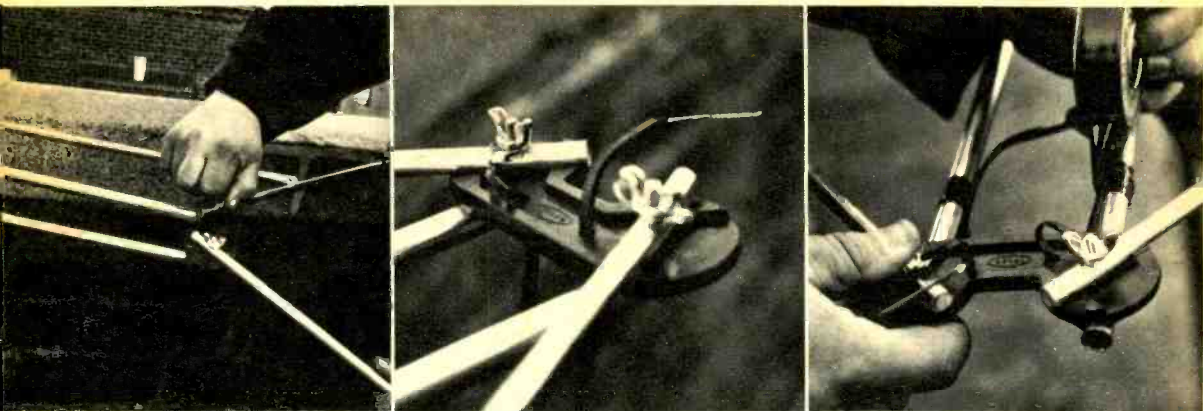


**After the straps have been tightened, mast is fastened to brackets by U-clamps.**



**Channel Master**

**Mast clamps should not be fully tightened until antenna is oriented, to permit rotation.**



**Do as much assembly as possible before fastening the antenna to the mast.**

**Lead-in wires are connected under wing nuts. A washer should be placed under nut.**

**Each lead-in wire should be secured by plastic friction tape for strain relief.**

the signal. This is more pronounced in UHF (ultra high frequency) TV. Leafy trees or even humidity can cause an attenuation to occur.

Next is reflection, one of the main reasons for ghosts, more precisely termed "multiple images." What happens is that the antenna receives a direct signal, then, a brief instant later, is struck by a reflected signal that has bounced from some nearby surface. In effect, the set is displaying two or more images. Reflection can be useful when the signal angles down to an antenna sandwiched between tall buildings. Narrowing down a source of undesirable reflection can be difficult. One known case was discovered to synchronize perfectly with the daily passage of trains just within sight of the antenna. Fortunately, antenna manufacturers have devised antennas that receive only a narrow arc, thus rejecting the reflected signal.

The most apparent aspect of the signal, touched on before, is strength. In primary areas, a "rabbit ears" atop the set may suffice. But it can be annoying to reposition it each time the channel is changed. The superior types incorporate a switch to afford a better "match" into the set. If you do use an indoor type, explore the room with it. The signal could be cancelling itself out in one specific spot.

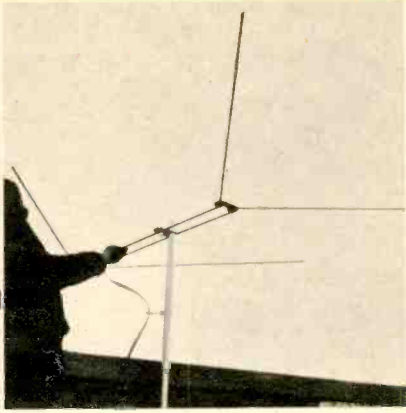
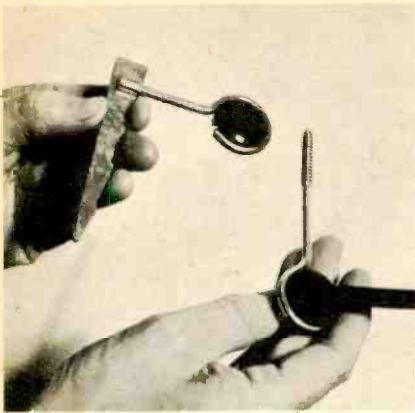
The more distant your location, the more elaborate antenna type required.

Multi-element antennas intercept more of the available signal. Obviously, height is valuable. In the fringe areas it is a virtual necessity since the signals travel "line of sight" and refuse to bend with the earth's curvature. The mast must project up into the prevailing field. The straight-line path of signals becomes serious at roughly 50 miles out. Appraise your location on the basis of signal strength and you're prepared for the next step—selecting the type of mounting.

A typical TV mast is sold in five-foot sections. Slide two together and you reach the maximum height of ten feet—without the need for guy wires. A five footer goes nicely atop an apartment house but in some areas local regulations state that the antenna elements be at least six feet above the surface of the roof. It is a good idea to use the 10 feet anyway to reduce interaction between the antenna and nearby surfaces. It also permits the lead-in to run straight down the mast, another desirable practice. This prevents the lead-in from acting as an antenna element itself, and thus disturb the reception pattern.

The large number of antenna mounting brackets available enable you to fasten the mast in almost any conceivable location; chimney, wall, eave, pipe, peaked and flat roofs (see the illustrations). Literally hours can be saved if you select a convenient type of mount.

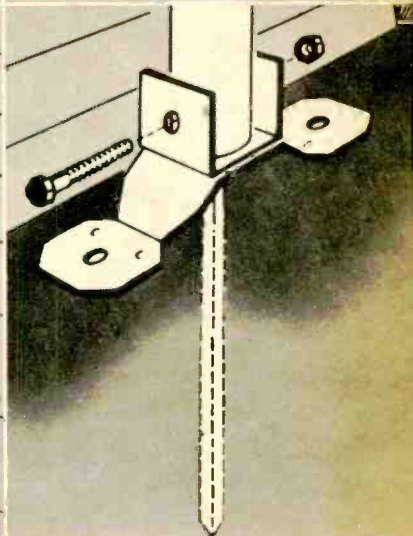
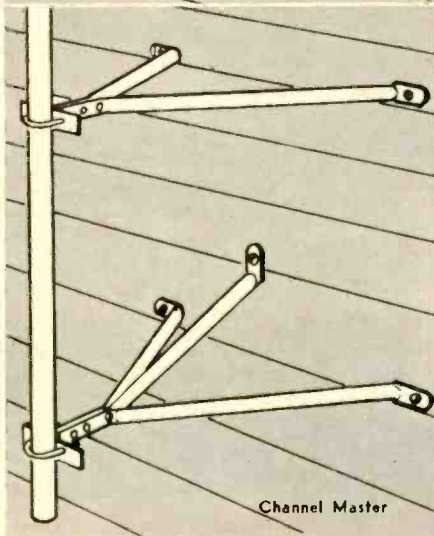
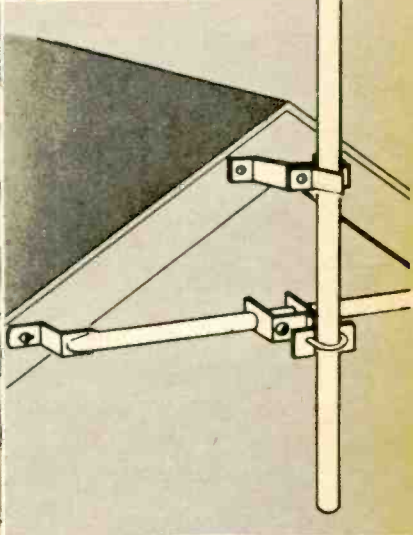
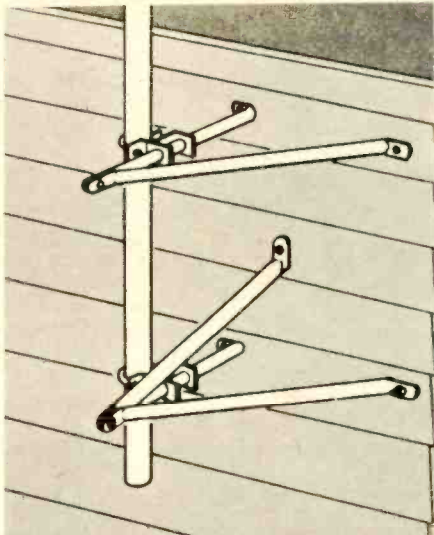




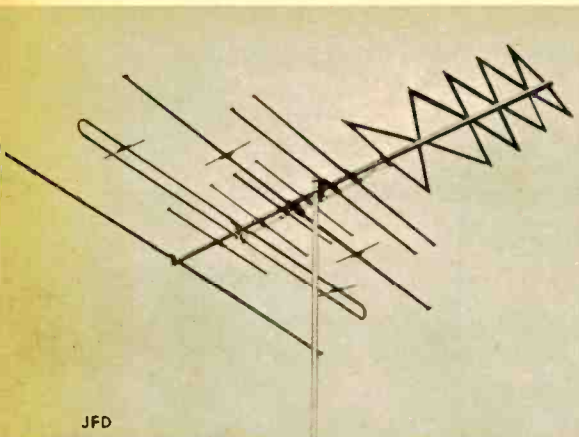
Two kinds of standoffs may be used to insulate leadin; concrete nail and wood screw type.

Note the clip-on type standoff on mast to lead wire down. Antenna is double-V type.

Various types of antenna mounts. The two at the left are wall type. In the upper one the distance of mast to wall is adjustable. Eave mount is at upper right, ground type below it.



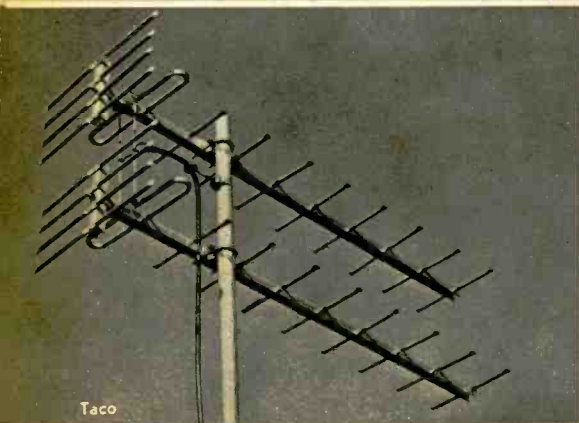
Channel Master



JFD



JFD



Taco

Wide band VHF antenna, upper left, uses helix-type front elements for channels 7-13.

Typical UHF "bowtie" antenna with corner reflector, top, is aimed toward transmitter.

In far fringe areas, good reception may require two yagi antennas, stacked as at left.

Hammering a star drill into a brick wall with a chimney just a few feet away is a waste of energy. Chimney straps can be slipped on and tightened in a few moments. Try to avoid a mounting site that requires wood screws driven directly into the surface of the roof. This can lead to water leaks.

Don't overlook the possibility of locating the antenna in an attic, just below the roof. Since enough signal might be present there, it certainly is worth a try. You'll avoid the deteriorating effects of wind and corrosion.

Without doubt, *safety* is the most important factor to be keenly aware of during your installation. There is no need to emphasize the injury that could result in a fall from a roof or ladder. But, an equally dangerous situation exists—accidental contact with power lines. A metal mast or antenna is an excellent electrical conductor. As you

handle them, your effective reach is increased by several feet. If you are not wary you may unwittingly strike bare electrical cables that run in the vicinity of the roof. Remember that the service entrance for the house current is usually located high up on the building. Watch where you swing those elements!

The myriad of antenna types on the market can be divided into several groups. The very simplest is the dipole, consisting of a horizontal rod cut in the center for attaching the two lead-in wires. Actually, the term "folded dipole" is more apt here since it matches the TV set more closely. If you look at the most complex antennas you should be able to discern the basic folded dipole (it looks like two trombone sections joined at their open ends). The gain of complex antennas is based on reference to the basic dipole.

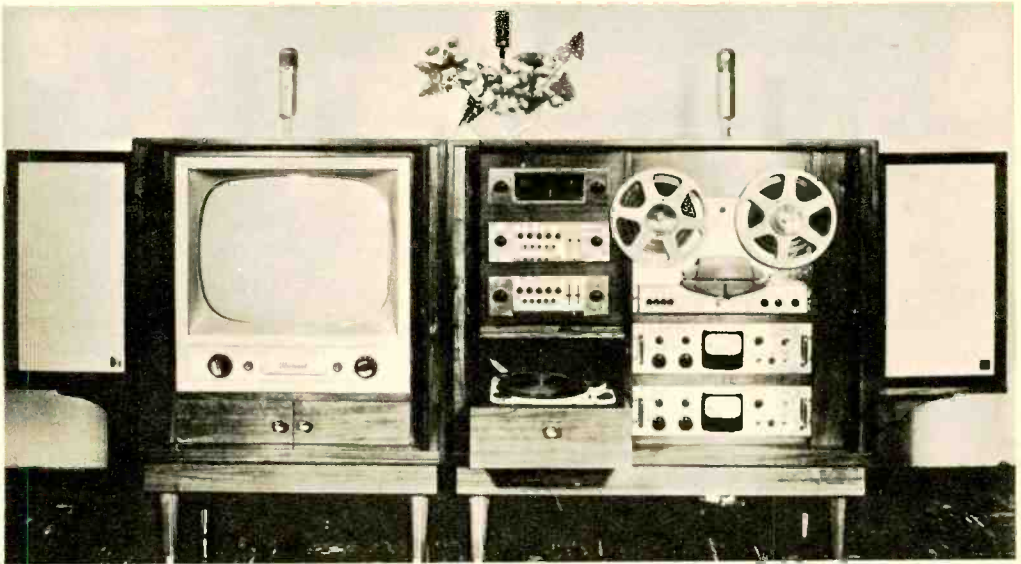
[Continued on page 102]



Here's a complete stereo reproduction system set functionally into a wall decorated with white ash panelling. Easy access to all the components is accomplished through fold-back, shutter-type doors. Designed by Robert C. Sands, the heart of the rig is situated in the lower right-hand compartment that houses two McIntosh 30-watt amplifiers. A special touch-latch on the front panel opens that section of the installation. A Scott 330-C stereo tuner and a Scott 130 stereo preamp (in the upper right section) cover almost any broadcasting eventuality. Disc recordings get double treatment. Below the tuner is a Rek-O-Kut B12 turntable with a matching stereo arm and a G-E GC-7 stereo cartridge. Also, for automatic record playing, the system uses a Garrard RC88-4 changer with a G-E monophonic cartridge. Without room for free-standing speaker enclosures, special soffits of  $\frac{3}{4}$ " plywood were affixed on the wall to the right. Two infinite baffle arrangements each contain a 12" Lansing woofer, and a crossover and tweeter of the same make. The Zenith TV rides on ball-bearing casters. Cost of entire rig is in excess of \$1000.

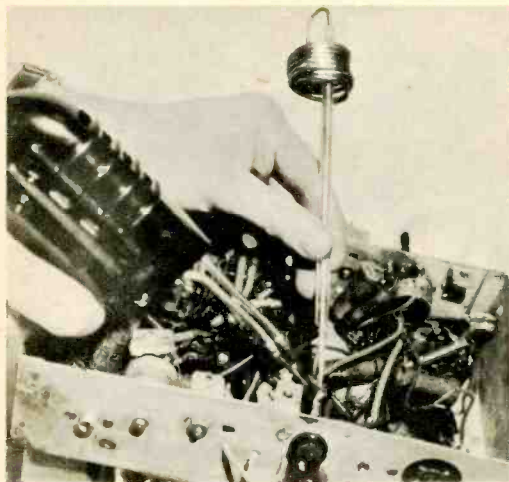


## Two Stereo Installations



This custom-built sound system is owned by Dr. Henry Weeth, a Seattle dentist. The walnut cabinet houses a Magnecord M90 stereo tape unit that will record and replay any sound played through the system. For recording there are no less than four mikes, two Telefunken U47 and two Sony condenser types. Two pairs of direct wires from an electric organ are also fed through the mixing panel. The AM-FM tuner, adaptable for multiplex, is a Fisher Series 80. Master controls are also Fisher, and two 60-watt amplifiers, not visible, are also part of the audio system. AR-1 speakers flank the cabinet and the Fleetwood television. Push button controls make it possible to play and record combinations such as radio and organ, with echo effects. Total cost is in excess of \$5000.

# Try These

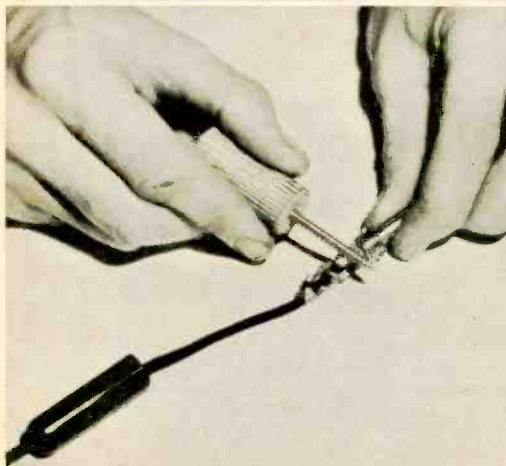
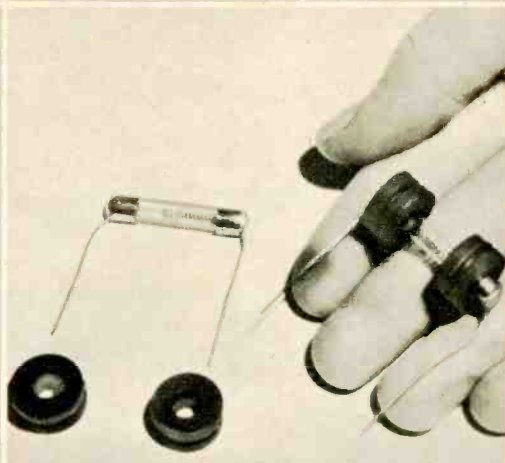


## Soldering Aid

A short length of plastic tubing will serve as a convenient holder for solder. The solder is pulled through, feeding from the top as shown. The plastic also serves as an insulator if the circuit is "live."

## Fuse Insulation

The bare metal caps of a pigtail-type fuse may short out adjacent wires. To prevent this, remove it and slip two rubber feed-through type grommets over the caps. They will act as "bumpers."



## Solder File

When an ordinary file is used on solder the teeth tend to clog up. An effective file may be made by driving a long wood screw through a length of wood dowel. It's good for other soft materials, too.





Dr. Singer tells *EI* about the difficulty of getting data to prove his theories. This interview was taped on the Transitaape unit.

# All About Radiation Belts

**They may be our major defense against intercontinental ballistic missiles—here is what they are.**

**O**N August 27, 1958 the U.S. Navy missile-test ship *USS Norton Sound* sent aloft the first of three atom-bomb tipped rockets to start Project Argus. Nearly eight months later the world learned that these bombs had exploded 300 miles above the earth and sent out electrons to form something called a "radiation belt" around the earth for several days. We knew it had existed because the geiger counter tubes in the Explorer IV satellite, orbiting through the belt, detected its presence. This experiment may indicate a defense for intercontinental ballistic missiles or may lead to more reliable communication but, for the present, it confirms a theory long expressed by Dr. Fred Singer, of the University of Maryland, who predicted in early 1957 that radiation belts could be formed. Actually the earth is even now surrounded by two radiation belts which may be the cause of the auroras and may influence space travel. To learn more about this, *EI* visited Dr. Singer in Washington, D.C. and made the following tape interview.

**Ques.**

*Dr. Fred Singer, exactly what is your connection with radiation belt research?*

**Ans.**

Theoretical, as Professor in the Physics Department at the University of Maryland, I supervise post graduate research. We are mostly concerned with upper atmosphere and cosmic ray research. I have worked in this field for about 13 years.

**Ques.**

*Is some of the research you do government supported?*

**Ans.**

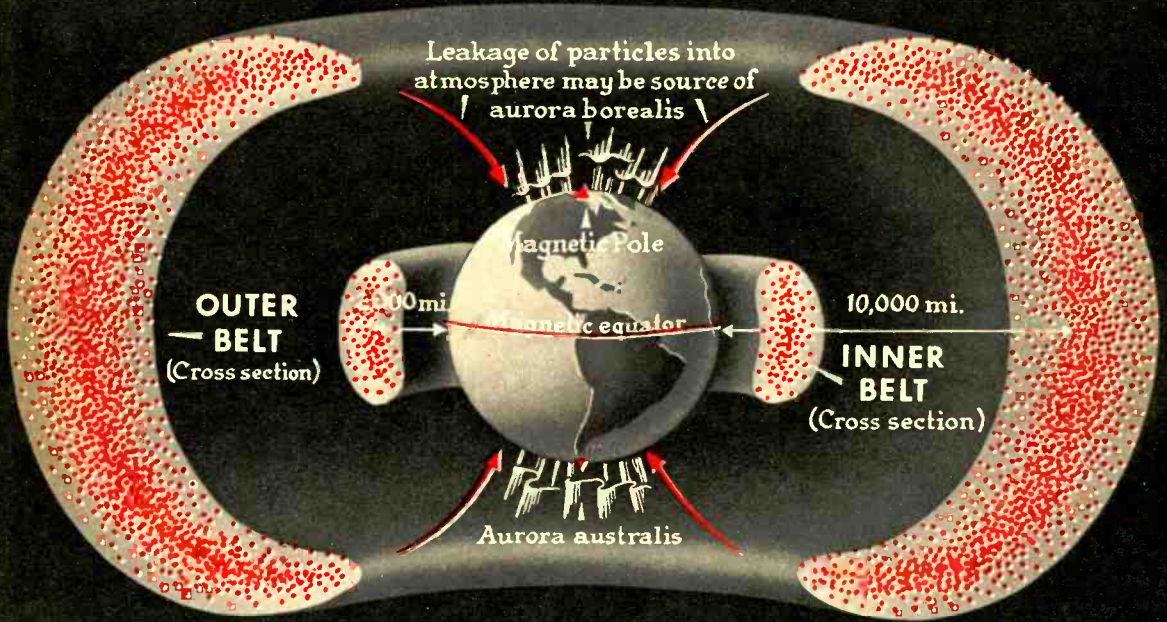
Practically all of it is supported by various governmental agencies and departments.

**Ques.**

*Dr. Singer, because of the news of Project Argus in which the United States exploded three atom bombs 300 miles up, the term radiation belt has become prominent. Could you tell us just what these radiation belts are, what they consist of?*

# RADIATION BELTS

(Maximum radiation intensity of charged particles equals 10-100 roentgens per hour)



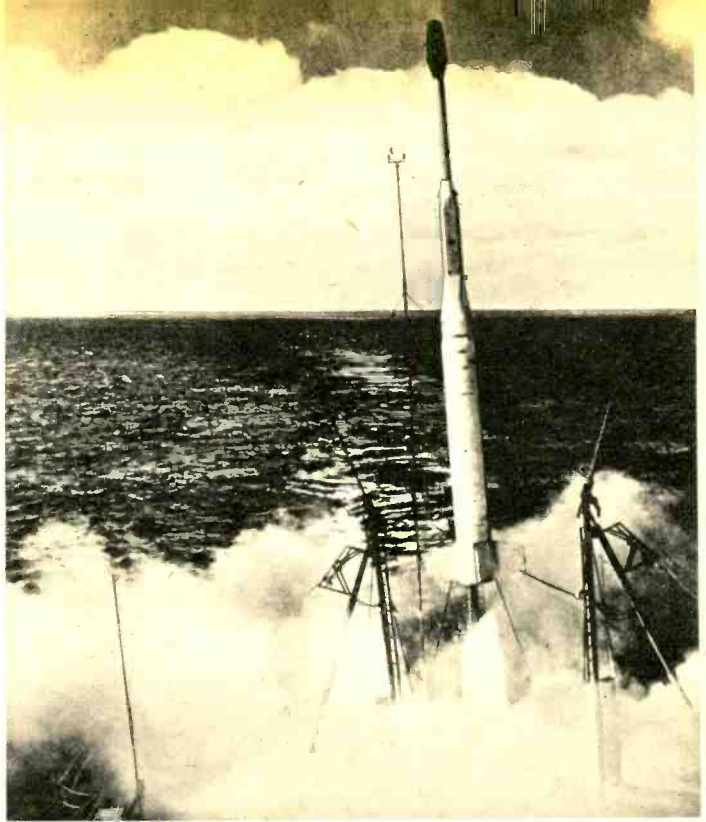
by R. M. Chapin, Jr.

Ans.

First of all, they consist of charged particles which are trapped in the earth's magnetic field. I personally became interested in the subject a few years ago at which time I hypothesized that such trapping of particles could occur in the earth's magnetic field in order to explain the auroras. This trapped radiation is believed to come from the sun and consists of fast protons and electrons moving with about one-hundredth the speed of light. Once they enter the earth's magnetic field they stay there for appreciable periods of time. Now the first discovery of such trapped radiation at the equator by the Explorer satellite came as a surprise to me because I thought it would exist only near the poles, where the auroras are, and should extend from these outward in an arc roughly following the earth's magnetic lines of force. Therefore, according to my hypothesis, at the equator this belt should have an altitude of something like 20,000 miles. However, when trapped radiation was discovered at only 500 miles above the equator, this led me to think there must be another way radiation is introduced into the earth's magnetic field where it can become trapped. And one theory which I've been particularly interested in working out is that cosmic rays produce the equatorial radiation belt at low altitude by a very peculiar process. Cosmic rays as you know are very high energy particles which come from somewhere in the cosmos, partly from the sun, but mostly from supernova in our galaxy. Anyway, they finally reach the earth's atmosphere where they smash up some of the atmospheric nuclei. In this breakup



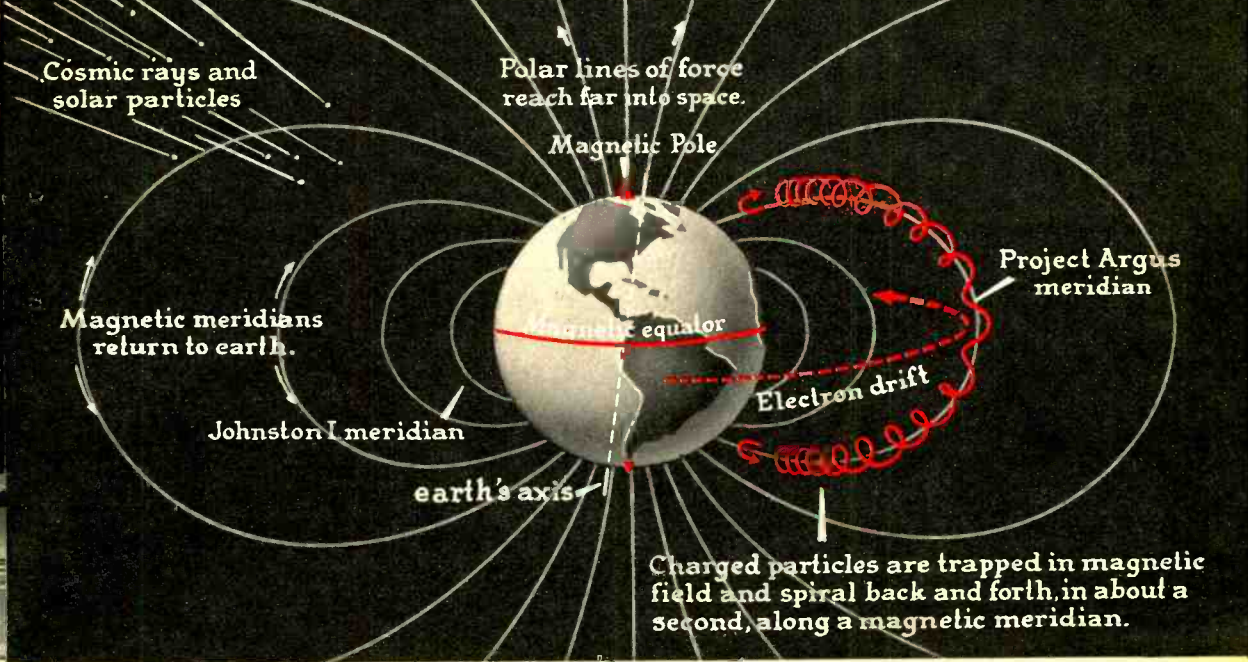
During Project Argus, three solid fuel rockets similar to this one were fired from sea to an altitude of 300 miles. There, the atom bomb on its nose exploded, releasing electrons which raced around the world, forming a shield around Earth.



