Citizens Band: How to Install CB on Your Boat
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This is the Electronic Age. Electronic Equipment is already being used to count, weigh, control flow of liquids, solids, gases. Control exposure in photography, detect fumes, or fire. Inspect at remote points. Supervise traffic. Survey land areas and ocean contours. Search for oil, miles beneath the surface. Measure radiation and control power levels in atomic installations. Control air traffic. Translate one language into another. The MILITARY applications of Electron- . . . particularly in space rockets and missiles, tracking devices, ... probably equal all of the uses above. Electronic equipment is used to machine parts through complex cycles. It is used in business to process data, control inventory, prepare payrolls, post, calculate, and in medicine for electro-diagnosis, measure body characteristics, electro-surgery.

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- Radio Operator
- Transmitter Engineer
- Aircraft Technician

A Message from
J. Morrison Smith
President
National Radio Institute

"Many men seem to have the idea that only engineers — with college degrees — are needed and are able to succeed in Electronics. Nothing is further from the truth. Authorities point out that: for every *one* engineer required, Electronics needs *four* to *seven* technicians. This NRI course trains you to become an Electronic Technician and opportunities are almost beyond belief."

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ELECTRONICS ILLUSTRATED

May, 1961 Vol. 4, No. 5

A Fawcett Publication

In This Issue:

Special Features

Short Features

EI Projects

EI Reports

Theory & Practice

Departments

ELECTRONICS ILLUSTRATED is published monthly by Fawcett Publications, Inc., Fawcett Place, Greenwich, Conn. W. H. Fawcett, Jr., President; Gordon Fawcett, Secretary and Treasurer; Roger Fawcett, General Manager; Roscoe K. Fawcett, Circulation Director; Donald P. Hanson, Assistant General Manager.

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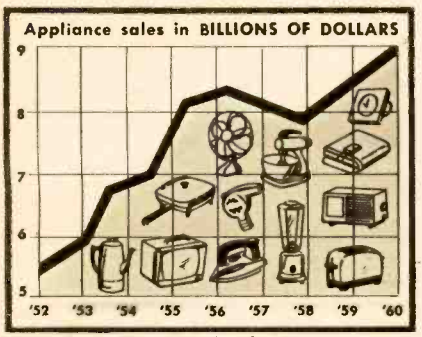
Record-Shattering Boom in Electrical Appliances Opens Up Exciting Profit Chances for Men Who Can Repair Them

OVER FOUR HUNDRED MILLION electrical appliances are in use right now in American homes — and are increasing at the rate of 76 MILLION a year! No wonder that men who know how to service them properly are making $3 to $5 an hour — in spare time or full time. FREE BOOK tells how you can quickly and easily get into this profitable field.



(Above) Based on chart in Electrical Merchandising Week Magazine.

Just look at how dependent American homes have become on electric appliances!

Here are some of today's common appliances, and the number of U.S. homes containing each.

Air Conditioners (Room)	6,500,000
Bed Coverings	10,800,000
Clocks	40,268,000
Coffee Makers (automatic)	27,000,000
Freezers	11,200,000
Frypan Skillets	20,600,000
Heaters, Portable (Elec.)	14,415,000
Heating Pads	19,925,000
Hotplates	12,105,000
Irons (Standard)	44,850,000
Steam Irons	28,200,000
Mixers	27,000,000
Ranges	17,200,000
Refrigerators	49,605,000
Sandwich-Waffle Comb.	17,615,000
Shavers	34,500,000
Toasters	40,195,000
Vacuum Cleaners	36,700,000
Washers	47,100,000

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Course includes all parts to assemble a portable, sturdy Appliance Tester. Use it to locate faulty cords, short circuits, poor connections, etc. in a jiffy; find defects in house wiring; measure electricity used by appliances; many other uses. Helps you earn while you learn.

THE "ELECTRICAL APPLIANCE BOOM" is in full swing. For example, annual sales of coffee makers have zoomed in the last decade from 900,000 to 4,750,000. Room air conditioners have gone from 200,000 a year to 1,800,000 a year. In just the last five years Americans have bought 26 million electric fans, 9 million electric heaters, 5 million deep-fat fryers!

The coming of the auto created a multi-million dollar service industry, the auto repair business. Now the same thing is happening in the electrical appliance field. But with this important difference: anybody with a few simple tools can get started in appliance repair work. No big investment or expensive equipment is needed.

We Tell You Everything You Need to Know

If you'd like to get started in this fascinating, profitable, rapidly growing field—let NRI give you the home training you need in Servicing Electrical Appliances. Here's your chance to build up "a little business of your own" without big investment — open up an appliance repair shop, become independent. Or keep your present job, turn your spare time into extra cash.

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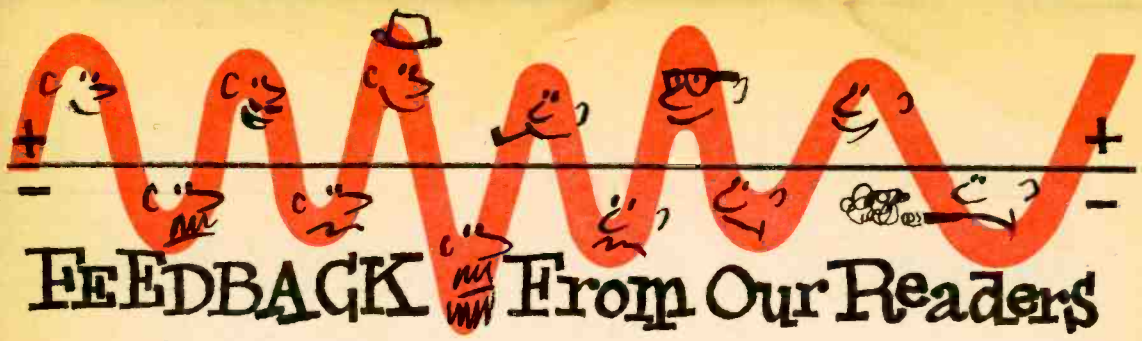


FEEDBACK From Our Readers

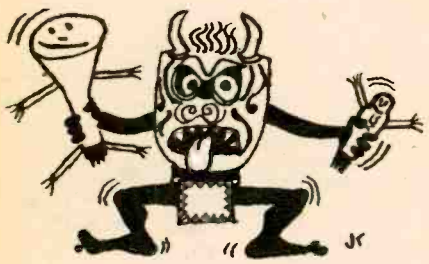
● *South Africa Calling*

I have just bought a tape recorder and I would very much like to find out whether there are any of your readers who are interested in corresponding by tape with me, a South African. I can hardly afford to be fussy but I would prefer young people, as I am 21. My recorder has three speeds and four tracks.

A. M. Meiring
722 Park St.
Arcadia, Pretoria
Union of South Africa

Any EI readers interested? Send your tapes directly to Mr. Meiring.

● *Electronic Doctor*



After reading your article on electronic frauds (September '60 EI) we want to know any information regarding Dr. A- - - and his work. We are enclosing mimeographed copies of two circuits of his medical machines. Would you please advise us as to whether the tube connections as shown are likely or whether the machine works?

R.G.B.
Toronto, Ont.

Sorry, but EI is not qualified to dispense such advice. Try contacting such organizations as your local medical society and the Better Business Bureau.

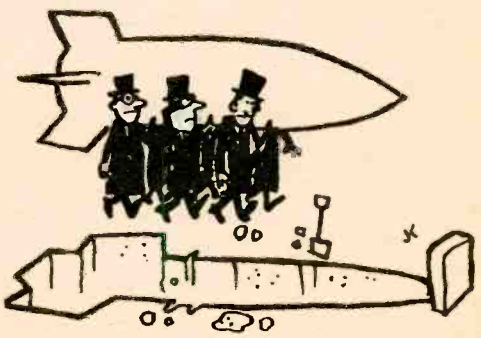
● *Winds of Change*

In your November '60 EI you published an article on a front-loading satellite stereo speaker system. I am interested in building it but would like to let my speaker set out in the open in the center of my wall and have it balanced looking. If I center the speaker and drill three 1-in. holes in each end would it have any effect on the performance?

C. L. Harrison
Macon, Ga.

The specific arrangement shown was arrived at after a great deal of testing. We would not suggest changes or modifications without testing them.

● *Moon Boom Bust*



I read your story about the moon probe (February '61 EI). Maybe I'm mistaken, but isn't the probe you wrote about the same one that never got off the ground? If it is, I'd sure hate for you guys to go into weather forecasting.

Buddy Smith
Chicago

You're not, it was, and nobody has asked us about the weather. Maybe we're getting lucky.

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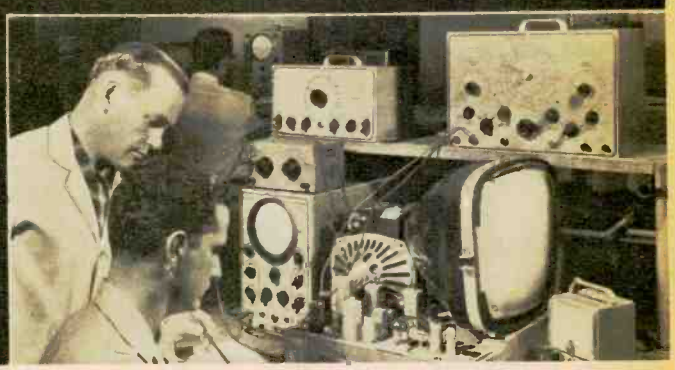
AM-FM and Auto Radios Transistors—Printed Circuits—Test Equipment

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



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FEEDBACK

● *Correction*

In your article VOICE CONTROL YOUR MODEL TRAINS (December '60 EI) I have found a few corrections that I believe should be made.

1. In the pictorial diagram the center arm of R2 should go to the second lug from the right on the terminal strip. You have it going to R1, and the top of control you have going to primary of T2. It should go to R1.

2. In last sentence of the text you call the pilot light PL1. It should be PL2.

3. The relay you call for in the parts list is 6VDC and you list a 12VDC power supply. Which is right?

Sol Abramowitz, WØWSK
Sol's TV Service
Denver, Colo.

You are right on Nos. 1 and 2, Sol, and we're right on No. 3 (6VDC relay, 12VDC power supply). Thanks for writing.

● *They Went Thataway*

As author of the article on Civil Air Patrol stations (DXing THE CAP, March '61 EI), I have some frequency changes to report. The new channels are as follows:

Channel 1	2374 kc
Channel 2	26620 kc
Channel 3	4467.5 kc
Channel 4	4507.5 kc
Channel 5	4585 kc
Channel 6	143910 kc
Channel 7	148140 kc

By the way, the CAP (official auxiliary of the Air Force) is looking for members. Men and women citizens 14 through 18 are eligible for the Cadet program, over 18 for the Senior program. Write to the Commander, Headquarters, Civil Air Patrol, U. S. Air Force, Bolling AFB, Washington 25, D. C. for details.

Tom Kneitel
Operator, Station Empire 22
New York Wing Headquarters
Civil Air Patrol

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...electronics in the news

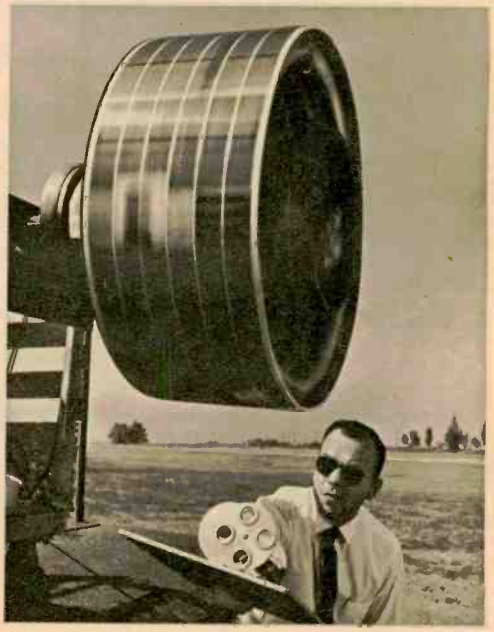
IS NOTHING SACRED? . . . How old is the wine or brandy in those imported bottles? The label may read 1948, 1936 or even 1910 but since the Bureau of Internal Revenue has a tax stake in the matter it wants to find out for itself. And the investigators use, of all things, a kind of geiger counter.

The method used to determine the age of the liquor is similar to that discovered by Nobel Prize winner Dr. Willard F. Libby. He was able to determine the age of ancient materials by measuring the radioactive carbon in them. Tritium, the radioactive form of hydrogen, is the age-determining material in liquor. Although there is only about two pounds of tritium in all the water on earth, it is readily detectable in minute quantities with instruments developed through nuclear research. Since tritium has a known half-life of 11 years, comparing a fresh bottle of tritium-containing water or liquor with an aged bottle will give the actual vintage. But what about us beer drinkers?

—o—

Communications via space . . . 1961 promises to be an exciting year in space. A chimp named Ham not long ago came back from way out there after paving the way for the first astronaut, who might be out of this world himself by the time this is published. Russia has launched a seven-ton satellite, heaviest man-made object in space. And the U. S. soon is to send the privately built, cake-shaped, lightweight (32 pounds) satellite pictured below into orbit 22,000 miles above the equator to speed up global communications. The space vehicle will be in stationary orbit, that is, its speed will be synchronized with the earth's rotation so it will always be positioned directly above the mouth of the Amazon River (or at any other spot chosen later). The relay satellite will be in line-of-sight to ground

Solar cells, 2700 of them, surround satellite. They power communications repeater system.



Satellite whirls through test at Hughes—1962 may find it whirling 22,000 miles overhead.

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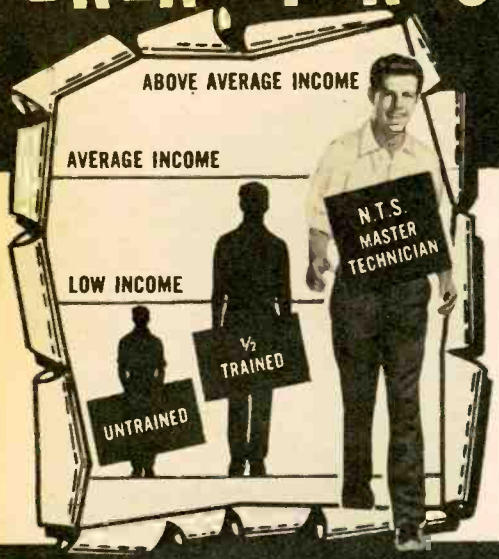

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- Technician in Computers & Missiles
- Electronics Field Engineer
- Specialist in Microwaves & Servomechanisms
- Expert Trouble Shooter
- All-Phase Master Technician

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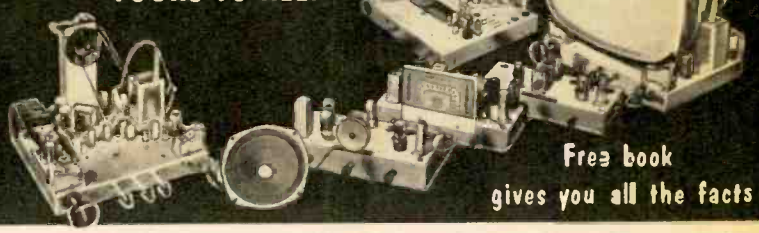

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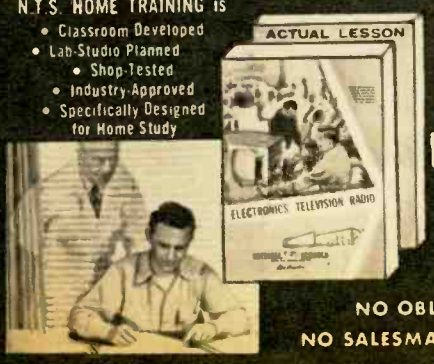

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. . . News

stations throughout most of North and South America, Western Europe and the western half of Africa. The broadcast material will be picked up by the satellite and re-broadcast to any country in "view." This will give us instant inter-global communications and permit exchange of TV programs. Those Scotland Yard boys finally will find out how Peter Gunn operates and the gals will be able to see Paris and Rome fashions firsthand.

—o—

Looking ahead . . . David Sarnoff, Chairman of the Radio Corporation of America, has made four interesting prognostications for the future in space.

First, satellite systems for world-wide communications to add speed, versatility and reliability to domestic and intercontinental communications.

Second, he expects the development of maneuverable satellites capable of detecting, identifying and rendezvousing with other satellites.

Third, a peace force of reconnaissance satellites. These satellites would be equipped with television, infrared and radar facilities to take pictures of the earth from several hundred miles in space, even in total darkness. They could furnish dependable data that nations are not arming for war, or perhaps warn us that they are.

And last, missile-bearing satellites able to launch retaliatory attack at a moment's notice against ground targets anywhere in the world. Such a weapon could be orbited at the convenience of the military forces, then directed to its target by ground stations.

—o—

Still they come . . . There seems to be no end to the transistor deluge. New ones appear so rapidly that one big electronics distributor issues a weekly bulletin to keep his customers up to date. At last count there were at least 4,000 different transistor types manufactured by 19 companies. By the time this item appears, the total will probably exceed 5,000 transistors with different specs. Where will it all end?

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

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

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The Grantham Communications Electronics Course prepares you for a *FIRST CLASS* F.C.C. license, and it does this by TEACHING you electronics. Each point is covered simply and in detail, with emphasis on making the subject easy to understand. The organization of the subject matter is such that you progress, step-by-step, to your specific objective—a first class F.C.C. license.

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

	License	Weeks
Richard M. Wilhoit, 2104 Santa Paula, Las Vegas, Nev.	1st	12
Larry R. Perrine, 7 Normandy Place, Champaign, Ill.	1st	15
Marion Woolsey, 3246 Warwick, Kansas City, Mo.	1st	12
Harold W. Johnson, 5070 Hermosa Ave., Los Angeles, Calif.	1st	15
Ralph Frederick Beisner, 2126 Grand, Joplin, Mo.	1st	12
N. B. Mills, II, 110 So. Race St., Statesville, N.C.	1st	12
Dean A. Darling, 403 S. Chase Ave., Columbus 4, Ohio	1st	12
Gerald L. Chopp, 518 Audubon Road, Kohler, Wisc.	1st	12

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18-E

Electronic Marketplace

Nine-transistor CB transceiver . . . By using transistors throughout, the makers of the Osborne 300 have been able to produce a CB transceiver measuring only 6″ x 7″ x 1⅞″. In its rugged metal case, it is suitable for mobile use in automobiles and boats as well as for fixed station service. Circuit features

include four-channel selection, crystal controlled receiver and transmitter, push-to-talk switching, high sensitivity and selectivity and low battery drain. Price is about $140. Osborne Electronic Sales Corp., 13105 South Crenshaw Blvd., Hawthorne, Calif.

—o—

Battery operated tape recorder . . . A miniature, two speed tape recorder has been announced by Lafayette. The RK-120 operates on either six self-contained penlight batteries or an external AC power pack. It features meters for battery condition and recording level and accommodates standard three-inch reels. The playing time is 68 minutes at 1⅞ ips and 34 minutes at

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

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You will receive training for the Novice, Technician and General Classes of F.C.C. Radio Amateur Licenses. You will build 20 Receiver, Transmitter, Square Wave Generator, Code Oscillator, Signal Tracer and Signal Injector circuits, and learn how to operate them. You will receive an excellent background for television, Hi-Fi and Electronics.

Absolutely no previous knowledge of radio or science is required. The "Edu-Kit" is the product of many years of teaching and engineering experience. The "Edu-Kit" will provide you with a basic education in Electronics and Radio, worth many times the complete price of $26.95. The Signal Tracer alone is worth more than the price of the entire Kit.

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

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

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

You begin by examining the various radio parts of the "Edu-Kit." You then learn the function, theory and wiring of these parts. Then you build a simple radio. With this first set you will enjoy listening to regular broadcast stations, learn theory, practice testing and trouble-shooting. Then you build a more advanced radio, learn more advanced theory and techniques. Gradually, in a progressive manner, and at your own rate, you will find yourself constructing more advanced multi-tube radio circuits, and doing work like a professional Radio Technician.

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

THE "EDU-KIT" IS COMPLETE

You will receive all parts and instructions necessary to build 20 different radio and electronics circuits, each guaranteed to operate. Our Kits contain tubes, tube sockets, variable, electrolytic, mica, ceramic and paper dielectric condensers, resistors, tie strips, coils, hardware, tubing, punched metal chassis, Instructions Manuals, hook-up wire, solder, selenium rectifiers, volume controls and switches, etc.

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

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- **SOLDERING IRON**
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- **HIGH FIDELITY GUIDE • QUIZZES**
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- **PRINTED CIRCUITRY**

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You will learn trouble-shooting and servicing in a progressive manner. You will practice repairs on the sets that you construct. You will learn symptoms and causes of trouble in home, portable and car radios. You will learn how to use the professional Signal Tracer, the unique Signal Injector and the dynamic Radio & Electronics Tester. While you are learning in this practical way, you will be able to do many a repair job for your friends and neighbors, and charge fees which will far exceed the price of the "Edu-Kit." Our Consultation Service will help you with any technical problems you may have.

J. Stataitis, of 25 Poplar Pl., Waterbury, Conn., writes: "I have repaired several sets for my friends, and made money. The "Edu-Kit" paid for itself. I was ready to spend $240 for a Course, but I found your ad and sent for your Kit."

FROM OUR MAIL BAG

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

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

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

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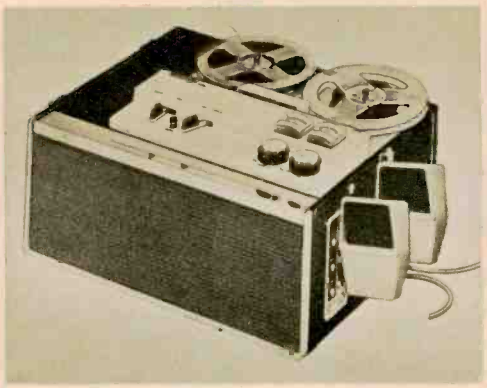
PROGRESSIVE "EDU-KITS" INC.
1186 Broadway, Dept. 536AE, Hewlett, N. Y.

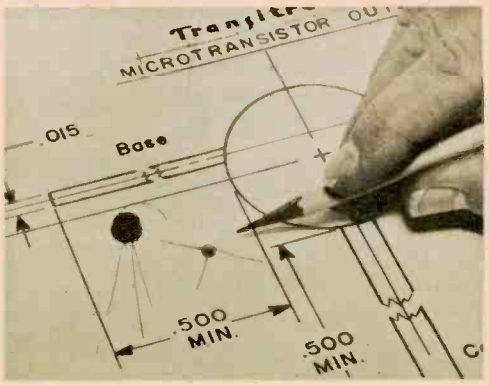
Marketplace



dental erase and two illuminated volume meters for positive balance of stereo recordings. Weight: about 30 pounds. Price: $250 including 2 microphones. Further information is available from the manufacturer at 100 N. Western Avenue, Chicago, Ill.

—o—

Glass enclosed transistors . . . By eliminating the possibility of leakage, the all-glass hermetic seal of a new line of micro-transistors assures operating stability of a very high order. Available in both amplifier and switching types, these silicon devices have a maximum



collector rating of 45 volts and a power dissipation of 200 milliwatts. They are about a sixth of an inch in diameter. Transitron Electronic Corp., 168 Albion Street, Wakefield, Mass.

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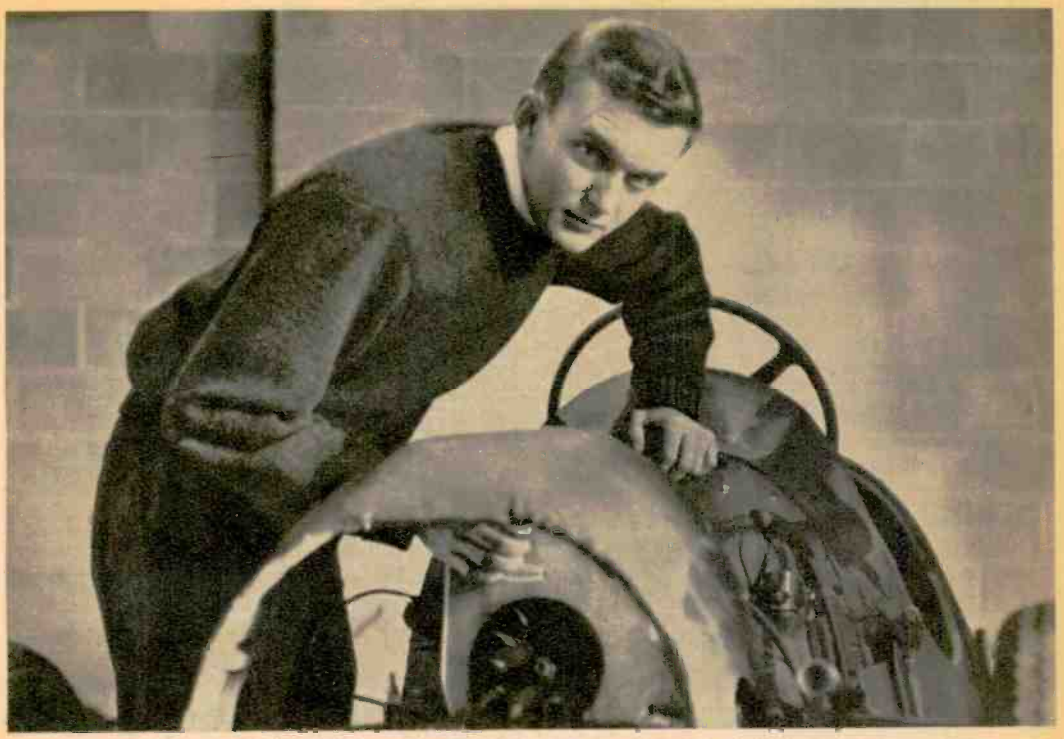
Marketplace

AM wireless microphone . . . Hollywood Voice-Speech Institute introduced their Model TR-18 transistorized transmitter which, when used in conjunction with a high impedance crystal microphone, enables the user to speak over any AM radio receiver without wire hookup to either the receiver or electrical outlet. Primarily developed for use in voice, speech and public speaking training, the TR-18 is also excellent for home entertainment, parties, etc. It is sold complete with microphone and stand, 25 ft. mike cable, instruction and technique manual. $24.95 from Hollywood Voice-Speech Institute, 5504 Hollywood Blvd., Hollywood, Calif.

—o—

Yes, it's a grandfather clock-radio . . . The base of this unusual piece contains a five-tube superhet receiver; the top, an eight-day wind-up clock. The entire 27″ unit can be placed on a table or hung from the wall. Price is about $70. With AM/FM receiver in same unit, the price is $90. TeleTone Company of America, 1668 Webster Avenue, Bronx, N. Y.



18-year-old Ronald Satterfield of Atlanta, Georgia, asked...

"Where should I build for the future?"

Ronald Satterfield answered this question last year by joining the Air Force. This year about 100,000 young men will also choose this highroad to the future.

Many will become expert technicians in such fields as airplane and missile maintenance, radar, communications. The future will find others in supervisory positions in important support specialties: administration, supply, air police work.

Numerous personal benefits go with service in the Air Force. Steady advancement, the opportunity for more education, medical and dental care, thirty days' vacation yearly. Most important, the Air Force can help a young man prepare himself for the age in which he will have to make his way—the Aerospace Age.

Could this be the place for you to build for the future? Use the coupon below. There's no obligation.

U.S. Air Force

Airman 2C Satterfield whose civilian hobby was building "hot rods," is presently enrolled in a 45-week electronic computer course at Keesler Air Force Base in Mississippi.

Career Information
Dept. ME15, Box 7608
Washington 4, D. C.

I am over 17 and a citizen (or resident) of the U.S.A. Please send me your illustrated booklet.

Name_____ **Age**_____

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Marketplace

New short-wave receiver . . . Slim-line styling gives the Hallicrafters S-120 an attractive look. Most of the front panel is devoted to an open-face dial

over which the four tuning bands, from 1600 kc to 30 mc, are spread. The loudspeaker is self-contained. There is a ferrite loop antenna for the broadcast band and an adjustable whip for the short waves. The S-120 is actually a stepped-up version of the Hallicrafters S-38E, a long-time favorite of SWL's.

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After two years of research and development, a speaker system we can offer to the public on a 100% MONEY BACK GUARANTEE. Compare the A. E. S. Gigolo, to any bookshelf speaker, regardless of price and if you do not feel that the Gigolo is the most outstanding unit you have heard, you may return it for a full purchase price refund.

Thousands of these gigolos are now in use all over the country. The acceptance has been unbelievable. Never before a sound so realistic to so many people in so many different homes! These are the facts that enable A.E.S. to make this bold offer.

Size —
24" wide, 12" high, 9½" deep.

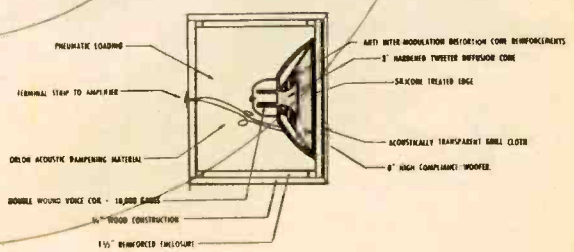
Power Handling Capacity —
The Gigolo is extremely flexible. May be used with small economy amplifiers of very low wattage, as well as with the highest power component amplifiers with satisfactory results.

Frequency Response —
The Gigolo will reproduce both high and low frequencies in excess of the requirements of even the most critical home listener.

Order now to insure prompt delivery

Price — $15.00, F.O.B. factory
Unfinished only

Price subject to change within thirty days of the issuance of this magazine



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A.E.S., Inc.
3338 Payne Avenue, Cleveland, Ohio

Gentlemen please ship ..... GIGOLOS.

I understand these units are guaranteed and if I am not satisfied I may return for a full refund of sales price, $15.00 each.

Name .....

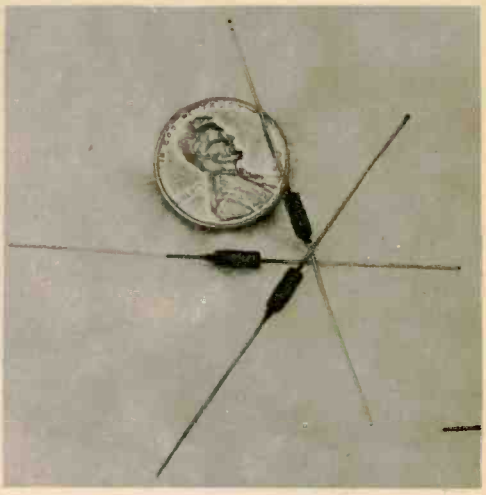
Address .....

City and State .....

Enclosed find check ..... money order .....

Marketplace

Low impedance zener diode . . . An extremely low dynamic impedance 6.2-volt, temperature compensated zener diode, #1N821A, has been introduced



by Motorola. It is designed for ultra-stable voltage control in transistor equipment having critical requirements. Motorola, Phoenix, Ariz.

—o—

Directional hearing aid glasses . . . Otarion Listener Corp., in an effort to permit people with hearing defects to hear in a more normal manner with the aid of amplification, has developed eye glasses with a tiny microphone buried in the front instead of at the temples.

[*Continued on page* 99]

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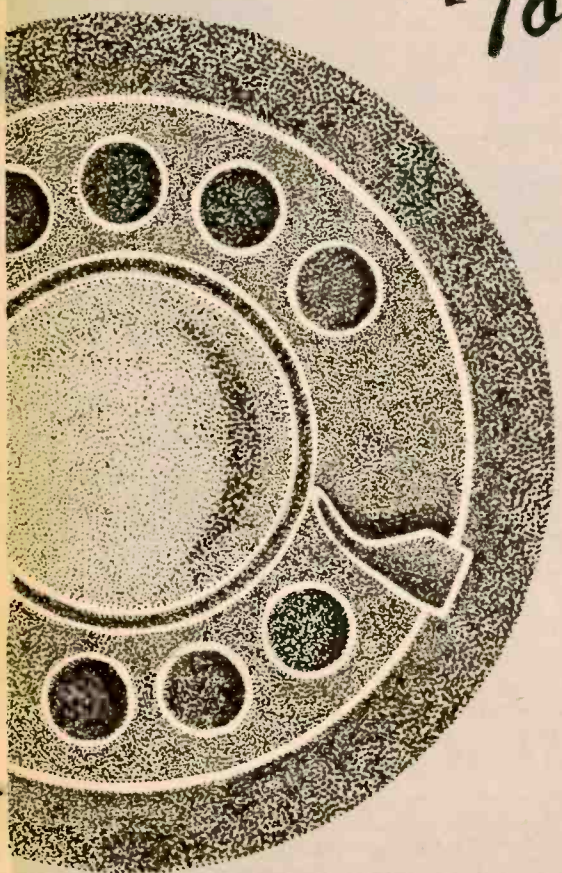
MAY 1961

Tomorrow's TELEPHONE Today!



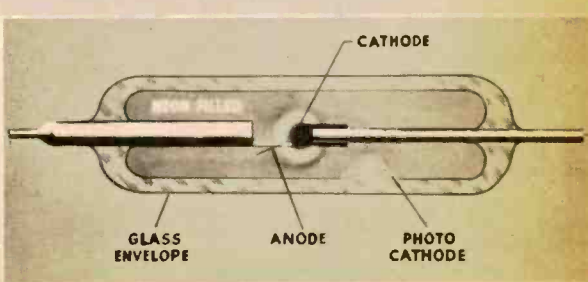
By Sanford Maizel

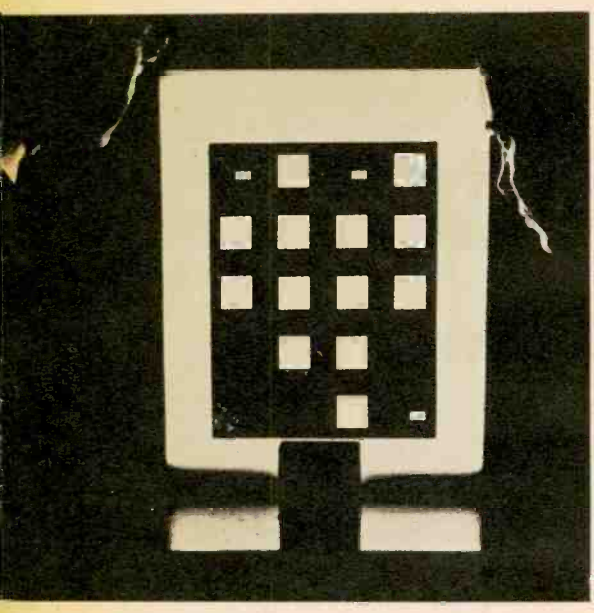
THE ROOM looks like most any other. There's a sofa, some comfortable chairs, perhaps hi-fi and TV, and a telephone. It's at the phone that the resemblance ends. This home happens to be in Morris, Ill., 40 miles from Chicago, and at the other end of the telephone line is the newest brainchild of Bell Telephone Laboratories. It is an experimental Electronic Central Office.

If you happen to be one of a group of telephone subscribers in Morris who are hooked to the experimental central office you can get some services that not long ago didn't seem possible for close to a decade.

