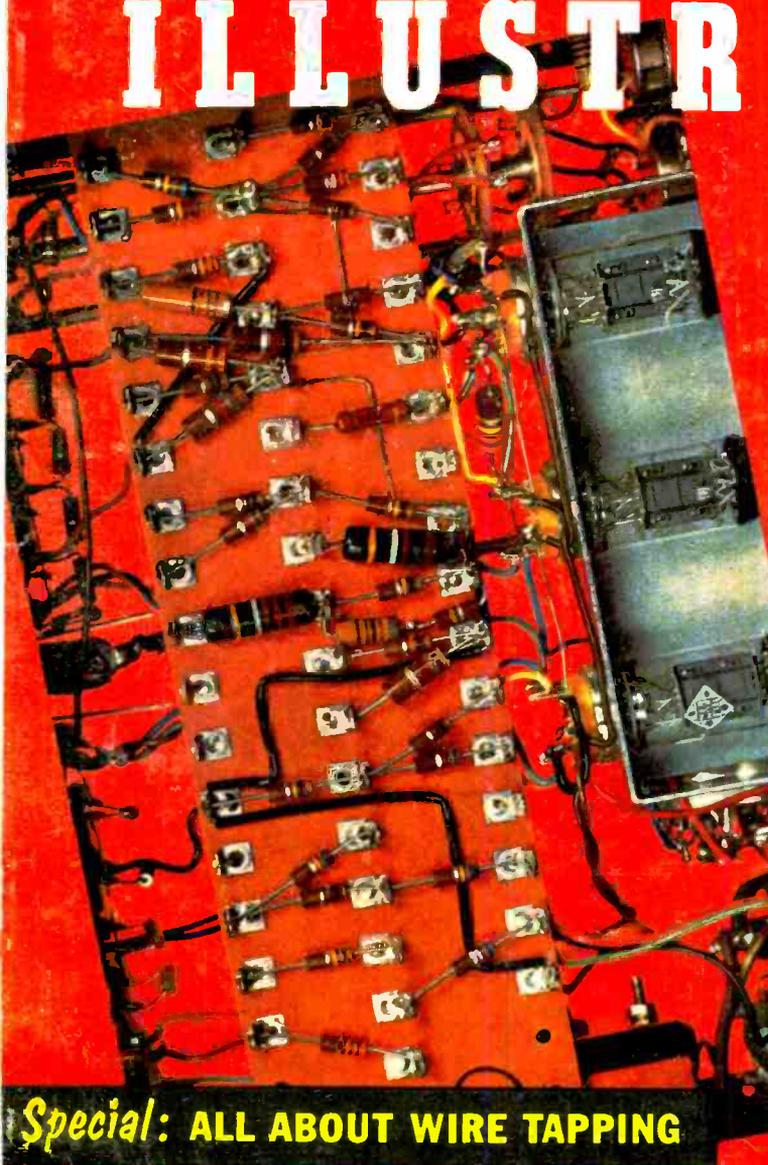


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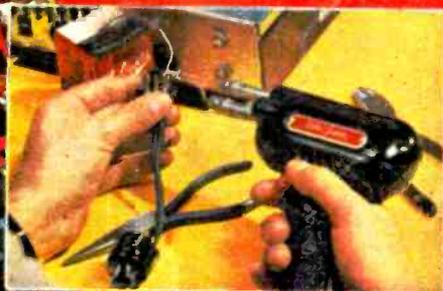
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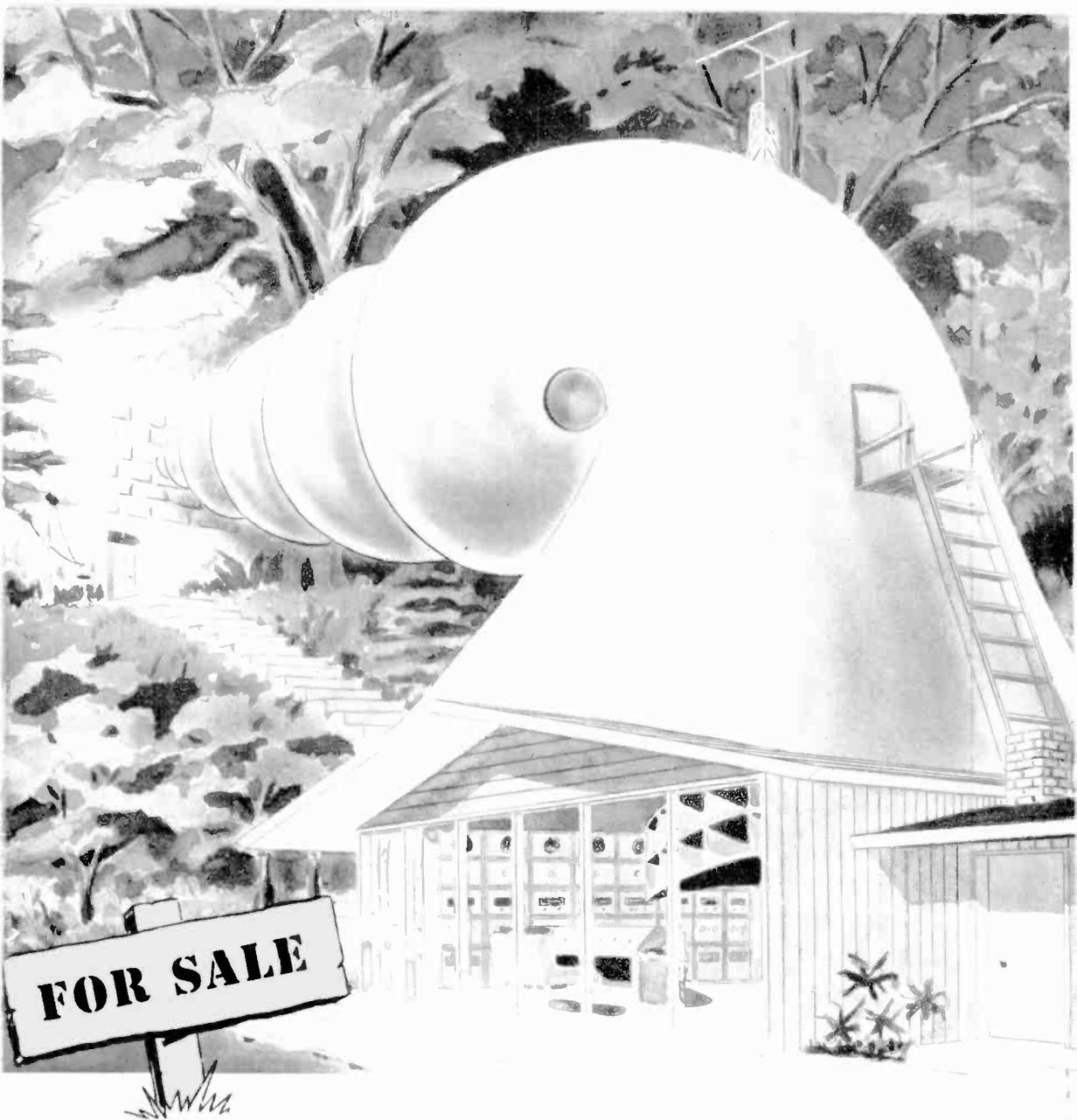
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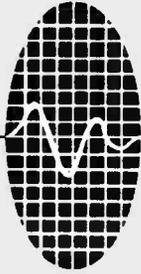
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May 1958



# ELECTRONICS ILLUSTRATED

A Fawcett Publication  
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Vol. 1 No. 1



Special Project



Hi-Fi HiLite



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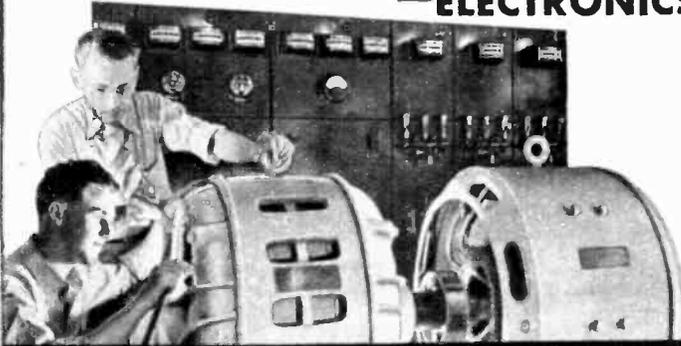
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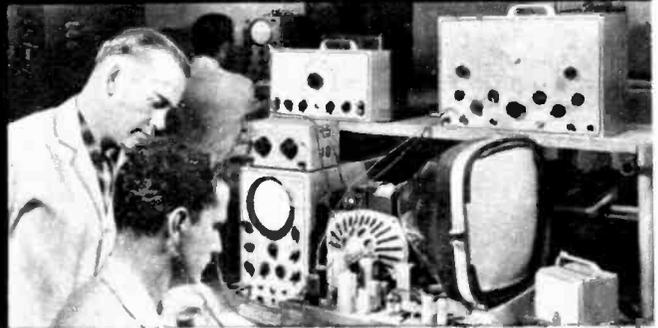
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# A Message from the Editor



The first issue of a new magazine is usually launched with a weighty and platitudinous statement from the editor advising the reader of the reasons for the new publication. But the obvious way in which electronics affects our life really makes a justification for our magazine unnecessary. However, let us say this: If you are interested in the world in which you live; if you want to know about electronics as a force that vitally affects your life today; if you want to use it in your home, your hobby and your work; and if you want to read a spritely, interesting, and highly pictorial magazine, then **ELECTRONICS ILLUSTRATED** is for you!

During this period of high interest in *space travel* we tell you about a new electronic fuel that may make space travel a reality. *Wiretapping* is in the news and we tell you how it is done and how *you* can do it for legitimate purposes. Stereo is the big news in high fidelity — we tell you about the newly developed *stereo records*.

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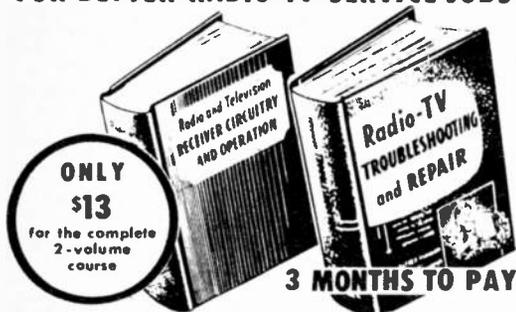
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Our first issue contains a project that has been especially designed for us; this is the EI Radio Garage Door Opener. We know it works, we've had it on two garages! We describe a simple-to-build code practice oscillator for would-be radio amateurs (Hams), a DC power supply for model trains, a hi-fi system that records radio broadcasts automatically, and more.

Everyone has an old table model radio around the house; next month, we'll show you how to convert it to an intercom and still use it as a radio. There will be articles for transistor fans, short wave listeners, and more.

If we encourage you to install your hi-fi system we feel that we should also answer your installation questions. Therefore, the next issue will introduce a new department: *Hi-Fi Clinic*. Also, look for the feature called *The Electronic Brain* in which an expert will answer your questions regarding circuits, equipment, etc.

Our next issue will attempt to answer a question that is close to home for all of us: Is the defense setup of our country adequate in this age of missiles and electronic warfare? You will read about our anti-missile program and other developments that have been kept under wraps. We will also continue our survey of career opportunities in electronics.

ELECTRONICS ILLUSTRATED will score a major scoop in its next issue with the beginning of a "how-to" series on building and launching small rockets. We will show you how to build a safe rocket, how to launch it, how to put test instruments in it to follow its flight and how to bring it back to Earth. The writer of this series is a nationally prominent rocket expert. We'll also have a special announcement for all interested in rockets and space travel—watch for it.

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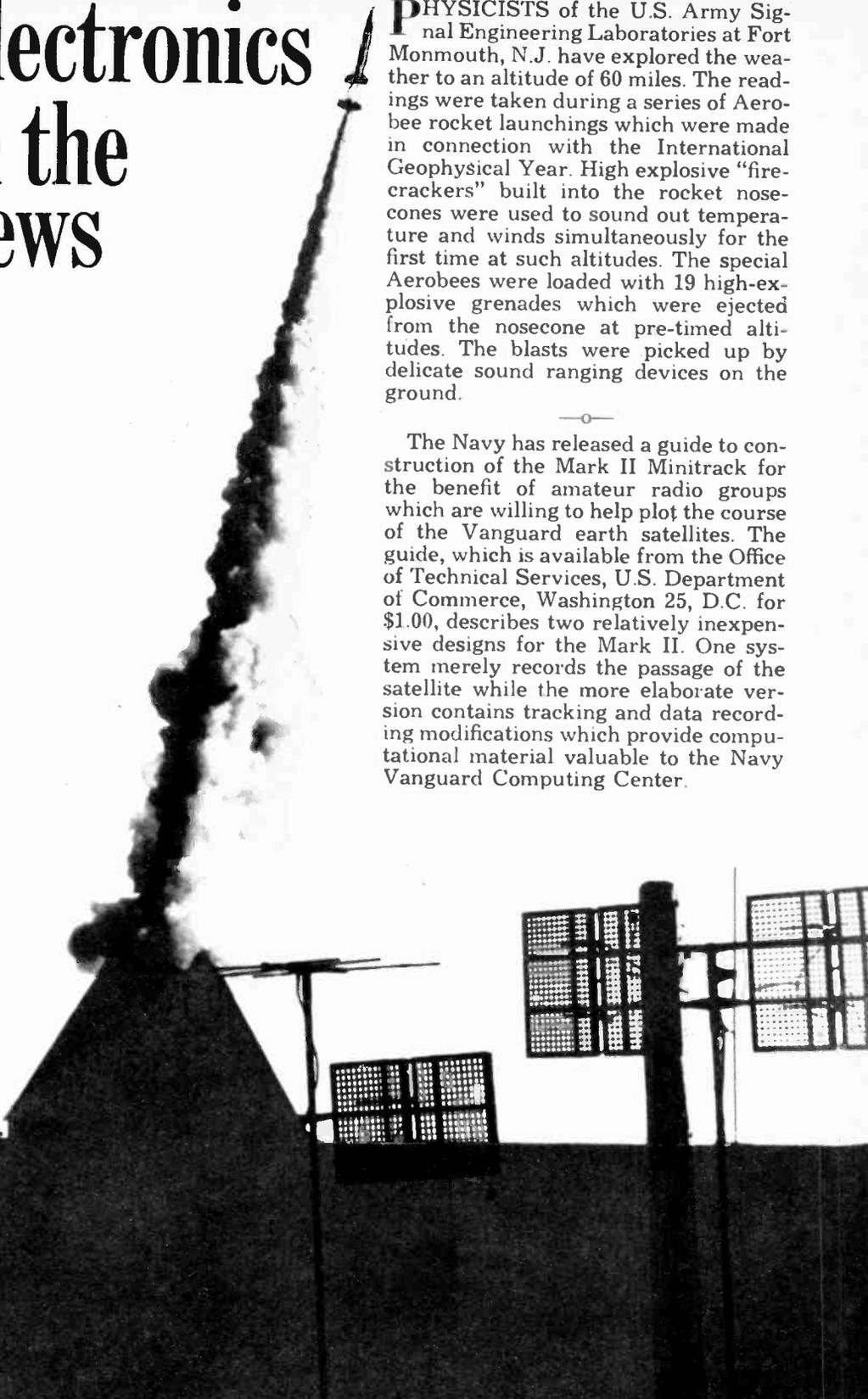
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Welding</li> <li><input type="checkbox"/> Industrial Engineering</li> <li><input type="checkbox"/> Industrial Instrumentation</li> <li><input type="checkbox"/> Industrial Metallurgy</li> <li><input type="checkbox"/> Industrial Safety</li> <li><input type="checkbox"/> Machine Design</li> <li><input type="checkbox"/> Machine Shop Practice</li> <li><input type="checkbox"/> Mechanical Engineering</li> <li><input type="checkbox"/> Professional Engineer (Mech)</li> <li><input type="checkbox"/> Quality Control</li> <li><input type="checkbox"/> Reading Shop Blueprints</li> <li><input type="checkbox"/> Refrigeration and Air Conditioning</li> <li><input type="checkbox"/> Tool Design</li> <li><input type="checkbox"/> Tool Making</li> </ul> <p><b>RADIO, TELEVISION and General Electronics Tech.</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Industrial Electronics</li> <li><input type="checkbox"/> Practical Radio-TV Eng'g</li> <li><input type="checkbox"/> Practical Telephony</li> <li><input type="checkbox"/> Radio-TV Servicing</li> </ul> | <p><b>RAILROAD</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Car Inspector and Air Brake</li> <li><input type="checkbox"/> Diesel Electrician</li> <li><input type="checkbox"/> Diesel Engr. and Fireman</li> <li><input type="checkbox"/> Diesel Locomotive</li> </ul> <p><b>STEAM and DIESEL POWER</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Combustion Engineering</li> <li><input type="checkbox"/> Power Plant Engineer</li> <li><input type="checkbox"/> Stationary Diesel Engr.</li> <li><input type="checkbox"/> Stationary Fireman</li> </ul> <p><b>TEXTILE</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Carding and Spinning</li> <li><input type="checkbox"/> Cotton Manufacture</li> <li><input type="checkbox"/> Cotton Warping and Weaving</li> <li><input type="checkbox"/> Loom Fixing Technician</li> <li><input type="checkbox"/> Textile Designing</li> <li><input type="checkbox"/> Textile Finishing &amp; Dyeing</li> <li><input type="checkbox"/> Throwing</li> <li><input type="checkbox"/> Warping and Weaving</li> <li><input type="checkbox"/> Worsted Manufacturing</li> </ul> |
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# Electronics in the news



**P**HYSICISTS of the U.S. Army Signal Engineering Laboratories at Fort Monmouth, N.J. have explored the weather to an altitude of 60 miles. The readings were taken during a series of Aerobee rocket launchings which were made in connection with the International Geophysical Year. High explosive "firecrackers" built into the rocket nosecones were used to sound out temperature and winds simultaneously for the first time at such altitudes. The special Aerobees were loaded with 19 high-explosive grenades which were ejected from the nosecone at pre-timed altitudes. The blasts were picked up by delicate sound ranging devices on the ground.

—○—

The Navy has released a guide to construction of the Mark II Minitrack for the benefit of amateur radio groups which are willing to help plot the course of the Vanguard earth satellites. The guide, which is available from the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C. for \$1.00, describes two relatively inexpensive designs for the Mark II. One system merely records the passage of the satellite while the more elaborate version contains tracking and data recording modifications which provide computational material valuable to the Navy Vanguard Computing Center.



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Here is an evening's homework for Pop so that Junior can have his own transistorized pocket radio receiver. Allied Radio of Chicago is offering a low cost 1-transistor kit, the "Trans-Midge" which is only slightly larger than a cigarette pack. When used with a headphone and an external antenna, the set is said to provide good sensitivity and selectivity over the standard broadcast band. The radio will operate for months on a single penlite battery which, when it needs replacing, won't dent the small fry budget too seriously as they sell at from 10¢ to 15¢.

After over a year of intensive design effort, the Electronic Instrument Co., Inc. (EICO) of Long Island City, N.Y., has marketed an FM tuner available as a kit or completely wired. This unit uses a unique pre-wired r.f. (front end) section which is virtually drift-free and completely prealigned. Thus, even novices can assemble the model HFT 90 FM tuner and be assured of good results. The unit also includes a traveling neon tuning indicator and multiplex output. This attractively-styled low-silhouette tuner is available as a kit for \$39.95, or completely wired for \$65.95.

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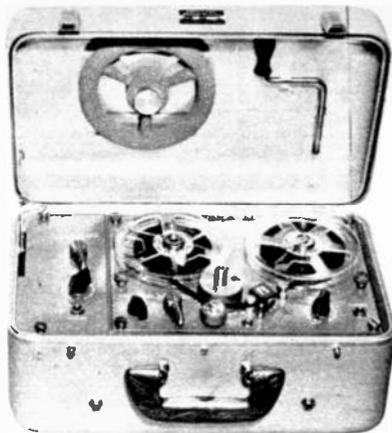
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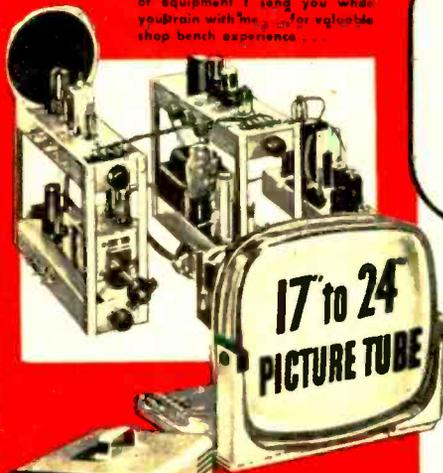
Amplifier Corp. of America, 398 Broadway, New York 13, N.Y. has designed a new, self-contained stereophonic tape recorder for field use. Three single speed models are available for either 3.75, 7.5 or 15 inches per second. Measuring 8½" x 11" x 10", the "Stereo-Magnemite" weighs only 17 pounds. Its high gain recording-playback amplifiers are powered by drycells and one "B" battery which last 100 hours. Constant tape speed is achieved by means of a patented centrifugal ball-bearinged, triple compensated flyball governor on the spring motor. Tapes made on this machine can be played back on any standard stereo playback unit.

General Transistor Corporation, 91-27 138th Place, Jamaica, N.Y. has issued a "How Not To Do It" instruction book as a switch on the tackle-it-yourself trend. The booklet of real "mad" cartoons tells how not to use transistors and will be sent without charge on request to those eager beavers who want to improve each minute of the coffee break.

In a more serious vein, Shure Brothers, Inc. of Evanston has come out with a "do-it-yourself" kit which makes stereophonic playback available at low cost to fans with Revere or Wollensak tape recorders. The kit includes an in-line stereophonic magnetic tape head which is designed to replace the monaural head with which the recorder is equipped. Camera stores, record shops, and appliance stores carry the kit.

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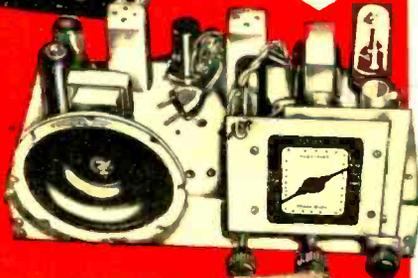
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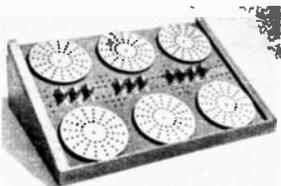


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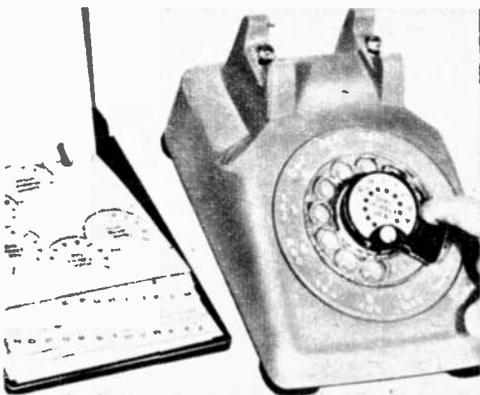
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Mohawk Business Machines Corporation of Brooklyn 33, N.Y. has brought out a transistorized version of its battery operated pocket-size tape recorder as the "Midgetape" #300. The space saved by replacing the vacuum tubes by the tinier transistors makes room in the case to include a self-contained loud-speaker for high volume playback.



A California inventor, Carl Tilden, has come up with a "Phone-O-Matic" phone-number selector which automatically "remembers" phone numbers, exchanges, and area codes for long-distance dialings. Each digit is dialed as it appears in the lens of the convenient little gadget which fits over your regular phone dial. An index box holds over 180 numbers. The indexed number disc is placed in the center of the ring on the phone and the figures are dialed. For the absent-minded... a real boon. The product is being marketed by Dial Direct Dex, 209 Los Molinos, San Clemente, California.

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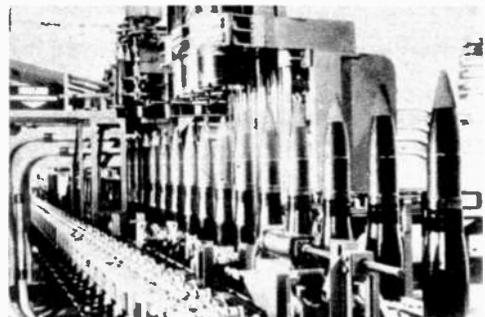
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Texas Instruments Incorporated of Dallas, Texas has developed a new light-weight transistorized land mine detector for the U.S. Army. The use of transistors has permitted miniaturization of the device to the point where all parts, except the antenna, can be carried under the operator's clothing. This is of special importance where the detector is to be used in the Arctic regions. Just to be on the safe side, the company has also fungus-proofed the unit for tropical use.

Dr. V. K. Zworykin, honorary vice-president of RCA, told a group of 1000 highway engineers and administrators attending the Highway Research Board meeting in Washington that the ultimate solution to the problem of traffic accidents that now claim more than 100 lives daily is an electronic system that provides automatic control of vehicles on the highway. He called for cooperation among highway engineers, administrators, and the electronics industry in bringing such a system to practical reality in the near future.

American Machine & Foundry Co. has built a fully automated shell-filling line for the Joliet Illinois Arsenal of the U.S. Army Ordnance Department. The unit will handle either 75 or 90 mm. shells. The fully automated line is divided into twelve stations, all of which are monitored by a single operator sitting at a control console. In addition to elaborate instrumentation, the operator watches five television monitors that tie in with cameras focused on critical operations in the process. Any malfunctioning will be caught immediately and rectifying steps taken to prevent a shutdown of the assembly line.



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Richard Meelan, 166 Jerome St., Brooklyn, N.Y.	1st	10
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The Scouting world's first Science Explorers post has been established in Newport Beach, California. Sponsored by the Helipot Division of Beckman Instruments, the Scouts have already begun a series of individual projects, ranging from the construction of a small-scale cyclotron to solid state diffusion research! Science Explorers Posts are planned for other areas.



An oldtime specialized radio products manufacturer that has only recently entered the high-fidelity equipment market, the J. W. Miller Company of Los Angeles California, has just announced a new FM tuner for \$59.95. This unit offers AFC, a tuning indicator, Foster-Seeley discriminator, grounded-grid r.f. amplifier and two outputs. The drift is said to be negligible with the automatic frequency control in operation and the sensitivity is quoted as 3 microvolts with 20 db quieting. This tuner is self powered. The model 560 FM tuner is of the "pancake" design and is quite stylish. Altogether it seems to be a worthy product at a moderate price.

It is designed to be stacked with other units, or can be mounted as a built-in as part of a Hi-Fi system.

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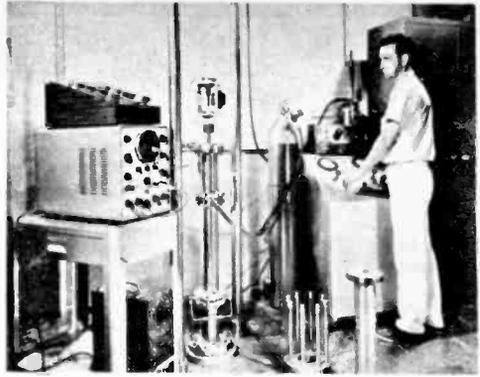
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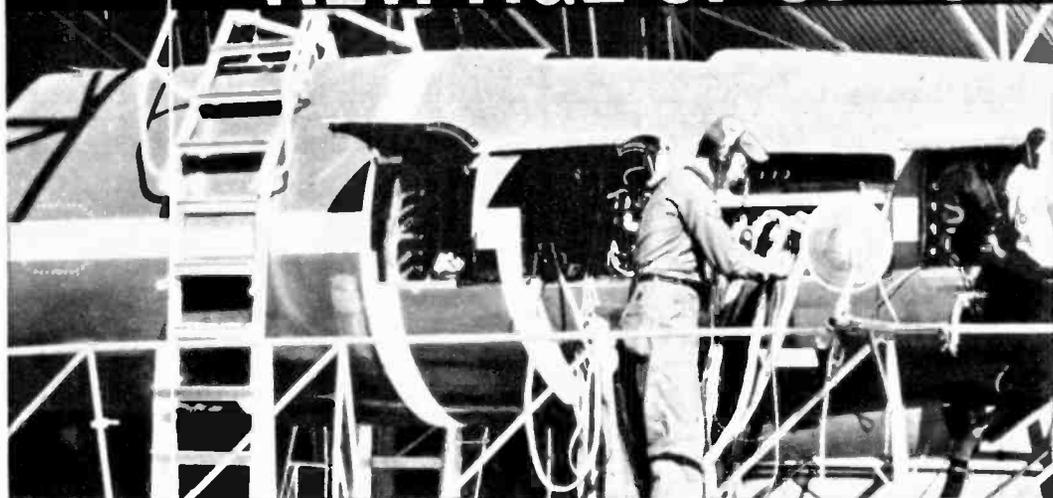
The National Bureau of Standards in Washington reports that the standard ampere maintained by the Bureau has drifted no more than a few parts per million in the last 15 years. The standard was recently measured in absolute amperes using two different sets of apparatus. One was the current balance used in the 1942 evaluation and the other was a Pellat-type electro-dynamometer which was introduced to reduce the possibility of systemic errors. So, what is all this about inflation?

The Electronic Industries Association, trade group for equipment and set manufacturers, has reported that through November 1957 some 5,636,881 TV and 7,689,841 radio receivers were sold to the public. Compared with 1956, TV set sales are down but radio sets are going over the counters at top speed. The same group revealed that almost 26 million transistors were sold during the first eleven months of 1957 as compared with 11.2 million a year earlier. Through November, transistor sales made manufacturers happy to the tune of \$63,120,000!

If there is any doubt that transistors are revolutionizing the electronics industry, these figures should prove it. •

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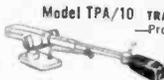
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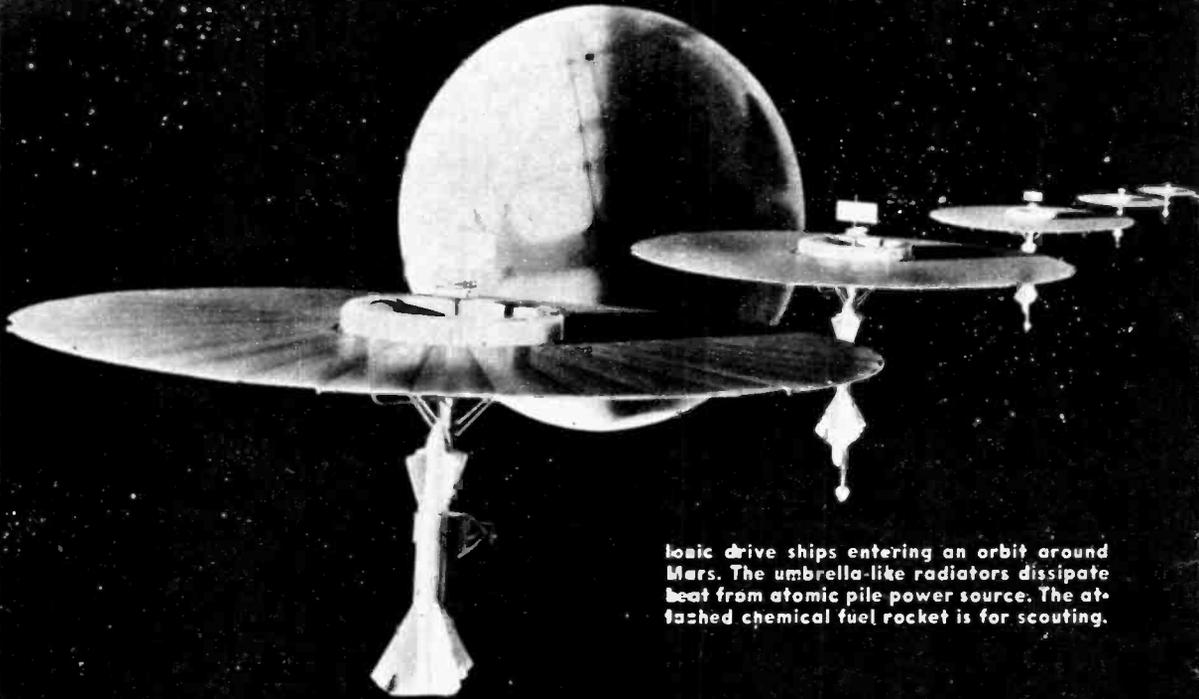
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# New Ion Fuel For Rockets

By Paul Beame

How will our space ships of the future store enough fuel to navigate between planets?



Ion drive ships entering an orbit around Mars. The umbrella-like radiators dissipate heat from atomic pile power source. The attached chemical fuel rocket is for scouting.

**W**HILE the eyes of the world are still focused on the flame-belching rockets spurting skyward from Florida, there's a quiet little revolution in the works which may steal their thunder. Even before man sets foot on the moon, his costly, monster chemical-propelled rockets may be relegated to the obscurity of shuttle runs from Earth to orbiting space stations.

The real work—bridging the gap between the planets—may fall to a vehicle far more suited to the huge distances involved. That next step is expected to be the ion drive space ship, using a concept once the exclusive property of science fiction writers, but today the object of intense study in the United States,

Russia, and in laboratories elsewhere.

Ion propulsion, rocket engineers believe, is not only feasible, but highly practical. Far more practical for interplanetary space, as a matter of fact, than chemical drive. All that's required, they believe, is enough concentration of research and development funds to bring it from the drawing board to actuality.

Any physics classroom can demonstrate how the ionic drive works. Ions, of course, are atoms which have been stripped of one or more electrons, thus gaining a positive charge. In a classroom, if we build up a sufficient positive charge on a freely rotating arm whose ends are bent at right angles, we find it will be sent spinning as the ions leak off

the ends. Were we able to accelerate these ions, the arm would spin much faster. Basically, this is the ion drive.

### Action and Reaction

The ion motor works on the same principle as the chemical rocket motor: every action has an equal and opposite reaction. In other words, when a chemical rocket is fired, the mass of gases rushing out of the motor in one direction causes the rocket to "react," and move in the opposite direction. A gun, for instance, acts in exactly the same manner. When the bullet explodes from the muzzle (action), the stock kicks against your arm (reaction).

So with the ionic drive. In this case the reaction is supplied by the charged particles rushing out from the rear of the ship, kicking the ship forward.

It has been found that, in a chemical rocket, the faster the gases escape, the faster the ship will travel. In the ion rocket, the same principle holds true—

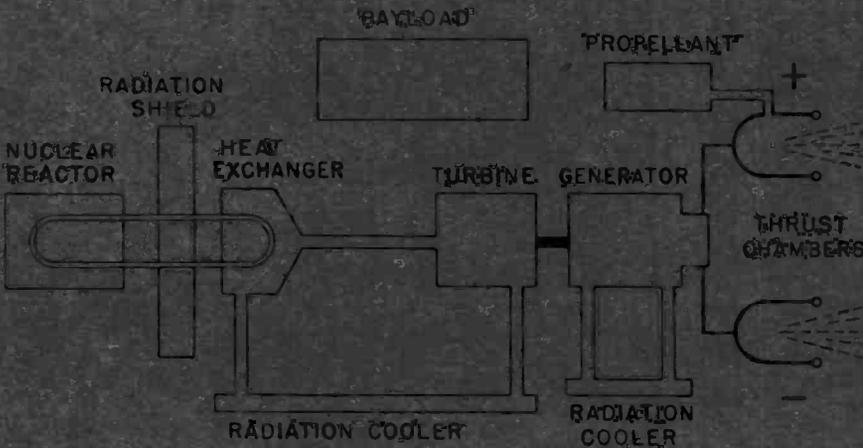
the faster the ions escape, the faster the ion rocket will move. And fortunately, there is a rather simple way to speed up ions. This is the electric field. If we pass a stream of ions through a properly oriented electric field, their speed will be boosted. The more intense the field, the greater the speed imparted. This is somewhat analogous to the way the electron beam in a television picture tube gets a "shot in the arm."

Therefore, in its simplest terms, all we need for an ion motor are two things: fuel to be ionized and a source of power to ionize the fuel and energize the electric field. We have these basics today, but the problem we face is in putting them together properly, and in the right place.

Before we examine the workings of an ion ship, let's find out why we need it.

### The Fuel Problem

The chemical rocket, we know, is



American Rocket Society

Block diagram of Dr. Ernst Stuhlinger's ionic space ship is shown above. Note that both positive ions as well as negative electrons have to be expelled to keep the ship's charge neutral. The electric field used to accelerate the particles is generated in the thrust chambers. At right is shown the Walt Disney conception of the interior of an ionic space ship's control center. Living quarters are atop the umbrella radiators.

highly inefficient. It eats up tremendous quantities of fuel in its drive to space. So much fuel, as a matter of fact, that we have as yet been unable to pack enough into such a rocket to kick it up to 25,000 miles an hour, which would allow it to escape the Earth's gravitational pull and push its way into empty space.