Courtesy TIME; copyright Time Inc., 1959

# MAGNETIC TRAP

(Lines of force of earth's magnetic field shown in gray)



# PROJECT ARGUS

**MAN-MADE SHELL OF RADIATION**  
(Aug.-Sept., 1958)

**2** Electrons created man-made aurora when they hit atmosphere.

Two Johnston I. explosions 100 mi. up

Electron drift

Magnetic equator

Missile ship Norton Sound

Aurora seen from Samoa

**3** Band of electrons enveloped earth in an hour.

**1** Three atomic explosions 300 mi. up sent electrons racing back and forth along magnetic meridians.

by R. M. Chapin, Jr.

Courtesy TIME; copyright Time Inc., 1959

**Ques.**

*In other words, then, around the equatorial latitude the radiation belt probably consists to a great extent of trapped protons.*

**Ans.**

We cannot say for sure what these particles are. Experimental results show the presence of trapped radiation, this could be electrons, protons or X rays. One thing that speaks very strongly for my particular hypothesis is the fact that I predicted two belts and two belts have now been found.

**Ques.**

*The low altitude belt would consist of energetic protons, the high altitude belt. . . .*

**Ans.**

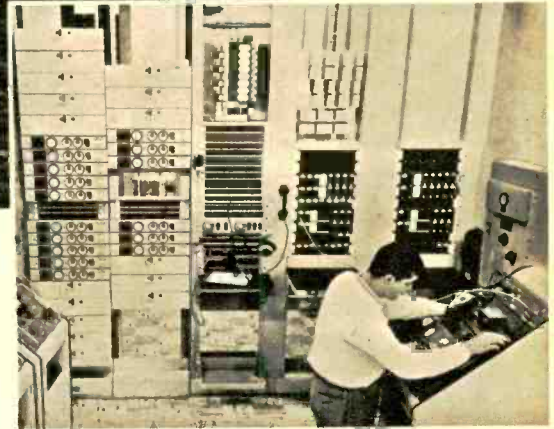
. . . would consist of rather low energy particles, electrons and protons. The significance of this conception lies in the fact that the inner belt is hard, by this I mean that it consists of particles with great penetrating power, and the outer belt consists of particles which have very little [Continued on page 90]





Historical first: Men from the U.S. Navy's radar picket ship, USS Roy O. Hale, upper right, prepare to board the Soviet fishing trawler Novorossisk to investigate damage to five American trans-Atlantic cables 120 miles off the coast of Newfoundland. Their findings stirred an international controversy that is not yet decided, and proved that our communications links to Europe are not quite as good as they ought to be.

Intricate switching, testing and power equipment is located inside cable terminal on this side of Atlantic at Clarendville, Nfd. From this station, personnel can determine exactly where along the ocean floor a cable has been damaged, and extent of damage.



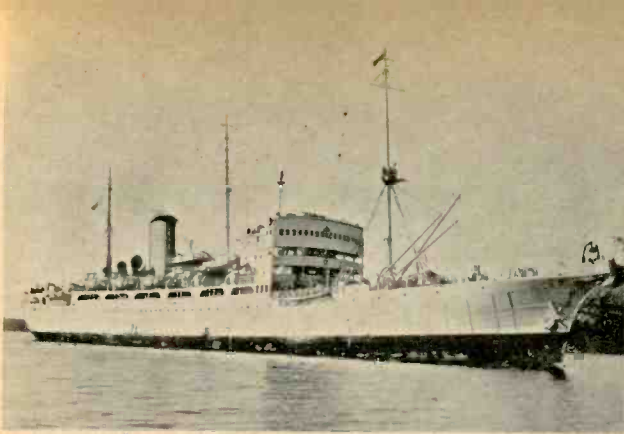
## We Can Be Cut Off from Europe!

By K. C. Kirkbride

**Potential enemies can cut our cables and jam our broadcasts. But there is a way we can get through.**

**T**HE skies overhead were grey and sullen, the seas churning. The day before, a United States communications company plane had flown over the Russian fishing trawler, Novorossisk, told it to move out of the area. Now, on Thursday noon, February 26, 1959, the United States radar picket ship, USS Roy O. Hale, pulled to within flaghoist distance of the Soviet trawler and raised its signal flags:

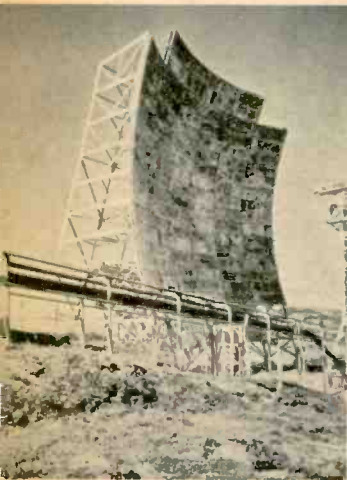
"Heave to: we are sending boat."



The Monarch, left, is the largest cable-laying ship in the world. She has placed over 4,000 miles of underwater voice cable which, to the Defense Department's recent consternation, can easily be cut by innocent-looking fishing trawlers.

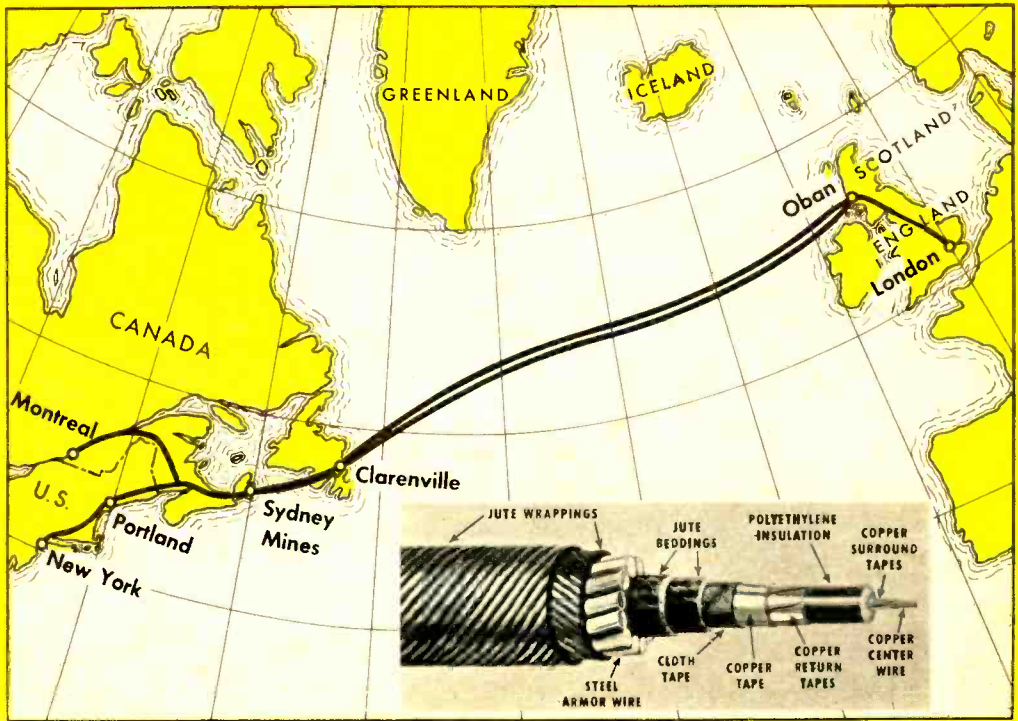


Cable aboard the Monarch is kept in one of four huge cable tanks such as one at left. Operated by American Telephone and Telegraph Co., she can carry about 2,000 miles of cable at one time. The present submarine cables cost over \$42-million.



In tropospheric "scatter" propagation, microwave radio signals are beamed outward toward the layer known as the troposphere, and are reflected back to earth. Microwaves have high signal reliability and are generally free from interference. Because of highly directional beaming, they are very difficult to jam, and only a minute portion of the signal is actually received. Sensitive amplifiers are required. Huge antennas, such as square "movie screen" at left, are part of a scatter communications system with Cuba that can handle remarkable volumes of traffic, including TV. Parabolic antenna, right, links Spain and Italy with direct service.





The route of the trans-Atlantic voice cable is shown on map above. The 2,250 miles from Clareville to Oban are spanned by twin repeater cables. Cutaway diagram shows intricate make-up of cable. Impervious to teredo worms and moisture, it still can be cut by trawlers.

A young American, Lieutenant Donald M. Sheely from Fairmount, Minnesota, and his party of four unarmed enlisted men climbed into the Hale's motor whaleboat. Minutes later they clambered up the Jacob's ladder of the Soviet ship.

A parka-clad skipper stepped forward to greet the American boarding party. On board the 1,670-ton Soviet trawler, there were 54 people, men and women, dressed in the heavy, quilted clothing of fishermen. They were neither friendly nor hostile. After a 70-min. inspection of the ship's log and trawling gear, Lieutenant Sheely and his men returned to the Hale.

Then the controversy started.

The Soviet fishing trawler had been in the Grand Banks area, 120 miles Northeast of St. John's, Newfoundland, for five days. In those five days, five United States trans-Atlantic cables had

been cut! The Soviet ship's trawling gear had been damaged. It had aboard a 2,500' to 3,000' sounding cable, with a six-pound iron cylinder at the end of it. The ship carried "excessive" radio equipment for a fishing venture. And a bespectacled, commissar-type gentleman in a brass-buttoned uniform took pictures of the Americans as they came aboard.

The cutting of the cables led to immediate military alert. Sheely told reporters: "I believe it definitely possible and probably quite likely the trawler had something to do with breaking the cables."

Pentagon sources said it was highly unusual to have five cables of the AT&T, and the Western Union companies cut within five days, all in the same area. Cable company officials said it wasn't unusual for fishing trawlers to damage

[Continued on page 92]



Cable from headset to amplifier may be any convenient length. If desired, a 4-terminal plug and socket can be inserted in the line for quick removal.

# \$7 Stereo Hi-Fi Headset

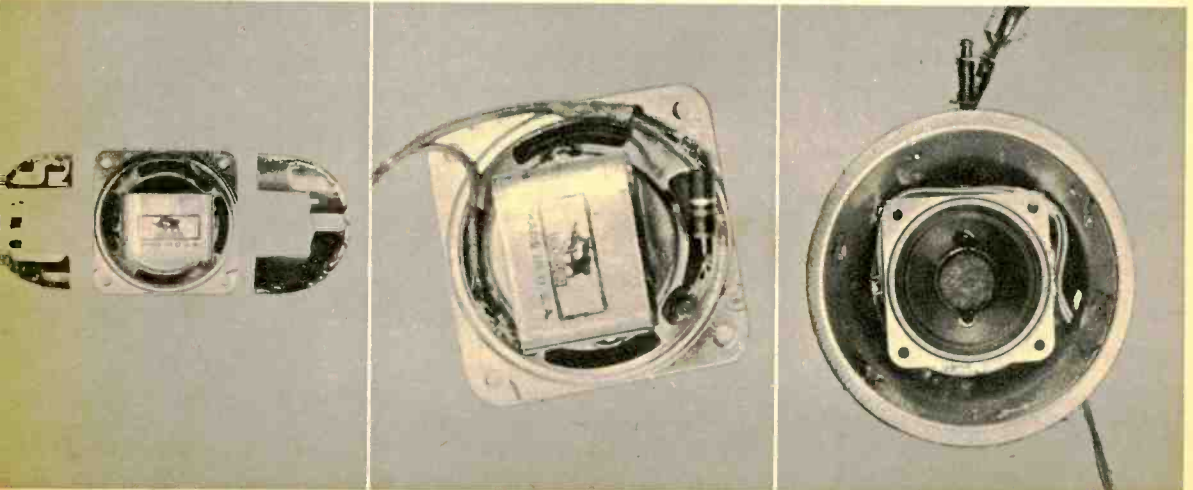
By H. R. Emison

Two tiny speakers, easily mounted in earphone style, form an excellent accessory for stereo listening.

Cut collar from a coffee tin to fit snugly on the speaker magnet frame (at center).

Wire the resistor to one speaker lug and tape any bare wire to avoid shorts.

Install speaker by soldering its collar to pie tin. Note where the two wires emerge.





**T**WO-INCH speakers mounted in earphone style can give surprisingly good sound. This arrangement compares very favorably with commercially available headphones for stereo and can be built in about three hours. You can use them with monophonic systems for the interesting effect of surrounding yourself with sound. They also enable you to enjoy your records or tuner during the late hours of night, or other occasions where conventional speakers would be objectionable.

Begin construction by cutting a hole in the back of the pie tins to fit the magnet frames of the speakers so the two will slip together without difficulty. Then cut two pieces of coffee can tin to act as a collar for the speaker, fitting it snugly where the speaker cone frame and the magnet frame join. The collar must be in two pieces. Fasten the wires to the speaker terminals. Insert a 100 ohm resistor in the line, on either lug of the speaker. Tie the wire to the cone frame with string through the mounting holes. Cut the baffles so they will recess into the pie tin about half way between the face of the speaker and the rim of the pie tin. Cut a one inch hole in the center of the baffle. This acts as an acoustic baffle and keeps your ear out of the speaker.

After the collar is placed on the speaker, it is spot soldered to the cone frame. Bore a hole in the side of the pie tin to take a grommet of the proper size to fit the wires. Now is the time to make a right and a left out of the pair since the place where the hole is located on the pie tin is important. Looking at the pie tins from the rear side, the one for the left side will have the grommet hole at 9 o'clock and the right side will be at 1 o'clock. This gives freedom of movement to the earpieces after completion. Now install the wires into the grommet and slip the speakers into the pie tins. Solder the collar to the pie tin.

Bore the holes for the headband, which attaches to the frames of the speakers. Mask off the openings in the speaker frames to prevent any cuttings from adhering to the magnets in the speakers. It isn't necessary to make the holes clean through since the headband

[Continued on page 97]

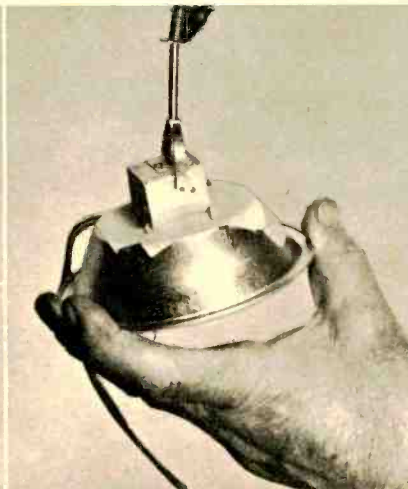
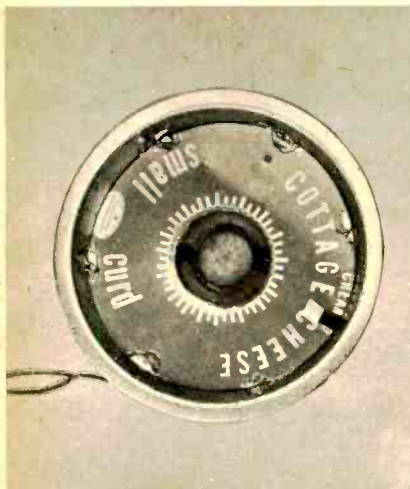
**PARTS LIST**

- 1—Headset Frame (Army surplus)
- 2—100 ohm, 1/2 watt resistors
- 2—5-inch pie tins
- 2—2-inch speakers (Oxford 2AMS) A 2 1/2" unit by Quam is available, 2 3/4" by Jensen
- 2—6-inch sheepskin polishing heads. (Type used for buffing wheel on electric drill)
- Misc.—Coffee tins, wire, and if desired, Cinch-Jones socket and plug P304CCT, S304CCT

Mount metal baffle plate to pie tin. Solder six points around its circumference.

Mask off the openings of speaker frames. Drill holes, then snap on the headband.

To complete headset, cut holes in sheepskin and install on each of the pie tins.



# Infrared: New Wonder Tool

Now a booming member of the electronic family, IR was an underrated specialty before Sputnik.

**E**LECTRONICS has already pushed most sciences to achievements that were previously thought to be generations away. Infrared, the newest electronic marvel, will play an increasingly important role in future developments. Many infrared instruments are still in the blueprint or proto-type stages, or in the mind's eye of the inventor, but proven devices based on infrared radiation have been in production for years.

By far the most important is the electronic infrared camera, an ingenious, costly machine that "photographs" the IR radiation given off naturally by every human being. It can detect breast and other cancers and infections lying close to the skin more quickly than any other method—and without even touching your body!

Dr. Ray N. Lawson, a dedicated young Canadian surgeon, was first to think of using the infrared scanning camera for early

|               |             |       |                 |               |              |        |            |
|---------------|-------------|-------|-----------------|---------------|--------------|--------|------------|
| RADIO COMMUN. | NAVIG. AIDS | RADAR | <b>INFRARED</b> | VISIBLE LIGHT | ULTRA VIOLET | X-RAYS | GAMMA RAYS |
|---------------|-------------|-------|-----------------|---------------|--------------|--------|------------|

## WHAT IS INFRARED?

Everyone senses infrared everyday. You feel it as heat. Although it can be focused with mirrors and lenses like light, it cannot be seen because it exists just below the visible spectrum. Still further down the frequency scale is the microwave region. Like microwaves, infrared can pass through some opaque materials, such as silicon and germanium, the stuff used in transistors.

Everyone gives off infrared radiation, as does every object above absolute zero ( $-273.1^{\circ}\text{C}$ ). All the enormous heat of the sun reaches us as infrared. But most things do not generate enough infrared to be felt by the human skin. In order to make use of this weak radiation, detectors are being devised that can sense an object many miles away, even if it's only a few fractions of a degree warmer than its surroundings. Infrared researchers have actually succeeded in measuring the temperature of the moon!

Infrared radiation was discovered in 1800 by the English scientist Sir William Herschel. It has taken a century and a half to capitalize on his discovery. Herschel created a visible spectrum by passing the sun's rays through a glass prism. Checking each section of the spectrum with a thermometer, he perceived that instrument was heated not only in the visible areas, but also below the red.

## INFRARED'S OTHER JOBS

### IR Scanning Camera:

- Detects voids in wall and freezer insulation
- Monitors height of oil in tanks from central location in big oil tank farm
- Detects weak spots in walls of giant blast furnaces
- Detects overloads in power plant circuit breakers

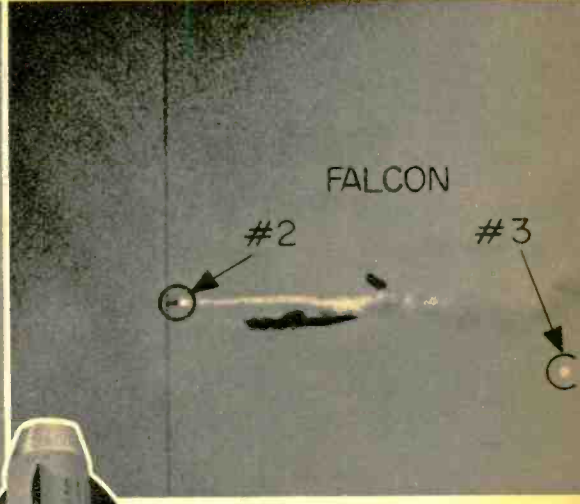
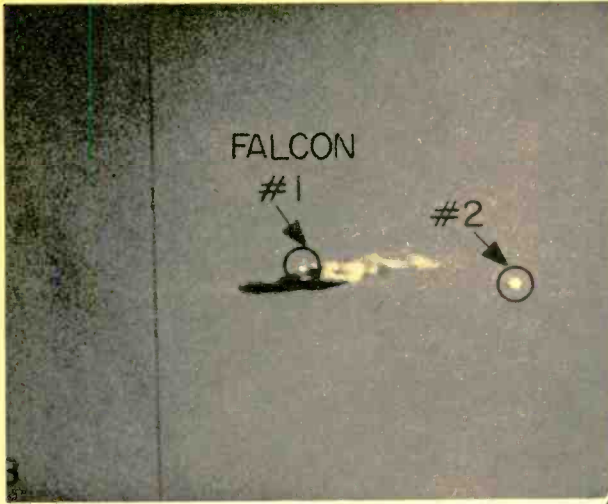
### IR Pyrometer:

- Monitors temperature in center of textile bolts
- Checks for dangerous heating of cutting tool's point
- Determines bull's virility from distance of 50 feet

### IR Analyzer:

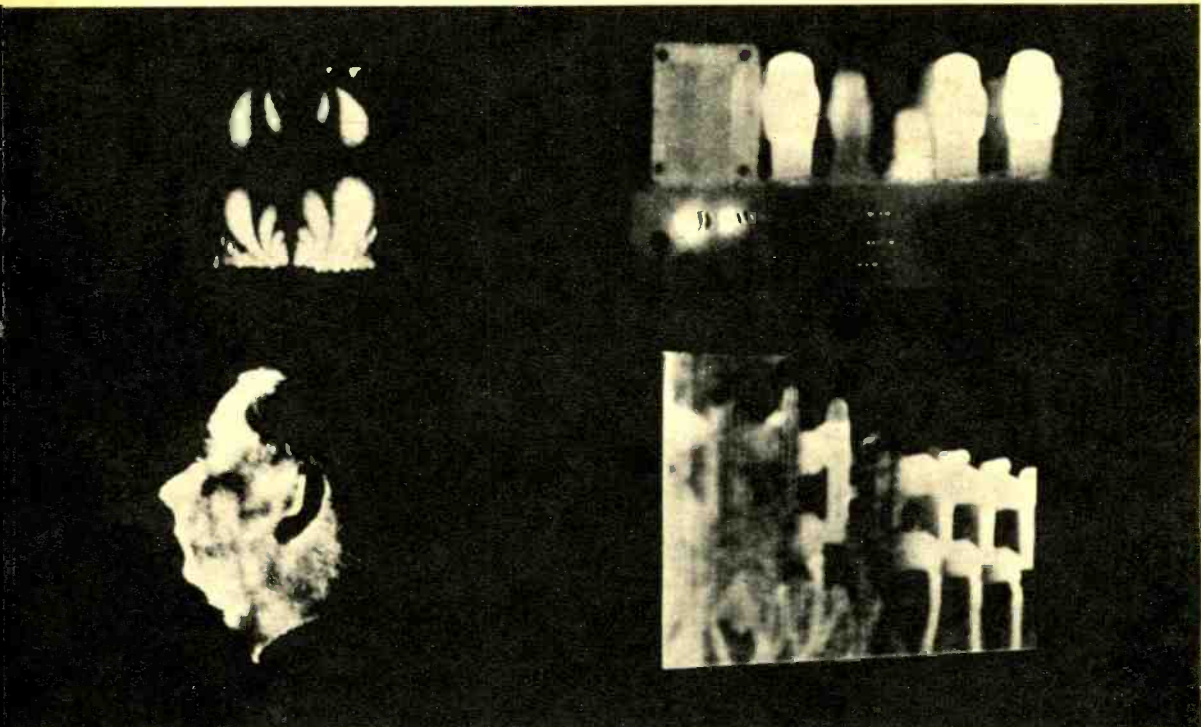
- Monitors the atmosphere in atom-powered submarines
- Checks effects of new chemicals on plant growth by determining changes in exuded gases to a few parts per million accuracy
- Monitors impurities in chemical plants
- IR detectors 20' above hot sheet steel spewing from a rolling mill at 4000' per minute can monitor width of the sheet





Advanced missiles such as Hughes' IR-guided Falcon GAR-2A, seek out target by homing on its infrared radiation. Its nose is an IR-dome, transparent to infrared energy. Before launching, these missiles have guidance systems "slaved" to the target. They guide themselves on an intersecting course despite target's maneuvers. Dramatic photos above show three Falcons (without warheads) destroying a Matador guided missile. In first photo, Falcon 1 rips off missile's tail. Number 2 is hot on the heels of its predecessor. In second photo, number 2 has passed through same spot, while number 3 closes in for the final kill.





detection of cancer. He started investigating the connection between malignancy and heat with a contact-type thermometer. Using a hand-held device to build up a picture of temperature patterns is a slow and not particularly accurate procedure. As soon as he heard that the military was declassifying a camera that built up a "heat" photo in a series of lines, he got in touch with the manufacturer, Barnes Engineering Co. of Stamford, Conn. The company allowed Dr. Lawson to experiment with their first commercial model.

Subsequently, Dr. Lawson was able to borrow another similar camera from a small electronics manufacturer in Skokie, Illinois, Radiation Electronics Corp. Since that time Dr. Lawson has taken hundreds of IR photos of cancer victims, and they leave no doubt in his trained mind that IR is a quick, easy way to detect this dread disease before it can be felt—and when life can still be preserved. Eventually, he hopes to see a network of IR camera clinics established to take diagnostic photos on a regular

basis, like the X-ray vans that check for TB.