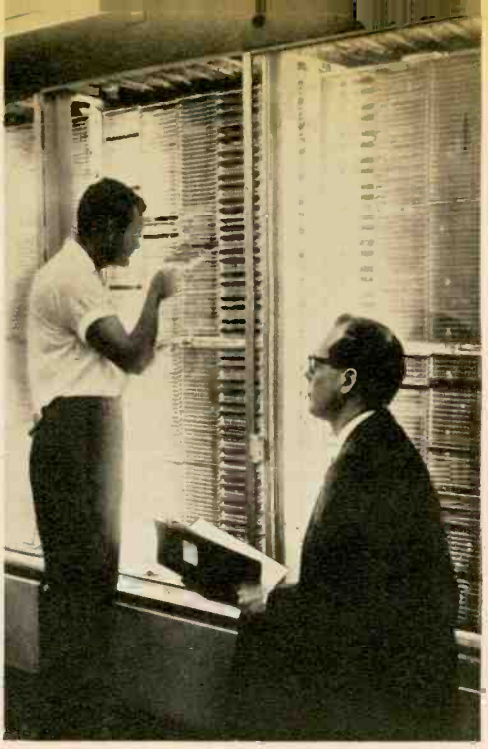
What'll you have? Want your phone to serve as an intercom? Just ask. Want to be able to call your friends by dialing just two digits? That's easy. Would you like your calls automatically rerouted to your brother's phone if yours happens to be busy? A cinch. Or maybe you're going on vacation and would like all

Speed demon in new telephone exchange is gas tube relay, replacing slow mechanical unit.





Photographic memory plate as seen in darkroom. Squares hold 30,000 bits of information.



Gas tubes arrayed to form switching network. The white dots at right are tubes now in use.

your calls to go to your mother's phone. Presto—it's done!

These unusual telephone services are not just dreams. They are being performed today by Morris's Electronic Central Office (ECO). They seem to be not long off for the rest of the country, either.

There's another change in this phone-service-of-tomorrow that Morris residents are getting today, but it may not be quite as noticeable. In central telephone offices every place else in the country you can see racks and racks of electro-mechanical relays that click away day and night. When you call across the street dozens of these relays close to complete the circuit.

In the ECO there are no chattering relays. They have been replaced by noiseless neon-filled tubes that are about as large in diameter as a fountain pen and 2½ inches long.

Inside are two elements, a cathode and an anode. Apply voltage to the cathode and you get a gas discharge across the tiny gap to the anode. The all-electronic tube will now carry your telephone conversation, just as would the contact points of an electro-mechanical relay.

What all this means is speed. An electro-mechanical relay requires a few milliseconds to close (the exact time depends on the condition of each relay). The gas tube acts roughly 1,000 times faster. Trying to cut off milliseconds may not at first seem worth the effort but consider this: a coast-to-coast call involves thousands of relays and the closing time of them all adds up to something like ten seconds. Cutting that interval to the thousandth part begins to mean something. It may mean even more in the future when we have a worldwide telephone system.

The gas tube relay actually is the heart of the Morris operation, which originally was planned largely to test this device. The experiment is designed to iron out bugs in the system, and it also will determine just which of the additional services we mentioned at the beginning of this article are most useful to subscribers.

Those additional services now available to Morris residents are possible because of a [*Continued on page* 109]

No need to make any electrical connections to your transistor radio with this converter. Rubber bands hold the units close enough for inductive coupling.

Piggy-Back CB Converter

Inexpensive two-transistor strap-on unit turns any radio into a sensitive double-conversion CB receiver

By Harry Kolbe

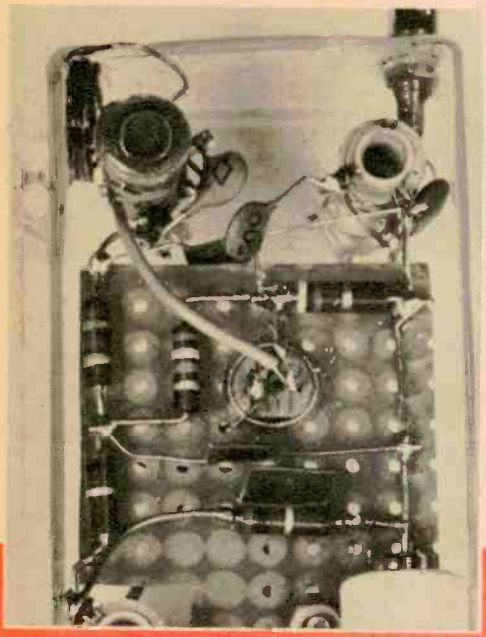
HOW would you like to have a pocket-sized, super-sensitive Citizen Band loudspeaker receiver for about eight bucks? Hang this little two-transistor converter on your AM transistor pocket radio and you've got it. And you won't have to perform any surgery on your radio; for normal broadcast band reception simply unhitch the converter or just turn it off.

The converter contains a tunable oscillator (Q2) which operates about 1.6 mc below the incoming signal. A second transistor Q1 mixes the output of the oscillator with the incoming CB signal, to produce a third *difference* frequency of 1.6 mc which is picked up by the broadcast receiver. This process is known as double conversion because the received signal is first converted to a 1.6 mc IF by the converter then to 455 kc by the radio. Double conversion affords far greater sensitivity and selectivity than the more common single conversion technique.

Construction

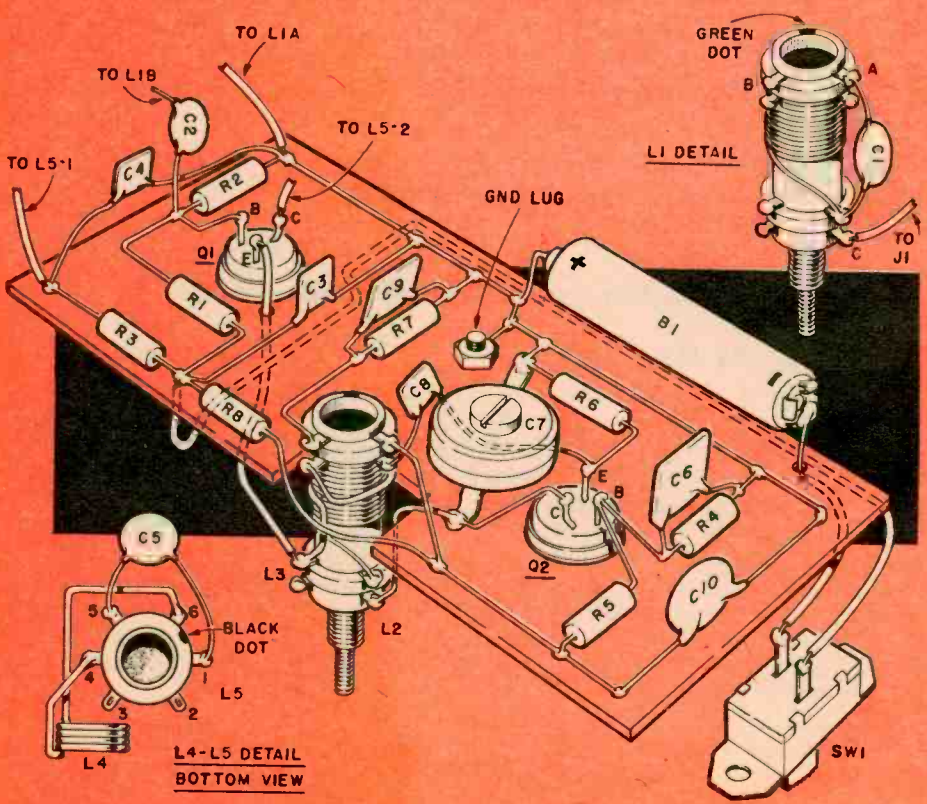
The unit is built in two sections: the

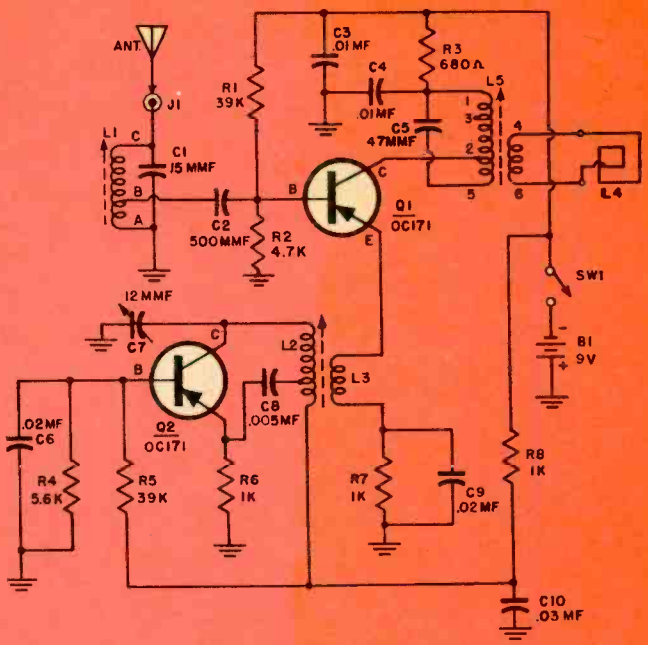
Coil L1 is in the upper right corner under J1. L4 is in extreme upper left corner next to L5.



PARTS LIST

Capacitors: low voltage disc ceramics
C1—15 mmf
C2—500 mmf
C3,C4—.01 mf
C5—47 mmf
C6,C9—.02 mf
C7—3.5-12 mmf trimmer (Centralab 827B)
C8—.005 mf
C10—.03 mf
Resistors: ½ watt, 10%
R1,R5—39,000 ohms
R2—4,700 ohms
R3—680 ohms
R4—5,600 ohms
R6,R7,R8—1,000 ohms
Q1,Q2—OC171 transistor (If not available at your distributor, write to Amperex Electronic Corp., 230 Duffy Avenue, Hicksville, L. I.)
B1—9-volt mercury battery
SW1—SPST slide switch
J1—banana jack
L1—20 turns of #28 enameled wire on North Hills F-1000 coil form. Tap at fourth turn. (Form available at Radio Shack Corp. and elsewhere)
L2—20 turns of #28 enameled wire on North Hills F-1000 coil form. Tap at 5¼ turn
L3—1 turn of #22 enameled wire around the center of L2
L4—3 turns of #22 enameled wire
L5—Oscillator Coil (Lafayette MS-165 or equiv.)
Misc.—15" collapsible antenna, piece perforated phenolic board, plastic box, hdwe., etc.





The output of oscillator Q2 is inductively coupled to L3 and then transferred to the emitter of the mixer stage Q2. Difference frequency in standard broadcast band is coupled to radio through L4.

chassis and the case. The case is a 4½"-x2"x1¼" plastic box with a hinged cover drilled to mount L1, L2, L3, T1, J1, S1, and the chassis mounting bolt. The rectangular slot for S1 is made by drilling several holes close together and then shaping them with a small flat file.

In order to eliminate hand-capacitance detuning and to improve stability, the case should be shielded by cementing aluminum foil around the long inside dimension of the box. Do not shield L4. (The author's model was left unshielded for photographic purposes.) Electrical contact must be maintained between the foil on the top and bottom halves of the case. Cut the foil leaving a ½" wide strip between the top and bottom pieces. Leave enough slack in the strip to permit cover to open and close.

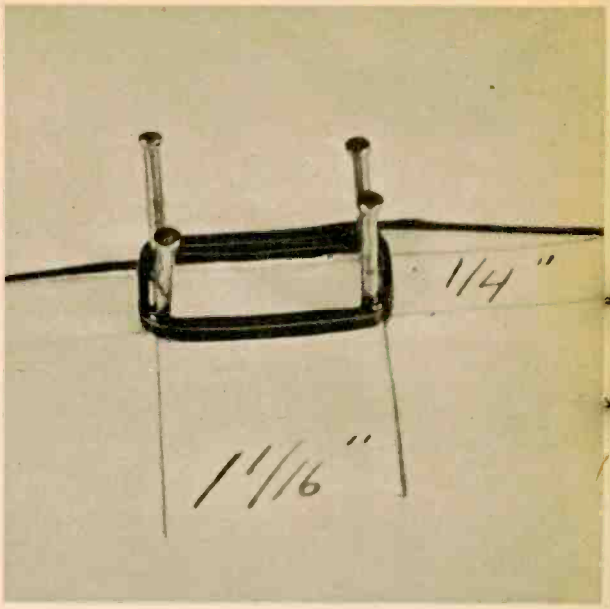
Coil Winding

The most critical step in the converter construction is winding the coils. Antenna coil L1 consists of 20 turns of #28 enameled wire tapped at the fourth turn. (See parts list for forms). Wind on four turns starting at the bottom end of the coil form, slip a small rectangular piece of paper under the fourth turn, and con-

View of case after mounting all of the coils. Hole to right of L2 is for adjustment of C7.

tinue winding. Carefully scrape the enamel off the section of the fourth turn where it has been raised by the paper. Tin the bared section, cut one lead of C2 to ½" and solder to the tinned portion. Coat with coil dope then solder C1 across the two terminals of L1.

The primary of oscillator coil L2 is also wound with 20 turns of #28 enameled wire, but the tap is brought out at 5¼ turns. Solder a ¾" lead of C8 to the tap. L3 is one turn of #22 enameled wire wound around the center of L2 and coated with coil dope. A temporary coil form must be made to wind output coil L4. Mark out a ¼" x 11/16" rectangle on a block of wood and nail in four wire brads at the corners. Wind three turns of #22 enameled wire around the brads and coat them liberally with coil dope. After the dope has dried completely, carefully pull out the brads and cut the coil free from the wood block. L5 is a Lafayette MS-165 transistor oscillator coil with the terminal lugs clipped so it will fit in the case.



Wind 3 turns of wire around brads to form L4. Remove brads from block after coil dope dries.

Final Assembly

Mount L1, L2, L3, and L5 in the appropriate holes. Place the lock washer supplied with the coil forms between the form and the case foil. This insures good electrical contact between the coil slugs and the foil. L4 is cemented to the inside of the case next to L5. Solder the leads from L4 to lugs 4 and 6 of L5. Connect C5 between lug 1 and 5 of L5 and a ½" long lead of C4 to lug 1. Connect one end of a 3" length of hookup wire to the top lug of L3 (lug closest to case). The other end of this wire will later be pushed up through one of the perforations in the chassis and connected to the emitter of Q1. Now mount SW1 and J1.

The chassis is a 1⅝" x 3⅝" piece of perforated board in which three holes are drilled to accommodate the two transistor sockets and the chassis mounting bolt.

After parts mounting and wiring, mount the chassis in the case and solder two short leads between SW1 and the chassis. Secure the chassis with a ¾" bolt through a ⅜" metal spacer and a lock washer between the spacer and the foil shielding. Make the remaining connections between the chassis and the coils.

Operation

Attach and position the converter to the side of your AM radio (using rubber bands as shown) so that L4 is parallel with the radio's loopstick antenna. Plug the whip antenna into J1, turn on the radio and converter and tune the radio to a dead spot on the dial around 1600 kc. Set C7 for maximum capacitance and adjust the slug of L2 until you hear a signal from your CB transmitter or signal generator (tuned to 26.9 mc-27.2 mc). Adjust C7, L1, and L5 for maximum signal strength. L3 and C7 tune very sharply, so go slow or you will miss the signal. The converter may have a tendency to drift slightly as its distance from the transmitter increases. If it drifts, a small adjustment of C7 will bring the signal back in.

The converter will also tune above and below the Citizens Band. Although tuning is quite sharp, we have been able to listen to hams, international shortwave, and service stations.

BONANZA FOR PROSPECTORS

The pan and the sluice have taken a back seat to electronic gear that leads you to the treasure.

By John D. Lenk

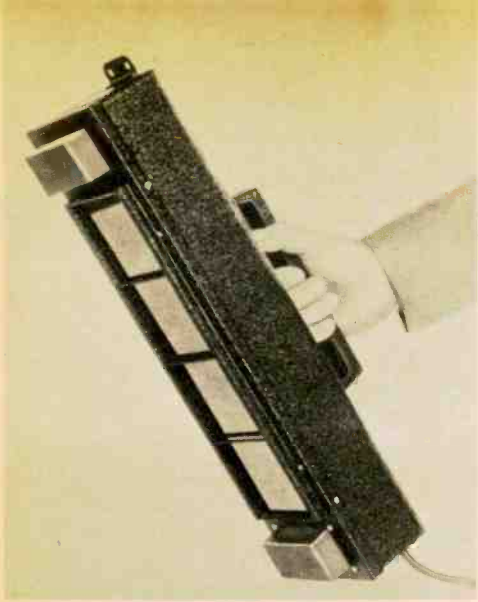
GRIZZLED prospectors of old would be in for a big surprise, and maybe a chuckle or two, if they got a look at their modern counterparts. The treasure hunter of today has traded the burro for a Jeep and the beard for an auto-home razor. More importantly, the pan and sluice-box have given way to a back-seat full of electronic gear.

Shoe clerks on the New Frontier march through desert heat listening to clicks on a geiger counter. Nice old ladies from Dubuque examine mineral samples with ultraviolet lamps, and teen-agers search beaches and caverns with metal locators. It is estimated that 300,000 amateur prospectors are equipped with electronic apparatus of some sort. There are many electronic aids for the prospector. This article deals with the three most useful pieces of equipment.

Although prospecting is an interesting hobby, strikes found in the last few years with the aid of electronics stagger the imagination. Anyone familiar with the recent uranium boom knows how Charles Steen, exploring the Colorado Plateau, hit it rich with his Mi Vida claim, worth tens of millions. Of course,

Elaborate metal locator has a 27-ft. depth range for buried treasure; it costs $195.

Underwater metal finder by Goldak is for use by diver in salt or fresh water, costs $195.



Ultra-Violet, Inc., San Gabriel, Calif.

Powerful ultraviolet lamp for field use will cover 8x10-ft. area, carries a $179.50 tag.

he was an experienced geologist. But amateurs also have hit the jackpot. Such a person was Vernon Pick, who owned an electrical shop in Minnesota. When fire destroyed his small shop, he went prospecting and unearthed the Hidden Splondor mine which he sold for $9,000,000.

Is anything left for you to find? In short, yes. The uranium boom is over, but high-grade uranium ore still is marketable. More importantly, many materials found in association with uranium-hunting are valuable. An example is the rare-earth deposit discovered at Mountain Pass in California. The prospectors were looking for uranium with a geiger counter, but all their samples were rejected as containing too little uranium. They were about to pack up when one of the men examined a sample with a pocket spectroscope, which indicated the material was in the cerium group of rare earths. The mineral turned out to be bastnasite and the resulting mine brings in $90,000 every day of operation.

Finally, the government recently estimated that we have dug up only 10 per cent of the gold deposits in this country. The remaining 90 per cent is just waiting to be found.

How is electronic equipment used to prospect? In the case of uranium, the two tools are geiger counters and scintillation counters.

The geiger counter's detecting element is a Geiger-Mueller tube. Weak impulses are triggered when gamma rays emitted by radioactive substances strike its face. These pulses are amplified to produce a click in an earphone or loudspeaker, or to flash a neon lamp. Geiger counters are now going for panic prices. A good one can be had for as little as $25.

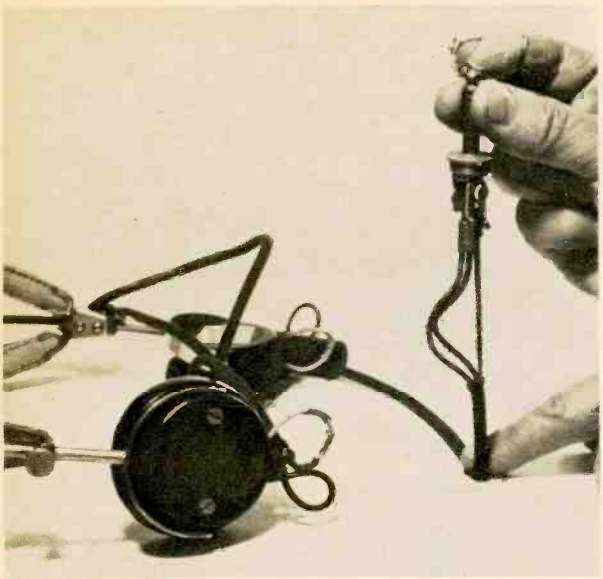
The scintillation counter's detecting element is a crystal of some phosphor, such as potassium iodide or sodium, which emits scintillations of light when struck by alpha, beta or gamma rays. Scintillation counters are more sensitive than geiger counters, and more expensive.

Geiger and scintillation counters are simple to operate, involving little more than turning them on and holding them near materials to be checked. Detailed instructions on interpreting the readings are easily procured.

Ultraviolet lamps are useful in prospecting because of an effect known as fluorescence. Light is given off by certain mineral and organic materials when ultraviolet rays strike them. Most important ultraviolet target is scheelite or tungsten ore. To date, over $100,000,000 worth of [*Continued on page* 111]

Average-size geiger counter has headphone and meter readout system. List price is $99.50.

Goldak, Inc., Glendale, Calif.



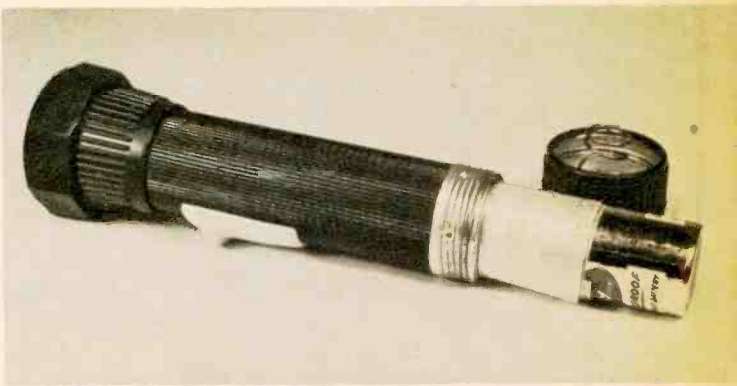
Try These

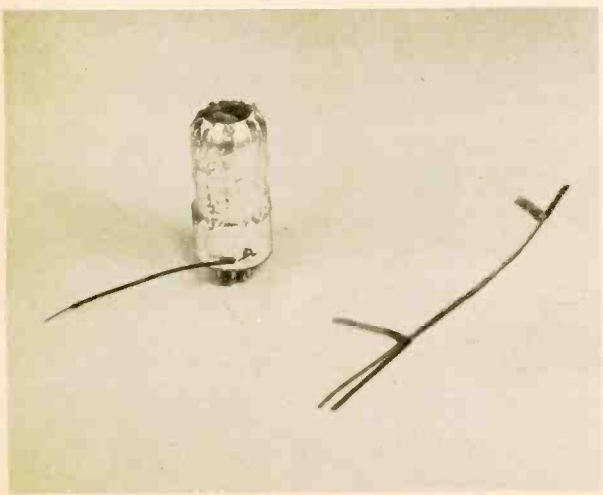
Strain Loop Protects Earphones

Many people buying earphones for the first time are puzzled by a string emerging from the end of the connecting cord near the tips. This is a strain loop, and its purpose is to protect the relatively fragile cord (which is actually made of tinsel, not wire) from pulling away from the tips when it is pulled too hard. Tie the string to the phone plug so that it is shorter than the connections proper, as shown.

Waxed Paper Protects Flashlight

With certain types of flashlight dry cells there is always the danger of swelling, splitting, and the releasing of corrosive electrolyte which will ruin the flashlight. As a simple precaution wrap the batteries with several thicknesses of waxed paper before fitting them into metal or plastic flashlight case.

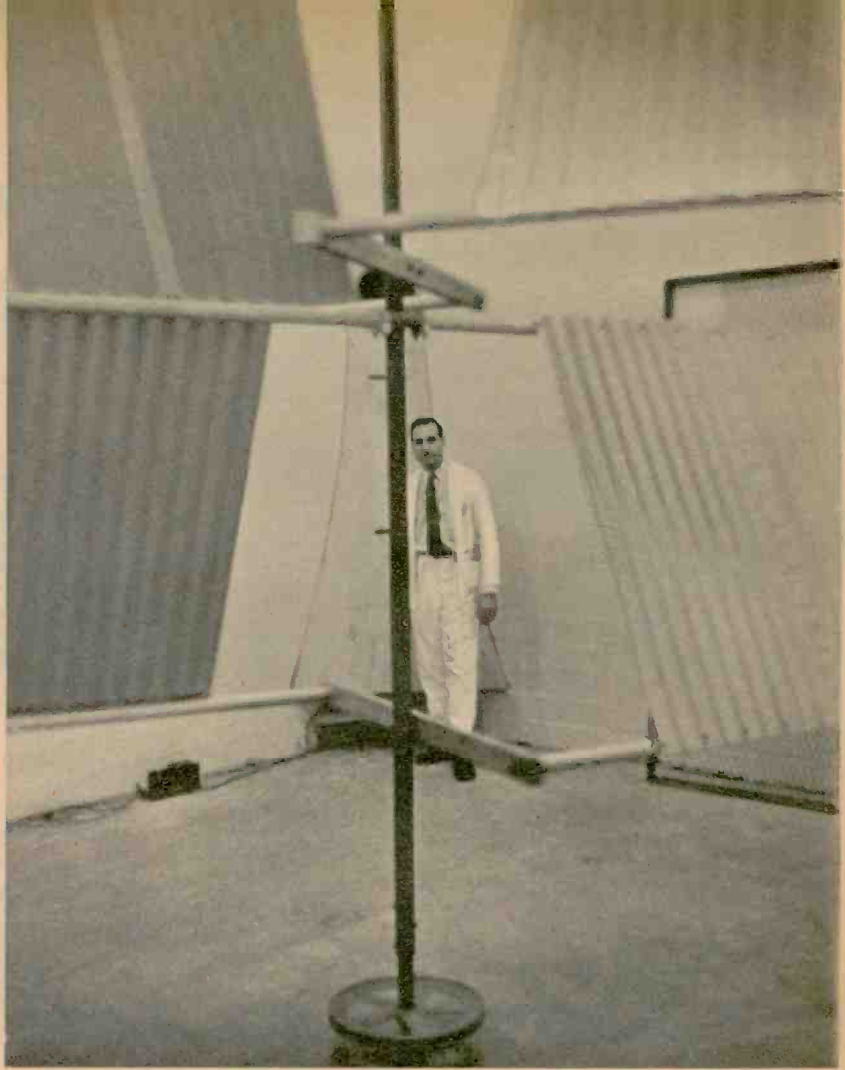




Aluminum Foil Shielding

Aluminum foil can be used for most applications where electrostatic shielding is required. For example, as a tube shield, the foil can be wrapped around the tube and a piece of wire soldered to the foil then grounded. Leave a large opening at the top for ventilation.

For shielding cable, the foil can be cut into a 1/4" wide strip and spiralled round a length of insulated wire. Aluminum foil can be tinned with rosin-core solder and a good hot iron. Solder rapidly to keep from melting the foil.



Dr. Robert I. Henkin is standing in one corner of his reverberation room behind a windmill-type circulation system which he used to distribute sound in an even pattern through chamber.

The Secret Power of Sound

This is one end of a long closed tube used to study the physiological changes in rats.

Zinc-sulfate electrodes were attached to each hand to detect changes in the skin resistance.

The mind and body of man are greatly influenced by music and other sounds, and now a scholar analyzes sound to determine the power of its basic elements.

THE power that music hath over the savage beast is well known to even the elementary school pupil. And we've all been stirred by a Sousa march, or excited and horrified by a combination of sight and sound in horror movies.

Just offhand you might say that, sure, sound and music have a strong effect on people, and the same sounds probably produce the same reactions in just about everybody. But how do you know for sure?

A young doctor asked himself this question, and a good many others, and the result was a research project in which he attempted to analyze the various basic elements of sounds and music and to arrive at some conclusion as to the predictable human response to each element.

The researcher is Robert I. Henkin who, just coming up on 30 years of age, probably is one of the most qualified men for such a project who could be found. He holds an AB in music from the University of Southern California, a PhD in music-psychology from UCLA and an MD from the latter school. He is a practicing composer, has written several films in Hollywood, composed background music for radio and theater and has had several performances of his serious works in the United States and Europe.

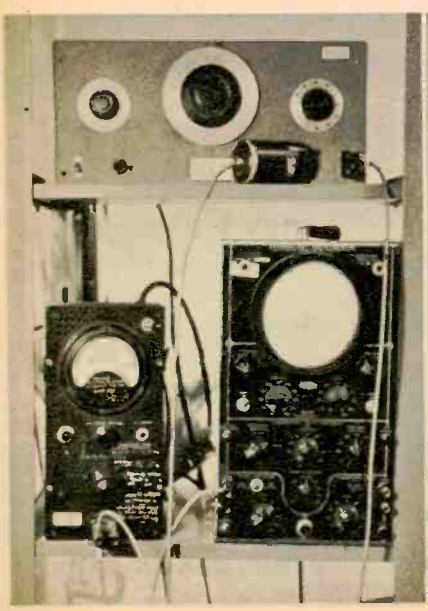
Dr. Henkin is knowledgeable also in the fields of psychology, advanced mathematics, statistics, engineering and acoustics. He has recently been working in the field of neuro-endocrinology, which encompasses the interaction of the nervous system and the endocrine system.

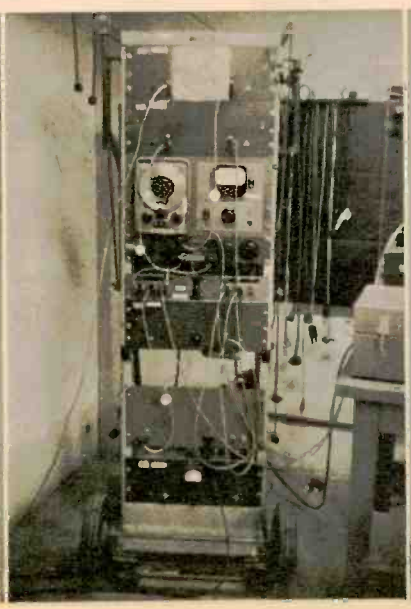
It was while interning in Los Angeles (he is now [*Continued on page* 95]

A voltmeter and oscilloscope were used to monitor sound intensity in tube for animals.

Instrument rack included a power supply and amplifier to control sound in reverb room.

Dr. Henkin beside rear-loading horn which was used to test listener's response to music.





build this

Transistorized Chord Organ

Ideal as a solo instrument or accompaniment to a piano. Can be preset to play a variety of chords.

By Fred Maynard
Motorola Semiconductor Products

ONE of the more encouraging present day phenomena is the growing interest in "play it yourself" music. This fad, if you want to call it that, has resulted from the intensive marketing of organs from the inexpensive air-driven reed types to the relatively elaborate electronic organs. One of the reasons for the popularity of organs is that they are easy to play, and even a rank amateur doesn't sound bad at one. The popular chord organs further simplify playing by the use of numbered or lettered music. The Monochord, which is of this design, is an easy-to-play musical instrument that produces organ-like tones by depressing any *one of five* keys. The correct chord harmony is created automatically but it should be kept in mind that the instrument's simplicity limits its musical flexibility.

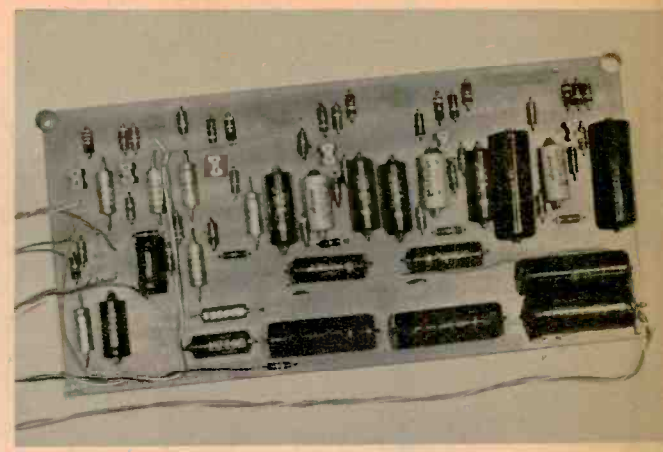


Fig. 1. Commercially available printed circuit board includes all but Q7, power supply, and RT resistors.

This article is intended as a take-off point for the advanced experimenter who may wish, through circuit expansions, to develop the Monochord into a full-sized organ with increased tonal capabilities such as auxiliary preset chords, bass, pedal bass, dynamic swell, and a larger amplifier. The Monochord is completely transistorized and can be built for as low as $50 by judicious selection of surplus components.

Since this project is to serve as a foundation on which to build, more space will be devoted to circuit theory than to construction details. Specifications for a cabinet are not included since the Monochord may be housed in anything from a simple box to the "console" shown in the photographs. One suggestion might be to purchase a small toy piano

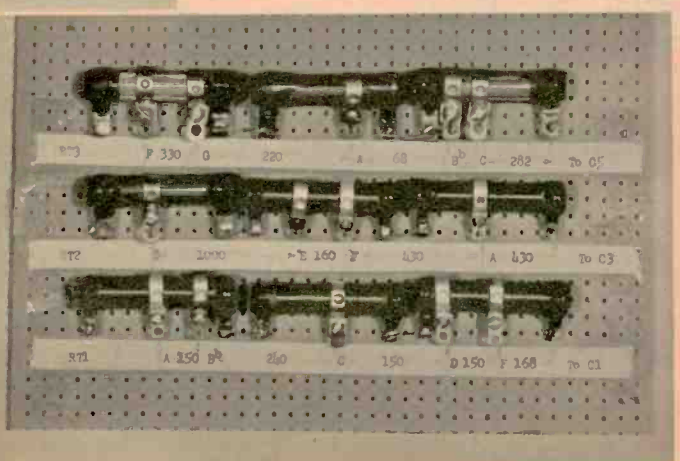


Fig. 2. Tuning resistors used with EI's printed circuit board. Use and adjustment of other parts is suggested in text.

EDITOR'S NOTE

Because of the complicated nature of the Monochord organ, we recommend it as a project for the advanced electronics hobbyist. The ability to wire, troubleshoot, or trace circuits is required. We suggest that beginners select less complicated projects. Mr. Maynard, designer of the Monochord, is a Project Engineer with the Semiconductor Products Division of Motorola, Inc., 5005 East McDowell Road, Phoenix, Arizona.

and use part of the keyboard for the organ. The extra keys could be used later in an expanded design if desired.