Even if we got the ship into an orbit about the Earth and were prepared to refuel it from a space station, we would find that it would need so much fuel for a trip to Mars that there would be little room for a payload such as crew, food, water, air and equipment.

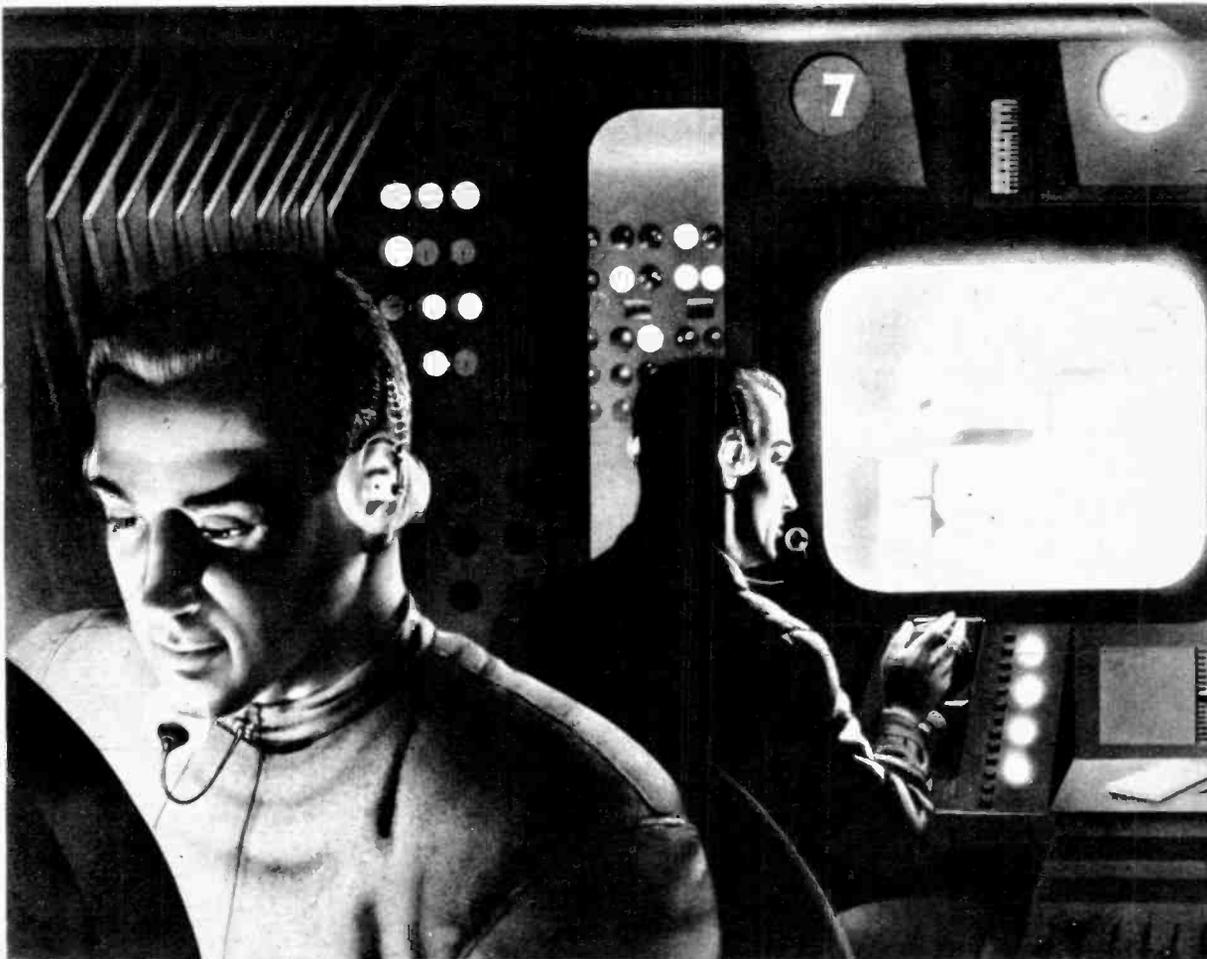
But here is where the ionic drive ship would come into its own. Such a ship could carry enough fuel for perhaps a year's constant operation, and this supply would take an area of only a few square yards. We would then have licked our biggest problem. We could get to Mars and back, and later, with more efficient design, we could push our

cruising radius out to much of the rest of the Solar System.

There are drawbacks, of course. The ion motor does not have the thrust necessary to enable such a ship to escape the heavy gravity of Earth. But since we would have to refuel a chemical rocket via a space station, we could just as easily do the same with an ion rocket. It could be sent into an orbit as the third stage of the chemical rocket, from whence it could be fueled and sent on its way by ionic drive.

Another drawback is the speed of such a ship. It has been calculated that a chemical rocket could get to Mars in about 260 days. It would take about 400 for the ion ship. This is not felt to be of sufficient consequence since space travelers would have to expect to spend long periods of time in accomplishing such journeys.

Weighing these pros and cons, proponents of the ionic drive feel such a ship holds the key to opening up the



Solar System to spacemen from Earth.

### Atomic Reactor Makes Ions

There have been several plans advanced for ion space ships. One of this country's top rocket experts, Dr. Ernst Stuhlinger, one of wartime Germany's foremost V2 designers and now at the Army's Redstone Arsenal at Huntsville, Alabama, is certain ion propulsion is the coming thing.

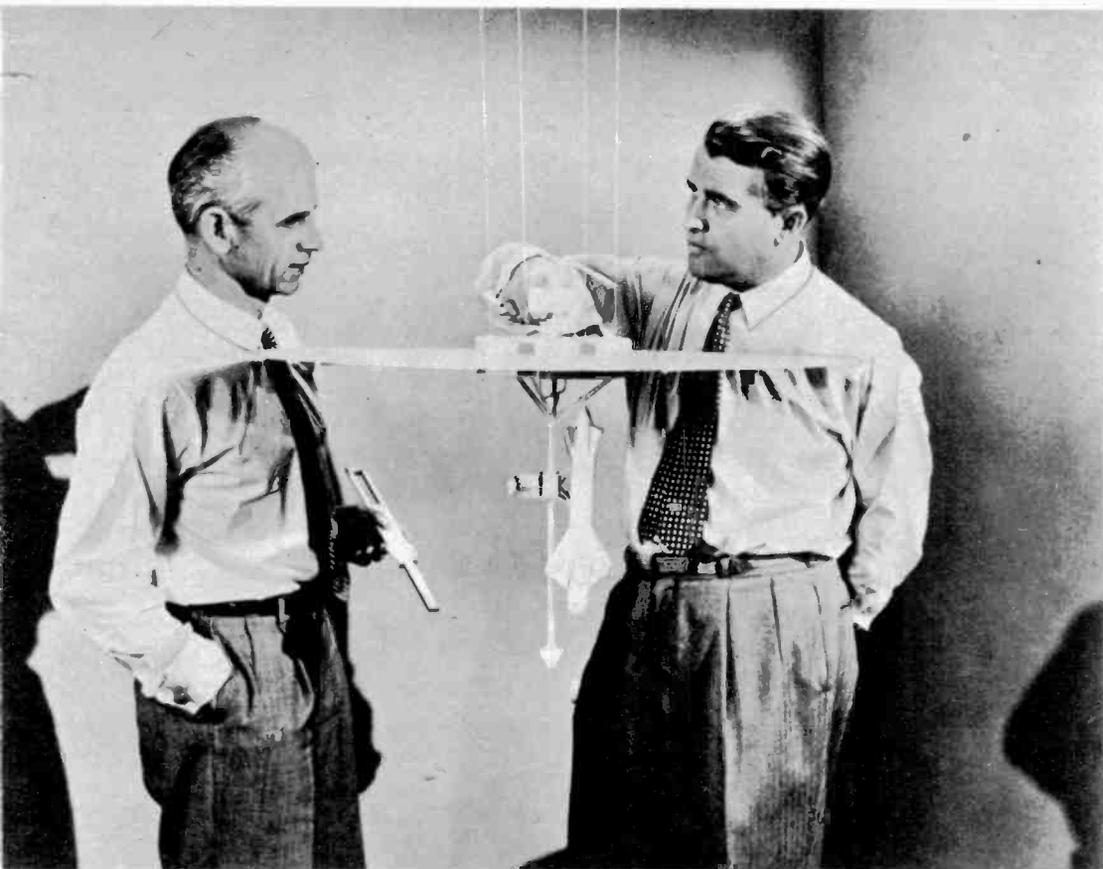
His plans call for an atomic reactor as the source of power. It would run a generator through a heat exchanger coupled to a steam turbine. The generator would heat to incandescence platinum ionizing grids, against which the fuel, cesium, would be sprayed. Cesium has the property of shedding electrons and ionizing easily upon contact with sufficient heat. These ions would be passed through an intense electric field, built up by the generator, which would accelerate them tremendously and expel them from the rear. The greater

the intensity of the field, the greater the speed of the ions and the greater the thrust. At the same time, the electrons which have been stripped from the cesium atoms would be sent through a similar field and expelled, so that the ship would remain electrically neutral.

M. I. Willinski and E. C. Orr, engineers at *Rocketdyne*, a division of *North American Aviation*, have gone one step further. They have outlined "Project Snooper," a program for reconnaissance of the Solar System using unmanned ion ships of a design somewhat similar to Dr. Stuhlinger's. These "Snooper" ships would be guided by preset instructions and would be powered for flights of a year or more. They would record everything they "saw" in orbits about Mars and the other planets, then head back for Earth and "report."

Ships using such a system of heat exchange would of necessity have to cool the hot steam so it could be recycled. The "Snooper" [Continued on page 106]

Dr. Werner von Braun (right) checks with a Disney specialist on construction details of the ionic space ship. Von Braun is the U. S. Army's top rocket expert and designer.



# Electronics Tracks Ills

**M**ORE and more the frontiers of medicine are being pushed into the land of the minute, the smallest of the small. The basis of scientific investigation, measurement, would be almost impossible in this region were it not for the techniques and instruments developed by electronics. The advances shown on this page are fruits of the increasing application of electronics to medical research and clinical diagnosis. •



Radio Corporation of America

Small capacitance pickup on patient's chest detects and records heart murmurs that may reveal heart defects at a very early stage.



General Motors Corp., Medical College of South Carolina



Arthur Schatz, Black Star

Electrogastrograph developed by research team at Columbia-Presbyterian Medical Center detects ulcers in stomach electronically.

Left, two scientists demonstrate a "radio pill," a small FM transmitter which is sent through the intestinal tract and followed externally.

The capacity pickup on the left is used in a soundproof room; the instruments for recording murmurs are located outside, below.



# All About Wiretapping

*Modern pickups are so sensitive that detection is almost impossible.*

*Article describes how "bugs" are made and tells what to guard against.*

*By Miguel Vega*

**P**RVACY of the American individual in his person, his home, his papers, and his communications has been an established principle of our way of life, at least on paper. By the far and the large the various law enforcement agencies and private detectives do not and have not invaded these rights. However, the news has been full recently of cases where wiretapping has been used by both government agencies and private individuals. Just as electric chairs and nooses do not deter murderers so will recent strict laws fail to prevent telephone taps or their equivalent. This article is written primarily to acquaint the reader with how easy it is to gain knowledge of your telephone talks by showing how it is done so that you can be on your guard. It may be too late to call a policeman after damage to your business or your reputation.

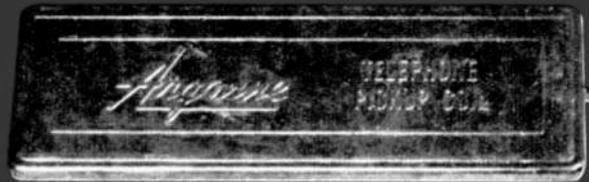
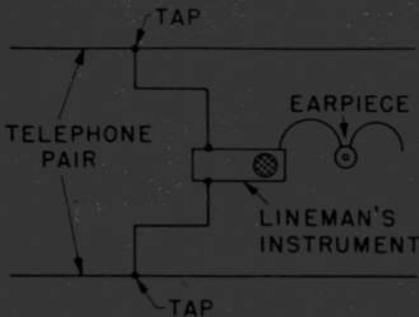
First, though, we mention the old style

tap. It consisted of a lineman's test phone or other portable telephone instrument connected across the two line wires to a telephone, called a "pair." (Below.) This was actually a tap. The telephone company could easily locate such a job and remove it. Whenever a call came over the line the "tap" phone would ring too and so would the phone on the line tapped although more weakly than normal. And the conversation over a tapped wire was weaker than normal. Hence such could be detected rather readily. *Modern electronic "taps" do not cause this characteristic lowering of the signal, a common fallacy.*

Modern tapping devices do not make a physical connection with the phone wires. All operate on the principle that they intercept the invisible and inaudible magnetic or capacitative field around telephone wires created by

**Old method of wiretapping bridged telephone lines making a noticeable reduction in sound.**

**Modern induction pickup coil can be slipped under a telephone and does not affect sound.**

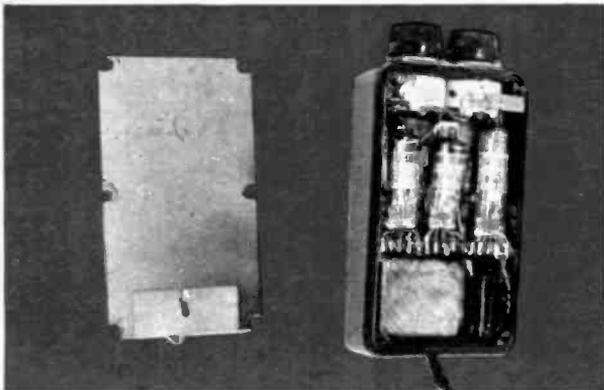




# TELEPHONES

Homemade induction coil used with a miniature wire recorder for wiretapping public phone.

Typical small portable amplifier for wiretapping. Others use transistors instead of tubes.



telephone currents: voice, ringing and dialing currents. An amplifier builds up the weak signal into an audible one or feeds a recorder for a permanent record.

Quite legal almost everywhere is a common practice in business of tapping your own phone with an induction pick-up as shown at left, center. A variety of these units for different phone types can be obtained from mail order and other electronic distributors. Such a unit is placed near the phone, its cradle, or ringer box. The output feeds an amplifier so that several can hear both sides of the conversation through a loud-

speaker, or several headsets or individual earphones.

Not always so legal is the *recording* of a phone conversation. A high pitched "beep" note is ordinarily required to apprise the distant talker that his remarks are being recorded. Check your local laws before attempting this. Almost all the various induction pickups can be fed directly into one of the input circuits of a tape or wire recorder. Some may require a matching transformer if the impedances are too different. Consult the pickup dealer or manufacturer if trouble is experienced so he can suggest the proper matching device.

### Unauthorized Interceptions

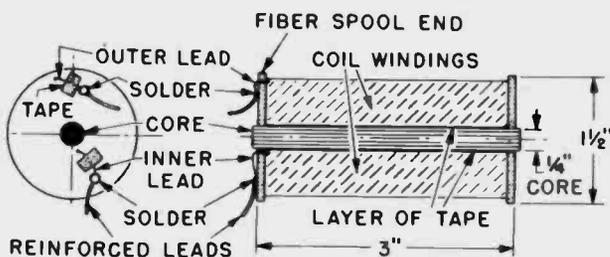
It is easy to see taps like those just mentioned. You can disconnect or move the induction coil away from the phone and the tap is broken. But a blackmailer or extortionist, etc., is certainly not that obvious. He would use another phone. Nor is an individual safe in foregoing a private phone for a public phone booth. They, too, can be "bugged" temporarily as we shall see.

A knowledge of the methods employed and types of equipment used enable you to safeguard your telephone talks.

Let's start with a simple type of capacity "bug" to illustrate what can be accomplished. A piece of wire may be strung along an exposed telephone pair of wires as shown at right. This wire forms a small capacity with the telephone wires like a condenser. With a very high gain amplifier both sides of the conversation become audible. This method is so effective that some private detectives have picked up telephone conversations on their hidden microphone lines when these were adjacent to phone wires. The phone conversation interfered!

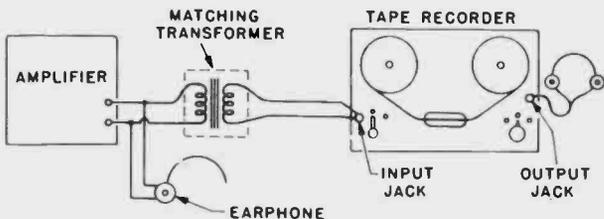
On page 29 is a portable hearing aid amplifier that is often used with such a pickup. The conversation may be recorded on a tape recorder (below left). Most tape recorders require an auxiliary preamplifier to boost the signal from a capacity wire pickup unless the length of the pickup wire is over about 10 feet. The output of the tape recorder or amplifier is monitored.

Construction details of typical induction pickup coil used for wiretapping.

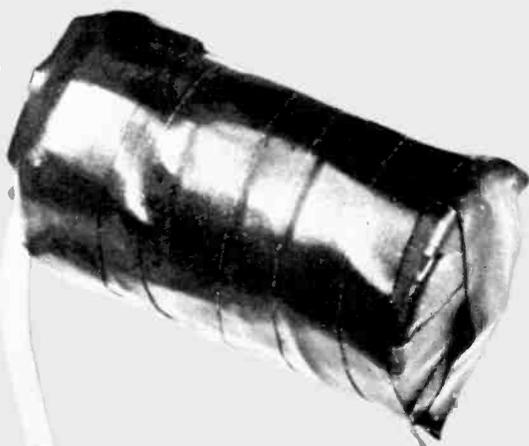


ONE POUND NO. 36 "FORMVAR" INSULATED MAGNET WIRE. FERRITE ROD FROM A LOOPSTICK.

Matching a recorder to pickup amplifier.



Finished pickup coil covered with black plastic tape and with microphone cable.





Core and semifinished pickup coil covered with Scotch tape; note reinforced leads.

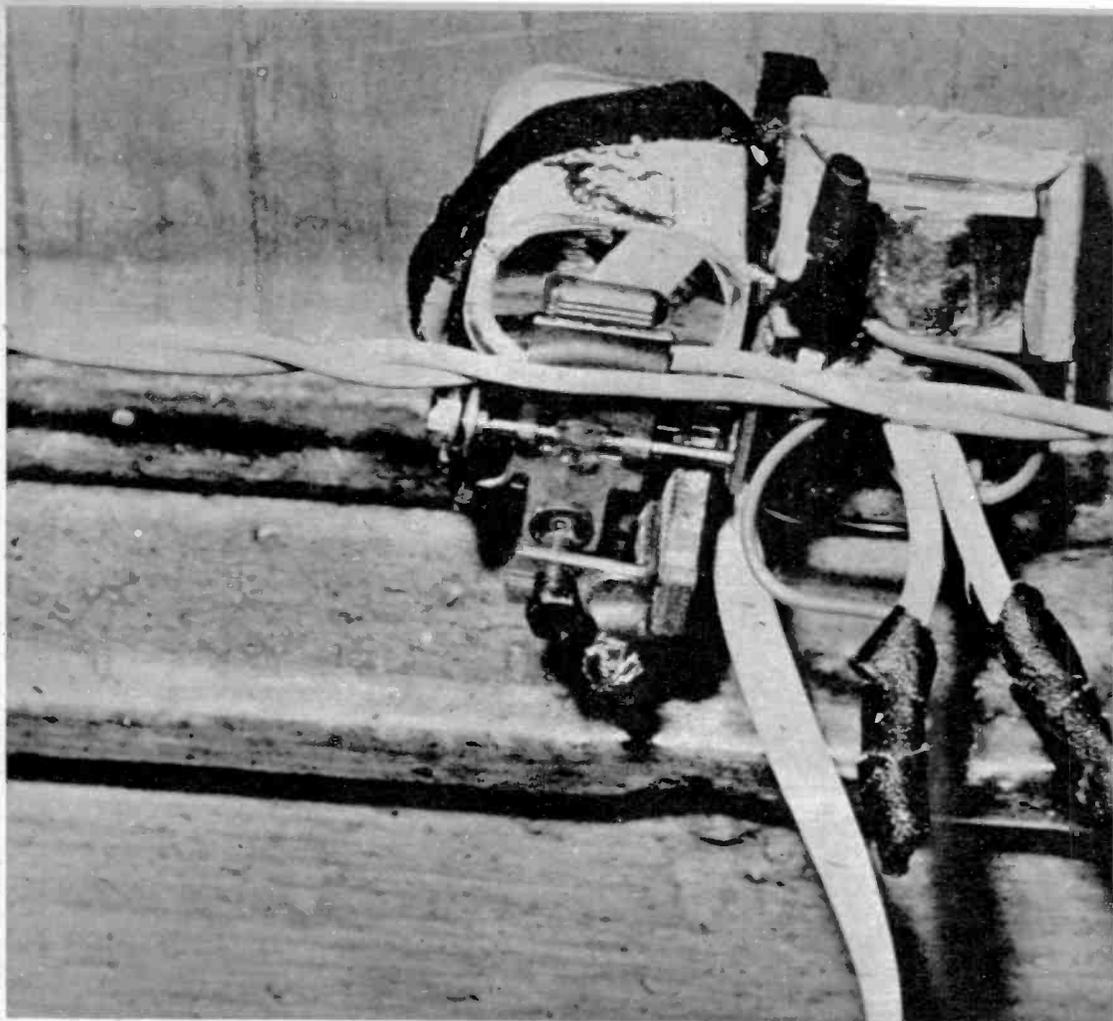
Simple wire slipped between twisted pair of phone leads picks up sound, must be amplified.

### Induction Pickup

Due to the low sensitivity of the capacity-wire type pickup some form of induction pickup is most commonly used. A smaller and less sensitive amplifier is required with this device than for the capacity "bug." Page 33 has a pictorial sketch of how one type is hooked up. The matching transformer may be deleted if the impedances of the pickup coil and the amplifier input are approximately the same. A tape recorder may be substituted for the amplifier.

A simple induction tap is shown on





above. Here, a common sensitive radio relay, a *Sigma* "4F," is used as the induction pickup. One of its contacts is unscrewed enough so the armature will open sufficiently for a telephone wire to enter the gap between armature and pole piece. The telephone wire acts as one turn of a transformer winding while the coil on the relay is the other winding. (This particular relay coil has an a.c. impedance of about 25,000 ohms, so a matching transformer must be used to step down the impedance to about 1000 to 1500 ohms to match the input of a transistor amplifier or to step up the impedance to about 100,000 ohms for a vacuum tube amplifier. Small transformers for this purpose are readily

available; *Argonne* models AR 104 or AR 100 are two examples.)

Now these methods work if the telephone wires are exposed. If not, then a junction box is opened and the induction pickup is slipped onto the wire. Or the line may be tapped by inserting a small capacitor from each wire (there are two) to the two input terminals of the amplifier. The capacitor used is always less than about 0.001 mfd. This direct tap cannot be found except by visual inspection.

#### **Tapping Pay Phones**

So you think you are safe to go to a phone booth and make a call? Maybe. You go to a phone booth. Somebody



Small inexpensive relay used as an induction pickup on a twisted pair of telephone leads. Note one telephone lead in gap between relay armature and pole piece. Matching transformer goes with relay.

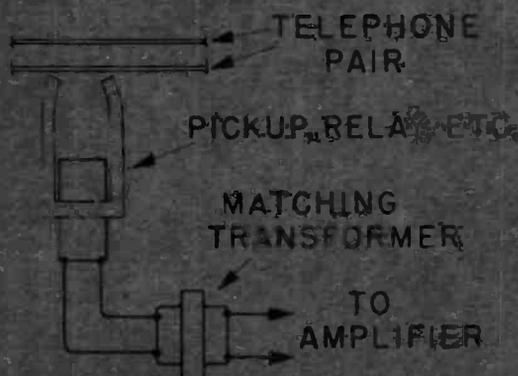
Schematic diagram of the setup in the photo above. Note how matching transformer is used between pickup and amplifier or tape recorder.

enters the adjacent booth and you hear them drop a coin in the slot and dial—maybe even talk. Can they hear what goes on over your line? Yes! Or maybe someone is looking up a number in a nearby directory while you're making your call. Beware!

Page 29 shows the use of a powerful induction coil near the ringer box in a phone booth. The unseen magnetic field around the ringer box is picked up by the coil and fed to a hearing-aid type amplifier and earphone. Or the talk may be taken down on a portable tape recorder. Even the dial impulses from a dial phone can be recorded in this way, and deciphered later to tell just what number you dialed.

You avoid such possible intrusion of your privacy by assuring yourself that no one loiters near the phone you are using—within 10 feet of the handset, the phone proper, or its ringer box. Furthermore, do not employ the same phone habitually. Habit is noticed by criminals like those who "case" a payroll.

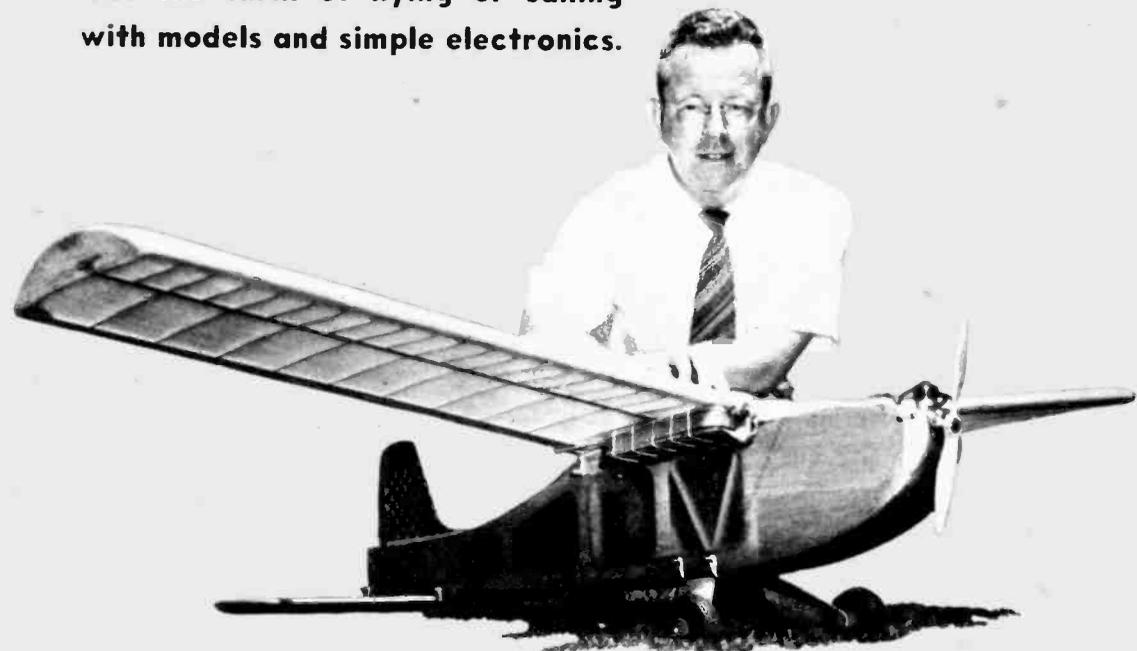
The oversize induction coils used for these pickups are simple to make. In-  
[Continued on page 111]



# Radio Control—Hobby Extraordinary

By William Winter

Get the thrill of flying or sailing  
with models and simple electronics.



This model winged over water from Catalina to L.A. via radio control.

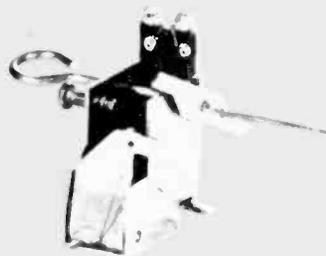
**I**N the short 13 years since VJ Day, no division of electronics has made more spectacular gains than the tight little industry that produces equipment for the hobbyist who goes in for radio-controlled model airplanes, boats, and cars. It's quite a business.

In the all-out competitive battle to increase reliability and degree of control, to reduce weight and current drain, perhaps a dozen manufacturers wage war against each other with printed circuitry, transistorization, subminiaturization, and all of the latest "secret weaponry" of electronics. Guided missiles and drones may be the major interest of some of these people—Babcock and CG Electronics, for instance—but victory in this "side line" battle

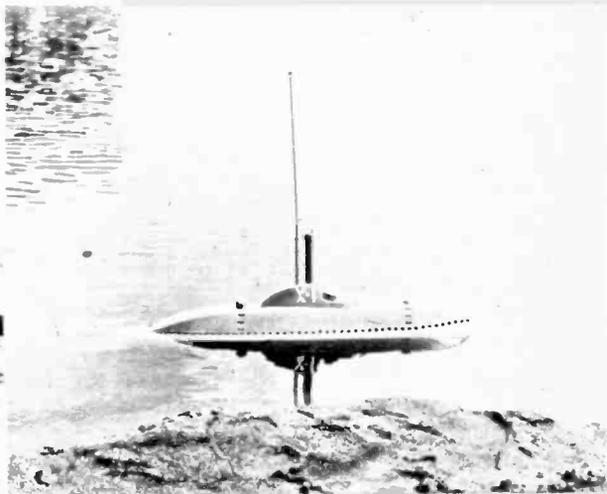
seemingly is for survival. The hobbyist loves it.

At the 1957 National Model Airplane Meet, held at Willow Grove Naval Air Station, near Philadelphia, 367 people entered the "RC" event. Throughout the week of July 29—August 3, miniature planes spun, looped, flew inverted, snap rolled and slow rolled, did Cuban eights, touch-and-go landings and many other "air show" maneuvers. When it was all over, Bob Dunham of California held a half-point lead over Harold deBolt, of Buffalo, N. Y. Both flew eight-channel equipment capable of operating every control you can find on a real plane. Eight-channel receivers were commonplace. Truly remarkable, was the fact that almost all this exotic

Right, typical rubber-band powered escapement with built-in relay. Arm turns when radio-controlled receiver "pulls in" relay.



Below, this 3 1/2" scale model yacht is one of a number of kits designed for radio control.



Above right, electric motor powered submarine model dives, steers under water, and surfaces all in response to radio control.

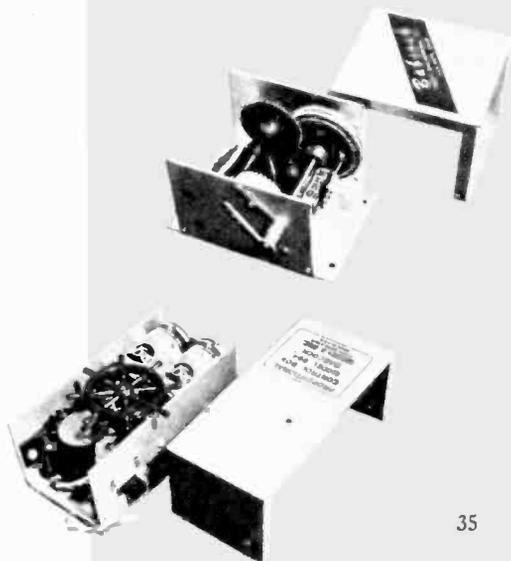
Right, various radio control parts. The 5-reed relay is activated by tones and controls five circuits—compare its size with the nickel! Below it is a servo and its boat control unit.



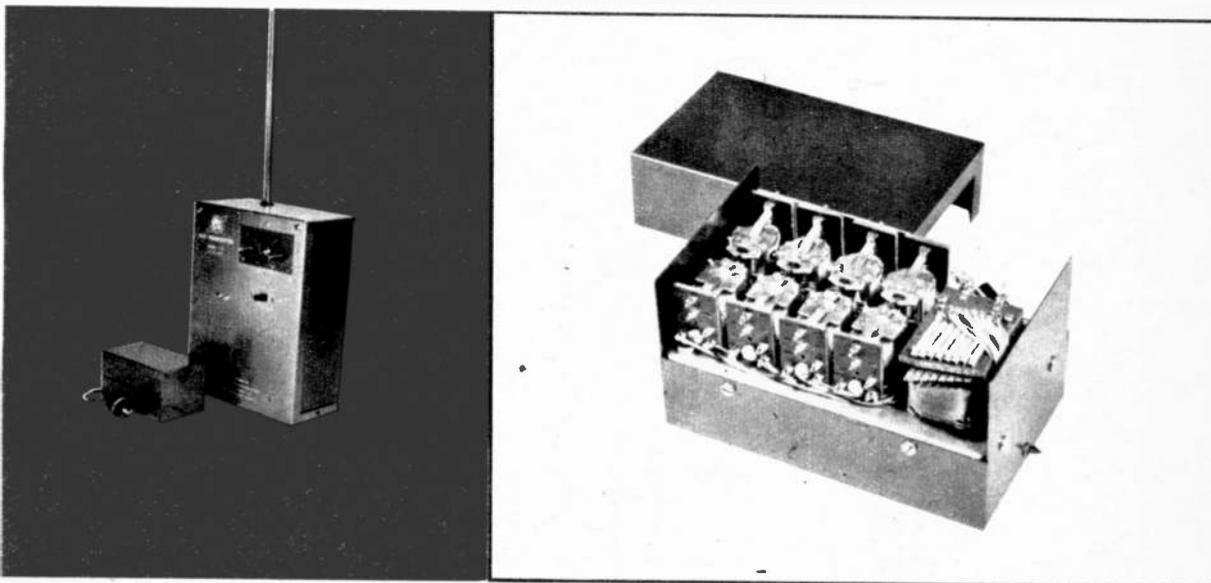
equipment was right off the dealers' shelves. And most of the fliers barely knew the difference between a transistor and a resistor. Anyone can do it!

Gone are the days when the hobbyist had to team with a "ham." When a day's outing involved diddle sticks and earphones, test sets and meters, car-battery soldering irons and rabbit's feet. Now you put in the batteries, turn on the switch, and burn up the sky—or skim the waves if boats are your pleasure. The only tough problem is deciding what system and equipment to use. For a pair of ten spots—or C notes, there's something for everyone—school kid or bank president.

The Orbit eight-channel that won the Nationals (CG Electronics, Bramco and



CG Electronics' 8-channel transmitter, left, and receiver, right. The flight of a model airplane is completely controlled by the two sticks on the front of the transmitter. The receiver is all transistorized with a reed relay and eight operator relays in a compact, shockproof package.



others have similar equipment) weighs only nine ounces and fits in a "can"  $2\frac{1}{16} \times 2\frac{1}{4} \times 3\frac{3}{4}$ —and that includes eight miniature relays and a reed bank. Operating on the Citizens frequency of 27.255 megacycles, Orbit equipment, like all the others, requires no code test or written examinations for a "ham" license. The frequencies of 465 and 27.255 mc are examination-free. You fill out, and file with FCC, the form 505 which comes with the equipment. This gets you a "station license."

Small size and low weight and versatility, however amazing, only suggest the story.

The Orbit receiver uses a 1AG4 sub-miniature tube and two transistors in its circuits (the remarkable CG doesn't even use a tube!). A lightweight hearing aide battery (such as a Burgess 30-volt U20), and a single pencil for filament is the power supply. In fact, one firm, B & S Products, produces a tiny transistorized power supply for receivers. This is correct—for receivers!