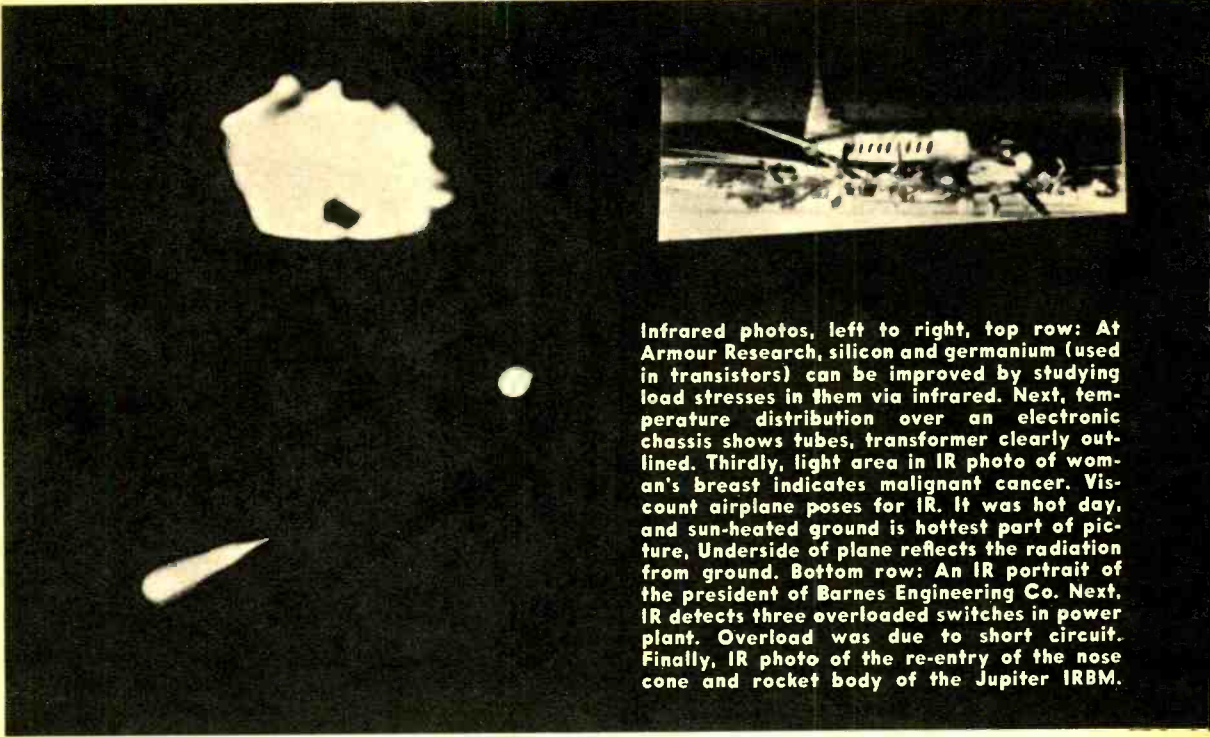
Before you get the idea that infrared is only connected with fighting disease, important and exciting as that job is, let's outline some of the other IR wonders.

Infrared guidance systems on anti-aircraft and anti-missile missiles are so accurate they can lead these small missiles right up the hot tailpipe of an enemy jet.

Because IR detectors cannot be "jammed" like radar, the Pentagon is pressing hard for development of a variety of infrared detection systems. According to reliable sources, these would include an earth-girdling system of IR-detector-equipped "synchronous satellites," which could hang over pre-determined spots on the globe. If this sounds out of this world, remember that Vanguard II, overhead at this moment, contains an IR system for measuring the cloud cover of the entire world.

Scientists are also working on ultra-sensitive detectors that will be able to "spot" a hostile missile launching a con-





Infrared photos, left to right, top row: At Armour Research, silicon and germanium (used in transistors) can be improved by studying load stresses in them via infrared. Next, temperature distribution over an electronic chassis shows tubes, transformer clearly outlined. Thirdly, light area in IR photo of woman's breast indicates malignant cancer. Viscount airplane poses for IR. It was hot day, and sun-heated ground is hottest part of picture. Underside of plane reflects the radiation from ground. Bottom row: An IR portrait of the president of Barnes Engineering Co. Next, IR detects three overloaded switches in power plant. Overload was due to short circuit. Finally, IR photo of the re-entry of the nose cone and rocket body of the Jupiter IRBM.

continent away! Airborne IR detectors might prove to be the very items that would provide foolproof monitoring of nuclear bomb tests throughout the world, thereby opening the doors to disarmament and an end of the "Cold War."

IR "hotbox" detectors are starting to cut down on the staggering \$300,000,000 annual loss in railroad train wrecks directly attributable to undetected, burned-out wheel bearings.

The IR spectrophotometer, a delicate instrument used in thousands of advanced laboratories, matches materials found at the scenes of crimes with those found on the criminal. The police are also using this instrument to determine the country of origin of confiscated dope. And some criminologists hope to develop the IR pyrometer as a lie detector—to measure sudden changes in the suspect's skin temperature.

IR reconnaissance systems can prepare accurate "heat" maps that reveal the location of underground missile bases and factories. What's more, these "maps" can be made from high-flying

This Avion CODES gear is slated for IR satellite detection. Note cigarette "burn" on scope.



aircraft at night and in bad weather. However, at present these IR reconnaissance systems are adversely affected by water vapor in the air.

The IR spectrophotometer and a related instrument called the IR analyzer are helping to find the cause of deadly smog, and an IR system detects hidden, man-swallowing crevasses in the ice ahead of ground parties moving across arctic regions.

Industry is buying all sorts of IR devices to help cut costs and improve services—all of which contributes to the maintenance of our high standard of living. All of these advances, plus those listed on the first page of this article help explain why IR, a minor electronic specialty in pre-Sputnik days, has matured into a full-fledged, \$100,000,000-a-year department of the electronics industry.

Considering how conservative and slow-moving the nation's railroads are, the IR hotbox detector has gone over with a bang in the few short years since its introduction by Servo Corporation of America, New Hyde Park, N. Y. The \$20,000 system consists of a pair of IR detectors set on either side of a railroad track and connected to a recording instrument in a nearby switching station.

The switchman can read the record for each passing car and tell exactly which wheel in which car is running

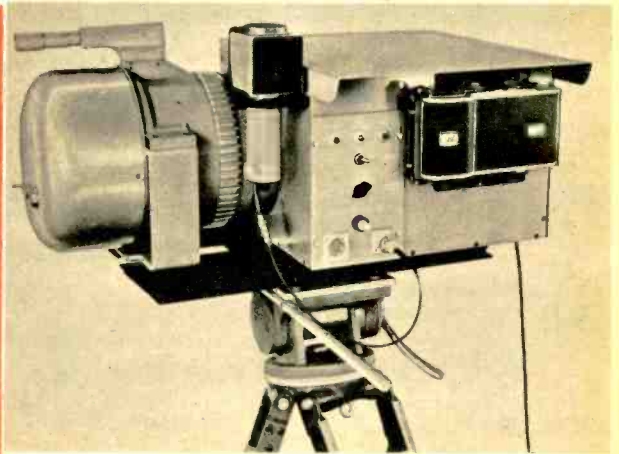
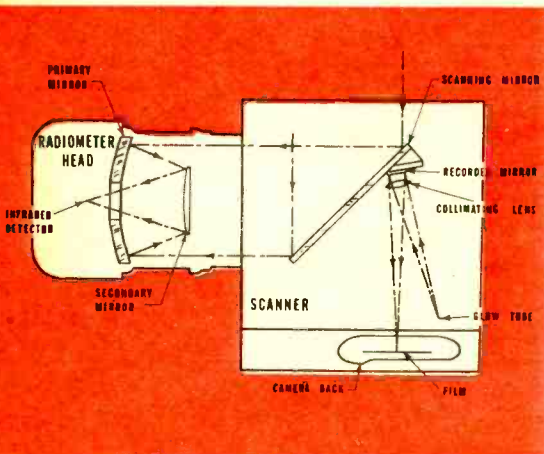
destructively hot. The switchman then usually warns the engineer by radio—electronics to the rescue again!

Since an IR pyrometer was used as far back as 1880 to measure the temperature of the moon, it's not surprising that enterprising engineers early recognized IR as a potentially valuable aircraft detector. In 1922 General Electric engineers built an IR system that detected a bomber 22 miles away. They also built infrared wireless transmitters that would insure reliable, intercept-free communications on the battlefield. However, radar was discovered shortly afterwards. With the electronic components available at the time, radar seemed the more fruitful approach to detection. Therefore, IR development was unfortunately slowed.

The Nazis, however, were not disenchanted with infrared. By the end of World War II they had an experimental IR-guided missile. Before they could put it into production, the war ended. During the war, the only IR equipment the Allies used was the famous "snooperscope," which is classified as an "active" IR system. Active IR systems depend on reflected radiation. The snooperscope "saw" enemy troops and tanks by infrared light produced by nearby giant searchlights invisible to the naked eye. However, if the enemy

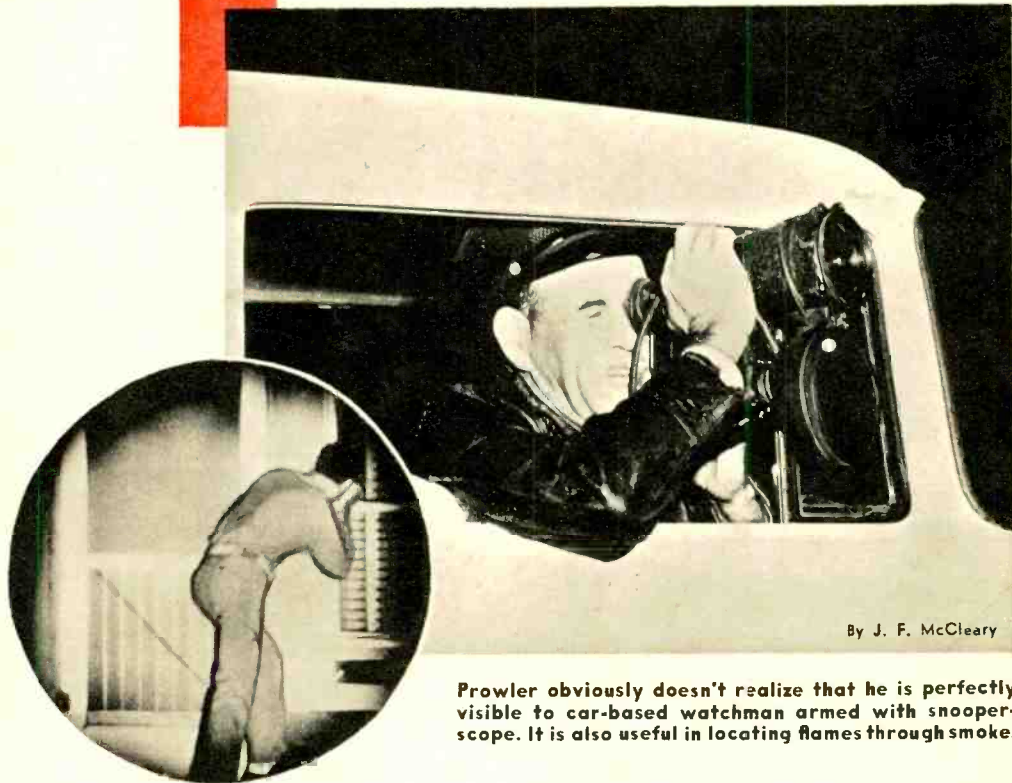
[Continued on page 101]

Diagram shows structure of Barnes IR camera. It has radiometer, telescopic sight, camera.





*catching prowlers red-handed with*  
**See-in-the-Dark Snooperscope**



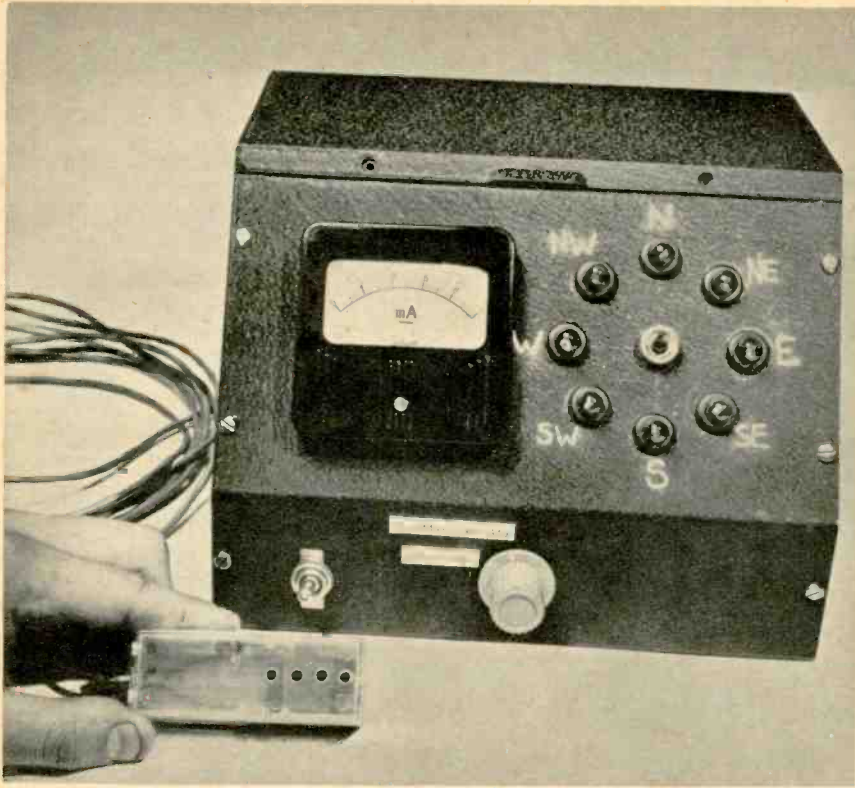
By J. F. McCleary

**Prowler obviously doesn't realize that he is perfectly visible to car-based watchman armed with snooperscope. It is also useful in locating flames through smoke.**

**E**VERYONE knows that cats can see in the dark, but with a surplus Navy "snooperscope" night watchmen, law officers and just plain "folks" can penetrate the blackest darkness and actually see what's going on without being seen themselves. An infrared searchlight floods the scene with invisible light. Through the snooperscope, images appear as various shades of green, regardless of their color in daylight.

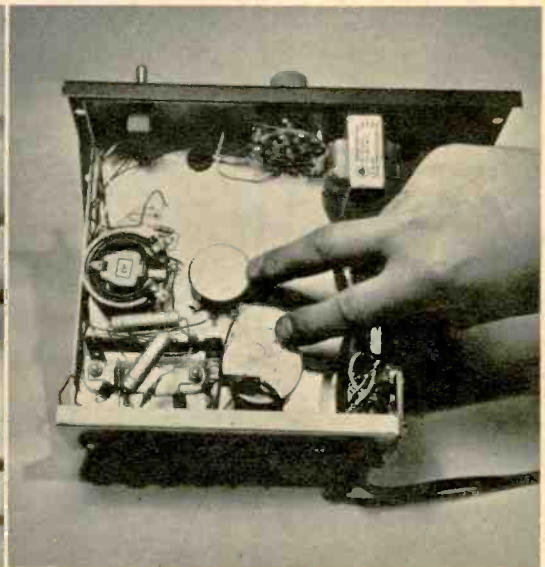
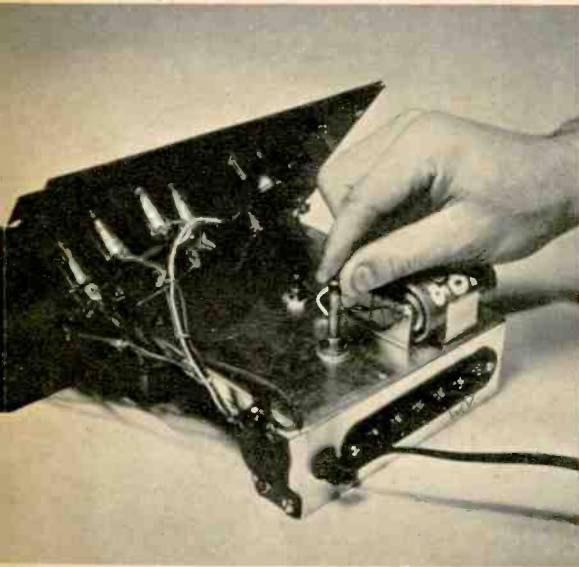
The lens of the scope focuses the invisible and inverted image on the face of the famous 1P25A image converter tube. Electrons are emitted from the photoemissive surface inside the tube. An electrostatic potential of about 4000 volts on the focusing anodes forces the electrons toward a phosphor screen. A visible image is produced. On their journey through the tube, the electrons rotate through 90 degrees, and the resulting image is right side up.

Effective up to 400 feet, the snooperscope gets its power for both searchlight and image converter tube from a miniature vibrator transformer which can operate, in some models, on two standard flashlight cells. AC-DC converters, auto cigarette lighter plugs for 12-volt systems, rechargeable 6 volt batteries are also generally available. Complete units cost about \$150 and are available from government surplus dealers and some optical-supply houses.

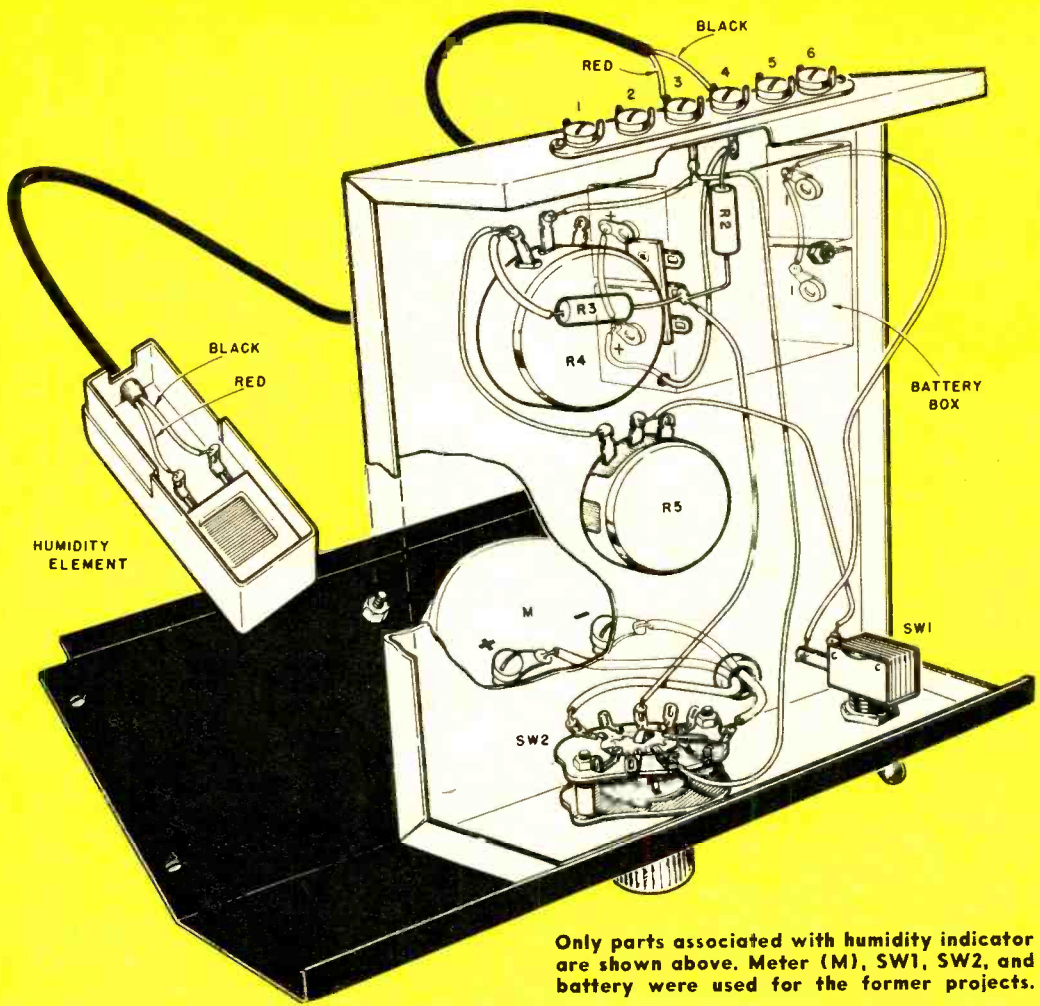


Hand holds the humidity indicator. Meter on panel reads relative humidity.

Lower left, R4 is adjusted to balance circuit. Lower right points out R4, R5. Most other components are used in the earlier projects—wind direction and velocity.







Only parts associated with humidity indicator are shown above. Meter (M), SW1, SW2, and battery were used for the former projects.

## *build your own* Weather Station-3

By Paul Hertzberg

**Add a humidity indicator to the wind speed and direction indicators described in May and June.**

**T**HE heart of this humidity indicator is a sensing device called a Hygropak. It is coated with a special film which changes its resistance when in contact with moisture in the air. The resistance ranges from about 25 ohms when dry to 100 ohms when soaking wet.

With a milliammeter as an indicator, the circuit can be adjusted to read 0 at 0% humidity and full scale (1 ma) at 100% humidity.

If the project is a continuation of the previous indicators in the weather station, there is ample room on the chassis to mount the few parts required. The switch, batteries and meter are already a part of the circuit.

After assembly on the chassis, hook up a 0-100 ohm variable resistor set to the Hygropak's resistance when dry (about 25 ohms) across terminals 3 and 4 where the humidity element will be attached. Set the Full Scale control (R5) to maximum resistance, turn on the power and rotate the Balance control until the meter reads 0. Next, turn off the power, change the resistance value across the terminals to one equal in value to the humidity element's resistance when wet (about 100 ohms). The circuit will not be balanced when the resistor is used and the meter needle may swing below zero. Flick the power on for an instant and observe the needle. If it goes in the wrong direction it will be necessary to reverse the leads to the meter. If the needle goes beyond the full scale reading of 1 ma you will have to increase the resistance of the Full Scale control. If the reading is within the range of the meter, adjust to read full scale (1 ma) representing 100% humidity. Turn off the power, disconnect the variable resistor across the termi-

nals and connect the humidity element. The meter will now show relative humidity—.5 for 50%, .6 for 60%, etc. During this calibration procedure an ohmmeter will enable you to compare the Hygropak's resistance with that of the temporarily connected variable resistor.

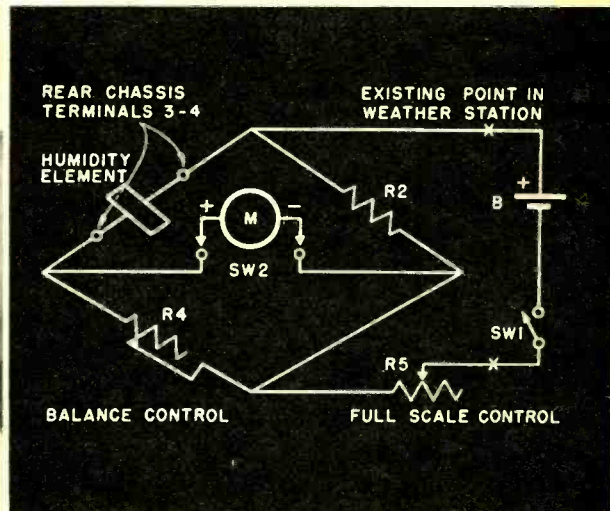
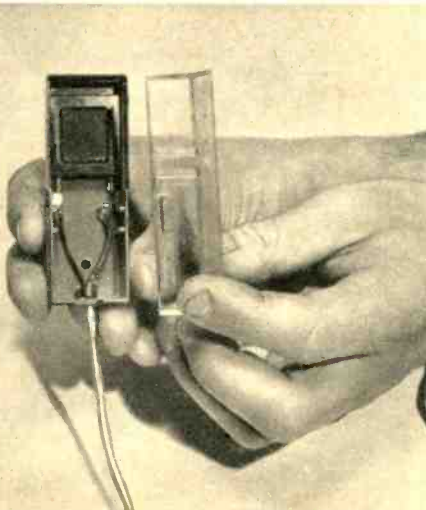
The holder for the element can be made from any small box. The one used in this project was a shipping container for a spark plug. Two phono cartridge pin connectors are used to attach the ends of a two-conductor cable to the humidity element. An ideal spot to place the Hygropak is under the eave of your house or fastened to a window frame. Run the cable to the unit and hook it  
 [Continued on page 101]

#### PARTS LIST

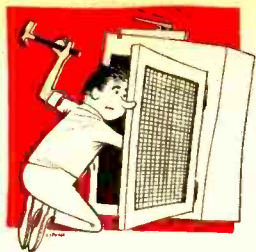
New Parts  
 R2,R3—600 ohm 1/2 watt resistor  
 R4—50 ohm variable potentiometer (Mallory R50L)  
 R5—25 ohm variable potentiometer (Mallory R25L)  
 Humidity element—Hygropak (Lafayette MS-407)  
 Old Parts (used in previous project and used again with no circuit change)  
 M—0-1 ma DC meter  
 B—Two size D cells 1.5 volts each, with holder  
 SW1—On-off switch SPST  
 SW2—Rotary switch 2-pole 4-position  
 Misc.—Small plastic box, 2-conductor intercom wire, tie lug with one insulated contact.

To permit circulation of air around humidity element, drill small holes in plastic housing.

Two "X"s on right side of schematic show new connections to B and SW1 in existing circuit.





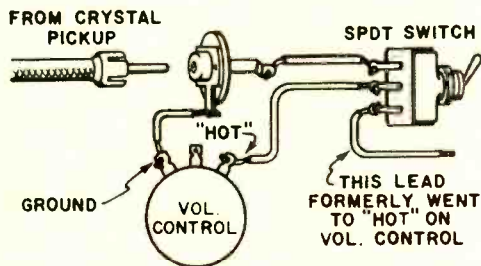


# Hi-Fi Clinic

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

## Phono Input

*I would appreciate directions on how I can install a phono input on my portable radio for use with a crystal pickup.*  
Thomas A. Weir, Williamsville, N. Y.



The points you connect to are shown in the diagram. Bring a shielded lead from the crystal pickup to the radio. For convenience, a jack receptacle should be installed somewhere on the radio cabinet or chassis for this cable. The shield and center lead connect to two outside lugs of volume control.

Find the hot lug of the volume control in the following manner. Turn the volume full up with the power on. With your finger, touch each of the outside lugs of the control, the other hand kept in your pocket. Don't touch any other points or you might get a jolt from the B+ voltage. When you touch the lug that produces a loud hum in the speaker you have found the "hot" one.

Note the switch included in the diagram. It is a "Radio-Phono" selector and is mounted where you can find the room. A likely spot is on the cabinet.

This procedure is not recommended for use with AC-DC table model sets due to the shock hazard involved when connecting the radio ground to the shield of the phono cable. However, it is safe if an isolation transformer is used with this type radio.

## Test Equipment

*I am interested in getting started in*

*hi-fi and radio repair and am looking for an all-purpose meter. Can you recommend one?*

Thomas Ciulla, Brooklyn, N. Y.

ET will publish, starting next month, articles dealing with the use of basic test instruments. They will emphasize their features and how to use them. With this information you will be able to select a unit suited to your needs.

