RADIO — ELECTRONICS

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HUGO GERNSBACK, Editor

OCT
1950

30¢
U. S. and CANADA

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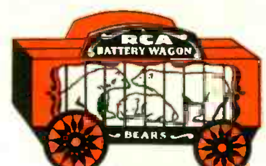
VS019



VS050

VS057

and VS047

NOW . . . a toy Circus Truck

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Here's good news . . . it's another RCA Battery first . . . an entirely new shipping container that any child can easily assemble into an exciting and realistic Circus Truck!

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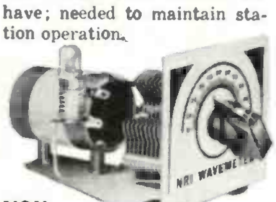
YOU MEASURE current, voltage (AC, DC and RF), resistance and impedance in circuits with Electronic Multitester you build. Shows how basic transmitter circuits behave; needed to maintain station operation.

YOU PRACTICE setting up code, amplitude and frequency modulation circuits (put voice, music, etc., on "carrier signals" you produce). You learn how to get best performance.



YOU BUILD this Wavemeter and use it to determine frequency of operation, make other tests on transmitter currents.

Ever think HOW FAST Radio-Television Communications is changing, developing, growing? Have you considered what this amazing progress can mean to you?

Look at these facts. In 1946 only 6,000 Television sets were sold. In 1949 almost 3,000,000. By 1954, 20,000,000 Television sets will be in use, according to estimates. 100 Television Stations are operating in 35 states. Authorities predict there will be over 1,000 Television Stations. This rapid growth means new jobs, more jobs, good pay for qualified men all over the U. S. and Canada. Then add development of FM, Two-way Radio, Police, Marine, Aviation and Micro-wave Relay Radio! Think what all this means! New jobs, more jobs for beginners! Better jobs, better pay for experienced men!

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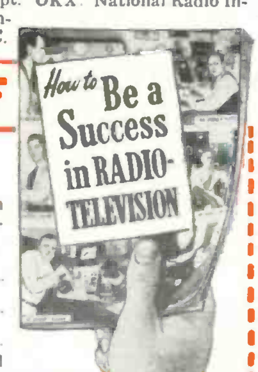

MR. J. E. SMITH, President, Dept. OKX
National Radio Institute, Washington 9, D. C.

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RADIO — ELECTRONICS

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MEMBER
AUDIT BUREAU OF CIRCULATIONS

CONTENTS — OCTOBER, 1950

ON THE COVER: Miss Doris Fesette feeds Simon the perforated tape on which his instructions are programmed. *Kodachrome by Avery Slack.*

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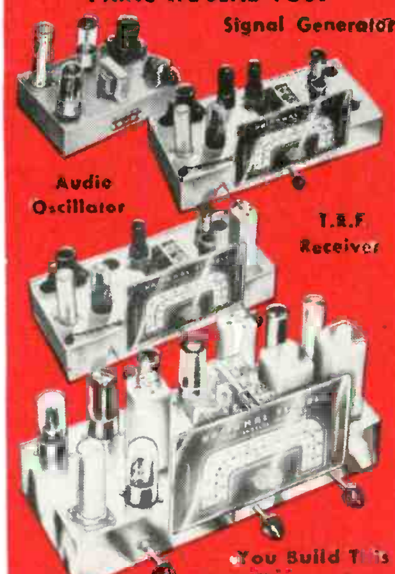

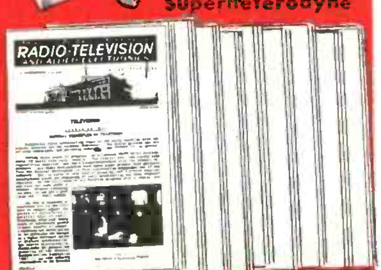

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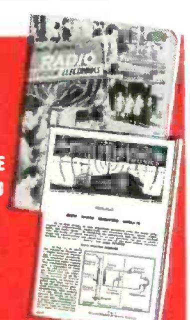

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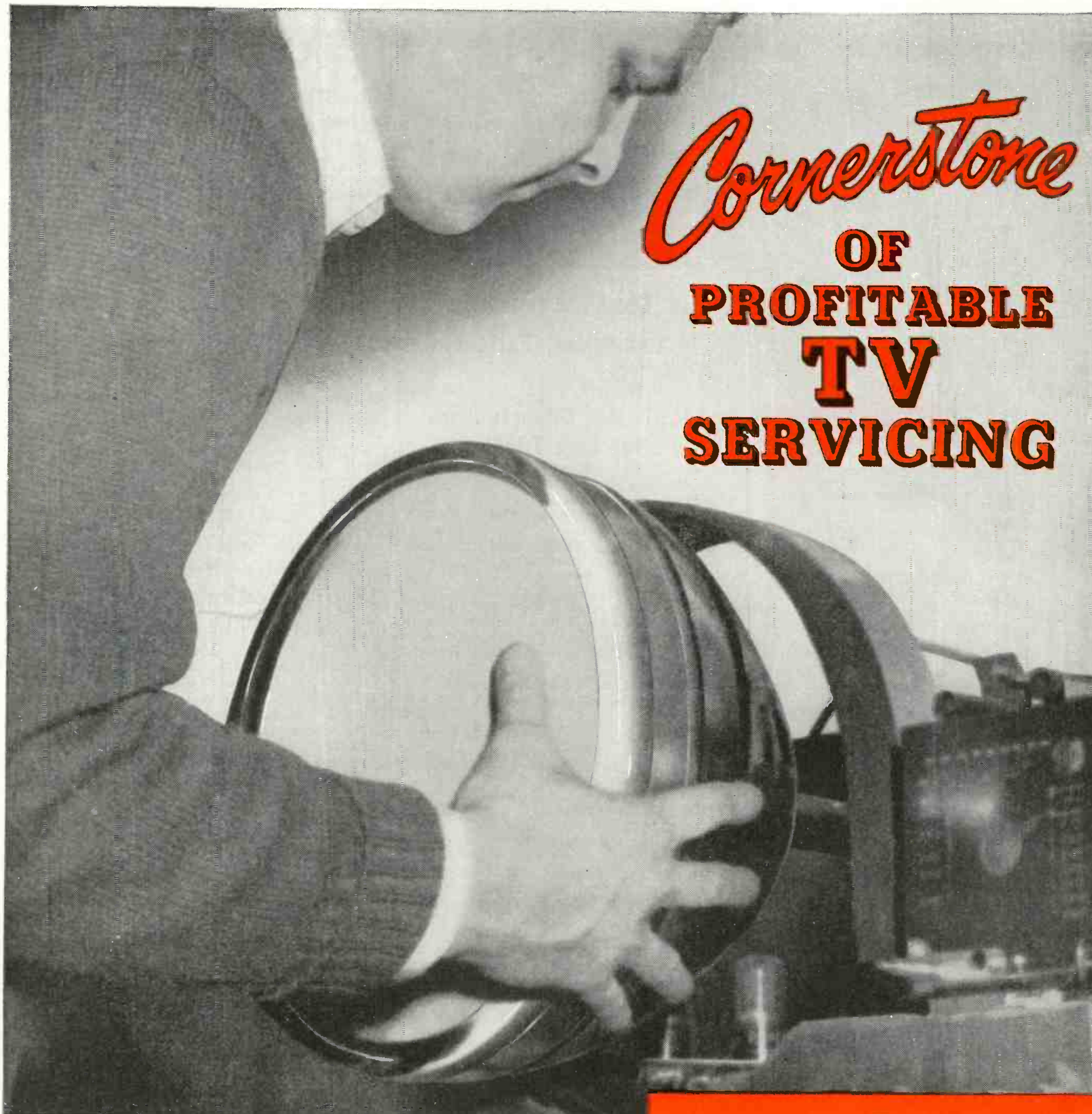

"It's a Du Mont!" No further sales talk required. For everybody knows that Du Mont in tubes and sets alike means "First with the Finest in TV Tubes."

And by eliminating costly call-backs and adjustments often based on customer misgivings, your full profit margin is assured. Always remember that Du Mont Teletrons cost no more than lesser-known brands.

See your Du Mont jobber about this cornerstone of profitable TV servicing.

ASK FOR THE DU MONT CRT CHART

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Teletrons*

ALLEN B. DU MONT LABORATORIES, INC.

CATHODE-RAY TUBE DIVISION

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*Trade-mark

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RCA speakers are engineered for dependable performance . . . popularly priced for replacement needs . . . and designed to meet the majority of your requirements for home and auto radios, television receivers, as well as public address and high-fidelity systems.

From the miniature 2"x3" to the superb new 15" duo-cone—each RCA speaker is skillfully designed, fabricated from the finest materials, and mass-produced under rigid quality-control methods.

RCA speakers offer you a better selling potential, because they're backed by the greatest name in radio —a name that insures unqualified customer acceptance.

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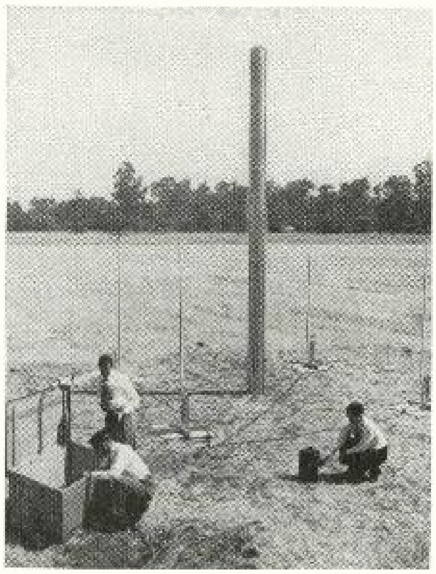
RADIO CORPORATION of AMERICA

ELECTRONIC COMPONENTS **HARRISON, N. J.**

METEORS now make it possible to measure wind velocities at 55 to 80 miles above the earth. Radar-like equipment, developed by scientists of Stanford University, uses these "shooting stars" to measure the speed of winds at altitudes twice as high as can be reached by sounding balloons.

As a meteor disintegrates in the outer atmosphere, electrical disturbances are set up by the heat generated. These disturbances can be detected on shortwave receivers, and are excellent reflectors of radio waves.



Stanford University scientists, under direction of Professor O. G. Villard, checking adjustments of the equipment for measuring velocity of "high winds."

Each disturbance lasts only a second or two, but during that time the trail of hot gases drifts with the wind like a puff of smoke.

The "electronic anemometer" determines the rate of drift and direction of each disturbance, and by averaging the results of several hundred of such measurements, the scientists can find the average motion of the air mass at these high altitudes. This motion varies from day to day and has been as low as 30 to as high as 125 miles an hour. The results of these studies will be valuable for long-range weather forecasting, guided missile design, and studies of the composition of the outer atmosphere.

A technique which uses sound waves for the same purpose has been developed by the Denver University Institute of Industrial Research under the direction of Col. Victor Huffsmith. In this project, 200-pound TNT bombs are exploded. When the sound waves from these explosions reach a heated area in the atmosphere, they are refracted and travel back to the earth about 150 miles from their starting point where they are picked up with special microphones and recorders. Temperature of the area and wind velocity are determined from the time of travel and angle of arrival. Wind velocities at altitudes up to 40 miles are found by this method.

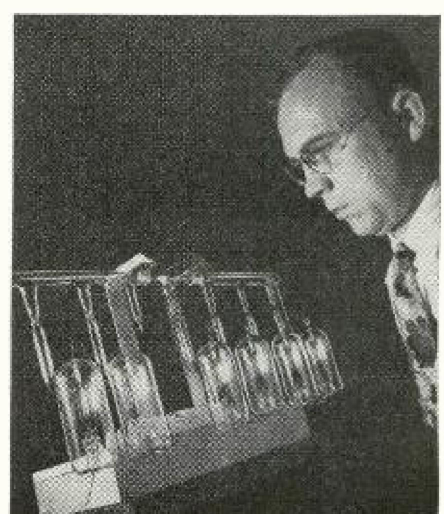
COLOR DECISION, tentatively adopting the Columbia Broadcasting System's field sequential color television as the national standard, was made by the FCC on August 31 after nearly four years of bitter rivalry within the TV industry. While favoring the CBS system, the decision does not yet rule out other possible systems as set manufacturers have until December 5 to demonstrate something better.

Frank Stanton, president of CBS, stated that plans are now under way for producing full color broadcasts and that the network will have 20 hours of color programs a week within 30 days after the final decision. At that time the FCC will ask set manufacturers to begin making sets that will receive both color and black-white programs. *Present sets will require a converter to receive the CBS color broadcasts as the system is not compatible.*

Opponents of the CBS system, notably RCA and CTI, expressed the opinion that this tentative decision would not be final. CTI has recently developed a new system which has not yet been shown to the FCC but will be ready before the December 5 deadline. RCA has been developing a single tricolor tube for color reception. Both of these systems are fully compatible so that present sets would not need converters to receive color broadcasts in black-and-white.

A VACUUM GAUGE that can measure almost complete nothingness has been made by scientists of the Westinghouse Research Laboratories. Called an ion gauge, the instrument can detect the presence of air in a vacuum if only one molecule remains out of every 10,000 billion originally present. At this pressure, an air molecule travels 500 miles before striking another.

Developed by Robert T. Bayard, the gauge looks like a large radio tube and acts in a similar way. The gauge is sealed tightly to the vacuum system, and a stream of electrons flows from its cathode. These electrons collide with any air particles in their path, and create ions. The number of ions formed per second is a measure of the pressure.



Some of the new supersensitive gauges.

MICROWAVE RELAY SPAN from New York to Chicago, the first link in a transcontinental system, made its debut in regular service on September 1. Capable of carrying hundreds of telephone conversations and several television programs, the new system will augment the American Telephone and Telegraph Company's existing coaxial cable network.

This concrete tower is one of the 34 stations between New York and Chicago.

The new route covers 838 miles in a series of 34 hops of about 25 miles each. En route it provides intermediate service for Pittsburgh, Johnstown, Cleveland, Toledo, and other cities.

Construction of the 458-mile Chicago-Omaha link is completed and will be ready for service September 30, and the Omaha-Denver section is now being equipped with the microwave equipment. Tests for paths from Denver to the West Coast are completed and service on this section will be ready late next year.

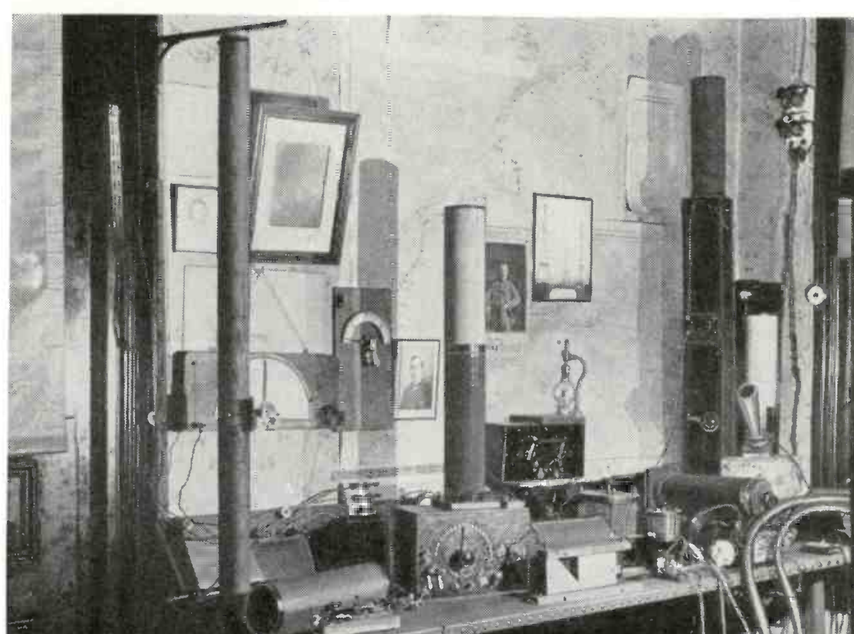
The line-of-sight relay stations in the New York-Chicago link are from 60 to 200 feet high depending on the terrain. The microwave signal is beamed between stations by large 10-foot square antennas which use highly efficient microwave lenses (see RADIO-ELECTRONICS July, 1950). The transmitter power is only ½ watt.

ATOMIC PROPERTIES are being studied by a new application of r.f. circuits. Since atomic particles spin and are electrically charged, they behave like small magnets. Placing these small magnets in an alternating magnetic field causes electric forces which can be measured by standard r.f. techniques. By varying the electric and magnetic forces, new information about the structure of these particles can be determined.

CHARLES E. APGAR, veteran radio experimenter, died at his home in Westfield, New Jersey August 18, at the age of 85.

Mr. Apgar is famous for revealing to the United States Secret Service the spy ring which, during World War I, communicated with Germany through the station at Sayville, Long Island. The station transmitted apparently meaningless signals from time to time. Apgar suspected they might be very high speed telegraphy and copied the transmissions on phonograph records. Playing them back at greatly reduced speeds, they were revealed to be dot-dash cipher transmissions. The Secret Service, on deciphering the code, obtained information which led to the discovery of the spy headquarters and confiscation of the station.

Mr. Apgar was an enthusiastic amateur astronomer as well as radioist. He was a member of the Royal Astronomical Society of Canada, for whose publication he had written a number of articles, and also a member of the Amateur Astronomical Association of New York.



Charles Apgar's station at the time he "broke" Sayville's secret transmissions.