Construction

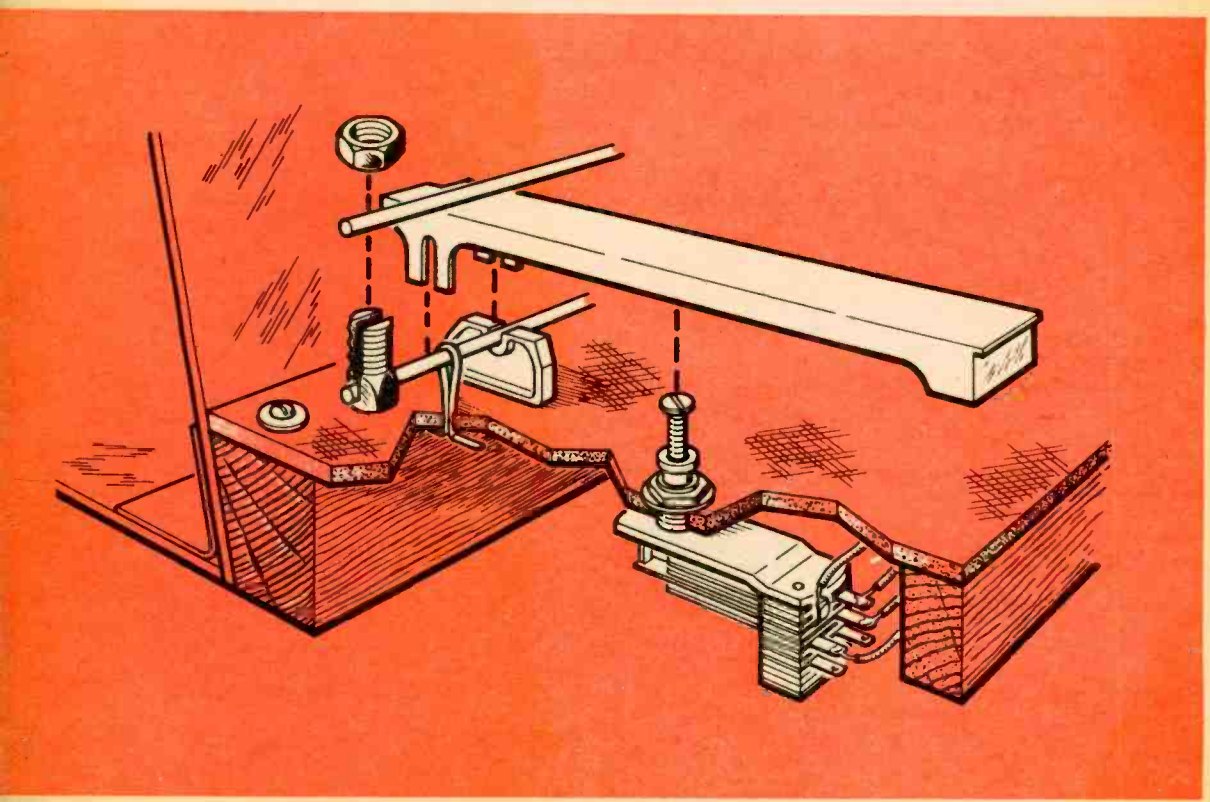
To simplify construction, EI has made arrangements to supply a printed circuit board for $5.00 (see parts list). This board includes all the circuitry except the power supply, power transistor Q7, and the RT tuning resistors. Power transistor Q7 should be mounted on a heat sink and the RT resistor strings may be made up of adjustable wire-wound resistors or potentiometers mounted on a perforated phenolic board along with the power supply.

Components

The components specified in the parts list have been selected on the basis of size, tolerance, cost and availability. Most of the resistors have 5% tolerance although 10% resistors could be used by selecting close values. This may, however, put some of the oscillators out of range and create tuning problems but this can be corrected by adjustment of the RT resistor taps. If an oscillator cannot be tuned by varying the RT tap, the value of the bridge resistors (for example R1 and R2 in oscillator O1) should be changed. Increase the value of *both* resistors by the *same* amount to lower the frequency and decrease their value to raise the frequency. Smaller capacitors may be used if their tolerance is 10%. Electrolytic capacitors C7, C8, C15, and C16, used in vibrato oscillator OV should also be of the specified value if a 6 cps vibrato frequency is desired. The other electrolytics, such as emitter bypass C18, should be at least 5 mf but may be larger.

It is quite feasible to use the oscillator section only in conjunction with another amplifier, such as a record player, tape recorder, or hi-fi amplifier. If so, only

Fig. 3. Button of key switch is drilled and tapped. Screw is adjusted for correct key action.



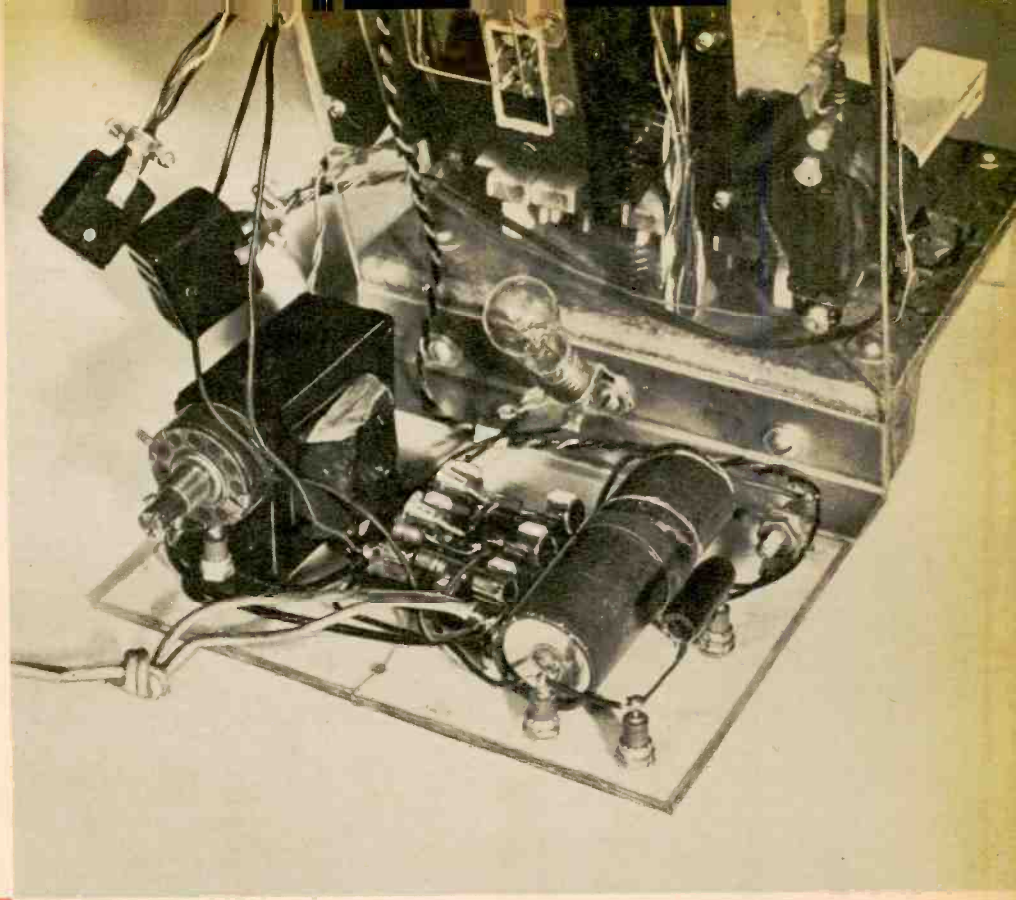
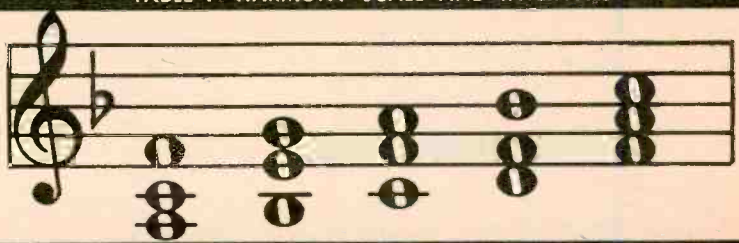


Fig. 4. Power supply of author's model. Four rectifier diodes ore mounted in standard cartridge fuse holders. A metal, plastic, or plywood chassis may be used.

TABLE 1—HARMONY SCALE AND INTERVALS



Melody	do	re	mi	fa	so
Harmony	F maj	C^7	F maj	F^4	F maj
Key Number	1	2	3	4	5

TABLE 2—OSCILLATOR TUNING FREQUENCIES

O1	O2	O3
F-349 cps	F-349 cps	C-523 cps
D-294 cps	E-330 cps	Bb-466 cps
C-262 cps	C-262 cps	A-440 cps
Bb-223 cps		G-392 cps
A-220 cps		F-349 cps

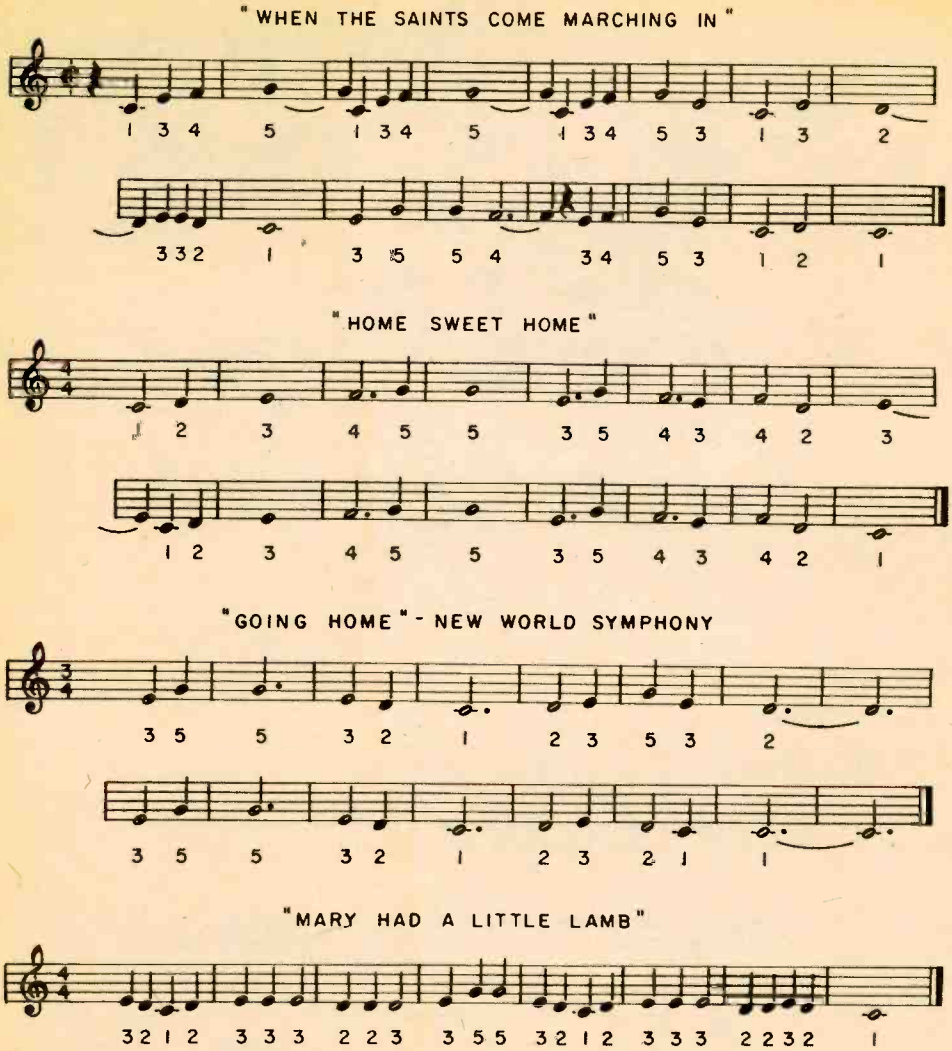


Fig. 5. Organ is tuned for music in C. Figures correspond to keys numbered from left to right.

the circuitry shown in Fig. 7 will be required and the output is taken directly from the wiper of R45 and the ground buss.

The keyboard for the organ consists of five keys about 7/8" wide and 4½" long. They may be made of wood, plastic or other material and should be painted a glossy white. Toy piano keys were obtained from Theo. J. Ely Mfg., Co., Girard, Pa. for the author's model. Switchcraft switches No. 1009 were modified slightly by drilling and tapping the knob to accommodate a 4-40 screw. This construction is shown in the cutaway view of the keyboard.

Tuning and Playing

As is shown in Table 1 the keys of this instrument play consecutive intervals of the diatonic scale in F (three-note chords). The topmost or melody notes are the consecutive intervals of F, G, A, B^{b} and C. The oscillators (O1, O2 and O3) provide other intervals in the same scale key to generate a pattern of preset harmony.

Though the model has been tuned to the F Scale, relative tuning to the diatonic intervals in any scale may be set up. The F Scale frequencies to the nearest unit value are given in Table 2. These are based on the American Stand-

ard Pitch musical scale with A above Middle C at 440 cps. Final tuning of the intervals to this scale may be done by the comparison technique using a calibrated audio signal generator, or audibly with a well-tuned piano or other musical instrument. An experienced musician can tune the instrument to relative correct intervals by ear.

The Monochord scale and several suitable musical selections appear in Fig. 5 and Table 1. Note that the instrument itself is tuned to the key of F, and the music written in the key of C. This was done to obtain better harmony, and so the music could be played on white keys.

Key Function and Tuning

Tuning and control of the oscillators is accomplished by the switches associated with the keys. The taps on RT3 provide melody notes F, G, B♭, and C; RT2 provides the second, and RT1 the third harmony.

When K5, for example, is depressed, the ground (+) spring engages with the contacts connected to the C, A, and F taps on RT3, RT2, and RT1 in that order, generating an F major chord with C in the upper or melody position. In a like manner, K4 generates the F⁶ (B♭ major) chord with B♭ on top; K3, the F major chord with A on top; K2, a C⁷ dominant chord with G on top; and K1, the F major chord with F on top.

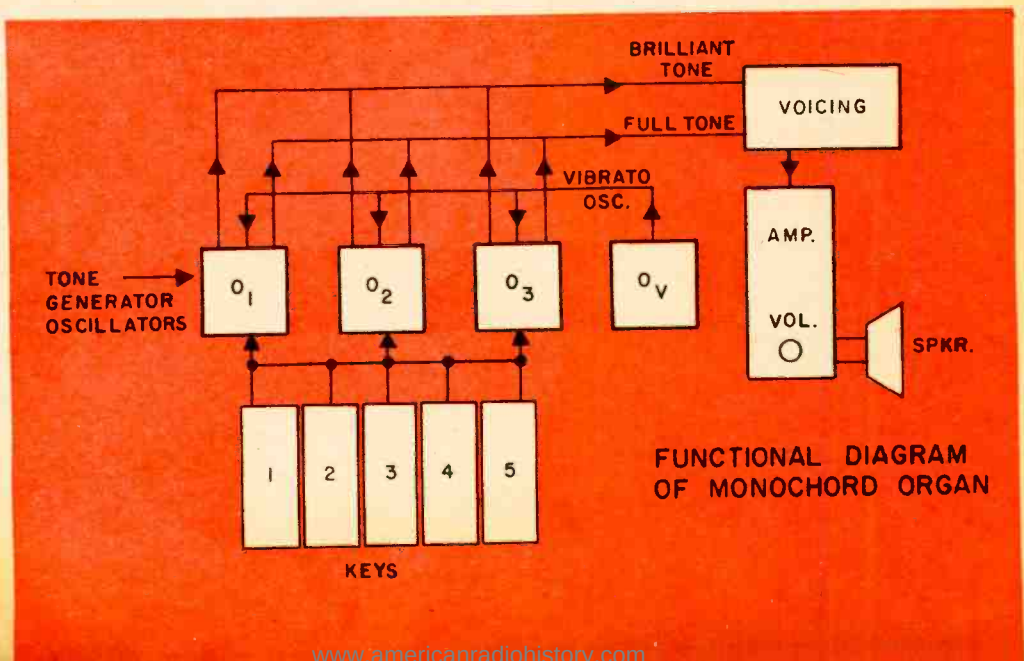
If the specified components are used in the oscillator circuits, the tuning strings (combination of resistors such as in RT3; 282 ohms, 150 ohms, 68 ohms, 220 ohms, and 330 ohms) may be made with fixed resistors of the values shown and the instrument will be reasonably in tune. However, due to component tolerances, it will probably be necessary to adjust these values somewhat to obtain precise tuning. When making these adjustments, use less resistance to obtain a higher frequency, and more for a lower frequency. The tuning must be done from the high end of each RT string first. For example, on RT3, tune the C accurately by altering the 282 ohm resistor before adjusting B♭, etc.

A very good substitute for fixed resistors in the RT strings are adjustable wirewound resistors, potentiometers or any cheap surplus components.

Amplifier

The amplifier (Fig. 8) is simple, transformerless, and has good fidelity with low distortion up to about ½-watt output. The first stage, Q5, a high-gain amplifier with some degenerative emitter feedback, is coupled to emitter follower Q6 to match the amplifier to the input of power transistor Q7.

Fig. 6. All oscillators are activated when a key is depressed. Tuning resistors set frequency.



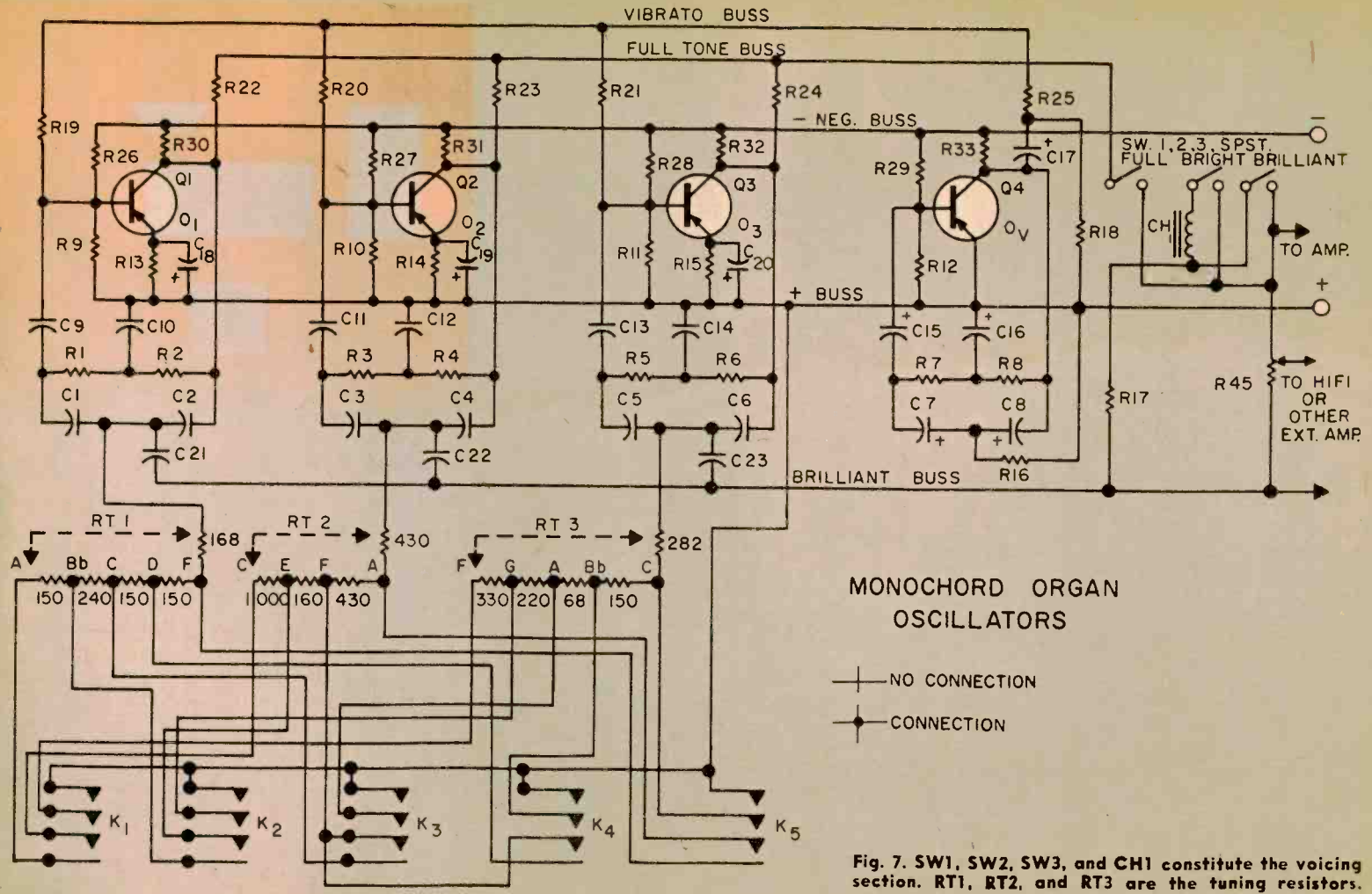


Fig. 7. SW1, SW2, SW3, and CH1 constitute the voicing section. RT1, RT2, and RT3 are the tuning resistors.

PARTS LIST

Resistors: ½ watt, 5% unless otherwise indicated
R1,R2—4,700 ohms
R3,R4—11,000 ohms
R5,R6—9,100 ohms
R7,R8—10,000 ohms
R9,R10,R11,R12—18,000 ohms
R13,R14,R15—200 ohms
R16—430 ohms
R17—15,000 ohms
R18—47,000 ohms
R19,R20,R21—300,000 ohms
R22,R23,R24—510,000 ohms
R25—150,000 ohms
R26,R27,R28—200,000 ohms
R29—470,000 ohms
R30,R31,R32,R33—2,400 ohms
R34—6,800 ohms, 10%
R35—1,600 ohms
R36—4,700 ohms, 10%
R37—30 ohms
R38—30,000 ohms
R39—2,000 ohms, 2W potentiometer
R40—3,600 ohms
R41—100 ohms, 10%
R42—47 ohms, 2 watt, 10%
R43—1 ohm, 5-watt wirewound 20%
R44—50 ohm, 10-watt wirewound 20%
Capacitors: 200 volt, 10%, tubular
C1,C2,C9,C12,C14—.22 mf
C3,C4,C5,C6,C11,C13—.1 mf
C10—.5 mf
Capacitors: 30-volt ceramic disc
C21,C22,C23—.002 mf
Capacitors: 25-volt electrolytic unless otherwise indicated
C7,C8,C15,C17,C24,C25,C26—5 mf
C16,C27—10 mf
C18,C19,C20—25 mf
C28—2,000 mf, 15 volt
CH1—6.3-volt filament transformer (Lafayette TR-11 or equivalent)
D1,D2,D3,D4—Motorola 1N1563 diode
DZ1—Motorola 10M12Z Zener diode
K1-K5—Guardian Relay series 200 contact parts or switchcraft type 1009 3PDT switches
Q1,Q2,Q3,Q4—2N655 or Motorola 2N1193 transistor
Q5,Q6—2N653 or Motorola 2N1191 transistor
Q7—2N176 or Motorola 2N669 transistor
RT—Tuning resistors. 10-watt wirewound adjustable, carbon potentiometers, or Mallory FT series sensitivity controls
SW1,SW2,SW3,SW4—SPST slide switch
SW5—SPDT slide switch
T1—24-26-volt filament transformer
Misc.—Intercom speaker, 45-ohm voice coil, Quam 4A1Z45; power transistor mounting kit, Motorola MK-15 or equivalent; 6 transistor sockets; toy piano keys available from Theo J. Ely Mfg. Co., Girard, Pa.; Printed Circuit board available from Detroit Electronic Corporation, 13000 Capital Avenue, Oak Park, Michigan for $5.00

R39, the volume control, provides a "swell" effect. Q7 is a 2N176 power transistor which should be mounted on a Motorola MS-10 heat sink or an aluminum sheet at least 3" x 3".

The speaker used in the Monochord is a 45-ohm intercom type speaker coupled to Q7 through capacitor C27. This arrangement wastes a little output power, but improves the sound quality by keeping DC out of the speaker voice coil. Ordinary 8-ohm radio speakers will *not* operate well in this circuit.

Power Supply

The simple power supply (Fig. 8) has been designed for low ripple. A zener diode maintains the output very close to 12 volts under all load conditions since regulation is essential to the stability of the oscillators. The instrument can also operate successfully on a 12-volt storage battery.

Circuit Theory

In the block diagram of Fig. 6, tone oscillators O1, O2, and O3 are adjusted to the correct frequencies and connected in such a way that when a key is depressed they're energized and tuned to the intervals required for both the melody and harmony. Thus a melody with two-part harmony is produced by each key. Two waveforms are generated by the tone oscillators to provide two of the organ voices and a third voice is derived from one of these in the voicing section.

The music is made more pleasing by the introduction of an electronic vibrato generated by oscillator OV.

Refer now to the schematic in Fig. 7. The tone generators (O1, O2, O3) and vibrato oscillator (Q4) are twin-T R/C circuits that are easy to build and very stable.

Tone oscillators O1, O2, and O3 are essentially identical except for some of the constants in the twin-T network. In oscillator O1 for example, this network is composed of C1, C2, C10, R1, R2, and RT1. C9 is a coupling capacitor and R26 and R9 provide base bias for transistor Q1. R30 is the collector load resistor, and R13 and C18 provide emitter stabilization. Feedback across the twin-T network between the collector (lower end of R30) and the transistor base results in oscillation. A 180° phase shift occurs at a definite frequency in the twin-T bridge to establish the oscillation frequency. Since RT1 is part of this bridge, its variation also changes the frequency. Various taps on RT1 are provided so that the chord intervals are generated whenever one of the taps is grounded. Grounding of the taps is accomplished by a multi-contact switch under each key which connects the taps to the + buss. To complete the circuitry

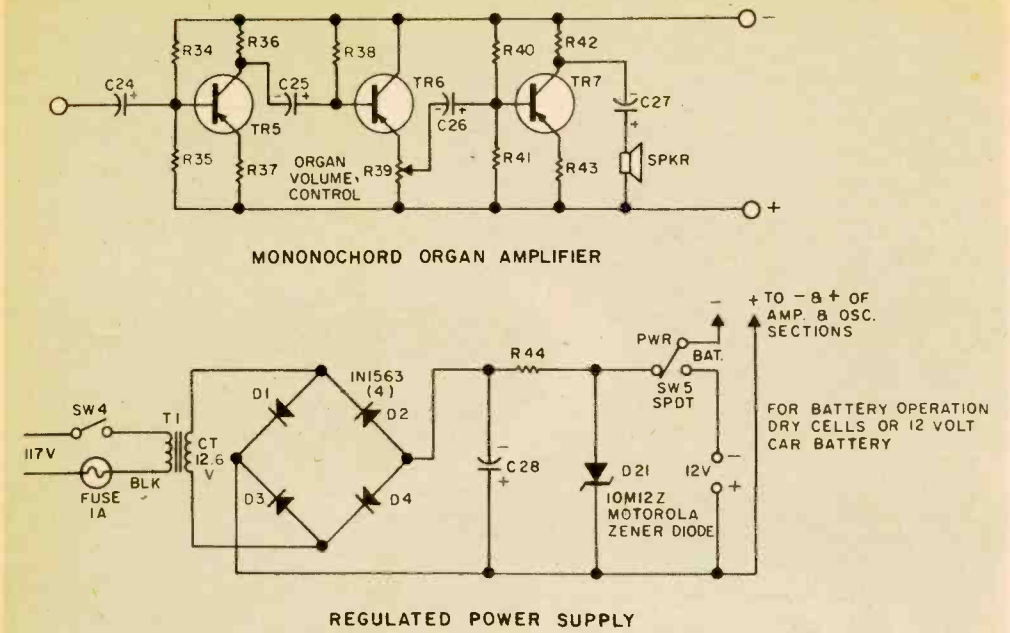


Fig. 8. An output transformer is not necessary since impedance of intercom speaker is 45 ohms.

of Q1, resistor R19 couples the vibrato signal from oscillator OV to the transistor base. Oscillators O2 and O3 are identical except for variations in the R and C values of the twin-T networks. These variations in component values provide the three frequency ranges required of the tone oscillators.

If you're thinking of setting up chords with notes out of the frequency range covered in Table 2, here's the way to determine the parts values to be used. The frequency of an oscillator can be lowered one octave (halved) by doubling the size of capacitors C1, C2, C9 and C21. Conversely the frequency can be raised an octave by halving their capacitance. Note the values of the parts associated with vibrato oscillator O4 which generates a 6-cps signal.

Organ Voicing and Vibrato

The twin-T oscillator has a useful feature as a musical tone generator. The branch composed of R1, R2, and C10 is a low-pass filter and that of C1, C2, and RT1 a high-pass filter. Tones of the same pitch but different waveform and musical quality can be tapped from this bridge at various places thus providing different organ "voices." In the Monochord, two of these tone outputs are used. A full tone, rather strong in the fundamental frequency, is coupled from the transistor collector load through R22 to the full tone buss. A brilliant tone, rich in harmonics, is tapped from the high-pass filter through C21 into the *brilliant* buss. The *full* tone buss, and the *brilliant* buss outputs are brought to the voicing switches SW1 and SW3 respectively. The *brilliant* signal is also fed through choke CH1 to SW2 to impart a resonance in certain ranges of the brilliant tone, giving a trumpet-like effect. CH1 is the 117-volt winding (black leads) of a small filament transformer; the secondary winding is not used. R17, in the *brilliant* buss, is used to balance the full and brilliant outputs. If the *brilliant* tone is too loud compared to the *full* tone, R17 may be made larger than the indicated value and vice versa. The output of the voicing section proceeds

to the power amplifier shown in Fig. 3.

Oscillator OV generates a 6-cps sine wave vibrato signal. Large value electrolytic capacitors are used to provide this low frequency. The emitter stabilization resistor and capacitor used in the other oscillators are not required here since the stability of this oscillator is not as important as in the tone generators. The frequency of the vibrato is established by R16 and can be made variable if desired by substituting a potentiometer. The vibrato signal is coupled from the oscillator through C17, and attenuated by the divider composed of R18 and R25, to the vibrato buss. The intensity can be varied by making R25 adjustable. This vibrato signal modulates the base inputs of the oscillator transistors through coupling resistors R19, R20, and R21 causing a combination of amplitude *and* frequency shift which is a combination vibrato-tremolo effect. Vibrato is frequency modulation of the sound and tremolo is amplitude modulation. These embellishments result in a periodic fluctuation of the tone to give the music a live sound.

The playing range of the Monochord can be somewhat expanded with more keys to allow playing a greater variety of selections.

It is believed the Monochord may introduce some new ideas, not only in interesting and useful transistor oscillator circuitry, but in simplified musical instrument design as well. These features, combined with economical straightforward and easy constructional approach, should make the Monochord of interest to hobbyists, embryo musicians, to children as quality toys, and to youngsters as a school science project. If you have a piano, your playing can be enhanced with an expanded model which includes many more chords.

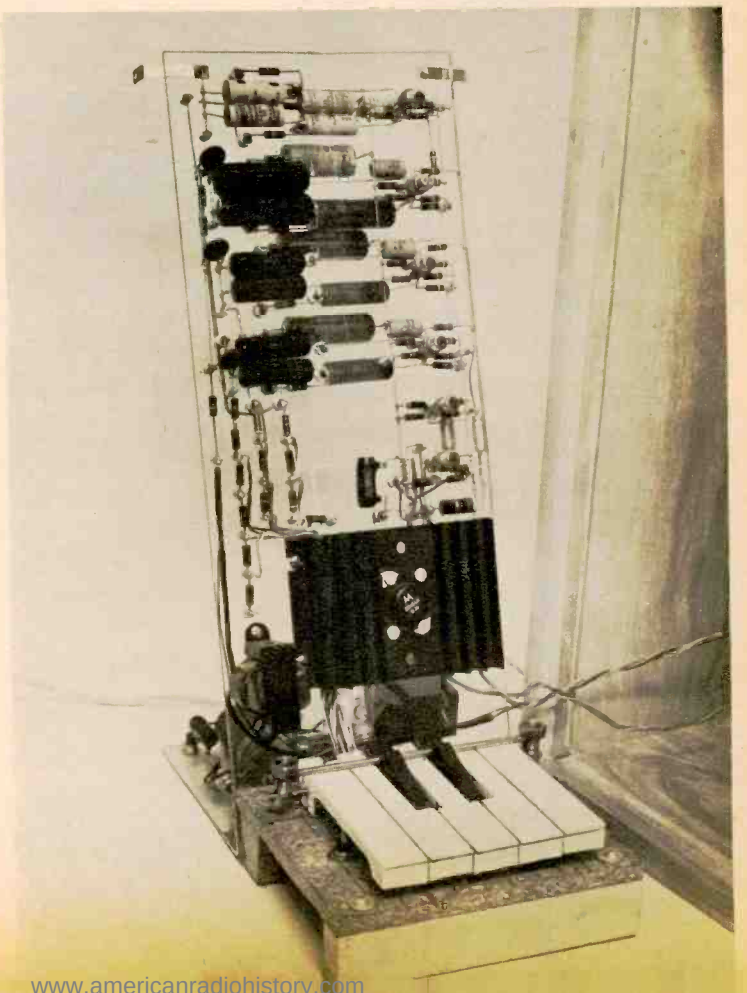
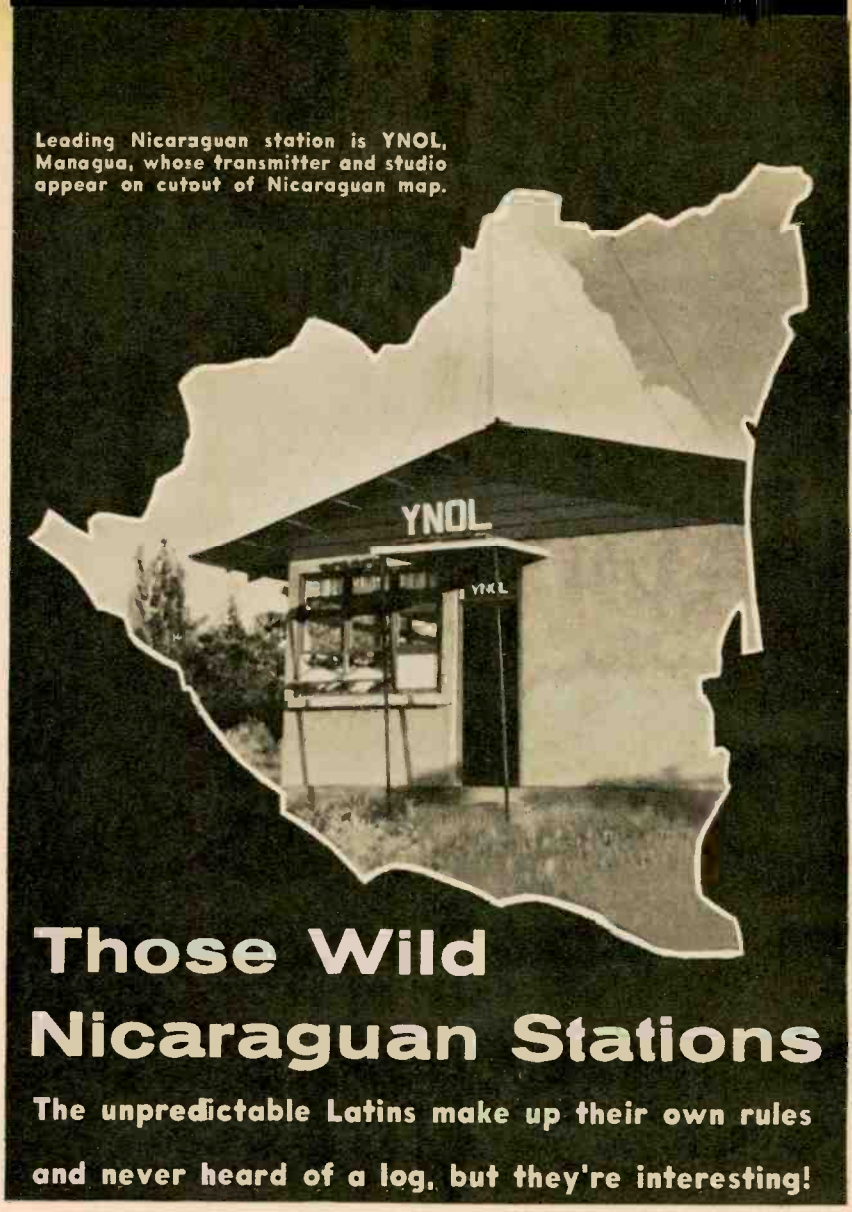


Fig. 9. Author's model built on plastic template. Fixed tuning resistors appear to left and above Q7's heat sink. Black keys are not in use.