## Single Track Recording

*I have a single track pre-recorded tape that I want to play on my double track recorder. Will I damage the recording and will the bass and treble play back correctly?*

John Creighton, Meinrad, Indiana

Even though your tape is full track the recorder picks up only the half track. There will be some loss of volume but no harm to the tape will result.

Conversely, if you play a dual track tape on a single track machine (fairly uncommon these days) you will hear both channels in the speaker at the same time.

## Bass Response

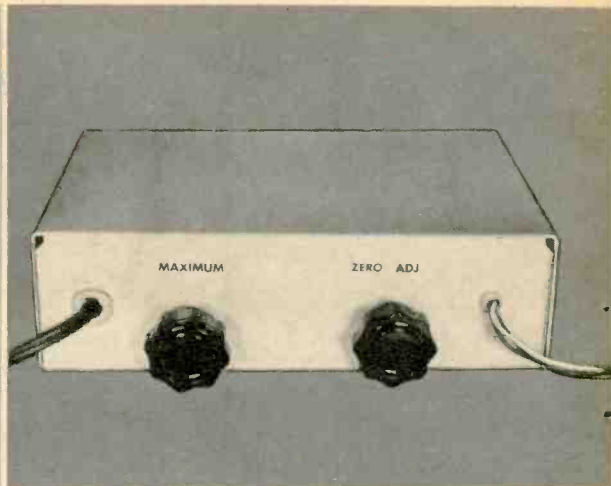
*Until lately I've been using a \$5 replacement type 12" speaker in a cheap bass reflex cabinet. Recently, I switched to a \$160 speaker system. To my ear, the cheap speaker has more bass. How do you account for this?*

Kermit Keller, Decatur, Illinois

What you interpret as more bass in the inexpensive speaker is probably a peak in the bass response caused by a speaker resonance at the lower frequencies. Unfortunately, any orchestral instrument producing a tone in this region will cause the speaker to vibrate of its own accord and produce a booming sound that obscures the desired tones. You will find it difficult to discern the difference between the sounds produced by these instruments, though much bass is heard coming from the speaker. ●



Front panel of the unit. BFO tuning changes pitch of code signal. S-meter is at center.

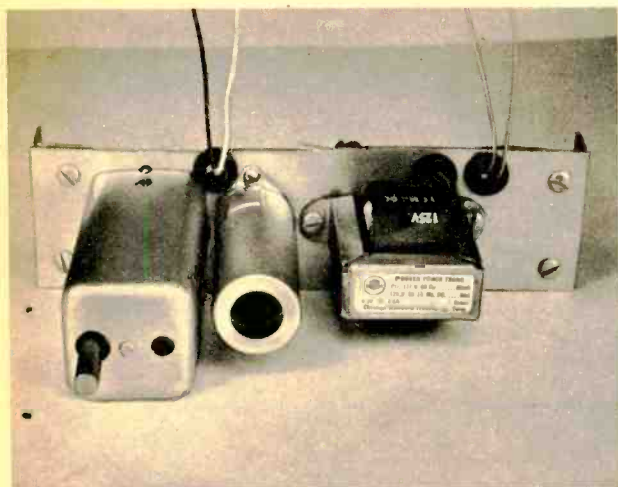


Two rear knobs calibrate meter. AC cord is at left, wires to receiver at right.

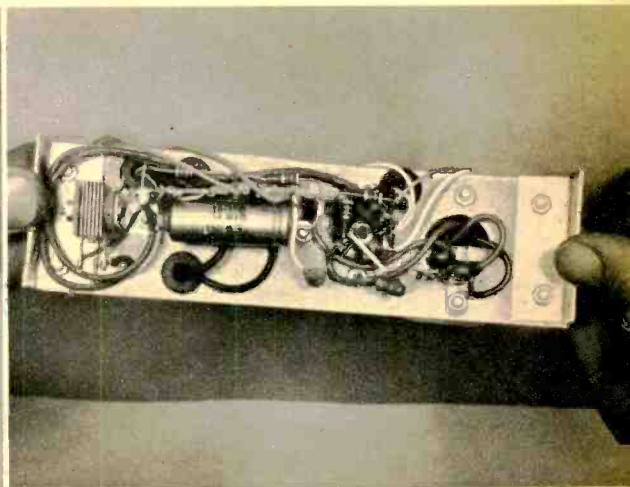


Unit may sit atop receiver. S-meter needle rises and falls as stations are tuned. Author is adjusting BFO for pleasing tone.





Top view of subchassis. BFO can at left has projecting shaft for the BFO tuning knob.



Underside of subchassis, ready to be mounted in chassis. Note L-brackets at both ends.

# Add an S-Meter, BFO to Your Receiver

By Harvey Pollack

**Improve your short-wave set with an S-meter to read signal strength and a BFO for code reception.**

**T**WO simple connections and this outboard S-meter and BFO combination converts any short-wave set into a real communications receiver for either 'phone or code reception. When correctly calibrated, the S-meter tells you just how strong the incoming signal is in terms of standard strength "S" units so that you can provide the received station with precise information. Besides this, the S-meter is an invaluable tuning indicator; a maximum reading on the meter means best possible tuning. The beat-frequency oscillator makes it possible to hear code signals as audible tones.

Only two connections to the short-wave set are required: one is from the AVC bus in the receiver, the other is a connection that joins both chassis together for a common ground. The BFO signal is impressed on the receiver circuits by radiation and need not be connected to any point in the short-wave set at all. Its lead may be strapped to the glass envelope of the IF tube with a piece of tape, or secured under the lid of the receiver near the antenna terminal.

When you begin to get away from standard chassis layouts, some improvisation is usually necessary. In this case, the inside







New computers combine talents of mathematicians  
and job foremen to run machines and processes in . . .

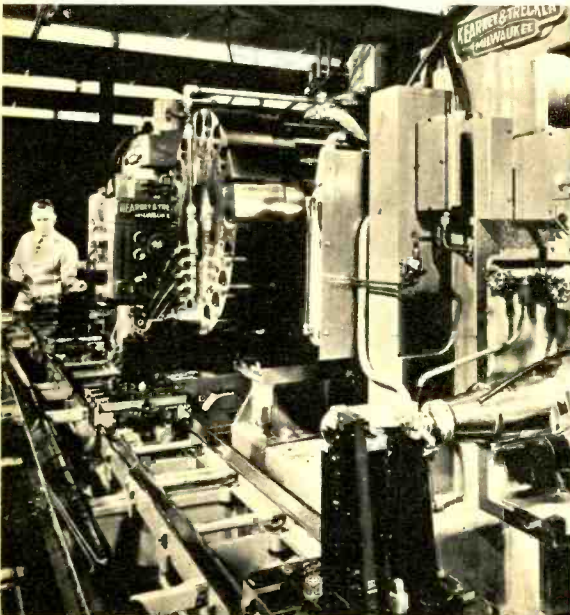
# Factories that Run Themselves

By James Joseph

A NEW genus of electronic computer has turned factory foreman. Single-handedly these specialized computers are running industrial plants and their processes, blending gasoline for your car, making detergent for your wife, and batching cement for that backyard patio.

On the job—say at a refinery—the computers operate valves, read meters, adjust mixtures and keep many processes running and productive. At least one of the new transistor-brained factory foremen understands English in the form of abbreviated 100-word technical vocabulary. Tell the robot to “ON KUL, ON SPN, GO RGT,” and it savvies your instructions: “Turn on the coolant, turn on the spindle, go right with the tool.” As a kind of interpreter for less linguistic computers, it translates English-language orders into math, the only “language” most computers under-

All electronically controlled machine tool line (left) at Hughes Aircraft takes taped-program and directs drilling, boring and milling operations, turning out finished parts without human assistance. At right is transistorized RW-300 automation computer that needs no special cooling system. It not only controls complex processes, but types out a log of its actions.

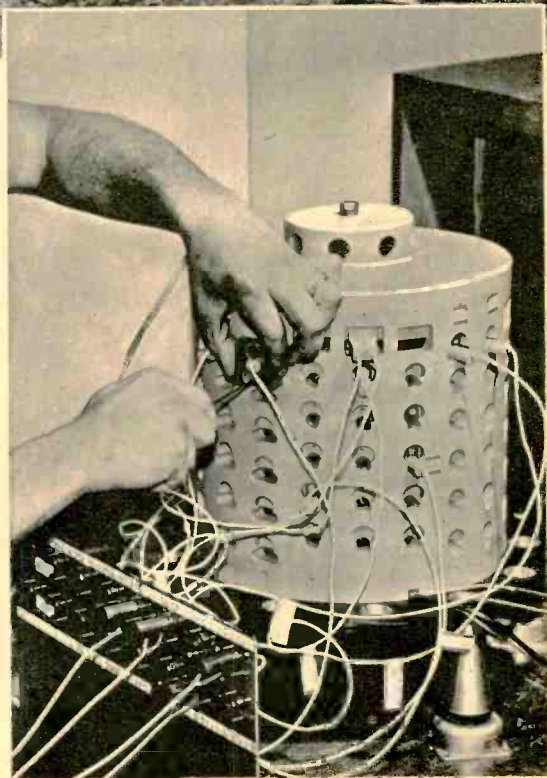






The sprawling Riverside Cement Co. plant in Oro Grande, Calif., has its entire batching operation controlled by an RW-300 computer. The various materials that go into a bag of cement are automatically assayed and monitored by the computer, and just the proper amount of each is portioned into the batch mixer, thus insuring consumer an absolutely uniform product.

At right, magnetic drum for an automation computer is assembled. All the necessary mathematical and operational data for any given factory process is stored by the drum, which automatically recalls that information at the right moment. A human vocabulary has been devised so that it is no longer necessary to call in a mathematician to make changes in a programmed process.





stand, and tells other machines how engineers want the job done.

The Texas Company has just put one of the new electronic factory foremen to work bossing a polymerization unit at its Port Arthur refinery. The computer is overseeing the recovery of a high octane ingredient for gasoline.

Another installation is bossing the production of vinyl chloride (a basic material for some plastics, including floor tile) at B. F. Goodrich Chemical Company's Calvert City, Kentucky, plant.

In Oro Grande, Calif., Riverside Cement Co. has assigned a computer foreman to batch cement. The combination digital and analog automaton device samples various raw materials, assays their chemical composition, then formulates a batching recipe calculated to turn out an unvarying product.

At Hughes Aircraft Company's electronics plant in Los Angeles, a computer, taking taped orders from engineers, runs the nation's first all-electronically controlled line of machine tools. Operating dozens of drilling and boring tools single-handedly, the computer can order the machining of sev-

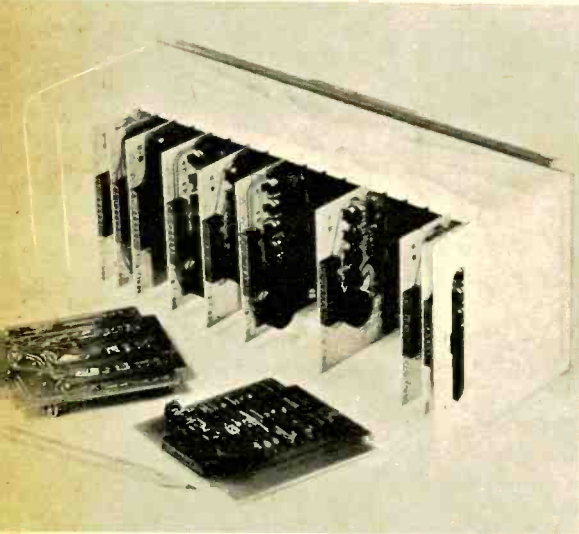
eral completely *different* parts on the same production line.

"Control" is the key word," says one factory manager. "In these special automation computers we've got a computer that can do a man's job, that can control an entire plant or process and control it better than a human operator."

How so? Well, suppose as in one chemical plant, a computer is assigned to boss a complex process involving miles of piping and scores of valves, meters and gauges. To complicate things, the process is fed by a dozen different tanks storing as many different ingredients. The computer's job: to make sure that the product is made exactly to specifications. What's more, it is expected to print a written record of its every decision and action. And not only must the end-product be chemically correct, but at least 1000 gallons must be produced every hour! . . .

Flesh-and-blood operators, faced with orders no more exacting, have been known to throw up their hands and walk off the job. But not the computer. Once briefed, it takes over without a whimper.

[Continued on page 106]



New module circuits, such as this one of several in the RW-300, can be switched around to change production control when a new product is to be made or controlled in the same facility.



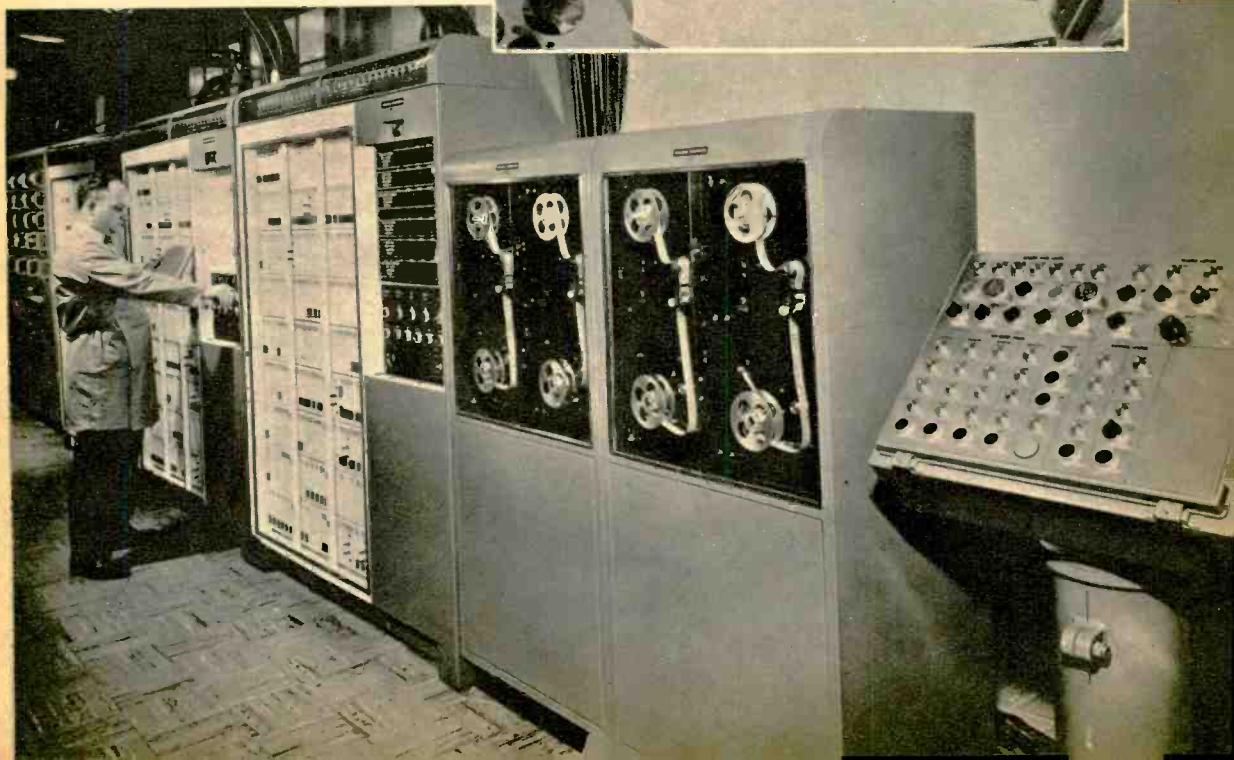
Engineer at Hughes Aircraft glances down the one bank of circuitry through which all information to milling and boring machines is fed before it is converted into pneumatic actions.



Dozens of tapes can be fed to Hughes automation computer, simultaneously making all the parts shown in this photo. The aim here is to bring automation to small job production lots, which constitute most of the machining done by United States industry.



At extreme right is the control panel for the Hughes milling machines. Tape readers convert punched instructions into electrical, then pneumatic commands to the fabricating machines. Research assistant Charles Trott makes routine check of program.





Surfaces of the completed kit are pre-sanded, ready to receive stain finish. Overall height is 26½".

*EI* assembles

## An Extension Speaker

**The Windhaven speaker system, an easily-assembled kit, improves the sound of a table radio or TV set.**

**R**EAIZING that much of the poor sound from the table radio, TV set, or inexpensive phono stems from the tiny speaker, *EI* set out to discover the improvement possible with a fairly large, well enclosed extension speaker. The results were surprising!

Parts supplied with kit include speaker, glue, and hardware.

Panels are assembled first. They are then screwed after gluing.





The system selected was the Windhaven kit, a unit that recently appeared on the market. Essentially, it's a "knocked-down" cabinet and an 8-inch speaker. No carpentry skill is assumed on the part of the builder. Various panels are pre-cut, pre-drilled, and pre-sanded.

Assembly time ran about three hours using a hammer, screwdriver, knife, and ice-pick. Though the manufacturer has endeavored to make the job as fool-proof as possible, the builder should observe several important precautions—it takes very little to mar the appearance of a home-built piece of furniture.

The panels are glued, then screwed together. As the screws draw them tight, some glue tends to be squeezed from the joint. This excess must be wiped off immediately with a damp cloth. Otherwise it will form a discoloration that will show through after the cabinet has been stained.

The most important precaution became apparent during construction. To perfectly match the fit of various sections, they should be held together by hand first. This "dry run" will minimize chance of error. One deviation did show up in the joining of the top and side panels. At the right angle where they meet a long slat is inserted and tapped down into the joint. It acts as

a spine. However, in this particular kit it was slightly too wide and didn't permit the two panels to flush together perfectly. This can be corrected by sanding the slat down by just a small amount. A possibility exists that the slats absorbed more moisture than the other wood and swelled more.

Another phase of the construction demands care. The front molding trim is screwed on from the inside of the cabinet. If the screws are not driven in at the proper angle, they will protrude out through this trim. It can be avoided simply by visualizing the path of the screw before applying the screwdriver.

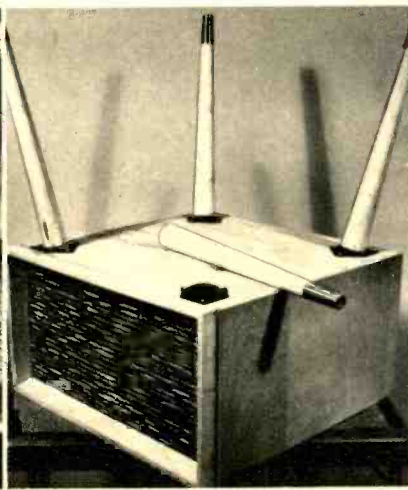
Upon completion, a TV set was placed on top of the cabinet and the TV speaker wires cut. The leads from the Windhaven were clipped onto the TV's speaker wires and the circuit was complete. The sound reproduced was eminently superior to the small, poorly baffled speaker of the TV set. Its bass reflex action was quite effective in extending the low range.

The legs supplied give the Windhaven a furniture-like appearance, enabling you to place it in a living room if carefully finished. Another location could be at a bedside with a table radio playing through it. At \$29.50 (which doesn't include the stain) *EI* rates the Windhaven a Good Buy. —

Ducted port is nailed at rear of black front panel.

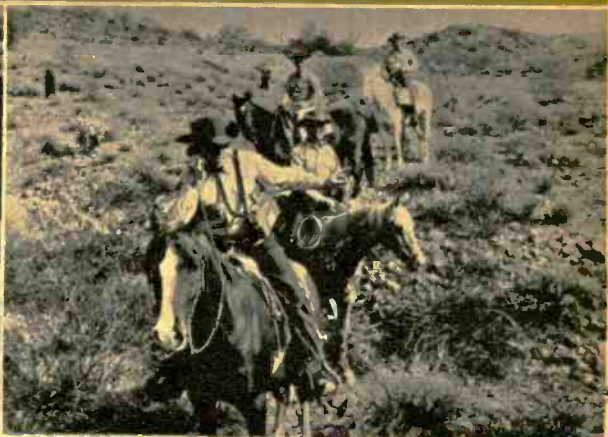
Legs, tipped with brass, are screwed into brackets.

Back panel is mounted after cabinet is lined with felt.





Before takeoff, Capt. Burton calls signals from map, while Frank Shelton of air posse looks on.



Leader of this mounted group directs searchers over rough terrain while he calls headquarters.

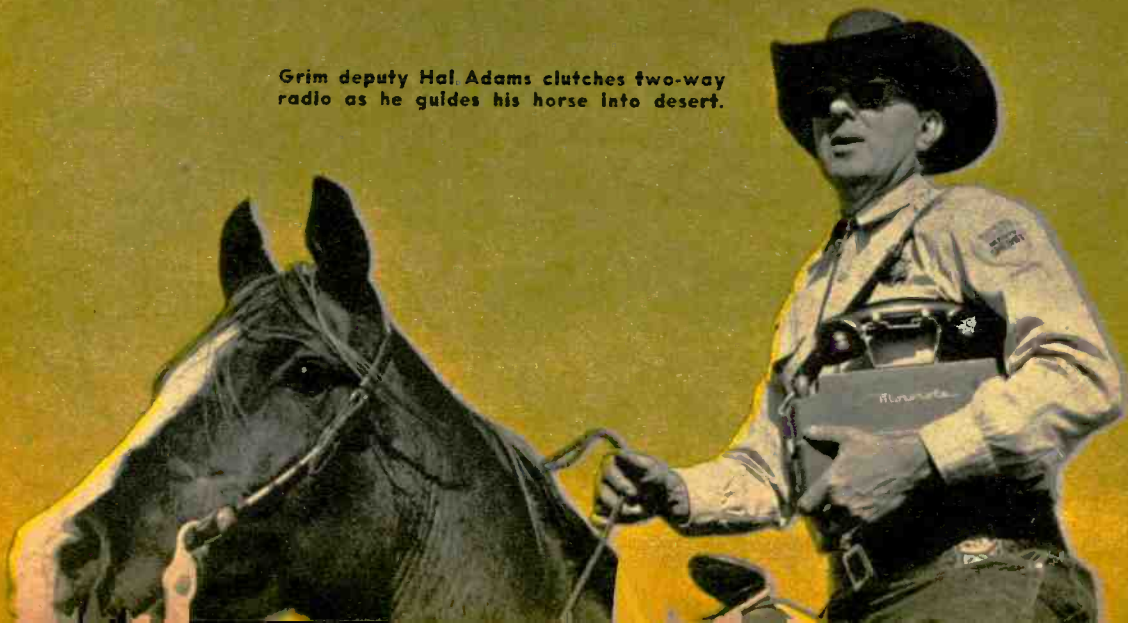
## *sheriff's posse covers the desert with* **Horseback Radio**

By Henry F. Unger

**M**ARICOPA County, Arizona, is a sprawling 9,226 square miles, mostly desert and rough terrain. Since it contains half the state's million-plus population, the sheriff, who is charged with keeping the peace, might be hard pressed were it not for his 500 volunteer possemen—and their two-way radios.

The Rangers, the jeep posse, the water posse, the air posse and the mounted posses have the job of seeing that citizens and visitors lost in the desert and, escaped convicts are returned to

Grim deputy Hal Adams clutches two-way radio as he guides his horse into desert.







**Closing in on an escaped convict, one posseman readies gun while other calls for aid.**

safety or prison, as the case may be.

Radio plays a life-or-death part in tying together the vast operation of this, the nation's largest posse. Each of the volunteer possemen buys his own equipment, uniforms, and maintains his own horses. The county taxpayer saves anywhere between \$50,000 and \$75,000 annually in police protection, and can rest assured that should he, by some accident, be stranded in the desert, it would not be for long.

When a prisoner escapes from the state prison or a local jail, when a plane crashes, or when a picnicker or prospector is unaccounted for, the posse goes into action. From the sheriff's office in downtown Phoenix, the word is relayed to heads of posse groups. The possemen themselves are alerted in great or small numbers, depending on the terrain or expected difficulty. From offices, factories, private homes and ranches, the possemen rush to their jeeps, horses and airplanes.

If the air posse of 25 planes is called into action, Capt. Jesse Burton and volunteer Frank Shelton send out radio reports and instructions not only to other aircraft on the UHF band, but also to the all-important horse and jeep posses who have poorer visibility on the ground. From his sheriff's Tripacer, Captain Burton reports on the progress of the search. Most of the planes at 5,000 feet can transmit 30 miles or more.

On the ground, mounted possemen



**News of finding lost, exhausted prospector is radioed to other units who can now head home.**

escort their animals to special vehicles which move them quickly to the general search area. Equipped with three radios for every five men, these horsemen set up the search pattern via radio as they swing into groups which will scour the difficult terrain. Transmissions are on the sheriff's frequency back to the ambulance or official car which, in turn, relays the information to the downtown headquarters. About 250 horsemen are on 24-hour call.

About 50 jeeps can swing into a search, with about half the group carrying RCA, GE, Motorola and Federal two-way radios. Operating on 160 mc with 10 watt transmitters, the posses spread out once they know the search plan. J. A. Barth, communications officer for the posse, bases his jeep on a high elevation for better reception.

A probationary period, ability to provide equipment, and a knowledge of two-way radio are prerequisites for volunteer possemen. They attend classes, learn more about radio operation and how to repair their gear in the field under the worst conditions.

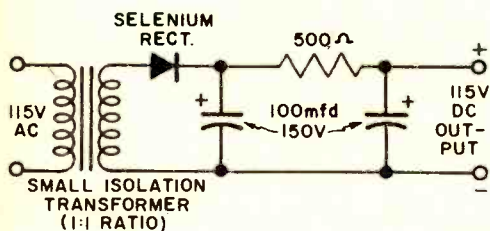
When Sheriff Cal Boies asks his volunteers to "Head them off at the pass, boys," he speaks with much more authority than the TV hero saying the same thing. He knows that with swift radio communications at his finger-tips, he can keep in contact with a well-trained group of deputies eager to save lives. —

# The Electronic Brain

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

## AC To DC Rectifier

How can I convert 115 volts AC to 115 volts DC without loss of voltage? It is important that the cost be kept low.  
Michael Stolnicki, Detroit, Mich.



The method you use to obtain 115 volts DC from the 115 volt AC line will have to be determined by the amount of current you expect the output system to furnish to the load. This can be done inexpensively only if the anticipated load power is low—of the order of 10 watts or less. The diagram shows a low-cost isolation transformer and selenium rectifier-filter system that will accomplish this.

For a power range up to, say, 100 watts you might use a husky isolation transformer such as the Solar type 30-886 in conjunction with a high current silicon rectifier now available from General Electric Co. The circuit would be exactly the same as that shown in the accompanying diagram except for the substitution of the larger transformer and rectifier.

Should you want even more power than this, it would probably be expedient to purchase a motor-generator set having the ratings you need.

Both of the last alternatives are costly. For example, the 30-886 transformer sells for \$33.00 and the rectifier for approximately \$12.00. Motor-generator sets range from about \$60.00 up to several hundred dollars depending upon the power requirements.