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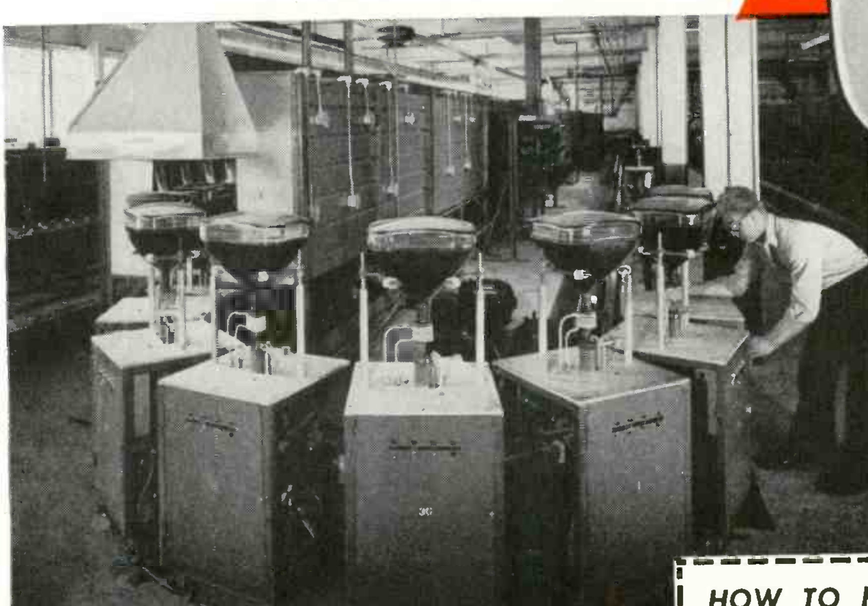

NEW PLANT

Hytron's big new TV tube plant at Newburyport, Mass., uses latest of fast, automatic, precisely-controlled equipment to give you more tubes . . . better tubes.

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Makes pulling 7-pin miniatures a cinch. New, seventh Hytron shop tool now available at Hytron jobbers. Order yours today! Only 75¢ net.

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R.E.

The Radio-Television Manufacturers Association (RTMA) at an emergency meeting appointed a special committee to represent the entire industry in the Government's procurement program. R. C. Sprague, president of RTMA and the Sprague Electric Company, said the committee was formed to work for greater national security in an advisory capacity.

Members of the committee include Malcolm P. Ferguson, Bendix; W. J. Barkley, Collins Radio; Benjamin Abrams, Emerson; Harold Buttner, International Telephone and Telegraph Company; Dr. W. R. G. Baker, G-E; W. A. MacDonald, Hazeltine Electronics Corp.; William Balderston, Philco; Frank Folsom, RCA; O. F. Adams, Raytheon; R. E. Gilmour, Sperry; F. R. Lack, Western Electric; Walter Evans, Westinghouse; Paul Galvin, Motorola; E. F. McDonald, Zenith; Ross Siragusa, Admiral; Max Balcom, Sylvania; A. D. Plamomdon, Jr., Indiana Steel Products; Ray Sparrow, P. R. Mallory; J. J. Kahn, Standard Transformer; Arie Liberman, Talk-A-Phone; and W. J. Halligan, Hallicrafters.

New Plants and Expansions

Sylvania Electric Products Inc. opened two new West Coast buildings. An office and warehouse building was dedicated in Los Angeles and a modern office building and distribution center was opened in Emeryville, Cal.

La Pointe-Plascomold Corp., makers of Vee-D-X antennas and accessories, expanded their facilities by leasing additional space in Plainville, Conn.

National Union Radio Corp. announced plans for acquiring another plant which will be devoted to the production of miniature tubes.

Espey Manufacturing Co. increased its production capacity by 35% with the leasing of 26,000 square feet of additional space in their New York City plant. The company now occupies the entire building.

JFD Manufacturing Co. leased additional factory space in a Brooklyn, N. Y. radio-TV plant.

Cornell-Dubilier Electric Corp. is completing its current expansion program at South Plainfield, N. J. The company's 1950 budget of $765,000 allowing for overall expansion, is the second largest in its history.

Phoenix Electronics Inc. has more than doubled its space by leasing 28,000 square feet of space in Lawrence, Mass.

Tele-Tone Radio Corp. has leased an additional plant in Bayway, N. J. The new plant adds about 200,000 square feet to the company's manufacturing facilities.

Financial Notes:

(First six months of year)

	1950	1949
American Phenolic Corp.		
Earnings	$457,811	$325,530
Sales	not given	
Allen B. Du Mont Labs. Inc.		
Earnings	$2,797,000	$1,780,000
Sales	$26,786,000	$18,487,000
National Union Radio Corp.		
Earnings	$528,557	$10,873
Sales	$5,600,874	$3,677,038
Radio Corp. of America		
Earnings	$20,961,643	$10,122,049
Sales	$248,784,358	$187,257,987
Sylvania Electric Products Inc.		
Earnings	$2,259,453	$1,555,067
Sales	$61,086,101	$49,665,548

Hytron Radio & Electronics Corp. declared a 10¢ dividend on common stock payable September 15. A similar dividend was paid on June 15, 1950.

Raytheon Manufacturing Co. offered 289,459 shares of common stock to stockholders at $6.75 a share. Stockholders may buy one new share for each five held. Proceeds will go into working capital to finance anticipated higher sales volume.

The RTMA announced that TV receiver production of 3,100,000 for the first six months of 1950 equalled that of the entire year of 1949. Radio receiver production of 5,228,170 was also up about 50% over the same period last year. The radio receiver total included 3,850,712 home radio sets, (including 1,034,757 portables) and 1,377,458 automobile radios. 539,852 FM and FM-AM radios were made during this period, an increase of 115,000. In addition, 225,673 TV sets (more than 7% of the total) had FM reception facilities.

Reporting on radio receiving tube sales, the RTMA announced that the 170,375,921 tube sales for the first half of 1950 more than doubled sales for the same period in 1949.

A survey by **Daniel Starch & Staff** revealed that five television manufacturers make about 60% of the total TV receiver sales. The "big five" are RCA, Admiral, Philco, Du Mont and Emerson. Another five firms handle about 15% of total sales so that 75% of all TV set sales are made by ten companies. About 50% of the survey inquiries were made in New York City.

Sprague Electric Co., North Adams, Mass. and **Philips Industries, Inc.**, Hartford, Conn. jointly announced the formation of a new company, the Ferroxcube Corp. of America, with headquarters in New York City. The new company will make Ferroxcube, a new ferro-magnetic core material for TV coils and transformers. Officers of the new company are Robert C. Sprague, president, John P. Adams, vice-president in charge of sales and T. James Reed, manager of the factory in Saugerties, N. Y.

James M. Blacklidge, chairman, the **Association of Electronic Parts and Equipment Manufacturers**, named an electronics industry mobilization committee to aid government agencies in war conversion and production. James P. Quam of Quam Nichols Co. is chairman. Other committee members include William J. Halligan, Hallicrafters Co.; Jerome J. Kahn, Standard Transformer Corp.; John H. Cashman, Radio Craftsmen, Inc.; S. N. Shure, Shure Bros., Inc.; Herbert C. Clough, Belden Mfg. Co.; H. L. Kunz, Sangamo Electric Co.

RCA, in conjunction with Rudolph Wurlitzer Co., has begun a program to introduce 45 r.p.m. records in automatic coin-operated phonographs. Wurlitzer is making available a kit for converting 78 r.p.m. machines to 45 r.p.m.

Business Briefs

Sylvania Electric Products announced a new price protection policy for Sylvania Television and Radio dealers. Dealers and distributors will be protected against any price reductions until Dec. 1, 1950 . . . Tel-A-Ray Enterprises, Inc., Henderson Ky. manufacturer of TV and FM antennas, is publishing a news letter for the benefit of its distributors and dealers . . . Directors of Wilcox-Gay Corp., Garod Radio Corp., and Majestic Radio & Television Corp., approved association of the three companies in a new integrated company . . . Chicago Parts Distributors Show official attendance figures for 1950 revealed a total distributor registration of 2,531, including 1,487 individual jobbers and 774 distributor companies listed . . . Rocky Mountain Chapter is the latest addition to the growing organization of the "Representatives". Gordon G. Moss was elected first president of the chapter and Franklin Y. Gates and Arthur J. Nelson vice-president and secretary-treasurer respectively . . . Telrex Inc., Asbury Park, N. J. antenna manufacturer, is putting out a monthly house organ for dealers and service technicians . . . Stromberg-Carlson has announced a one-year warranty on all parts and tubes. Policies will date from the time of the original consumer installation . . . Decca Records and Columbia Records, Inc. have entered the 45 r.p.m. field. This move puts all of the "big four" in production on 45 r.p.m. records . . . U. S. Government announced it would make a roster of the nation's scientific personnel and encourage increases in skilled technical manpower where needed . . . Renewed public interest in FM was noted by a survey in Washington D. C. . . . New York's WCBS blasted claims that TV is killing radio in a brochure titled *What Television Didn't Do to Radio in New York*. Booklet shows N. Y. C. radio listening increased during the first four months of 1950 . . . NBC has reinstated its war time policy protecting personnel who enter the armed services. . . . Construction of a new TV tower on New York's Empire State building got under way officially with Mayor O'Dwyer placing a 14-carat gold-plated rivet in the first steel beam . . . Institute of Television Service Companies was organized by a group of Boston servicing firms to promote better relations between service companies and the public on one hand and service companies and manufacturers, dealers and distributors on the other . . . Minnesota Mining and Manufacturing Co. established a grant which has permitted Minnesota's Board of Education to establish its "Tapes for Teaching" program. By the end of 1950, 90% of the state's schools will have tape recording machines.

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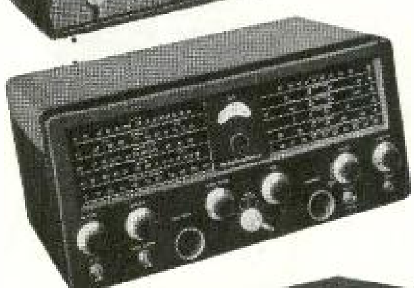
Model SX-62 World's finest receiver for the all-wave listener. Outperforms any broadcast receiver on any frequency—continuous coverage from 540 kc to 109 Mc in six bands. Crystal calibration oscillator built in. Six position selectivity with crystal filter. Two stages r-f, three stages i-f amplification. 10-watt push-pull high fidelity output. Phonograph jack. 14 tubes plus regulator and rectifier............. $269.50



Model SX-71 Value-packed with features specifically asked for by the Hams. Extra sensitivity, selectivity, and stability; double super-heterodyne, plus built-in Narrow Band FM. One r-f, two conversion, and three i-f stages. Range 538 kc to 35 Mc, 46-55 Mc. Extra wide dials for Main and Bandspread Tuning. Sensitivity, Volume, BFO Pitch, Selectivity, and Crystal Phasing controls.; AVC, BFO, Rec./Standby, ANL, Tone, and Phono-Rec. switches. Phonograph input jack. 500, 3.2-ohm output....... $189.50

Model S-40B New version of an old favorite. Temperature compensated oscillator; tuned r-f stage, two i-f stages for better selectivity. Covers 540 kc to 43 Mc in four bands. Sensitivity, volume, three-position Tone, BFO Pitch, controls; AVC, BFO, Rec./Standby, and Noise Limiter Switches. Built-in PM speaker. External power, remote control connections. 7 tubes plus rect.
S-40B $89.95

Model S-38B Pulls in broadcast stations in weak signal areas where ordinary sets fail. Also offers world-wide reception for the short-wave listener and the new amateur. Covers Broadcast Band and three short-wave bands 540 kc to 32 Mc. Separate Fine Tuning control. BFO, Rec./Standby, Speaker/Phones switches. Built-in PM speaker. Four tubes plus rectifier. For 115 V. AC or DC......................... $49.50

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War Uses for Television

. . . Important television war applications are now under way . . .

By HUGO GERNSBACK

TELEVISION and modified television techniques are becoming more and more important for war purposes at a steadily increasing tempo. Modern war is not primarily an instrument to kill the enemy. Furthermore new techniques are constantly devised to protect not only the soldier in the front lines but also to safeguard the lives of the civilian population, plant workers and all others engaged in the war effort. In modern war front lines between the land forces are frequently miles apart; on water the contending navies may be separated by 25 miles and more. To give but a single illustration:

The United States Navy during the sea war with Japan sank a number of Japanese war ships which the U. S. personnel never even glimpsed. The shooting was directed by radar—often even during the night—with the Japanese ships partly below the horizon.

Guarding our war plants, power plants and public utilities is of the utmost importance. Saboteurs are always busy scheming to destroy property. This necessitates the use of continuous patrolling by policemen, and even Armed Forces personnel. Usually these plants are huge and difficult to watch and protect day and night. Special television cameras can be set up at the corners of walls and other strategic important points so that long stretches of walls or large enclosures can be visually under constant surveillance. It then becomes much simpler to watch every foot of the enclosure from a central monitoring board. At night infra-red searchlights can be used to illuminate the walls or fences with light which is invisible to the human eye. Any trespasser will be detected immediately on the television receiving screen.

This makes it much easier and safer to control a huge property without a large patrolling force. When and if a saboteur is spotted on the screen, a small, fast moving patrol can be on the endangered spot within seconds.

The same idea can be used to advantage within the plant itself. Every part of the interior can readily be watched from a central point, thus making internal surveillance much more efficient than at present.

This would also do away with loafing and slow production, as the workers would realize they were under observation at all times.

Already in the last war it was possible for patrolling soldiers on the front to see the enemy in front of them by means of the snooperscope and sniperscope. Both instruments use television-related techniques. It is true that the snooperscope only gives a vague picture with very little detail of enemy troops. Moreover the enemy soldiers cannot be recognized at all with the snooperscope if they lie prone and use some sort of camouflage.

It is possible to improve on the snooperscope by using a modified television camera which will be effective during the night and which will give a sharp and clear picture not possible with the World War II snooperscope. The RCA Vidicon is an important step in that direction and could possibly be modified for infra-red use.

Frequently as we have seen in Korea, most of the troops as well as guns and tanks, are moved at night. It would, therefore, be advisable to use special television cameras by aerial spotters. They would reveal tanks and large troop aggregations clearly. These could then either be bombed by the spotting plane or bomber, or by artillery—directed by the plane—as the exigencies dictate.

The tendency of modern warfare is towards the so-called push-button war. It is now in its infancy, but is rapidly being developed for offensive purposes. For extremely hazardous warfare—when front lines have to be stormed and where the casualties of the attackers are always high—robots should be used wherever possible. Such a device was first described by the writer in the April, 1945, issue of this magazine under the title of "Robot Television Tank." This is a manless tank, television equipped so that it can be steered from protected rear quarters while its guns and rockets are fired by remote control. By television the terrain ahead of the tank is watched on the screen behind the lines. It is as if the operator, miles away, were actually in the tank himself. Such a manless tank will, of course, result in no casualties for the attacker.

Another device which the writer calls "The Television Controlled Machine Gun" was first described in this magazine in the December, 1944, issue. Here we have a machine gun in an advanced post with a television camera overlooking the terrain. Operators behind the lines work both the television camera and the machine gun by remote control, thus do not expose the personnel to enemy fire. Necessarily both the television tank and the television controlled machine gun must be safeguarded by appropriate means so that the television camera cannot be easily damaged by gunfire unless at very close quarters.

These are only a few illustrations of what can be accomplished by television war applications today. For security reasons, many other practical ideas cannot be divulged at this time.

Television Interference On Broadcast Receivers

Some practical methods to reduce annoying radiations from TV sets

By MATTHEW MANDL*

A FREQUENT problem for the service technician is interference from a newly installed television set on nearby radios. In some cases it is severe enough to disturb radios several homes away from the offending television receiver. The noise in the radio consists of squeals and whistles over the entire dial and an occasional buzzing, sharply tuned signal.

The interfering signals are generated by the high-voltage systems of television receivers and are due to either an unshielded power supply, *incorrect adjustment of horizontal linearity*, or transients developed by a defective damping tube. In the flyback (sometimes called kickback) power supply the 75-kc oscillations in the deflection circuit are pulsed into operation at a 15.75-kc rate. Fig. 1 shows the waveforms in standard flyback supplies. Each time the sawtooth sweep drops to zero the system is pulsed into oscillation by the collapsing magnetic field. The sharp negative spike developed during the first cycle of oscillation is "kicked" back into the primary of the horizontal output transformer and rectified by the 1B3/8016 high-voltage rectifier, while the rest of the oscillations (shown by the dotted lines in Fig. 1) which would occur are removed by the damping tube.

If the high-voltage power supply is not completely shielded (except for air vent holes), the 15.75-kc oscillation will radiate and cause squeals, hash, and whistles on nearby radios by heterodyning with the local oscillator. More than one interfering signal is received because of the high harmonic content of the spurious signal. A defective damping tube will not damp out the oscillations which occur in the high-voltage system and will cause increased interference.

Even the r.f.-type high-voltage power supply may radiate interfering signals because these systems generate frequencies ranging from 50 kc to well over 200 kc. A typical r.f. power supply is shown in Fig. 2. All the components of this system must be well shielded to reduce spurious radiation.

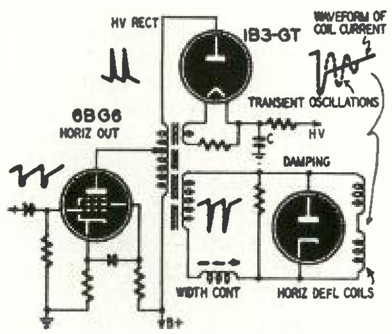


Fig. 1—Schematic of a typical flyback type high-voltage supply. The correct waveforms at critical points are shown.