Leading Nicaraguan station is YNOL, Managua, whose transmitter and studio appear on cutout of Nicaraguan map.

Those Wild Nicaraguan Stations

The unpredictable Latins make up their own rules and never heard of a log, but they're interesting!

OF ALL the Latin American countries, Nicaragua probably is the wildest to DX. Until the mid-Fifties, there were only a handful of stations in this jungle country, which is equal in size to Pennsylvania, Maryland and Delaware combined.

Within the last five years many new stations have come on the air but they haven't done much for the DXer. Most have low power and broadcast entirely in Spanish, factors which make it rough for the beginning DXer. But a thornier problem is that most stations do not QSL. Some don't even keep an accurate log to check [*Continued on page* 110]

DX GUIDE TO NICARAGUA

Call	Kc	Location/Operator
YNX	750	Managua Estacion X
YNOL	825	Managua Evangelical clergy
YNW	935	Managua Radio Mundial
YNBB	1145	Granada Ondas de la Alegria
PZA	1662	Puerto Cabezas (beacon) Lineas Aereas
YNWW	5965	Granada Radio Sport
YNWA	6140	Managua Radio Mundial

Power Wiring For Your Ham Shack

By Paul Hertzberg, K2DUX

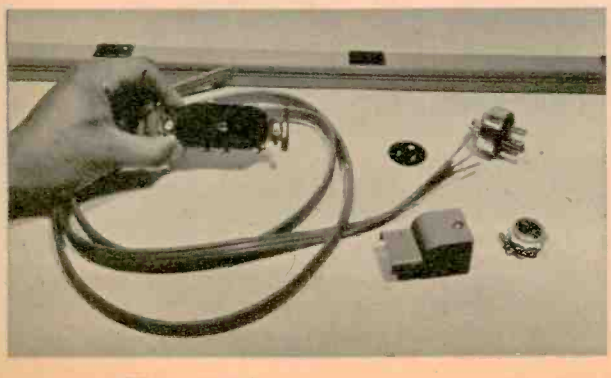
ELECTRICAL codes, convenience, neatness and safety should be considered when installing a master power wiring system in a ham shack.

We used one of the new three-wire outlet strips, mounted under the edge of the table, in our own shack. The equipment and layout can be changed to suit your needs and tastes. The basic requirements are shown here.

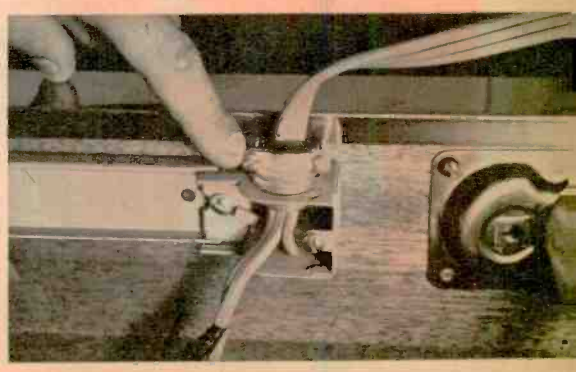
There are two types of grounding systems. If your house has BX cable the wiring can be grounded to the outlet box. If your house wiring is the insulated type, use a ground rod.

Safety device is this DPST toggle switch which with one flip turns off everything on the alert ham's table.

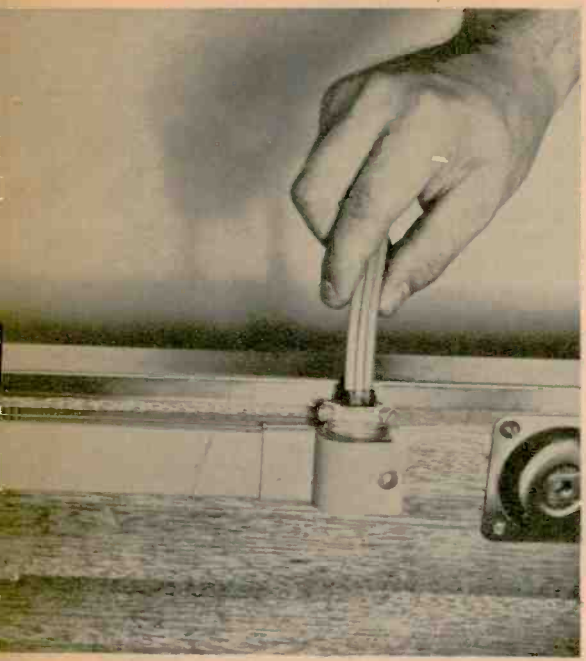
Needed components for wiring job include an outlet strip (Wiremold shown), 3-conductor wire, a 3-prong plug and wall outlet to fit.



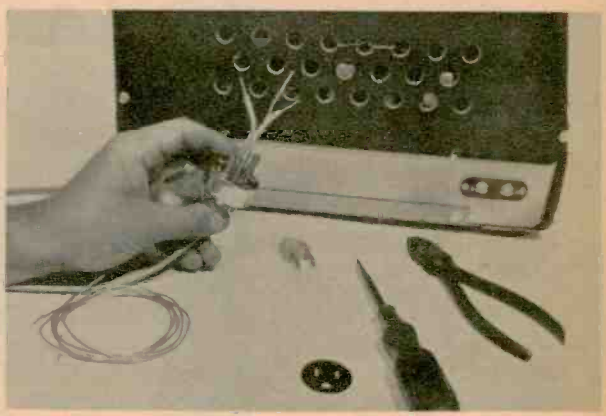
The end fitting for outlet strip is easy to mount. Strip is under edge of table with leg to right. Third wire is grounded to strip.



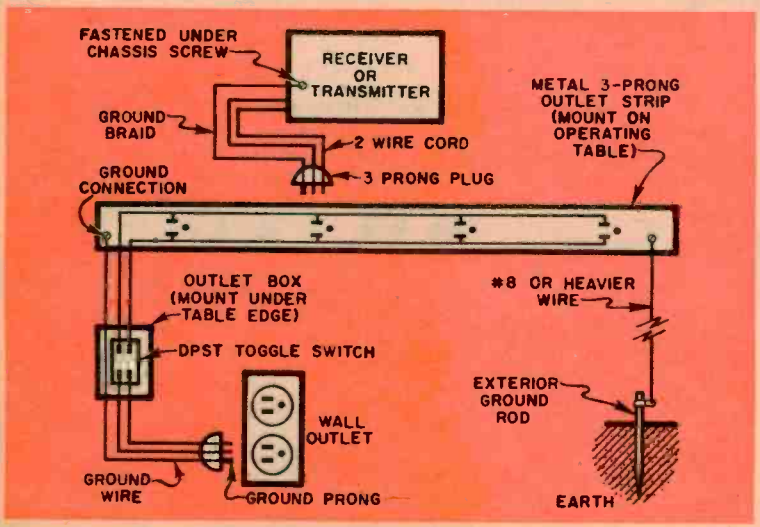
When the new 3-contact outlet is installed the third contact is grounded to the metal outlet box. Piece of braid is best for job.



Mounted and assembled strip looks neat. The metal table edge can be made an RF ground by wiring it to strip via a .001 mfd capacitor.



The ground braid is taped along power cord. One end is attached to the third prong of the new plug, other goes to chassis screw.



Master power wiring layout shows basic requirements, can be adapted to your own shack. Note that two ground systems are shown, one to outlet box if house has BX cable. If not, the ground rod is used, as indicated at the right.

EI field tests a

New CB Handie Talkie

FOR those who want to keep in touch while hiking, boating or camping or have a need for a special temporary wireless intercom, Lafayette's new HE-29 Citizens Band Walkie-Talkie is ideal. EI checked out a pair recently and found that at $49.95 each you get a lot of circuitry including nine transistors, two wired-in crystals, a diode, and a thermistor.

The receiver section is a fixed-tuned crystal-controlled superhet and of course the transmitter is also crystal controlled. The manufacturer states that input to the final stage is 100 mw so you'll be transmitting in compliance with the FCC requirements for low-power unlicensed operation. (A license is not required if final stage input is 100 mw.)

We checked the units in several locations and were amazed at what they accomplished. In a section of New York City dominated by 6-story buildings, noise-free, clean and strong signals were received for quite a few blocks. Performance was even better out of town. In a hilly suburban area the range was extended up to about half a mile and all indications pointed to a greater range under line of sight conditions.

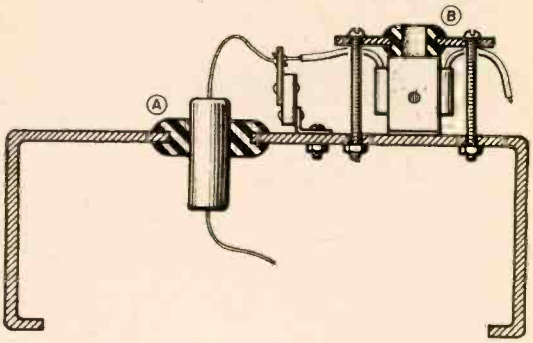
We noticed a big difference in the range and sensitivity of the units if the voltage of the eight penlight cells is the slightest bit low. For optimum performance, it is probably a good idea to use fresh "Energizer" cells such as Eveready No. 1015.

Sound from the speaker, which doubles as a microphone, was distortion free. The manufacturer states the receiver sensitivity is 1 microvolt for a 10 db s/n and that the selectivity or bandwidth is 5.6 kc at 6 db down. About half the price of competing units, the HE-29 offers top value in its field.

new jobs for GROMMETS

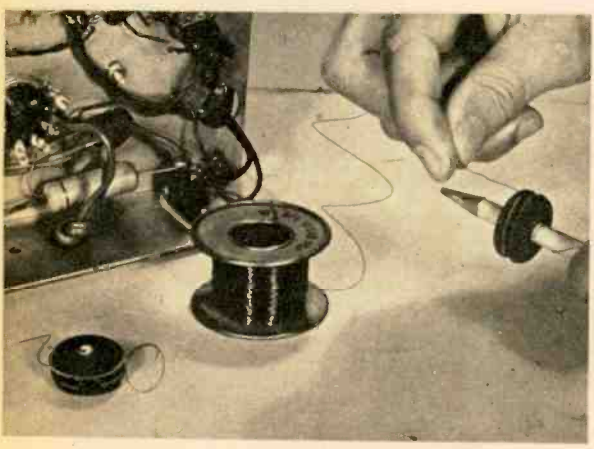
These little rubber doughnuts have a thousand and one applications for the build-it-yourself fan.

By Joe W. Rocke



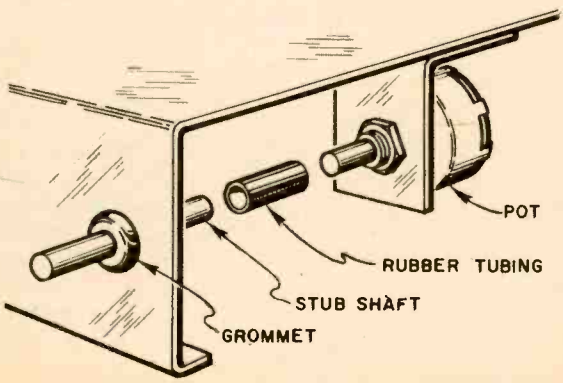
Special Mounts

Use grommets to hold a capacitor in place on a chassis (A) and as a cushion for hold-down straps to mount small transformers (B) or components without mounting lugs.



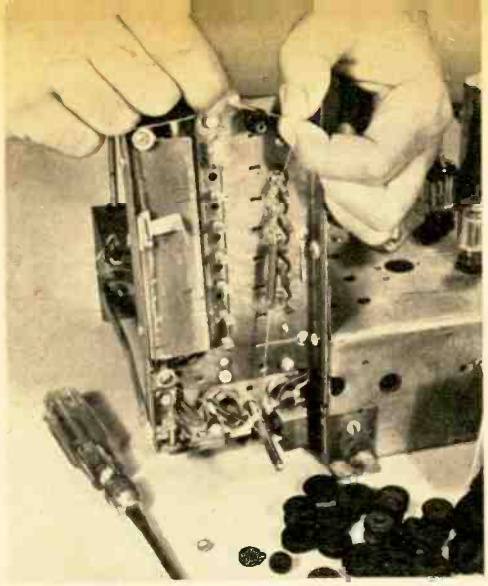
Grommets For Coil Forms

When you have to wind your own coils, use large grommets which provide plenty of room for the wire needed to make special chokes or tuning coils. Slip the wire leads through a cut made in the rim of the grommet. Dip the completed coil in insulating varnish for full protection.



Shaft Extension Bushing

Use a grommet to support an extension shaft or to insulate a control shaft from the chassis. A snug-fitting sleeve made from a piece of rubber tubing should be used to couple the extension shaft to the bracket-mounted control in the rear.

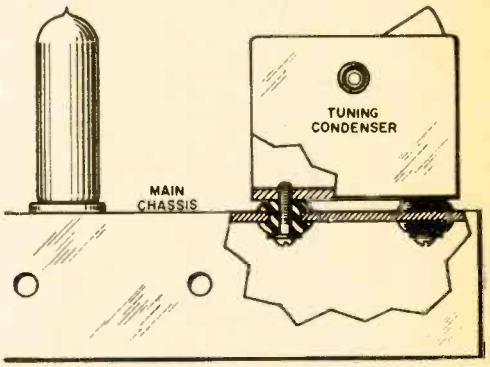


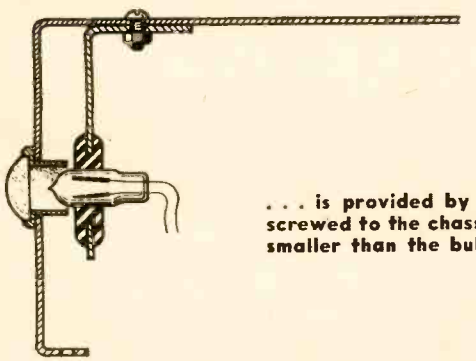
Pulleys From Grommets

. . . reduce friction wear on dial cords. Select a grommet that fits freely over the mounting stud. A slight bit of talcum or powdered graphite applied to the grommet opening acts as a lubricant for easy tuning.

A Friction Drive Wheel

. . . for drum type dial drive or for low-speed motor applications may be made from a grommet that is cemented to the drive shaft. The grommet also makes an excellent substitute for a tuning knob thus preventing hand capacity from affecting the tuning adjustments.



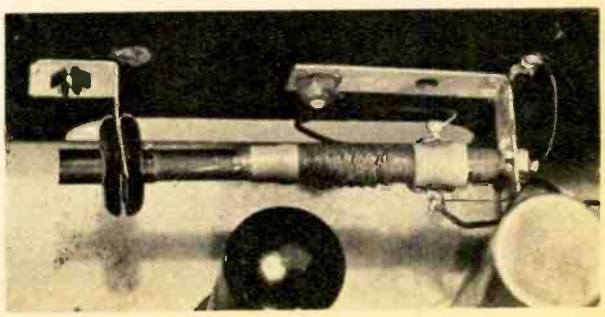


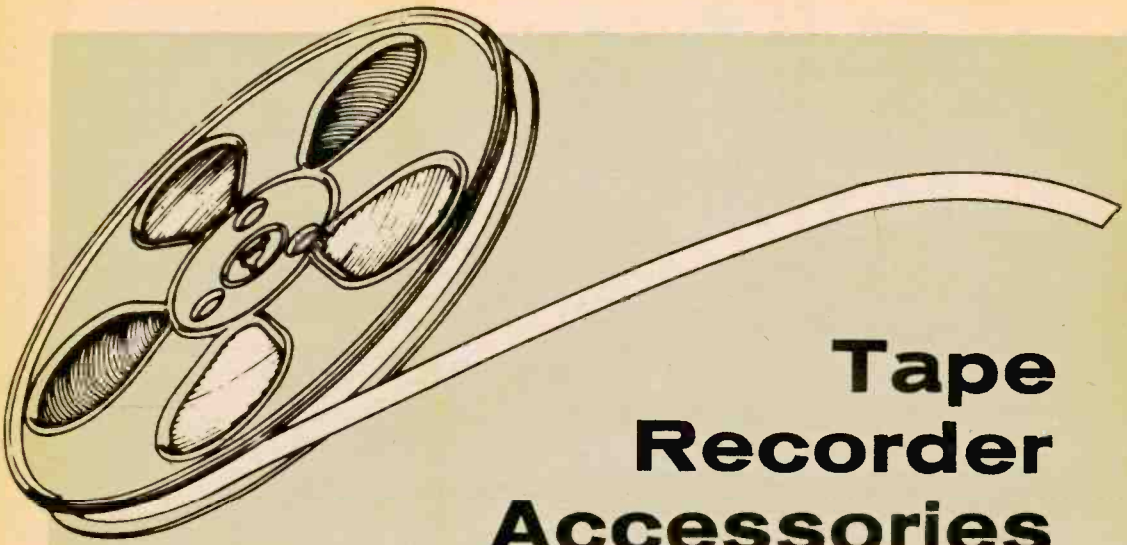
A Neon Bulb Mount

. . . is provided by a grommet mounted in a small bracket that is screwed to the chassis. Select a grommet that has a hole size slightly smaller than the bulb diameter to be sure there will be a snug fit.

A Tuning Slug Support

. . . for king-sized loopsticks makes adjustment easier and minimizes vibration effects. Cut the grommet bracket from tin-can stock and force the grommet into a "U" shaped slot cut in one end of the bent bracket.





Tape Recorder Accessories

A team of little assistants is ready to help you keep your tape equipment in top operating order.

By Norman Eisenberg

THE growing popularity of tape recorders is reflected in the appearance of more and more accessories. These items—some old, many new—are designed to make playback of prerecorded tapes and the recording of one's own tapes easy, foolproof and acoustically correct.

Accessories fall into two categories—those related to the tape itself, and service aids for the tape recorder itself. We discuss the latter class in this article.

There are recorder accessories which fall into the professionals-only class but many are for do-it-yourself maintenance, designed to prevent maladies that might afflict the head or parts of the body of a tape deck.

To begin with, there is the matter of head alignment. The head should be fixed at right angles to the tape so it presents a uniform gap. With stereo heads alignment can be more critical than with mono heads, since each gap, as well as the area on the tape being covered by that gap, is smaller. What might be a slight misalignment with mono tapes becomes serious with stereo. The new quarter-track tapes point up this problem even more sharply.

Alignment is basic to how a recorder sounds, affecting frequency response, distortion, equalization and even the loudness of a signal. A bad case of misalignment could cause a loss of high frequencies, with treble response down as much as 12 db at 5,000 cycles.

On machines using a combined recording-playback head only the one head need be checked, of course. Separate heads mean separate alignments.

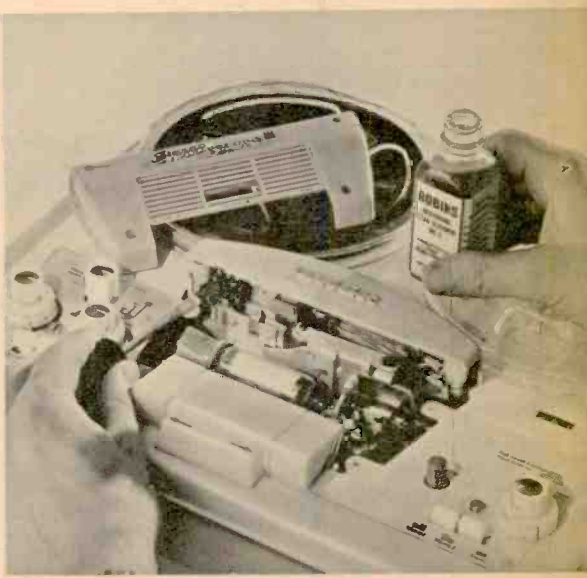
The key to head alignment is alignment test tapes, which provide signals that you can use to determine how effectively the heads are aligned. You have to do the aligning but the tapes tell you how you're doing.

Tape heads are held in place by small screws. Gently turning one or more of those screws while listening to the sig-

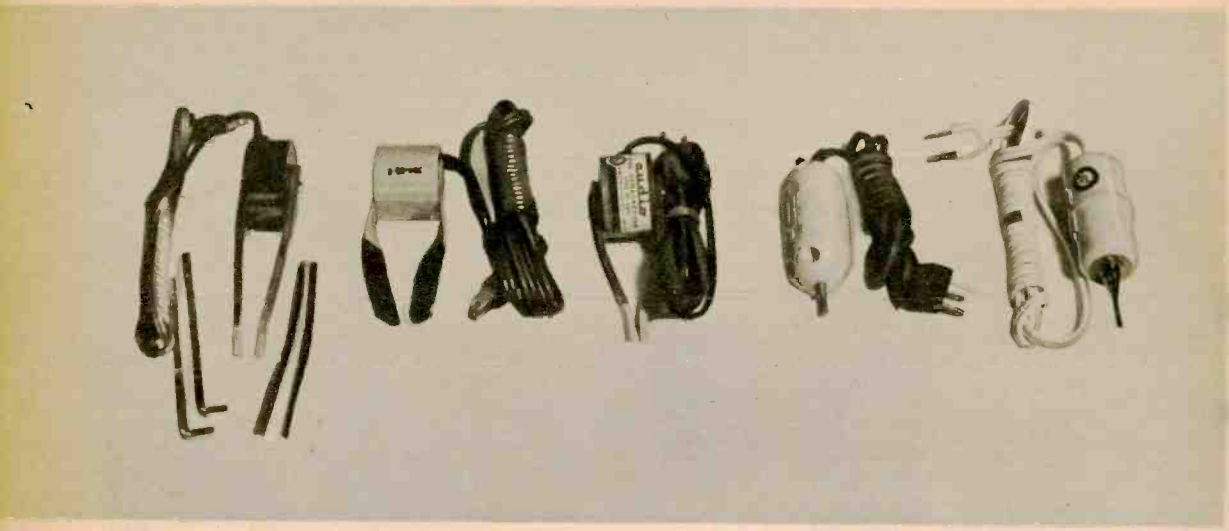
Alignment tape supplies a signal which can be used to align the recording and the playback heads of equipment. The tape is by Ampex.

Alignment adjustments are made with tape head guard removed. Procedure involves adjusting screws, listening by ear to results.

Layout of tape-head cleaning products shows cotton swabs, a reel of cleaning tape and three bottles and a can of liquid cleaner.



Cleaning liquid is applied with small brush to one of the tape heads. Cleaners and oil must be applied carefully to tape recorders.



Five tape head demagnetizers by (l. to r.) Lafayette, Ampex, Audio Devices, Ferrograph, Robins.

nals on the test tape provides a basic alignment. This method is crude and less than completely accurate but it can improve the sound of a badly and obviously misaligned recorder. On the other hand, a fumbling attempt may make things worse than before. The rule here must be: when in doubt, stay out.

For those not in doubt, there's Alignment Tape No. 5563 by Ampex Audio, priced at $14.50. Audio Devices offers an alignment tape for $6 and Nortronics sells its AT-100 for $3.60. Audiotex offers two tapes, a standard one at $6.50 and the professional one at $8.25. The signals on both Audiotex tapes are the same. According to the manufacturer, the lower-priced version is produced to standard tolerances while the costlier tape is made with more precision.

If a tape head must be on straight, it also must be clean. A clean tape head is one that is physically clean on the outside and magnetically clean inside. The former is simply a matter of dirt, the latter one of residual magnetism.

Tape head assemblies are usually protected by a cover but dust and other foreign matter—including microscopic particles of the tape's oxide coating—can be deposited there. These invisible deposits can cause loss of response. What's more, dirt can collect on capstans, tape guides, rollers and other parts to cause slippage and erratic speed.

Heads can be cleaned with a swab of cotton dipped in alcohol. Many tape fans prefer the cleaning kits made specifically for tape equipment and generally priced under $1. Liquid tape head cleaners are packaged by Ampex, Audio Devices, Audiotex, Chemtronics, EMC, General

Tape head demagnetizer's pole piece is placed across the tape head gap for a few seconds and then slowly drawn away from recorder.

Cement, Robins and Walsco. Additionally, both Walsco and Audiotex offer Kleen-Tape, which actually is a reel of impregnated cloth intended to be run on the tape deck. The fabric brushes across the heads to clean them.

Electrical cleaning of the tape heads means removing residual magnetism. Although the recording and playback heads (or head, as the case may be) generate a magnetic field during operation, they are not supposed to become magnetized themselves. Yet after some use they may become partly magnetized —a condition that reduces high frequency response on both playback and recording and can produce a hiss.

To restore the heads to a neutral state, you should use a head demagnetizer. Basically, this is a wound coil with an extended pole piece. Some models have two pole pieces. Either type appears effective. The demagnetizer must be connected to a 117-volt AC outlet. The pole piece is placed across the tape head gap for a few seconds and then slowly drawn away. This simple procedure, which should be repeated every ten hours of tape recorder use, often can perk up a recorder's sound.

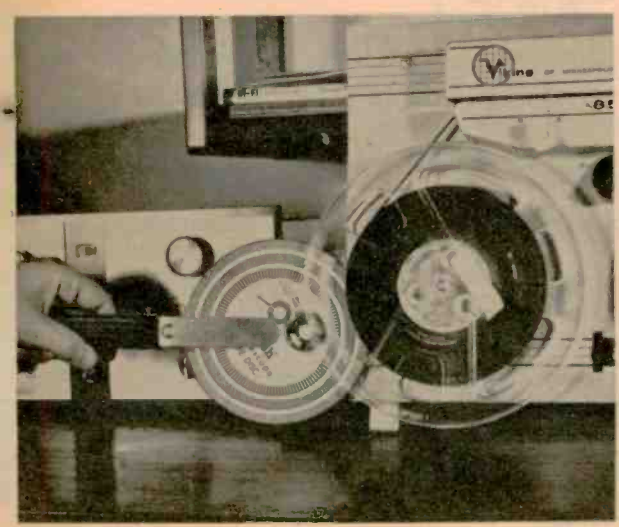
Among the twin pole piece demagnetizers are the $8.25 Ampex, Audio Device's 400 listing at $10 and Lafayette's model MS-694 which includes three interchangeable sets of pole pieces to fit different head assemblies and costs $3.95.

Single pole piece models include a $9.95 offering by Audiotex, the Robins HD-6 listing at $10 and a recent entry from England, the Ferrograph Defluxer at $9.95. A unique feature of the Ferrograph model is its off-on button (the others go on when the line cord is plugged in). Aside from general convenience, the button makes it possible in tape editing to erase short and precise sections of tape with the defluxer.

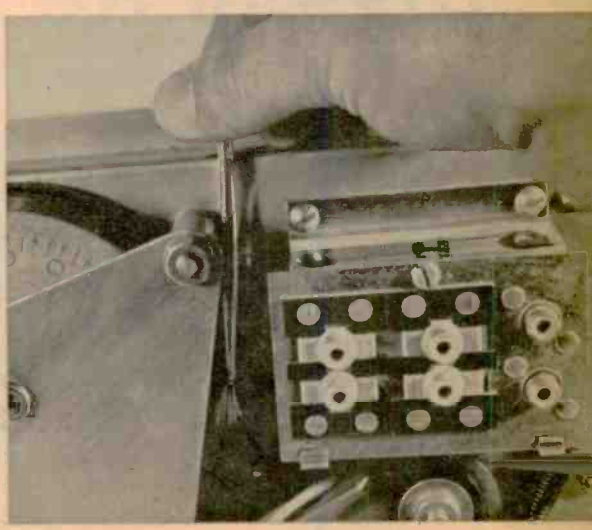
Accuracy of speed is closely related to how well a tape deck sounds. Too slow a speed produces tones that are lower pitched than normal as well as a dragging tempo. Too rapid a speed results in just the opposite. Everything sounds too high-pitched and too fast.

A handy gadget for checking recorder speed is the strobe wheel made by ORR and priced at $4.95. The wheel is suspended in a frame to which a handle is attached. By holding the device so that its rim contacts the tape reel, you can observe the strobe markings and judge the accuracy of the machine's speed. A costlier device [*Continued on page 96*]

Strobe wheel enables you to check the speed of your tape recorder. The rim of the device is held in firm contact with the tape reel.



Non-slip compound can be applied to the drive belt of tape recorder to insure proper speed. A small brush is the best applicator for job.



build a

Souped-Up Crystal Receiver

Boost the volume of a diode radio by adding two inexpensive transistors and just five other parts.

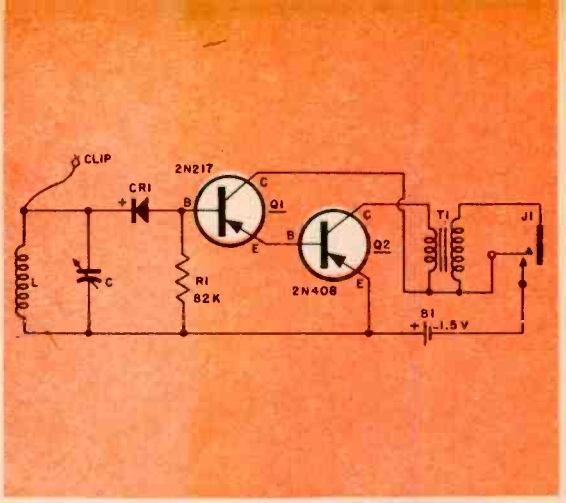
By I. C. Chapel

IT'S possible to soup up a simple crystal diode receiver beyond the dreams of the designer. If you add about $3.00 worth of parts to a small diode receiver such as the Lektron unit shown, you'll end up with a high-power sensitive radio. The receiver is about 3" square, and has enough space inside to add two transistors and the miniature transformer. An unusual part of this circuit is that it only draws about 300 microamperes between stations. Even on strong signals, the current drain is only 5 ma.

Construction

Since you are modifying an existing receiver most of the

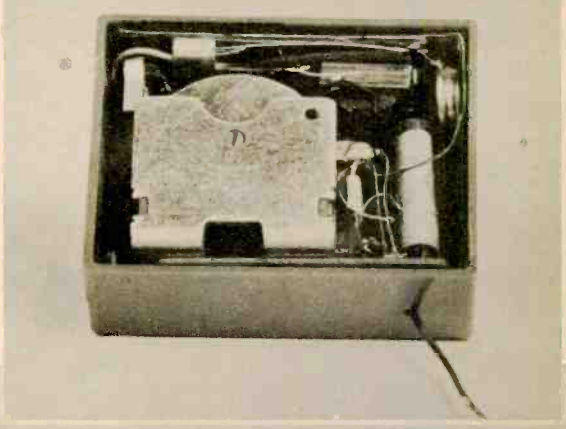
Input impedance of added amplifier is increased to match output of original radio composed of C, L, and CR1, by direct coupling emitter follower Q1 to Q2.

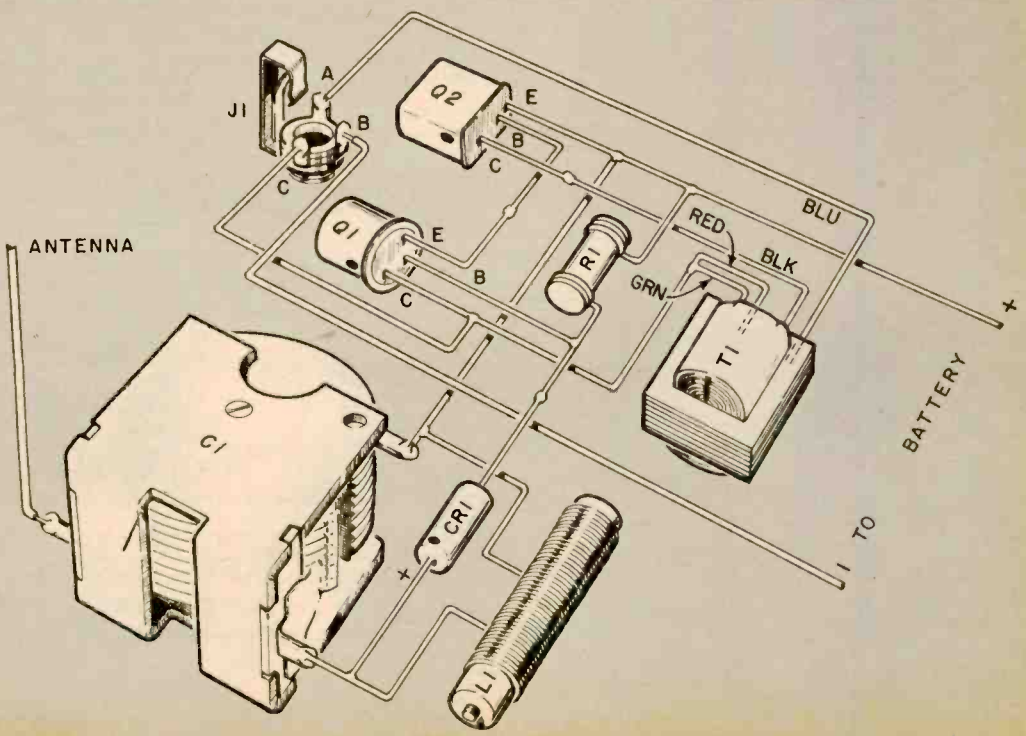


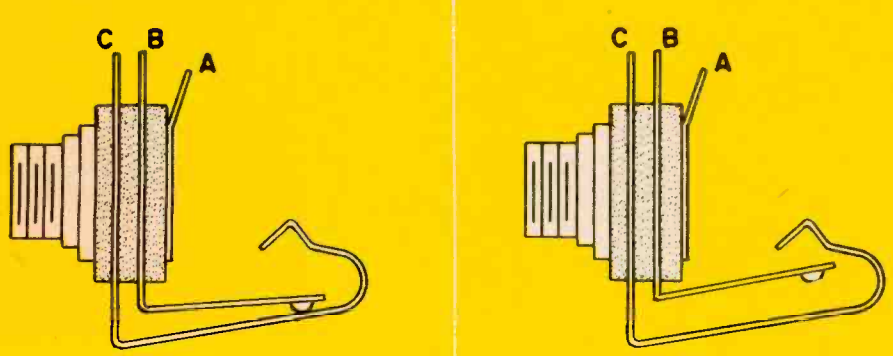
PARTS LIST

C,L,CR1—Original diode radio parts (Crystal radio No. AB9326 available from Lektron, Inc., 131-133 Everett Ave., Chelsea 50, Mass.)
R1—82,000 ohm resistor
Q1—2N217 transistor
Q2—2N408 transistor
T1—Transistor transformer, 100 ohms to 100,000 ohms, (Burstein-Applebee part 18B65B or equivalent)
J1—Miniature closed-circuit jack and plug
B1—1.35-volt mercury cell
Misc.—Mounting strip, copper eyelets, tin for cell holder, etc.

At right note added parts in top of modified receiver. There is no switch in pictorial as radio is turned on by plugging in phone which closes B and C of J1.







