HUGO GERNSBACK, Editor

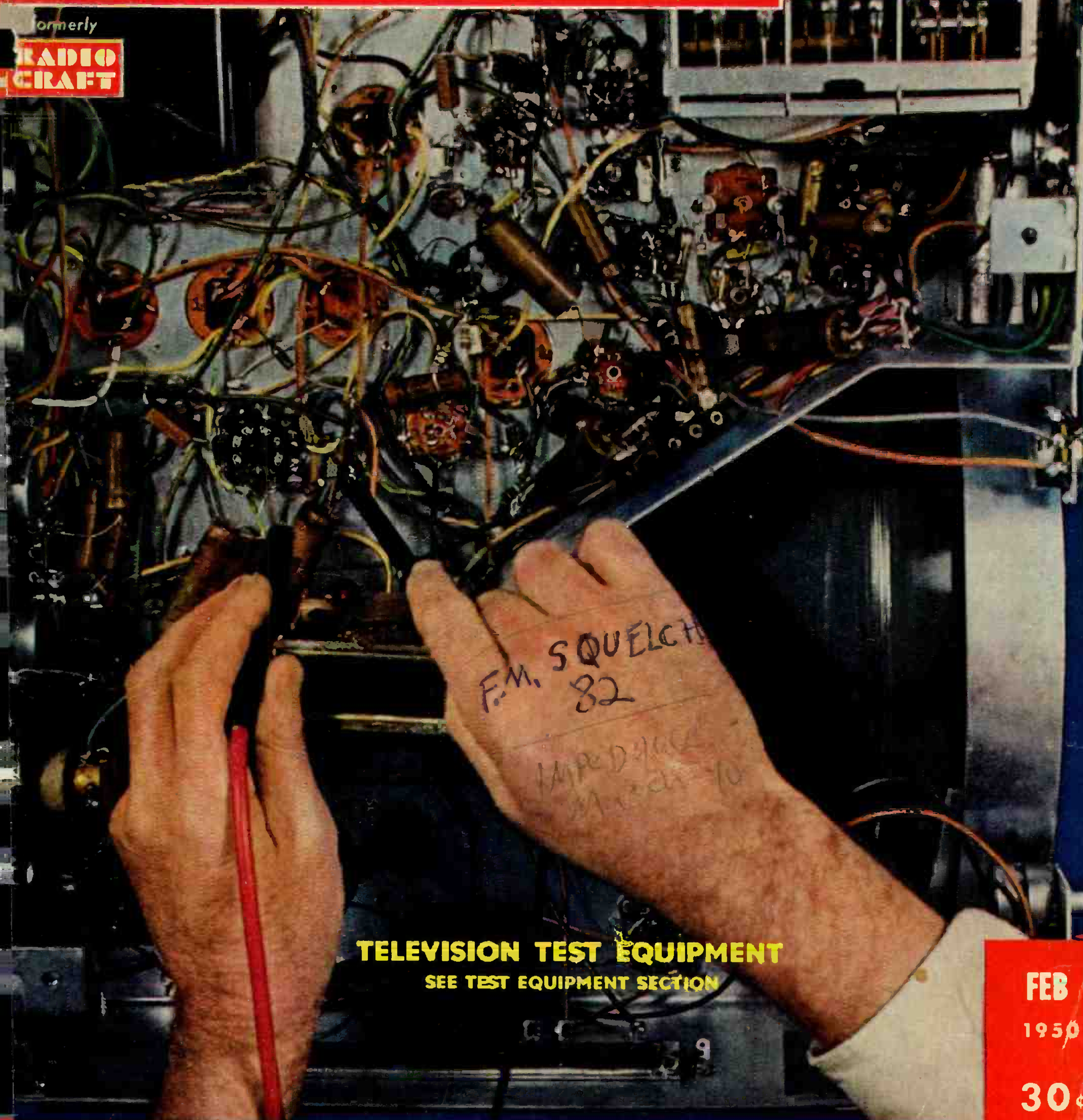
RADIO-ELECTRONICS

2" SCOPE - 30

TV Front End 39

K

Formerly RADIO CRAFT



F.M. SQUELCH 82

TELEVISION TEST EQUIPMENT

SEE TEST EQUIPMENT SECTION

FEB 1950

30¢ U. S. and CANADA

LATEST IN RADIO — ELECTRONICS — TELEVISION

A clear selling field

You can sell MORE RCA Batteries because...

RCA BATTERIES give you a clear selling field —they're distributed primarily to the radio trade!

You have less competition from non-radio neighborhood stores. Sell RCA Batteries and repeat sales stay with *YOU!*

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Closely co-ordinated production meets seasonal demand, assures fresh stock always.

RCA provides the greatest array of battery selling aids in the industry—all geared to the *radio trade.*

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See your RCA Battery Distributor for fast, reliable service.

RCA

RADIO CORPORATION of AMERICA

RADIO BATTERIES **HARRISON, N. J.**


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I Send You Parts To Build This Equipment
As part of my new Communications Course I send you parts to build your own Transmitter. Conduct actual procedure demanded of Broadcast Station Operators, practice many interesting experiments and tests, learn how to put a transmitter on the air.
NEW
You Practice Radio SERVICING
On This Modern Radio You Build With Parts I Send
As part of my Servicing Course, I send you the speaker, tubes, chassis, transformer, loop antenna, EVERYTHING you need to build this modern Radio Receiver that brings in local and distant stations. You use it to conduct many tests and experiments.
BE A RADIO-TELEVISION TECHNICIAN
Learn Servicing or Communications by Practicing in Spare Time with MANY KITS OF PARTS I Send
N.R.I. TESTER
YOU BUILD this Tester as part of my Servicing Course. It soon helps you earn $5, $10 and more a week EXTRA MONEY fixing neighbors' Radios in spare time while learning.
YOU BUILD this Power Pack as part of my new Communications Course. Use it to conduct fascinating experiments with frequency amplifiers and multipliers, buffer stages, etc.
YOU BUILD this Superheterodyne Receiver Circuit and conduct Frequency Modulation experiments and many other tests as part of my Servicing Course.
Want a good-pay job in the fast-growing Radio and Television industries or to be boss of your own money-making Radio and Television shop? I've trained hundreds of men with no previous experience to be Radio technicians. I can do the same for you! Or now, for the first time, enroll in my new practical course in Radio—Television Communications—learn to be a Broadcasting and Communications technician. You learn Radio and Television principles from clear, illustrated lessons. You get practical Radio experience with MANY KITS OF PARTS I SEND in my train-at-home method. All equipment yours to keep.
J. E. SMITH, President National Radio Institute
MAKE EXTRA MONEY IN SPARE TIME
As part of my Radio Servicing Course, I send EXTRA MONEY booklets, starting the day you enroll. Use your know-how to make $5, $10 and more a week EXTRA MONEY fixing Radios in spare time while training. The next step is your own Radio shop or a good-pay Radio servicing job. Or, if you prefer, get into Government, Police, Aviation or Marine Radio, Broadcasting, Radio Manufacturing or Public Address Work.
BRIGHT FUTURE IN TELEVISION
Think of the present and future opportunities in the fast-growing Television field. New stations are going on the air every month. . . . Television manufacturers are producing over 100,000 sets a month. It's a fast-growing field and the man who knows Television will be in demand.
GET ACTUAL LESSON AND BOOK FREE
Send now for my special DOUBLE FREE OFFER. Get actual lesson on Radio Repairing short-cuts absolutely free. Also get 64-page book, "HOW TO BE A SUCCESS IN RADIO—TELEVISION—ELECTRONICS." See how quickly, easily you can start. J. E. SMITH, President, Dept. OBX, National Radio Institute, Pioneer Home Study Radio School, Washington 9, D. C.
YOU BUILD this Signal Generator as part of my Servicing Course for more valuable experience. It provides amplitude-modulated signals for many interesting tests and experiments.
VETERANS
GET THIS TRAINING WITHOUT COST UNDER G. I. BILL
MAIL COUPON
YOU BUILD this Wavemeter as part of my new Communications Course. Use it with Oscillator you also build that furnishes basic power to transmitter and determines transmitter frequency.
I TRAINED THESE MEN AT HOME
Good Job In Radio Station
"Am Chief Engineer of Station WORD, in charge of four men. Owe all I know about Radio to NRI."—CLYDE J. BURDETTE, Spartanburg, South Carolina.
Makes Extra Cash In Spare Time
"Earned enough spare time cash to pay for my course by time I graduated. NRI training is tops!"—ALEXANDER KISH, Carteret, New Jersey.
Operates Own Radio Business
"Now have two Radio shops servicing about 200 sets a month. Have largest service establishment in Southeast Missouri." — ARLEY STUDYVIN, DeSoto, Mo.
MAIL COUPON! FIND OUT ABOUT THIS TESTED WAY TO BETTER PAY
Good for Both-FREE
GETTING ACQUAINTED WITH RECEIVER SERVICING
How to Be a Success in RADIO-TELEVISION
MR. J. E. SMITH, President, Dept. OBX
National Radio Institute, Washington 9, D. C.
Mail me FREE Sample Lesson and 64-page book about how to win success in Radio and Television—Electronics. (No salesman will call. Please write plainly.)
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Address.......................................
City.......................Zone..........State.......
☐ Check If Veteran APPROVED FOR TRAINING UNDER G. I. BILL

RADIO — ELECTRONICS

formerly RADIO-CRAFT

Incorporating
SHORT WAVE CRAFT* TELEVISION NEWS*
RADIO & TELEVISION
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Contents — February, 1950

ON THE COVER: Voltage check on the underchassis of a television receiver. Kodachrome by Avery Slack.

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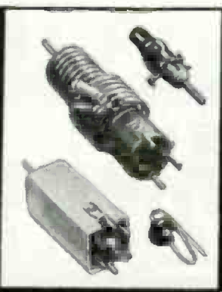
ABC MEMBER AUDIT BUREAU OF CIRCULATION

Picture and Sound IF and Video Coils—Kit #204X1 containing 15 coils for picture and sound if stages, and video circuits.



Type 208T2 Vertical Blocking-Oscillator Transformer—Generates 60-cps pulses to drive vertical-discharge tubes.

Type 204T2 Vertical Deflection Output Transformer—For vertical-deflection circuits using RCA-201D1, 201D3, or 201D12 Deflecting Yoke.

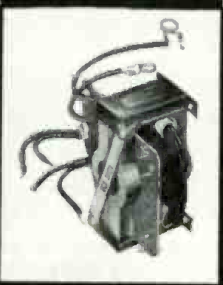
Type 203R1 Horizontal Oscillator and Synchronizing Control Coil—Permeability tuned center-tapped oscillator coil.

Types 201D1, 201D3, and 201D12 Deflecting Yokes—For RCA kinescopes 10BP4, 12LP4, and 16AP4.

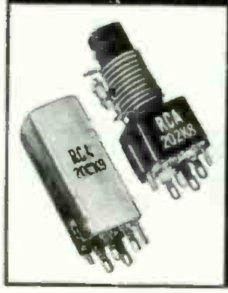
Type 202D1 Focusing Coil—For kinescopes such as the RCA-10BP4 operating at anode potentials up to 10 kilovolts.

Type 203D3 Ion-Trap Magnet—For use with kinescopes which utilize ion-trap guns and operate with anode potentials of 7 to 14 kilovolts.

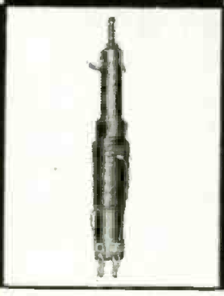
Type 211T5 Horizontal-Deflection-Output and High-Voltage Transformer—For pulse operated power supplies up to 13.5 kilovolts.



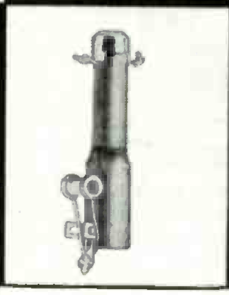
Type 208T3 Horizontal Blocking Oscillator Transformer—Designed to drive the grids of the horizontal discharge tubes.



Picture IF Transformers—Type 202K5 to 202K11—Seven coils for stagger-tuned IF systems such as used in RCA TV receiver models 8T241, 8T243, 8T244.



Type 201R4 Width Control—For controlling picture width in receivers using RCA-16AP4 kinescopes.



Type 203L5 Video-Circuit Trap—A 4.5-megacycle video-circuit trap designed to operate in the plate-circuit of the first video amplifier.

Original RCA TV COMPONENTS COST NO MORE

THEY CUT DOWN SERVICE RETURNS, AND INSURE SUPERIOR PERFORMANCE

RCA television components are "Originals," developed by famed RCA television engineers, and specifically designed to work with the tube types and circuits used in the top television receivers in the field. Millions of RCA TV Components are in use today. Play safe . . . replace with RCA "Originals." Use them in *your* shop.

GET YOUR FREE COPY OF THIS COMPONENT DIRECTORY

Tells at a glance the type numbers of RCA TV Components for replacement in 214 television sets of 38 manufacturers. Only guide of its kind! Get yours today from your RCA Distributor. (*Specify Form SP-1006.*)

RADIO CORPORATION of AMERICA
ELECTRONIC COMPONENTS **HARRISON, N. J.**

RADIO RELAY LINKS are being used to send television network programs to central and northern New York cities, the Long Lines department of the American Telephone and Telegraph Co. announces. The programs are carried from New York to Albany by co-axial cable and take to the air from there. Four radio relay stations have been constructed between Albany and Syracuse — at Rotterdam, Cherry Valley, Deerfield, and Sullivan. These buildings are of square, concrete design and are 60 feet in height. At their tops are the 10-foot-square horn-shaped antennas which receive and beam the video signals along the path.

Syracuse-bound telecasts will be channeled to the Long Line offices in the New York Telephone Company's Albany building at 158 State Street by the co-axial cable. They will then be beamed on a line-of-sight path by antennas which have been installed on a 60-foot tower on top of the building, to Rotterdam, which is located 21 miles away.

After the Albany-Rotterdam hop, a thirty-two-mile jump lies ahead to Cherry Valley. Close to 33 miles separates Cherry Valley from Deerfield and the distance between there and Sullivan is 40 miles. Slightly over twelve miles lie between Sullivan and Syracuse. Schenectady is served out of Rotterdam by a seven-mile link and Utica out of Deerfield by a three-mile jump.

IONIC ENERGY is being used to produce winds of formerly unheard-of velocities in a wind tunnel at the University of Michigan, *Science News Letter* reported last month.

The equipment consists simply of an electric arc generated between a copper cylinder and a surrounding copper ring. Application of a strong magnetic field causes the arc to rotate like a wheel. The rotating motion of the arc causes the air in the tunnel to revolve at extremely high speeds as it is dragged around with the arc.

This ionic tunnel can produce winds with velocities five to ten times the speed of sound (normally about 760 miles per hour at sea level). A small model is at present in use and a larger one will be built shortly. It will be used with artificially reduced pressure to simulate conditions in the earth's upper atmosphere.

TELEVISION TRADE SHOW and fifth annual "Television Institute" will be held in New York City February 6 through February 8. The event, which will be held at the Hotel New Yorker, is expected to attract 50,000 persons, according to Irwin A. Shane, general chairman.

Panel speakers will include industry leaders, sponsors, advertising men, film and program producers, engineers, and educators. Some 500 representatives of the film industry will also be present for the annual Television Film Conference, which, though combined with the Television Institute, will hold its own sessions February 8.

HIGH-DEFINITION TV broadcasts began last month in Paris. The 819-line standard (described in the March 1949 issue of RADIO-ELECTRONICS) is being used. The power of the new transmitter will gradually be stepped up to serve a larger area as more and more of the necessary receiver converters become available.

ELECTRON MICROSCOPES may be subjecting their users to dangerous doses of X-ray radiation. This discovery was made recently at the University of California at Los Angeles by Drs. Louis B. Silverman, Sylvia B. Elliot, and M. A. Greenfield, in the course of a general radiation survey of the atomic energy project at the medical school.

Detection instruments showed radiation at the intermediate viewing port of 70 milliroentgens per hour. The maximum radiation exposure permitted at the atomic energy project is only 50 mr per day. The scientists report that the radiation is caused by the electron beam striking metal parts of the instrument and the accidental use of ordinary instead of lead glass in the viewing ports of a few of the instruments.

They suggest that other electron microscopists survey the radiation from their instruments to determine whether X-ray intensity is above the biological safety level.

MAGNETIC SOUND TRACKS were used by Universal Pictures last month to make the first full-length feature ("Confidential Squad") ever recorded on magnetic tape. Heretofore, the sound had been recorded optically on film, a high-cost, delicate process. The recordings for the new picture were made on 35-mm film coated with magnetic material, then dubbed (after editing) to standard film.

NEW ELECTRONIC COMPUTER was revealed last month by the Boeing Airplane Co. It will be used to study the probable flight of war missiles. The new machine is an analog computer which shows its results as a series of rapidly moving dots on an oscilloscope screen. A high-speed motion-picture camera photographs the dots, the film then becoming a permanent record for retention.

V.H.F. RADIO will be used to communicate with an elevator in the new British television station at Sutton Coldfield, near Birmingham, England. The elevator will run inside the station's 750-foot mast, between ground and the 600-foot level.

The station, England's second, which started operation December 17, 1949 will cover the British Midlands, serving an estimated 6,000,000 people. Its vision transmitter has a power output of 35 kw and works on 61.75 mc, while the sound transmitter works on 58.25 mc with a radio-frequency power output of 12 kw.

A third television transmitter, to serve the north of England, is under construction.

IRE OFFICERS for 1950 are Raymond F. Guy, president, and Sir Robert Watson-Watt, vice-president, the Institute announced recently.

Raymond F. Guy

Mr. Guy is currently manager of radio and allotments engineering for the National Broadcasting Co. and is one of the industry's first broadcast engineers. He became a member of the staff of WJZ, the country's second licensed broadcast station, in 1921, when it started operations. He has been with the National Broadcasting Co. since 1929, and has participated in many international radio conferences.

Sir Robert Watson-Watt is one of the world's outstanding workers in the field

Robert Watson-Watt

of radar, and has been deputy chairman of the radio board of the British cabinet as well as scientific adviser on telecommunications for the British Air Ministry. He was the recipient in 1947 of the IRE Fellow Award for his "early contributions to radio and his pioneering work in radar."

The IRE Directors for 1950-51 are William H. Hewlett of Hewlett-Packard, and James McRae of Bell Telephone Labs, directors-at-large; and regional directors Professor Herbert J. Reich of Yale University, North Atlantic region; Professor Ferdinand Hamburger, Jr., Johns Hopkins University, Central Atlantic region; John D. Reid, Crosley Division of Avco Mfg. Corp., Central region; Professor Austin Eastman, University of Washington, Pacific region.

HARBOR RADAR was inaugurated in the port of Baltimore December 13th last, making Baltimore the first United States Atlantic coast port to have radar as an aid to merchant shipping. It was preceded only by Long Beach, Calif. (RADIO-ELECTRONICS, January, 1949, page 95) and the world's first civilian harbor radar installation at Liverpool, England (RADIO-ELECTRONICS, December, 1948, page 22).

The Baltimore installation will have more advanced features than the first two stations. It will work with a radiotelegraph station and the ship-to-shore phone, all in one building. Besides aiding ships to dock in foggy weather and advising them as to objects in their immediate vicinity, it will help to find convenient anchorages.

OVERLOADED POWER LINES during popular program periods is a new television complaint. The additional drain of large numbers of tele receivers in certain areas and housing projects already running close to the load limit is sufficient to reduce voltage appreciably. The television pictures come down in size proportionately. One housing project resident reports, "Between 5 and 9 pm I get a fine 7-inch picture on my 10-inch screen."

RADAR PROBES HUMAN BODY

A new technique developed at the Naval Medical Research Institute in Washington, D. C., uses a radar-like device to detect gallstones, bullets, shell fragments, bits of glass or wood, or other foreign matter in the human body.

Ultrasonic energy is transmitted by a crystal transducer into the body by placing the transducer against the skin. The waves are reflected by bones and by anything else whose acoustical properties are different from those of surrounding tissues. The reflected waves are fed to an oscilloscope. A foreign body which may or may not be visible by X-ray appears on the screen as an "echo," very much like the pip caused by an aircraft in radar detection. The distance of the echo pip from the incident pip shows the depth of the object.

CONGRESS BY TELEVISION was proposed last month by Senator Alexander Wiley, Wisconsin Republican, as a method of decentralizing government in case of atom-bomb attack. Under the proposal, senators and representatives would disperse to 30 or 40 points at which television receiving and transmitting apparatus would permit them to vote and participate in discussions.

JAPANESE radio receivers have reached an all-time high of 7,592,625, the Broadcasting Corp. of Japan announced last month. There were almost this many in 1944 but bomb destruction reduced the number by a little over 2 million. The present number of receivers means that about 42% of Japan's 16 million households are "radio homes."

RCA Victor, Harrison, N. J., has developed an electron-tube carton which features an ingenious new sleeve insert to provide greater protection against handling damage.

The new "snug-fit" tube carton, in addition to "preserving the quality built into the tube at the factory," the company said, "permits easier shelf identification of tube types and presents a more attractive appearance."

The carton-insert is a cone-shaped cardboard sleeve into which the tube is inserted by hand. The wide ends of the sleeve fold inward to lock the tube in place. To extract the tube, the folded ends are simply flicked outward. The tubes are held so securely that even a vigorous shaking will not cause movement or rattling of the tubes in the carton. For quick identification and selection of tubes, type numbers are printed in large figures on the outside flap of the new carton. The new snug-fit sleeve will be used for conventional glass and metal types. A corrugated sleeve will be used as the insert in the new carton for miniature types.

The Parts Distributors Show of 1950, to be held in Chicago, May 23, 24, and 25, will feature a three-day conference and clinic on sales and merchandising.

Nationally known keynote speakers on each of the three days will be followed by other authorities on each topic, selected from the electronics industry.

Tuesday afternoon, May 23, the program will feature sales and merchandising. It will be in charge of LES A. THAYER, of **Belden Mfg. Co.,** Chicago, and JACK A. BERMAN of **Shure Bros., Inc.,** Chicago.

On Wednesday afternoon, a program on inventory control will be in charge of JOHN F. RIDER of **John F. Rider Publisher,** New York, and H. L. DALIS, of **H. L. Dalis, Inc.,** New York.

Financial management will be the topic of the Thursday afternoon program, under the direction of WILLIAM O. SCHONING, **Lukko Sales,** Chicago, and HOWARD W. SAMS, of **Howard W. Sams & Co.,** Indianapolis.

Portfolios of material to supplement the daily discussions will be provided for all distributors attending the meetings, it was announced.

A detailed practical discussion of every phase of merchandising, sales, inventory control, and financing of interest to distributors is on the agenda. Case histories and actual experiences of distributors will be analyzed as illustrations, with a questions-and-answers period to follow each talk. Charts, films, and animated scale models will be used to demonstrate problems in display and inventory control.

Hytron Radio and Electronics Corporation of Salem, Mass., reported for the six months ended June 30 a net profit of $247,977, equal to 43 cents a share. For the same period of last year, the net profit was $47,598, or 8 cents a share.

The Radio Manufacturers Association, Washington, D. C., reported that sales of cathode-ray tubes for television receivers during the first nine months of 1949 were nearly double the value of such sales during the entire year of 1948. Sales of picture tubes totalled 2,129,210 units valued at $62,525,446 in the first three quarters of 1949, compared with 1,309,176 units valued at $33,459,554 in the full year of 1948.

The sharp trend toward larger pictures in television receivers was revealed in the breakdown of sales to equipment manufacturers. In the third quarter 65% of the picture tubes sold to set manufacturers were 12 inches or larger, whereas in 1948 they represented only 6% of sales to set manufacturers.

RMA member-companies reported shipments of 503,352 television receivers to 49 cities and a few unspecified areas during the third quarter of 1949. At the beginning of October, 2,209,724 television receivers had been shipped.

Third-quarter shipments brought total TV set shipments by RMA members for the year 1949 to 1,255,346. The RMA reports represent about 80% of total industry shipments of television receivers.

John F. Rider Publisher, Inc. of New York announces *Rider Manual Volume XX*, the latest volume in the series of manufacturers' authorized data, as a January, 1950, publication.

Manufacturers' servicing data on AM, FM, and auto receivers and record changers give complete coverage as of the publication date. A "How It Works" book with cumulative index for Volumes XVI through XX is another prominent feature.

All pages are filed in their proper places, making the volume available for immediate use on the service bench.

Built-in TV Antennas are not efficient and work in only a minority of locations, according to a survey of dealers in three cities, Chicago, Philadelphia, and New York, conducted by *Retailing Daily*. Dealers report that the public has responded to advertising, but that their own experiences show that the safer course is to steer customers toward conventional installations when possible. Even the usual indoor antennas appear to give better and more consistent performance than built-ins.

ANOTHER HYTRON FIRST YOU'LL BE BUYING SOON

NEW HYTRON RECTANGULAR all-glass 16RP4

Meet Hytron's space and money saver. The new Hytron 16RP4. Revolutionary 16-inch rectangular picture tube. Takes approximately same cabinet space as 12LP4. Automatically sets the pace for more compact and economical TV set design. You'll be seeing it . . . buying it . . . soon.

The new 16RP4 is latest in a long series of Hytron firsts. Including: The GT tube. Over 50 GT types. The subminiature. Many new miniatures. Special low-cost TV deflection-circuit tubes: 1X2, 6BQ6GT, 6U4GT, 25BQ6GT. Check the 16RP4's many features. Watch for it. Buy the best by the leader. Buy Hytron!

OLDEST MANUFACTURER OF RECEIVING TUBES
HYTRON
RADIO AND ELECTRONICS CORP.

HYTRON RADIO TUBES

MAIN OFFICE: SALEM, MASSACHUSETTS

With old-style round tube, you lose the corners.

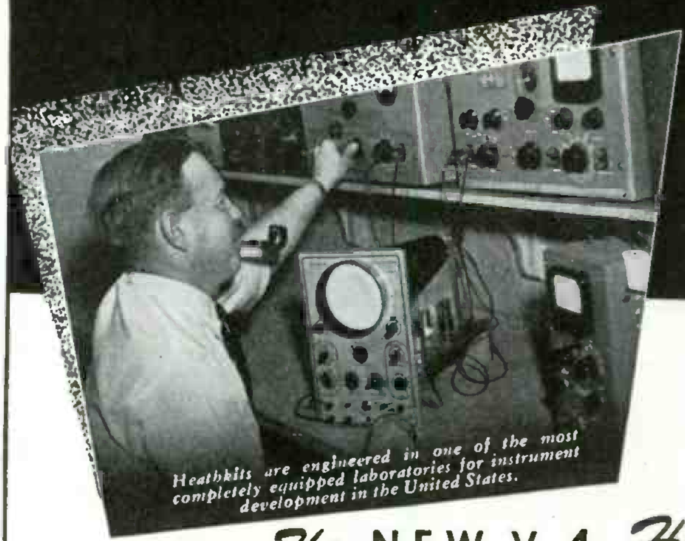
With Hytron 16RP4, you see the picture just as transmitted.

Features of HYTRON 16RP4

1. Rectangular shape permits smaller, less costly cabinets.
2. Also just as short as 12LP4.
3. Weight is approximately two-thirds that of 16-inch, all-glass round tube.
4. Easy to mount. Can't roll or twist.
5. No high-voltage isolation of tube required.
6. Neutral gray face . . . increases contrast ratio.
7. Large viewing screen. You get the entire transmitted picture; no lost corners. Gives picture (with standard 3 by 4 aspect ratio) 10⅛ inches by 13½ inches.

Write for Bulletin E-147 giving complete data.

Heathkits ARE LABORATORY ENGINEERED . . .



Heathkits are engineered in one of the most completely equipped laboratories for instrument development in the United States.

The NEW V-4 *Heathkit* VACUUM TUBE VOLTMETER KIT

Features

- Meter scale 17% longer than average 4½" meter.
- Modern streamline 200 ua meter.
- New modern streamline styling.
- Burn-out proof meter circuit.
- 24 Complete ranges.
- Isolated probe for dynamic testing.
- Most beautiful VTVM in America.
- Accessory probes (extra) extend ranges to 10,000 Volts and 100 Megacycles.
- Uses 1% precision ceramic divider resistors.
- Modern push-pull electronic voltmeter circuit.
- Electronic AC circuit. No current drawing rectifiers.
- Shatterproof plastic meter face.

The new Heathkit Model V-4 Vacuum Tube Voltmeter has dozens of improvements. A new modern streamlined 200 microampere meter has Alnico V magnet for fast, accurate readings. The new electronic AC voltmeter circuit incorporates an entire new balance control which eliminates contact potential and provides greater accuracy. New simplified switches for quicker assembly. New snap-in battery mounting is on the chassis for easy replacement.

The Heathkit VTVM is the only kit giving all the ranges. Check them — DC and AC full scale linear ranges of 0-3V, 0-10V, 0-30V, 0-100V, 0-300V, 0-1000V and can be extended to 0-3000V and 0-10,000V DC with accessory probe at slight extra cost. Electronic ohmmeter has six ranges measuring resistance accurately from .1 ohm to one billion ohms. Meter pointer can be offset to zero center for FM alignment.

The DC probe is isolated for dynamic measurements. Has db scale for making gain and other audio measurements.

The new instruction manual features pictorial diagrams and step-by-step instructions for easy assembly. The Heathkit VTVM is complete with every part — 110V transformer operated with test leads, tubes, light aluminum cabinet for portability, giant 4½" 200 microamp meter and complete instruction manual.

Order now and enjoy it this entire season. Shipping weight 8 lbs., Model V-4

$24.50

THE FINEST VTVM KIT AVAILABLE FOR THIS PRICE.

Accessory: 10,000V high voltage probe, No. 310, $4.50.
Accessory: RF crystal diode probe kit extends RF range to 100 Mc., No. 309, $6.50.

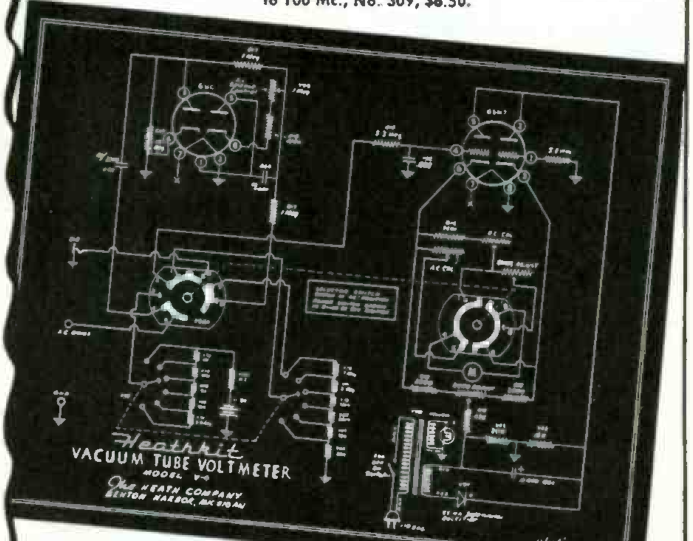
New Heathkit HANDITESTER KIT

Features

- Beautiful streamline Bakelite case.
- AC and DC ranges to 5,000 Volts.
- 1% Precision ceramic resistors.
- Convenient thumb type adjust control.
- 400 Microampere meter movement.
- Quality Bradley AC rectifier.
- Multiplying type ohms ranges.
- All the convenient ranges 10-30-300-1,000-5,000 Volts.
- Large quality 3" built-in meter.

A precision portable volt-ohm-milliammeter. An ideal instrument for students, radio service, experimenters, hobbyists, electricians, mechanics, etc. Rugged 400 ua meter movement. Twelve complete ranges, precision dividers for accuracy. Easily assembled from complete instructions and pictorial diagrams. An hour of assembly saves one-half the cost. Order today. Model M-1. Shipping wgt., 2 lbs.

$13.50



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Heathkits ENABLE THE BUILDER

New 1950 VERNIER TUNING RF

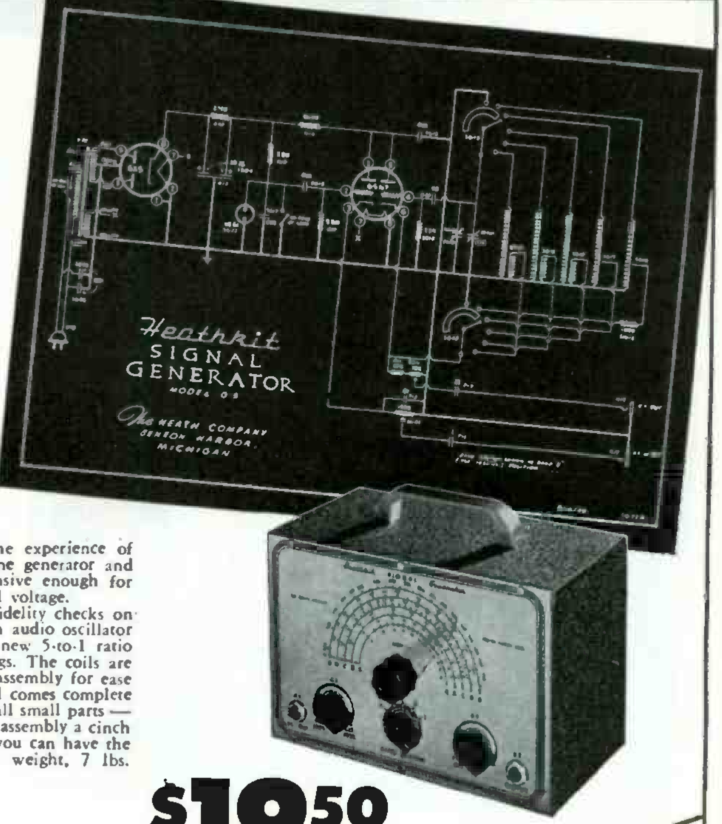
Heathkit SIGNAL GENERATOR KIT

Features

- New 5-to-1 ratio vernier tuning for ease and accuracy.
- New external modulation switch — use it for fidelity testing.
- Covers 150 Kc. to 34 Mc. on fundamentals and calibrated strong harmonics to 102 Mc.
- 400 cycle audio available for audio testing.
- Most modern type R.F. oscillator.
- New precision coils for greater output.
- Cathode follower output for greatest stability.

The most popular signal generator kit has been vastly improved — the experience of thousands combined to give you the best. Check the features in this fine generator and consider the low price $19.50. A best buy for any shop, yet inexpensive enough for hobbyists. Everyone can have an accurate controlled source of R.F. signal voltage.

The new features double the value — think of being able to make fidelity checks on receivers by inserting a variable audio signal. Internal 400 cycle saw-tooth audio oscillator modulates R.F. signal and is available externally for audio testing. The new 5-to-1 ratio vernier drive gives hairline tuning for maximum accuracy in scale settings. The coils are already precision wound and calibrated. Uses turret type coil and switch assembly for ease of construction. The generator is 110V. 60 cycle transformer operated and comes complete in every detail — cabinet, tubes, beautiful two color calibrated panel and all small parts — new step-by-step pictorial diagrams and complete instruction manual make assembly a cinch even for novices. Why try to get along without a signal generator when you can have the best for less than a twenty-dollar bill. Better order it now. Shipping weight, 7 lbs. Model G-5.



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Heathkit SINE AND SQUARE WAVE AUDIO GENERATOR KIT

Experimenters and servicemen working with a square wave for the first time invariably wonder why it was not introduced before. The characteristics of an amplifier can be determined in seconds compared to several hours of tedious plotting using older methods. Stage by stage, amplifier testing is as easy as signal tracing. The low distortion (less than 1%) and linear output (± one db) make this Heathkit equal or superior to factory built equipment selling for three or four times its price. The circuit is the popular RC tuning circuit using a four gang variable condenser. Three ranges 20-200, 200-2,000, 2,000-20,000 cycles are provided by selector switch. Either sine or square waves instantly available at slide switch. All components are of highest quality, cased 110V. 60 cycle power transformer. Mallory F.P. filter condensers, 5 tubes, calibrated two-color panel, grey crackle aluminum cabinet. The detailed instructions make assembly an interesting and instructive few hours. Shipping weight, 12 lbs. Model G-2.

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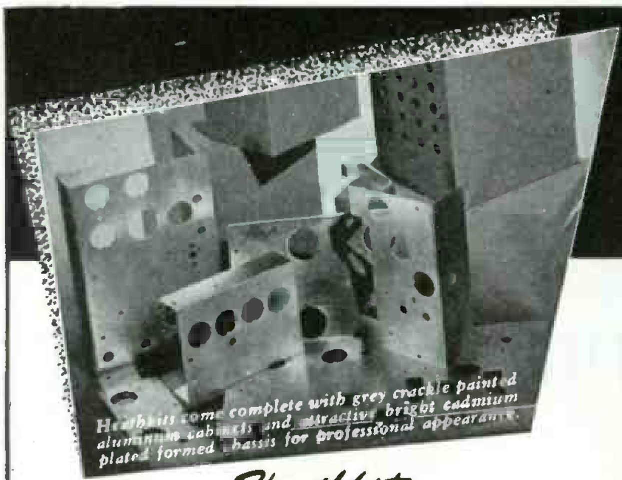

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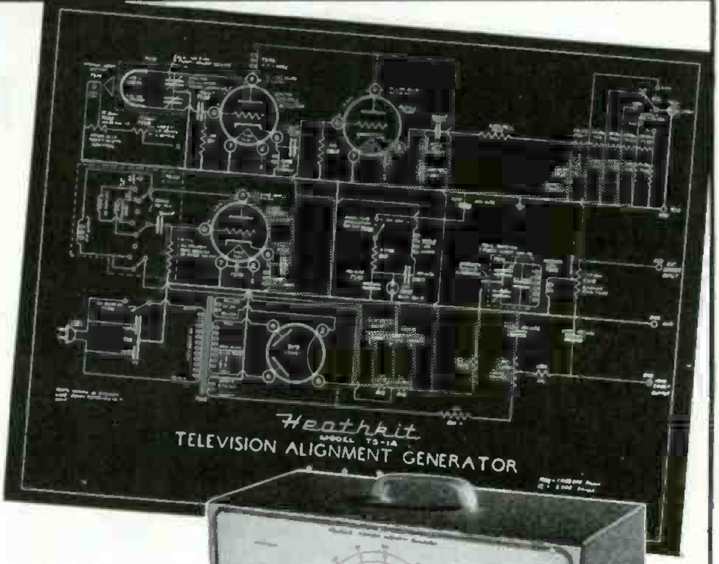

Heathkit TELEVISION ALIGNMENT GENERATOR KIT

Everything you want in a television alignment generator. A wide band sweep generator covering all TV frequencies 0 to 46 — 54 to 100 — 174 to 220 Megacycles, a marker indicator covering 19 to 42 Megacycles, AM modulation for RF alignment — variable calibrated sweep width 0-30 Mc. — mechanical driven inductive sweep. Husky 110V, 60 cycle power transformer operated — step type output attentuator with 10,000 to 1 range — high output on all ranges — band switching for each range — vernier driven main calibrated dial with over 45 inches of calibration — vernier driven calibrated indicator marker tuning. Large grey crackle cabinet 16⅛" x 10⅜" x 7-3/16". Phase control for single trace adjustment. Uses three high frequency triodes plus 5Y3 rectifier — split stator tuning condensers for greater efficiency and accuracy at high frequencies — this Heathkit is complete and adequate for every alignment need and is supplied with every part — cabinet, calibrated panel, all coils and condensers wound, calibrated and adjusted, tubes, transformer, test leads — every part with instruction manual for assembly and use. Actually three instruments in one — TV sweep generator — TV AM generator and TV marker indicator.

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Model TS-1A

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Shipping weight 15 lbs.
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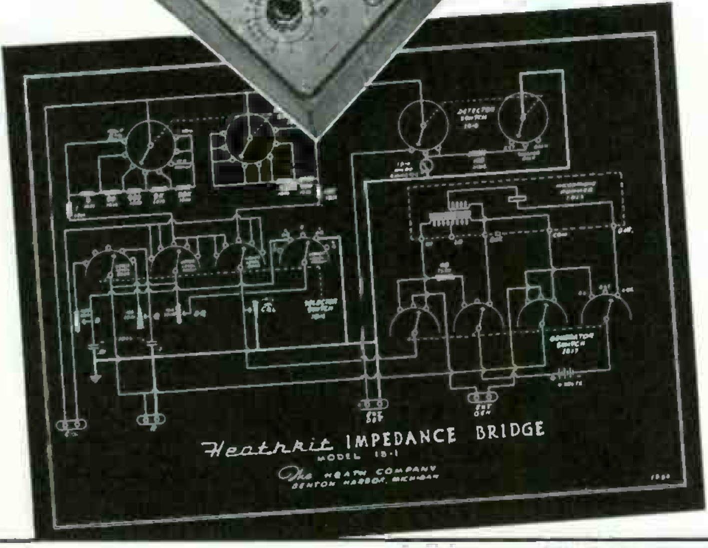

New Heathkit IMPEDANCE BRIDGE KIT

A LABORATORY INSTRUMENT NOW WITHIN THE PRICE RANGE OF ALL

Measures inductance from 10 microhenries to 100 henries capacitance from .00001 MFD. to 100 MFD. Resistance from .01 ohms to 10 megohms. Dissipation factor from .001 to 1. "Q" from 1 to 1000.

Ideal for schools, laboratories, service shops, serious experimenters.

An impedance bridge for everyone — the most useful instrument of all, which heretofore has been out of the price range of serious experimenters and service shops. Now at the lowest price possible. All highest quality parts. General Radio main calibrated control. General Radio 1000 cycle hummer. Mallory ceramic switches with 60 degree indexing — 200 microamp zero center galvanometer — ½ of 1% ceramic non-inductive decade resistors. Professional type binding posts with standard ¾" centers. Beautiful birch cabinet. Directly calibrated "Q" and dissipation factor scales. Ready cailbrated capacity and inductance standards of Silver Mica, accurate to ½ of 1% and with dissipation factors of less than 30 parts in one million. Provisions on panel for external generator and detector. Measure all your unknowns the way laboratories do — with a bridge for accuracy and speed.

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DIFFICULT METAL FABRICATION....

NEW *Heathkit*

SIGNAL TRACER AND UNIVERSAL TEST SPEAKER KIT

The popular Heathkit Signal Tracer has now been combined with a universal test speaker at no increase in price. The same high quality tracer follows signal from antenna to speaker, locates intermittents, defective parts quicker, saves valuable service time, gives greater income per service hour. Works equally well on broadcast, FM or TV receivers. The test speaker has assortment of switching ranges to match push-pull or single output impedance. Also tests microphones, pickups, PA systems; comes complete — cabinet, 110V. 60 cycle power transformer, tubes, test probe — all parts and detailed instructions for assembly and use. Shipping Wt., 8 lbs. Model T-2.