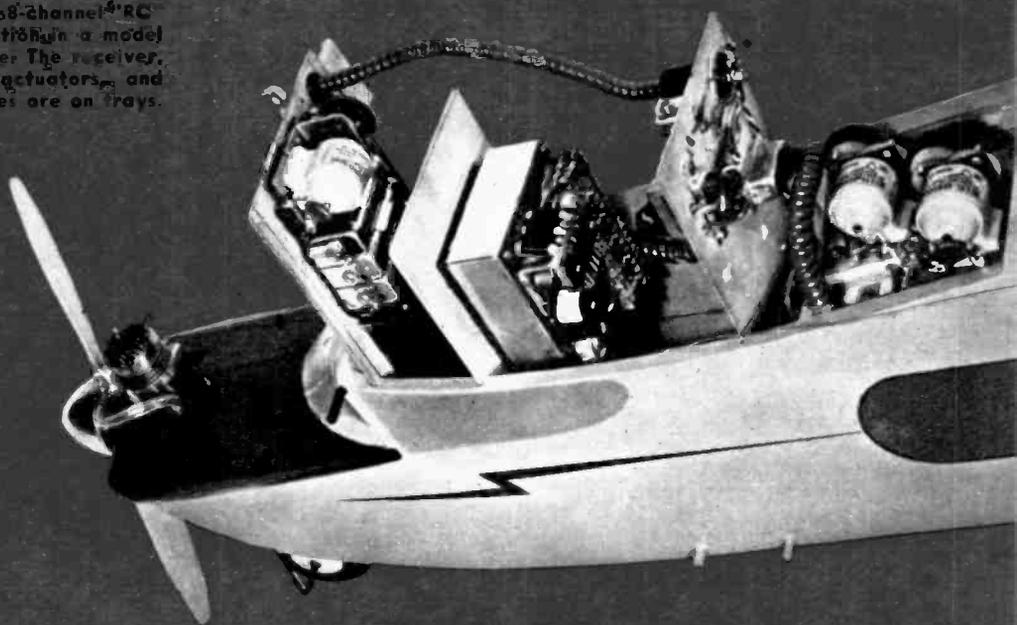
### How They Work

Basically, the "RC" system consists of the transmitter which puts out the

signals; the receiver, which picks up the signals and puts them to work; and the actuator(s) which moves the control surfaces on a plane, rudder on a boat, or steering mechanism of a car or truck. Equipment is distinguished by the number of channels, or different control orders that can be transmitted and picked up independently of each other. The popular single channel sets may be either carrier wave- or modulated tone-operated; multi-channel sets are invariably tone modulated. What means this Buck Rogers' gibberish?

In the carrier wave (CW) job, the transmitter sends out a steady signal as long as the control switch is closed. Reception of this signal at the receiver causes a significant change in the idling current, and this change in current through the relay of the receiver in turn, causes the relay to open or close, as the case may be. Everything exists just to work that relay—and a relay is nothing but a switch to close a second electrical circuit to the actuator. The actuator is either an escapement (powered by a rubber loop) which is released by a built-in magnet to move the control surface one position, or an electric motor-

Typical 8-channel RC installation in a model airplane. The receiver, servo actuators, and batteries are on trays.



driven servo with the same function. In any single-channel set, all additional controls must be achieved by Rube Goldberg variations on the actuator—you can vary the number, the length or the spacing of the signals to select auxiliary motions of the actuator.

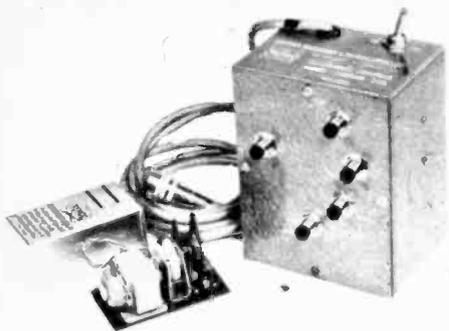
The tone-modulated rig functions much like a household radio. The carrier wave generally is transmitted steadily. Upon the CW a tone may be imposed, just as sound is carried on the CW to the household radio. In the receiver this tone evokes a response, again used to change the current through a relay.

Additional channels are easily had with tone-modulated rigs. Each tone is sorted out in the receiver and directed to its particular actuator by means of either a reed bank or a filter block. The reed bank consists of a magnet and a set of vibrating reeds of various lengths, usually thin strips of metal. The lengths of the reeds govern the resonant frequency at which the given reed will vibrate madly. The idea, of course, is to have each reed vibrate when its tone is sent out by the transmitter. When it vibrates the reed causes a relay to close.

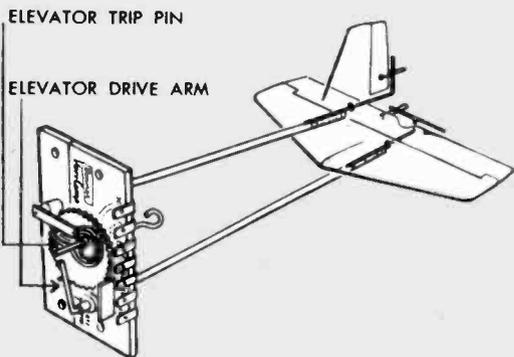
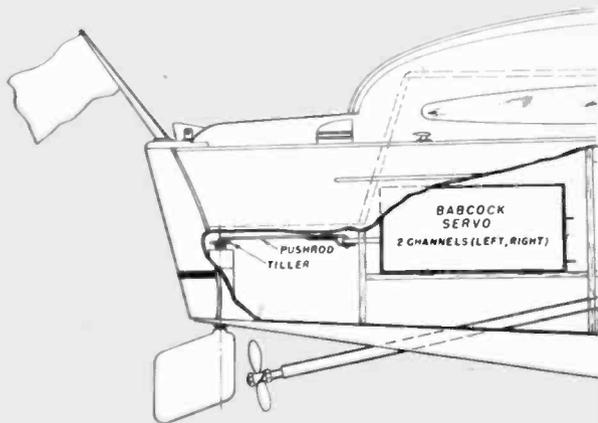
A filter block is nothing but a network of condensers and resistors that do the same job as a reed bank but entirely electronically. Either reed bank or filter block operates as many as ten relays (one for each channel). Filter blocks are heavy and usually are limited to two or three channels.

As in the single channel sets, the relay(s) close additional circuits to actuators—almost always servos in this case. For example, movement of a control stick at the transmitter for "up elevator" will vibrate one reed, close one relay, and supply "juice" thereby to one side of the motor in the servo. To move the servo in the other direction, the stick would be pushed to "down," vibrating a different reed in the receiver, closing another relay, hence sending current to the other side of the servo motor, causing it to run in the reverse direction.

Any of the better eight-channel receivers and transmitters provide simultaneous action of controls. Two channels may be connected for left and right rudder, two for up and down elevator, two for proportional engine throttle, and two for ailerons. Some modelers connect a fifth servo to operate landing

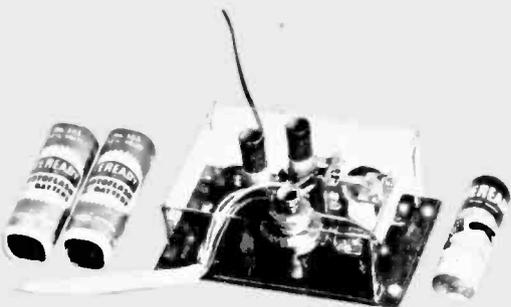


Pushbuttons on this transmitter control different model plane functions through servo shown.



Drawing shows how an escapement controls more than one function on a model plane with but a single-channel radio.

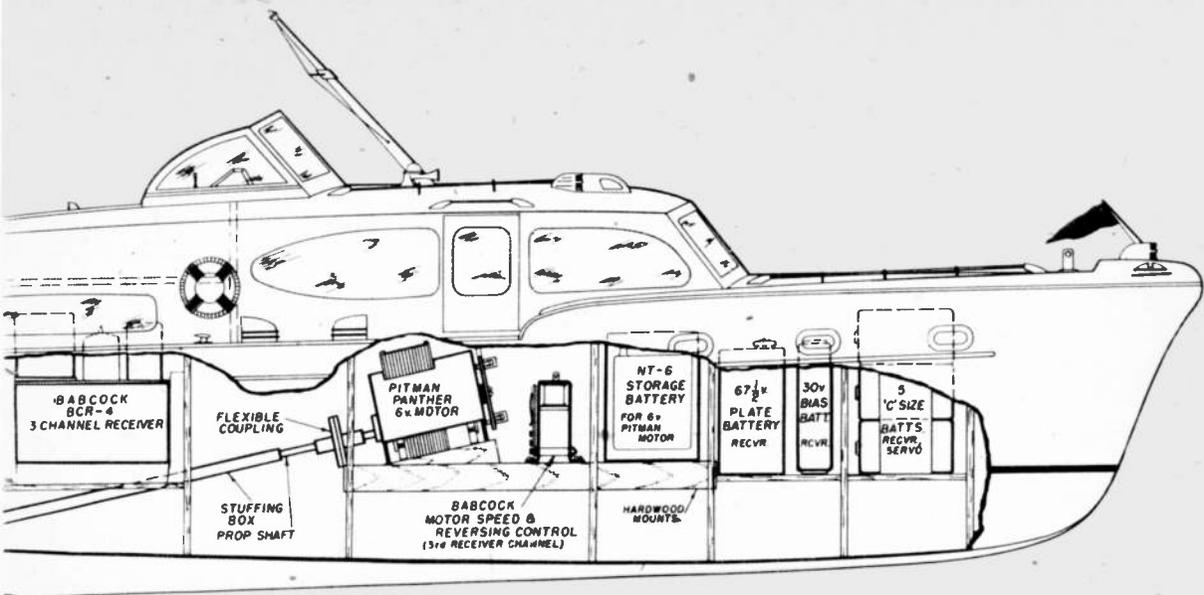
Typical single-channel receiver operates on pencil and 2 hearing-aid batteries.



flaps. Wheel brakes operate by magnetic clutch systems, or mechanically from the extreme up elevator control on the ground.

Model planes taxi out slowly, swing into the take-off position, lock their brakes and rev up their engines before "climbing out." They land with motor throttled back, roll down the runway and, by brakes and steerable tail wheel (works with the rudder), taxi back to the pilot, threading their way through people, cars, and other obstacles. If boats are your weakness, flags unfurl, gun turrets swivel (one mad genius fires blanks!), while the boat speeds along, or slows down, and even reverses. The writer has seen an incredibly detailed Mississippi stern wheeler belching smoke to the strains of Dixie coming from its gadget-filled hold.

With his high-powered rig, it isn't surprising that the "ham" looks down his nose at the tiny-power transmitters used by hobbyists. But the hobbyist does things with his "peashooter" that make the "ham" mumble in his beard. For example, the CG tone transmitters use an antenna one-eighth wave length long and deliver to it only  $\frac{1}{4}$  watt of power. This won't cause Arthur Godfrey to talk from the fillings in your teeth. Yet, one of CG's standard transistorized receivers was attached to the wing of a



Typical Chris-Craft cabin cruiser (Sterling) showing installation of 3-channel receiver. Boats are becoming more and more popular for "RC," they are less risky than planes; easier to work.

New Mexico National Guard F-80 jet trainer, with an 18-inch antenna. At an altitude of 1,000 feet, the ground range was in excess of four miles. At 25,000 feet, the equivalent ground range was 15 miles, not considering the five miles above the ground. The tiny RT-1 single-channel receiver was then tuned to 20 mc and Sputnik I came in loud and clear on a four-foot antenna. 'Nuf said, (At 1/2 mile, a six-foot model plane is a black dot, at 1/4 mile it is extremely difficult to control properly. Visual limitations, therefore, prevent practical operation beyond these distances.)

Though this might convince the "ham" that low output does have range, it would be almost impossible to convince him that such gimmickry is reliable. It is.

For the benefit of the technically minded, the following statement might be of interest:

"A powerhouse transmitter is not necessary for reliable range," states Frank Hoover of CG. "Weight is of no consideration in a transmitter but battery economy is a major factor, especially where B batteries are concerned. Battery drain is eight to 10 ma for the

plate batteries. Under normal use one set of batteries will provide six months' reliable operation.

"Reliability? The modulator in the transmitter must modulate the carrier at least 90% for reliable operation. The audio tone generators must stay within two cycles to give reliable reed-relay operation. The reed relay has a band width of approximately three cycles at the center frequency of 300 cycles per second." This requires stability of 1% or better over a range of 1 to 1 1/2 volts and a plate voltage of 100 to 135 at any temperature from zero to 150 degrees F."

All CG receivers have surface barrier transistor detectors. This front end is not a crystal detector, as one might suspect, but is true super-regenerative detector with a sensitivity of six to 10 microvolts. This sensitivity compares to the tube detectors and is temperature compensated.

### Buying Your Equipment

To make heads and tails out of the raft of RC equipment at the hobby shop, one must think in terms of the kinds of  
 [Continued on page 102]

# World's Smallest TV Station

**This Port Jervis, N. Y., studio operates without need of FCC license.**

**By Robert Hertzberg**



The "studio" is a converted 19- by 20-foot garage.



**A** CONVERTED two-car garage is the studio. The staff numbers two men. The technical equipment consists of a single camera and four photoflood lights. The station does not have and does not need an FCC license, but it operates on Channel 6. Viewers get perfect reception all the time. From its start, the enterprise has been self-sustaining, and local business people are clamoring for more commercial time.

Here in a paragraph is a description of what is probably the smallest but most unique television service in the world. It calls itself PJ-TV, the first part representing the initials of Port Jervis, New York.

Port Jervis is a thriving town of 10,000 inhabitants, located about 60 air miles from New York City at a point where the states of New York, New Jersey and Pennsylvania form a corner. This is definitely an unsatisfactory "fringe area" as far as reception from New York or any other television center is concerned. Some residents have their own big antenna arrays and sometimes obtain passable programs from two or three of the Empire State stations. Most set owners, however, have found it better to subscribe to a community service called Port TV. This organization maintains an elaborate "farm" of seven antennas on a nearby hill. These funnel



Station PJ-TV's one camera handles all programs and commercials. Organ provides live music.

Outdoor features are shot in front of the garage with camera pointed out door.

strong signals from all the New York City stations into a cable network that honeycombs Port Jervis.

Any family can avail itself of the Port TV facilities for an initial installation charge of \$125 and a monthly fee of \$3.00. In return, the company guarantees perfect 24-hour-a-day reception. The deal is a very good one.

Last summer it occurred to three local business men that while Port Jervis was enjoying better television reception than do many sections of New York City, the town itself had no TV representation. The men were Ernest Winkler, an insurance executive, Jerome Cohen, a lawyer, and Robert Shevlin, a radio





Slide and movie projector plus still photographs are used to cover local news stories.

station personality. They knew that it would be prohibitively expensive to apply for an FCC station license and then buy and install a TV transmitter and its necessary high antenna.

"Port TV already has pipe lines into several thousand homes. Why go on the air at all? Why not just pipe local programs into the existing system?" This was their general reasoning.

The idea was so simple that it created its own misgivings. But the three-man team went ahead. It formed a company called PJ-TV, Inc., made arrangements with Port TV as a fee-paying subscriber in reverse, rented a 19-by-20 foot garage on the grounds of a motel on the edge of town, and bought one solitary television camera, associated equipment to feed the video signals into the Port TV cables, and some bright lights. The signals were adjusted to correspond to Channel 6, which is not used by any Station in the vicinity.

Note carefully here that PJ-TV does not "broadcast" over the air at all, but sends its programs only through a closed wire circuit to viewers' homes. People using regular outdoor antennas with their sets cannot pick up PJ-TV, for the

simple reason there's nothing to pick up. However, Port TV subscribers can flip their channel selectors to 6 and see pictures fully as good as anything on the New-York channels.

With an investment of only about \$18,000 in a midget "station," the PJ-TV boys never dreamed of competing with NBC, CBS, ABC and the other giant television interests. Instead, they concentrated from the start on Port Jervis, and Port Jervis only. The first program went into the cable on October 18, 1957, and overnight PJ-TV became part of Port Jervis life.

PJ-TV provides strictly local news, with still pictures secured from local sources. Its live programs, all originating in the garage-studio, are folksy, friendly, personal and regional. Practically all the performers and staff double in brass at something else. A tape recorder provides sound effects, a small organ the only live music.

What the station lacks in production facilities it makes up in ingenuity and improvisation. For example, when an unexpected blizzard hit Port Jervis shortly after PJ-TV opened, commercial-manager Shevlin had a local auto-



Programs are informal and folksy. Nearly everyone on the staff performs several duties.



Corner of studio holds all the equipment used to operate the world's smallest TV station.

mobile dealer bring a new car up the driveway to the garage to show how well it performed in snow; the lone camera was merely wheeled to the door and caught the whole performance perfectly.

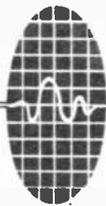
The staff is looking forward eagerly to the summer because also on the motel grounds, just within convenient camera range, is a swimming pool. The boys envision swimming and diving competitions, fashion shows, and of course a little interesting swim-suit cheesecake. What big-time television station has a swimming pool in its back yard?

When calling on active or prospective sponsors, Shevlin carries a Polaroid camera, does a lot of fast shooting with flash, and has approved program pictures in hand before he leaves.

The best indication of PJ-TV's success is its waiting list of sponsors. Plenty of camera-time is available, but the small staff just can't work up non-conflicting programs fast enough. Less than two months after inception, the client list includes three car agencies, two banks, and one each hotel, men's clothing store, appliance dealer, liquor shop and toy store. •

The staff consists of local residents. Here, one enters studio after a morning's hunting.



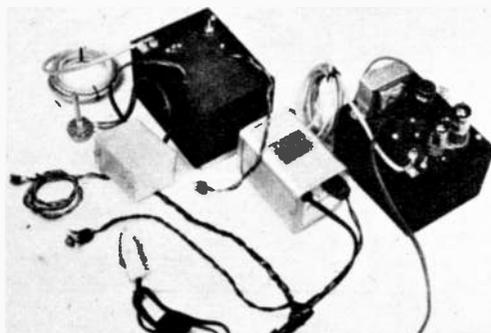


Special Project

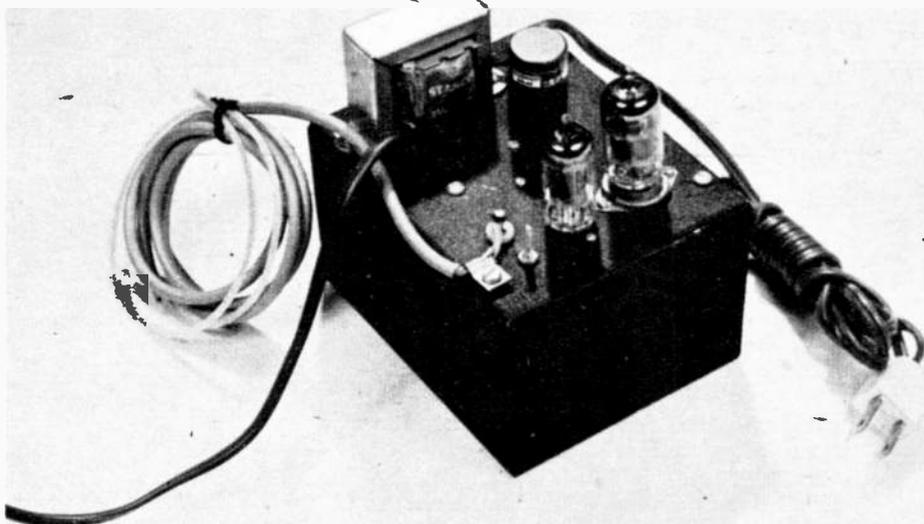
# the **EI** radio garage door opener

By E. J. Lorenz

**Press a button on your dash and your garage door opens  
—rain or snow won't bother you. This unit is foolproof.**



All of the units of the garage door opener are shown on the left, the receiver alone is shown below. The receiver is mounted anywhere in the garage where it can conveniently turn on the electric motor which actually lifts door. Note its simplicity.



**T**HIS radio-controlled garage door opener is the result of over one year's design and testing. It is as fool-proof and as simple to build as such a circuit can be.

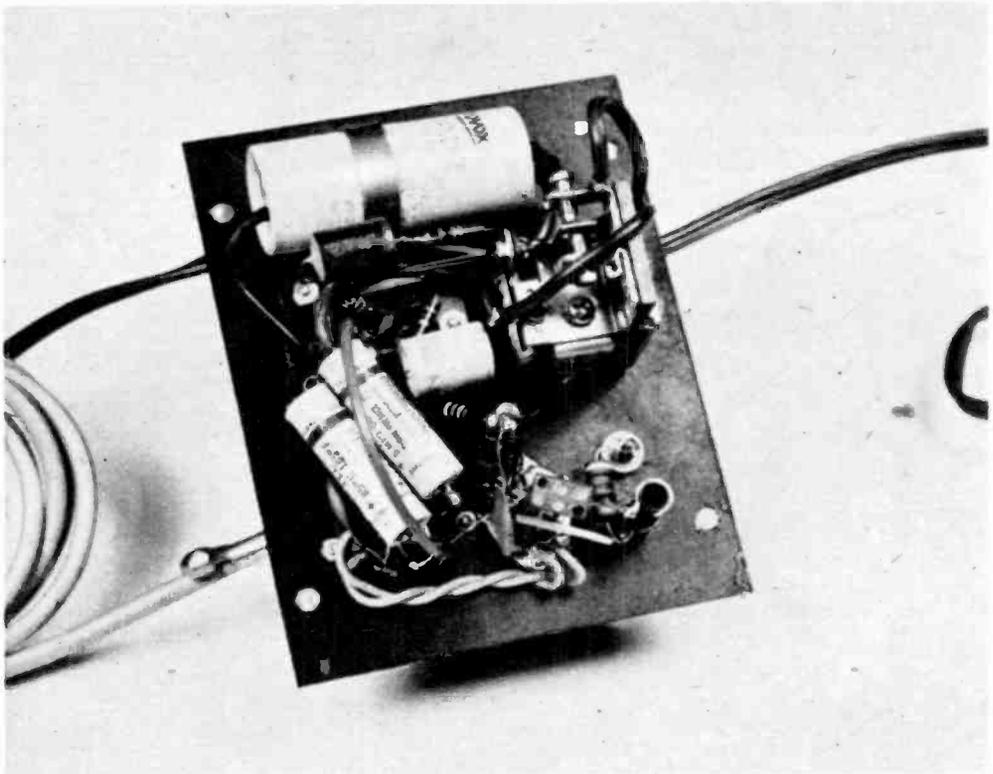
Now let's see what happens when we wish to open our garage door, turn on the garage or house lights or operate some other mechanism from our car. A conveniently located push-button on the dash of the car, is held closed for about two seconds. This turns on the power supply which actuates the transmitter in the trunk, or some other out of the way spot in the car. The transmitter operates on the license-free frequency (be sure to fill out an FCC form #505, obtainable from local FCC offices or most hobby shops) of 27.255 mc. and is modulated by a 190 to 510 cycle tone. Total transmitter power requirement is about 2.9 watts. The signal is picked up by the receiver (detected by the 6C4 tube, with the audio tone being ampli-

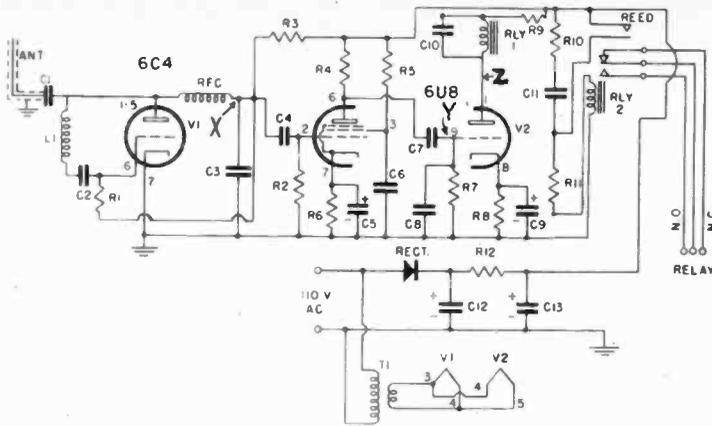
fied by the pentode section of the 6U8 and then fed to the triode section of the 6U8), for operation of a reed coil. The resonant-reed relay (in the plate circuit of the 6U8 triode section) responds only to the desired audio frequency. Total receiver power consumption is about 3 watts.

Before getting into the construction of this unit, it should be pointed out that a multi-channel unit for remote operation of as many mechanisms as desired can be made with no change in the electronic circuit. Reed relays may be had with up to 8 reeds per relay. Single reed relays are obtainable from *CG Electronics*, as are 2 and 3 reed units. 5 and 8 reed units can be obtained from *W. S. Deans & Company*, Downey, California. Single reeds may also be obtained from some model hobby shops.

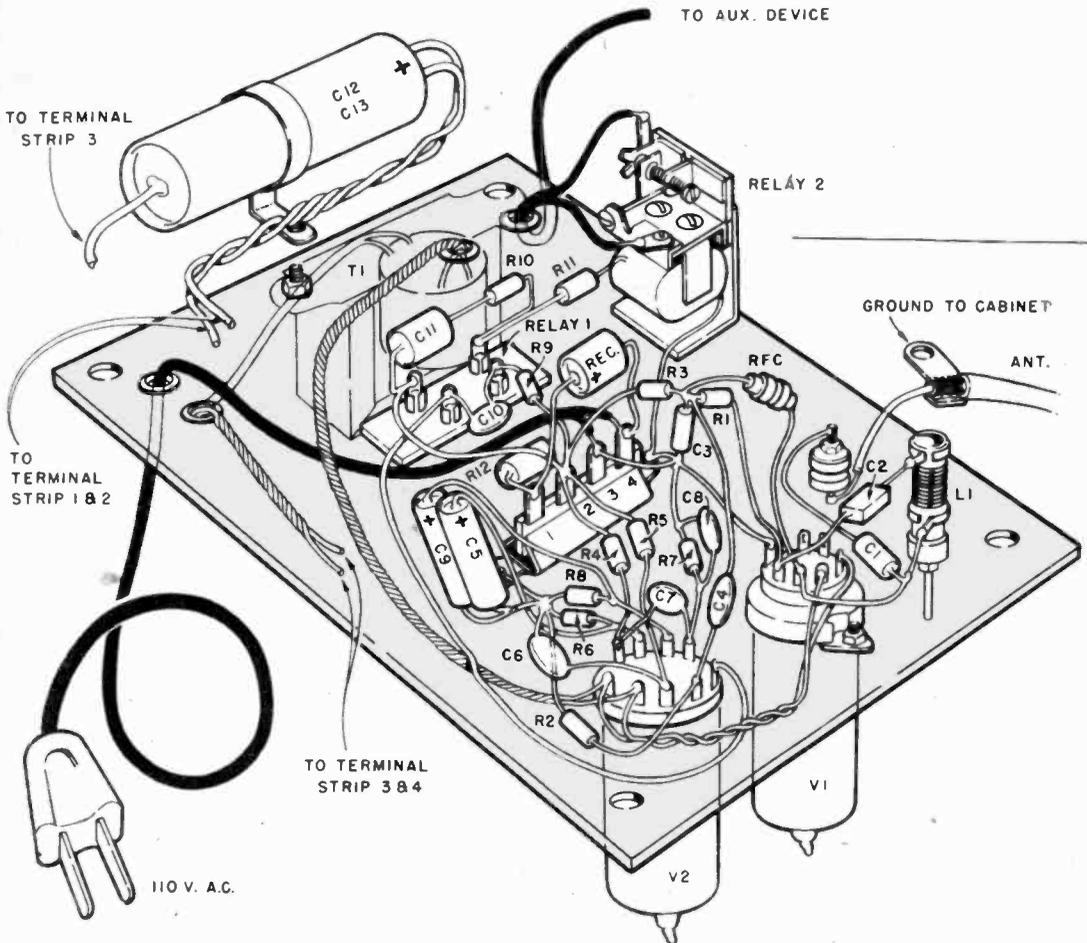
The range of this system has been checked well in excess of 300 feet, the exact range depending upon the trans-

**Underchassis view of the receiver. If a larger chassis is used the parts may be spread out.**





Above, schematic diagram of the receiver unit; the point-to-point wiring guide is shown below. For the best results use components exactly as specified on the parts list on the facing page.



#### Capacitors.

C1—5 mmfd. TC (Erie NPOA-050 or silver mica)  
C2—33 mmfd. TC (Erie NPOL-330 or silver mica)  
C3, C8—.001 mfd.  
C4, C6, C7, C10—.01 mfd. disc (Erie 811-01)  
C5, C9—5 mfd., 50 v. electrolytic (Sprague TVA-1303)  
C11—.25 mfd., 200 v. (Aerovox P82Z)  
C12/13—20/20 mfd., 250 v. dual electrolytic (Aerovox PR5)

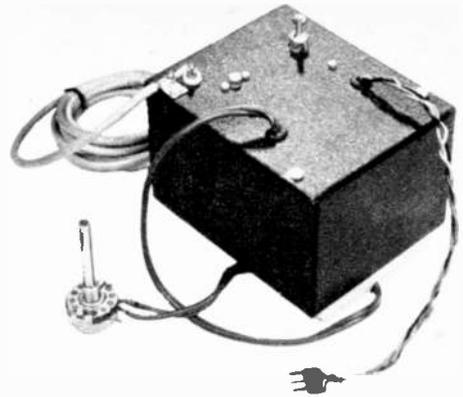
#### Resistors:

R1—2 megohm, 1/2 w.  
R2—3 megohm, 1/2 w.  
R3—47,000 ohm, 1/2 w.  
R4—75,000 ohm, 1/2 w.  
R5, R7—270,000 ohm, 1/2 w.  
R6, R8—3000 ohm, 1/2 w.  
R9—4800 ohm, 1/2 w.  
R10—100 ohm, 1/2 w.  
R11—39,000 ohm, 1/2 w.  
R12—2700 ohm, 1 w.

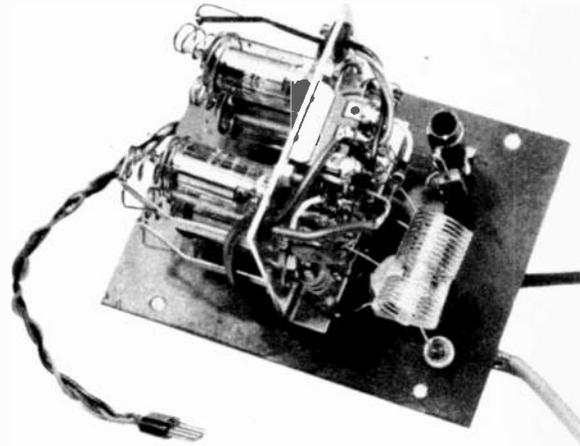
#### Misc.:

RFC—50 microhenry choke (National R-33)  
Rect.—selenium, 20 ma., 130 v.  
L1—40 turns No. 32 wire closewound on 1/4" dia. CTC form LSM  
T1—filament transformer, 6.3 v. sec. (Stancor P-6134)  
RY1—reed relay 200 to

500 cps (see text) CG Electronics, Albuquerque, New Mexico  
RY2—Sigma 4F relay (Sigma 11F or equiv. may be used if switching load is light)  
V1—6C4 tube  
V2—6U8 tube  
Cabinet 4"x5"x3" (Bud # CU-7288)  
7-pin miniature tube socket  
9-pin miniature tube socket  
4 position terminal strip (Cinch # 2004)  
Antenna feed-through insulator (National XS-9)  
6' microphone/hi-fi cable (Alpha # 1704)  
Small piece of aluminum for relay mounting bracket  
3 rubber grommets (5/16" mounting hole)  
Lamp cord of suitable length  
Short lengths of insulated hookup wire and spaghetti  
Small machine screws for mounting parts (#4—5/16" or 3/8" long)  
Small cable clamp and several small soldering lugs



The transmitter is completely enclosed in this chassis. Potentiometer varies tone frequency.



All of the transmitter parts are affixed to underside of top plate. Note the tube clamps.

mitter antenna installation, terrain and location of the receiver antenna. Construction of the receiver and transmitter is straight forward and should present no difficulties if the schematics, wiring guides and photographs are followed.

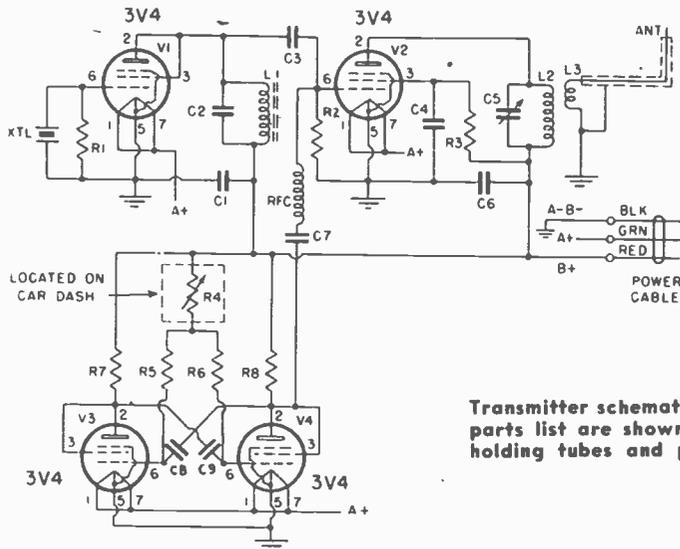
### Receiver Construction

The receiver shown is built into a 3" x 4" x 5" case, as is the transmitter, but may be built into a larger case or chassis if additional channels are desired.

Lay out the receiver chassis panel and drill or punch mounting holes as indicated. Note that the receiver is built entirely on one panel, the case serving only as a support and dirt shield. Mount tube sockets, making sure the pin numbers are properly located as per the sketch. Mount transformer, rectifier, reed relay socket and terminal mounting strips as shown. Place a soldering lug and lockwasher under each nut



Glue a piece of foam rubber or plastic to bottom of transmitter to ease vibration.



Transmitter schematic diagram, wiring guide and parts list are shown here. Note how subchassis holding tubes and parts is fixed to top plate.

**Capacitors:**

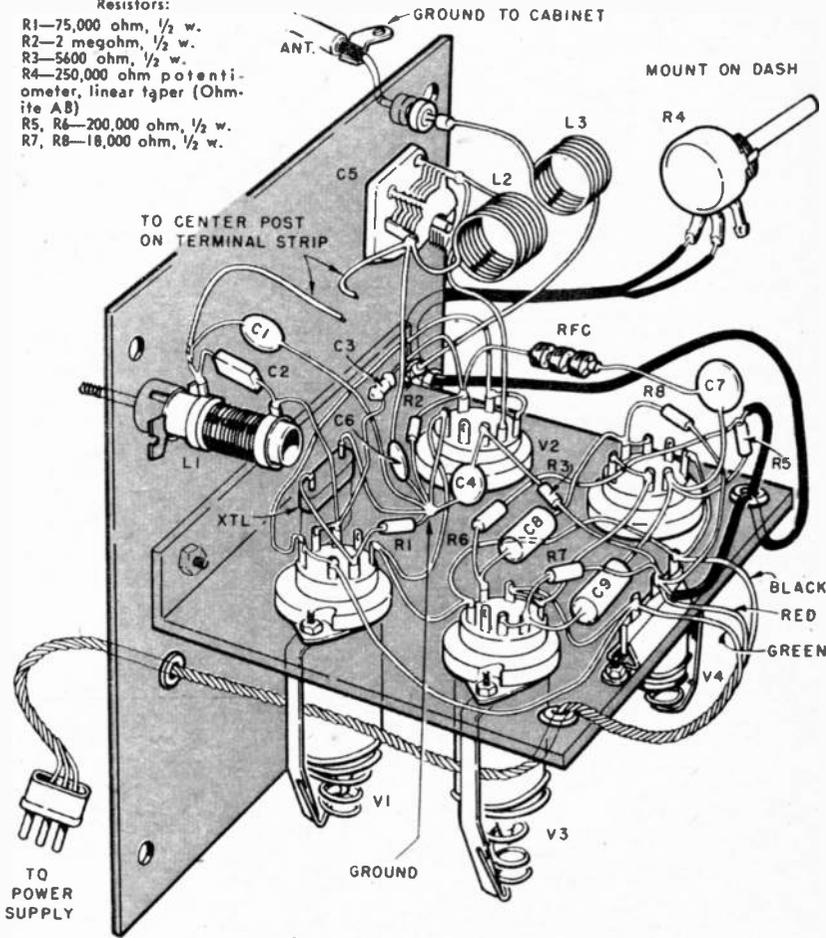
- C1, C4, C6—.005 mfd., disc
- C2—20 mmfd. TC silver mica
- C3—48 mmfd.
- C5—35 mmfd. variable (Hammarlund MAPC-35)
- C7—.01 mfd. disc
- C8—.03 mfd., 200 v. (Aerovox F82Z)
- C9—.02 mfd., 200 v. (Aerovox P82Z)

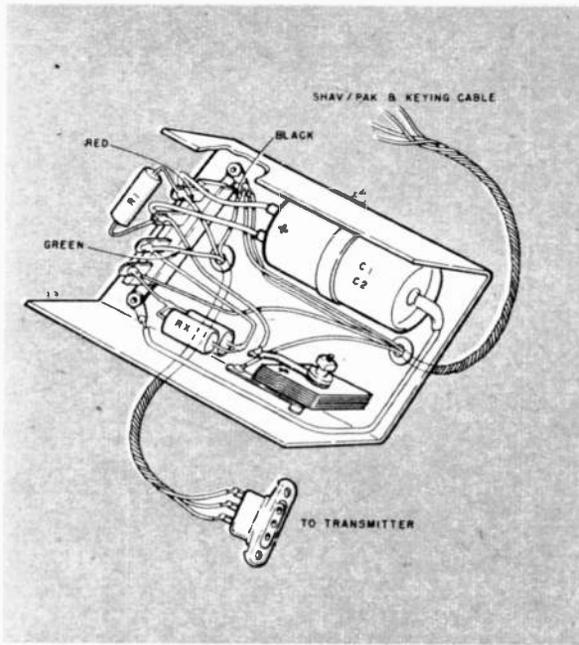
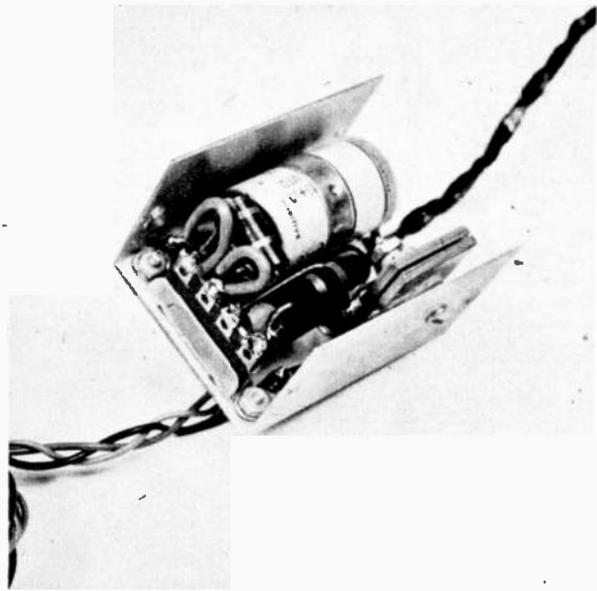
**Resistors:**

- R1—75,000 ohm, 1/2 w.
- R2—2 megohm, 1/2 w.
- R3—5600 ohm, 1/2 w.
- R4—250,000 ohm potentiometer, linear taper (Ohmite AB)
- R5, R6—200,000 ohm, 1/2 w.
- R7, R8—18,000 ohm, 1/2 w.