Incorrectly adjusted horizontal linearity may cause excessive radiation of radio-interfering signals, particularly if the nonlinearity is a sharp rise of the modified sawtooth waveform as shown in Fig. 3. Some 6BG6-G horizontal output tubes are often pulsed into parasitic oscillation which shows up (Fig. 4) as vertical lines near the edge of the viewing screen. (The contrast control has been turned down to bring out the vertical lines.)

Reducing interference

The first step in servicing interfering TV receivers is to check horizontal linearity. Do this by using a station test pattern or with a crosshatch generator.

A small a.c.-d.c. radio played near the TV receiver will check for interference reduction. Battery portables are particularly useful and can be carried around to find the extent of the noise at various distances.

When a radio is too near the TV set, it will pick up some interference regardless of how well adjusted the television receiver is. Portable radios therefore only indicate interference reduction during the servicing procedure, and are not likely to have completely noise-free reception until moved some distance from the televiser.

Some horizontal output tubes are more likely to oscillate than others. The best solution is to replace the 6BG6-G if it is oscillating. Eliminating the vertical line trace on the screen, whether by correcting linearity or replacing a critical 6BG6-G tube, reduces markedly the noise generated in the radio. If these measures fail to reduce interference enough to make radio reception satisfactory, try a new damping tube.

Many television receivers have unshielded or only partly shielded high-voltage supplies and cause serious radio interference. Window screening can be used for shielding by shaping it to fit over the exposed parts and soldering or bolting it at several places to hold it in place. The screening also allows adequate ventilation.

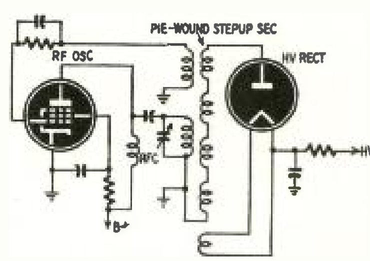


Fig. 2—Circuit of an r.f. high-voltage power supply. Frequency of the oscillator is generally between 50 and 100 kc.

If the ribbon line connector from the tuner to the antenna terminals of the television receiver picks up interference signals, they will travel along the transmission line and radiate from the antenna. The receiver then acts like a miniature broadcasting station and

* Technical Institute—Temple Univ.

the signals sent out may cause trouble.

To minimize radiation of such spurious signals, place the connector as far as possible from the high-voltage system and the yoke of the set. It may be necessary to replace this twin-lead connection with a longer one so that it can be spaced farther from interfering components. If interference persists, shielding the yoke more adequately

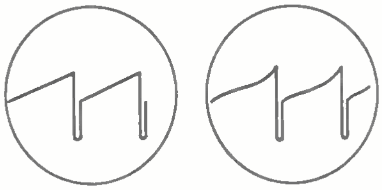


Fig. 3—Correct waveform for magnetic horizontal deflection (left) and nonlinear shape with a sharp rise (right).

may help. Many yokes are shielded only by the mounting bracket assembly. Interference can be reduced by placing metal foil around the yoke and grounding the foil. A section of tin from a discarded tin can cut as wide as the yoke and wrapped around makes a good shield. Part of the metal shielding should be grounded to the chassis.

Picture-signal interference

The picture-signal frequencies at the video detector range from approximately 50 c.p.s. to 4 megacycles (4,000 kc) and some of these frequencies fall

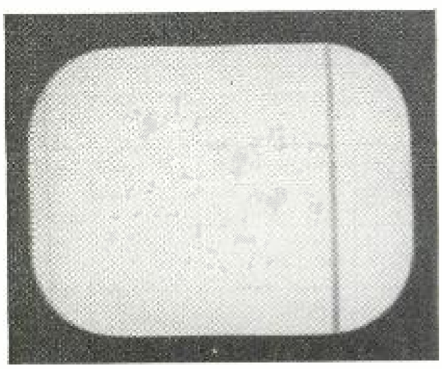


Fig. 4—Oscillation in the horizontal output tube appears as vertical lines near the edge of the viewing screen.

within the radio broadcast range (550 to 1600 kc) or the radio i.f. (455 kc).

All these frequencies are potential interfering signals for radios and may cause hash and buzzing. These signals are usually radiated by the lead from the chassis to the grid of the picture tube. While the radiation is not strong, it may cause interference with radios if they are too close to the receiver and particularly where the television receiver in one home is placed against a wall so that it is back-to-back with a radio in the adjacent home. In this case either the radio or the television receiver should be moved to the opposite wall. The best solution is to move *both* as far apart as possible, though this is often inconvenient for the television receiver because of lead-ins, and occasionally antenna control cables, etc.

The connector from the TV tuner may pick up sufficient video signal to radiate it from the antenna. If moving the connecting lead does not help, try shielding the wires carrying the signal to the picture tube. Do not replace the wires with shielded cable, however, because the high capacitance between the signal-carrying wire and the shield may cause loss of the higher-frequency picture signals and reduce fine detail. A section of RG-11/U coaxial cable can be used, for this has much less capacitance between inner and outer conductors than ordinary shielded wire.

TV input filters

Many TV receivers have a highpass filter at the input to the tuner as shown in Fig. 5 so that signals below the television frequencies are passed to ground and do not enter the receiver. The filter bypasses radio-frequency interference arising within the TV receiver and feeding out into the transmission line.

Check the schematic of the offending receiver to see if it has such a filter in the front end. If there is none, it can be added to help reduce transmission line and antenna radiation. Capacitors of approximately 10 μμf will be adequate with the special center-tapped choke. The capacitors can be any small ceramic or mica, but the center-tapped choke should be an exact replacement part so it will have the proper highpass characteristics. The RCA T1 transformer can be used (part No. 71507) and other manufacturers furnish a similar unit: Emerson part No. 950049 (T-13), and Admiral L127 part No. 98A 44-3 highpass filter.

Place this filter directly at the tuner across the transmission line entry. High frequencies will be passed because the coil has a high reactance and not much bypassing effect. Low frequencies, however, find a low-reactance path to ground.

If these measures do not entirely eliminate the trouble, there is a leak somewhere. Check the condition of the 500-μμf high-voltage filter capacitor (C in Fig. 1) and the grounding strap to the cone of the C-R tube. The capacitor must be good and the grounding solid to insure that 15.75-kc harmonics are not radiated by the high-voltage lead to the C-R tube.

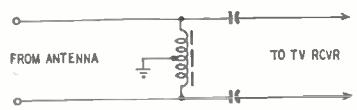


Fig. 5—Circuit of a highpass filter as often found in a TV receiver input.

In some sets, the power cord runs close to the high-voltage power supply in which case the line may pickup the interfering signal and radiate or "pipe" it directly to nearby sets. To prevent this, bypass both sides of the a.c. line directly to the chassis with .005- to .01-μf capacitors. Be sure to keep the ground leads short.

In severe interference cases, it may be necessary to shield the entire inside of the cabinet. Reynolds Wrap or similar metal foil will do the job if you are sure to lap all joints and ground the foil securely to the chassis of the televiser.

Television DX Reports

DX REPORTS are coming in so fast that we can't possibly put them all in one issue of the magazine, so this month the reports listed are only those with reception of over 900 miles. Even this limit includes most of the reports we have received this month.

The enthusiasm of dx'ers is overwhelming and we again express our thanks to those who have sent in reports. We are still interested in the usual dx reports—reception of better than 1,000 miles—and will print as many as space permits. When submitting reports, please include the date *and time* of reception, make and model of receiver, the type of antenna used, and the make of booster if one is used.

As in last month's dx column, the reports are listed in two tables. Table I shows the various reports of reception, giving the station received, the date and time (if reported) and the approximate mileage from transmitter to receiver. Table II lists the name of the reporter again and gives his location, receiver used, booster, and type of antenna. A cross reference on the two tables gives complete information on each individual case of reception.

Several dx'ers have reported seeing a station KRPC-TV in Houston on channel 2 where our old familiar KLEE-TV usually resides. A call to the Television Broadcasters Association revealed that KLEE-TV has changed ownership and now is on the air with the new call letters. The table below shows the call letters of both stations.

The U.S.A. isn't the only place where TV travels long distances. *Radio en Televisie Revue*, a Belgian magazine, tells of a Russian broadcast that was picked up on a TV receiver located in Belgium. The Russians have transmitters in Moscow and Leningrad. *The Short Wave Listener*, a British magazine, reports that Mr. H. Rieder, of Capetown, South Africa, was able to pick up a BBC television broadcast originating in London. This is well over twice the distance from New York to San Francisco. This beats any dx reports we have received so far, but we will be satisfied when we get the first verified report of a transcontinental reception.

(*Continued on page* 24)

TABLE 1—REPORT OF RECEPTION

STATION	REPORTED BY	TIME RECEIVED	MILEAGE
KCRP-TV Channel 4 San Francisco Cal.	R. Budinger	7/10	1,750
KEYL-TV Channel 5 San Antonio Tex.	T. Morris R. G. Ulbrich	6/24, 10-11 am 7/13	950 1,325
KLEE-TV Channel 2 Houston, Tex.	J. Hines G. Pine J. P. Taylor P. Vincent K. D. Anderson R. G. Ulbrich G. H. Blackman	6/27, evening 6/19-6/21 6/24, 5-8 pm 6/18 6/27 7/13 6/19, 1pm 6/20, 9 pm	1,000 1,070 1,280 1,120 1,000 1,190 1,300
KMTV Channel 3 Omaha, Neb.	P. K. Krause W. J. Golden F. L. Burnham	7/18, 5.30-7.45 pm 7/17, 5.20-6 pm 7/16	1,175 1,310 1,000
KPRC-TV Channel 2 Houston, Tex.	H. L. Gerischer G. Pine C. Robinson	7/14, evening 6/24 7/11	1,050 1,070 1,070
KRLD-TV Channel 4 Dallas Tex.	R. & S. Thayer E. D. B. Magee	7/27 6/18, 12.25 pm	1,100 1,200
WABD Channel 5 New York, N. Y.	H. L. RIGGS	7/16, 2.05 pm	1,000
WAGA-TV Channel 5 Atlanta, Ga.	C. Robinson	7/11, 10.15 pm	920
WAVE-TV Channel 5 Louisville, Ky.	W. Bashta	6/11, evening	1,180
WBAP-TV Channel 5 Fort Worth, Tex.	G. H. Blackman R. & S. Thayer	6/22, 6/27 7/27	1,230 1,130
WBEN-TV Channel 4 Buffalo, N. Y.	D. Rawlinson	6/23, 1 pm	1,100
WBKB Channel 4 Chicago, Ill.	R. D. Waite	7/6, 10-12 am	1,100
WBTV Channel 3 Charlotte, N. C.	R. Ballew K. D. Anderson	6/25, 12-2 pm 6/27	910 920
WCBS-TV Channel 2 New York N. Y.	E. Jackson R. D. Waite B. Ballew R. Sanders D. Rawlinson	6/24, 1-2 pm 7/8, 10-11 am 6/25, 12-2 pm 6/7 6/24	910 1,100 1,400 1,340 1,200
WDAF-TV Channel 4 Kansas City, Mo.	E. H. Dean R. C. Fisher R. Reider E. Sonder R. D. Waite	7/18, 7 pm 7/31, 2.30 pm 6/24, 3 pm 7/8, 4 pm	1,110 1,050 1,000 1,000 1,100
WDTV Channel 3 Pittsburgh, Pa.	R. D. Waite R. Sanders B. Ballew	7/8, 10-12 am 6/25 6/25	1,000 1,000 1,080
WFIL-TV Channel 6 Philadelphia, Pa.	R. Sanders H. L. Riggs	7/7 7/16, 1.50 pm	1,250 950
WFMY-TV Channel 2 Greensboro, N. C.	F. Sklenar, Jr. L. Gerischer K. D. Anderson B. Ballew	6/16, 7.30 pm 6/27, 8.30 pm 6/27 6/25	950 950 960 960
WHAM-TV Channel 6 Rochester, N. Y.	R. Sanders	7/7	1,150
WJBK-TV Channel 2 Detroit, Mich.	R. D. Waite W. Bashta D. Rawlinson B. Ballew	7/8, 10-12 am 6/11, evening 6/23, 1.05 pm 6/25	1,090 1,320 950 1,000
WKY-TV Channel 4 Oklahoma City, Okla.	E. Sonder C. Tripp R. E. Walker R. C. Ulbrich E. D. B. Magee	6/24, 3 pm 6/27 5/25, 11 pm 7/13 6/27	1,200 1,300 1,000 1,010 1,115
WLW-C Channel 3 Columbus, Ohio	B. Ballew R. D. Waite	6/25, 5 pm 7/18	910 910
WMAR-TV Channel 2 Baltimore, Md.	H. L. Gerischer R. Ballew	6/27, 9.10 pm 6/25	920 1,210
WMBR-TV Channel 4 Jacksonville, Fla.	K. O. Davis K. D. Anderson	6/27 6/24	900 1,210
WMCT Channel 4 Memphis, Tenn.	W. J. Golden	6/22	1,100
WNBK Channel 4 Cleveland, Ohio	D. Rawlinson R. Ballew	6/23 6/25	910 1,000
WNBQ Channel 5 Chicago, Ill.	D. Rawlinson R. D. Waite	6/24 7/8, 10-12 am	1,100
WNBT Channel 4 New York, N. Y.	H. L. Gerischer B. Ballew	7/10, 7/15 6/25	1,060 1,400
WNBW Channel 4 Washington, D. C.	G. Sandstedt R. Sanders	6/16 7/7	900 1,110
WOAI-TV Channel 4 San Antonio, Tex.	J. Hines L. Gerischer	6/19 7/14, 7.30-9 pm	1,110 1,100
WOI-TV Channel 4 Ames, Ia.	W. J. Golden J. C. Fisher	7/17, 6.30-7.30 pm 7/16, 7 pm	1,170 900
WOW-TV Channel 6 Omaha, Neb.	C. Johnson	7/18	960
WPTZ Channel 3 Philadelphia, Pa.	H. L. Gerischer H. Garrett D. Rawlinson B. Ballew R. Sanders	7/10, evening 6/27, evening 6/24 6/25 7/7	1,010 1,000 1,110 1,310 1,280
WSYR-TV Channel 4 Syracuse, N. Y.	G. Sandstedt B. Ballew R. Sanders	6/16 6/25 7/7	970 1,350 1,230
WTAR-TV Channel 4 Norfolk, Va.	H. L. Gerischer B. Ballew V. Holec K. D. Anderson	6/27, 9.15 pm 6/25 7/5 6/27	1,090 1,200 925 1,100
WTCN-TV Channel 4 Minneapolis, Minn.	W. J. Golden R. Peek, Jr.	7/17, 7.30 pm 7/10	1,120 1,100
WTMJ-TV Channel 3 Milwaukee, Wis.	D. Rawlinson R. D. Waite	6/23 7/8, 10-12 am	900 1,200
WTTG Channel 5 Washington, D. C.	G. Sandstedt	6/16	910
WTVJ Channel 4 Miami, Fla.	K. O. Davis W. J. Golden	6/28 6/22	1,190 1,230
WWJ-TV Channel 4 Detroit, Mich.	B. Ballew	6/25	1,010

TABLE 2—RECEIVER DATA

NAME	LOCATION	RECEIVER	BOOSTER	ANTENNA
K. D. Anderson	Kerkhoven, Minn.	Emerson 647	Masco	Taco Lazy H
B. Ballew	Ft. Worth, Tex.	Admiral		Amphenol
W. Bashta	Albuquerque, N. M.	Admiral	Masco	Circle x
G. H. Blackman	Derby, N. Y.	Hallicrafter T67		Ward folded dipole
R. Budinger	Des Plaines, Ill.	Meck 12-inch		In-line
F. L. Burnham	Jeffersonville, N. Y.	Regal 16-inch	Regency	Channelmaster 4-bay Superfan
K. O. Davis	Bainbridge, N. Y.	Admiral 10-inch	National	Taco stacked Yagi
E. H. Dean	Falls Village, Conn.	Motorola VT73A	R.M.S.	Vee-D-X Yagi
R. C. Fisher	Sherburne, N. Y.	RCA TC 126		Taco 1-bay Yagi
H. Garrett	Sedalia, Mo.	Admiral 20x11	Astatic	folded dipole with director and reflector
H. L. Gerisher	Slayton, Minn.	Admiral 24x16		Taco 980
W. J. Golden	Oak Bluffs, Mass.	Emerson 571		Lazy H
J. Hines	Spooner, Wisc.	Admiral		Vee-D-X Yagi
V. Holec	Cedar Rapids, Ia.	RCA 630	Regency	Taco double doublet
E. Jackson	Deepwater, Mo.	Hallicrafter 715	Astatic	Lazy H
C. Johnson	Little Falls, N. Y.	G-E 16-inch	Regency	Taco 4-element Yagi
P. Krause	Pittsfield, Mass.	Tele-Tone 7-inch		dipole
E. D. B. Magee	Toronto, Can.	Homemade 630	Bud	
T. Morris	Moline, Ill.	Admiral 29x15	Astatic	Amphenol 114-291
R. Peek, Jr.	Galveston, Tex.	630 TS (kit)		Ward folded dipole with reflector
G. Pine	Lansing, Mich.	Plymouth 516M		
D. Rawlinson	Houma, La.	Arvin 3120 CM		2-bay double-V conical
H. L. Riggs	Boone, Ia.	Motorola 9T1		1-bay conical
C. Robinson	Rush City, Minn.	RCA 12-inch		Amphenol 114-307
R. Reider	Schuylkill Haven, Pa.	RCA 630		Telerex conical
R. Sanders	Stillwater, Okla.	RCA 9T-244		channel 6 Yagi, channel 4 modified Yagi
G. Sandstedt	Kansas City, Mo.	RCA 630	Regency	circular
F. Sklenar, Jr.	Tekemal, Neb.	Hallicrafter 513	Anchor	folded dipole with reflector
E. Sonder	Milton, Pa.	Radio Craftsman		
J. P. Taylor	San Diego, Cal.	Emerson 609	Astatic	Stacked folded dipole with reflectors and directors
R. and S. Thayer	New Florence, Pa.	Hallicrafter 680		folded dipole
C. Tripp	Dannemora, N. Y.	DeWald	Anchor	stacked Yagi
R. G. Ulbrich	Erie, Pa.	Motorola 10VK	Channel Master	
P. Vincent	Yale, Mich.	Admiral 12-inch		double stack Tel-Rex
R. D. Waite	Orlando, Fla.	Homemade 7-inch		double stacked conical
R. E. Walker	Belle, W. Va.	National 1201	Channel Chief	Ward 2-bay conical

Television Service Clinic

Conducted by
WALTER H. BUCHSBAUM

SEVERAL readers have asked for a simple method of connecting the sound signal from their table model TV set to the audio amplifier of a nearby console radio or phono amplifier. Many different circuits are possible, some using switches, others relays, but the simplest solution is the one shown here.

