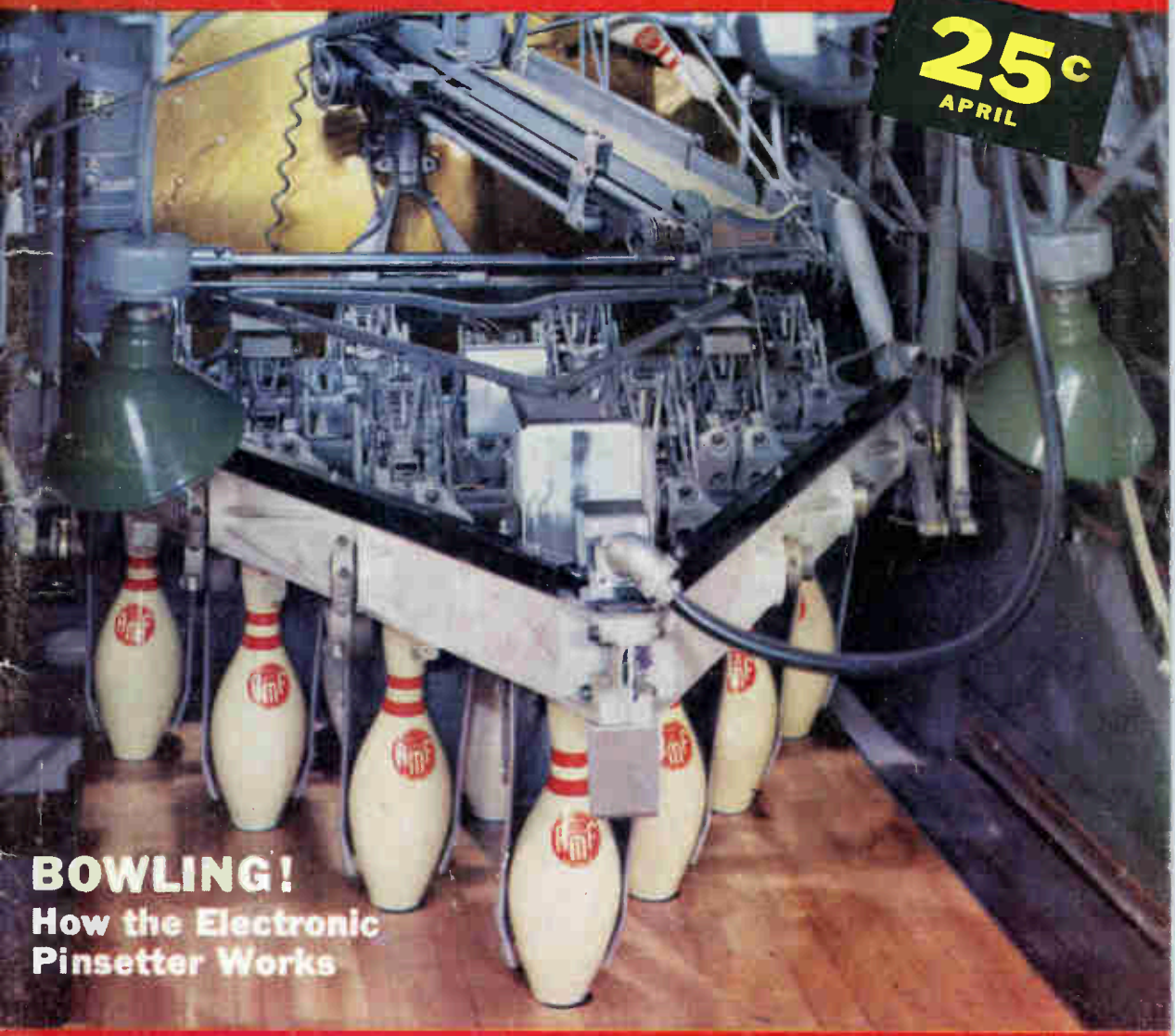
The Coming World of Sun Power

ELECTRONICS ILLUSTRATED

25c APRIL



BOWLING!
How the Electronic Pinsetter Works

Build a Hi-Fi Tester • Adapt for FM Multiplex

How to Buy a Ham Receiver and Transmitter

Model EL 3516/G53
Technical Specifications

Three Tape Speeds—7½, 3¾, and 1⅞ inches per second

Tracks—Dual

Heads—Stacked

Head-Gap—0.0002 inches

Frequency Response—
at 7½ ips; 50 to 16,000 cps
at 3¾ ips; 60 to 10,000 cps
at 1⅞ ips; 60 to 5,000 cps

Wow and Flutter—0.15% at 7½ ips
0.2% at 3¾ ips
0.35% at 1⅞ ips

Volume Indicator—Magic Eye (Type EM-84)

Loudspeaker— Integrated, heavy magnet, wide range

Controls—Piano-key pushbutton

Fast Forward and Reverse—Less than 2 minutes for 1200 ft. of tape

Automatic Stop—At ends of reel (with metalized strips)

Program Indicator—Built-in, adjustable

Inputs—(1) radio/phono; (1) microphone (with mixing facilities)

Outputs—(1) for external speaker; (2) for external amplifiers with controls; (1) for external amplifier without controls; (1) for headphone monitoring recording circuit

Microphone—High-Impedance Dynamic

Tubes—EF-86 (2), ECC83 (2), ECL82 (1), EZ90 (1), EM84 (1)

Line Voltage—117 volts AC 60 cycles

Power Consumption—80 watts

Dimensions—15¾" x 13" x 8"

Weight—32 lbs.

Case—Rugged, European-designed portable carrying case (internally designed for optimum acoustic baffling)

A matching companion piece, identical in appearance, containing a second amplifier and speaker, is available to those who seek the convenience of a complete portable stereo-tape playback system.

YOU ARE LOOKING AT A *Modern* Dutch Masterpiece

The STEREO version of the *Norelco* 'Continental' TAPE RECORDER

Developed & Guild-Crafted by Philips of the Netherlands

We feel that the Stereo version of the Norelco 'Continental' is the ideal tape recorder for those recordists, high fidelity enthusiasts and music lovers who seek a professional quality machine at a truly modest price. The data listed here, represent painstaking, conservative and substantiated laboratory measurements. If you find that these data satisfy your technical requirements, and reflect those qualities that you consider mandatory in your stereo equipment, by all means listen to the Stereo version of the Norelco 'Continental' at your favorite HI-FI center or Camera store. There, we feel sure, you will agree with us that the Norelco Stereo 'Continental' is, indeed, a modern masterpiece . . .

Norelco®

For further descriptive literature write to:
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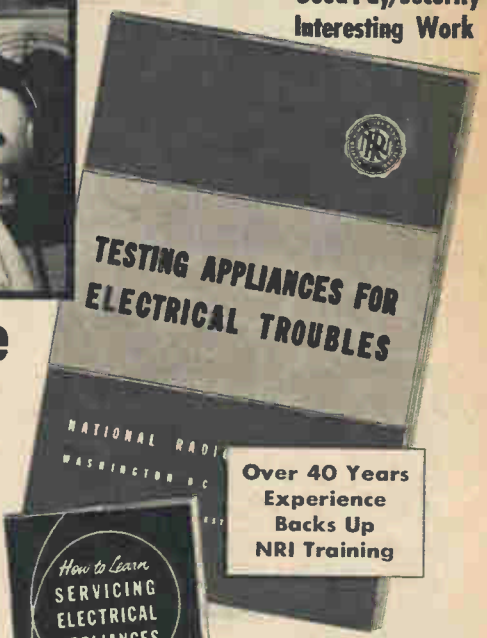

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ELECTRONICS ILLUSTRATED

A Fawcett Publication

Vol. 2 No. 4 April 1959

Contents

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.

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A Message From the Editor

Blind radio hobbyist uses a broille-calibroted voltmeter to test electronic project he built. "Reading" is audible.

Next month we'll include the plans for radio-controlled ferryboat shown here. It's a sensation at local ponds.

ALMOST all TV manufacturers now use printed circuits in their receivers—yet one manufacturer loudly proclaims that his receivers do not contain any printed circuit boards. Are printed circuit boards bad, do sets using them require more service calls? The RCA Service Company recently undertook a study of this question and found that of 5000 service calls on equipment containing printed circuits less than one trouble call in 50 had anything to do with the circuit boards themselves. Another six month analysis of service calls throughout the country indicated that on the average, an active technician had to replace a circuit board in a TV set only once in 5000 calls. This factual study would seem to dispel the suspicion with which many people look on printed circuitry.

This seems to be the time for surveys and here are the results of another interesting one. Of 513 FM broadcasters contacted recently, 65 are now multiplexing commercial background music to restaurants, industrial buildings, etc., simultaneously with their regular programming and another 61 plan to be multiplexing by next year. Most of these stations are seriously contemplating stereo multiplexing when and if F. C. C. approval is obtained. Are you prepared to receive stereo on your FM tuner? If not, the article starting on page 32 of this issue will tell you how to adapt your present FM tuner to receive multiplex broadcasts.

In our January issue I asked for suggestions from readers for article topics for our 1959 issues. I was slightly overwhelmed by the response. So many of your suggestions are useable that it would be useless for me to mention them now, however, I intend very soon to give you a report on some of our work

in progress which you will see published this year. At the moment, however, I would like to assure you that we will continue to welcome your suggestions.

In this issue, on page 40, is our tape recorded interview with Bob Gunderson who answered our questions on how to buy amateur radio equipment for both the beginner and those who are ready to progress past the novice stage. Bob Gunderson is one of the most interesting people we know both because of his excellent knowledge of electronics and amateur radio and because of the pioneering work he has done toward helping blind youths develop a facility in electronics. He has obtained jobs in the electronics industry for over 200 of the people he has trained. Standing in a laboratory next to one of the technicians is an inspiring experience. We watched them cut out chassis holes, mount components, solder in wiring and perform tests on a circuit with braille-calibrated meters. Bob is editor of a monthly magazine called the Braille Technical Press which he sends to blind people all over the country. In it are articles on electronics which he writes as well as reprints of articles from magazines such as this. He would like to print and distribute more than the seven or eight hundred he now publishes. However, he needs outside help to do this because the amount that his subscribers pay for this magazine is not sufficient to cover the cost of publishing it. We can't think of a more worthwhile endeavor deserving of your support. Bob points out that donations to the Braille Technical Press are income tax deductible. Checks should be made out to the Braille Technical Press and sent to the New York Institute for the Education of the Blind, 999 Pelham Parkway North, Bronx, New York.

Our May issue is full of interesting items for you to build. These include a specially designed radio-controlled ferryboat, a bass reflex enclosure for any size loudspeaker and a wind speed indicator.

Charles Tuttle

BIG JOB BOOM FORECAST!

Can You Get Ready in Time?

Right now job opportunities are tight all along the line. Economists now predict a period of mild ups and downs. Look for the "big break" to come in the next three years, they say. That's when good jobs will open up as never before. And men who are preparing themselves *now* will ride the crest of the boom.

DARK OUTLOOK FOR UNSKILLED WORKERS

Those with little or no training will find the going tough. Fewer openings. More competition for existing jobs. The tide is against the unskilled worker. It's getting stronger. Nor will the boom help. The new opportunities will go first to the skilled, next to the semi-skilled.

BIGGEST DEMAND IN THESE FIELDS

What's ahead? According to the best estimates, here are the industries due for the sharpest employment rise: Heavy transportation equipment. Mechanical, electrical, chemical, aeronautical and highway engineering. Industrial electronics. All metals. Business services. Natural gas and oil. Paper products. On the other end of the scale, employment may lag in agriculture and leather. Check the trends in *your* field. Are you prepared to switch, if necessary?

GETTING YOURSELF READY—NOW

All the experts agree: Education, skill, specialized training will net the greatest rewards in the coming boom. The time you spend improving yourself is perhaps the wisest investment you can make *right now*. Your future success and happiness could hinge on your mastering a certain subject or acquiring a special skill. But there are obstacles. You may have a family to support. Or a job to hold down. You may feel you're too old to learn.

HOW I.C.S. CAN HELP YOU

For the man who can take his training hard and fast—without time off from his job or heavy expense—I.C.S. offers real advantages. A total of 259 courses to choose from (see partial list below). A spare-time method that lets you progress as rapidly as you're able. Up-to-date, authoritative text material. Thorough, personalized instruction. Industry-recognized diploma to graduates. I.C.S. is the oldest and largest school accredited by the Accrediting Commission of the National Home Study Council. Its long list of successful graduates reads like "Who's Who."

Can you be ready for the next job boom? You can if you act quickly. Your first step: mark and mail the coupon below. What you do right this minute may determine how you make out in the coming boom!

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Get the details on the fields that offer the best jobs in the immediate future. Get these three valuable books free—(1) "How to Succeed"—pocket-size guide to advancement, (2) Sample lesson (Math.) demonstrating the I.C.S. method, (3) Opportunity catalog on the subject you check in the coupon. Just mail the coupon.

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Furthermore, after buying four selections you receive your choice of a Columbia or Epic Bonus record (stereo or monaural) free for every two additional selections you buy.

HOW THE CLUB OPERATES

You enroll in any one of the six Club Divisions: If you have stereo equipment you enroll in either the Stereo Classical or Stereo Popular Division.

If you have monaural equipment you enroll in any one of four Divisions: Classical; Listening and Dancing; Broadway, Movies, Television and Musical Comedies; Jazz.

Each month the Club's staff of musical experts selects outstanding recordings from every field of music. These selections are described in the Club Magazine, which you receive free each month.

You may accept or reject the selection for your Division, take any of the other records offered (stereo or monaural), or take NO record in any particular month. You may discontinue membership at any time after purchasing four records.

The records you want are mailed and billed to you at the regular list price: Popular Monaural Selections, $3.98; Classical Monaural, $4.98; all Stereo Records, $5.98 — plus a small mailing charge.

To receive your three stereo or monaural records FREE, fill in and return the coupon today!

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Terre Haute, Indiana

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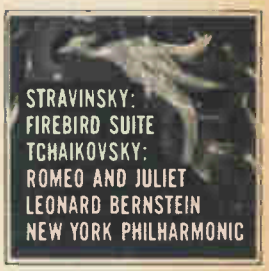
5. Where or When, The Way You Look Tonight, Be My Love, 9 more

6. 43 hits for listening and dancing—in the smooth Lanin style

7. The ingratiating Miss Holliday in her biggest Broadway hit

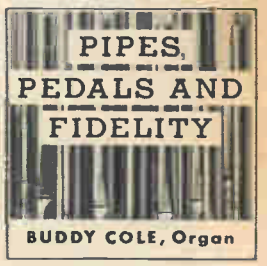


8. Bernstein's exciting performances of two colorful scores

10. A truly magnificent performance of this majestic symphony

11. The great tunes from Rodgers and Hammerstein's fabulous hit

12. The two fiery Roumanian Rhapsodies—plus 2 more works



13. Organist Buddy Cole plays 11 tunes—Mine, Caravan, Carioca, etc.

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(Indicate here whether you want your 3 records in Stereo or Monaural):

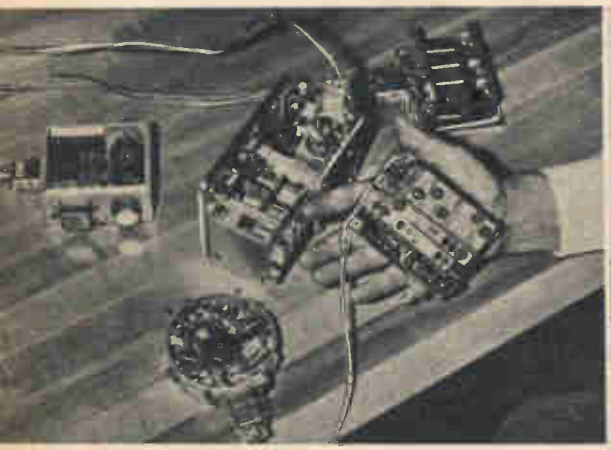
☐ STEREO L-50 ☐ MONAURAL L-49

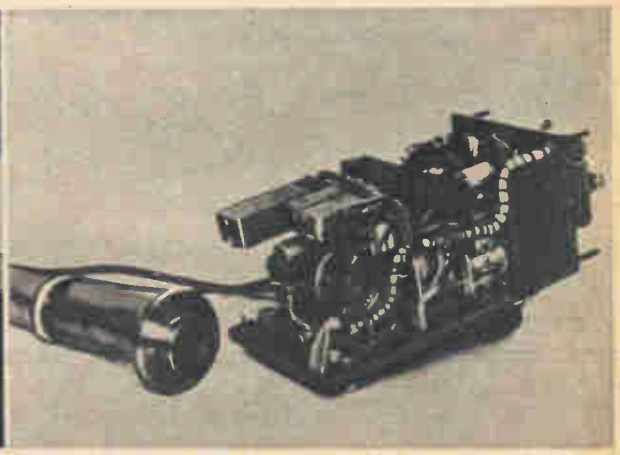
1. Johnny Mathis — Warm
2. Grofe: Grand Canyon Suite
3. Sing Along With Mitch Miller
4. Grieg Piano Concerto; Rachmaninoff Rhapsody
5. 'S Marvelous — Ray Conniff
6. Lester Lanin at the Tiffany Ball
7. Bells Are Ringing — Original Broadway Cast
8. Firebird; Romeo and Juliet
9. Black, Brown and Beige
10. Beethoven: Eroica Symphony
11. Percy Faith Plays "South Pacific"
12. Roumanian Rhapsodies 1, 2; plus two more works
13. Pipes, Pedals and Fidelity
14. Cugat Cavalcade
15. Tchaikovsky: Pathetique Symphony
16. Listening in Depth (Available in stereo only)

Electronics in the News

Television now commands the Tokyo skyline with the erection of a 1,092-foot Eiffel-like antenna tower. This Japanese skyscraper is 118 feet taller than the original French version. Atop the tower are the broadcast antennas of the Nippon Television City Company for telecasts to the greater Tokyo area. Studios are at the foot of the tower. The observation platform is open to visitors.

The two photos below compare some of the electronic equipment in the U.S. Atlas satellite (left) with that in the Russians' new artificial planet. In the hand at left is a 10-ounce transistor receiver which picks up messages from Earth. The unit behind it activates the magnetic tape recorder. The round unit in the front sends out the steady tracking signal. The Russian device at the right is used for measuring ion composition and density in the environment of the satellite.





. . .News

C & D Products of Old Marlboro Road, East Hampton, Conn., has announced a new dual function record cleaner—the "Stardust." It permits the record to be washed in running water without damage to either label or record and serves as an air-tight container for the sponge. The two plastic halves hold the record during washing and wiping to avoid prints on the playing surface. $3.95. A descriptive circular is available from the manufacturer.

RCA is now marketing a line of factory-rebuilt TV picture tubes with a 1-year warranty. The "Monogram" line will sell for approximately 35% less than the all-new "Silverama" tubes with the return of an acceptable old picture tube.

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RCA Institutes celebrates Fifty Years of Electronic Training by introducing its newest Home Study Course . . .

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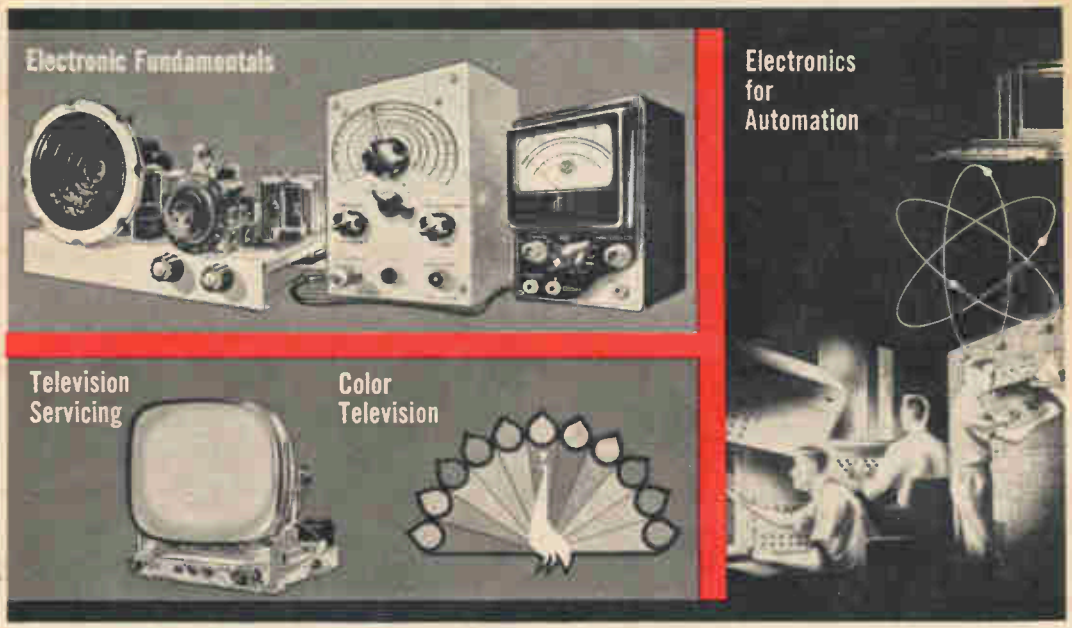

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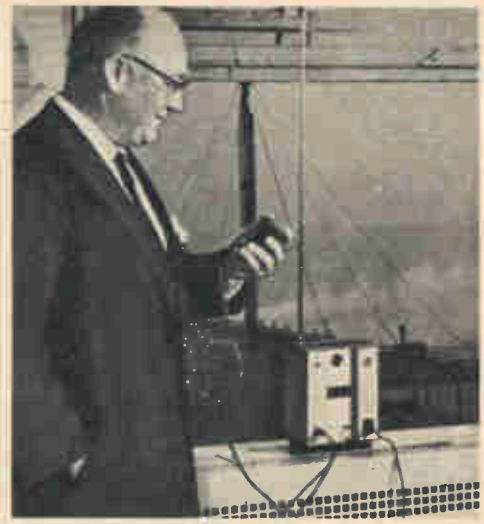
. . . News



A two-way radio for the new citizens band on 27 mc has just been announced by RCA. The "Radio-Phone" operates on the citizens band frequencies recently set aside by the FCC for personal use. This band is open to all citizens of the U. S. over 18 years of age.

The "Radio-Phone" is capable of voice transmission over a distance of several miles. It sells for about $100 per unit and two are needed for two-way conversation.

The unit weighs about 10 pounds and operates from a 6 or 12-volt battery or a 115-watt AC power source.

—o—

Stromberg-Carlson is now manufacturing and marketing high fidelity auto radios. The new radios feature transistor push-pull amplifiers, seven tuned circuits and an RF stage. The use of transistors in the audio amplifier reduces hum and noise pickup.

The radios are available in two models, one with a signal seeking tuner, the other with a standard manual tuner, shown above.

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Model Y-784 **$19.95** (less cover) $2.00 down

Never before has there been so much solid hi-fi value and quality performance at such low cost. **Guaranteed specifications:** frequency response, 30-15,000 cps ±1½ db at half power; less than 1% distortion at full power. **Has 15 db of inverse feedback.** With preamp stage equalized for magnetic cartridge; inputs for phono and tuner; separate bass and treble with boost and attenuation. 5 x 9¾ x 7" with cover (cover $3.95 extra). 7½ lbs.

Thrilling "Space Spanner" Receiver Kit

Model Y-259 **$18.95**

Thrilling 2-band receiver, easy to build, fun to operate—a terrific value. Bandswitch selects exciting short-wave, including foreign broadcasts, amateur, aircraft, police and marine radio (6.5 to 17 mc), and standard broadcast. Highly sensitive regenerative circuit. Built-in 4" PM speaker and beam power output for strong volume. Headphone jacks and switch to cut out speaker. Handsome cabinet, 7 x 10½ x 6". AC or DC operation. 7½ lbs.

there is a money-saving knight-kit for every electronic need

HI-FI KITS
60-Watt Stereo Amplifier
Stereo Deluxe Preamp
Stereo Control
18-Watt Amplifier
25-Watt Basic Amplifier
30-Watt Amplifier
FM-AM Tuner
FM Tuner
Hi-Fi Preamplifier
Speaker Systems, etc.

HOBBY KITS
"Span Master" 4-Band Receiver
"Ranger" Radios
Clock-Radio
Radio-Intercom
"Ocean Hopper" Radio
5-Transistor Portable
2-Transistor Pocket Radio
1-Transistor Radio
Electronic Lab Kits
Photoelectronic System, etc.

INSTRUMENT KITS
Tube Checkers
5" Oscilloscopes
VTVM
VOM's
RF Signal Generator
Signal Tracer
Audio Generator
Sweep Generator
Capacitor Checker
R/C Tester
Transistor Checker
Flyback Checker
Battery Eliminator, etc.

AMATEUR KITS
Communications Receiver
50-Watt Transmitter
Self-Powered VFO
100 kc Crystal Calibrator
RF "Z" Bridge
Code Practice Oscillator

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Send for this value-packed catalog featuring the complete KNIGHT-KIT line, as well as the world's largest stocks of **everything** in Electronics. It's the leading, money-saving Buying Guide.

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Ship the following KNIGHT-KITS_____

_____ $_____ Enclosed

☐ Send FREE 1959 ALLIED 452-Page Catalog

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As last, tape recorder fans now have a way to check the speed of their machine as easily as turntable owners. The manufacturers of Irish brand recording tape is now selling a stroboscope device for tape recorders.

The instrument is scaled and ruled in three concentric rings of radiating lines representing 3¾, 7½ and 15 ips, the three most common recording speeds. When held against the surface of the moving tape, the disk will revolve at the same speed as the tape and indicate the speed at which the tape is moving. Available from ORRadio Industries, Inc., Shamrock Circle, Opelika, Alabama. $4.95.

—o—

Allied Radio's new Knight Stereo Adapter is designed to provide centralized control for any stereo system using two separate amplifiers rated up to 12 watts each. The adapter, KN-750, is housed in a brown leathertone finished cabinet with white panel 3¾"x6"x3½" and contains balance and volume controls, phasing, channel reverse and stereo-monaural switches. It sells for $14.95 net.

Do you WISH you were EMPLOYED in ELECTRONICS?

F.C.C. LICENSE—THE KEY TO BETTER JOBS

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

WHICH LICENSE FOR WHICH JOB?

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

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

GRANTHAM TRAINING PREPARES YOU

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

OUR GUARANTEE

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

Get Your First Class Commercial F.C.C. LICENSE in 12 Weeks!

CORRESPONDENCE OR RESIDENCE CLASSES

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

This booklet FREE!

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

HERE'S PROOF...

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

	License	Weeks
Henry M. Best, 1003 Vermont St., Fremont, N.C.	1st	11
Harold V. Jones, P.O. Box 705, Alamogordo, N. Mex.	1st	13
Michael F. Aperio, 916 Townsend St., Chester, Pa.	1st	12
Norman R. Cook, 130 Olive St., Neodeska, Kan.	1st	12
Antone Melle, 68 Union Street, Nantucket, Mass.	1st	10
John Ward, 407 E. Cowden Ave., Midland, Texas	1st	10
F. T. Verga, 538 - 7th Street, Buffalo, N.Y.	1st	12
Philip J. Hooks, 4825 N. Capitol, N.W., Washington, D.C.	1st	12
Anthony Giaquinta, 404 Dale Dr., Silver Springs, Md.	1st	12
J. Milton Candit, 1312 N. 78th Street, Seattle, Wash.	1st	8
James W. Reichard, 707 Arlington Street, Tamaqua, Pa.	1st	8
G. Carl Patschke, 3220 Conn. Ave., NW, Washington, D.C.	1st	12

Grantham School of Electronics

Hollywood Division — 1505 N. Western Ave. Hollywood 27, Calif. *(Phone: HO 7-7727)*

Washington Division — 821-19th Street, N.W. Washington 6, D.C. *(Phone: ST 3-3614)*

Seattle Division — 408 Marion Street Seattle 4, Wash. *(Phone: MA 2-7227)*

MAIL COUPON TO SCHOOL NEAREST YOU

(Mail in envelope or paste on postal card)

To: GRANTHAM SCHOOL OF ELECTRONICS

821-19th, NW Washington • 1505 N. Western Hollywood • 408 Marion Seattle

Gentlemen:

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

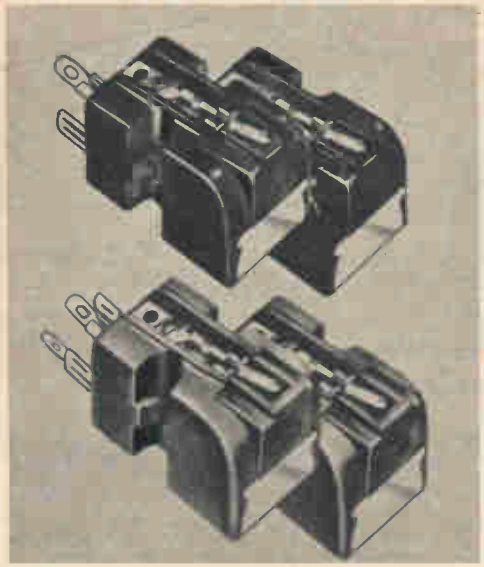
Name_____ Age_____

Address_____

City_____ State_____

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

. . . News



Four versions of the Columbia Constant Displacement Stereo Cartridge have been announced by CBS-Hytron. The basic twin-ceramic cartridge can be purchased with either a diamond or sapphire stylus and in either the "in-phase" or "out-of-phase" connection.

In-phase cartridges provide conventional phasing of the output signals for each channel or can be used in monaural systems by connecting the cartridge outputs in parallel. The out-of-phase cartridges have been specifically designed for the new "simplex" type stereo amplifiers which use one push-pull stage for two channel output. Such amplifiers are now used by Columbia Records in its latest phonographs. These amplifiers require opposite or out-of-phase polarity at the cartridge terminals.

The diamond cartridge, SC-1D, is priced at $24.25 net and the sapphire cartridge, SC-1S, is $17.00 net.

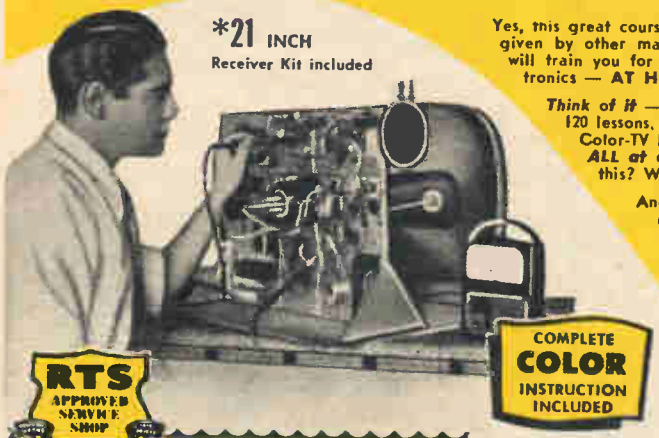
—o—

At the end of 1958 there were a total of 571 FM stations in the U. S. broadcasting good music to hi-fi fans. This was an increase of 34 over the previous year. The number of TV stations has mounted to 546.

AT LAST!

RADIO-TV and ELECTRONICS TRAINING

....AT A PRICE YOU CAN AFFORD!



Yes, this great course costs *far less* than *any* training of its kind given by other major schools! Radio-Television Training School will train you for a good job in Television or Industrial Electronics — **AT HOME IN YOUR SPARE TIME.**

Think of it — a complete training program including over 120 lessons, Fourteen Big Radio-Television Kits, Complete Color-TV Instruction, Unlimited Consultation Service . . . ***ALL at a really big saving to you.*** How can we do this? Write to us today . . . and find out!

And what's more — you can (if you wish)
OPEN YOUR OWN RTS-APPROVED AND FINANCED RADIO-TV SERVICE SHOP

We Want Many More Shops This Year

This 37 year old training organization — called RTS, that's Radio-Television Training School — wants to establish a string of Radio-TV Repair Shops in principal cities throughout the U. S. So far, a great many such shops are NOW IN BUSINESS AND PROSPERING. We are helping and training ambitious men to become future owners and operators of these shops in all areas.

FOR UNSKILLED INEXPERIENCED MEN ONLY — WE TRAIN YOU OUR WAY!

We must insist that the men we sign up be trained in Radio-TV Repair, Merchandising and Sales by our training methods—because WE KNOW the requirements of the industry. Therefore, we will TRAIN YOU . . . we will show you how to earn EXTRA CASH, during the first month or two of your training period. YOU KEEP YOUR PRESENT JOB. TRAINING TAKES PLACE IN YOUR OWN HOME, IN YOUR SPARE TIME!