**Misc.:**

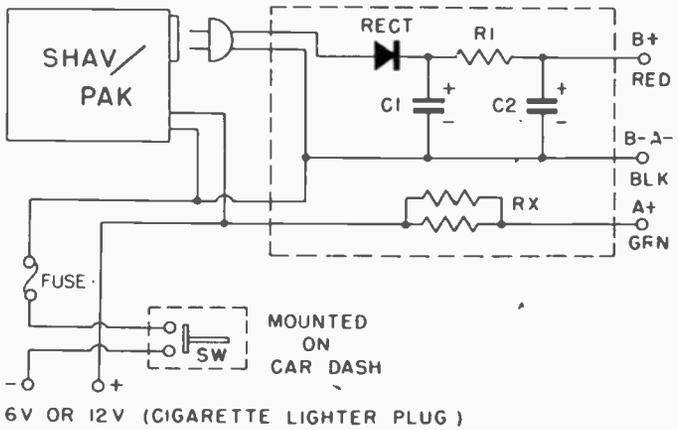
- XTL—13.627 mc. crystal (Available from Ace Radio Control, Higginsville, Mo., or Polk's Modelcraft Hobbies, 314 Fifth Av., N.Y.C.)
- RFC—750 microhenry choke (National R-33)
- L1—22 turns No. 26 enameled copper wire on 3/8" slug form (CTC L53)
- L2—10 turns B&W No. 3007 Miniductor
- L3—5 turns B&W No. 3007 Miniductor
- Cabinet: 4"x5"x3"
- 4—7-pin miniature tube sockets, flange mounting
- 4 tube retainers
- Feed-through insulator (National XS-9)
- 3 position terminal strip
- 6' microphone/hi-fi cable
- 3' No. 26 enameled copper wire
- Short lengths of insulated hookup wire and spaghetti No. 16 stranded plastic coated wire for hookup between transmitter and power supply/battery.
- 4 rubber grommets to fit 5/16" mounting hole
- 2' length lamp cord
- Small machine screws for mounting parts (#4—5/16" or 3/8" long)
- Small cable clamp and several small soldering lugs
- Piece 3/4"x1" thick foam plastic 3"x5"
- Small piece .040" or 1/16" aluminum, brass or steel for chassis





The small transmitter power supply unit is shown here. This may be fitted behind dash.

Wiring guide for the power supply; the parts list and schematic diagram are shown below.



- C1/C2—20/20 mfd., 150 v. electrolytic capacitor
- R1—2700 ohm, 2 w. resistor
- RX—for 12 v. operation: 2—56 ohm resistors, 2 w., 5% in parallel
- 6 v. operation: 2—22 ohm resistors, 1 w. 5% in parallel
- Rect.—selenium rectifier, 65 ma., 130 v.
- Shav-Pak made by ATR, 15 w. or equiv., specify for 6 or 12 v. operation

- SW—momentary contact, normally open pushbutton switch
- Box: Bud # 3000 Minibox
- 1—4 position terminal strip (Cinch # 2004)
- 2—rubber grommets for 5/16" mounting hole
- 1—#6-32 screw 1" long w/nut and lockwasher
- 3—4-40 screws 5/16" long with nuts and lockwashers
- Necessary No. 16 stranded wire for hookup
- 2 soldering lugs

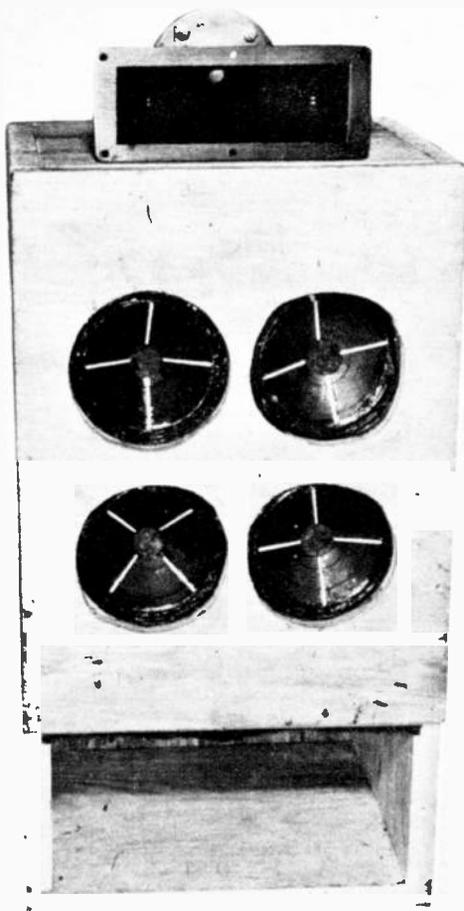
holding the terminal strips in place. Wire in the filament circuit for both tubes and mount the tuning coil, L1. Do not substitute values or type of parts unless you are sure they are the exact equivalent. Since this receiver will remain on at all times and may be exposed to changes in temperature, high quality parts with an adequate safety rating are specified.

[continued on page 103]

# Build A Stereo Speaker

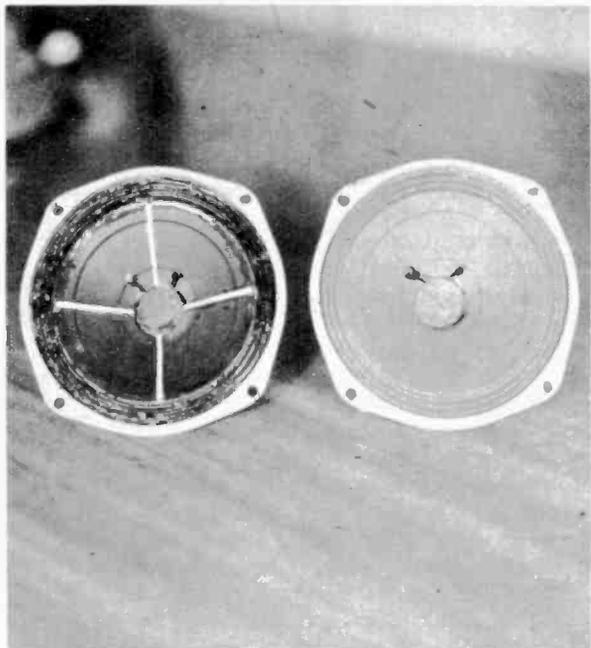
By Ernest Wayland

Stereo Hi-Fi need not be costly —this complete second speaker system costs you less than \$30.

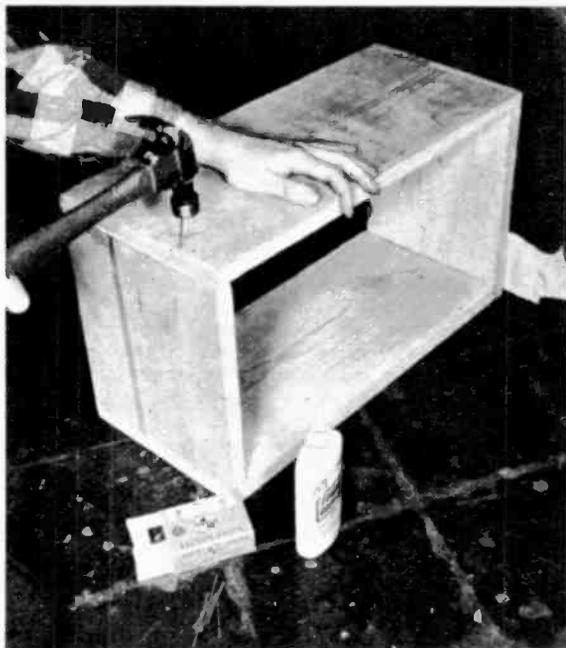


Four inexpensive replacement type 5" speakers make up the bass unit of this system. The speakers are modified to improve their bass response as described in the text. The photo above shows slits being cut along the rim of the speaker. The next step is to stiffen the speaker cone by adding toothpicks to the cone itself. All tools needed to modify the speakers are shown in photo.

The complete speaker system is shown at the left. This unit may be inserted into a piece of furniture already in the room or it may be covered with grill cloth and Contact paper. The horn tweeter may be positioned in opening at bottom.



Inexpensive speaker on the right has its rim loosened and its cone stiffened as on left to improve its frequency response for system.



The sides of the speaker enclosure should be glued first and then nailed together to furnish a stiff, rattle-proof speaker box.

**I**F you've been swayed by recent pronouncements that stereophonic hi-fi is here and you'd like to add it to your present hi-fi system, it needn't cost too much if you build the second speaker system you'll need. The opinion is widely held by many who know that the second channel speaker need not equal in quality the first, if it balances the first and does not introduce distortion.

The little speaker system described here can be built for a minimum outlay of cash. Yet, it will give audio reproduction far beyond what you would expect. Basically, it consists of a 4-speaker woofer and a horn tweeter.

### The Bass End

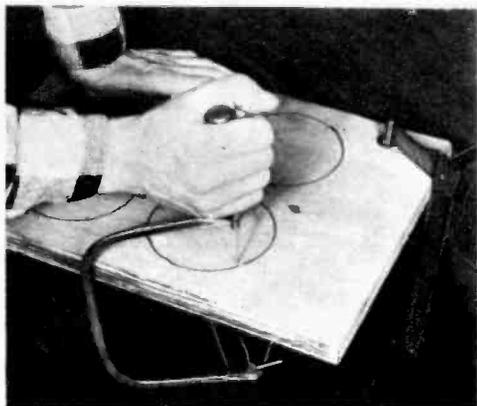
The problems encountered in the selection or construction of a stereo bass reproducer are not overly difficult. The lower audio frequencies tend to spread out and hence their point source is not apparent to the ear. The low rumble of the kettle drum, if well reproduced by the master speaker, will not suffer much in stereo if the smaller second speaker does not do it full justice. Real econo-

mies therefore can be realized at the bass end of your second channel without excessive sacrifice of quality.

It's been found that four inexpensive 5" speakers, if properly modified and assembled in a small enclosure, can provide surprisingly good sound considering their cost and size. The problem is to lower the resonant frequency of the speakers and by doing so *not* introduce distortion.

The tools needed to adapt the 5" speakers to function efficiently as woofers are a razor blade, a bottle of glue, a jar of Vaseline, a can of light machine oil, sixteen toothpicks, and a can of acrylic spray. The toothpicks should be the flat type. Follow this procedure in the order given with reference to the chemical treatment of the cone as a step out of turn may ruin the speaker.

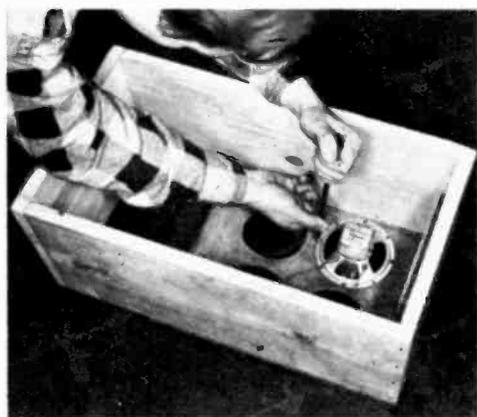
First, considering the speaker as a clock face, make twelve cuts with a sharp razor blade in the edge suspension of the speaker; each cut should be on an hour position. These cuts should run from the innermost suspension corru-



The front of the enclosure should be made from  $\frac{3}{4}$ " plywood so that it will not split when the four speaker holes are cut into it.



Tack Fibreglas insulation, old towels, etc., to the inside of the back and sides of the enclosure to absorb undesirable sound waves.

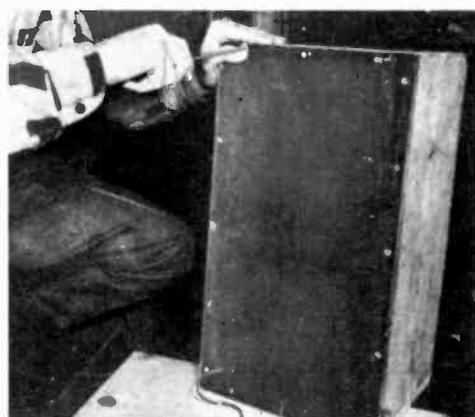


Screw the speakers to the inside of the front panel. When all are installed, they are wired in series as explained in text.

gation (C) to the outer rim (D).

Now break each toothpick to a length which will extend from the edge of the voice coil of the speaker (A) to the point where the first ripple of the rim suspension is encountered (C). Cement four toothpicks into place with the glue as per the photograph. (The glue used should be of the type which does not contract on drying. A Borden's product, "Elmer's Glue-All," proved to be ideal.) Now form a complete circle of glue along the inner edge (C) of the same rim ripple. The purpose of the glue is to prevent the edge slits from extending themselves and to act as a barrier to the spread of the oil, which is next applied.

A light machine oil should be spread lightly on the rim suspension between the glue barrier at (C) and the outer edge of the speaker (B). Immediately after the oil, a moderately heavy coating of Vaseline should be applied over the same area, taking care that neither substance is allowed to leak by the glue barrier. The acrylic spray is now brought into action and two coats are applied to the front and rear of the speaker cone. It doesn't matter if the frame of the speaker interferes with a thorough rear spraying. Now with the aid of a pipe cleaner or swab, remove the excess Vaseline, leaving a thin layer, and the modification is complete. Each of the four speakers should be treated similarly.



The back is screwed tightly to the sides of the box to prevent rattles and sound leaks. First drill pilot holes for screws. Note the cable.

## Building the Cabinet

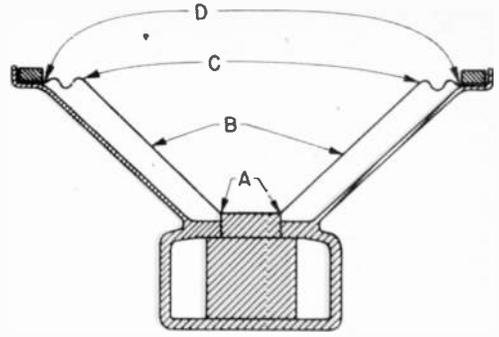
The construction of the cabinet is simplicity itself. Since butt joints are used throughout, no difficult mitering or other fancy woodworking is required. A 6' pine board of 10" width and 1" finished thickness will provide the top, bottom, and side pieces. The front and back sections of the cabinet are made of  $\frac{1}{2}$ " or  $\frac{3}{4}$ " plywood. Note that the cabinet dimensions are only accurate for 5" replacement type speakers modified as suggested. Drill a  $\frac{3}{16}$ " hole in the back panel for the leads to the amplifier, and a series of  $\frac{3}{16}$ " pilot holes  $\frac{3}{8}$ " deep along the back panel edge for screws. The panel is mounted with 2" No. 8 flathead screws. Fiberglass insulation, rug backing, old towels or any other handy coarse material can be used for cabinet damping. Tack it to the back panel and walls of the cabinet. If the bass sound when the speaker is tried out seems "wooden" or "hollow," add an extra layer or two.

After the four modified 5" speakers are installed in the cabinet, they'll have to be connected *in series, in phase*. Simply connect the right hand terminal of each speaker to the left hand terminal of its neighbor, leaving the left hand terminal of the first speaker and right hand terminal of the last speaker open. Connect a 2" length of wire to each of

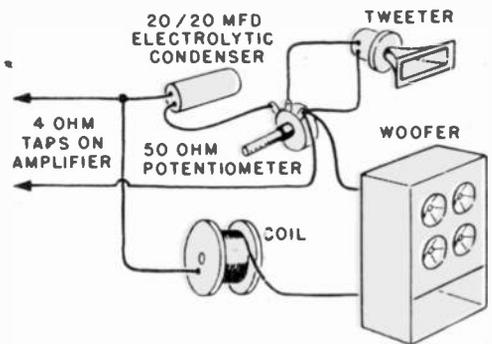
[Continued on page 100]



Wind the coil for the crossover network fairly tight. Make certain that you fill up evenly the coil form with 250 turns of wire.

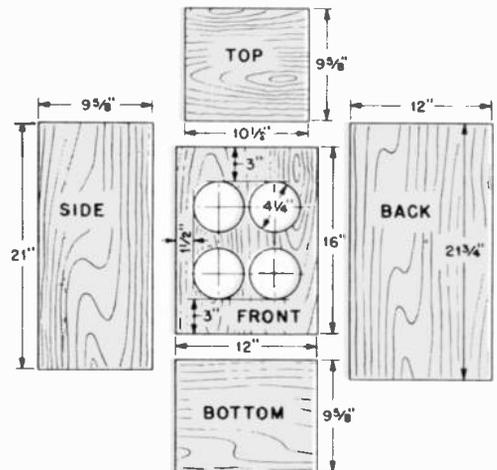


Cross section of a typical replacement type speaker. The letters refer to parts modified.



Wiring diagram showing how the tweeter and bass unit (woofer) are connected together through the homemade crossover network.

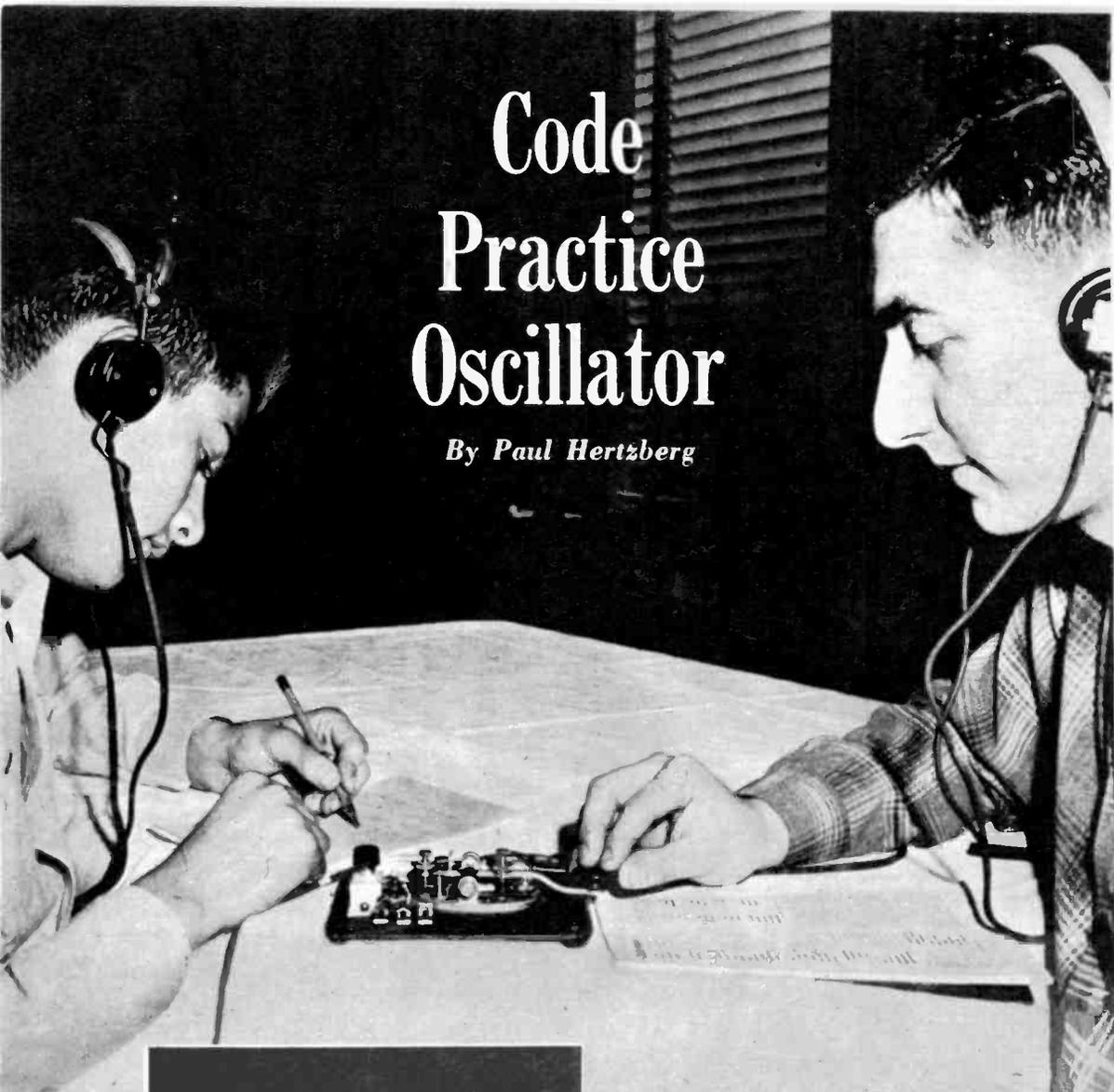
## SPEAKER ENCLOSURE PARTS



Dimensions of the various parts of the enclosure. Don't change these sizes since they have been carefully determined for 5" speakers.

# Code Practice Oscillator

By Paul Hertzberg



—2N007 transistor  
2—01 mica paper capacitors  
1—50k potentiometer  
1—2.7k  $\frac{1}{2}$ w resistor  
1—22k  $\frac{1}{2}$ w resistor  
1—1.8k  $\frac{1}{2}$ w resistor  
5—faststock clips  
5— $\frac{1}{8}$ " #32 Phillips machine screws  
5—32 nuts  
7— $\frac{1}{32}$ " volt penlight cells  
1—two-cell holder  
1—small knob  $\frac{1}{4}$ " hole  
1—telegraph key  
1—pair more pairs of 2000 ohm ear phones  
Strip of metal  $3\frac{1}{2}$ " $\times$ " $\frac{3}{4}$ " for mounting on  
Masonite pegboard  $5\frac{1}{4}$ " $\times$ " $6\frac{1}{2}$ "  
2 feet of insulated hookup wire

Two potential amateur radio operators, are shown practicing the Morse code by means of the code practice oscillator described in this article. The complete device is only slightly larger than the telegraph key itself. The bottom view of the oscillator, on the right, shows how simple the wiring is. The schematic diagram is on the far right.

*Be a HAM! But first, learn the code with this simple device.*

**P**RACTICE makes perfect. Constant practice of the code is the way to pass your ham license requirements.

You can use a simple buzzer and key combination but very often the sound is annoying to those not interested in your practice. Also, the buzzer does not sound like CW (continuous wave, radio telegraphy) as you would hear it on a receiver. The solution is to build a private listening device.

A very good, variable tone, code practice oscillator can be made with a few easily obtained parts. It uses a 2N107 transistor in a feedback oscillator circuit. Two paper capacitors and four resistors comprise the remainder of the circuit.

The entire code practice set is just a little larger than the telegraph key itself. This has been designed specifically for space-conscious apartment dwellers who may want to tuck this item out of the way when not in use. After the ham ticket has been won, the key itself can be removed and used separately with the complete transmitter; the parts may be used for some other devices.

Arrange the parts as shown in the photos. The potentiometer for the tone

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 -----

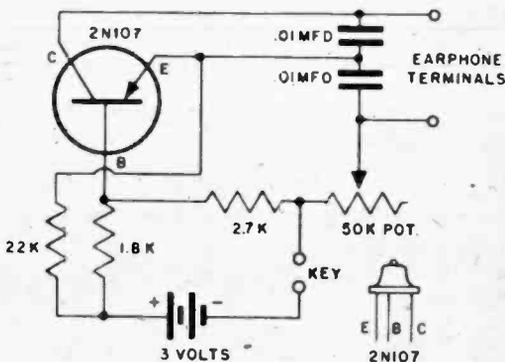
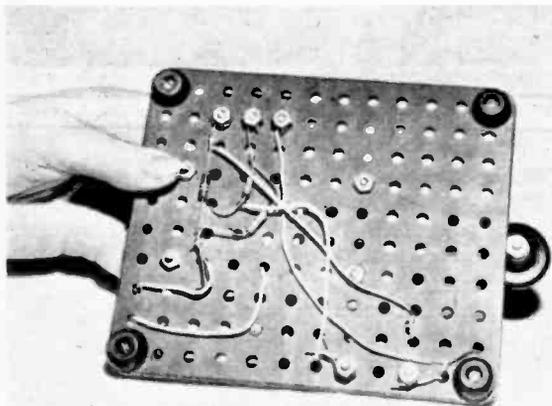
Error .....

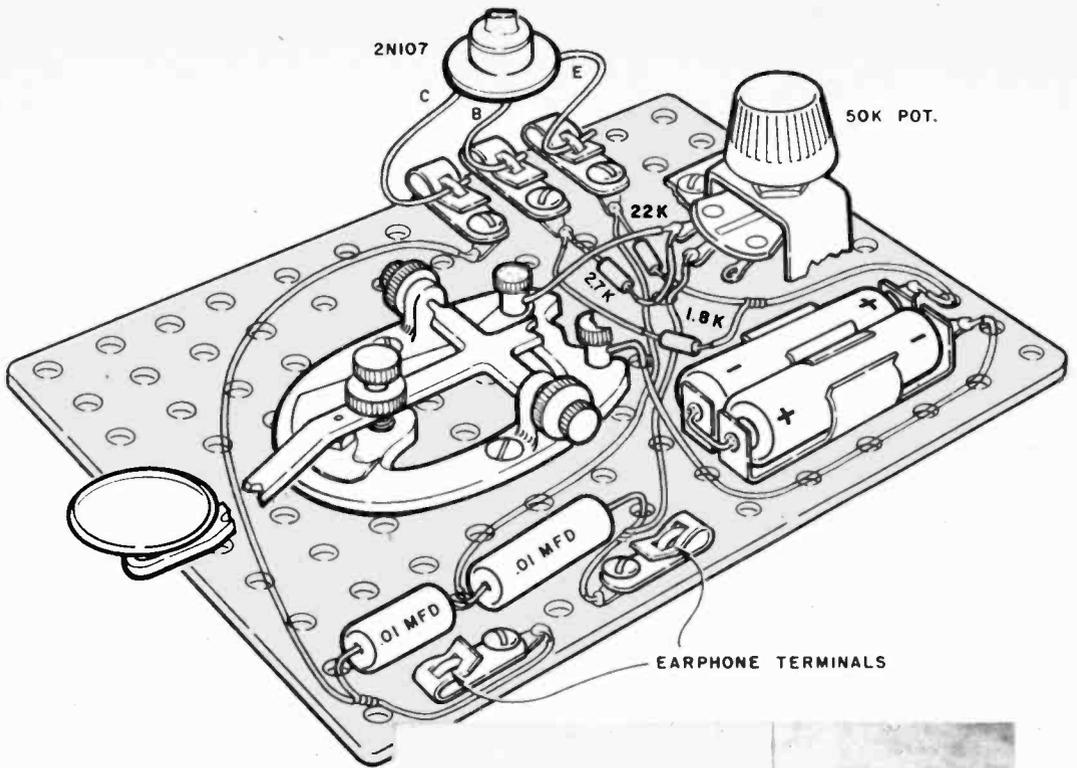
Double dash -----

End of message -----

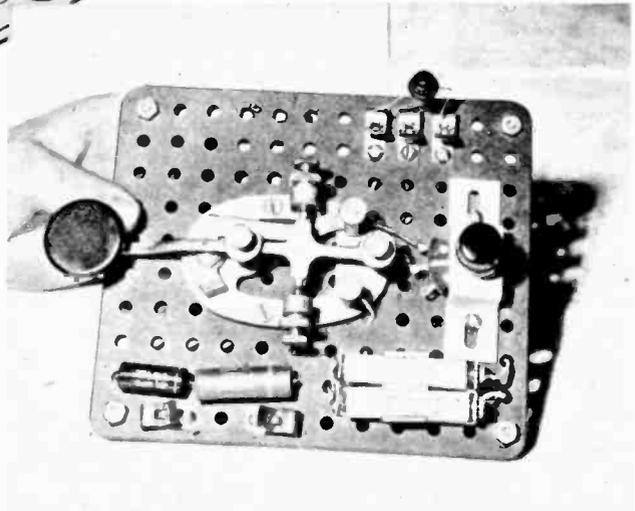
Invitation to transmit ---

End of work -----





The pictorial diagram above shows how to wire the oscillator and where to place the various parts. Note the transistor near the top edge of the device in the top view, right.

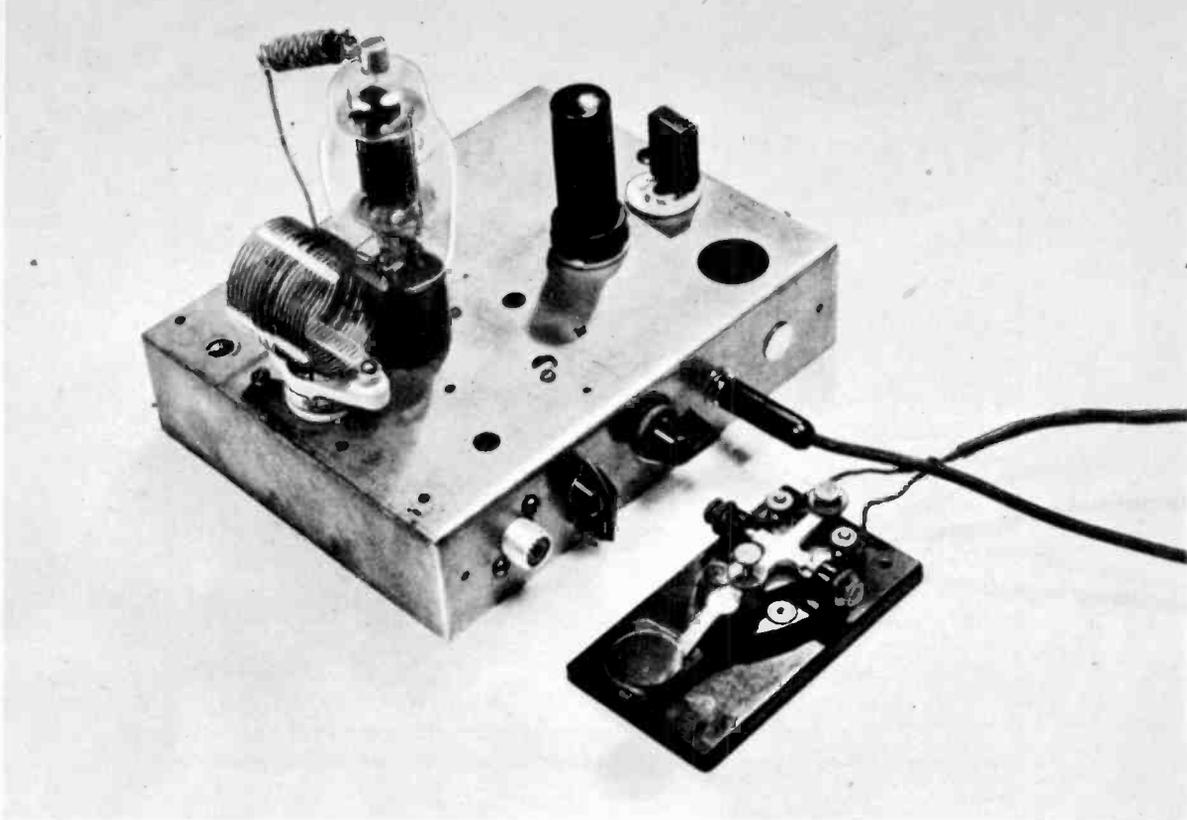


control, key, batteries, transistor and two capacitors are mounted on the top of the masonite board. The resistors and other wiring are on the underside. Note that the transistor is not soldered into the circuit. It is held by three fahnestock clips and can be easily removed and used for other experiments. A small bracket to support the pot can be made from a scrap piece of tin or brass. Solder all connections except the transistor leads.

Assembly time should be about one hour.

Attach a pair of the earphones to the two earphone clips and adjust the potentiometer for the most pleasant tone to your ears as you close the key.

It is advisable to practice the code with another person. Use two sets of earphones connected in parallel to the phone clips. The more you practice the easier it will be to pass your code examination. •



The complete transmitter contains two tubes and requires only a simple power supply.

# A First Transmitter for the Novice

*By Joseph Warren*

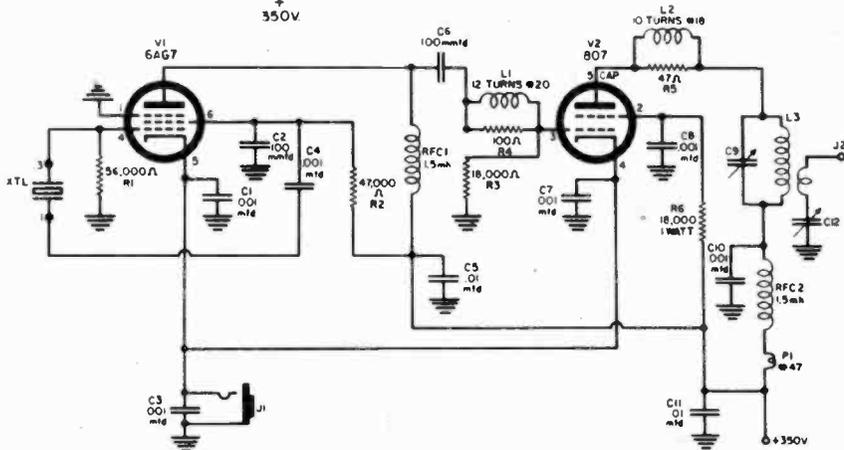
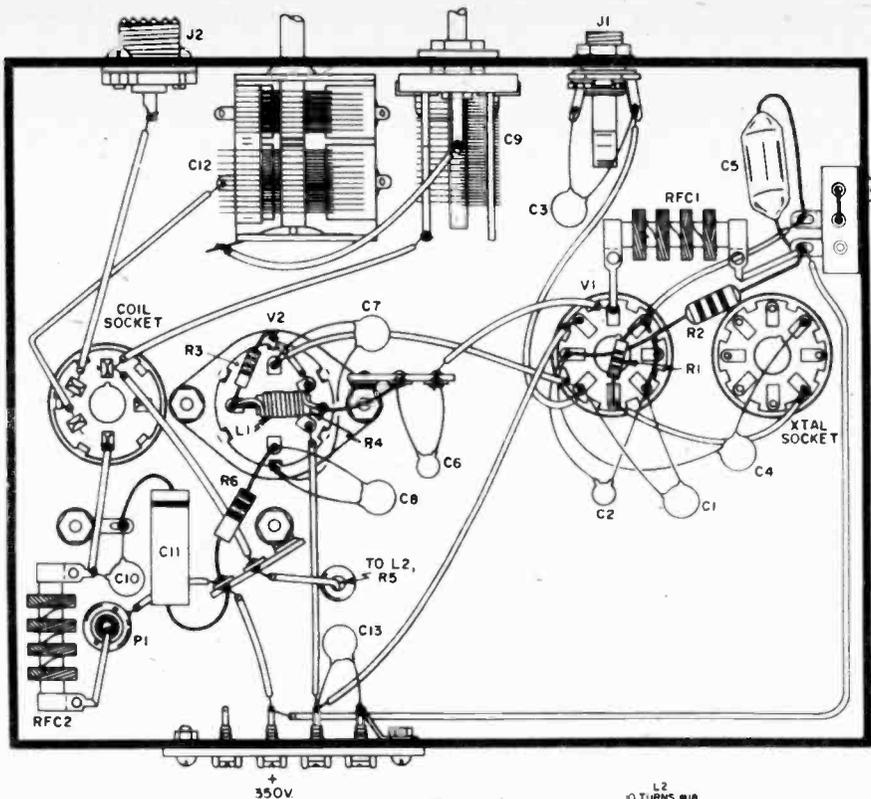
*This 40-meter rig is easy to build, foolproof, and inexpensive. It is also flexible so that advance features may be added later.*

**A** RADIO transmitter designed for the novice's first attempt should be simple, easy to build, foolproof and inexpensive, involving no complicated circuitry or tuning procedures. It must also be adaptable, enabling the builder to add to its serviceability later on as he becomes more familiar with the amateur operation in general and wants to expand his facilities.