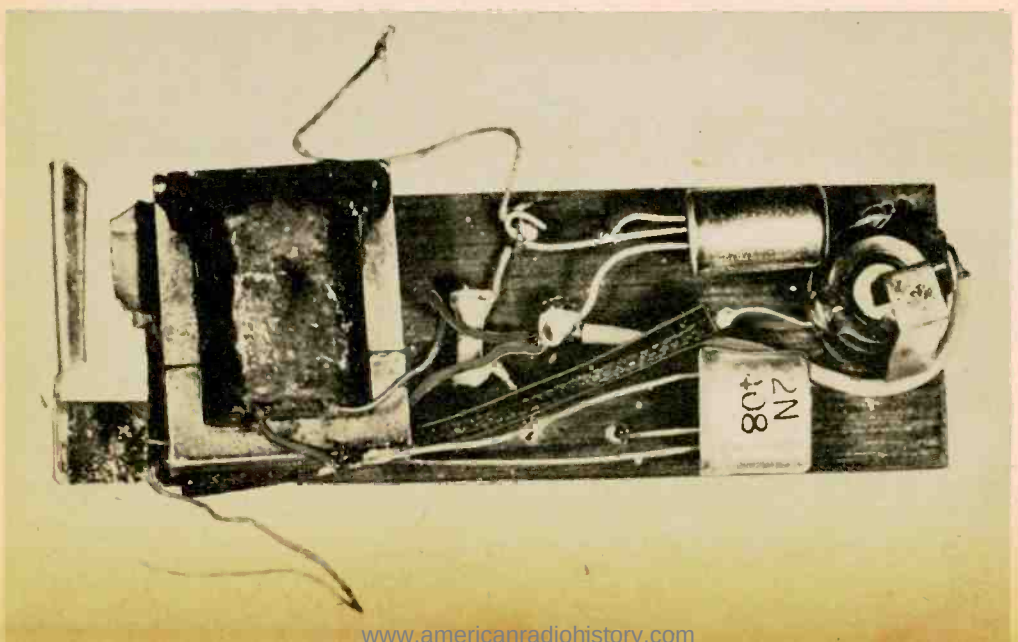
At left is unmodified closed-circuit jack. Contacts of altered jack at right are closed by plug.

mechanical work has already been done. The original tuning capacitor, calibrated dial, earphone, coil and case are all used. Of course you can also build the unit from scratch. The additional required parts are two transistors, a transformer, and a mercury cell. A 2N217 transistor (Q1) was used because of low standby current, and high power handling capacity when a signal is received. The 2N408 is a good cheap output transistor.

The transistor amplifier in the author's model was built on a removable strip of micarta which permits the soldering of parts in the open, instead of in cramped quarters. Phone jack J1 is also the power switch and is made by modifying a closed-circuit miniature jack as illustrated by bending the center piece so it touches the outer contact when the plug is inserted. The contacts must separate when the plug is out.

For best pickup, clip the aerial wire to a convenient metal object, such as a floor lamp, wire magazine rack, or screen door, then tune in a station. Strong local stations will furnish enough power to work the earphone to its limit, but the weak stations will require a better antenna.

Tin strips at left firmly hold mercury cell in place. Transistors are supported by their own leads.



Those Oddball Tubes

Is it a bird? Is it a plane? Nope! It's just a weird new electron tube made for a very specialized job.

By Saunder Harris

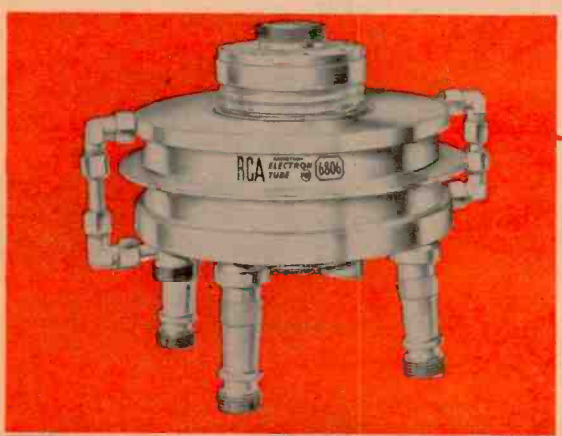
That big black pot, looking like something Grandma made soap in, is a new Bendix electron tube, a backward wave oscillator that handles 10,000 phone calls at once.

IN 1883 Thomas Edison discovered an electric current flowing between two elements in one of his glass bulbs. At the time, he was looking for a filament material for his electric lamp but as a good experimenter he noted this strange new phenomenon in his records, and it later became known as the Edison Effect. The Wizard of Menlo Park, it developed, had produced the first diode and unknowingly opened the age of electronics.

Electron tubes now are selling at the rate of almost half a billion a year, bringing in nearly a billion dollars. Modern tubes are used for everything from opening garage doors from a distance to reproducing Elvis Presley's voice faithfully to triggering a satellite camera. Some strange things are happening to tubes. They are getting smaller, and larger, and longer and thinner, and shorter and squatter, and they are taking on weird shapes. One new tube is smaller than a thimble, an-

World's most powerful tube is this RCA job which weighs 150 pounds and can produce up to 5 million peak watts at 450 megacycles.

A traveling wave tube by Amperex lies in front of its complicated socket, or mount. It is an amplifier in 3800-4200 mc range.



Grid-driven power amplifier by RCA (typical output is 28 kw at 550 mc) became oddball because its heating demanded water as a cooling agent.

Smallest electron tube is the Nuvistor, which fits neatly into thimble. It has ceramic-metal construction and can take big temperature changes.

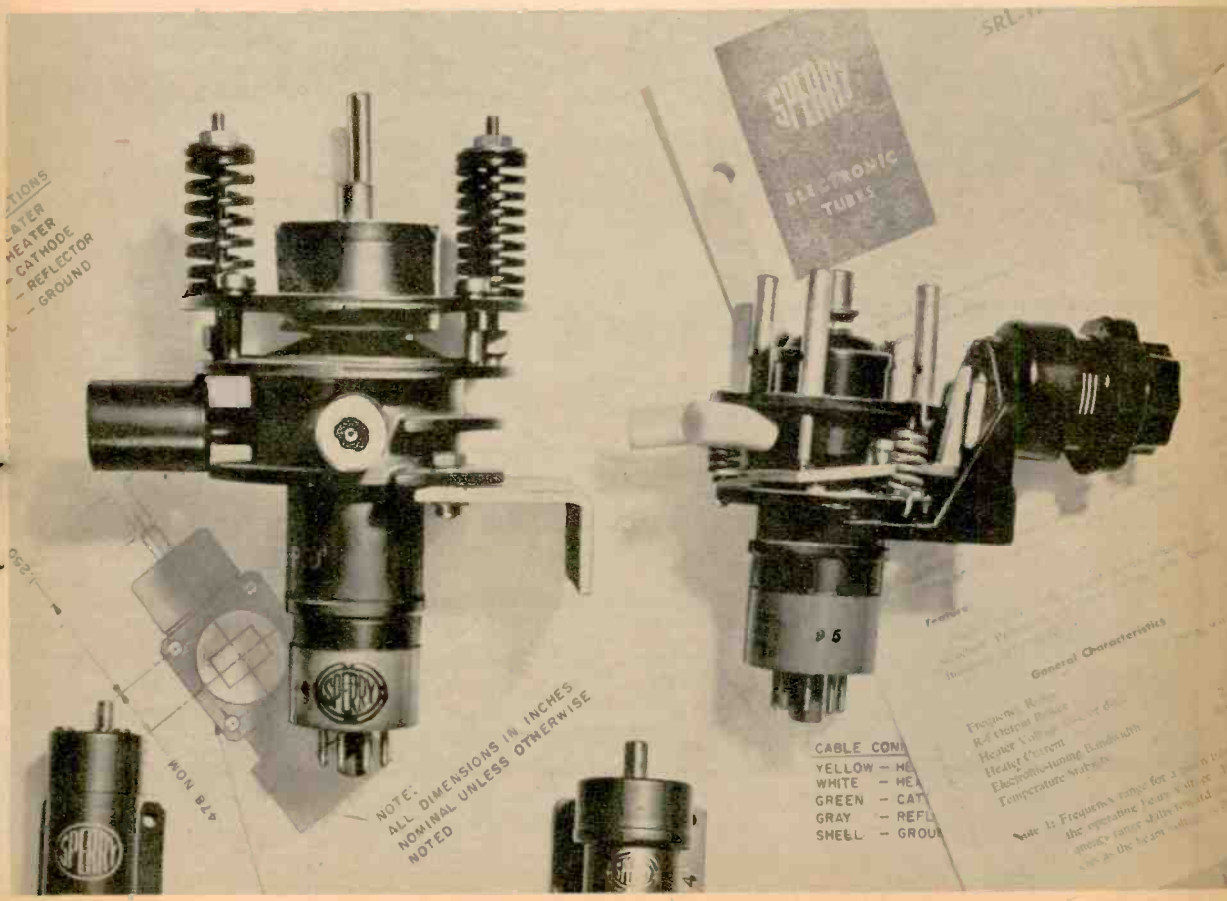
other weighs 150 pounds and delivers 5 million watts at 450 megacycles. Many of the new tubes bear no resemblance to those we find in a radio or TV set. In short, they are oddballs, either in looks or operation. But they have a reason to be so.

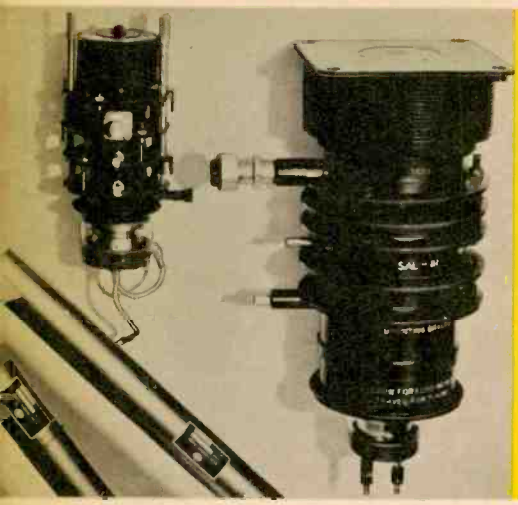
All electron tubes from a diode to the most complicated multi-circuit jobs have certain things in common. They have a cathode, or source of electrons, and a plate, or receiver of electrons, and they are operated in a near-vacuum. Most tubes also have one or more grids to control the electron flow between cathode and plate. The manner in which this electron flow is controlled (the grid bias) determines the type of tube.

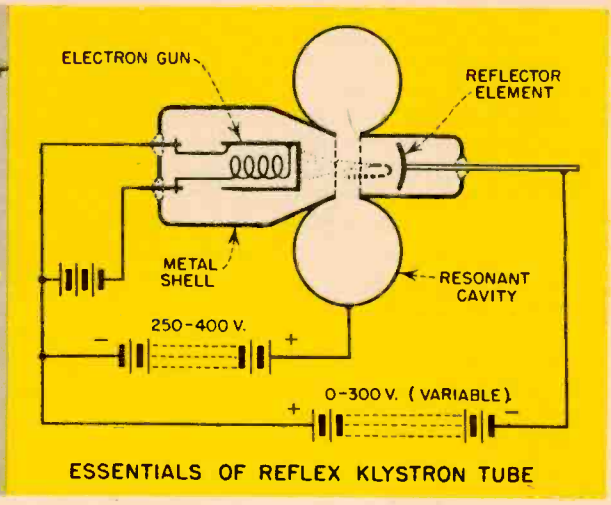
In designing a tube, an engineer runs into four basic problems: 1) inter-electrode capacitance; 2) heat; 3) inductance of tube leads and 4) transit time. When tubes are used at mid-range radio frequencies these problems are simple. However, when equipment is miniaturized or designed for microwave frequencies the troubles begin.

The *inter-electrode capacitance* problem comes about because the elements act as capacitor plates with respect to each other. This means there is a capacitive effect between the plate and grid, the cathode and grid and the plate and cathode. At ordinary radio frequencies these capacitive reactances can be corrected by components outside the tube, such as neutralizing capacitors. At high frequencies, however, reactances cause power losses within the tube and also affect the resonant frequency of

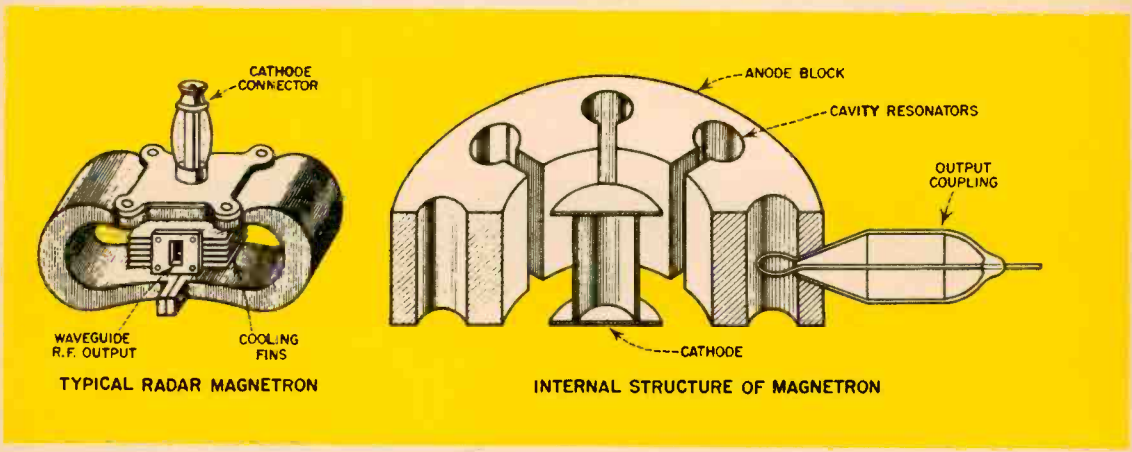
Sperry reflex oscillators have myriad adjustments and can be used in great many applications.





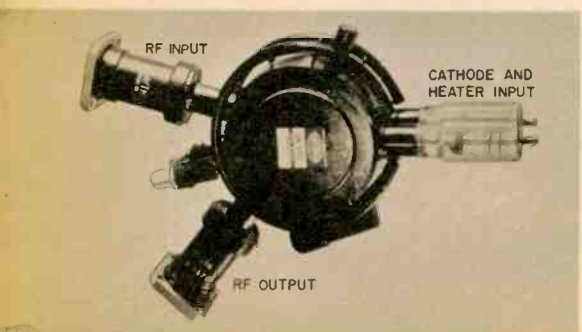


These Sperry klystrons, whose operation is shown in the diagram, have odd shapes, performance.



Magnetron's strange resonators and other components are shown in drawing by Aerovox Co.

Amplitron by Raytheon was designed mainly to perform high-frequency pulsed radar jobs.

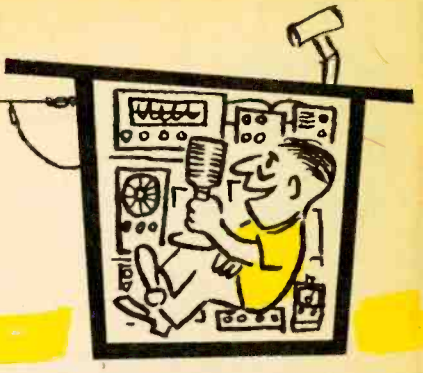


the tuned circuit that it is in.

One way to reduce capacitance is to add a screen grid between control grid and plate (the critical area of operations). The screen grid is connected to a grounded capacitor, which siphons off radio-frequency energy but has no effect on the screen grid's DC potential. The screen grid thus becomes a shield between grid and plate and minimizes grid-plate capacitance. This type of setup would have to be classified as slightly odd, although the visible layout is not.

Reducing the [*Continued on page* 104]

The Ham Shack



By Robert Hertzberg, W2DJJ

SAFETY FIRST . . . About this time of year a young ham's thoughts may be divided between a new girl friend and a new beam antenna. He risks a broken heart with the first and a broken neck with the second.

Clambering over a slippery roof with a bunch of tools in one hand and three or four awkward aluminum rods in the other is dangerous. Just getting onto some roofs is a problem.

In many cases it is more sensible to erect a three- or four-legged mast on the ground, its height depending on your pocketbook and nerve. The main problem is pouring a concrete footing although it's really just mud-pie-making on a larger scale. All masts are sectionalized for shipping, and assembly is easy with no more than a wrench. For convenience and safety, invest a few more bucks in a tilt-over tower, which you can crank up or down.

The results are worth the trouble. There's nothing like a good beam for boosting effective radiated power of your transmitter and putting your signals where you want them to go.

—o—

Hello, Girls . . . A few years ago the wife of an amateur filed for divorce and named the husband's ham shack as co-respondent. The case probably was laughed out of court but the idea must not have been lost. The result? Many wives became hams (see photo right). Nowadays, feminine voices on the air are numerous, especially during the day. With the kids off to school and the laundry in the washer, what better way to relax? And the gals are good operators with microphone or key. You'd think they would gab a lot, but they don't.

Incidentally, male operators are "old man" to each other but don't you dare use "old lady," not even if the gal happens to be W1ZR, who is close to 84 and has held a license half her life!

—o—

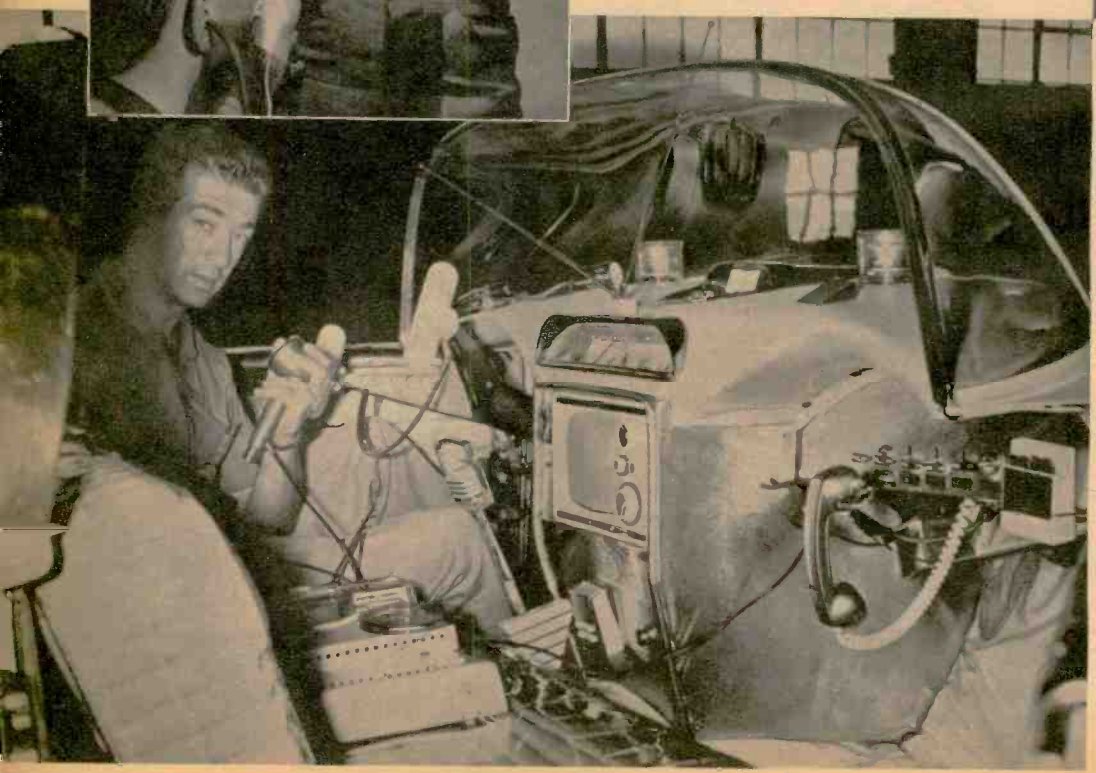
Code Corner . . . Old-timers who got their ham tickets years ago and newcomers who are still studying for the test are both a little hazy about examination procedure, according to the FCC. Here's the [*Continued on page* 100]

An outstanding YL is Mary Burke, W3CUL, of Morton, Pa., who holds an Edison Radio Amateur Award for handling messages for servicemen.

E I Picturescope

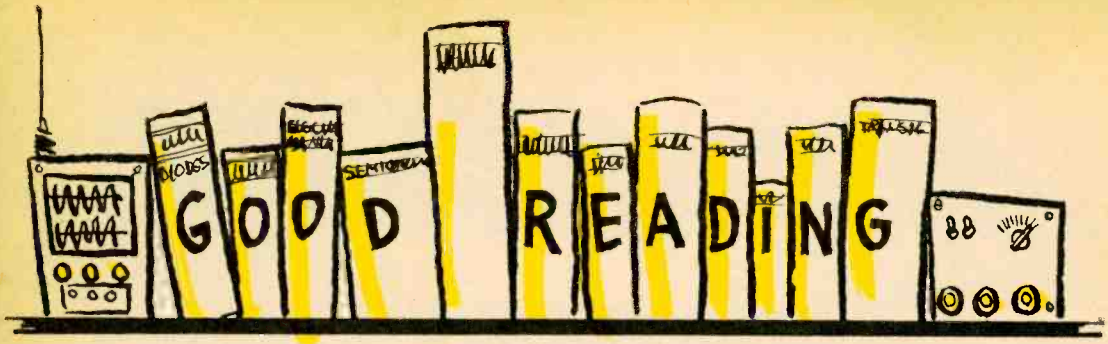
Strange devices demonstrated by two tots are called Solar Space Phones. Wireless toys (receiver is the one nearest to the camera) are powered by solar energy modulated by voice. Sunlight is directed by the transmitter mirror into a solar cell in receiver. Voice flexes the mirror, varying the solar cell's output.

A workhorse generator is obviously the crying need of this kooky car, which can be controlled by voice, has TV, mobile phone, an intercom and hi-fi. It was shown at a custom car exhibition by the builder, Jim Skonizaker of Dayton, Ohio.



These two dishes in a dish are employees of IT&T, the people who constructed the 40-ft. parabolic antenna, which is designed for use with equipment monitoring signals from satellites or those bounced off the moon.

Into the chamber of a Van de Graaff particle accelerator goes a new solar cell that operates even under atomic radiation. It was designed by the Army. Silicon cell is mounted on copper and surrounded by phosphor.



COMPUTERS AND HOW THEY WORK. *By James D. Fahnestock. Ziff-Davis, New York. 228 pages. $4.95.*

If you don't mind a little spoon-feeding now and then, here's a worthwhile introduction to computers in all their many-splendored roles. While the author won't walk off with any prizes for style, he does manage to make a complex subject more than understandable. The book thoroughly covers the language and arithmetic of computers, showing how they acquire their logic and memory. Whether you consider these awesome monsters friends or foes, here's your chance to get fully acquainted.

BUILDING UP YOUR HAM SHACK. *By Howard S. Pyle. Howard W. Sams and The Bobbs-Merrill Co., New York and Indianapolis. 128 pages. $2.50.*

Whether you're a newcomer to the world of ham radio or a grizzled veteran, this book will provide you with a wealth of useful information, all of it down-to-earth and pertinent. The author, Howard S. Pyle, has been a frequent contributor to EI, and his long list of credentials includes a stint as Assistant U. S. Radio Inspector and License Examiner. For the newcomer, he provides plenty of sound advice on choosing and installing equipment. The veteran can expect an equally useful array of tips for climbing the amateur radio ladder, including advice on how to trade up for advanced equipment with a minimum outlay of cash. The illustrations include many interesting solutions to the space problem. Altogether, this slim but informative volume should help you to know the ropes almost as well as Mr. Pyle does.

ALL ABOUT CROSSOVER NETWORKS. *By Howard M. Tremaine. Howard W. Sams and The Bobbs-Merrill Co., New York and Indianapolis. 80 pages. $1.*

Here are just about all the answers for the audiophile who's been thinking about designing his own multi-speaker system. This book covers the design and theory of crossover networks, shows how to build and test them, and tells how to determine the right crossover points for the speakers you have in mind. Included are many charts and tables to help compute component values. The author is a professional audio engineer of long standing and his approach is detailed and comprehensive.

FUN WITH ELECTRICITY. *By Tom Kennedy, Jr. Gernsback Library, New York. 128 pages. $2.65.*

Fun is definitely the keynote of this book of electrical experiments. It's unabashedly intended for the beginner who's more interested in seeing how it works than in assembling his own radar station from a kit. Starting with a brief outline of the theory of electricity, the author goes on to blow-by-blow instructions for building everything from a simple DC motor to a fairly complex meter. Along the way, he manages to provide a painless introduction to many of the mysteries of electricity. Both in style and content, the book is aimed at the young reader who may never have seen a soldering iron in action, and the tools of the electrician's trade are described in great detail. The experiments which the author outlines fall pretty much in the classic category, but if you know someone who's just beginning to wonder what makes the world go 'round, this book can hardly be bettered as a gift.

EI builds

A Stereo Preamp

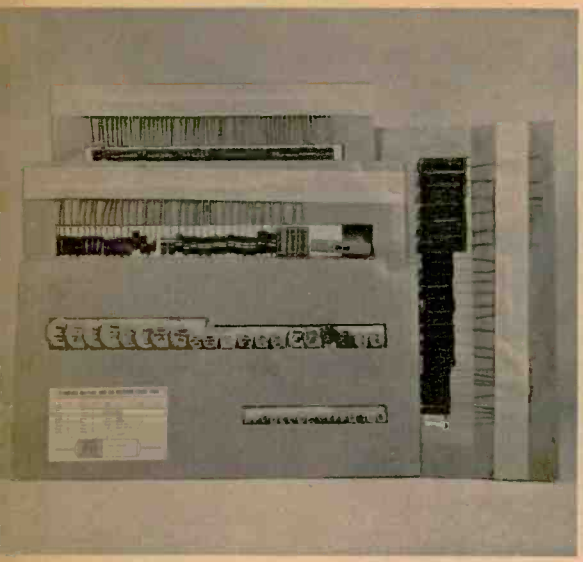
ALTHOUGH a late comer to the kit field, Harman-Kardon's Citation line introduced several innovations in electronic design and sales approach that made the old timers sit up and take notice. Since an H-K kit may cost more than a competitor's factory-wired unit, the question arises—what does the audiophile get for his money? We won't attempt a general answer here for all the Citation components, but let's look at one of the recent additions to the line, a stereo preamplifier control center, and see what it has to tell us.

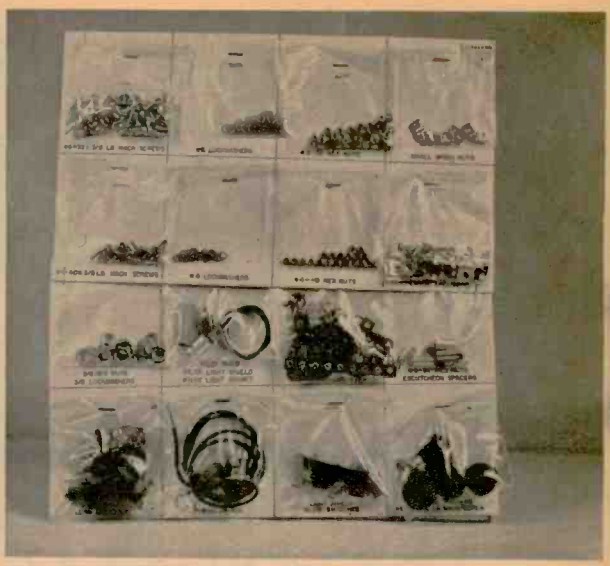
Note that the kit (Model IV) which we obtained for review is the less expensive of the two Citation preamps ($119.95 in kit form, $189.95 factory wired), but it includes all the packaging features that drew such high praise from reviewers of other Citation kits. Even an absolute newcomer to the world of nuts, bolts, resistors and capacitors need have no fear of losing his way in a chaos of components. Every small part is packaged in a pliofilm bag that is clearly labeled.

The soldering instructions included in the kit book may leave a few questions unanswered for the novice. And since 25 to 30 hours are going to be devoted to putting this kit together—much of it involving soldering—it's a good idea to brush up on your technique if you're in doubt. The dealer probably can help you.

Assembly

The preamp is wired in separate subassemblies: main chassis, function switch, terminal boards, power supply and control panel. Although H-K has made it practically impossible to mistake one component for another, it *is* possible to mount the components incorrectly. Be particularly careful of the tube sockets, phono jacks (page 8 of the manual) and function switch (page 9).





Citation's packaging techniques leave nothing to chance. It's practically impossible to make an error in selection of the components required for each step. The packs are used consecutively.

The bulk of the electronic components are mounted and wired on terminal boards—which resolves a lot of potential problems for the builder. There's no question of proper lead length or placement. And the pretinned terminal lugs almost pull the solder onto themselves, which goes far to eliminate the chance of a bad solder connection.

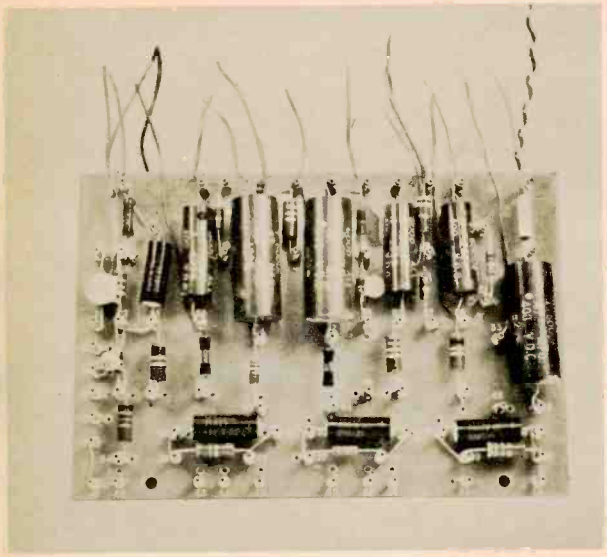
All in all, with the minor exceptions noted above (which H-K has already rectified), the physical design of the kit makes it a pleasure to build. There are no inaccessible corners and no impossible three-handed assemblies. No reaming, drilling, hammering or twisting are required to make the sub-assemblies fit.

Equalization Circuit

As might be expected, there are also a host of new approaches in the circuitry of the Citation units. These innovations are not for the sake of novelty but represent an attempt—and a successful one—to apply new thinking to old problems. Considering one of the channels (p. 74), we run into an instance of this new approach right at the phono input stage. Whereas most phono and tape head preamps achieve playback equalization by inserting a network in a negative feedback loop, the Citation IV takes an altogether different approach. Distortion-reducing negative feedback is there, all right, and plenty of it, but it is flat (non-frequency discriminating) over an extremely wide range. You can see the feedback tap-off point at the plate (pin 1) of V4. It travels back via R57 and C35 to the cathode (pin 8). Note that in addition to the negative loop, there's a positive feedback connection from cathode to cathode of V4's two triodes. This incorporation of a positive loop *within* a negative loop combines the distortion-reducing advantages of pure negative feedback, but without the great loss of gain.

Equalization is achieved by the maze of components clustered around the switch labeled 2 (front). There's a choice of two phono equalizations (RIAA and LP) in addition to a high gain NARTB tape head equalization. Note that this is a *passive* network in that it does not rely upon feedback for boost and cut action.

In this application, a passive network has a number of advantages. Since feedback-type equalizers achieve the required bass boost by *decreasing* the negative feedback at bass frequencies, dis-



Channel B circuit board before installation. Stand-off terminals eliminate the problems of correct lead length and component placement.

tortion is unfortunately inevitably boosted along with the bass. Passive equalization between the stages enables a high feedback to be used across the audio spectrum.

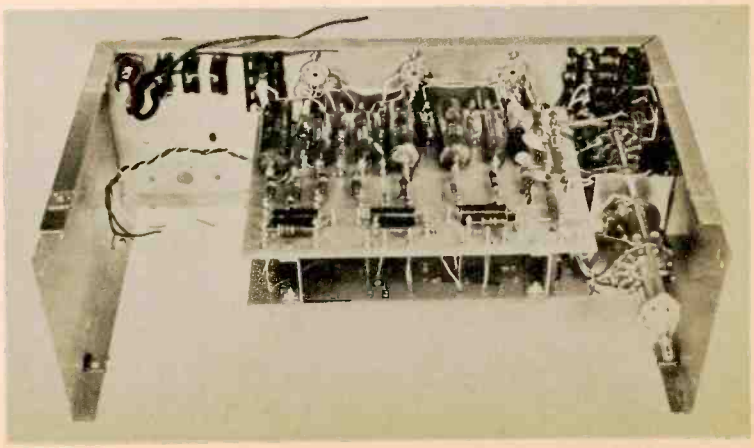
The next stage (half of V5) is encircled by another negative feedback loop via resistor R68. In addition to the normal distortion reduction afforded by this loop, a low output impedance is also obtained at the *tape out* jack J4. This guarantees that the output signal to a tape recorder is at low impedance and no special precautions need be taken to avoid high-frequency roll-off in the connecting cables to the recorder.

The design of the output stage also leaves the beaten path in the search for the low distortion. Instead of the usual cathode follower, the stage has a pair of triodes (both sections of a 12AX7) in a normal cascade amplifier hookup, but with an extremely high level of negative feedback (via R46) from output plate to input tube cathode (see schematic). Dubbed an "anode follower" (it isn't, really), the gain of the two stages is way down but a low output impedance is realized and the distortion is significantly lower than that of the standard cathode follower configuration. However, you're not getting something for nothing, for here as in the preamp stage it costs an extra triode to realize these advantages.

Special Features

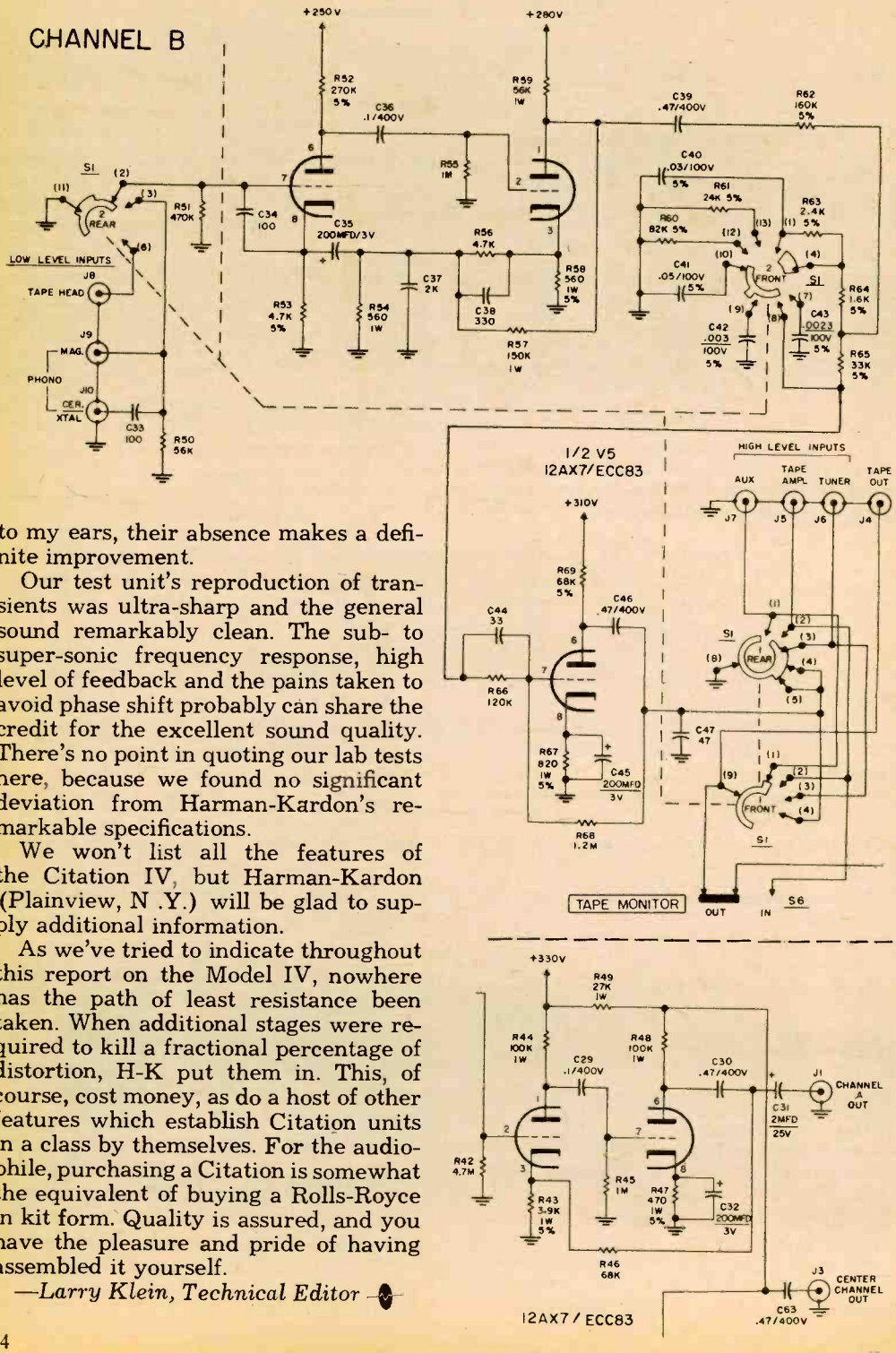
Space does not permit an extended analysis of the remainder of the circuit but a few salient features should be mentioned. The noise level of the completed unit was so low as to be inaudible at normal listening levels. Low-noise resistors at critical points, good shielding practices, avoidance of ground loops and a DC filament supply contribute to an excellent signal-to-noise ratio.