Get your free book on the
FAMOUS RTS BUSINESS PLAN
find out how you can open
A REPAIR SHOP OF YOUR OWN

We supply and finance your equipment

When you are ready and qualified to operate one of our RTS-Approved TV Repair Shops ***WE WILL SUPPLY AND FINANCE EVERY BIT OF EQUIPMENT YOU NEED TO GET STARTED*** plus an inventory of parts and supplies. In other words ***we will stake you*** . . . **AN OFFER NEVER MADE BEFORE BY ANY TRAINING ORGANIZATION.** Under the RTS Business Plan you receive:

1. An electric sign for the shop front.
2. Complete laboratory of test equipment.
3. Letterheads, calling cards, repair tickets, etc.
4. Basic inventory of tubes, parts, supplies.
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6. Plans for shop arrangement.
7. Instructions on how to go into business.
8. Continuous consultation and help.
9. The right to use RTS Seal of Approval, and the RTS Credo.
10. The right to use the Famous Trade Mark.

you build these and other units

*tubes excluded

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SEND ME FREE — all of these big opportunity books — "Good Jobs in TV-Electronics," "A Repair Shop of Your Own" and "Sample Lesson." I am interested in:

☐ Radio-Television ☐ Industrial Electronics (Automation)

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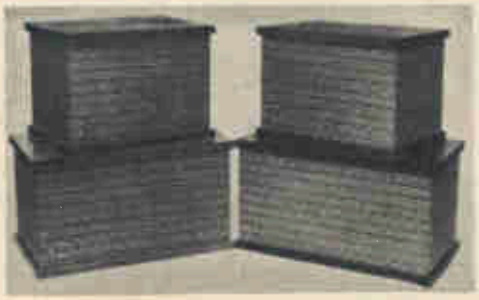
. . . News



A new line of high fidelity speaker systems called the Mardis Gras is being marketed by the JFD Electronics Corp., 6101 Sixteenth Avenue, Brooklyn 4, New York. These low efficiency speakers combine specialized driver components with precision interior construction. The ALC acoustic loading principle used permits the enclosure to be small. Power handling capacity is 10 to 15 watts continuous; efficiency at 400 cps is 10%; power required is at least 5 watts.

One of the two versions of this speaker, the model ALC1, measures 18" x 10" x 10" and is priced at $45 Net. The other, model ALC2, is 14" x 10" x 10" and sells for $30 Net.

—o—

New Catalogs:

Catalogs containing listings of stereo and monophonic high-fidelity equipment, and related audio products are available from Leonard Radio, Inc., 60 Cortlandt Street and Terminal Radio Corporation, 85 Cortlandt Street both of New York City. Both catalogs contain the 1959 models available at publication date.

—o—

Do you have an old Atwater Kent radio in your attic that you would like to rehabilitate as an antique and conversation piece? To put it into working order, however, you'll need the schematic diagram of the receiver.

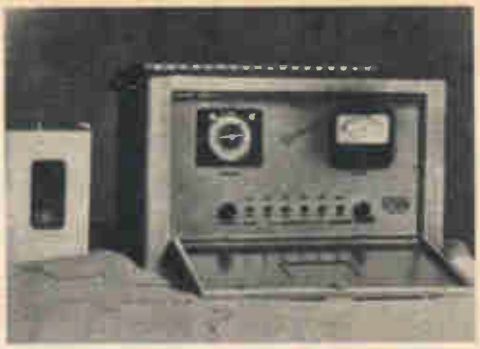
Diagrams for old time radios are available from Supreme Publications, 1760 Balsam Road, Highland Park, Ill. Individual schematic diagrams sell for 40¢ and a complete manual covering the years 1926 to 1938 is available for $2.50.

. . .News

Allied Radio's new Knight KN-130 "Bantam" Stereo FM-AM Tuner, permits separate FM and AM tuning for stereophonic reception. The AM and FM sections in this unit are independent of each other permitting reception of AM-FM stereo.

The tuner has dual outputs for stereo or monaural tape recording of programs and automatic frequency control. FM sensitivity is said to be 4 microvolts for 20 db quieting; on AM, 10 microvolts for 20 db signal-to-noise ratio. The unit has 8 tubes plus selenium rectifier. It measures 3⅜" x 11⅜" x 9", is finished in brown with a brushed brass panel and ebony trim. Price is $79.50 net.

—o—



Naturally, when the better mousetrap was to be built, it had to be electronic! But, instead of trapping the rodents, the new device chases them off in a frenzy. The generator produces an ultrasonic signal which is sent out of the accompanying tweeter. These signals are inaudible to humans and pets. The rats, however, simply cannot stand the sound and within 72 hours have run off or destroyed themselves.

This equipment is available through Supersonics Industry, Inc., 20510 Lorain Road, Cleveland 26, Ohio.

BUILD 16 RADIO CIRCUITS AT HOME

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

Reg. U.S. Pat. Off.

only **$22.95**

A Practical Home Radio Course

Now Includes

- ★ 12 RECEIVERS
- ★ TRANSMITTER
- ★ SIGNAL TRACER
- ★ SIGNAL INJECTOR
- ★ CODE OSCILLATOR

- ★ No Knowledge of Radio Necessary
- ★ No Additional Parts or Tools Needed
- ★ EXCELLENT BACKGROUND FOR TV
- ★ School Inquiries Invited
- ★ SOLD IN 79 COUNTRIES

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

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

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

You will learn the basic principles of radio. You will construct, study and work with RF and AF amplifiers and oscillators, detectors, rectifiers, test equipment. You will learn and practice code, using the Progressive Code Oscillator. You will learn and practice trouble-shooting, using the Progressive Signal Tracer, Progressive Signal Injector, Progressive Dynamic Radio & Electronics Tester and the accompanying instructional material.

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

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

THE KIT FOR EVERYONE

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

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

PROGRESSIVE TEACHING METHOD

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

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

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

THE "EDU-KIT" IS COMPLETE

You will receive all parts and instructions necessary to build 16 different radio and electronics circuits, each guaranteed to operate. Our Kits contain tubes, tube sockets, variable, electrolytic, mica, ceramic and paper dielectric condensers, resistors, tie strips, coils, hardware, tubing, punched metal chassis, Instruction Manuals, hook-up wire, solder, etc.

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

FREE EXTRAS

- **SET OF TOOLS**
- SOLDERING IRON
- ELECTRONICS TESTER
- PLIERS-CUTTERS & ALIGNMENT TOOL
- WRENCH SET
- VALUABLE DISCOUNT CARD
- CERTIFICATE OF MERIT
- TESTER INSTRUCTION MANUAL
- HIGH FIDELITY GUIDE & QUIZZES
- TELEVISION BOOK & RADIO TROUBLE-SHOOTING BOOK
- MEMBERSHIP IN RADIO-TV CLUB: CONSULTATION SERVICE & FCC AMATEUR LICENSE TRAINING
- PRINTED CIRCUITRY

SERVICING LESSONS

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

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

FROM OUR MAIL BAG

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

Robert L. 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."

UNCONDITIONAL MONEY-BACK GUARANTEE

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

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

It is understood and agreed that should the Progressive Radio "Edu-Kit" be returned to Progressive "Edu-Kits" Inc., for any reason whatever, the purchase price will be refunded in full, without quibble or question, and without delay.

The high recognition which Progressive "Edu-Kits" Inc., has earned through its many years of service to the public is due to its unconditional insistence upon the maintenance of perfect engineering, the highest instructional standards, and 100% adherence to its Unconditional Money-Back Guarantee. As a result, we do not have a single dissatisfied customer throughout the entire world.

ORDER DIRECT FROM AD—RECEIVE FREE BONUS RESISTOR AND CONDENSER KITS WORTH $7

- ☐ Send "Edu-Kit" Postpaid. I enclose full payment of $22.95.
- ☐ Send "Edu-Kit" C.O.D. I will pay $22.95 plus postage.
- ☐ Send me FREE additional information describing "Edu-Kit."

Name .....

Address .....

.....

PROGRESSIVE "EDU-KITS" INC.
1186 Broadway, Dept. 510AE, Hewlett, N. Y.

. . . News

Republic Aviation Corporation of Farmingdale, L. I., N. Y. has published a glossary of space terms designed to help space enthusiasts understand the new vocabulary used by astronautical pioneers. Designed to help the interested laymen to better understand news reports it defines such terms as "ablation," "doppler effect," "mach," etc. This 19-page booklet is available free.

—o—

A new moving-magnet stereo cartridge with a .6 mil diamond stylus is now available from the Heath Co. The frequency response is said to be within ± 4 db from 20 to 15,000 cycles. The output level of each channel is at least 3 millivolts and induced hum level about 55 db below recorded signal. Tracking force is 2 to 4 grams. This cartridge, the SF-1, has been designed for Heath by the Fairchild Recording Equipment Corp. It fits all tone arms. $39.95.—●—

FASTEST, EASIEST WAY TO LEARN CODE EVER DEVELOPED

NEW *RIDER 'SOUND-N-SIGHT' CODE COURSE*

by Lewis Robins & Reed Harris

W2RIO

Combines sound and sight plus an imaginary instructor to speed code learning.

Now you can learn code faster, easier than ever before thanks to a scientific breakthrough in learning called REINFORCED LEARNING. The psychological principle behind this new method of learning code has already proved successful by the Armed Forces in teaching Morse and Blinker Code and typing.

REINFORCED LEARNING

. . . a dramatic step forward to faster learning

REINFORCED LEARNING is a form of training without memory —requiring no conscious effort to memorize. It teaches communications skills such as code by applying the psychological principle that people learn more quickly when the act they are trying to learn is immediately given some reinforcement or reward, like a pat on the back or a word of praise. It holds that a correct guess immediately followed by the instructor's approval will remain more firmly embedded in the student's memory than if he learned the signals by memory alone.

The 'Sound-N-Sight' course applies the REINFORCED LEARNING approach. It is the first code training course that combines sound and sight and actually puts an imaginary instructor at your side to speed your learning of three separate abilities necessary to learn code:

1. Hearing the signal correctly or sound perception—telling the difference between the **dits** and the **dahs.**
2. Identifying the correct letter for each signal pattern, or sight identification.
3. Combining sound and sight to recognize the signal and immediately identify it.

EXPERTS SAY . . .

"REINFORCED LEARNING—AN OUTSTANOING SUCCESS"

In the Armed Forces and industry, the REINFORCED LEARNING method has produced astoundingly successful results:

From the Educational Review, November, 1958: *"The Lewis Robins-Reed Harris reinforced learning system . . . is achieving almost incredible results in shortening training time. The original tests conducted in the Navy . . . showed that if the reinforced learning system were used, typing and code could be learned in about half the time formerly required. Tests then conducted by an unofficial organization, the staff of Navy Times in Washington, quickly proved the validity of the conclusions. Now IBM, RCA and the Chrysler Corporation are trying the method."*

From William Haddad, The New York Post, November 14, 1957: *"Dr. Harry J. Carman, world-famous historian, Dean Emeritus of Columbia College and Co-chairman of the President's Committee on the Arts & Sciences, said that Lewis Robins had adopted a 'brilliant approach' . . ."* In a later article, November 22, Mr. Haddad reported: *". . . Captain Philip Winston, commander of the Fleet Training School . . . said . . . 'The group is learning faster than any other group we've ever had . . .'"*

From Richard M. Mansfield, military writer of the Norfolk Virginian-Pilot: *"Professor Fred S. Keller . . . one of the nation's top psychologists, has been quoted as citing Robins 'as one of the five or six persons who really have seen what the learning process is all about, and have really brought any fresh thought to bear upon it!'. . ."*

MOST COMPLETE, MOST UNIQUE COURSE EVER OFFERED

The course combines sound (clearly transmitted signal patterns on records with the instructor's voice *immediately* informing you if you are correct) with sight (47 identification cards with individual signal patterns and the letter, number or punctuation mark for which they stand). A clearly written book tells you how to apply the course, increase your speed, practice with someone else, transmit and provides charts to check your day-by-day progress.

The records start by giving signal patterns and an imaginary instructor at your side tells you immediately if you have recognized the correct pattern of dits and dahs, teaching you to hear and recognize signals correctly. Next, by using the identification cards you learn the correct letter associated with each signal pattern. Finally, the records tie together your ability to hear the signal correctly and identify the letter for which it stands. You can learn to receive as rapidly as you learn to send—proof positive of the effectiveness of this method. The instructor's voice is on hand at all times to give you the correct answer immediately. From this point on it's a matter of increasing speed. With the 'Sound-N-Sight' course many people have learned to receive 5 words per minute within 9½ hours!

THREE INDIVIDUAL COURSES

COMPLETE COURSE—*covers all licenses up to commercial (0 to 20 words per minute)*
Six 10" LP records (192 minutes of recording. 46 recordings), 47 identification cards and book train you to receive up to 20 words per minute. Also trains you to transmit. #REC-020, **$15.95.**

NOVICE COURSE *(0 to 8 words per minute)*
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Coming Age Of Sun Power

By James Joseph

From laboratory to practical electronics in five short years—Here's how we're harnessing Ol' Sol.

THE first man to reach the moon will look to the sun for survival. His space suit will be heated and air-conditioned by solar energy; his plastic-domed lunar home electrified by sunlight; his every breath purified by sunpower.

Solar floodlights will brighten the long lunar nights (as long as 14 earthdays). His heated space suit, powered by solar cells, will protect against nighttime temperatures down at the —250° F mark. By day, despite sizzling heat, he'll stalk the Sahara-hot lunar plains as comfortably as if he were lunching in earth's swankiest air-conditioned restaurant.

Sunpower will grow his food in lunar greenhouses whose solar-controlled lights will emit only wavelengths in the "growing spectrum." He'll cook on mirrored solar stoves, order his supplies by sun-powered telephone. And from deep lunar caves,

Electrical output of solar battery is compared with total energy available from sun. Bell Labs engineer makes measurements with a pyrheliometer.

Twenty solar cells soak up rays, convert them to current to power Palm Springs, Cal., clock.

Water pumps using converted solar energy will be used to turn sunny deserts into fertile plains.

sun-run factories, electrolysing oxygen from ice, will pump life-giving air to home and lab. Sunlight will be his salvation, incinerating his wastes, automatically focusing his research cameras and energizing the transmitters beaming his voice earthward.

Fiction? Not at all. Scores of moon-minded researchers are now preparing man for lunar life, grooming him to look toward the sun for survival. What's more, your survival here on earth is as inescapably tied to the sun. Mankind faces a survival deadline, the year 2000 AD. By then, less than half a century away, earthbound man will have depleted most of his natural sources of energy—oil, gas and coal. Controlled atomic fission will probably take over as the largest energy supplier, but a safer and more limitless source is the sun.

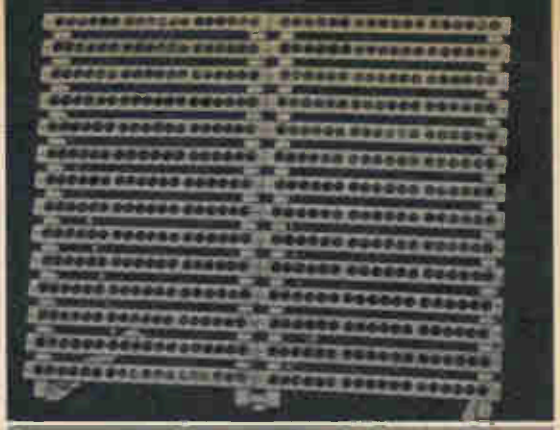
It is toward the sun and its everlasting power that scientists are reaching. Time is running out, but by 2000 AD we'll have harnessed the sun and made it our servant.

Right now, in fact, we are on the threshold of an energy breakthrough ushering in a new era: The Solar Age. Five short years ago, in April 1954, Bell Telephone Laboratories unveiled the silicon solar battery, the first device to wring electricity from sunlight in an efficient manner. Today, silicon batteries power transistorized radios, hearing aids, navigational beacons and have in some way energized most of the satellites man has lobbed into space.

Slowly at first and now with increasing urgency, we are tapping the immense electrical reserve bottled up in the sun. It is a reserve of astounding potential; 9000-trillion kilowatt hours bathe the United States annually, only a small portion of the total that falls on the entire earth. If even a small fraction of this could be economically captured, we'd have more than enough power to run every home and factory.

SOLAR FURNACES

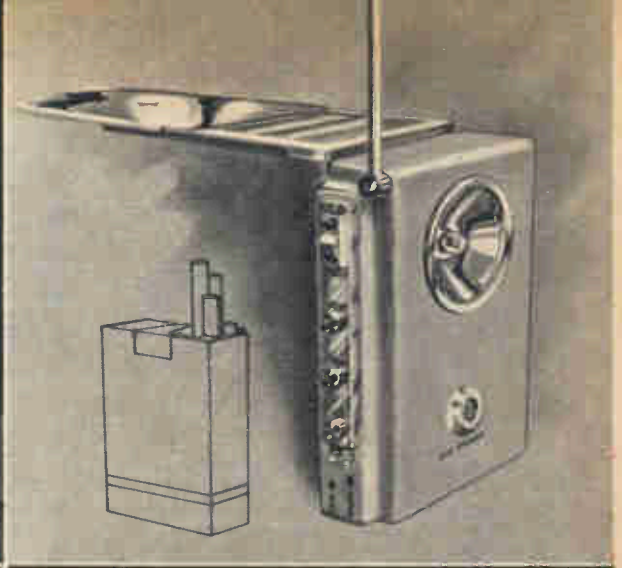
The problem: How to convert radiant power (light) to electrical energy cheaply and efficiently. One way is the solar furnace. The huge unit recently put into operation at Natick, Mass., by the Army's Quartermaster Research and Engineering Center, focuses solar energy to a fiery 5000°— twice the heat needed to wring electrical current (DC)



Big Bertha solar energy converter at right has 504 cells. Coast Guard has installed it atop lighthouse wall (arrow) to power flashing beacon over big light.

Transistorized mobile radio transmitter is powered by solar cells at Bell Labs. Man in distance with receiver gets clear signal. Effective range is several miles.

Silicon cells, 144 in all, are linked together to charge batteries rated from 6 to 48 volts.



Design for small rescue radio, with transmitter, receiver and lamp, would have cells in top.

Flat-type solar stills to purify sea water are under study by Dr. Maria Telkes of N. Y. U.

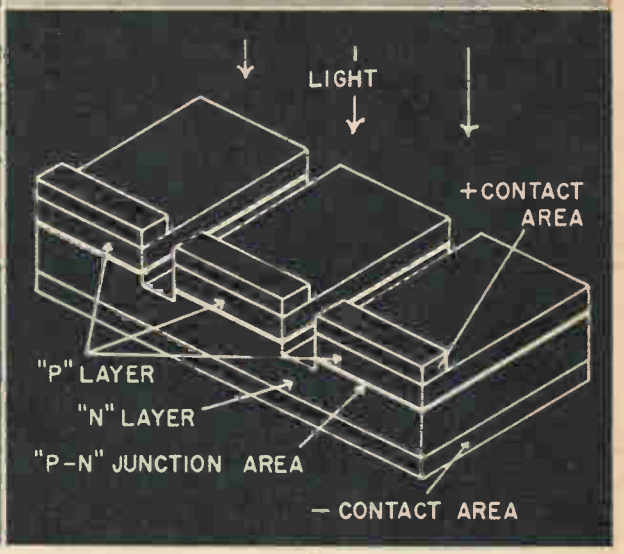


Diagram of new photovoltaic readout cell used in computers shows contacts, P-N junction.

from oxides of nickel, manganese and lithium-cobalt. Such *thermoelectric* materials are a promising new source of power.

When thermoelectric compounds (oxides in pellet or powder form) are heated to about 2000° F, their electrons are disturbed. The result: Direct current produced simply, silently and without moving parts. Sunpower focused by parabolic mirrors in giant solar furnaces promises to fuel the conversion process. Our future factories may get most of their electricity from thermoelectric furnaces, stoked by earth-common metals and fueled by sunlight.

Solar furnaces themselves are not complex. In theory, they borrow the magnifying glass you used as a child, and for the very same purpose: To focus the sun's rays to fiery combustion.

One mirror, 147 feet high and 151 feet wide, with a flat mosaic of 1162 smaller mirrors, will ride along a rail as it automatically tracks the sun. This reflector is called the heliostat. It is designed to

Solar highway flasher can operate at night from power generated and stored during day.

Now on market is this transistorized portable radio. Solar cells are embedded in the handle.

Lens of camera is set automatically as International Rectifier cells react to light levels.

Eyeglass hearing aid by Zenith recharges miniature battery from silicon cells on temple bar.

reflect the solar energy to a dish-shaped collecting and focusing device called a concentrator, which features a 108-foot-wide parabolic face composed of 4800 precision-ground mirrors.

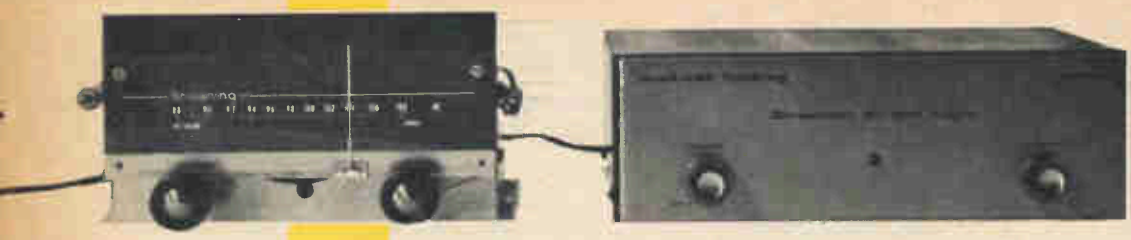
Concentrated, the sunlight can be focused down to a spot only four inches in diameter. This is the furnace's hearth, set atop an 80-foot tower. Here the heat will rise to within 50 percent of the sun's surface temperature.

SOLAR BATTERIES

Organic materials have become a new and exciting power source. University of California researchers recently announced the first successful solar battery concocted from organic materials. The battery converts sunshine to energy as green plants, through photosynthesis, converts it to oxygen. Built of multi-colored layers of synthetic organic dyes, the wafer-thin battery (⅜″ wide, $\frac{1}{16}$″ thick) generates enough current in sunshine to trigger a low-powered transistorized relay.

Another sun-triggered current producer is the thermocouple—two different conductors joined at one end. A temperature difference at the juncture generates the current. Thermocouples now power circuits that keep our most sophisticated missiles on course. Although the direct current produced by thermocouples is modest, the device has

[*Continued on page* 92]



adapt your

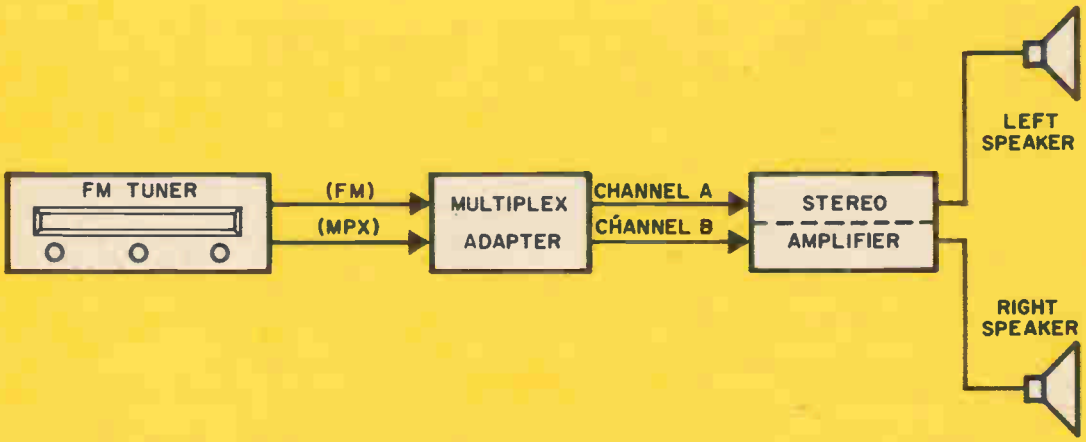
FM For Multiplex

By Norm Eisenberg and Len Feldman

Prepare your tuner for the reception of stereo broadcasts by adding a multiplex output jack.

FOR some time now, many FM tuners have been featuring a "multiplex" output in addition to their normal signal output. The multiplex jack is for feeding the "second" signal that could be transmitted by an FM station along with the regular FM program. Up to fairly recently, that multiplex jack was of relatively little interest to home listeners. For one thing, they didn't have access to the required multiplex adapter into which this second signal must be fed. Equally important, there wasn't much worth listening to on multiplex: this "hidden signal" technique

Basic setup for receiving FM multiplex. The adapter (see Madisan Fielding unit at top of page, right) picks up signals from jacks on rear of FM tuner.



was being used largely for providing so-called background music (not very exciting to hi-fi enthusiasts) to business establishments on a private subscription basis.

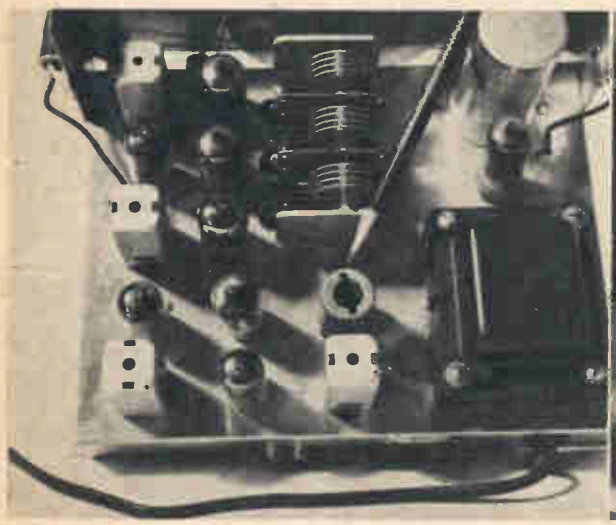
The multiplex jack was being supplied, however, against the day when it would have importance for home listeners. In some areas, that day has arrived with the advent of stereo broadcasting by FM multiplexing. In New York City and in Wilmington, Delaware, at the time of writing, broadcasters are using a multiplex signal to transmit "compatible" FM stereo. These experimental broadcasts are transmitted by permission of the FCC. The listener with an ordinary FM set hears a full, monophonic version of these programs. Listeners who have a multiplex jack on their FM sets (plus a multiplex adapter and—of course—the second amplifier and speaker needed for any kind of stereo) can tune in to a thrilling stereo program in which all the depth and fullness of the new sound medium can be enjoyed via the noise-free, wide-range benefits of FM on both channels.

All right, you say. I'm sold on multiplex. I'm even willing to go out and buy the new adapter. I don't, however, happen to have anything on my present FM tuner that resembles a "multiplex output." Does this mean that I must buy a new FM tuner as well?

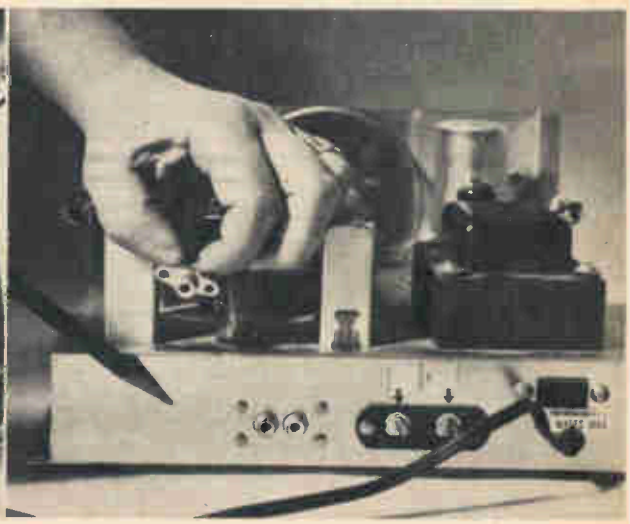
The answer simply is that you can wire in your own multiplex jack very easily. Once installed, this new jack will provide a correct takeoff point for feeding multiplex to the adapter. It will not interfere with, or detract from regular FM quality; it will not prevent your FM set from being used in the normal manner as before.

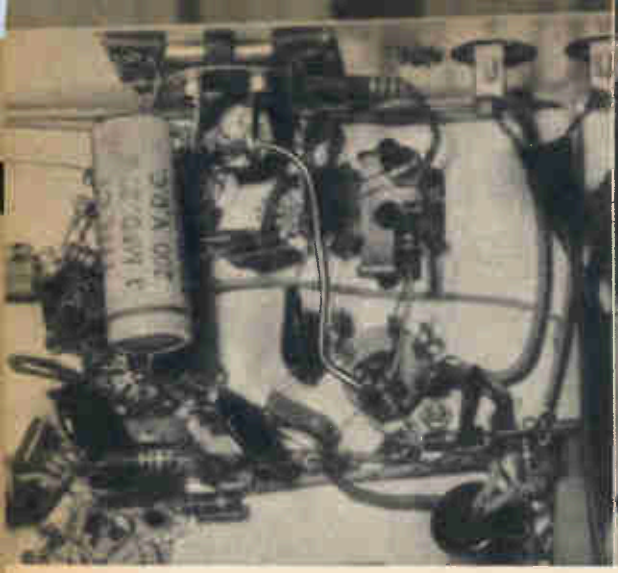
Can such a jack be installed in any FM set? Will it work in any FM set? To both questions, the answer is yes. The multiplex signal (in the presently used Crosby system at least) rides in at 50 kc, high above the audio range. Even with that 50 kc modulated with the second channel there's enough electronic "space" in the average FM set for the signal to get through. In fact, each time you tune in your FM set, you are also admitting whatever "hidden signal" happens to be riding along. It rides on the multiplex carrier which itself rides along on the regular FM carrier frequency. In normal FM detection, the main signal is slipped out of its FM envelope; this envelope and any extraneous matter is filtered out and not heard. So, to nab that "hidden signal," you must get to it just after the entire

First step is finding the detector tube on FM set, usually a 6AL5, toward rear of chassis.

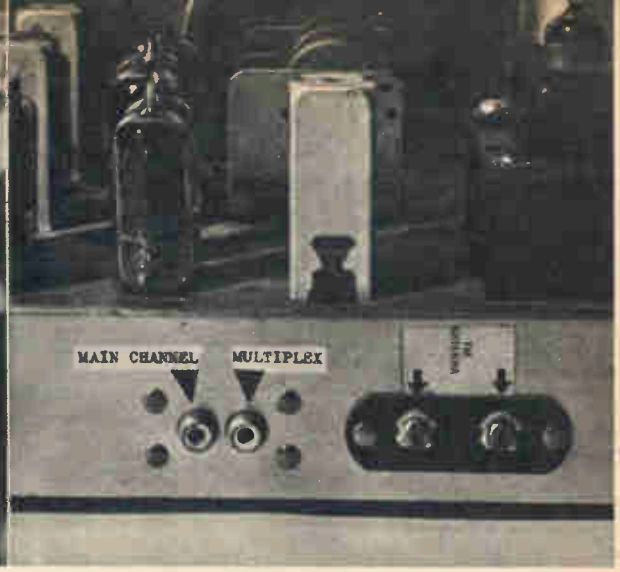


Although this tuner already has a spare jack, one may be added on the chassis' rear apron.





White wire, just right of center, runs from multiplex jack to "X" point on the detector.



Label shows position of new multiplex output. Shielded cables will bring signals to adapter.

FM signal has been detected, but before filtering (de-emphasis) action has started.

In any FM receiver there is one—and only one—point in the circuit where you can pick off the multiplex signal. Just where it is in your own tuner depends on what kind of a tuner it is. So, before explaining how to add the multiplex output, we must first tell you how to find the spot in your set where it all begins.

There are two kinds of detector circuits commonly used in FM sets. One is the "limiter-discriminator" type; the other is the "ratio detector." Either works satisfactorily; either can be used for adding a multiplex output.

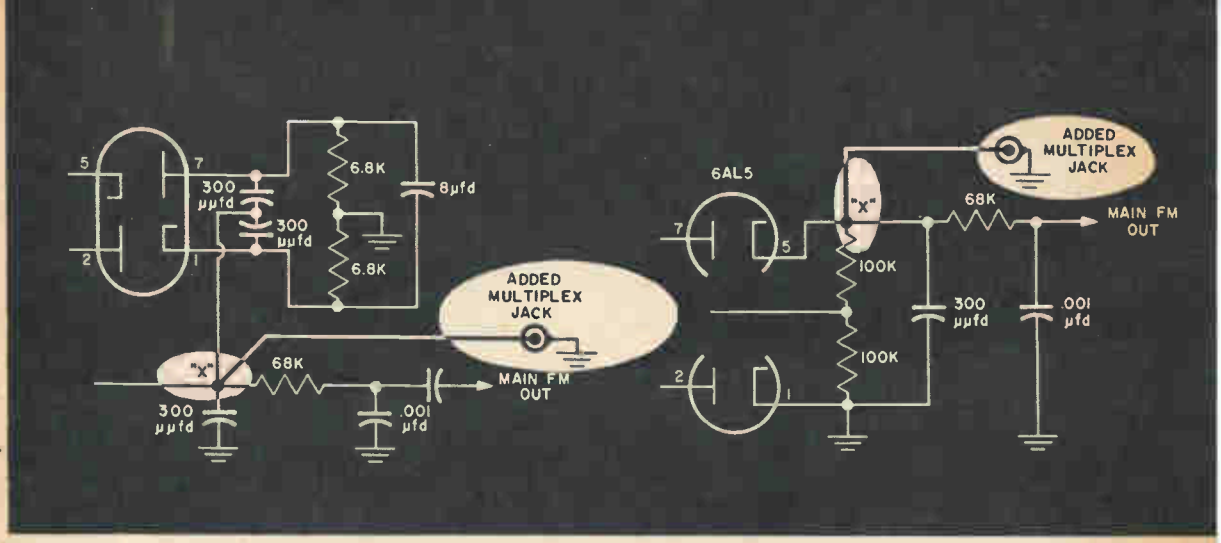
Both types of circuits are shown schematically. Compare these diagrams with the schematic for your own set to determine which circuit you have. If you don't have that schematic, a simple way to check which circuit is used in your tuner is to note the arrangement of the detector. Almost every tuner built in the last few years employs a type 6AL5 tube. This is a miniature double-diode. Sets of really ancient vintage may use an octal-socket type tube known as a 6H6. Some very recent tuners employ germanium diodes, rather than conventional tubes, but these most likely have multiplex jacks already.