## Carrier Current Transmitter

Where can I find some circuits for

carrier current transmitters? I want to pipe our church services into the homes of shut-ins nearby and would appreciate any references to this subject that you may have.

Robert B. Glazner, (K4TNG),  
Cordova, N. C.

Your ham call brings to mind the fact that carrier current transmitters were extremely popular during the war years between 1942 and 1945 in radio amateur circles. Many types having all ranges of power were described in QST of those days.

If your local library does not carry back issues of QST this far into the past, you can certainly get all the help you require by writing the Amateur Radio Relay League in Hartford, Connecticut. If you merely tell them what you want they should be able to supply the magazines containing the necessary information.

## Tuner Through Tape Recorder

Can I convert my tape recorder into a radio receiver at will by adding special circuits to it? If so, how is this done?

W. F. Stevenson, Kennewick,  
Washington

For anyone who might be inexperienced at high-frequency construction, the best way to accomplish the objective you have is to purchase an AM or FM tuner designed for use with the amplifier found in your tape recorder. Many excellent units of this type are now available in both monophonic and stereo output. This equipment is costly, however, as you will discover when you refer to an electronics catalog.

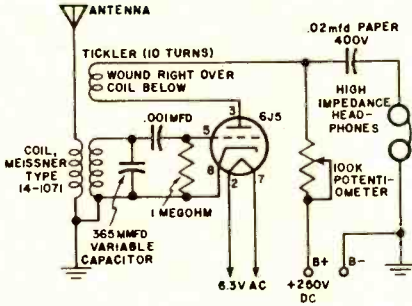
An alternative solution is to purchase an FM tuner kit such as the Heath-kit Model FM-3A and build it yourself. This kit may be obtained directly from the Heath Company, Benton Harbor 10, Michigan for \$25.95. If your purse can stand the strain, you can buy a hi-fi AM-FM tuner kit from Allied Radio, 100 N. Western Avenue, Chicago 80, Illinois for \$49.95 (Model 83 YX 787).



## One-Tube Receiver

Can you tell me how to construct a one-tube radio receiver using a 6J5 metal tube? Are the connections for the glass 6J5 the same as for the metal type?

Ed Holmes, San Jose, California



A fairly sensitive one-tube broadcast receiver can be constructed using a single 6J5 in the circuit shown. Either the metal or glass tube can be used since the pin connections are identical except for pin No. 1. If the metal tube is used, ground this pin to the chassis; if the glass tube is preferred, merely leave this pin unconnected.

The circuit shown is that of a regenerative receiver using a standard antenna coil available at electronic distributors. The tickler winding must be added, however. Wind about 10 turns of any thin insulated wire over the main coil and connect as indicated in the diagram. When tuning to a station, a loud whistle will be heard in the headphones when the potentiometer is set too far to the right. As this control is backed off, a spot will be found where the whistle disappears, leaving the station signal still there. If you don't get the whistle, reverse connections on the ends of the tickler coil.

A long antenna—about 50 feet—is recommended for use with this little set.

## Short-Wave Antenna

The antenna I use for my short-wave radio picks up considerable interference from a nearby power line. Can this be eliminated without moving the antenna? If not, can I build a satisfactory indoor antenna to replace the outdoor one?

Jerry Mattson, Box Elder, S. D.

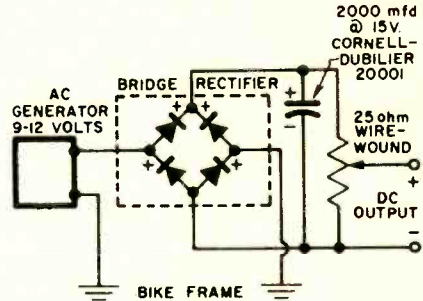
Since the interference is arriving at

your antenna in the form of a modulated radio wave radiated from the power line, it is impossible to eliminate it with your present setup. Such signals have the same status as the ones you tune to and, as such, are received by the short-wave radio without discrimination. A built-in noise limiter serves to reduce the annoyance but cannot be expected to do away with it entirely.

An indoor antenna that will approach the outdoor wire in performance can be built by stringing an insulated wire around your room several times. Keep the wire as close to the ceiling as possible and try to complete loops of the room as a primary experiment. Then add another loop and compare the results. A little experimentation will soon disclose the best length for the indoor antenna.

## DC From Bike Generator

Can you give me a circuit with which I could convert the AC 9-12 volt output of a bicycle generator to variable DC output running from 1.5 volts to 6 volts? Bradley J. Geissinger, Hialeah, Florida



The best way to approach this problem is to construct a rectifier system using a full wave bridge rectifier such as the Mallory 1B12R coupled with a husky electrolytic filter capacitor. A 25 ohm, wirewound potentiometer used as a voltage divider may be connected across the DC output terminals to give you the variation you want. Since the rectifier is rated at 1.3 amperes continuous drain, it can easily supply the 0.4 amperes that the potentiometer would take and still have 900 milliamperes left over for operating the device mounted on the bicycle. This is more than adequate even for a 7-transistor superheterodyne radio. ●

# An Electronic Harmonica

By Ronald Benrey

**Build this transistorized "musical instrument." Its range is one and a half octaves in the Key of C.**

**Y**OU can assemble this complete "harmonica" in just a few evenings and a little practice will quickly turn you into a musical virtuoso. It consists of an audio oscillator tuned across the musical scale by inserting different values of capacitance into the circuit with key switches, each corresponding to one note.

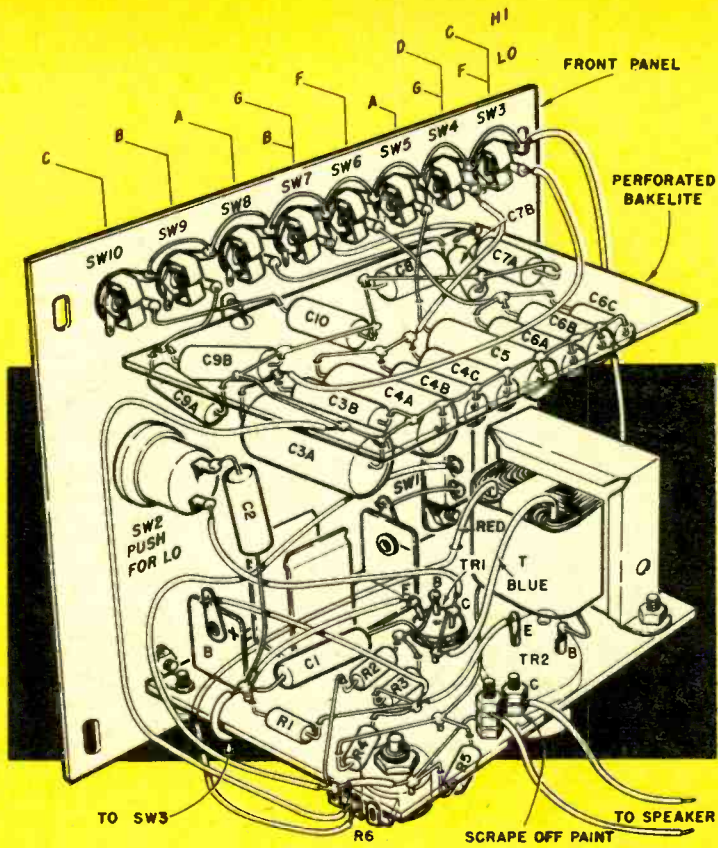
To produce a compact unit the range was limited to one octave, or eight keys, plus several additional notes provided by a "low range" switch that lowers the entire scale approximately one-half octave. Although there is no provision for sharps or flats most familiar melodies can be played if they are transposed into the key of C. Chords, however, are not possible since only one key may be pressed at a given time. Another feature of the "harmonica" is that vibrato, necessary for a pleasing tone, is added by the player modulating the speaker output with one hand, while manipulating the keyboard with the other.

Begin construction by assembling the oscillator subchassis,

**The vibrato is produced by rapidly moving hand toward and away from the 3 speaker holes on side of the case.**



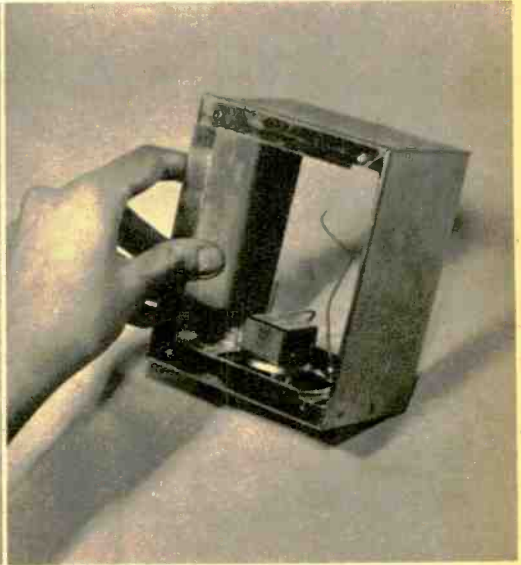
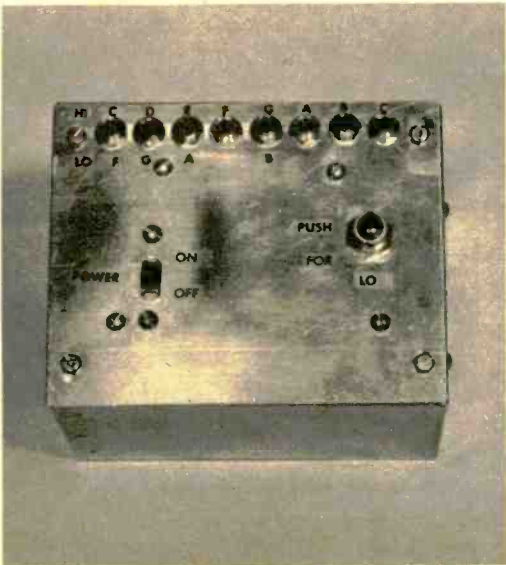


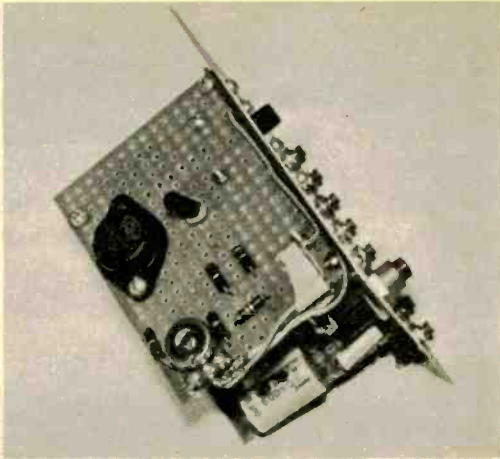
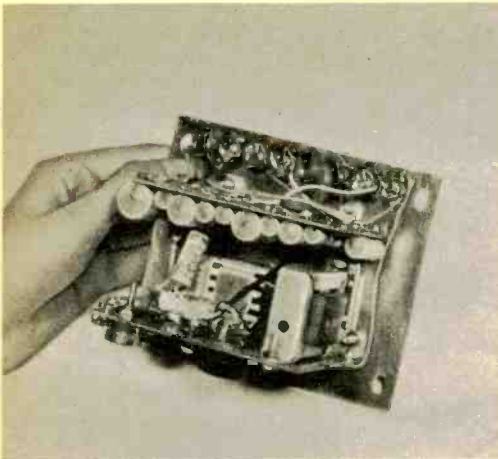


Wiring guide shows upper and lower subchassis. C3 to C10, on upper, determine pitch of notes.

Front face showing keys at top. "Push for LO" button shifts range down a half-octave.

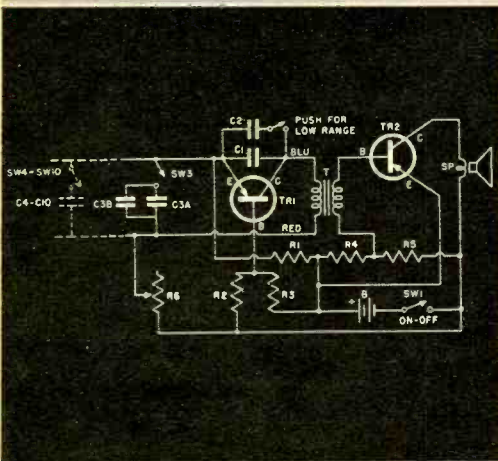
Note notch filed at upper right of case to permit clearance for sliding in key switches.





Upper left shows unit ready to be mounted in case. Key switches are at top edge.

Above, large black transistor is TR2 in underside view. TR1 is to right of it.



In schematic SW4 to SW10 and C4 to C10 are dotted lines since symbols are the same.

using the illustrations as location guides, and the major components themselves as templates for all necessary holes. Take care when mounting the power transistor TR2 so the metal case, which

is the collector terminal, cannot short out against any other components or stray leads on the assembly. Terminal connectors for the base and emitter  
[Continued on page 94]

#### PARTS LIST

(All capacitors may be found in Lafayette Capacitor kit KT-51. C2 through C10 values were used in author's model, but are subject to change as described in text. All are paper tubular types rated at 600 working volts.)

- C1—.01 mfd
- C2—.02 mfd
- C3A—.1 mfd, C3B—.01 mfd (Represents one note, in this case HI C)
- C4A—.05 mfd, C4B—.01 mfd, C4C—.01 mfd
- C5—.05 mfd
- C6A—.01 mfd, C6B—.02 mfd, C6C—.005 mfd
- C7A—.02 mfd, C7B—.005 mfd
- C8—.02 mfd
- C9A—.002 mfd, C9B—.01 mfd
- C10—.01 mfd
- R1—15,000 ohm (all resistors 1/2 watt)
- R2—3,300 ohm
- R3—1,000 ohm

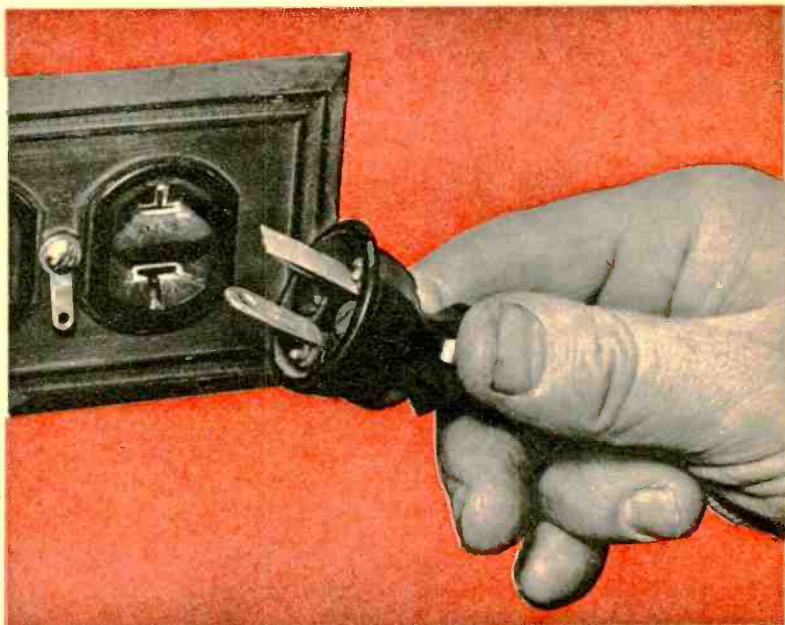
- R4—22 ohm
- R5—8,200 ohm
- R6—10,000 ohm miniature potentiometer (Lafayette VC-34) (Used for shifting overall range during tuning)
- T—Audio transformer 5000 ohm to 40 ohm (Stancor A-3877)
- SP—2 1/2" PM speaker, 10 ohm voice coil
- SW1—SPST slide switch
- SW2—SPST normally open push-button switch (Grayhill 4001)
- SW3 through SW10—SPST normally open push-button miniature switch
- B—22 1/2-volt hearing aid battery (Burgess UI5)
- TR1—RCA 2N109 transistor
- TR2—CBS 2N255 transistor
- Case—3"x4"x5" utility cabinet (Bud AU-1028)
- Misc.—2 perforated Bakelite boards 3 1/8"x2 1/8", flea clips, battery holder, transistor sockets.



# Polarize Your Plugs

By Robert Hertzberg

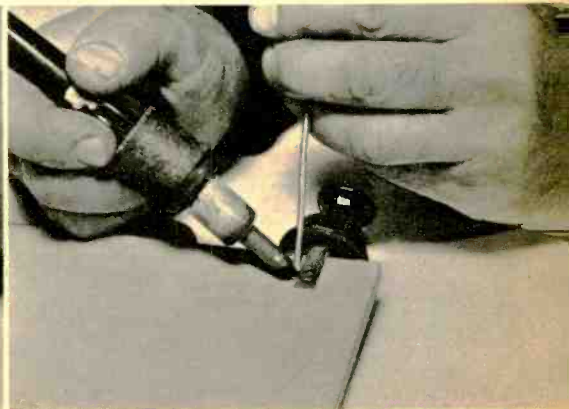
Fused plugs can be deceiving. Protect yourself from a hot chassis with this simple modification.



The AC receptacle has a narrow slot on top with a wide "ground" slot below it. The plug here must be rotated so its wide prong matches the ground.

A thin brass or copper strip (not aluminum) is cut to  $5/16$  inch wide by 1 inch in length.

Place the strip under one prong of the plug and solder. Then, trim off excess length.



**I**F YOU own any "hot" chassis AC-DC electronic equipment, think twice before you add a fused plug to it in the hope of protecting it and the power line against overloads and short circuits. A fuse will blow if its rated current capacity is exceeded, but if the equipment remains plugged in it can readily become deceptively dangerous to the extent of the full line voltage.

The fused line plugs commonly found in radio and hardware stores contain two small cartridge fuses of the same rating. Suppose that by chance the plug is inserted in the power outlet as shown in Fig. 1. (This represents the usual series-filament arrangement of AC-DC television and radio sets, with the last filament "grounded" to the metal chassis.) Fuse 1, in the "hot" leg of the power line, goes to the on-off switch; fuse 2 completes the circuit between the grounded leg of the line and the chassis of the set. Suppose that a short somewhere in the ground leg kicks out both fuses. The set is now completely isolated from the power line and is therefore entirely safe to touch and handle. However, it is much more likely that only one fuse will blow out. To test the probabilities of the situation, ten pairs of fuses were tried with a typical four tube AC-DC table model receiver. The "short-circuit" was a deliberate jumper across the filter capacitor. Only once did both fuses burn out together.

If only fuse 1 in Fig. 1 happens to

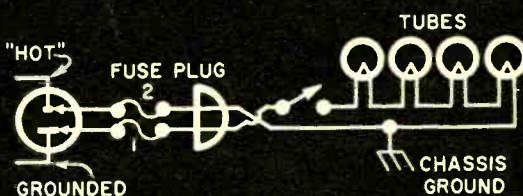
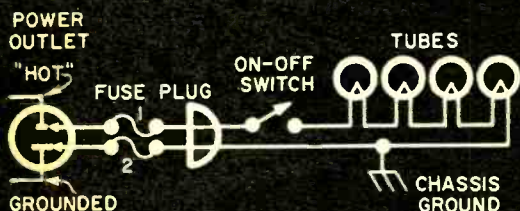
blow, the set is just as safe as if both had blown, because the hot leg of the line is separated from the set and no further live circuit is possible. Suppose now that fuse 1 stays put and that fuse 2 opens. If you have the presence of mind to snap the line switch to "off", the set again goes completely dead and you stay alive. If you forget the switch, and if the tube filaments are intact (as they are most likely to be, since any open filament merely silences the set without affecting the fuses), you can expect trouble if you are partially grounded through a floor or if you touch the chassis with one hand and any grounded object or surface with the other. Figure out the electrical path: the hot leg of the line, fuse 1, the closed switch, the filaments of the tubes (which have a very low resistance when cold), the chassis, *your body*, and the grounded leg of the line.

There is always a 50-50 chance that the line plug will be inserted the other way, as in Fig. 2. This situation is much worse than that of Fig. 1, because with the fuses intact and the set working normally, the metal chassis is "hot" in relation to any ground; the set doesn't even have to be turned on. Trace the current path again: the hot leg of the line, fuse 2, the chassis, your body, and the grounded leg of the line. If fuse 1 blows, the same dangerous condition prevails, since this fuse has no control

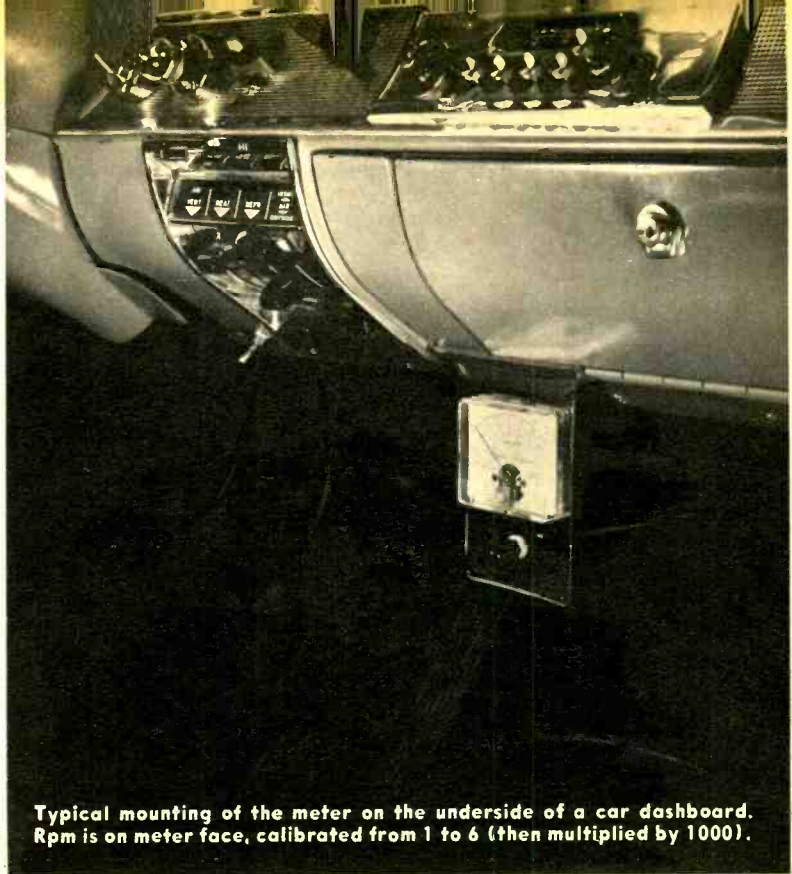
[Continued on page 97]

Fig. 1. AC-DC set with fuse plug. If fuse 2 blows and switch is on, chassis remains hot.

Fig. 2. Note that "hot" side of power outlet connects 117 volt line directly to chassis.







Typical mounting of the meter on the underside of a car dashboard. Rpm is on meter face, calibrated from 1 to 6 (then multiplied by 1000).

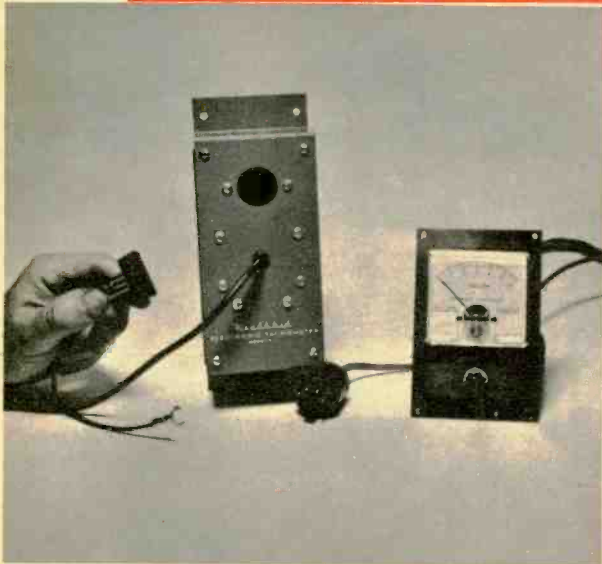
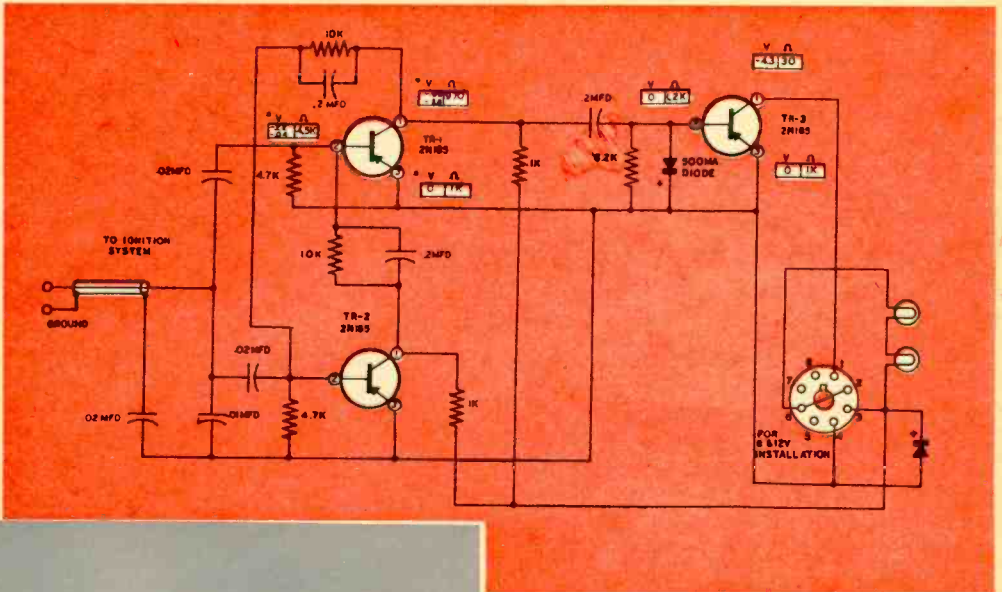
*EI assembles*

## A Tachometer Kit

**The new Heath TI-1 will measure car or boat engine rpm and features an accurate calibration method.**

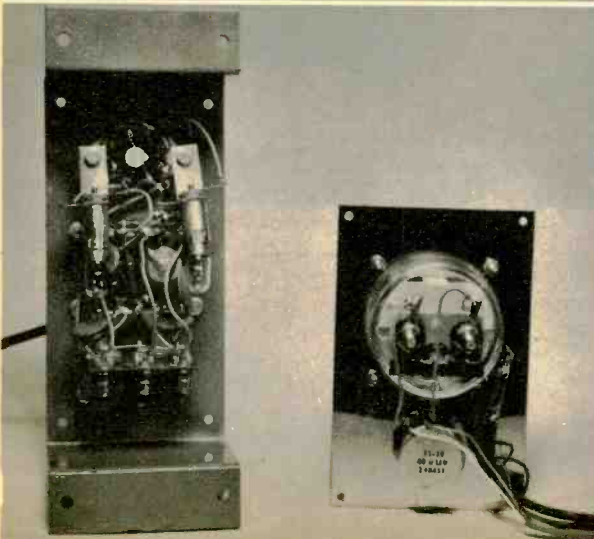
**I**T'S ONE thing to make an electronic tachometer for a car or boat engine, quite another to calibrate it so that its readings are really significant. In Heath's new Model TI-1 tach, the problem is solved very neatly by the inclusion in the kit of a neon bulb and resistor which serves as the calibration source. This is energized directly off the AC house line, and since the frequency of the latter is maintained very accurately throughout the United States at 60 cycles per second the tach can be adjusted very precisely. Bear in mind that 60 cycles per *second* is equivalent to 60 times 60 or 3,600 cycles per *minute*, a very convenient figure in view of the fact that 3,000 revolutions per minute represents the center of most tachometer scales. The neon arrangement is needed for about five seconds, which is how long the calibration job actually takes. After that, you can use it for a night light!