An uncommon feature of the Citation IV is its provision for switching the tone controls of both channels completely out of the circuit. (Again, these are "passive" rather than feedback types.) And



View from front (prior to control panel installation) shows location of circuit boards. Function switch is at right directly in front of the input jacks. Output jacks and power outlets are mounted in rear panel upper left.

Partial schematic showing input and output stages of one stereo channel.



to my ears, their absence makes a definite improvement.

Our test unit's reproduction of transients was ultra-sharp and the general sound remarkably clean. The sub- to super-sonic frequency response, high level of feedback and the pains taken to avoid phase shift probably can share the credit for the excellent sound quality. There's no point in quoting our lab tests here, because we found no significant deviation from Harman-Kardon's remarkable specifications.

We won't list all the features of the Citation IV, but Harman-Kardon (Plainview, N .Y.) will be glad to supply additional information.

As we've tried to indicate throughout this report on the Model IV, nowhere has the path of least resistance been taken. When additional stages were required to kill a fractional percentage of distortion, H-K put them in. This, of course, cost money, as do a host of other features which establish Citation units in a class by themselves. For the audiophile, purchasing a Citation is somewhat the equivalent of buying a Rolls-Royce in kit form. Quality is assured, and you have the pleasure and pride of having assembled it yourself.

—Larry Klein, Technical Editor

opportunities in electronics

Lie Detective

Screening of job-seekers for truthfulness now is done by high-paid operator of a psycho-polygraph.

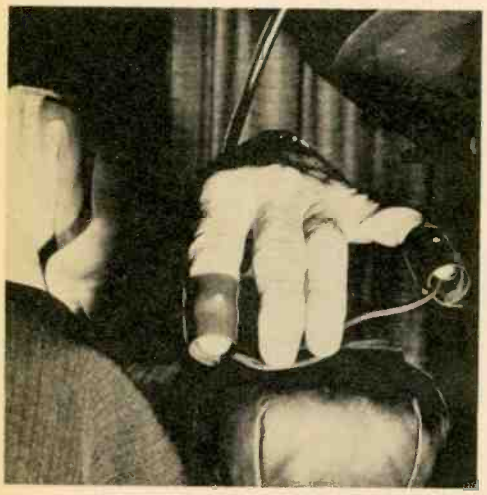
By Jim Joseph

MAYBE it pays to tell the truth, but the fact that at least a few people go in for mild fibs or great whoppers is richly rewarding to one Chris Gugas, and it could be for you, too. Chris is a for-hire electronic mind-reader who makes a mint out of a psycho-polygraph.

That double-jointed name might not be familiar to you but

Lie detective Chris Gugas notes involuntary response of job applicant on psycho-polygraph when questions are asked.

Polygraph's respiratory sensor goes around chest, monitors breathing rate of applicant.



Galvanometers go on non-adjacent fingers, tell about skin resistance and perspiration rate.

An indication of question asked goes on graph beside the recorded response of the applicant.

it's just a new handle for a well-known apparatus, the crime-tested lie detector. Besides a dressed-up monicker, the machine now has a new role as industry's hottest ally for evaluating job-seekers. It also represents an opportunity that can mean a five-figure income for you, as Chris Gugas has proven.

Polygraph at hand, the 40-year-old Gugas last year put more than 1,000 job applicants to the electronic truth-test, determining the accuracy of statements they'd made in their applications, probing their work attitudes and sizing them up mentally, physically and morally. His clients were more than 125 big-time industries who willingly paid $20 to $50 for each half-hour truth session.

The nation's estimated 300 in-business-for-themselves polygraph experts are hard-put to meet industry's new and growing demand. Most ask and get $35 per employee screening. They may quiz up to 1,500 job hopefuls yearly and earn a respectable $20,000 to $35,000 while doing it.

Required for electronic mind-reading is a $1,500 polygraph, anywhere from six weeks to six months of specialized training (few states have any definite educational requirements) and a knack for asking the right questions (and interpreting results on the polygraph).

You certainly don't have to be a psychologist to turn industrial fact-finder. It's enough that you savvy the polygraph's three wavering needles and the graphs they etch.

Gugas was called in recently by a big truck company and asked to double-check a prospective driver, a fellow who would be entrusted at the wheel of a $40,000 truck hauling a cargo worth $100,000.

The driver—we'll call him Bill—had filled out a job application, agreed to have it checked for accuracy and signed the necessary release form (stating he submitted voluntarily to questioning). Easing himself into a chair in Gugas's Los Angeles office, he sipped coffee, relaxed and confident. Gugas girded his arm with a blood-pressure cuff, snapped a respiratory recorder around his chest and attached galvanometers to two non-adjacent fingers [*Continued on page* 95]

Electronic Brain

Have you a question on electronics? Send it in and the Electronic Brain will provide the answer.*

Ham Band Operation

I have several questions: (1) If a transmitter is designed to be operated on 80, 40, 20, 15, 11, and 10 meters, will it work on 160 meters when driven by a 160 meter VFO? (2) Is phone transmission the same as voice modulation? (3) What is a balun coil? (4) What is the best antenna where space is at a premium? (5) What is the frequency range covered by 10 meters through 160 meters?

Richard Kuenzig
Pittsburgh, Pa.

(1) Since the transmitter cannot be tuned to 160 meters, a 160 meter VFO will have no effect upon the transmitter at all. That is, this transmitter will not work on 160 meters under any conditions unless its resonant systems are redesigned.

(2) Phone and voice modulation are synonymous in ham parlance.

(3) Most transmitting antennas are balanced or symmetrical with respect to ground; many transmission lines such as co-axial cable are unbalanced with respect to ground, the shield being at ground potential and the center conductor above ground. A balun coil isolates the BALanced antenna from the UNbalanced line (thus BALUN), providing for efficient transfer of energy without affecting the balance of the antenna.

(4) Usually this is a question about which there is much disagreement. Quarter-wave vertical antennas with either a good ground or a counterpoise are frequently used by those who do not have the space for a half-wave antenna. It is also worth investigating the performance of the so-called ground-plane antenna. (See the ARRL handbook for 1961.)

(5) The frequency range over which these wavelengths extend is from 1,800 kc to 29,700 kc. It should be mentioned here that 160 meter operation is not permitted in all the states; for exact details you should refer to the frequency allocations as given in the ARRL handbook.

Intermittent Transistor Radio

I have a transistor superheterodyne radio that works fine as long as the temperature is above 82° F. At all temperatures below this, it cuts out after about 10 seconds. Can you diagnose this trouble for me?

Webster B. Walton
Tacoma, Wash.

Transistors are notoriously temperature-sensitive, and are especially troublesome in circuits that have no temperature stabilizing components. Although electrolytic capacitors often exhibit erratic behavior under varying temperature conditions, it is more likely that one of the transistors changes its characteristics due to a variation of collector cutoff current with temperature.

The most likely source of the trouble is the transistor that is serving as the superhet local oscillator. If this stops oscillating, all signals will disappear but you will still be able to hear some background noise. This is helpful in determining whether this transistor is the source of your trouble and spares you the job of disconnecting it.

If one of the audio transistors is at fault, the noise level without signal should drop severely or disappear altogether. You might also investigate the condition of the diode detector. A defective detector will permit some noise to be heard but not as much as you get when the oscillator stops working.

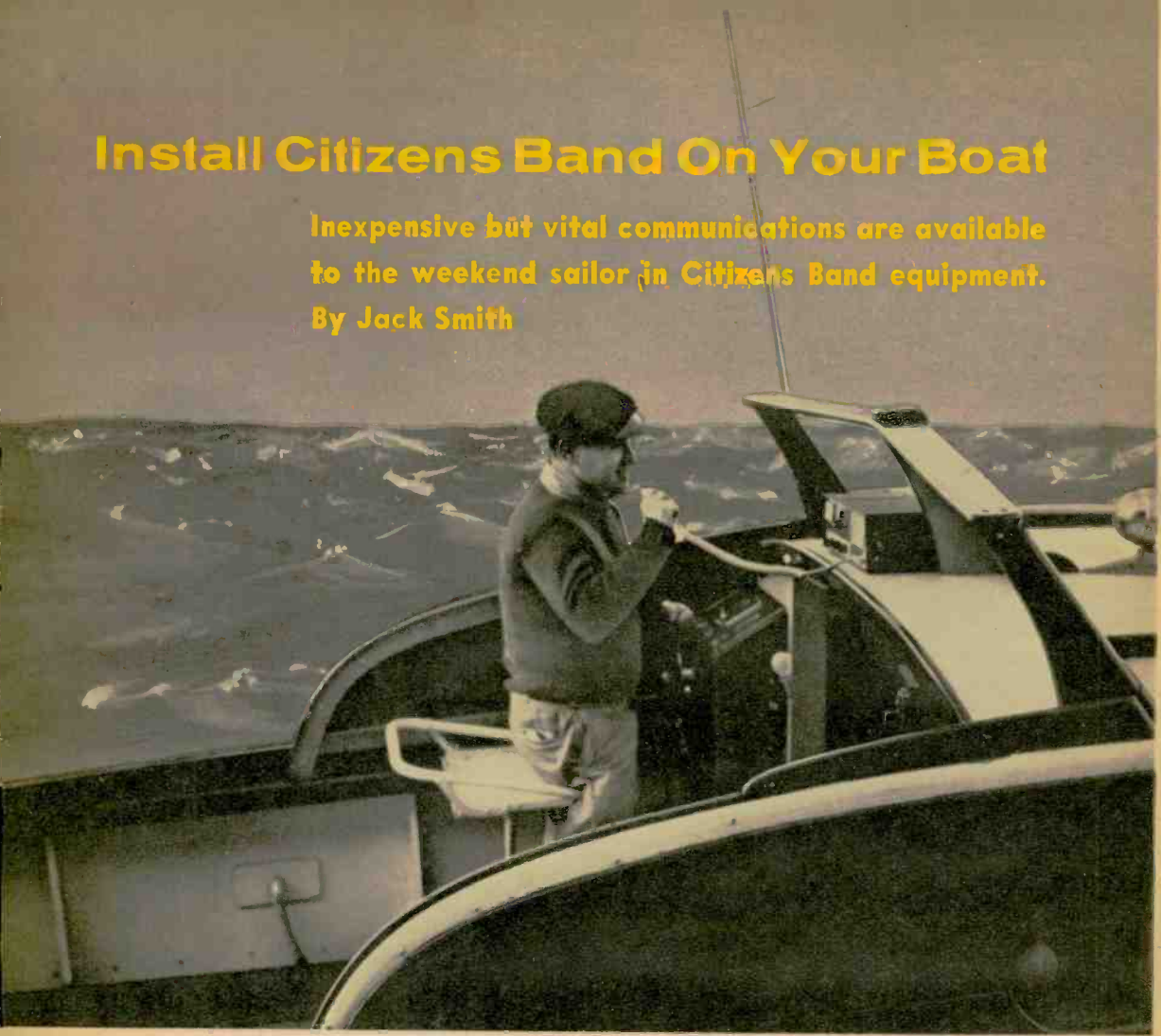
[*Continued on page* 106]

*Write to the Electronic Brain, Electronics Illustrated, 67 West 44th Street, New York 36, New York. Enclose a stamped, self addressed envelope for a prompt reply.

Install Citizens Band On Your Boat

Inexpensive but vital communications are available to the weekend sailor in Citizens Band equipment.

By Jack Smith



EVERY boat owner has wished at some time for a means of communicating with other boats and with the shore via something a little better than his lungs. The size, cost and installation requirements of Class D Citizens Band equipment now answer that desire for just about every weekend sailor.

CB can end those fruitless, fuel-wasting hunts to join another craft when only guessing at its location, the anxiety caused on shore when you're delayed by a storm and overdue, and your own concern over the possibilities of being stranded with engine failure. Hardly more worthwhile use for CB as defined by the FCC could be found.

Our choice of equipment for our 22 ft. inboard cabin cruiser was an HE-20 Citizens Band Transceiver carried by Lafayette Radio and listing at $99.50. The superheterodyne receiver section has four crystal-controlled receiving channels or may be continuously tuned through all 23 CB channels. Squelch control keeps the receiver quiet until a message is received and an automatic series gate noise limiter helps subdue interference. An S meter with a two-position switch is incorporated.

The transmitter delivers the maximum of five watts and has four crystal-controlled transmit channels. Crystals for any four of the 23 channels may be inserted. The set comes with matched transmit and receive crystals for channel 9. The HE-20 has a 12-volt power supply built into its 5½x8x12½-inch dimensions and also runs on 117 volts AC. Operation from the boat battery

or dockside current is simply a matter of switching cords.

Installation of CB on a boat is simple. The most convenient mounting place is near the helm, yet as far from the compass as possible. The set can go behind the flying bridge windshield on a cabin boat or on a shelf on the side of the cockpit. It may be inside the cabin if you're prepared to stop to talk or have someone take the helm while you're running. Under a deck or seat is a good place in an open boat—anyplace protected from rain and spray. Just secure the unit so it stays put and make a plastic cover or go the limit and build a cabinet.

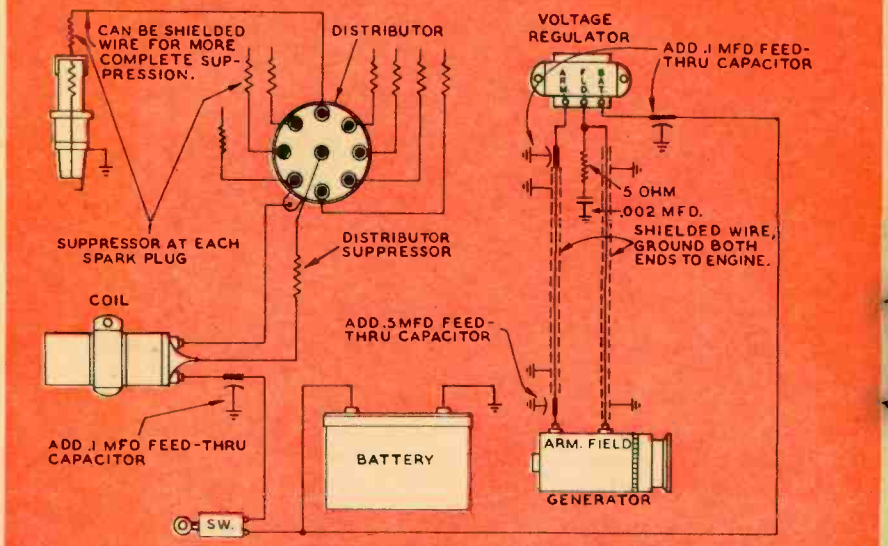
The antenna may be an inexpensive, base-loaded whip (Lafayette model HE-19), which will provide good results for communication up to about three miles. Greater range may be obtained with a quarter-wave vertical whip of stainless steel. Both these types, however, make use of a ground plane. If the hull is metal it serves as the ground plane; if it is wood the ground plane must be introduced at the base of the antenna by means of a metal plate, screen or radial wires.

An antenna which does not require a ground plane is made for marine purposes by Mark Mobile, Inc., of Skokie, Ill. It is the Heliwhip model HW-11-6M costing $38.25. This six-foot, top-loaded antenna operates in half-wave resonance. At the base it incorporates an impedance launcher-matcher coax cable for 50 ohms. An accessory is a Quick-On Connector which allows the whip to be removed with a flick of the wrist if you're passing under a low bridge. Naturally, the antenna should be mounted as high as possible.

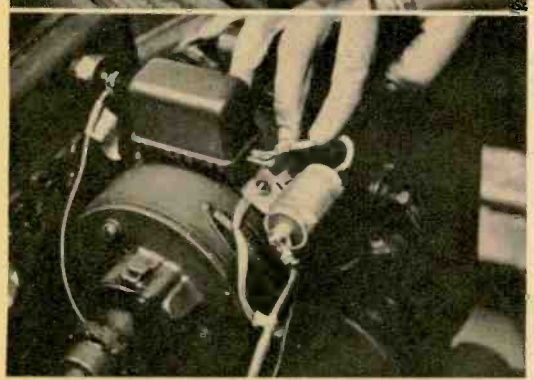
You do not need a ground plate on the bottom of your boat for CB radio. Grounding one side of your battery to the engine block is enough.

High quality CB transceiver for the boatman is the HE-20 by Lafayette Radio. Author put set behind flying bridge windshield of cruiser (see photo opposite).

Noise suppressors are necessary on either outboard or inboard engine. The diagram indicates points of installation of the various components that are required on boat.



Spark plug suppressors are simply pressed on terminals. These suppressors should not be used with resistor-type spark plugs. Resistor plugs must be used on outboards.



A .5 mf capacitor goes into lead from the generator, which has a cutout instead of a voltage regulator. Braided armor on wire from capacitor to the ammeter is grounded.

Arrows indicate resistor in wire from coil to distributor, .1 mf capacitor in coil's battery terminal and the strap grounding the capacitor to mounting bracket of coil.

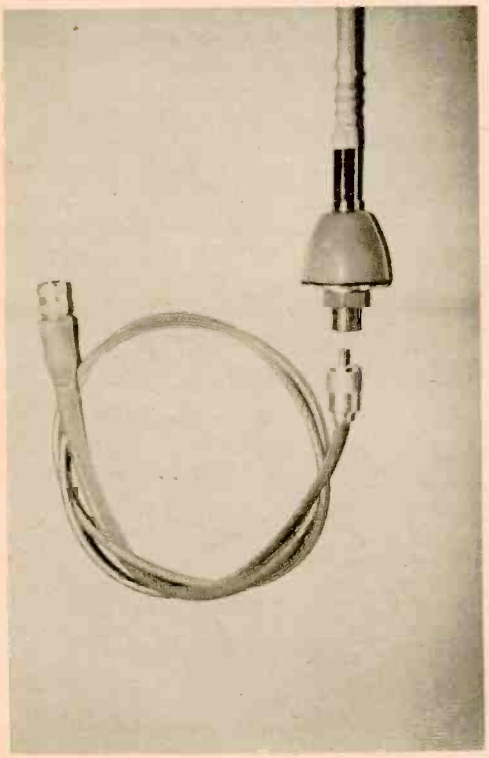
A critical requirement for operation while running is suppression of electrical noise. In an engine's electrical system you have many tiny radio transmitters wherever arcing occurs.

Make sure your electrical system is in good condition and all connections tight. A noise suppression kit made by the E. F. Johnson Co., Waseca, Minn., is available from Lafayette for $13.50. Instructions with the kit are detailed and the wiring diagram makes the installation quite clear.

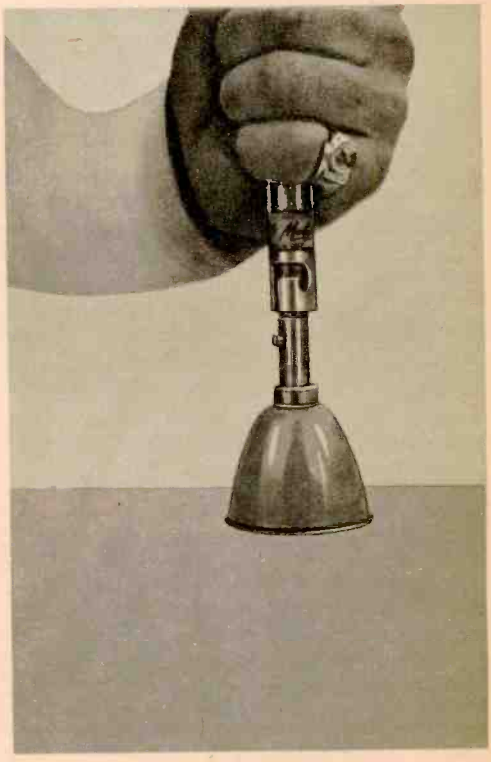
Your first installation should be suppressing devices in the ignition wiring. These consist mainly of: 1) resistors for distributor and spark plug suppression; 2) coaxial capacitors which filter out or bypass directly to ground the electrical noise caused by the generator and regulator and 3) shielded wires which prevent the escape of remaining noise from the generator and regulator. The spark plug suppressors are simply slipped on; the high-voltage wire from the coil to the distributor is cut and the ends are threaded into the resistor; the capacitors are installed on the proper coil, generator and regulator terminals, and the wiring is hooked up with a minimum of soldering.

Outboard engines generally have the voltage regulator mounted outside the shroud. The kit should be installed without using shielded wires from generator to regulator. Later, if noise persists, the shielded wires may be added. Though Autolite resistor spark plugs may be used in either inboard or outboard engines, they are recommended for outboards instead of spark plug suppressors.

Only the usual CB license is required for operation on the water. That's all there is to giving your boat a vital communication link.



Impedance launching cable, an accessory of Heliwhip antenna, eliminates the need for a ground plane when installed on a boat.



Spring-loaded Quick-On Connector accessory allows the whip to be disconnected from the base when boat approaches a low obstruction.

EI's Hi-Fi Doctor . . . .

Second Thoughts on Stereo—Part Two

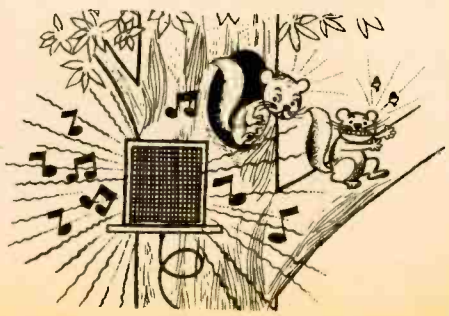
LAST month I started to re-explore the road to good stereo listening, making the point that stereo is far from an exact science and that it demands experimentation by the audiophile. I'd like to pursue the point a little further.

Even if audio engineers were to agree tomorrow on uniform standards for stereo recording, we would still be a long way from uniform rules for stereo listening. Keep in mind that what we're pursuing via stereo is an *illusion*, the "feel" of live sound. And it's an elusive goal. Only a few months ago, engineers at Bell Laboratories discovered that our ability to see and hear in three dimensions is due not only to our having two eyes and ears but also to our moving our heads almost imperceptibly as we watch and listen. Small movements of our heads helps us to see and hear "around" things and perceive them in depth. Whether and how recording engineers are going to make a try at applying this fact to stereo recording remains to be seen. The point is that stereophiles can count on being on their own for quite a while to come, with no sure-fire techniques for turning every living room into a concert hall, and with new factors constantly coming up.

What do we do in the meantime? And where do we put our speakers for good stereo? Well, one compromise technique that seems to work pretty well is to place your stereo speakers to reflect sound off the walls of your living room rather than having them beam directly at you. What you gain with indirect sound is less variation of the stereo effect from record to record, in other words, less dependence on the particular mike placement employed by a recording engineer. What you lose is a bit of directionality and impact in your stereo, sacrificed in the interest of a good stereo blend with maximum depth and spaciousness.

The technique of indirect sound radiation is undoubtedly gaining popularity, and several speaker manufacturers are marketing systems with speakers beaming sideways—rather than straight at the listener—from both ends of a single enclosure. Not all of them seem to work equally well. Some of them don't make use of any reflections in the listening room itself for good dispersion—particularly of highs—and wind up sounding muddy. One manufacturer (James B. Lansing) points his speakers inwards at a curved reflecting surface on his enclosures, but this technique really seems to work at its best only on the biggest and most expensive enclosures using it. Fortunately, it's easy enough to come up with your own scheme for indirect stereo, using separate speaker systems of practically any size or shape. The important thing is to find a good reflecting surface in your living room; you can't bounce much sound off an overstuffed armchair. One usually effective technique is to aim your mid-range speakers and tweeters upwards into a room corner. Whatever location you find for reflecting the sound from your speakers, you'll probably want to advance your tweeter's level control beyond its normal setting to compensate for losses in the reflected highs.

Although indirect stereo is definitely a compromise, it looks to me like the best one for now. It pays its biggest dividends in giving you a much wider choice for a favorite listening spot.



and Clinic

Hi-fi questions are all answered by mail.* If of general interest they will appear in this column.

Printed Circuit Boards

While shopping around for a hi-fi set, I chose one that looked good but my friend says it has a printed-circuit board and they are no good. Is he right?

B. Stockler
Plainfield, N. J.

The printed-circuit board has been accused of being brittle, breaking easily, being hard to solder to (in kits), impossible to troubleshoot, etc. But let's not forget hand wired circuits can also have problems such as poorly soldered components, instability caused by long leads, etc.

Some of the earlier high-power printed circuit amplifiers *did* run into trouble because their boards would not stand up under heat. Redesign of the chassis and improved board material has licked that problem. In short, choose your amplifier on the basis of other factors than the use or non-use of the printed board. Be assured that if you purchase any amplifier from a reputable hi-fi manufacturer, he will stand behind his product.

Inductive Hum Interference

I have built a record player with the amplifier and phono unit in the same case, and the amplifier seems to be picking up AC hum interference from the phono motor. How can I go about eliminating this hum?

Edwin C. Horacek
Yankton, S. D.

It is possible that your amplifier is actually picking up hum from the nearby phono motor, but it is far more likely that your trouble stems from radiation of hum from the amplifier to the pickup cartridge.

To check this, shut the phono motor off but leave the amplifier turned on with its volume control set at the usual position, and swing the pickup arm just above the turntable platter. If the hum varies in intensity as the arm moves, it is coming from the power transformer in the amplifier. If the hum remains constant, the pickup is either poorly shielded or is improperly connected. If there is no appreciable hum when the phono motor is shut off, then *this* is the component which is feeding inductive hum to the pickup.

If the pickup cartridge is receiving hum from the amplifier or phono motor, you have no choice but to replace it with either a high-quality ceramic unit or with a magnetic type having unusually low susceptibility to hum fields.

If you are already using a ceramic cartridge, then the hum is most likely due to inadequate shielding of the leads from the pickup cartridge to the amplifier, or lack of adequate grounding of the turntable assembly.

If the phono drive motor is located *very* near the amplifier's output transformer, the slight hum that results may be eliminated by rotating the output transformer on the chassis, fastening it at the angle which gives the least hum.

Connecting Cable

What is the best wire or cable to use to connect a hi-fi speaker to the output terminals of my amplifier?

Max Goldring
Trenton, N. J.

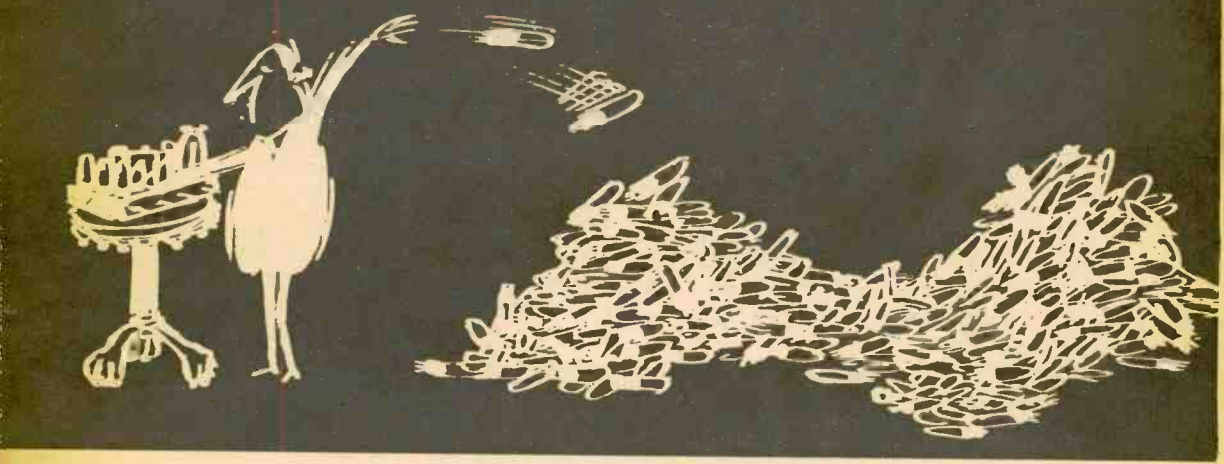
The factors to be considered when choosing speaker lead wire are the following: the resistance of the wire, the capacity between its two conductors, and the ease of installation. Standard AC "zip cord" can be used for runs of 50 feet or more without detectable loss of volume or affect on the amplifier's damping factor. For shorter runs, where it is convenient to place the wire under the carpet, use TV 300 ohm flat line.

***Write to the Hi-Fi Clinic, Electronics Illustrated, 67 West 44th Street, New York 36, N. Y. Enclose a stamped self-addressed envelope for a prompt reply.**

How to Repair Radios

Part IV—The concluding article in this series.

By George Gordon



IN this fourth and final article in the series we will discuss low volume, noise, distortion, and intermittent reception.

Low Volume

The procedures that were used in the no reception section will also serve here. Recall that you checked out half the circuit by touching the top of the volume control with a screwdriver. If a healthy buzz appeared at the loudspeaker, the audio section was okay. You can use the same method now. If the buzz is weak, the trouble is either in the audio section (V-3 and V-4), or the power supply.

To eliminate the power supply as a possible trouble source, measure the B-plus at both ends of R-7. It should be about 100 volts, ±20%; if the voltage is low, change the 35W4. If this does not do the trick, disconnect each of C-7's leads one at a time, and temporarily connect a capacitor of similar value in place of each section. If either section were leaky, it would have lowered the voltage at R-7.

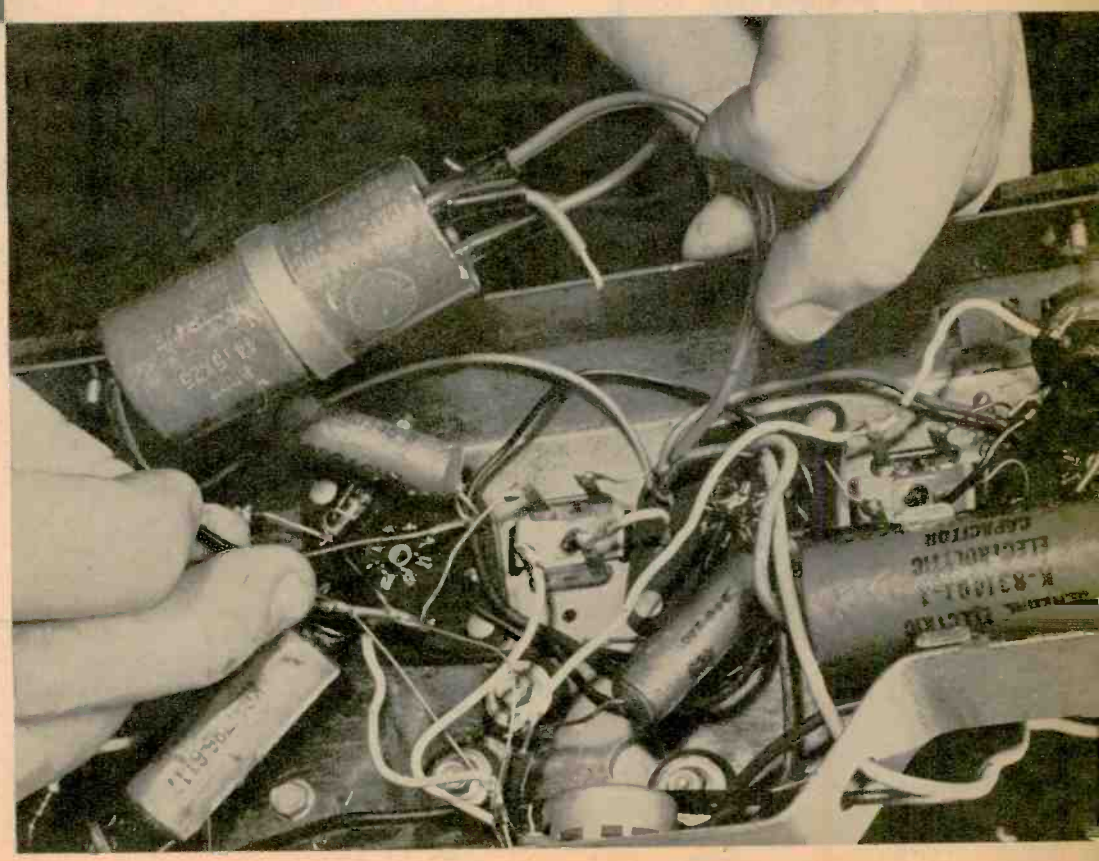
If power supply voltages are okay, check voltages and resistances at V-3. Note that if C-6 were partially shorted, the B-plus voltage on the plate of V-4 will be okay, but the audio signal will not get to output transformer T-3. If all is normal, replace each tube in turn and check the set for operation. A jammed speaker voice coil may cause a weak sound. Metal filings or other dirt can lodge between the voice coil and speaker pole piece and prevent the cone from moving. The result will be a weak tinny sound. Gently press the cone with the fingers to see if it moves back and forth freely.