Fig. 1 shows the main features of this circuit. To make sure the TV sound is piped to the amplifier only

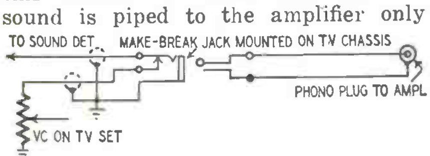


Fig. 1—Hookup for connecting TV sound.

when desired and to avoid an extra switch, the jack used is of the make-break type. When the plug is not inserted, the sound signal travels from the output of the detector through the contacts on the jack to the volume control on the TV set and thence to the TV receiver audio section. When the plug is inserted, this connection is broken and the TV volume control has no effect. Instead the volume and tone can be adjusted at the console amplifier.

To simplify this further, the plug is wired to a cable at the other end of which a phono plug is connected. Most console radios have a phono jack into which the TV sound can be connected. All leads should be shielded cable and all shields soldered to the chassis. Some TV receivers use no power transformer and one side of the a.c. line goes to the chassis. In this case the ground connections should be made through a .1-μf capacitor.

The jack can be mounted on the chassis by drilling a ⅜-inch hole, or it can be mounted on the rear cover of the TV set.

Distorted image

On my Philco model 48-2500 projection receiver the images in the background of the picture seem short and squatty while those in the foreground appear in correct proportions.—C. H. B., New Orleans, La.

This condition is rather rare. To correct it you may have to open the optical barrel which houses the projection picture tube. At the face of this tube you will find two permanent magnets set in a clamp and tilted towards the screen. These magnets create a keystone-shaped picture. This picture is again distorted when it is reflected at an angle, and the result should be a good picture.

In your case one of the magnets may need readjustment, or one of them may be aged and no longer has enough strength to shape the picture properly. You might try replacing it with a 4-ounce Alnico piece from a PM speaker.

Converting the Admiral 30A1

I would like to revamp my Admiral 30A1 10-inch receiver by adding a larger picture tube, a.g.c., and a better a.f. section.—R. C., Chicago, Ill.

Most of the basic circuits of this model are very much like those in the 630. The i.f. section, video amplifier, vertical sweep and horizontal flyback are practically identical. Only the audio amplifier and the horizontal sweep oscillator are different.

For conversion purposes, all the data given for the 630 ("Revamping a 630-Type TV Set," RADIO-ELECTRONICS for January, 1950) apply to the Admiral 30A1, the Zenith 28F20, and many others of the early TV receivers patterned after the 630.

Vertical bars

My Olympic DX 950 TV receiver had a glow on the screen which spoiled the picture. My service technician replaced the flyback transformer, the coupling capacitors, the tubes in the horizontal output, oscillator, damper and rectifier. The glow disappeared, but in its place are vertical bars that appear on the left side of the picture.—C. E., Detroit, Mich.

These vertical bars are called damping bars. Here are some suggestions.

Before replacing any components, move all leads from the deflection yoke away from the kinescope socket leads. Tighten the horizontal drive trimmer capacitor. Exchange the 6W4 damper tube for a new one. Try a new 6BG6 tube. Try holding a grounded sheet-metal piece on either side of the deflection yoke; mounting a small shield between the yoke and the video amplifier may eliminate the bars. Replace the 47-μμf capacitor inside the deflection yoke with a 100-μμf capacitor.

Eliminate ion spot

I had to replace the 7JP4 in my Hallicrafter 505 receiver because of an ion spot. Can I build an ion trap to avoid this trouble in the future. I would also like to know if I can change the 7JP4 for a 10HP4.—H. E. Z., Marietta, Pa.

Every ion trap has two parts; one is in the tube in the structure of the electron gun, and the other is an external magnet. Since there is no internal trap in the 7JP4, no external device can be applied.

The 10HP4 and the 7JP4 are electrically interchangeable so you can use the larger tube. You should have sufficient deflection for this tube.

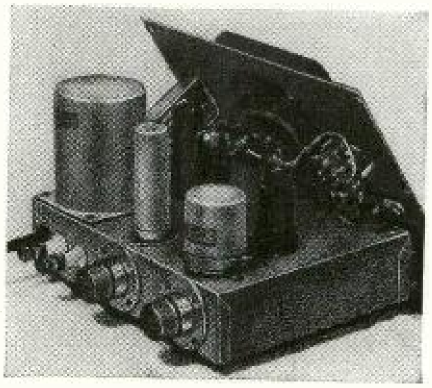
Ghost on channel 5

How can I get rid of a ghost on channel 5.—L. D., New York, N. Y.

To make sure the ghost is not due to transmission line mismatch, grasp the line in your hand at the receiver and move your hand for about 10 feet. If the picture gets better or worse at any point, your antenna lead-in is at fault. Cut the lead-in at 6-inch intervals until you get a good picture.

If the lead-in is not at fault, use a reflector on your antenna and rotate it until you get the best picture. You may find it necessary to relocate your antenna. In some parts of New York City the ghosts originate near the transmitter and are impossible to get rid of.

Remote Amplifier For Broadcasters



The compact, lightweight amplifier shown above is built to the highest broadcast standards. At right is a rear view of the unit with its cover removed to show the layout of parts.

By RICHARD G. FINKBEINER

A useful addition for any broadcast studio, this unit will take care of almost all remote broadcasting work

WHEN the number of remote broadcasts at WHRV in Ann Arbor, Michigan, began to increase rapidly, with some on the same day from points as far as 30 miles apart, an additional remote amplifier was needed.

A compact, lightweight, two-channel unit could meet the requirements of over 90% of all remote broadcasts handled. The bulkier four-channel amplifier was needed only for the few more elaborate pickups where three or four microphones were actually used.

Since practically all remote amplifiers on the market now meet FM broadcast standards, this amplifier should also meet these standards in full-range frequency response, low noise, and low distortion. Fig. 1 is a schematic of the amplifier.

The amplifier is basically a three-stage, resistance-coupled circuit. Mixing is accomplished in the low-level, low-impedance primary circuit of the input transformer with two attenuators. These constant-impedance T pads are designed for 30-ohm input and 30-ohm output impedances and have a 2-db attenuation per step. The resistors R1 and R2 maintain an effective 30-ohm impedance when two attenuators are used in parallel. The input transformer is a 30-ohm microphone-to-grid input broadcast quality unit.

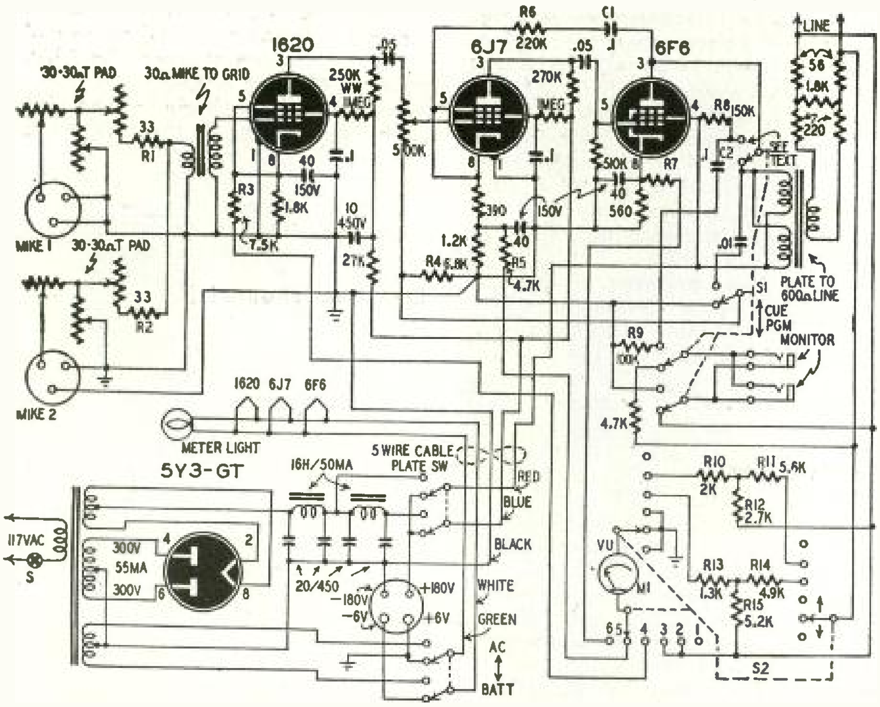


Fig. 1—The amplifier circuit. The power supply is built on a separate chassis.

Low noise input

A type 1620 low-noise pentode is used for the first stage of the amplifier to keep noise to a minimum. The 1620 tube is actually a 6J7 which has been hand-picked for low noise and microphonics, and, although it costs considerably more than a 6J7, its use is recommended.

A 250,000-ohm, wire-wound resistor is used as the plate load resistor of the 1620 to reduce noise further. A precision resistor is not necessary, but a small wire-wound resistor of the value required is available only as a precision unit.

Immediately following the master gain control is the second stage. These two stages have sufficient gain to permit even the lowest level broadcast microphone to be used.

Output impedance matching

A 6F6 pentode power amplifier is used in the output stage and is coupled to the telephone line through a 6F6 plate-to-600-ohm-line transformer and a 5-db isolation pad. For best results, a hand-picked 6F6, the 1621, may be used.

To understand the function of the isolation pad more fully, imagine that it is removed and the output transformer secondary is connected directly to the line. Under these conditions the proper plate load on the 6F6 is reflected only when the line impedance is 600 ohms. But the impedance of any given line may be far above or below this value, depending on its length and condition and the audio frequency being transmitted. This is where the pad comes in. Table I shows a few widely separated line impedances and the load which the amplifier sees with and without the 5-db isolation pad.

The table indicates that with a line impedance variation of 20 to 1, the amplifier works into a load variation of only 2 to 1. In practice, no line would vary over these limits, but the example shows the effectiveness of the isolation pad.

The secondary circuit must not be grounded in any manner because this upsets the balance of the telephone line, and increases the line noise.

TABLE I

Line Impedance (ohms)	Load (ohms) (Without Pad)	Load (ohms) (With Pad)
50	50	550
100	100	600
250	250	700
600	600	900
1,000	1,000	1,100

Inverse feedback is a must in any amplifier which works into a telephone line. The feedback circuit works along with the isolation pad to allow greater freedom in match between the amplifier output and the line. It also flattens the frequency response curve and reduces noise and distortion originating in the amplifier. With the circuit constants shown, there is a 16-db feedback signal at 1,000 cycles from the plate of the output tube to the cathode of the second stage 6J7.

To keep the hum level down, shielded wire is used for the heater and VU meter lamp wiring. Twisting would probably be satisfactory, but shielding is preferred. Double-ended tubes, like the 6J7, keep hum at a minimum by placing the grid circuit wiring above the chassis away from the heater terminals and wiring. All the usual hum-reducing precautions should be observed when building this amplifier.

All the low level wiring from the microphone connectors to the primary of the input transformer is shielded to prevent crosstalk and hum. The leads which run from the output terminals to the VU meter range switch should be shielded. All the wiring should be neat and kept as short as possible for best results.

Cue amplifier

An integral cue amplifier is included in this amplifier to simplify the pre-broadcast line-up by allowing two-way conversations between the studio and remote location at the simple flip of a switch. At WHRV there is at least 6 miles of telephone line between the station and any remote pickup point because the station is that distance from Ann Arbor and the line must go through the Ann Arbor telephone exchange. As a result the cue signal level is too low to be picked up with headphones across the line.

With the line switch S1 in CUE position, the output transformer becomes an input transformer, and the signal on the line is fed to the secondary winding. The induced voltage in the primary is fed in series with the lower end of the master gain control, which is connected to the grid of the second stage 6J7. From the plate of the 6J7 the signal is passed on to the 6F6, which is now a resistance-coupled amplifier, and then to the monitor jacks. The position of the master gain control has no effect on amplification.

Switching back to the PROGRAM position grounds the lower end of the master gain control, the 6F6 stage becomes a transformer-coupled amplifier, and the headphone monitor jacks are reconnected across the line output.

A minor modification must be made on the line switch S1 to prevent damage to the 6F6 when the switch is in the center or OFF position. The contact which connects to R8 must be bent so that the plate voltage is not removed from the 6F6, because this would cause excessive screen dissipation and damage to the tube. Making this change simply puts the B-plus voltage on the plate through R8 when S1 is in the OFF position.

Resistor R9 is added to allow C2, the blocking capacitor in the plate circuit of the 6F6, to charge before the headphones are connected to the plate by S1 in the CUE position. This prevents the ear-shattering click that would result if C2 were allowed to charge through the headphones. Also, loud clicks will be prevented if the line switch is changed slowly from CUE to PROGRAM position.

If more cue signal amplification is desired, the value of R4 may be increased to about 100,000 ohms maximum. If less amplification is necessary, a resistance in series with C2 should suffice.

The VU meter

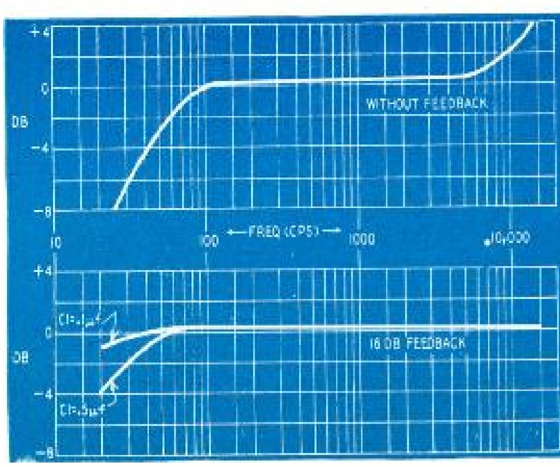
The volume indicator is a standard broadcasting unit and is calibrated with the reference level of 0VU representing 1 milliwatt in 600 ohms. The VU and the db based on 1 milliwatt are identical and may be used interchangeably.

In this amplifier the meter is used with multiplier pads which give ranges of 10 and 14 VU. The former represents the level used to feed a program on an enclosed toll cable. Allowance is made for a 2-db insertion loss when an external repeating coil is used, bringing the actual line level down to 8 VU, the value recommended by A.T.&T. A 14-VU multiplier is included for feed over an open line. It allows for an insertion loss up to 6 db if an equalizer is used.

Any number of multiplier pads may be chosen from Table II to make up the VU range switch. The resistors may be mounted directly on the switch if room permits.

To facilitate maintenance and to spot tube failures with minimum lost air time, a tube check circuit is included. Since the VU meter has a full-wave rectifier, it may be used in d.c. circuits without regard to polarity. Resistors R3, R5, and R7 are chosen to give a 0-db indication when normal plate current flows through the 1620, 6J7, and 6F6, respectively.

An OFF position should be included in the range switch so that slamming



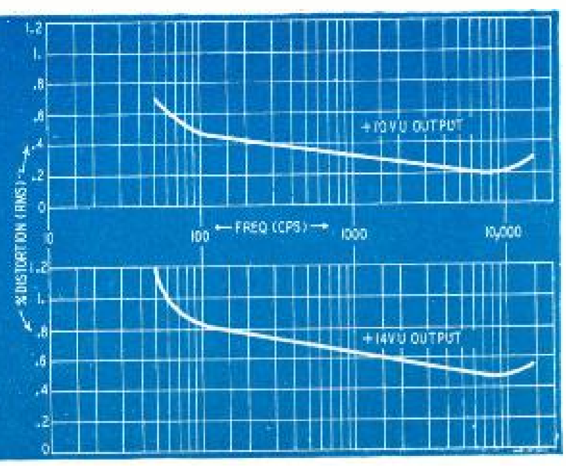


Fig. 2, left—The frequency response curves of the amplifier. Fig. 3, right—Distortion curves of the unit.

the meter needle is avoided when using the CUE-PROGRAM switch.