In the discriminator circuit *both* plates (pins 2 and 7) are connected to terminals of the discriminator transformer. This transformer is readily identified as the "can" nearest the detector tube. In the ratio detector, one plate of the double-diode is connected to a can terminal, and the cathode of the other diode section (pin 5) is connected to another terminal on the can.

Regardless of which circuit is used, installing a multiplex jack is easy.

The model chosen for this project was the Browning L-300 tuner. This set is fairly representative of many popular-priced reliable tuners bought a few years ago and still being used by thousands. The L-300 has a discriminator circuit, followed by a cathode follower for audio output.

The job turned out to be simpler than anticipated because two output jacks were already provided on the L-300 chassis. Both jacks were actually connected to the audio output of the cathode follower. Browning had "doubled up" on output jacks to enable the user to connect from one jack to his regular "listening" amplifier and from the other jack to a tape or disc recorder. Since most present-day amplifiers or preamps also are equipped with recorder feed jacks, we felt that nothing would be lost by reconnecting one of the two available jacks on the L-300 from its present circuit point to the point required for multiplex.



Two typical FM detector circuits; ratio detector at left, discriminator at right. Multiplex points are "X" and found by tracing back from main FM jack. 68K resistor is blue-gray-orange.

This point is at pin 5 of V7, the 6AL5 tube. Of the two jacks available, the one formerly labeled "audio output" happened to be closer to pin 5 of the tube. We gave it the new assignment. A short (two-inch) piece of wire was connected between pin 5 of the 6AL5 tube and the "audio output" jack. The connection between the "audio output" and "recorder" jacks was broken. The two ends of the new wire were soldered in place. This job took all of five minutes.

We then changed the labeling on the rear of the chassis to read correctly in accordance with the new connections: "Main Channel" for normal FM signal, and "Multiplex" for multiplex signal.

Using a Madison Fielding MX-100 multiplex adapter, we made the following interconnections: From the new multiplex output jack on the L-300 to the multiplex input on the adapter. From the "old" output jack on the L-300 (FM audio output) to the "FM IN" jack on the adapter. From the output jacks on the adapter to the "left" and "right" tuner inputs on a stereo amplifier.

At 11 a.m. we turned it all on and tuned to WBAI in New York for this station's daily multiplex broadcast. We caught the announcer as he opened with: "Station WBAI, also operating as KE2XXT, for stereo multiplex experimental purposes, brings you. . . ." We turned up the "dimension" control on the adapter (this control provides stereo "spread" for such broadcasts) and the announcer suddenly moved to the right side of the living room. Then came the music. It didn't take long to realize that the faithful Browning had come through surgery unscathed—and with something new added, provisions for receiving multiplex.

The point at which to connect a multiplex output for both discriminator and ratio detector circuits is shown in the schematic diagrams. If your tuner does not happen to have two output jacks on its chassis, as did the L-300, you can install a new jack. Arrange it to be as near as possible to the detector tube so the wiring is kept short.

The input impedance on the adapter, at both its FM and multiplex receptacles, is 500,000 ohms. This is high enough to operate correctly with reference to the output impedances of tuners at their FM and multiplex takeoff points. In any case, keep interconnecting cables as short as possible for best results. You may find, too, that in certain areas reception of multiplex signals will require a good outside antenna.

Even if multiplex stereo hasn't reached your area yet, you can be reasonably sure that some form of multiplex will eventually arrive. So you may as well update your tuner now, and be ready for it.

All About Computers-2

By R. W. Yates

How computers work—what electronic "magic" enables machines to receive, store and process data.

NO discussion of how electronic computers work can proceed very far before a fundamental distinction is made: the distinction between analog and digital computing systems.

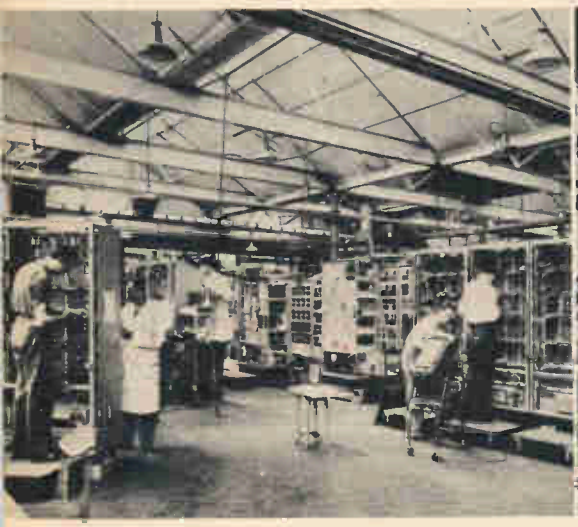
Both use electronic circuitry, vacuum tubes and/or transistors, magnetic amplifiers, etc., to perform complex mathematical calculations at millisecond speeds. Both work automatically on the basis of predetermined instructions or "programs," and both have had a revolutionary effect on the ability of human brains to deal with large amounts of factual information. Beyond that, they have nothing in common.

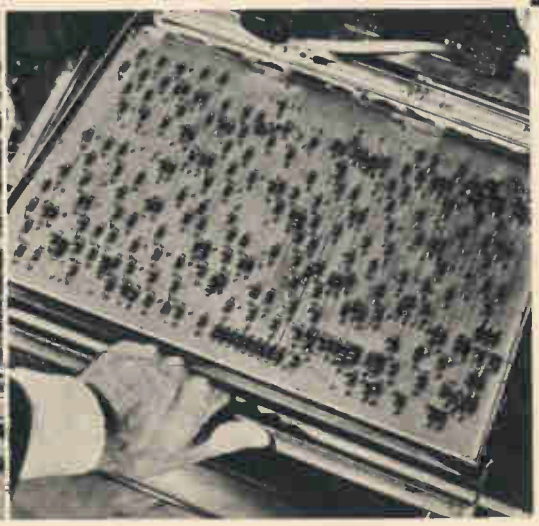
The automobile speedometer is a simple analog device. Without actually counting the revolutions of the wheel within a given time span and repeatedly dividing to determine the number of miles per hour, its mechanism senses the constantly varying rate of revolution and interprets that rate in terms of the constantly wavering needle on its miles-per-hour dial. In contrast, the ordinary desk calculator is a digital device. Its keys activate mechani-

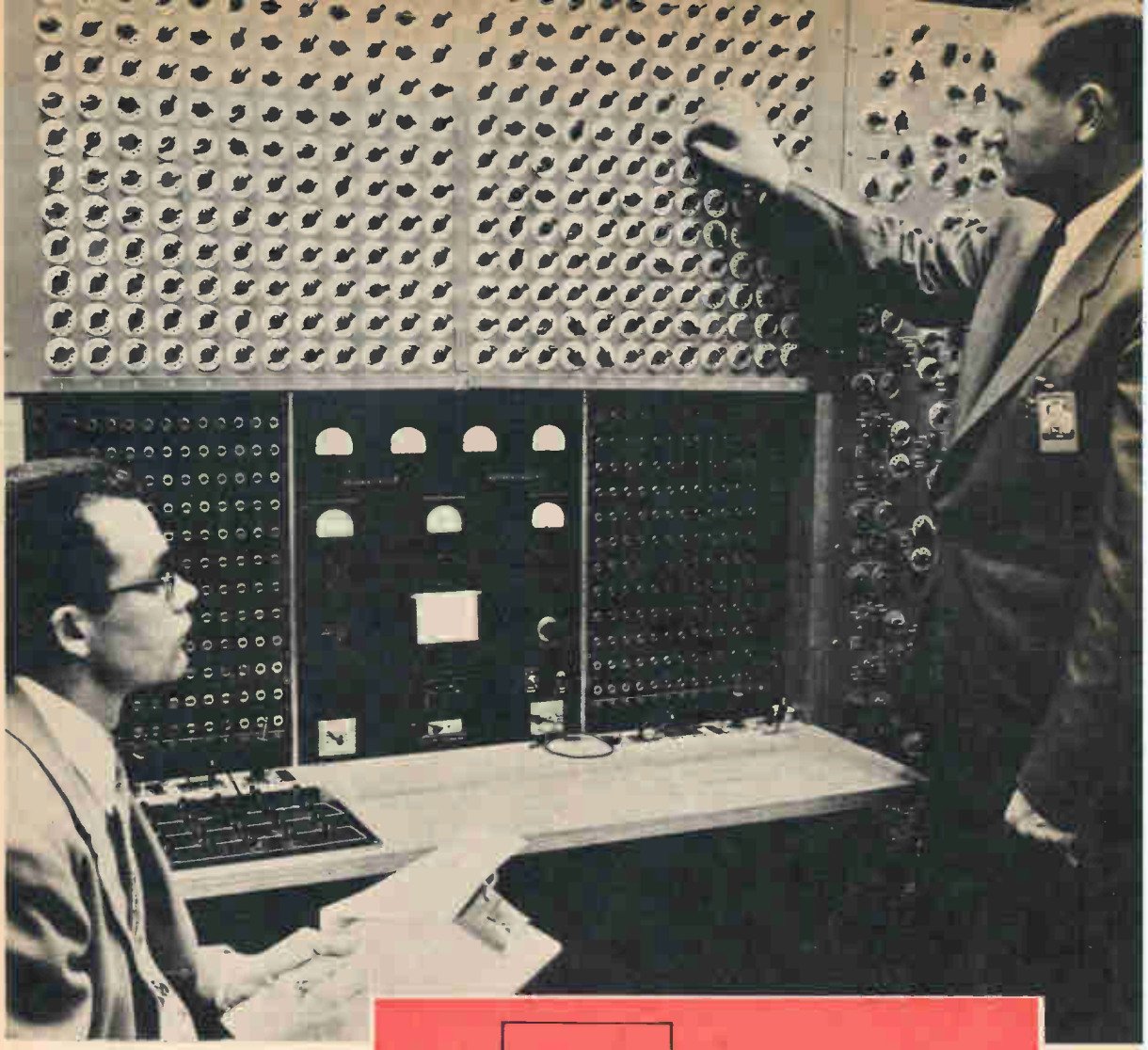
At the Hanford atomic plant in Richland, Wash., two GE engineers set up a computer program designed to solve knotty heat transfer problems.

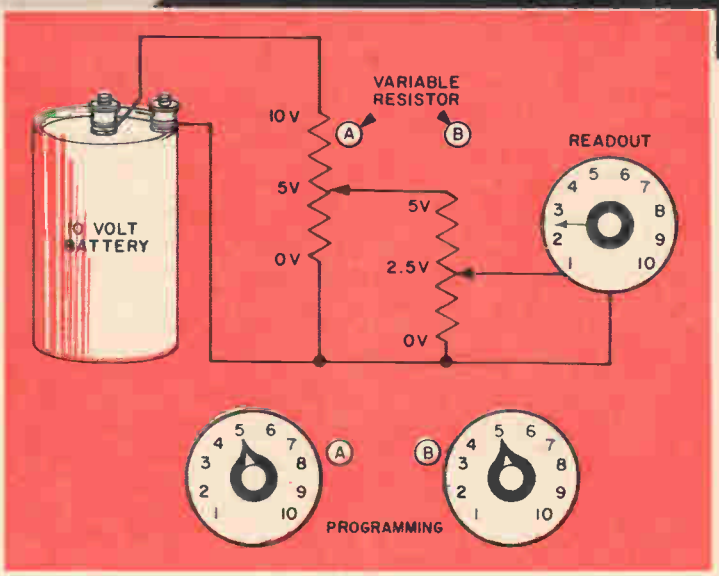
British computer by EMI Ltd. (left) has 2400 equipment racks to be assembled. It can absorb Encyclopedia Britannica's data in under 4 minutes.

Control circuits like one in Royal McBee's LGP-30, below, govern the signal gating so that everything happens at the right time in proper relationship.

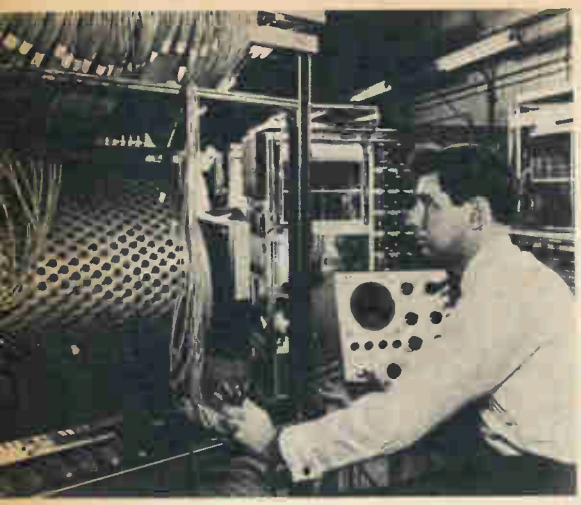




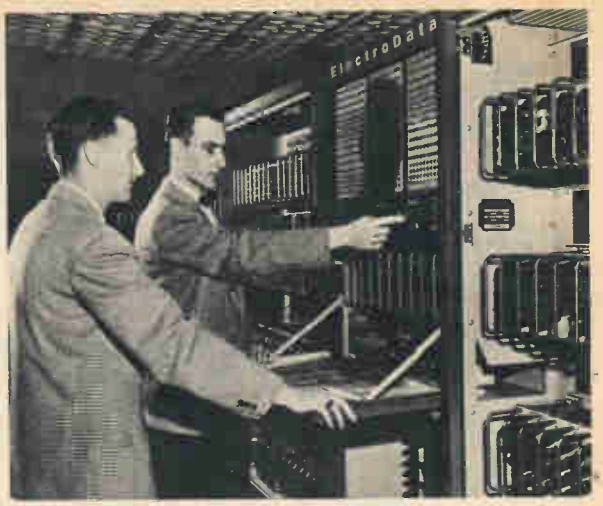




At right is diagram of simple analog computer. Problem: Multiply 5x5. Battery sends 10 volts through circuit. Dial A, controlling moveable arm linked to variable resistor A, is set at halfway point (5). Resistor B now receives only 5 volts. Halve this again and the meter reads 2.5. Rearrange decimal point and you have the answer. Setting of dials is "programming"; meter corresponds to "readout."



Univac memory drum, here being assembled, is a cylinder with sensitive surface. It spins inside jacket with magnetic reading heads.



Programmers, most important element in computer operation, here trace through steps of insurance company's digital data problems.

cal parts representing the *actual* numerical quantities involved in arithmetic.

The same difference prevails in electronics. Analog computers use varying physical magnitudes (voltages, light intensities, shaft positions, and the like) as factors *analogous* (corresponding) to mathematical values. Digital computers work from pulses representing actual numerical (and alphabetical) symbols.

Within the category of analog computers, a further distinction must be made between special- and general-purpose systems. The small airborne computer used to guide an anti-aircraft missile is a special-purpose analog system, in that its program is unchanging. It solves the same problem over and over again.

The force that activates this computer —its "input"—is the missile's radar equipment. The radar signal supplies information on the constantly changing position of the enemy plane and enters this information, via a synchro-link, to the computing circuitry. Its "output"—the physical result of its analog computation—is the automatic control of machinery which makes constant, delicate readjustments of the missile's steering gear until the target is hit.

General-purpose analog computers are generally used by engineers to test the value of their designs under theoretical conditions. They are capable of handling a great variety of problems. The terms of each problem assigned to it are wired into a removable program panel—a plugboard on which the *mathematical constants* of the problem have been translated into specific circuiting instructions.

The input of this computer is the engineer's hand, which adjusts a number of control dials to variable settings, each representing one of the *variable factors* of the problem and each applying an appropriate amount of current through the programmed circuits. Its output might be a series of readings on indicator dials, or it might be a wavering line drawn on graph paper—representing, say, the behavior of a theoretical airplane wing or tail assembly under the stress of supersonic flight.

Analog computers are perfectly accurate so long as the *physical* relationships it handles (voltages, etc.), are valid representations of the *mathematical* relationships in the problem. But, generally speaking, it is less *precise* as an instrument of calculation than a digital system, as well as slower. Another important distinction is that the memory capacity of an analog computer is static

Part of this country's satellite computing center, IBM 704, above, calculates and predicts course of artificial moons and space rockets.

in nature. It can store information for later reference, but it can't automatically adapt itself to changes occurring within that stored data.

Chiefly for these reasons, the popular term "electronic brain" might be more appropriately applied to digital than to analog systems. A basic understanding of digital computers must begin with the knowledge of a traditional mathematical code called the binary digit system—a way of expressing an infinite variety of numbers through the use of only two symbols, "1" and "0", otherwise known as "on" and "off." In conventional binary digit coding, the ten numerals, 0-9, are expressed by varying combinations of 1 and 0 in a four-digit frame, as follows:

Zero is	0000
One is	0001
Two is	0010
Three is	0011
Four is	0100
Five is	0101
Six is	0110
Seven is	0111
Eight is	1000
Nine is	1001
Ten is	1010

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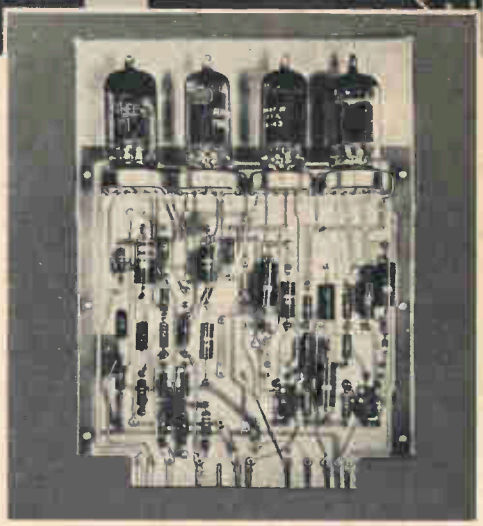
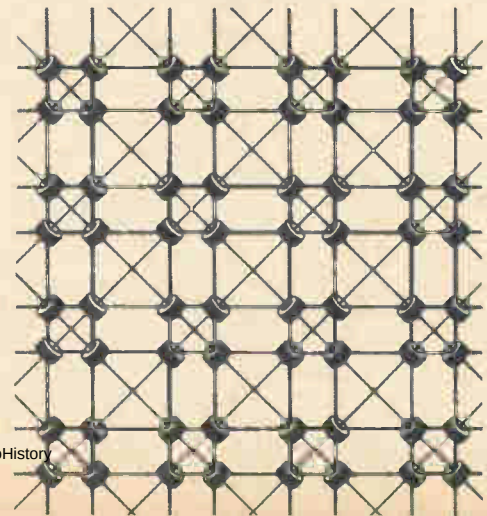


Plug-in circuit (for easy maintenance) is one of many in LGP-30 to set up math routing.

Memory grid shows magnetic cores which store data as patterns of magnetic fields.



Above, Gunderson points out the basic features in ham receiver; band-spread, selectivity, stability. At left, *EI* editors tape record his comments.

how to buy

Ham Equipment

Tape interview with ham authority tells you how to get started, how to buy a receiver and transmitter.

BOB GUNDERSON, W2JIO, has been an active radio amateur for over twenty years. He has won the Edison Award, the highest commendation a ham can aspire to. He has taught ham radio to countless numbers of people, and has invented many electronic instruments and devices. He is totally blind!

Many beginning radio amateurs and short-wave listeners have met Bob at the New York City and Newark stores of Hudson Radio, a large retailer of ham equipment. Bob answers their questions on what to buy, and incidentally, may give them a brief course on hamming. Here he answers some typical questions.

Ques. *Bob, you've handled all kinds of ham equipment and have spoken to many people interested in amateur radio. How much does it cost to get started in amateur radio?*

Ans. Well, I guess anywhere from $50 to $1000. You can buy a transmitter and a receiver, put up the antenna, and plug the three units together and you're on the air; or you can buy a few well chosen parts and build up a very simple receiver and single tube transmitter and you're on the air.

Ques. *Bob, which way do you favor?*

Ans. So many of us today lose sight of the fact that when we become hams we not only do something in which we will enjoy ourselves, but in this way we have an opportunity to become trained technicians, yes and even engineers. For this reason, I would be in favor of the beginner's building his first transmitter and maybe even his receiver. I can remember my first transmitter, it used four oatmeal boxes as the coil forms, the coils were made of bell wire, and the tuning condensers were out of broadcast receivers. I couldn't afford electrolytic capacitors so I made them from aluminum and borax in cans or glass jars.

Ques. *Just what equipment does one need before going on the air?*

Ans. Well, the first thing that you need the minute you decide to become a ham is a buzzer or oscillator and a key to practice the morse code. Every ham must learn the code, whether he decides to stay with code or go on the air with voice transmission. Also, the beginner should build, as-

The relative merit of building or buying equipment is discussed. A National NC-303 receiver is shown, with a Viking transmitter, available in kit or wired form, above it.

Gunderson fires up rig by a unique telephone dialing system of his own design. It controls power, tuning, and band of homebrew transmitter.

semble, or buy a receiver at the same time to become familiar with the way hams talk and behave. He can also get code practice from his receiver. I think the transmitter is last. One thing about the receiver that is very important is that if the beginner decides to buy rather than build, he should buy the best one he can afford.

Ques. *Well now you say that a person should get the best receiver that he can afford. That is an interesting point. Why spend so much on a receiver—is it because the ham has to be able to hear a distant station first before he can contact it?*

Ans. Well, don't think of a receiver as useful only for listening to incoming signals, it is also an excellent piece of test equipment. For example, you can use it to monitor your own transmitter which, of course, is delivering a tremendous signal right next to the receiver. If the receiver has sufficiently good frequency stability you'll be able to check on the modulation and frequency of your transmitter. A good receiver will not be overloaded by the transmitter.

Ques. *What do you think are the important specifications, the minimum specs, that a good receiver should have?*

Ans. I think if it's going to be operated from the AC line there should be a transformer between the receiver and the power line for minimum noise pick-up. It should have a beat frequency oscillator with good stability and with sufficient signal injection so that you can hear the CW signals very well. It should have an RF stage and, of course, be mechanically stable so when you find W1AW on 3555 kc tonight it is still on 3555 tomorrow night. It should have adequate bandspread so that you can separate stations, and a sensitivity control and audio gain control. Then you can go from there, the crystal filter or the Q multiplier or both, or the mechanical filter if you can get way up in price, single sideband provisions, etc.

Ques. *Bob, as you know, there are several inexpensive superregenerative receiver kits available. What do you think of these for the beginning ham?*

Ans. I think anything that a beginner can build or assemble and make work is wonderful. These kits have gotten people interested in ham [*Continued on page* 84]

Hi-Fi Sound From Your TV Set

By Bob Wynn

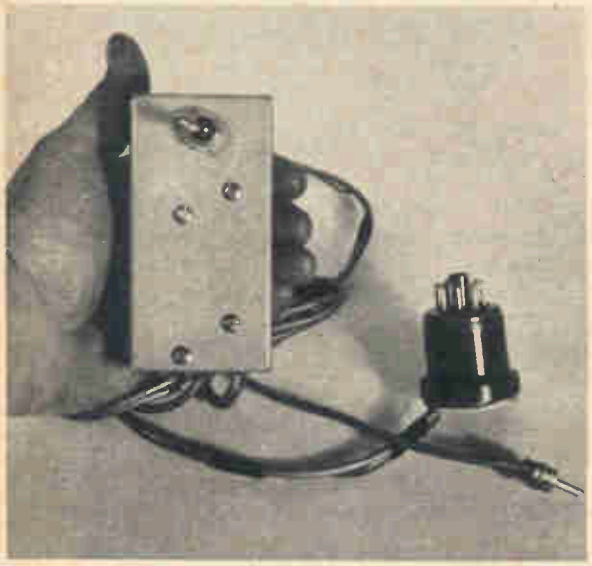
Hear TV sound through your hi-fi with this plugin unit—no rewiring of the TV set is necessary.

THE range of sound capable of being transmitted by a TV station is excellent. A frequency modulation system is used that compares favorably to the regular FM stations, the main difference being in "deviation" rather than frequency response. The FM broadcast station has a greater deviation, which means that less noise will be received in deep fringe areas for a given signal strength. If you are receiving a reasonably good picture, the sound portion has hi-fi potentiality, especially during live shows.

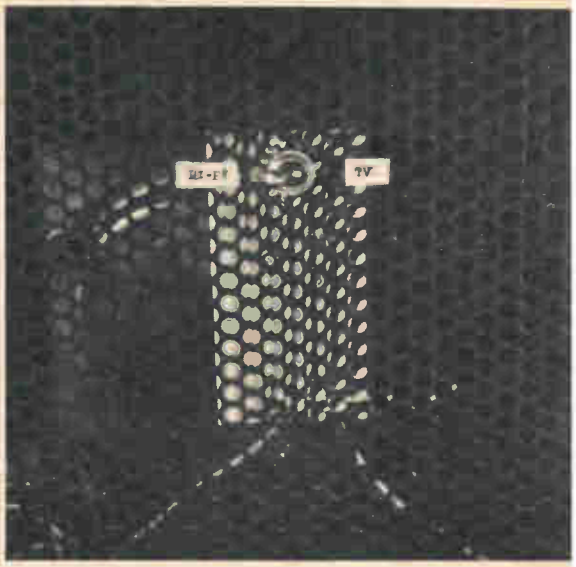
A good deal of the distortion that is heard on TV sound is produced by the set itself; tiny speaker, inexpensive output transformer, and simple audio circuitry. Thus, if you pick off the signal from the voice coil leads of the TV set to feed your hi-fi, these distortions are amplified and heard.

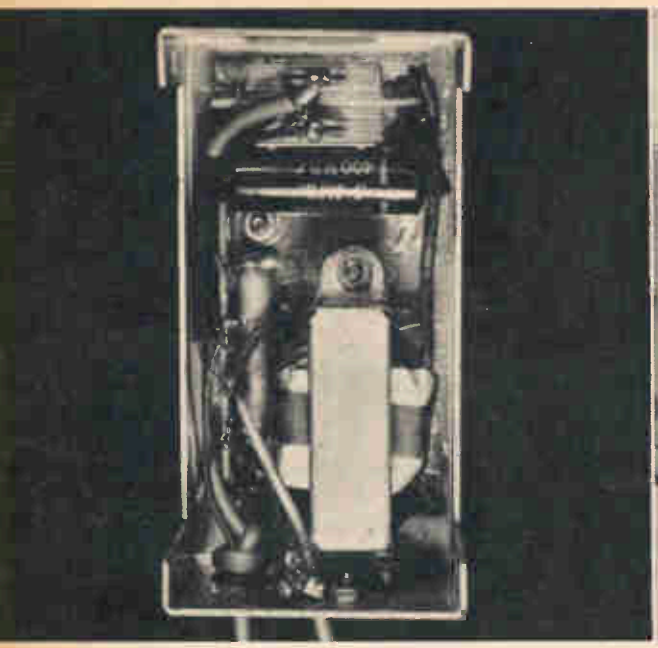
The approach described here is to tap off the sound *ahead* of the point where this deterioration occurs. The most likely spot is just after the detector tube. Unfortunately, to do this, the chassis must be removed and modifications to the circuits be

The unit and its two plugs. Large octal plug goes to TV, small phono type to hi-fi set.

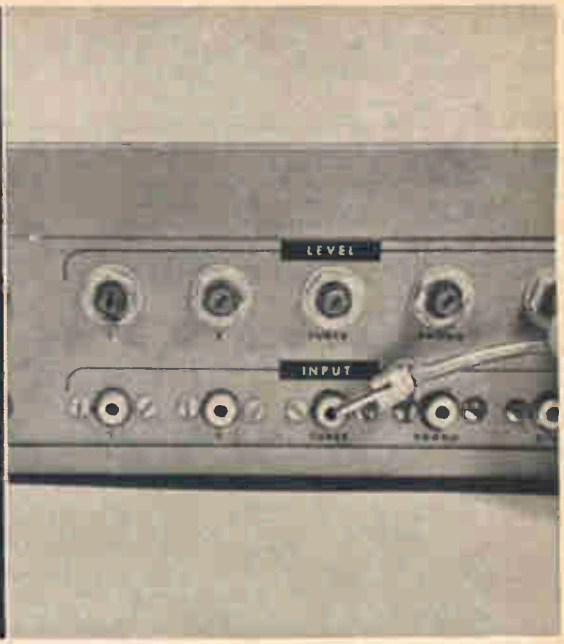


A likely mounting spot for the unit is behind the rear cover of TV. Note selector switch.





Components within the case are seen behind front cover. Transformer T is at lower right.



The unit's phono plug goes to a high level input on the hi-fi set—Tuner or Auxiliary.

made. But, with the unit described here, you simply pull the sound output tube from its socket, insert the Vector socket in its place, then plug the sound tube back in.

The phono plug emerging from the unit is inserted into the TV, TUNER, or AUXILIARY jack on your hi-fi set. An important feature is visible on the front panel of the unit—there is a switch that enables you to hear the sound in the TV speaker as before, or channel it to the hi-fi set.

After securing the necessary parts, locate the sound output tube in the TV set. There is usually a chart pasted inside the cabinet that indicates this, or better still, secure the schematic which is readily available from the manufacturer or electronic supply house.

Construction is simple. Carefully follow the diagram, grounding to the metal case of the unit only where shown. A transformer was incorporated in the circuit for two important reasons. First, the cable running to the hi-fi may be any desired length. Since the transformer changes the impedance from a high to a low value, hum and high frequency losses are avoided. Second, the transformer acts as an isolation device, keeping the various chassis from direct contact with each other.

The Vector socket shown is an octal type. It is originally intended for use as a test unit—bringing all the tube socket terminals above a TV chassis so meter readings may be taken without the need for pulling the chassis out of its cabinet. This feature makes this device possible since it provides a convenient takeoff point for audio, and a means of reducing the sound in the TV speaker while feeding the hi-fi. The various cables were easily soldered to the Vector unit after all the wires were

[*Continued on page* **110**]

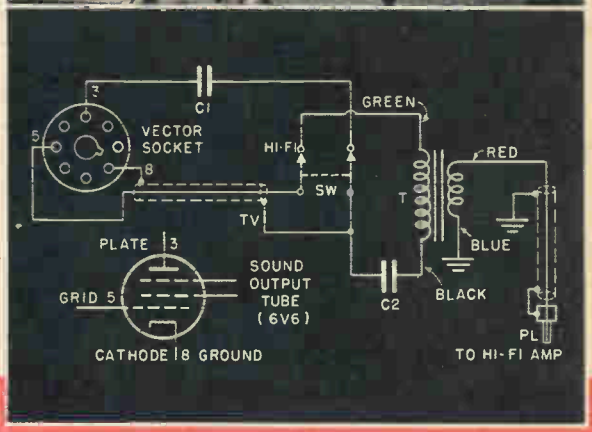
PARTS LIST

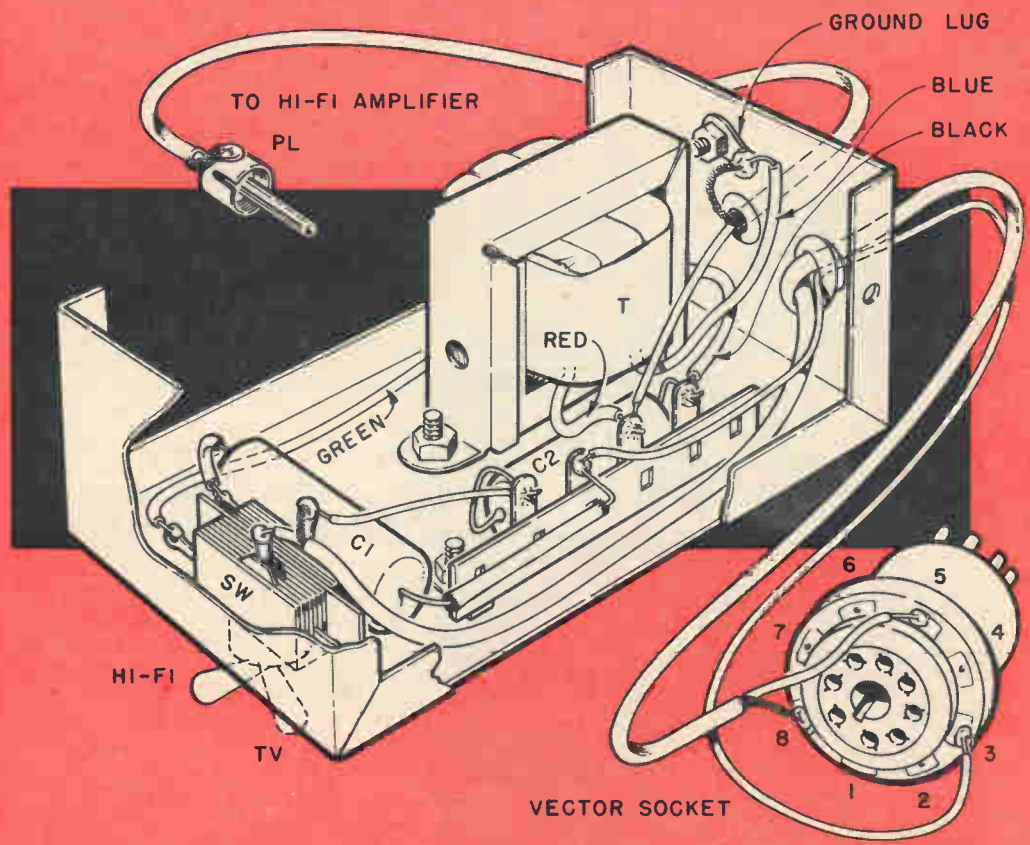
C1—.1 mfd 600 volt paper capacitor
C2—.25 mfd 400 volt paper capacitor
T—200 ohms to 80,000 ohms audio transformer (Stancor A-4705)
SW—Double-pole single-throw switch
Vector Socket—Octal T-8-O or miniature 7-pin T-7-M
P1—Phono plug, RCA type
Case—4"x2⅛"x1⅝" aluminum (Premier PMC-1002)
Misc.—4-lug terminal strip, shielded phono cable, two rubber grommets

View of TV chassis. Vector unit plugs into audio output socket. Audio tube then plugs into Vector.