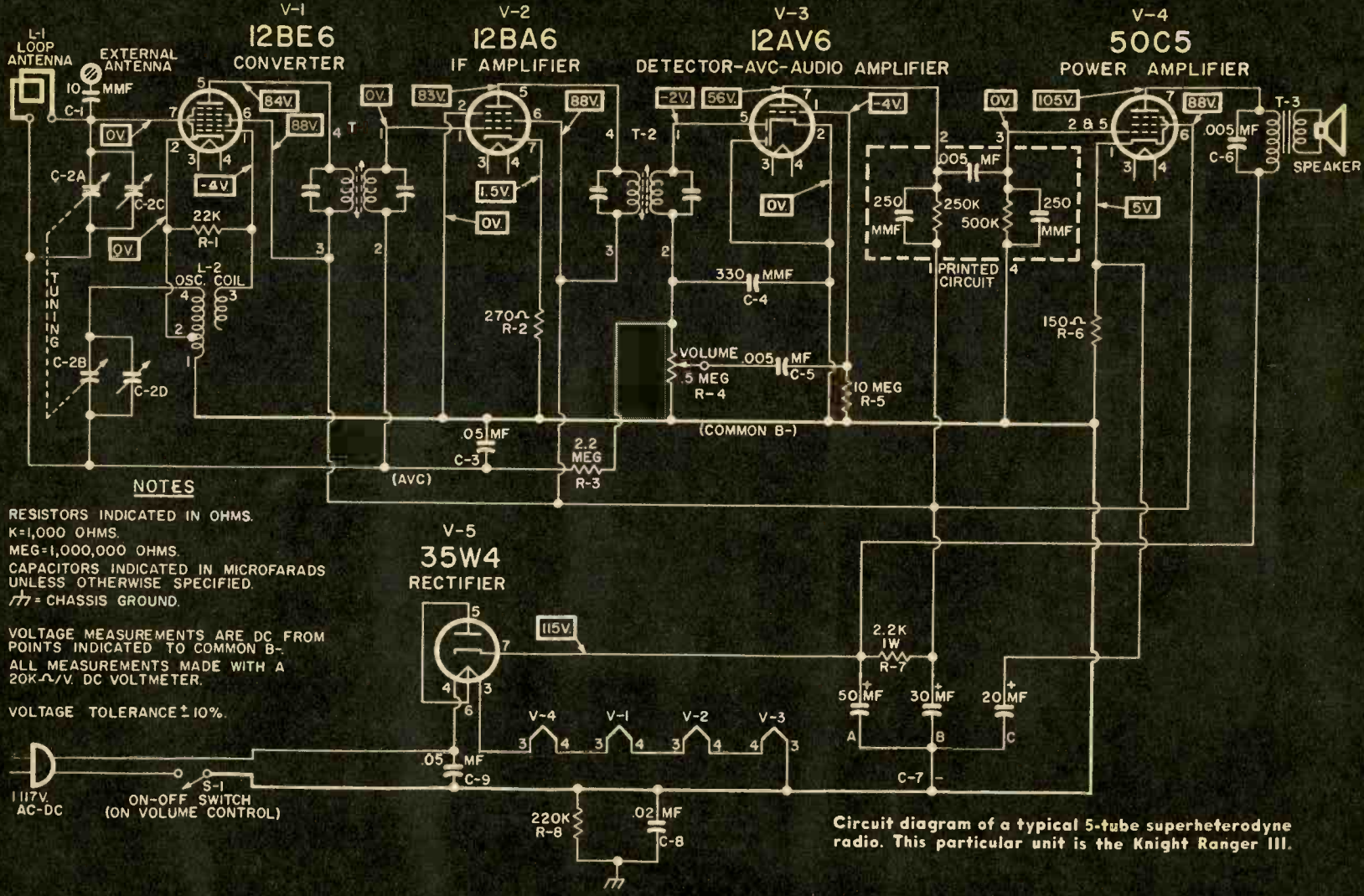
After the audio section proceed to check voltages at V-1 and V-2. Then replace each tube in turn. In addition to faulty tubes, the AVC circuit could be causing trouble. If C-3 opens, the signal will be weak and if C-3 is leaky, the bias on the first two stages will drop causing the sound to be distorted on strong stations.

Note: The position of the loop antenna affects the volume of the radio. Try the set in a different place and position. A steel building may also affect the volume. A decrease in line voltage (108

The speaker is a possible cause of distortion. Gently depress the cone and if rubbing is noticed, it's better to install a replacement speaker than attempt a repair.

If an open electrolytic is suspected, try shunting each section with a good capacitor. Replace the entire unit even though only one section is found to be defective.





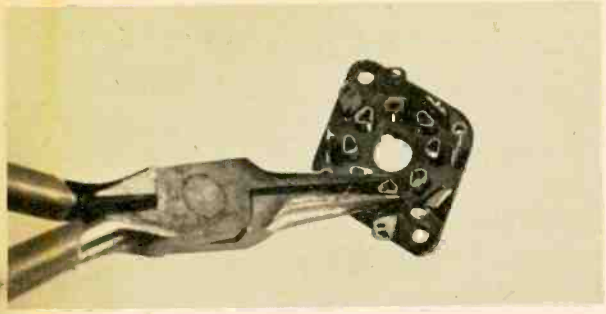
NOTES

RESISTORS INDICATED IN OHMS.
K=1,000 OHMS.
MEG=1,000,000 OHMS.
CAPACITORS INDICATED IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
⏚ = CHASSIS GROUND.

VOLTAGE MEASUREMENTS ARE DC FROM POINTS INDICATED TO COMMON B-.
ALL MEASUREMENTS MADE WITH A 20KΩ/V. DC VOLTMETER.

VOLTAGE TOLERANCE ± 10%.

Circuit diagram of a typical 5-tube superheterodyne radio. This particular unit is the Knight Ranger III.



Noisy or intermittent reception may be due to poor socket connection. Try crimping contacts.

volts or less) can cause weak reception, or even total loss of sound.

Hum

One of the most common causes of loud hum is a defective power supply filter capacitor. A bad electrolytic will also often cause "motorboating," a putt-putt sound similar to that of an outboard motor.

To determine which section of C-7 is at fault, temporarily connect a good electrolytic (about 30 mf or more) across each section. Be sure to observe polarity and voltage rating. If the hum is reduced or stops, replace C-7.

Tubes can also cause hum, particularly in the audio stages due to filament to cathode leakage. Try replacing V-3, V-4, and V-5 first. Because hum can originate in any stage, let's isolate each by working backward from V-4. This time we will ground the signal that appears at the *grid* of each tube. Thus the signal coming to the grid will be eliminated, and only hum originating in that particular stage will still be heard at the speaker. Once again, ground the top of the volume control. If the hum disappears, you know that it is coming from the RF or IF sections. If the hum remains, then ground the grids of V-4 and V-3 in turn until you've isolated the stage.

Do the same with all stages. Don't ground the tube's plates directly; use a .1 mf capacitor so you can ground the signal without shorting the B-plus. Once you've found the faulty stage, check for an open grid resistor, poor grounds, bad tubes or a short to the AC line.

Noise

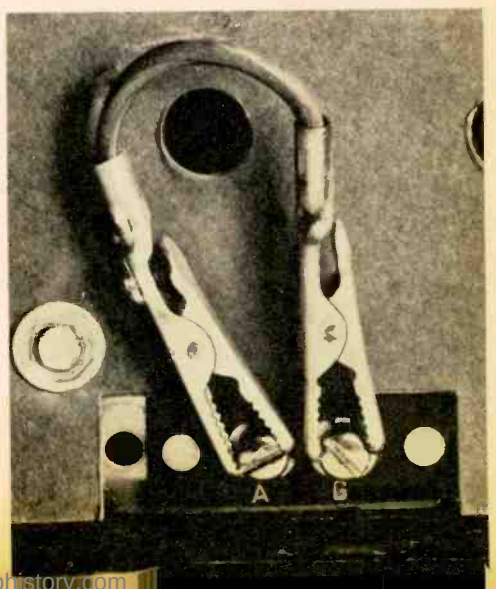
This problem may originate *outside* or *inside* the receiver. First, let's prevent outside noise and signals from entering by grounding the input grid (pin 7) of V-1. If the noise stops, we can assume that it originated outside the receiver.

Note: A faulty loop antenna connection could cause noise. Check these connections carefully.

Outside noise can be caused by power lines, TV sets, atmospheric conditions, fluorescent fixtures, and many other things. Determine if the noise is picked up on one or many stations. If it affects only one station, the broadcast signal may be weak and therefore the signal-to-noise ratio poor. Nothing can be done for this. If the noise is bad on all stations, try repositioning the radio. If the noise is caused by electrical appliances connected to the common power line, a commercial noise filter (available at radio supply stores) inserted between the outlet and the receiver plug may help.

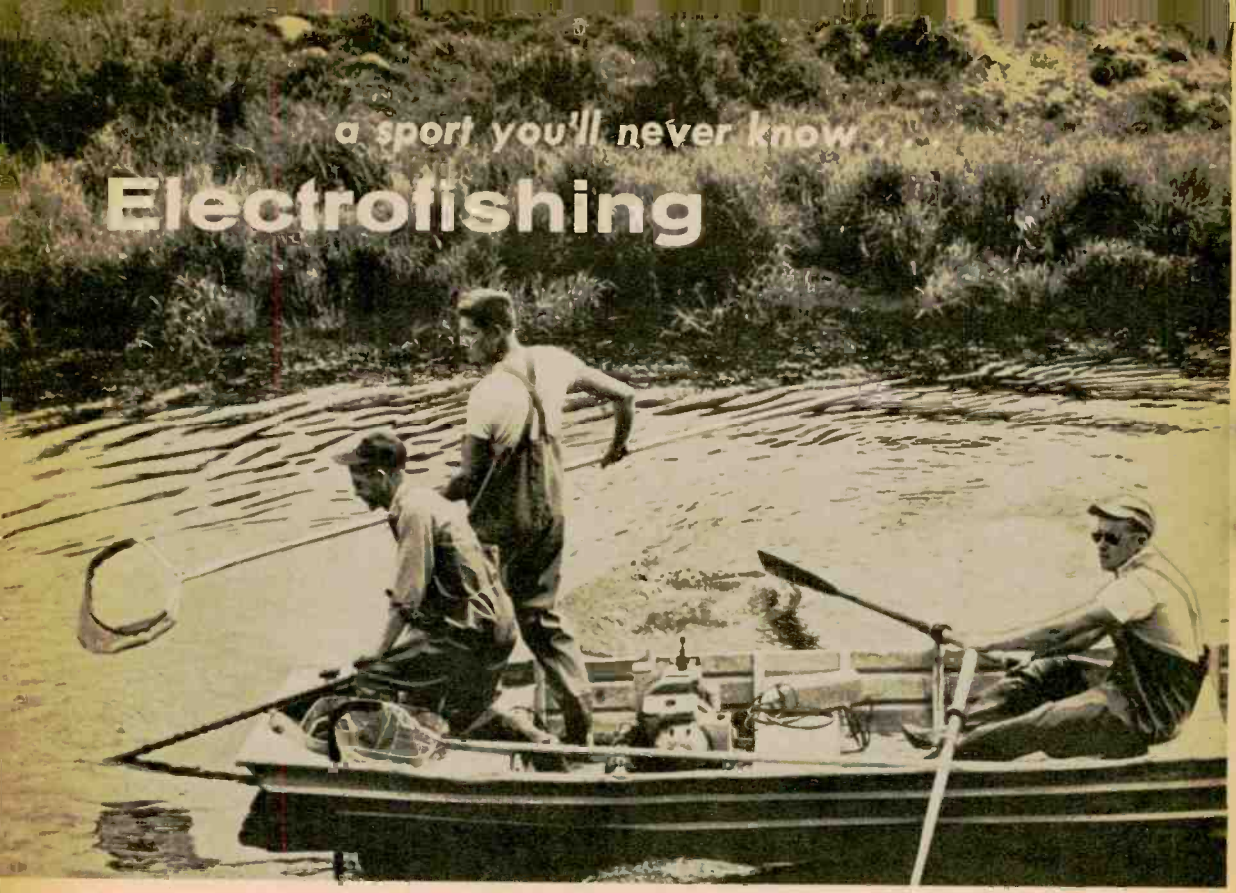
If grounding V-1's grid did not stop the noise, we know the trouble originates in the receiver. The following components may be at fault: loose tube elements, cor- [*Continued on page* 98]

If noise continues after the antenna input has been shorted, the trouble is within the radio.



a sport you'll never know . . .

Electrofishing



ELECTROFISHING is a term you've probably never heard before, but if you're a fisherman its implications won't be lost on you. Using this system in most any stream, you'd have to hire a truck to take home your haul. You might also have to do something about hiring a lawyer. Electrofishing is not for the sportsman.

The U. S. Fish and Wildlife Service invented electrofishing as a means of obtaining truly accurate samples of fish in streams and lakes. All other methods, such as seining, have drawbacks because fish like to hide under brush and amongst rocks at census-taking time.

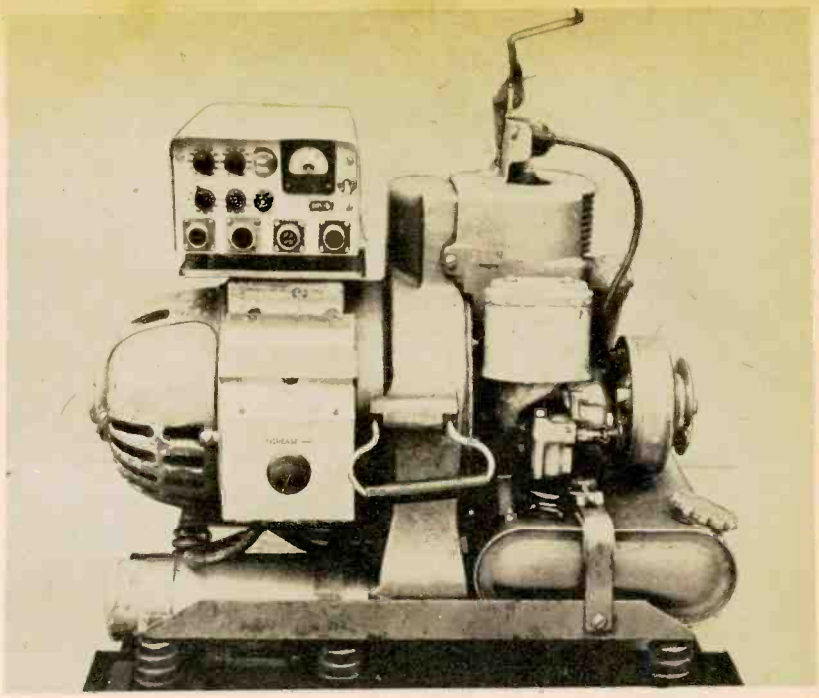
The basis of electrofishing is something called galvanotropism, which describes a condition wherein a fish, caught in an electric current, involuntarily is forced to orient itself against the path of current flow with its head toward the positive pole or anode. If the current then is pulsed each pulse produces a muscular spasm in the fish and causes electro-taxis—the fish involuntarily swims toward the electrode.

The electrical field and voltage gradient become stronger closer to the electrode and the fish eventually is electro-narcotized, lying immobile in the water. It then may be picked up easily with a dip-net. After examination, it can be put back in the water and swims away as a healthy specimen.

In some cases, fish swim so close to the electrode before being electro-narcotized that they are electrocuted instead. Taken as a whole, however, electrofishing is a humane way to accomplish a necessary fish conservation task.

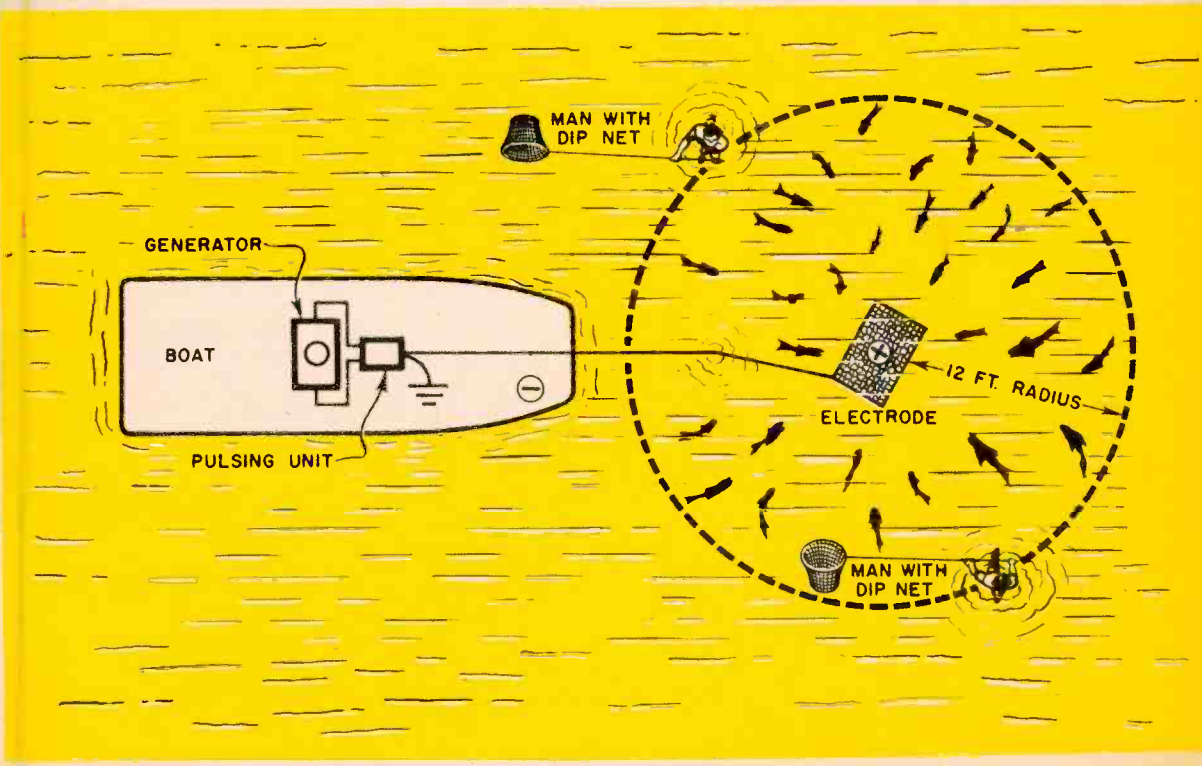
The electrofishing setup currently used by the Wildlife Service operates from a small metal-hull boat. A 2,500-watt Homelite generator mounted in the boat produces the necessary power of 230 volts DC. The boat hull becomes the negative electrode. The positive electrode is an aluminum grid mounted on a 6-foot pole sticking out underwater from the bow.

Current from the generator is first fed into a square-wave pulsing unit which



Gasoline-powered generator produces 230 volts of DC current for electrofishing. Hybrid transistor-tube pulsing unit sits on top. Unit mounts in the boat.

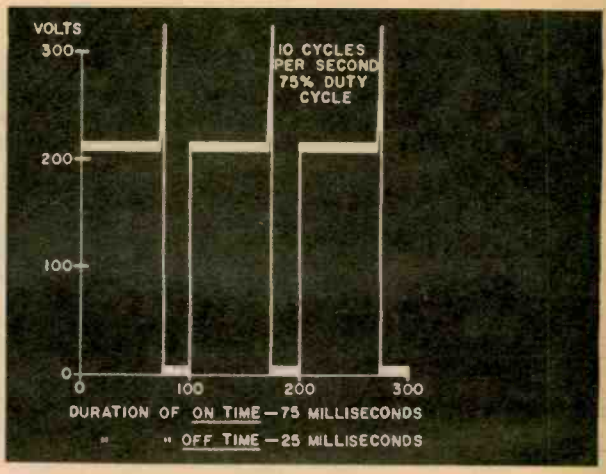
This is the way the men of the Wildlife Service count the fishy population in streams and lakes. Boat is negative electrode. Positive electrode is aluminum grid; 12-ft. radius marks optimum operating area. Drawing is not to scale.



Gear for electrofishing can all be hauled in station wagon and set up on bank of a creek.

Young biologist holds 5¼ lb. bass taken from stream, with electrode and pole in left hand.

Specimen fish are examined. Rubber waders protect dip-net men from shock in the water.



Schematic of square-wave DC impulses fed to electrode; in actual fishing 50 cps is used.

has a hybrid circuit using transistors and thyratrons. Experiments have shown that about 50 cycles per second produces the best results and that the duty cycle ("on" time) should be 40 to 70 per cent of the whole. The pulsing unit feeds through an insulated wire to the positive grid under the water. The electrical field can be felt (by fish) about 20 feet out from the electrode and down to 12 feet underwater. In operation, the useful field covers a circle around the electrode measuring about 12 feet in radius.

Three men go on electrofishing jaunts. One man operates the generator and boat, and the other two, wading near the electrode or riding in the bow, use dip-nets to pick up the fish.

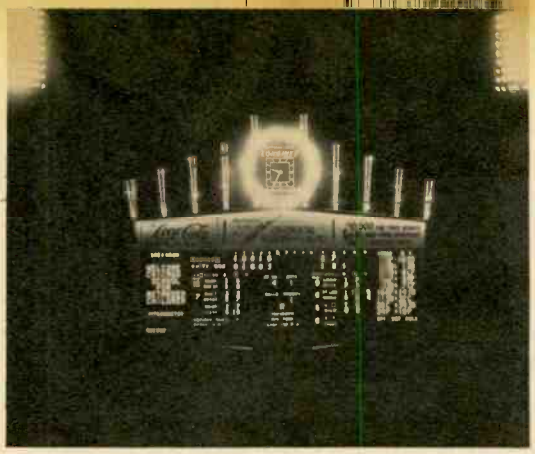
Wildlife experts have been surprised to find that electrofishing works better with large fish than small ones. It seems the big ones absorb greater voltage because of their longer length.

Engine Of Tomorrow

Full-size model of an ion engine designed to shoot man through outer space at speeds up to 100,000 mph has steel plates held apart by ping-pong-ball shaped porcelain insulators. Engine is a foot long, has a tiny thrust.

A FULL-SCALE model of an ion engine, the power plant that may propel man through outer space, was shown off recently by its builders, Goodrich-High Voltage Astronautics. The firm has a working demonstration unit. Although an ion engine's push is measured in millipounds, it could propel a large vehicle at high speeds in space because of lack of resistance. Prime power source would be atomic. This would drive a high-voltage electrostatic generator which would supply electrons to the engine, where they would be mixed with accelerated mercury ions and shot out a nozzle, creating a propelling force under Newton's Third Law of Motion. GHVA is carrying out ion engine research under contracts from both Army and Air Force.

Electricity to operate engine may come from this high-potential electrostatic generator.

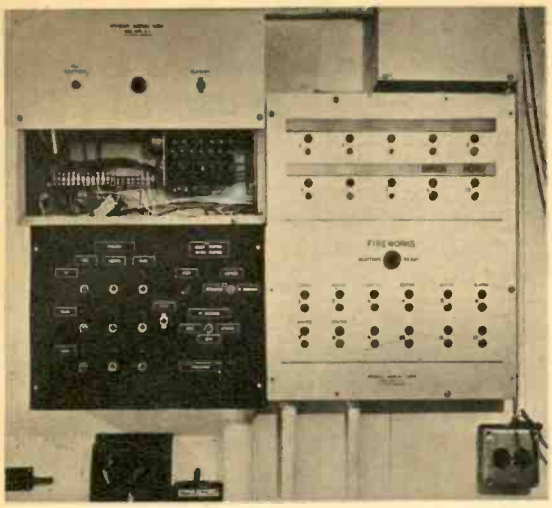


Chicago skyline is lit up by electronically controlled scoreboard when White Sox hit a homer. Stacks on top give fireworks display for crowd.

The Great Chicago FIREWORKS

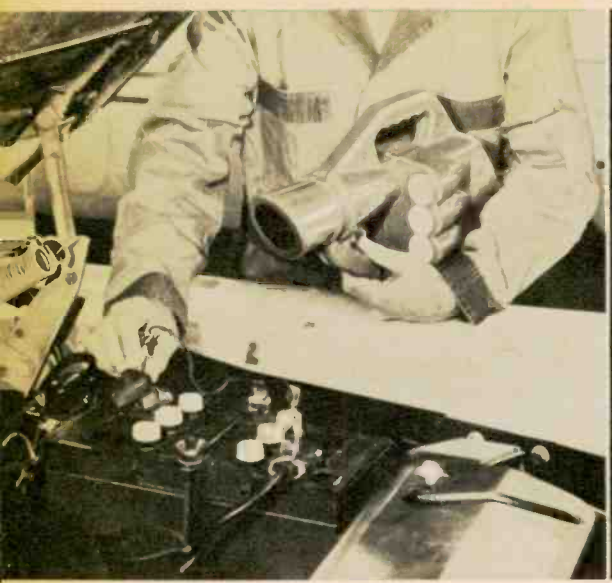
IF YOU live in Chicago it's hard to ignore the fact that showman Bill Veeck is running the White Sox. When the team performs well the sky lights up with barrages of fireworks. Patrons get all kinds of spectacular effects on the big scoreboard, along with a variety of messages spelled out in foot-high letters. Veeck directs the spectaculars with two-way radios, complicated electronic circuits, miles of cable and control boards that do a battleship proud. It's bright in Chicago!

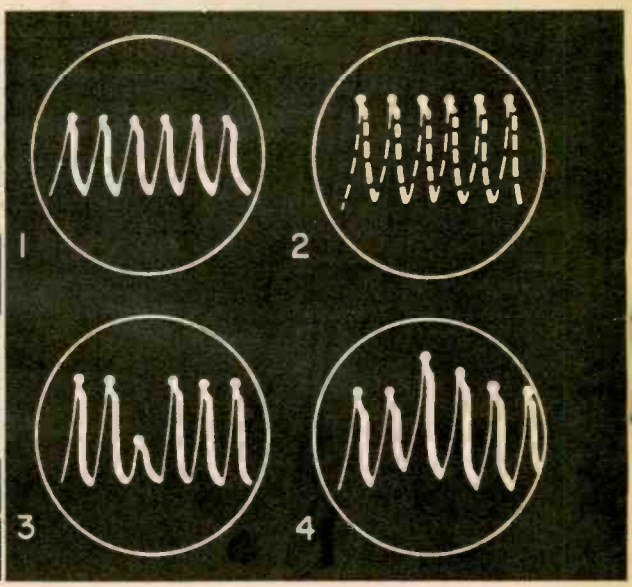
Sox chieftain Bill Veeck (right) and assistant keep tab on and direct the goings-on around the park, communicating with each other via radio.



Fireworks and other spectacular scoreboard effects are triggered by control panel at the left. Pushbuttons on huge board are punched to spell out message to crowd on the big scoreboard.

The rocket's red glare high over scoreboard tells all Chicago about the home run just hit.





Handyman's analyst tells the condition of all spark plugs via waveform on scope, which is compared to key figures shown on the right side of instrument. List price is $44.95.

1. Scope's waveform when plugs are normal.
2. Six pips say all plugs are lead-fouled.
3. Low pip says plug No. 3 is oil-fouled.
4. Electrode wear is interpretation here.

New Engine Analysts

New professional oscilloscope that sells for $449 analyzes some ten operations of engine.

TWO NEW oscilloscope assemblies designed to diagnose trouble in a motor car engine have been put on the market recently. One unit, the ACilloscope, is meant for the home handyman who likes to check up frequently on his car and take measures to prevent trouble before it comes. It is made by the AC Spark Plug people and sells for $44.95. The ACilloscope is hooked to the distributor, one spark plug lead and the battery. A separate pip appears on the scope face for each spark plug. By comparing each waveform with master diagrams mounted on the instrument, the owner can tell what his plugs are or aren't doing.

A professional engine analyst put out by DuMont Laboratories is much more sophisticated and sells for $449. It indicates mechanical or electrical condition of breaker points, ignition coil, distributor with wires and capacitor, dwell angle of engine and timing, and gives several other readings.

The Secret Power of Sound

Continued from page 39

with the Jacksonville, Fla., Memorial Hospital) that Dr. Henkin undertook his sound-analysis research project. He started with the known elements of music—melody, rhythm and what he calls orchestral color (actually his experiments dealt mainly with melody and rhythm). He then chose musical compositions which contained one of these qualities to the exclusion of the others. These were played to selected listeners.

To each listener Dr. Henkin attached a galvanic skin response apparatus—a pair of electrodes fastened to the hands. Changes in the skin, such as tension, would cause changes in the electrical resistance, just as in a lie-detector test. Dr. Henkin took continuous readings on his instruments while giving his listeners various types of music, disorganized sounds and periods of silence. Changes in skin resistance would indicate actual physiological changes in the body.

Dr. Henkin found that there were such changes in the body in response to music and, further, that the response depended on the type of music. When melodic music was played an increase in skin resistance was noted, indicating relaxation. Rhythmic music produced tension and decreased resistance. The young researcher at length was able to predict with great accuracy exactly what would happen when he played a particular type of music.

There were exceptions, mostly having to do with the prior experience or lack of it on the part of the listeners. If a listener heard a combination of sounds that was totally new to him, his response did not follow the pattern but was nearly akin to that caused by silence.

To carry out his human experiments, Dr. Henkin built a reverberation room to exact specifications and employed a back-loading speaker as a sound source. A windmill-type arrangement of blades was used in the center of the room to distribute the sound in an even pattern.

Proceeding further, Dr. Henkin ran a group of experiments on white rats, which he placed in a long sealed tube. The animals then were subjected to 200-cycle sounds at extremely high levels on the order of 135 decibels, or the sound intensity of a jet airplane.

After such exposure, the amount of hormone produced by the adrenal gland was ascertained through surgical procedures. Dr. Henkin found a marked rise in adrenal hormone output after sound stimulation, which meant simply that the animal's physiological processes had been speeded up markedly.

Dr. Henkin's experiments so far have been on a basic level. Much is yet to be done, he believes. What value can his data have? He answers this way:

Music plays an important role in technology and medical science, as well as in aesthetics. He hopes that a scientific basis for musical therapy can be useful in the rehabilitation of mental patients. Other medical uses also are possible, of course. Firms which supply piped music to restaurants and such places, using Dr. Henkin's data, could presumably select music on the basis of the response that would be caused. Even a composer could make use of knowledge about responses to music. His compositions might be arranged to cause a certain response in the body rather than a sound pleasing to the ear.

Music and sounds produced by other cultures enable us to give them an evaluation that might be even more meaningful than an examination of the cooking pots they used or the arrangement of their bones in graves.

Perhaps a little closer to everyday life is the possibility of using facts such as established by Dr. Henkin to select background music for offices or homes, making both our business lives and home lives more pleasant.

Lie Detective

Continued from page 76

on his left hand. Now he was all set.

"Fire away," said Bill. "I've got nothing to hide."

Nor did he, if you judged by his application and letters of recommendation.

Yet in 20 minutes the long-haul hopeful had admitted, almost with relief, that he considered himself accident-prone. He recounted a string of accidents, blamed them on hard luck and finally said he just seemed to blunder into road trouble.

Some of his trouble, he conceded, stemmed from his home life. His wife's 3½-month confinement in a hospital had plunged him $2,500 in debt. Shaken, he'd started drinking—while driving. He confessed that on the road he often carried two vacuum bottles, one filled with coffee, the other with bourbon.

Gugas said later: "When it was all over the guy shook my hand and said, 'heck, I don't like truck drivin' noways.' "

Electronics in a matter of minutes had seen through the man, dredging up facts he'd never have put in writing.

What of Gugas's $35 fee for the half-hour interview? It was a bargain, compared to the smash-up of $140,000 worth of truck and cargo.

Industry's growing reliance on the psycho-polygraph is booming the electronic mind-reader to big-time income, and with reason. Studies show that 95% of all job-seekers fib (mostly about reasons for leaving their previous jobs, their marital status, actual job experience). Of the fibbers, at least 25% conceal facts—physical disabilities, criminal records, work attitudes—which make them unsuitable for the job they apply for.

The polygraph and its operator also have a more delicate chore: to evaluate the whole man, digging deeply into his personality to determine how long he intends to stay on the job, how he evaluates himself and his own abilities, and his trustworthiness in terms of honesty and job stability.

A company could hire sleuths to dig into a man's past and a psychologist to probe his attitudes. Both cost time and money. The polygraph usually gets the facts faster and at far less cost.

Says one electronic mind-reader: "An hour with an applicant and I can tell whether he's at peace with his wife, with his creditors, whether he drinks excessively, and whether he's concealed medical facts which might limit his job usefulness."

Who hires an electronic screener? Literally thousands of companies, big and small.

For a major drug firm, Gugas spotchecks for past narcotic addiction. For a company that develops many new, unpatented processes (and fears competitors may be tipped by a loquacious employee), Gugas determines how close-mouthed a man is. For others with defense contracts he culls potential security risks.

In the culling, Gugas travels two weeks out of every month (his beat is nationwide). Last year he screened 400 prospective employees for one firm alone.

The polygraph's switch from criminal sleuth to corporate fact-finder has been dramatic. Fully 80% of all polygraph screenings now are done by industry. A mere 20% (conducted by police and other law-enforcement officers) involve criminal matters.

Chris Gugas has unusual qualifications for his job. He was a wartime polygraph expert as a Marine Corps intelligence officer, holds a college degree and is a licensed detective. But all that is not required. You can pick up the polygraph art in six to 24 intensive weeks.

Half a dozen universities teach polygraph technique. There is an all-service polygraph school at Camp Gordon, Ga., and Chicago's Keeler Polygraph Institute offers a stiff six-week course plus field training.

Licensing isn't required in most states. Where it is, as in California, you're required to hold a detective license, pass oral and written tests and qualify for bonding.

The psycho-polygraph operator is among the most skilled of electronic specialists. He has become industry's most reliable hidden fact-finder, and he is proving that it's better to tell the truth. You'll be found out if you don't.

Tape Recorder Accessories

Continued from page 59

for doing this is a $22.95.indicator made by Scott Instrument Laboratories, Inc.

Variations in tape speed generally are caused by dirt or lack of oil on moving parts. Dirt can cause slippage of idler wheels, belts, pulleys and the like. Lack of oil can cause friction, usually associated with mechanical noises as well as untrue speed.

Slippage often can be stopped by simply cleaning various parts. Alcohol will do, or you can use a commercial preparation such as Robins RC 2-56 liquid. A two-ounce jar lists for $1.

Lubrication is a more delicate matter. You must know just where oil may be required, as well as where it can be damaging. A thin film of oil on such parts as pressure rollers can cause erratic operation.

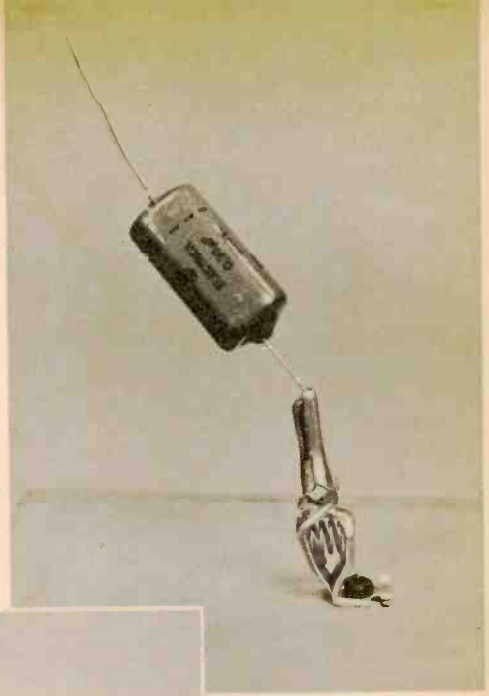
As a matter of fact, most recorders today are permanently lubricated at the factory and conceivably never need additional oiling. Still, an occasional drop of oil on capstan or motor bearings may be required, as for example when there is evidence of reduced speed due to mechanical friction. The safest thing to do is apply just one drop of oil and exactly in the spot indicated in the equipment instruction book. Unless the instructions specify otherwise, a No. 10 motor oil is best. Suitable oils also are offered by Robins (75¢ for a jar with rod applicator) and by Audiotex (65¢ for a plastic vial which squeezes out one drop at a time).