A separate power supply

The power supply is built on a separate chassis so it may be placed away from the input transformer. It has change-over switches and batteries may be used if the power line fails. Two 90-volt B-batteries and one 6-volt "hot-shot" A-battery are required for the external battery pack. It is a worthwhile standby unit for emergencies.

A two-section filter with two chokes and four capacitors is used to keep hum at the lowest possible level. The first filter section supplies the B-plus voltage for the power amplifier stage only. Both sections are used for the voltage amplifier stages for maximum decoupling and freedom from motorboating. In addition, the pre-amplifier stage has an additional R-C decoupling network.

TABLE II

VU Multiplier Pads			
VU Level	R10 (R13)	R11 (R14)	R12 (R15)
4	3,600-ohm series resistance		
6	450	4,000	17,000
8	900	4,500	8,200
10	1,300	4,900	5,200
12	1,700	5,300	3,700
14	2,000	5,600	2,700

The five-conductor cable which connects the power supply to the amplifier is wired in directly. This saves four connectors and makes the set-up operation quicker.

To avoid the usual difficulties with extension cords and their unreliable connections, a 25-foot line cord is wired to the power supply. One good line cord saves a great deal of troubleshooting when the a.c. doesn't seem to be getting to the supply. It also saves carrying extra extension cords.

Construction details

An old aluminum-base transcription disc is used to make the 5x8x1½-inch power supply chassis. The 7x9x2-inch aluminum chassis used for the amplifier fits into an 8x10x8-inch cabinet. It is necessary to space the panel ½ inch from the chassis to provide clearance between the back of the line switch and the output transformer. This allows the microphone connectors to extend far enough beyond the back of the cabinet so that the lock releases may be reached easily. The chassis must also be spaced up ½ inch by screws in the bottom flange to center the microphone connectors in the back opening provided in the cabinet.

Notches are cut in the control knobs and marked with white paint. The notches allow the position of the knob to be determined by touch. White cardboard stock is used for the meter range switch, and lettering is done with India ink.

Amplifier performance

Frequency response, noise, and distortion measurements were made with the aid of a General Radio noise and distortion meter.

The first frequency response curve was made without inverse feedback so the amount of correction necessary could be determined. Adding a feedback network, consisting of R6 and C1, gave the second family of curves shown in Fig. 2. The final curve is flat within 1 db from 20 to 15,000 cycles.

Feedback also gave a substantial reduction in the total harmonic distortion of the amplifier. For example, at an output of 10 VU the distortion at 1,000 cycles was 1.3% without feedback, and dropped to 0.3% when feedback was added. A graph of distortion *versus* frequency is shown in Fig. 3.

In making the noise measurements, the fact that most of the noise is contributed by the first stage had to be taken into account. With the master gain control half on, an over-all noise level of 55 db below 10-VU output was measured with a 6J7 in the first stage and of 70 db below 10 VU with a 1620 tube. Running the master gain as low as possible keeps noise at a minimum in this as in any other remote amplifier.

This amplifier is very stable if a few lead dress precautions are followed. To prevent coupling between the grid lead of the second-stage 6J7 and the meter terminals, dress the lead as close to the tube as possible and away from the front panel. Also, keep the 1620 grid lead away from the meter range switch. In some cases a small shield may be needed between these tubes and the meter and its range switch. No deflection should be noted on the VU meter with the master gain wide open and the amplifier in its case.

Materials for Amplifier

Resistors: 3—33, 2—56, 2—220, 1—390, 1—560, 1—1,200, 1—1,300, 2—1,800— 1—2,000, 1—2,700, 2—4,700, 1—4,900 (handpicked 4,700, 10%), 1—5,200 (handpicked 5,100, 10%), 1—5,600, 1—6,800, 1—7,500, 1—27,000, 1—100,000, 1—150,000, 1—220,000, 1—270 000, 1—510,000 ohms, 2—1 megohm, ½ watt; 1—250,000 ohm wire-wound; 1—500,000-ohm potentiometer; 1—30/30-ohm T pad, 2 db per step.
Capacitors: 1—.01, 2—.05, 4—0.1 μf, 600 volts, paper; 1—10 μf, 450 volts; electrolytic; 1—40x40x40 μf, 150 volts, electrolytic.
Transformers: 1—30 ohms to input grid; 1—6F6 plate to 600-ohm line.
Miscellaneous. VU meter, jacks, switches, microphone connectors, chassis, tubes, sockets, hookup wire, and shielded wire.

Materials for Power Supply

Capacitors: 1—20x20x20x20 μf, 450 volts, electrolytic; Transformers and chokes: 1—power, 300-0-300 volts, 55 ma; 2—16-henry, 50-ma chokes.
Miscellaneous: Chassis, tubes switches, plug.

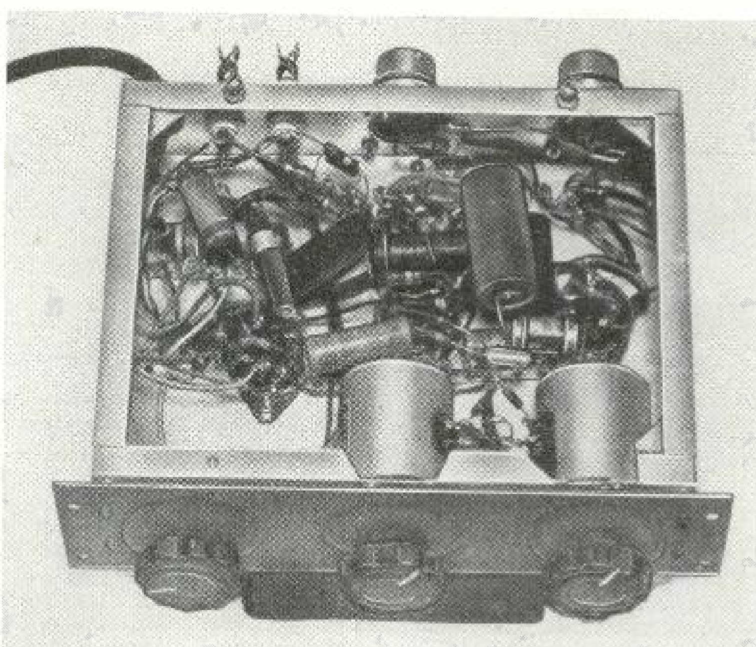
SLIDE-RULE CALCULATION

A slide rule method for solving $Z = \sqrt{A^2 + B^2}$ was described on page 69 in the July issue. This equation is very common in radio work, and its solution aroused much interest. Mr. R. F. Sturrock of Edmonton, Canada sends a method which simplifies the work to some extent. His system is as follows.

Take the equation $Z = \sqrt{18^2 + 28^2}$. Place left index at 18 on D and slide cursor to 28 on D. Note 2.42 which appears on B. Mentally add unity, obtaining 3.42, and move cursor to this number. The answer is read on D, 33.3 The proof is similar to that given in July. Mr. Sturrock notes also that the power factor may be read off on C1 when the final answer appears.

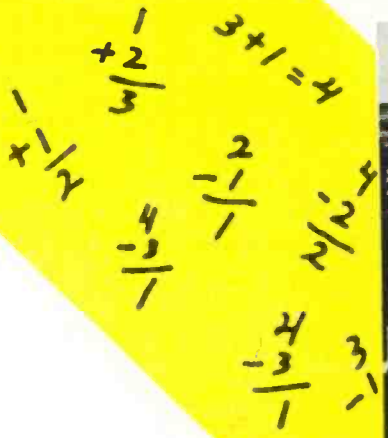
Other contributors note that another method may be used if a Log Log Duplex Decitrig rule is available. In this case set index to the larger number and push hairline to smaller one. Read angle on T under hairline. Draw same angle on S under hairline and read answer on D at index.

We are indebted to Howard T. Hoffman of St. Louis and to John T. Frye of Logansport, Indiana, for the latter method.



A look under the chassis. All of the low-level wiring is carefully shielded.

World's Smallest Electric Brain



By EDMUND C. BERKELEY*
and ROBERT A. JENSEN

E. C. Berkeley explains how Simon gets instructions from a piece of punched tape.

Part I of a series of articles outlining principles and describing construction of electric and electronic computing devices

ON THE COVER of this issue of RADIO-ELECTRONICS is a picture of the smallest existing, complete electric brain. This midget electric brain is named Simon, in honor of Simple Simon of Mother Goose fame. He can be called electric or mechanical for he uses relays; but not electronic, for he does not use a single electron tube. Nevertheless he illustrates in solid hardware the principles of all the giant artificial brains, electronic, electric, or mechanical. He is perhaps the only electric brain small enough to be understood completely by one man.

Simon is about 24 inches long, 15 inches wide, and 6 inches high. He weighs (not counting his power supply) about 39 pounds. He runs on 24 volts d.c., drawing at most about 5 amperes. And in number mentality, Simon at present compares with a child of two years, for he knows only four numbers, 0, 1, 2, and 3.

Simon is slow. He performs each operation in about ⅔ second—unlike the electronic brain finished in 1949 called Binac, which adds at the rate of 3,500 additions per second. And yet Simon is a true mechanical brain, for he has the two essential properties that define a mechanical brain: he can transfer information automatically from any one of his 16 registers to any other, and he can perform endlessly long sequences of reasoning operations.

What is the purpose of this little idiot of an electric brain—or should he be looked on rather as a baby, with capacity to grow? Why was it worth while to build him?

The purpose of Simon

An editorial entitled "Simple Simon" in the *Wall Street Journal* for May 22, 1950, expressed in part the purpose of Simon: it said, "The world may admire a genius but it loves a moron." The same may perhaps be true of the crew of men who want to know how electric brains work, what they are all about, and how to construct them. It may be rather easier to understand the working of a little moron of an electric brain, that a student can easily feel superior to, than it is to understand the working of a giant electric brain, that a student can easily feel inferior to.

Simon was designed and built to exhibit in simple understandable form the essential principles of any artificial brain. He will be useful in lecturing, educating, training, and entertaining—just as a spinning toy gyroscope is both entertaining and instructive. For it is certainly true that the demand for computer-trained electronics engineers, operators, maintenance men, mathematicians, etc., is steadily growing in the new field of automatic computing machinery.

There are now more than a dozen kinds or species of these giant artificial brains. Most are represented by just one example, such as the rather old—but still spry—Harvard IBM automatic sequence-controlled calculator, finished in 1944. This machine handles numbers of 23 decimal digits and can remember 72 of them at one time. There are now in use more than 20 machines of the type known as the International Business Machines card-programmed calculator, and more than 80 of the type known as the Reeves electronic analogue computer.

Digital and analogue computers

These artificial brains are of two main types: *digital* and *analogue*. A digital machine expresses information by the positioning of devices in any one of a small number of exact positions. For example, a human hand with fingers up or down may express 0, 1, 2, 3,

Fig. 1—Diagram showing a register of Simon expressing the information "1,0".

4, 5; or a counter wheel can stop at any one of the spots 0 to 9; or a light can be on or off, 2 positions; or a relay may be energized or not energized; or an electron tube may be conducting or not. All these devices are *digital*.

An analogue machine, on the other hand, expresses information as the measurement of a physical quantity, such as distance moved, or amount of rotation, or electric potential, etc. The

* *Author:* Giant Brains

measurement is *analogous* to a number in the computation.

But there is no easy way for an analogue machine: (1) to manipulate alphabetic information given in letters; (2) to express random numbers; (3) to express any numbers with an accuracy of more than 5 or 6 decimal digits; (4) to handle problems where the solution requires different decisions and subroutines, depending on what happens in the course of the problem. All these things a digital machine can do easily. Thus a digital machine can do rather more than an analogue machine. In fact it begins to look as if the digital machine of the future has within itself an unlimited capacity to think. This series of articles will deal mainly with digital electric brains.

How an electric brain works

How does an electric brain work? A good mental picture of the working of an electric brain is an isolated telegraph system, with a number of communicating central stations and a traffic control. The messages that this telegraph system handles are usually pieces of information of standard length, with a standard number of digits.

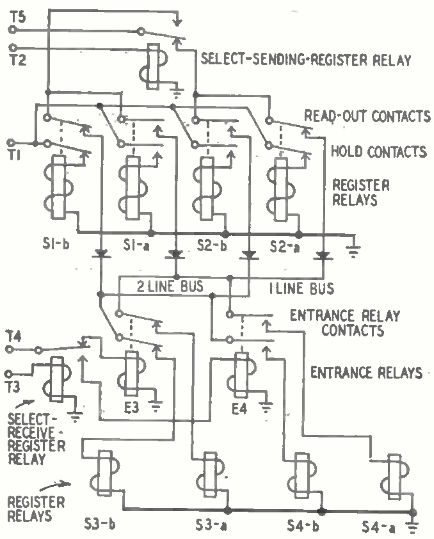


Fig. 2—A simplified schematic showing how Simon transfers information from either of two read-out storage registers to either of two read-in registers.

One of the stations is called INPUT. Here information comes in from the outside world to the telegraph system; it is put into a form ready to be sent somewhere else in the system.

Another of the stations is called OUTPUT. Here information that the telegraph system has produced is given back to the outside world.

There are a whole flock of stations called STORAGE No. 1, STORAGE No. 2, STORAGE No. 3, and so on. Here information may be stored without changing while waiting for some other part of the system to call for the information and do something more with it.

A very important station with room for several incoming pieces of information is the COMPUTER. This station is combined with a factory, a calculating device that can accept several pieces of information and manufacture new information out of them.

For example, the calculating device may have four receiving points or platforms. On two platforms, the computer takes in two numbers such as 140 and 25. On the third platform the computer takes in an order to subtract, multiply, or find which is bigger, etc. On the fourth platform the computer delivers a result (for example, 115), the result of combining 140 and 25 according to the order to subtract.

To calculate with this telegraph system, we must have some way of organizing traffic through it. That is the duty of the central traffic control. The most automatic way for sending information through the system is:

(1). At any one time connect just two telegraph stations, such as "Albany" and "Boston";

(2). Specify the direction of traffic, such as "from Albany to Boston." Then as soon as the proper connections have been completed, send the signal "go," and the information at Albany will be transferred automatically to Boston.

There are two ways to get the central traffic control to function properly. One is to have all the orders ready ahead of time, and tell it to do just as it is told. This is dictatorship. The second way is to have some special wires of the telegraph system run into the central control, and let information from time to time (though not all the time) come from the system into the central control—feedback. The central control then knows what is going on and can direct the following steps. This is democracy. This second technique of course is a honey, even with electric brains, and a good electric brain does compute some—or even most—of its own instructions.

Information

Such then is the mental picture of the working of an electric brain. But just what do we mean by information?

For the purposes of an electric brain, information is simply the arrangement of certain physical equipment. For example, a hand with two fingers up and three down is regularly considered to express the number two. Or suppose we take a pair of relays, a left-hand one and a right-hand one. Either one of these relays may be energized (let us report this condition as 1) or not energized (report this condition as 0). The information therefore that this pair of relays can represent is 00, 01, 10, and 11—four possibilities. (Here 10 is not ten, and 11 is not eleven). Let us number these four possible pieces of information 0, 1, 2, 3. Now we have the exact way a register of Simon expresses numbers (see Fig. 1).

Transfer of information

An electrical brain, like an automatic telegraph system, can transfer information automatically from one register to another. How does this take place?

Suppose we take some registers of Simon (a little simplified) and see how transfer does take place. Let us take two storage registers S1 and S2 (S for storage) from which we may read out information, and two more storage registers S3 and S4, into which we may read information. Each of these registers has two relays to supply the four possible pieces of information. Suppose we desire to transfer information from register S2 into register S3.

Looking at Fig. 2, we see 12 relays, of which eight are the relays for registers S1 to S4. We also see five terminals, T1 to T5, which energize the relays. The terminals are energized, that is, carry current, in the sequence of their numbers.

Let us consider time 1. At this time the circuit running from T1 to ground passes through both the closed HOLD contracts and the coils of (two out of) four relays S1-b, S1-a, S2-b, and S2-a. By a previous operation, the two relays S1-b and S2-a were energized and are now held up by continuous current from terminal T1. We see that information "1,0" is stored in register S1 and that information "0,1" is stored in register S2.

Let us pass to time 2, and look for terminal T2. At time 2 we see that the SELECT-SENDING-REGISTER relay is energized, and consequently register S2 is selected to send out its information.

Now let us pass to time 3, and look for terminal T3. The SELECT-RECEIVING-REGISTER relay, whose pickup coil is connected to T3, is not in this case energized. As a result, register S3 is selected to receive.

Passing to time 4, we look for terminal T4. As current flows along the wire from T4, the entrance relay for register S3 is energized. We have connected the pickup coils of register S3 to the bus, and therefore S3 can receive information from the bus.

We have now completed all the preparations needed to transfer information from register S2 to register S3. We now pass to time 5. Pulsing terminal 5, we see that the pulse of current flows as follows:

(1). through the selection circuit that selects the sending register S2;

(2). through the readout contacts of the sending register S2;

(3). through the rectifiers (which prevent back circuits);

(4). through the bus;

(5). through the contacts of the entrance relay belonging to the receiving register S3;

(6). into the coils of the receiving register S3 (naturally and properly, only the right-hand relay S3-a is energized, however); and

(7). to ground.

This then is an illustration of the principle of transferring information from one register to another. The scheme is entirely general: a pattern of information "written" in one register is "copied" in another.