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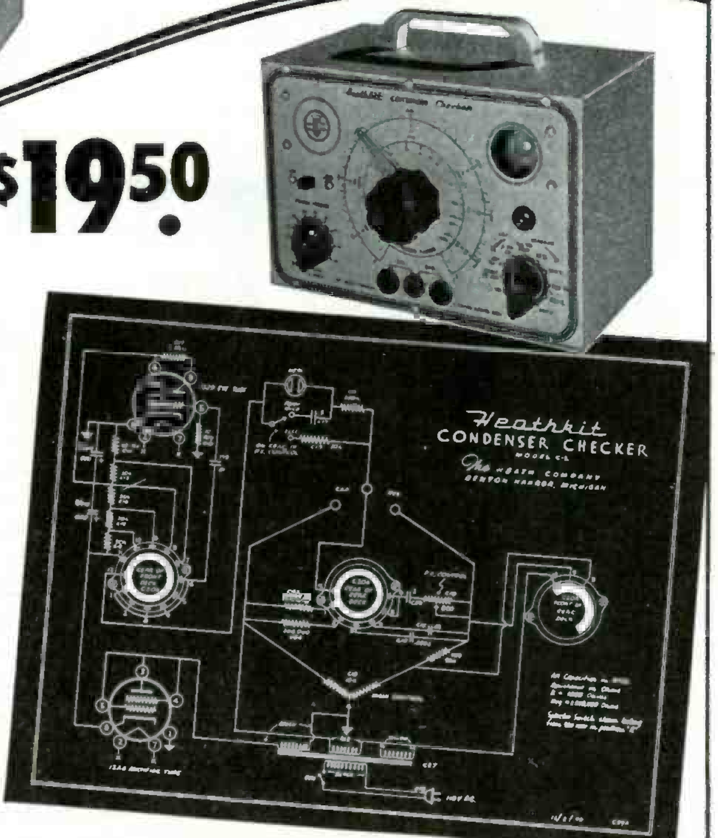

Heathkit

CONDENSER CHECKER KIT

Features

- Power factor scale
- Measures resistance
- Measures leakage
- Checks paper-mica-electrolytics
- Bridge type circuit
- Magic eye indicator
- 110V. transformer operated
- All scales on panel

Checks all types of condensers, paper-mica-electrolytic-ceramic over a range of .00001 MFD. to 1000 MFD. All on readable scales that are read direct from the panel. NO CHARTS OR MULTIPLIERS NECESSARY. A condenser checker anyone can read without a college education. A leakage test and polarizing voltage for 20 to 500 volts provided. Measures power factor of electrolytics between 0% and 50%. 110V. 60 cycle transformer operated complete with rectifier and magic eye tubes, cabinet, calibrated panel, test leads and all other parts. Clear detailed instruction for assembly and use. Why guess at the quality and capacity of a condenser when you can know for less than a twenty dollar bill. Shipping weight, 7 lbs. Model C-2.

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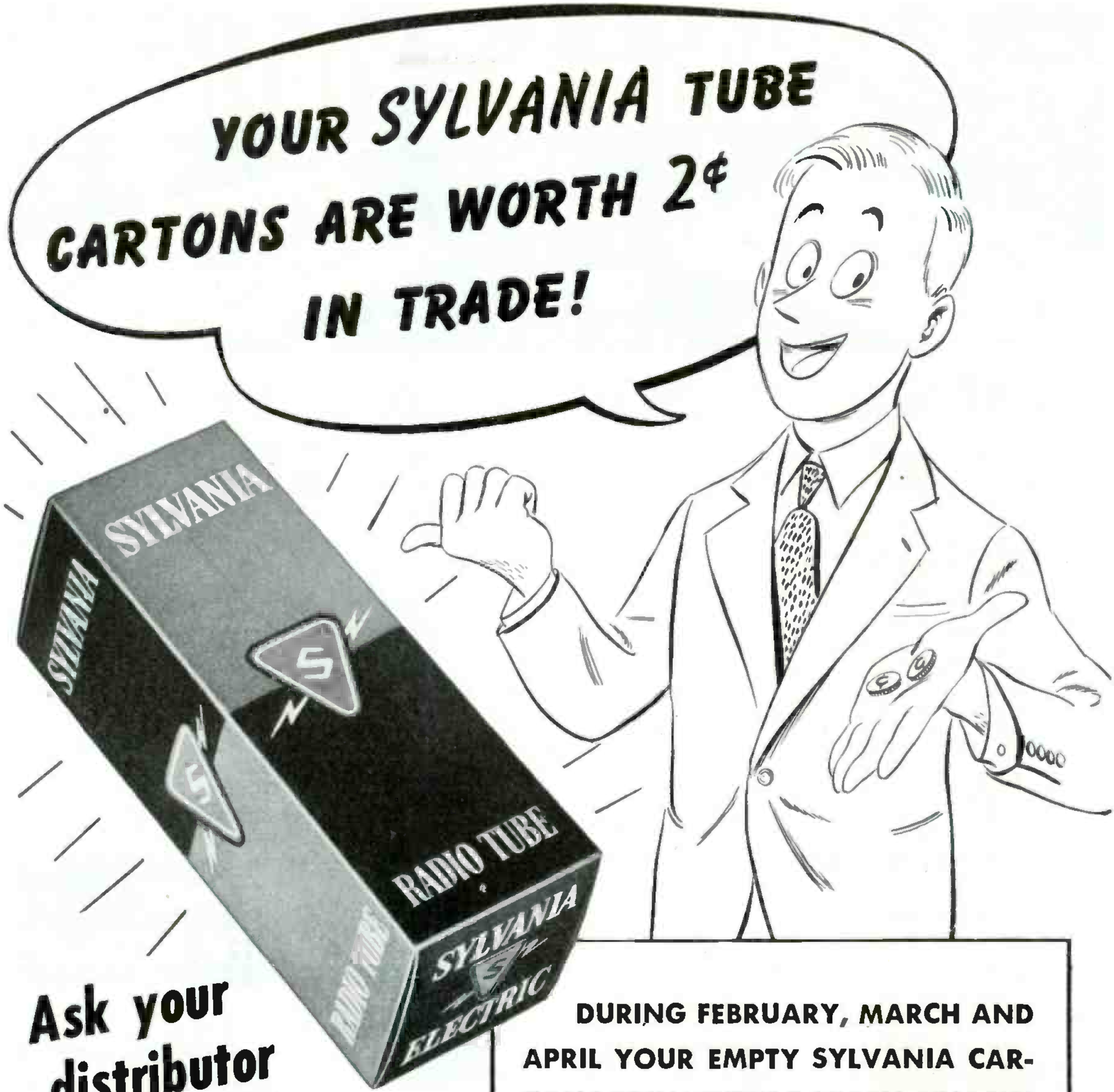

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Safeguarding your Inventions

... Documentary evidence is vital for inventions ...

By HUGO GERNSBACK

READERS of this magazine send us a continuous stream of letters asking advice how to proceed to safeguard new inventions, how to patent and how to sell them.

Practically every inventor is suspicious of his fellow man. Everybody—he feels—is out to steal his invention and to do him out of a fortune. He is suspicious even of a patent attorney and is loath to discuss his idea even with him. Yet he wishes to sell his invention to some big corporation and wants to collect royalties.

Most new inventors who have not had much experience with inventions and patents fall into this pattern. Here is a random example:

> "Editor, RADIO-ELECTRONICS:
>
> "Your editorial in the December issue sets out needed improvements in airplane public address systems. O.K., I have that problem solved, as well as several others in the electrical or electronic fields, but when I contact those who might be, or should be interested in buying such inventions they invariably try every way in the cards to steal the idea, and will not go into contract beneficial to me, even though I do guarantee each and every claim, etc."
>
> H. L.
> West Plains, Missouri

Certain elementary things *must* be observed to safeguard an invention. The most important of these is *documentary evidence*. Every inventor should put the elements of his invention on paper, preferably typewritten, or at least written in ink. Explanatory sketches made in ink should be on the same page. If the inventor knows he has a valuable idea, the piece of paper which now is the original conception of the invention, should be dated and signed before one or two witnesses, who should also sign their names on the same sheet of paper. It is not necessary that the witnesses know the contents of the invention, *they merely witness the inventor's signature.*

For further safeguarding, the document should be taken to a notary public and officially signed and stamped with date, notary public's name, etc.

Such a document often is worth more than a patent. It can be used in court as evidence and indeed has been so used in many court actions.

Edison, Lee de Forest, Tesla, and many other inventors of note have always used this system. It has paid big dividends.

One day on a visit to the late Edison, the writer noted that Edison always had before him a yellow paper scratch pad, size 4 x 6 inches. He personally made copious notes of anything that occurred to him during his work day. His secretary dated each sheet of note paper every day. Once a month these sheets were bound into a book. These books later were used in patent suits by Edison and were admissible evidence as to actual conception dates of his inventions.

The same was the case in the famous audion suits where Lee de Forest finally established his claims on the invention of regeneration.

Most inventors have little money. It is the exceptional inventor who is so fortunate that he can patent every invention and every important idea that he has. Patents are expensive—but in the end the good ones usually pay out.

The inventor should always be cognizant of the fact that it is one thing to invent something, but a totally different thing to protect the invention legally with a patent. The average inventor little realizes that *to have a valuable patent he must also anticipate various improvements that someone else could make on his original idea.* That is the reason why all patents, if they are good, are granted a number of important "claims" by the patent office. It is the number and scope of these claims that make a patent valuable.

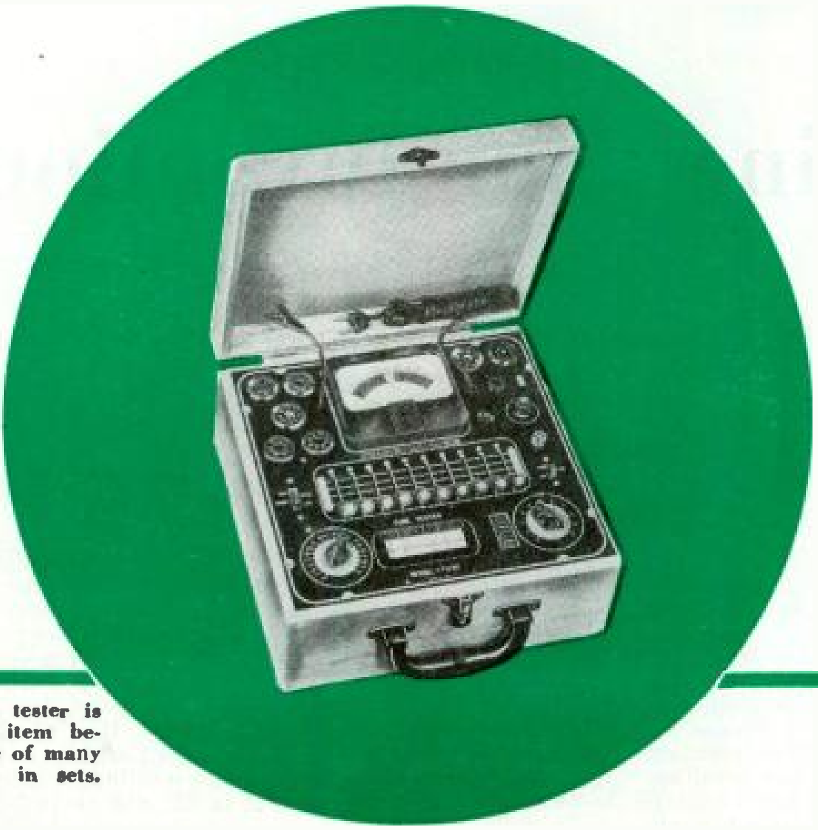
But the average inventor, knowing nothing about legal phraseology and practice is not competent to draft such claims. A good patent attorney will foresee the improvements that someone else could make on the original idea and will, therefore, try to obtain as many claims—anticipating such improvements—as he possibly can. These claims act like a ring of fortresses around a beleaguered city. Without them the invention becomes a prey to clever imitators.

Big corporations, as a rule, never appropriate inventions outright. What they do, however, often is improve on the original device, so much so that frequently the original inventor hardly recognizes his brainchild.

It is for this reason that it is never safe for an inventor to deal with commercial interests unless he has at least applied for a patent. It is better in most instances to wait until the patent has been issued.

Many inventors have tried to sell inventions by submitting photostats of their original documentary evidence sheets. Some have succeeded, most have not.

Large concerns dislike to buy inventions from mere documentary evidence—unless the invention is a very important one and fits into the company's operations. In no case does an inventor fare as well when selling his invention from an original document as from an actual patent. Thousands of successful inventions have been patented even if the inventor had no money at all. This has usually been accomplished by the inventor in taking some moneyed friends into his confidence. By showing them the document and perhaps a model of the invention he then sells a share in the invention to his friends in return for money used to patent the invention. This has always been a safe and sane means for handling new inventions.



Tube tester is vital item because of many tubes in sets.

TELEVISION TEST EQUIPMENT

● HOW MUCH IS NEEDED AND HOW TO USE IT

BY WALTER R. JONES*

THE rapid increase in the number of television receivers in operation has made life increasingly complicated for the radio technician. Not only are the problems of installation greatly aggravated; the customer must be educated in order to reduce to a minimum the number of unjustified complaints. In addition, the service technician must determine how much money he can afford to spend on test equipment and just what equipment he really needs. The confusion is in no way reduced as he examines test-equipment literature and encounters such terms as crosshatch generators, genescopes, signal alignment generators, dynatracers, markers, signal tracers, sweep generators, and field-strength meters. The problem can be eased, however, by reviewing what must be done and then deciding how to do it.

First, let us review the over-all problem. Two signals must be received, the picture and the sound. They are always separated by 4.5 mc as shown in Table I. The over-all bandwidth of each channel is 6 mc. Fig. 1 shows how the adjacent channels can cause trouble if traps are not properly tuned and any or all of the circuits improperly aligned.

Channel frequencies run from 54-88 mc and from 174-216 mc. The r.f. and mixer stages must operate in these ranges while the oscillator operates at frequencies spaced above or below the r.f. by the intermediate frequency. At present there is no real standardization of intermediate frequencies. They range from 15.2-37.3 mc for video with the sound i.f. 4.5 mc away (the 4.5-mc separation is, of course, common to all receivers).

For purposes of simplification a television receiver may be broken down into five sections based on the signals handled:

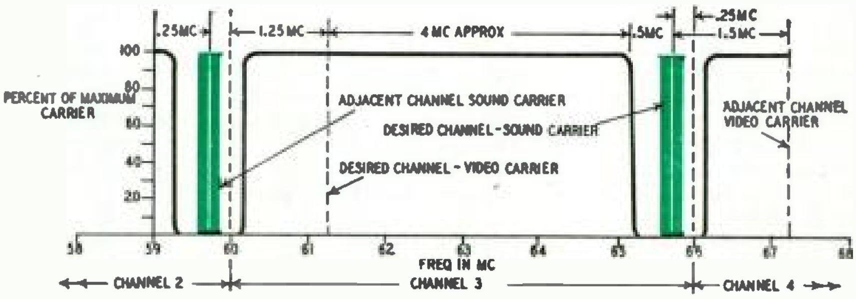
1. R.f.;
2. Sound;
3. Video or picture;
4. Sweep;
5. Power supply.

The technician should automatically break down the schematic into these sections. This can be done with red pencil right on the schematic diagram itself.

The most important part of servicing any equipment is to locate the source of trouble. Isolation of the difficulty to one of the sections listed is the first step.

Since the low-voltage power supply is common to all sections, that is the logical place to start. There are several ways to check it without using specialized equipment. The simplest check is to see whether the sound section is operating; if so, the low-voltage power supply is delivering voltage. If the picture tube shows a raster, the high-voltage supply is working. If either of these indications is not present, then a voltmeter with an insulated case will serve to check the voltages delivered by each supply. (A special, insulated probe is usually necessary for the high voltage.)

If the power supplies are satisfactory, the technician can start signal tracing. A modulated signal can be applied to the input and a crystal rectifier probe used to detect the passage of the signal through the various stages. Once the defective stage has been located, the difficulties can be found with other test equipment. The procedure just mentioned can be tabulated as follows:



From Photofact Television Course, © Howard W. Sams, Inc.

Fig. 1—Adjacent channels can cause trouble if a set is not aligned correctly.

* Television Technicians Lecture Bureau.

TEST EQUIPMENT REQUIRED

1. Check low-voltage supply	20,000-ohm/voltmeter or v.t.v.m.
2. Check high-voltage supply	20,000-ohm/voltmeter or v.t.v.m. with high-voltage probe
3. Trace signal	Modulated signal generator; 1N34 crystal detector probe
4. Check components in defective stage	Voltmeter, ohmmeter, or v.t.v.m.
5. Sweep circuit	Oscilloscope

Thus we find necessary, or at least extremely useful: a high-resistance voltmeter, preferably a v.t.v.m.; a modulated signal generator; signal-tracing equipment including a 1N34 crystal detector probe; an ohmmeter; and an oscilloscope.

After the receiver is operating again it may be necessary to check alignment. *This should be done only if necessary.* One of the greatest temptations when one has new alignment equipment is to try it out on the first television receiver that comes in. Use good common sense and a little restraint.

For television r.f., i.f., and oscillator alignment a sweep generator, signal and marker oscillators, crystal calibrator, and scope are necessary.

The tube tester

In all stages of a television receiver the tube tester may be useful. More service calls are ultimately traced to bad tubes than any other cause.

As most service technicians have found out in their nontelevision work, the only reliable test for a tube is to put it in the circuit with which it must ordinarily work and see whether it actually functions. The same is true to an even greater degree in television. If a tube is suspected, a new tube should be substituted if at all possible.

The technician familiar enough with his tube tester to distrust it, can, however, often make intelligent judgments based on what the tester tells. Obviously, for instance, if the tube does emit (emission-type testers) or does amplify (mutual-conductance testers), there must be some good in it; though whether it is good for the circuit in which it belongs or in some other is still open to question. If, however, it does neither, it can be thrown away.

To summarize: if the tube tester says "bad," the tube is almost certainly bad. If it reads "good," it may be either good or bad in its circuit.

Voltohmmeters

Table II shows the resistance which the voltmeter places across the circuit being measured, depending upon which scale is employed and the sensitivity of the meter movement. If one has a 1,000-ohm-per-volt meter, it is obvious that only on the higher scales is it likely to be useful other than as a device for measuring *relative* values of voltage. The effect of using the meter may be to alter the circuit conditions seriously.

Measurements of high voltages must be made only after considering the effect of the meter on the circuit. The drain on these circuits is usually very low, and the meter resistance, unless a 20,000-ohm-per-volt unit is employed, may seriously affect the readings. A special probe and special insulation are required to make the measurements safely. Study the service manual on the test instrument before attempting high-voltage measurements.

Ohmmeters

The values of the various resistors encountered in service run from a fraction of an ohm to 10 megohms with an occasional value even higher. A survey of the components of a TV set indicates that this part of the voltohmmeter is likely to see plenty of use. The scales should be clear and easy to read.

Current meters: Often it is desirable to read the current flowing in a circuit so that the voltage across part of it can be calculated without the upsetting influence of a voltmeter. A good example is the oscillator circuit of a receiver. If we were to place a voltmeter across the grid leak, we would probably stop its oscillation. By opening the low side of the grid leak and inserting a microammeter in the break, we can read the current flowing, provided the leads at the chassis are bypassed. This is one way to get around some of the problems mentioned. The voltage developed will be the product of the current times the resistance.

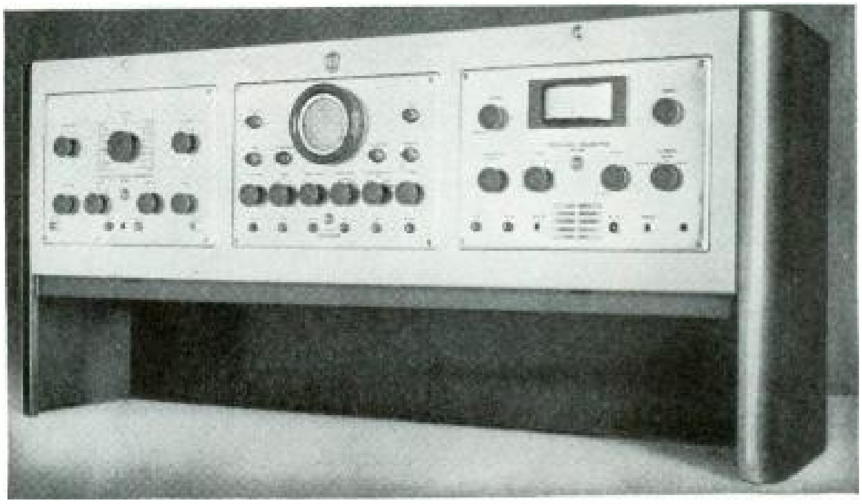
Vacuum-tube voltmeters

Table II indicates that the influence of a voltmeter, even with 20,000 ohms per volt, may seriously affect some readings. A vacuum-tube voltmeter has a high-resistance input which is nearly constant for all ranges. In an instrument of this type the meter will usually not be damaged if the wrong scale is used, as would be the case with a regular voltohmmeter.

There are other upsetting influences besides input resistance on some circuits. The capacitance of the meter and its leads may, in many circuits, cause a false reading. A probe having a 1-megohm resistor at its tip serves very well to reduce this effect.

Some v.t.v.m.'s are provided with circuits which will permit reading capacitances from 1.5 μμf to 100 μf or more. This is very useful, as many capacitors are employed in the average receiver.

V.t.v.m.'s can be employed for peak-



A unitized collection of television test instruments like this RCA rack will save time for technicians who can afford to make the necessary original investment.

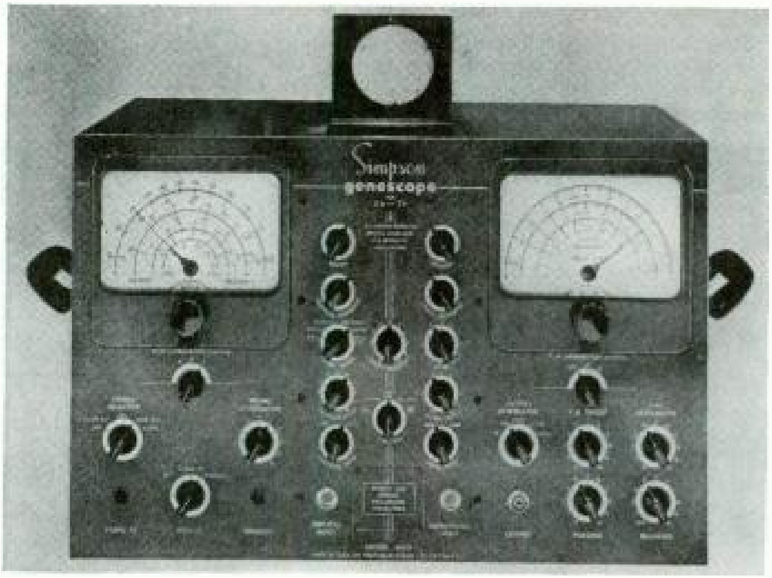
TABLE I

Channel Number	Channel Freq. (Mc)	Picture Carrier Freq. (Mc)	Sound Carrier Freq. (Mc)
2	54–60	55.25	59.75
3	60–66	61.25	65.75
4	66–72	67.25	71.75
5	76–82	77.25	81.75
6	82–88	83.25	87.75
7	174–180	175.25	179.75
8	180–186	181.25	185.75
9	186–192	187.25	191.75
10	192–198	193.25	197.75
11	198–204	199.25	203.75
12	204–210	205.25	209.75
13	210–216	211.25	215.75

TABLE II
VOLTMETER RESISTANCE

Range	Resistance 1,000 ohms/volt	Resistance 20,000 ohms/volt	V.t.v.m.
0–2.5	2,500	50,000	10 meg
0–10.0	10,000	200,000	10 meg
0–50.	50,000	1 meg	10 meg
0–250	250,000	5 meg	10 meg
0–1,000	1 meg	20 meg	10 meg
0–5,000	5 meg	100 meg	10 meg

to-peak voltage measurements; but, since the waveform is likely to be anything but a sine wave, there will be no fixed relation between the peak and average values. In making these measurements, the input loadings, resistive and capacitive, are still very important because they can radically affect the waveshape. The manual supplied with the v.t.v.m. indicates precautions to be taken with the meter, and also shows its limitations.



Some instruments combine two functions. This is scope and generator.

Cathode-ray oscilloscopes

There are times when it is desirable to look at the waveform in addition to measuring its peak value. The cathode-ray oscilloscope makes that possible. The vertical amplifier in the scope must neither distort or change the shape of the waveform, or the results will not be of much value. If the amplifier response is flat up to at least 300 kc, the scope can be used for measurement of video, sync, and sweep signals. The low-frequency response must also be good.

If the horizontal sweep gain is reduced to zero, then the vertical trace may be used as a voltmeter which can be calibrated for various positions of the vertical gain control. The loading of a circuit by the scope must be taken into consideration. The vertical amplifier circuit has an input resistance of approximately 1 megohm, whereas the input capacitance may vary from 20 to 100 μμf. The shielded cable adds considerable additional capacitance; the total may be close to 200 μμf. There are many points in the receiver at which this amount of capacitance will disturb the circuit sufficiently to change the waveshape radically. A special probe is usually supplied to reduce the loading of the circuit under test to a few micromicrofarads. To achieve this reduction, an attenuation of signal of the same order as the capacitance reduction will take place. This will amount to as much as a 6-to-1 reduction in signal voltage; but the signals to be measured usually being on the order of 10 volts, this will not be serious, and readable signals will still be obtained if the scope has reasonable vertical amplifier gain.

To obtain maximum usefulness, connections to the plates of the cathode-ray tube should be brought out to terminals so that the scope amplifiers—either vertical or horizontal—can be bypassed if the signal is large enough to show on the screen. The amplifiers must have minimum phase distortion if a true reproduction of the waveform is to be obtained.

Alignment generators

A television alignment signal generator is a piece of equipment which many service technicians have not as yet acquired.

The problem of alignment can be broken down into such steps that the requirements of the equipment can more readily be determined. The suggested order is as follows:

1. I.f. sound traps;
2. Adjacent-channel traps;
3. I.f. amplifiers;
4. Sound channel;
5. Oscillator;
6. R.f. amplifier.

The chief difference between a conventional signal generator and a television alignment generator lies in the width of sweep required to show the response curve on the oscilloscope. The sweep width should be 10 mc or more wide so that the trap settings may be checked.

The generator must be capable of covering the entire TV band either by fundamentals or harmonics. Since intermediate frequencies as low as 5 to 7 mc may be encountered in older TV receivers, the generator must be able to tune to at least these frequencies.

To determine that the i.f. response curve has been properly adjusted, an auxiliary piece of equipment known as the marker oscillator must be employed. Often this is built in with the alignment generator. This marker oscillator must be accurately calibrated and should cover the range from 20 to 30 mc. This will enable the user to make certain that, not only is the response curve shape of the receiver correct, but the shape is correct at the proper frequency points. Provision is usually made to modulate this oscillator with an audio signal. It can thus be used for tuning traps as well as adjusting stagger-tuned receivers.

Using test equipment

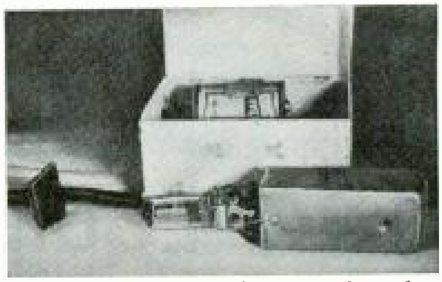
All test equipment together with the receiver under test should be placed on a metal-top bench. The ground connections for each piece of equipment should then be tied to the bench top with short lengths of ½-inch braided-copper ribbon. If a metal bench top is not available, the equipment must be bonded together with short lengths of braided-copper ribbon. The effectiveness of this bonding can be checked during alignment by placing the hand on the metal chassis being aligned and on the metal cases of the various pieces of test equipment. If the response pattern or meter reading changes, the grounding must be improved before the circuits are aligned.

In using test equipment for radio and television receivers, perhaps the most important factor which should be emphasized is that it is necessary to understand fully the limitations and capabilities of the equipment. If one purchases the best piece of test equipment available and neglects to learn its exact utility, that person is not taking full advantage of the investment he has made; and the results he will obtain with this equipment will certainly not be comparable with those obtained by a competitor using the same equipment and familiar with its correct usage. Unless one is willing to invest sufficient time to understand his test equipment very thoroughly, it is probably unwise to purchase it at any price. On the other hand, if one is willing to spend the time necessary to learn what the equipment will and will not do, the investment becomes worth many times the original expenditure.

After the equipment has been purchased and is ready to be used, it is equally important to understand the manufacturer's instructions regarding its use in servicing a *specific* television receiver. Unless one takes the pains to utilize service data which usually is available from the manufacturer himself or from other services who make this information available, a great deal of time will be wasted without actually solving the customer's problem.

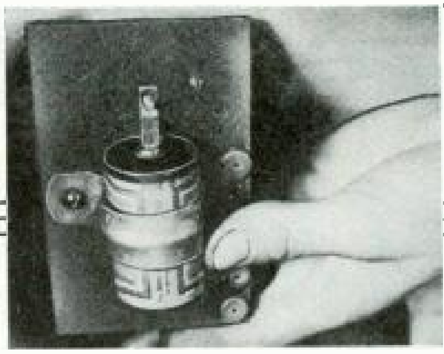
A collection of service data is indispensable to the television receiver technician. In the final analysis, the only purpose of a test instrument is to determine whether a circuit is operating in accordance with the manufacturer's specifications. If the specifications are not known, the test instrument loses a great deal of its value.

Small Signal Tracer



Tracer and probe.

Portable test instrument fits in metal card-file container



Filament battery is held by cable clamp.

By HOMER L. DAVIDSON

THIS small, portable signal tracer is constructed inside a 3x5 index-file box. A 67.5-volt B-battery furnishes plate and screen voltages, while a flashlight cell lights the filaments of the two miniature tubes. The B-battery lies flat on the bottom of the box, with enough space left above it for a 1S4 amplifier stage. The probe is homemade.

The circuit, given in Fig. 1, is familiar. With screen and plate of the 1S5 in the probe tied together, this tube functions as a triode detector and amplifier. Several small tubes were experimented with, but the 1S5 gave greatest pickup gain and least distortion.

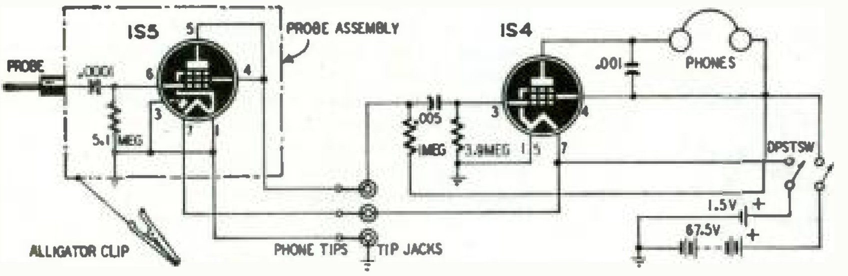


Fig. 1—Complete signal-tracer diagram. The 1S4 and its circuits are in the box.

The chassis is cut from a piece of Masonite. The filament cell is mounted with the aid of a cable clamp, as the photo indicates. Five small, colored tip jacks at the edge are for the probe leads and the phones. A ⅛-inch metal bracket is tightly wrapped around the miniature tube socket and bolted to the chassis. The chassis fits snugly in the index box. Two small metal screws go through the thin metal and come out just above the chassis and hold it down snugly against the flat 67.5-volt B-battery.

Making a probe that would allow the miniature tube to stand rough knocks was rather difficult. Finally the small probe was built inside a small i.f. can, as Fig. 2 shows. The probe needle itself is a solderless prod tip. The insulation core was tapped; a screw going through a hole in the top of the can holds it tightly. The lead from the 100-μμf mica capacitor is placed through one of the trimmer holes and screwed up tightly on the prod tip.

A small mounting bracket was drilled to take the 1S5 tube socket, two holes being drilled and tapped in it. Before this strap is screwed to the metal can, it is best to place the 1S5 in its socket and place a rubber sponge around it to reduce microphonics and prevent damage from rough handling.

Three colored leads in a rubber-covered cable come from the probe. It is a good idea to paint the corresponding colors near the tip jacks on the Masonite chassis, assuring correct connections.

Another piece of Masonite is cut and drilled to be fastened to the open end of the i.f. can with the two mounting lugs already on the can. The three-wire cable is held in place by wrapping a few turns of steel wire around it tightly and then looping one end over one of the lugs.

After the small signal tracer was constructed, it was tried on a troublesome receiver. Surprising results were obtained. It located weak stages, defective tubes, bad coupling capacitors, open coils, and almost any condition one could name.

One of the tracer's biggest advantages is that no line isolation transformers have to be used. Moreover there is no bothersome a.c. interaction between it and the receiver. Fasten the alligator clip to the common negative or ground of any receiver and touch the grid cap of the first r.f. stage or the antenna coil, and a local station can easily be heard in the phones. Always tune in a local or powerful station while checking the first r.f. stage because the r.f. energy here is very small. Now try placing the probe on the plate of this first r.f. amplifier and notice the volume. From this stage on through the rest of the receiver, the probe doesn't necessarily have to touch the soldered contacts but can be held close to the wire carrying the signal. When checking the last one or two audio stages, it is best to have the volume turned way down on the receiver, for the signal has been amplified quite a few times and is sometimes rather hard on the user's ears.

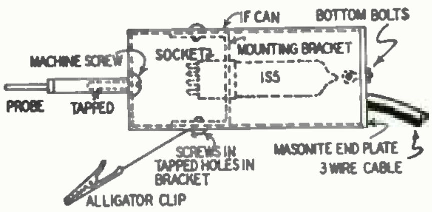


Fig. 2—Probe and 1S5 are in i.f. can.

This small audible signal tracer is inexpensive to build, but it is mighty effective for tracking down signals. If you don't desire to build it in an index file box, it can easily be made part of your regular service panel or can be placed in any other container.

Test Equipment for Television

by
ROBERT A. STANG*

THERE has been a dearth of comparative data on television test equipment. With this in mind this survey has been compiled to give the prospective buyer an opportunity to make an objective, informed comparison of available commercial equipment. The survey has been limited to television sweep generators and oscilloscopes, these two instruments being the most important in television servicing.

The general list of sweep generator and oscilloscope characteristics is followed by a tabulation specifically describing various commercial units to aid the reader in determining what to look for in making his purchase.

Television sweep generators

Frequency coverage: For use on present TV bands, should cover from as low as possible to 216 mc. A generator which starts at 2 mc will complement your present AM generator for over-all broadcast coverage.

Fundamental range: The use of fundamentals throughout minimizes spurious-signal interference and insures adequate power output on the higher bands.

Sweep width: Should be adjustable up to 12 mc. A linear sweep produces a

* Blair-Steinberg Co.—395 Broadway, New York City.

SWEEP GENERATORS

	Precision E400	Hickok 610A	Jackson TVG-1	RCA WR59A	McMurdo Silver 911	Simpson 479 480[4]	U.S. Tel. TVFM	Triplett 3434	RCP TV-75	Supreme 675	GE ST-4A	Kay Mega-sweep	Philco 7008[3]
Freq. cover-age	2-480 mc	10-250 mc	2-216 mc	18 fixed freqs.; 5-216 mc	2-226 mc	2-260 mc	0.5-110 mc	0-240 mc	5-270 mc uncali-brated	18 fixed freqs.; 4.5-216 mc	4-110 mc; 170-220 mc	50 kc-1,000 mc	2-260 mc
Fund. range	2-195 mc 5 bands	10-125 mc 3 bands	2-216 mc 6 bands	ditto	2-177 mc 1 band	2-260 mc 2 bands	0.5-110 mc 1 band	0-120 mc 2 bands	5-270 mc 1 band	ditto	ditto 2 bands	50 kc-1,000 mc	4-260 mc
Sweep width	0-1 mc 0-15 mc	0-15 mc	0-0.1, 0.2, 0.5, 1, 2, 6, 12 mc	1.5-10 mc	0-10 mc	0-15 mc	0.2-10 mc	0.5-12 mc	0.1-10 mc	0-10 mc	0.5-15 mc	0-30 mc	0-15 mc
Fund. marker range	sockets for four xtals. no var. osc.	20-40 mc	4-54 mc	none	fixed 1 mc and 5 mc xtals. no var. osc.	5 mc xtal 3.2-8 15-38 75-125 mc	1 mc and 10 mc xtals. no var. osc.	19.5-40 mc	2.5 mc and 5 mc xtals.; 5-125 mc 3 bands	19-50 mc	none	none	3.2-250 mc
Phasing control	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes		yes
Number of tubes	6 plus rect. and volt. reg.	6 plus rect.	6 plus rect. and volt reg.	5 plus rect.	3 plus rect.	7 plus rect.	5 plus rect.	5 plus rect. and volt. reg.	3 plus rect. and volt reg.	6 plus rect.	3 plus rect	9 plus 2 rect.	10 plus 3 rect.
External xtal. pro-vision	yes	yes	yes	yes	no	no	no	yes	yes	no	no	no	no
Price	$124.75	$195.00	$220.00	$325.00	$78.50	$245.00	$295.00	$149.50	$89.50	$179.50	$379.50	$395.00	$395.00

true response curve picture and avoids the necessity of interpretation. A sweep adjustment in steps including several narrow sweeps is useful when aligning the sound i.f. strip and discriminator.

Crystals: Provision for crystal insertion at the panel is very useful in adjusting adjacent-channel and other traps where an accurate signal source is required.

Phasing: This is a knob-controlled device for shifting the phase relation of the trace and retrace patterns so a single pattern is observed. Useful in alignment.

General: Many aspects cannot be covered in an article of this type, two of the most important being radiation and frequency stability. Radiation, if excessive, will operate the a.g.c. circuits and prevent optimum alignment. It can be prevented only by careful internal shielding and r.f. wavetraps in the a.c. line of the generator. Stability can be obtained only by careful design including voltage regulation. These characteristics should be carefully investigated before making a purchase, and price alone should not be the determining factor.

Oscilloscopes

Vertical amplifier bandwidth: Not critical for observing i.f. response curves because here only the low-frequency modulation pattern is viewed. Broad band (over 2 mc) important for viewing fast-rising patterns such as sweep circuit and sync-pulse waveshapes. Valuable, if over 4 mc wide, for signal tracing when used with a crystal probe. In this latter case, a scope can be used as a valuable signal tracer instead of only as an indicator.

Deflection sensitivity: Minimum output from the signal generator should always be used to keep below the a.g.c. threshold. This requires good scope amplifier sensitivity to produce a visible pattern. Better than .05 v/in. is desirable.

Cathode-ray tube size: Not critical but the 5-inch tube seems to be most popular.

Sweep range: Not critical. For TV use, 25 cycles to 30 kc is adequate for all usual applications.

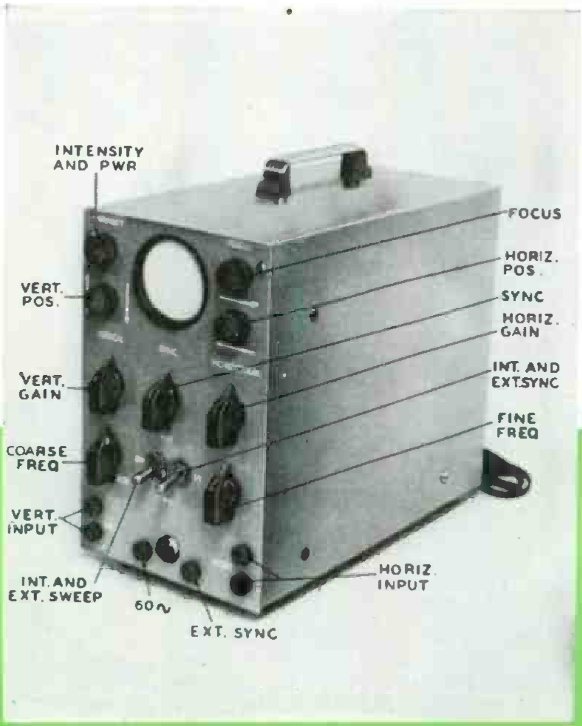
Grid modulation: Useful when using an external return-trace blanking oscillator or for some techniques which require a Z-axis-modulated pattern.

OSCILLOSCOPES

	Pre-cision ES-500	Hickok 195B	Jackson CRO-1	RCA WO5BA	Dumont 304	Triplett 3440	RCP TV-90	Reiner 508	Supreme 660	GE ST-2A	Syl-vania 131	Trans-vision 450A	Philco 7008[3]
Vert. amp. band width	10 c.p.s. -1 mc	30 c.p.s. -1 mc	20 c.p.s. -4.5 mc	5 c.p.s. -2 mc	d.c. amp. 0-100 kc a.c. amp. 5 c.p.s. -100 kc	20 c.p.s. -1 mc	5 c.p.s. -200 kc	2 c.p.s. -100 kc	5 c.p.s. -5 mc	20 c.p.s. -1 mc	10 c.p.s. -100 kc	20 c.p.s. -450 kc	
Vert. amp. defl. sensit. (v/in.)	.02	.03	.018	0.5 peak to peak built-in volt-meter	.01 built-in volt-meter	.02	0.285	.01	0.1	.015	0.5	0.5	.025
C/R tube size(in.)	5	5	5	5	5	5	3	5	5	5	3	5	3
Sweep range	10 c.p.s. -30 kc	10 c.p.s. -25 kc	20 c.p.s. -50 kc	10 c.p.s. -100 kc	Sine or sawtooth 2 c.p.s. -30 kc	10 c.p.s. -60 kc	10 c.p.s. -45 kc	2 c.p.s. -50 kc	7 c.p.s. -100 kc	10 c.p.s. -100 kc	15 c.p.s. -40 kc	20 c.p.s. -50 kc	60 c.p.s.
Pro-vision for grid modu-lation	yes	yes	no	no	yes	yes	yes	yes	yes	no	no	yes	
Price	$149.50	$156.00	$195.00[1]	$345.00	$285.00	$189.50	$127.50[2]	$265.00	$276.80	$279.50	$69.50	$99.50	$395.00

NOTES—[1] Signal-tracing probe $9.95. [2] Has built-in 0.5-45-mc generator. [3] Instrument is combination generator and scope. [4] Model 479 plus built-in scope. Price $375.

Making a 2-Inch Scope



The complete 2-inch oscilloscope in its metal case.

Construction data for a scope complete with amplifiers and sweep

BY CHARLES W. WELCH, W5MHK*

THERE is a very real and very wide gap between the inexpensive cathode-ray modulation-checker, with its extremely limited usefulness as a test instrument, and the elaborate and expensive test oscilloscopes on the market. The oscilloscope described in this article attempts to bridge that gap.

Its most obvious feature is its small size, which was not gained at the expense of versatility; full-sized components are used throughout. The 2-inch tube, while not large enough for a laboratory instrument, shows large, brilliant figures bright enough for photographing and certainly bright enough for viewing. Its other features are:

1. Vertical and horizontal amplifiers flat over the audio range.
2. High sensitivity which permits convenient viewing of 1 volt or less. Even the direct output of crystal pickups and microphones can be viewed.
3. Internal sweep oscillator with frequency variable in five steps, plus vernier fine-frequency control.
4. All usual oscilloscope features and functions.
5. Low cost.

The foundation unit

The complete oscilloscope is built on a foundation unit assembled from two commercial chassis plus a panel and a few simple parts cut from sheet metal. It measures roughly 5 x 8 x 9½ inches. All these parts, including the chassis, should be made of steel or other ferrous metal, as nonferrous metals do not have good magnetic shielding qualities. By using a steel chassis 5 x 9½ x 1½ inches and a sheet-iron panel and case, with the power supply mounted on the lower chassis, no magnetic shield is required on the cathode-ray tube itself.

The panel is cut out and drilled. You can use the photos as guides. It should then be lacquered the desired color and labeled.

The two chassis should be drilled and cut out, again referring to the photos. Transformers and chokes should be mounted on the lower chassis and as far to the rear as possible, to minimize magnetic interference. Do not cut any large holes in the upper chassis which might allow magnetic flux to cause trouble at the cathode-ray tube.

The lower chassis is mounted 1/16 inch above the bottom of the panel, with 1/16 inch of panel sticking out on either side of the chassis. It is fastened to the panel by angle brackets which bolt to the chassis and fasten under the mounting nuts of the input jacks on the panel.

The upper chassis is inverted, as shown in the photographs, so that the side flanges turn up. It is fastened to the panel with angle brackets, mounted with the bottom 2½ inches below the top of the panel, and centered so that 1/16 inch of panel extends on both sides of the chassis. The rears of the two chassis are fastened together with a sheet-metal spacer strip. The distance between the two mounted chassis should be about four inches to permit the 884 tube to be inserted in its socket.

In the upper chassis the four controls are mounted on sheet-metal brackets to the rear of the 2AP1 socket. Shaft extensions are of insulating material.