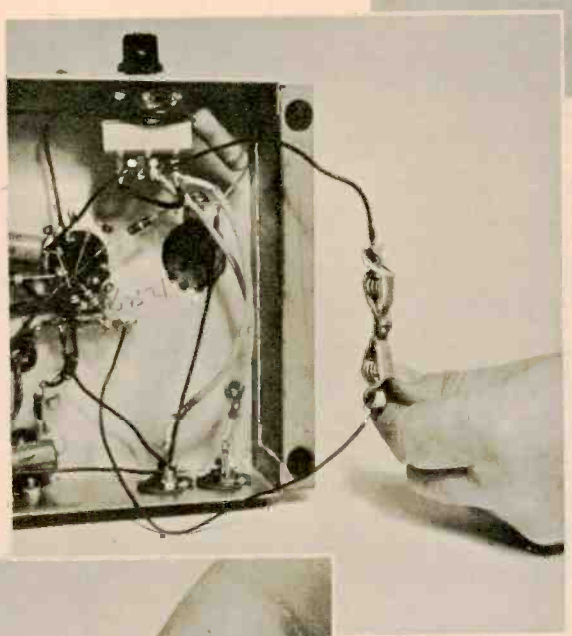
All these items are intended as simple maintenance aids for anyone who uses tape equipment. Serious maintenance problems, of course, should be taken to a qualified technician.

CLIP TIPS

Miniature Vise

An alligator clip mounted on your work bench is a handy gadget for holding small parts. Remove the screw from the wire end of the clip and enlarge the hole to accommodate a small wood screw. Bend back this end of the clip and fasten it securely to the workbench.



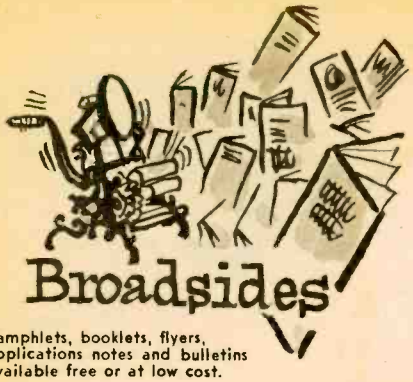


Double Clip Facilitates Connections

Join two alligator clips with a single screw and you have a very convenient quick connector for two loose ends of wire. A handful of these hybrids is useful in experimental and service work.

Alligator-Clip Stripper

To remove wire insulation in hard to get at places where a knife or regular stripper can't fit, try using an alligator clip. File down the front jaws of the clip to form sharp upper and lower edges. Use a triangular file to make a small hole to accommodate the diameter of the wires that are to be stripped.



Pamphlets, booklets, flyers, applications notes and bulletins available free or at low cost.

THE Care and Control of Thyratrons by Bud Tomer is the latest Tech Tips from CBS. The 4-page pamphlet describes how thyratrons are controlled, what their ratings mean and a few typical applications. Free from CBS Electronics, Danvers, Mass.

Hoffman's latest **SPAN** features articles on quality assurance and reliability and photovoltaic readout circuitry. Free from Hoffman, 1001 N. Arden Drive, El Monte, Calif.

Want to learn all about the Accutron, Bulova's electronic watch? A 40-page **Accutron Manual** explaining the workings of the new timepiece is offered free by the company. Write to Haskill C. Titchell, Bulova Watch Co., Inc., Bulova Park, Flushing, N. Y.

The fifth edition of Stan Cor's **Tips for the Serviceman** is available free from Chicago Standard Transformer Corp., 3501 W. Addison Street, Chicago, Ill.

Radio Products Sales Company has introduced a new **Products Catalog** containing merchandise listings of 185 manufacturers. It is indexed by product and manufacturer and contains a special section on hi-fi equipment. Free. Address is 1501 S. Hill Street, Los Angeles, Calif.

A **High Fidelity Equipment Catalog** has been issued by Sound Foyer, 1421 S. Hill Street, Los Angeles, Calif. It is free.

Bulletin R-19, showing French provincial cabinetry for hi-fi equipment is offered free by Rockford Special Furniture Co., 1803 W. Belle Plaine, Chicago, Ill.

Jerrold Electronics Corp. is offering a catalog on TV-FM and master antennas. **Catalog DSD-179** may be had by writing to Jerrold at 15th and Lehigh Avenues, Philadelphia, Pa.

Power Supply Catalog No. 401 is now available from Invar Electronics Corp., 323 W. Washington Boulevard, Pasadena, Calif. The catalog shows all electrical and mechanical specifications of Invar's standard industrial transistorized power supplies.

How to Repair Radios

Continued from page 87

roded IF transformer windings, a dirty volume control, loose tube socket connections, tubes not properly seated in sockets, noisy resistors, dirt between plates of tuning capacitors or the rotor not making good ground contact.

Again, ground the grid of each stage. When you've isolated the trouble, tap the tube to see if it's noisy, tap the stage components, look for bad solder connections and any other obvious troubles. A volume control will cause noise if the arm rests at a dirty spot. One good method of removing this dirt is to lay the receiver on its side and apply a few drops of spray cleaner ("Quietrol," "No-Noise," etc.). If this doesn't do it, change the control.

Distortion

Possible causes of poor tone, and garbled, shrill voices and music include incorrect grid bias, gassy tubes, a shorted or leaky coupling or AVC filter capacitor (C-3), and a rubbing speaker voice coil. Unfortunately, we cannot use the isolation technique to find the source of the distortion since it is present only when the signal is passing through each stage. If we touch a grid, the buzz will be heard in addition to the distortion; if we ground the grid, the distortion will disappear with the signal. So, we must go to the possible sources of distortion directly.

The first and easiest thing to check is the speaker voice coil. If when you gently press the speaker cone with your fingers you feel the coil rubbing against the metal slug, this is the trouble. A new loudspeaker is advisable unless you wish to recenter the voice coil which can be a tedious job. Since replacement 5″ speakers can be had for about $1.50, the best bet is probably to replace the speaker.

The next possibility is a gassy output tube (V-4). Gassy conditions in the other tubes are possible, but less likely. Try changing V-4.

Since incorrect grid bias can cause distortion, check the grid and cathode voltages working backward from V-4. A shorted or leaky coupling capacitor from the plate of V-3 to the grid of V-4 will place B-plus on the grid of V-4 and change the bias drastically.

In the Knight circuit shown, the coupling capacitor is part of a printed-circuit plate and a bad capacitor may make it necesary to replace the entire unit. If AVC

capacitor C-3 is leaky or shorted it may change the grid basis of V-1 and V-2.

Squeals and Howls

These may be caused by oscillations set up by an open decoupling capacitor in the RF and IF circuits (not shown in this schematic), a poorly grounded tube shield, and stray radiation from an external cause such as a diathermy machine or TV set.

Squeals and howls will probably occur across most of the broadcast band if any of the above conditions exist. The solution to the problem is to check tube shields and leads in the RF and IF circuits and to parallel any suspected decoupling capacitor with a good one. A microphonic tube can also cause howl. Tap all the tubes gently to locate the culprit.

Intermittent Reception

Almost anything in the circuit can be at fault or it may be a foreign particle (like a drop of solder or metal filing) shorting out a vital section.

The following likely trouble spots:
TUBES—elements intermittently shorting due to vibration or heat.
RESISTORS—those that dissipate much heat may change in value or open.
CAPACITORS—bypass or coupling capacitors with B-plus voltage on them may break down intermittently or open.
VOLUME CONTROL—a dirty control can periodically cut off the signal.
TUNING CAPACITOR—a bent plate or a particle between the plates can cause trouble whether or not you're tuning.
LINE VOLTAGE—if line voltage should drop below 108, volume may disappear.
CONNECTIONS—loose connections, poor soldering, poorly seated tubes.

In other words, any of the things that can cause a set to go dead or operate poorly (as described in preceding sections), can also cause an intermittent condition.

The best thing to do is to let the set play until the trouble occurs. If you'd like to expedite proceedings, shake the set or tap it a few times. When the trouble develops, it's best to work fast, for at any moment the set may start working again. Tap the tubes and capacitors with a fiber rod or pencil eraser, move loose leads about, and look for loose solder or metal particles. If the set remains dead, consider yourself lucky, for then you can start to troubleshoot using the techniques outlined.

When you've finally found what you think was the trouble, give the set several hours of playing time to make certain the intermittent condition has cleared up.

Marketplace

Continued from page 24

This allows the wearer to select the voice to which he wants to listen and other nearby voices and noises are relegated to the background. Otarion Listener Corp., Ossining, N. Y.

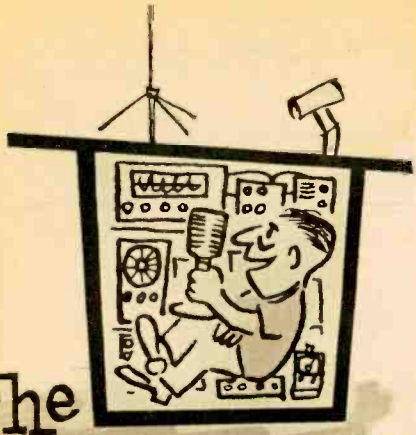
—o—

Power resistor box . . . Twenty different values of resistance from 2.5 to 15,000 ohms, all at 20-watt rating, make the Sencore Big 20 substitution box a valuable addition to the workbench of any service technician, experimenter or

ham. After the correct value for a particular circuit position has been determined by temporary use of the box, a fixed resistor of that size can be installed with the assurance that it will do the job. Sencore Instruments Company. Addison, Ill. Price $13.00.

—o—

A new name in the electronics equipment manufacturing field is the Accurate Instrument Co. of 9 West Prospect Ave., Mount Vernon, N. Y. The firm plans to market a line of test instruments, the first of which is a streamlined tube tester which lists for $21.95. Accurate's claims for the checker say it will make all necessary tests, has a rotary selector switch and offers highly damped meter movement.



The Ham Shack

Continued from page 67

straight stuff on some important points:

1) For all classes of license, you must pass the code test *before* you proceed to the written part. Flunk the code and out you go. You may return in 30 days, and can keep coming back every 30 days until you finally get through. Many applicants have the impression that the two halves of the test are averaged; 'taint so!

2) For the general class ticket, you listen to five minutes of code at 13 words a minute. You pass if you produce correct copy for any one minute of this time. You do not have to copy the entire text. Think of what this means. Five minutes of code is a lot of dits and dahs. You can well afford to sit back for the first minute, get accustomed to the sound, overcome your initial nervousness, catch the rhythm of the sending, and then put your pencil to work. This is much better than stumbling over the first few words and getting all worked up because you think you muffed them.

The novice and technician speed rate is 5 wpm. The test consists of 25 words of five letters each and to pass you must copy any 25 consecutive letters. This is easy. I mean it. KN1MJA was only 8 years old . . . and a girl, at that . . . when she recently acquired her license!

—o—

Tape It! . . . Tests for the novice and technician licenses are given by volunteers who are hams, not by FCC engineers. This puts the examiner on his honor to give fair code tests, neither too slow nor too fast. Since hand sending is bound to vary and difficult to time, it is smarter to use off-the-air tape recordings of code-practice transmissions by W1AW, the American Radio Relay League station in Hartford, Conn.

—o—

Bootlegging, 1961 . . . Recently I received a QSL card from a Citizens Band operator in Louisville, Ky., confirming a contact he said he had with me on one of the CB frequencies. Sorry, 18B1258, either you got the call down wrong or someone was bootlegging at my expense. At any event, I would not have answered a CB station 600 miles away. This is exactly the kind of prohibited operation that is giving CB a bad name.

Bootlegging seems to be rife in the CB field, despite the fact that getting a license is duck soup. In hamming, bootlegging has long existed, but only on a small scale. A lad can't be too bright and fail the license test, and he quickly betrays himself when he borrows another man's call to get on the air.

—o—

Status Symbol? . . . Some people will play an expensive game of politics to obtain automobile license plates bearing their initials, first name or nickname. And a few think the FCC can be pressured into issuing corresponding call-letter combinations, but they have another think coming. In fact, any outside efforts in this direction usually only delay a ticket.

The FCC is a busy (and understaffed) agency. Among other things, its 1960 records show authorizations for more than 730,000 radio stations in different categories, of which 218,000 were amateur. Call-letter combinations are selected and issued in order, and that's that.

Incidentally, the 218,000 hams represent an increase of more than 11,000 over the previous year. There are a lot of us . . . and there are times when I think we're all on the air at the same time!

—o—

Morale Builder . . . A problem in Veterans Administration hospitals is to keep patients occupied with something more than basket-weaving. The VA has come up with what it thinks is a wonderful answer: a network of ham stations linking several dozen institutions in various parts of the country. Since ham radio is one of the most time-consuming of all hobbies, the men who get into it will surely develop a new outlook. Instead of worrying about themselves and their families, they'll worry about band conditions and QRM from the X-ray rooms.

For serious-minded men desiring higher income and status-

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- Federal Electric Corporation
- Florida Power & Light
- Pan American Airways
- United Airlines
- The Martin Company
- All America Cable & Radio
- Voice of America
- . . . and many others

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Assembled Model GWW-10 ..... **99.95**

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Kit Model DF-3 ..... **$99.95**

Assembled Model DFW-3 ..... **169.95**

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Model XR-2P (plastic) . . 6 lbs. **$29.95**

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Those Oddball Tubes

Continued from page 66

size of tube elements also can beat the inter-electrode capacitance problem. This is fine, except as elements shrink their power-handling capacity also is reduced until they are unable to throw off the large amount of heat they generate. This can cause the tube to destroy itself, which brings us to yet another problem, *heat*.

If you want to build a small tube that still operates at a high, heat-producing rating you must have some means of draining off those excess BTU's. Some tubes have jackets which carry circulating water, others have radiating fins outside the envelope and still others use massive plates (massive for the current they handle) and a physical design which draws and radiates heat away from the tube envelope along paths of heat-conducting metal. The RCA Nuvistor has this type of design.

The Machlett Co. uses a novel means to beat the heat in their Dynamax X-ray tubes. Here an anode potential of 100 kilovolts and a current of 700 milliamperes would produce destructive heat in seconds without a clever design feature. The anode is rotated by an induction motor whose rotor is sealed into the neck of the tube. The tube is then set into a housing which contains the stator coils. The anode is rotated at a speed of 3,300 rpm so the heat-producing electron beam does not concentrate on any one spot.

These constructions give us some strange looking tubes, all because of the need for a cooling system. Still other odd configurations are made necessary by *tube-lead inductance*. Each element of a tube must have a lead through which it connects to a circuit. At higher frequencies these elements introduce inductance, even though they are straight wires. This inductance, added to the inductance of the outside circuit, causes detuning and feedback through the cathode and plate circuits.

The inductance headache can be minimized by shortening the tube leads but the real solution is in circuit design. At extremely high frequencies the leads do not make parallel exits, as in tubes with regular bases, but are brought out from different sides of the package, as far away from each other as possible. In the case of microwaves (1,000 mc and up), the solution is to do away with wire leads entirely, substituting hollow waveguides which completely contain the electric current, not allowing it to radiate. These waveguides look more like lengths of pipe than parts of an electronic circuit.

Most interesting of all tube-design problems is *transit time*. Simply stated, transit time is the interval required for an electron to travel from cathode to plate. In normal radio-frequency operation it is not a consideration because the trip is short with respect to the time of a full-frequency cycle. However, in the ultra-high ranges transit time becomes a real headache.

At frequencies around 400 mc, and with electrons traveling through the tube at close to the speed of light, transit time becomes greater than the time of the RF cycle, and the tube is unable to react properly to signal changes. It can't amplify faithfully or oscillate with stability.

Solving this problem is a cinch, you say: just push the elements closer together. Logical, but it won't work. The electron's travel distance would be shortened and so would transit time, but other conditions are involved. As the elements are moved closer the inter-electrode capacitance increases to the point where it becomes a source of trouble. There is also an increased danger of shorting. Where do we go from here?

Engineers working on transit time took a novel approach, turning a drawback into an advantage with a new tube which operates by bunching electrons as they go through. It is called a velocity modulation tube and was created to work in frequencies up in the thousands of megacycles. The klystron, magnetron and the traveling wave tube are typical velocity modulation tubes. The British version of the magnetron made long-range radar possible in the early days of World War II. Velocity modulated tubes today are extremely important in radar, space communications and satellite control.

All velocity modulated tubes use a beam from an electron gun similar to that in your TV picture tube. The beam goes through the tube to a collector plate. What happens to it along the way is different in each tube.

In the klystron, electrons radiating from the cathode run into a high-frequency electrical field between buncher grids. The field's strength varies and as it does the electrons are slowed or accelerated accordingly.

Next, the electron stream enters a drift space where accelerated electrons catch up with the slower ones. This creates bunches, or dense spots in the electron stream. The bunched electrons enter a catcher section and cut across catcher grids. This induces an RF voltage in the output section. Oscillation is obtained by feeding back a part

of the catcher energy to the buncher section.

There are different types of klystrons—the Pierce tube, the McNally tube and others. They differ for the most part in the means used to tune the resonant cavity. In some cases this is done by flexing the sides of the tube. In others it is done by adjustable screw plugs. Whatever the means, the klystron certainly qualifies as an oddball tube.

In the magnetron, the cathode is set in the center of a resonant cavity cut into the copper body of the tube. This body is placed within a permanent magnetic field and is divided into two segments. This gives this particular magnetron its name, the split anode magnetron.

Without an imposed signal, the fixed magnetic field is adjusted so that an electron leaving the cathode will not reach the cavity wall. Instead, it will take a circular path back to the cathode.

When the magnetron is operating, an alternating current is applied between the two halves of the anode. One section takes on a higher potential than the other. This condition shifts back and forth between the two with the AC cycle. This frequency is adjusted so its time for one cycle equals the time for an electron to make one circular trip through the resonant cavity.

As the potential on the split anode changes, some electrons in the chamber gain energy while others lose it. The electrons gaining energy return to the cathode. The others remain circling in the field. The pickup loop takes this energy and uses it to sustain oscillation in the resonant circuit connected between the two anode plates.

Because of the need for a strong, concentrated magnetic field in magnetron operation, the dimensions of the tube are small. This presents a heat problem and so air may be blown over the tube or a water cooling jacket is built around it. In the end, the magnetron is a queer-looking duck.

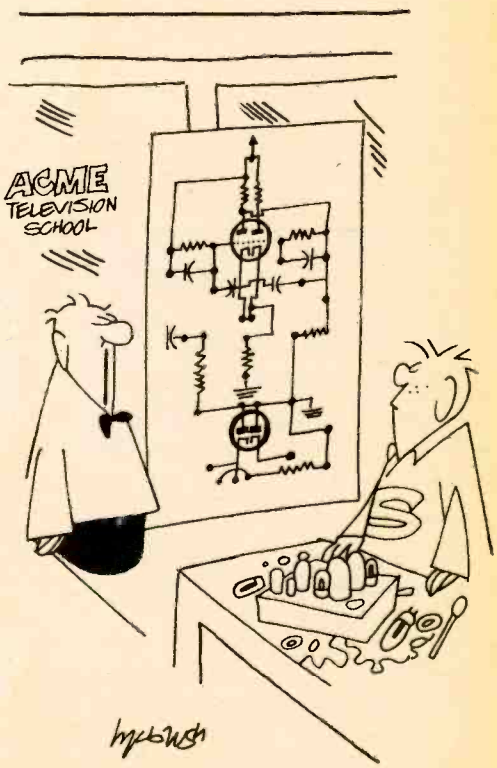
In the traveling wave tube, the electron beam passes from cathode to collector plate along the axis of a wound coil. A magnetic field, similar to that of the magnetron, holds the beam to this path. The velocity of the electron beam is controlled by a potential difference between the cathode and the coil.

In operation, an ultra-high-frequency radio wave is passed along the coil from input to output. This is fed in from a separate oscillator circuit. The wave builds up a magnetic field around the coil, the field changing in polarity as it advances.

As electrons pass along the coil axis to the collector plate, they are accelerated, decelerated or unaffected, depending on the field potential as they enter its influence. This again creates a bunching of electrons, which tends to slow down the velocity of the electron stream. The stream then gives up a portion of its energy. Since, by the Law of the Conservation of Energy, this cannot be destroyed, the lost energy must go somewhere. It is transferred to the radio-frequency wave passing through the coil and amplifies this signal. The attenuator section of the tube prevents energy from being reflected back into the tube. This reflection might cause self-oscillation.

The traveling wave tube is an amplifier. Its beauty, from an engineering standpoint, lies in the fact that it amplifies a broad frequency range, covering a 2,000-mc bandwidth.

As engineers and designers delve further into the ultra-high-frequency ranges, the oddballs amongst our tubes of today may not appear so odd, after all. By that time we'll have a new crop of strange new electron tubes doing tasks we can't even envision today.



"Well, in a way you're right. It DOES look like a map of New York. However, ... "

Electronic Brain

Continued from page 77

Thyratron Dimmer

Are there electronic devices that can be used for dimming theater lights?

Earl Crain
Washington 17, D. C.

Electronic theater light dimming is now handled by a type of tube called a *thyratron* in many installations. The thyratron is a gas-filled triode (or tetrode in the case of smaller units) that can control the flow of large amounts of current with a relatively tiny change of voltage in their grid circuits.

The usual circuit is based upon what is known as "phase-shift control." The plate circuit of the thyratron is in series with the lights; the voltage drop across its cathode to plate circuit is very small and does not affect the brightness of the lights. This is true provided that the small AC voltage applied to the control grid is in perfect phase with the AC voltage in the plate circuit. By means of a comparatively simple phase-shift network consisting of capacitors and coils, the relative phase of the grid voltage may be changed with respect to the plate. As the two go further and further out of phase, the thyratron conducts for shorter periods of time. This results in an average light current that steadily decreases. When the phase is 90 degrees, the thyratron stops conducting and the lights are extinguished.

Unknown Inductance

I have a number of good filter chokes of unknown values in my scrap box. How can I determine their inductance?

A. Gordon
Los Angeles, Calif.

A very close approximation to the correct inductance of a filter choke may be made by taking the series of measurements indicated below, and substituting the values obtained in the equations given.

Step 1: Measure the DC resistance of the choke with an accurate ohmmeter. This is *R* in the equations that follow.

Step 2: Apply a small alternating voltage such as 6.3 volts or 12.6 volts from a step-down transformer across the choke with an AC milliammeter in series. Measure the voltage you are using; this is *E*. Measure the AC current flowing; this is *I*.

Equations

(1) Find the impedance (Z) of the choke from:

$$Z = \frac{E}{I}$$

(2) Find the inductive reactance (X_L) of the choke from:

$$X_L = \sqrt{Z^2 - R^2}$$

(3) Find the inductance of the choke in henrys from:

$$L = \frac{X_L}{377}$$

Capacity Computation

I have a variable capacitor with 9 rotor blades, each 2.5 sq. in. in area, and 10 stator sections, each 3.1 sq. in. in area. It measures 7/8 in. from front to back. How can I compute the capacitance?

George W. Becker
Festus, Missouri

We can obtain a very close approximation of the maximum capacitance (fully-meshed) of this capacitor by using the equation:

$$C = \frac{22.45\ K\ A\ (N-1)}{10^8\ t}$$

in which C = capacitance in microfarads, K = dielectric constant, A = average plate area, t = spacing between plates, and N is the total number of plates. Since the dielectric in this case is air, the dielectric constant K may be taken as unity. The average plate area is roughly the average of 2.5 and 3.1 square inches or 2.8 square inches. There are 18 spaces between the blades, stretching over 7/8". Assuming for the moment that the blades are negligibly thin, this would make the spaces equal to .049 inch. From our knowledge of the metal used in variables of this size, we would say that the thickness of each blade is close to 0.009 inch, hence the actual spacing may be taken as 0.04 inch. Substitute these values in the equation.

$$C = \frac{22.45 \times 1 \times 2.8 \times (19-1)}{10^8 \times .04}$$

C = 284 micromicrofarads

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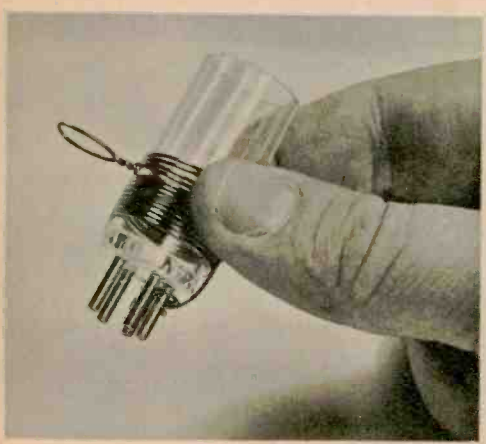
HAM TIPS

Spray Protects Antenna

Rear-bumper mounts for Citizens Band and ham antennas will stay clean and bright much longer if they are sprayed, when new, with several coats of lacquer. You can protect the trunk of the car with newspapers or an old blanket. If there's lacquer left, do the bumper.

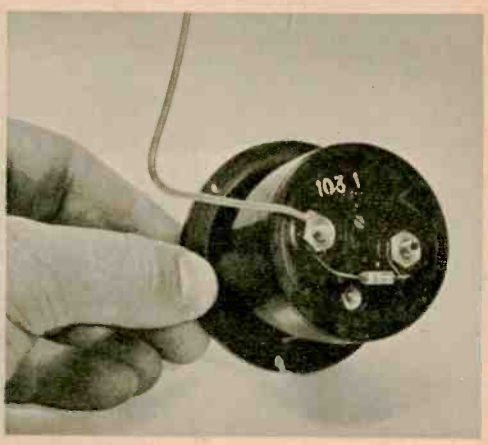
Clean Crystals Work Better

Sluggish operation of CB and ham equipment can often be traced to dirty quartz crystals; many holders are far from air tight. Hold a crystal carefully with a tweezers, dunk it several times in dry-cleaning solution (carbon tet), dry it by waving it gently in the air, and replace without touching with fingers.



Easy Coil Tap

Simple way to tap a coil; wind to the position of tap, form a loop and twist. Continue winding then scrape insulation before soldering.



RF Indicator

A 1 ma meter is a good field-strength indicator with a 1N34 across the terminals. Put cathode and a short wire on positive terminal.

Tomorrow's Telephone Today

Continued from page 30

photographic memory system devised by the Bell people, who have made that vague phrase into a scientific term. This photographic memory makes it possible to have calls rerouted automatically, to make a call merely by dialing two digits and various other minor miracles. First, of course, the subscriber gives instructions as to what he wants, and these are stored as bits of information.

The bits (more than 2,000,000 of them) are filed away as a series of tiny dots on a set of photographic plates. To read the information, a flying spot scanner (cathode ray tube) checks each bit with incredible speed—each line on the exchange is scanned ten times a second.

When you place a call the gas tubes go to work and before you get the receiver to your ear your number is ringing. But between the dialing and the ringing the system has checked a temporary memory to see whether your party has left any special instructions!

The temporary memory is slightly different in operation from the photographic one. This is another cathode ray tube with a mica plate inside. Information is stored on the plate in the form of small electrostatic charges. These charges are placed or erased electronically.

Naturally, since the principle memory function is on photographic plates, and since the system makes wide use of plug-in printed circuitry, major changes in function can be prepared at the lab and plugged in when needed without loss of operating time. This is why you'll have so many variations in service when ECO becomes a reality in the rest of the system.

But what about reliability? Well, for one thing, malfunctions of any major component will show up immediately by a warning signal which will then type out a concise analysis of the trouble. The same plug-in feature that makes new circuits so easy to insert makes it possible to hold in reserve many of the critical segments that might hold up repair.

And as for the likelihood of breakdown: the neon tube relay has no moving parts and none has worn out yet! Bell Labs haven't even projected their useful lives. And because of the sealed, dust-free nature of the design, troubles that go with dirt and grime are unlikely.

Better remember the letters ECO. Your telephone may soon be hooked to one!

Nicaraguan Stations

Continued from page 50

your report against. Those that do verify are likely to be haphazard about it. All in all, Nicaraguan stations can leave you pretty frustrated. There is one bright spot, a little DX oasis. That is YNOL, the Tower of Light, at Managua.

Now don't start looking for YNOL on your short-wave bands. You won't find it. YNOL is a broadcast-band station, but there's plenty of DXing fun to be had in these frequencies, too. The Tower of Light is a cinch to pull in anywhere in North America, except for the Minneapolis and Dallas-Fort Worth areas.

YNOL transmits on 825 kc, a split frequency between U. S. stations. Except for a Mexican transmitter which occasionally drifts to this spot, the channel is clear.

Peak reception will occur generally in two periods. A sunset skip hits this channel about two hours after sunset but, like other DX phenomena, it varies from night to night. YNOL reaches its second peak again just before it signs off at 11 P. M. EST. This pattern does not apply to the West where the two periods frequently coincide, a condition which exists all across the country in the dead of summer.

Reception via sunset skip, although spectacular, is erratic and often brief. Further, it usually occurs while YNOL is transmitting in Spanish. Reception during the final half-hour of YNOL's schedule is more dependable and English is used.

YNOL, known in Spanish as Ondas de Luz, is a missionary and cultural station, loosely affiliated with TIFC in San Jose, Costa Rica's best-known short-wave outlet, and HOXO, another BCB station at Panama City. But unlike most missionary transmitters, it is locally controlled. Operated by Managua's evangelical clergy, it came on the air with 500 watts and a daily schedule of two hours. In slightly over a year, YNOL has become Central America's best-known broadcast-band station.

YNOL chief engineer David Solt looks forward to reception reports and answers them promptly, by letter or a picture postcard type QSL. Eventually, Ondas de Luz plans to send out regular QSL cards but the letterhead is a fine addition to a DX collection. A report for YNOL should contain date, time, a description of the program heard, signal strength, interference and a run-down on your equipment. And don't forget that International Reply Coupon.—*C. M. Stansbury II*

Bonanza For Prospectors

Continued from page 36

tungsten ore has been found by ultraviolet lamps.

There are two basic types of ultraviolet lamps, long-wave and short-wave. The short-wave lamps are most useful because more minerals fluoresce under short waves. As you might guess, the short-wave units are more expensive than the long-wave (black light) units. Ultraviolet lamps come in battery-operated portable form and fixed home or laboratory models. There also are adapters which convert your auto battery power to operate a lamp. The price range is from $15 to $200. You should be able to buy a good lamp for $50.

There's no trick to operating ultraviolet lamps. However, you must learn what colors are produced by various minerals. Since thousands of varieties of some 150 basic minerals fluoresce, a short-cut is necessary. So the people who sell lamps also sell samples of just about every mineral for comparison. When you've studied the samples under the lamp at home you will be able to identify them in the field.

Metal locators are used for locating metallic minerals—gold, copper, silver, lead, etc.—and, of course, buried treasure. Although there are many types of metal locators, they all operate on the same principle. In the presence of metal, the inductance of the detection coil shifts, which in turn causes frequency shift that is indicated on a meter or in headphones. There are a great number of metal locators on the market. Most of commercial models are sold with elaborate instruction books which describe their operation. Metal locator prices range up to $200. Some transistorized models are on the way.

In addition to electronic equipment, there are several tools and instruments that are musts for serious prospecting. These include a survey compass, measuring tape, drawing pad, scales, triangles, protractors, maps, hatchet or ax, prospector's pick and possibly a mineral assay kit.

One final word to the would-be prospector. Stay alert for scientific developments that can create a big demand for ores and minerals. Yesterday it was uranium. Today it's mercury and thorium. Tomorrow it could be lithium or tungsten. Watch for government notices. When the need for a particular mineral becomes critical the government invites citizens to look for it. With the proper equipment, you could be one of the lucky claim-stakers.

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FEEDBACK

Continued from page 8

● ***Attention, Troublefinders***

I would like to hear from some EI readers who have built the RADIO-TV TROUBLEFINDER as illustrated in the November '59 issue.

J. Bennett
416 South 18th St.
Mattoon, Ill.

● ***A Friend***

I think your magazine is the best on the market today. I am an electrician and I save every copy for reference.

John Ralph
Hammond, Ind.

Thanks.

● ***No Friend***

Put something in the magazine that's fit to read and build. We are sick of far-away stuff and sick of transistors. Give us some fundamental triode, pentode, detector and amplifier circuits.

R.S.B.
Chicago, Ill.

Shouldn't that be sick-sick-sick?

● ***Lo-Dough Hi-Fi?***

I have just finished reading your piece on buying hi-fi (SHOPPING FOR HI-FI, October '60 EI). The author makes good sense in categorizing people into financial groups according to their listening habits. However, unless he buys from a handler of "hot" goods, I would be interested in learning where you can purchase a mediocre stereo system for $250 or a good one for $400.

I do not have the finest available equipment but my list comes to better than $3,000.

W. B. Grawe
Encino, Calif.

Our author claims he doesn't know any fences, W.B., and we'd have to agree that his estimates may have been on the low side. Unfortunately for us working people, the most important ingredient of good stereo is money.

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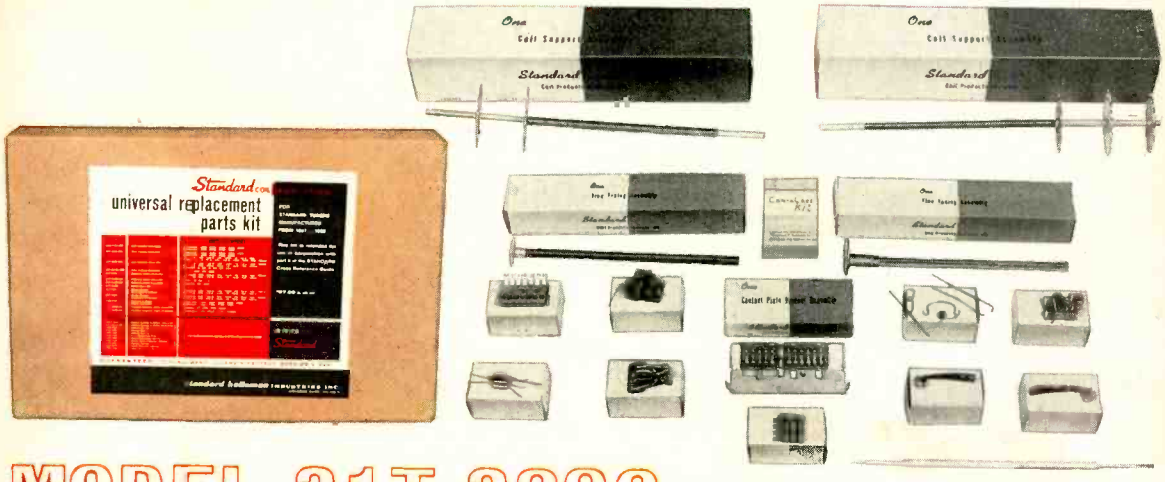

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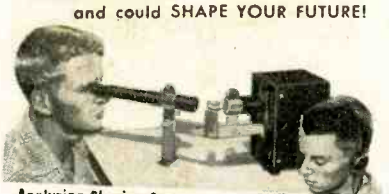
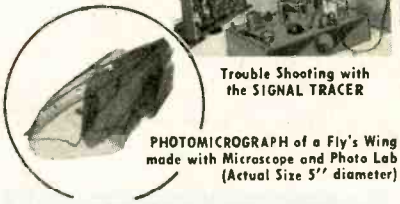


Analyzing Glowing Gases with the SPECTROSCOPE



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