The Model TI-1 tachometer itself is a simple construction project that can be completed easily in a couple of hours. It consists of a transistorized "sender" unit, mounted in the engine compartment, and a separate meter unit, which is placed in the front of



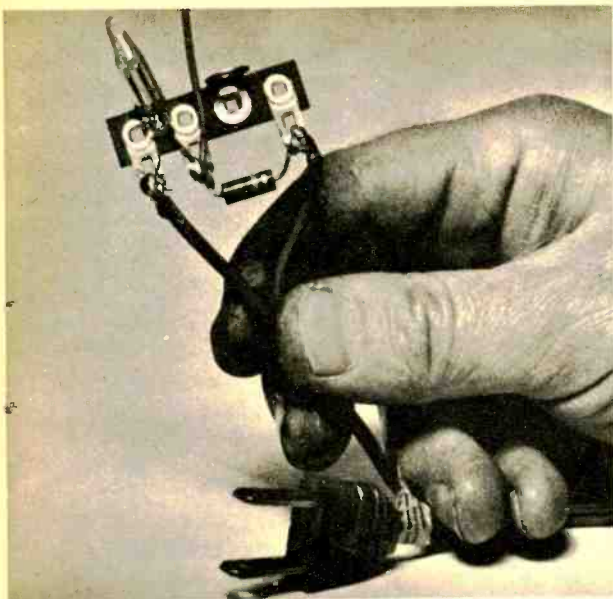
Schematic above shows 3-transistor circuit, easily adaptable to 6, 12, 24, or 32 volt ignition systems.

Hand is holding clamp that picks up pulses from the high-tension cable. Sender unit is located at the center.

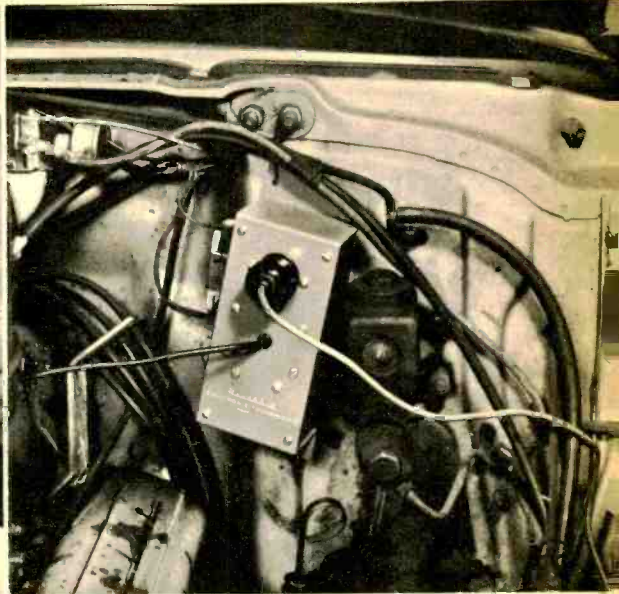


Rear of sender is at left and has most of the circuit parts. Right, rear of meter and calibration pot.





Neon bulb and resistor provide accurate 60 cycle calibration source from house current.



Sender mounts on firewall. Its upper lead goes to meter, lower clamps on ignition cable.

the car within view of the driver. The ignition system is not disturbed or affected in any way.

The three transistors in the sender work directly from the car's storage battery and draw negligible current. The primary leads in the diagram marked "BLK" and "RED," for negative and positive, can be connected across the low-voltage side of the ignition coil so that the tach goes on and off with the latter when the ignition key is turned.

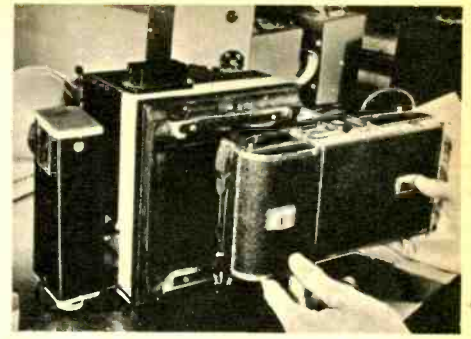
The tach picks up the engine pulses by means of an ordinary wide-jaw paper clip. The clip is merely clamped over the heavy outer insulation of the high-tension lead coming from the ignition coil. It does *not* make actual metallic connection with this lead, but forms a capacitor with the internal wire acting as the second plate. The actual capacitance is very small because the "plates" are small, but it is enough to pass pulses of energy from the ignition circuit. Thus there is no direct contact with the 8,000 to 15,000 volts.

The sender comprises a multivibrator, a wave-shaping circuit, a meter amplifier, and a voltage regulator. The ignition pulses are delivered to the multi-

vibrator, whose action is such that the first pulse turns it on and the second turns it off. Thus, there is only one output pulse for every two input pulses. The amplitude of the multivibrator output pulses is constant, but their frequency varies with the input repetition rate; that is, with the engine speed.

The calibration control is simply a 40 ohm variable resistor connected across the meter movement, to provide an alternate path for excess current. For the calibration operation, the tach is energized from the car battery and the input clamp is placed over a short wire connected to the neon tube calibrator which simulates the engine pulses. The resistor is then adjusted so that the meter registers various speeds for various types of engines, in accordance with a chart included with the instrument. For example, a standard eight-cylinder, four-stroke automobile engine is set to read 900 rpm; a two-cylinder, two-stroke marine engine to 1,800 r.p.m. The meter scale is linear. Its readings throughout its range checked remarkably well against a large professional tach in a service station. At \$29.95, *EI* rates the TI-1 a Good Buy. ●

Solenoid wired to camera shutter gets additional wire to light bulb. This bulb alerts returning owner that film is exposed.



Custom camera casing is fitted with an electronic flash, 125mm lens, 4x5 mounting and a quick-developing Polaroid attachment. It will make an exposure when shutter is tripped by the solenoid.



Control box interior features on-off switch, transformer, AC input, remote buzzer alarm, relays, 3 output sockets (two 110-volt, one 24-volt).



Doormat camouflages special switch mat, which operates under slightest pressure to trip camera and alarms that are attached to control box.

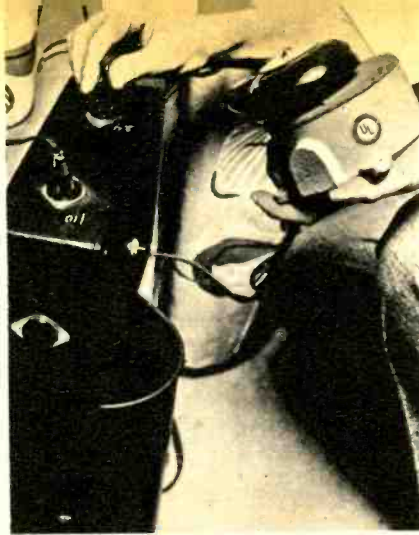
*thief takes his own photo with*

## Electronically Tripped Camera

**S**INCE 1930, Francis Sirchie has been supplying police, FBI and Scotland Yard with modern crime detection equipment such as ultra-violet devices, lie detectors, "bugging" units, one-way mirrors, etc. As an ex-member of the crack Texas Mounted Police, he has gained his knowledge of criminology first-hand. Most devices are sold only to law agencies, but now under development in his Camden, N. J., lab is a consumer item—a camera so rigged that a would-be burglar succeeds only in taking his own picture before being frightened away. Total price: \$240. —



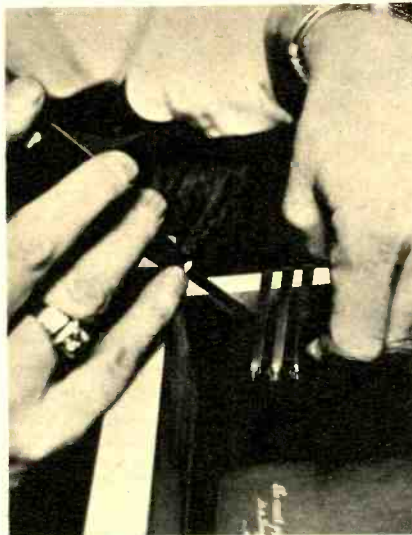
Raucous burglar alarm is plugged into control box along with camera. Once it sounds, intruder isn't likely to hang around to search for the camera.



The small size of control box makes it easy to hide. Here it is placed inside wastebasket. Note camera placement on the fourth shelf of bookcase.



Another way to trip camera is to attach copper strips to inside of desk or bureau drawer so that when drawer is opened, switch contact is made.



Would-be burglar arrives through window, thus avoiding switch mat, and starts to rifle drawers. Alarm bell goes off and camera takes startled man's photo.



With alarm ringing in his ears, burglar does not wait around. He runs for the nearest exit. First person on scene may then remove prowler's photo.



Positive identification is very important to lawmen. A photo like this will not only help to find criminal, but will also help the D.A. in court.



# The ABC's of Electronics-13

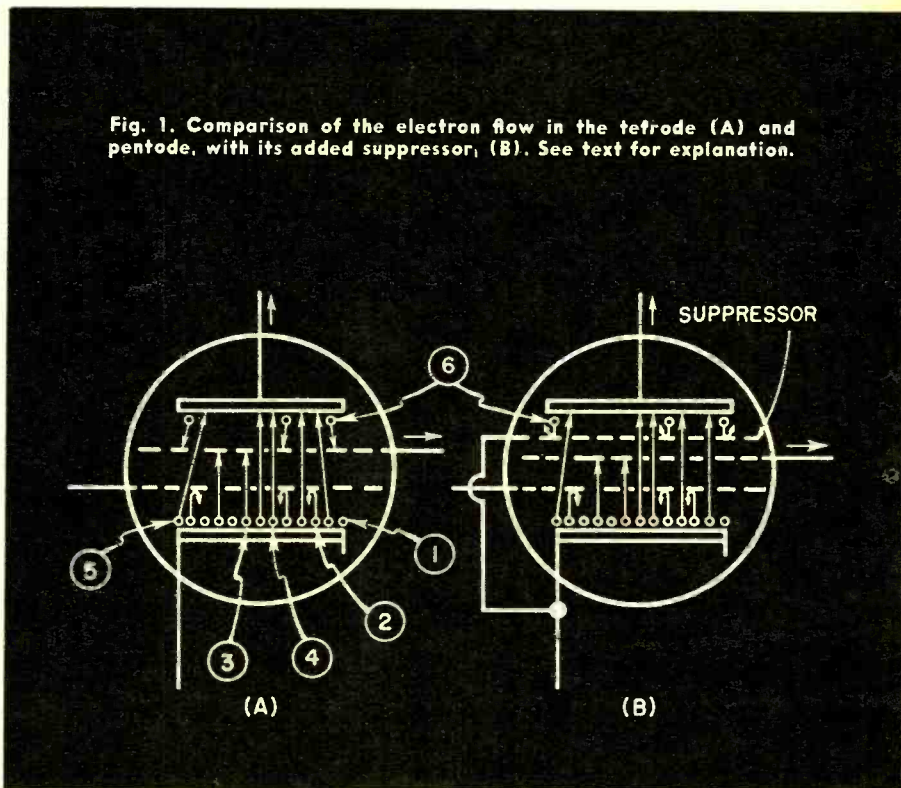
By Donald Hoefler

**Beam power and remote-cutoff tubes are explained in this discussion of how a pentode operates.**

**T**HE screen grid tube is distinctly superior to the triode for many high frequency applications, but the effects of secondary emission limit its usefulness. Here is a case where the solution to one problem creates another, for while secondary emission undoubtedly exists also in diodes and triodes, in these tubes it has no undesirable effects.

There are a full half-dozen different electron actions in the tetrode, as shown in Fig. 1 (A). When an electron is emitted from the cathode, any of these things may happen to it:

1. Remain suspended in the space charge surrounding the cathode.
2. Be repelled by the control grid.
3. Strike the screen grid and become part of the screen current.





4. Strike the plate and become part of the plate current.
5. Strike the plate and dislodge secondary electrons.

And this secondary emission sets up a reverse current:

6. Flow from plate to screen grid and add to screen current.

This last item results in a lowering of the efficiency of the tube as an amplifier, for this reverse current in effect subtracts from the normal plate current flow and thus limits the overall amplification of the tube. Furthermore, in the negative-resistance region of its operating characteristic, the tube is erratic in operation and exhibits considerable distortion.

The most common cure for this problem is an additional grid, known as the *suppressor*, placed between the plate and screen. The suppressor grid is connected electrically to the cathode, often inside the tube itself. The potential on the suppressor is therefore negative with respect to the plate.

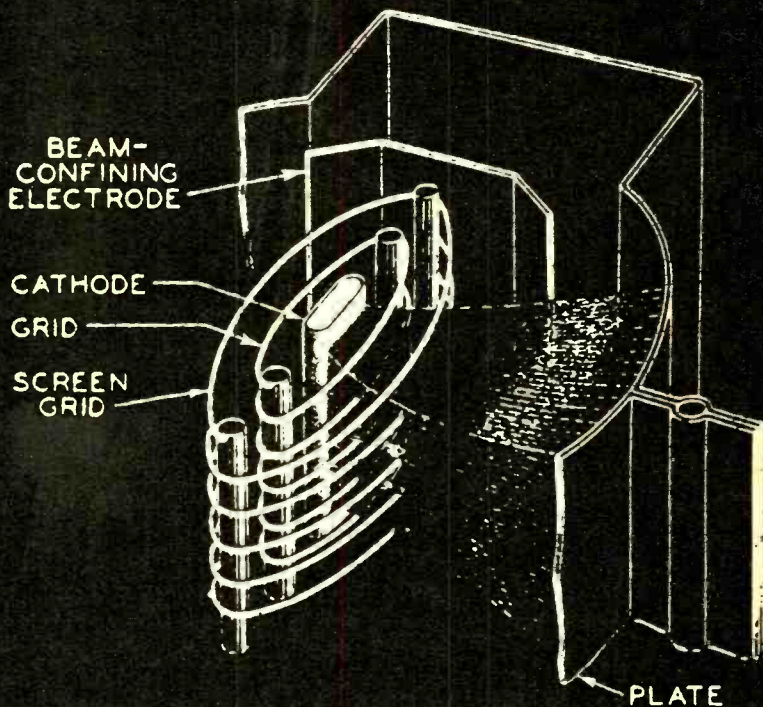
Now the electron action within the tube is a little different, and shown in Fig. 1 (B). The first five types of movement are the same as in the tetrode, but item 6 now becomes:

6. Secondary electrons are repelled by the suppressor and return to the plate.

An even more sophisticated method for eliminating the undesirable effects of secondary emission is space-charge suppression, in which an electron beam provides the negative potential for repelling secondary electrons back to the plate. This method is employed in the *beam power tube*, of which the 6L6 is the classic example. The internal structure of this tube is shown in Fig. 2.

As the illustration shows, the beam power tube has a cathode of flat cross section, surrounded by two oval-shaped grids. The two grids have exactly the same number of turns and identical spacing between turns. In installation they are lined up directly opposite one another so that as far as the electron

Fig. 2. Sheets of electrons travel to the plate in beam power tube.



From RCA Tube Manual

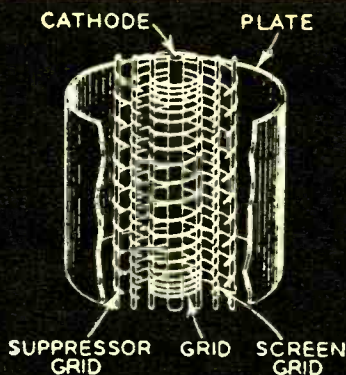
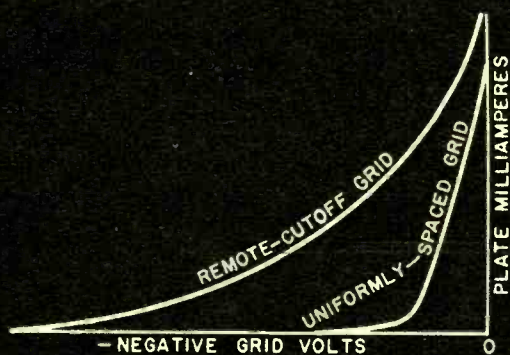


Fig. 3. Remote-cutoff pentode. At left, note smooth upper curve of remote-cutoff grid. Drawing at right shows grid wires close-spaced at top and bottom to achieve this with varying grid voltage.

stream is considered, the screen grid is in the "shadow" of the control grid.

Two solid metallic beam-forming plates are placed at the ends of the grid structures and electrically connected to the cathode. They should not be thought of as the equivalent of a suppressor grid, however, as the principle is different. The anode plate is circular in shape in the region where it is struck by the electron beam.

As the electrons are emitted from the cathode, they are naturally attracted by the positive charges of the screen and plate. But instead of scattering in all directions as in other tubes, they are confined to two wedge-shaped beams by the electrostatic effect of the end plates.

These two beams, which are emitted from opposite faces of the cathode, are composed of a series of lateral "sheets" of electrons, formed as they stream through the spaces between the in-line grid and screen wires. Because of the high velocity of the electron beam, plus the fact that the screen grid is effectively "shaded" by the control grid, nearly all the electrons fly right on by the screen. Thus the screen current is quite small, even though the screen voltage may equal or even exceed the plate voltage.

When the plate voltage drops below the screen voltage, here is where we run into real trouble from secondary emission in the tetrode, and where space-charge suppression is most effective in

From RCA Tube Manual

the beam tube. To understand this, we must first consider what causes the variation in plate voltage.

The amplified plate current signal is useful only if it is used to develop a voltage across a suitable load device, such as a resistor, coil or transformer. But this voltage drop across the load acts against the DC plate supply voltage. That is, the voltage applied to the plate at any moment is the supply voltage less the drop across the load. Since the drop across the load will be constantly varying with the signal, so too will the actual voltage on the plate be changing.

Efforts are made to minimize this effect, using by-pass circuits or shunt feed, but in power tubes especially it is desirable that the plate be able to go through wide voltage "swings" without distortion. At the same time, it is desirable that the screen voltage be maintained as high as possible, and so it is inevitable that at times the plate voltage will swing below the screen potential.

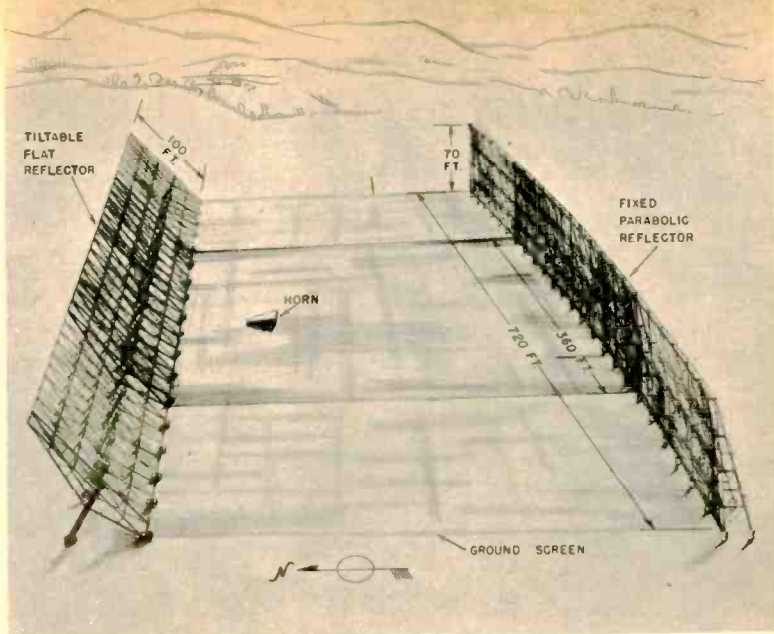
It is at these times that the screen grid in the tetrode is most effective in drawing off the secondary electrons and adding them into the screen current. But in the beam power tube quite a different phenomenon occurs. Here a space charge is set up between the plate and screen, to form an electron barrier against the secondary electrons.

As the electron beam moves out of the region of the screen, it slows down when

[Continued on page 95]



Each unit already longer than a football field, drawing shows how additions may be placed on the ends of the existing antenna arrays to provide even better separation of distant radiostars.



# New Radio Telescope

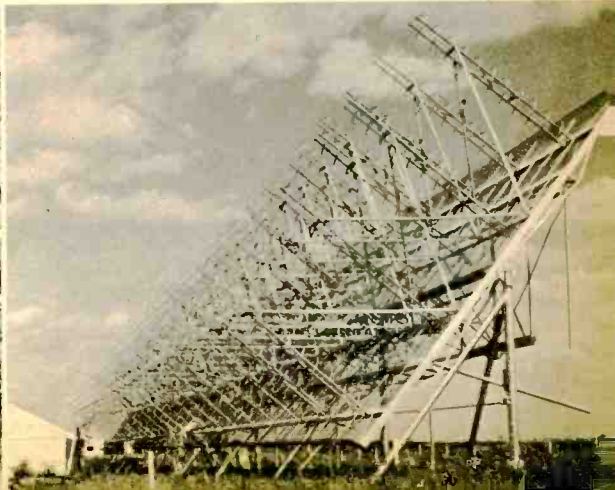
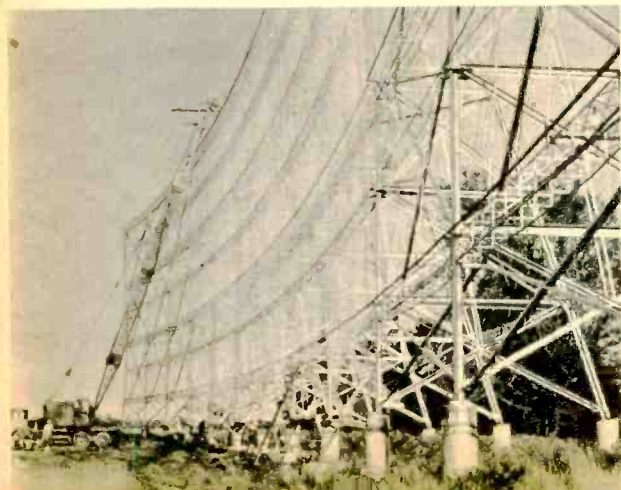
By Kirk Polking

**T**HIS giant radio telescope will enable man to learn more about outer space than ever before. Built at Delaware, O., by Ohio State University and the National Science Foundation, the telescope consists of a fixed parabolic reflector 70' high and a tiltable flat reflector 100' high. Both units extend for 360' along a 20-acre tract furnished by Ohio Wesleyan University.

The flat reflector, with its array of helix-type coil antennas, is designed to detect and deflect very weak radio waves from stars galaxies away. These signals are reflected into the parabolic antenna which, in turn, focusses them through a horn and waveguides to a sensitive receiver. The receiver amplifies the signals and activates recording instruments. This process is similar in function to an optical telescope, which gathers light waves and focusses them by means of a series of lenses.

Workmen with a 90' crane place the finishing touches on the telescope's parabolic section.

This flat reflector features 96 coil antennas. Structure, lower left, houses the receiver.



## All About Radiation Belts

Continued from page 46

penetrating power. The next step is to check this experimentally by firing a lead-coated detector through both belts. If the inner belt is really hard and the outer belt soft, then the lead shielded radiation counter will show the inner belt about as it is now but the outer belt will be very severely attenuated. All the experiments so far have done is to show the approximate locations of the belts, and their intensities.

**Ques.** *These belts do appear in the opinion of some space scientists to be of some danger?*

**Ans.** Very true, the problem is they pose a health hazard to manned space flight. In my opinion, the outer belt should not be too dangerous as it easily can be shielded against, but the inner belt may pose serious consequences if one remains in it for a long period of time. But if one simply rides through it rapidly, then the amount of radiation accumulated will not be serious.

**Ques.** *Are the high energy belts which immediately surround the earth a deterrent to radio communications?*

**Ans.** No, their densities are extremely small. The inner belt in my opinion should have little if any effect on communications. The outer belt in my view is connected with the aurora and the aurora does interfere with communications often causing radio blackout at the high latitudes.

**Ques.** *If the trapped low energy outer belt is responsible for the aurora effect, then this would indicate that the belt is not a continuous thing, that its energy is rapidly drained into the atmosphere. . . .*

**Ans.** . . . and used to produced aurora. In order for the belt to continue it has to be replenished often by the sun. The inner belt on the other hand is replenished continuously by cosmic rays at a very low rate because it loses very little of its energy to the atmosphere.

**Ques.** *How is the electrical energy of the outer belt converted to the aurora effect?*

**Ans.** Well these fast particles often

can be redirected so that they move deep down into the atmosphere, and when they do they don't come back out again. They dissipate energy into the atmosphere, producing luminosity and ionization.

**Ques.** *This luminosity is what we see as the aurora, but just how do these particles produce the luminosity?*

**Ans.** They will hit atoms in the upper atmosphere and knock off the electrons and when the electrons combine with the ions again, radiation is emitted.

**Ques.** *We've discussed trapped particles and radiation, perhaps you can explain just how a radiation particle is trapped in the earth's magnetic field since this is fundamental to the Project Argus experiment.*

**Ans.** A particle in the magnetic field spirals about a line of force—and is trapped by it. This line of force goes from the northern hemisphere to the southern hemisphere so the particle moves in this direction while it spirals.

**Ques.** *In other words, this trapping perhaps is similar to what happens to an electron in a cyclotron?*

**Ans.** Yes, where it spins about under the influences of magnetic forces.

**Ques.** *Do you think other planets and the moon have radiation belts surrounding them?*

**Ans.** If the moon has a magnetic field then it also will have a radiation belt or maybe two belts. We feel fairly sure that Venus and Mars should have magnetic fields and therefore radiation belts.

**Ques.** *Where does this magnetic field come from?*

**Ans.** We think the planetary magnetic field comes from the planet's liquid core through which current flows. The earth, for example, has a core which consists of a conductive fluid, an electric current which flows in this liquid core produces our magnetic field.