In lower left of schematic, typical audio output tube is shown (6V6). Text gives several other examples.

Follow wiring guide below. Take care to ground wires to case only at the ground lug point shown.





Completed kit is above. It may be used at a point remote from the stereo equipment. All knobs are explained in text.

Layout of parts supplied. The assembly manual includes templates, useful if the unit is to be mounted behind a panel.

The balance control, far left, and function selector, right, are both dual controls, wired before being bolted to panel.

EI assembles

A Stereo Adapter

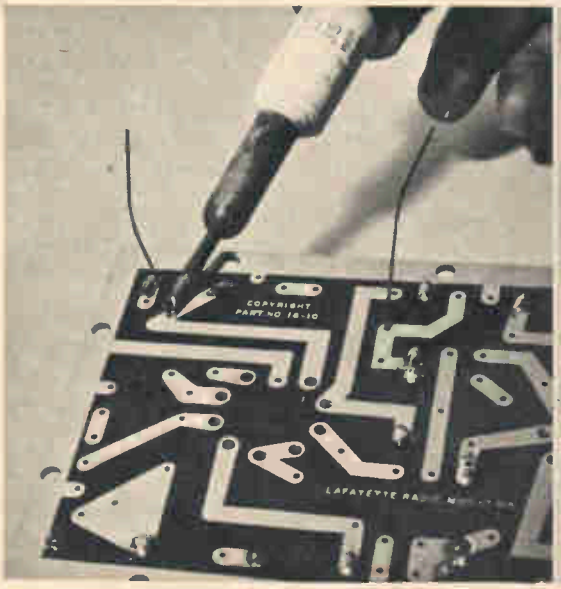
Remote control of two stereo amplifiers and third channel are features of Lafayette kit.

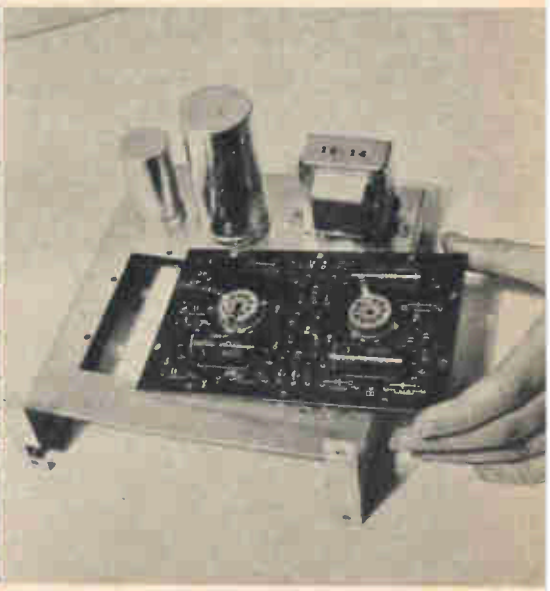
RECENT stereo amplifiers group their balance and speaker phasing controls conveniently on one panel. By use of ganged volume controls, the level of both channels is adjusted simultaneously. Such is not the case for the person who chooses to convert to stereo by adding another amplifier to his existing monophonic set-up. The Lafayette Stereo Remote Control, Model KT-315 should hold special appeal for him. Without a stereo adapter, he must jockey between separate units to make various adjustments.

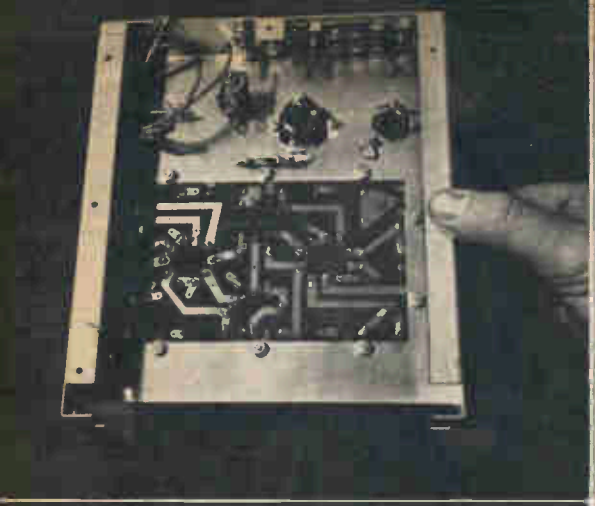
Essentially, this unit ties together both amplifiers and centralizes the controls. In addition, it provides extreme switching flexibility and a unique balancing system.

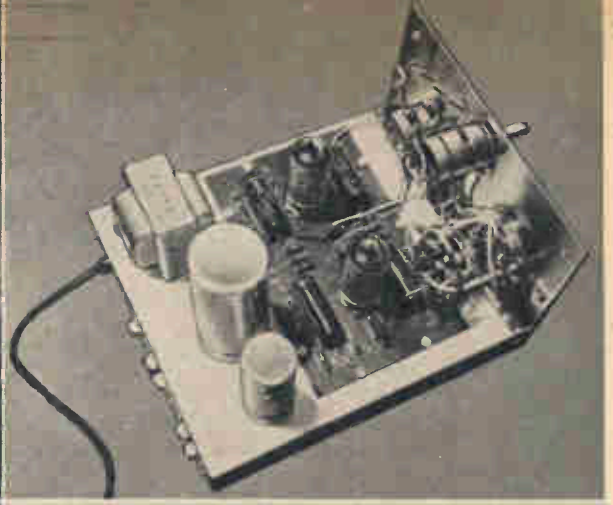
Here's what it does, in detail. Channels A and B (right and left amplifiers) appear on an outer and inner volume control knob. When the inner knob is clicked in, the two are ganged and work together. Selector switches permit instant reversal of the channels so they may be heard in opposite speakers. Phasing of each channel may also be inverted so the speaker cones will move in unison. If monophonic material is being reproduced, either channel can be selected.

At below left two leads of a capacitor have been pushed through holes in the printed board. A low wattage iron is touched briefly to the foil as solder is applied to joint. Leads are then clipped. At right, top of board is seen.









Top left shows underside of chassis, printed board in place. Parts just above board are in the power supply, to be wired to board.

Top right shows unit completed; controls on front panel have been wired to board, and two tubes (center) inserted in sockets.

Along rear of chassis, left, bridged output feeds third channel, AB output drives main amps, input gets signals from preamps.

Variable channel separation is another feature of this unit. If the program appears to have a "hole in the middle" effect, it is possible to crossfeed audio from one channel to the other.

For those who wish to use the more elaborate 3-channel stereo, with an additional amplifier and center speaker, a bridge output is supplied. A front panel control permits any mixture of the right and left channels to appear in this center amplifier and speaker.

The most singular feature about this unit is the balancing provision—for feeding equal level to both amplifiers. A selector is switched to a calibrate position and the volume control on one of the main amplifiers (or preamps) is set at a comfortable listening level. Then, the volume of the other amplifier is rotated until the sound in the speakers completely disappears! Switch back to normal position and the volume controls are electronically equal. This "nulling" system is possible since the adapter uses tubes, as opposed to the passive types.

Installation of the unit may be done in several ways, depending on your equipment. In any case, it must be between the preamps and main amplifiers. This is simple when the preamp is on a chassis separate from the main amplifier —several shielded cables with phono plugs will do it. However, if the preamp is on the same chassis, it must have Tape input and output jacks for signal takeoff points. If there are none, jacks can be wired.

Construction of the unit went smoothly, taking about six hours.

At $27.50 the KT-315 represents a Good Buy for those desiring flexibility in the use of their stereo equipment.

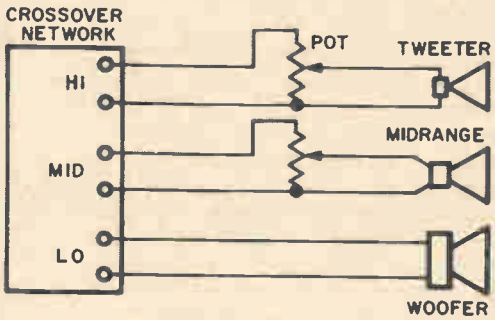
Hi-Fi Clinic

Do you have any questions on the adjustment, installation, or repair of hi-fi equipment? The clinic provides an answer to each query.

Speaker Balance Controls

I would like to install separate volume controls on my midrange speaker and tweeter. What is the recommended way of doing this?

Nat Berkowitz, San Diego, Calif.



Ordinary two watt wirewound potentiometers may be used according to the circuits shown above. The resistance values of the pots should be three to five times the impedance of the speakers. They are installed between the speaker and the crossover.

Although they are somewhat more expensive, L-pads of the *same* impedance as the speaker may also be used. They provide a better match between the speaker and amplifier, and thus a more efficient transfer of power takes place. Instructions for wiring in these pads are customarily enclosed in the box they are packed in. The procedure is simple except for the manufacturer's use of terminology. Instead of speaker and amplifier, the words "Source" and "Sink" are sometimes used on the wiring diagram. Just consider the amplifier (or crossover) as the Source and the speaker as the Sink.

A somewhat better system for matching with a volume control is through use of a T-pad. Since this type has an additional section as compared to the L-pad, the price is higher. For the simple setup that you require, the additional expense is not warranted since the difference is negligible.

Push-Pull Tubes

One of the push-pull output tubes in my amplifier seems to have an exceedingly short life in comparison to the other. Have you any idea of what might be causing this?

Claude Segall, Seattle, Wash.

The first thing to check is the grid voltage at the socket of the short-lived tube with a voltmeter. It is common that the coupling capacitor going to this pin has become partially shorted, causing a positive voltage to appear on the tube grid. The positively charged grid will cause the current to increase beyond a safe value in the tube and shorten its life.

Four Track Stereo Tape

I heard that four track stereo tape is shortly going to be available. Does this mean that it will be necessary to add two more speakers and amplifiers to my present stereo setup?

Robert Strom, Chapel Hill, N. C.

The new four track stereo was designed to increase playing time and not the number of sound channels. In order to play these tapes, the pickup head of the tape recorder must be changed to accommodate the new arrangement. The number of amplifiers and speakers remains the same as conventional stereo two channel sound.

The new tape permits you to run both sides of the tape through the transport, thereby doubling the playing time. Since stereo requires two channels in each direction, a total of four tracks is necessary to accomplish this. Conventional stereo tapes may only be run through the tape transport in one direction.

bowling with the

Electronic Pinspotter

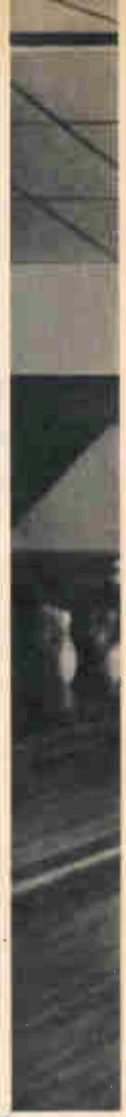
WHETHER you hook into the 1-3 pocket for a strike, or bounce the ball into the gutter, you can be sure the pinboy isn't making any nasty cracks under his breath—that is, providing you're bowling with one of those efficient automatic pinspotters.

With the AMF Automatic Pinspotter, a neat little electronic control box, affectionately called the "brain," sees to it that the pins are on spot when you want them on spot.

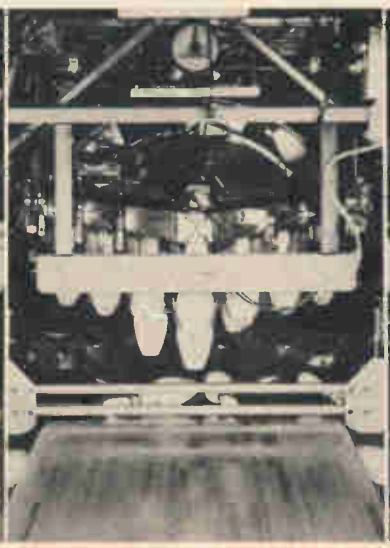
The whole unit, which stands 5′ 2″ tall, goes into action when the ball hits the cushion in the pit. Inside the cushion is a switch. Should the bowler be lucky enough, or skillful enough to roll a strike, a sweeper arm drops to the alley and waits while the respotting table descends. Finding no pins in the upright position, the table reascends to allow the sweeper arm to clear the deadwood into the pit. There the pins fall onto a conveyor belt which transports them to a wheel-like conveyor known as the "pinwheel." This unit lifts the wood to the top of the machine, and feeds them into the spotting table's cups as required.

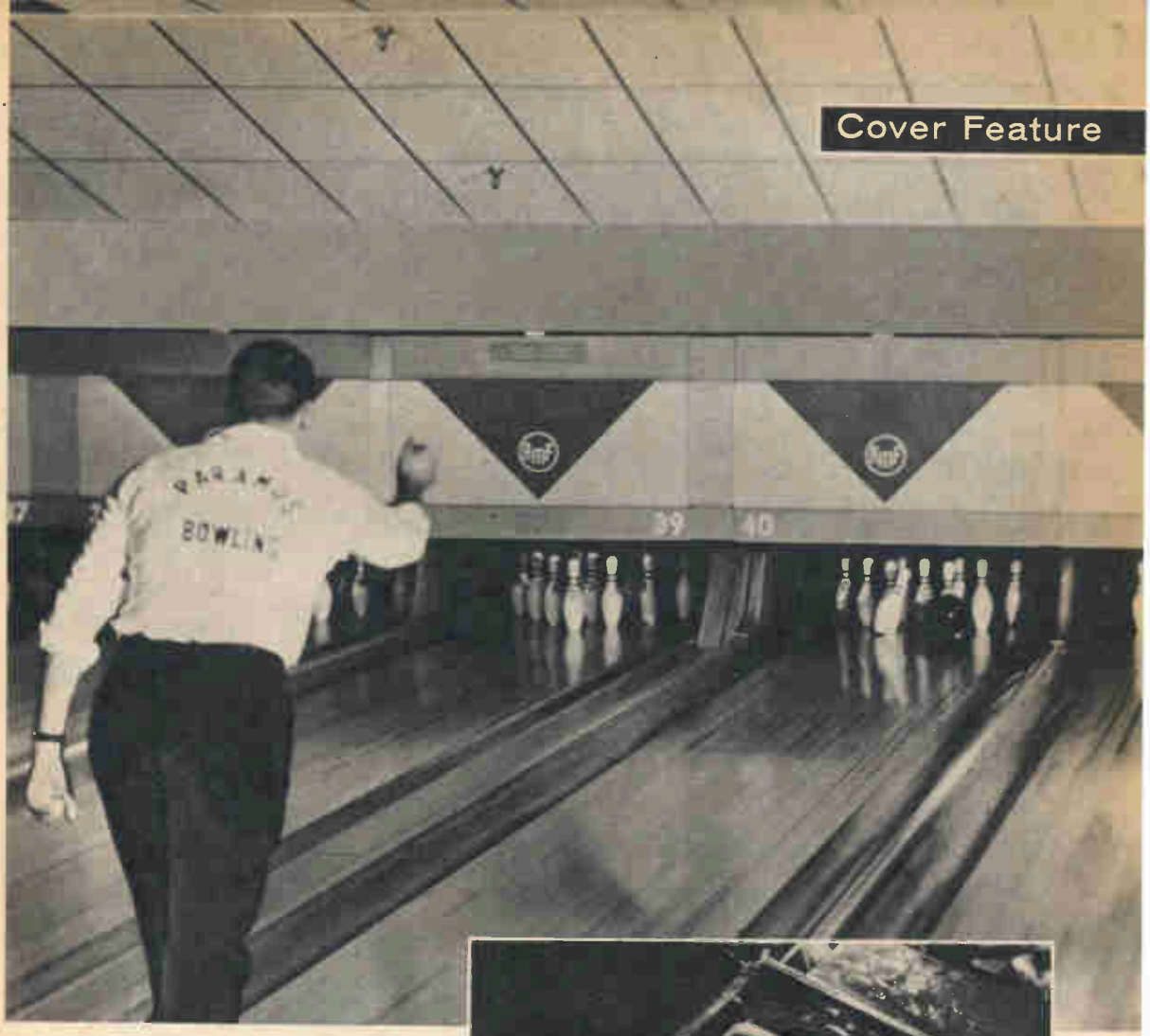
Meanwhile, the spotting table has already spotted a new set of pins. There is little delay because there are two complete sets assigned to each alley, and while one set is being cleared, the other is in ready position for spotting.

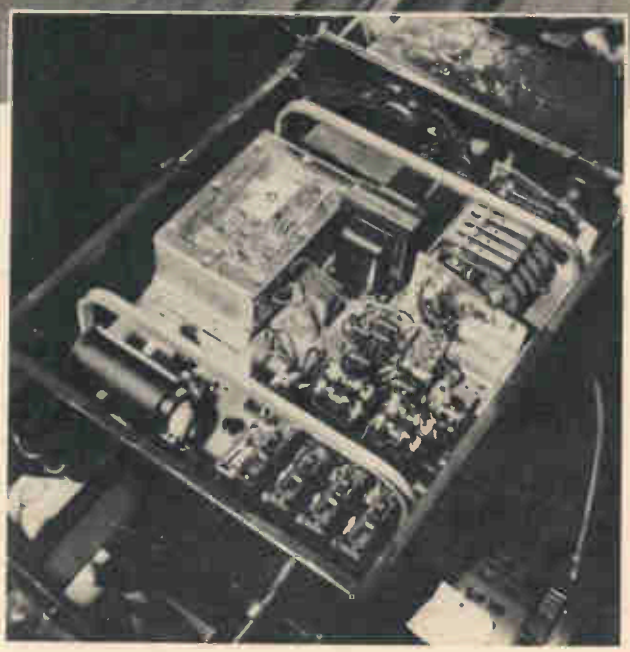
This automatic pinspotter really shows its versatility when the first ball fails to knock down all the pins. The sweeper arm drops and waits. Then the [*Continued on page* 113]



Left, ball leaves some pins erect. Upright pins (those extending well below respot table, center) are lifted as arm clears away deadwood, then set down again. Pinwheel, right, sends pins to top where they are reloaded.







The only time a bowler must push a button is when he gets a spare in the tenth frame. Automatic pin-spotter can handle nine games an hour, returns ball very quickly.

This is the "brain" which guides the electro-mechanical unit through each game. The electronic control center is located over automated alley out of sight.

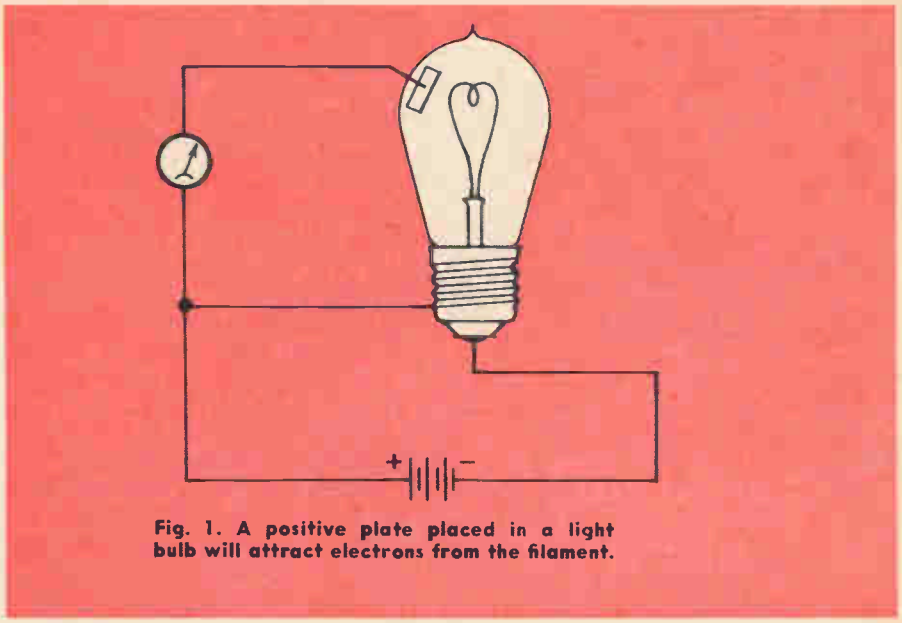


Fig. 1. A positive plate placed in a light bulb will attract electrons from the filament.

The ABC's of Electronics-10

By Donald Hoefler

How does an electron tube work? Part 10 explains the operation of the simplest type—the diode.

THOMAS A. EDISON made a most important contribution to the modern art of electronics in 1883, only he didn't know it. Twenty-two years passed before another man in another country suggested the possibility of applying Edison's discovery to the then infant art of radio communications.

Edison's momentous experiment is illustrated in Fig. 1. Using an ordinary carbon filament light bulb of the day, he added a metal plate inside the same bulb. When the plate was connected to the positive terminal of the filament battery as shown, the ammeter deflected. Apparently there was a flow of current right through the empty space, from the filament to the plate.

When the plate connection to the battery was removed, the current ceased. Also, when the plate circuit was connected to the negative battery terminal, there likewise was no current flow. Obviously, current could flow in one direction only in the bulb. From the heated filament to the positive plate, it was quite feasible, but from plate to filament it was impossible.

Edison duly recorded the phenomenon, but made no effort to explain or use it, nor did anyone else at the time. And there matters stood until 1905, when Prof. J. A. Fleming of London suggested a practical application. He proposed that a two-element

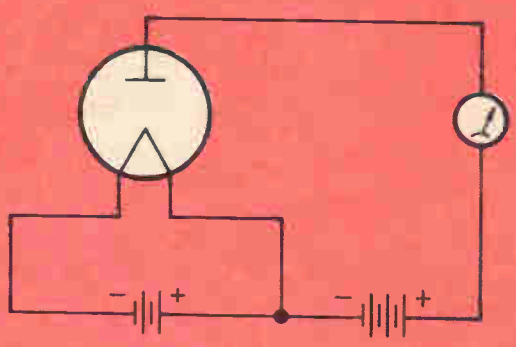


Fig. 2. Diode powered by 2 batteries; left one heats filament, right charges plate positively.

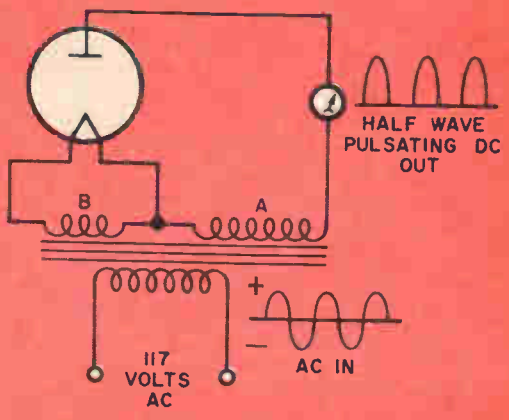


Fig. 3. When the batteries are replaced by a transformer, the 117 volt AC is rectified.

tube or valve, based on the "Edison Effect," might be better than the galena crystal then used for the detection of radio waves from spark transmitters.

Thus was born the "Fleming Valve," which is the basis of today's diode vacuum tube. Such a tube is shown schematically in Fig. 2, where we see it is very similar to the experimental Edison bulb in Fig. 1. The two elements are still commonly called the filament and plate, or more technically, the cathode and anode.

The filament may be simply a loop of tungsten wire within the evacuated tube. When a suitable voltage is impressed across the filament terminals, the wire heats up and begins to throw off electrons by a process known as *thermionic emission*. The usefulness of the vacuum tube depends upon the proper control of this electron cloud or *space charge*.

The emitted electrons are, as we know, elements of negative electricity. Consequently they will be attracted by a positive element, but repelled by a negative one. When the plate is made positive with respect to the filament, therefore, the free electrons will rush to the plate and ultimately return to the filament through the plate battery.

A very common application of the diode can be readily understood solely on the basis of principles just discussed. This is its use as a *rectifier* in power supplies, which permits the use of the AC house current for operating voltages in place of batteries. But in order to do this, the 117 volt AC must be converted to smooth DC.

If we removed the plate battery from the circuit of Fig. 2 and replaced it with an AC generator, current would flow only during the positive alternations of the AC cycle. And if we were to connect the plate line and the positive filament terminal into an AC outlet, this would in effect be connecting an AC generator across the plate circuit.

But the operating voltages required in electronic equipment often are greater than the 117 volts normally available from house circuits, so a transformer is usually used to step up the voltage. This results in the arrangement of Fig. 3. Notice that we are also using AC on the filament. This is perfectly all right, since the filament current is used solely for heat.

The voltage across plate winding A of the transformer, and hence the voltage on the plate, is several times the 117 volts impressed across the primary.

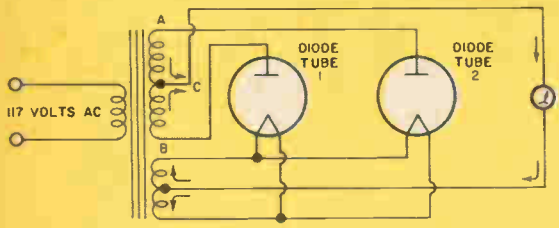


Fig. 4. Full wave rectifier uses 2 diodes; DC pulses are closer together than in Fig. 3.

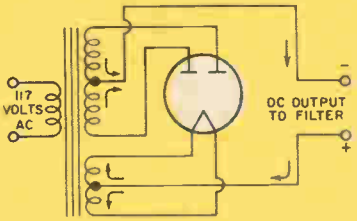


Fig. 5. Two diodes are commonly enclosed in a single tube. One filament serves both plates.

Whenever the plate end of winding A becomes positive, current will flow through the meter. But, when the pulse is negative there will be no current flow. The negative pulses are therefore effectively cut off, and the resulting output is pulsating DC as shown.

It would seem, however, that this scheme could be improved upon if we could somehow avoid wasting those negative halves of each cycle. And indeed we can, simply by using two tubes in the circuit shown in Fig. 4. This provides us with a *full wave* rectifier, as opposed to the half wave circuit in Fig. 3.

Let us begin by assuming a moment in time when the AC input tends to cause current flow from A to B in the transformer winding. This would mean that current would flow from the plate of tube 2 through the winding to the plate of tube 1. But this is impossible, for the electron flow would then have to continue across to the filament of tube 1.

There is another possible course for the current, however, from plate 2 to A to C. So far so good, but where does the current go from there? Continuing along, it can go through the meter and then into the center tap of the filament winding. From there it might go to the filament of tube 1, or of tube 2, or both. But the polarity of tube 1 is wrong at this time, tending to force current in just the opposite direction. And so all of the electrons go to filament 2, where they travel across to the plate and complete the circuit.

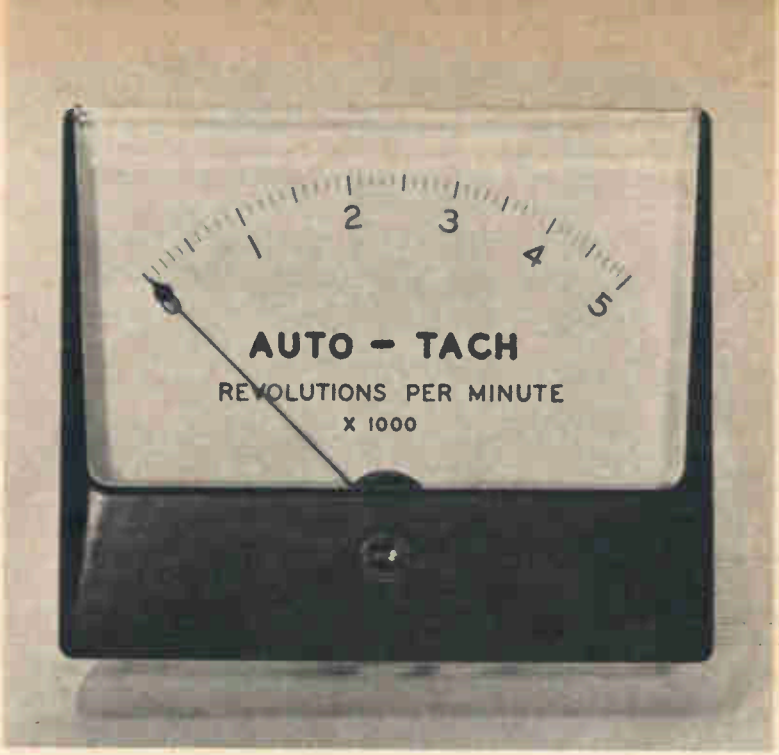
On the next alternation, all of the polarities will be reversed. Tube 2 will now be cut off, but tube 1 will begin to conduct. Then current will flow from plate 1 to B, to C, and through the plate meter return circuit and into the filament winding.

Note that although the current in the transformer windings reverses, the current through the output meter is *always in the same direction.* The negative alternations have been flopped over and become positive, to fill in the gaps of the output waveform of Fig. 3.

Even the full waveform is still far from smooth and must be evened out to pure DC before it is useful for operation of other electronic equipment. This is done by means of a *filter* comprising chokes and condensers, or resistors and condensers.

The circuit of Fig. 4 can be simplified and improved if we consider that the filaments are both connected to the same point, and could therefore perhaps be reduced to one, common to both plates. This is quite possible if both plates are in the same envelope, to make up a twin diode as shown in Fig. 5. The operating principles are just the same as for the two single diodes just discussed.

This completes our coverage of the two-element diode. Its ability to change its input from AC to DC finds wide usage in electronic equipment. Next month we shall add an element and describe the triode tube and how it is capable of amplifying minute voltages.



A half-circle of white paper was pasted on the face of a 0-1 milliammeter. Numbers 1 through 5 were positioned just below original meter graduations.

An Auto Tachometer

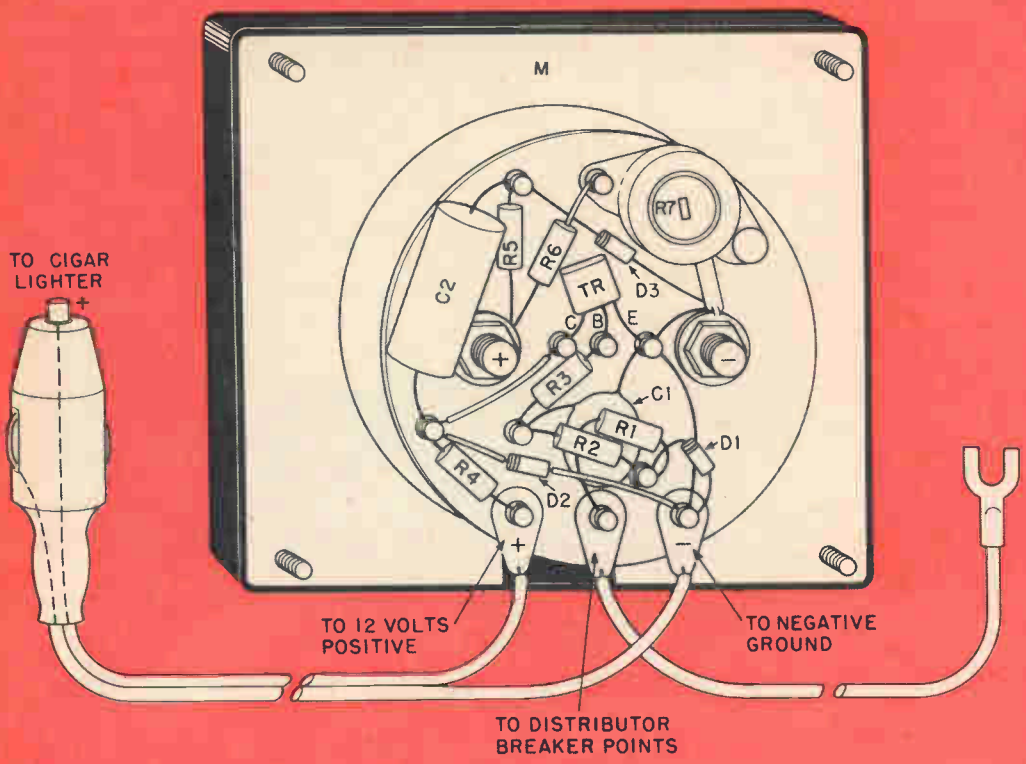
By R. L. Winklepleck

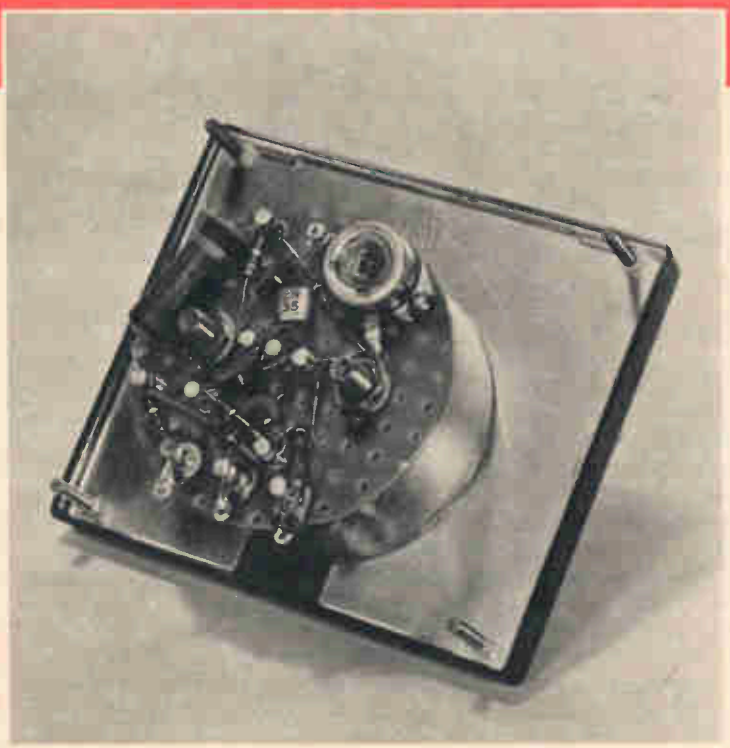
One key to your car or boat engine performance is rpm. Check it with this all-electronic tachometer.