Many novice rigs are designed to provide advanced features from the start, such as bandswitching and crystal

switching which are desirable in themselves for the more advanced novice. However, for the beginner who may have very little electronic background and a limited budget, such features may prove cumbersome.

The transmitter described here is designed to avoid complications and to incorporate the desirable features described above. So, if you are a beginner, the fellow who has perhaps never before attempted to build a radio transmitter and has to start from scratch, this



Wiring guide and schematic diagram for transmitter are shown above; parts list is below.

**Capacitors:**

- C1, C3, C4, C7, C8, C10—.001 mfd. ceramic disc
- C2, C6—100 mmfd. ceramic disc
- C5, C11—.01 mfd. plastic
- C9—75 mmfd. variable air padder
- C12—360 mmfd. broadcast type

**Resistors:**

- R1—56,000 ohms, 1/2 w.
- R2—47,000 ohms, 1/2 w.
- R3—18,000 ohms, 1/2 w.
- R4—100 ohms, 1/2 w., see L1
- R5—47 ohms, 1 w., see L2
- R6—18,000 ohms, 1 w.

**Misc.:**

- L1—12 turns No. 20 enamelled wire wound on R4, in parallel with it.

- L2—10 turns No. 18 enamelled wire wound on R5, in parallel with it.

- L3—B&W # 3111 40 JCL coil for 40 meters or B&W # 3112 80JCL for 80 meters

- RFC1, RFC2—1.5 millihenry r.f. chokes

- V1—6AG7 tube

- V2—807 tube

- XTL—40 or 80 meter novice band crystal

- P1—# 47 pilot lamp

- J1—open circuit phone jack

- J2—coaxial chassis mount connector

- 2 sockets, 5 contact ceramic

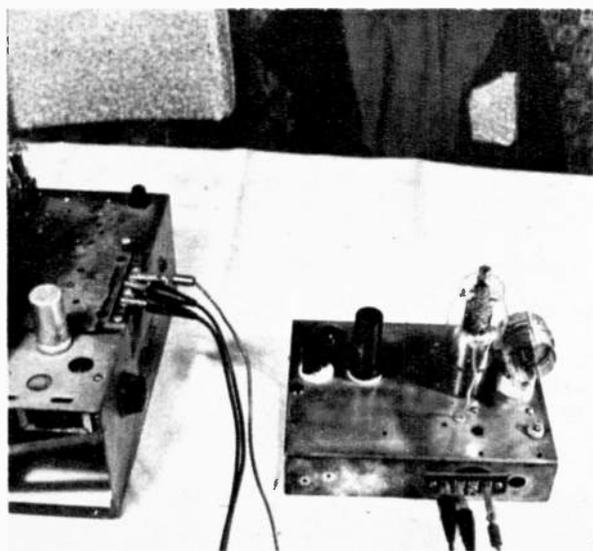
- 2 knobs

- 1 terminal strip

- 2 octal sockets, ceramic

- asst. terminal strips

Power from any handy source (even a table radio) is fed to transmitter by clip leads.



The rig is shown here being used with a key. An audio modulator may be added for voice.



rig is a natural for you. The more advanced novice, too, might well take note for this rig is capable of 60 watts input, it can be easily modulated, it can be used with a VFO and it can be easily converted for bandswitching. It may also be kept in readiness as a standby auxiliary rig in case of failure of your present rig, or it can be used as a driver or exciter, for a high power final amplifier.

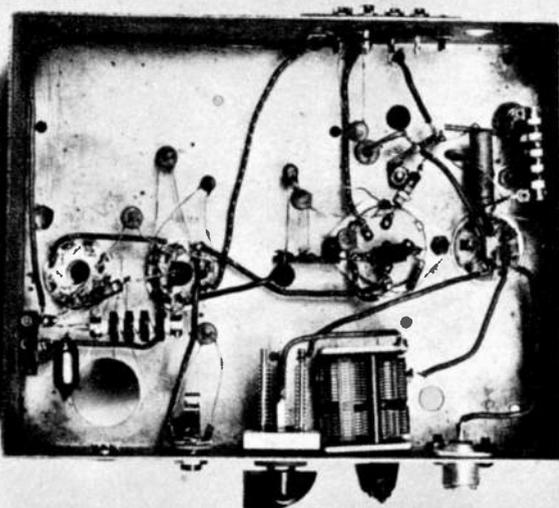
The forty meter band was chosen as the preferred novice band after consideration of the following factors. First of all, medium to long range DX is available most all year round on this band and high power is not a prerequisite. Next, TVI—the bugbear of many an oldtimer, is not as difficult to eliminate as it is on the 15 meter band. Antenna space requirements are the third consideration, a forty meter wire should be just about half as long as an 80 meter wire and can easily fit in the average-backyard. The output circuit is designed to feed a center-fed 40 meter dipole antenna via a length of 50 or 72 ohm transmission line. The antenna should be about 67 feet long overall.

If 80 meter operation is desired it is only necessary to change the output coil (see parts list). Be sure you are

using an 80 meter crystal and, of course, an 80 meter antenna—137 feet overall, fed at the center. For forty meter operation either an 80 or 40 meter crystal may be used. The 6AG7 provides adequate drive for operation of the 807 final on either band.

The 807 was chosen for the final amplifier tube because it is easily obtainable, inexpensive and will operate satisfactorily over a wide range of plate voltages. For economy's sake, power can be supplied from an old receiver or a utility supply and any voltage ranging from 250 to 600 DC will suffice. It is advisable to use a DC milliammeter in series with the power supply when tuning the rig, especially if over 400 volts DC is used for the plate supply. If desired, the meter could be mounted on the chassis of either the transmitter or the power supply. If the meter is mounted on the transmitter it should be connected in place of the resonance indicator *PK*. The filaments require 6.3 volts, readily available from almost any power supply chassis.

The 6AG7-crystal oscillator is designed to provide stable operation without any necessity for adjustment. With any crystal of average activity and stability this circuit will prove to be



Underchassis view of transmitter. To help the reader follow the wiring, the components' long leads were left on. These are shortened in wiring.

thoroughly reliable. An octal socket is used as the crystal socket for three reasons. First, the operating crystal can be mounted in the operating position, holes 1 & 3. Second, a spare crystal can be mounted and stored in holes 5 & 7, ready for instant use when the occasion arises and you want to pick a different operating frequency. The third purpose of the octal socket is to provide a convenient means of connecting a VFO later on (holes 3 & 8), after the General class license has been won.

The output circuit is the standard link-coupled type and is straight forward in operation. Band changing is accomplished as explained before. Note that the power supply must be turned off before changing the coil in order to avoid shock. Both the 807 plate cap and the 807 coil carry the DC plate voltage on them whether the key is closed or open.

The telegraph key, through its jack, keys both the oscillator and final amplifier cathodes and no difficulty should be encountered with key clicks or chirps if the schematic diagram is followed and any layout similar to that shown in the accompanying photographs is used. The entire rig is quite adequately bypassed and it is recommended that all the by-

pass condensers shown in the schematic be used. Another very important component, sometimes sacrificed, is the parasitic suppressor *R4-L1* in the 807 grid circuit. *This item is a must.* Remember, don't cut costs. All the parts are necessary, and each has its own definite function. One more thing—all power supply leads should be bypassed at the point where they leave the transmitter chassis.

To operate the transmitter, first connect the power supply leads, B+ for the plates, 6 volts for the filaments, and ground. Place a crystal in the crystal socket (holes 1 & 3) and insert the key plug in the key jack. A DC milliammeter range 0-200 ma., should be placed in series with the B+ lead from the power supply, but if none is available use the resonance indicator lamp *P1* to indicate resonance. Turn on the power supply and wait about a minute for the filaments to warm up. After this interval, depress the code key and immediately adjust *C9* for minimum deflection of the meter, or a decrease in brightness of *P1*. Now connect a length of transmission line to the coaxial connector, and connect a 40 watt light bulb to the other end of the coaxial line. Once again de-

[Continued on page 98]

# Small Rectifier— Big Current

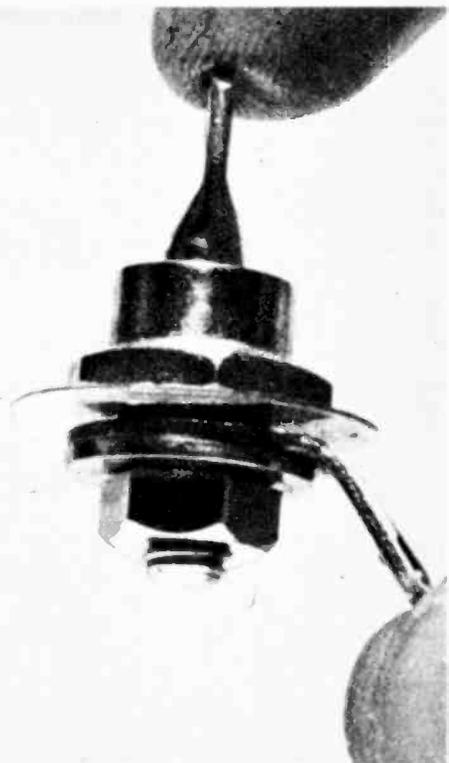
By Robert Hertzberg

*One of the most important developments of recent times is this silicon rectifier which operates at 300 degree temperatures*

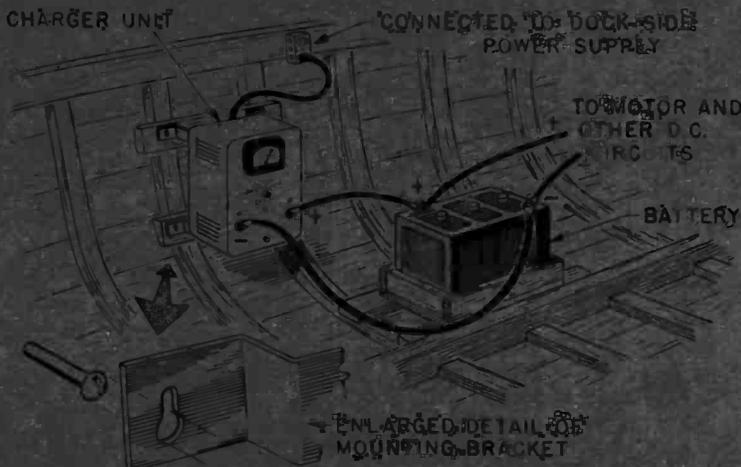
**H**IGH current-handling capacity, very small size, good heat resistance and sealed construction are features of the silicon rectifier that make it one of the important electronic developments of recent times. Used in very simple circuits, a rectifier equivalent in size to a  $\frac{5}{16}$ - $1\frac{1}{4}$ -inch bolt can handle up to 20 amperes at 6 volts or 10 amperes at 12 volts, *continuously*; or 50% more intermittently. Other types of dry-disc rectifiers capable of doing the same job are actually scores of times larger and much less efficient.

Any device carrying 20 amperes is bound to get warm. The silicon diode does too, but it is designed to operate safely at temperatures slightly in excess of 300 degrees Fahrenheit. In practice this temperature is never encountered, unless the equipment is burning up for some other reason!

The sealed construction makes the silicon rectifier especially suitable for marine devices, which are normally exposed to considerable moisture. Salt water spray is particularly wicked, as



The bolt-like device shown above is the new type silicon rectifier, able to handle 20 amperes. The illustration is larger than full size. This rectifier mounts in tight spots.



any tidewater sailor knows only too well.

The Heath people have put this rectifier to work in a new "Marine Converter and Battery Charger" kit, which is of interest to any boat or car owner who is concerned with keeping storage batteries in top condition. This is a very rugged, heavy-duty appliance. It consists of a step-down power transformer having moisture- and fungus-proof insulation, a 1N248A silicon rectifier, a control switch, and a 0-25 ampere meter to show the charging rate.

The transformer has two 6-volt secondaries, which are connected in parallel for 6-volt service and in series for 12-volt service. Changeover from one type of operation to the other is a matter of shifting two small wire links on a terminal board on the chassis. The transformer's primary is tapped, to provide three-step adjustment of the charging rate. It is also fused as protection against overloads or accidental shorting of the output wires.

The assembly of the parts to the chassis and the front panel takes only about 20 minutes. The wiring, as the schematic diagram indicates, is very simple, and takes another half hour. The completed unit measures 9½ by 8 by 5½ inches overall and weighs 12 pounds. The back of the case is fitted with slotted feet to permit the charger to be mounted vertically on a bulkhead or a garage wall.

For marine applications this "con-

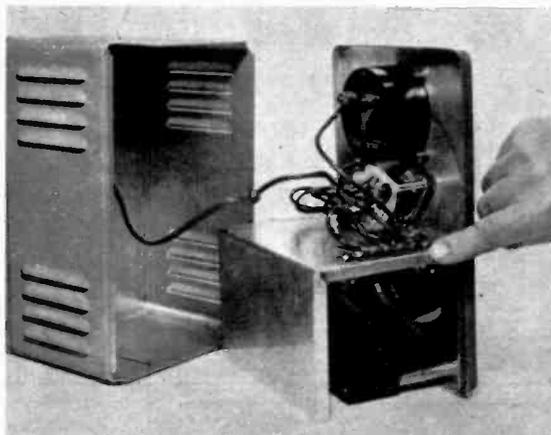
verting" can be used only when a boat is tied up to a dock having nearby AC power outlets. To facilitate connection to the latter, the unit is provided with a 15-foot line cord instead of the usual 6-foot length.

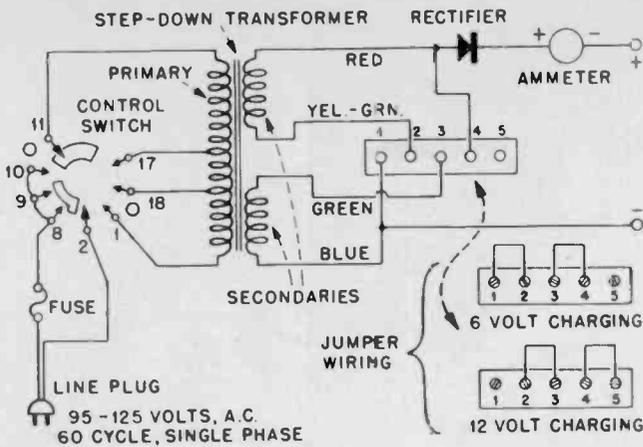
Two days after I finished the sample charger shown in the accompanying pictures, the battery in my car went dead because I inadvertently had left the radio going overnight. I hooked the charger up, cranked the output to the

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Chassis view of Heath Model MC-1 charger. The power transformer is below subchassis.





Wiring of charger is shown here. Secondaries are jumped in parallel for 6-volts, in series for 12-volts on terminal board.

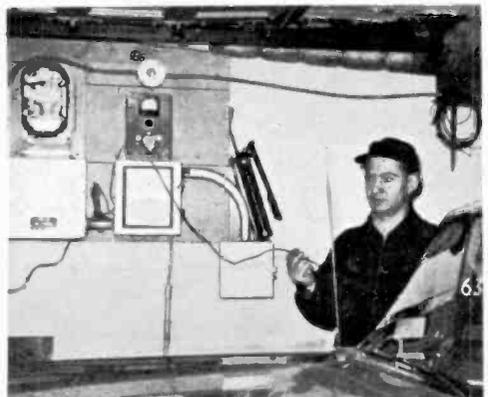
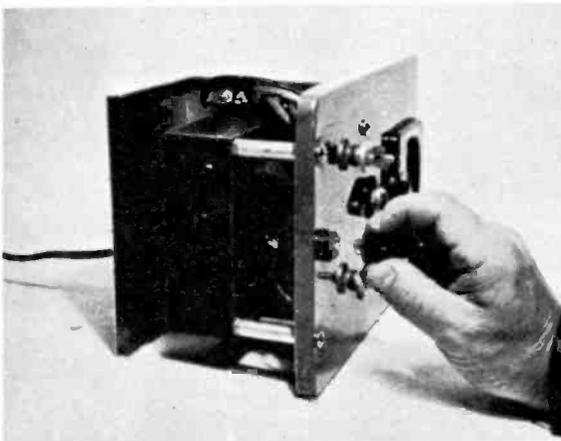
Identify output voltages by putting a sticker on the panel between the output binding posts.

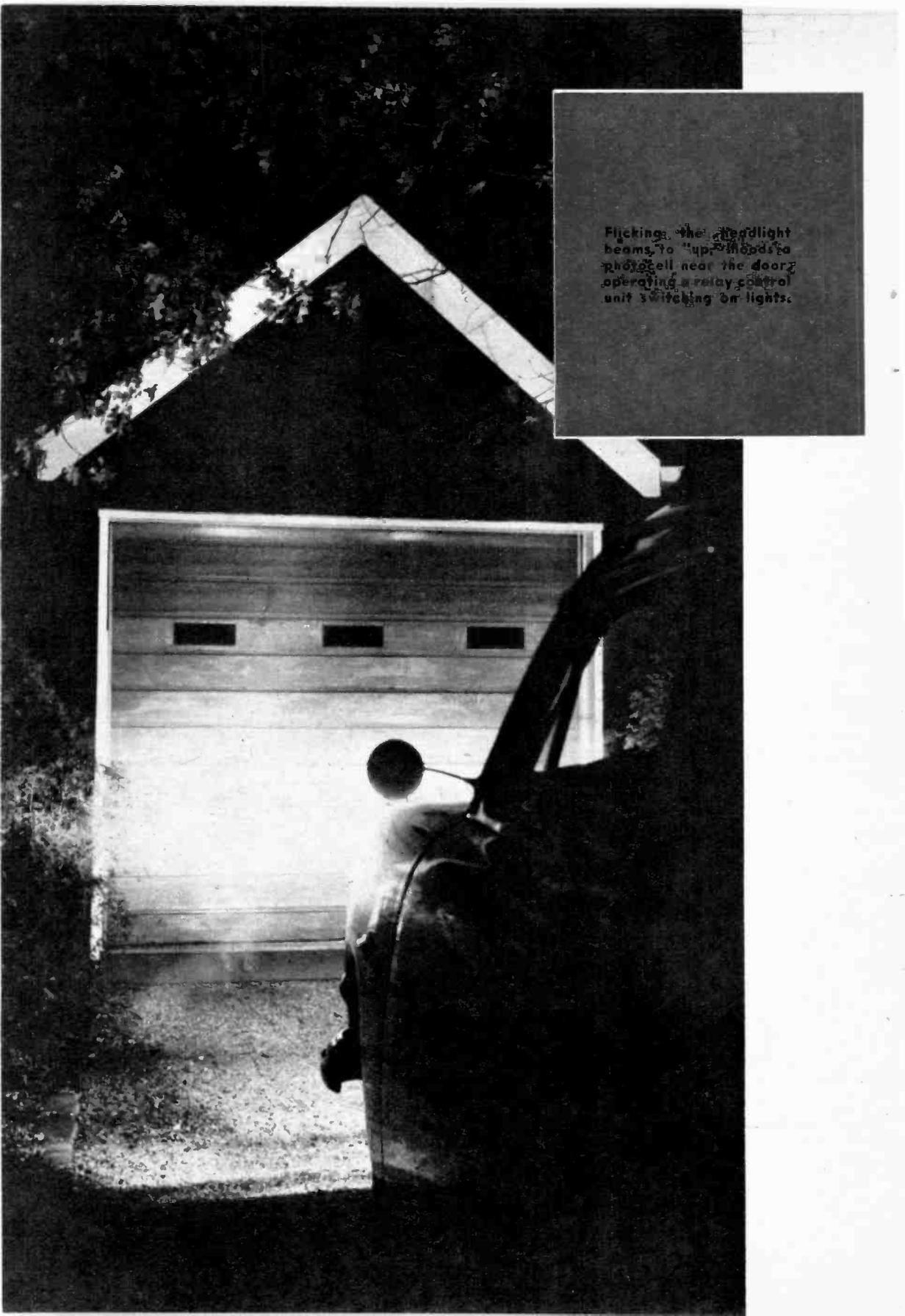
maximum of 10 amperes (for a 12-volt battery), and let it run. Five hours later the battery had recuperated sufficiently to kick the engine over. I have installed the charger in a place of honor on the garage wall and have fitted the output wires with a plug that fits the cigarette lighter. Any time the temperature goes below freezing, I give the battery an overnight "trickle" charge of a couple of amps, and in the morning it responds with vim and vigor! •

Heavy power transformer mounts to front panel by four studs. Fuse is easy to replace.



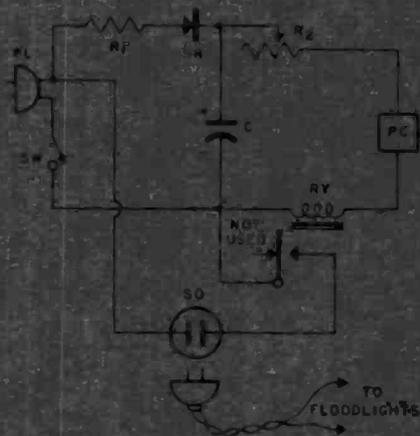
In typical garage, charger mounts conveniently on wall near power, as shown below.





Flicking the headlight  
beams to "up" leads to  
photo cell near the door,  
operating a relay control  
unit switching on lights.

# Driveway Floodlight Control



By Harvey Pollack

**Light up your driveway, garage—without getting out of your car!**

**M**ORE than ever before, the family automobile is now a "His and Hers" vehicle. Modern automatic transmissions have placed the wheel into the hands of the ladies and do they love it! But ask your wife or daughter what scares her most about driving and chances are she will answer, "Pulling into the garage alone when I come home after dark."

Here's your opportunity to kill two of those proverbial birds with one stone. Build this simple photoelectric automatic driveway floodlight control. Not only will you make late homecomings safe for the women of your house but you can prove to them once and for all that electronics works for them as well as for you!

The design of this interesting project is based upon an extremely sensitive cadmium sulfide photocell of vastly improved performance. This cell is so responsive to light of even low intensity, that it can operate a sturdy, inexpensive relay with no amplification of any kind. The absence of vacuum tubes and transistors in the circuit reduces the initial expenditure for parts substantially and makes the control unit extremely easy to assemble in a night or two.

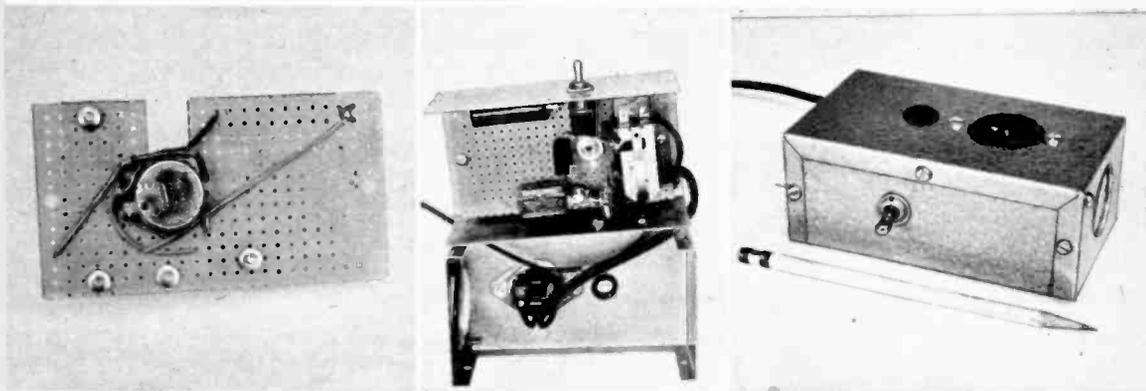
The sequence of "operations" goes something like this: when the car is taken out for the evening, the driver

turns the system on by throwing the switch on the control unit. The little box containing the photocell is mounted within easy reach, sheltered from rain or snow but located in such a manner that your car's headlight beam can reach the photocell when you approach the driveway. Thus, as the car enters the driveway, the light from the headlamp beams reaches the cadmium sulfide cell through the aperture at the front of the case, triggers the relay which in turn turns on the floodlight. For extremely sensitive response, a 49¢ magnifying glass is used as an intensifying lens. With this lens in place, the relay will be triggered at distances up to 100 feet. If your driveway is shorter, or if you want to limit the range of operation to 50 feet or so, the lens may be omitted.

The relay contacts are rated at a maximum of 5 amperes, which means that you can use up to 500 watts of floodlighting without fear of damaging the contacts provided that the auxiliary wiring is heavy enough for the job.

## How It Operates

Alternating current from the AC lines is converted into direct current by the circuit comprising R1, SR, C, and SW. The selenium rectifier SR produces pulsating DC; capacitor C smooths out much of this pulsation to



Various views of the complete control unit are shown above. At the left is the underside of the bakelite panel with the sensitivity control; the rectangular notch is for the switch. The other side of the bakelite and the components mounted on it are shown in the center photo. The complete unit, closed, is on the right.

#### PARTS LIST

##### Electrical

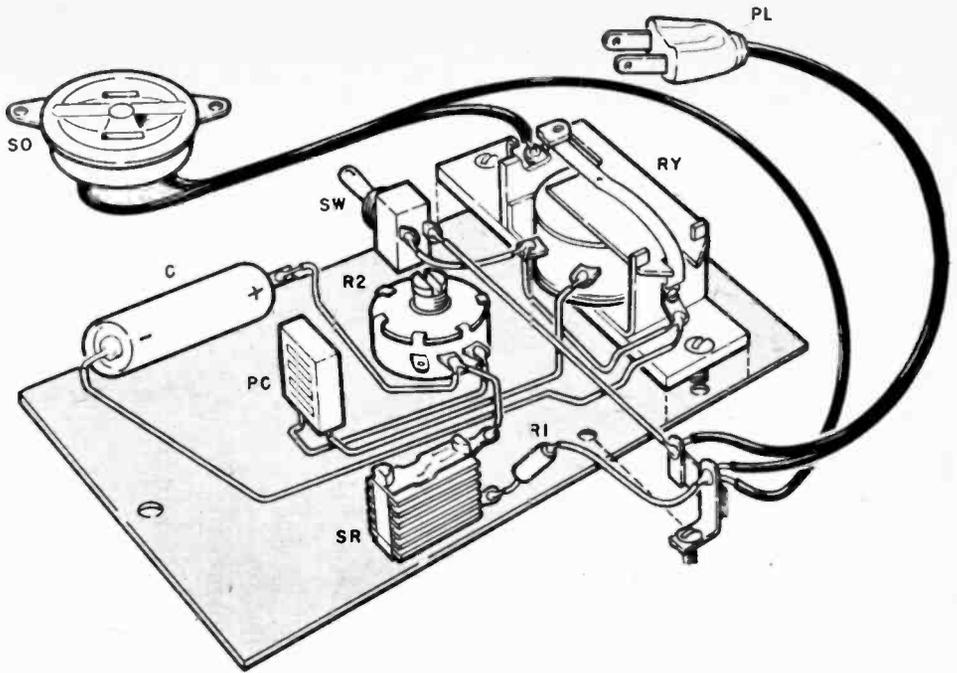
- C - Capacitor, electrolytic, 20 mfd @ 150 volts.
- PC - Photocell, cadmium sulfide, Hupp Manufacturing Co.; type CDS-10 (available from Lafayette Radio Corp., 165-08 Liberty Ave., Jamaica, N. Y. Listed as CDS-10 Powermaster).
- PL - AC line cord and plug.
- R1 - 37 ohms, 1/2 watt resistor.
- R2 - Potentiometer, 25K ohms linear taper, small size.
- RY - Relay, 10,000 ohm coil, spst, 5 ampere contacts such as Potter and Brumfield type LB-5.
- SO - Receptacle, chassis-mounting type, for standard AC plug.
- SW - Switch, spst toggle, bat-handled type.
- SR - Selenium rectifier, 120 volt, 75 ma rating.

##### Mechanical and Optical

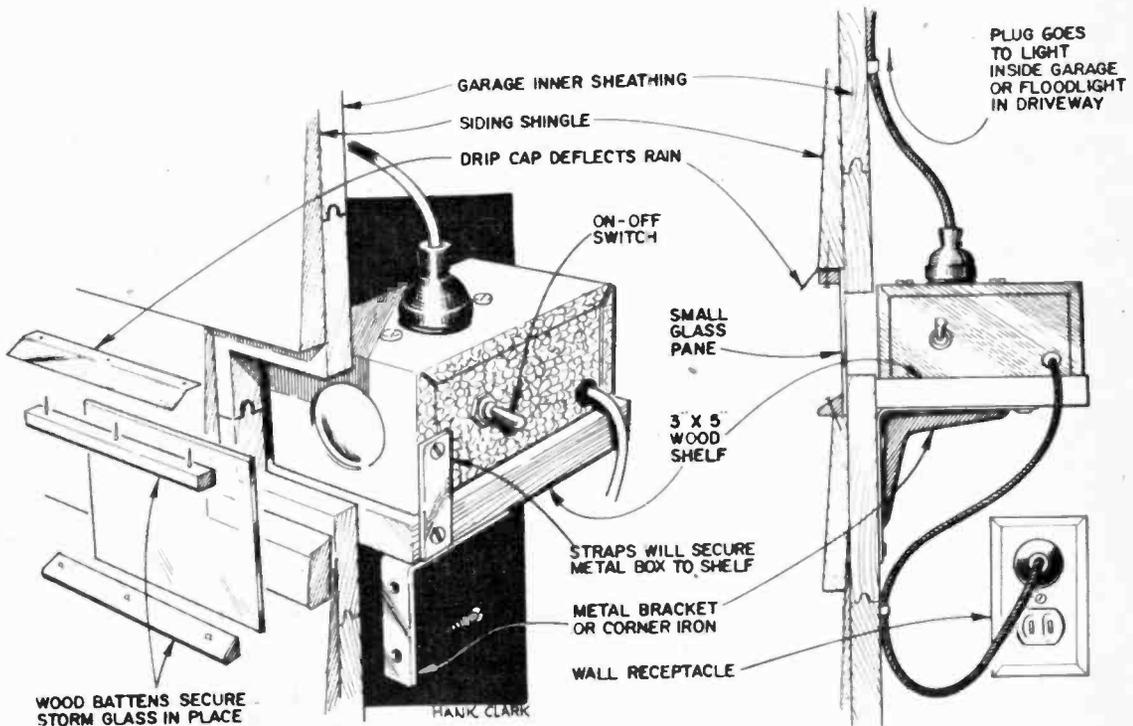
- CABINET - aluminum, grey hammertone miniature case, 5 1/4" x 3" x 2 1/8".
- BAKELITE, PERFORATED - One sheet, 3 1/8" x 6 3/4", 1/16" thick.
- LENS - Focal length 3 1/2", diameter 1 1/4". Lens used in this model is Lafayette =F-46 and sells for 49c.
- SPACERS - BRASS, 1/2" in length to pass 4-46 screw, 2 required.
- MISCELLANEOUS - Hardware, hookup wire, solder, etc.

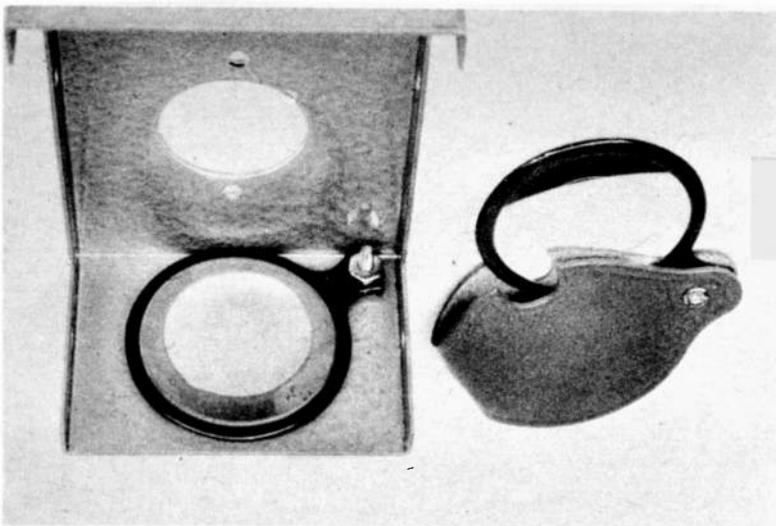
yield more-or-less pure DC at its terminals. Resistor R1 is a surge resistor that prevents damage to the rectifier when SW is first turned on and capacitor C charges. Without R1, the capacitor would take an initial surge of current that might be large enough to overheat the rectifier.

PC is a photo-resistive cell whose resistance is very high when there is little illumination on its sensitive surface (well over a megohm). Light causes the resistance of PC to drop substantially. In the high resistance condition, the current through the series circuit consisting of R2, PC, and the relay RY is too small to pull down the relay armature. As the resistance of PC drops due to incident light, the relay current rises and the armature drops in, closing the contacts and feeding line voltage to the output receptacle SO.

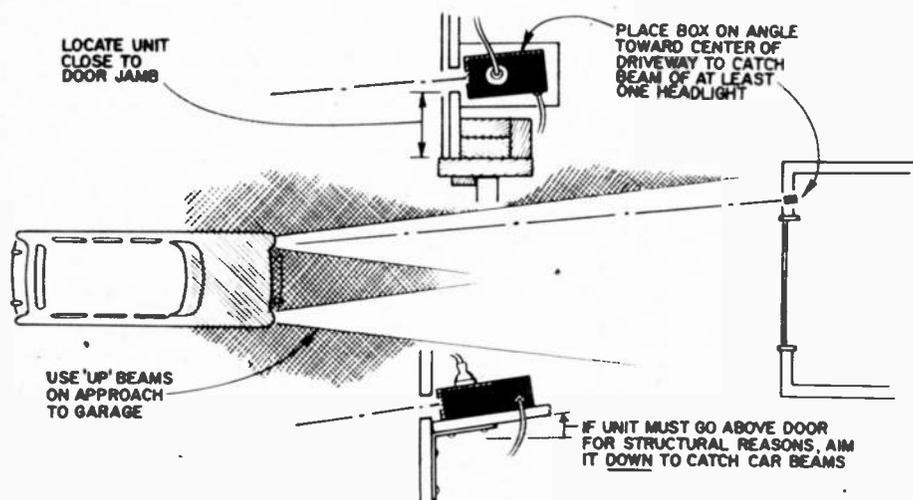


Follow the pictorial diagram shown above to avoid mistakes in wiring, use parts specified. The control box is secured to the inside of the garage wall, facing out, as shown below.





The lens is sold with a leather cover secured to the lens handle by a rivet. Cut the rivet off with a saw, etc., and use the hole in the handle for mounting the lens. The control unit may be mounted at the side or above the garage door as shown below. Make sure to angle the unit so it "sees" car headlights.



### Construction

All the components of the Floodlighter, except for the On-Off switch and the output power receptacle, are mounted and wired on a piece of perforated bakelite cut to fit into the lower section of the miniature case. This thin, sheet phenolic may be cut very easily with an ordinary pair of metal shears. The perforated sheet is held away from the bottom of the case by means of two 1/2-inch brass spacers through which two 4-36 machine screws are passed. The spacers are just long enough to permit the potentiometer to clear the case; the latter is mounted underneath the perforated sheet so that its short shaft projects above the bakelite and can be

reached through a hole in the top of the cabinet.

The placement of the parts is critical in only one respect: the cadmium sulfide photocell should be mounted on the bakelite sub-chassis so that its sensitive face (glass window) is 2 3/8 inches back from the front or aperture side of the case, just in the event that you decide to use a lens. At this distance, the easily available lens described in the parts list focuses an excellent concentration of light on the photocell. Even if no lens is used the photocell should be placed far behind the aperture to minimize the chance of light other than that from the headlamps reaching the sensitive element.