Radio-Electronics in the Home

Winners in Fourth Monthly Contest

A sound switch built to solve the problems of a deaf-mute couple but with many other uses takes First Prize. Second Prize goes to a commercial killer that works on certain FM broadcast stations. Fine weather alarm takes Third Prize.

First Prize—Sound Switch

George H. Bateman, Grand Rapids, Mich.

This entry was first built to solve the problem of a deaf-mute couple to whom a child had been born. The child was premature and, because of a growth in its throat, was subject to choking spells while it was asleep. Since neither of the them could hear the child, the parents had to keep a constant watch over the child for months with no promise of relief until this sound switch was built.

This switch is not limited to the use for which it was built, but can be used for many other purposes such as opening the garage door at the sound of the car horn or perhaps as a burglar alarm. Anyone with imagination could think up at least a dozen uses.

The circuit, shown in Fig. 1, is simply an audio amplifier with a relay in the output circuit. The pickup is a 2-inch PM speaker used as a microphone. It is mounted in a meter case with a screen for protection. Three stages of high-mu triodes make the device sensitive to very low sound levels and allow for tube slump. The choice of tubes is not critical—6SC7's, 6SL7's, 12AT7's, or 12AX7's could easily replace the 7F7's. Four stages of amplification will cause oscillation, so the extra half 7F7 is used as a cathode follower to feed the rectifier and relay control tube.

The sound alarm's three components are shown in this photo. The alarm device is at left, the amplifier center, and the speaker used as pickup is at right.

The Winners

Sound Switch	
George H. Bateman	$50
Commercial Killer	
James Aagaard	$25
Fine Weather Alarm	
Alfred Haas	$15
Carrier-Current Switch	
Edwin A. Kucharski	$10

Germanium diodes can be used in place of the 7A6 duo-diode, but in this case reliability was of prime importance and one overload could destroy the crystal. For the same reason a sturdy relay with its telephone type contacts in parallel was used.

In the case of the deaf-mute couple, the controlled circuit was an electromagnet with a small air gap in the core. They had been using it for several years tied to the bedsprings and energized by the 117-volt a.c. line. It operated when the alarm clock went off. The vibration was enough to waken them.

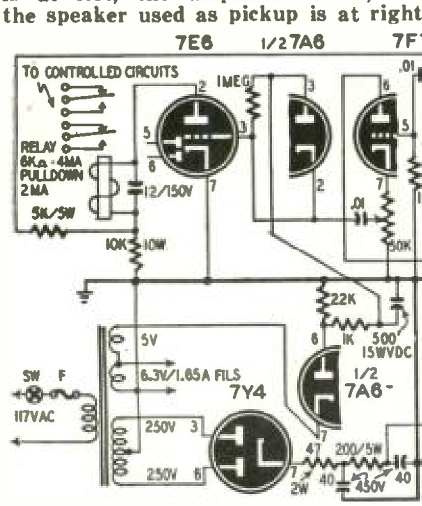
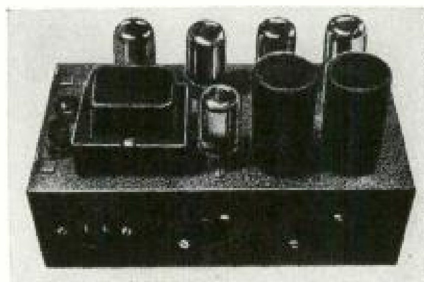


Fig. 1—Circuit of the sound alarm. The three amplifier stages give it enough sensitivity for a variety of uses from baby sitting to opening garage doors.



Rear view of the sound alarm amplifier with cover removed to show the layout.

Second Prize—Commercial Killer

James Aagaard, Chicago, Ill.

Many FM broadcast stations use supersonic tone signals to control receivers. These signals are used to select different receivers, to increase the volume of a receiver, or to mute a receiver during announcements. This entry takes advantage of these signals to quiet the receiver during the announcements.

The first step is to determine which stations if any are using these signals. This can be done with an a.c. voltmeter or an oscilloscope connected across the detector. (All connections described here must be made ahead of the de-emphasis network, since it may kill the signals.) If such a signal is present, it will appear as a steady indication on the meter. Two systems are in general use. Either the signal is transmitted throughout the entire announcement (the more common system), or there may be a short signal before the announcement and another just after of a different frequency. This check should be made both in the daytime and in the evening, as some stations do not use the signal during the entire day.

To make use of the first system a circuit like that of Fig. 2 is needed. It consists of a signal amplifier, tuned circuit, rectifier, and relay tube. The second system requires two each of these with a special control section like that shown in Fig. 3. The two 41,000-ohm, 4-watt resistors in the plate circuits are each made up of two 82,000-ohm, 2-watt units in parallel.

The signal amplifier should have as

much gain as possible, and the tuned circuits must have a high Q. In the original model UTC HQA inductors were used, but these are rather expensive and could be replaced by an

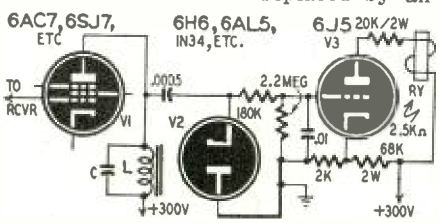


Fig. 2—Circuit for using the continuous signal during announcements.

iron-core r.f. choke. If the detector has a high output the Q is not so critical. In some cases more than one stage of amplification may be needed.

The next step is to find the frequency of the control signal. The easiest way to do this is by using Lissajous figures with an oscilloscope and audio oscil-

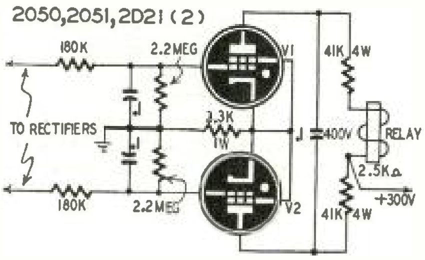


Fig. 3—Basic control circuit used on stations transmitting one signal before announcements and another one after.

lator. If the oscillator range extends high enough, it can also be used to make a rough adjustment of the tuning controls. Connect a high-resistance voltmeter from grid to ground of the control tube and adjust the trimmer for maximum d.c. voltage. If the control tube is a thyratron, remove it from its socket before making the adjustment.

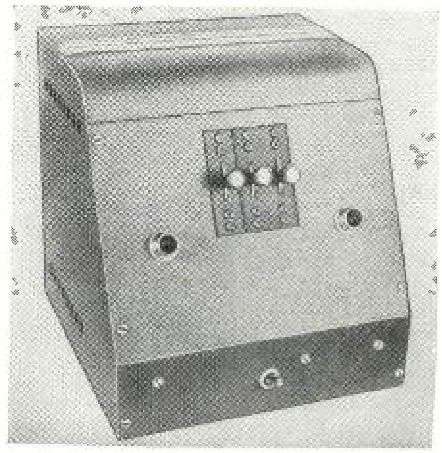
The circuit of Fig. 4 can be used with both systems. When using system 1, the output of both rectifiers are in parallel so that either frequency will trip the 6J5. The coupling capacitor C1 is made small to eliminate as much audio signal as possible. The switch S1 selects either system 1 or 2, S2 is a manual trip switch, and S3 bypasses the circuit completely. The lamps which appear on the panel in the photo are connected to spare contacts on the relay.

The resistors in the plate circuit of the thyratrons allow about 6 ma plate current. If this is not enough to operate the relays at hand, these values can be changed. Plate resistors of about 15,000 ohms (10 watts) and a 1,000-ohm, 1-watt cathode resistor will allow enough current for almost any low-current relay. It may also be necessary to increase the value of the plate-to-plate capacitor.

If more than one station uses the same signal system but at different frequencies, a switch can be used to select different trimmers. If only the first system is used, a 15 kc highpass filter might be used instead of the tuned circuits. To get completely silent muting, the change in plate voltage of the control tube could be used to control a cutoff bias on one of the audio tubes of the receiver, but this requires more tubes and a source of negative d.c. voltage.

With the connections as shown in the diagram. L2-C3 should tune to the signal preceding the announcement and L1-C2 to the following signal. C2 and C3 are the largest compression type trimmers available and are shunted with fixed micas to get enough capacitance to tune with the coils at the desired frequency. R1-C4 is the de-emphasis circuit removed from the receiver and put into this unit. C5 is made just large enough for stable operation and will be between .01 and .01 μf. The switches are all of the lever type as shown in the photo.

A rear view of the commercial killer.



Operated by supersonic signals from FM stations, this unit automatically cuts off the receiver during announcements.

Third Prize—Fine Weather Alarm

Alfred Haas, Annecy, France

When you plan to get away early on Sunday morning for a fishing trip it is discouraging to be wakened by the alarm clock at dawn only to find that it is raining outside. This prize winner lets an alarm go off only when the sun is out and lets you sleep through if the weather is cloudy.

It consists of a 930 phototube which fires a 2050 thyratron when there is sufficient light (Fig. 5). The potentiometer R1 varies the sensitivity. At maximum sensitivity the thyratron will fire when a lighted candle is placed a

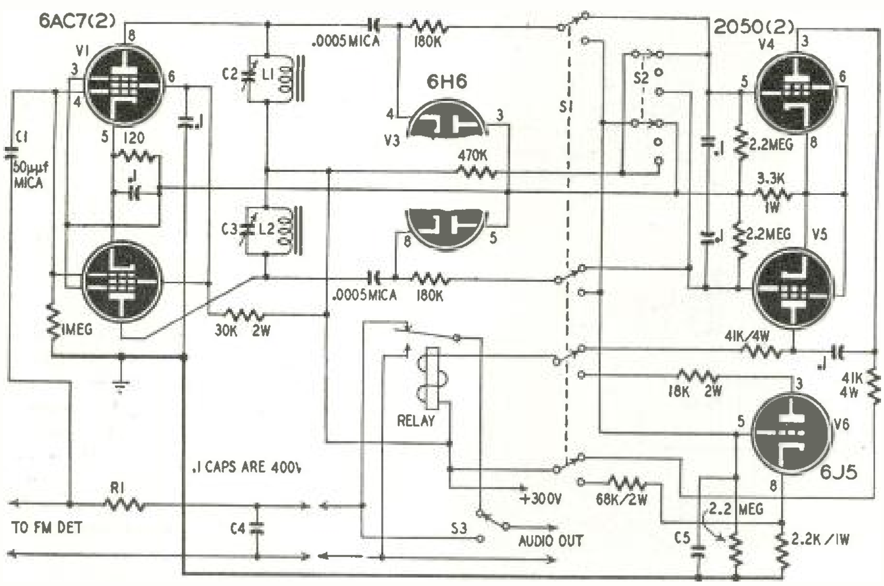


Fig. 4—This complete control circuit makes use of both types of signal. To use several frequencies, trimmers can be switched across the tuned circuits.

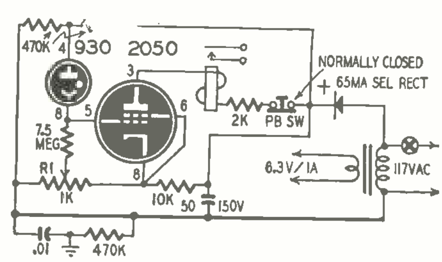
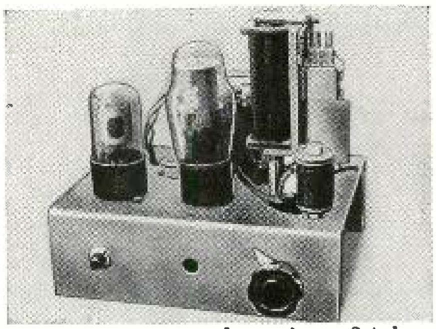


Fig. 5—Schematic of the fine weather alarm. It lets you sleep on rainy days.

yard from the phototube. To avoid direct sunlight on the phototube, a simple paper screen is placed in front of it.

The relay in the plate circuit of the thyratron controls the wakening device. The simplest form of this is a bell and battery, but any other suitable arrangement can be used. If the relay has an extra set of contacts, these could be used to switch on an electric percolator so you can abate the displeasure of early rising with a cup of good hot coffee.



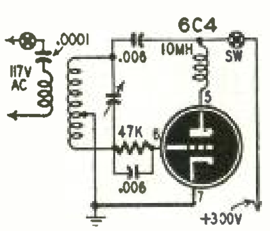
The fine-weather alarm is a 2-tuber.

Fourth Prize, Carrier-Current Switch.

Edwin A. Kucharski, Tarrytown, N. Y.

This entry is a carrier-current switch for remote control of any electric appliance in the home. The transmitter, shown in Fig. 6, is an ordinary shunt-fed Hartley oscillator that feeds its output directly into the 117-volt a.c. electric light line.

The receiver (Fig. 7) has two tubes and can be tuned to operate between 100 and 600 kc for best results. The r.f. coils are rebuilt 455 kc i.f. transformers. The 1N34 crystal rectifies the r.f. so that the bias on the 6N7 becomes less negative. The increasing plate current in the tube operates the relay. Both transmitter and receiver take little current, and the device has many uses around the home.



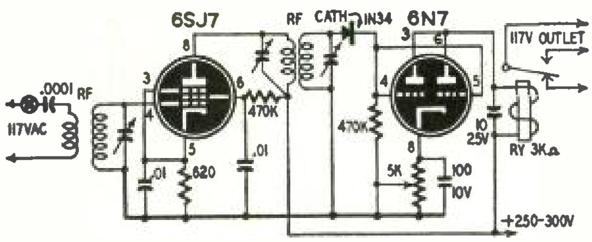
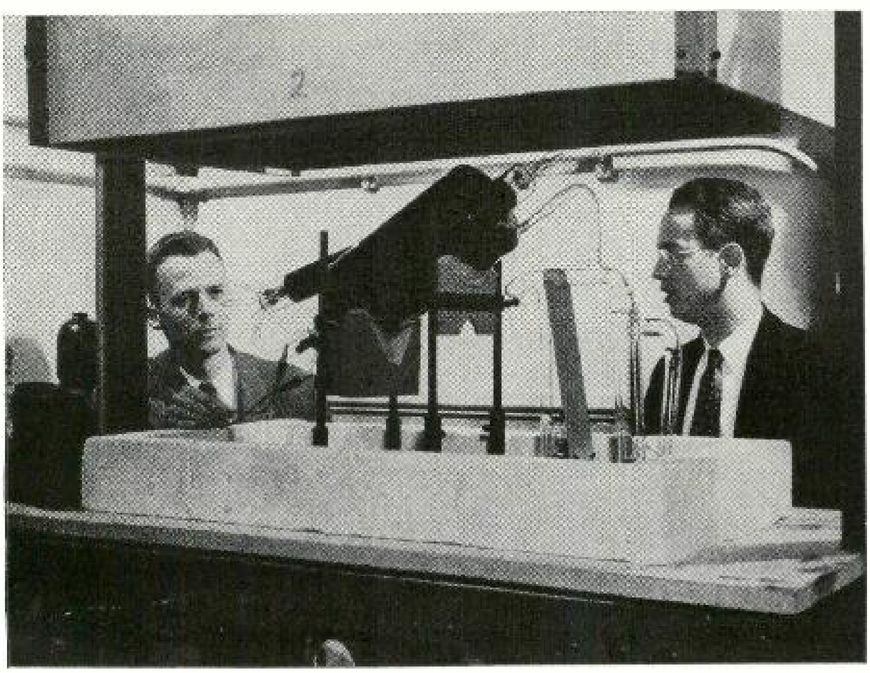


Fig. 6, left—The carrier-current transmitter is a simple Hartley oscillator. Fig. 7, right—The 2-tube receiver uses remade i.f. transformers for r.f. coils.

Memory Tube Aids Electronic Brains



The tube in the photo is a memory tube for computers which remembers as many as 400 digits. Air in the tube is being removed and it will be "cured" in this oven-like apparatus. At left is J. W. Forrester and at right S. H. Dodd of the MIT Servomechanisms Laboratories, where the new tube was developed.

FLUORESCENT HAZARDS

The following excerpts are from Safety Division Bulletin No. 41 of the Florida Power & Light Company:

Recent disclosures regarding the handling of fluorescent lamp tubes indicate an alarming hazard.

Metal beryllium, a powder used to line the interior of the lamp, is extremely toxic. In disposing of old tubes, every possible caution should be exercised to prevent this dust from entering the human system either through a wound or through the nose or mouth. Old tubes should be broken under water to prevent this dust from spreading in the air.

In addition to the beryllium powder in the lamp tube, there is the toxic material mercury which, when released in dilute quantities in the air, is poisonous.

There is the possibility of very serious injury from a cut from the glass of a tube, where the dust enters the wound. Chronic inflammation may result which can require surgery and take many months to heal. The dust when inhaled can develop lung tumors. *Death from this source has occurred.*

Special precautions which should be observed in handling these tubes are as follows:

1. Never discard fluorescent lamps by placing them with rubbish or where they can be carelessly handled or broken.
2. Never destroy them in incinerators.
3. Do not permit them to get into the hands of children.
4. If a lamp should fall or break, leave the immediate area until the dust has settled.
5. Do not attempt to pick up any of the broken bits of glass with your bare hands.
6. Sprinkle or spray water over the area before attempting to sweep up.
7. Use heavy gloves in handling any of the broken parts.
8. Should you receive a cut from the lamp glass, consult a physician at once. —*R. P. Balin*

COSMIC RAYS PHOTOGRAPHED

Cosmic rays smashing atoms to bits were photographed from a V-2 rocket 100 miles above the earth. The photograph was made possible by Dr. Herman Yagoda and co-workers of the Experimental Biology and Medicine Institute of the National Institutes of Health in Bethesda, Md.