IF YOU are interested in your car's engine speed as well as road speed, perhaps the only thing that has kept you from adding a tachometer is the high price of a commercially made instrument.

Many good tachometers require an internal battery for accuracy since the auto battery may vary over a range of several volts due to voltage-regulator adjustments and variation in engine speed. The extra battery in such tachs increases the size of the instrument and requires regular maintenance. This tach is designed to use the automobile battery; but the supply voltage is regulated to a constant value through the use of one of the relatively new Zener or voltage-reference diodes, D2 in this unit.

The physical layout can take any convenient form. There is only one important point that must be watched carefully. In so compact a layout the leads are quite short. There are three diodes and one transistor that can be easily damaged by excess heat. In some instances there may be two or three heat-sensitive leads going to one solder point. Be very careful to use the minimum heat which will assure good connections and use needle-





Wiring guide shows cigar lighter plug. However, if tach will be installed permanently, it is wired to ignition, as per text.

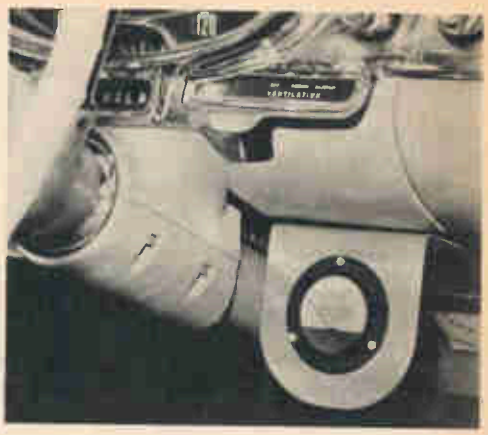
Circuit board with all the parts mounts directly onto the meter terminal posts. Calibrating pot R7 is at top of board.

nose pliers or some other type of heat sink on such lead, leaving it in place until the connection has cooled.

Small size and low value do not go hand in hand in potentiometers but this requirement is admirably met for R7 by one of the inexpensive hum reducing variable resistors used in the filament circuits of many amplifiers. The one in the illustration is called the Humdinger. The meter may be any size or shape. Any value under one milliampere may be used by reducing the value of R6 to shunt more of the current. The recommended meters are; 0-1 milliammeter for 12 volts and a 0-500 microammeter for 6-volt systems.

Installation consists of mounting the meter either through the instrument panel or in a small box which may be attached wherever convenient. The negative lead goes to any nearby ground point and the positive lead should be connected to the ignition switch terminal which is "hot" only when the ignition is on. The pulse terminal connects via a well insulated lead to the ungrounded side of the breaker points in the distributor. It is from this point that a lead goes to one of the low voltage

[*Continued on page* 113]

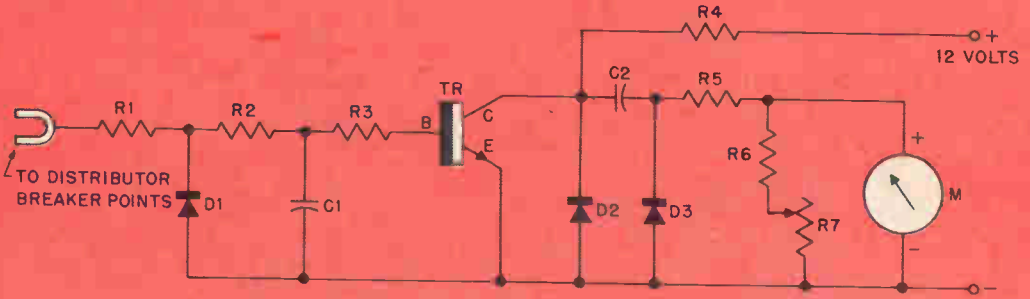


A smaller meter may more conveniently be mounted under dash. Circuit remains the same.

PARTS LIST

R1—3300 ohm ½ w resistor
R2, R3—2200 ohm ½ w
R4—680 ohm ½ w
R5—330 ohm ½ w
R6—68 ohm ½ w
R7—100 ohm potentiometer (see text)
C1—.1 mfd 15 volt capacitor
C2—.5 mfd 15 volt
D1, D3—Diode 1N90
D2—For 12 volts use Zener diode 9 volt (Texas Instruments 1N757 or Transitron SV11). For 6 volts, Zener diode, 5 volt (Texas Instruments 1N751)
TR—Transistor 2N35
M—For 12 volts use 0-1 DC milliammeter. For 6 volts use 0-500 DC microammeter

12 volt connection is shown here. For operation on 6 volts, see parts list.



How To Prepare A Chassis

By Len Buckwalter
Associate Editor

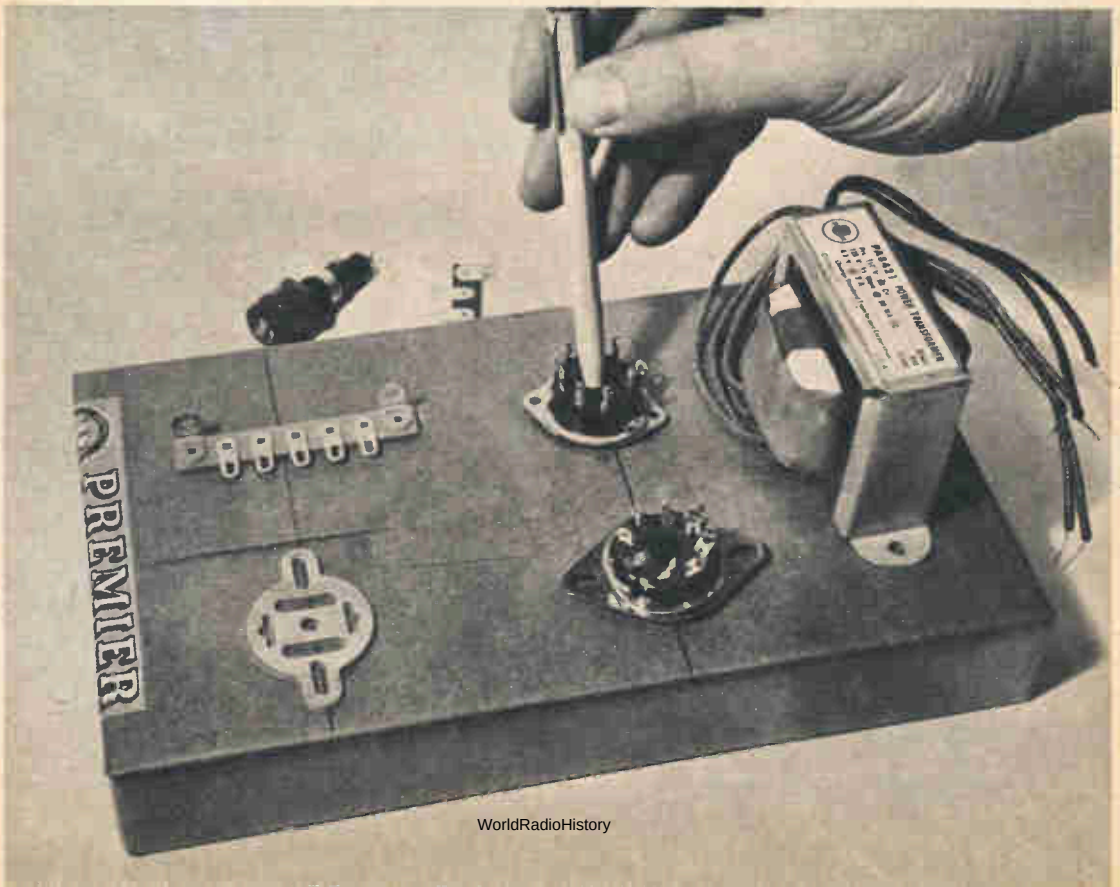
Follow these tips. They'll speed the job and give your electronic projects a professional appearance.

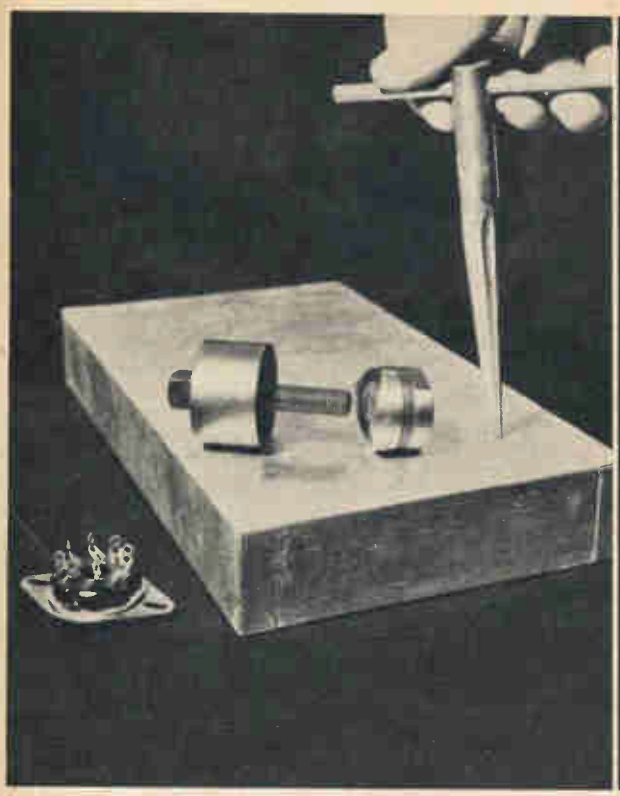
QUITE often, about half the time spent in building a piece of equipment is devoted to readying the chassis for wiring. Several tools and techniques, available to the hobbyist, can go a long way toward reducing this period of time and give the device the appearance of a commercially manufactured unit.

Relatively inexpensive punches, as illustrated, should practically do away with the old method of making holes—drawing a circle, drilling a series of holes on it, then sawing them through. Certain odd shapes, of course, must be done this way, but count on the round or square punch for most of the cutting. If you require a somewhat larger hole than the punch will provide, a

[*Continued on page* 104]

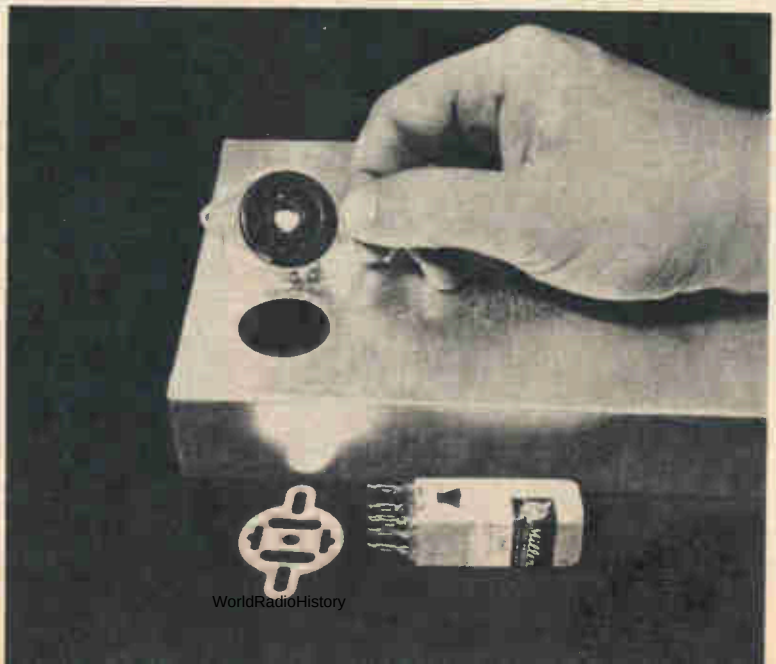
If you don't want to mar the surface of the chassis, leave its wrapping on while working on it. Use the components themselves as marking templates.



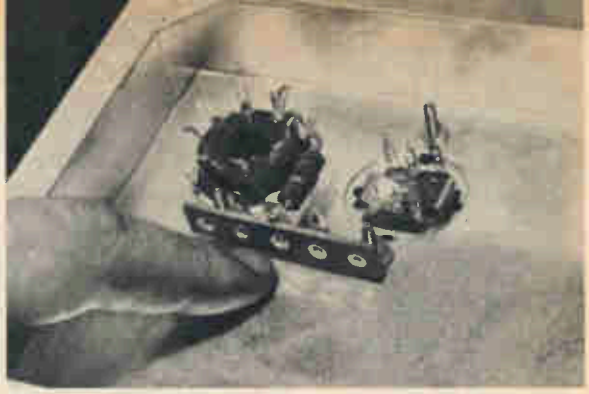


Perfect holes can be made with a variety of round or square punches. The Greenlee punch shown here is for the octal socket at left. First a hole is drilled, then widened with a hand reamer. The long bolt is inserted into the hole and the two halves of the punch are drawn together with a wrench.

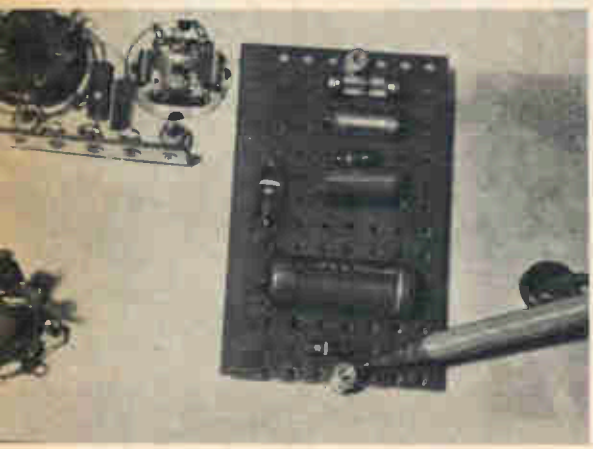
Hole is ready to receive the octal socket. Note miniature transformer can and its adapter plate. This plate may also be used with the octal hole.



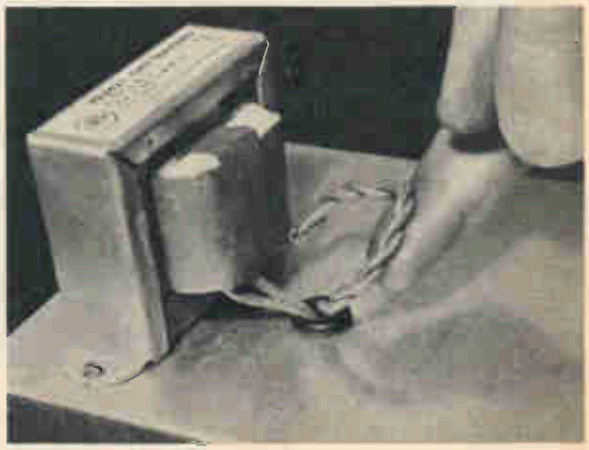
Parts can mount directly on this turret type socket (tube plugs in above chassis). It is useful where leads must be kept short.



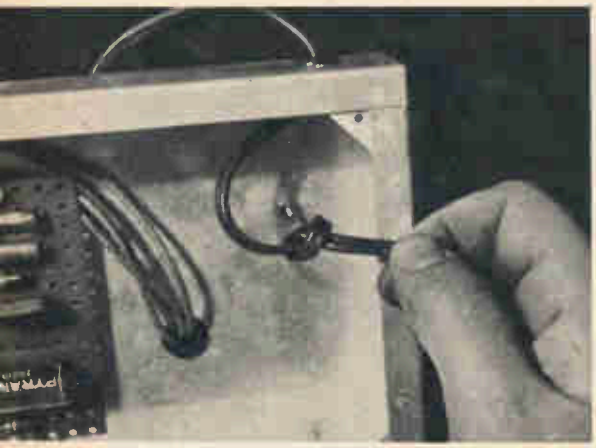
Terminal lug strips are often a necessity near sockets. They provide insulated anchor points for parts going to tube socket lugs.



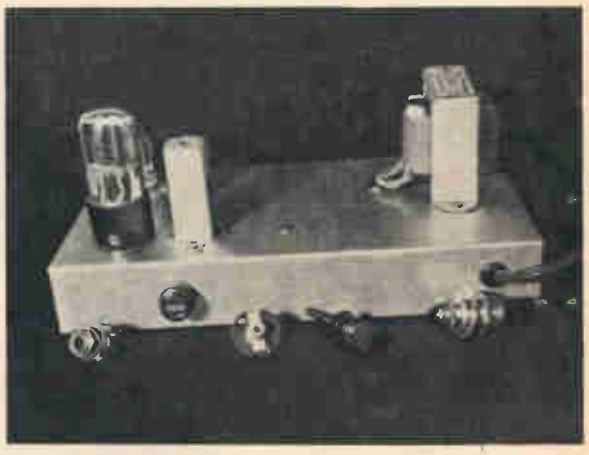
A perforated phenolic board makes a good subchassis. It is mounted with long screws. Space board from chassis by nuts or washers.



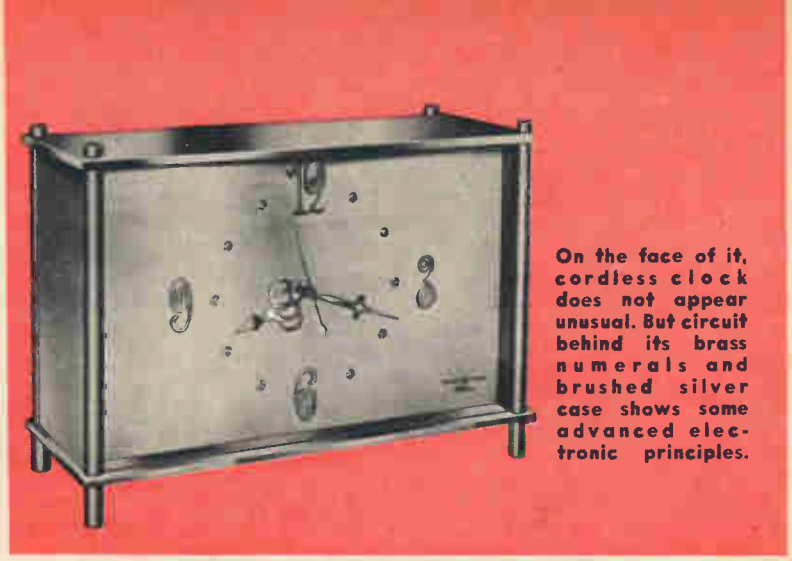
Always twist filament leads to reduce hum radiation. Use a rubber grommet for cables entering chassis to prevent chafing wire.



A knot in the AC line cord will provide strain relief in case the cord outside the chassis is pulled. Note the grommet at top.



Some parts you may mount on the apron of the chassis are, left to right; phone jack, fuse, phono jack, binding post, pilot lamp.



On the face of it, cordless clock does not appear unusual. But circuit behind its brass numerals and brushed silver case shows some advanced electronic principles.

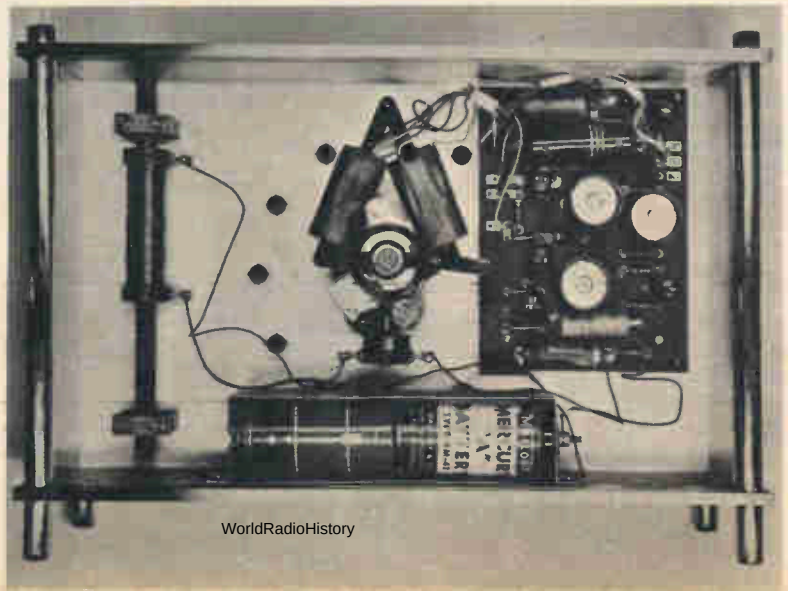
Unique Electronic Clock

HERE'S an electronic clock that keeps accurate time without a cord or direct electrical attachment. It is synchronized through a circuit which takes advantage of the 60-cycle magnetic field radiating from power wiring in the home.

Alternating current in power lines throughout most buildings radiates a weak magnetic field at 60-cycles-per-second. This radiation is picked up by an inductive coil in the clock and fed through three stages of transistorized amplification to the motor. The motor's armature, geared to the clock's hands, synchronizes with the 60-cycle alternations of the field picked out of the air. Mercury batteries provide an extremely long-lived power supply for the transistors.

Designed to retail at $195, this General Electric-Telechron appliance is said to be the first to operate on this principle.

Compact inner workings reveal an inductive coil, left, which picks 60-cycle magnetic field out of the air, feeds it to a transistorized amplifier, right.



E I Picturescope

Nerve cells in the human eye and ear have been simulated at Bell Labs on an inexpensive printed circuit. These electronic "cells" can deliver a series of pulses when stimulated, and even show fatigue like a living cell by slowing down under prolonged stimulation. When combined with other "cells," systems which imitate some workings of human nerve networks are created, thus providing a new approach to medical study.

Here is a new triple-threat ultraviolet sensitive alarm that can detect and warn of smoke, fire and dangerous vapors separately, or all three at once. As the Minneapolis-Honeywell engineer lights his pipe, a four-inch tube detects the ultraviolet rays in the room and makes appropriate contacts which illuminate both fire and smoke indicators. Combustible gases in beaker also are detected, lighting the vapor warning slot in portable unit.

Above, secret documents of government contractor are guarded by ceiling-mounted ultrasonic transmitter which floods room with sound at 19,200 cps. Any movement in room disturbs sound waves, and the disturbance is picked up by monitor (right) which sounds audible alarm. Below, new color television projector called Eidophor, developed for Ciba Pharmaceuticals, projects sharp color picture onto theater screen. It is now being used in medical conventions.

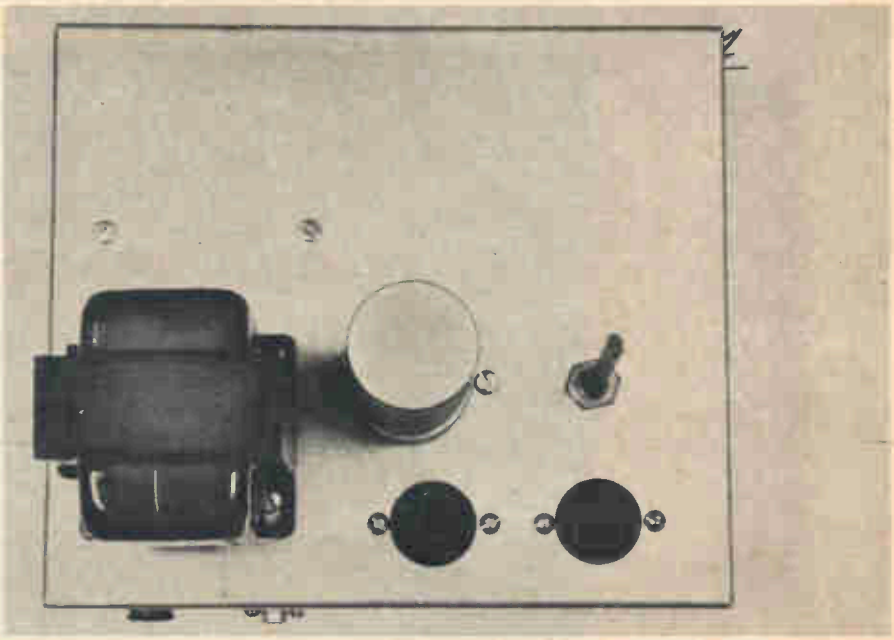
On the front panel upper left to right, frequency selector, VU meter, output switch, jacks.

Hi-Fi Tester

By Harvey Pollack

This unit enables you to check amplifier frequency response and resonance of speaker and enclosure.

Top view of chassis shows power transformer, filter can C5 with tube sockets below—V2 (left) and V1. Shaft above V1 is R13, for waveform.



HERE'S a compact package with which you can check the frequency response and resonance characteristics of your hi-fi system.

The basic section of the tester is a stable Wien bridge oscillator that provides instantaneous selection of 10 different spot frequencies from 20 to 20,000 cycles per second. An additional control is provided to make available a continuously variable output signal from about 300 cycles per second down to 15 cycles per second for locating points at which the speaker system or the speaker enclosure resonates.

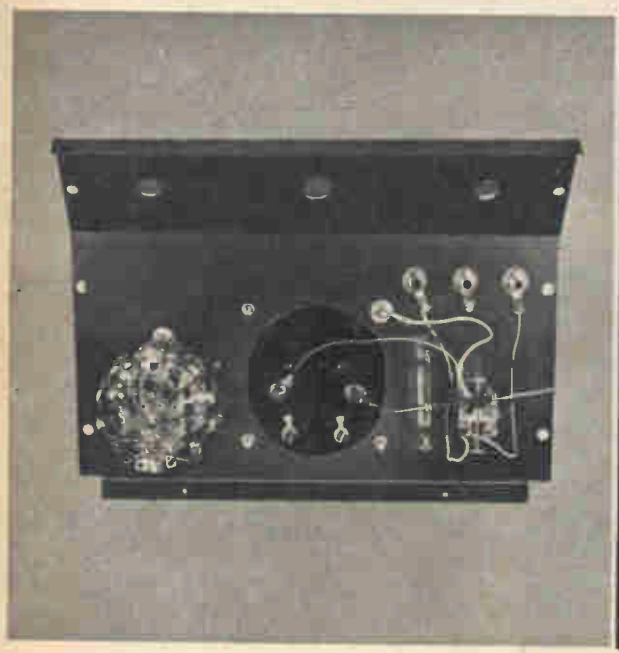
A great deal of effort is expended in modern hi-fi equipment to insure that the speaker and its enclosure resonate at different frequencies to avoid disastrous vibration. This tester, locates the resonant frequencies and provides the information required with regard to padding material, volume, or wood stiffening members.

The second principal section of the tester includes a Volume Unit (VU) meter, a dummy load, and a three position switch. By means of the latter, it is possible to measure and maintain a constant input signal to the amplifier under test, measure the voltage drop across a dummy load, and measure the voltage applied to the speakers—all independently of one another.

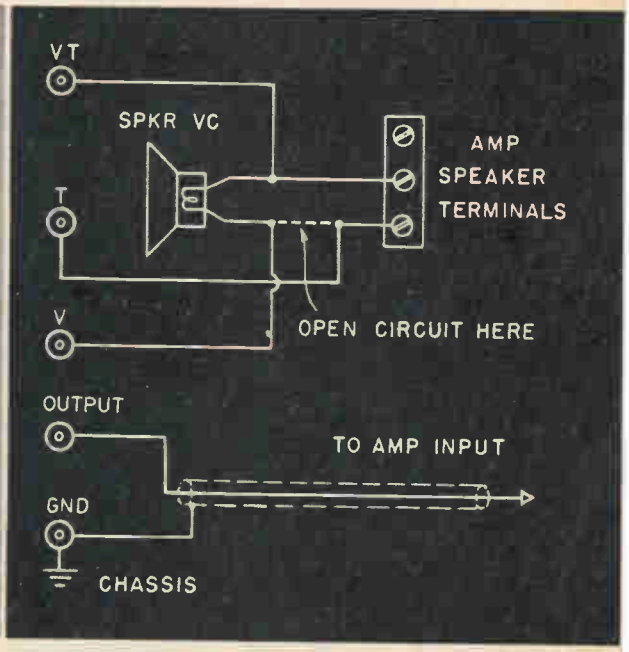
Prepare the frequency selector switch in advance. A small piece of perforated bakelite or stiff fiber is mounted on the free end of the switch and a large solder lug secured to its center. Resistors R3A through R12A are then soldered to this lug, their opposite ends being joined to the appropriate switch terminals on the rear wafer. Two large hole solder lugs—the kind that are used around the bushing on standard volume controls—are then placed on the shaft of the rotary switch. These serve as the ground tie points for all the resistors from R3B through R12B. The remaining lead on each of these resistors is, of course, connected to the matching terminals on the front wafer. Prepare the output switch SW3 in advance, too. This is a 4-circuit, three-position key switch that is quite easy to wire and use.

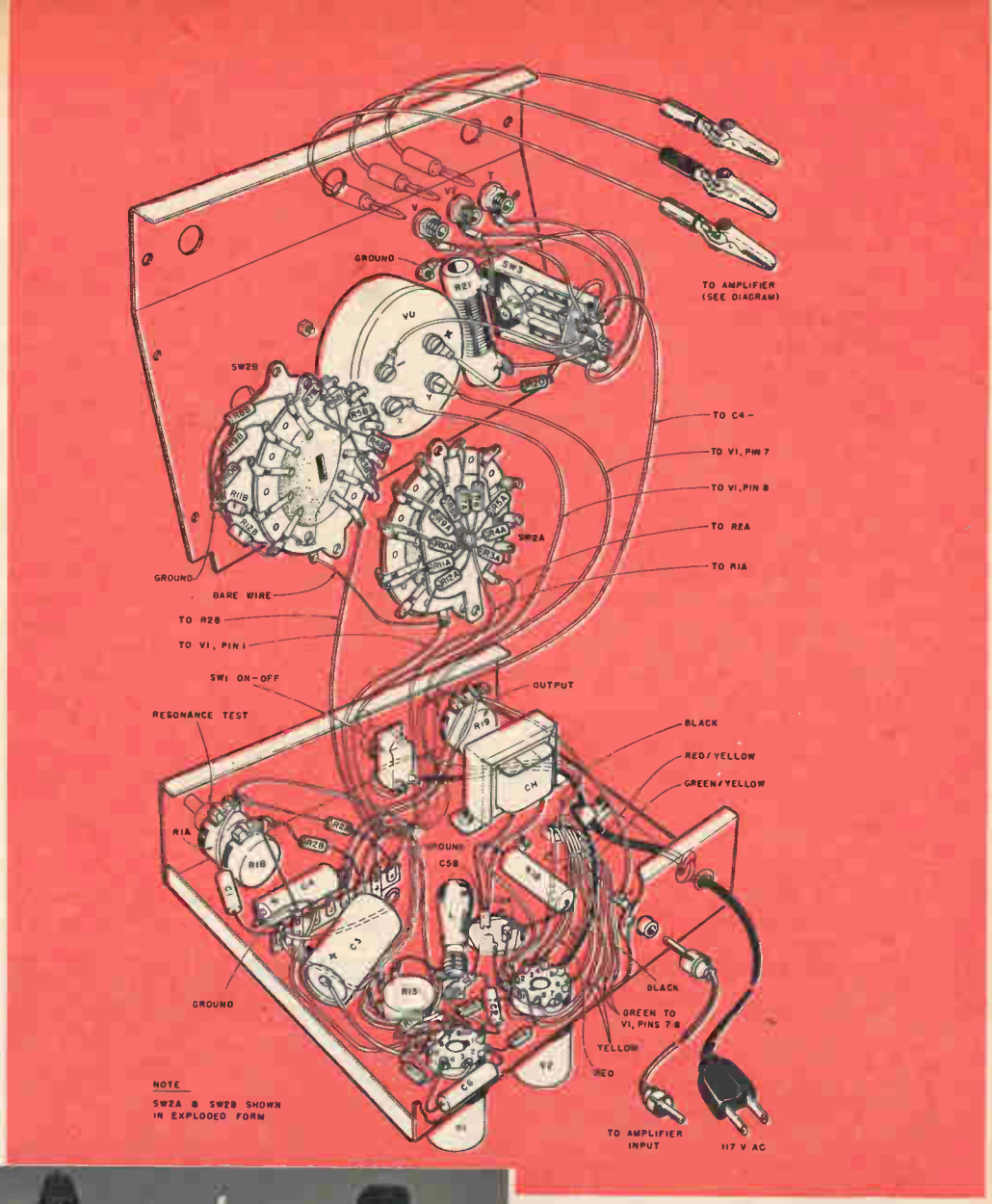
Secure the panel to the chassis using the bushings of the on-off switch (SW1), the resonance dual potentio-

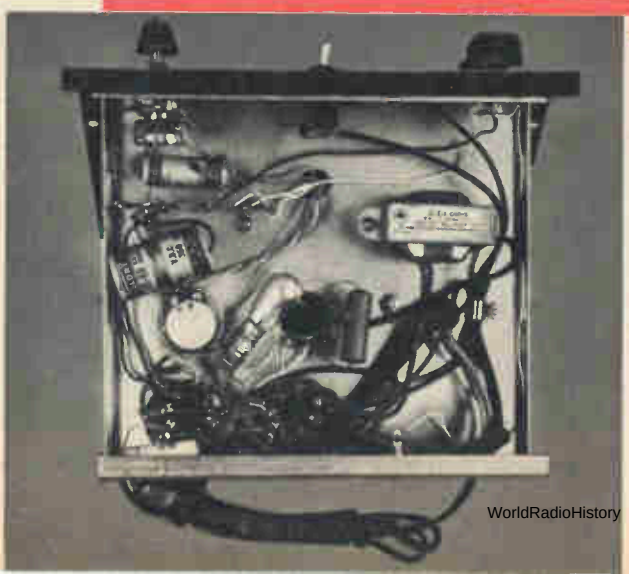
Rear of front panel. Visible, left to right, are SW2, VU, R21, SW3 with jacks above.