The power supply

The high voltage for the cathode-ray tube in this scope is supplied by the same receiver-type transformer which feeds the other stages. It is obtained by taking the a.c. off one side of the high-voltage secondary winding, rectifying, and then boosting it by the action of the electrolytic capacitor C1. Note that the high-voltage rectifier 6X5-GT and C1 are reversed from normal polarity, because the high voltage must be negative. Be careful in mounting and insulating C1 not to ground the high-voltage power supply.

The output of the high-voltage section is a little over 500 volts. In choosing a power transformer, do not select one which has a lower output voltage than specified, as the 2AP1 is rated at 500 volts *minimum*. While this voltage is adequate, it cannot be reduced very much without serious effects.

Scope and controls

The next step is wiring the cathode-ray tube with its controls. The intensity control, which has the a.c. line switch on the back of it, is mounted so that its knob is brought out to the upper left side of the panel. The focus control comes out on the upper right side of the panel. The two holes just

* Transmitter Engineer WNAD AM/FM.

below these are for the two centering controls. The controls are identical electrically, but common practice places all vertical controls on the left-hand side of the panel.

The resistor network of which the centering controls are a part is the centering system of the scope. The resistors are arranged to give about 100 volts with the slider at full travel one way, zero in the center, and 100 volts at opposite polarity when the slider is at the other end of its travel. The spot can be moved entirely off the screen of the tube in either direction. When the network is completed, it may be necessary to juggle the fixed resistors slightly to get the right voltages, because of slight variations in power transformers.

Two jacks and plugs are mounted on an angle bracket behind the cathode-ray tube. An opening is cut in the rear of the case to make them readily accessible from the back of the 'scope. They permit disconnecting all controls from the deflection plates to apply r.f. voltages directly to the plates.

Now turn on the a.c. and let the filaments warm up. Set the centering controls to approximately mid-travel, and advance the intensity and focus controls. If no spot appears on the screen, try various positions of the centering controls. Frequently a 'scope works, but the positioning controls push the spot clear off the screen so that nothing is visible. If no spot can be found, check wiring until the trouble is located.

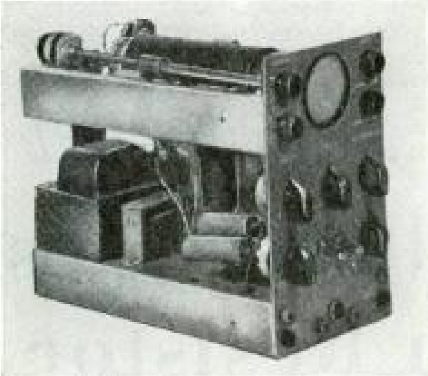
When the spot is located, retard the focus and intensity controls until the sharpest possible spot is obtained. Note that these controls work together with considerable interaction, which is normal. When the spot is as sharp as the controls will make it, look it over carefully. Any unusual shape or a large, sharp spot which cannot be focused down to a reasonable diameter, probably indicates magnetic interference coming from the power supply. If this is not too serious, don't worry about it for the present, but continue wiring the scope. The metal case which is put over the chassis will help eliminate it.

Amplifiers and sweep

The horizontal amplifier should be located on the right-hand side, using the tube, gain control, and jacks on that side. The amplifier is reasonably straightforward, except for what may be considered unusual bypassing. The amplifiers were built and rebuilt and modified, in the attempt to get them flat without the use of peaking inductances. They are perfectly flat from 100 to 12,000 cycles, and rough tests indicate that they are reasonably flat over the rest of the audio range.

If it is decided that the range should be extended further, or if the high frequencies are down in the finished amplifiers, the range can be increased with peaking inductances. In calculating such inductances, it should be kept in mind that this circuit has unusually high stray capacitance, because the input capacitance of the 2AP1 and its wiring must be considered as well as the output capacitance of the 6AC7. The screen bypass C2 should be grounded to the ground end of C3, the cathode-bypass capacitor.

The gain of the amplifiers as shown is as high as will be needed in normal use. When the amplifier is finished, put an audio voltage into the input and advance the horizontal gain control with the position and focus controls properly set. The spot on the screen should



Parts mount on two chassis and a panel.

spread out into a streak. If the trace is not horizontal, rotate the 2AP1 socket until it is properly oriented—unless, of course, it is nearly vertical, in which case check to see that you have the amplier hooked up to the right deflection plate.

The next step is wiring the sweep oscillator. It is a simple gas-triode circuit, described in every radio handbook, so we will not go into the theory of it here.

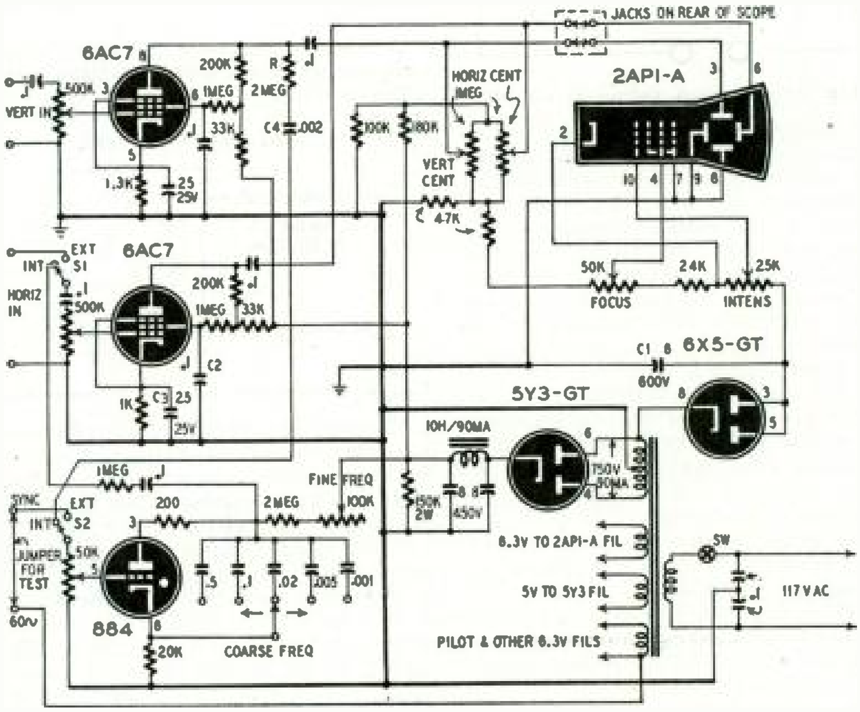
For the present, testing the sweep oscillator will simply be to see that it oscillates. When it is hooked up correctly and switch S1 is in the INTERNAL position, advance the horizontal amplifier gain control. A horizontal trace should appear on the screen; there is nothing tricky about getting a gas-triode oscillator to "take off." Try all the positions of the frequency controls, to make sure they are working.

There is little in the construction of the vertical amplifier which is not identical with the horizontal amplifier. The only difference is that the sync circuit takes a small amount of the output of the vertical amplifier and feeds it into the grid of the oscillator to make it lock in and hold the figure steady on the screen of the 2AP1. The sync voltage is taken off the amplifier plate through R and C4.

Testing

The 'scope is now ready for the final testing. Curves are run on the two amplifiers with an audio oscillator, carefully measuring the input to keep it constant, measuring the length of the trace on the screen of the scope, and plotting the output curve. It is best to make this test with only the output of the amplifier under test on the screen, so that you get a straight line to measure, rather than a figure. When the two amplifiers have been tested this way, test the sawtooth generator.

Two things demanded of the sawtooth generator are linearity and short flyback time. The test for length of flyback time is to apply a sine voltage to the vertical input and adjust the sweep frequency to stop several cycles on the screen. Then observe the return trace. If it is too bright, the flyback time is too long. The object, of course, is to make the flyback time as brief as pos-



Complete schematic of the 2-inch oscilloscope. A 2AP1 or 902 may also be used.

sible, so that the return trace disappears altogether or at least is dim enough not to confuse the desired pattern. This test can be applied only to the finished scope.

The best check for linearity is viewing the output of the oscillator on another scope, and seeing if the sawtooth wave is perfectly straight-backed. Another scope is also useful in checking flyback time. In the absence of another scope, however, the linearity may be checked by the new scope.

Again apply a sine voltage to the vertical input and set the sweep frequency to show two or more complete cycles on the screen. Stop these with the fine-frequency and sync controls, and adjust the gain of the amplifiers until the pattern does not take up much more than a inch on the screen. Then measure the peak to peak distance horizontally on the trace. These distances should be the same. If they start wide and narrow down in succeeding cycles, the sweep oscillator may not be linear. One note of caution: Due to the "stacking effect" which occurs when the electron stream passes near the positive, grounded deflection plate in the tube, the pattern will crowd up near one end of the screen. Therefore, the gain should be adjusted to keep the pattern small and near the center of the screen before deciding that the oscillator is or is not linear. "Stacking" is perfectly normal in an oscilloscope when single-ended deflection is used.

Keep in mind, too, that the amplifiers are sensitive and overload easily. Severe distortion will then occur. Very little input is required—a volt or less—though somewhat higher voltages can be accommodated by keeping the amplifier gain-control knob turned well down.

The final check of the circuits should be made to see that the various switches and controls function properly. It being always advisable to use as little sync as possible, the sync voltage on this scope has been made rather small. In locking the oscillator in, the trace should be as nearly stopped as possible by the fine-frequency control, then finally synchronized with the sync control, advancing it only as necessary.

Constructing the case

The case is made after the 'scope is finished. It, too, should be made of ferrous metal, and dimensioned to slip over the chassis, sliding up to position behind the 1/16 inch of panel left all the way around the chassis. The panel and the case should not be made of galvanized iron if other iron is available, as it is difficult to make paint or lacquer stick to a galvanized surface. However, if it must be made of galvanized metal, a primer made especially for the purpose will work nicely (ordinary automobile body primer will not). Provide for ventilation, because the tubes generate considerable heat. Ventilated plugs in the rear of the chassis are a satisfactory method. Don't forget that the case is a necessary part of the magnetic shielding and should not be cut up any more than can be helped.

After the case has been installed and fastened by self-tapping screws into the side flanges of the chassis, the scope should be checked again for any persisting magnetic deflection. If the case has not helped, a shield may be made from iron pipe, covering as much of the tube as the amplifier wiring will permit. Shielding about two-thirds of the way up from the base and grounding at the socket end will suffice. This should be necessary only in extreme cases. It was used in the oscilloscope pictured, but *only as an added refinement*. The trace before the addition of the shield was as fine as that of most commercial scopes; with the shield it is possible to get a trace that is finer than the line made by the average pen.

Certain interactions in this scope may, at first glance, appear to be bad, such as that between the intensity and the focus controls and certain characteristics of the sync circuit. These are perfectly normal and occur in any unit, commercially built or otherwise; they do not hinder the operation, once the operator is familiar with them.

MATERIALS FOR OSCILLOSCOPE

Resistors: 1—200, 1—1,000, 1—1,300, 1—20,000, 1—24,000, 2—33,000, 2—47,000, 1—51,000, 1—100,000, 1—180,000, 2—200,000 ohms, 3—1, 2—2 megohms, 1/2 watt; 1—150,000 ohms, 2 watts; 1—25,000, 1—50,000, 1—100,000, 2—500,000 ohms, 2—1 megohm potentiometers.

Capacitors: 1—.002 μf, mica; 1—.001, 1—.005, 1—.02, 10—0.1, 1—0.5 μf, 400-volt, paper; 2—25 μf, 25 volts, 2—8 μf, 450 volts, 1—8 μf, 600 volts, electrolytic.

Switches: 2—s.p.s.t. toggle, 1—1-circuit, 5-position rotary, 1—s.p.s.t. for attachment to intensity potentiometer.

Inductors: 1—power transformer, 750 volts center-tapped at 90 ma, 6.3 volts at 3 amps., 5 volts at 2.5 amps; 1—10-henry, 90-ma choke.

Tubes: 1—2AP1-A, 1—5Y3-GT, 2—6AC7, 1—6X5-GT, 1—884.

Miscellaneous: 2—chassis, 5 x 9 1/2 x 1 1/2 inches; 1—iron panel, 5 x 8 inches; tube sockets; miscellaneous hardware.

Using a Voltmeter as a Precision Resistor

By JOHN T. BAILEY

THE common multirange voltmeter is a handy source of precision resistors which can be used for calibration work without removing them from the voltmeter. When the multimeter is switched to read d.c. volts, the circuit consists of a simple series arrangement of meter

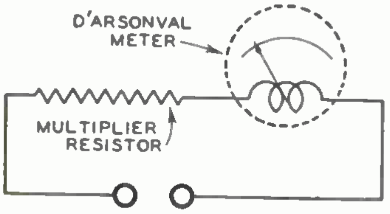


Fig. 1—Common voltmeter circuit

and multiplier resistor as shown in Fig. 1. This series circuit is connected to the test leads for convenient use. The total resistance of the series circuit is determined by the voltage range and the meter sensitivity. It can be computed quickly simply by multiplying the voltage range by the ohms-per-volt rating of the multimeter. For instance, if the sensitivity is 1,000 ohms per volt and the 30-volt range is used, the resistance is 1,000 times 30 or 30,000 ohms. This will be accurate to ± 1% for the average instrument. If two multimeters are available, they may be connected in series or parallel to increase the combinations of resistors.

Pay no attention to any reading that may occur on the meter unless, of course, it goes off scale.

This method may be used on a.c. work without any damage to the meter since it cannot follow the cyclic fluctuations of the alternating current.

Laboratory electrodynamometer voltmeters have an accurate, temperature-compensated, swamping resistor in series with the meter coils, as in Fig. 2. This resistor is in the order of a few thousand ohms for a 150-volt meter, usually the meter carries the resistance value on the data nameplate. The meter will read on d.c. or a.c., and thus can be an indication of when a safe current value has been reached when it is used for resistance purposes.

Because the resistance value given for both meters includes the resistance of the meter coils, no correction need be made.

A vacuum-tube voltmeter is not suitable for this use since it operates on a different principle.

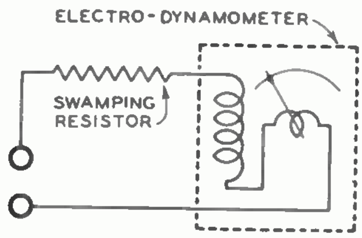


Fig. 2—Swamping resistor is accurate.

Uses for precision resistors include voltmeter multipliers, reference resistors for checking ohmmeters, bridge arms, calibration resistors for checking instrument dials, and others.

When using a meter as a precision resistor, it is always an excellent idea to make a few calculations beforehand to find the voltage that will be placed across the meter and multiplier. Be sure it is not greater than the maximum reading of the scale you plan to use.

Television Dictionary

(Continued from page 64 of the January issue)

By ED BUKSTEIN

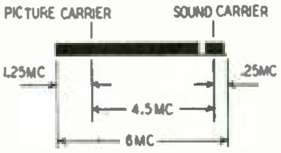
Centering
The process of shifting the trace on an oscilloscope or the image on a television tube so that it is centered on the screen.

Centering control
An adjustment for shifting the pattern on the screen of a cathode-ray tube. The vertical centering control moves the pattern up or down, and the horizontal centering control moves it to either side. The pattern is centered by varying the d.c. potential applied to the deflection plates (electrostatic deflection) or by varying the d.c. current through the deflection coils (electromagnetic deflection).

Channel
A band of frequencies. Twelve channels have been assigned by the Federal Communications Commission for commercial television broadcasts.

Channel	Freq. (mc)
2	54–60
3	60–66
4	66–72
5	76–82
6	82–88
7	174–180
8	180–186
9	186–192
10	192–198
11	198–204
12	204–210
13	210–216

Each channel is 6 mc wide. The audio carrier is 0.25 mc from the

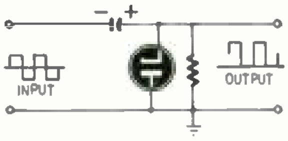


high-frequency end of the channel. The picture carrier is 1.25 mc from the low-frequency end. The picture and sound carriers are separated from each other by 4.5 mc. The diagram shows one TV channel.

Chromatic abberation
See Aberration.

Clamper
A circuit which establishes the d.c. level of a waveform (the baseline of an a.c. wave with a d.c. component). Clampers are also known as *d.c. restorers.*

Clamping
The process of establishing the d.c. level of a waveform. This may be done with a diode tube in series with a capacitor, as indicated. On



the negative alternations of the input signal, the diode conducts current and charges the capacitor. The capacitor adds its charge in series with the signal on the positive alternation.

Clipper
A circuit designed to remove all of a waveform above or below a given level. (See Amplitude separation.)

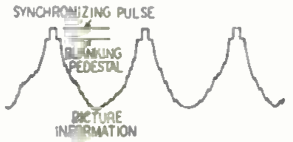
Clipping level
The amplitude level at which a waveform is clipped.

Color
The visual sensation produced when light enters the eye. The color perceived depends on the wavelength of the light. A wavelength of 4,000 Angstrom units is perceived as violet and a wavelength of 7,000 Angstrom units produces the sensation of red. All other color wavelengths are between these limits.

Color disc
A rotating disc containing red, blue, and green windows, placed in front of the television camera or C-R tube in the CBS color TV system.

Complementary colors
Two colors which, when properly combined, produce white light. A red light and a green light of proper intensity will combine to produce white light. Yellow and blue are also complementary colors.

Composite signal
The complete television signal containing the picture information and the synchronizing and

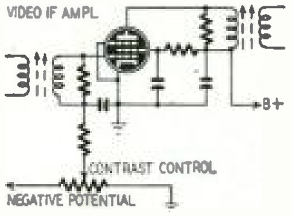


blanking pulses. Typical composite waveforms appear in the drawing above.

Concave mirror
A reflecting surface of such shape that it causes the rays of light striking it to focus upon a point on the principal axis, the concave mirror is also referred to as a spherical mirror. (See Center of curvature.)

Contrast
The total range of light intensities between the darkest and brightest portions of an image on the television screen.

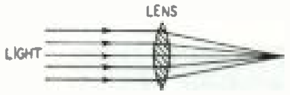
Contrast control
An adjustment for increasing or decreasing the range of light intensities of an image by varying the amplitude of the picture signal. Contrast control in the television receiver corresponds to gain control in a sound receiver. Often the contrast control varies



the gain of a remote-cutoff tube in the video i.f., as in the figure.

Converging lens
A lens which causes the light passing through it to converge to a point. (See Convex lens.)

Convex lens
A converging lens which is thick-



est through its center and thinner toward the edges.

Counter
A circuit whose output frequency is a submultiple of the input frequency. The counter circuit, also called a frequency divider, produces a stair-step waveform. (See Frequency divider.)

Critical viewing distance
The ratio between the distance at which the line structure of a television image is indiscernible and the height of the image.

D

Damping tube
A diode connected across the horizontal deflection coils to prevent shock-excited oscillations when the magnetic field collapses.

D.c. reinsertion
The process of establishing the d.c. level or baseline of a waveform. (See Clamping.)

D.c. restoration
Same as d.c. reinsertion and clamping.

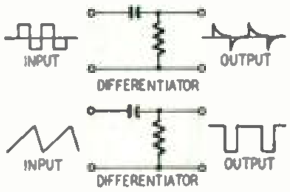
D.c. transmission
Transmission of the d.c. level of a television signal. The d.c. level determines the background intensity of the image.

Definition
That quality of a television image which enables an observer to distinguish fine detail.

Deflection
The process of bending or altering the path of the electron stream in a cathode-ray tube.

Deflection coils
Coils placed around the neck of a cathode-ray tube to deflect the electron stream. The magnetic field created by the flow of current through the deflection coils causes the electron stream to deviate from its normal path. This system is electromagnetic deflection.

Differentiator
A circuit whose output waveform represents the rate of change of the input waveform. As the figure shows, a square or pulse waveform fed into a differentiator produces a narrow, peaked wave in the out-



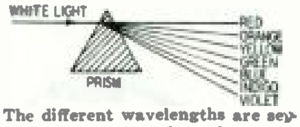
put. A sawtooth fed into a differentiator produces a pulse in the output. A differentiator is sometimes used in an oscilloscope to blank out the retrace. The sawtooth produced by the sweep circuit is fed into the differentiator, and the negative pulse produced in the output is used to bias the cathode-ray tube to cutoff.

Dioptric
The name applied to an optical system employing lenses but no mirrors.

Direct-view
The name applied to a television receiver in which the image is viewed on the face of the cathode-ray tube. This feature distinguishes it from the indirect-view or projection-type receiver, in which the image is optically projected from the cathode-ray tube to a special viewing screen.

Discharge tube
A tube so operated that it is normally cut off and made to conduct at periodic intervals. A capacitor connected in parallel with such a tube charges from the plate-voltage supply when the tube is cut off and discharges through the tube when it conducts. The voltage across the capacitor is sawtooth in form. A discharge tube is often used in a blocking oscillator.

Dispersion
The separation of white light into its component colors, as in a prism. Light passing through a prism is refracted to an extent dependent upon its wavelength.



The different wavelengths are separated in passing through a prism because they are refracted by different amounts. The result appears above.

(To be continued)

Television "Sight Effects"

Radio has its sound effects and television its "sight effects." This article tells how unusual scenes are produced on your TV receiver screen

By H. W. SECOR

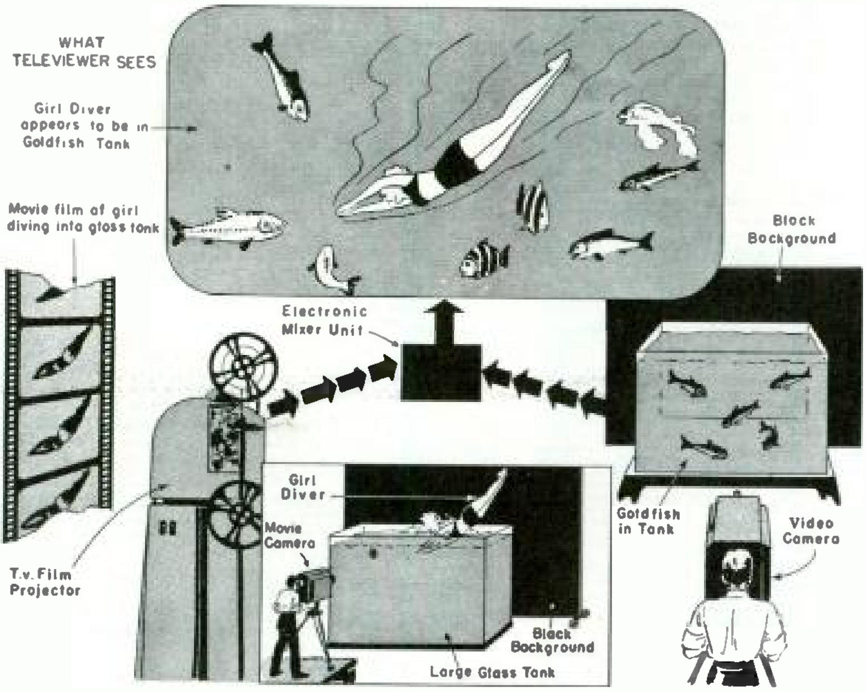


Fig. 1—How movie projector and camera squeeze girl swimmer into fishbowl.

THE directors and producers of television plays and other programs are finding that TV is much more than an "instantaneous movie." Because pictures are transformed into electrical signals, they can be mixed, faded, and made to produce the most unexpected effects. That is why the average viewer is no longer surprised—though he may be mystified —when he sees a lissome young lady swimming around in a goldfish bowl. Cleverly controlled electrons are responsible, too, for some of the trick commercials, where the sponsor's name and a picture of his product appear to float above a baseball field.

Squeezing a girl into a goldfish bowl looks like an impossible feat until you take a look at Fig. 1. The diver did her stuff in a giant glass tank while a motion-picture camera took pictures of the act. At the television studio the film was run off through a projection camera which passed the image to the mixing board. At the same time, another camera was trained on a real goldfish bowl. The control operators superimposed the two pictures so that viewers saw both at once. At the top of Fig. 1 you see what the viewers saw: a young lady in a bathing suit playing tag with the goldfish!

Have you ever sat home on a Saturday afternoon listening to a radio description of a ball game? Time for the commercial announcement comes around, and the announcer begins to tell you about El Ropo cigars. Right in the middle of his sales talk you hear the crack of a bat in the background and a great roar from the crowd. You're aching to know what's going on—but you have to wait for the end of the commercial before you find out.

In television it's different. The baseball game stays right on the screen. But you'll see a picture of the sponsor's product or a printed message superimposed on the picture. Often it

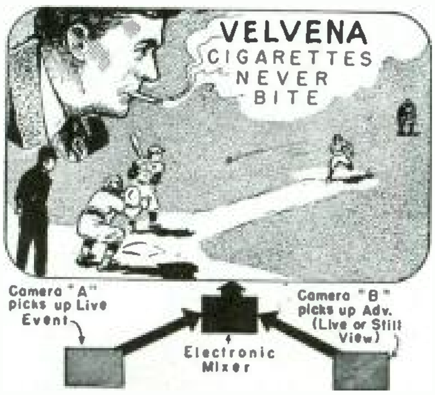


Fig. 2—Blurb appears above field.

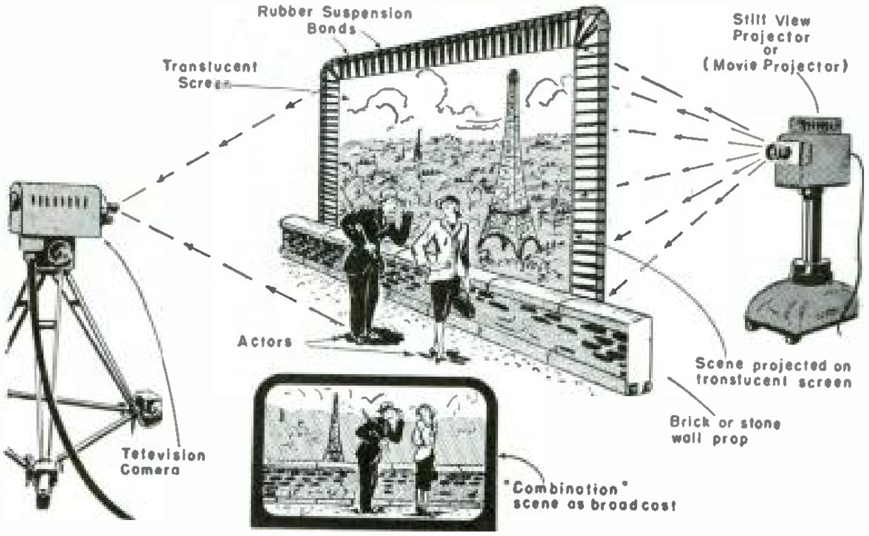


Fig. 3—Still picture projected from rear provides background for Paris short.

looks like sky-writing, or as if a gigantic transparent frame with drawings were suspended over the playing field.

Once again it's the mixers that do it (see Fig. 2). One camera picks up the ball game, and another is aimed at a live or pictured advertisement. Outputs of the two cameras go to a mixer where just the right amount of signal from each is sent on to the transmitter.

Unusual studio tricks

Not all television's effects are produced electronically. For instance, you may see a pair of actors standing on a Paris roof with the Eiffel Tower looming in the background. To paint a backdrop or build a set would cost more money and take more time than the scene is worth. But to find a small picture and use a magic lantern is the work of a few minutes.

As Fig. 3 shows, the actors stand on a small imitation rooftop with a white, translucent screen behind them. In back of the scene a still picture projector flashes the Paris view on the translucent screen. The audience sees the picture as a whole—the actors apparently looking at the tower.

The same technique has been used in railroad-train scenes. The action takes place inside the train, but through the window you can see the telephone poles go by and trees and fields appear in the background. This time a movie projector is used instead of a magic lantern. Pictures taken from a train window are projected on a translucent screen set in the window frame.

At present, only CBS is using rear projection. The projected scene must be very bright and powerful lamps are used—one, for example, rated at 5,000 watts. Storm and cloud effects are but one of the myriad possibilities. The screen is a special one, using a plastic-type material with fine metallic particles in it.

One of the most dramatic devices for heightening suspense and tenseness in a play is thick fog. TV producers don't wait for a bad night and shoot the scene outdoors; they make the fog to order. Fig. 4 shows how.

The air in a small box is saturated with titanium chloride mixed with castor oil. In the bottom of the box is a pan of water cooled with dry ice. When the smoke created by the sprayed mixture passes over the cold water, it becomes very thick and billowy. As it comes out the slot on the other end of the box, a fan directs it to the desired places.

Cartoon figures walk and talk

One of the cleverest versions of television's puppetry is Du Mont's Magnetoons, produced by J. M. Seiferth Productions. Small figures slide across a painted scene, moving arms and legs and gesturing realistically. These animated cartoons are operated by small magnets. The figures are made of cardboard and a magnet is fastened to each of several strategic places. A like-shaped cutout is against the plastic scenery behind the figure, and it, too, is fitted with magnets.

Fig. 5 shows how the Magnetoons work. As live actors give voices to the characters, an operator behind the scenes moves the magnets. The figure on the front of the screen follows.

All kinds of startling things happen. Characters appear out of nowhere, balls suddenly drop into sight or disappear. Not only do the characters move around, but jaws open and close as words are spoken and the cardboard actors swing their arms up and down to emphasize their points. To keep perspective as it should be, several cardboard replicas of each figure are used, each in a different size.

Television's heyday is just beginning—but already producers and engineers are outdoing each other in ingenuity. When a little more time has gone by, you may expect to see productions with effects exceeding those possible even in the movies—and with that sense of immediacy which helps to make television programs more enjoyable than even the best of "canned" entertainment.

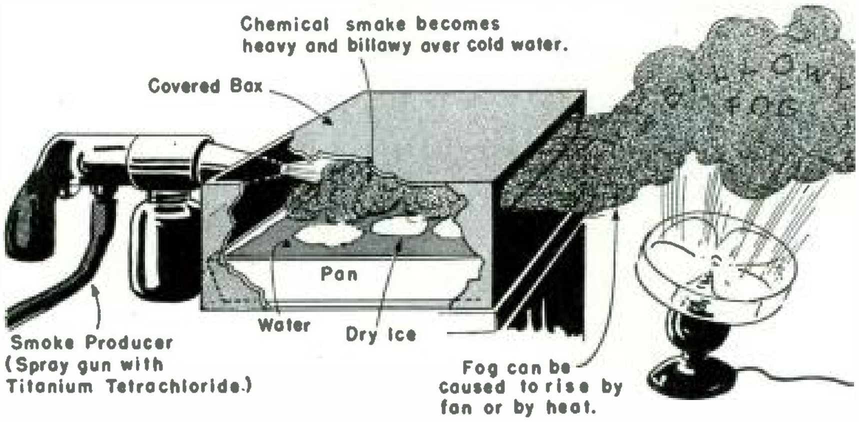


Fig. 4—Spray gun, cooling box, and fan produce a thick, billowy fog in studio.

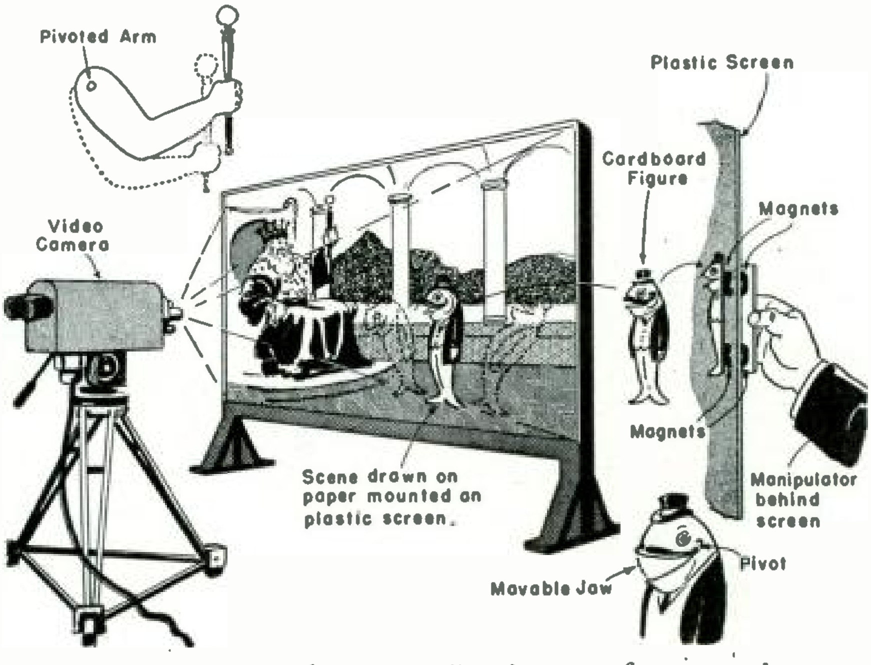


Fig. 5—In Magnetoons productions, cardboard cartoon figures are the actors.

Theory and Practice of Intercarrier TV Part II

By
SEYMOUR D. USLAN*

MANY television receivers today utilize the intercarrier sound system. The combined i.f. circuits of these receivers up to the video detector are not much different from each other or for that matter from the conventional receiver, except as pointed out in the first part of this article. Overcoupled or staggered i.f.'s are primarily employed to obtain the necessary bandwidth. Adjustment of these i.f.'s for the proper intercarrier response shaping does not require changing the i.f. design greatly. The primary difference among intercarrier receivers is the method of 4.5-mc sound i.f. takeoff. Let us study a few 4.5-mc sound takeoff circuits in typical intercarrier TV receivers.

Fig. 1 is the sound takeoff circuit arrangement employed in the Delco model TV-201 receiver. The output signal from the video detector is fed to the first video amplifier through a high-frequency compensating network. This coupling circuit should be peaked to the point at which its bandwidth will also pass the 4.5-mc beat note. In the plate circuit of the video amplifier is a series-resonant circuit C16-L14, sharply tuned to 4.5 mc. The grid circuit of the first sound i.f. amplifier is connected to the junction of these two components. In other words, the grid-to-cathode circuit of the sound i.f. amplifier is across the inductance of the tuned circuit. Since, in a series-tuned circuit, the voltage across either reactive component is maximum at resonance, then a maximum 4.5-mc signal is applied to the sound section of the receiver.

Fig. 2 is the 4.5-mc sound takeoff circuit used in the Admiral 19A1 chassis. The 4.5-mc signal takeoff is also from the plate of the first video amplifier. However, a parallel-tuned, 4.5-mc takeoff circuit L1-C1 is employed, connected directly across the grid-to-cathode circuit of the first sound i.f. amplifier. The voltage across a parallel-tuned circuit being maximum at resonance, a maximum 4.5-mc signal is applied to the sound section of the receiver.

One other common type of 4.5-mc sound takeoff unit used is a double-tuned transformer. In Fig. 3 we see two typical circuits employing such transformers. In Fig. 3-a the parallel-tuned primary is in the plate circuit of the video amplifier, while the tuned secondary is in the grid circuit of the sound i.f. amplifier. In Fig. 3-b the primary of the 4.5-mc transformer is in the *screen-grid* circuit of the video amplifier stage rather than the plate circuit.

After the point of 4.5-mc takeoff the video signal must be coupled to the picture tube without any 4.5-mc sound signal being present, as this would distort the picture. Consequently the video coupling circuits *after* the 4.5-mc sound takeoff points should not be peaked to pass any 4.5-mc signal. In like manner the 4.5-mc sound takeoff resonant circuits should be so sharply tuned that no video signal finds its way into the sound section of the receiver.

Advantages of intercarrier

The major advantages of the intercarrier system over the conventional TV system are:

1. In the conventional receiver a fine-tuning control is almost always needed because of local oscillator drift, which causes the sound i.f. signal to move away from the resonant frequency of the sound i.f. tuned circuits.

In intercarrier systems oscillator drift will not produce such defects. Any drift in the local oscillator results in the same frequency drift in both video and sound i.f. carrier outputs from the mixer tube. Thus, if the oscillator increases in frequency, say by 50 kc, the carriers of the resulting video i.f. and sound i.f. also increase by the same 50 kc. The final sound i.f. signal (4.5 mc) is dependent upon the *difference* between the video and sound i.f. carriers, not their absolute values. Thus, even when the oscillator drifts, the difference remains the same and the resultant beat note is always 4.5 mc.

Many intercarrier receivers do, of course, have a fine-tuning control.

2. Disturbances of the local oscillator in any receiver that cause it to change in frequency at a specific rate actually make the oscillator output an FM signal. This defect can easily be caused

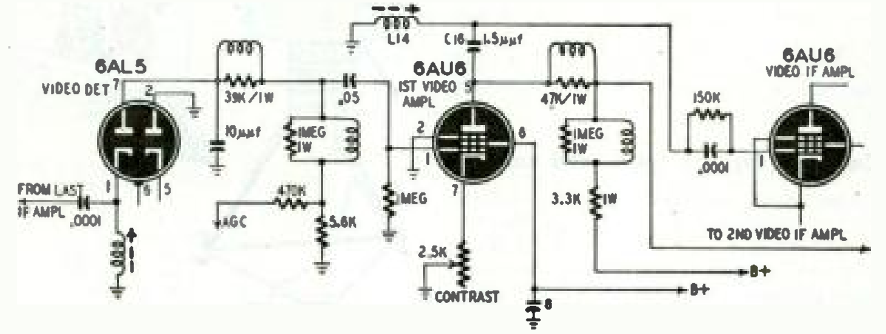


Fig. 1—Diagram of portion of Delco TV-201. Trap is also the takeoff coupler.

* Chief Technical Editor, John F. Rider Publisher, Inc.

by microphonism. Frequency modulation of the oscillator signal can also be caused by hum from the power supply. In both types of TV receivers this undesired frequency modulation is imparted to the sound and video i.f. signals. In the conventional receiver the sound i.f. signal has no way of getting rid of it; it is detected along with the desired FM and appears in the audio output.

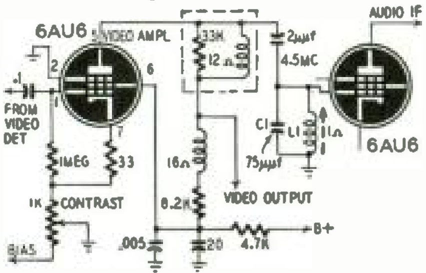


Fig. 2—A different trap-type takeoff.

In the intercarrier receiver, FM of the local oscillator will not reach the sound output. The frequency deviations of the video and sound i.f. signals are in phase. The 4.5-mc difference remains the same, and the undesired FM effects cancel out.

3. Amplification of the sound i.f. signal by the combined i.f. amplifiers and of the 4.5-mc signal by the video amplifiers adds greatly to over-all amplification of the signal input to the sound section of the intercarrier receiver.

A

B

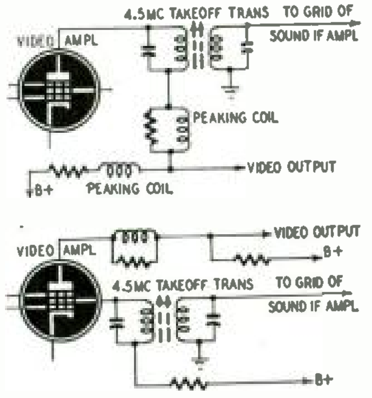


Fig. 3—Tuned-transformer takeoffs.

Economically, this is highly advantageous because fewer stages are needed for the sound signals alone. Only one is usually employed in today's receivers.

4. In intercarrier receivers the local oscillator can be tuned above the incoming signal for the lower channels and below it for the upper channels, because the sound and video i.f. carriers will always be the required 4.5 mc apart. This possible tuning system, although considered very advantageous, has not been used very much at the present. It allows the over-all tuning range of the oscillator to be cut down.

Disadvantages

There are two chief disadvantages of the intercarrier system, both of which originate at the video transmitter, not the receiver. This is significant because it means that any major correction work will have to be done to the relatively few transmitters rather than to the thousands of intercarrier receivers.

The two disadvantages each result in distorted sound and are caused by defects of the video carrier signal. The sound output distorts when the video carrier is overmodulated or near-overmodulated and also when it is phase- or frequency-modulated beyond a certain degree.

When the video carrier is overmodulated, there is no signal present during the periods of overmodulation. When this happens in the intercarrier receiver, there is no video i.f. carrier for the sound i.f. signal to beat against in the video detector, and hence no audio output from the speaker.

Since the overmodulation is usually repetitious at the frame rate (it is ordinarily caused by a bright object in the picture), the repeated loss acts as an additional frequency change in the 4.5-mc signal and is therefore demodulated by the FM detector as a 60-cycle buzz.

Most carrier signals of AM transmitters undergo a certain amount of phase or frequency modulation due to transit-time effects and other causes. In most cases this does not cause any trouble. It is not objectionable in the conventional TV system because the video detector will detect changes only in amplitude and not in frequency; but it is objectionable in the intercarrier type system since it means a periodic change in the difference between the sound and picture carriers. The changes in frequency are demodulated by the sound detector. Undesired phase and frequency modulation of the video carrier is greatest in those transmitters operating on the higher-frequency channels because transit-time effects at high frequencies cause greater degrees of frequency modulation of the carrier signal than at the lower frequencies.

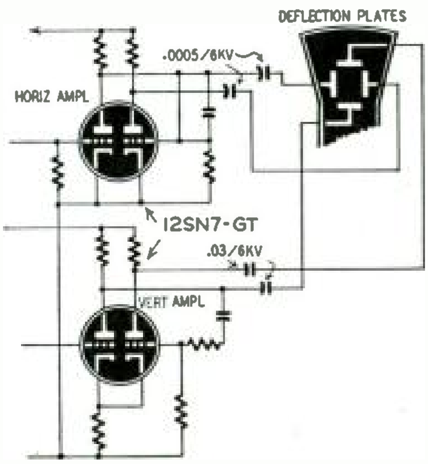
More Television Queries

By DAVID GNESSIN

Climbing Pix

? I own a 7-inch Hallicrafter set. When the picture is first put on, it is quite normal; but after an hour the picture tends to grow in height. Adjusting the height in back, I find that it grows upward, forcing me to move the picture down also. After about 3 hours of use, the picture has grown up so much that I cannot move it down any further and I can fill only the top two-thirds of the screen. Can you suggest a cure for this annoying condition?—J. C., Detroit, Michigan.

A. Fortunately, Jack Luck of Columbus, Ohio, who has had the same trouble, forwards the following solution: The two horizontal blocking capacitors—.0005 μf at 6000 volts—and the two vertical blocking capacitors—.03 μf at 6000 volts—become leaky, causing this pix growth. Since you have vertical growth trouble, you probably have one or two leaky vertical blocking capacitors. I recommend replacing all the four described above. See diagram.



The .0005-μf capacitors may be leaky.

Vertical Problems

? Receiver is a General Electric Model 811. Two or three wide, faint gray bands appear on the face of the picture tube. These bands are about 1½ inches wide and roll upward very slowly. They appear with or without a station on the air, on blank channels such as Channel 8, and with the antenna disconnected from the receiver. Any suggestions?

Also, how does one center the picture vertically on this receiver?—W. W. G., Briarcliff Manor, New York.

A. With the symptoms you describe, I'll take a shot in the dark and say they're due to unstable high voltage. In that case, check the h.v. supply and 500-μμf filter capacitor. You might replace the 470,000-ohm filter resistor as a check. A new 1B3-GT might help. Clean the 1B3-GT socket and assembly with carbon tetrachloride.

For your last question: Centering adjustment (as taken from *Sams Photofacts*): Centering adjustments are made by two circular magnets mounted on the focus and deflection assembly. The assembly may be turned the necessary direction, and the amount of correction may be changed by rotating the large magnet with respect to the smaller one and by sliding the two magnets together or apart. Maximum effect is with the two magnets close together and aligned. Minimum effect is achieved by turning the large to oppose the small magnet.