[Continued on page 108]

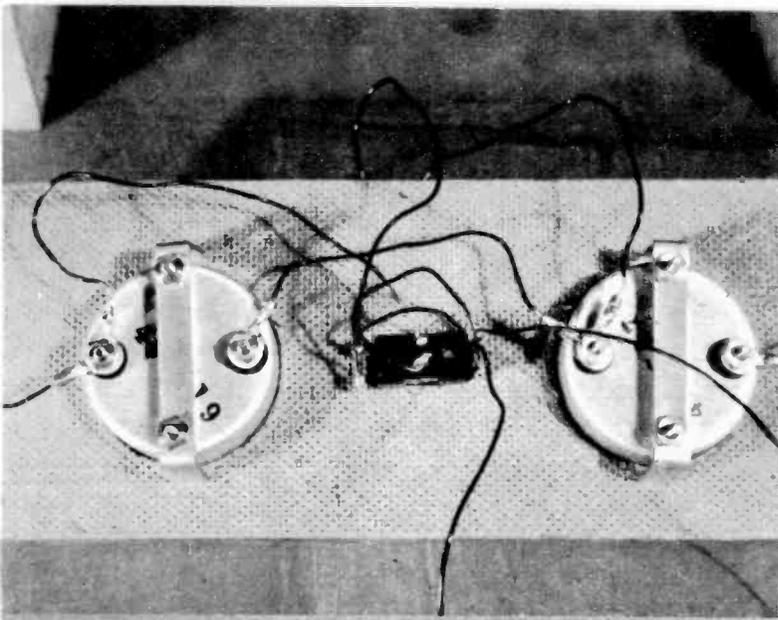


Complete new DC power supply for new model trains of HO type is shown above. Old AC transformer from larger model train set is basis of the power pack. Meters are useful accessory, not needed for successful operation.

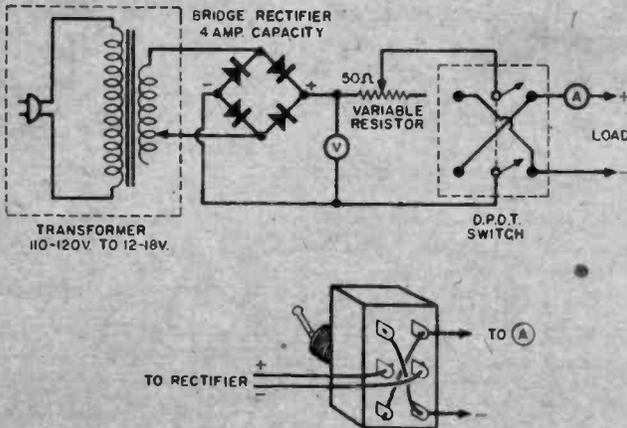
## A Power Pack for HO Trains

**Use your old transformer plus few parts for new DC supply.**

**O**NE of the biggest problems the model railroad fan faces is that of room—living room, bedroom or playroom, you name it, and it's too small. Too small, that is, for the conventional O and S gauge systems which are scaled at one-quarter and three-sixteenths of an inch to the foot respectively. All of us who started with these sizes at one time or another have found that any sort of track layout beyond a simple oval or figure eight forced the family to move out of the room. And reluctantly, most of us put these trains away, to be pulled out only at Christmas time to amuse the children. But some fans have discovered HO, a



Rear view of meter panel showing how meters and reversing switch are mounted and wired on Masonite panel board.



Schematic diagram shows how to wire up power pack. "V" is voltmeter, "A" is ammeter, both are optional. Details of wiring switch are also shown at left.

relatively new railroad system scaled 3.5 mm to the foot, a far more workable size, since it is slightly more than half that of the O gauge.

With HO, large track systems can be laid out on a simple four by seven piece of plywood, which can be hinged to the wall or suspended from the ceiling by pulleys, allowing the complete works to be put away in a matter of moments. Unfortunately, although HO is generally less expensive than the larger sizes, many hesitate to buy them because of the previous investment in larger trains. However, by building a power pack yourself, you can save anywhere from \$8 to \$15 or \$20. The commercial

packs run anywhere from \$10 to \$30, but if you have a transformer which came with the larger trains, you can build your pack for a minimum of cash.

The power pack is a simple project. Since the HO trains use tiny, powerful, direct current motors compared to the alternating current jobs in larger trains, we must supply our new system with DC. The trains draw about eight-tenths to one ampere at about 12 volts, and fortunately the transformers supplied with most of the O and S gauge systems have a working AC voltage of 12 to 18 volts.

If you have no transformer, you can buy used models of the proper size at many hobby shops. It would be advis-

able to buy one with a built-in circuit breaker, which is a must for the power supply. Most transformers built in the past five years which have a rating of above 50 watts, have such safety features. The cost shouldn't be more than \$3 to \$5 tops, although if you're interested in a really high-powered job at a reasonable price, you may find a 150-watt model, new, selling at about \$8.50.

The secret to getting direct current out of a transformer is to use a selenium rectifier. The current rating of a rectifier is for continuous output, but normally in HO use it wouldn't be called upon for steady high current. Mostly it will work at well below its rated capacity, with short stretches of full load. The selenium rectifier can stand high-current overloads for short periods—say two or three minutes—providing it's allowed to cool down afterward. You can take advantage of this to buy a smaller rectifier than you'd normally consider. Since one train draws about one ampere or slightly less, you could consider using a rectifier rated at about an amp and costing about \$5 but this may be uneconomical for you, since you would have to change later if you add trains. For the purposes of this project, the author used a Sarkes-Tarzian rated at 4 amps. It costs about \$10.

Normally, we might consider filtering the output with a 1000 mfd. capacitor to obtain smooth current, but in the case of HO equipment, that's just what we don't want. It's a fact that these small trains start easier if they're subjected to the pulses of unfiltered current.

Commercial power packs are generally controlled by a rheostat to supply the needs of the engine, but since we already have a built-in means of control in our transformer, we can bypass that expense. However, it might be a good idea to insert a variable resistor—much cheaper than a rheostat—in the line if the output of your power pack is high.

It may be advantageous to use a voltmeter and an ammeter in the circuit to allow for precise control, and to eliminate the possibility of overload. These Shurite models are very inexpensive—about \$2 each—and should be purchased with a 0-5 DC ampere scale for the ammeter and, say, 0-25 DC volts for

the full-scale reading of the voltmeter.

There is only one other control necessary before we start building. Most, if not all, HO engines have no reverse relay. Therefore, if we put a double pole, double throw switch in the line, we can reverse polarity—and the train—at the flick of the switch.

The author found it simple to use a small board rather than a metal chassis, simply because of price. You can use a chassis if you wish, but by using a board to mount the parts, it is extremely simple to cut openings for the meters and the switch in a narrow length of Masonite or other composition material. This assembly can then be fastened to two pieces of one inch board cut at a slant, at the far end of the chassis. The transformer can be mounted at the front of the board, and the rectifier next to it. Put the resistor somewhere between to make wiring easy.

One point: Don't fasten down your control panel until it is completely wired and checked out, or it will be difficult to get at. It would be best to use spade lugs for connection to the meters and the transformer, for firm seating. One other thing you may wish to do, which the author didn't. You can add an on-off light to the panel—a 110-volt miniature bulb wired in parallel to the primary of the transformer will do. That, however, is incidental.

The power pack is now ready to go into operation. Check all connections; see that there aren't any shorts. Make sure the rectifier gets plenty of air, so there'll be no overheating, then turn it on. Put a load across it. (A couple of alligator clamps attached to the output wires are perfect for attaching to the track terminals, by the way.) The train motor will check out at about eight or ten ohms, so a resistor of that size, at 15 watts, should be used as a test load.

Without such a load, your voltmeter should read about 10 to 14 volts, and the ammeter will barely budge. With the load, the voltmeter will drop down to, say, six or eight volts, and the ammeter will skip up to a half or eight-tenths of an amp. If you find your output more than this, adjust your variable resistor (more resistance) until you get readings of the above nature. •

# The ABC's of Electronics

by Donald Hoefler

*This dynamic new force touches the lives of all in our jobs, our recreation, our homes, in medicine, in defense.*

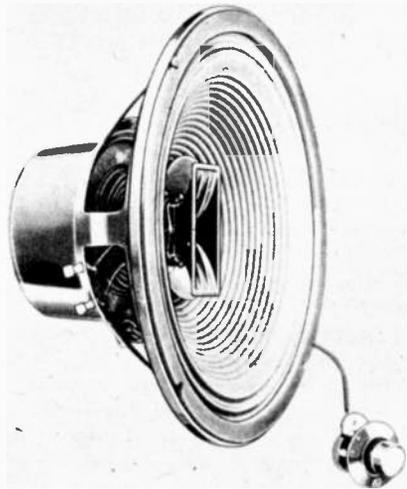
**W**HAT is electronics? This question is asked hundreds of times each day, and yet electronics engineers and scientists themselves are still grappling with the problem of answering it. The vastness of this rapidly-growing art is so great that a description which was accurate yesterday may be out of date tomorrow.

For electronics is a science serving all of the other sciences, and most of the arts as well. Unlike other modern discoveries, such as atomic and nuclear energy, or jet and rocket propulsion, electronics affects each one of us in hundreds of ways every single day.

It is the telephone through which we hear from a friend or call the doctor. It is the radio we listen to and the television we watch. It is the eyes of the pilot, both on the sea and in the air, when no human eye can see.

It is the remote control for our model airplanes, or full-scale drone planes, or guided missiles, or a farmer's tractor. It opens garage doors, operates drinking fountains, turns on street lights at sundown, and tunes up cars.

It is medical radiology, diathermy and physiotherapy, and the unseen net around our continent protecting us against military attack. It is an automatic bread wrapper, a radio telescope, a color matcher for cans of paint. It is phonograph records and



sound movies and a super-human mathematical wizard. And this doesn't begin to tell the story.

What is electronics, did we ask? What, indeed, *isn't* it?

It is staggering to realize that electronics, this huge factor in our daily lives, depends upon man's knowledge of the electron, the *tiniest* known particle of matter.

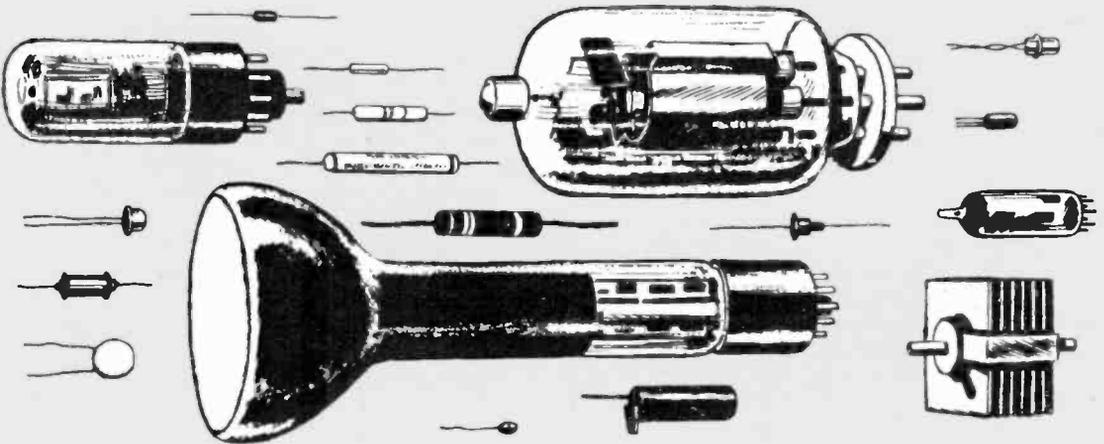
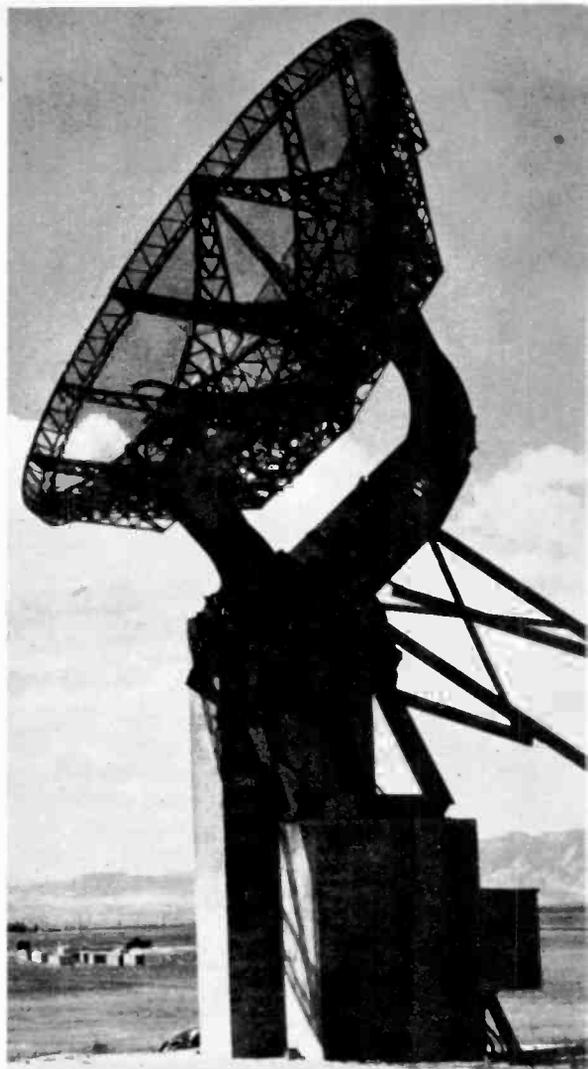
At one time we could have said that an electronic device was one using a vacuum tube, so familiar in radio sets, but this is no longer true. Many electron tubes now contain gasses instead of a vacuum, and the transistor is no tube at all. The magnetic amplifier in fact uses neither tubes nor transistors. Yet all of these are electronic devices.

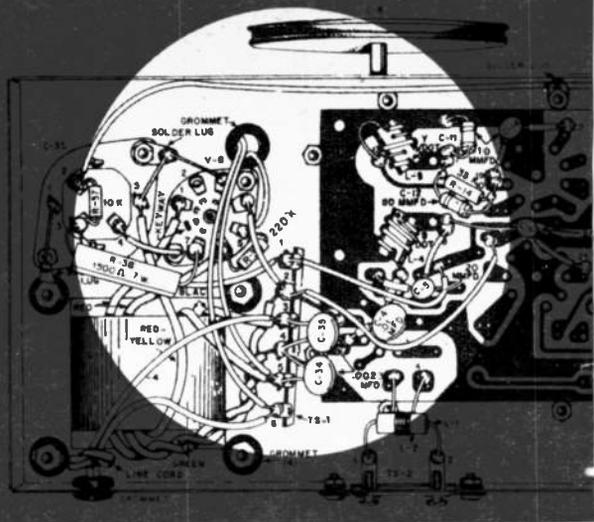
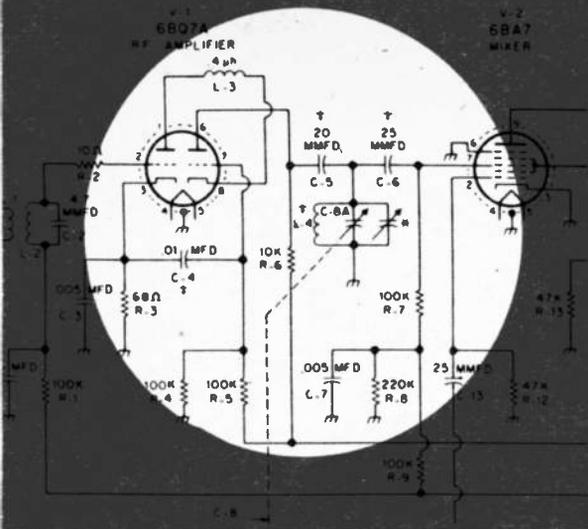
Electronics was once confined to very small electrical currents, but now it is being used more and more in the field of electric power, not only for control systems, but for the actual generation of the power itself.

No, this wonderful world of electronics is revolving too fast for any of us to say precisely what it is. The best we can do is tell what it does and how it does it.

### Electronic Circuits

Every electronic device comprises one





On the left is shown a schematic diagram, the specialized blueprint used by the electronic engineer or technician for a particular circuit or piece of equipment. Each part of this diagram symbolizes a component such as those shown in the wiring diagram on the right.

or more *circuits*, the heart of which is usually a tube or transistor. The complete circuit also has other electrical components, such as coils, condensers, resistors and connecting wire. Thus the electronic circuit can be roughly compared to a mechanical system in which the tube represents a motor and the other components act as the belts, chains pulleys, gears and shafts.

Not long ago engineers used to go through a mental "shifting of gears," thinking of an electronic circuit in terms of an equivalent mechanical system, in order to understand its operation. For example, it was common to compare the flow of current in a wire with the movement of water through a pipe.

This practice led to some bad guesses, however, and only a few unreconstructed old-timers still hold to it. Electronic advances have been so rapid, furthermore, that now it's more common to find the mechanical engineer using electronic concepts in analyzing his systems.

The ties between electronics and mechanics are still strong, however. One of the fundamental ideas in practical electronics is the varying voltage which stands for some changing physical value. Sound becomes an electrical voltage, for example, through the medium of the microphone. Light is converted into electricity by a photocell or video

camera. Even changing temperatures can result in varying voltages.

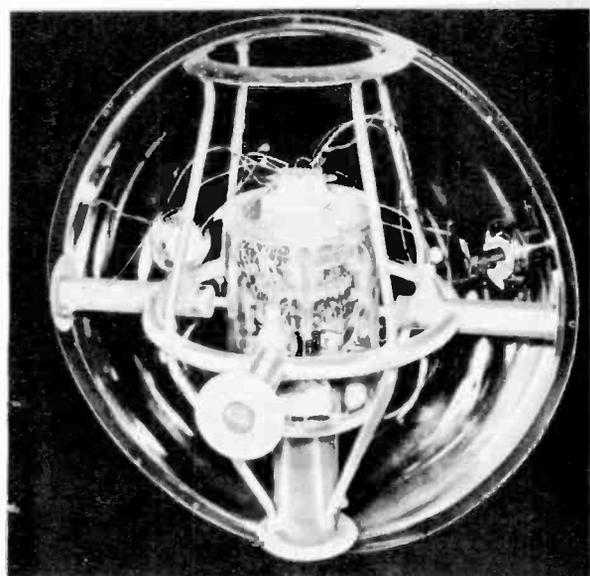
### Electronic Signals

Electrical voltages of this type are called *signals*, and the device that generates them after stimulation by an outside source is known as a *transducer*. In addition to the microphone and tv camera, other transducers include the phono pickup and tape reproducer.

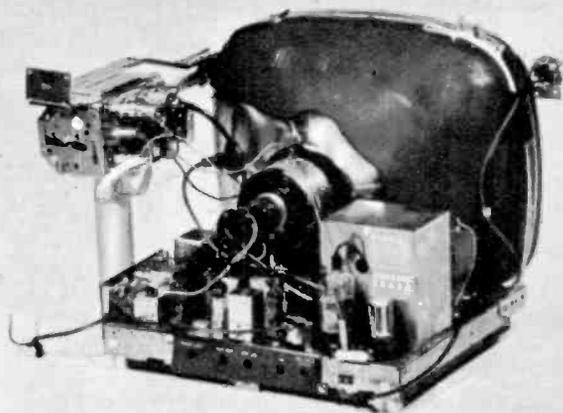
It will be noted that all of these appear at the *input* of the electronic circuit. That is, they convert some other physical quantity into a signal which is then fed into the electronic circuit. Another family of devices which is equally important is the *output* transducers. These have the job of converting the electronic signals back into physical form, either the same as or different from the original. Examples in this group are tv picture tubes, loudspeakers, meters and various types of recorders.

All of the signal movement we have discussed so far is of the *closed-circuit* variety. The signal, that is, has remained at all times confined within the circuits of the electronic devices. But this doesn't have to be so, for there is a way in which these signals can escape the bounds of electronic circuitry and shoot out in every direction in space.

For this to happen, the electronic sig-



Transparent model of the U. S. satellite. The core consists of several round printed circuit boards for data transmission.



Internal view of new Zenith portable TV. Most of components are on the horizontal "chassis," no larger than the picture tube.

nals must be converted again, this time into electromagnetic waves. This conversion, as well as the reconversion from electromagnetic waves back into electronic signals, is the basis of radio, television and radar. The transducers in this case are transmitters, antennas and receivers. But the wondrous thing is that between the transmitting and receiving antennas, even though they may be miles apart, there need be absolutely nothing but empty space.

### Electronic Communication

One important branch of electronics, then, is communications. Its purpose is to send intelligence or information of some sort from place to place: a telephone call, TV show, police call or instructions from an airport control tower. In every case the information is converted into an electronic signal by a transducer such as a telegraph key, microphone, TV camera or teletypewriter.

The signal is then carried by wire line, radio waves, or both. Depending on the nature of the signals, electronic communication is called telegraphy, telephony, television or telemetry. The first three are quite familiar, but the fourth, the baby of the family, is still showing off its great potential.

Telemetry is also known as data transmission, which means the sending  
[Continued on page 96]



Electron microscopes are being produced in smaller and smaller versions for more rapid utilization for fighting disease.

# Careers in Electronics

By Harry Kursh

**Electronics will control the age of space—  
learn it, and great opportunities will be yours!**

**A** COUPLE of years after World War II, three young Boeing Aircraft engineers—Martin K. Lilleberg, Howard H. Suskin, and Louis P. Hanson—were trying to develop some control devices for the new Stratocruiser. Something besides ordinary electrical and mechanical devices was needed. They decided to take a crack at electronic controls.

Within a year, encouraged by Boeing Aircraft, they started gathering after working hours in the basement of Louis Hanson's home and it wasn't long before they saw the handwriting on the wall—electronic control was the key to their futures. In 1948 they formed a corporation, United Control Corp. of Seattle, and borrowed \$2,000 to start producing electronic temperature control units for aircraft windshields. But it remained strictly a sparetime business until one by one they left their jobs at Boeing, and by 1950 all were working fulltime for their own company, United Control.

The cynics said they were nuts. It seemed that way, too. Their total sales in 1950 went to \$47,000, not much to split three ways. Today, the three sole stockholders of United Control can afford to have the last laugh. They employ a staff of more than 600 and their last year's sales figures were zipping along at a \$10,000,000-a-year clip.

Unusual? Not at all. The story of United Control and its three young engineers is typical of the entire electronics industry. At the time these three were starting out, electronics was still a strange word associated mostly with radio, television, radar and screwy gadgets to open garage doors.

Since that time electronics has blazed its way from 40th on the list of American businesses to the fifth largest industry in the nation. From only a handful of companies in electronics, there are

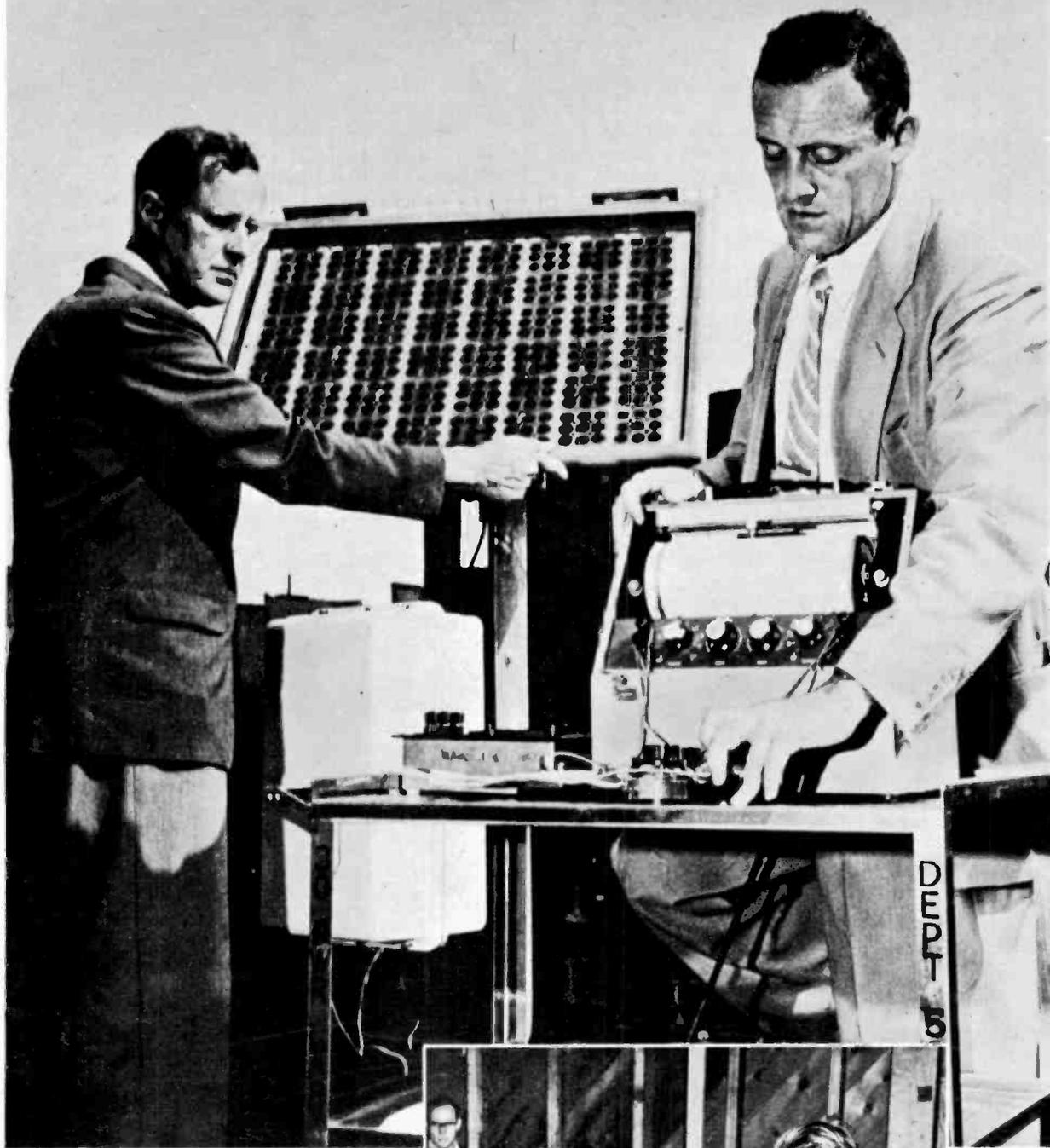
now 4,000. From sales totaling only a few hundred million dollars, the annual take for the industry already exceeds eight billion dollars—and this does not include the radio and television industry. While the three bosses of United Control were carving themselves a chunk of the booming pie, employment in the industry, says the Bureau of Labor Statistics, doubled.

Yet this is only the beginning. Thanks to the transistor, the printed circuit, and the mushrooming needs of defense, research, science, and industry, experts everywhere are predicting that electronics will vie only with aircraft and automobiles for first place in the economic spotlight.

Says one of the nation's leading business voices, *Business Week*: "In the United States today, a handful of industries has an inherent growth capacity greater than the economy as a whole: electronics, chemicals, oil, power supply, possibly some of the rare metals. Of these, the brightest is electronics."

Once again the handwriting is on the wall. For whom? For the 1,200,000 young Americans to be graduated from high school this year. For the 190,000 getting set to pick up college degrees. For the countless thousands of employed Americans who'd give anything to switch their jobs or find new careers. For those restless and hardy souls who want to build quick fortunes in business or invention.

It would take a veritable encyclopedia to catalog the scores of occupations and opportunities opening up in electronics. Even now there is scarcely a business or industry that is not or will not be affected by electronics, ranging from the two-by-four TV service station to the miracles of automation, rockets, missiles, and nuclear energy. Electronics has begun to revolutionize



Above, two engineers make tests on the Bell Telephone Labs. sun battery, the first successful device to convert the sun's energy directly and efficiently into electricity. Right, service technician repairing a two-way radio of type used in trucks, cars, other vehicles.



chemistry, and it has already established a solid beachhead in medicine. As Dr. C. Guy Suits, vice-president and research director of General Electric puts it: "In the next decade we will be completely saturated with electronics."

Everyone knows this calls for more engineering brains. But it will also call for a wide variety of skills, from the technician who has been trained on the job, to the junior engineer or sub-professional with only a year or two of technical school education behind him.

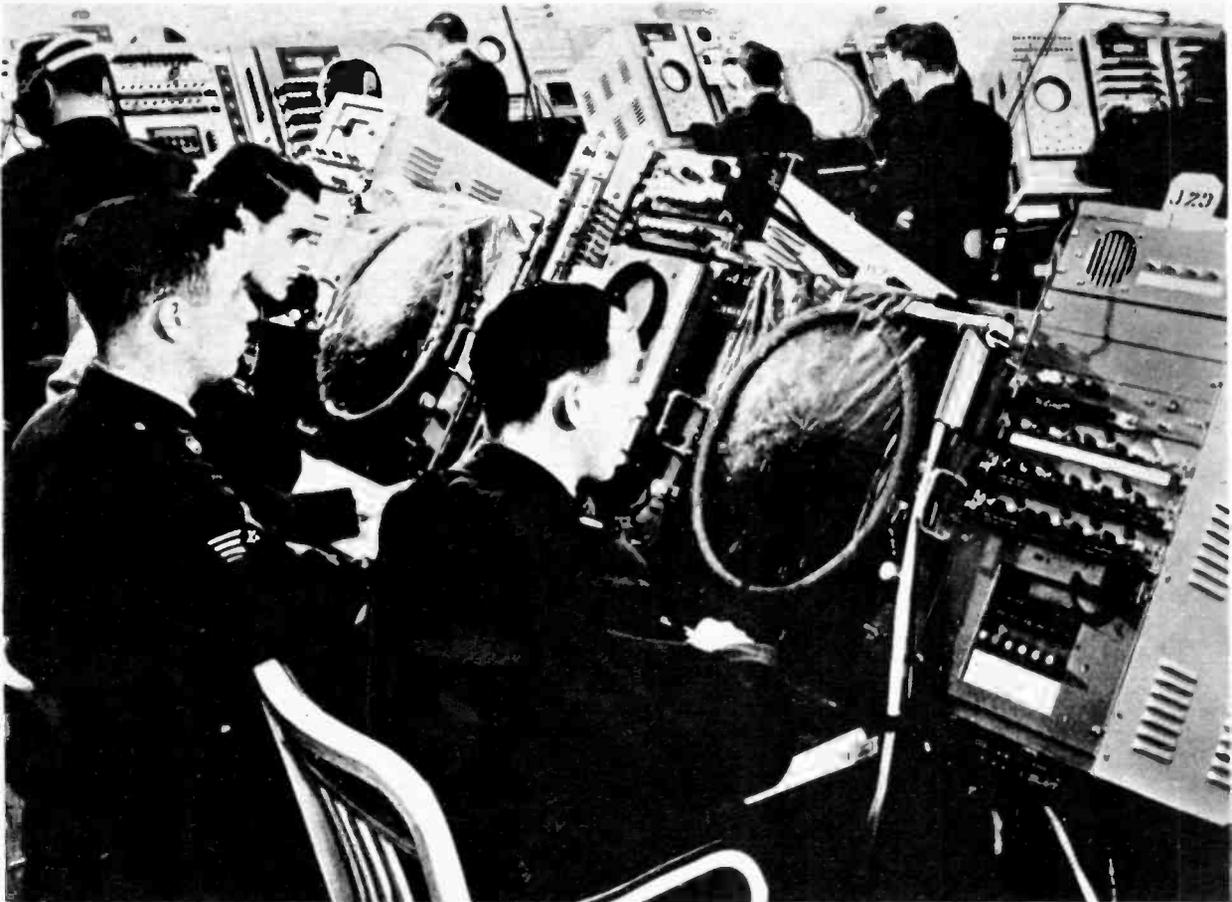
How can you hop on the gravy train and ride electronics to a brighter future?

Let's face it. You'll need more than just inspiration. You'll need specific advice on training and qualifications and where and how to look for the job you want. You'll want to know something

about present-day wages, future earning potentials, working conditions, chances for advancement, and chances for self-employment. Forthcoming issues of **ELECTRONICS ILLUSTRATED** will delve into all these details, to bring you a step-by-step, blow-by-blow account for a career in just about every occupation imaginable in electronics.

Meanwhile, if you've been nudged up to the starting line, don't just sit back and wait for someone to blow the whistle. Start investigating the whole picture, the background and the future. See where you fit in now or may fit in for the future. Let's consider this point by point:

1. *Look for specific vocational guidance.* This means check into the opportunities in your hometown area, and





U. S. Air Force technicians observe radar scopes of the early warning air defense system of the continental U. S. in the photo on the facing page. On the left, a complete community or factory television broadcasting unit is shown being operated by one man.

get a fresh look at your own aptitudes. Your best source of information is your local state employment service. There are more than 1,800 such offices scattered throughout the 48 states, and most of them have free professional guidance-counseling and aptitude-testing services. You can also receive advice and assistance by writing to the *American Personnel and Guidance Association*, 1534 O St., NW, Washington, D. C.

2. *Look into trade and industrial education courses.* Many communities today are providing free or low-cost training designed to help produce more trained technicians and sub-professionals. You can get detailed information from your own state supervisor of industrial education. There's one in every state. If you don't happen to know where to write in your own state—or perhaps in some other state that may interest you—write to the *U.S. Office of Education, Division of Vocational Education, Washington 25, D. C.*, and ask for the list of “supervisors of trade and industrial education by states.”

3. *Check on-the-job training opportunities.* Some fourteen percent of the nation's work force consists of skilled workers and technicians. But there aren't enough to go around now, and there won't be enough in the foreseeable future. Heavy unemployment, if any, in

the future will be largely among unskilled and untrained workers. These are the conclusions of recent studies published by the U.S. Department of Labor. And because of this many companies today have launched their own on-the-job training programs. It's earn-while-you-learn. A number of major corporations are even paying their on-the-job trainees to go to outside technical schools and colleges in order to develop them into junior and professional engineers, with comparable pay. Once again your best overall source of information for on-the-job training programs is your own state employment service. If you have trouble locating the information you want, write to the *U.S. Department of Labor, Bureau of Employment Security, Washington 25, D. C.*

4. *Investigate apprenticeship opportunities.* The electronics industry has yet to develop a widespread system of recognized apprenticeship training, which is considered the best means of developing top-notch craftsmen. But a number of apprenticeable skills in other industries fit into electronics, and the idea of setting up apprenticeships in electronics itself is catching on. For guidance along these lines, write to the *U.S. Bureau of Apprenticeship and Training, Office of Information, Washington 25, D. C.*

5. *Can't go to school? Can't leave your job? How about correspondence school courses?* The list of successful correspondence-school graduates in the electronics industry would fill a library shelf. Some of the most famous men in the business possess nothing more in the way of education than a correspondence school diploma. For information about accredited schools or courses in electronics, write to the *National Home Study Council, 1420 New York Ave., NW, Washington, D. C.* You may also obtain a free list of home-study schools by mailing a request to *ELECTRONICS ILLUSTRATED, 67 West 44th Street, N.Y. 36, N.Y.*

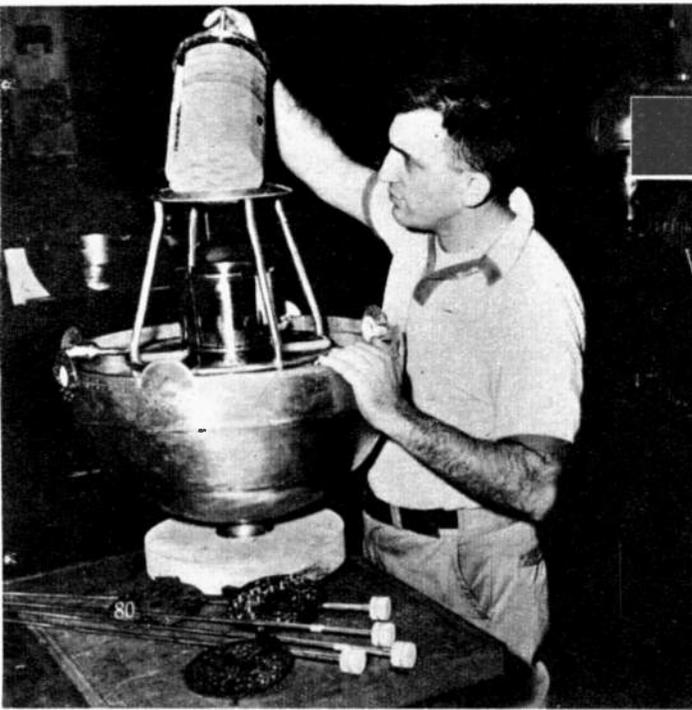
6. *Read all you can about the business outlook and career opportunities in electronics.* You can obtain some of the best and most accurate information at low cost directly from Uncle Sam's own reports, booklets and pamphlets. Here's how: Write to the *U.S. Government Printing Office, Division of Public Documents, Washington 25, D. C.*, and ask for "price lists on occupations and careers." This will tell you exactly what is available, and the price. You order accordingly. Also have your local librarian show you the way to the shelves containing publications on vocational information.