Follow this diagram for connecting tester to amplifier. Jacks at left are on the tester.







In wiring guide above, front panel has been raised and switch SW2 separated for reasons of clarity.

Underside view of chassis, front panel bolted on. Follow this recommended layout of components.

meter (R1A and R1B), and the output potentiometer (R19) as supporting elements. Use of sheet metal screws to hold panel to chassis is unnecessary.

Wire the 5 volt and 6.3 volt heaters, including the panel lamps of the VU meter first. Keeping the other transformer leads apart, test this wiring by plugging in the unit and turning it on. The heaters of the 6SN7GT and 5Y3GT, plus the panel lamps, should all come on.

Wire the power supply next. When fully wired—right through R18 of the filter network—test the DC output voltage without a load. This should be about 350 volts. *Discharge the capacitors by shorting the B+ to the chassis before continuing with the wiring.*

Mount and wire all other components, including both switches (SW2 and SW3). Before applying power, test for B+ to B— shorts with an ohmmeter.

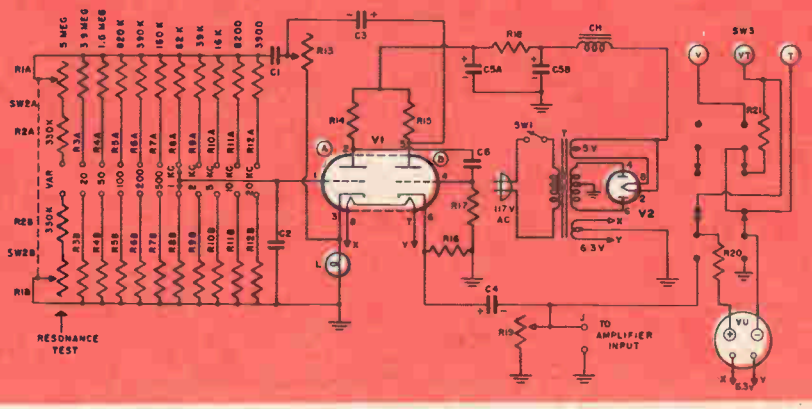
R13, a 5K potentiometer, is mounted on the chassis rather than on the panel because this control is generally not touched after the initial adjustment is made.

The testing procedure is quite simple. Connect a pair of ordinary magnetic or dynamic headphones (or even a small speaker) to the output terminal. This is a phono jack of the standard variety on the rear apron of the chassis. Set R13 on about midscale and the wiper of R19 all the way to the ground end of the potentiometer. Position the rotary se-

[*Continued on page 93*]

PARTS LIST

All resistors ½ watt, 5% unless otherwise stated
R1A,R1B—Dual potentiometer 5 megohms each section (IRC PQ 11-141 plus rear section M11-141)
R2A,R2B—330,000 ohm
R3A,R3B—3.9 megohm
R4A,R4B—1.6 megohm
R5A,R5B—820,000 ohm
R6A,R6B—390,000 ohm
R7A,R7B—160,000 ohm
R8A,R8B—82,000 ohm
R9A,R9B—39,000 ohm
R10A,R10B—16,000 ohm
R11A,R11B—8,200 ohm
R12A,R12B—3,900 ohm
R13—5,000 ohm potentiometer (IRC Q 11-114)
R14—47,000 ohm
R15—22,000 ohm
R16—1,500 ohm
R17—1 megohm
R18—500 ohm 5 watt
R19—1,000 ohm potentiometer (IRC Q 11-108)
R20—3,900 ohm
R21—7.5 ohm 10 watt (dummy load)
C1,C2—.002 mfd 500 volt capacitor
C3—20 mfd 350 volt electrolytic
C4—50 mfd 25 volt electrolytic
C5A,C5B—30-60 mfd dual electrolytic, 350 volts each section
C6—.02 mfd 600 volt
V1—6SN7GT
V2—5Y3GT
SW1—Single-pole single-throw toggle switch
SW2—11-position 2 deck rotary switch (Mallory 1321L)
SW3—4-circuit 3-position lever switch (Lafayette type SW-20)
T—Power transformer 240-0-240 volts @ 55 ma, 5 volts @ 2 amps, 6.3 volts @ 2 amps. (Stancor PC-8402)
CH—Choke 9 henry @ 50 ma (Stancor C-1215)
VU—Volume unit meter (Lafayette TM-80, —20 to +3 db, 0-100% @ 600 ohms)
L—Lamp 117 volt 6 watt candelabra base
Sockets—2 octal, 1 candelabra
Chassis—7"x8"x2" open end (Bud CB-39)
Cabinet—6½"x9 1/16"x7 5/16" (Bud C-1585B)
Terminals—3 insulated banana jacks with shoulder washers for panel mounting, 3 banana plugs, 1 phono jack, 1 phono plug
Misc.—Line cord, decals, hardware, wire, alligator clips



The large group of resistors on left side of schematic (right), R3A through R12B, are mounted on the rotary switch.

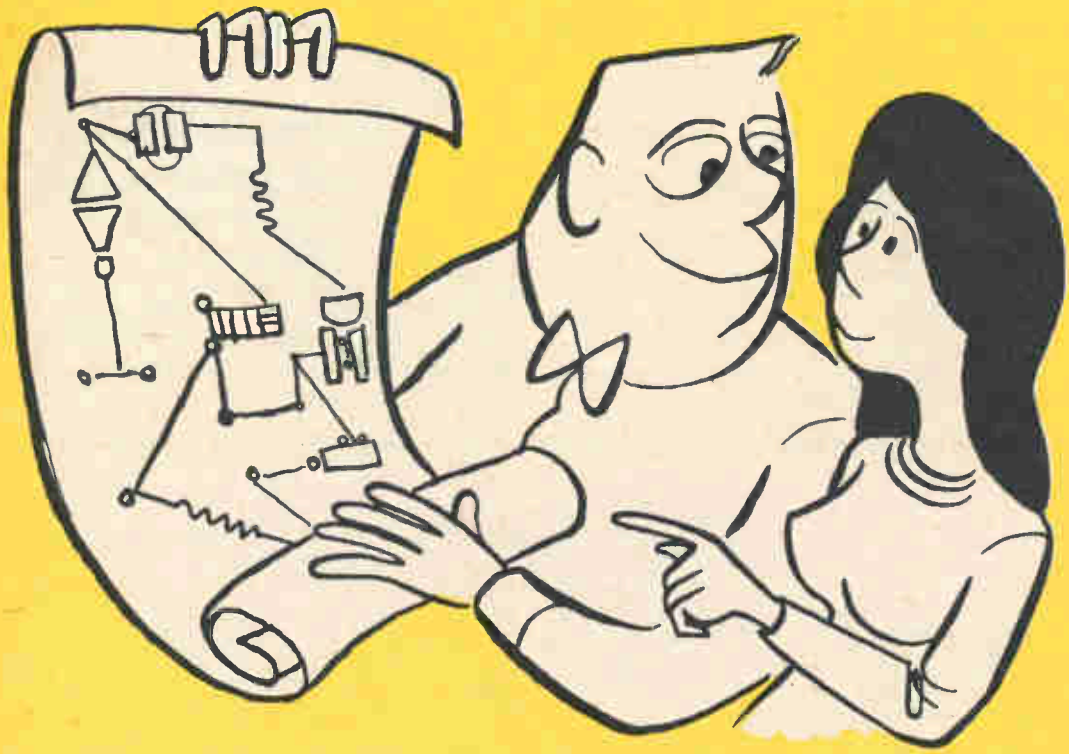
She may not know a sun battery from a superhet, but by following this *schemeatic* you may be able to . . .

Sell Her On Your Electronic Projects

By Carl Kohler

HERE is a practical home project which, if successfully completed, will insure many, many happy hours of electronic enjoyment without feminine static rankling your nerves. Although primarily of interest to married men, it behooves the bachelor to pay attention. A sudden change in marital status might otherwise catch him with his current turned off.

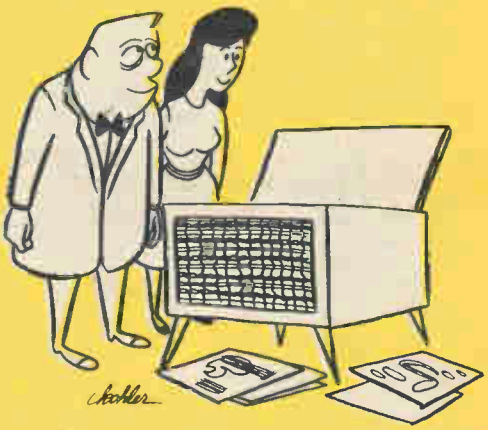
Most wives (and girl friends) are chronically incapable of



Drawings by the author

She must be made to believe that *her* interest is basically responsible for at leost 60 percent (if not 90 percent) of your electronic achievements.

Arouse her "curiosity". Cunningly replace her women's magazines with ones on electronics.



Lead her to appreciate the marvels of electronics with a "rigged" hi-fi demonstration.

ever becoming interested in electronic achievement beyond that of owning a television set or an automatic washing machine. Assuming that you are an electronics buff and that you would like the woman in your life (we'll call her "Wife") to develop a tolerant interest in your various electronic activities, we shall proceed with the campaign elements.

Advance Propaganda

Keeping in mind the fact that Wife is something of an outsider, electronically speaking, you should lead her gently to the threshold of this fascinating world. Remember, at this point she doesn't know an electron from an electric eel, so go slowly, man, slowly! Don't even try to expose her tender mind to the richness of *Booberlinck's Theories of Boolean Algebra*. If you do, you risk imparting a negative polarity to her personality that will never be reoriented.

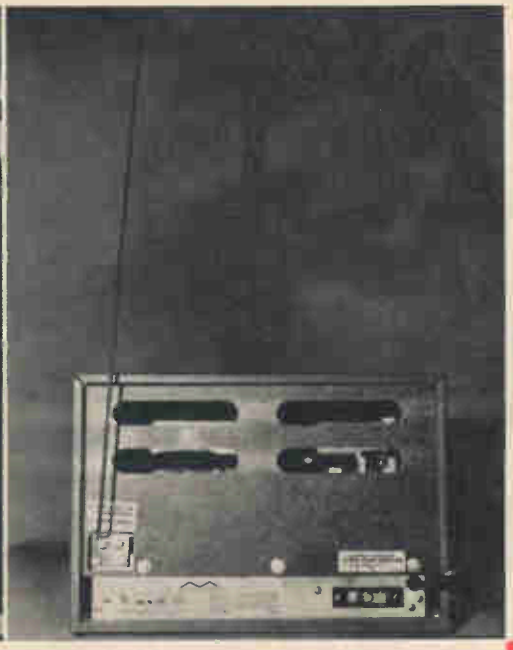
Something lighter, but tinged with mystery and drama, both dear to the womanly heart, would be advisable. Cunningly and casually leave a copy of *Practical Magic in Electronics* in plain view on the coffee table. Women like to think they are practical, but nevertheless are fascinated by mysticism. You might see to it that a matched set of *The Romance of R/C Models* appears about the house. It's rather regrettable that no one has yet written a tome entitled *Woman's Role in Modern Electronics*. Such a book would insure almost immediate interest. Until someone *does* write it, round up all the women's magazines in the house and replace them with bright, crisp copies of the magazine you now hold in your hands. This is to focus Wife's attention on the word "electronics." How you account for the missing women's magazines is a problem best handled by innocent silence. In short order Wife should be sufficiently curious to ask: "What's with this electronics jazz, anyhow?" This is your cue to launch Phase Two of the campaign.

Elementary Orientation (use restraint, man)

You must have something tangible to point to—or you will find yourself muddling around in an abstract lecture which, so far as Wife is concerned, makes less sense than last week's headlines. Avoid this at all costs. Arm yourself with some kind of electronic instrument, device or related components with which to illustrate your delightful explanation of electronics.

If you happen to be an introvert, you need more than one tangible instrument

[*Continued on page* 96]



Fire trucks often are equipped with VHF. All you need to listen in is compact receiver, such as Monitoradio MR-10 (152-174 mc), 18" of wire as antenna.

In your home, car and boat, you can keep abreast of emergencies and disasters as they happen on . . .

VHF-Your Hometown Shortwave Radio

By Lee Craig

IN my New Jersey home on the morning of September 15, 1958, I tuned my FM communications receiver across the 152-174 megacycle band. In a few moments I learned that tragedy had struck very close to home: A commuter train bound for New York City had crashed through an open draw bridge and plunged into Newark Bay.

The news came over the VHF band long before it broke over the commercial and television stations and hours before it appeared in the newspapers. Dispatchers could be heard directing rescue squads to the disaster scene and for hours afterwards news bureau dispatchers and mobile units were heard relaying new information.

There are more than a million mobile and fixed radio stations authorized to operate at frequencies above 25 megacycles. About 243,600 police, fire and other public safety vehicles are equipped with two-way radio, and they report to [*Continued on page* 100]

Model railroad fans can learn a great deal about actual railroad procedure by eavesdropping on VHF transmissions from trains and operators at wayside signal towers.

If you live near a harbor or a major inland waterway, you will find that the airwaves offer many interesting conversations between men who live and work on the water.

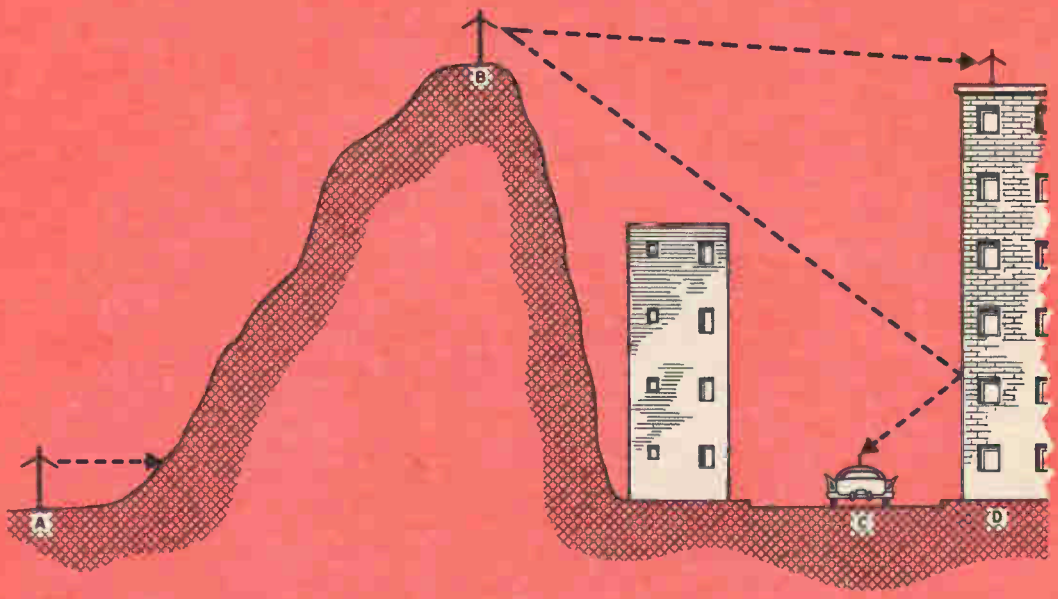
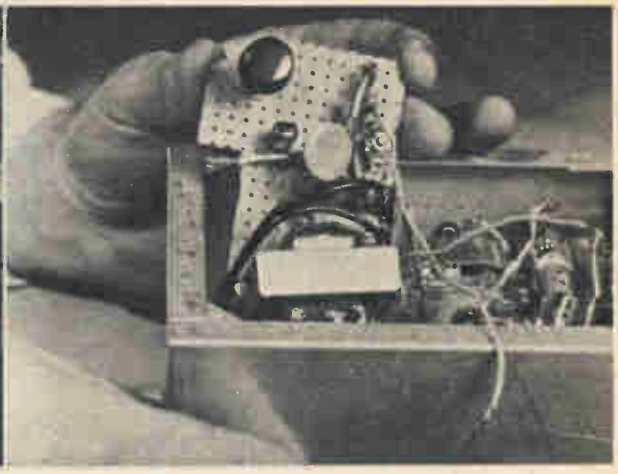


Diagram shows line-of-sight transmission characteristics of VHF. Station sending signal from point A cannot hope to reach mobile station C directly because hill is in the way. Station atop hill at point B can contact car even though smaller building is blocking direct path. VHF waves tend to be reflected by buildings. Height of transmitting antenna affects range of station.

With a meter added, the unit is able to check the operation of its own or other transistors.



Oscillator section is on its own subchassis. The knob seen at upper left controls the tone.

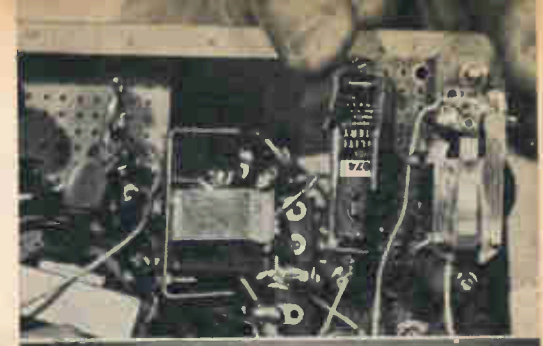
An Experimenter's Control Center

By Ronald Benrey

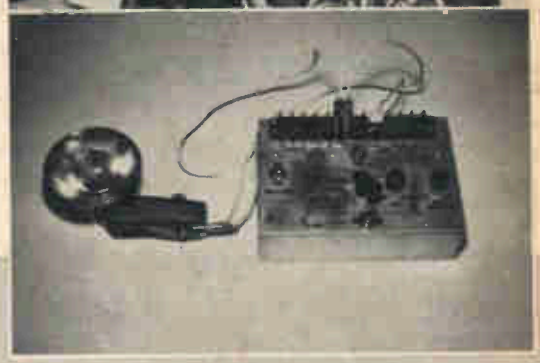
This amplifier-oscillator will act as the heart of countless alarm, control, or measuring systems.

HERE is a transistorized relay control system that's as versatile as it is easy to construct. Coupled with a few simple accessories, it can be quickly transformed into any of a multitude of useful devices covering controls, indicators, and alarms. These include photocell relays, fire and burglar alarms, and sound relays, just to mention a few. What's more, this unit has a bonus value. It can easily be converted into many different meter indicating devices such as electronic thermometers, field strength meters. and light meters. It will even test its own transistors! All operational controls and switches are mounted externally and connections to the unit are made via a 12-terminal barrier strip. All other components, with the exception of B1, are mounted on two perforated Bakelite subchassis: the internal oscillator on one, and the amplifier-relay subassembly consisting of TR1, the relay, and B2, on the other.

Begin construction by cutting both subchassis. Using the accompanying photographs as a location guide, and the major components themselves as templates, locate and drill all necessary mounting holes. Before mounting any components on the oscillator subchassis however, be sure to cut a small notch along the right hand 3¼" dimension. The correct location with respect to the major components of this notch, which provides clearance for panel mounted switch 4, can be ascertained from the photo-

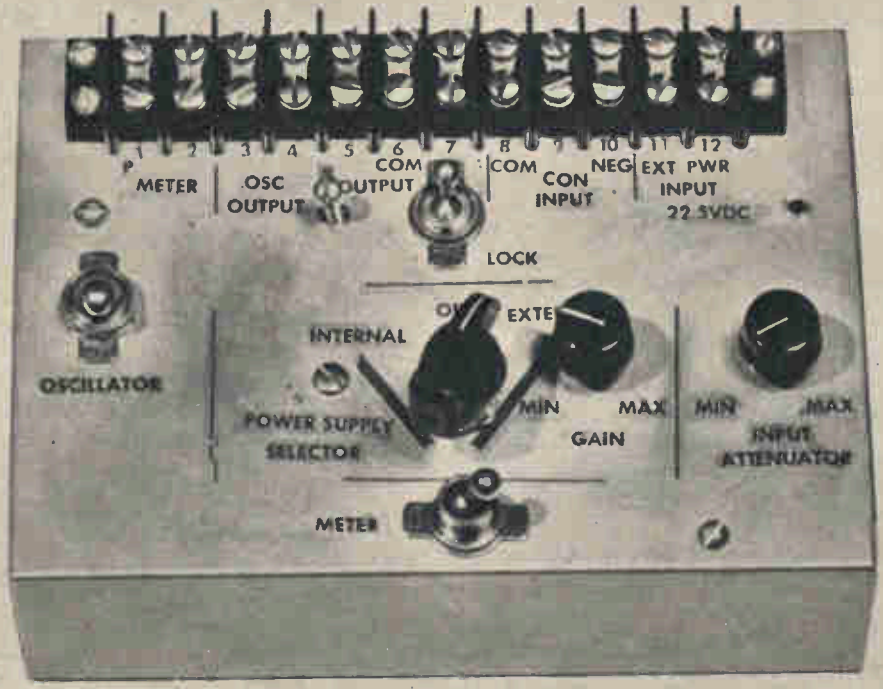


The amplifier-relay section is also on its own Bakelite subchassis. The relay is to the right, with B2 in the battery holder.

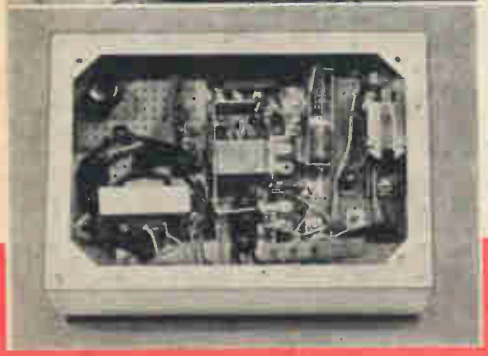


Slave photoflash. A photocell is wired to terminals 8 and 10 and picks up light from main flashgun. Slave gun goes to 5 and 6.

Front panel of the complete control unit. Various inputs and outputs are connected to 12-terminal barrier strip along top edge.

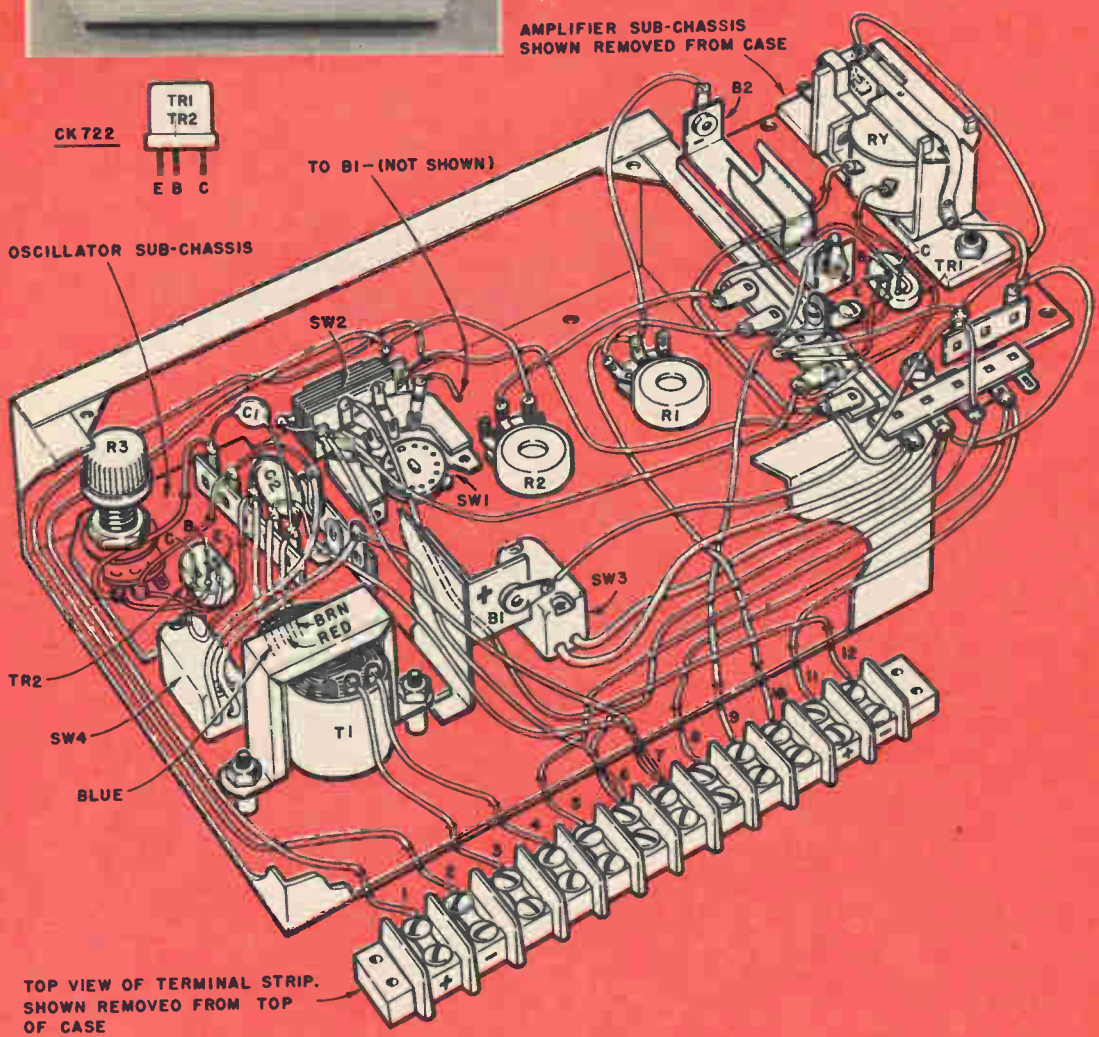


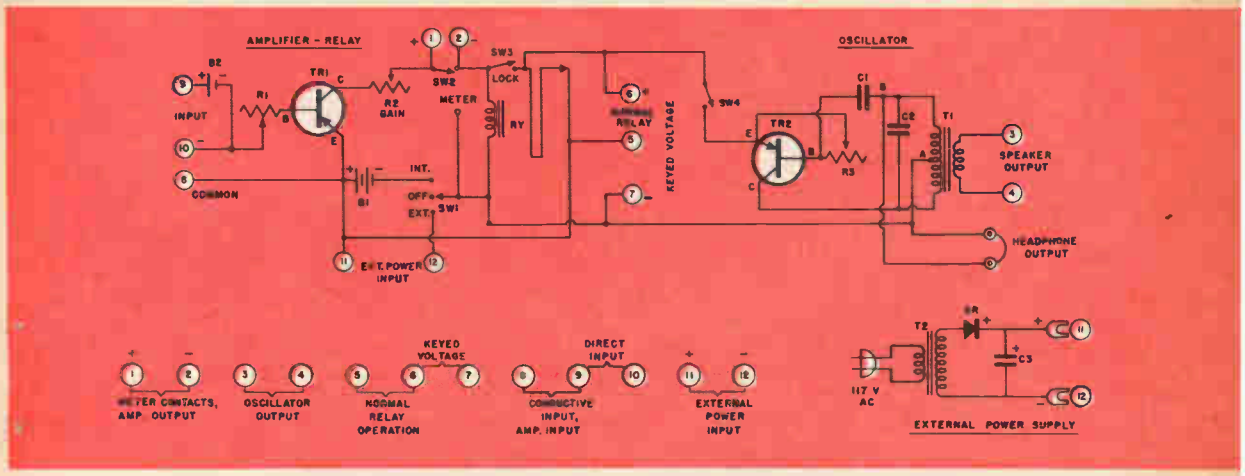
With a telegraph key and loudspeaker the unit is used for code practice. In this mode, the internal audio oscillator supplies the tone.



Underside view of wiring. To simplify assembly the two subchassis are wired before they are bolted to the inside of the metal chassis.

The guide below indicates all the wiring. Note that the amplifier section has been drawn outside the main chassis for clarity.





Circled numbers throughout schematic correspond to the 12 terminals on barrier strip (above).

graphs. Its proper size is of course determined by the size of switch 4 and may vary with the brand of switch used. However, in most cases the notch will measure about 1⅜″ long by ⅝″ deep.

Using scrap aluminum or tin can stock, fashion a bracket approximately 1⅞″ long by 2″ wide with a ½″ flange. A commercially available battery holder used to secure B1 is attached to this bracket, which in turn is mounted in the aluminum housing with ⅜″ 6-32 machine screws.

Position the completed subassemblies allowing approximately ¼″ clearance between the subchassis edges and the chassis walls. Three 1″ 6-32 machine screws, spaced to form a "triangle" with its apex toward the panel bottom are used to mount each unit, support being provided by a ⅜″ spacer on each screw.

After completing all wiring between panel components mount the amplifier-relay subassembly, employing two 5-lug tie strips attached to the subchassis to facilitate the task of hooking up the subassembly to the panel. Then, install the oscillator subassembly, checking to see that the polarities are correct when the power leads are connected.

It was found that for most purposes loudspeaker oscillator operation is desirable. However, if you prefer headphone operation, connect the oscillator output terminals to points A and B on the diagram instead of to the transformer secondary as shown. In either case, adjust R3 (tone control), for the most audible tone.

The relay used in this device was chosen for its low cost, relatively small size, and large contact current carrying capabilities. However, it will be necessary to "sensitize" it before the circuit will operate properly. If you own a low range milliammeter (0-5 ma, 0-10 ma, etc.) the relay can be sensitized very quickly. Connect the meter to terminals 1 and 2; set SW1 to "Internal," SW2 on, SW3 "off," SW4 "off"; set both R1 and R2 to maximum re-

[*Continued on page* 106]

PARTS LIST

C1—500 mmfd disc ceramic capacitor
C2—3300 mmfd disc ceramic capacitor
R1—25,000 ohm miniature potentiometer
R2—5000 ohm miniature potentiometer
R3—.5 megohm miniature potentiometer
TR1,TR2—CK722 transistor
RY—5000 ohm plate circuit relay (Potter & Brumfield LB5 5000 ohms)
T1—Audio output transformer, 3.2 ohm voice coil
B1—22.5 volt battery (RCA VS-084)
B2—1.5 volt penlite cell
SW1—Single pole 3-position rotary switch (Centralab 1461)
SW2,SW3,SW4—SPST switch
Barrier strip—12 terminal (Cinch Jones 12-141)
Misc.—Battery holders, knobs decals, flea clips, spacers, tie strips, aluminum chassis 7″x5″x2″ (Bud AC-402) Bakelite subchassis—Amplifier-relay 3¼″x2½″, oscillator 3¼″x1⅞″

Parts for external power supply, if desired:

T2—Power transformer 117 VAC to 24 VAC
SR—Selenium rectifier 20 ma.
C3—250 mfd electrolytic, 50 volt

Electronics and geriatrics (the study of old age and its diseases) have combined forces to . . .