A De Luxe Televiser

Part II—The r.f. tuner is designed to cover any 9 of the 13 TV channels

By
CHARLES A. VACCARO

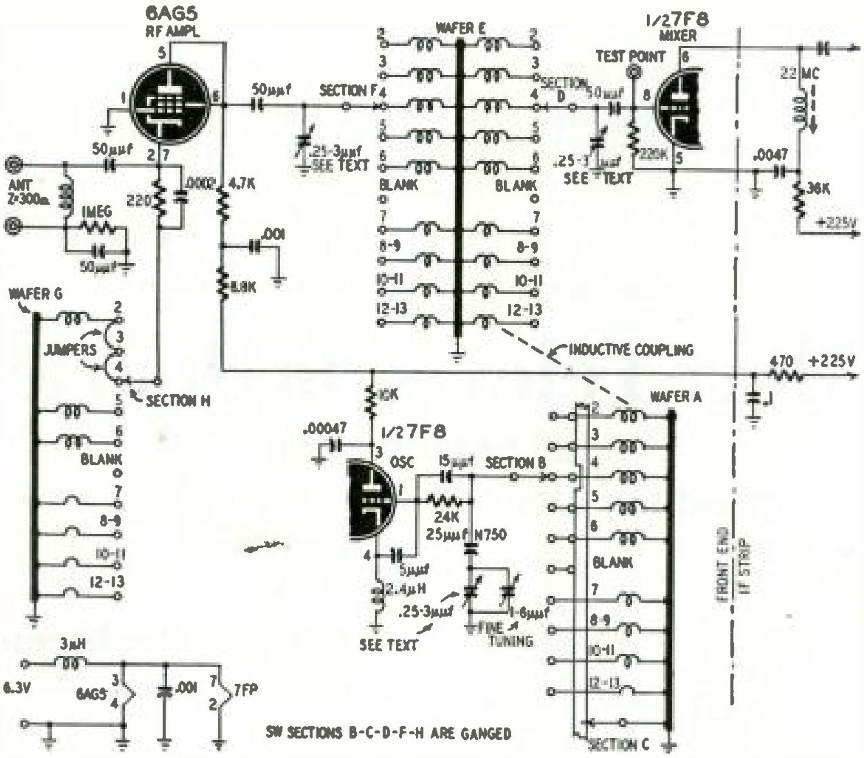


Fig 7.—The complete schematic diagram of a nine-channel television front end.

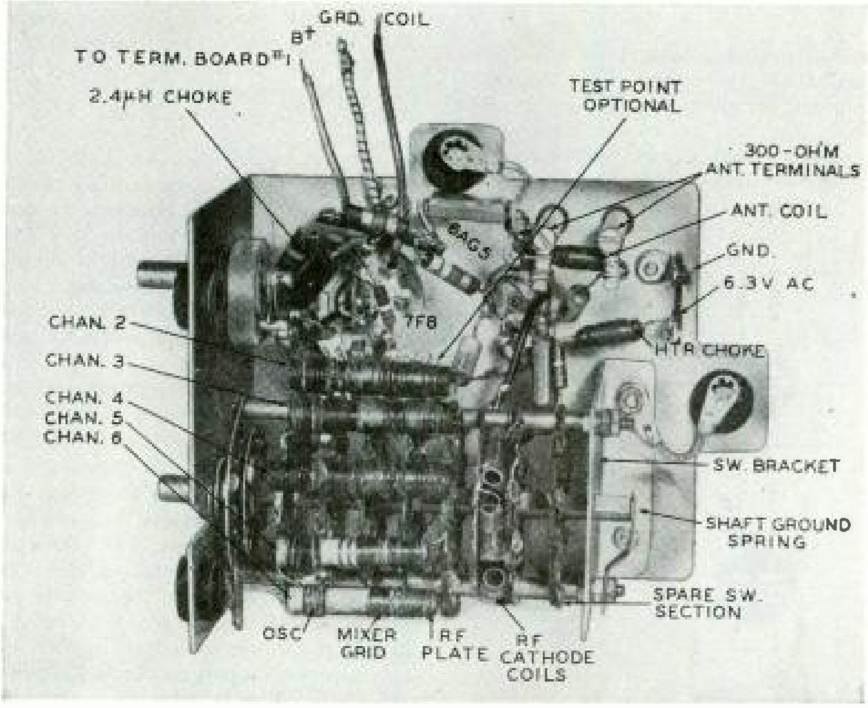


Fig. 8—Underchassis view of the tuner, with the main points and parts indicated.

LAST month we described the construction of two standard video i.f. strips, either of which can be used in constructing this deluxe TV receiver or to modernize obsolete sets. This installment will discuss the construction of the tuner or front end. Designed to cover any nine of the existing twelve TV channels, this tuner can be used in constructing TV field-strength meters, and remote tuners.

A schematic of the tuner is shown in Fig. 7. The 6AG5 is a grounded-grid r.f. amplifier, and the 7F8 is the oscillator and mixer.

The tuner circuit

The antenna signal is applied across a 300-ohm input consisting of a high-pass coil in parallel with an inductance in the cathode circuit of the 6AG5, which is a high-gain, triode-connected, grounded-grid amplifier. The cathode inductance is switched for various frequencies to maintain the proper termination for the antenna. The r.f. amplifier is transformer-coupled to the mixer section of the 7F8 by overcoupled r.f. transformers which are switched for each channel. The other half of the 7F8 is a modified Colpitts oscillator. The coils are switched for each channel and a small variable capacitor is used for fine tuning. The oscillator output is inductively coupled to the mixer input because the oscillator, mixer, and r.f. coils are wound close together on the same axis. See Fig. 8. The mixer output contains both the audio and video i.f. signals. A 25-μμf capacitor, Erie type N750, stabilizes the oscillator against changes in frequency with heat. Three 0.25- to 3-μμf variable capacitors compensate for differences in tube interelectrode capacitances when it is necessary to change tubes. If these were not used, all the coils in the circuits of the tube or tubes changed would probably have to be realigned. With these three capacitors installed, it is necessary only to adjust them for one high-frequency station and the rest of the channels automatically fall back into alignment. Construction of these variable capacitors will be described later in this article.

Constructing the tuner

Figs. 8, 9, 10, and 11 show the construction of the channel-selector switch, which consists of five switch wafers and three metal shield plates. Switches D, F, H, and I are single-pole, 10-position wafers mounted with their terminals facing the rear of the switch frame. Switch sections B and C are mounted back-to-back on a single wafer mounted on the frame so that section B is on the front of the wafer. Section B is a single-pole, 10-position switch, and C is made from a shorting-type switch having a circular wiper which shorts all except one of its 10 contacts as it is rotated through its positions. Wafers with two switch sections back-to-back are not normally available; therefore, contacts and wiper were taken from a 10-position, shorting-type switch and mounted on the back of the wafer of switch section B.

Take care in selecting wafers for this switch because some available types have too much inductance in the contacts and others are difficult to convert for sections B and C. (Greenwich Sales Co., 59 Cortlandt Street, New York, N. Y. has three-deck rotary switches having two 10-position wafers and one shorting-type wafer which are suitable for use on the channel-selector switch.) Three of these switches will supply all the wafers needed.

Disassemble one of the shorting-type wafers by drilling out the eyelets which hold the contacts. Loosen the circular wiper by pinching its nibs together on the opposite side of the rotor. Remove it by prying evenly with a knife blade, being careful not to bend the wiper or damage the contacts during these operations.

Remove the contacts from positions allotted to channels 2, 3, 4, 5, 6, and the blank position on the wafer selected for sections B and C. Do this by cutting through the folded-over section of the eyelets in five or six places with a sharp knife or wood chisel. Remove the rotor. Mount the wiper from the shorting-type switch on the back of the rotor just removed so that its open section is opposite the circuit-closing contact on the front. Anchor it in place by spreading the nibs with a screwdriver.

Insert the rotor in the wafer, making sure that the contact for section B is toward the front. Place a contact and eyelet in position from the side of the wafer; turn the rotor until it engages the contact. This leaves section C open and its contact can be placed over the eyelet. Fold over the eyelet with a punch and put a little solder on both sides to insure a good connection between contacts. Add the other five contacts in the same way.

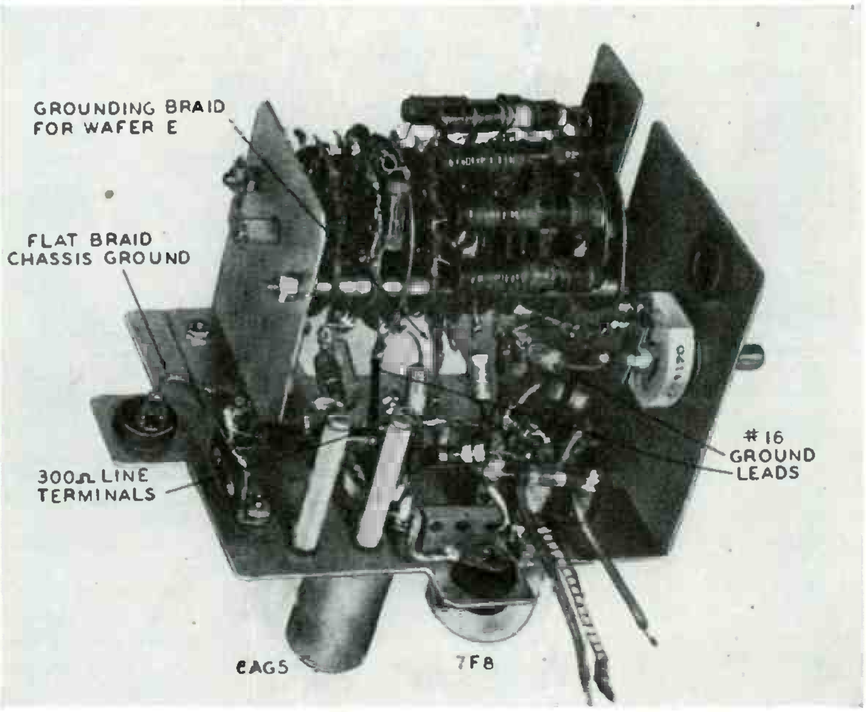


Fig. 10—The chassis from another angle. Look it over well for construction hints.

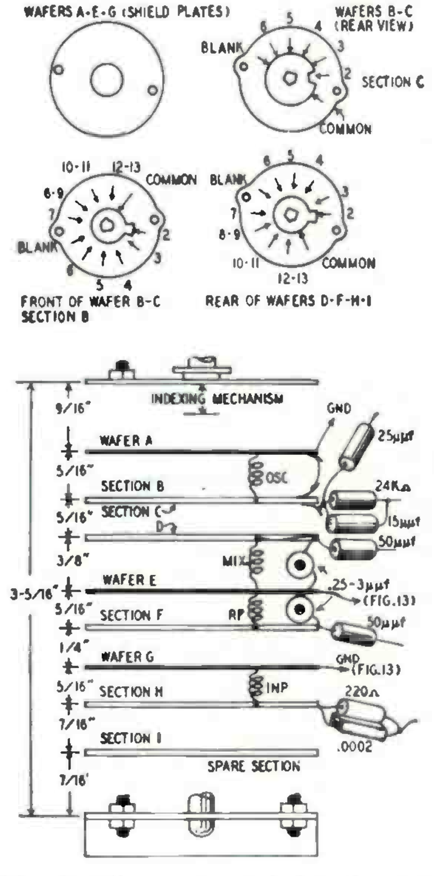


Fig. 9—Construction of the channel-selector switch is shown in the drawings.

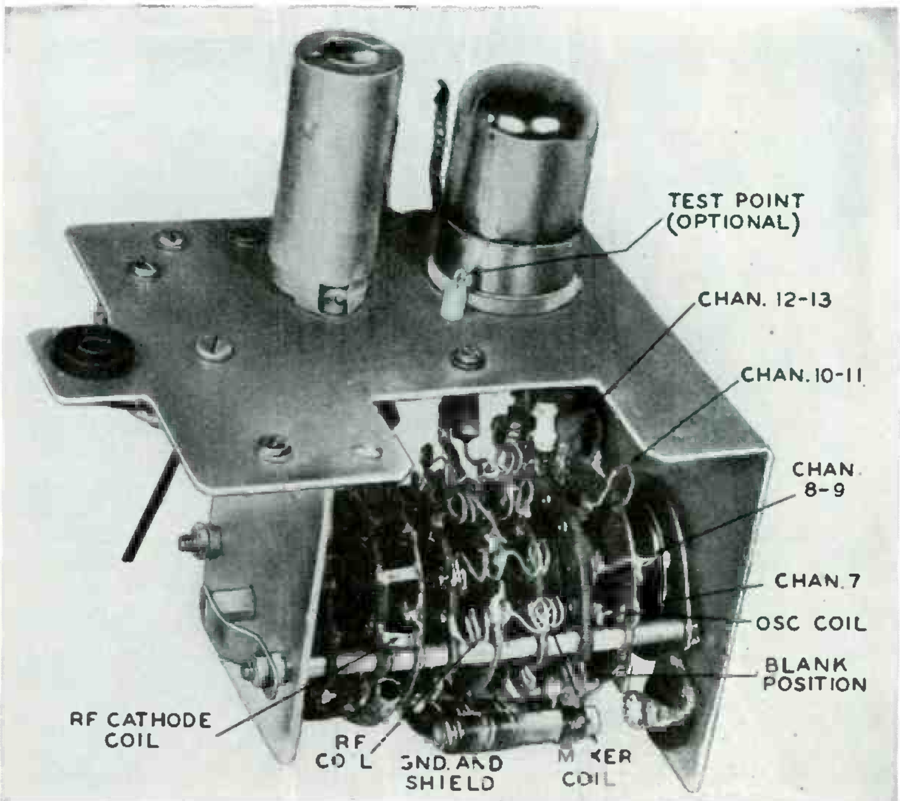


Fig. 11—The high-band coils show up in this view. Note the cathode inductors.

Section C shorts the unused low-band coils to prevent them from resonating with the high-frequency circuits. The high-band coils are not long enough to cause trouble.

Cut out and drill the three shield plates from 20-gauge copper, brass, or tin. Their exact size will depend on the sizes of the wafers and frame used. Cut spacers so the wafers are spaced as shown in Fig. 9; then reassemble the switch. The rear section is not used. It has been installed for possible future

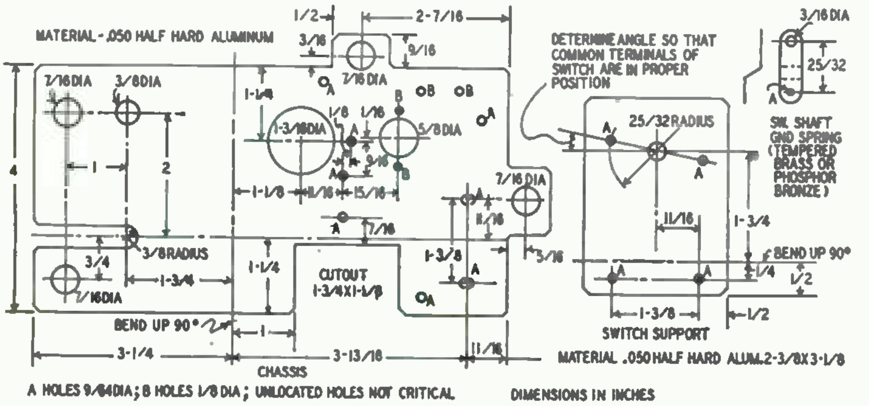


Fig. 12—Layout guide for the chassis and support for the selector switch.

use for antenna switching, station indicators, or preamplifiers. Install stops on the front of the switch to cover the 10 positions.

If the stops on the switch are not movable and are in the wrong positions, bend them back and install new ones where required by drilling holes and screwing in small self-tapping

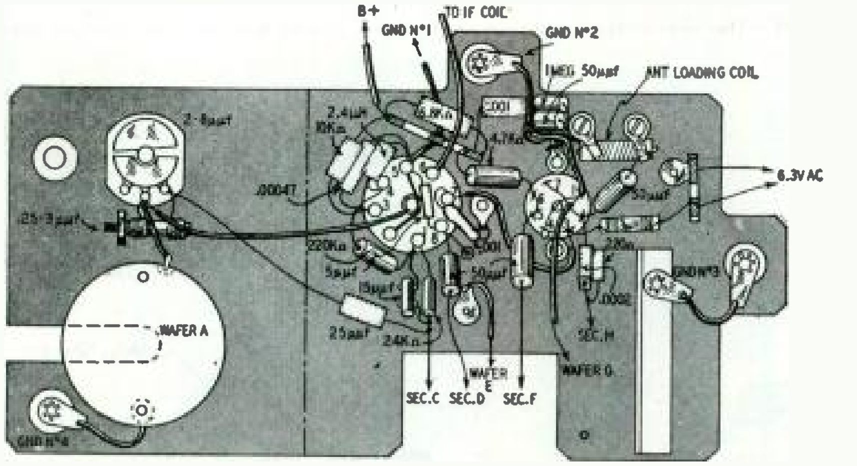


Fig. 13—A partial pictorial diagram of the tuner. The selector switch was omitted from the drawing for clarity as were two compensating capacitors.

screws. Let them project just far enough to stop the rotor without interfering with the indexing springs.

Note that the shafts on this switch and the fine-tuning control are short (about ¾ inch long) and are connected with an extension shaft in the final assembly. This facilitates installation and removal of the tuner from the chassis and also is used to advantage during the alignment of the h.f. channels. All of the switch reworking as outlined above is much easier than it sounds and can be completed in a couple of evenings.

The tuner chassis and switch support are cut to the correct dimensions (Fig. 12) from .05-inch, half-hard aluminum sheet. Drill the holes and bend to shape. Install the tube sockets, fine-tuning capacitor, tie points, etc., using internal-tooth lockwashers under each screw and nut. Leave out the switch until later. Wire in all components and wires, except those leading to the switch. Follow very carefully the layout (Fig. 13) and photographs (Figs. 8, 10, and 11). This is very important because changes from this layout can make the coil data useless.

Fasten the switch to its rear mounting bracket and slide the switch down the slot in the front of its panel and into position (do not fasten it down yet). Solder the components and ground leads which go to the switch at the tube socket end, using the switch for positioning. Use No. 16 stranded wire for the ground leads except for the ⅛-inch flat copper braid from shield section E directly to the chassis. At the switch end, pass the wires and leads through the proper switch terminals but do not solder yet. Make these leads just long enough to pass through the switch terminals so that the switch can be removed easily for servicing if necessary. Now pull the leads away from the switch and slide it out of the slot. Although all the coils can be soldered to the switch after it is installed, it is much easier to solder some of the high-band coils to the switch prior to installing it.

Refer to Fig. 14 for the data on all the coils and r.f. chokes. Note that all coils for the same channel are wound in the same direction. The winding length and spacing between coils was measured after all channels were aligned and should be a help in presetting them. Mixer and r.f. coils for channels 2 through 6 are closewound rather loosely around the form so they can be spread out easily after they are added to the switch. Later each coil turn will be held in place with soft wax. The oscillator coils can be wound fairly tight around the forms as they consist of only a few turns and do not have to be spread very much. All the coils for channels 2 through 6 are wound with Formex or Formvar-insulated wire or tubular forms. Those for channels 7 through 13 are No. 22 bare, tinned wire and are self-supporting. The cathode coils for these channels are made from .005 x ⅛-inch copper strips connected directly between the points on wafers G and H as shown in Fig. 11. The high-frequency coils are so critical that two lengths are given, a length to cut the wire, and the length to be used. Cut a piece of the bare wire to the "cut" length given in Fig. 14; then bend the two ends so that the "use" length is between the two bends. Form the coils as shown in the drawings and photos, and solder to the switch so that the solder covers the bent ends only up to the bends.

The r.f. amplifier cathode chokes or coils are close-wound on 3/16-inch Textolite or insulating paper tubing for the low channels. These are cemented when finished as they are very broad in response and require no adjustments. The cathode coil for the h.f. channels consist of bare wire soldered directly across the switch terminals.

Solder the two sets of coils for channels 12-13 and 10-11 to the switch, and then slide the switch back down the slot into the front-end assembly. Fasten the switch and its mounting, and complete the connections to the switch. Now add the coils for the rest of the channels, and finish by spreading them to the dimensions indicated on the coil data. The three variable capacitors that compensate for the variation in interelectrode capacitances of different tubes are easily made. (See Fig. 14). Use a piece of 3/16-inch (outside diameter), low-loss paper or Textolite tubing with walls thin enough to allow an 8-32 screw to slip in and out. Wind the six turns of No. 20 tinned, solid copper wire at one end. Remove it from the tubing, tighten the turns and then replace it. Flow in enough solder to produce a solid band of metal; let cool long enough so that the rosin from the solder forms a bond between the resulting metal band and the tubing.

Closewind four turns at the other end of the tubing in a counterclockwise direction, place a ⅞ or 1-inch cadmium- or chrome-plated 8-32 screw

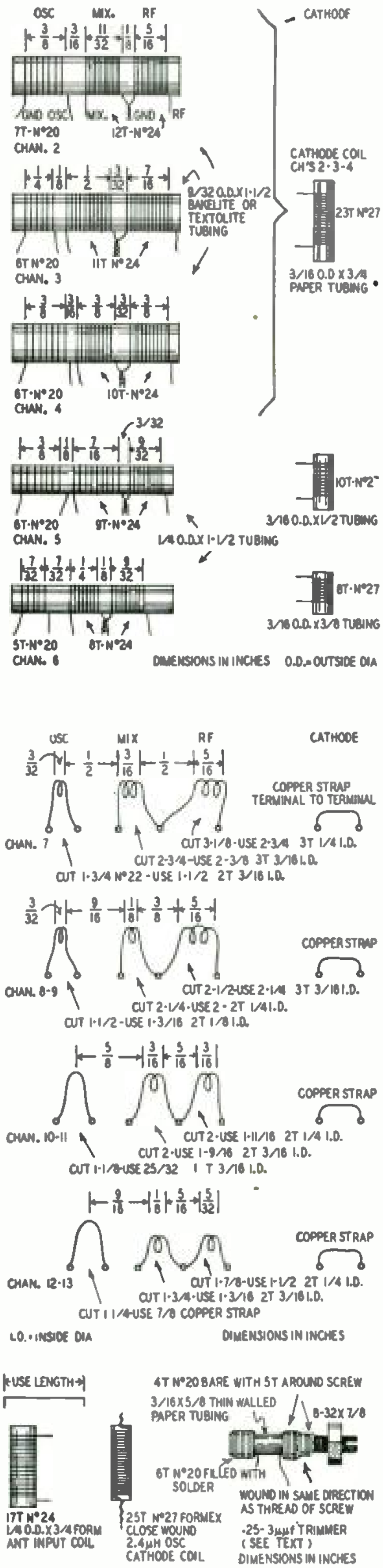


Fig. 14—These drawings show the construction of the inductors and the special low-capacitance capacitors which compensate for differences in the tubes.

about half-way in the tubing and wind the additional five turns around the screw. The wire size has been selected so that the last five turns form the threads for the screw. Remove the screw and the turns of wire from the tubing, tighten them slightly and replace. Now flow the solder into the four turns that are on the tubing, again using enough heat to allow the rosin in the solder to flow down to the tubing. Apply only enough solder to the turns over the screw to form a solid band. Turn the screw continuously while the solder is cooling so that neither the solder nor the rosin will set the screw. Again let it cool until the rosin sets against the tubing. The resulting variable capacitor is a compact unit with leads that are solid enough to keep it rigid and self-supporting in the wiring. Adjust the screw so its bottom is approximately even with the inside edge of the lower band and lock it in place with a hex nut or round battery nut, using only hand pressure. These capacitors need no further adjustment and should be left in this position until it is necessary to replace either the 6AG5 or the 7F8 after the receiver has been aligned.

Solder two of these capacitors to the switch with the screw side of the capacitors connected to the grounded shield and with the screws up, away from the chassis so that they will be easily accessable. Solder the third one across the fine-tuning capacitor, connecting the screw end of the capacitor to the grounded side of the tuning capacitor.

Now check the wiring of the front-end against the schematic and the layout.

There are numerous applications for small variable capacitors like the ones just described. For example; some home-made TV and FM boosters take off and oscillate at the slightest provocation. These circuits can be stabilized by installing small variable capacitors between plate and grid using any of the standard neutralizing schemes.

Gimmicks or twisted insulated leads are commonly used to couple the output of the b.f.o. to the second detector in communications-type receivers. Sometimes the b.f.o. is too strong to give a good beat with a weak signal. Furthermore, a strong b.f.o. will cause the a.v.c. voltage to rise and reduce the sensitivity of the receiver. This trouble can be cured by using one of these home-made variables to replace the gimmick. You can make the screw longer so it protrudes through the panel where it can be used as a b.f.o. injection control.

These low-capacitance variables can be used to neutralize the plate-to-grid capacitance of low-power transmitting tubes like the 6L6, 3E29, 3C24, and 807. Capacitors for medium-power tubes can be made in the same manner. Use thin-wall ceramic tubing and adjust the length of the screw and windings for the desired capacitance range and breakdown voltage.

TELEVISION DX REPORTS

THE incoming mail in response to our requests for long-distance television reception reports discloses at least one interesting fact. Over 75% of all the letters reporting true dx reception (many listed only fringe-area results) logged reception of KLEE-TV in Houston, Tex., at least once. All the reports were from four closely grouped states, Illinois, Michigan, Iowa, and Indiana. No other station was mentioned in more than two letters.

Here's the list of those who reported receiving KLEE-TV:

Howard X. Anderson, Rockford, Ill. Nov. 16, 1949; G-E 821 receiver, Amphenol 114-005 antenna.

John B. Sevec, Joliet, Ill. Nov. 16, 1949; Amphenol dipole antenna.

Tom Bromeling, Albion, Mich. Nov. 16, 1949; RCA 8TZ41 receiver, two-bay Amphenol antenna, and booster.

Larry Shaw, Port Huron, Mich. July 15, 1949; Hallicrafters T-54 receiver, Taco double-doublet antenna.

Leo Yarusinsky, Streator, Ill. Nov. 17, 1949; RCA-type receiver, two-stack conical antenna.

Clifford R. Butler, Burlington, Iowa. Nov. 16, 1949; Westinghouse receiver, two-bay Amphenol antenna.

Arnold Zarek, Lafayette, Ind. Nov. 16, 1949; Emerson 611 receiver, two-stack conical antenna. (Mr. Zarek also received WOAI in San Antonio on the same day.)

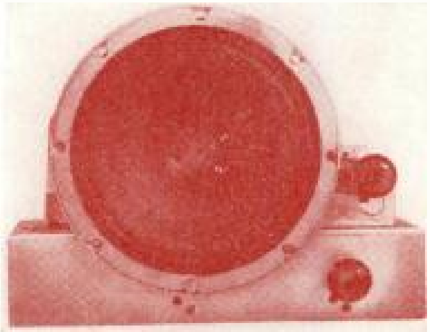
Lewis R. Ronk, Port Clinton, Ohio. April 27, 1949. Philco 1002 receiver, Amphenol 114-302 antenna. Mr. Ronk reports that many viewers in his area picked up a baseball game on KLEE-TV at the same time he did and that the *Toledo Blade* wrote an article about it on April 28. He picked up KLEE-TV again on May 7 and May 21, as well as WKY-TV in Oklahoma City, Okla., on July 13, 1949. Mr. Ronk is on an island and has excellent overwater reception from many distant stations.

A letter from B. Waters of Oneida, Tenn., reports reception of WBAP in Ft. Worth, Tex., and WBZ, Boston, Mass., intermittently. Mr. Waters apparently believes in television although he is about 150 miles from the nearest station (Louisville). He owns two receivers, an Admiral at home and a Motorola VT-71 in his service shop. He, as well as many other correspondents, reports consistent reception over this and larger distances, indicating that even fringe areas extend over much more territory than anyone used to think possible.

G. Hampton Allison of Richmond, Va., reports receiving stations in New York and points slightly south on a Pilot TV-37 with a modified Yagi-type antenna.

Many other letters were received, too many to quote here. They reported reception up to 200 or 300 miles; there was enough of this, in fact, to make one wonder if reception at 200 miles might not be called almost normal.

One-Tube Loudspeaker Receiver



The set gives good loudspeaker results.

A single-coil permeability tuner, a duo-triode, and two batteries give speaker-volume reception

by SANFORD MILLER

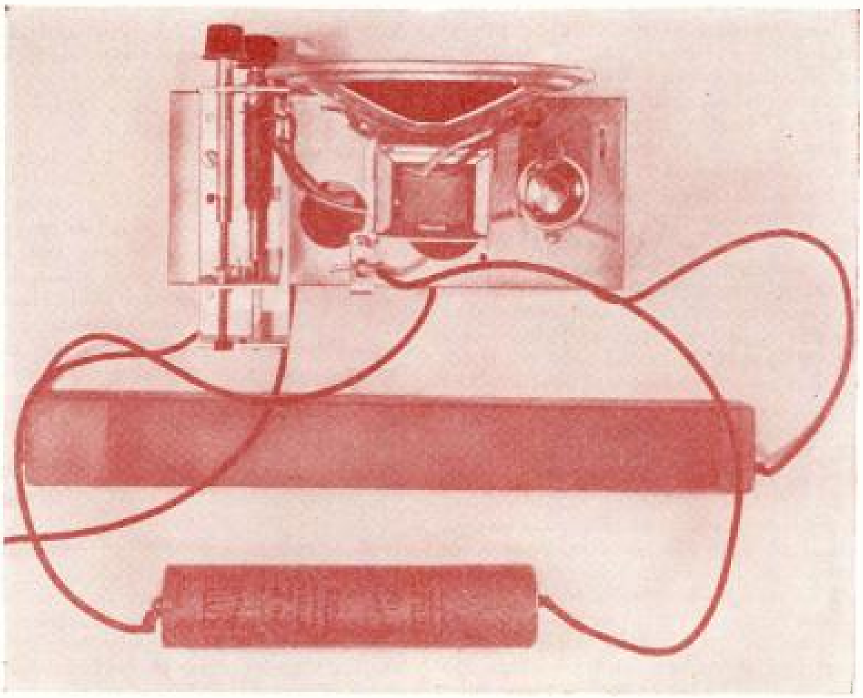
THE one-tube loudspeaker receiver has long been the goal of constructors and experimenters. This one combines low cost and good volume without sacrificing sensitivity. Adding a small capacitor and a telegraph key makes it an excellent code-practice oscillator.

The set was designed during a search for a simplified, basic receiver. The crystal set was ruled out because of low selectivity and sensitivity and limitation to headphones. The superhet is too complicated for a simple receiver. Ordinary regenerators are undesirable because of radiation and the skill required to operate them properly. But grid-leak detectors are most sensitive, and enormous gain can be obtained by regeneration, the incoming signal being amplified many times over.

The choice was narrowed down to the circuit shown in the figure, a special type of ultraudion with a certain amount of superregeneration. When components are carefully selected and permeability tuning used, regeneration is automatic. No manual regeneration control is necessary, and no tickler winding is required on the coil. Regeneration is provided by the ultraudion connection of the first triode.

The 24-μμf coupling capacitor was chosen as a happy medium. A larger capacitor requires more feedback or regeneration and a smaller one reduces the volume, though it improves the selectivity. An adjustable trimmer can be used here, the best value for local conditions being chosen.

The detector plate bypass capacitor, shown as .0025μf in the diagram, is critical. Too little capacitance causes oscillation and too much reduces the volume. Various capacitors should be tried until one is found that permits tuning over the whole range without oscillation but with the detector very close to the "squeal point." If a very small capacitor is required here, the Q of the tuning circuit is low. A tuner that operates best when this capacitor is large probably has high gain and low losses. Choose a tuner that has stranded litz instead of solid wire for the coil. One with a universal (honeycomb) winding is usually much better than a plain solenoid.



The permeability tuner is at the left. The batteries are special surplus types.

Though not nearly as critical, other parts may be varied to meet special conditions. In locations near powerful stations, reducing the grid leak from 10 megohms to 3—or even 1—will minimize overloading on strong signals. Increasing the plate bypass capacitor will make operation smoother. Since sensitivity is not required, the set need not be run near the point of oscillation. In places remote from powerful stations, this capacitor should be as small as possible without causing signal-distorting oscillation, and the grid-leak resistance should be high.

The second half of the 3B7 is the audio amplifier, which is resistance-coupled to the detector plate through an 82,000-ohm resistor and .02-μf capacitor. The 390,000-ohm grid leak connects to the negative end of a 1,000-ohm bias resistor, putting just enough negative bias on the grid to make it operate at minimum distortion. All these values are uncritical. The coupling resistor may be increased to as much as 150,000 ohms (if the detector plate bypass capacitor is selected to give best results at that value) and grid leak values between 220,000 and 1 megohm will work. Higher values of either resistor may increase sensitivity, though the present values were considered—after some experiment—to be the best all-around combination.

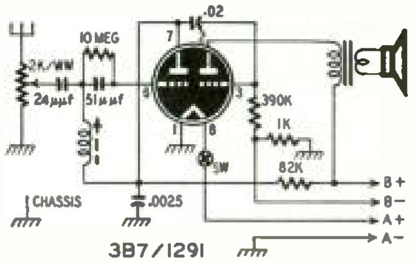
Since only one tube is used, battery operation is simplest and most economical. It is also safest, if the set is built or used by a beginner. The A-battery can be made by paralleling two flashlight cells. The B-battery in the photograph is a surplus 103½-volt surplus unit. Two ordinary 45-volt batteries in series can be used instead. Current requirements being low, battery life is long.

An outdoor antenna is recommended for proper operation. Antenna length should be fitted to the needs of the location. Near powerful broadcast stations 25 to 50 feet should be sufficient, but in remote rural areas at least 100 feet flat-top, hung as high as possible, will be needed.

A weak A-battery causes low volume and broad tuning. Keep a flashlight cell handy to check it by the substitution method.

All components are cheap and easy to obtain, though high quality is needed to produce best results. The volume control is a 2,000-ohm, wire-wound unit. The inductance of the wire winding appeared to be of value, and a carbon type is not recommended. The tuner was actually a superhet permeability tuner with the oscillator coil and trimmer capacitors removed. If loudspeaker reception is to be obtained, a good speaker, and most especially, a good output transformer, will be required.

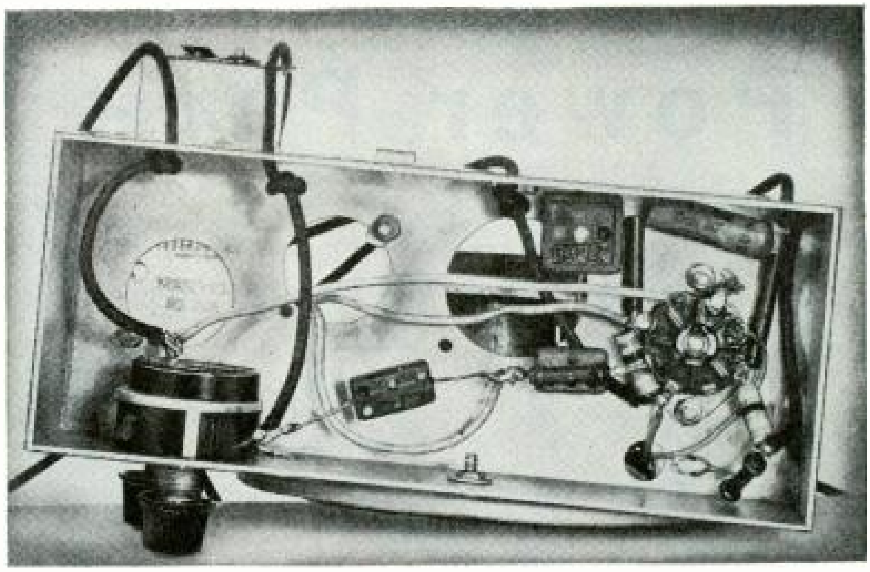
To use the receiver as a code-practice oscillator, a 100-μμf capacitor may be soldered to pin No. 2 of the tube socket. Connect the other end of the capacitor with a short wire to a telegraph key, and the key's other terminal with a short wire to pin No. 6. Audio growl with the key up if it occurs, may be removed by connecting a 100-μμf or larger capacitor between the output tube plate and ground.



One-tube set is ultraudion regenerator.

MATERIALS FOR RECEIVER

Resistors: 1—1,000, 1—82,000, 1—390,000 ohms, 1—10 megohms, ½-watt; 1—2,000 ohms, wirewound potentiometer with switch.
Capacitors: 1—24, 1—51 μμf, 1—.0025, 1—.02 μf.
Miscellaneous: 1—permeability tuner; 1—3B7/1291 tube; 1—output transformer, 25,000 ohms to voice coil; 1 octal tube socket; chassis and miscellaneous hardware; 1—1.5-volt A, 1—90-103.5-volt B batteries; 1—PM loudspeaker.



Receiver has few parts, is easily built. Much smaller chassis could be employed.

Relay Timing Test Circuit

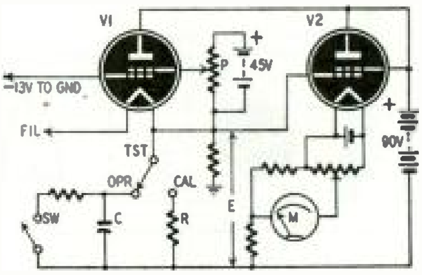
Many types of telephone central-office equipment include timing circuits, the accuracy of which must be high. Some depend on slow-acting relays, others on vacuum-tube circuits with R-C time-constant delays. Checking the equipment to see that the time intervals are as specified is important to smooth and faultless operation. This job can be done with a direct-reading instrument designed by E. R. Morton, described in the *Bell Laboratories Record.*

The heart of the instrument is a vacuum-tube voltmeter. This measures the voltage of a capacitor C which is allowed to charge only during the action time of the circuit under test. The charge at the end of any given time will indicate the time itself.

A bias of —13 volts is ordinarily applied (by another circuit unimportant to this discussion) to the grid of the tube V1. That is enough to cut off the tube. Switch SW is closed to discharge C. At the start of the timing cycle to be measured, SW is opened. The —13 volts is removed from the grid of V1, and ground is substituted. The operator has set the test key at OPR.

Now, while the positive end of the B-battery is connected to the plate of V1, the negative end is connected to the cathode only in series with capacitor C. The tube is so biased and the screen voltage set so that reasonable changes in plate voltage do not appreciably change the plate current. From the time the cutoff bias is removed, therefore, until full conduction, the plate current is constant.

The plate current passes through C, charging it, the charge increasing with time. The voltage across the capacitor at any given time is equal to its charge Q (in coulombs) at that time divided by the capacitance: $E=Q/C$. If the charging current is constant, as in this case, the charge is determined by the current and the time during which it has flowed: $Q=IT$. Substituting IT, the equivalent of Q, for Q in the first equation, the voltage of any given time is



equal to the charging current multiplied by the time it has flowed, divided by the capacitance: $E=IT/C$. The current I and capacitance C are fixed, so the voltage E across capacitor C depends solely on the time T allowed for the charge. The voltage increases directly as time.

The grid of V2, the v.t.v.m. tube, is connected to the cathode side of C; therefore, the voltage developed across C by its increasing charge is indicated on the meter. While the meter effectively measures this voltage, it is calibrated in terms of time (which is directly related to the voltage, as shown). As the voltage across C depends not only on time but also on capacitance, four different time ranges may be measured by substituting different vales of capacitance. The ranges are 0-20, 0-100, 0-500, and 0-5,000 milliseconds.

Potentiometer P calibrates the instrument. When the test key is switched to CAL, resistor R is substituted for capacitor C. The resistor's value is such that the voltage drop across it is the same as the charge would be on C when the maximum time for the scale in question (100 milliseconds, for instance) is being measured. P is then adjusted for a full-scale reading on the meter.

Power Pack Design

How to choose transformer and input capacitor values to obtain required voltage

By P. E. LEVENTHAL

POWER supplies, particularly capacitor-input filters, are usually built on a system of hit-or-miss guesswork. There seems to be great difficulty in deciding the correct value of the input or reservoir capacitor. The amateur generally regards the power supply as the least important part of his equipment and simply wires up the standard full-wave circuit, using any capacitors on hand.

This is an unfortunate state of affairs, for a power pack is required for practically every piece of apparatus in the station and may give rise to many troubles, from intolerable hum in a receiver to frequency creep in a transmitter.

The waveform of the output voltage across the resistance load of a simple half-wave rectifier system (Fig. 1-a) is shown by the graph, Fig. 1-b. The waveform which results when a capacitor is placed across the load is shown by the solid line in Fig. 1-c. The corresponding figures for full-wave rectification are shown in Figs. 2-a, 2-b, and 2-c. The dotted line represents the d.c. output voltage while the thick line is the superimposed ripple voltage.

The ripple voltage, or hum, has twice the frequency of the supply in the full-wave case and is therefore more easily filtered off.

Each rectifier conducts fully only during a part of each cycle when the applied voltage is near its peak, and the reservoir capacitor charges up to this peak value. The charging ceases when the peak is passed, and the capacitor begins to discharge through the load until the voltage across the capacitor becomes lower than the rising voltage of the next half-cycle (or full cycle in the case of a half-wave rectifier), when the charging begins again. It is clear that the capacitor acts as a reservoir which is partially emptied and refilled during each half-cycle.

The smaller the charge and discharge with respect to the total charge on the capacitor, the less will be the fluctuation or ripple of the voltage. That is, the larger the capacitor for a given current drain, the less the ripple or the better the smoothing.

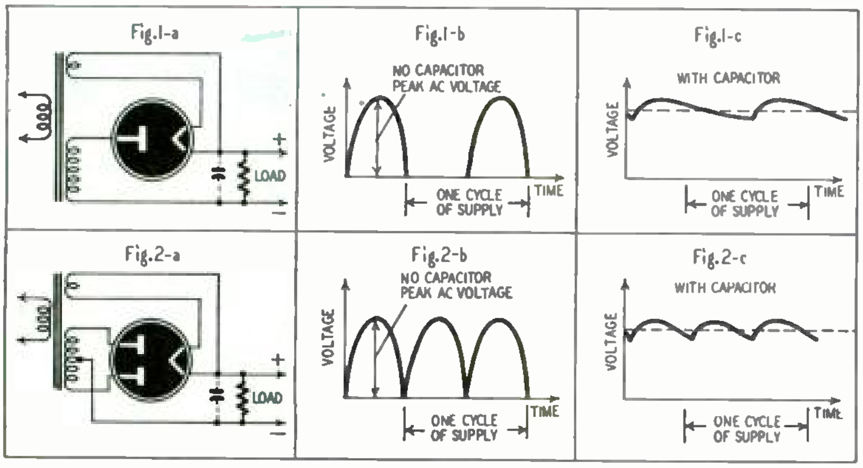


Fig. 1—The half-wave rectifier, with output waveforms with and without capacitor. Fig. 2—Higher ripple frequency of full-wave output makes it easier to filter.

The d.c. voltage across the capacitor equals the peak a.c. voltage minus the average ripple voltage. Since the ripple decreases as the value of the reservoir capacitor increases, it is evident that increasing the size of the capacitor increases the effective d.c. voltage up to the limit at which the ripple is negligible, and the d.c. voltage across the capacitor (or load) equals the peak value of the applied a.c. voltage.

A simple analysis shows that $V = E_{peak} - (\pi IX)$, where V is the d.c. voltage across the reservoir capacitor, E_{peak} is the peak value of the applied a.c. voltage, I is the load current in amperes, and X is the reactance of the capacitor at the ripple frequency. Rearranged to show the filter capacitor required for given output voltage when a.c. peak, load current, and ripple frequency are known, $C = 1/2f(E_{peak} - V)$.

The equations may be used as they stand to give most of the information necessary in the design of a power supply, but the author has constructed a nomogram which greatly simplifies the task.

Using the nomogram

The nomogram may be used to find the value of the reservoir capacitor necessary for a required output from a given transformer, to determine the transformer necessary to give a stated output using a specified capacitor, or to find the output obtained using a specified transformer and capacitor.

Constructed for full-wave rectification of 50-cycle a.c., the nomogram may be used for half-wave rectification or any other frequency by multiplying the values of capacitance on the left-hand scale A by 100/f, where f is the lowest-frequency component of the ripple (120 cycles for a full-wave rectifier and a 60-cycle supply, for example).

It is necessary to calculate the value of $E_{peak} - V$, where E_{peak} is 1.4 times the rated r.m.s. voltage of the transformer secondary (or of half the secondary for a full-wave rectifier), and V is the required d.c. output voltage. To simplify matters to the utmost, a "yardstick" has been provided to convert r.m.s. values to peak values. Its range may be increased by multiplying both sides by 10 or 100 as required.