The photograph showed that there are more than three times as many cosmic ray collisions at 100 miles up as at 20 miles up. The energetic cosmic rays penetrated the rocket to get a direct hit on the nucleus of an atom on the photographic plate. The nucleus was splattered around in the surrounding emulsion and left tiny tracks visible under the microscope.

Special equipment had to be built to protect the fragile photographic emulsion from the shocks of firing and landing.

Fundamentals of Radio Servicing

Part XX–The Converter Stage

By JOHN T. FRYE

DID you ever see sausage being made? A lot of different ingredients were tossed into the hopper of the meat-grinder, but when they came out the other end of the machine, they were all sausage.

The superheterodyne receiver, as we learned last month, is a lot like this sausage grinder. The receiver can accept radio signals of widely different frequencies and convert them into a single "intermediate frequency" to pass them through the i.f. amplifier. The grinder that reduces all the radio signals to a common denominator goes by the name of "converter" or "mixer" tube, and this chapter concerns itself with what kind of business goes on inside that tube.

The names applied to the tube give excellent clues to how it performs its presto-chango miracle: it "converts" the incoming signals of various frequencies into a single intermediate frequency, and it does this by "mixing" each of those incoming signals with another signal that is generated in the receiver.

To understand why we can take a broadcast signal that is operating on, say 1,000 kc, mix it with another signal brewed in the receiver, and end up with a signal exactly on the 455-kc intermediate frequency, we must explore the phenomena known as "beat frequencies."

The authorities tell us: "If two or more alternating currents of different frequencies are present in an element having unilateral current flow properties, not only will the two original frequencies be present in the output but also currents having frequencies equal to the sum, and difference, of the original frequencies. These two new frequencies are known as *beat frequencies.*"

Mixers may vary widely in appearance.

How a mixer works

Now that is just dandy, but we want to know *why*; so let us take a look at Figs. 1 and 2.

Fig. 1 shows two alternating-current generators, a diode rectifier tube, and a resistor, all connected in series. One of the generators is labeled SIGNAL and is operating at 12 cycles per second. The other, labeled OSCILLATOR, operates at 10 cycles per second. The reason for this name-calling will be given later.

Fig. 2 portrays what takes place in various sections of the circuit of Fig. 1. Fig. 2-a shows the voltage output of the signal generator for a period of 1 second. At Fig. 2-b we have the output of the oscillator generator *during the same second.*

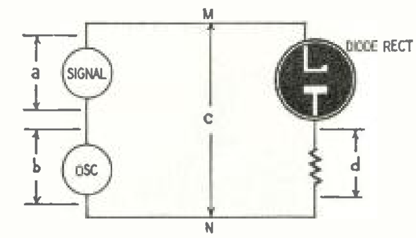


Fig. 1—A diagram showing the elements that are needed in a converter.

Since the generators are connected in series, the voltage across points M-N will be affected by voltages a and b from both generators. When the outputs of the two are in the same direction—that is, when corresponding terminals of the generators have the same polarity—the two voltages aid each other and the total voltage appearing across M-N is equal to the sum of the separate voltages. On the other hand, when one generator is positive while the other is negative, the two voltages buck each other, and we have to subtract the negative voltage from the positive voltage.

Fig. 2-c shows this interaction of the two generator voltages. The two voltages start out exactly in step, both rising from the zero line; but since 2-a has to make 12 complete cycles during the time that 2-b is making only 10,

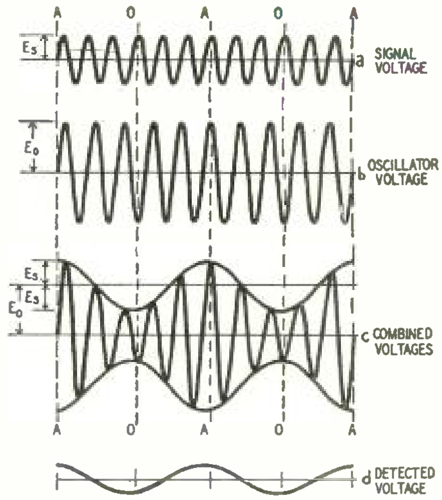


Fig. 2—When the 12-cycle curve (a) is added to the 10-cycle curve (b) the result is a curve (c) modulated at the difference frequency of 2 cycles. (d) is the intermediate frequency voltage.

they obviously cannot stay in step or "in phase." By the time 2-b starts rising on the first quarter of its second cycle, 2-a starts falling on the second quarter of its second cycle. When 2-a is at the end of the first quarter of its fourth cycle, 2-b is ending the third quarter of its third cycle. Voltage 2-c is at minimum because 2-a and 2-b are bucking. However, by the time 2-b is rising on the first quarter of its sixth cycle, 2-a is also rising on the first quarter of its seventh cycle. The dashed lines, labeled A for aiding and O for opposing show that the output of the two generators aid and oppose each other at a rhythmic, regular rate; and this alternate helping-hindering action causes the amplitude of the combination voltage envelope shown at Fig. 2-c to vary.

To see the matter from another angle, suppose we consider the analogy of two clocks, one of which goes tick-tock 40 times a minute and another which makes this sound thirty times a minute. At the beginning of the minute, both say "tick" so nearly at the same time that the result is a very loud sound. Then the ticks start drawing apart until finally one clock is saying "tick" at the same time the other is saying "tock." From that point on, the ticks start drawing closer together again until finally, at the end of 6 seconds, both clocks say "tick" simultaneously again, and we have another exceptionally loud sound.

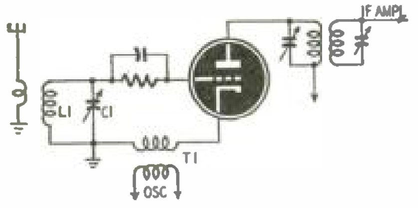


Fig. 3—Circuit of a triode mixer. It looks almost like a grid leak detector.

This cycle repeats with a reinforced "tick" every 6 seconds. If we counted all of the ticks and tocks and then divided by 2, we should find that we had 70 tick-tock combinations per minute. The exceptionally loud ticks happen every 6 seconds; so we should have 10 of those per minute.

In other words, combining the 40-cycle-per-minute sound with the 30-cycle-per-minute sound, gives two new sounds: one is the sum of the two sound-frequencies, or 70 cycles per minute; and the other is the reinforced sound at 10 cycles per minute.

The positive and negative voltage peaks of our two generators combine in precisely the same way, and they also produce two new frequencies: one is equal to the sum of all the positive peaks plus all the negative peaks (of both generators) divided by 2—or simply the sum of the two frequencies; and the other, that results from the periodic reinforcing action of coinciding "in-phase" peaks, is equal to the difference between the two frequencies.

Why detection?

In Fig. 2-c we see that the voltage envelope goes through a contraction-expansion cycle two times a second; and this frequency is the difference between the signal frequency of 12 cycles and the oscillator of 10 cycles.

But we must do something else to get our hands on this difference frequency. True, the two frequencies have been mixed and so the result is a voltage envelope that is modulated at the desired difference frequency; but we must first extract that modulating frequency from the envelope.

That is where the "element having unilateral current-flow properties" comes in. In Chapter XVIII we learned that the way to recover modulation from a modulated envelope is to pass it through a "detector." We also learned that a detector is a device that either passes current in only one direction or reacts much more enthusiastically to a voltage in one direction than it does to one in the opposite direction.

The diode tube of Fig. 1 is such a device, for we know that current can pass through it only from the cathode to the plate. This means that only half of the envelope of Fig. 2-c can pass through the tube and the resistor. As a result, the voltage d across the resistor will rise and fall right along with the outline of the top or bottom edge of 2-c. Fig. 2-d shows the alternating-current voltage that appears after 2-c passes through a detector.

Now that we know the *modus operandi* of mixing two frequencies to get a third, let's try our hand on a practical circuit. Look at Fig. 3. A triode tube is connected as an ordinary grid-leak detector with a couple of important differences: between the bottom of L1 and the cathode is a coil that is inductively coupled to an "oscillator," and the primary of an i.f. transformer appears in the plate circuit. In the next chapter we shall take up in great detail the subject of oscillators, but for the present it is enough to know that an oscillator is a generator of alternating current and can be made to operate on practically any desired frequency.

Now, suppose a radio signal of 1,000 kc strikes our antenna and appears across the tuned circuit L1-C1 resonated to that frequency. At the same time, suppose our oscillator is operating on a frequency of 1,455 kc and that

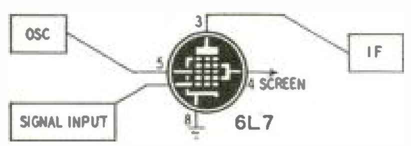


Fig. 4—Circuit for frequency conversion with a mixer tube. This type of circuit needs a separate oscillator.

this frequency is delivered through T1 so that it appears between the bottom of L1 and the cathode. In other words, the 1,000-kc and the 1,455-kc frequencies are in series so that their combined voltages are presented to the grid circuit of the tube.

Our study of the similar circuit of Fig. 1 tells us that this mixture of frequencies will result in a voltage envelope that is modulated at a frequency equal to the difference between the other two — in this case 1,455 – 1,000 or 455 kc. We further know that when this envelope is passed through the detector tube, the modulating frequency will appear in the plate circuit. The tuned circuit of the i.f. transformer selects this "difference frequency" from the others that also appear in the plate circuit and starts it on its way through the i.f. amplifier.

If we want to receive a signal on 1,400 kc, we adjust our oscillator to a frequency 455 kc higher (to 1,855 kc), and once more the difference frequency is the required intermediate frequency. By the same token, a 600-kc signal can be converted to the i.f. frequency by mixing it with a 1,055 kc frequency from the oscillator.

Image rejection

You are wondering why bother with a tuned circuit connected to the antenna when we can change any signal to the intermediate frequency simply by parking the oscillator 455 kc away from that signal. You are forgetting one thing: *two* signals can be 455 kc from the oscillator frequency, one above it and one below it. For example, when we set our oscillator to 1,055 kc to receive a station on 600 kc, another station on 1,510 kc could also beat with our oscillator and produce a difference frequency of 455 kc. This would be accepted by our i.f. amplifier just as readily as the one produced by beating with the 600-kc signal, and both signals would be heard at once. A tuned circuit that selects one of these signals and rejects the other is the solution.

In a practical modern receiver the tuning of the oscillator and of the signal input circuit are mechanically coupled together and so arranged that there is always a difference between them equal to the intermediate frequency of the receiver. Usually, in a broadcast receiver, the oscillator operates on the high-frequency side of the signal being received; so, if we have an intermediate frequency of 470 kc, the oscillator frequency is always 470 kc higher than the resonant frequency of the input circuit. Any station operating on the "image frequency" 470 kc higher than the oscillator frequency will be rejected by the input circuit that is always tuned 470 kc lower than the oscillator.

Some modern circuits

Modern receivers usually use mixer tubes specifically built for the job of frequency conversion. Such a tube is the 6L7 shown in Fig. 4. In addition to the usual plate, screen, cathode, and suppressor elements, this tube has *two* input grids, both of which can control the plate current. That means that

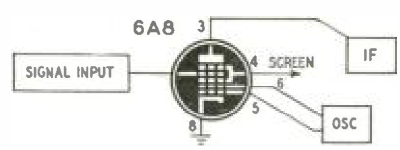
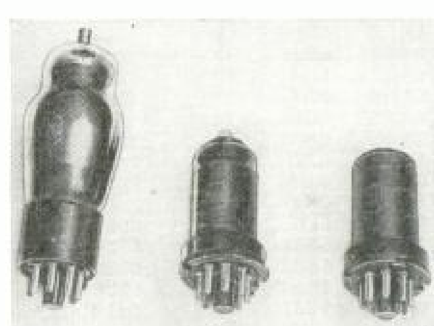


Fig. 5—Pentagrid converter circuit. The first two grids act as the grid and the anode of the oscillator stage.

when the signal voltage is connected to one grid and the oscillator to the other, these combined influences determine the



Three tubes commonly used in converter circuits. From left to right they are: 6L7-G pentagrid mixer; 6K8 triode-hexode, and a 12SA7 pentagrid converter.

plate current, just as they did when both appeared together on the grid of our triode. The only difference is that the mixing now takes place in the electron stream instead of the grid circuit.

The tube operates over a nonlinear

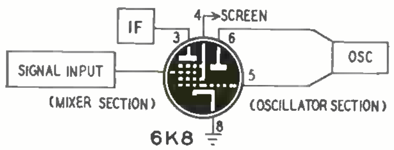


Fig. 6—A triode-hexode mixer circuit. The triode is used for the oscillator and the hexode section is the mixer.

portion of its curve and so gives "power detection" action to the mixed frequencies. In Chapter XVIII we learned detectors of this type are not sensitive to weak-signal carriers. A substantial portion of the bending part of the tube's curve must be brought into play to get the unequal amplification of positive and negative peaks required for detection. A very small portion of the curve, such as used by a weak carrier, does not have enough bend to accomplish this.

In the 6L7 the local oscillator always furnishes a strong "carrier"—usually better than 20 volts peak-to-peak—and the strength of the signal itself merely determines the depth of the i.f. modulation impressed on this supplied "carrier." A close study of Fig. 2-c will reveal this is true. Thus we see that the oscillator voltage is not only necessary for mixing with the signal voltage, but also improves the efficiency of the detector part of our converter.

The 6L7, however, requires a separate oscillator tube; therefore the "pentagrid converter," combining mixer and oscillator in one tube, is more popular. Fig. 5 shows a 6A8 pentagrid converter in a typical circuit. Grid Nos. 1 and 2 form the control grid and anode, respectively, of a triode oscillator, with pulses of current flowing to grid No. 2 at the oscillator frequency. Not all of the electrons that reach grid No. 2 stop there, however. Some of these spurts of electrons continue on toward the plate and are further modified by the signal voltage impressed on grid No. 4. Thus the electron stream that finally reaches the plate has been shaped first by the oscillator frequency and then by the signal frequency. The detector action of this five-grid tube is like the 6L7's.

Still another popular mixer is the triode-hexode 6K8 illustrated in Fig. 6. In the envelope of this tube we have a triode oscillator and a hexode mixer. The grid of the oscillator section is connected internally to one of the two input grids of the mixer section and so causes the oscillator voltage to appear on that grid. The signal input frequency is connected to the other input grid, and the mixing and detection action from this point forward is quite like that of the 6L7.

You will meet various modifications of these basic mixer circuits from time to time, but you can unscramble them all if you keep the following in mind. When two a.c. frequencies appear together, they produce a voltage envelope that is modulated at a frequency equal to the difference between them. This difference frequency can be separated from the other two by passing the mixture through any one-way-action "detector" device.

100-TUBE STOCK FOR TELEVISION

IN AREAS where TV is just starting, the service technician may not know just what an adequate TV tube stock should include. If a leading TV set manufacturer has preceded others into the area, you should stock just those tubes required for the one or two models in use. Where the area has been invaded by dozens of different manufacturers, this complete tube list should provide a basis for elementary stocking. The whole stock can be provided for $100 or less. *It is better to have the tube than have the customer go elsewhere.*

Certain tubes will fail more often than others. To cite a popular example,

Basic Tube Stock

1B3[1]	6AT7	6SK7	7W7
1N34[2]	6AU6[1]	6SL7	7Z4
1X2	6AV6	6SN7[1]	7JP4[3]
2X2	6BA6[1]	6SQ7	10BP4[3]
5U4[1]	6BA7	6SR7	12A6
5V4[1]	6BE6	6T8	12AL5
5Y3	6BG6[1]	6V6[1]	12AT7[1]
6AC7[1]	6BH6	6W4	12AU6
6AG5[1]	6BJ6	6X4	12AU7[1]
6AG7	6BQ6	6X5	12H6
6AH6	6C4	6Y6	12SQ7
6AK5[1]	6CB6	7A6	12SN7
6AL5[1]	6H6[1]	7AF7	19T8
6AL6	6J5	7AG7	25BQ6
6AL7	6J6[1]	7B4	25L6
6AQ5	6K6[1]	7B5	25Z6
6AQ7	6L6	7C5	35L6
6AR5	6S8	7F7	35Z5
6AS5	6SC7	7F8	50B5
6AS7	6SH7	7H7	50L6
6AT6[1]	6SJ7	7N7	Sel Rect.[4]

1. Two or more should be stocked.
2. Germanium crystal.
3. Cathode-ray tube.
4. Stock a .150 amp selenium rectifier.

when a customer phones in bewailing the fact she has perfect sound but absolutely no light in the picture tube, in most cases it will simply be the high-voltage rectifier tube.

Cathode-ray tubes last a long time. C-R tube manufacturers make exhaustive tests of this rather expensive type of tube to show up the poor ones before they leave the factory.

Many service shops don't even stock replacement C-R tubes. Our minimum shelf will have one 7-inch C-R tube for electrostatic check and one 10-inch for electromagnetic sets.

In TV, certain tubes are rather ticklish. They will test good in a tube checker, but perform poorly in certain stages. Don't be a tube-snatcher. The tubes you borrow from another set for testing may not be returned to identical sockets. It isn't fair to the good set's owner to risk upsetting his alignment because the stock shelf is low.