Add Years To Your Life

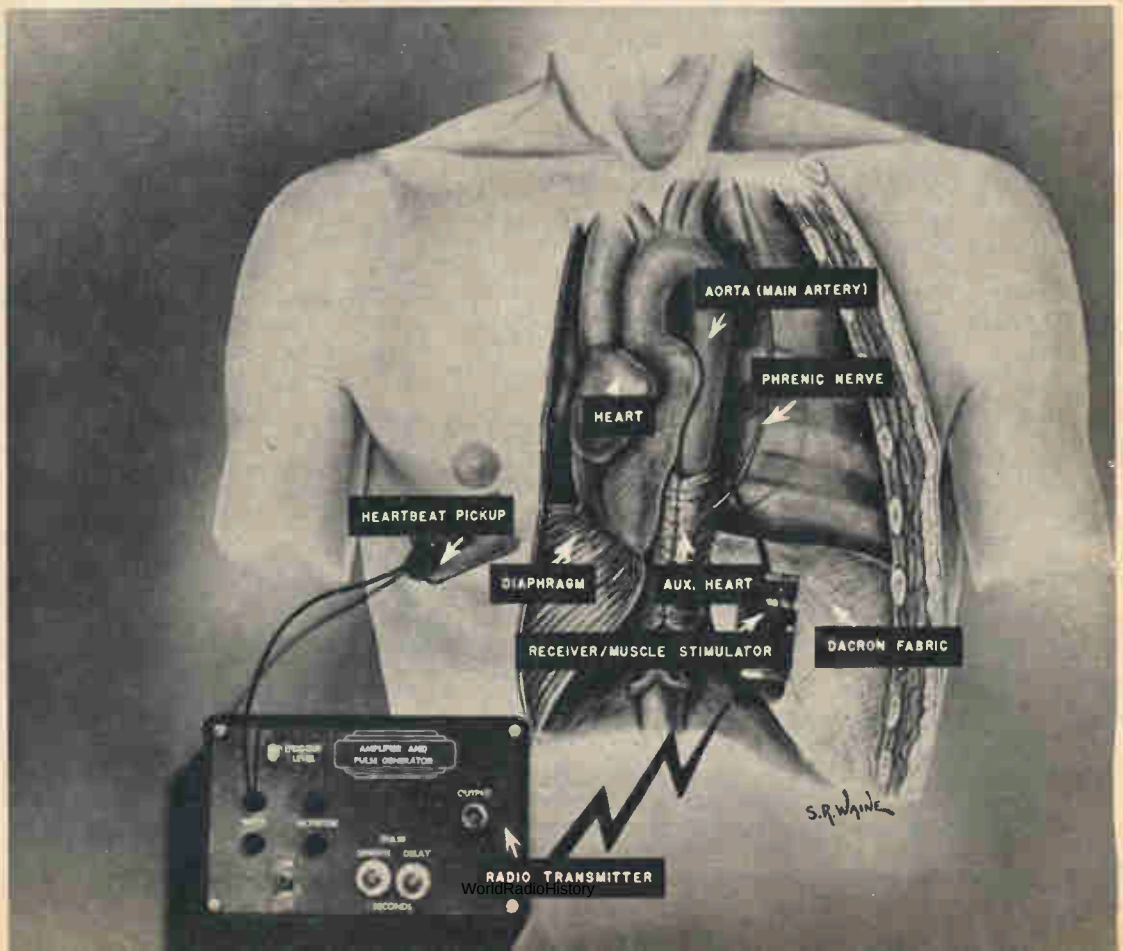
By R. E. Atkinson

"YOU'RE as old as your arteries" is a truism that bears special attention. The principal ravages of time are indeed evidenced in heart and blood vessel difficulties, which killed over 400,000 persons in the United States last year and disabled hundreds of thousands more. The need for research and progress is apparent against this bleak background.

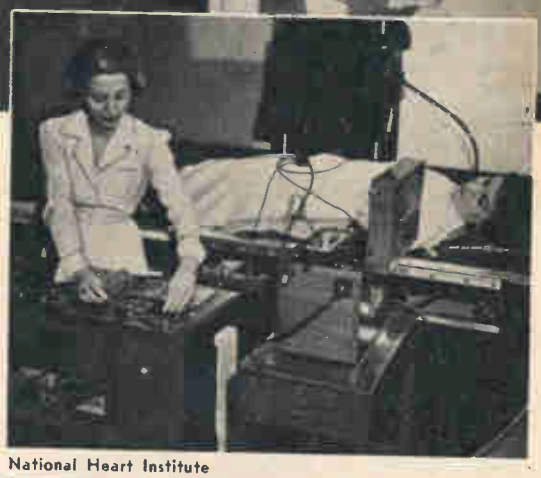
Medical electronics is fighting a holding action by helping oldsters to stay alive in spite of heart and circulatory ailments. At the same time, the basic causes of these difficulties are under investigation.

A 76-year-old Brooklyn grandfather who survived a heart attack that nearly killed him went home from the hospital recently after depending 96 days upon an electronic heart stimulator. One of these stimulators was on hand at home when he arrived for Thanksgiving dinner and it stood by ready to mimic

Maimonides Hospital of Brooklyn



Baltimore City Hospitals



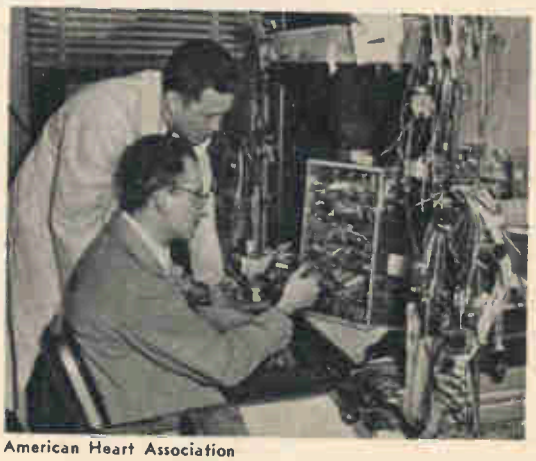
National Heart Institute

Left, auxiliary heart gets cadence from actual heart via radio wave. Dacron fabric replaces section of diaphragm used as muscle around the main artery.

Top: As electronic instruments, including oscilloscope, monitor oldster's pulse, device on arm sends pressure waves into artery to determine its elasticity.

In Framingham, Mass., many healthy persons, such as women on ballistocardiogram table, are being studied year after year to determine the effects of aging.

Combining medicine and electronics, Dr. Adam Denison uses surgical instrument (hemostat) to hold parts while soldering them into unique blood flow amplifier.



American Heart Association

National Institutes of Health photos

Studies of fats in blood are aided by precise analysis possible with mass spectrophotometer, which sorts out electrified particles, identifies foreign elements in a blood sample.

Electronic beams will look into this cartridge, here filled with human blood plasma, while it whirls in high velocity centrifuge that separates cholesterol molecules from the blood.

his heart rhythm while sending low voltage shocks to stimulate his heart to action.

Important advances in designing electronic equipment to stimulate the flow of blood in a patient have been made by Drs. Adrian Kantrowitz and William McKinnon at Maimonides Hospital of Brooklyn. A section of animal diaphragm, which may come from the patient himself, is wrapped around the aorta, the main blood supply line from the heart. It acts as a muscular booster and is made to contract in alternate rhythm with the heart by means of electronic stimulus.

The stimulus is applied to the phrenic nerve by a tiny, lucite-encased radio receiver which has no moving parts. Implanted in the body, it remains there permanently. This combination receiver and nerve stimulator gets signals from a transmitter. The transmitter, in the experimental stage, is now the size of a cigar box, but is subject to miniaturization. It must have contact with the patient's skin, where it picks up the natural heart beat and converts the signal into a radio wave. The wave is then picked up by the in-body receiver, which passes it on to the stimulating nerve of the "man made" heart. The auxiliary heart is thereby synchronized with the regular heart, helping it to pump the blood throughout the body. Already capable of taking over as much as 25 percent of the work of the heart, it will eventually be improved to take over half the workload, or even more.

Artificial hearts, lungs, kidneys and other electronically maintained organs have been predicted, but they come under the heading of spare parts. They are only stop-gaps. Prevention of the woes of aging, not of aging itself, is the real goal toward which allied medical and electronics scientists are working.

Fundamental research in geriatrics, the branch of medicine that deals with aging, has made it known that blood fats are related to premature aging. The arteries harden and narrow with fatty cholesterol deposits. Cholesterol is a crystalline alcohol which is deposited in the body after certain fatty meats and other foods have been digested. Its effect is cumulative, and in later life may lead

[*Continued on page* 86]

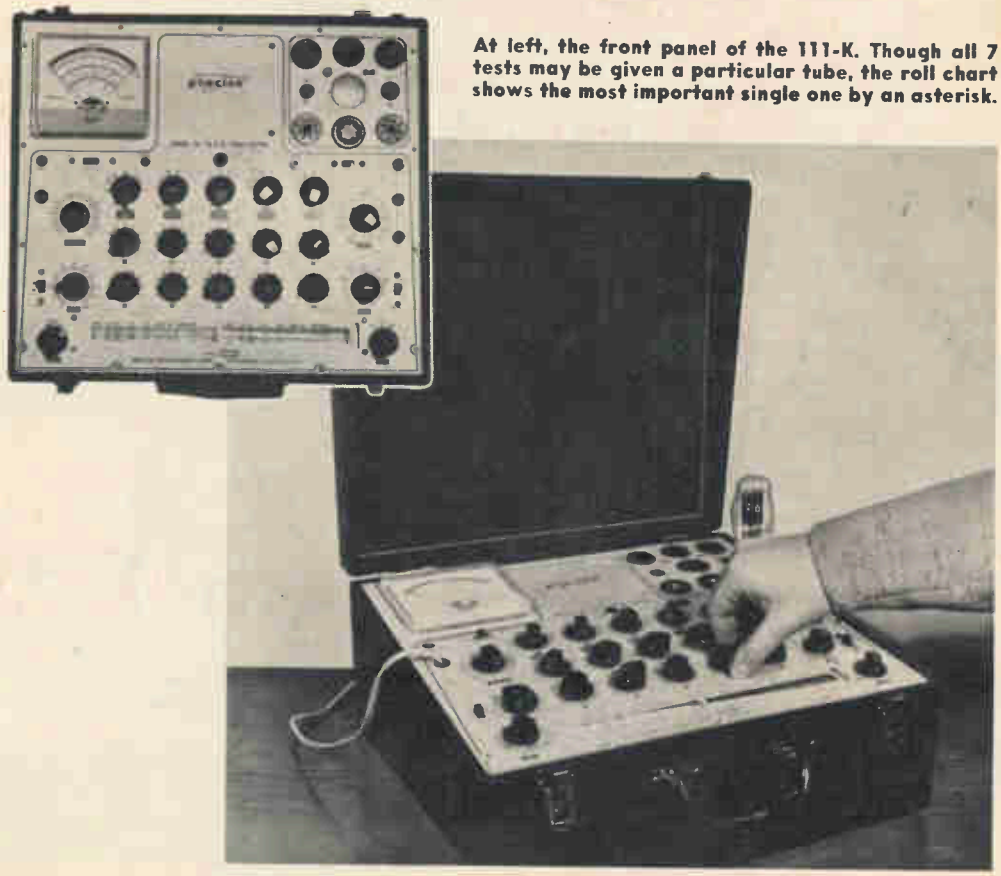
Precise 111-K

Tube Tester Kit

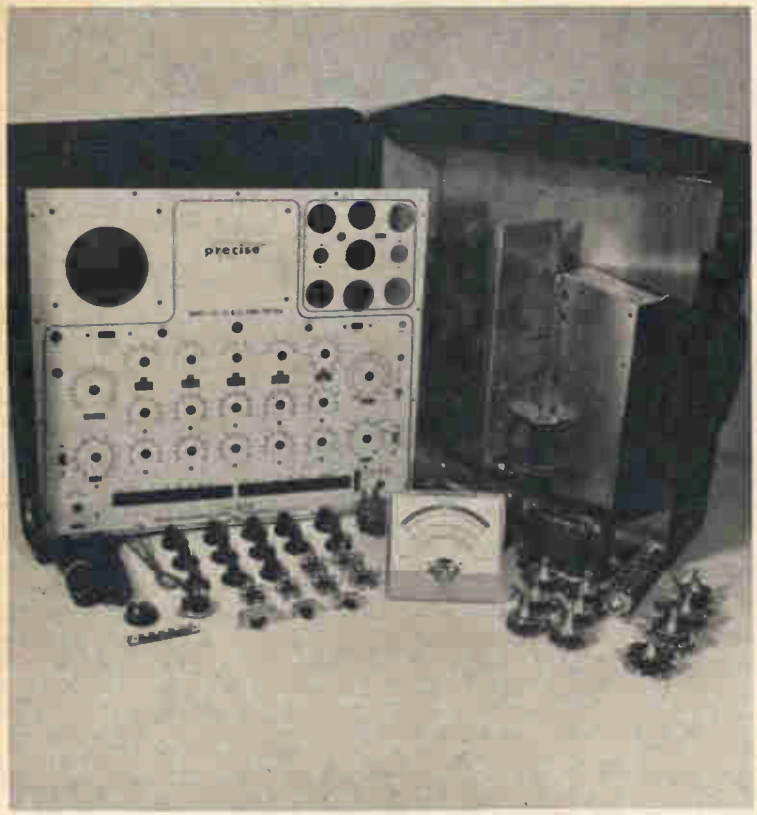
Seven different characteristics of a tube may be checked with this advanced type tube tester.

THE mutual transconductance tube checker actually supplies an operating circuit for the tube being checked. The usual, or emission type checker simply measures the current flow. This is a "static" test, with certain shortcomings. It does not reveal how the tube is acting "dynamically" with a varying signal passing through it. In many critical circuits, normal tube current is no guarantee of top performance. A more revealing test indicates how effectively the tube's grid is controlling its plate current flow.

Precise Development Corporation's Model 111-K (for Kit) will check Gm, the symbol for mutual transconductance, plus six other tube factors; plate emission, filament current, leakage



At left, the front panel of the 111-K. Though all 7 tests may be given a particular tube, the roll chart shows the most important single one by an asterisk.

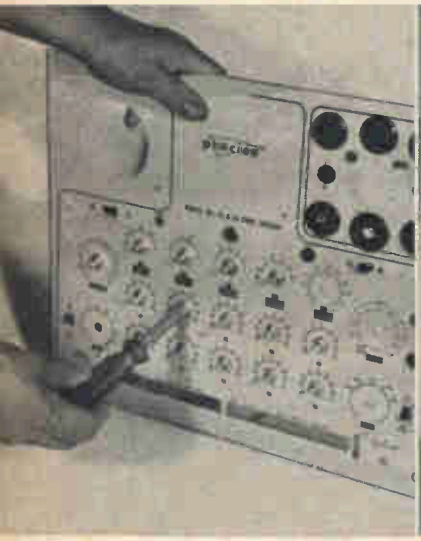


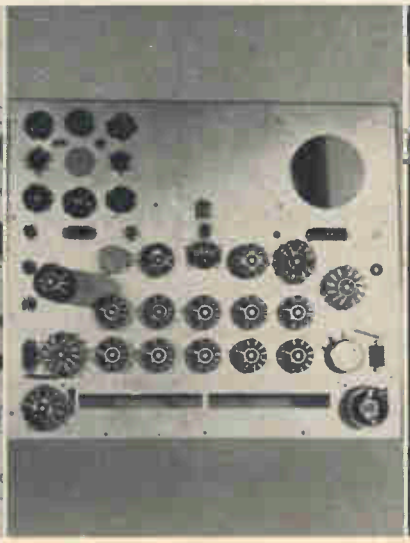
Major components supplied with kit. Many switches are stamped with their identifying numbers.

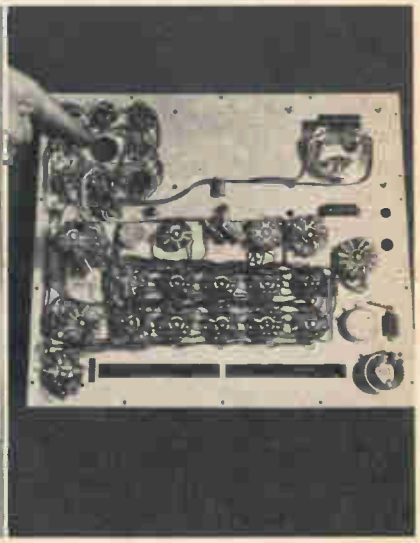
Use a ½-inch nut driver when mounting switches to avoid marring front panel.

Rear view of panel showing rows of rotary switches and tube sockets at upper left.

First, the parts on front panel are wired. Note spare tube socket at upper left.







and shorts, gas, noise, and life. These features, plus its price tag of $79.95, definitely places it in the laboratory and servicing category, but not too far out of reach of even the hobbyist and ham.

As apparent from the photos, construction is a lengthy process—it took over thirty hours to complete. The instruction manual departs from the customary format found in kit construction. Many individual steps are not represented by separate printed lines in the manual. Any time the steps are identical you are told to do the same to other components. After actually performing this type of wiring several times, relying heavily on the diagrams, it did not appear as difficult as originally thought to be.

The diagrams too are somewhat unconventional. Instead of the usual pictorial drawings, they are photographs, with the wires drawn on them in red ink. Their clarity was good, except for the orienting of the tube sockets. It took close examination of several photos to determine the direction of the tube socket keyways and pins.

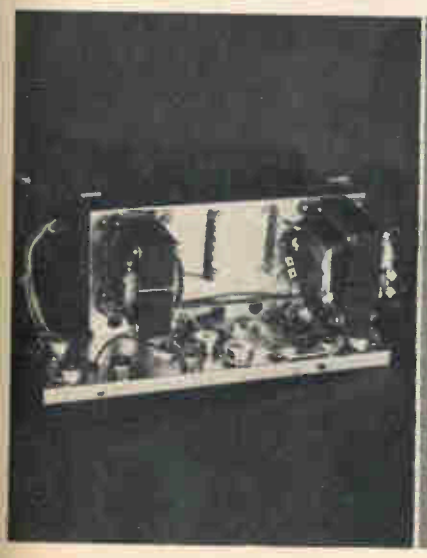
A valuable feature in the instructions is the Wiring Check Chart. After completion of the kit, this 2-page list is used to quickly retrace all connections. It indicates what color lead should connect to each specific switch lug or terminal.

Since many of the switch and tube socket lugs are close together, care should be taken to keep adjacent bare wires from shorting. Quite often one lug is used for three or four leads.

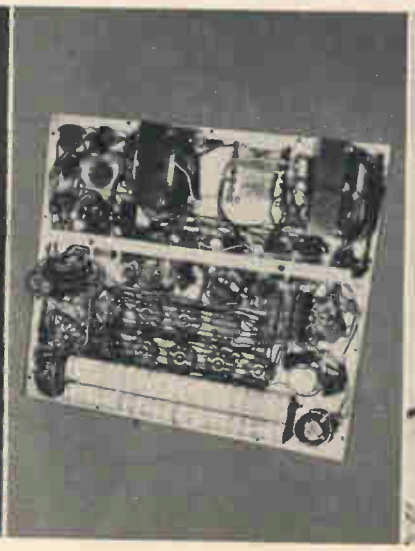
Once the tester is complete, accidental shorts between its tube socket lugs are easy to detect. The Shorts switch is rotated, and, if the neon bulb lights on any of the numbered positions, you're informed of which lugs are shorting. This test will not pinpoint the exact socket that's at fault, just the pin numbers. Therefore, these numbers must be checked on each of the ten sockets. If shorts are in other parts of the circuit, the tester's fuse bulb protects the power supply.

After calibration of the completed instrument, the results were gratifying. Rather than to simply check the tube, this unit "evaluates" it. Considering the cost of a wired Gm checker, the 111-K is a Good Buy in that it places a professional instrument within the reach of many.

Next, the components for the power supply are mounted on a subchassis.



The power supply subchassis is bolted to the front panel and wiring completed.



Pilot holes are drilled in carrying case to receive the panel wood screws.

The Electronic Brain

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

Silver Plating

Would it be possible for me to re-silver two small silver mirrors using the copper plating process described in the January 1959 issue of Electronics Illustrated?

Clarence Williams, Sylacauga, Alabama

Silver plating and copper plating are essentially the same processes. For the kind of silver plating one sees on tableware and other objects of this nature, commercial electro-plating plants use pure silver bars as the negative electrodes and the objects to be plated as the positive electrodes. The solution for the electrolytic action may be silver nitrate plus carefully controlled amounts of sodium or potassium cyanide. Since all of the cyanides are deadly poisons, we cannot recommend the use of this material in any home plating process.

If you are willing to experiment a bit, try this procedure: (Concentrations of chemicals will have to be determined separately for each plating operation).

1. In an *aluminum* pot, place about 1 teaspoonful of washing soda (sodium carbonate) and the object to be plated.

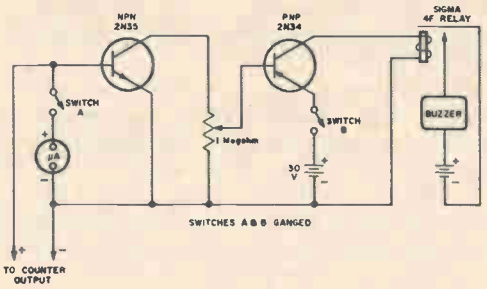
2. Boil for about 10 minutes. This will remove all the silver tarnish and other materials deposited on the old silver surface. DO NOT USE VINEGAR AS WITH COPPER PLATING.

3. Follow the instructions in the copper plating article, using a sterling silver spoon or fork as the negative electrode and a solution of silver nitrate as the electrolyte. DO NOT ADD SULPHURIC ACID. Use a somewhat higher voltage—6 volts or so—inspecting the deposition coat every 15 or 20 minutes. Keep the silver nitrate away from your hands and clothing.

Alarm For Scintillation Counter

How can I add an audible warning to a scintillation counter that is now equipped only with a 0-50 microampere meter. This device should be adjustable and should call my attention to the meter reading when the current exceeds some predetermined value.

Bert Clemens, Seattle, Washington



Since the output of your scintillation counter is evidently direct current, a good audible warning device can be built using two transistors and a relay in the form of a very sensitive DC amplifier circuit. When the output current exceeds a preset figure, the relay will pull in and cause a buzzer or bell to sound. Before constructing the amplifier-relay circuit, however, it is suggested that you measure the voltage that your counter can develop across a 7000 ohm resistor connected in place of the microammeter. If this voltage is in the vicinity of 30 millivolts (.030 volts), the circuit will provide positive action; if the voltage is less than this value, it would be necessary to add another amplifier stage prior to the output meter.

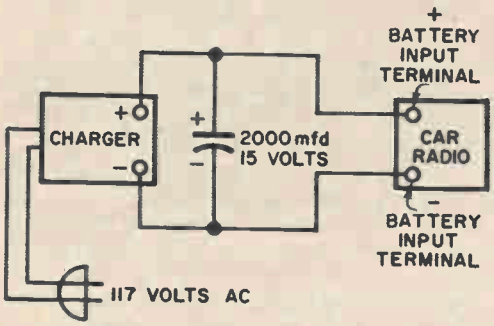
The voltage for the buzzer battery is not given in the diagram since it depends on the unit selected.

To set the relay for audible operation, open switch A to disconnect the meter from the circuit and adjust the potentiometer for the sensitivity desired. Once the alarm sounds, the switch is opened and a meter reading may then be taken.

Powering An Auto Radio

Can I run a 6.3 volt automobile radio by tapping off 6.3 volts from one of the tubes of an AC-DC home radio and using this to replace the storage battery?

Guy C. Milne, Cynwyd, Penna.



No, you cannot!

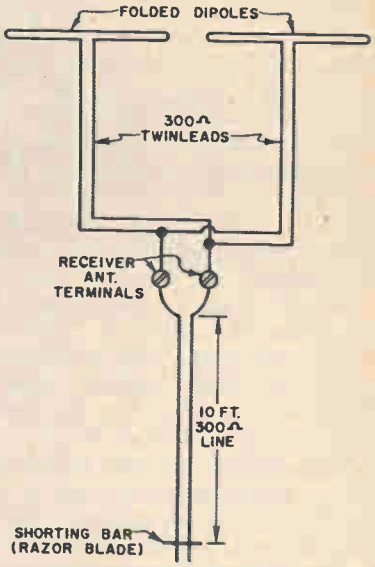
First of all, ordinary AC-DC radios do not have 6.3 volt tubes and there is no convenient place where this voltage can be obtained from such a radio. Even if the radio is of the AC type in which 6.3 volt tubes are used, this is AC, not DC; car radios are designed to be operated by pure DC from storage batteries. Furthermore, the 6.3 volt DC supply must be capable of delivering upwards of 8 amperes of current during operation of the radio. This is a lot of current!

What you can do is obtain a 6 volt battery charger of any type and add a filter capacitor as shown in the accompanying diagram. Be certain that the output voltage of the charger does not exceed 8 volts under load. Your radio or TV serviceman can check this for you by connecting a 32 candlepower headlight lamp or a sealed beam unit across the terminals of the charger while the voltage is measured. Virtually all chargers of the old "Tungar" type can handle an auto radio without difficulty. A trickle charger will not do, however, since its current output is too small for this purpose.

TV Antenna Matching

How may several half-wave folded dipole antennas for television reception be connected to a single receiver without destroying the impedance match? I would prefer information on a method using a matching stub or harness.

John Chalmers, Galeton, Pa.



The principal reason for establishing the best impedance match between a transmission line and a television receiver is to avoid reflections and standing waves that cause multiple images and loss of signal.

If you don't mind a little experimentation, you can make an excellent matching stub or impedance transformer using a 10-foot length of ordinary twinlead transmission line as shown in the accompanying diagram. After making the connections as shown, tune in a channel and note the extent of multiple image display. Then, starting at the far end of the open stub, short-circuit the two conductors by means of a razor blade pressed through the insulation, repeating the process inch by inch. When you find the point at which the best match is obtained as evidenced by the display of minimum multiple images, mark the stub here and repeat the procedure for other TV channels. It is generally possible to find one shorting point where all receivable channels are vastly improved. At this point, cut the stub, splice and solder the two conductors together and tape joint.

How To Buy Ham Equipment

Continued from page 42

radio who never heard of it before.

Ques. *Should the beginner go into single sideband immediately, or wait until he has had experience as an active ham?*

Ans. If he is going to buy his equipment I don't think it's going to make a bit of difference; if he's going to build it he shouldn't by any means fool with single sideband because it will be beyond him.

Ques. *Now as to the transmitter. What do you suggest to the beginner on this subject?*

Ans. I think he should build a CW transmitter, he can even make it out of triodes and learn how to neutralize it so that the final amplifier doesn't take off. He can get the plans from the magazines. It should be as simple as it can be. It's so easy to take a 6L6 and add it to a crystal oscillator and get on the air. Let the beginner get a handful of crystals and try different frequencies as the first part of his education. When I started out I used a receiving type 45 tube and it was harder to drive it on 40 meters than it was on 80 and it was much harder on 20; on 10 it was practically worthless unless I sawed the base off the tube.

Ques. *Now to sum up, you would say that after the beginner gets a code practice oscillator and learns his code and his radio theory, and then passes the test for his Novice or General class amateur radio license, you suggest that he buy the best ham receiver he can. You then suggest that he build the easiest transmitter he can to learn about transmitters and to get on the air. Now suppose he wants the refinements that a commercial transmitter can give him. How does he select a good transmitter?*

Ans. Well, the transmitter should be completely enclosed in a metal box with all incoming and outgoing lines for microphone, key, AC, etc., properly bypassed using high-pass capacitors. To assure that the harmonic output to the antenna is small, a low-pass filter should be at the antenna terminal. I think the amplifier in the transmitter should be such that it can be made either class C or linear so that it can be used for single sideband. Good frequency stability is also necessary.

Ques. *How can the buyer determine the frequency stability of a particular transmitter?*

Ans. A lot of transmitters come with a built-in VFO, this is highly desirable for stability. But stability and some of the other important transmitter specs are best tested by use. If possible, the buyer of a transmitter should try to get one on a home trial basis, or else he should talk with other hams who have used the equipment he's interested in. One of the best sources of information on all ham gear is fellow hams.

Ques. *Bob, what accessory equipment does the beginning radio amateur need?*

Ans. Test equipment. I've contacted hams and asked them how much plate current they've got and they will answer that they don't know. This is crazy. If a ham is going to build or service his equipment, he's got to have test instruments; a multitester, an oscillator and a grid dip meter at least. Then perhaps he can build an absorption type wavemeter using a lamp, condenser and a coil. And, oh yes, a frequency standard is mandatory. A 100 kc crystal oscillator will do for this.

Ques. *What kind of transmitter antenna do you recommend?*

Ans. It's got to be way up in the air, away from everything. A dipole is as good as anything, for example, about 65 feet for 40 meters.

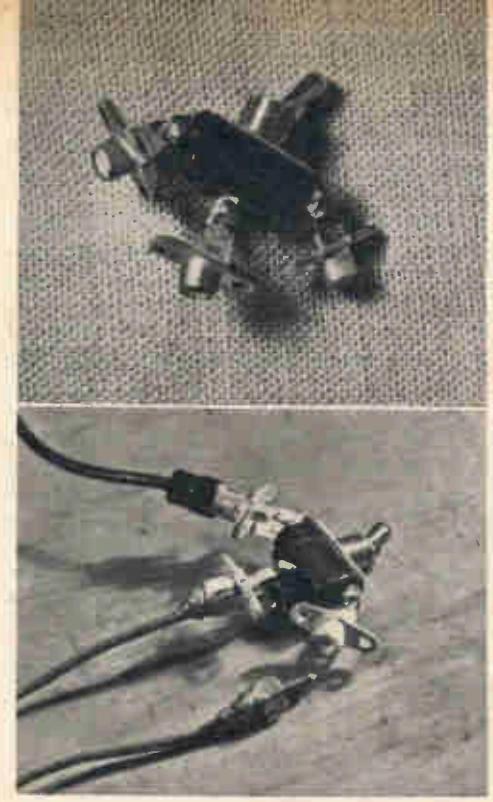
Ques. *So many novices and beginners want to go to phone operation immediately, are there any advantages to staying with code?*

Ans. Well, of course, with code or CW you can talk farther for less power, and therefore for less dollars.

Ques. *What band should the beginner go on?*

Ans. I would start with the lowest frequency, 80 meters, because here there is the minimum interference to television and other services. He can work up gradually as he learns, trying 40 meters next and then 15 for CW and finally 2 meters for phone.

Thank you, Bob Gunderson, for this special interview for EI's readers.



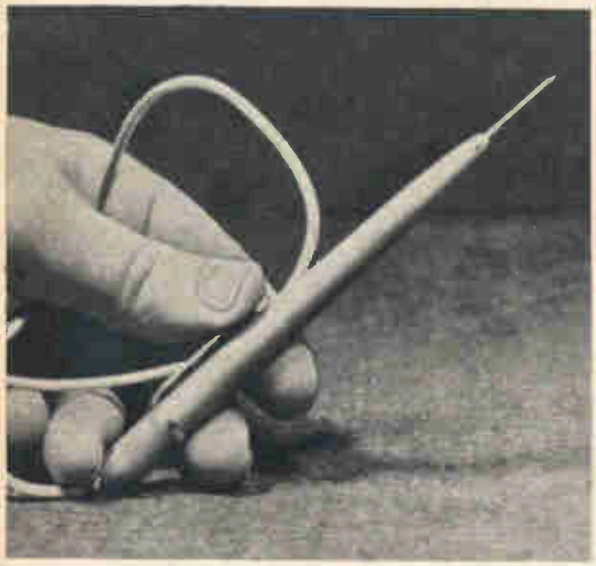
Try This

Switching Cables

A compact and uncomplicated switch for high impedance leads can be constructed using an ordinary DPDT toggle switch and three RCA type phono jacks. The hookup is useful for testing and comparing audio equipment such as phono cartridges, preamps or amplifiers.

The center (hot) lug of each of the jacks should be shortened to the same length as the ground lug. Each jack is soldered to one pair of switch terminals. Make sure that all the ground lugs of the jacks are soldered to one side of the switch and the hot lugs to the other. By switching the ground leads, in addition to the signal carrying ones, ground loop hum problems are avoided.

In use, the signal lead to be switched is plugged into the middle jack and the leads from the two inputs are plugged into the end jacks.



Ballpoint Pen Bushing

Insulating bushings or grommets of any length can be quickly devised by using the sleeve from a discarded plastic ballpoint pen. They are also useful as insulating sleeves for test prods. A thin nail (see photo) is the probe.

Lower Solder Melting Point

It is often necessary to apply as little heat as possible to transistors and other small components as they are soldered. The melting point of solder may be lowered by pinching or hammering the solder flat.

Add Years To Your Life

Continued from page 78

to strokes and heart attacks by choking off blood supplies to vital organs.

Scientists have separated and isolated certain giant fat molecules in blood plasma by whirling the plasma in an electronic ultra-centrifuge. This not only spins a blood sample at a velocity greater than the speed of a bullet, but also reports through an electronic optical system on the spectrum of fats in the whirling sample.

Blood fats have been notoriously difficult to separate and purify for study, but researchers have found that the spectrophotometer is also a good analytic instrument. It can sort out and identify streams of electrons in vaporized blood fats, and produces graphs that identify different components of human blood.