Sample calculations

A receiver requires a power supply of 300 volts at 120 ma. The rectifier is of the full-wave type, connected to a 50-cycle supply. If the input capacitor of the filter (reservoir capacitor) is 8 μf, what is the required a.c. voltage?

Place a straightedge between 120 on the load scale B and 8 on the capacitance scale A. The straightedge then intersects scale C at 80 volts. Therefore the peak a.c. input required is 300 + 80 = 380 volts. Converting this to r.m.s. values, we have 271 volts.

Hence a 275-0-275-volt transformer capable of supplying 120 ma would be suitable.

In another case, given a transformer

with a secondary delivering 350 volts r.m.s. each side of the center tap, what size input capacitor is required to obtain a d.c. supply of 480 volts at a load of 5 ma?

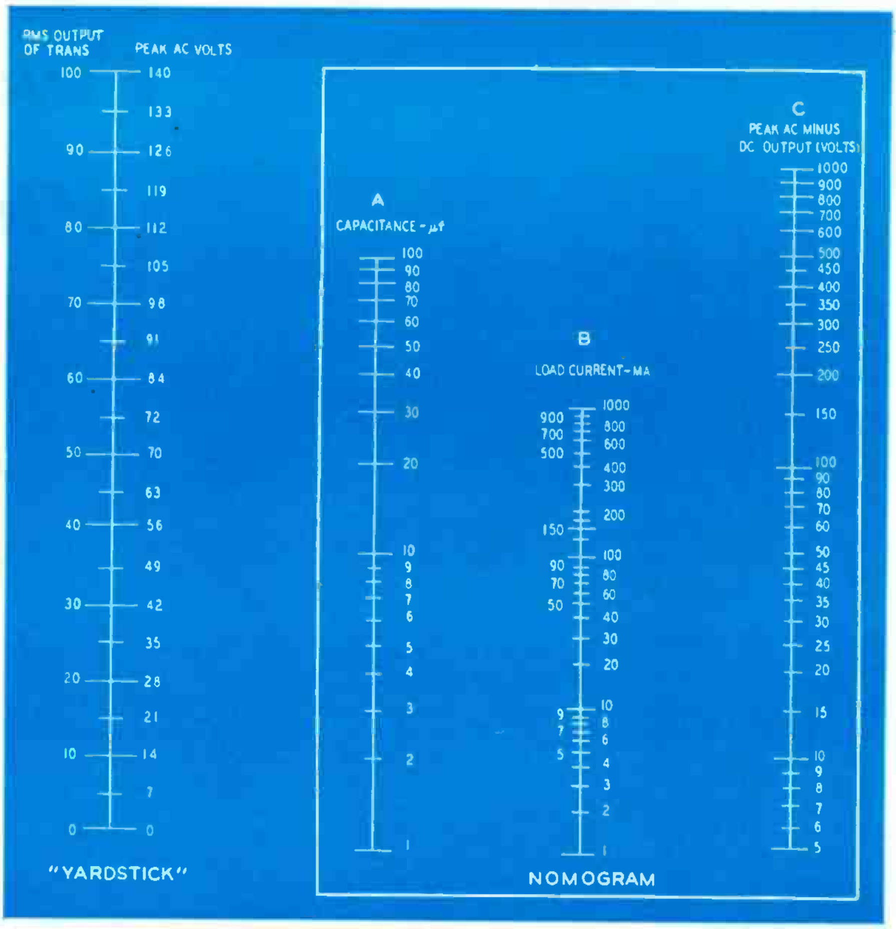
The peak a.c. voltage is 350 × 1.4 (or from the "yardstick") = 490 volts. Therefore, peak a.c. — required d.c. = 490 — 480 = 10 volts. A straightedge placed between 10 on scale C and 5 on scale B intersects scale A at 2.5 μf; this is the capacitance required.

Another problem: a 500-volt transformer used on 50-cycle a.c. is to have its output half-wave-rectified. What will be the resulting d.c. output at 200 ma if an 8-μf capacitor is used at the filter input?

The peak a.c. is 700 volts (from the "yardstick"). Since the fundamental ripple frequency is now 50 cycles, we must multiply all numbers on scale A by 100/50, or 2. The original 4-μf mark now becomes 8 μf. Placing a straightedge between 4 on scale A and 200 on scale B, we have an intersection at 250 volts on scale C. Therefore the d.c. voltage output equals peak a.c. — 250 = 450 volts.

If the resistance of the smoothing choke following the reservoir capacitor is known, the voltage drop across it may be found by Ohm's law and added to the required d.c. voltage. If the rectifier tube is a mercury-vapor type, an extra 15 volts may be added for the drop across the tube. A tube handbook must be consulted for the drop across a vacuum tube.

The nomogram may be employed for all values of load current from 1 ma to 1 ampere. It may be used for all voltages, since the value E_{peak} — V does not depend at all on the absolute value of E_{peak}.



Nomogram is for 50-cycle supply. Text explains its use for other frequencies.

The filter circuit

The smoothing filter is another piece of apparatus which, though very important, is often imperfectly understood.

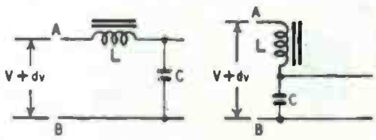


Fig. 3—Filter drawn as voltage divider.

Fig. 3 represents the ordinary type of filter circuit used by amateurs, terminals A and B being connected across the reservoir capacitor. The input to A and B, therefore, consists of a steady voltage V, with a superimposed ripple voltage dV.

If the filter circuit is redrawn in the form shown at right, its operation at once becomes apparent, as it is no more than a voltage divider or potentiometer.

As far as the d.c. component V is concerned, the capacitor presents an infinite impedance to this and the total d.c. voltage is obtained across the capacitor, minus only the ohmic loss due to the resistance of the wire in the choke.

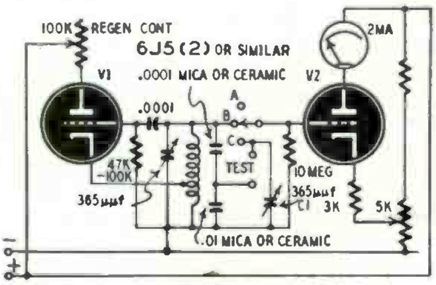
The ripple component (which is a.c.) fares differently. The choke presents a high impedance to the ripple frequency, while the capacitor acts almost as a short circuit. Thus, the greater part of the ripple voltage appears across the choke and only a very small part across the capacitor with the d.c. component. In this way, the filter performs its operation of smoothing the rectified supply.

Attenuation of the ripple depends upon the values of L, C, and f (the ripple frequency), the ripple becoming smaller as these are increased. Therefore, to obtain good smoothing, use full-wave rectification (f = twice supply frequency), and make L and C as large as possible. It is, of course, necessary to see that the working voltage of the capacitors is not exceeded and that the chokes can pass the required current. The resistance of the chokes must be such that they do not cause too great a voltage drop at the required load current.

(Thanks are due to the British *Short Wave Magazine* for permission to reprint this article. Note well that the nomogram and the calculations are based on a 50-cycle line frequency, common in Britain and in other countries. Instructions are given in the text for converting capacitance values for other frequencies such as the 60 cycles common in the U. S.—*Editor*)

Meter Measures Coil Q

A simple Q-meter which consists of a calibrated oscillator and a simple v.t.v.m. is shown. V1 is the oscillator tube, and V2 is the v.t.v.m. The meter



has a 2-ma scale with 20 equally spaced divisions.

With the switch set at A, adjust the meter to zero. Throw the switch to B and adjust the regeneration control until the meter reads 10 (half-scale). Connect the coil to be measured to the TEST terminals, throw the switch to C, and adjust C1 to resonance as indicated by a maximum reading on the meter. A coil having a Q between zero and 200 can be read on the meter. The accuracy of the instrument is not affected by losses through the 10-megohm resistor and through capacitor C1.—*J. Kober*

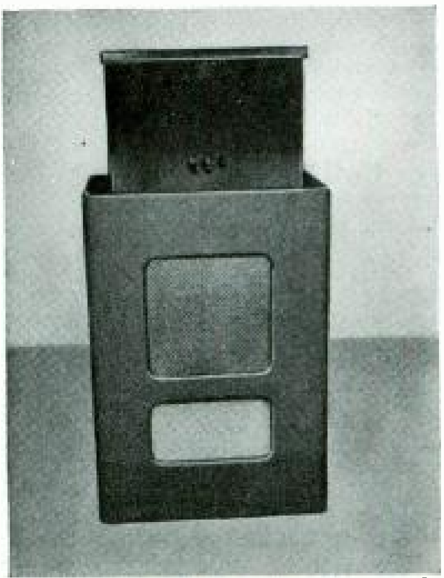
Custom-Built Phonograph

Optimum-quality LP-standard reproducer

By RICHARD H. DORF

I HAVE always felt that if you really want to hear recorded music at its very best, you have to build or assemble your own equipment. You *can* get a standard radio-phonograph console that will sound as good as one you build; but of the $500 to over $1,000 you'll pay for it, a shockingly high percentage will go into fancy cabinetwork. While many people like to have beautiful furniture in their living rooms, lots more have only a limited amount of money and they'd like to spend it on sound, not furniture.

My brother—and sister-in-law are such people. They are discriminating listeners to good music. But when they went the rounds of the radio stores, they found that the only record players they could afford had boomy bass or no treble or screechy highs or noisy turntables or record-chipping changers or some combination of these and other faults. Some expensive units sounded fine (though most had inadequate tone controls), but looking over the sets showed that much of the price was tied up in solid mahogany cabinets and electrical doodads like shortwave bands, push-button tuning, dynamic noise suppressors, and turnover record changers, none of which they needed or wanted.



The bass-reflex speaker enclosure with player on top make a compact phono.

So we decided to *build* an instrument. We determined on an instrument like this:

1. A phonograph only. To provide for future use of a good AM-FM tuner, a special input jack would be included on the phonograph amplifier.
2. The instrument had to play both 78- and 33⅓-r.p.m. (long-playing) records.
3. There was to be no compromise on audio quality at any point.
4. A changer was unnecessary—undesirable, in fact, because few if any changers can give the best audio quality (to say nothing about the fact that most tend to wear the center-holes of the records).
5. Both high- and low-frequency treble and boost controls should be included, with a calibrated flat position for each.

Selected components

The success of the finished phonograph is due to the selection of good, standard parts and to the straightforward, gimickless design of the amplifier.

A pickup was needed that would play standards and microgrooves: the Astatic FL-33 filled the bill. It's fashionable nowadays to distrust crystals when looking for optimum quality, but this crystal (with its FL filter, which removes a resonant peak in the high range) is flat within a fraction of a decibel to 10,000 cycles with LP's. Its output being about 0.5 volt from LP's, a preamplifier is not needed. Changing styli isn't a mere matter of throwing a lever, but changing the cartridge is something even a child can learn to do and takes only about 3 seconds.

There are better turntables than the General Industries DR selected. But they are bigger and cost a good deal more. This one has steady speed, simple lever speed change, and more torque than I've ever seen in a motor in its price class before. There is some rumble, but, even with the good bass response of this system, it isn't annoying.

The speaker is a General Electric S-1201-D. The maker claims 50-13,000 cycles on it. Listening to a harpsichord record through it (the plucked sound has high-level, high-order harmonics) is a thrilling experience. And it has enough good, clean bass to give your stomach a healthy push.

Parts must be mounted so as not to interfere with the turntable motor above.

To house the turntable assembly and amplifier, a case made for Webster changers was used. The speaker cabinet is a bass-reflex unit. Both were obtained from Terminal Radio Corp., New York, N. Y. Together, they accounted for only $30 of the total $120 cost of the whole instrument.

The amplifier

The schematic diagram of the amplifier reveals its simplicity. Essentially, it's a single voltage-amplifier triode, a "self-balancing" phase inverter, and a push-pull triode output stage. The tone control circuit has separate continuous bass and treble controls, each giving either boost or attenuation. It was adapted from a circuit in the June, 1949, issue of *Audio Engineering*. A second triode amplifier was included to make up for the 20-db loss in the tone control.

The most important feature of the amplifier is the feedback. Before inserting the feedback resistor R (at the suggestion of Harvey Gernsback—see his article in the August, 1949, issue of RADIO-ELECTRONICS) the response drooped off above about 8 kc, as expected with the UTC CG-16 output transformer. With feedback, the needle of the output meter—*connected across the voice coil, not a resistive load*—doesn't waver from the lowest to the highest point at which my test oscillator will percolate. In addition, it *sounds* 100% better—cleaner, more natural.

The motorboard circuit appears in the diagram with the amplifier. J1 and P1 are a two-prong, shielded jack-and-plug assembly. Through it, the TUNER-PHONO toggle switch (at the right rear of the motorboard in the photo) connects either the pickup or the tuner jack on the rear chassis apron to the volume control.

Note the Astatic FL filter. This is essential to eliminate a peak in the crystal response.

Building the phonograph

The motorboard can be made from 3-ply wood or from linen-filled bakelite obtained in a surplus store. (If the latter, put a thin sheet of asbestos on the bottom so it doesn't conduct heat so well.) Mount the turntable with the motor as near the front as possible, but scribe a 12½-inch circle around the centerpin location to be sure there will be room for 12-inch records. Locate the table as near the front left of the board as you can.

Screw and glue wooden supports for the board to the inside walls of the case, making them high enough to have the pickup on its rest just clear the top of the cabinet. That will leave the maximum room below, between the chassis and the motorboard. In my job, the top surface of the motorboard is 2⁷⁄₁₆ inches from the top of the case. Since the inside height of the cabinet is 10 inches, that leaves about 4½ inches to play with above the chassis. If you don't use the same cabinet I did, don't forget to do some measuring before you buy transformers!

The turntable being higher than usual, the pickup cannot be mounted on the motorboard. I got a shiny pipe escutcheon at a plumbing supplier's store. You can see how the pickup is mounted in it to raise the arm high enough. Follow the instructions that come with the FL-33 pickup to the letter—there's a mounting template, so you shouldn't have any trouble.

Locate the arm rest as near the right side of the board as possible, but far enough away so the user can get his fingers around the head to remove the cartridge. Be sure the rest leaves the pickup head at or above the level of the record surface. Glue a small cotton-lined container for the unused cartridge to the motorboard.

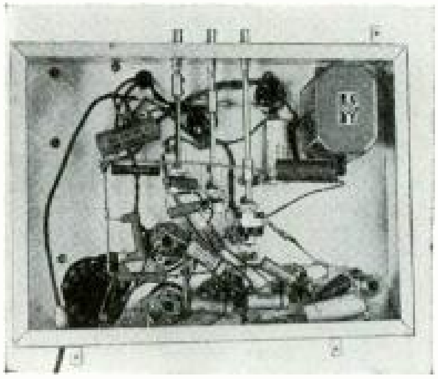
Get a 10 x 14 x 3-inch chassis—of aluminum unless you're ambitious for hard work. Before laying out the components on it, mark out the area above which the motor will be, as you can't put anything but J2 in that area.

The photo shows the parts layouts. Variations are possible, but the layout shown seemed most suitable for keeping the power supply away from low-level stages. Because of their height, 6A5-G's must be submounted. Get some long screws, put them through the socket-mounting holes on the chassis, and fill them up with nuts to make very rigid mountings for the sockets underneath. Don't forget to make the holes large enough for the bases of the 6A5-G's. These tubes, by the way, are similar to 2A3's but have a 6-volt filament and a cathode, which cuts down hum. They aren't made by RCA, but are made by Sylvania and perhaps others. The filament centers are tied to cathode internally, as shown; therefore, *be sure you don't ground either side or the centertap of the filament winding*. The arrangement puts the filaments of all tubes a few volts above ground.

Adjustments

The first adjustment is the feedback. Start off by leaving out R; see that everything works normally. Then insert R and listen for squeals. If there are none, put a low-range (3-volt) a.c. meter across the voice coil and watch for an indication *with no input to the amplifier*. If the meter rests contentedly on zero, you're away. If not, increase the value of R by slow degrees until the meter is at zero.

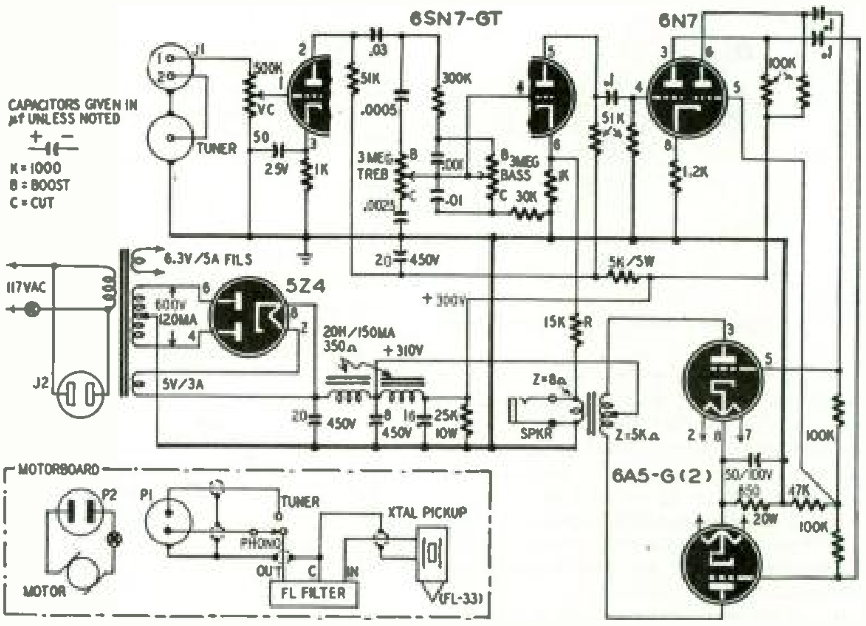
If you get squeals or the output of the amplifier increases when R is connected, reverse either the primary or the secondary connections to the output transformer (not both). Then sound should decrease when R goes in, and you can go ahead with the instructions in the last paragraph. I got approximately 11.5 db of feedback with the



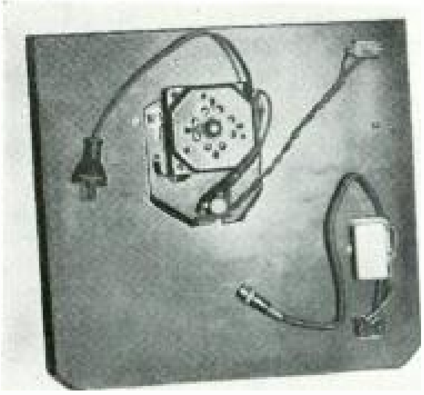
Extension shafts allow the controls to be put in the most convenient positions.

output transformer used. With a slightly different layout or another transformer, you may not be able to use so much; but you'll still get enough for a very fine amplifier. The higher the resistance of R, of course, the less feedback.

With the 11.5-db feedback, maximum output volume is, of course, cut down. It is more than plenty for the average living room, but nothing like the 10 watts at which the 6A5-G's are rated. The extra available power from the 6A5-G's insures against overloading on peaks. If you want to use this amplifier for PA work, add another triode voltage amplifier between the 6SN7-GT



Push-pull 6A5-G amplifier with feedback (resistor R) gives wide-range output.



FL filter mounts under the motorboard.

and the 6N7 and raise the value of R to prevent too much feedback.

The tone controls should give flat response with the knobs pointing up. To guarantee this, install the amplifier in the case, connect an audio oscillator to the tuner jack and an output meter (a nonfrequency-sensitive one—v.t.v.m. preferred) across the voice coil of the speaker.

Set oscillator and volume control for any convenient meter reading at 1,000 cycles. Then set the oscillator to about 8,000 cycles and adjust the TREBLE control for the same meter reading. Go down to about 70 cycles and set the BASS control for the same reading. Leaving all controls alone, take a run; the output should be flat from approximately 40 or 50 cycles to higher than you can hear.

You may get either a bump or a dip in the bass range. If it's a hump, add a small amount of capacitance across the .01-μf capacitor associated with the BASS control. If it's a dip, do the same with the .001. Experiment till all is flat. Then install the knobs pointing straight up. Make marks on the cabinet front at the maximum- and minimum-rotation points of both controls so the knobs can be put back right if they're removed or loosened. Clockwise rotation should boost in each case; swap connections to the outside lugs of the controls if it doesn't.

Tack a piece of the padding material that comes with the speaker cabinet to each side and two pieces to the rear cover (inside, of course) to prevent sound bounce. Run as long a lead as needed of rubber-covered lamp cord to a phone plug.

When you plug the speaker cord into the chassis jack and connect the amplifier to the a.c. line, put on a record and listen. For $120 you'll have a phonograph your friends will rave about and your customers will want to buy!

MATERIALS FOR PHONOGRAPH

Resistors: 2—1,000; 1—1,200; 1—15,000; 1—30,000; 1—47,000; 3—51,000; 4—100,000; 1—300,000 ohms, ½ watt; 1—25,000 ohms, 10 watts; 1—850 ohms, 20 watts; 1—500,000 ohms; 2—3-megohm potentiometers.
Capacitors: 1—500 μμf, mica; 1—.001; 1—.0025, 1—.01, 1—.03, 3—0.1 μf, 400 volts, paper; 1—50 μf. 25 volts, 1—50 μf, 100 volts, 1—98, 1—16, 2—20 μf, 450 volts, electrolytic.
Inductors: 1—power transformer, 600 volts center-tapped at 120 ma, 5 volts at 3 amps., 6.3 volts at 5 amps; 2—filter chokes, 20 henries, 150 ma; 1—output transformer, 5,000-ohm push-pull plates to 8-ohm voice coil.
Tubes: 1—5Z4, 2—6A5-G, 1—6N7, 1—6SN7-GT.
Connectors: 1—male and female 2-pin, shielded; 1—1-pin, shielded microphone connectors; 1—male and female (chassis-mounting) 2-prong, 117-volt connectors; 1—single-circuit, nonshorting phone jack and plug
Player assembly: 1—Astatic LP-33 pickup with standard and microgroove cartridges; 1—Astatic FL filter; 1—2-speed motor and turntable.
Miscellaneous: Chassis, hardware, cabinetry, and loudspeaker as described in text.

Placing A Speaker in The Home

ONE of the problems encountered by the owner of a composite high-fidelity reproducing system is where to place the speaker. The owner of a standard console radio-phonograph has no choice, since his speaker is already placed a few inches above the floor, within the cabinet. Buying separate components and assembling them, however, affords the possibility of a better location for the reproducer with a consequent improvement in sound.

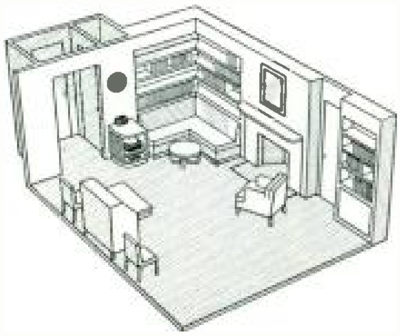


Fig. 1—Speaker hole in a closet wall.

Since most live sounds originate at a height of 4 to 6 feet above the floor, raising the speaker to this level seems to increase presence. Enclosing the back of the speaker in a closed air chamber of at least 6 to 10 cubic feet is necessary to insure genuine reproduction of the bass notes, except where special enclosures (such as the bass-reflex) are used.

In a booklet of instructions for installing home-music-system components, the Altec Lansing Corporation makes some excellent suggestions on placing speakers to satisfy both acoustical and esthetic requirements. These are shown in the drawings on this and the following page.

In Fig. 1 a hole is made in a wall which forms one side of a clothes closet. The closet furnishes the required closed air space behind the speaker. The enclosure should be deadened—made sound absorbent—and the clothes that are normally hung in the closet absorb sound excellently.

A somewhat similar idea is shown in Fig. 2. Here, however, the enclosure is the space under the stairs. In most homes this is either a closet or a stairway to the cellar. In either case, it can easily be coated with sound-absorbent material. The speaker should be placed where it is 4 to 6 feet above the floor and far enough along the stairway so that it is under the steps and out of the way.

The mountings of Figs. 1 and 2 are suitable only for those at liberty to make holes in walls. This is usually not possible in an apartment or a rented house. A mounting suitable for rented premises is shown in Fig. 3. Here the door of a closet is removed (and carefully stored away for the landlord) and a new, stronger door substituted. A hole is cut out of the door and the speaker mounted in it. When the door is closed the closet forms an excellent sound chamber. As the illustration indicates, the amplifier and record changer may also be mounted on the inside of the door.

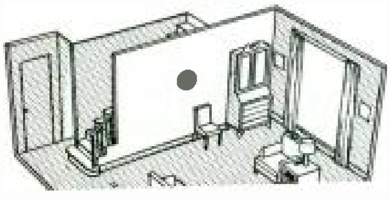


Fig. 2—Mounting speaker under stairs.

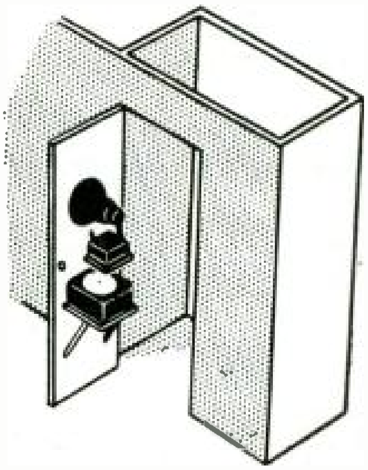


Fig. 3—Entire assembly on closet door.

Many homes include a set of book cases built along one wall by either the owner or the tenant. A section of these can be altered for use as a speaker enclosure, as in Fig. 4. Since the volume of this enclosure is not likely to be very great, it may have to be used as a bass-

(*Continued on page* 49)

Controlling Sound Liveness

A VERY interesting article on "Binaural Amplifiers" appeared in the October, 1948, RADIO-ELECTRONICS. It described binaural pickup and reproduction for public address. The same method would not be practical in broadcasting because two separate channels are required. However, a clever technique has been developed for attaining somewhat similar results merely by proper placement of the microphones used for the broadcast.

With this technique, *liveness* rather than loudness is controlled by the studio engineer. A nondirectional mike is used for general pickup. One or more directional mikes are used in accentuate desired sounds, for example, a solo. By balancing these sounds it is possible to give a remarkable illusion of actual "presence" in the studio or auditorium. In fact, it is claimed in the original article on the subject* that the listener can be "placed" anywhere in the hall, from the front row to the rear, at the discretion of the studio engineer at the controls.

Since this mike technique permits greater liveness or apparent reverberation, the sounds appear to be louder at the receiver. A gain of up to 6 db may be obtained without an increase of transmitted power.

The useful range of liveness for different types of programs is listed in the Liveness Table. When a value near the lower limit is used, the reproduced sounds appear to originate just beyond the loudspeaker. When the value is near the upper limit of its range, the sound appears to come from a much greater distance because of the increased reverberation.

The distance of the general-pickup mike in feet is determined by the equation

$$D = \frac{\sqrt{LV}}{T},$$

where L is the liveness value, V the room volume in thousands of cubic feet, and T the reverberation time of the room. Optimum values of T are given in Fig. 1. The distance of an accentuation mike is 1.7 times greater than that of the general-pickup mike as given by the above equation.

Liveness values given in the table apply to over-all liveness. Since the general-pickup unit is in the circuit at the same time as the accentuation mike, the liveness values for each are calculated as follows:

For the general-pickup mike multiply the liveness value (from the table) by 1.5. This allows for loss due to the other mike. For the accentuation mike, multiply by 0.67 to allow for the gain due to the general-pickup microphone.

In a practical case it is better to plot the distance-*vs*-liveness equation for both mikes. Then no further calculations are needed for that particular auditorium. If the graph is made on log-log paper with D measured horizontally and L vertically, it comes out a straight line making an angle of 60 degrees with the horizontal. Therefore, it is necessary to calculate only one point for each graph, and draw the straight line.

The correct mike balance is determined by starting with the general-pickup mike alone and gradually fading in with the other. If in doubt, less accentuation is preferable because the average living room may add some liveness.

Liveness control technique has been used by CBS to broadcast the New York Philharmonic Symphony Orchestra. Fig. 2 shows the approximate arrangement of microphones to broadcast these Sunday afternoon concerts. Favorable comment was received from many listeners who were unaware that a new pickup technique was being used at the time.

* *Western Electric Oscillator*, January, 1947.

LIVENESS TABLE

Type of sound	Liveness range
Piano	4-16
Symphony orchestra	5-20
Small orchestra	3-12
Solo violin, cello, etc.	1-4
Solo singing	1/2-3
Speech	1/6-2/3

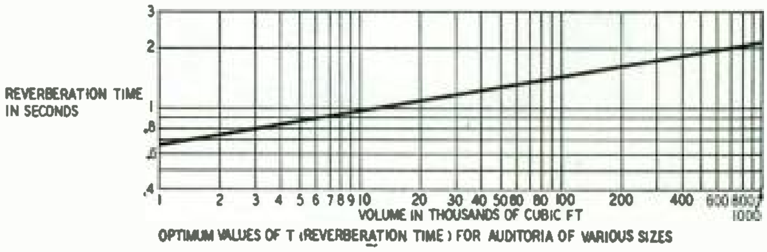
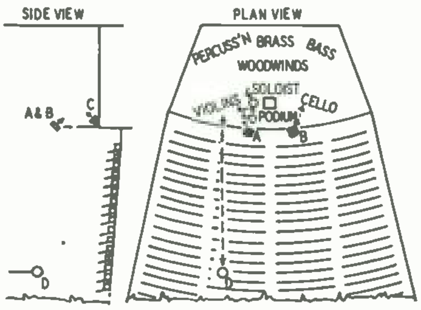


Fig. 1—This graph shows optimum liveness values for various-sized halls.



MIKES—A-B: ACCENTUATION; C: SOLO; D: GENERAL
CARNEGIE HALL SETUP

Fig. 2—Setup for Philharmonic broadcast.

PLACING A SPEAKER IN THE HOME
(*Continued from page* 48)

reflex cabinet and a port should be cut in it for that purpose.

There are many variations on these schemes. Speakers may be mounted in real or false fireplaces (after cautioning everyone concerned to refrain from building fires in the future). They have been placed in transoms, over corner cupboards, in boxes built to conceal vertical steampipes in a corner of the room, and in other likely and unlikely places.

The drawings show the speakers as black circles for clarity, but they should be covered with very porous grille cloth to protect them and for the sake of appearance.

As a matter of protection against careless people who may lean on the cloth or kick a hole in it if it is near the floor, the cloth should be underlaid with a piece of quarter-inch-mesh galvanized screen, as heavy and stiff as possible. If that is not available, ordinary copper window screen can be used, but be sure to stretch it tight across the hole and tack it down solidly all around. Do not depend on the tack bodies placed through the mesh to hold it, but tamp the tack heads (upholstery nails are even better) down against the screening.

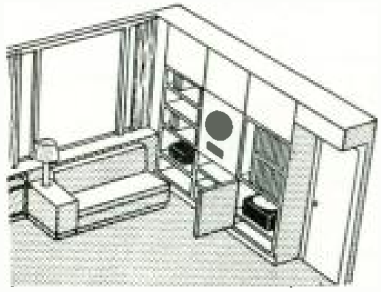


Fig. 4—Bookcase is bass-reflex baffle.

F M Phonograph Pickup

The oscillator needed for the FM pickup is fastened to the rear of the cabinet.

How to build a transducer of unusually high a.f. quality

By ARTHUR TRAUFFER

FASCINATED by the superior phono record reproduction possible with the FM capacitance pickup, the writer has spent many happy hours building and rebuilding them and figuring out various circuits for them. This much neglected pickup, if well designed, has the lowest distortion and the most linear response over the widest range of any phono pickup ever conceived. An invention of Benjamin F. Miessner, the capacitance pickup generates no voltage; it simply frequency-modulates a low-power oscillator. The r.f. signal is then detected and passed into an audio amplifier.

The mechanism consists of a free-moving needle, with a stationary metal plate mounted beside it. The plate is insulated from the needle, and there is a small air space between them. As the needle follows the grooves in the record, it vibrates from side to side, in accordance with the modulation, which results in a variation of capacitance between the needle and the stationary plate. When the two are connected across the tank circuit of an oscillator, the mean frequency of the oscillator is shifted from side to side by the small changing capacitance, in accordance with the waveforms in the grooves. Since the only work required of the needle is to follow the waveforms, the response is linear (assuming the bearings are satisfactory) regardless of whether the needle moves once in 24 hours or 20,000 times per second!

Though far from beautiful the simple and economical capacitance pickup shown in the illustrations does work excellently and it will give the experimenter something to start with. The complete pickup cost about $1.50 to build.

Pickup construction

The arm assembly (shown in Fig. 1) should be made up first. The pivot was removed from a cheap crystal pickup arm and attached to a new arm made from hardwood. (The objection to using a metal arm is its bad effects on the pickup's capacitance.) The shape of the wooden arm can be copied from that of the original metal one, or, for better results, copy the shape of some fairly long transcription arm. Leave a little overhang at the rear for counterweighting if necessary. Sand the arm well, and cut grooves in its sides for the pickup leads. Keeping them far apart reduces the capacitance between them. The paint I used had some metal content, so I left the underside of the head—where the pickup is attached—unpainted. The arm is ⅝ inch thick.

There are only three parts to the pickup proper: the needle chuck, the needle, and a metal plate. The needle and plate form the capacitance which is connected across the tank of an oscillator to frequency-modulate it.

The chuck was taken from an Astatic L-26-A crystal cartridge, though any similar cartridge will do. Fig. 2 shows how these cartridges are made with rubber trunnion bearings. Don't use an old one in which the rubber may have dried out and hardened.

Saw through the cartridge just behind the needle-chuck housing, as indicated by the vertical dashed line in Fig. 2. Then, with screws through the two mounting holes, fasten the housing to the underside of the arm.

Fig. 3 shows the copper plate which is mounted near the needle to act with the needle as a capacitor. *The copper must be heavy enough to prevent its vibrating.* Any vibration of the plate will swing the frequency of the FM oscillator at the vibration rate and will ruin reproduction. Fig 4 is a head-on view of the pickup showing how the copper plate is fastened to the side of the arm so that the lower tab is parallel to the needle and very close to it.

Wiring precautions

The wire connections should be made to the copper and to the needle-chuck housing. The leaf for the plate can be soldered to it, but *don't solder to the chuck housing*. The heat may soften and ruin the rubber trunnion bearings. Clamp this lead to the housing by ending it in a lug clamped under one of the mounting screws. No direct connection to the needle or chuck is necessary, as the capacitive coupling between it and the housing through the bearings is sufficient. Run the leads to the rear of the arm in the grooves cut in the sides. Use rubber-insulated, flexible leads, gluing or cementing them in the grooves. Mount a piece of plastic to the underside of the arm as a handle, which can be seen plainly in the photo of Fig. 5.

The needle

The most critical part of the whole assembly is the needle or stylus. While the compliance, which limits the top frequency, is controlled by the rubber trunnion bearings, a needle which is mechanically resonant will produce a bad peak in the response somewhere in the upper audio range. When a resonant needle is used in a crystal pickup, the resonance is noticeable enough; but cheap crystals have poor response, generally, as well as peaks of their own. In a capacitance pickup, however, with its nearly perfect response to every fluctuation of the needle, resonances stand out like a house on fire! (The once disadvantage of a capacity pickup seems to be the complete lack of electrical damping, which is very much present in modern magnetic cartridges and to at least some degree in crystals. If a resonant needle in the capacitance pickup is shock-excited at its natural frequency—by a sharp transient in the music or by a piece of grit in the record—it is likely to generate a long damped-wave train which not only distorts the reproduction badly but also increases the surface noise greatly.—*Editor*)

The needle should have the lowest possible amount of mechanical resonance. Curved, offset, hollow, or tubular needles are poison. The shank should be straight, solid, and preferably of soft metal of uniform cross section. The needle in use now is a Pfanstiehl straight-shank unit with a precious-metal tip. The needle has very low resonance in spite of a thin part in the shank, which you can see in Figs. 4 and 5. If you want to play microgroove discs, you can have a .001-inch tip ground on the needle at the factory (Pfanstiehl Chemical Co., 104 Lake View Ave., Waukegan, Ill.).

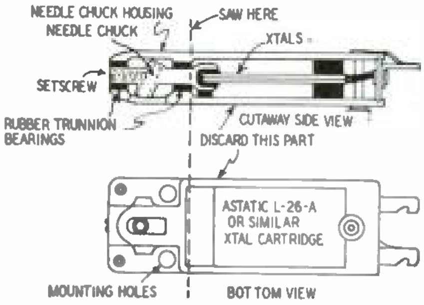


Fig. 2—The needle chuck housing is removed from a crystal pickup with a saw.

Circuits

Fig. 6 is a diagram of the simple Hartley oscillator used in most of the experiments. It is completely battery-powered to deliver a humless carrier.

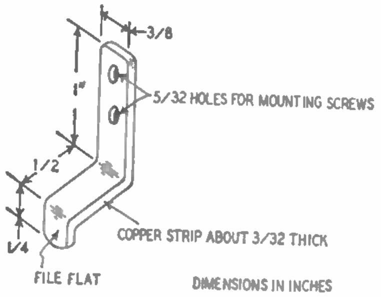


Fig. 3—Copper strip, mounted next to the needle, acts as capacitor plate.

Its output can be picked up and slope-detected on a standard receiver.

Choice of frequency is a matter of compromise: the lower the frequency, the more stable the oscillator; the higher the frequency, the more deviation the pickup causes. I work mine on

Fig. 4—This head-on view shows separation of the needle and copper strip.

about 160 meters (just above the broadcast band), using a commercial coil 1 inch in diameter and having about 98 closewound turns, with a 100-μμf shunt tuning capacitor.

With the unshielded capacitance pickup, the metal-to-metal contact of the turntable shaft and its socket creates an annoying noise, which can be killed at the source by replacing the metal

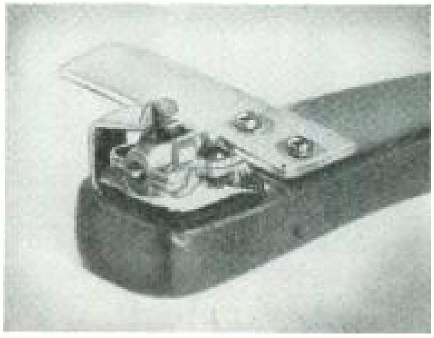


Fig. 5—A handle made of clear plastic helps prevent hand-capacitance effects.

turntable shaft with a plastic or fiber duplicate. I took the original to a machine shop and had the mechanic turn out a duplicate from a piece of polystyrene rod. Both appear in Fig. 7. The price was low (only $1) and the job well worth doing.

The Hartley oscillator will produce audio without a demodulator if a pair of phones is placed between plate and B-plus. The phones can be replaced with a high-quality audio transformer and the signal fed to an amplifier. In either case, it isn't the FM that counts, but the AM caused by absorption modulation. Output obtained in this way is very low.

You can also make a simple crystal tuner by placing a tuned coil in series with a 1N34. If the coil is close to the oscillator coil and is tuned to a frequency near it, the crystal tuner will slope-detect, and you can feed the detected audio signal to an a.f. amplifier and loudspeaker.

Another good circuit is diagrammed in Fig. 8. The tanks C1-L1 and C2-L2

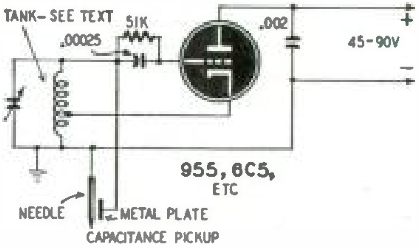


Fig. 6—Output of this frequency-modulated oscillator can be slope-detected.

are tuned to the same frequency. The secondary of L2 is connected to a standard Foster-Seeley or ratio detector. For slope detection, detune C2 slightly and feed the secondary to an ordinary AM detector. Contrary to popular opinion, slope detection can give very fine quality if the frequency swing stays within the straight part of the slope curve. With this circuit you can adjust for best conditions with

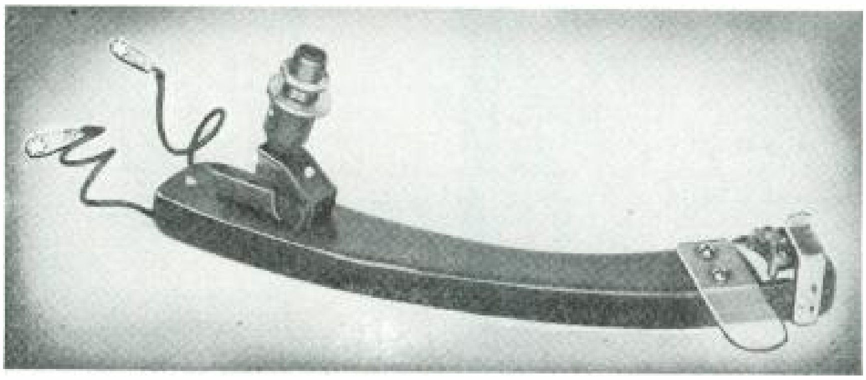


Fig. 1—The complete pickup. The swivel was taken from a cheap phono arm.

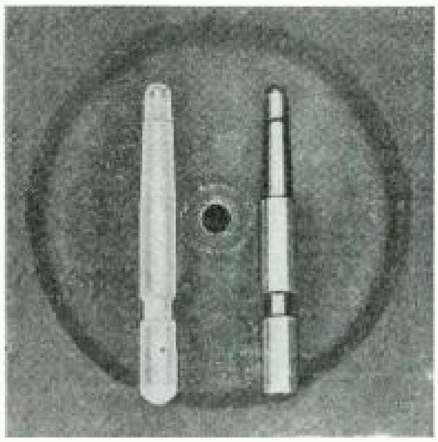


Fig. 7—Poystyrene turntable shaft at left was made cheaply by a machinist.

C2 and by varying the distance between the needle and the metal plate on the pickup (and, of course, by selecting the right frequency on which to operate the oscillator).

There are several other ways of recovering the audio, but experimenters will think of them all and probably improve them, too. In general, the method of Fig. 6 is probably the easiest, though not the kindest to the neighbors, as it may interfere with their radio reception. It is best, for a permanent unit, to make a demodulator of some kind and put a shield around it and the oscillator so that as little r.f. as possible is sprayed into the surrounding air to interfere with the neighbors' radio reception.

It's really surprising that with such simple equipment and so little work you can make such a fine pickup. When

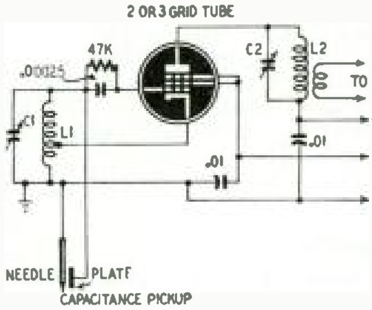
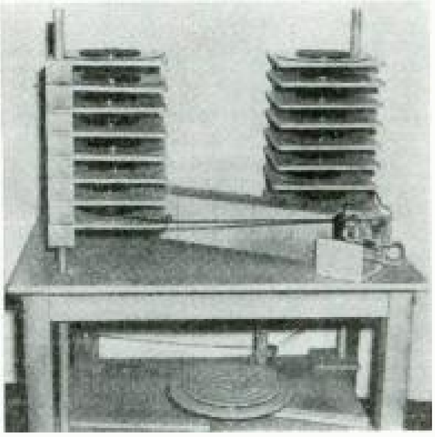


Fig. 8—Output of this circuit can be fed to either an FM or AM demodulator.

better records are made, the FM player will be waiting for them!

Magnetic Tape "Contact Prints"



This experimental duplicator can turn out 960 hours worth of program daily.

MAGNETIC recording has a number of advantages over disc recording and, conversely, several disadvantages. One of its most serious drawbacks is the relative difficulty of duplicating recordings. Disc records are printed by the hundreds from a metal master disc. Tape records have been reproduced by re-recording, a much slower and more expensive process.