7. *Opportunities in government service.* Three major branches of the armed forces—Army, Navy and Air Force—

employ tens of thousands of skilled men and technicians. Many have been trained directly on government payrolls. This is especially true in the field of electronics. It is estimated that half the electronics output of the nation today goes to the armed forces. Most of these training opportunities are announced through Civil Service bulletins. Watch for these at post offices, state employment offices, and Civil Service field offices. As a matter of fact, if there happens to be a Civil Service field office near you it would be a good idea to drop in and look around and have a chat with any of the officials there. Look in the telephone book under "United States Government" to locate the nearest field office, or write to the *U.S. Civil Service Commission, Washington 25, D. C.*

If you want to know more about civilian employment and electronics training opportunities in the armed forces, write to the *U.S. Department of Defense, Pentagon, Washington, D. C.* But make your information request specific, that is, ask for *civilian employment* opportunities with either the Army, Navy, or Air Force, so that your letter will get sent around to the proper office without delay.

Remember, this is only the beginning for electronics, and perhaps for you. Future issues of *ELECTRONICS ILLUSTRATED* will show you which way is up, step-by-step. •



The electronic circuits responsible for the gathering and coding of space information obtained by the Vanguard satellite are contained in the cylindrical unit shown being lowered into the satellite. This unit consists of printed circuits of the type on the table. Antenna elements are also shown in the foreground on the table.

# Movie Camera With Electronic Brain



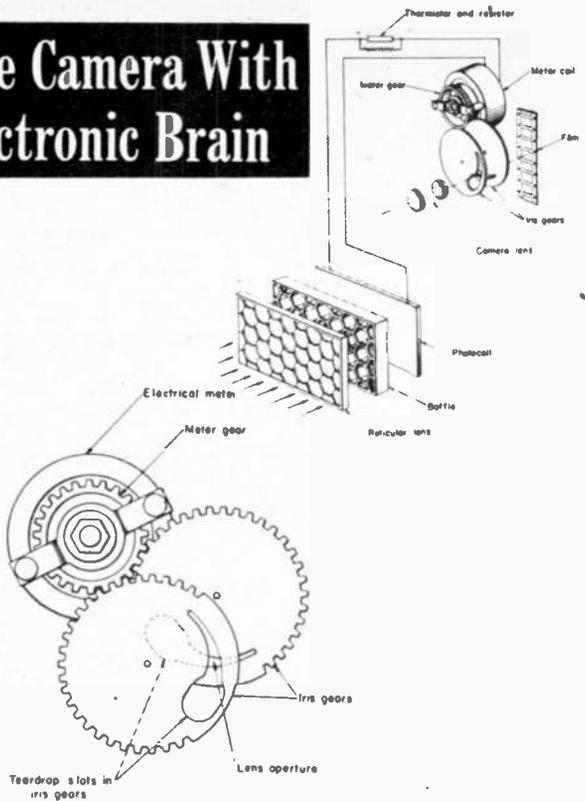
*Light-operated photocell adjusts lens automatically*

THE energy from solar or light rays has been harnessed to set the lens of a new automatic 8mm movie camera introduced recently by Bell & Howell Company. The new camera is the first in the world in which light energy alone supplies the power to generate the electric current which adjusts the lens. No batteries, motors or springs are used for the exposure setting. The movie maker winds the camera, sights and shoots. The electric eye, which adjusts to changing light faster than the human eye, sets the lens for proper exposure before the starting button is touched. It can operate the lens through its full range of stops from  $f/1.9$  to  $f/16$  in less than one second.

The automatic control is intended primarily for color film having an ASA speed rating of 10 or 16. A slide under the photocell adjusts the mechanism for either value. Black and white film, which is generally much faster than color, can be used if a knob above the lens is turned from "Auto" to "Manual"; the lens must then be adjusted in the conventional manner.

No focusing is necessary and the camera can be used with indoor or outdoor color film. This means that without knowing what an  $f$ /stop is, the movie novice can now be sure of properly exposed film every time, a result not consistently achieved by experts. He can also follow a subject from light to shadow, confident that the electric eye is accurately computing the light changes and automatically adjusting the lens. With an ordinary camera he would have to interrupt shooting to change the exposure setting.

An amber exposure beacon in the camera's viewfinder glows as long as the available illumination is adequate. It turns black to signal



that there is insufficient light for movie making.

Like the human eye, which continually adapts to the brightness of its surroundings, the electric eye works continuously as long as light reaches the photocell. It "rests" only in darkness or when there is insufficient light for movie making. It never wears out or weakens under normal conditions.

To make feasible the design approach of the electric eye, Bell & Howell engineers developed a new type of lens iris so sensitive that it moves at the touch of a human hair. Yet it is sturdy and shockproof and has withstood the most vigorous environmental and field tests.

Light reflected from the subject enters a reticular honeycomb lens which controls the angular coverage to match that of the camera lens. Upon reaching the photocell, the light generates an electric current which is fed to the meter mechanism. The meter computes the correct exposure and opens or closes the lens as required.

The use of a thermistor in the circuit compensates for temperature variations. The photocell generates more current at low temperatures, less at high temperatures. The thermistor has high resistance to current when cold, low resistance when warm. Thus at low temperatures the thermistor "slows down" the increased current from the photocell. At high temperatures the thermistor takes the current from the cell and gives it an easier path to the meter mechanism.

Linked to the control mechanism is a needle pointer which moves back and forth along a visible scale, indicating the opening at which the lens is set. The scale is marked in  $f$ /stops of 1.9, 2.8, 4, 5.6, 8, 11 and 16. •

# Transistor tester

**Check that transistor or crystal diode before you discard it!**

**Here's how to use a typical tester to pick out the good ones.**

**O**UT of the laboratory and into practical use the transistor has come full tilt. Its progress has been so rapid that many technicians and experimenters have been caught by surprise. A transistorized set goes bad. Where does one begin his service procedure? As with a vacuum-tube set, the obvious start is with a check of the transistors. Transistor testers comparable to the ordinary tube checker are widely available. No technician, serviceman and experimenter should be without one.

It will indicate leakage and current gain for all types of both P-N-P and N-P-N transistors: junction, point-contact and surface-barrier. It will also test germanium and silicon diodes, and selenium and copper-oxide rectifiers.

This checker will enable the experimenter to determine quickly the general fact of whether the transistor under test is good or bad, and the specific information concerning its current gain. In the case of diodes and rectifiers, their value depends upon their inherent ability to conduct current in one direction. The transistor-diode checker reads both their forward and reverse currents, and therefore indicates positively whether or not the unit is satisfactory.

Most transistor checkers operate by placing the unit under test into an actual amplifier circuit which has a DC milliammeter acting as the collector load.

In the typical tester shown here, a LEAKAGE-GAIN selector switch determines the function being tested. When testing leakage, the base circuit is open, and the only current indicated by the meter will be the leakage across the base-emitter and base-collector junctions. In the case of a defective unit, this leakage current will be considerable.

When testing for gain, a DC signal is

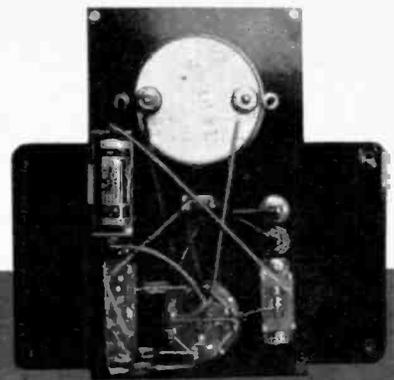
applied to the transistor base element and the meter reads the amplifier collector current. This figure is easily converted into the value of current gain and compared with manufacturers' published data.

Operation of the transistor-diode checker is quite simple. With the power switch off, a junction type or point-contact transistor may be inserted in the socket. (Testing of surface-barrier transistors is identical, except that the 15-volt battery must be replaced with one of 4.5 volts.)

The type selector switch is set to either P-N-P or N-P-N as required. The LEAKAGE-GAIN switch is set for leakage first, the power turned on, and the meter read directly as GOOD, FAIR or POOR. The switch is then turned to whichever of the GAIN positions gives the maximum meter reading without the needle going off scale. There are three such positions, with range multipliers of 20, 50 or 100. This multiple range switch permits readings of up to 300 without throwing the meter off scale.

Then to find the base current amplification, first subtract the LEAKAGE reading from the GAIN reading. Then multiply this difference by the appropriate range multiplier (20, 50, or 100). This is the base current amplification to be compared with the manufacturer's published data for the transistor under test.

In circuits where absolute minimum noise level is important, it is possible to try a batch of the same type transistor, giving them an aural check for noise. A pair of jacks is provided on the tester, into which a pair of crystal headphones may be connected directly, or a pair of sensitive magnetic phones with a 0.05 mfd. condenser in one lead.



Inside view of tester. 15 v. battery is changed to 4½ v. to test surface barrier units.

To test a point contact or junction transistor, plug it into the socket under the meter and find the leakage first and then gain.

Diodes are plugged into the terminals on the left of panel; the switch is thrown from PNP to NPN, allowing meter to indicate crystals forward and back currents.



Diodes and rectifiers are tested by reading the amounts of current they pass in each direction. In one direction the current should be negligible, while in the other it should be about equal to the short-circuit battery current. With the power switch off, test leads from the jacks are connected to the appropriate terminals on the diode or rectifier. Then with the power on and the selector switches set to P-N-P and LEAKAGE, the reverse current is indicated. This

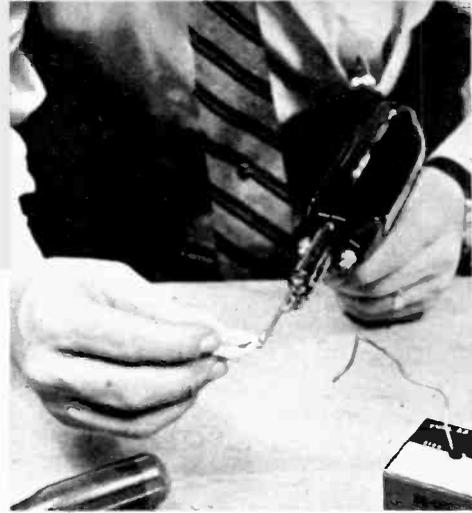
should never exceed 3 subdivisions on the scale. Then the selector switch is turned to N-P-N to read the forward current, which should not be less than 2 milliamperes. In the case of rectifiers, which operate at much higher voltages than that in the checker, a unit which tests OK at this low voltage may not perform satisfactorily at normal working voltage. If the test is NG, however, the suspected rectifier must be replaced. •

Solder with a clean tip! Use a piece of canvas or toweling rag.

# How To Solder

By Art Craig

*Learn to solder as well as the "pro's" and avoid mistakes when assembling kits or making repairs—just follow these instructions.*



**L**OOK at the underside of any radio or amplifier chassis and you will agree that the *solder joint* is about the most important element in the circuit. It is a bond that securely terminates component leads and circuit wiring at strategic points in the mechanical design of the chassis. In the construction of an oscilloscope kit, I recently made no less than 375 solder joints!

Technicians servicing TV, radio or hi-fi equipment have found, after spending much time checking voltages and measuring resistances, that the source of trouble was often a poorly-soldered connection. After spending much time and effort in constructing an electronic kit many a home builder has had to recheck his solder joints to get the unit into operation. This should not be necessary because once the proper techniques of soldering are learned, this part of construction or repair becomes the easiest part of the job.

## What Is Solder

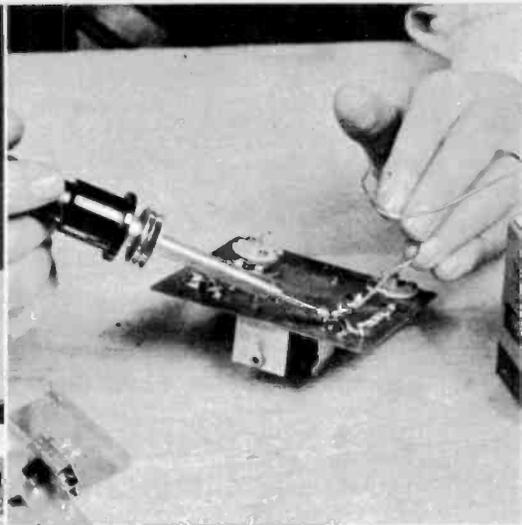
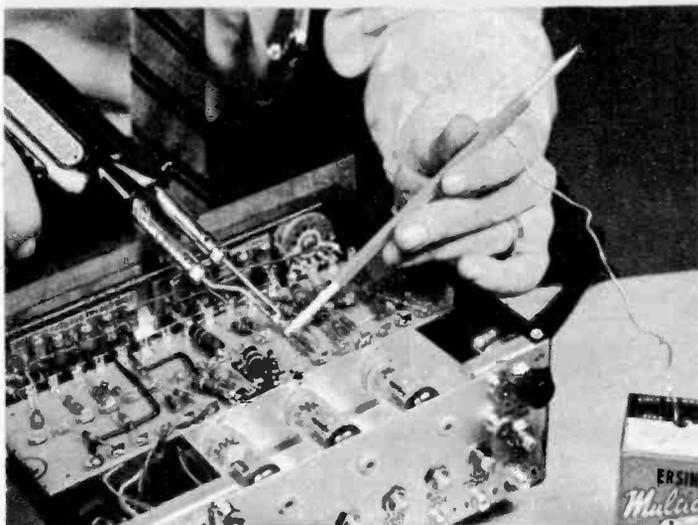
Solder is an alloy of tin and lead that has a melting point much lower than

the metal it bonds. Soft solder as generally used in radio and electronics is available in a variety of gauges (thicknesses) and alloys. The alloy most widely used in radio work is 60/40 (60% pure tin and 40% lead). 60/40 has a lower melting point than 50/50 or 40/60 alloys, and it melts rapidly with the standard soldering irons and guns used today.

In contrast to bar solder and the can of rosin flux of yesterday, modern solder is manufactured in wire form and contains a center core or cores of rosin flux. Most metals (especially copper) tend to oxidize unless they are coated with nickel or tin. And, when heat is applied to a terminal lug, further oxidation tends to form on the lug and the wires or leads connected to it. The purposes of flux are to remove the oxidation, if any, on the leads and terminal lugs and prevent further oxidation during the soldering operation as well as reduce the surface tension of the molten solder as it flows through the joint.

A good grade of solder containing a non-corrosive rosin flux should only be

Remove a component from a wiring board by applying heat to its solder lug, using the notched end of a solder aid to lift the lead (left). For printed wiring use a low wattage iron (right).



used in radio and electronic construction. Never use *acid-core* solder or an *acid flux* for this work! Acid flux will eventually corrode wires or leads in the circuit. More important, it is extremely hazardous to use acid flux when soldering delicate crystal diodes, coils, transformers, etc.

#### What Gauge To Use

Selection of solder gauge should be determined by the work being done. For work on printed circuits use thin gauge solder such as 18 S.W.G. (about  $\frac{1}{16}$ " diameter). Such solder instantly melts on contact with the soldering tip, permitting "touch soldering" to avoid the excessive heat not recommended for printed circuits. In general work, especially where there are large areas at connecting terminals, 16 gauge (about  $\frac{3}{32}$ " diameter) or heavier solder may be used. In all cases, it is a good idea to follow this rule: A thinner gauge in any alloy will melt more rapidly and should be used where small areas must be "touch-soldered" and excessive heat avoided at the terminal.

#### The Soldering Tool

The modern soldering gun is almost standard equipment with the service technician and has gained favor with the home constructor and hobbyist. Of course, when there is a good deal of bench work involved, the service technician keeps a hot "iron" going all day by means of a thermostat device so the heating element in the iron will not burn out. Such a device, when home-made, usually consists of a low wattage lamp in series with the soldering iron; the lamp is bridged by a switch. When the lamp is in the circuit, it maintains a predetermined temperature at the iron tip. When the soldering iron is to be used for a period of time, a flick of the switch bypasses the lamp and the soldering iron quickly reaches operating temperature.

In modern radio and electronic work incorporating miniature components, printed circuits and transistors, a large high wattage soldering tool is quite unnecessary and can prove to be cumbersome and unwieldy. For this type of work, a good quality "pencil iron" or an instantaneous-heating solder gun is

more efficient and safer for the parts.

A solder gun uses a step down transformer with a trigger-type switch. When the line voltage of 110 to 120 volts is reduced, the current increases and the solder tip, which is part of the secondary of the transformer, quickly develops heat. When the switch is released, the tip cools quickly and the solder gun can be placed on the table without any danger of damage.

Regardless of what type of soldering tool you use, the tip should always be clean and free from oxidation and pitting. It's a good idea to keep an old piece of toweling or canvass handy and to wipe the tip as often as required. Constant filing of a tip in a pencil or bench iron is not advisable. By keeping it clean with an occasional wipe of the towel or canvass rag, you avoid the necessity of filing and wearing the tip down. It is not recommended to carry solder on the iron tip to the joint. However, the tip should be "wet" so that it will not oxidize from the heat. A dirty or oxidized tip will not efficiently transfer heat to the solder lug and the soldering operation becomes difficult.

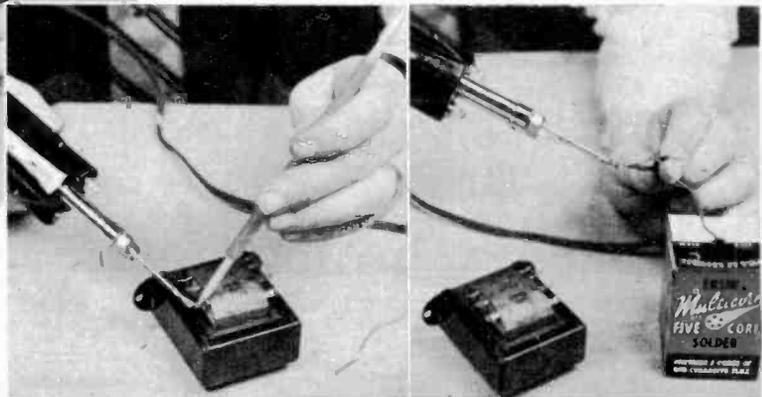
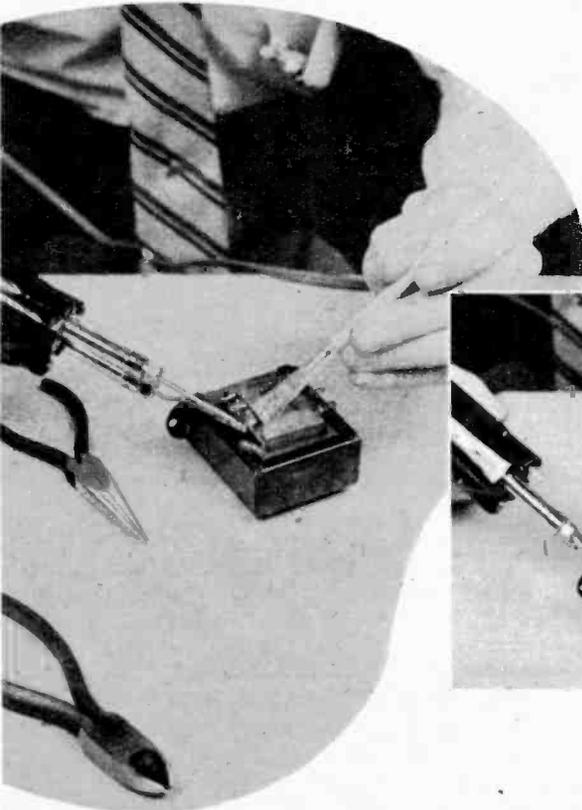
All soldering operations should be rapid and the flux should "sizzle" as it touches the heated solder lug. Always heat the connection or lug to which a wire or part is to be soldered, not the wire or part itself. Solder should flow freely and penetrate the wires of leads in the lug, forming a permanent bond.

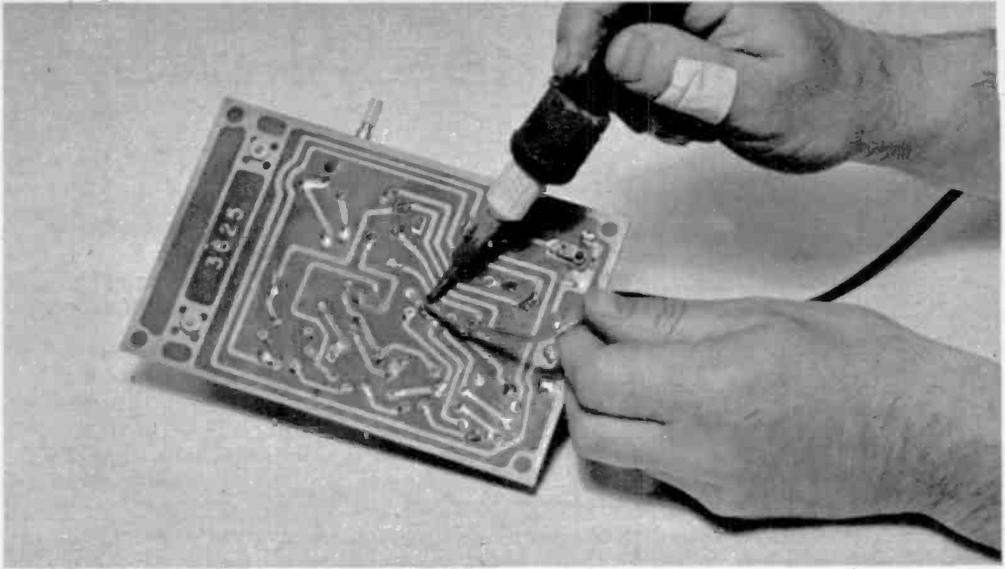
### Keep Work And Wires Clean

A good job of soldering requires more than a good soldering tip and a good grade of solder. The connecting lug, the wires, and the leads should be free of oxidation. Therefore, a certain amount of preparation must be done to assure a trouble-free solder joint. Here are a few good rules to follow:

1. Keep a ball of fine steel wool or emory cloth in the tool box or near the work bench.
2. Make it a practice to "tin" wires or leads as you cut them to size and remove insulation. This is done by heating the exposed wire ends and apply a thin layer of solder.
3. When a good ground to chassis is necessary, one of two methods may

When soldering new wires to a previously used part, such as the transformer shown below, the solder lugs should be cleaned with a wire brush and hot soldering tip before making the new connection. Open the hole in the lug by inserting the tip of a soldering aid, then tin leads.





When using a printed wiring board, use a minimum of solder to avoid spillover on adjacent wires.

be used. The first is to scrape part of the chassis where the ground connection will be located with emery cloth and heat it with the tip of the iron, at the same time, "tin" the area with a film of solder. The second method is to drill a small hole in that part of the chassis. A solder lug is then fitted with a screw and nut and

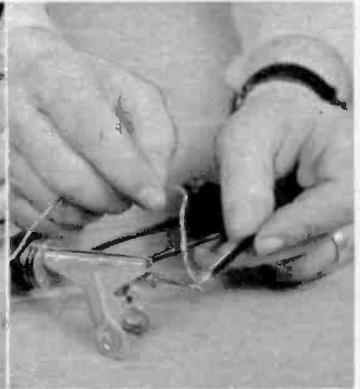
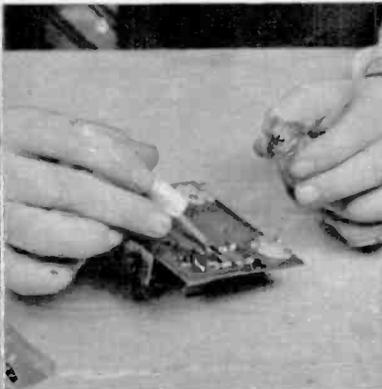
heated and "tinned" thoroughly. The hole in the solder lug can be kept open by inserting the tip of a solder tool or awl.

4. When soldering wires or leads to terminals of a transformer, loudspeaker, etc., care must be taken to see that the solder lugs are free of wax, grease, and insulating varnish. •

Insert the new lead into the solder lug on the transformer and heat the lug until the solder flows onto the wire and into lug making strong bond.

When checking a piece of equipment for cold solder joints, dab with nail polish those joints which pass inspection. When done, resolder only unpolished joints.

Sometimes a third hand would be useful when tinning a lead or soldering a component. A spring clip can be used at such times to hold the soldering iron, leaving the hands free.



# Stereo Makes News

By Donald Hoefler

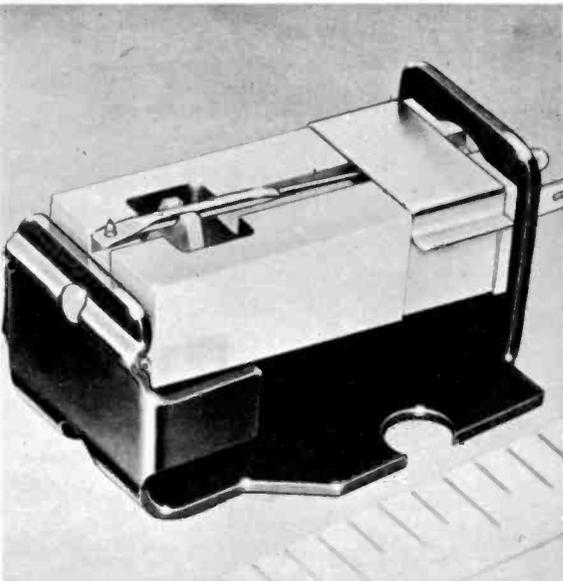
**The big hi-fi news of the year is stereo on records, but it has long been available on tape and broadcasts.**

**S**TEREO sound, the most exciting audio development since hi-fi itself, will be made available to hobbyists and music lovers this year as never before. Every medium of sound transmission—tape, records, radio broadcasts and soundfilm—have all successfully been used for stereo reproduction, and it is almost a certainty that all of them will soon be enjoyed at almost any time the listener wishes.

Stereo sound, like stereo pictures, gives a greater sense of presence, depth and direction. And just as stereo pictures are a possibility because we see with two eyes, so stereo sound is realized because we have two ears.

But stereo is *not* achieved simply by putting two microphones in front of an orchestra or two loudspeakers in a living room. Multiple mike setups have been used in broadcast and recording for years, and while they often provide better balance they don't

New cartridge developed to play stereo discs is shown below left. This ceramic pickup of Electro-Voice, Inc. plays stereo records and conventional discs and costs only \$19.50. One of the first stereo records offered to the hi-fi listener is shown below right. It utilizes the Westrex "45-45" system.





The JBL Ranger "Paragon" integrated stereo reproducer containing two multi-speaker systems.

provide stereo. Multiple speakers placed some distance apart often present a very pleasing spatial effect, but this isn't stereo either.

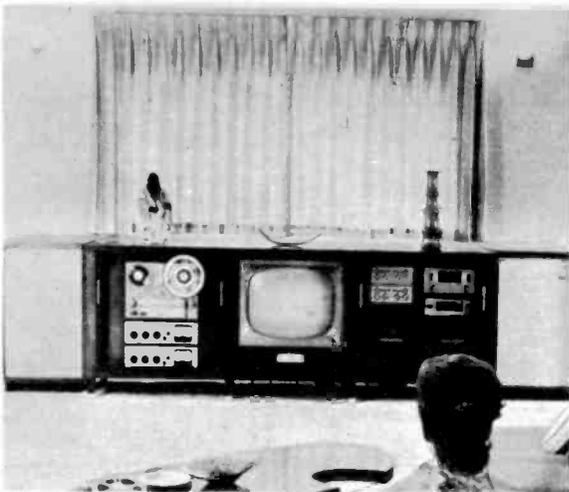
Stereo sound requires two or more completely separate transmission channels all the way from the original sound source right up to the loudspeakers. Although as many as 10 or more channels have been used in some experimental systems, program material for home use is all of the two-channel type.

By far the most popular source of stereo sound today is prerecorded magnetic tape. This has become possible through rapid advances in tape quality, which now permit using less than half the width of the tape for each recorded

channel. Not too long ago the idea of recording a signal on anything less than the full quarter-inch width of the tape would have been unthinkable.

The stereo tape reproducer has two separate playback heads, one to scan channel 1 and another simultaneously to scan channel 2. The rest of the stereo system involves two separate playback preamplifiers, two sets of cables, two audio power amplifiers and two complete and independent loudspeaker systems. Such a setup is obviously more complex and expensive than ordinary monaural hi-fi, but there are many who think that the outstanding results more than justify the investment.

Stereo sound in motion pictures is



**Complete home installation for stereo tape and radio. Equipment need not be so costly.**



**Stereo tape test and evaluation setup at the Minnesota Mining and Manufacturing Co.**

now commonly heard in many leading theatres, but the first production of any importance to use the process had to carry its own sound equipment around from place to place. This was the Fantastone system employed in the original version of Walt Disney's *Fantasia*, which first appeared about twenty years ago. Today, of course, processes such as Cinerama, Cinemascope and others employ very elaborate stereo setups.

Several methods of broadcasting stereo have been used. One system involves co-operation between two separate FM stations, with each station carrying one of the channels. At the receiving point two receivers feed two amplifier and speaker systems. Another approach uses both an AM and an FM station in the same way. This is a little easier on the hi-fi fan's budget as several current AM-FM tuners are designed to receive two signals simultaneously, and thus constitute an all-in-one stereo receiving unit.

The newest method of stereo broadcasting, and one which shows great promise, uses only one FM station in a system known as multiplexing. In this arrangement a conventional modulator superimposes an audio signal on the FM carrier in the usual way. At the same time a supersonic frequency is imposed on the FM carrier and audio superimposed on that as well. Thus the supersonic signal acts as a sub-carrier for the second audio signal, which really makes the system FM within FM.

Since there is absolutely no inter-

action between the two signals noticeable at the receiver, it is of course possible to present two completely separate programs on the same carrier. But it is also possible to present both channels of the same program in stereo. Stereo multiplex program transmissions for the home are still experimental, but they are on the increase.

There are also a number of possible ways of achieving stereo sound on a disc. The earliest attempts were made in the Bell Telephone Laboratories in the early 1930's. Since the earliest days of recording, when the Edison cylinders had an up-and-down motion impressed on their grooves and the disc records had a side-to-side motion in theirs, there have been two basic methods of cutting a record.

The Bell system simply combined the two motions in a single groove, with the lateral part representing one channel and the vertical movement representing the other. The trouble was that it was exceedingly difficult to separate the two signals coming out of the pickup, and it was equally difficult to turn out quality discs on a mass-production basis. Consequently the idea was dropped.

But at the London audio show last year Arnold Sugden demonstrated his "Connoisseur" stereo disc and reproducer, and quite a sensation was created. The basic principle was the old vertical-lateral system of Bell Labs. The difference is that Sugden has shown that he can reproduce without objectionable cross-talk between channels.

Another stereo disc method is the Cook system, in which the first half of

the grooves are engraved with one channel and the inner half with the second channel. Then a Y-shaped tone arm with two pickups drops a stylus into the lead-in groove of each band.

At the New York hi-fi show in October of last year, there was demonstrated still another type of stereo disc which in many ways is the simplest and most direct yet. The basic notion of the system, which has been dubbed the 45-45, is simplicity in itself. Since every record groove has *two* walls, why not modulate each one separately for each of the stereo channels?

The 45-45 system does just that, with a special cutter with two styli at right angles to one another and each making about a 45° angle with the record surface. The first pickups were hand made in the laboratories of the developer, Westrex, but trade reaction to this system has been so favorable that already several pickup manufacturers have completed development work and are ready to get into mass production on 45-45 pickups as soon as records appear on the market.

Just which stereo disc system will become the standard is still not a closed issue. Recently another entry, this one from Components Corporation, was demonstrated to the trade and press. This is somewhat similar in principle to the FM multiplex system for stereo broadcasting. This method engraves first a conventional lateral groove. In addition there is an FM carrier on which a "difference" signal is modulated. Because of the high frequencies involved,

the second signal is not really the other "ear" of a complete stereo system, but rather only enough information to establish a distinct difference between the two reproducers. Development work on this system is continuing, and it shows distinct promise.

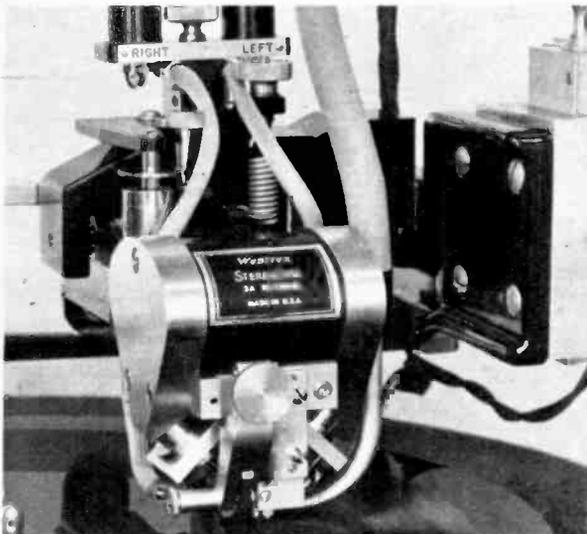
Reproducing systems for stereo, regardless of the program source, will require two loudspeakers, two power amplifiers, and in most cases two preamplifiers. The transducer at the input end will depend upon program source.

For tape the reproducing machine must have stereo playback heads, but is, conventional in every other way. Stereo home movie equipment is not yet being made, but there is no technical reason why it could not be, and if a demand develops the equipment will most certainly become available.

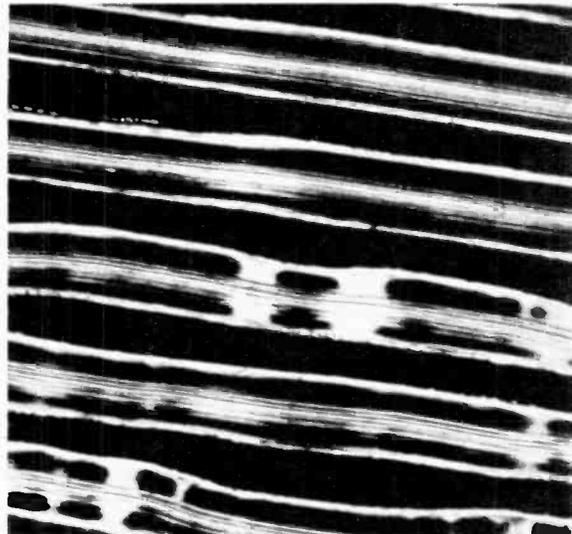
Stereo broadcasts require two FM tuners, an AM and an FM tuner, or an FM multiplex tuner, depending upon the method of transmission. As for stereo discs, most record manufacturers are setting up to make stereo records depending upon customer demand. Both the Record Industry Association of America and the Electronic Industries Association have urged adoption of the Westrex 45-45 system as the standard. But still other competing systems are now in the laboratories, and which one will take the brass ring is a matter for some conjecture.

The only thing which can be said for a certainty is that the next few months are going to be mighty interesting stereo-wise! •

Westrex "45-45" stereo head cutting a disc.



Microphotograph of "45-45" stereo grooves.





Set your automatic timer to wake you to hi-fi music from your tuner.

## Automatic Music System

*Don't miss important music broadcasts when you're busy—use an automatic timer to record them and, incidentally, to wake you to music.*

**I**T'S three minutes away from the time of the Maestro's farewell performance broadcast from Carnegie Hall.

In your living room there's a sudden *click!* An FM tuner dial lights up; the tuning meter swings wildly for a moment and then locks in.

Tape recorder reels start to revolve; a recording level eye winks greenly. Your hi-fi speaker tells an empty living room—"We now take you to Carnegie Hall." And every thrilling moment of the concert is captured on tape—at the same time you were out on that important date or business conference.



Automatic control of factory machines have been making the news for many months. Drill presses and lathes turn on and off without human hands at the switches. The wheels of industry go round controlled by punched tapes, clockwork timers and many other types of programming devices. By using the same techniques, you can adapt your hi-fi set and/or tape recorder to catch once-in-a-lifetime broadcasts—automatically.

The "brain" of the operation is an Intermatic time switch Model T675. Although not as clever as those employing feedback principles, it has a number of special features. The Intermatic can be adjusted to turn equipment on or off at two hour intervals over a twenty-four hour period. Furthermore, it can be set to determine at each interval how long it will remain on. Other timers that are useable are the Tork Model 801 and the Reliance Model W33.