Some researchers have gone all-out in combining medical careers with electronics to design new, highly useful tools for medical measurements. Two such men are Drs. Merrill Spencer and Adam Denison of Bowman Gray Medical School in Winston-Salem, N. C. They have developed an experimental amplifier to measure the flow of blood through an intact artery. The device is called an electro-magnetic flowmeter. Blood to be metered flows through a magnetic field generated by a magnet applied to the outside of a blood vessel. The very small electrical potentials from the blood are picked up by tiny electrodes, which detect the voltage generated as the moving blood cuts the magnetic lines of force. This signal is transmitted to a special amplifier which raises it to a readable level. Studies with this instrument have revealed many hitherto unknown characteristics of blood vessels.

More ordinary electronic instruments, such as oscilloscopes, pulse generators, etc., have been adapted to examine aging arteries. Rebounding wave patterns in arteries studied electronically have provided valuable information on how arteries become less elastic with age and fail to expand and contract as blood surges from the heart.

Electronics is also playing an important part in a long term study of the people of Framingham, Mass. They have become a "population in a test tube." Examinations of thousands of healthy volunteers over the last ten years will be continued for another ten years. The results may show just how heart disease develops as people grow older. Recording instruments attached to electrodes and amplifiers are useful in picking up electrical potentials that give clues to body function, locate scar tissue on the heart, etc. One such instrument, the ballistocardiograph, is based on Newton's law of motion that every action has a reaction. It measures the recoil when the heart rockets out a supply of blood into the arteries.

One finding from this Framingham study indicates that after 45 years of age and into the 60's men with any two of the three conditions of abnormally high blood pressure, overweight, or high fat content in the blood are about nine times as likely to develop coronary heart disease (cause of heart attacks) as men who are normal in those respects.

Basic research in solid state materials that have thermal-electric effects which electronically produce heat and cold, can be of considerable benefit to the aged. Air conditioning, for example, is a boon that many of us take for granted, but for the oldster with heart trouble it may mean the difference between life and death. It gives his heart a rest on hot, humid days when the demands of body-cooling blood circulation mechanisms might otherwise strain the heart.

Electronic air conditioners without moving parts are now on the drawing boards and some prototype models have been constructed. It may not be too far in the future when miniaturization will bring them down to a size that can be sewn right into an oldster's suit, enabling him to carry on normal activities outside his home in cool comfort.

With the indispensable aid of electronics, medical science is meeting some of the emergencies of aging. It is also trying to find out why some of us remain young and virile at 100, while others never make it past 50. Most important of all, electronics aids geriatrics research in the quest for the next best thing to the fountain of youth—a healthy, vital old age. —

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from right to left. The far right column may be thought of as the one in which all the "1s" appear, the next all the "2s," then the "4s," "8s," "16s," etc. But the values only register if a 1 appears in the column. For instance, to represent the number 47 in binary coding you would have 101111 or, starting from the left, one 32, (no 16), plus one 8, one 4, one 2 and one 1. Add 32, 8, 4, 2 and 1 and you get 47.

When the frame is expanded, many additional combinations of 1 and 0 are possible—enough to represent all 26 letters of the alphabet as well as punctuation marks and Greek math symbols.

This is the language of digital computation. All the electronic elements inside a digital computer are bistable devices, capable of only two possible states of existence: The switches of its circuitry are either on or off (its tubes and transistors are either conducting or nonconducting; its *magnetic cores* are either charged or not) depending on the presence or absence of a pulse.

With these fundamentals in mind, we must now conceive of the digital computer not as a single machine, but as a system of five related components, each with a separate and simultaneous job to do. The five interdependent units are:

1. *Input,* which converts written facts and figures into the binary code;
2. *Storage,* which holds each incoming batch of facts to await its turn;
3. *Arithmetic,* which performs the actual calculations;
4. *Sequence control,* which directs the whole procedure;
5. *Output,* whose function is simply to re-translate the pulses back into the form of printed information.

In a typical large-scale digital system, the input mechanism consists of an electric typewriter equipped to translate every numeral and character it writes into a specific pattern of charged spots or "bits" on multi-channel magnetic tape. One channel represents each column of the expanded binary-digit coding system.

The storage unit consists of hundreds of thousands of separate magnetic cores —tiny doughnut-shaped devices, each of which either become instantly charged on receiving a pulse, or remain uncharged to register a negative value.

The arithmetic section in early computers is based wholly on the use of vacuum tubes. These have been replaced in newer models by transistors. In either case, the action is the same: Electrons travel through circuits causing numerical values to be added, subtracted, multiplied, divided or compared.

The control circuits, meanwhile, operate as a timing mechanism to make sure that everything happens at the right time in relation to everything else —"reading" instructions from storage, interpreting them and making the necessary connections throughout the system. Thus, as soon as arithmetical results are achieved, they are assigned to output—flashed back in the form of pulses to charge new bits on a fresh spool of tape, which can then be fed to an automatic high-speed printing device and re-translated into human language.

The action of the entire system is monitored by a man who sits at a supervisory control console, a panel of buttons and lights by means of which the computer can be started, stopped and regulated. This man can send in new instructions or corrections, can test any portion of the memory and functional circuits, and can spot the occurrence and location of circuit failures. But he is not technically the master of the machine.

That role belongs exclusively to the programmer, a man without whom the most elaborate computer in the world is useless. It is the programmer's job to break the problem down into a series of logical arithmetical steps, to feed it to the computer in the right sequence, and literally tell the machine what to do and how to go about it every step of the way.

No computer, analog or digital, is anywhere near as smart as the man who programs it. But by freeing human minds from the drudgery of routine calculations, and by working at superhuman speed with superhuman accuracy, computers can be made to accomplish nearly incredible feats—some of which will be told next month.

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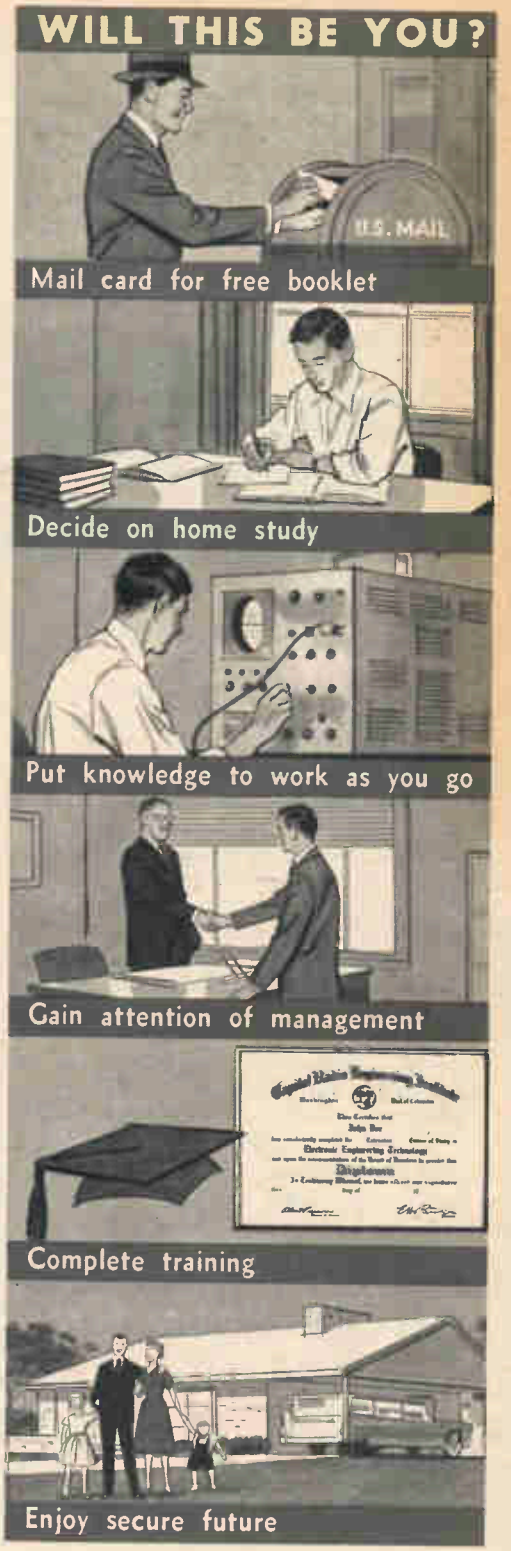

Coming Age Of Sun Power

Continued from page 31

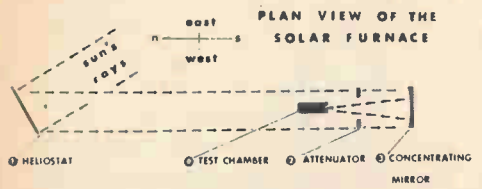

Photo and diagram show Army's massive solar furnace at Natick, Mass., where extremely high temperatures are used for thermal tests.

become a sun-energized switch essential to space navigation and guided missiles.

SILICON SOLAR CELLS

With today's most efficient silicon cells able to convert 14 percent of the sun's light to current, a square yard of cells would provide the moon mortal with fully 140 watts of useable electricity, enough to power his oxygen rebreathing gear, air-conditioning system, radio and heater. Now under development at International Rectifier Corporation is a solar suit, glass cloth woven with metallic threads, a kind of prewired circuit to which silicon cells are soldered.

Solar cells already power clocks, highway-warning flashers, and remotely located relay stations such as the repeater post atop Santiago Peak in California's Cleveland National Forest. There a 125 watt-hour sun battery composed of 504 silicon cells powers a transmitter which relays messages to a center 50 miles away.

Ingenious is the newly announced silicon photovoltaic "readout cell." This miniaturized, self-contained power plant can convert light directly to electricity (600 millivolts when bathed in 3000 foot-candles) and can actuate complex business machines. When, for example, a punched card passes over a bed of readout cells, light shines through the holes in the card and falls in a pattern on the cells. The cells, in turn, are wired to the computer's circuits and the tiny dabs of trigger-quick energy strip the card of its data in microseconds.

But silicon cells are about two years away from sheathing the first moon man and decades distant from the day they'll supply your home with power. "The problem is to increase silicon's efficiency and cut its costs," concedes Norman Regnier of Hoffman Electronics Corporation, a leader in solar research. "Right now we tab 'good' a cell with 10 percent efficiency. That is, it converts 10 percent of available sunlight into current."

Recently, Hoffman began marketing a 5-watt solar battery composed of 144 separate silicon cells (price: $500). That's $100 per watt. Nor does the price include the nickel-cadmium battery (6-48 volts) charged by the 5-watt module. And almost always necessary is a storage battery—a sun-charged reservoir for cloudy days.

Typically, a solar cell (seldom more than 1" long and about 1/25" thick) is composed of two slices of super-refined silicon. One, the "N" (negative) layer, is covered with boron. The other, the "P" (positive) layer, contains arsenic. Bonded together, their area of meeting is called a "P-N" junction. And here is created an electrical field.

When light, solar or artificial, bathes the cell's surface, a voltage difference occurs across the P-N junction. Apply a load across the cell, and electric current flows, the result of a direct conversion of light to electrical energy.

But silicon cells are inefficient. They respond to but a small portion of the solar spectrum (to visible light only). Response to infrared or ultraviolet wavelengths is nil. Theoretically, silicon cells optimum efficiency is limited to about 23 percent.

But inefficient though the silicon cell is, it's a veritable power plant compared to some other photovoltaic materials. Selenium, for example, manages to convert no more than 2 percent of sunshine into electrical current. Silicon's greater efficiency tabs it as a comer in the space age, essential both to man's survival on earth and in space.

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lector switch for 1000 cycle output (in contact with R8A and R8B) and the key switch to the INPUT position. This is *up* if your wiring follows that of the model.

Now apply power and give the equipment about 2 minutes for a warmup period. Slowly bring up the gain by rotating R19 clockwise. As sound begins to be heard in the headphones, the VU meter should show an increasing deflection. It should be possible to run the needle all the way up-scale to + 3 db.

Next, rotate the selector switch from one frequency to the next to be sure that the bridge is oscillating freely at all points. If it fails to do so at the very low frequencies, try adjusting the setting of R13 slightly one way or the other. The test is conclusive if you can get oscillation on all 10 points of the spot frequencies.

To check the operation of the resonance section, rotate the selector switch to its last position at the low end (R2A and R2B contact point). As the setting of R1A-B is now changed, the frequency should vary smoothly from about 15 cycles per second to possibly 250 cycles per second.

The next step is to connect an amplifier to the test equipment as shown in the diagram.

Unsolder or otherwise disconnect one terminal of the voice coil from the secondary of the output transformer, leaving the other undisturbed. (In multiple speaker installations, the circuit should be opened between one terminal of the output transformer and the corresponding terminal of the crossover network.) This will provide three connection points:

VT—(stands for Voice coil and Transformer) where the transformer is still joined to the voice coil terminal

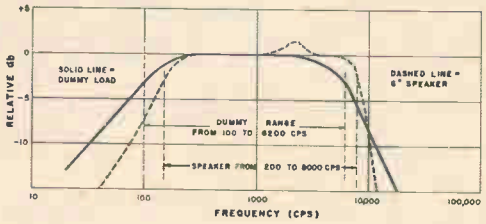
T—(Transformer only) where the transformer has been freed from the voice coil

V—(Voice coil only) where the voice coil has been disconnected from the transformer.

Join these points to those correspondingly labeled on the panel by means of banana plugs on one end of each lead and alligator clips at the other end.

The equipment is now ready for an amplifier frequency-response and resonance check. With the output control of the tester (R19) and the gain control of the amplifier *both at zero*, warm up both units for a few minutes. Set the tester key switch (up) to INPUT and, using R19, bring the meter pointer up to 0 db (100%) at 1000 cycles. Move the lever of the key switch to DUMMY and *slowly* bring up the amplifier gain until the meter again reads 0 db. No sound should be heard from the speakers in either of these two positions. If the key switch is now moved all the way down (SPKR position), the 1000 cycle tone should be heard from the speakers and the VU meter reading should be appreciably different from its former value when the dummy load was used.

A frequency response run of an amplifier into a dummy load serves to provide information as to the performance of the amplifier only, thus establishing a basis for judging the electronic equipment. A similar frequency response run into the amplifier's own speaker system will point out sharply just how much of the lack of flatness is due to the amplifier and how much is due to the speakers. As either type of run is carried on, the key switch should always be shuttled back and forth between INPUT and either DUMMY or SPKR to be sure that the input signal remains at a constant level. When drawing up response curves, use a semi-logarithmic paper having its frequency scale logarithmic and its db scale in linear divisions.



Frequency response curve on a small amplifier showed much high and low frequency drop-off.

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- Quality of 100% of all condensers . . . (leakage, shorts, opens and intermittents)
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OUTSTANDING FEATURES

- Ultra-sensitive 2 tube drift-free circuitry
- Multi-color direct scale precision readings for both quality and value . . . (in-circuit or out of circuit)
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Check all power rectifiers in-circuit whether SELENIUM, GERMANIUM, SILICON, etc. with the

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- Checks all types of power rectifiers rated from 10 ma. to 500 ma. (selenium, germanium, silicon, etc.) both in-circuit or out-of-circuit.
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- Large 3" highly accurate multi-color meter . . . sensitive yet rugged.
- Separate meter scales for in-circuit and out-of-circuit tests.
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Just clip SRT-1 test leads across rectifier under test right in the circuit without disconnecting rectifier from circuit. Press test switch and get an instant indication on the easy-to-read three-color meter scales . . .

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

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No other tube tester made at any price can match the value of the FAST-CHECK.

RANGE OF OPERATION

- Checks quality of over 700 tube types, employing the time proven dynamic cathode emission test. This covers more than 99% of all tubes in use today, including the newest series-string TV tubes, auto 12 plate-volt tubes. 0Z4s, magic eye tubes, gas regulators, special purpose hi-fi tubes and even foreign tubes.
- Checks for inter-element shorts and leakage.
- Checks for gas content.
- Checks for life-expectancy.

IMPORTANT FEATURES

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

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

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OUTSTANDING FEATURES

● Checks emission, inter-element shorts and leakage of over 600 tube types. This covers 0Z4s, series-string TV tubes, gas regulators, auto 12 plate volt, hi-fi and foreign tubes ● 3 settings enable a test of any tube in less than 10 seconds ● Employs dynemic cathode emission test principle ● 3½" D'Arsonval type meter — most accurate type available ● 3½" greater sensitivity means more accuracy . . . its jewel bearing means longer life ● 17 long lasting phosphor bronze tube sockets ● Combination gas and short jewel indicator ● 9 filament positions ● Handy tube chart contained in special back compartment ● New tube listings furnished periodically at no cost ● Detachable line cord

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

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

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A resonance check of a speaker is handled this way: Set the frequency selector switch on its VAR position and adjust the output and gain controls for comfortable volume in the speakers. Be sure that the VU meter is not off scale on this setting, however. Starting at the high frequency end of the resonance potentiometer (R1A-B) slowly reduce the frequency while you watch the meter. If speaker resonance exists, there will be a sharp rise in the reading at one point in the adjustment. Although it was not considered necessary to calibrate the resonance control, you may do so by zero beating the tester against any standard audio generator. Good approximations can be obtained, however, by aurally comparing the resonance frequency with the pitch of the 20, 50, 100, and 200 cycle spot pitches.

The waveform of the tester is controlled by the setting of the chassis potentiometer, R13. A pure sinusoidal wave having less than 2% distortion can be obtained when R13 is properly adjusted. The surest way to make this adjustment is to feed the signal to the vertical terminals of an oscilloscope and make the necessary adjustments visually. If a scope is not available, good waveform can still be obtained by setting R13 at that point where the tone *sounds* pure in the headphones; you would be surprised at the efficiency of the ear as a detector of waveform distortion.

Unless the resonance potentiometer (R1A-B) has equal tapers in front and back sections, some difficulty may be experienced in maintaining oscillation over its entire range when R13 is correctly adjusted for sinusoidal signal output. Should this occur, merely advance the resistance setting of R13 slightly so that the action is smooth throughout the rotation of the resonance control. This

Should you wish to build in the same degree of precision found in only expensive instruments, each of the bridge resistors might be made a potentiometer of suitable range. Then, when each potentiometer is individually adjusted, the output frequencies will be right on the nose! For the average hobbyist, however, this would involve needless expense.

Sell Her On Your Electronic Projects

Continued from page 69

to assist you. This is no time to lose the campaign for want of a gimmick. A good tape recorder is highly recommended. There is simply nothing like the sound of her own voice to instill Wife with considerable enthusiasm for the gadget that makes this wonderful phenomenon possible. Then you can ease her into how it operates, even the principles involved, providing you tell her she has a beautiful speaking voice (whether she has or not doesn't matter) and ought to be in show business.

Hi-fi is also endorsed as an invaluable aid in garnering Wife's interest. Here, however, you must proceed with great care. Say for instance, you want to add a full range electrostatic speaker to your rig. Now this speaker is probably priced to fit the pocket of any wealthy person.

But don't let that stop you. Go out and buy the speaker. Proceed to your present rig. Place an old, scratchy 78 rpm record on the turntable and turn it up full volume. The more "music" you can filter *out*, the better. When Wife storms into the room, calmly agree with her that it sounds terrible. Next, produce the speaker, hook it up, change the equalization settings on the preamp to provide optimum results, then play your finest laboratory hi-fi record (in stereo if possible), to show her the wisdom of her decision in your favor.

All right, let's assume you not only have skillfully introduced the little woman to the world of electronics and heightened her curiosity. Now you hope to guide her in to accepting the fact that your electronic projects take time—time which Wife would rather have you spend cutting grass, painting, shopping, cuddling, etc.

Closed-Circuit Psychology

No wife in her right mind is likely to become interested in her husband's projects unless she has been made to believe *her* interest is basically responsible for at least 60 percent of her husband's achievement.

Quite casually, begin dropping statements like, "I've got to hand it to you

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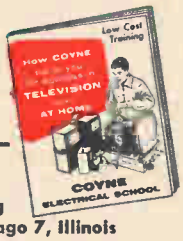

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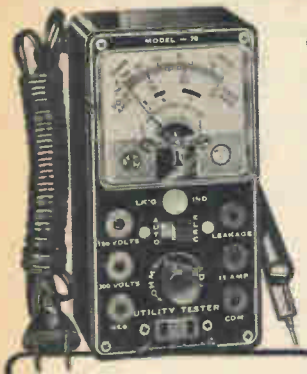

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honey. There aren't many women who understand a man's need to own a really good voltmeter."

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Naturally, she will wonder what the heck you are talking about but, being a woman she will recognize the gratitude in your statements, your "sincere" tone of admiration—and would sooner go to the supermarket without makeup than destroy these strange, wonderful expressions of appreciation.

When friends drop in, compound the effect by favoring Wife with one of those "secret" smiles across the room. Then say in a loud, clear voice for all to hear, "Jane (or whatever her name may be) certainly is getting savvy to the electronics game!"

Or, "Any day now, I wouldn't be surprised to find Alice reading those complicated schematics better than I can!"

She will not, of course, ever do any such thing. But these public pronouncements will make her feel obligated to keep the hot coffee coming while you're working on your projects, if only to pick your brains for enough electronics "talk" to be able to tell her friends, "Oh, I just wouldn't *ever* have the patience Harry has when it comes to wiring one of those cross-over systems, but I guess I know how to use a Philips screw driver if I have to!"

The first time you come home with an armload of boxes and she pleasantly inquires, "*More* components for the digital computer, dear?" you may safely assume you have magnificently carried off the campaign.

VHF—Your Hometown Short Wave

Continued from page 70

some 23,300 base stations. Thousands of railroad, bus, taxicab and truck offices communicate daily with radio equipped cars, trucks and trains.

Much of this activity takes place in the 152-174 megacycle VHF (very high frequency) band.

To listen in on this band, you need a suitable receiver. If you are interested in hearing the entire band, a tuneable receiver is required. However, if you

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are interested in monitoring only one or two specific stations, a fixed-tuned receiver can be used. The Monitoradio Models MC-40 and MC-160 are fixed-tuned sets for about $100.

Among the tuneable FM receivers are the Monitoradio MR-10, which covers the 152-174 megacycle band, and the MR-33 for coverage between 30 and 50 mc. They are tuned in the same manner as a home broadcast radio, but also have a squelch control to cut down background noise. Monitoradio also builds a lower priced 5-tube set called the "Police Alarm."

Hallicrafters manufactures FM receivers for covering these bands. The model S-94 tunes from 30 to 50 mc and the S-95 covers from 152-173 mc. The SX-104 and SX-105 are nine-tube models for 30-50 mc and 152-173 mc coverage respectively and can be equipped with crystals for fixed-tuned operation. The several factory-made receivers range in price from $50 to $150.

Besides a receiver, you need an antenna. And, the better the antenna, the happier you will be with the results.

These FM sets can be used at home or in your car or even in a boat. Ordinarily they operate from house current and when used in a car, a DC-to-AC converter is required.

Don't expect to hear distant stations, although this happens occasionally through skip transmission. Reception range depends upon the height of the transmitting antenna as well as the height of your own receiving antenna. Range is apt to be greater in winter than in summer because foliage tends to absorb VHF signals. The power of the transmitter also has a bearing on range, but not as much as antenna height.

You should be able to receive fixed stations up to 25 to 30 miles away and mobile units four or five miles away.

To identify the stations you hear, you need a call book. The Official Registry of Radio Systems in transportation, public safety, industrial, and telephone is available in four volumes from Communication Engineering Book Company, Radio Hill, Monterey, Mass.

So, to keep ahead of the news in your hometown, try tuning in on VHF. It is truly an unexplored vista for the short-wave listener.

How To Prepare A Chassis

Continued from page 58

flat, semicircular, or rat-tail file will enable you to neatly enlarge it.

Unless your piece of equipment is destined for extremely rough usage, work with an aluminum chassis. It is far easier to cut than steel. Perhaps the only drawback to aluminum is that you can't solder to it easily—but, ground lugs under various mounting nuts overcomes this. These chassis are available in natural or painted finishes, gray hammertone seemingly the most popular. Otherwise, a variety of hammertone, wrinkle, or flat paints may be used, if desired. Consult the catalogs of electronic supply houses and you'll find a variety of types to house the completed chassis.

Here are some suggestions for underchassis wiring. Run all leads except those carrying radio frequencies close to the metal chassis to utilize its shielding effect—and keep them short. When mounting resistors or capacitors make it a habit to orient any numbers, color dots, or other designations so they are visible after construction is complete. This makes troubleshooting much simpler.

In some of the projects appearing in *EI*, special wiring or construction methods may be recommended by the author. Follow them carefully since they usually contribute to the stability, proper heat dissipation, or other factor necessary for reliable operation of the device.

Chassis is finished with black wrinkle paint. Spray can, right, gives gray hammertone finish.

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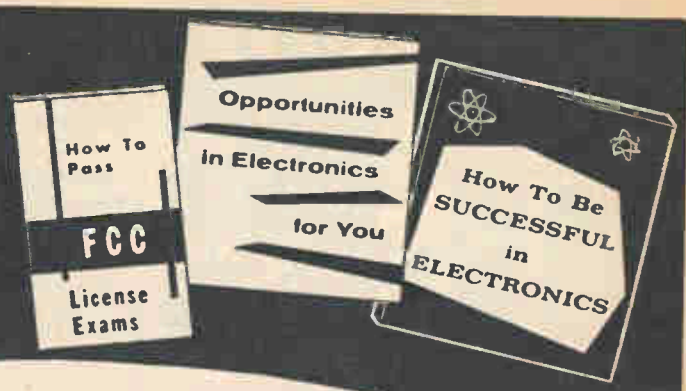

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Desk EI-7

An Experimenter's Control Center

Continued from page 75

sistance. Short terminals 8 and 9, and back off on R1 until the meter reads 4 ma. Leaving all other controls alone, flip SW2 "off" and set R2 for minimum resistance. Adjust the relay until it pulls in by gently pressing the armature spring toward the relay frame just above the single machine screw, with needle-nose pliers. Reset R2 for maximum resistance as before and flip SW2 on, adjusting R1 until the meter reads 3.5 ma. Again adjust the relay as before, continuing the process until it operates dependably at 3 ma. If you do not have a meter, adjust the relay as described above until it pulls in when R1 is at about ¾ maximum resistance.

The meter terminals are used to connect a low range milliammeter into the circuit. When the meter switch (SW2) is flipped to ON the relay is shorted out and the meter terminals are connected in series with the transistor and power supply. When the meter is on, R1 becomes a current limiting resistance and should be set so as to prevent the meter from being pinned. In addition, when at maximum value, it "simulates" the relay and provides a means of fast and accurate calibration of the device.

The output circuit controls the mode of operation. Normal relay operation is provided at terminals 5 and 6. There is not enough space on the strip to provide every function, that's why normally closed relay operation, which does not find much use, was sacrificed. If you desire this type of operation however, bring out the normally closed lead to a binding post and use it, and terminal 6, to make contact. A keyed voltage. which can be used to power auxiliary equipment such as relays, is available at terminals 6 and 7, terminal 7 being positive. The "lock-in" feature, which is controlled by SW3 and used for alarm circuits, can be used *only* with the keyed voltage or oscillator. If normal relay contacts on a lock-in basis is desired, connect an external relay (a sensitized LB5 is a good choice) to terminals 6 and 7. Of course, the normal relay contacts (5 and 6) with SW3 off can control a latching relay for first

pulse—make; second pulse—break operation.

The input circuit permits the use of all types of sensing elements. Elements that produce current such as selenium photocells should be connected between terminals 8 and 10, while those that change resistance upon the action of some outside phenomenon should be connected between terminals 8 and 9. An example of the latter is the thermistor used in fire alarms. Besides the photocell and thermistor, the partial list of sensing elements includes the following:

A tuned circuit for a field strength meter.

A small microphone and amplifying system with a rectified output for a sound relay.

A mercury switch for a change of position indicator.

A commercial moisture element for an electronic hydrometer or moisture alarm.

An AM tuner tuned to 1240 kc for automatic Conelrad alarm.

Terminals 11 and 12 are the external power supply connections. A small AC power supply can be used when a semi-permanent installation, such as a fan control for hot weather, is desired.

To test transistors with the device, set both R1 and R2 to maximum resistance; SW2 on and SW1 "Internal"; connect a 0 — 5 milliammeter across terminals 1 and 2 and note reading obtained as "Leakage." If this reading is almost full scale, the transistor is shorted and is worthless. For most transistors it should be under 1 ma. If it is, turn SW1 to "off"; place a 0 — 1 milliammeter across terminals 8 and 9; turn R1 until the meter reads 1/20 ma; leave the meter in the circuit or short out terminals 8 and 9; turn SW1 to "Internal" and note the reading on the 0 — 10 milliammeter. This reading divided by the bias (1/20 ma) is approximately equal to the beta gain of the transistor. The correct value can be found in many manuals. If no meter reading at all is detected, the transistor is "open" and worthless. The device is set up to test PNP transistors *only*. NPN units could be tested if the connections on both batteries are reversed.

Hi-Fi Sound From Your T.V. Set

Continued from page 44

inserted about a half-inch into proper holes. Though an 8-pin unit is shown here, 7-pin versions are also available if your TV set uses a miniature tube in the audio output. A 6AQ5 is a common example.

Notice that in the schematic three points of the sound tube are used; grid, ground, and plate. The correct pin numbers for the 6V6 tube used with the author's unit are 5, 8, and 3. A survey of TV schematics, going back about five years, revealed that the 6V6 is commonly used. Several others appeared which, incidentally, have the identical pin arrangement. They are 6W6, 6Y6, 6F6, 6K6, 6L6, 25L6—all octal, or 8-pin types. Two 7-pin miniature types also appeared; the 6AQ5, which uses pin 1 for grid, 2 for ground, and 5 for plate—and the 6AS5 that has pin 2 for grid, pin 1 for ground, and pin 7 for plate. Any variation in tube types for your particular set must be determined from a diagram.

Installation of the unit is outlined in the photos. A likely spot for the case is inside the rear cover of the TV set. Plug in the Vector socket as illustrated and run the phono cable to a high level input of the hi-fi set as described before. The TV set should be off.

Switch to the "Hi-Fi" position and adjust your amplifier volume control to its usual position. Bring up the TV volume control until a comfortable listening level is heard. If there is feed-through of sound in the TV speaker, reduce the TV volume control and raise the hi-fi amplifier volume. If hum is heard under the normal sound, reverse the AC plugs (one at a time) on the hi-fi or TV. One precaution to observe is not to use the magnetic or mike input on your hi-fi for use with this device. If you plug into one of these jacks, the signal levels will cause distortion.

While the unit is in hi-fi operation some very low level sound may barely be heard in the TV speaker. Since this should not prove annoying, no attempt was made to eliminate it entirely. However, it may be cut down even more by increasing capacitor C1.

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Electronic Pinspotter

Continued from page 50

respotting table lowers and its gripper pads tighten around those pins that remain standing, lifting them out of the way. The sweeper arm quickly clears the deadwood, and the table replaces the standing pins to the *exact* locations from which they were taken, ready to be bowled over by the second ball. Pins offspotted by the first ball are put right back on their offspot position.

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The only occasion a bowler would have to push a button is to get a new setup after the tenth frame.

An Auto Tachometer

Continued from page 57

terminals of the ignition coil and the connection can be made at either point.

Calibration can be carried out at the nearest garage. Have the mechanic attach his tachometer, rev up the engine and adjust R7 so the meter agrees with the garage instrument.

Variations in the value of the components may require a change in the value of R6 to place exact calibration within the range of R7. If, by adjusting R7, the tach reads too high, R6 should be reduced in value. Conversely, if the tach cannot be adjusted to read high enough, increase the value of R6.

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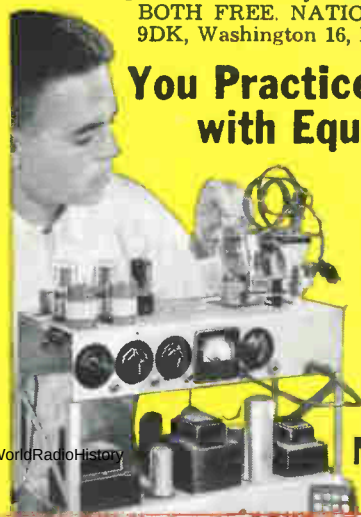

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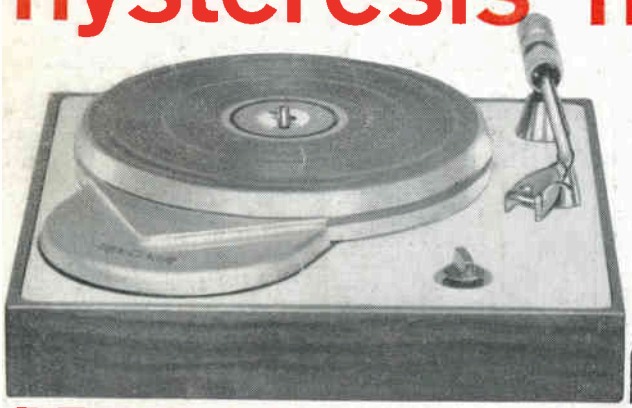

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