The announcement of a magnetic method of printing magnetic tapes by a process similar to that used for discs may herald a new advance in the acceptance of this new recording medium. A duplicating machine can turn out eight 1-hour reels every 2 minutes (using double-track tape and running the tape at a speed of 10 feet per second). A machine of this type has a conservative output of 960 hours of recording per day, the equivalent of well over 10,000 4-minute discs.

The process is actually very simple. A recorded tape and a blank one are held in contact with each other and passed through a high-frequency magnetic field, called the "transfer field," which produces a distortionless magnetization of the copy tape. See Fig. 1. Frequency of the transfer field current may be as low as 60 cycles and higher than 100 kc, though in practice frequencies close to those used in regular tape recording have been best.

It has long been known that, if a blank tape is held in close contact with a magnetized one, it will pick up the magnetic pattern. But the recording so picked up is very weak, and its level does not vary linearly with that of the "master." The transfer field changes all that. Level is within a few decibels of the master, and distortion is low.

The master tape is made of durable

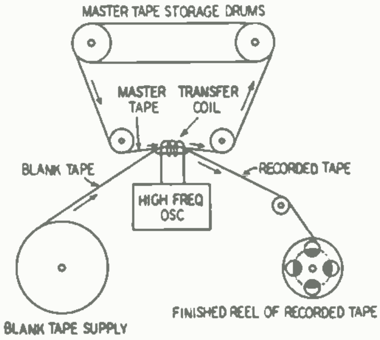


Fig. 1.—Master tape contacts copy in a magnetic field set up by transfer coil.

material having high magnetic retentivity. Mechanical ruggedness is essential, as it may have to make thousands of copies. The requirement of high retentivity is due to the transfer field. If this field is strong, there is a tendency to demagnetize the master tape. Yet it is in just such a strong field that the best record is made on the copy tape. Thus the easier it is to magnetize the copy, the more likely it is that the master will be harmed. Good results are obtained with a copy tape of easily magnetized material and a transfer field held just below the point at which it demagnetizes the master.

The copy is a mirror image of the master. This caused no difficulty in single-track tapes, but an attempt to play back some of the increasingly popular double-track and stereophonic recordings resulted in the copy's always playing backward. To avoid this difficulty, the master record runs backward, producing copies which play correctly on a standard machine.

In a practical machine, such as the one in Fig. 2, the beginning and end of the master tape are spliced together to form an endless belt. The extra length of long tapes can be handled by winding around drums or in a number of other ways. The tape is then run through a number of copying heads, each with its own transfer field, to produce as many recordings as desired. The process is continuous, and the master tape itself is not affected by the copying (except as noted above).

The process was developed independently but almost simultaneously by Marvin Camras of the Armour Research Foundation and Robert Herr of Minnesota Mining and Manufacturing Co. The information above draws on both those sources. The illustrations, however, are all from Armour.

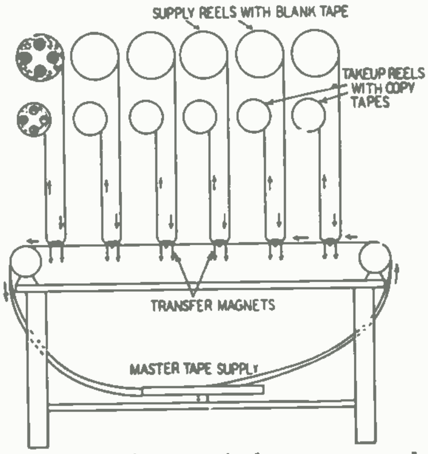


Fig. 2—In the practical setup several copy tapes are made at the same time.

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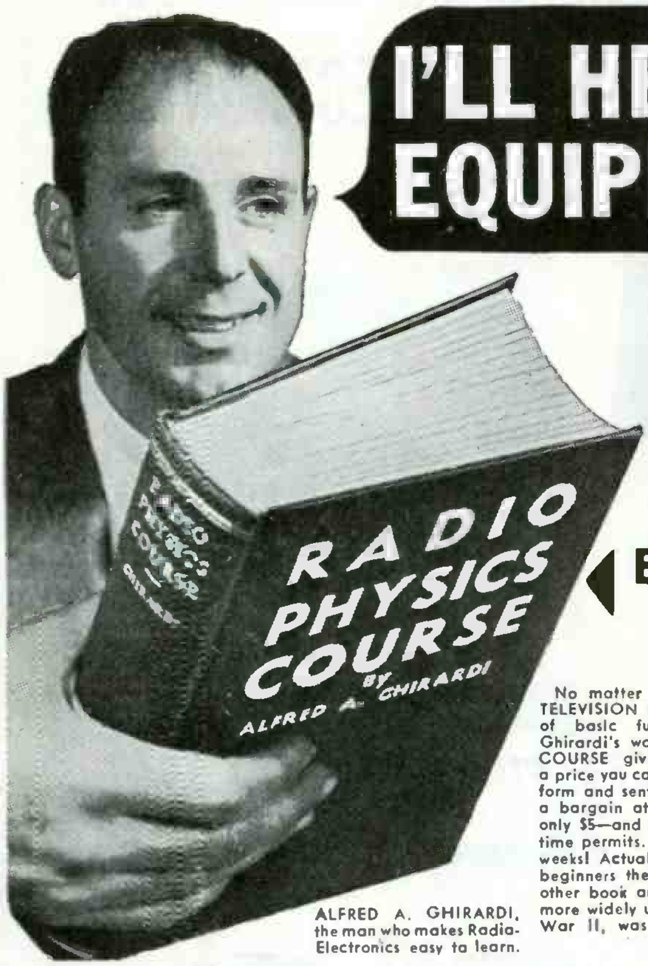

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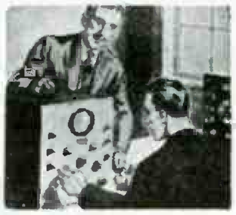

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Fundamentals of Radio Servicing

Part XII—Vacuum-tube characteristics

By JOHN T. FRYE

THE story of a vacuum tube can be told only very superficially in words. We can say how many pins it has, what kind of an envelope, the filament voltage, the number of elements, and the interelectrode capacitances. But that doesn't give much of an idea of what to expect from the tube when we use it in a circuit. The real questions are:

1. How much amplification (or in some cases, how much power output) can you get under a certain set of conditions?
2. How much voltage (a.c. and d.c.) should be applied to each element?
3. What impedances should be connected to the elements? (RADIO ELECTRONICS, December, 1949, page 52, second column.)

These three points are important because they alone determine how the tube will perform electrically, whether it will do a specific job, and how the circuit elements must be chosen for best results in a particular case. They are not easily summed up in a single statement, for they are interdependent; change any one of them and the others change, too.

The best way to show interdependent and variable quantities is in a graph. That is how most tube data is given in manuals.

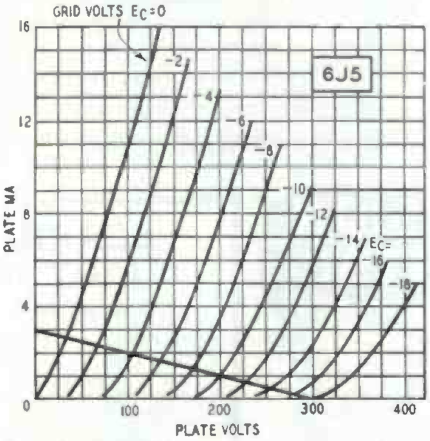

Fig. 1—Family of plate curves shows performance of the tube graphically.

The usual tube book gives a set of curves like those in Fig. 1 for each tube. Plate current is plotted here against plate voltage with a separate curve for each value of grid voltage. All voltages are direct. The test circuit used in plotting the curves appears in Fig. 2. Filament and grid voltages are held constant while the plate voltage is varied. At each plate voltage value the plate current is read. Then the grid voltage is changed and the plate-voltage changes are gone through again and plotted.

To obtain the curves of Fig. 1, for instance, the grid voltage was set at zero (grid grounded) with the potentiometer, the plate voltage set at various values and the plate current measured at each voltage. Dots were made at these points and the curve drawn. Then the grid voltage was raised to —2 and the same procedure followed with the new grid voltage. Several of these curves form a *plate family*. The same thing is done with tetrodes and pentodes, with fixed screen voltages. Often screen current is plotted on the same graph, using dashed lines to distinguish it from plate current.

The same information can be given in a slightly different way. Plate current plotted against grid volts, with a separate curve for each value of plate voltage, forms a *transfer* or *mutual characteristic* graph, which gives essentially the same information as a plate family.

We learned in Chapter X that the *amplification factor*, or "μ", of a tube is simply a number telling how many times more effective grid voltage is than a plate voltage change in producing a change in plate current. For example, look at the —4-volt curve of Fig. 1. At one convenient point the plate voltage is 105 and plate current 2 ma. Now look at the —6-volt curve. At 105 volts the current is only about 0.2 ma. To get the 2-ma plate current again (keeping grid voltage —6) we have to go to approximately 145 plate volts. A 40-volt change in plate current is necessary to restore to its original value a current that was varied by a 2-volt grid change in the opposite direction. The μ is 40/2, or 20, just as you will find in the book (RCA Tube Manual RC 15) if you look up the 6J5's ratings.

The plate resistance of a tube is found by dividing a small change in plate voltage by the change in plate amperage it causes. For example, if we check a number of the curves on Fig. 1,

The basic tools of the circuit designer—tube handbook, slide rule, scratch paper.

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+ 22 to + 36 db
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★ The Model TV-10 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.

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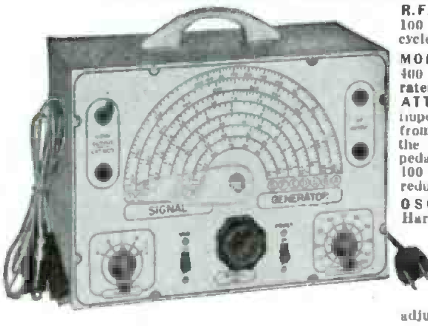

R.F. FREQUENCY RANGES: 100 Kilocycles to 150 Megacycles.

MODULATING FREQUENCY: 400 Cycles. Also available separately.

ATTENUATION: The constant impedance attenuator is isolated from the oscillating circuit by the buffer tube. Output impedance of this model is only 100 ohms. This low impedance reduces losses in the cable.

OSCILLATORY CIRCUIT: Hartley oscillator with cathode follower buffer tube. Frequency stability is assured by modulating the buffer tube.

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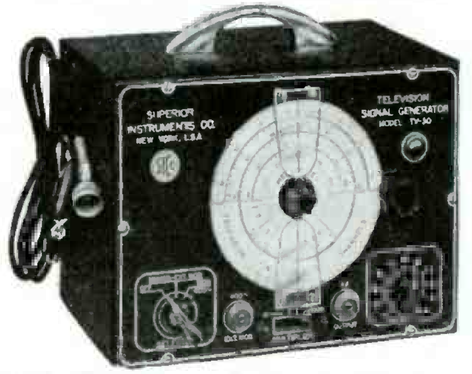

Enables alignment of Television I. F. and front ends without the use of an Oscilloscope

Specifications: Frequency Range: 4 Bands—No switching. 18—32 Mc. 35—65 Mc. 54—98 Mc. 150—250 Mc. Audio Modulating Frequency: 400 cycles (Sine Wave). Attenuator 4 position, ladder type with constant impedance control for fine adjustment. Tubes Used: 6C4 as Cathode follower and modulated buffer. 6C4 as R.F. Oscilator. 6SN7 as Audio Oscillator and power rectifier.

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INDUCTANCE: 1.75 to 70 Henries; 35 to 8,000 Henries.

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The model 670 comes housed in a rugged, crackle-finished steel cabinet complete with test leads and operating instructions. Size 5½" x 7½" x 3".

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Specifications: 6 A.C. VOLTAGE RANGES: 0-15/30/150/300/1500/3000 volts. 6 D.C. VOLTAGE RANGES: 0-7½/15/75/150/750/1500 volts. 4 D.C. CURRENT RANGES: 0-1½/15/150 Ma. 0-1½ Amps. 2 RESISTANCE RANGES: 0-500 Ohms. 0-1 Megohm.

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selecting parts where they are straightest, we find that changing the plate voltage by 10 or a little less, with grid voltage unchanged, produces a change of 1 ma in plate current. The plate resistance is then 10/.001 (ampere) or 10,000 ohms. The book gives values between 7,000 and 8,000, so we are a little high. A bigger graph would read more accurately.

Control-grid-plate transconductance or simply *transconductance* or *mutual conductance* (it's called more names than a baseball umpire) is abbreviated g_m and is probably the best value by which to judge how good a tube is as an amplifier. It is defined as "the small change in plate current divided by the small change in grid voltage required to produce it." All other voltages are supposed to remain the same. Since our smallest divisions of grid voltage are a full 2 volts, we cannot readily make this measurement on the chart, though it could be done easily on the actual test setup.

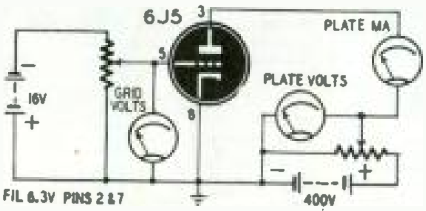

Fig. 2—Test circuit for making chart.

As an example, if a grid shift of 1 volt produces a change of 2.5 ma in the plate current, the transconductance is equal to .0025/1, or .0025 "mhos." The *mho* (ohm spelled backward) is the basic unit of conductance—which is the reciprocal or opposite of resistance.

A handier, pocket-size unit is the *micromho* or millionth of a mho. The transconductance of the 6J5 under typical operating conditions may run between 2,500 and 3,000 micromhos. See how close you can come to it using the graph.

Dynamic characteristics

The measurements and curves you have seen so far are *static* characteristics, made under standing-still conditions. You get about as much useful information from them as you would out of watching a new driver maneuvering a car in a large deserted lot. By watching him in the lot, you can tell whether he knows what the pedals are for and if he has the strength to turn the steering wheel (and in the right direction!). But none of that information and ability is useful until he gets out on the road and reacts to different—and *changing*—conditions that he will encounter there.

The same is true of the tube. Used in an amplifier circuit, it will encounter impedances not present in the tests; it will deal with a.c. voltages and currents; it will have to adapt itself to changing conditions. A little simple calculation, using ruler, pencil, and paper, will tell us what the tube will do under *dynamic*—moving—conditions, when it is in useful operation as an amplifier.

Suppose we are to use the 6J5 in the simple voltage-amplifier circuit of Fig. 3. We choose the value of R1 (which, as we saw in the December issue, makes it possible to pass the amplified voltage to another tube) at 100,000 ohms. C1 is merely a blocking capacitor preventing d.c. from passing into the following stage. A grid resistor in series with the bias battery permits us to place a negative (d.c.) voltage on the grid without any likelihood of shorting out incoming signals.

What will happen with the values for R1 and the bias and B-voltages we have chosen? What values are needed to obtain the amplification we want? If we know the answer to the first of this pair of questions, the second question answers itself.

If the bias does not cut off the tube, the plate current causes a d.c. voltage drop in R1; therefore, the plate has *less* than 300 volts on it. The static curves in Fig. 1 no longer tell the whole story, for, if we choose a certain grid voltage, the chart shows that the plate current depends on the plate voltage—but with R1 in the circuit we don't know what the plate voltage is!

The solution is to draw a *load line* on the graph to show just what the plate voltage is for each value of grid voltage, with R1 in circuit.

It's a simple matter of reasoning. If the voltage at the plate is really 300 volts in the circuit of Fig. 3, there is no drop across R1, which means that plate current must be zero. On the graph, we place a dot at the intersection of 300 plate volts and zero current.

If the plate voltage is zero, the tube must be effectively a dead short between cathode and plate, and *all* the B-voltage is across R1. This never happens in practice (unless the tube has shorted elements, in which case, watch things burn!), but it is useful as a piece of brainwork. If all the B-voltage is across the resistor, we can easily figure the current: I=E/R=300/100,000=.003 ampere or 3 ma. That means that if the plate voltage approaches zero, plate current approaches 3 ma; and we can dot the appropriate intersection on the graph. Joining the two dots with a line will show the true dynamic characteristic of the tube when it is placed in its circuit.

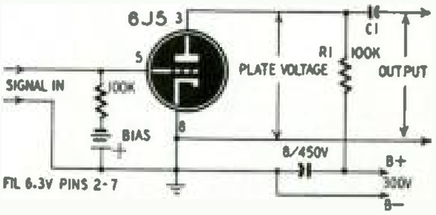

Fig. 3—A typical 6J5 voltage amplifier.

Note that the value of R1 and the B-voltage determined the placement of the *load line*. Other values would give other lines. The static plate family, on the other hand, is a set of curves that remain the same no matter how the tube is used. We can define dynamic

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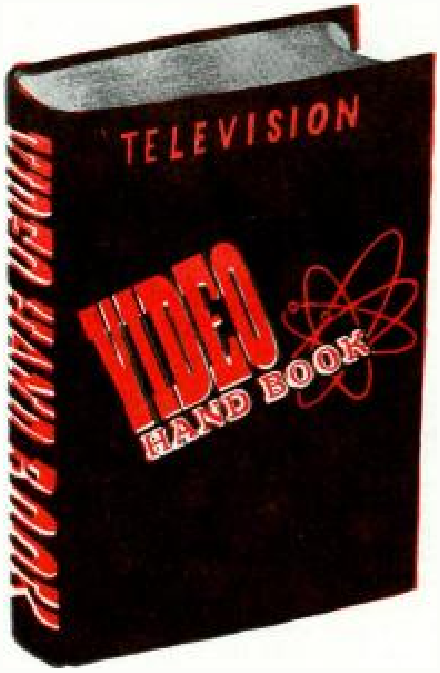

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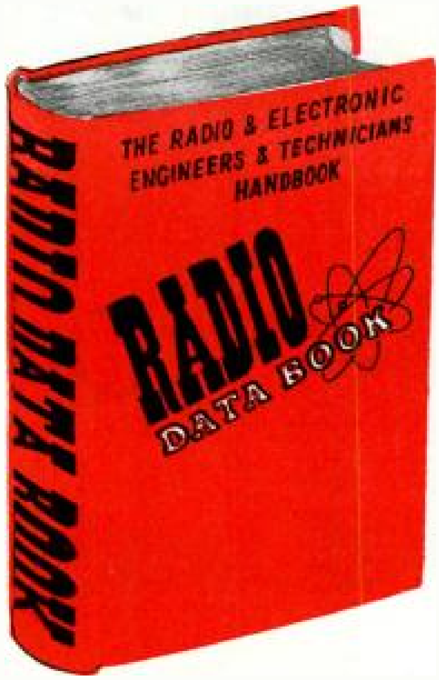

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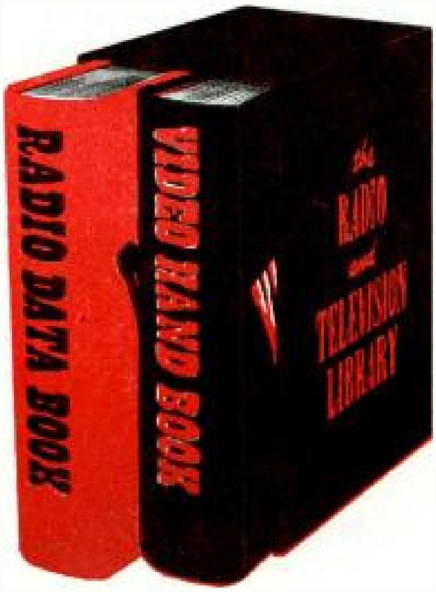

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characteristics, therefore, as the characteristics of the tube *in the actual circuit and under the actual conditions in which it is used.*

The load line tells us what the plate voltage, plate current, and grid voltage really are at any time while the tube is working. We need know only one to find the other two. If we have a grid voltage of –10, for example, the plate current is 1 ma and the plate voltage is 200.

These values are dynamic—they apply just as much to a.c. as to d.c. Suppose we connect an audio generator to the input terminals. Assume for the moment that the bias battery is shorted. The audio signal has a peak amplitude of 10 volts. At its 10-volt negative peak, the tube's plate voltage is 200; when the audio is at zero, plate voltage is 35. The tube's plate voltage has changed during the half-cycle by 200–35 or 165 volts. Since the change is at an audio rate, it goes through C1 and appears at the output terminals as an enlarged replica (more or less perfect) of the input signal. The enlargement is easy to figure: the input signal was 10 volts peak; the output was 165 volts peak. The magnification, *amplification,* or *voltage gain,* was 165/10 or 16.5 times. Note that the voltage gain, like other dynamic characteristics, depends on the circuit used.

The dynamic characteristics are too important to be brushed over thus lightly here; we will discuss them more thoroughly later in relationship to amplifiers.

Meanwhile, note that the three main tube characteristics are related to each other, as would be expected. Multiply the transconductance (mhos) by the plate resistance to get the amplification factor, or: $g_m = \frac{\mu}{r_p}$, to recast the equation.

Thus, if we know two of these characteristics, we can always find the third one.

Each major tube manufacturer publishes a tube manual in which all of the above characteristics, as well as many other items of useful information, are given for the tubes he produces. Such a book is as important and necessary to the radio technician as a cookbook to a career-girl bride. You will realize why when future chapters refer to and *use* over and over the tube characteristics to which you have just been formally introduced. If you have not already done so, this is the time to latch onto a tube manual and give it a good look-through.

Voltmeter Measures Current

By J. T. CATALDO* and S. J. RICHARD†

IN troubleshooting a radio it is frequently necessary to determine whether a circuit current is normal. However, current readings are difficult since it is necessary to open the circuit by unsoldering components, insert a milliammeter, make the measurement, and then resolder the components. If many measurements are to be made, much time and patience is required.

Voltage and resistance measurements are easier to make since it is not usually necessary to disturb the circuit.

According to Ohm's law, I = E/R, you can find the current through a circuit by measuring the voltage across a resistor of known value through which the current is passing. However, ohms are very small quantities in radio work, and amperes are very big ones. It is better to use the following units: E = volts, I = milliamperes, R = thousands of ohms (K-ohms).

To illustrate, assume a typical a.c.-d.c. five-tube radio set employing a 50L6 output tube, as in Fig. 1. The question is whether the cathode current of the output tube is normal. The bias resistor is 150 ohms (determined with an ohmmeter or otherwise). When the set is turned on, a voltmeter placed across the resistance indicates 7.5 volts. Applying Ohm's law, I = E/R, or 17.5/150,000 = .05 = 50 ma, which is normal for a 50L6 biased with 150 ohms. Here is one case where ohms and amperes are easier, though the equation could have read 7.5/.15 = 50.

Referring again to Fig. 1, assume that we want to determine the plate current of the triode section of the 12SQ7. The plate load resistor is 500,000 ohms and a voltmeter across it indicates 60 volts. Again applying Ohm's law, I = E/R, or 60/500 = 0.12 (ma), which is normal for this type of tube. The input resistance of the voltmeter should always be at least 10 times the resistance across which it is connected. In this case, a v.t.v.m. must be used.

This method may also be used for higher-current circuits, a.c. or d.c. This is convenient since the average multimeter usually has a.c. voltage ranges but seldom has a high milliampere or an ampere range. Suppose the current drain of a radio receiver is to be found. The receiver must be connected as shown in Fig. 2, with a 1-ohm, 10-watt resistor in series with the line. A 1-ohm resistor is chosen because the current drawn through it will be numerically equal in amperes to the drop in volts across it.

* General Research Laboratories
† Radio Div., Delehanty Institute

The authors wired the resistor in a box with a female receptacle on one end and a plug and line cord at the other end. Terminals connected across the resistor were provided on the top of the box.

Using the gadget, the receiver under test is plugged into the female receptacle, and the line cord of the tester is plugged into the 117-volt line. The voltmeter is, of course, across the resistor terminals.

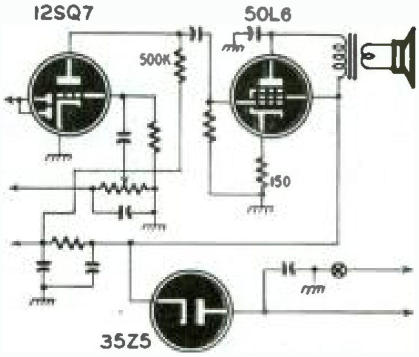

Fig. 1—Portion of a standard receiver.

An a.c. receiver generally draws about half its final current right away; then the current rises slowly to the final value. A transformerless receiver has an initial heavy surge which drops immediately, then the current rises to the final value.

The power drawn by most receivers is indicated on a chassis label or can be found in the servicing diagram. Since P = EI, the power drawn is equal to the line volts times the amperes through the resistor, which is numerically equal to the voltmeter reading. With a 120-volt line, a 1-volt reading indicates 120 watts, but, for quick figuring, you can assume that the wattage is about the same as the voltmeter reading multiplied by 100.

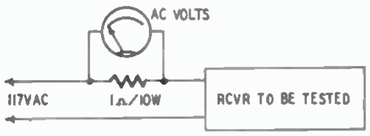

Fig. 2—Simple device checks power.

If the receiver mentioned above is rated at 100 watts, the reading should rise gradually to around 0.5 volt, then slowly increase to a little less than 1 volt. But if it continues rising past 1 volt, pull the power cord quickly; you can bet your bottom dollar the set has short-circuited filter or bypass capacitors.

A.c-d.c. receivers usually pull 35-40 watts, with voltmeter readings around 0.3 to 0.4. If the reading goes past about 0.5, disconnect in a hurry and investigate.

HANDY TOOLS FOR SERVICING

Every service technician needs certain special test instruments and tools, but a little ingenuity converts many ordinary items to valuable radio-repair implements. A practical repairman illustrates some of his own ideas. You will think of many more.

By H. LEEPER

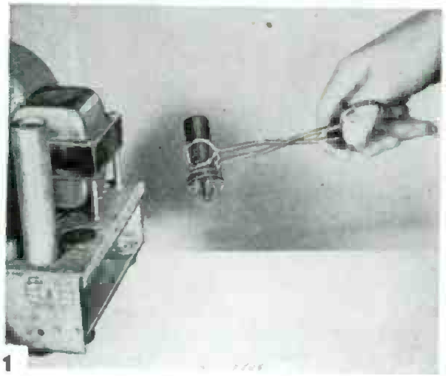
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Photo 1. Start with a trip to your local department store to pick up a pair of kitchen tongs like those in the photograph. If you've ever tried to pull a red-hot metal tube out of its socket for replacement (and what service technician or experimenter hasn't), you will appreciate the cool comfort of removing the tube with the tongs. It's as good as a regular tube puller but costs less.

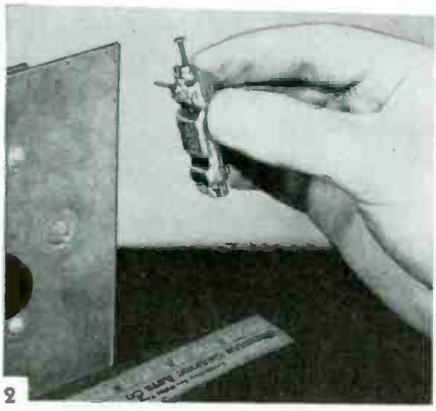
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Photo 2. Everyone knows that all you need to scribe out markings on radio chassis and panels is a piece of metal with a sharp point; and you must have thought often that a phonograph needle would be ideal if there were only some way to hold it. Why not use an old crystal cartridge?

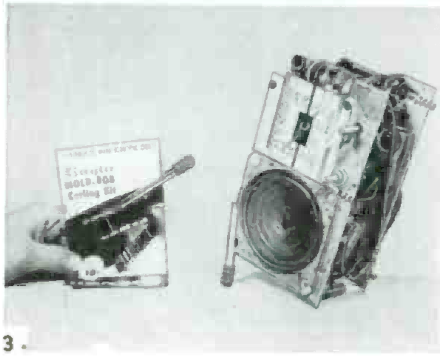
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Photo 3. Suppress your embarrassment and buy one of those small hair-curling kits at the dime store, one with those convenient split, metal, rubber-tipped curlers. Clip them to chassis to keep the chassis from falling over or use them to anchor test leads to chassis or terminals.

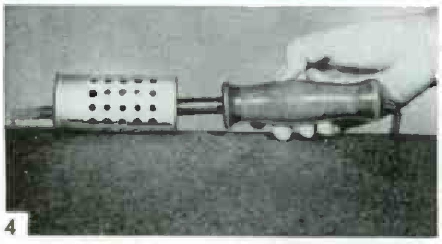
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Photo 4. Ever find yourself needing two hands for a job, when one of them is already holding a hot soldering iron —and not a stray ashtray in sight to rest it on? The book says you should have a regular iron holder; maybe it's hiding from you. Take a tip and keep a few of the large, old-style tube shields around the bench instead of in the junk box. They're fine iron holders!

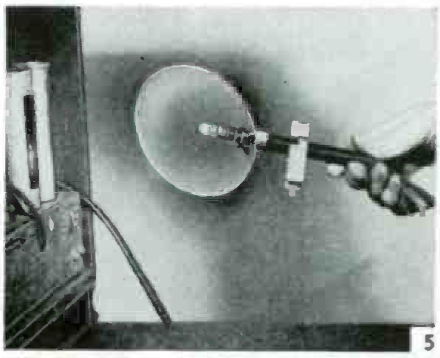
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Photo 5. A 4½-inch chrome reflector—you can find them at the camera store —keeps light out of your eyes and adds many lumens to the brightness of your probe lamp. Slip the upper part of the probe through the hole in the reflector and tighten the fit with tape.

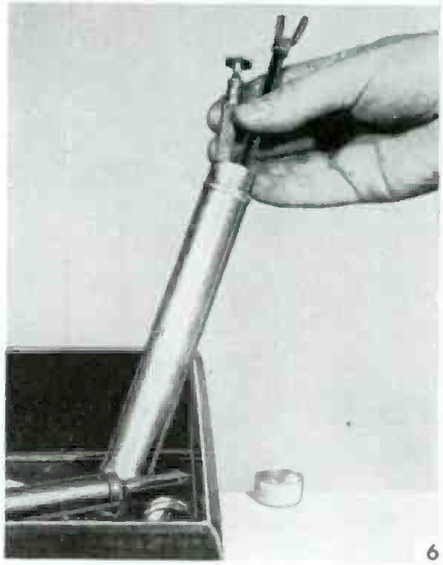
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Photo 6. No good repairman has holes in his pocket knowingly; but what he doesn't know may hurt him, especially if he carries small screwdrivers or alignment tools in the pocket. A metal toothbrush carrier like the one shown carries the tools neatly and requires a much bigger hole for loss.


7

Photo 7. When you want to concentrate a stream of liquid, you use a funnel. Why not do the same when you want a little spot of light for a delicate job? Tape the funnel over a flashlight lens. The holder in the photo was made from a clamp sold for holding flashlights to

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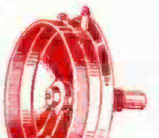

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PW-5M	5000	SW-50	50
PW-7500	7500	SW-60	60
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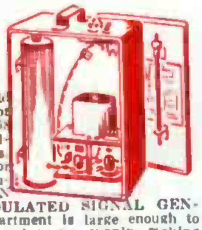

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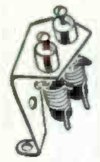

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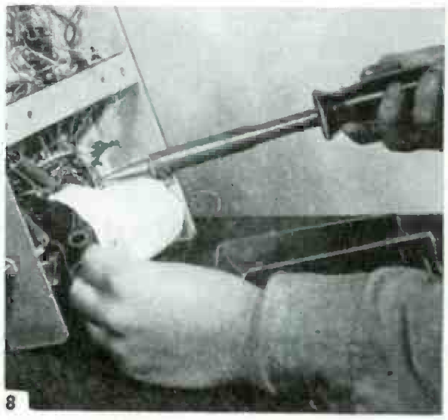

8

the steering columns of automobiles. **Photo 8.** A piece of asbestos paper may easily be worth several times its weight in burned capacitors and insulation. Before you stick your soldering iron in a tight place, cover the surrounding components with the asbestos.

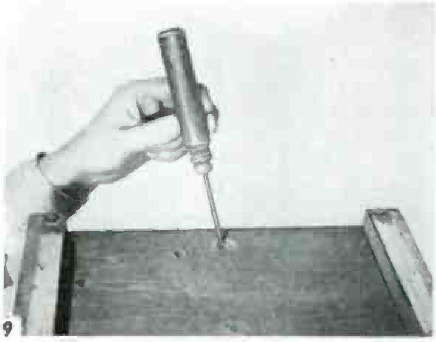

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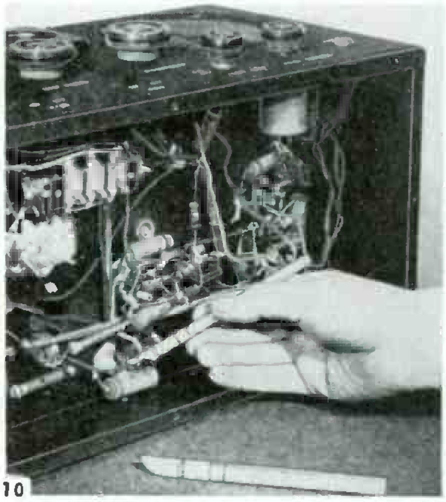
Photo 9. A radioman without an ice pick is like a painter without a brush. Use it to line up chassis holes with those in the cabinet, pick bits of solder out of unlikely places, strip shield braid from microphone cable, poke holes through solder-filled terminals — you could exhaust a ball-point pen writing down all its virtues!

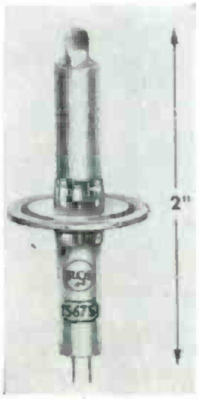


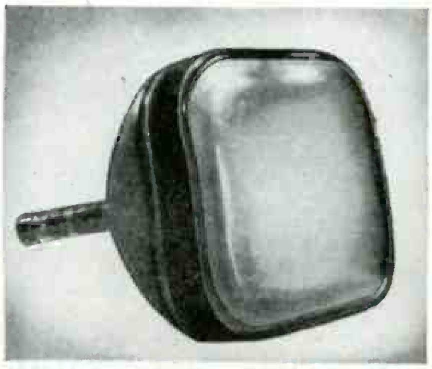
10

Photo 10. There are lots of tight places where you have to strip off insulation. When there isn't room to pull it off, you have to slice. When you try your jackknife, you wish you had a surgeon's scalpel. Next best is a modelmaker's knife like the two in the photograph, X-actos or similar.

Review of Recently Issued Tubes

At the left, 12AY7; at right, the 6BC5.





The new 16RP4 rectangular Pix

SEVERAL new tubes were announced last month. Three, by Sylvania, include the 12AY7, a miniature medium-mu duo-triode especially suitable for the first stage of audio amplifiers where noise and microphonics would be bothersome. A center-tapped heater provides for 6.3 or 12.6-volt operation.

Sylvania's 6BC5 r.f. amplifier is a sharp-cutoff miniature pentode with high mutual conductance, designed for r.f. and i.f. use in TV receivers. It is equivalent to the 6AG5 but has higher gain.

The other Sylvania type is the 6BQ6-GT, a horizontal deflection amplifier for TV. It is intended for transformer-operated sets where high peak interelectrode voltages are encountered.

RCA announces four types. The 6AU5-GT is a high-perveance beam-power amplifier. Its features include low mu, high plate current at low plate voltages, and a high ratio of plate to screen current. It is designed for use in horizontal deflection circuits where the plate voltage is supplied partly by the circuit and partly by the low-voltage supply of the receiver. One 6AU5-GT will fully deflect a 10BP4, 12LP4, or similar tube having a deflection angle up to 60 degrees and up to 12 kv anode voltage.

Type 1V2, also by RCA, is a high-voltage half-wave rectifier, a nine-pin miniature. When used in a doubler circuit transformer-coupled to a horizontal deflection circuit employing the 6AU5-GT, the 1V2 is especially suited to rectify the high-voltage pulses for the picture-tube anode.

The RCA 5675 is a new, "pencil-type," medium-mu triode for use in grounded-grid circuits at frequencies as high as 3,000 mc. As a local oscillator, it is capable of giving a power output of 475 mw at 1,700 mc and about 50 mw at 3,000 mc.

The 5675 utilizes "pencil-type" construction for minimum transit time, low lead inductance, and low interelectrode capacitances. Other features are small size, light weight, low heater voltage, good thermal stability, and convenience of use in circuits of the co-axial-cylinder, line, or lumped-circuit type. In grounded-grid circuits, the grid flange permits effective isolation of the plate circuit from the cathode circuit.

The "pencil-type" design employs a co-axial-electrode, double-ended structure in which the plate cylinder and the cathode cylinder, each only ¼ inch in diameter, extend outward on opposite sides of the grid flange. The over-all length of the structure is only 2⅜ inches.

The 6CB6 is a miniature sharp-cutoff RCA pentode designed especially for video i.f. amplifier service at around 40 mc. It is also well suited for use as an r.f. amplifier in v.h.f. television tuners. Featured in the 6CB6 is very high transconductance combined with low interelectrode capacitances, and separate basepin terminals for grid No. 3 and cathode. The separate terminals permit the use of an unbypassed cathode resistor to minimize regeneration.

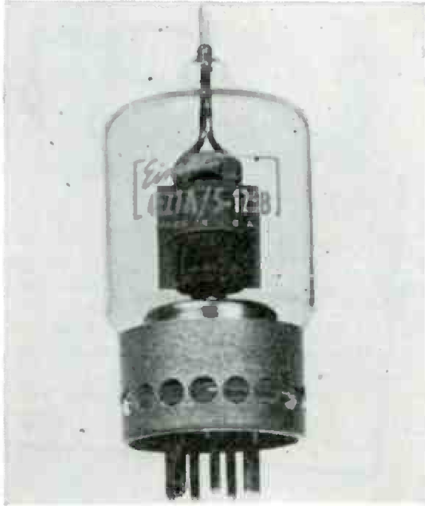
Hytron announces the 16RP4, the first commercially available rectangular television cathode-ray tube. The face of the all-glass tube has the standard 4-to-3 aspect ratio so that the entire screen is used for television pictures. Required cabinet space is approximately the same as that for a 12-inch round tube. Weight of the 16RP4 is about two-thirds that of round 16-inch glass tubes. The face has a neutral gray tint to increase contrast. Magnetic focus and deflection are used.

General Electric announces a new miniature, the 6BC5, designed principally for r.f. and i.f. service in television receivers. It is a higher-transconductance version of the 6AG5, with which it is interchangeable.

G-E has also put into production two miniatures for use in altimeters, radio compasses, control equipment, and high-frequency aircraft receivers and transmitters. These are the GL-5814 and the GL-5751. The former is a heater-cathode, medium-mu twin triode; the latter is a high-mu twin triode. Heater voltages are 6.3 at 350 ma or 12.6 at 175 ma. Maximum plate voltage is 330.

Eitel-McCullough has redesigned the 4E27 pentode for longer life, simpler cooling, and increased plate dissipation rating. The tube is rated at 125 watts plate dissipation in v.h.f. service.

Tung-Sol's new 5687 is a twin triode miniature for 6.3-volt, 900-ma, or 12.6-volt, 450-ma operation. Amplification factor of each section is 16.5 to 18, transconductance 4,100 to 11,000 μmhos.



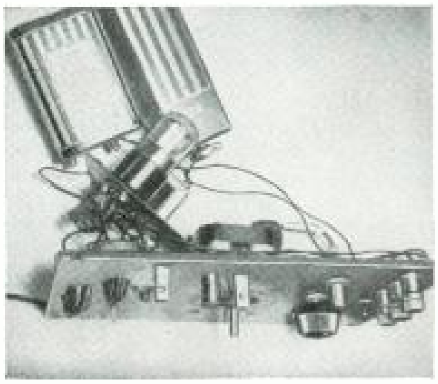
The newly redesigned Eimac 4E27A.

CODE PRACTICE OUTFIT

BY HARRY C. AICHNER, JR.

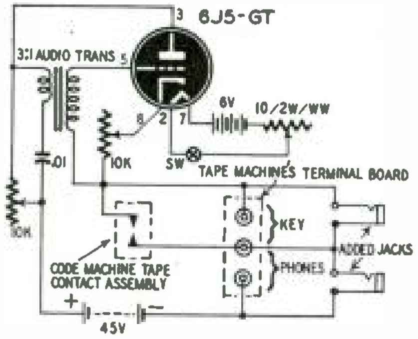
IT'S sure-fire! And you can take that literally. The compact, inexpensive, one-tube code-practice oscillator described here will take any except crystal headphones. In fact, you can use several sets of headphones and keys, or even PM speakers, for the unit will operate with almost any reasonable impedance as a load.

The oscillator was constructed on a piece of sheet metal, measuring 4 x 5 inches for easy mounting within the case of a commercial tape code-practice machine. Actually, the physical layout of the circuit is not important, and you could build your unit in a standard 3 x 4 x 5-inch cabinet and use it as an ordinary code-practice outfit.



In the circuit proper, a 6J5 triode tube and a 3-to-1-ratio audio interstage transformer are employed to set up the required oscillations. Pitch of the signal is controlled by the .01-µf paper capacitor and the three variable resistances.

Operating power is supplied by a 45-volt B-battery and a 6-volt A-battery. The latter lasts longer than it normally would because of the 10-ohm rheostat in the filament circuit. Most 6J5 and similar tubes do not need full 6.3 volts for their filaments in this circuit, so cutting down on battery use saves power.



For convenience, standard phone jacks were installed in addition to the binding post terminals already on the tape machine panel.

A final word about the versatility of this oscillator. The author applied various impedance loads from 450 ohms to 10,000 ohms. At no point within this range did the unit refuse to oscillate!

How to Become a Ham

Part V—The factors that count in designing transmitter output tanks

By GEORGE W. SHUART, W4AMN

BECAUSE you, the faithful follower of this series of articles, are probably well on the way toward earning that coveted amateur radio operator's license you have been preparing for, it is time to consider some factors in the design of the transmitter you will soon be building.

Reactance, impedance, and phase—though they may be important to the beginner—we will leave to handbooks and textbooks which are able to cover the subjects in greater detail.

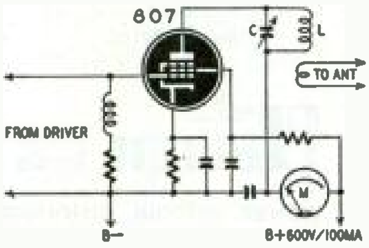


Fig. 1—The 807 r.f. output amplifier.

Every tuned circuit—your transmitter will probably have several—has capacitance (C) and inductance (L). There are almost endless combinations of L and C which will tune (resonate) at a given frequency. Regardless of the specific values of inductance and capacitance which will resonate at a given frequency, the product of the inductance in microhenries (μh) and capacitance in micromicrofarads (μμf) will always be the same for that frequency.

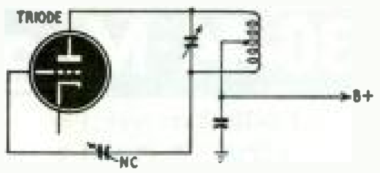


Fig. 2—Tube is across half of the tank.

The product of LC for any frequency can be found from the formula:

$$LC = 25{,}330/f^2, \qquad (1)$$

where L is in μh and C in μμf, and f is the frequency in megacycles. When the capacitance is large, we have a *high-C* circuit. A large value of inductance gives us a *low-C* circuit.

While there are many combinations of capacitance and inductance which will tune to a given frequency, the efficiency of the circuit will be governed by the ratio of capacitance to inductance. (L/C).

Because of factors which we need not take up at this time, the Q of a plate tank circuit should be neither too high nor too low in class-C amplifiers. As a result, designers compromise and select a Q of 12 as the design factor. Because the total capacitance in the tank plays a large part in determining the Q of the circuit, we can use the formula

$$C = \frac{300 \times Q \times I_p}{f \times E_p} \qquad (2)$$

to determine the total capacitance needed in the circuit. I_p is the d.c. plate current in ma, E_p is the d.c. plate voltage, f is the frequency in mc, and Q is 12.