**Ques.** *Would you say that the discovery of these radiation belts is one of the most important results of the International Geophysical Year?*

**Ans.** As far as new phenomenon in the upper atmosphere of the earth, I would count this as number one.



**Ques.** *Is knowledge about these radiation belts of practical use to us or is it of theoretical use only as a stepping stone for obtaining other knowledge?*

**Ans.** I would say that some of the information should be of reasonably practical use soon. Since the outer belt may be related to the aurora, knowledge of it gives us a better understanding of the aurora and of radio communication at high latitudes.

**Ques.** *In other words, you think perhaps that we can in some way affect his outer radiation belt so that it has less effect on our communications?*

**Ans.** I'm not saying that we can control it very easily because you remember it is replenished by the sun and it has, so to speak, a very high metabolism rate. On the other hand I think we can do quite a lot to the inner radiation belt which has a very low turnover rate. We may be able, for example, to do such things as dump radiation into the atmosphere by distributing the magnetic lines of force. This can be done perhaps by exploding a hydrogen bomb at high altitudes. Or we could introduce additional radiation by carrying up a small cyclotron or other type of accelerator and releasing particles directly which would then stay trapped for long periods of time. That's a very exciting possibility for modifying the radiation belts. A third possibility is to absorb the radiation by releasing a number of large satellites in this region which would cut down the level of radiation.

**Ques.** *Do you think these radiation belts have any effect on our weather?*

**Ans.** The Soviets have said that they have a theory for that. We've examined what has been published by them on it and frankly it is very doubtful whether the relationships that they state have any validity. The inner radiation belt does not, in our opinion, interact very much with the atmosphere and therefore shouldn't have much effect on the weather. The aurora may affect the temperature of the upper atmosphere and perhaps indirectly affect some weather phenomena.

**Ques.** *What direction should future research take for getting more information about these radiation belts?*

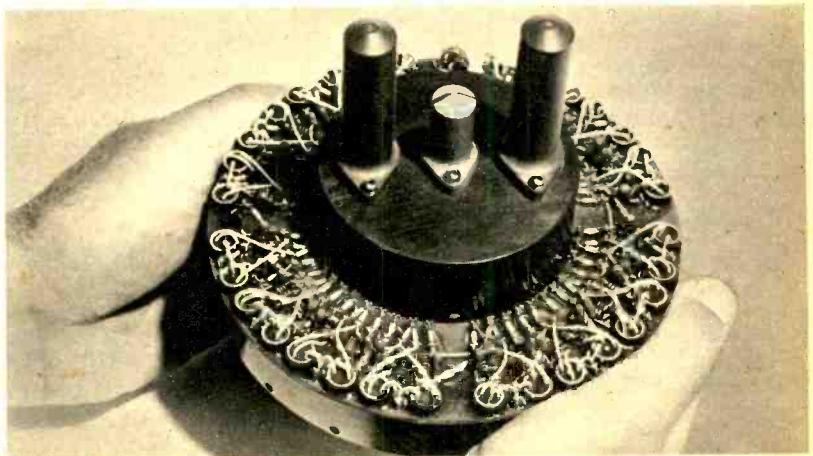
**Ans.** The immediate problem is to find out what they are, what types of particles they are made of and what the energies of the particles are. Once you've done that you can decide quite clearly among differing theories for the origin of the belts.

**Ques.** *And to discover this we just send up more rockets and more satellites?*

**Ans.** Yes, with more sophisticated instruments to measure more than just the number of counts, to tell us precisely what the particles are. Some of these instruments are scintillation detectors, proportional counters and ionization detectors.

*Thank you very much, Dr. Singer.* —

Radiation analyzing equipment like this is now being used to determine what the belts consist of. The two outer tubes are Geiger counters with lead shields; the voltage supply tube is in center. Diameter of unit is about 6 inches.



## Electronics with a French Accent

ALTHOUGH the language of the Frenchman interested in electronics is of course French, his American colleague will find many familiar English words in the most popular French radio and TV publications. For example, the following are perfectly good French words: *résistance*, *potentiomètre*, *voltmètre*, *oscilloscope*, *impédance*, *cathode*, *filtre*, *tube cathodique*, *polarité*, *capacité*, *préamplification*. There are dozens of others. Some differ slightly more from the usual American expressions, but the reader can guess the meaning: *condensateur* (condenser); *bobine* (bobbin or coil); *amplificateur* (amplifier); *lampe* (tube); *interrupteur* (switch) and; *convertisseur* (converter).

The surprising thing is the extent to which pure English words have caught on in French. All of the italicized words below have been taken from standard French radio magazines and books.

The *serviceman* has mounted on his rack a *signal tracer* or a *multi-tracer*, an *outputmètre*, and possibly a *wabulateur* (wobbulator). To test the performance of an amplifier, with or without an *étage final push-pull* (final stage), he may use a *pickup* connected through a *jack* and feeding a speaker mounted on a *baffle*. Common parts that he would have in stock would be *condensateurs by-pass*, *trimmers*, *ferri-loops*, *bobines de self-induction* (choke coils), *clips*, *lampes de la série loktal* (loktal tubes) and *transistors*. The television repairman would know such un-French terms as *diodes booster*, *le blanking*, *transformateur blocking lignes*, *feeder*, *flicker*, *folded* (diopole), *circuit fly-wheel*, *flyingspot* and *top vertical*.

All these terms are naturally pronounced *a la française* with a good Maurice Chevalier accent. In print they are familiar friends testifying to the international nature of electronics.

by Lawrence A. Sharpe

## We Can Be Cut Off From Europe!

Continued from page 49

submarine cables, but it *was* unusual to happen that far from shore.

The picket ship's skipper, Lieutenant Ernest J. Korte, announced that the trawler had equipment aboard capable of cutting the cables.

The Kremlin protested the U. S. Navy inspection calling it "provocative," and a White House note to the Kremlin on March 23, revealed the results of the inspection. Twelve breaks had been made in five cables between February 21 and 25, all of them along the route of the Soviet trawler! The evidence, the note said, indicated the trawler had scooped up the United States cables with its drag, then cut the cables, ostensibly to free its fishing nets.

But whether or not the cutting of five United States cables in a 50-mile radius within five days was "accidental or intentional," the incident dramatized the fact that, in time of national emergency, the Russians *could* cut our trans-Atlantic cables!

Overseas communications are vital to our national defense. Without intact communication links, defense and supply lines cannot operate and chaos results. At the moment, we depend for communication links between the United States and Europe on just two methods: radio circuits (mainly short-wave), and submarine cable.

"We can be cut off from Europe. Cables can be cut. Shortwave can be jammed. We can be cut off from our own allies, and our own NATO bases in Europe!" These are the urgent, oft-repeated words of Henry F. Holthusen, international lawyer-diplomat and consultant to the Smith-Mundt Committee that originally set up the "Voice of America" broadcasts. Holthusen says, "I only hope we wake up to this situation before it is too late!"

Russia has built 5,000 stations capable of jamming our shortwave. She spends almost \$100-million a year jamming our overseas broadcasts. This amount equals *all* we spend broadcasting it, plus the cost of our entire information service.

The American Telephone and Tele-



graph Company cable that was cut is our only present voice cable circuit across the North Atlantic! Laid in the Summers of 1955 and 1956, it is jointly owned by AT&T, the British Post Office, and the Canadian Overseas Telecommunications Corporation. In mid-ocean it may lie two miles deep. It is as narrow as 1¼" in diameter and weighs as little as one pound per foot.

Closer to shore, the cable is heavier, weighing nine pounds per foot, and is 2½" in diameter. Capable of carrying at least 36 telephone conversations at one time, this \$42,000,000 cable is laid in two sections, 20 miles apart on the ocean's floor. But if only one section of this cable was cut, two-way conversation would be disrupted.

The other 20 cables lying along the floor of the Atlantic are all telegraph cables, some of these so antiquated they carry only one message at a time. These are owned by Western Union (ten), American Cable and Radio Corporation (six), and the remainder by Great Britain and France. Repaired time and time again, some of these telegraph cables date back to the days of Cyrus Field, when cables were first installed across the Atlantic. Eight of Western Union's cables have been modernized by adding near-shore repeaters, and their three permalloy cables laid in 1924, '26 and '28 carry a considerable traffic load; but no new trans-Atlantic telegraph cables have been laid since 1928!

In 1958, telephone traffic between the United States and England stood at 261,183 calls, with total overseas calls at 1,873,000. This is peacetime traffic. What would a national emergency with today's weapons, demand of these facilities?

How can we be sure of having reliable communications with our allies in time of emergency? Many recent proposals point to outer space, such as bouncing signals off meteor trails or carefully placed satellites, or the moon itself. These all hold great hope for the future. But what of the present? What if the cold war should suddenly turn hot?

A new type of transmission facility is ready. Until recently, and for many years, there was no alternative but to

depend on submarine cables and the easily-jammed radio circuits across the North Atlantic. At that time microwaves that relay television across the land were believed incapable of ever traveling beyond the 30-100 mile horizon, depending on the height of the transmitter.

In 1931, ITT scientists conducted some tentative experiments with microwaves across the English channel. Ten years later, they beamed signals beyond the line of sight, in a series of tests from ship to shore off the coast of Toulon, France. World War II sparked hope again that the microwave might finally be trained to longer travel when radar crossed the horizons during favorable weather conditions.

But hope of regulating the microwave to consistent travel over the horizon seemed feeble until, in 1950, Bell Laboratories' Kenneth Bullington predicted an over-the-horizon system of "scattering" the microwave could be worked out. He designed the first forward tropospheric scatter propagation system, based on the conception of beaming the wave toward the troposphere, where it would be reflected or scattered forward over the horizon to directional antennas.

At much the same time, RCA's researchers were checking theories that particles of ionized air in the troposphere might reflect these waves, scatter them forward toward the earth much as a searchlight's beams are reflected back to earth by the atmosphere. Many thousands of times the power used in conventional microwave line-of-sight transmission, and 60' directional antennas were applied, and forward tropospheric scatter propagation went into the testing stage.

In 1954, Bell Labs tested over an 188 mile distance between Holmdel, N. J. and the M.I.T. Round Hill Research Station near New Bedford, Mass. In March 1955, both Bell Labs and RCA announced they were beaming microwave signals over the horizon.

At first, the weak signals barely reached the distant receiving antennas, but by adding power, adjusting antennas, scatter propagation of hard-to-jam microwaves was beginning to prove itself a useful tool.

On September 13, 1957, an historic broadcast of forward tropospheric scatter beamed the television picture 185 miles across water for the first time! A ten-round prize fight held in Syracuse, N. Y., was telecast over the horizon from AT&T antennas in Miami, Florida, to receivers in Havana, Cuba. This telecast carried not only the wide-band, six-million-cycle television picture, but 36 telephone circuits as well!

ITT followed this dramatically successful scatter link with over-the-horizon relays 230 miles across the Mediterranean between Minorca and Sardinia Islands, opening overseas telephone circuits between Italy and Spain. Followed another 238-mile link in the Caribbean joining Dorado, Puerto Rico, and Ciudad Trujillo in the Dominican Republic. Other recent links include one joining Buenos Aires and Montevideo, in Uruguay, and one spanning the Straits of Gibraltar, linking air bases in Spain and Spanish Morocco.

These tropospheric scatter links prove daily that scatter can travel up to 250 miles. To cross between the island land masses of the North Atlantic, it must travel 290 miles, the distance between Iceland and the Faeroe Islands. Through the use of new low-noise amplifiers (see "Those Amazing Masers," in the February 1959 issue of *EI*) forward tropospheric scatter can now travel 350 miles!

It could carry two television channels simultaneously; or one television channel and 120 telephone calls—or one television channel and 2160 telegraph messages. If used for telephone messages alone, it could send 600 phone circuits simultaneously. If it were to be used entirely to transmit telegraph messages, a chain of these links could carry as many as 10,800 messages across the North Atlantic simultaneously.

Scatter transmission is extremely difficult to jam. It is also the least vulnerable to enemy penetration. Dr. Beverage says an airplane might possibly be able to jam a relay if the plane could reach within 50 miles of the directional wave. But in time of emergency, if one relay is destroyed by an enemy, a United States plane with portable relay could pick up the wave and send it on.

Airplane relay proved out in the Fall of 1954 when NBC broadcast the World Series baseball games to Cuba, by relay to a plane circling in a five-mile radius 8000 feet in the air. Combinations of ship to ship or plane to plane relay could Scotch-tape a microwave system across the North Atlantic if an enemy managed to destroy more than one relay.

Senator Karl Mundt calls communication links across this sensitive North Atlantic area as important to our national safety as guided missiles. The cost of tropospheric relays to Europe would be about \$50,000,000, a "small" amount when compared with other defense expenditures.

Communications and defense officials say these tropospheric relays are not being built because of costs, yet reliable communications across the sensitive North Atlantic area could well mean the difference between national survival and possible defeat. It is our contention that these relays must be built—quickly.

## An Electronic Harmonica

*Continued from page 78*

leads of this transistor can be fashioned from ordinary "flea clips." Keep all leads neat and short, and position all components not attached to the chassis as close to it as possible. This is a precaution to insure that everything will fit properly into the small case.

Due to variation in the value of parts, the tuning process must be done by trial and error. From C2 through C10, combinations of capacitors in parallel (or series to raise the tone), can be connected until the proper values for a complete octave are determined. The author's values are shown in the parts list and should serve as a rough guide. Note that groups of two and three capacitors were used for single notes. Use a piano as a standard during calibration. Label each capacitor combination as it is made so that there will be no confusion when the capacitor bank is wired to the key switches. Increasing the capacitance by paralleling one or more units will lower the pitch of the note.



However, large value capacitors are both physically large and expensive, therefore the above mentioned range was considered the most practical. If you have a well-filled "junk box" you might already have all the values needed. If not, purchase the inexpensive capacitor kit mentioned in the parts list. This will cost less in the long run than individual units, and you will have a much greater variety of values on hand for many different value combinations. Mount the chosen capacitors on the perforated board, positioning them so that the leads for each note cannot short circuit against each other. The two subassemblies are secured to the front panel with small angle brackets. When mounting them be sure you have provided sufficient clearance for the speaker which is mounted inside the case.

The "low range" capacitor can be soldered into position after both subchassis have been installed on the panel. The correct value of this unit will probably be between .01 mfd and .02 mfd, and can be determined by experimentation as before. Choose a value that lowers the complete range by about one-half octave, and provides "on tune" notes for the lowered scale.

Don't be disappointed if your first attempts to play the instrument produce rather cacophonous results. Skill, easily acquired, is necessary to properly manipulate the keyboard, to operate the "low range" switch, and to provide vibrato. —●—

## ABC's of Electronics

*Continued from page 88*

the plate voltage is less than the screen voltage. There is then a low-velocity region between screen and plate, when the electrons pile up into a high-density space charge. This region is shown by the heavy dashed lines between screen grid and plate in Fig. 2. And since electrons themselves are negative charges, this dense space charge cloud is intense enough to repel the secondary electrons back to the plate where they belong. With secondary emission under control,

both pentodes and beam tubes have greater output, sensitivity and efficiency, as compared to tetrodes.

Radio and TV receivers usually incorporate automatic volume control (AVC) circuits, but when ordinary tube types are used for this purpose they produce considerable cross-modulation and modulation distortion. Cross modulation results in an interfering station riding through on the carrier of the desired station, and modulation distortion results from partial rectification of the signal.

AVC acts to vary the gain of a system by changing the grid bias on one or more stages. But as we have already learned, the grid bias operating point is ordinarily chosen to be in the middle of the straight-line portion of the tube operating characteristic. And we have seen that distortion results when operation moves into the area of excessively curved portions represented by cutoff at one end and saturation at the other.

A special remote-cutoff tube has been developed for these applications, resulting in a much less abrupt curvature at the cutoff bend of the curve. The resulting characteristic, as compared with a conventional type, is shown in Fig. 3. This gentle slope is the direct result of the special control grid construction also illustrated in Fig. 3.

In conventional tubes the control grid wires have the same spacing between each turn, and as a result each one is equally effective in controlling electron flow. The remote-cutoff tube, however, has grid windings which vary from close spacing at the ends to quite wide spacing at the middle.

Now when the grid bias is low, for the reception of feeble signals, the operating point will be somewhere near the middle of the curve and the action will be about the same as with conventional tubes. But when the grid becomes more negative to permit handling stronger signals, the closely-spaced ends cut off the electron stream in these regions, but the widely-spaced center turns continue to function in the usual fashion. Thus the center portion reaches cutoff after the ends, and the point of absolute cutoff is reached more gradually. —●—

## How To Learn Code

Continued from page 35

There are several code courses that take the beginner to 20 wpm on only one 12" LP record. One advantage is that these single record courses are relatively inexpensive. In some cases the student has to learn the code (in terms of dits and dahs) from the printed instructions, then receive his practice from the record. In all cases he can compare his receiving with what was actually "sent" merely by checking it against a printed version of the "transmission." Almost all these courses use random groups of letters to discourage memorization of the transmitted text. In other words, just by listening to plain text over and over again, the student would soon know what follows. With random groups, the records retain their training value over longer period of time. It is difficult to remember "RNZFI KN208 3QVDP," etc.

Manufacturers of complete courses on 12" LPs included Lafayette (Smith), Allied Radio, American Electronics Co. (AMECO) and Elektra (distributed by Cowan Publishing Co.)

Similar to the above courses is one called the Uncle Sam Code Course. It is the only one we examined that is issued on 45 rpm records—seven records in all. It takes the student up to 20 wpm.

Perhaps the course that comes closest to actually learning code from a "live" instructor is one called Tapecode. It is recorded on 1200' magnetic tape at 3¾ ips. You must be careful not to inadvertently erase the tape. One big advantage: Chances are that you can plug a headset into your tape player, thereby sparing those friends and relations who do not share your code-learning enthusiasm. The novice Tapecode course contains one hour of basic instruction of all letters and numbers. Side two of the half-track tape yields one hour of practice material at 4-8 wpm. There is no printed material to follow while working with the code. The tone and harmonic content is varied from time to time to guard against listener fatigue.

Also, the characters are hand sent in such a way that the student becomes accustomed to the rhythmic sound of each character, and cannot actually count the number of dots and dashes. An advanced course of two hours of material at 9 to 18 wpm is also available. The Novice course costs \$6.50 and the advanced \$5.50. The tapes, of course, can be erased and used for other recording after one becomes thoroughly proficient with code.

The Instructograph is a special machine that sends code characters from punched tape. The speed of the tape can be varied by the student and several tapes provide a considerable amount of code practice. The dits and dahs can be read right off the tape.

The Rider "Sound-N-Sight" code course uses 10" LP records of code signals and instructor's voice, along with an instruction book and flash cards. The object in the Novice course is to advance the student to 8 wpm. Telling the difference between dits and dahs is stressed early in the course. The student listens to a signal pattern and writes it as dots and dashes, i.e. — — · — Then a voice says that the pattern was "dah dah dit dah," and the student determines if he was right or wrong. Then, after several pattern runs, the identifying letter for each pattern is added by means of the flash cards. Next, the student listens, writes what he hears in dots and dashes *and* in letter form. Then the voice gives the correct answer in "dits and dahs" and the phonetic equivalent, such as Quebec for Q. The student begins to receive solid code at 3 wpm, increasing his speed gradually until he is receiving 8 wpm. John F. Rider Publisher, Inc., issues the complete course (six 10" LP records, 0-20 wpm) for \$15.95; Novice course (0-8 wpm on 3 records) \$9.50; and the advanced course (9-20 wpm, 3 records) for \$8.95. This code course claims to eliminate speed plateaus.

Once code proficiency is acquired, it becomes a language replete with abbreviations, short-cuts, and slang. Many operators "copy in their head," just occasionally jotting down a name or address. As experience increases complete



words or phrases are heard, rather than a series of dits and dahs.

The code courses described in this article are available from the following:

- Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.
- American Electronics Co., 1203 Bryant Ave., New York 59, N. Y.
- Elektra Code Course, Cowan Publishing Corp., 300 W. 43rd St., New York 36, N. Y.
- Instructograph Co., 357 W. Manchester Ave., Los Angeles 3, Calif.
- John F. Rider Publisher Inc., 116 W. 14th St., New York 11, N. Y.
- Smith Code Course, Lafayette Radio, 165-08 Liberty Ave., Jamaica, N. Y.
- Tapecode, Box 31, Langhorne, Pa.
- Uncle Sam Products, 993 Milwaukee Ave., Burlington, Wis.

Some of the courses can be obtained from local electronics parts stores.

### The Code

|        |         |
|--------|---------|
| A ..   | S ...   |
| B .... | T -     |
| C .... | U ...   |
| D ...  | V ....  |
| E .    | W ...   |
| F .... | X ....  |
| G ---  | Y ----  |
| H .... | Z ----  |
| I ..   | 1 ----- |
| J ---- | 2 ----- |
| K ---  | 3 ....  |
| L .... | 4 ----- |
| M --   | 5 ..... |
| N ..   | 6 ..... |
| O ---  | 7 ..... |
| P .... | 8 ..... |
| Q .... | 9 ..... |
| R ...  | 0 ----- |

Period .....

Comma .....

Question mark .....

Error .....

End of message .....

Invitation to transmit ---

End of work .....

## Polarize Your Plugs

*Continued from page 80*

whatsoever over the circuit from the hot leg through fuse 2 to the chassis. If fuse 2 pops the danger goes with it, as hot side of line is then isolated.

It now becomes obvious that only a single fuse in the hot leg of the power line is needed for overload protection and that the chassis must be connected to the grounded leg by some foolproof method for user protection. A *polarized* plug that can be inserted only one way into wall outlets is the basic requirement. Plugs of this type are difficult to obtain, but fortunately it is very easy to revamp the usual fused line plug, which, like most plugs, is non-polarized. Examine the prongs closely and you'll note that they are exactly  $\frac{1}{4}$  inch wide. A polarized plug has one prong of this width and the other  $\frac{5}{16}$  inch wide; the latter always represents the grounded leg of the line as wired to the receptacle in the *wider* of the two slots in a standard outlet. Cut a piece of thin brass or copper  $\frac{5}{16}$  inch wide and solder it to either prong. Then, solder a jumper wire across the fuse clips associated with this prong using a piece of No. 18 wire. There will be no need for this fuse any longer. Find the wire on the line cord that goes to chassis ground of the set and connect it to these same clips. Leave one fuse in the other "hot" position, and you're safe. —

## \$7 Stereo Hi-Fi Headset

*Continued from page 51*

will be held on by its own tension. Locate the holes so there will be freedom of action in all directions, about  $\frac{3}{8}$ " down from the top edge of the frame.

Install the baffle and spot solder in about six places. Mount the ear pads and connect the wires to the speaker terminals on your amplifiers. You'll notice that your amplifier volume control is run at a fairly high position for comfortable volume in the headset. This is due to the resistors, which prevent the small speakers from being overloaded. If higher volume is desired, simply reduce the value of the resistors. —

# SHIPPED ON APPROVAL

## IN-CIRCUIT CONDENSER TESTER

Model CT-1

### AN ABSOLUTE 'MUST' FOR EVERY SERVICEMAN!

Here is an in-circuit condenser tester that does the whole job. The CT-1 actually steps in and takes over where all other in-circuit condenser testers fail. The ingenious application of a dual bridge principle gives the CT-1 a tremendous range of operation. . . .

#### in-circuit checks:

- ✓ Quality of over 80% of all condensers even with circuit shunt resistance present . . . (leakage, shorts, opens, intermittents)
- ✓ Value of all condensers from 200 mfd. 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 . . . (leakage, shorts, opens and intermittents)
- ✓ Value of all condensers from 50 mfd. 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

#### SPECIFICATIONS

- Ultra-sensitive 2 tube drift-free circuitry • Multi-color direct scale precision 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 circuit megohms • Cannot damage circuit components • Electronic eye megohms • Cannot damage circuit components • Isolated power line balance indicator for even greater accuracy



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

**\$34.50** Net

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

## MINI-CHECK TUBE TESTER

Model MC-1

### A Real ECONOMY MULTIPLE SOCKET TUBE TESTER without sacrifice in ACCURACY, SPEED or VERSATILITY

Here is a multiple socket tube tester designed to meet limited budgets. Although low in price it boasts a unique circuitry that enables you to check over 600 tube types — and has a range of operation that far exceeds others in its price class.



Model MC-1 — housed in sturdy wrinkle finish steel case

**\$39.50** Net

SIZE: W-9" H-8 1/2" D-2 3/4"

#### SPECIFICATIONS

- Checks emission, inter-element shorts and leakage of over 600 tube types. This covers 02A5, series-string TV tubes, gas regulators, auto 12 plate volt, hi-fi and foreign tubes • 3 settings enable a test of any tube in less than 10 seconds • Employs dynamic cathode emission test principles • 3 1/2" Arsonval type meter — most accurate type available . . . its greater sensitivity means more accuracy . . . its jewel bearing means longer life • 17 long-lasting phosphor bronze tube sockets • Combination gas and short jewel compartment • 9 filament positions • Handy tube chart contained in special back compartment • New tube listings furnished periodically at no cost • Detachable line cord

#### plus these BONUS FEATURES . . . found in no other low price tube tester

- ✓ Checks for cathode to heater shorts
- ✓ Checks for gas content
- ✓ Checks all sections of multiple purpose tubes . . . will pickup tubes with one "Bad" section
- ✓ Line isolated — no shock hazard
- ✓ Variable load control enables you to get accurate results on all tubes
- ✓ Positively cannot become obsolete as new tubes are introduced.

## 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-3 1/4"

#### SPECIFICATIONS

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

#### SIMPLE TO OPERATE

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

## TRANSISTOR TESTER

Model TT-2

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

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, tetra-rod and unijunction types for current gain, leakage, opens, shorts, cut-off current • Checks all diodes for forward to reverse current gain • All testers' rated gain is not available • Tests of either transistors or diodes • Large 3" meter is extremely sensitive 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 clips enable tests without entirely removing transistor from circuit • Test terminals are identified by E.I.A. color coding so that connection to the correct 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-3 1/4"

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

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# NEW Battery Operated VACUUM TUBE VOLT METER Model VT-1

Peak-to-Peak WITH LARGE EASY-TO-READ 6" METER —

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- No extra probes to buy! The versatile MULTI-PROBE does the work of 4 probes
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The VT-1 is a tremendous achievement in test equipment. With its unique MULTI-PROBE it will do all the jobs a V.T.V.M. should do without the expense of buying additional probes. No longer do you have to cart around a maze of entangled cables, lose time alternating cables or hunting for a misplaced probe. With just a twist of the MULTI-PROBE tip you can set it to do any one of many time-saving jobs. A special holder on side of case keeps MULTI-PROBE firmly in place ready for use.