The three or four button timers found in clock radios have a disadvantage in that the period during which the unit remains "on" is not adjustable. If you try and set up an automatic taping system with one of these types, the chances are that you'll come home to find either the recorder has been shut off prema-

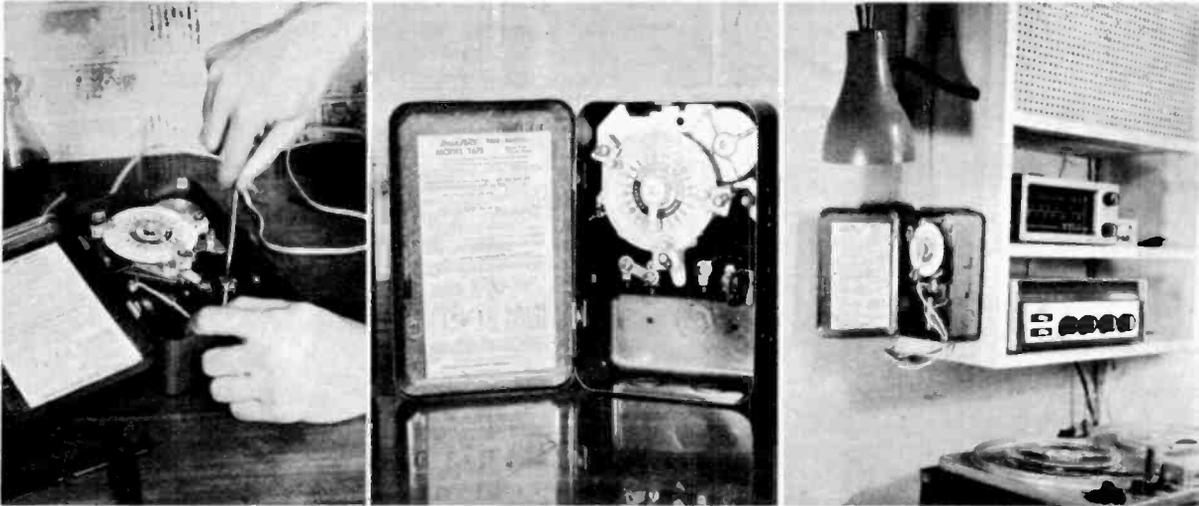
turely or the last few feet of tape have been beaten to shreds because the tape reel ran out and the recorder kept going.

The adjustable "on" interval type avoids these problems and can be set to tape a number of programs of different length at different times. As a low-fi example of the Intermatic timers' flexibility; Mother can set it up to record her favorite fifteen minute soap operas at 3¾ ips each day, all week, while she's away on vacation. She can then return home and get a full week's dose in one sitting.

Other uses of timers such as providing morning awakening to Brubeck or Brahms, depending upon your mood and taste, are obvious. Your morning program can either be set up in advance on your tape or record player, or be left to the discretion of your tuner.

Connecting the timer to the equipment to be controlled is simplicity itself, merely follow the directions and diagram on the timer cover.

The adaptability of these timers is amazing. They will find use in the kitchen, bedroom or living room. The day of automation is upon us and your ingenuity is the only limitation placed upon the how, when and where of time switches in your home. •



The Intermatic timer above and at left contains, on the front cover, full instructions and necessary diagrams for connecting the timer to your hi-fi set, etc. The timer is shown at the right controlling an FM-AM tuner, tape recorder and amplifier. The unit need not be exposed, it can be hidden.

# transistor electronic flash

*Lightweight and powerful, this unit operates off inexpensive flashlight batteries and uses a single power transistor.*

**E**LECTRONIC flash guns have long suffered from the disadvantage of excessive weight. This feature has been more or less unavoidable because of the nature of the high-voltage supplies used to energize the xenon-filled flash tubes. These consist generally of either of the following: 1) A single large dry battery developing several hundred volts; very expensive, and becomes useless when its voltage falls off only slightly. 2) The equivalent of an automobile radio's "B" section, comprising a small storage battery, a vibrator and a rectifier; the battery is full of lead, and the vibrator generally is unreliable.

The advent of the power transistor has changed the situation radically, and for the better. A West German manufacturer has hit the market with the first transistorized electronic flash, the Mecablitz 100, which is sold in the United States by *Burleigh Brooks, Inc.*, of New York, the well-known importers of the Rolleiflex cameras.

The technical concept of this unit is entirely different from that of its predecessors. A single large transistor is employed in a simple audio oscillator circuit, the frequency of which is not critical and lies between 5,000 and 10,000 cycles. The output of the oscillator is stepped up to about 500 volts by a small



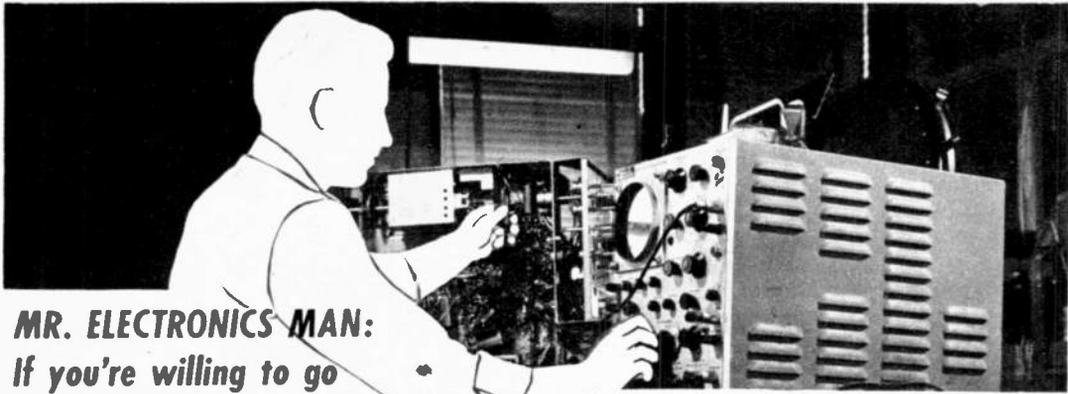
Top, inside of Mecablitz 100 flash unit. Finger indicates transistor, oscillator is under shield. The complete unit as shown above is book size, note position of convenient on-off switch.

transformer, and then turned into pulsating DC by a dry rectifier. From here on the operation is conventional. The DC, at a low value in the order of milli-amperes, dribbles into a large electrolytic capacitor, and when this is fully charged the camera shutter discharges it into the flash tube.

The transistor being essentially a low-voltage device, the source of energy for the oscillator can be obtained effectively and economically from six ordinary "D" size flashlight cells, available everywhere. One set of batteries is good for more than 700 flashes. The time required for the capacitor to charge up, between flashes, is about ten seconds. With batteries, the entire shoulder-slung unit weighs only four pounds.

I tried a stock sample of the Mecablitz 100 with a Rolleiflex and a Leica M3, and was delighted with its reliable, foolproof operation. A guide number of 110 (that is, 110 divided by distance to subject equals lens opening) gave fine, clear negatives on Verichrome Pan in the Rollei and Plus-X in the Leica, with normal development in D-76 and with prints on No. 2 paper. The flash duration is 1/800 second, which is more than fast enough for the shooting of such active subjects as children and pets.

—R. H.



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# The ABC's of Electronics

[continued from page 75]

of information gathered by instruments from an unmanned point. One of the first devices to telemeter information back to a control station was the radio-sonde weather balloon. Now when we want to know how high or how fast our last guided missile went, or what conditions are aboard an artificial satellite or inside an atomic reactor, telemetering gives us the answers.

## Electronic Instrumentation

This leads us to a closely related branch of electronics. As we implied earlier, almost any physical effect such as heat, light, sound, vibration, infra-red and X-rays, can produce an electronic signal if a suitable transducer exists. One of the advantages of electronic systems is the ability to *amplify*, that is to strengthen very feeble signals. Thus the transducer needn't be very sensitive, nor must it upset the physical condition it is attempting to measure.

At the output of the electronic circuit we have a *readout* device, which gives us the information we want. In the engine ignition analyzer the indicator is usually a cathode ray tube. On a Geiger counter it is an ordinary meter. The electrocardiograph provides a permanent photographic record.

Other electronic instruments include the photographic exposure meter and colorimeter, the electron clock and the ionization gauge used in physics laboratories. The chemist uses a *pH* meter to determine the acid or alkaline state of a solution, the engineer uses an electronic strain gauge, the doctor an electroencephalograph, the astronomer a radio telescope, and the weekend sailor an electronic fume detector to warn him of an explosive condition in the bilge of his boat. All of these are electronic instruments, and there are many, many more.

## Electronic Controls

In any system involving the use of power, there is also a need for controlling this energy accurately and rapidly. The hydraulic brakes on a car, or the switches on an electric stove, are just

two examples of low power devices which control high powered ones. It doesn't take much work to depress a brake pedal, yet this will stop a car weighing well over a ton. And little effort is required for turning on a stove, yet the voltages and temperatures controlled are powerful enough to kill a person.

The idea of using a low power device to control a high power system is the basis of the *servo* principle, and the devices themselves are called *servomechanisms*. Since they are in effect amplifiers of power, they can be at least partly electronic in nature. Electronic servomechanisms are widely used in automatic pilots, artillery fire control systems, and in many factory production and assembly processes.

Since even the best servo system is inanimate, it is still a slave to mankind and must be told what to do. It can have a "master" in constant attendance, pushing buttons, throwing switches or turning rheostat knobs. In this case the system is called an *open cycle* control.

But in many cases the instructions are prepared in advance, and recorded in some way, such as on a punched or magnetic tape. Or the system may be self-correcting, such as the automatic pilot which senses when the airplane is going off the set course and automatically makes correction. This type of operation, in which a human starts it off but then leaves the system to take care of itself, is known as *closed cycle* control and the process is called *automation*.

## Electronic Switching

Many electron tubes and circuits can be adjusted so as to act as on-off devices. That is, instead of passing varying currents as an amplifier does, they will pass either a fixed amount of current or no current at all. Thus they are in effect electronic switches. They don't wear out mechanically, and when they do fail, usually plugging in a new tube will make the repair.

A huge number of electromechanical switches and relays are employed in automatic telephone dialing systems, but

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4B97	6BY5G	7F8	50B5		
5AM8	6BZ7	7N7	50C5		
5AN8	6C4	7Q7	50L6GT		
5AQ5	6CB6	7Y4	80		
5AT8	6CD6G	7Z4	117N7GT		
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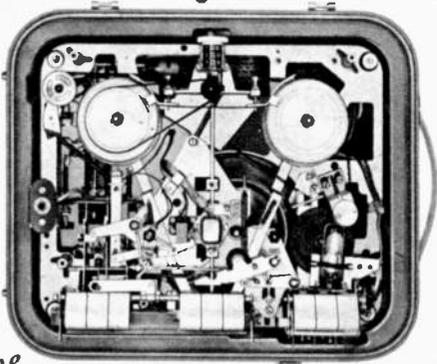
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the handwriting on the wall says that they are doomed for replacement by electronic switching circuits. Electronic data processing equipment, better known as computers or "electronic brains," also depend for their operation upon hundreds of electronic switches.

Now that we know just a few of the things this amazing art of electronics embraces, in the next issue we can begin exploring some of the habits of the tiny electron, which has been harnessed for the benefit of mankind. •

## First Novice Transmitter

*[continued from page 60]*

press the key and adjust C9 again for resonance, indicated by a sharp decrease in plate current. Now adjust C12, the loading control, for maximum brilliance of the 40 watt lamp, while at the same time keeping the output circuit resonance by alternately adjusting C9 and C12. The purpose of these adjustments is to obtain maximum brilliance of the 40 watt lamp, and adjustment of one condenser will affect the other. Go through these adjustments several times until you get the feel of it. Incidentally do not allow the plate current to rise above 120 ma. during these adjustments.

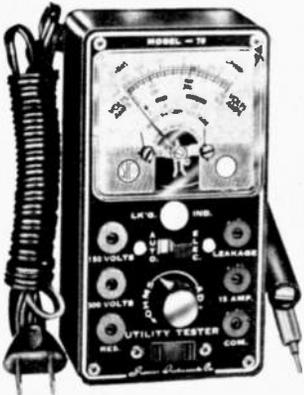
In making these adjustments you have been substituting the 40 watt lamp for your antenna. Now you are ready to go on the air so you can disconnect the lamp from the transmission line and connect your antenna to it in its place. When this has been done, once again, turn on the power supply and after warm-up, depress the key and adjust C9 for resonance. Touch up the loading condenser C12 until the plate-current reads about the same figure you read before when you lit the 40 watt lamp to maximum brilliance, at the same time keeping C9 (plate tuning condenser) adjusted for resonance. Once again do not exceed 120 ma. plate current.

One word of caution—check your crystal frequency and make sure you operate your transmitter within the confines of the novice bands. An on air check with a friend who has a reliable

*[continued on page 108]*

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With tester's cord in outlet, current consumption of appliance is read direct on meter when line cord is connected to receptacle on panel. This typical iron takes 7 amperes (Good).



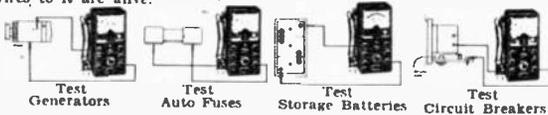
Small electric fan motor indicates 50 ohms (normal resistance).



Control circuits of most furnaces use 24 volts obtained from step-down transformer. Here's how to check room thermostat to see if wires to it are alive.



Manual supplied with Model 70 shows meter needle should move to right when test leads are connected to pins 3 and 4 of this 6AU6 tube. Procedure for testing all tubes used in TV are detailed in manual.



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## Build A Stereo Speaker

[continued from page 53]

these two terminals and touch the other end of each wire to one side of a flashlight battery. Watch the speaker cones at the moment of contact, you'll notice that they all either move in or out. If one speaker does not move in the same direction as the others, reverse the leads going to the terminals of that particular speaker. Then make the flashlight battery test again until all speaker cones move in same direction at same time.

### Crossover

A simple coil and condenser combination will serve to separate the high frequencies from the lows and feed the former to the separate tweeter used in this speaker system. For another dollar you can add a "brilliance" control. Any 8 to 16 ohm tweeter will work with the woofer described here provided it has a crossover of 2000 cps or under. Select one which matches, soundwise, the tweeter in your first speaker system.

The capacitor is a dual 20 mfd, 150-volt electrolytic. Simply cut off its negative lead and use the remaining two positive leads as terminals. Its effective capacity is now equal to one half of one section—or 10 mfd.

The coil is wound on a 1½" length of 1" wooden dowel. The end pieces can be made of Masonite, plywood or any nonmetallic flat material. Wind 250 turns of No. 18 enameled copper wire on this form. It is not necessary that the wire be accurately layer-wound, provided that the coil form is evenly filled.

The "brilliance" control, needed for balancing the higher frequencies, is a 50- to 100-ohm, 2 watt wirewound potentiometer.

The bass power packed in this little job will amaze you. Since the individual speakers used were rated at only 2 watts each, no more than a 10 to 15 watt amplifier should be used in driving it. For a modest investment, you've built yourself a speaker system that not only is a "stereo-mate" for your living room, but will be a welcome guest in a solo role as an extension speaker in any room in your house. •

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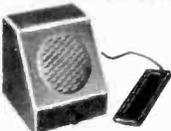


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## Radio Control—Hobby Extraordinary

[continued from page 39]

flying and the types of controls, from the "poor man's" rudder-only to the plush "multi-channel" sets.

Nine out of ten sets purchased today, regardless of make, are single channel. Three out of four airplanes fitted with these sets are "rudder only." Rudder-only planes are capable of loops, spirals, and, of course, any desired turns. They are ideal for sport and for beginners. By various means, additional controls can be worked with the "building block" single-channel receiver, including elevators and engine throttle.

Proportional rudder control can be had by substituting a magnetic type of actuator for the familiar escapement, and an electronic or mechanical pulser unit for the normal transmitter micro-switch control button. The relay, and hence the rudder, slaves to every minute movement of the stick control of the pulser.

As a general rule, single-channel radio operates one escapement. As made by Babcock, Bonner, and others, many of these escapements are capable of several functions. They give left and right rudder, high and low motor, and, in many cases, can operate a second escapement for other controls. Bonner's Vari-comp escapements feature printed wiring and can be hooked up in series, or "cascaded" so that closing and holding the transmitter control button or switch once gives right rudder; twice, left rudder; three times, up elevator;

four times, down elevator. One quick blip of the control button triggers the engine throttle control. So equipped, the single-channel plane can perform outside loops and fly inverted. To boil it down, competition falls in three classes: rudder only, intermediate (when gimmicks are added for more controls), and true multi (more than one channel) control. Equipment comes in single, two, three, five, six, eight and, soon to be, 10 channels. The operator's wits are the limiting factor!

Where real "muscle" is required, servos are preferred to escapements—deBolt (DMECO), Bonner, and Babcock mass produce a varied line of servos that do everything but think.

What are the costs? You can put a single-channel set into the air (or in a boat) for about \$50 to \$60. At this figure, Babcock Models, for example, offer a combination deal including the plane or boat kit, the receiver and transmitter, and the escapement or actuator. The electronic gear may be a kit (the lower figure) or assembled. You do have to buy glue, dope, and engine and tank. Figure another ten spot max. Low cost parts kits for many types of receivers are offered by many people, such as Lafayette Radio, and Essco. Imported single-channel receivers run from \$8.95 up, \$14.95 and up for transmitters. What you get for your money is roughly comparable to the investment. •

# The EI Radio Garage Door Opener

[continued from page 49]

It is suggested that the power supply and the detector be wired first, keeping all leads to a minimum length and neatly soldered in place. Use #22 standard plastic covered wire. The power supply delivers approximately 135-140v. DC with no load. Current drain of the detector is .5 to .7 ma.

Check output of the power supply with a 20,000 ohms-per-volt meter for proper operation. The receiver is checked by using a pair of headphones connected between ground and point "X". (NOTE: Connect a .01 mfd. capacitor in series with the headphones at point "X". This allows passage of the audio signal and prevents the DC voltage being applied to the phones.) With the headphones connected, a hissing or rushing noise will be heard. This is the characteristic super-regenerative hiss. If this noise is not heard, check the following: tube, short circuit in wiring, open connections, incorrect components. Rotate tuning slug in and out, using an insulated tuning wand. When tuned to a signal of from 26 to 30 mc. this rushing noise will disappear.

With the detector operating properly, wire in the pentode audio amplifier section of the 6U8. The amplifier should have all lead lengths as short as possible. Operation may be checked in the same manner as the detector, placing the headphones between ground and point "Y". At this point the audio level, or rushing noise should be greatly increased. If no signal, or a weak signal is noted at point "Y" check for the same faults listed for the detector circuit. In addition, check for a signal at the grid of the pentode section of the 6U8. This signal level should be the same as at point "X". If not, C4 is defective or there is a poor connection.

With the pentode amplifier operating, wire in the triode power output section of the 6U8. A 10,000 ohm,  $\frac{1}{2}$ w. resistor may be substituted for the reed relay coil and R9 for test purposes. Repeat the check for a signal on the triode section, checking at point "Z". The same symptoms and possible causes for no signal are the same as for the pentode

section. When the rushing noise feeds through the receiver and is progressively amplified up to point "Z", the reed relay connections may be made, along with the reed contacts and the secondary relay, RLY2:

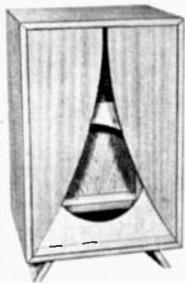
The antenna is connected as shown in the photo and wiring guide. Since the receiver may be located in the garage or house, it is desirable to run the antenna to a point where signal pickup is better. This is done by using a 4 to 6 foot length of shielded cable, prepared as shown in the pictorial sketch. Remove the outer braid conductor for about 16" to 18" from one end. The other end should be stripped back about  $\frac{3}{4}$  to 1 inch. The inner conductor from this end is soldered to the antenna post and the outer braid is secured under a solder-lug, as shown in the photo, spot soldered. A small cable clamp may be used to further secure the cable to the case and thus act as a strain relief.

The receiver is now ready for operation, however, the transmitter must be built before the receiver is placed in operation.

## Transmitter Construction

The mobile transmitter is built on one cover of a 3" x 4" x 5" case. Four filament type tubes, 3V4's are used. One is for the crystal oscillator on 13.627mc, one for the doubler output stage on 27.255mc. and two are used for the tone generating circuit. Drill or punch the front panel and chassis bracket as shown in the drawing. Assemble these pieces and add the tube sockets, tube clamps, grommets, terminal strip and final tuning capacitor. Use small lock washers under each nut and/or screw head. Be sure sockets are mounted with pins located as shown. Place a soldering lug and lockwasher under the nut holding the amplifier socket in place and the screw holding the chassis to the front panel. Wire in the filaments using #22 stranded plastic cover wire. All filaments are wired in parallel, thus requiring 1.5v. at .4 amp. for proper operation. Mount the oscillator coil form and then add balance of components to com-

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plete the oscillator. Add the power lead-in wires to the terminal strip, leaving them about 2 feet long. Use #18 standard plastic covered wire.

It is desirable to bench check the transmitter in the same manner as the receiver was checked, stage by stage. A single dry cell, or two size D flashlight cells in parallel, will supply the 1.5v. for the filament. A 67½v. or 90v. portable radio B battery will suffice for the high voltage. The radio frequency output may be checked by using a 60ma., pink bead, flashlight bulb connected to 2 loops of insulated wire, having a diameter of about ⅝" to ¾". Insert the crystal and oscillator tube and connect the filament supply. Place a 0-25ma. DC meter in series with the B supply. Make sure polarity is correct.

Until properly tuned, the plate current of the oscillator will be fairly high, in the order of 15ma. for 67½v. and about 22ma. for 90v. Rotate the tuning slug in or out until a current dip is indicated on the meter. This should be a drop to about 5-8ma. Note, that as the slug is moved into the coil area, the current reading will gradually decrease until it reaches minimum, whereupon further turning in a clockwise direction will cause a sudden increase to maximum reading. At this point, rotate slug counterclockwise, or out of the coil area, about 1 turn. Locating the loop on the flashlight bulb near the end of the coil will cause the bulb to glow. If the oscillator has been tuned for minimum dip and the bulb does not glow, check the following: defective bulb, circuit peaked too sharp (placing loop near coil knocks circuit out of oscillation, move slug out of winding about ½ to 1 turn); or more B voltage is required. A ham friend, serviceman, or local radio station operator can help you make the necessary adjustments.

When the oscillator is working properly, wire in the components for the doubler-amplifier. The tank coil consists of 10 turns of a B & W #3007 Miniductor. Cut a length of coil about ⅛" longer than the 10 turns and unwind turns from one end so as to leave about ⅛" of plastic supports exposed. This will allow for mounting of the antenna coil. If desired, L2 may be made from #16 enamelled copper wire. 9 turns on

a  $\frac{3}{4}$ " diameter form are required, with the length being about 11/16".

When the amplifier is completed it is checked in the following manner: insert amplifier tube and turn on filaments, apply B plus to oscillator and check to be sure the current remains at a minimum, place loop of bulb at end of amplifier coil and with B plus connected to the amplifier, rotate amplifier tuning capacitor slowly until bulb glows. The oscillator plate current must remain at a low level when the amplifier circuit is brought into resonance. Adjust the oscillator slug and amplifier tuning capacitor for maximum brilliance of the bulb.

The antenna pickup coil is made from 6 turns of the #3007 B & W Miniductor. Leave about  $\frac{1}{8}$ " of the plastic supports to protrude from one end. Allow about 2" of wire at each end of the coil for connections. The coil is positioned as shown in the photograph at the plate end of the tank coil. One end of the coil is soldered to the antenna feed-through terminal and the other end to a ground lug which is held in place by the screw holding the chassis to the front panel. The plastic supports should be cemented together or fused together by a hot soldering iron. Distance between the coil windings should be about  $\frac{1}{4}$ ".

Now assemble the two 3V4's for the audio frequency multivibrator circuit. Keep leads short and place components as shown in the photograph. Note that R4 is located external to the transmitter case. Conventional lamp cord or hookup wire may be used for lengths up to 2 to 3 feet. Over 3 feet it may be advisable to use a shielded cable for protection against ignition noise. R4 is a variable potentiometer used to tune the transmitter audio frequency, and should be mounted as close to the transmitter box as possible and also in a convenient spot for making adjustments. With the audio section completed, the transmitter is now ready for use and the receiver may be actuated. This may be done on the bench for familiarizing yourself with the system and then it may be necessary to check it out again when the final installation has been made.

Turn on the receiver and insert the headphones between ground and point "Z" using the .01 mfd. condenser in

series. A rushing noise should now be heard. Turn on the transmitter and then adjust the receiver tuning coil slug until the rushing noise disappears. This may be done with the multivibrator tubes removed or left in their sockets. If they are removed, the rushing noise will disappear. If they are left in place, an audio note will be heard. It will be noted that the audio frequency from the transmitter will vary somewhat with changes in B voltage. This is normal and will be held to a minimum when the transmitter power supply is operated from the car battery.

The transmitter power supply as shown in the photograph is a combination device. A 15-watt "Shav-Pak," which may be plugged or wired into the cigarette lighter, serves to supply 110v., 60 cps., AC to the rectifier. The rectifier circuit is built into a #CU-3000 Minibox, along with the dropping resistors for the filaments. The two units now supply 130v. DC at about 20ma. and 1 $\frac{1}{2}$ v. for the filament supply, from either a 6 or 12v. car battery. (Note: the voltage at the filament leads will not be 1 $\frac{1}{2}$  volts unless the tube filaments are in the circuit.) BE SURE that you use the proper voltage "Shav-Pak" to suit your car and that the filament dropping resistor is selected for either 6 or 12 volts. The input line to the "Shav-Pak" contains the momentary push button actuator switch. This switch should be located at a convenient place on the dash of your car.

Following are a few notes on installation and tuning of the system.

The receiver is self contained and should be housed in a sheltered spot. The basement of the house is satisfactory, with the antenna being run to the outside for better pickup. The relay contacts merely act as a remote switch to operate the door raising actuator or turn on lights. Thus the line between the relay and the remote-controlled device may consist of up to about 100 feet of lamp cord. This will of course depend upon the current drawn by the device and if you are in doubt it would be wise to check with your local electrician.

The transmitter wiring should be checked carefully against the schematic  
[continued on page 107]

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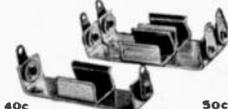
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## New Ion Fuel For Rockets

[continued from page 26]

ships would use a rather strange pair of batlike "wings" which would radiate this heat into space, since radiation is the only way to lose heat in a vacuum..

### Fantasy and Fact

In Walt Disney's newest space film, "Mars and Beyond," ionic ships are used to get to Mars, where they enter an orbit. Then small chemical rockets, which hang from the umbrella-like heat radiators, are used to descend to the surface. Dr. Wernher von Braun, the U. S. Army's top rocket expert, was design consultant for this ship. Dr. von Braun is also a former V2 designer.

There are several firms known to be at work on ionic drive research. In addition to the aforementioned *Rocketdyne*, which has a modest-sized Air Force Office of Scientific Research contract, *General Electric* has been doing work in the field. G. M. Giannini, a West Coast instrumentation manufacturer, has also shown interest, as has the National Advisory Committee on Aeronautics, which has been working on a form of ion gun.

On the other hand, there have been reports from Moscow that Russian rocket scientists have been working on "advanced propulsion systems," which are believed to be the ionic drive as well as an even more advanced idea, the photon drive. However, this latter is little more than a concept at this time, and it is felt that the main Soviet emphasis is on ionic propulsion. Photonic drive, which makes use of the propulsive power of particles of light, may come much later.

There can be little doubt, however, that the Russians have been pouring money and talent into all phases of rocketry. If they beat us to a workable ion ship, we may well expect to receive the first message from Mars in a Russian accent. We will, truly, have lost the race for space. •

## The El Radio Garage Door Opener

[continued from page 105]

and pictorial drawings to make certain all wires are connected properly. It is preferred that the transmitter be mounted in the trunk of the car, along with the power supply. Use #16 wire to connect the battery to the equipment, especially if it is a trunk installation. The prime concern is to eliminate as much voltage drop as possible due to the filament circuit being only 1.5 volts. The transmitter antenna may be a 4 to 6 foot length of #24 stranded microphone hi-fi cable (Alpha #494B). Prepare one end about 1½" back as per the wiring guide and remove 16-18 inches of outer covering and shielded braid from the other end, leaving the center conductor encased in the inner plastic insulation. This cable may be run through a grommet in the firewall or body of the car so that the exposed end is in the clear. The free end may be anchored and placed away from the car body by cementing a block or two of Styrofoam (obtainable in 10 cent stores), about 1" x 2" x 2", to the frame or body of the car. Use contact cement or Pliobond, making sure the metal surfaces are free of caked mud, grease or dirt. When these blocks have dried, sandwich the free end of the cable between similar blocks.

Place the antenna near the front of the car or in the open grill work. Do not locate it in such a manner as to shield the signal by the car chassis. If the transmitter is placed in the trunk, it would also be convenient to use a regular whip antenna. This antenna should be mounted in the normal manner, insulating it from the car body, and should be 3 to 4 feet long. If this is done, use a piece of shielded cable to connect the antenna and transmitter box connections to the antenna itself. This type of installation will greatly increase the useable range of the system.

Final tuning should be done with the component parts in place. Check the radio frequency section of the transmitter for proper operation, although if properly bench checked it should not

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need retuning. The pushbutton is depressed and potentiometer R4 is rotated until the reed relay in the receiver is actuated. It will be noted that the reed will increase in amplitude of vibration as the pot. is turned from maximum to minimum resistance. DO NOT set for maximum amplitude or strength of vibration, but rather back off toward the maximum resistance side of the pot. The reed relay should be chosen so that its frequency is not a multiple of the 60 cycle line frequency by closer than 10 cycles, i.e., omit frequencies between 230 and 250, 290 and 310, 350 and 370 cps., etc.

The transmitter rectifier section of the power supply could be built into the 3" x 4" x 5" box if you prefer, however, a tighter packaging of components will result, a feature which was avoided in laying out the present design for ease of assembly.

The mechanical section of a door opening actuator is not given due to the variation in doors, actuators and installation problems. The actuator mechanism can be obtained from the P. E. Hawkins Company, 631 Prospect, Dept. EI, Kansas City 24, Missouri; Alliance Manufacturing Co. Inc., Alliance, Ohio; the Perma Power Co., 4727 N. Damen, Chicago 25, Illinois; among others. Or, check with your local electronic parts distributor. You could also get information from your local garage door dealer on the type of mechanical actuator best suited to your door. •

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## First Novice Transmitter

[continued from page 98]

receiver will reassure you that your signal is clean and on frequency. Incidentally you can check your crystal oscillator frequency without overloading your receiver by merely removing the 807 from its socket and keying just the 6AG7 oscillator tube, and listening for the signal on your own receiver. Of course, the calibration on the receiver must be accurate to give you a correct indication.

So there you are—for approximately fifteen dollars and a few hours labor, the exciting world of amateur radio will be open to you. We wish you 73's and many hours of successful DX hunting. •

## Driveway Floodlight Control

[continued from page 68]

Once all the parts are mounted on the bakelite sheet, most of the wiring may be completed before mounting the little sub-chassis in the box. If you use sufficiently thin hook-up wire, you will find that it passes through the perforations nicely, thereby permitting much of the wiring to be located under the sheet.

Some additional precautions to reduce the hazards of short circuits and possible shock from live metal parts are:

(1) The photocell is mounted by pushing its brass leads through a suitable pair of perforations and then bending the leads over sharply to insure firmness of positioning. One of the leads is wired directly to the proper potentiometer lug as a further support; *be sure you cover all bare leads with insulated tubing (spaghetti) to avoid having them touch the case or each other.*

(2) Both wires of the AC line cord are brought into the box through a grommited hole and terminated securely at a two-lug terminal strip. *Neither AC lead must be permitted to touch the case!* All power leads that are fed from the AC are then brought to the lugs on the terminal strip.

(3) *Observe the polarity of the electrolytic capacitor carefully!* Note that the positive pigtail of the capacitor connects to the selenium rectifier.

(4) Install the selenium rectifier so that you know which terminal is the "plus" or "K" end. All good rectifiers are marked either "+" or "K" at this terminal. For chassis mounting types, such as the one in this model, the plus terminal is usually the one furthest from the chassis after mounting.

(5) Three holes are required in the top section of the case. A 1/2-inch hole which takes a 1/2-inch o.d., 3/8-inch i.d. rubber grommet is located directly over the slotted shaft of the sensitivity control potentiometer to permit sensitivity adjustments *in situ* should it be necessary to do so. This is best handled by a short length of 1/4-inch dowel stick cut to a screwdriver shape at one end. (It is not advisable to use a metal screwdriver

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since you may approach one of the lugs on the AC terminal strips too closely). Two 1¼-inch holes in this section are also required: one is the aperture for light entry and the other is fitted with the output AC receptacle. The aperture is centered in the small front panel of the case; the receptacle opening is placed above and somewhat in front of the photocell. Use No. 16 zip-cord or other AC wire for the connections between the receptacle, the relay contacts, and the AC line, especially if you intend to have over 200 watts of lighting.

### Testing and Adjustment

After the wiring has been completed, and before power is applied, you would be well-advised to carry out a few resistance or continuity checks to make certain that there are no short-circuits. These are suggested, using either an ohmmeter or a flashlight battery and lamp in series if the meter is not available. First check across the prongs of the AC plug and at the terminals of the output receptacle. The resistance should be quite high between these points with the switch either open or closed. Next, check across the filter capacitor C with R2 at both extremes successively. Again the resistance should be high. Advance the sensitivity control fully clockwise to its most sensitive position and darken the room. Apply power. The relay should not pull in. Allow some light to enter the aperture and listen for the relay as it triggers. Once this action is established, plug a lamp into the output receptacle and re-test the unit with several different light sources. The plugged in lamp should, of course, respond to abrupt changes in incident illumination. The sensitivity control should be left at its maximum position. Further adjustment, if necessary at all, should be made when the unit is in its final position.

In selecting the location of the Floodlighter in the garage, you will need to place your car in the position where you want triggering to take place. Mount the control box so that the aperture is in the center of the most intense part of the headlamp beam. Final adjustment of sensitivity is made after you have established reliable and consistent operation. Use as little sensitivity as is consistent with good performance. In this

way, you reduce the likelihood of a chance beam from a passing car spuriously triggering the relay. If this should happen despite the reduced sensitivity, no harm will be done since the floodlight will extinguish when the car passes on anyway.

## All About Wiretapping

[continued from page 33]

variably they consist of about a pound or two of fine wire (about No. 40) wound on a ferrite core and enclosed in a nonmagnetic case of brass or aluminum. Several coils of this nature may be hooked up in series. The complete coil can be enclosed in a discarded vibrator, brass, aluminum, or fiber case. The coil may be taped for convenience. An old TV flyback transformer may be used for this purpose.

The coil feeds to an amplifier as in the preceding instances. It may feed a recorder too. A matching transformer may or may not be needed, depending on the amplifier and the coil impedances.

Such a coil can easily be carried in a pocket and oriented with one hand. It need not be exposed to sight so that even in your own office or home you may not be safe from some unfriendly person listening to the other side of a telephone conversation. And the big coil does the job ten feet away from a phone booth.

A preamplifier of the hearing-aid type—either tube or transistor—may require matching to the tape recorder if one is used. Ordinarily an earphone is used to monitor either the tape recorder output or the amplifier output simultaneously.

In conclusion, a caution about the phone booth. Even the single booth is not immune. A pickup against the booth wall will do the job, and it may remain concealed in the interloper's pocket during use. So beware of any invasion of your privacy—you do not know who has designs on your property or your person.

In the next issue we will show that even a talk on a park bench, or in a car is not necessarily private. The menace of the high powered "bug" microphone is ever present to pry into your secret talks.

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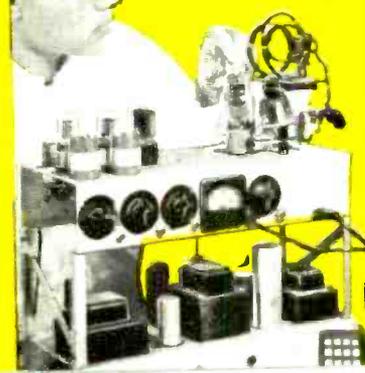
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"Thanks to NRI, I operated a successful Radio Repair shop. Then got a job with WPAQ; now I am an engineer for WHPE." **V. W. WORKMAN**, High Point, N. C.



"Have good job in a TV repair shop plus a small business in my home. In one year I went from lowest paid to head technician." **V. BARR**, Toronto, Ohio.

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