Varying the capacitance is the most common method of tuning a circuit. Every variable capacitor has a *capacitance ratio* which is C_{max}/C_{min}. For every tuned circuit, there is a similar ratio (F_{max}/F_{min}) between the maximum and minimum frequencies. This ratio of frequencies, called the *tuning ratio*, is equal to the square root of the capacitance ratio. Conversely, the relationship between capacitance and tuning ratios may be written

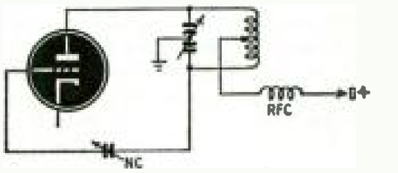


Fig. 3—Split-stator capacitor is used.

$$\frac{C_{max}}{C_{min}} = \left(\frac{f_{max}}{f_{min}}\right)^2 \qquad (3)$$

Let us apply what we have learned thus far to the design of a tank circuit for a transmitter to cover the 80-meter band (3,500 to 4,000 kc or 3.5 to 4 mc). The frequency ratio of the tank circuit is 4.0/3.5 or 1.143. The capacitance ratio is $(1.143)^2$ or 1.3.

Our transmitter will have an 807 beam tetrode connected as shown in

(*Continued on page* 72)

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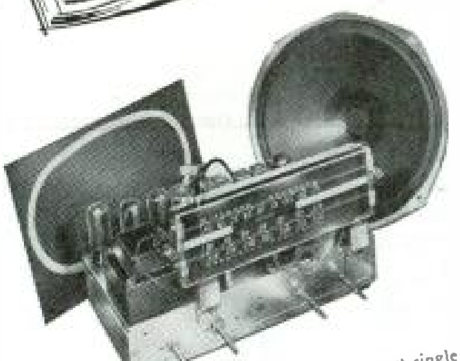

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Fig. 1. We will operate it with a plate voltage of 600 and a current of 100 ma. Substituting our known values in Equation 2, the total tank circuit for resonance at 3,500 kc (3.5 mc) is

$$\frac{300 \times 12 \times 100}{3.5 \times 100}$$

or approximately 170 μμf. Note that this is close to 2 μμf per meter.

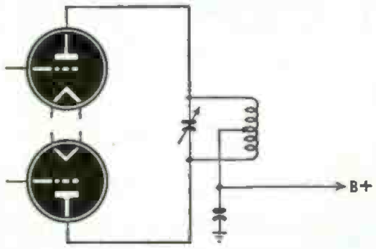
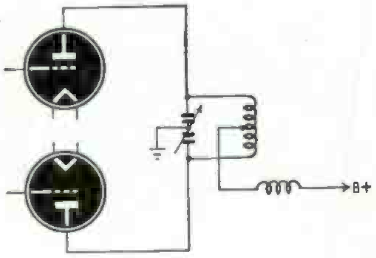


Fig. 4—A standard push-pull amplifier.

From the tube manual we find that the output capacitance of the 807 is 7 μμf. Stray capacitance due to leads will probably double this value. Subtracting this 14 μμf from 170 μμf shows that we will have to add 156 μμf to the circuit to tune it to 3.5 mc. When we mount our variable capacitor near the metal chassis, we greatly increase the fixed minimum capacitance and add to the over-all capacitance. Therefore we can use a capacitor smaller than 156 μμf. A standard 150-μμf capacitor will be about right.



Fg. 5—Push-pull and split-stator unit.

Because a total capacitance of 170 μμf is required to tune to 3.5 mc, and because the capacitance ratio is 1.3, the capacitance required to tune to 4 mc is 170 μμf/1.3 or approximately 130 μμf. This is well within the range of the 150-μμf unit we will use.

Next we will need an inductor or coil for the tank circuit. Transposing the factors in Equation 1 we have:

$$L = \frac{25{,}330}{f^2 \times C},$$

where L is in μh, f in mc, and C in μμf. Substituting in this equation, we have:

$$L = \frac{25{,}330}{4^2 \times 130},$$

$$L = 12.7 \text{ μh (approx.)}.$$

Various formulas for winding coils having a specific inductance are given in a number of texts and handbooks and will not be discussed here. The type A Lightning Calculator published by A.R.R.L. is a circular slide-rule which will give winding data for almost any type of coil. Coil-winding instructions are also given in construction articles in amateur radio handbooks, of which you should have more than one by now.

If you don't care to wind your own

(*Continued on page* 74)

coils, you will find that they are made for most amateur frequencies by such firms as Barker & Williamson, E. F. Johnson Co., James W. Millen, National Co., Inc., and a number of others.

Let's take another look at tank capacitors. The value we selected will work nicely for Fig. 1, but suppose that we had selected a triode which required neutralization. The circuit would then look like Fig. 2 or 3. In these circuits, the tube is connected across only one half of the tank circuit; therefore, the capacitance must be reduced to one-quarter of its calculated value C. Had we elected to use a split-stator capacitor as in Fig. 3, each section would

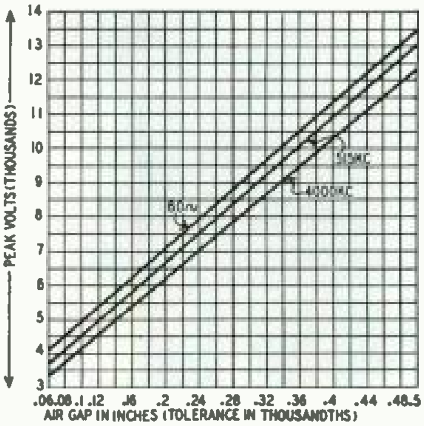


Fig. 6—Capacitor breakdown voltages.

have had to be ½C for a total capacitance of ¼C. The coil inductance would then have to be increased four times (Equation 1).

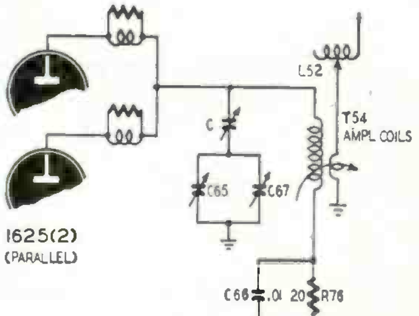
Suppose that we had a push-pull amplifier. Its circuit would look like that in Fig. 4 if we used a single capacitor or like Fig. 5 for a split-stator tuning unit. In both these circuits, the effective capacitance must be ¼C.

We know what capacitance we need, but how shall we select the proper unit for the job? Capacitors are made in all sizes and shapes. Some have the plates very close together; you can push your finger between the plates of others. The peak voltage between the stator and rotor is the factor which determines the spacing between these elements. If we use a circuit from Figs. 1, 2, or 4, the d.c. voltage is applied to both sides of the capacitor and the only thing we need worry about is the peak-to-peak r.f. voltage, which equals the d.c. voltage in these circuits. To use a circuit from Fig. 3 or 5, we must select a capacitor having a breakdown rating of at least *twice* the d.c. plate voltage. If we plan to modulate this amplifier (use phone), capacitors in Figs. 1, 2, and 4 should be rated at *twice* the d.c. voltage while those in Figs. 3 and 5 should withstand *four times* the d.c. voltage.

Fig. 6 shows the peak arc-over voltage for capacitors having different air gaps. The ratings are for capacitors with 0.025-inch plates with polished surfaces and rounded edges. Thinner plates reduce the voltage rating by approximately 8% and square-edge plates reduce the arc-over rating by as much as 20%.

20-METER SCR-274-N

THIS data is strictly for hams. The schematic diagram shows the p.a. plate tank of the SCR-274-N transmitter. (Use either the 7–9.1-mc unit or the 5.3–7-mc transmitter set retuned for 40 meters.) Open the lead from the stators of the parallel variable tuning capacitors. A good place to break the line is where the wire is soldered to the lug on the tank coil. Solder a midget three-plate capacitor (C in the diagram) on the tank-coil lug, making it self-supporting.



Using an insulated screwdriver, adjust the midget condenser while the transmitter is fired up, watching a resonance indicator. (A pilot bulb in series with a 3-inch-diameter closed loop will do fine; hold it near the tank coil.) When the bulb lights to maximum brilliance, showing resonance, you're through. Your 40-meter transmitter will now transmit on 20 meters with no further adjustments. What's more, the tracking between oscillator and p.a. stage is still correct, so that the dial calibration can be used.

If you're bothered about what you did—relax. The oscillator output contains harmonics, predominantly second and third. They are ordinarily insignificant in the output. Inserting the midget condenser and peaking it tunes the tank circuit to the second harmonic.

The assumption is that the harmonic being amplified is the second—thus doubling from 40 meters to 20. It could be the third. Better check before sending out a CQ.—*Earle E. Greer, W8ZYH*

Suggested by V. R. Lupia, Yellow Springs, Ohio

TAPE RECORDER

Amplifier Corp. of America
New York, N. Y.

A new continuous-play magnetic tape recorder, the Model 810-DV, eliminates the usual continuous tape loop. It will repeat any message from 1 second to 1 hour in duration.

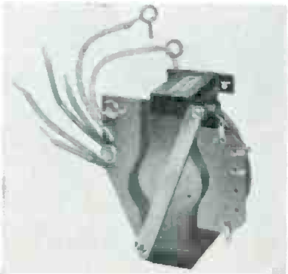
Continuous repetition is achieved through double reversal of standard magnetic tape. Half the message is recorded on one sound track in forward tape travel, and the other half on the second sound track in reverse tape travel. Special solenoids reverse the direction of tape travel in both directions.

Intimate contact between the tape and the driving capstan of the recorder is secured with only 20 grams of pressure, thereby permitting 10,000 or more playbacks of a recording without noticeable drop in volume or wear in the tape. Another desirable feature is the presence of an auxiliary pair of contacts which provide a pulse for synchronization of auxiliary equipment such as slide projectors. Frequency response is 50 to 9,000 cycles at 7½ inches per second of tape speed. An alternate model with a maximum message length of 30 minutes, operates at 15 inches per second with frequency response of 30 to 13,000 cycles. Cabinet dimensions are 13⅜ inches high, 16½ inches wide, and 14½ inches deep. Net weight 47 lbs. Finish is grey leatherette.

TELE TRANSFORMERS

Standard Transformer Corp.
Chicago, Illinois

The addition of three horizontal deflection output and high-voltage transformers to the Stancor line of television replacement transformers has been announced.



Included are the A-8119, an exact duplicate of RCA type 211T5, for use with the 16AP4 and similar kinescopes; the A-8127, an exact duplicate of RCA type 211T3 for use with the 10BP4; and the A-8128, designed to fill the need for a transformer between the 10 and 16-inch sizes and also for use in converting a smaller receiver to a 16-inch receiver.

WIRE RECORDER

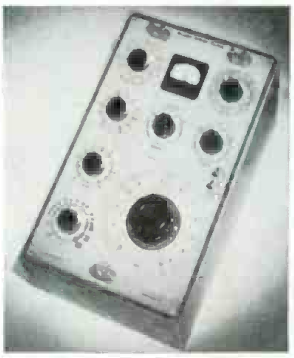
Allied Radio Corp.
Chicago, Ill.

The new Knight wire recorder plays 78-r.p.m. records and includes a phono oscillator. It records from microphone, records, or radio. A 5-tube amplifier and a PM speaker are built in.

IMPEDANCE BRIDGE KIT

Heath Co.,
Benton Harbor, Mich.

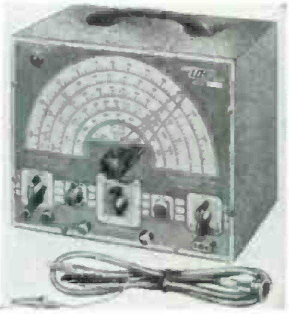
The new Heathkit impedance bridge is an accurate instrument for measuring inductance, capacitance, resistance, Q, and dissipation factor. Ranges include inductance from 10 µh to 100 h, capacitance from 10 µµf to 1,000 µf, resistance from .01 ohm to 10 megohms, dissipation factor from .001 to 1, and Q from 1 to 1,000. The main control and hummer are General Radio components. Ceramic, noninductive resistors of 0.5% accuracy, ceramic switches, and a zero-center, 200-µa meter are other features. All parts, marked panel and case, and complete assembly instructions are furnished.



TV SIGNAL GENERATOR

Electronic Instrument Co., Inc.,
Brooklyn, N. Y.

A crystal marker oscillator with variable amplitude is one of the features of the new model 360 TV-FM sweep signal generator.



Available in either kit or wired form, model 360 covers all TV and FM alignment frequencies between 500 kc and 228 mc.

Other features are: sweep width variable from 0-30 mc with mechanical inductive sweep, gain comparison of adjacent RF TV channels, injection of external signal generator marker, phasing control, dial directly calibrated in frequencies, stable oscillator. Size is 10 x 8 x 6¾ inches.

Tubes are 6X5GT, 12AU7, and two 6C4's.

TELEVISION BOOSTER

JFD Mfg. Co., Inc.,
Brooklyn, N. Y.

The Video Beam, model TV10, is said to have flat response over the TV spectrum, with separate circuits for high and low bands. Fine tuning controls are provided for each band. The booster matches all television receivers.

MINIATURE ELECTROLYTICS

Aerovox Corp.,
New Bedford, Mass.

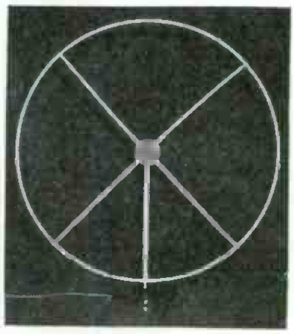
Miniaturized electrolytic capacitors handling full-sized functions, known as the Bantam or type SRE, are announced.

Bantams are hermetically sealed in tubular aluminum cases with wax-impregnated cardboard insulating jackets. New stud terminals provide maximum creepage distances between terminals and can. Leads are No. 18 gauge tinned copper.

INDOOR ANTENNA

Circle "X" Antenna Corp.,
Perth Amboy, N. J.

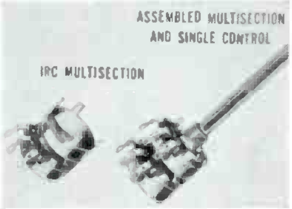
The Circle X antenna described in the August, 1949, issue is now available in modified form as an indoor TV antenna. It covers the complete television band with little adjustment and has a high gain.



MULTISECTION POTENTIOMETERS

International Resistance Co.,
Philadelphia, Pa.

This new product allows the service technician and experimenter to make up his own ganged potentiometer assemblies from a wide variety of types. Known as Multisections, the new units are complete control sections that can be added to standard miniature-type Q, PQ, or RQ controls, just as switches are attached. Each Multisection adds 19/32 inch to the basic control. As many as three can be added to make a quadruple control.



No special tools are required for assembly. Seventeen standard resistance values are available from 1,000 ohms to 10 megohms.

YAGI TV ANTENNA

Trio Mfg Co.,
Griggsville, Ill.

A new Yagi-type antenna with a double folded dipole has been announced. It provides improved performance with light weight (5 pounds for channel 5). A model is available for each TV channel. Gain is 10 db on tuned channel, front-to-back ratio over 25 db. The pattern is sharply directional.

GERMANIUM DIODES

Sylvania Electric Products
New York, N. Y.

Compact, moisture-proof, germanium crystal diodes enclosed in hermetically sealed glass cartridges are available in two types: 1N34A, a general-purpose diode; and 1N58A, a 100-volt diode.

Electrical characteristics, ratings, and prices of the new "glass"-type crystals are the same as those for corresponding "ceramic" types which have been marketed by Sylvania since the war.

VOLTMETER PROBE

Insuline Corp. of America
Long Island City, N. Y.

A new multiplier probe for voltmeters, called the Kilovolter, adds 15,000 volts to the scale readings of

high-resistance voltmeters used in radio servicing. Three models are available, for 50-, 100-, and 200-µa meter movements.

RIBBON-LINE STRIPPER

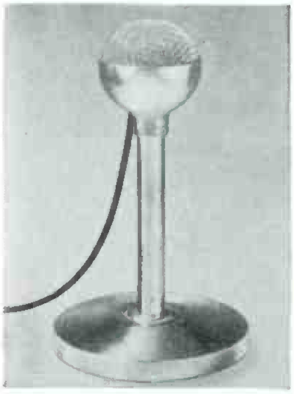
Holub Industries, Inc.
Sycamore, Ill.

Baring the ends of the 300-ohm ribbon lead so extensively used for television transmission lines is a nuisance at best. The Hi A-TV Stripper neatly removes insulation of both leads at the same time in one "squeeze." It will also cut the lead and strip other types of wire without changing blades.

CRYSTAL MICROPHONE

Electro-Voice, Inc.,
Buchanan, Mich.

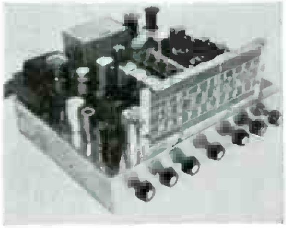
The Spherex is an omnidirectional crystal microphone with response from 60-7,000 cycles. Output level is —50 db. Net weight is 8 ounces.



FM/AM RECEIVER

Collins Audio Products Co.
Westfield, New Jersey

The 44-8 is a high quality FM/AM receiver embodying in one radio-chassis all the features for high quality listening. It uses 26 tubes, two of which are voltage regulators. Among its



other features are a 12-tube FM circuit, push-pull triode amplifier, FM squelch, broadband AM circuit, 10-microvolt sensitivity on FM, and an equalizer tube for magnetic phono cartridges.

LINE STANDOFFS

South River Metal Products Co.,
South River, N. J.

Three new versions of standard insulators for 300-ohm transmission line have been introduced. The first type may be fastened to the mast, the second is a nail-on, and the third has a screw base. Any of the three types may be had with dual insulators to handle a pair of lines.

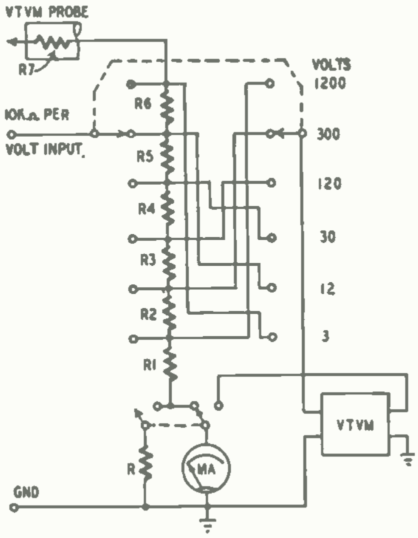
COMBINED VTVM AND STANDARD VOLTMETER

Roswell W. Gilbert, Montclair, N. J.
Patent No. 2,478,966
(Assigned to Weston Electrical Instrument Corp.)

Two basic types of voltmeters are used in radio measurements. The standard voltmeter uses a milliammeter in series with multiplying resistors. It is accurate and convenient to use since it does not require a power supply. However, the v.t.v.m. must be used when measuring across a high impedance, and it does need a power supply.

This invention discloses a combination instrument which may be switched to be either a v.t.v.m. or a standard meter. The same milliammeter and multirange resistors are used for both. The same voltage scales apply to both voltmeters.

The scales must be chosen in symmetrical progression, that is, their ratios must be the same when read from either direction. For example, the scales shown in the figure are 3, 12, 30, 120, 300, and 1,200 volts. The ratios are 4, 2½, 4, 2½, and 4, whether read from the beginning or the end. Under this condition the same voltage scales apply to both voltmeters.



The individual resistors from R1 to R7 may be calculated by the usual method for a standard voltmeter. Assuming a 10,000-ohms-per-volt meter, the total resistance for the 3-volt scale (R1+R) would be 30,000 ohms. Similarly, for the 12-volt scale the total resistance (R2+R1+R) would be 120,000 ohms. (R is the internal resistance of the milliammeter.) Note that the resistors are wired in reverse order to the right-hand set of taps, for the v.t.v.m. voltage divider.

When the switch SW is positioned as in the figure, the six resistors R1 to R6 are used as multipliers in series with the meter. When the switch is thrown to the right, the meter M is used in conjunction with the v.t.v.m. and the resistors now form a voltage divider. R replaces the meter resistance when the meter is removed from the resistor string. R7 is the v.t.v.m. isolation resistor.

ILLUMINATION CONTROL

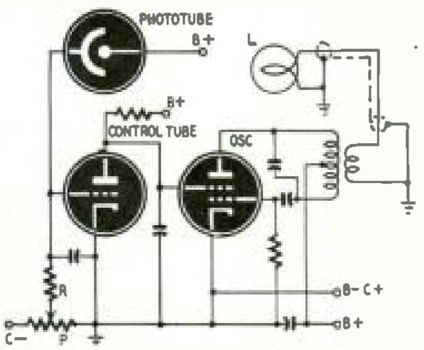
Patent No. 2,477,646
Gilbert J. Perlow and Glenn A. Johnson, Washington, D. C.
(May be used by U. S. Govt. without royalty payments)

Lamps supplied by a low-frequency line power tend to flicker. The flicker disappears when d.c. or r.f. power is supplied. For example, a 600-kc oscillator may be used to light the lamp. Variations due to changes in voltage or other causes may be eliminated by letting the instantaneous lamp brilliance control the power fed to the lamp.

The circuit shown here is an effective illumination control. A Hartley oscillator feeds the lamp through a transformer and a shielded cable. Light from the lamp excites the phototube. The invention also uses a control tube and an r.f. oscillator tube.

Bias for the control tube is the resultant of a negative C voltage (across a portion of P) and a positive voltage due to electrons flowing through P and upward through R.

If, for example, L tends to become dimmer, less electrons flow upward through R, making the effective bias go more negative. Plate current drops, and there is a corresponding rise in plate voltage of the control tube.



The oscillator screen is tied directly to the control tube plate. When the potential on the latter rises, more r.f. power is available at the lamp terminals. Therefore, the illumination from L returns to normal. Compensation in the opposite direction takes place if the lamp tends to become brighter for any reason.

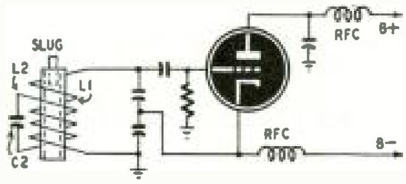
IMPROVED SLUG TUNING

Patent No. 2,479,438
Leonard O. Vladimir, Bridgeport, Conn.
(assigned to General Electric Co.)

One disadvantage of slug tuning is a relatively narrow tuning range. This inventor has discovered a simple method for increasing the range by approximately 7%: a secondary coil is coupled to the tuned coil, both being wound over the same slug-tuned form.

In the figure, L1 is a tank coil for a Colpitts oscillator. L2 is the secondary coil tuned by C2. The secondary circuit must be tuned to a frequency higher than the oscillator frequency, thus making the secondary capacitive throughout the oscillator range. The method of winding the two interwound (bifilar) coils is shown in the accompanying figure. Preferably, L2 should have slightly fewer turns than L1.

In circuit theory, a capacitive secondary reflects back into the primary an inductance which varies as the square of the mutual inductance between the coils.



As the slug enters the coil form, it increases the inductance of L1 and also increases the mutual inductance M. Due to reflected inductance, the tuning range of the primary is greater than it would be without the coupled circuit.

ULTRASONIC WASHING MACHINE

Patent No. 2,468,550
Hal F. Fruth, Chicago, Illinois.
(Assigned to Motorola, Inc.)

Washing machines generally clean clothes by agitating and rotating them through a cleaning fluid. The new type disclosed here relies upon ultrasonic waves to clean fabrics. The local agitation and intense bubbling action loosens dirt and grease, with less wear and tear on the clothes. An ultrasonic frequency above 20 kc is suggested.

Several activators or ultrasonic sources are fixed around the machine to circulate the fluid. These may be PM or dynamic speaker units excited by an ultrasonic vacuum-tube oscillator.

Among advantages claimed for this washing machine are the destruction of germs and the softening of hard water by the ultrasonic waves.

Radio Thirty-Five Years Ago

In Gernsback Publications

HUGO GERNSBACK
Founder

Modern Electrics	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931
Wireless Association of America	1908

Some of the larger libraries in the country still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

IN THE FEBRUARY 1916 ISSUE OF ELECTRICAL EXPERIMENTER

REPAIR WHILE YOU WAIT

The Belmont Radio Service in Washington, D.C., has come up with an unusual idea in radio servicing. This neighborhood radio repair and appliance shop specializes in fixing receivers while the customer waits; from 75 to 90% of the store's business is done this way.

The owner, Bud Sickmen, who has been operating Belmont for almost a year, says that among other advantages is the fact that customers who watch the work being done lose some of the suspicious attitude people so often have about radio repairs.

NO PERMANENT STYLI

So-called "permanent" phonograph needles are far from permanent, according to an article in the *Permo Reporter*, issued by Permo, Inc., producer of the Fidelitone styli. The writer points out that when two materials rub—record and stylus—there is inevitable friction and wear.

The point of a phonograph needle contacts the record groove with a pressure of 6,000 to 25,000 pounds per square inch. The friction-generated temperature is in the order of 1,000 to 2,000 degrees F. Both needle and record lose material. The jagged needlepoint that results then tears the record, so that the process is cumulative.

After the recent war, many cartridges were made with permanent points, replacement of which necessitated replacement of the entire unit. Manufacturers are now recognizing the stylus' impermanence and redesigning cartridges so the needle can be replaced.

SMALLEST B-BATTERIES

The tiniest hearing-aid B-batteries ever produced commercially were introduced recently by Olin Industries, Inc., New Haven, Conn. Available in two voltages, the batteries are built up from interlocked midget plastic cells, each producing a potential of about 1.5 volts. The square cells are almost flat. Thus merely stacking them in "layer-built" fashion connects them; there is

no need for soldered connections, the breaking or corrosion of which often results in trouble in multicell batteries.

The photograph shows the two sizes. The 15-volt unit at the left is made of 10 stacked cells and measures about ⅝ inch square and 1 inch long. The 30-volt unit at the right is made of two 10-cell stacks and is approximately twice as large.

In the photo the plastic framework of one of the cells is shown on a man's finger, the aspirin tablet beside it illustrating its small size. The new batteries are expected to make possible hearing aids smaller than a package of cigarettes.

RADAR AFFECTS BIRDS

Birds were observed recently to follow strange flight patterns in the vicinity of radar transmitters, the British publication. *The Sphere* reported. The story mentioned American observations of the phenomenon early in the year, then told of what has been going on at a radar-equipped lighthouse in the English Channel. Swallows fly madly about the tower on which the antenna is mounted, finally falling into the sea in exhaustion.

Bird watchers will observe future flights with great interest, to see how new radar installations (especially the radar "fence" to be erected around the U. S.) will affect birds' seasonal migration habits.

CORRECTION

A connection to the bias line was omitted from Fig. 2 of the article "Revamping a 630-Type TV Set," on page 39 of the January issue. Connect the junction of R1 and the 82,000- and 10,000-ohm resistors in the a.g.c. detector circuit to the –100-volt point in Fig. 1 on the same page.

ELECTRONIC LITERATURE

Any or all of these catalogs, bulletins, and periodicals are available to you if you write to us on your letterhead (do not use postcards) and request them by number. It is necessary to send only the number of item you want. We will forward the request to the manufacturers, who in turn will send the literature directly to you. This offer void after six months.

FY-1—PHONO NEEDLE CROSS-INDEX
Jensen Industries, Inc., is introducing a replacement needle chart which lists replacement needles, needlepoint material, size, name of cartridge the needle is designed to fit, name of the phonograph using the cartridge, brief installation instructions, and the list price.—*Gratis*

FY-2—OSCILLOGRAPH BOOKLET
The new Du Mont type 304 and 304-H cathode-ray oscillographs are described in a 12-page booklet issued by Allen B. Du Mont Laboratories, Inc. The booklet contains simplified schematics and a description of the various circuits, as well as photographs of various patterns which may be viewed on the scopes.—*Gratis*

FY-3—GUIDE TO HI-FI MUSIC
A 12-page booklet of information for the layman, the "High-Fidelity Music Guide," prepared by David Randolph, music consultant for Lafayette Radio. It consists of a glossary of some of the terms used to describe audio reproducing equipment, a definition of high-fidelity, and descriptions of various pieces of commercial equipment which can be used in custom installations.—*Gratis*

FY-4—THEATRE TV BOOKLET
A 16-page booklet, "Theatre Television Facts Every Theatre Owner Should Know," (Form 2R6154) has been released by RCA Theatre Equipment Sales Division. It briefly describes the instantaneous projection and intermediate film methods of projection. The booklet answers a number of questions likely to be asked by persons interested in theatre television.—*Gratis*

FY-5—CROSSOVER NETWORK DATA
Racon Electric Co. has released a four-page bulletin of practical instructions and a wiring diagram for building a 1-kc cross-over network. A range of inductance, capacitance, and resistance values is given for speaker impedances from 4 to 16 ohms. Coil-winding data is given for the specified inductances. Information on installation of woofers and tweeters is also included.—*Gratis*

FY-6—APPLIANCE CATALOG
The latest catalog issued by the Sheldon Electric Co., division of Allied Electric Products, Inc., lists various types of line plugs, cube taps, low-voltage, high-current rectifiers for battery chargers, movie projectors, and similar applications, flood and spotlights, and fluorescent starters. Inserts giving electrical and mechanical specifications on 11 television picture tubes are also included.—*Gratis*

FY-7—NEW RIDER TV MANUAL
John F. Rider Publisher, Inc., announces that TV Manual Volume III is now available. A How It Works book and a cumulative index to the three TV manuals are supplied with the volume.—*Price $21.00*

FY-8—TV ANTENNA CATALOG
Radiart Simpli-Flex television antennas are listed in this 8-page folder, which is punched for insertion in an 8½ x 11 binder. All the usual types of antennas are shown, with brackets, accessories, and so on.—*Gratis.*

FY-9—TELEMETERING SYSTEMS
General Electric's 19-page bulletin GEA-5233 describes the newest G-E telemetering equipment for electric power distribution and industry. Detailed information is given on frequency, torque-balance, and photoelectric systems, with diagrams of typical installations.—*Gratis*

FY-10—COIL CATALOG
An 8-page catalog lists all FM and TV coils made by Stanwyck Winding Co., Newburgh, N. Y. Exact replacements are given for RCA and Transvision receivers as well as universal types. Schematics are shown of the circuits for which the coils are designed.—*Gratis*

FY-11—WIRE MARKERS
An 11-page booklet (Bulletin 349) describes the uses of E-Z code wire markers in considerable detail.—*Gratis*

MOTOROLA 7-INCH TV

The vertical sweep drifted until it was impossible to hold the picture after the set had operated continuously for an hour or more. We removed the .05-μf, 600-volt capacitor from the vertical multivibrator and replaced it with one having a higher voltage rating. Tests on the unit removed showed its leakage resistance to be more than 1,000 megohms cold and approximately 50 megohms when slightly warmed with a soldering iron. The leakage tests were made at 600 volts.

This trouble can occur in almost any set having multivibrators in the sweep circuits.—*Gray Trembly*

HALLICRAFTERS TV-505

If the picture is out of focus and is not correctable with the focus control, look for an open resistor in the bleeder of the high-voltage supply.

When the raster is intermittent and the sound is OK, check the adjustment of the high-voltage oscillator. If this stage is not properly adjusted, the oscillator will be intermittent.—*Charles F. Otto*

ADMIRAL 20A1, 20B1 and 21A1

Audio output of early production runs of sets using these chassis can be increased by adjusting slug A9 (L106) on the tuner. Turn the slug while watching the picture to make sure that picture quality does not decrease with an increase in sound level. If this adjustment does not bring the sound up to a satisfactory level, replace the second sound i.f. transformer with part No. 72B86-2. Remove the 27,000-ohm resistor (R203 across the secondary of the second sound i.f. transformer) and use it to replace the 47,000-ohm resistor (R303 in the a.g.c. network). Realign all 21.25-mc sound i.f. and ratio detector circuits.

In later production runs the aforementioned changes have been made and the inductance of L105 increased to raise the a.f. level. The later chassis are marked with the run number 15 or higher and blue dots on top of the tuner near L106 and on top of T201.—*Service Division of Admiral Corp.*

ZENITH 12A58

Cross-talk or cross-modulation which causes a strong local broadcast station to blanket the short- and longwave bands is traceable to oxidized contacts on the bandswitch. Cleaning the contacts with carbon tet or alcohol restores the set to normal operation.

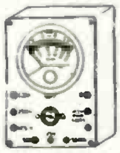
Advise the set owner that the contacts will not oxidize if the set is turned off before changing bands.—*Baron von Huenc*

BARGAIN SLEUTHS!

HERE IS YOUR CLUE TO LOWER PRICES!

AC-DC POCKET TESTER

This analyzer, featuring a sensitive repulsion type meter housed in a bakelite case, is the result of 15 years achievement in the instrument field by a large company specializing in electronic test equipment. Specifications of the AC-DC Model Volt-Ohmmilliammeter: AC and DC Volts—0-25, 50, 125, 250. Milliamperes AC—0-50, Milliamperes DC—0-50. Ohms Full Scale—100,000. Ohms Center Scale—2400. Capacity — .05 to 15 Mfd. Total price, prepaid anywhere in the USA—$7.00. Similar DC Meter, lacking AC operated ranges of above, $5.50 prepaid.



AUDIO AMPLIFIER

Brand new, dual triode amplifier having 2 of the valuable and scarce ouncer type audio transformers that sell for $12.80 apiece. Neat aluminum case, fully enclosed (largest dimension 6 in.). Perfect for intercom systems, phono amplifiers, mike amplifiers, or signal tracer amplifier for testing radio sets. A sensational bargain at only, each **$3.40**

CUT RATE BUYS

3 gang broadcast band **PERMEABILITY TUNER**, was $3.50, **NOW $1.50**

Push-pull **AUDIO AMPLIFIER** with hypersil core A. F. transformers— $30.00 value, now $3.40

LINE FILTER—Dual 14 mfd. oil condensers, High Inductance 50 Amp. Choke. Connectors included. $17.00 value for $1.98

Super Special highest quality all chrome Bullet shaped **CRYSTAL MIKE** of top-flight nationally known brand. Was $15.00, now $5.95

DYNAMIC MIKE .. formerly sold for $14.50, now $6.95

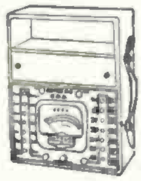
Push - to - talk Mike with switch on handle, was $1.69, now 98¢

MODEL 592 SPEEDTESTER

MADE BY SUPREME INSTRUMENT CORP.

WAS $58.95

NOW $48.95



The finest multimeter money can buy. "Tops" in quality, accuracy, complete coverage, and speed of operation. 44 ranges at your fingertips. 1 Microampere to 14 amperes. Either 1000 ohms per volt or 25,000 ohms per volt meter sensitivity, instantly available. 0.1 to 1400 D.C. Volts. ¼ ohm to 50 megohms. No removal of test prods necessary—1 pair pin jacks for all ranges. In beautiful oak case. Regularly $58.95, we are offering these brand new testers for a limited time only for $48.95.

AUTO PILOT AMPLIFIERS

Now only $9.95

RT1463 7 tube amplifiers containing 3-7F7, 1-7Y4, 3-7N7, 4 potentiometers, numeruus resistors, filter and bypass condensers, filter chokes, power and audio transformers, and six sensitive plate relays. A military development that provided amazing stepless control proportional to correction required for ailerons, rudder and elevator, in the original application. A control amplifier of the ordinary type would deflect the rudder by some arbitrary amount when the ship was blown off the course to port or starboard. The result would either be that the correction was insufficient and the plane continued off course, or the correction would be too great, starting a series of tackings and would greatly increase fuel consumption and elapsed time in reaching the objective. This phenomenal unit, with its 3 amplifiers and six 5000 ohm relays in bridge circuits, will accurately control any 3 operations, related or unrelated, in minutely adjustable uniquely quantitative variations in either forward or reverse directions. 9"x7"x8" black crackle aluminum case. Brand new in original carton, $9.95.

BUFRAD WILL BUY ANYTHING ELECTRONIC

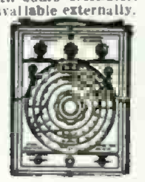
WE NEED AT ONCE:

- SCR 284, BC 654S, PE 103's
- BC-348 Receivers, AC or DC models
- BC-312 Receivers
- BC-221 Frequency Meters
- SCR-522 Transmitters & Receivers
- Hallicrafters BC-610 Transmitters
- Amateur or commercial sets
- Large stocks of tubes
- Large stocks of transformers
- Large stocks of condensers
- Large stocks of resistors
- Large stocks of speakers
- BC-224 Receivers
- BC-342 Receivers
- Collins ART-13 Transmitters
- Headphones in quantity lots
- Microphones in quantity lots
- Field telephones
- Sound-powered telephones

We are especially interested in large quantities, but will buy one to a thousand. Factories, dealers or other outlets please submit to us a list of surplus electronic equipment on sale so that we may submit our bid.

SIGNAL GENERATOR

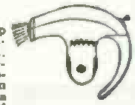
Genuine Laboratory-type precision signal generator. Manufactured and sold for $68.00 each in large quantities during the war by Northeastern Engineering Corp., one of the top manufacturers of electronic equipment for the U.S. Govt. Five fundamental bands starting at 150 KC. Strong harmonics up to 120 MC. Five step ladder type attenuator as well as potentiometer output control. Regular 1000 cycle audio oscillator using vacuum tube, not a cheap neon sawtooth audio oscillator. Audio output separately available externally. Weight without packing material 16 lbs. which should show what a world of difference exists between this signal generator and the ordinary cheap oscillator used by the average serviceman. Complete with fused plug and coaxial output lead. Super Special $38.75.



"DRILLMASTER" ELECTRIC DRILL

Ideal for hobbyists. Complete with sander, buffers, grinding wheels, etc. This is bankrupt stock! Only a few available. A real bargain at **$9.95**. Satisfaction guaranteed or money refunded if returned prepaid within 5 days.

HEAT GUN



Streamlined pistol grip heat gun. Vivid red housing. 20 Cu. Ft. per min. of hot air at 160°F. Lifetime-lubricated AC-DC motor of the rugged vacuum cleaner type. Produces a hurricane of hot or cold air. Blow out dust from radio chassis. Dry ignition system. Heat carburetors. Quick-dry paint. Thaw out radiators or water pipes. Will dry your wife's hair in half the time of ordinary hair dryer. Also good for drying stockings or clothing, or defrosting refrigerator instantly. Only **$12.95**. Satisfaction guaranteed or money refunded if returned prepaid within 5 days.

1000 CYCLE AUDIO FILTERS

Navy PD52010-1 low pass audio filters as mentioned in the "Peaked Audio" article in June CQ, and designated by the above number, are the exact electrical and physical equivalent of commercial audio filter units selling for $35.00 wholesale. They are infinitely better than the surplus "Radio Range Filters" being sold for reducing QRM, and at 2 KC off resonance for example, a 2 section filter using PD52010-1 is capable of twice the selectivity available through the use of the QR-er, (the BC453 section of the 274N which has provided the amateurs' previous highest standard of interference elimination). **EXTRA SPECIAL — NAVY PD52010-1** with diagram—$2.00.

BANDSWITCHING TUNING TURRET made by Western Electric. Covers 4 bands above 100 MC. All coils wound with No. 14 silver-plated wire. Complete with tuning condensers and powerful electric driving motor. Diagram included. ONE OF OUR MOST TERRIFIC VALUES—ONLY $2.95.

BUFFALO RADIO SUPPLY
219 Genesee St.
Buffalo 3, N.Y.
Dep't RE-2

DON'T MISS THIS 3 FOR 1 BARGAIN • $7.00 TAKES 'EM ALL

Aluminum Gear Box 18x8x7 contains 2 powerful electric motors and 2 matched gear trains, 62 gears in all, varying in size from ⅛ to 4" in diameter. Readily converted to rotate a beam antenna or any other similar use. $5.00.

Relay Box 730A Signal Corps Inter-connector Relay Box. This unit, made by Bell (BC616) in aluminum case 6½x5½x2½, contains 150 mfd. of condenser capacity, sensitive relays, resistors and terminal strips. Order several at this giveaway price of only $1.95.

Remote Control Aluminum case 4x3x2 contains revolution counter, 2 potentiometers, triple pole switch, 4 knobs, phone jack and gear mechanism. Includes 8 prong JAN connector to fit box—$1.39.

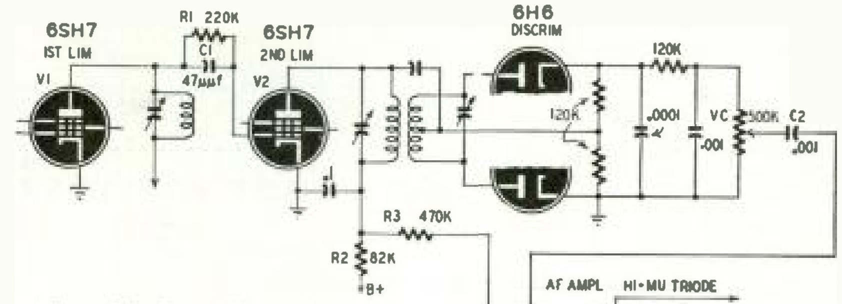
WORLD WIDE MAIL ORDER SERVICE!

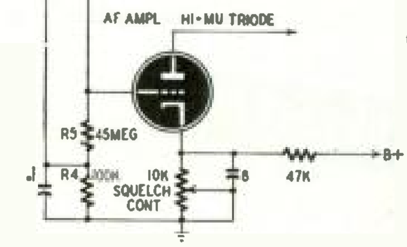
AUTOMATIC FM SQUELCH CIRCUIT

Automatic squelch or silencing circuits are used in FM communications receivers which may be turned on for long periods of time while no signal is being received and in some FM broadcast receivers to silence the set while tuning between channels.

The double-action FM squelch shown in the diagram was described in *Electronics*. V1 and V2 are direct-coupled cascade limiters working into a discriminator. Note that the grid resistor and capacitor combination C1-R1 is returned to the plate of V1 rather than to ground, thus placing a positive bias on the grid of V2. At low- or no-signal levels, the bias causes V2 to conduct heavily; therefore its plate voltage drops to a low level. When the tube is voltage across R2 is applied to a voltage divider consisting of R3 and R4. The a.f. amplifier is a zero-bias triode with the lower end of its grid resistor R5 returned to the junction of R3 and R4 so its grid is biased positive. The cathode is biased more positive than the grid; therefore the tube is cut off with no signal input. When the signal increases, the voltage rises across R2 and R4 and the a.f. amplifier immediately begins to conduct.

The time constant of C2-R5 should be short to have the a.f. amplifier conduct at the instant a signal is received. This allows the receiver to be used for fast break-in operation and also helps to avoid passing over a station while tuning the receiver.





operating with low plate voltage, its transconductance is low and the output is reduced. Furthermore, the positive bias lowers the grid-cathode impedance of V2 which shunts the tuned circuit of V1 and reduces its response to noise.

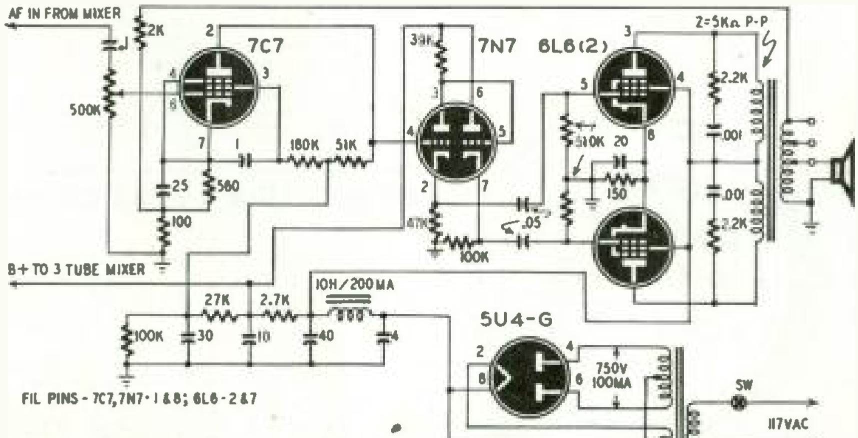
An average signal decreases the bias on V2 and causes its plate voltage to rise 50 volts or more. This change in

DIRECT-COUPLED PHASE INVERTER

A most interesting phase inverter was used in an amplifier circuit which appeared in catalog TR-49 published by Triad Transformer Mfg. Co. The speech amplifier, phase inverter, and power amplifier circuits are shown in the diagram.