## FUNCTIONS

**DC 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 OHMMETER** ... 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 tubes, 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
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- Large 6" 100-microampere meter, many times more sensitive than meters used in most V.T.V.M.'s
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- Simplified multi-color easy-to-read 4-scale meter
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SIZE: W-7 3/8" H-9" D-4 1/4"

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

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## SPECIFICATIONS

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- Ohms — 0 to a billion ohms, 10 ohms center scale — Rx1/10/100/1K/10K/100K/1M
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- Zero Center — available on all DC volt ranges with zero at mid-scale
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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 chose the FAST-CHECK above all other tube testers.

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## 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-terminal 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
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- Checks each section of multi-section tubes and if only one section is defective the tube will read "Bad" on the meter scale mounted on panel
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## Underwater Metal Detectors

Continued from page 30

site almost always produces historically valuable artifacts such as pistols, coins, drinking cups, crucifixes, and other interesting personal items, if not bars of gold and silver.

I've just recently researched the wreck of a schooner caught in a storm off Abaco Island, Bahamas, in the middle of the 19th Century. Tossed by heavy winds, the schooner hit a reef and sank. The crew had time to launch a small boat and take along the ship's strongbox, which contained \$25,000. As luck would have it, the small boat overturned while passing through a cut off the northern end of the Island, tossing men and strongbox into the water. The men were rescued, but the strongbox could not be located.

A few years ago, after a storm had shifted the sands, a local fisherman spotted the strongbox. He hooked his anchor onto it, but succeeded only in breaking off one of the flukes. The box is now covered by sand in 15' of water. A skin diver with an underwater metal detector working during slack tide should have little trouble locating it. On my next trip to the Bahamas, you can be certain that area is going to get a thorough going over.

A real success story is that of Roscoe Thompson, a Nassau shoe merchant and part-time treasure hunter. He struck pay dirt in 1950 working with simple diving equipment and an electronic metal detector. Research told him that a rich Spanish galleon went down in a storm near Gordo Cay Abaco, Bahamas. Thompson's own words tell the story:

"It was July and no hurricanes were known to be around. We provisioned the *Yes Sir*, our 42' craft, and set out for an area south of the Abaco mainland that we believed to be 'hot.' I did the diving, taking down an electronic metal detector.

"We had made a grid on the chart of the huge shelf area 15-30' deep that lies off New Providence Channel. Day by day I worked the ocean floor to the southwest, crossing and recrossing the grid areas. For six weeks nothing hap-

pened except an occasional brush with a curious shark or sting ray.

"I got excited every time the indicator dipped, but it was always the same old story—nothing but cannon balls, pieces of chain and other artifacts. Believe me, by that time we had very little use for relics, but their presence was encouraging. Where there are relics, there is usually a wreck.

"Our time, money and supplies were running out toward the end of August when we finally hit it. Although we were in very clear water no more than 30' deep, I couldn't see anything unusual but an odd coral formation. Yet the meter indicated metal.

"I used a pick axe and shovel to loosen some of the formation, and there it was—encrusted with coral, oblong, and very heavy for its bulk. In a few minutes we had it on the surface and were pounding away with chipping hammers. Although we weren't sure of its origin, we knew one thing for sure—it was a solid silver bar with plain markings."

Weighing 72 pounds, this silver bar is valued at more than \$20,000 on the present-day collector's market. Along with this ingot, Thompson found a number of rare Spanish coins, several sabres and cannon balls. Research indicates there still are undiscovered wrecks in the Bahamas carrying some \$200,000,000 in gold and silver, not counting the priceless historical artifacts and conversation pieces that lie among the debris. Now that new underwater electronic metal detectors have been made inexpensive and portable enough for manipulation by a skin diver, these treasures are not likely to remain idle for long.

If you are interested in doing a bit of treasure diving yourself, join a skin diving club or group that specializes in wreck hunting. They will know the techniques and locations of local wrecks, whether they be off Puget Sound, Long Island or the Bahamas. Perhaps more important, there will always be a diving partner for the "buddy system." Never dive alone!

Before going off on a sunken treasure hunt, plan ahead. It will pay you to know as much as possible about the area so that you will take along the proper equipment. As a starter, read up on local



shipping history for clues to battles and shipwrecks. This research alone can be an interesting educational experience.

After learning how to skin dive and becoming proficient with the aqualung, make sure you know how to operate your electronic metal detector. Read the simple instructions on how to handle and tune the device. Then practice with known hidden objects of different sizes and depths until you are able to find them without fiddling with the tuning knob.

There are thousands of old sunken sailing ships. At the present rate of discovery it will take hundreds of years to find and salvage them. Properly equipped and prepared, you have as good a chance as the next guy. —

## Infrared: New Wonder Tool

*Continued from page 56*

also had a scope, the searchlight acted like a beacon to draw his fire.

Much of the technology developed by the Germans has been appropriated for our present IR program. The only aspect they couldn't help us much with was the detectors. These tiny assemblies are the crux of any IR development. They convert IR radiation into electrical signals that can be handled by electronic circuits. The sensitivity and speed of the various kinds of detectors is being improved steadily. One type, antimony arsenide, is made 15 times as sensitive at extremely low temperatures. Such temperatures are natural in a high-flying interceptor, or in a satellite, but at sea level they must be created by bulky, expensive refrigeration equipment.

*Electronics Illustrated* has received exclusive information that one of the leaders among the 50-odd manufacturers in infrared has found a simple way to multiply the sensitivity of IR detectors by 300%. A few more breakthroughs like this one, and we may have what is only considered remotely possible today—an IR television camera. IRTV could follow rapid changes in heat patterns—of enormous interest to the military, industry, and medical researchers.

Sensitive IR detectors mounted in a series of synchronous satellites would constitute an "early warning system" against missiles comparable to our present radar early warning system against planes. Since a single IR detector, unlike radar, can't tell distance to the target, detectors on two or more synchronous satellites could triangulate on the target. A simple computer could then determine the speed and position of the target in fractions of a second.

Synchronous satellites, which would be fixed in space by small rockets called verniers, are well within the present state of the art of rocketry. All the technology needed to build them is known.

One of the big unanswered questions is, would the Russians, who know all about IR, permit such satellites to hang over their frontiers, in effect looking over the transom?

To date, military needs and defense budgets have largely supported the growth of IR, as is true of most other branches of electronics. Much of the knowledge and some of the equipment, such as the IR scanning camera, has been released for commercial purposes—and they are already doing a wonderful job fighting disease and waste. In a few years, many of the present secrets will be released. The further progress in electronics that will surely blossom should make "infrared" as common a household word as "stereo" or "transistor." —

## Weather Station—3

*Continued from page 60*

up to the terminals indicated in the diagrams.

The actual calibration will probably take no longer than the time necessary to read the instructions. If the project is being built independently from the rest of the weather station, it can easily be assembled in a small card file box. The finished job will be completely portable and compact.

The final part of the weather station will be a temperature-measuring device using the same basic meter as the indicator. —

## A TV Antenna

Continued from page 40

To increase the effectiveness of the dipole, a reflector rod (slightly longer) is placed on one side of it, and director rods (slightly shorter), on the other. The number of additional elements is limited by the physical size of the antenna—it can become too unwieldy. Stacking is another technique. Here, the director-dipole-reflector combination (known as a bay) is repeated, one over the other on a single mast.

Beside the factor of gain or the ability of the antenna to collect the signal, bandwidth is important. An antenna functions most efficiently on a very narrow range of frequencies. Its physical length theoretically should be changed for each channel. In actual practice, the length of the elements of TV antennas are cut to somewhere in the middle of the TV band as a compromise. Broadbanding is an attempt to make the antenna respond equally well to all channels. But, in doing this, the gain drops, necessitating additional elements. Once again it is a question of the available signal in your area. Multi-element "yagis" are available, cut specifically to individual channels. No compromise is necessary and thus gain is very high.

Most antennas are directional in their reception pattern. This poses a problem where you wish to receive stations lying in opposite directions from your antenna. One answer, is a mechanical rotator up on the mast that swings the antenna to the desired direction.

Once the signal is received at the antenna it has to be brought down to the set with as little loss as possible. Here is where "matching" is utilized. The purpose is to transfer the energy from the antenna, to leadin wire, to TV set. At the antenna terminals of the set, the input is 300 ohms, a standard value. By consequence, the line from the antenna should be rated at 300 ohms. This is the rating of familiar twinlead or ribbon-type transmission line. The antenna itself also approximates the 300 ohm value. If any departure from the 300 ohm value occurs, an impedance matching transformer will correct it. For ex-

ample, if your signal is supplied from a master antenna system, a 72 ohm coaxial cable might have been used. If there is insufficient signal strength, a 72 to 300 ohm transformer is placed between the co-ax and the ribbon leading to the TV set. Such a device is readily available from an electronics parts supply store. Mismatching can cause reflections on the leadin wire that result in ghosts.

Although the twinlead is impregnated with plastic, it should touch as few surfaces as possible. When routing it near metal keep it several inches away to avoid losses. Standoffs, such as the types illustrated, will accomplish this. In weaker signal areas noise pickup by the leadin can be reduced if the line is twisted along its length during installation. After the line has been brought down to the set don't coil the excess. Cut it short since a coil can cause losses.

Ghosts due to reflected waves on the line sometimes can be reduced by crimping some tin foil, for several inches, onto the leadin near the set. Observe the screen while moving the foil along the line to produce the minimum ghost.

After the leadin and antenna have been installed, orientation is the next step. The job requires two persons; one at the antenna and one observing the TV screen. The antenna is rotated by hand back and forth until the best reception is received on all channels simultaneously. Often this is a compromise since the transmitters may not be in the same direction. Attempt to reduce the ghosts as much as possible. For unusually bad multiple images, a highly directional antenna will solve the problem due to its ability to reject signals in all but a very narrow pickup arc. A relocation of the antenna is sometimes the only way to receive adequate signals. Just a few feet can cause a considerable change in conditions, especially if there are tall structures nearby.

Several types of lightning arrestors have been devised for use with twinlead. They all depend on a good ground connection for proper operation. If a ground is not available, a metal rod driven into the ground several feet will establish one. Grounding strap is then run from the rod to the arrestor. —



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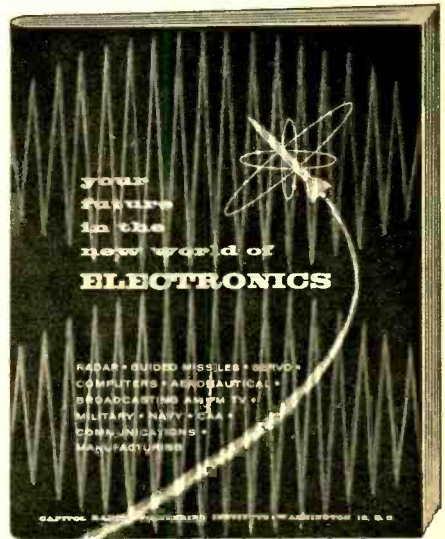
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## Add On S-Meter BFO

Continued from page 65

any convenient terminal on this line. Then connect the common ground interconnecting lead to the chassis of the short-wave set. (CAUTION: Although we have designed the instrument so that it is isolated from the AC lines, your receiver may not be if it is an AC/DC type. If the receiver chassis does go to one of the AC lines directly, make sure this is the ground leg. The easiest way to tell is to connect a 117 volt lamp from chassis to both legs of the AC, one at a time. If the lamp lights in either connection, reverse the plug of the receiver in its AC outlet.)

With the receiver turned off, remove the 12AU7 from the S-meter socket and move the key switch to its center position. Adjust the MAXIMUM potentiometer (R3) until the S-meter reads full scale. Move the key switch to OFF and replace the tube. Now shift the key switch to the BFO position (all the way up). The meter should go right up to full scale but as the tube warms up, the needle will drop. With the tube fully warm, adjust the ZERO-SET potentiometer (R2) for exactly zero reading on the scale. Once these adjustments are made, there will be no need to touch them for a long time to come. With the receiver still off, the needle should remain at zero when the key switch is moved to the center position (S-meter setting). Leave the switch there and turn on the receiver. The S-meter will now read a definite figure for each station tuned in, depending upon the strength of the signal. Very strong signals may drive the needle above S-9 while weak ones may cause an S-3 or S-4 reading. Note that this meter is calibrated up to +30 db above S-9 for extremely powerful signals.

Now tune in a fairly weak station, preferably one using voice. A broadcast station will do just fine. Turn the knob of the shaft coming out of the BFO can from the fully tightened position toward a looser point. Within a turn or two, a beat note should be heard between the station and the BFO. If you cannot obtain this heterodyne whistle within

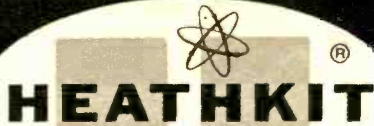
three turns from the tight position, it may be necessary to adjust the screw at the top of the can until the beat is obtained. This should not be necessary since these units come from the factory prealigned. You can be sure you have the right adjustment of the BFO when you can hear an audible whistle for each station tuned in. This sound should start very high in pitch as you tune, then drop to zero-beat (no sound) when the station is perfectly tuned, rising in pitch again as you pass through the correct point. Throughout the adjustments above, the radiating lead should be located near the first IF tube in the receiver. If the whistle is too loud, try the lead in various positions until the volume is comfortable, then tack it down with Scotch or masking tape.

We might add here that a BFO is not only used as an aid for CW reception but is also extremely useful for locating very weak short-wave broadcasts. A station is first located by its whistle with the switch in the BFO position; then the switch is returned to the S-meter position. A distant station that might otherwise have been missed in the tuning-in process is easily spotted this way.

Some receivers have utility power receptacles at the rear of their chassis. Generally, two of the output pins provide +150 to +250 volts and ground while the remaining two yield 6.3 volts AC for the heaters of outboard tubes. If your receiver has such an output socket, you can eliminate the little power supply in the instrument altogether. Merely connect the B+ lead (marked X +150 to +250 volts on the schematic diagram) to the corresponding pin on the socket, the B— output of the socket to the ground lead of the instrument, and the 6.3 volts AC from the receiver to pins No. 9 and No. 5 on the 12AU7. For this arrangement, section A of S1 is not necessary since the S-meter, BFO will come on as the receiver is turned on.

If the external power supply is used, the following parts may be eliminated; power transformer T, selenium rectifier SR, filter capacitor C1, and the line cord. —●—





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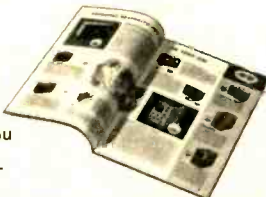
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## Factories That Run Themselves

Continued from page 69

Fed continuously to its analog-digital brain are readings, in the form of electrical impulses, from hundreds of meters and gauges. Upwards of 500 different data signals, from pressure analyzers, flow meters and temperature gauges, may stream to the computer from critical control points.

During any split-second, for example, the computer "knows" the temperature of chemicals in pipeline A, the flow-rate of raw ingredients from tank B, and not only what's being produced, but how much and at what level of quality. During the same split-second, the robot compares all this incoming data with what has been stored in its memory. (For a complete rundown on how computers work, and definitions of computer terms, see the three part series "All About Computers" in *Electronics Illustrated*, March-May 1959.) Suppose the temperature reading from pipeline A is half a degree too high. Instantly alerted, the computer "thinks" through the problem. Borrowing data stored in its memory, it mathematically weighs the effects of this seemingly minute temperature change not only on the end-product, but on the processes in between.

As the computer thinks, it automatically types out a memo (in a kind of shorthand), informing the plant manager of the trouble and telling him precisely how it plans to correct it. Having reached a logical decision to reduce the gas flame in tank C, the robot acts.

Out from the analog section of its brain flashes a control voltage—an electrical analog signal (perhaps one to 10.23 volts DC). But as in most complex industrial processes, it's air pressure, not electronic signals, which actually shut valves and actuate gauges. So the brain's electrical command is converted to a pneumatic command (3 to 15 pounds per square inch) in an E/P converter (a mechanism capable of converting electronic signals to pneumatic, or conversely, pneumatic to electronic).

The computer's command, now a

pneumatic pressure, triggers a control device which in turn adjusts the gas flame precisely as ordered by the computer. No human hand has intervened.

Elapsed time between receipt from a process meter of a trouble signal and robot reaction may be only a few thousandths of a second, or as long as five minutes. Some industrial processes require split-second control; others don't.

So simplified an explanation, of course, doesn't begin to detail the lightning-fast interaction between the computer and the myriad gauges, meters and valves it oversees. But it does underscore the vast differences between "control" computers, just now manning our factories, and their less versatile brethren.

For, where garden-variety computers are merely data handlers, computers that run factories are "doers"—manning pumps, motors and valves.

Corporation executives predict that within ten years, almost every part in your car, and almost every product you buy—from canned soup to golf balls—will be produced by electronic robots. True electronic automation will produce a new Industrial Revolution.

In the process of taking over the nation's production lines, computers are redefining "automation," a word as loosely applied in industry as in your dictionary.

"Until these robot foremen came along," says a factory manager in Detroit, automation's birthplace, "we've never had real automation."

What industries had, until now, is mechanization: machines capable of running themselves—and nothing more. Shove a magnesium missile casting or an auto's engine block into the automaton's maw, and the machine dutifully turns out a finished and precision part.

"But," says one electronic engineer, "the dumb repetition of a routine and pre-set manual of instructions isn't true automation. Automatic yes, but it's not automation."

Industry's "dumb" automatons, remarkable though they are, are capable only of routine chores. They can reject a faulty part, or shutdown a production line, but they can't correct a trouble,



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nor anticipate one. They can't, in a word, "think" for themselves.

The new computers, on the other hand, not only think for themselves, but take decisive and corrective action based upon lightning-fast electronic logic. Let's take a closer look at this logical process.

Consider again that 1/2-degree temperature rise in pipeline A. How did the computer "sense" it? The sensing device was a thermocouple, a sensitive-to-temperature device consisting of two dissimilar metals joined at one end. The rising temperature of fluid in the pipeline, warming one side of the thermocouple faster than the other caused a minute voltage change at their juncture. This small voltage (say, 2 millivolts) was fed to the computer and amplified.

Let's assume that the 2-millivolt "sensing" signal, now amplified to 4 volts, sets the computer to "thinking." From data stored in its memory, the computer "knows" that 4 volts represent a half-degree temperature rise. It also knows precisely where the change is taking place—in pipeline A.

The computer's logic is devastating. It traces the trouble back to its source—that gas flame in tank C. Simultaneously, it calls up a half-dozen memory-stored warnings: "Any temperature change in pipeline A will affect chemical B in tank C" . . . "any temperature rise in pipeline A will lower quality in the end-product" . . . "a dangerous reaction will occur between chemicals X and Y if temperatures in pipeline A rise more than one degree."

Its analysis complete, the computer dispatches a control signal (a voltage calculated to reduce temperatures by 1/2-degree) to the trouble spot.

Would a human operator, monitoring the plant's central control station, observe the same rise in temperature? If he's watching the meters, he would. But few flesh-and-blood operators can equate a single danger signal in terms of the *whole* process. Or do it in seconds.

Declares one plant manager, "we're not spending \$200,000 for a machine that simply does a man's job. We expect not only a better end-product for our money, but significantly greater produc-

tion. Our computer installation should pay for itself within two years."

Typical of these computer factory foremen is the desk-sized, lightweight (400-lb) Thompson Ramo Wooldridge RW-300. It requires no special power hook-ups or cooling systems and is groomed to fit any plant's control room.

Built into its control unit are a number of complex sections: Its digital computer—the mathematical section—receives a constant flow of electrical impulses from process meters and gauges. The impulses are translated into math, the "language" the digital unit understands. Some 14 plug-in modules (really complex transistorized etched circuits) do the arithmetic.

A memory drum stores process data. Some of this data concerns arithmetic; some concerns system "set points"—what the *reading* of a meter should be if the process is up to par. Stored in the memory, too, are instructions telling the computer what valves to open or close should flow fall off in one section of the process, or should a gauge indicate too much acid in another. Together, the memory drum's total content is called the *program*—really a mathematical description of the process or production line being controlled.

A program may specify that ingredient X and Y must be maintained at 100° F, or that pressure through valve A shouldn't exceed 50 psi nor fall below 48 psi. The computer, properly programmed, continuously calculates the amount of each ingredient necessary, then controls the flow rates.

"Actually," points out a factory manager, "some of our newer processes are so complex that humans simply can't keep up with them. It's not that a flesh-and-blood operator couldn't push a button. He could. Trouble is, he doesn't know which button—or maybe, which dozen buttons—to push."

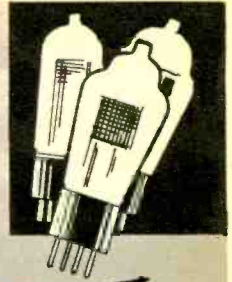
Right here is where the computer foremen pay their way: They *know* instantly what action to take, and why. One refinery figures that with a computer bossing production, it will increase output by 10 percent, or some \$300,000 a year.

[Continued on page 111]



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| 0Y4   | 3AU6  | 6A6    | 6B8    | 6CH8   | 6E7     | 7B4   | 12AT6   | 12SA7     | 36     |
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| 1B3GT | 3BZ6  | 6AF4   | 6BC8   | 6CM7   | 6E7GT   | 7B7   | 12AU7   | 12SN7GT   | 41     |
| 1C4   | 3CB6  | 6AG5   | 6BD6   | 6CN7   | 6E5     | 7B8   | 12AV6   | 12S07     | 42     |
| 1C7   | 3Q4   | 6AH4GT | 6BE6   | 6CQ8   | 6E7     | 7C4   | 12AV7   | 12V6GT    | 43     |
| 1F4   | 3S4   | 6AH6   | 6BF5   | 6CR6   | 6E7     | 7C5   | 12AX4GT | 12W6GT    | 45     |
| 1F5   | 3V4   | 6AK5   | 6BG6G  | 6C56   | 6E7     | 7C6   | 12AX7   | 12X4      | 50A5   |
| 1G4   | 4BQ7A | 6AL5   | 6BH6   | 6CU5   | 6E7     | 7C7   | 12AX7   | 14A7/12B7 | 50B5   |
| 1H5GT | 4B5B  | 6AMB   | 6B16   | 6CU6   | 6E7     | 7E5   | 12B4    | 14B6      | 50C5   |
| 1L4   | 4BZ7  | 6AN8   | 6BK5   | 6D6    | 6E7     | 7E6   | 12B6A   | 14D7      | 50L6   |
| 1L6   | 4C86  | 6AOS   | 6BK7   | 6DE6   | 6E7     | 7E7   | 12S17   | 19        | 56     |
| 1NSGT | 5AM8  | 6AQ6   | 6BL7GT | 6DG6GT | 6E7     | 7E7   | 12B04   | 18AU4GT   | 57     |
| 1R5   | 5AN8  | 6A07   | 6BN6   | 6DO6   | 6E7     | 7E8   | 12B6A   | 19B6G     | 58     |
| 1S5   | 5AT8  | 6AR5   | 6BQ6GT | 6E5    | 6U8     | 7E7   | 12B6F   | 1916      | 71A    |
| 1T4   | 5AV8  | 6A55   | 6BQ7   | 6E6    | 6V6GT   | 7H7   | 12B7    | 1918      | 75     |
| 1U4   | 5AZ4  | 6AT6   | 6BR8   | 6H6    | 6W6GT   | 7H7   | 12B06   | 24A       | 76     |
| 1U5   | 5BR8  | 6AU4GT | 6B5B   | 614    | 6X4     | 7D7   | 12B87   | 2526GT    | 77     |
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| 3A5   | 5X8   | 6AX4GT | 6CF6   | 6D7    | 7A7     | 12AB5 | 12L6    | 35W4      |        |
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## Factories That Run Themselves

Continued from page 108

Still, until last February when MIT unveiled its APT vocabulary—which teaches computers to understand English—factory computers labored under a language barrier. Understanding only complex math, the computers could take orders only from mathematicians. Backed by the Air Materiel Command, MIT scientists set about devising a vocabulary which, stored in a computer's memory, could turn it bilingual—capable of understanding English as well as math.

The first computer "taught" to understand an abbreviated English-language vocabulary was IBM's 704. At the moment, the 704 acts as interpreter between English-speaking engineers and digital computers. Later, says MIT, the same system will be applied to all computers, regardless of their size or manufacture.

How has APT turned factory robots bilingual? To understand the system—and the problem—put yourself in the engineer's shoes. Suppose you want to tell your automation computer to change its habits. Rather than take readings from meter A every half hour, you want them taken every 15 minutes.

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APT's vocabulary is straightforward. "ON KUL" means "turn on the coolant." "TAN TO" means "tangent to."

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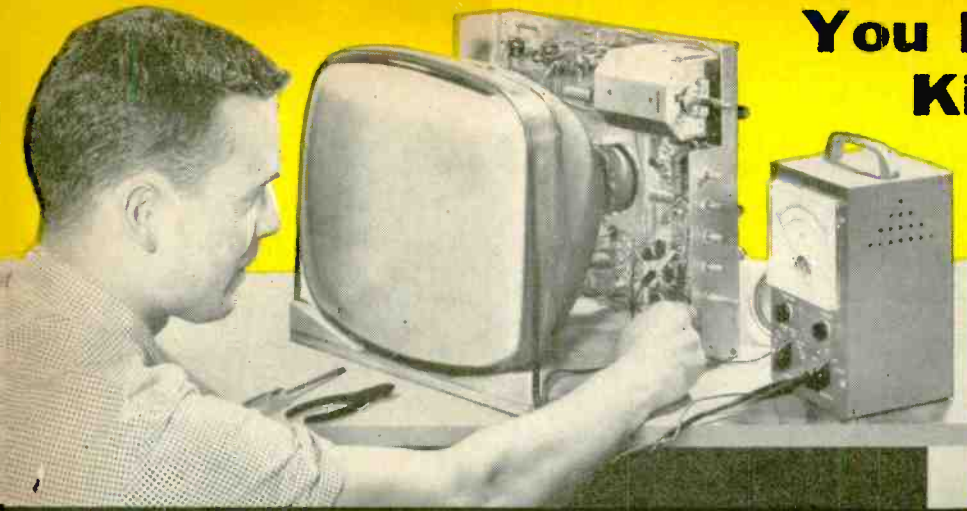
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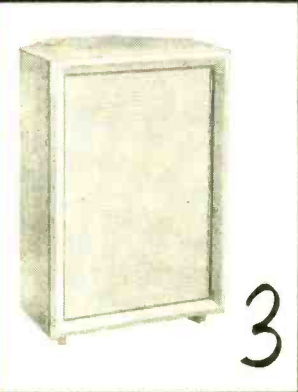
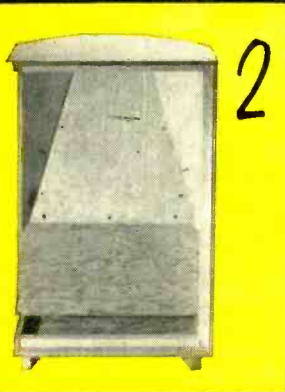
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