Note that the input grid of the 7N7 phase inverter is direct-coupled to the plate of the 7C7 speech amplifier. The put section. Output signals are taken from both cathodes of the 7N7 phase inverter tube.

The circuit is so connected that any incoming signal which makes the 7C7 conduct more heavily will cause the input half of the 7N7 to draw less current. Therefore its cathode and the grid of the upper 6L6 will be driven in a negative direction. Because the grid



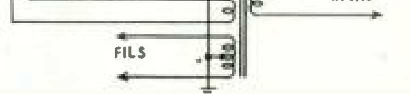
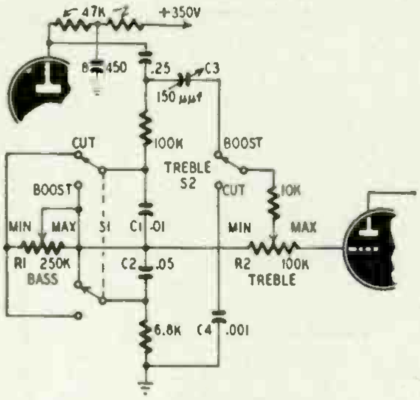


plate of the input section of the 7N7 is direct-coupled to the grid of the out-of the second section of the 7N7 is direct-coupled to the plate of the first, its grid will become more positive, thereby driving its cathode and the grid of the lower 6L6 in a positive direction.

WIDE-RANGE EQUALIZER

A versatile tone control or equalizer for boosting or attenuating bass and treble notes was described in *Wireless World*. The circuit shown in the diagram was designed for use between two triode-connected EF37 voltage amplifier stages. (The EF37 has an amplification factor of 28 and plate resistance of 10,000 ohms when used as a triode with 150 volts on the plate and screen, which are tied together at the socket.)



The controls are two potentiometers with individual BOOST-CUT switches. When the BASS control R1 is set to minimum resistance (counterclockwise position), low-frequency response is flat below 1,000 cycles. When S1 is set to BOOST accentuation begins at 1,000 cycles and increases to slightly more than 20 db at 10 cycles when R1 is turned to its maximum resistance position. The low-frequency rolloff begins at approximately 500 cycles and is —12 db at 10 cycles when R1 is at maximum. Increasing the value of C1 lowers the frequency at which rolloff begins and increasing C2 lowers the starting point for low-frequency boost.

Treble response is flat from 1 to 20 kc when R2 is set at minimum resistance. The highs rise gradually to 18 db at 20 kc when R2 is at maximum and S2 is set to BOOST. Rolloff begins at 1,000 cycles and is down 18 db at 20 kc when R2 is at maximum and S2 is set to CUT. Decreasing C3 makes treble boost begin at a higher frequency, and decreasing C4 raises the high-frequency rolloff point.

$3.00 FOR CARTOON IDEAS

RADIO-ELECTRONICS prints several radio cartoons every month. Readers are invited to contribute humorous radio ideas which can be used in cartoon form. It is not necessary that you draw a sketch, unless you wish.

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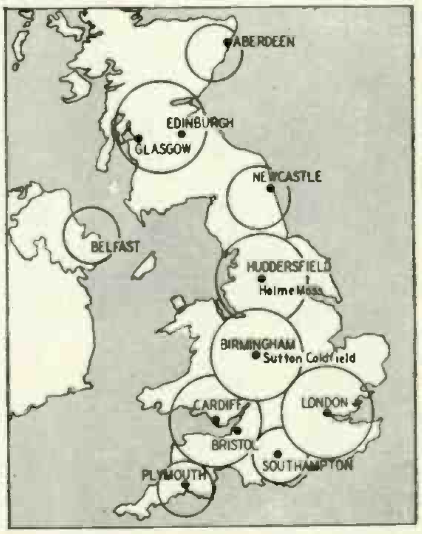
EUROPEAN REPORT

By MAJOR RALPH W. HALLOWS

SOME of you who use fluorescent lighting in your homes may have experienced a very annoying kind of interference with radio and television reception. I write "may have experienced" because it by no means follows that you are bound to have interference when a fluorescent tube is in use. Till a short time ago the whole business was rather puzzling, but recent research has given some interesting answers. It has been found that the trouble is caused by only a small proportion (about 5%) of new tubes, though others, which were blameless in their youth, may become interference producers after considerable service.

It is as a rule quite easy to discover whether or not a particular fluorescent tube is responsible for either radio or television interference. Switch on the fluorescent light while the set is working, noting the time. If the tube is to blame, interference will be noticed from 5 to 15 minutes later. Switch off the fluorescent tube. If the trouble ceases instantly, the tube is guilty. It is, in actuality, falling into oscillation and radiating fairly strongly. When you have a tube that behaves this way, take a look at the heaters through the narrow areas of clear glass (if any) at the ends. On the coating of one of the heaters you will find a bright spot.

Tap the tube sharply and the spot will disappear, together with the interference. Both, however, return after a time. So far, tube manufacturers do not know exactly how or why the condition is caused, or how to prevent it from happening. They attribute it to local "poisoning" in the heater coating. One firm, specializing in interference suppression has brought out a small



A television coverage map of Britain.

device which completely eliminates the interference caused by an oscillating fluorescent tube. Cylindrical in shape and measuring about 2¼ inches by 1 inch in diameter, it is easily fitted inside the casing of the ballast unit. Its cost is just over $1.00. I can speak of its effectiveness from personal experience, but there is much weightier evidence than mine available.

At Radiolympia hundreds of fluorescent tubes were in use, but there was no interference in any of the audio or vision demonstration rooms—not after the first day, that is. Rather surprised, I made some inquiries and learned that the Radio Industry Council had insisted that every fluorescent lamp in the show be fitted with the gadget described. On the opening day there was some interference, whose source was soon traced to one stand. Suppressors had been fitted to all its lamps, but examination showed that the electrician had done the job according to his own ideas and with a nonchalant disregard of the makers' simple instructions. When the connections had been made properly, there was no further interference anywhere.

Here are some particulars of the latest television receiver to appear in England. It is the first television product of the English Electric Company, with which the Marconi Wireless Company is now tied up. The design is the work of L. H. Bedford, one of the big men of the times in all that concerns the cathode-ray tube. The receiver is a console type, with a 15-inch cathode-ray tube and a 120-square-inch picture. Besides ordinary sound and vision reception, it can be switched to FM reception on the 88-108-mc band.

One of its outstanding features is its unit construction. There are three separate (and easily removable) sub-chassis in the vision part: the receiver, time-base (sweep) and power units. All have plug-and-socket connections. The technician is thus able to deal in remarkably quick time with any breakdown that may occur. Having traced it to a fault in, say, one of the time-base (sweep) circuits, he removes the complete time-base unit by disconnecting a plug from a socket, plugs in a replacement unit, and has the set in action again. He either repairs the faulty time-base unit in his own workshop, or, for a fixed price, sends it to the manufacturers' repair center covering the area in which his business is situated. The results are satisfactory to all concerned. The customer's broken-down televiser is as good as new in almost a matter of minutes. The service technician makes his rightful profit, for he knows just what his costs will be for the job. The price of this receiver is about $265 at the present rate of exchange, exclusive of purchase tax.

There is much to be said for designing, not only televisers, but ordinary broadcast receivers, on the socket-plug unit system. Servicemen would be saved a heap of time and trouble if they could whip out and replace, say, r.f., i.f., a.f., or power units in customers' homes and do all the serious repair jobs in their own workshops.

TV network planned

The accompanying map shows how Britain's television chain has been planned. The larger circles represent the service areas of the five big stations of 17 to 35 kw; the smaller are the five of from 2 to 5 kw, which are classed as low-powered. I imagine that the service area of the 35-kw stations is going to turn out to be considerably greater than predicted, largely because the great height of the transmitting antennas and the careful siting of them. The Birmingham antennas, for instance, are at the top of a 750-foot mast which is at the summit of a 600-foot hill.

All the English, Scotch, and Welsh stations seen on the map will be interconnected by both co-ax and radio links. Any television center will be able to work both inward and outward; that is, it will be possible for it to relay programs from other stations and to supply its own programs to them. Thus very few of the big events, sporting or otherwise, that occur in any part of Britain will be out of television range of the rest of the country.

(*Continued on page* 86)

If all goes well, the plan will be carried out within four years. Even should the service areas prove (as is most unlikely) to be no bigger than those shown on the map, the television system will then make reception available to nearly 90% of our whole population. My own prediction is that, with the possible exception of those who dwell in the more mountainous parts of Wales and Northern Scotland, the percentage will be much nearer 100 than 90. The rather larger bit of country eastward of areas 1, 2, and 3, may seem to be nobody's baby. But I believe it will be well covered, for most of it is nearly as flat as a pancake and it is only a very few feet above sea level.

A new pickup

The British Cosmocord Company decided to approach the problems of the high fidelity pickup from a new angle when working out their latest G.P.20 type of instrument. Their idea was to produce a pickup which would require no equalizing when used to play most ordinary records.

Using the crystal system, the stiffness of the assembly was first of all reduced until it would track commercial discs with a weighting of only 5-7 grams. As a compromise, to provide for warped records, the weighting was deliberately increased to 15 grams (or about ½ ounce), still an extremely low pressure.

Next, the vertical compliance was decreased until it was slightly less than the lateral. This was found to reduce needle talk, tracking distortion, as well as distortion due to pinch effects.

The desired frequency response was ingeniously obtained by giving the crystal assembly what is virtually the form of a terminated transmission line and so arranging the terminating section that it provides pre-emphasis of about 6 db per octave above 1,000 cycles, giving the pickup a constant-velocity characteristic.

The resulting characteristic is flat to 250 cycles, drops 6 db between 250 and 1,000 cycles, and is flat from that frequency to the upper limiting frequency of 10,000 cycles, above which the response falls at the rate of 6 db per octave.

The tone arm is pivoted on a single needle point, which means important reductions in vertical and lateral friction.

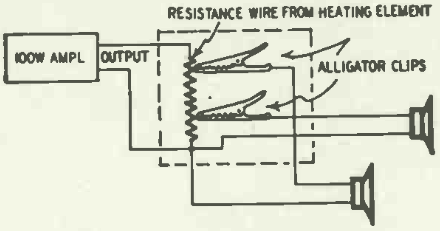
The output is said to be 5 to 20 times as great as that of comparable magnetic models.

CORRECTION

Captions were interchanged on the tables for cathode- and plate-loaded amplifiers in the third column, page 43, of the article "Design of Class-B Drivers" in the November 1949 issue. Data for plate-loaded amplifiers is in the top table and cathode-loaded amplifiers in the bottom one. We thank the author, Mr. W. H. Anderson, for this correction.

HIGH-VOLTAGE CONTROL

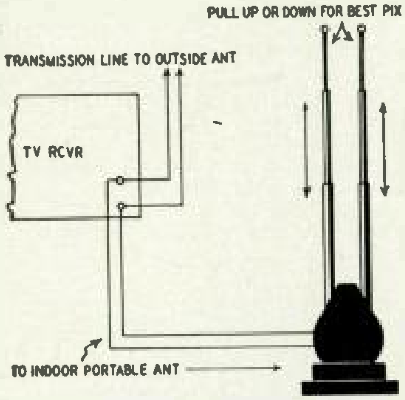
Recently a high-wattage volume control was needed for setting the volume levels of two speakers connected across the output of a 100-watt amplifier. From the resistance wire of a heating element, I cut off a piece having a resistance equal to the output imped-



ance of the amplifier. The resistance wire was then stretched between terminal strips mounted on an asbestos-covered block of wood. The speakers were connected to correct points on the wire with clips.—*Deloss Tanner*

ADJUSTABLE TV TRAP

An adjustable indoor TV antenna can be used as a variable trap to eliminate interference or to tune the transmission line for the best picture on any



channel. Connect the indoor antenna in parallel with the transmission line from the outdoor antenna, as shown in the drawing. Increase or decrease the length of the elements of the indoor antenna for the best picture.—*Melvin G. Claude*

SAFE A.C.-D.C. EQUIPMENT

Serious shocks and fireworks can be avoided if you make sure that the B-minus side of all a.c.-d.c. circuits is connected to the *grounded* side of the power line. This is particularly true when the equipment is used near radiators, pipes, and metal benches.

To check the polarity of the equipment, insulate one contact on a small neon lamp and place your finger over it. If the lamp glows when the uninsulated contact is touched to the chassis, the chassis is hot. Reverse the plug on the line cord.—*Henry Wong*

HIGH-VOLTAGE INDICATOR

A burned-out 2X2 rectifier can be used safely as an indicator of voltages up to 5,000. Connect one high-voltage test lead to a filament pin (No. 2 or 7) and another to the cap of the tube. High voltage is indicated by a purple glow in the tube.—*Hyman Herman*

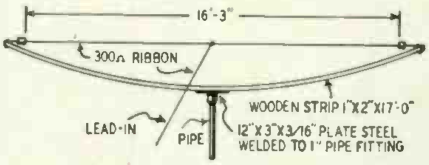
CLEANING LITZ WIRE

The ends of pieces of Litz wire are usually burned in a flame to remove the insulation. This often results in a number of the small wires fusing or breaking.

This will not happen if about one inch of the wire is compressed into a small ball about ⅛ inch in diameter, heated in a flame until red hot, then quenched in alcohol. The wire comes out clean without a trace of enamel and none of the small wires are broken. —*Van Klaveren*

A SIMPLE 10-METER ANTENNA

Unable to find two points suitable for suspending my 10-meter folded dipole, I constructed the mounting shown in the diagram. The antenna, a piece of 300-ohm ribbon line approximately 16 feet 3 inches long, is suspended between the bowed-up ends of a 17-foot piece



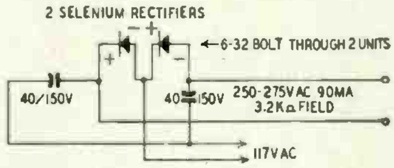
of 1 x 2-inch lumber. It is bolted to a 12 x 3 x 3/16-inch steel plate welded to a 1-inch pipe fitting. The mast is a length of 1-inch pipe fastened to the side of the house with brackets normally used in erecting FM and TV antennas.—*Leon S. Heesacker*

FLEXIBLE TEST CLIPS

A flexible clip-type test lead can be made from a metal cable release of the type used on cameras. Two small metal clips, alligator type, are soldered to the ends of the cable. The outsides of the clips may be coated with insulating lacquer to avoid short circuits. *Jaro Kober*

SPEAKER FIELD SUPPLY

I had a number of 15-inch electrodynamic speakers with 3,200-ohm field coils. To furnish field current, I made up several supplies like those shown in the figure. Ordinary selenium rectifiers



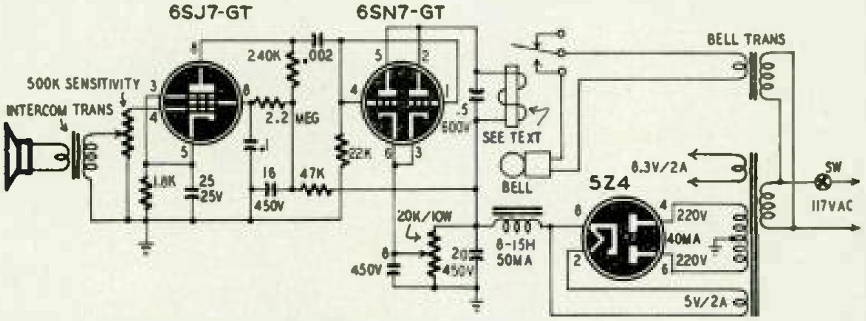
are used in a standard voltage-doubler circuit, providing 250 to 270 volts a.c. from a 117-volt a.c. line.—*Franklin W. Young*

LIGHT FOR RECORDERS

A low-wattage incandescent night light that comes with a plug base and a little rotatable hood is ideal for illuminating the turntable of a disc recorder. Pass the plug prongs through a pair of holes drilled in the motorboard, then set the assembly in place with Duco cement. You can rotate the little hood to get the light where you need it.—*R. A. Nelson*

SOUND-OPERATED TELEPHONE-BELL RELAY

? Please print a circuit of a sound-operated relay which will close an external circuit when a microphone picks up a sound above a preset level. I cannot get an extension bell for my telephone and I want to use this device to pick up the sound and ring a bell in my workshop when the phone rings in the house. Can I use a small permanent-magnet speaker as a microphone?—E. S., Newark, N. J.

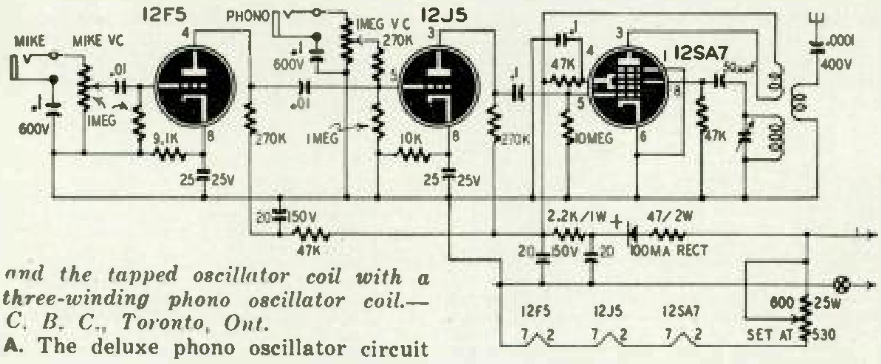


A. This circuit should do the job for you. To prevent the usual household noises from entering it and setting off the alarm, the microphone, which may be a small PM speaker, should be mounted as close to the telephone ringer box as practical. If the speaker is small enough, it may be fastened to the sides of the ringer box.

Many surplus plate-current relays can be used in this circuit. The coil should be capable of carrying currents up to approximately 15 ma and should pull in at approximately 6 ma. The bias control should be set just below the point where the relay pulls in. The sensitivity control should be so adjusted that the sound of the phone will trigger the alarm but normal household noises won't. If you find that slamming doors or dropping objects around the house does trigger it, try a slow-make type of relay with a 24-volt d.c. coil.

DELUXE MICROPHONE-PHONOGRAPH OSCILLATOR

? Please revise the phono oscillator described on page 42 of the April, 1947, issue to include separate volume controls for microphone and phono. Replace the 35Z5 with a selenium rectifier and the tapped oscillator coil with a three-winding phono oscillator coil.—C. B. C., Toronto, Ont.

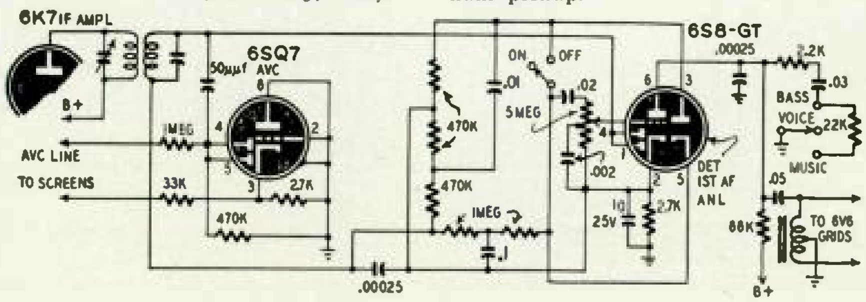


A. The deluxe phono oscillator circuit has been revised to your specifications. Do not use the chassis as a ground or negative return. Be sure that the pick-up arm and the microphone case are insulated from the chassis and B-minus.

AUTOMATIC NOISE LIMITER FOR AUTOMOBILE RECEIVER

? Please print a circuit showing how a noise limiter can be added to the circuit of a Motorola model 700 automobile receiver. The a.v.c., second detector, and first a.f. amplifier circuits are rather unorthodox and I can't seem to get a circuit which will work. I want to use a 6S8-GT as the automatic noise limiter tube.—F. S., Berkeley, Calif.

A. The second detector and first a.f. amplifier circuits have been redesigned as indicated in the schematic diagram below to permit the extra diode of the 6S8-GT to be used as an automatic noise limiter. Use short, well-shielded leads to the automatic noise limiter switch to prevent any possibility of hum pickup.

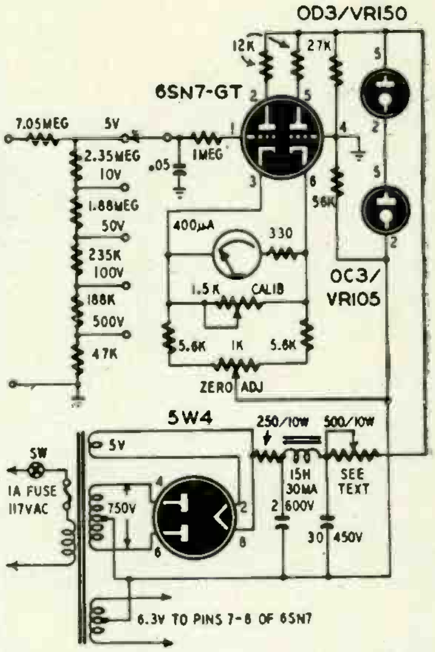


The American taxicab industry now has nearly $30 million invested in radio equipment FCC Commissioner George Sterling announced recently. More than 2,700 taxi radio systems have been authorized to date.

D.C. VACUUM-TUBE VOLTMETER

? *I have a 400-microampere d.c. meter which I want to use in a direct-current v.t.v.m. having 5, 10, 50, 100, 250, and 500-volt scales. Do you have a circuit which I can use? It should include a method of voltage regulation.—E. H., Petawawa, Ont.*

A. In this simple v.t.v.m. circuit the



voltage divider should be made up of precision resistors or standard resistors which have been measured on a bridge. You may have to parallel two resistors to get the correct values. The calibration control may be mounted behind the panel because it need not be touched after the initial adjustment, except when the 6SN7 is replaced. The zero adjust control is mounted on the panel. Set the slider on the 500-ohm, 10-watt resistor so the voltage-regulator tubes glow with medium brilliancy.

TV ANTENNA MATCHING

? *My TV booster has an output impedance of 300 ohms. How can I match this to my receiver, which is designed for use with a 72-ohm antenna? Can I use transmission line for matching?—J. G., Canton, Ohio*

A. All you need do is connect a quarter-wave length of 150-ohm ribbon line between the output of the booster and the antenna terminals on the receiver. Length of the matching stub in feet is found from the formula $\frac{246}{f} \times V$ where f is the frequency in megacycles and V is the velocity of propagation (77% for Amphenol type 14-079 150-ohm Twin-Lead or equivalent). It is recommended that the matching stub be cut to the frequency of the weakest station. In other words, the frequency of your weakest station (in megacycles) would be substituted for f in the formula.

Joseph T. McNaney, formerly with Consolidated Vultee Aircraft Corp. as a design engineer, has been appointed principal engineer in the communication and navigation engineering department of Bendix Aviation Corp., Baltimore, Md.

Mr. McNaney is the inventor of the Electrontype method of communication using the Charactron cathode-ray tube, described on page 87 of the December, 1949, issue of RADIO-ELECTRONICS.

Erling G. Fossum, an employee of STEWART-WARNER CORP. since 1926, has been appointed general manager of Stewart-Warner Electric, the company's radio and television division. This was announced by James S. Knowlson, president and board chairman of Stewart-Warner.

Fossum's appointment as division head, effective November 1, fills the vacancy created by the recent resignation of Samuel Insull, Jr. In his new position, Fossum will be responsible for all phases of engineering, production, and marketing of radio, television and other electronic products of Stewart-Warner Electric. He has been assistant to the president for the past year. He was formerly service manager of the Alemite, instrument and heater division.

R. T. Capodanno has been appointed director of engineering at EMERSON RADIO and PHONOGRAPH CORP., it was announced by *Dorman D. Israel*, executive vice president.

Mr. Capodanno comes to Emerson after eleven years with Philco, where he was active in government projects and in developing home, auto, and export radio receiver designs. Prior to this, he was connected with the University of Illinois, Physiological-Psychology Department, as engineering adviser on technical devices for the hard-of-hearing, brainwave studies, and spinal work, as well as engineering and construction of laboratory equipment for medical work.

Max M. Lee has joined the research staff of the NATIONAL BUREAU OF STANDARDS as chemist. In this capacity, he will investigate the applications of high polymers to electronics development projects in the Bureau's ordnance laboratory.

Before coming to the Bureau, Mr. Lee was a senior research chemist with the Hercules Powder Co., studying the application of plastics and plasticizers to rocket development.

Karl Hassel has been elected secretary of ZENITH RADIO CORP. of Chicago. With Zenith since its organization in 1923, is also a director and assistant vice president.

Harry J. Deines, of New York, an advertising executive with nearly 20 years' experience in the electrical manufacturing field, has been named manager of advertising and sales promotion for the WESTINGHOUSE ELECTRIC CORP., Pittsburgh, Pa.

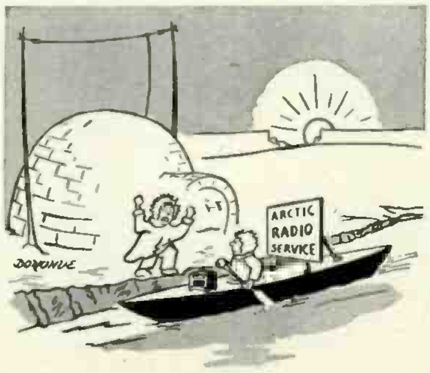
Mr. Deines will direct the development of advertising and sales promotion in conjunction with sales departments. His responsibilities also include the development of sales training programs as well as staff supervision over the application of such programs.

Anthony H. Lamb has been appointed vice president of the WESTON INSTRUMENT CORP., Newark, N. J., it was announced by *Earl R. Mellen*, president.

Lamb, who has been with the corporation since 1924 as acting chief engineer, will assume responsibility for the TAGLIABUE division, which was purchased in 1948 by Weston.

Frank M. Folsom, president of RCA, received an award for his many years of service to humanitarian causes at a testimonial dinner in his honor sponsored by the National Jewish Hospital at Denver.

In presenting the bronze plaque award, John B. Kelly, chairman of the dinner, pointed out that Mr. Folsom "typifies the men of broad vision, patience, understanding, and charity, who have made democracy work." He told the guests that they are "providing the means to carry on the fight against tuberculosis—a fight which has been so well advanced by the National Jewish Hospital at Denver."



"And you promised me overnight service almost six months ago"

QUESTIONS SURVEY

Dear Editor:

Although I'm not now working as a service technician, I feel moved to write regarding your survey to determine what your readers want regarding television articles (November, 1949, issue, coupon on page 52 and editorial, page 19).

According to your own statement, a survey made several years ago showed that 50% of readers were connected with servicing. How accurately does an old survey apply to the needs of 1949-50? On page 48 of the November issue, Commander Freedman gave a list of 25 new fields in radio-electronics. Only two of the 25 listed were in TV. Personnel working in the other 23 fields (I'm in research) also want to read and study RADIO-ELECTRONICS. Too many articles on TV or any other one subject could cause many readers to drop R-E in favor of other magazines which do not stress TV so much.

My own opinion is that the November issue represents a well-balanced magazine—there was something in it for everyone.

E. V. SCHWARTZ

Culver City, Calif.

(It was, of course, the fact that conditions have changed greatly during the past couple of years that inspired us to put out our questionnaire—a small-scale survey in itself. Our thanks for your kind comment on our November issue.—*Editor*)

TRAINING FOR FUTURE

Dear Editor:

I believe your present television presentations are very satisfactory. Although we do not have television in this area, I have had considerable training on the subject and realize it is to my advantage to further my education along those lines. I also appreciate good audio circuits and latest radio developments.

NORMAN HOEFS,
Service Manager,
Meyers-Taube Co.

Fargo, N. D.

NOT FOR SALE

Dear Editor:

I, too, say you put too much TV in your mag. I'd rather see you publish a radio magazine *and* a TV magazine. I doubt if you'd sell many of the latter, but at least you'd keep faith with those of us who are looking for a *radio* magazine.

If you don't change policy soon, I'll buy the darned rag and hire a new editor!

DEV DETSON

Lincoln, Nebr.

WANTS FULL TV DIAGRAMS

Dear Editor:

If any subject warrants a lot of space, it certainly is television in this day and age.

I found the most welcome schematic of the Motorola VT73 receiver in this month's (October) issue. I hope that this is a trend and that there will be a schematic of a different TV set each month.

WALTER J. WOJICH
Chicago, Ill.

A NEW FM PROBLEM

The following letter was received with a clipping announcing that WBRC-FM, Birmingham, was closing down permanently. The problem posed is serious. In spite of the merits of FM, and its undoubted acceptance by an ever-increasing number of listeners, a number of factors—chief of which is probably preoccupation with TV on the part of both listeners and broadcasters—are tending to squeeze it out. The clipping referred to stated that "plans for the expansion of WBRC-TV facilities will be announced later."

Dear Editor:

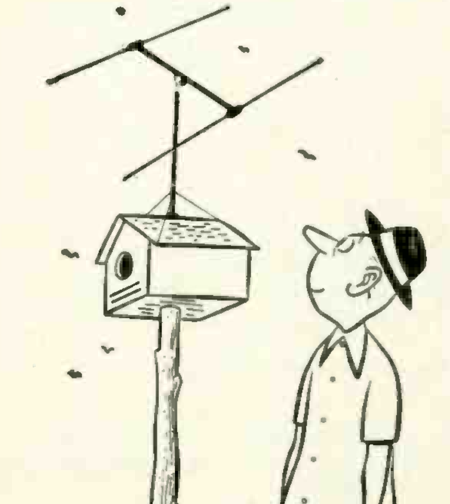
"I am inclosing a clipping from a local newspaper in regard to the suspension of one of our FM radio stations. This is one of our newest and most powerful stations with a power of 546,000 watts and an antenna 1,280 feet in height. It covers a radius of over a hundred miles. We have three other FM stations here but only one broadcasts programs direct from the FM studio; the other two offer AM duplicate programs.

"Is FM broadcasting going out as short wave did several years ago, or is this just a local condition?

"I have bought over $200 worth of high-fidelity equipment consisting of amplifier, co-axial speaker, bass reflex inclosure, and FM tuner which it seems I won't need.

"People here don't seem to appreciate high fidelity and look irritated when you tune in a program or play a record that goes up above 4,000 cycles. Most people seem to like a program with more natural bass than they do high notes."

HARRY RANDALL
Bessemer, Alabama



Suggested by John Norment, New York, N. Y.

SAVING TECHNOTES

Dear Editor:

The *Technotes* published in RADIO-ELECTRONICS are of permanent value and ought to be saved. I put mine right in the service data binder with the sets they refer to.

I take a piece of white paper as tall as the binder and about 3 inches wide. The edge is pasted on the inside edge of the first page referring to the set. Then I cut out the *Technotes* as they are published and paste them on the paper. Next time you have trouble with a set, look in the data book.

DAVID GNESSIN
Columbus, Ohio

SATISFIED CUSTOMER

Dear Editor:

I am writing to say how much I like RADIO-ELECTRONICS. I have subscribed to it now for some time. Like everything else written or done by man, it has some deficiencies; but, then, that is why they put erasers on pencils, is it not?

I wish you would print a circuit of a tunable signal tracer. I built a simple one but would like to try one of the other type.

K. MYERS
East Liverpool, Ohio

Build Your Career! Become an

RADIO SCHOOL DIRECTORY

OPPORTUNITY AD-LETS

Advertisements in this section cost 25c a word for each insertion. Name, address and initials must be included at the above rate. Cash should accompany all classified advertisements unless placed by an accredited advertising agency. No advertisement for less than ten words accepted. Ten percent discount six issues, twenty percent for twelve issues. Objectionable or misleading advertisements not accepted. Advertisements for March, 1950, issue, must reach us not later than January 24, 1950.
Radio-Electronics, 25 W. Broadway, New York 7, N.Y.

AMATEUR RADIO LICENSES. COMPLETE THEORY Preparation for passing amateur radio examination. Home study courses. American Radio Institute, 101 West 63rd St., New York City. See our ad in Page 94.

MAGAZINES (BACK DATES)—FOREIGN, DOMESTIC, arts. Books, booklets, subscriptions, pin-ups, etc. Catalog, 10c (refunded). Cicerone's, 86-22 Northern Blvd., Jackson Heights, N. Y.

FRANK COTTON—OMAK, Wash. has McMurdo Silver Test Instruments for sale. Reasonable.

Art reproductions exchanged for radio parts and books. Harry Cutler, 38, Tornay House, Hackney, London, E9, England.

WE REPAIR ALL TYPES OF ELECTRICAL INSTRUMENTS, tube checkers and analyzers. Hazleton Instrument Co. (Electric Meter Laboratory) 140 Liberty Street, New York, N. Y. Telephone—BArclay 7-4239.

BARGAINS: NEW AND RECONDITIONED HALLICRAFTERS, National, Collins, Hammarlund, Meissner, RME, other receivers, tuners, television receivers, transmitters, etc. Wholesale prices. Terms. Shipped on trial. Liberal trade-in allowance. Write. Henry Radio, Butler, Missouri and 11240 West Olympic, Los Angeles, California.

BARGAIN HUNTING? RADIO SERVICEMEN WRITE Sensational catalog. Henshaw Radio Supply, 3619 Troost Kansas City 3, Missouri.

HERMAN LEWIS GORDON, REGISTERED PATENT Attorney. Patent Investigations and Opinions. Warner Building, Washington, D. C.

LANCASTER, ALLWINE & ROMMEL, 436 BOWEN Building, Washington, D. C. Registered Patent Attorneys. Practice before United States Patent Office. Validity and infringement investigations and Opinions. Booklet and form "Evidence of Conception" forwarded upon request.

MAGAZINES—radio, electronic, etc., sold and bought. Landa, 157b Leverett, Boston-14, Mass.

Young Englishman would like to contact Americans with view to exchanging Radio Magazines, parts etc. Is there anything you want from England? Jack McNamee, 91 Green Lane, Blackburn, Lancs, England.

WANTED—SALES AGENT. Important nationally known manufacturer has developed lowest cost paging and alarm system now produced. Suitable for all medium sized factories, offices, hospitals, retail stores, restaurants, banks, etc. Our own salesmen cannot handle this product because they cover different trade. Exclusive agent appointments will be made at once—prefer man with small sales organizations now covering above mentioned outlets. Liberal commission and special discounts on samples. Write fullest qualifications to President, NuTone, Inc., Dept. SA-9, Madison & Redbank Roads, Cincinnati 27, Ohio.

SNIPERSCOPE & SNOOPERSCOPES wanted. Any condition. Needed immediately. Box F1, Radio-Electronics, 25 W. Broadway, New York 7, N. Y.

PHONOGRAPH RECORDS 15¢. Catalogue. Paramount TG-313 East Market, Wilkes-Barre, Penna.

TELEVISION—Bright and clear. Adjust present aerial. Build low-cost precision antennae. Instructions, charts, diagrams, dimensions, plans. Free—Television stations, kilowatts, tower heights. Propson Company, Lumberton, N. J.

Five Element TV Yagi Beams. High Band $6.75. Low Band $8.50. Aluminum Tubing. Etc. Willard Radcliff, Fostoria, Ohio.

URANIUM ORE!! (CARNOTITE) approximate ¼ lb. $5.00. Roszak, Herminie, Pa.

All steel TV tower—Shipped direct from the factory at $8.50 per 10' section. Easy to climb. Can be erected to 70' or more. The Youngstown Steel Towers, 1816 Wilson Avenue, Youngstown 8, Ohio.

ADVERTISING INDEX

RADIO SCHOOL DIRECTORY
(Pages 94-95)

FUNDAMENTALS OF ELECTRIC WAVES, second edition, by Hugh Hildreth Skilling. Published by John Wiley & Sons, Inc., New York, N. Y. 6 x 9½ inches, 245 pages. Price $4.00.

Students of radio have long been aware of a gap between the nonmathematical or slightly mathematical technical text and the one which assumes that the reader has become suddenly well grounded in Maxwell's equations and proceeds to deal with propagation theory on that assumption. Here at last is a book that bridges that gap. Written for the use of senior electrical engineering students, it is so planned as to meet the requirements of those who have no previous knowledge of electromagnetic theory, but have a good grounding in college mathematics and physics. Conversely, it will be extremely useful to the radioman who has discovered that a knowledge of calculus does not prepare him to understand radio propagation theory.

Such heretofore esoteric terms as "curl" and "divergence" are explained and illustrated with drawings.

The earlier part of the book deals with electrostatic and electromagnetic fields, leading up to Maxwell's hypothesis (in chapter VII). Chapters IX to XIV are given over to plane waves, reflection, radiation, antennas, wave guides, and waves in the ionosphere. The mks system of units is used.

RADIO TUBES, by E. Aisberg, L. Gaudillat, and R. de Schepper. Published by the Societe des Editions Radio (Paris, France.) 8¼ x 5¼ inches, 156 pages. Price 385 francs.

A novel work, this little book is really a tube manual (though the authors are careful to point out that it should be considered complementary to, rather than superseding, standard manuals).

The book consists of 858 schematic diagrams, each showing a standard European or American tube in a circuit suited to it. All pertinent voltages are given, together with currents when considered expedient. Maximum input and output signal voltages are often included. Characteristics such as plate resistance, amplification factor, and the like are included in a little table in an upper corner of each schematic. Typical values of plate, cathode, and other resistors are also given in the schematics. Most tubes are illustrated with one diagram, but some with widely differing applications have two, and the 6L6 has five.

Written in the international tongue of the schematic diagram, the text of the book is understandable to all readers. Explanatory prefaces in five languages are included.

While the exact field likely to be covered by the new book is not entirely clear, it is certain to be in demand by the experimenter (for its more than 800 circuits, if nothing else); the engineer, who can compare applications at a glance and also by service technicians and others who have to deal with equipment using European tubes.

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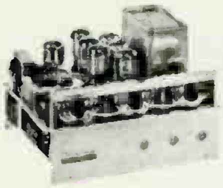

Beautiful 7 tube amplifier complete with 6 relays for servo system operation. Parts alone worth several times our low price. New in original packing —only $11.95.

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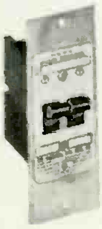

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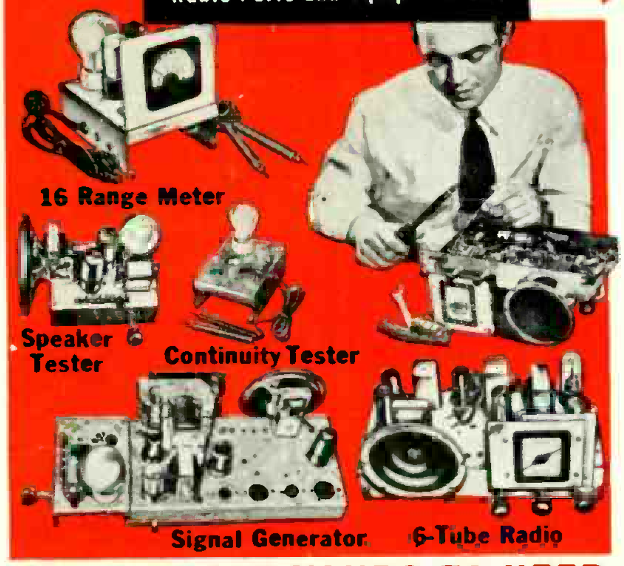

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LOREN D. SAUCIER of Coloma, Mich. reports that my training has made it possible for him to repair large numbers of Radio and Television receivers.

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You couldn't pick a better time to get into Radio-Television and Electronics. New Television stations are going on the air to serve every major city—hundreds of new AM and FM Radio broadcasting stations are also on the air to serve practically every community in America. All this creates new and bigger opportunities for the trained man who knows Radio-Television and Electronics. Good Radio and Television service men are needed NOW!

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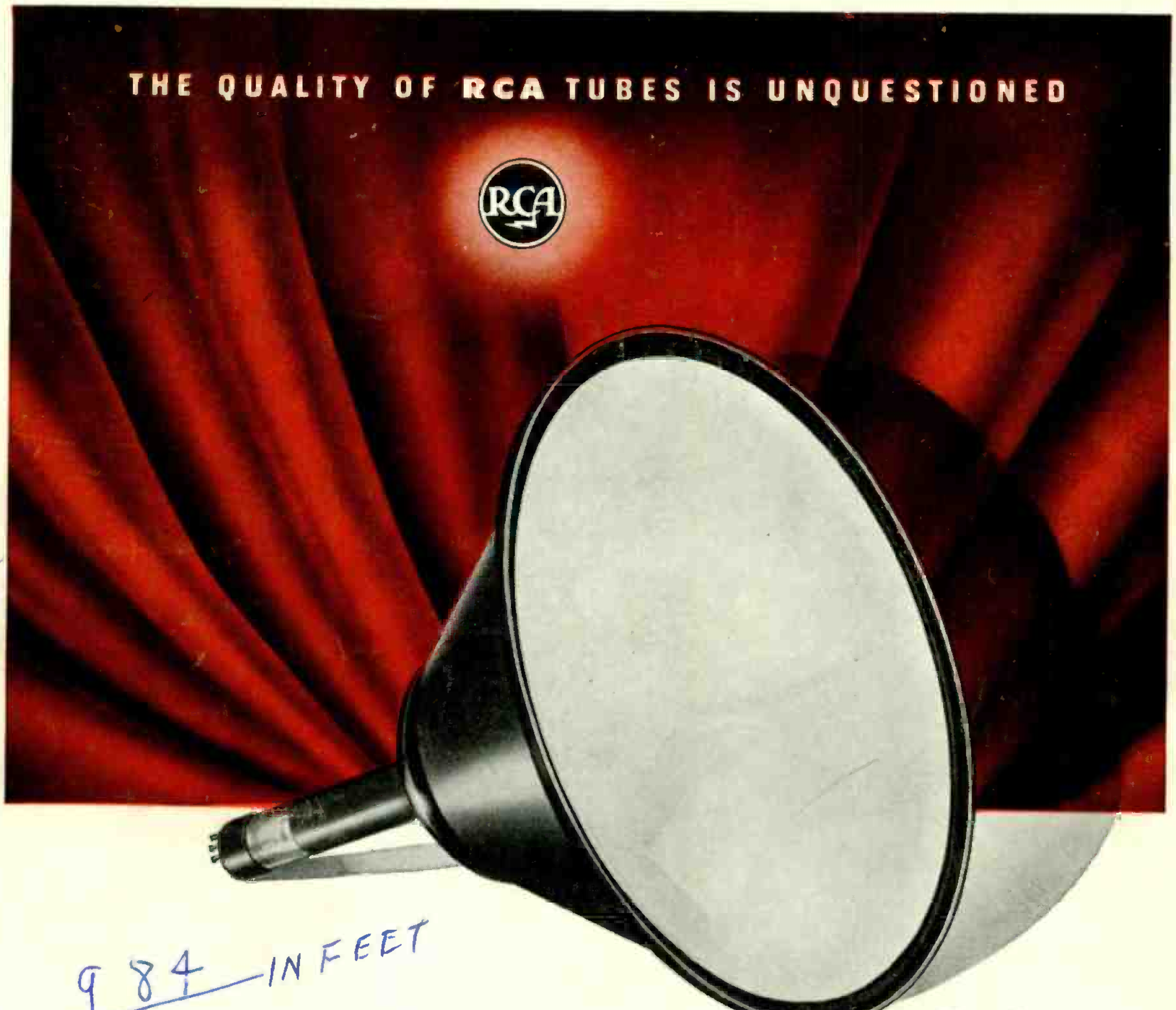

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