In certain cases a different tube type may be substituted *as an emergency measure* to keep a set going while the proper replacement is being ordered. If you must, you must—but give the customer a break and really order the replacement and install it when it comes. If tubes did not have different characteristics, they would not have different numbers. Some of these emergency tube exchanges are 6SJ7 for 6SK7, 6V6 for 6K6, 6SN7 for 6SL7, 6F6 for 6V6, 1651 for 6AC7. *Temporarily*, that is.

Germanium diodes and selenium rectifiers, both used to replace tube rectifiers, must be included in the tube stock. The 1N34 is used as video detector in many sets. Selenium rectifiers have a broad range. Some are used for d.c. filament supplies requiring 0.15 amp., while others supply only .069 amp. For the starting stock only *one* selenium rectifier, the 0.15 amp. type, is recommended. This provides emergency service for almost all sets.

Certain tubes are so common in TV that they must be included in even the most elementary stockpile. The 1B3 is used in over a hundred different TV models as high-voltage rectifier. (The new 1X2 miniature tube is used in the latest sets for this same application.) For low-voltage rectifiers such steadies as the 5U4 and 5V4 are popular.

Old standbys like the 25Z6 (five are used in a single Emerson model) and 35Z5 (two in a single Truetone) are used often in a.c.-d.c. TV sets. Occasionally such rectifiers as the 6X5, 6W4, 5Y3, and, in older electrostatic models, the 2X2 are used.

A number of the "7" series of loctal tubes are used, but they are found almost exclusively in Philco and occasionally in Silvertone sets.

TV tuners call for a stock of types 6AG5, 6AK5, 6AU6, 6CB6, and 12AT7. A half-dozen popular sets use the 6J6 exclusively in their tuners. These make good replacements even when the set is playing normally by improving gain and selectivity and reducing hum and should be adequately stocked.

The most popular TV detector is the 6AL5. Almost all TV sets use two, one for video and one for sound detection.

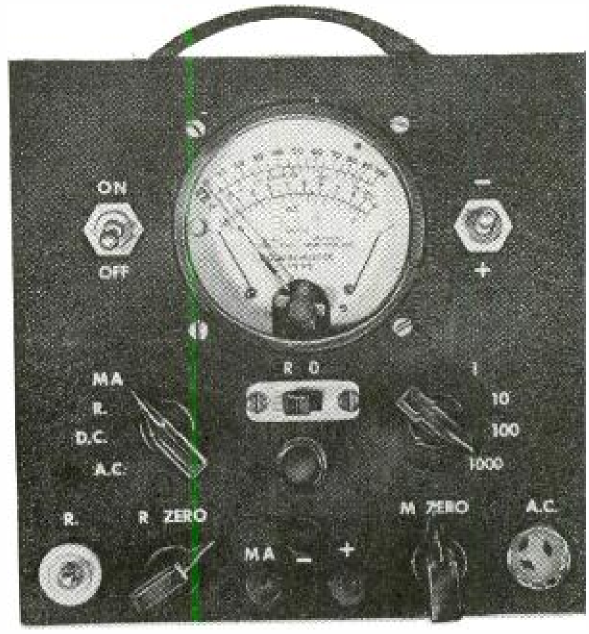
Here is the basic 100, listed numerically and alphabetically. No notation has been made of G, G-T, or other type suffixes in this list. The best recommendation is: get the smallest tube envelope of that type, with glass preferred over metal for TV applications.

—*Dave Gnessin*

A Sensitive V. T. V. M.

A vacuum-tube volt-ohm-milliammeter that uses a war surplus movement

By GEORGE W. SCHULTZE



Panel view of the v.t.v.m. The instrument is compact, yet simple to use.

A SURPLUS 1D-24/ARN-9 glide path indicator has a meter movement that is easy to convert for use in a sensitive voltmeter circuit. The circuit, shown in Fig. 1, has 1-, 10-, 100-, and 1,000-volt scales a.c. and d.c., with provisions for cancelling grid current and tube variation effects and a.c. probe diode contact potential. The instrument also serves as an ohmmeter with resistance readings up to 50 megohms, and as a milliammeter with full-scale readings of 1, 10, 100, and 1,000 ma.

The first step in constructing this unit is modifying the indicator. The original instrument has two D'Arsonal movements, a 0-200 μa and a 200-0-200 μa. The 0-200-μa movement and the case are used in the v.t.v.m. When you remove it from the case, you will see several screws and soldered leads. Remove these and lift the zero-center movement out of the assembly intact. Lay it aside for future use.

Discard the two original faces. The annular face, as well as the glass, is locked in by a press-fit sleeve, which may be pulled by a simple jack-screw device made to engage the two holes in the sleeve. The writer did not disturb the glass crystal but removed the superfluous zero-setting button.

Install a new dial made of 1/16-inch aluminum or brass with a spacing sleeve on one of the screws for the support formerly given by the zero-center movement. Make new wire needle stops to replace the original fiber ones. Face the dial with white drawing paper and lock it in place by the same tiny screws that hold down the dial and stops. The original needle is a thick pointer coated with luminous paint. You can convert the needle to a knife-edge pointer by judicious use of a pair of long-nose pliers. (Carefully squeeze the thin-walled tube forming the needle to collapse it to a flat strip.) This treatment automatically cracks off the luminous paint and leaves the pointer clean.

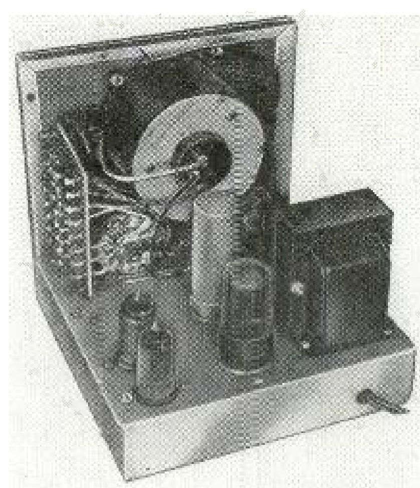
Removing the paint throws the needle system out of balance and it finds a different zero for each plane in which the meter is held. Coating the "knife edge" with red fingernail polish will restore part of the lost weight. You can then add more weight by cementing a small piece of copper wire to the needle at the base of the tube with additional nail polish. Make the final adjustment by building up the polish in the same place until you can turn the meter face from a horizontal to a vertical position without changing the zero setting.

To calibrate the meter dial in microamperes, use a 1½-volt battery, a 1-megohm potentiometer and a 0-200- or 0-300-μa meter in series. Make a rough calibration first in pencil, then do the final marking in ink with the meter in its case. The scale will be slightly nonlinear in the upper part, probably because the magnetic field arrangement is upset by removal of the zero-center movement. This does not detract from the usefulness of the instrument.

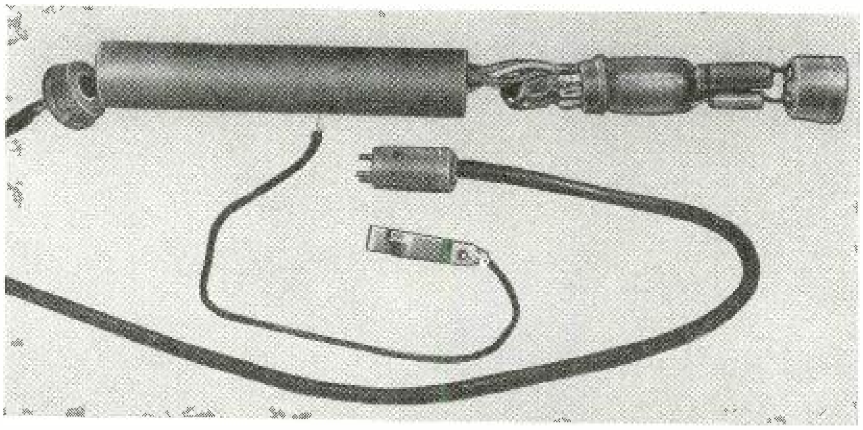
The v.t.v.m. circuit

The circuit is orthodox. The twin triode V2 is a cathode-loaded buffer stage that operates at very low plate voltage (about 15 volts) to eliminate grid current error. V2-a is the signal channel. V2-b balances out variations in supply voltages and tube characteristics, and, when using the tube probe to measure a.c. or r.f. voltages, provides a point of insertion for the contact potential compensation of the probe diode.

V3, the meter tube, continues the two balanced channels and practically eliminates errors due to supply voltage variations and change of tubes. The meter measures the difference in cathode potential for the two halves of V3. With everything balanced and no applied signal, the two cathodes are at the same potential and the meter current is zero. When a positive voltage is applied to the input, the grid of V2-a, and consequently that of V3-a, is more positive and the current in V3-a increases. This causes the cathode potential of V3-a to increase, and current flows through the meter. R13 balances V3 for zero signal. The writer used 12AU7's to conserve space. 6SN7's would do just as well but they are not as compact. The twin filaments in the



Rear view photo of the meter showing the parts layout. The voltage dividers are on the mounting boards at the left.



Closeup of the a.c.-r.f. probe showing how the parts are fitted in the tube.

12AU7's are connected for parallel operation on 6.3 volts.

The voltage divider R2- R3- R4- R5, together with the switching arrangement, gives a choice of full-scale voltage readings of 1, 10, 100, and 1,000. The input resistance is 50 megohms.

The a.c.-r.f. probe gives two choices of input capacitor, .02 μf for low-frequency signals and .0005 μf for radio- and high-frequency measurements. One half of the 6AL5 twin diode rectifies the signal being measured. The other half generates its normal contact potential current which is injected into V2-b to balance an equivalent contact potential from the rectifying diode injected into V2-a. R6, R7, R8, R9, R10 form a voltage divider to select the correct proportion of the balancing diode contact potential. R1 is a dropping resistor which reduces the peak voltage of the rectified signal to the r.m.s. value (sine-wave signal assumed), thus allowing the higher a.c. voltage readings to be read on the basic d.c. scale. Scales for the 1- and 10-volt a.c. ranges need special calibration because of the nonlinearity of the diode at low voltages.

Construction details

This instrument is built for compactness. The chassis is 7 x 7 x 1½ inches and the unit is enclosed in a 7 x 7 x 7-inch sheet steel case. The meter (altered as described above), the function selector switch S2, the range selector switch S1, the meter tube balance control R13, the ohmmeter zero control R11, the ohmmeter ZERO-READ selector S3, the ohmmeter battery switch S5, the meter polarity switch S4, the power switch, and the various input terminals are all on the front panel. The power supply voltage divider, the contact potential compensation control R10, and the meter calibration control R14 are mounted under the chassis. R10 and R14 are installed to allow screwdriver adjustment through the side of the case to make calibration easier.

The power transformer, the tubes, the filter capacitor, and the resistor mounting boards are on top of the chassis. The 12AU7 tubes require nine-pin miniature sockets. To keep leakage low, the selector switches and the ohms input terminal are ceramic insulated. S5 is a momentary contact, normally open, push-button switch.

The probe case is made from a 5-inch length of ⅞-inch outer diameter copper tubing of the type used for sweated-joint water piping. End plugs are turned from polystyrene rod. The capacitors in the probe should be the ultra-compact type. C1-a or C1-b are selected by providing two threaded holes to receive the ⅛-inch diameter brass probe tip. The probe shell should be lined with insulating paper or cloth. The probe lead is a three-conductor, shielded, rubber-covered cable.

Resistor matching

The resistors for the input, contact potential, and ohmmeter voltage dividers must be matched. Set up a resistance bridge as shown in Fig. 2. Ra-Rb is a 10,000-ohm, or better still, a 100,000-ohm wire-wound potentiometer. One of the surplus precision potentiometers which have been on the market for some time is ideal. This potentimeter must be carefully calibrated, and a pointer and dial arranged so that the resistance division made by the slider can be reproduced.

Choose the lowest value resistor in the divider first. R5 and R6 may be of any accuracy as long as the approximate total input resistance is maintained, and the ratio of one resistance to another in the same divider is accurately adjusted. For R12 use either a precision resistor or one selected on a resistance bridge.

Let us follow the matching procedure through for the input divider R2- R3- R4- R5. The resistor selected for R5 becomes the temporary standard Rs in Fig. 2. For the 200-0-200 microammeter we use the movement just removed from the indicator instrument. Rx is now to be our R4, carefully matched to be nine times the resistance of R5 (Rs). For R4 first select a resistor coded at something under 450,000 ohms. Then make up the difference with a much smaller resistor selected to balance the bridge exactly. When the current through the meter is zero and the ratio of Ra to Rb is 9:1, the ratio of Rx to Rs is 9:1. Next put the two, or possibly three, resistors making up R4 in series with R5 and insert these in the bridge as Rs. Pick a resistor slightly under the required value of 4.5 megohms and add a "trimming" resistor to balance the bridge again at 9:1.

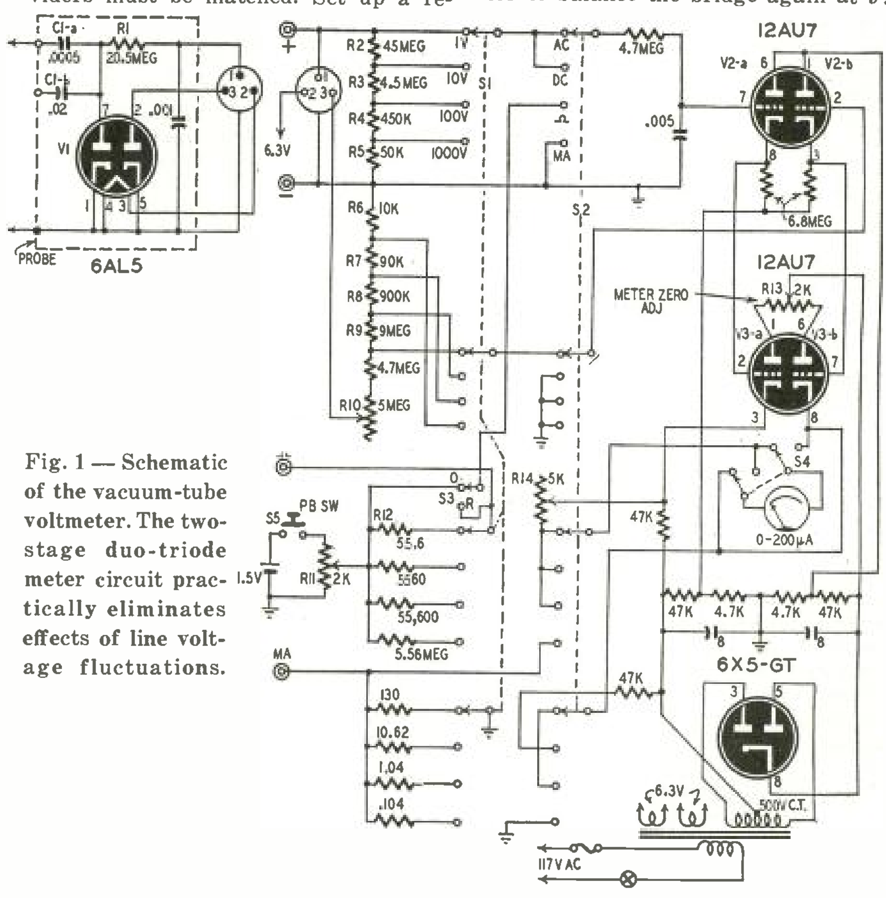


Fig. 1 — Schematic of the vacuum-tube voltmeter. The two-stage duo-triode meter circuit practically eliminates effects of line voltage fluctuations.

R2 is selected by the same method. R1 is matched by using R3, R4, R5 in series as Rs in the bridge, and balancing at an Rb/Ra ratio of 20.5:5 or 4.1:1.

Follow the same procedure to make the contact potential compensation divider and the ohmmeter resistors. The ohmmeter resistors give 500-, 50,000-, 500,000-ohm and 50-megohm readings at 90% full scale.

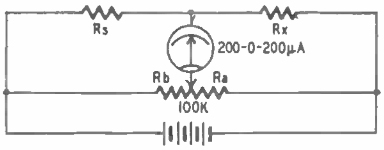


Fig. 2—This bridge circuit is used to select the voltage divider resistors.

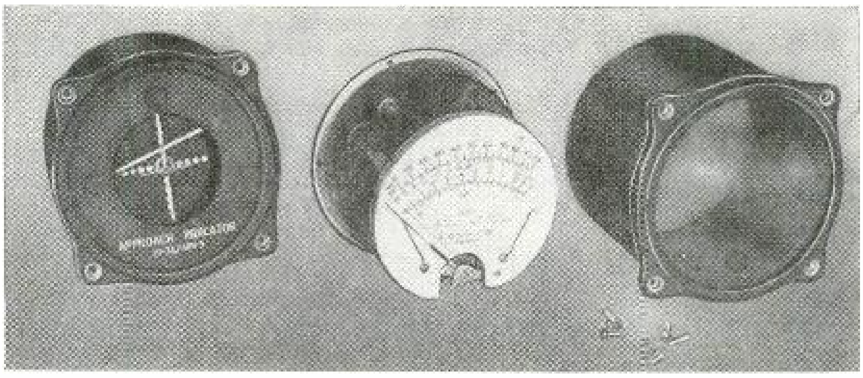
The milliammeter shunts should be precision resistors or selected with a resistance bridge. The required values depend on the meter resistance. The movement used by the author has a resistance of 520 ohms, and the shunt resistors listed are for that value.

Calibration and adjustment

The meter dial has four different scales: (1) the basic scale for d.c. volts, a.c. volts to 100 and 1,000, and milliamperes; (2) the 0-1-volt a.c. scale, (3) the 0-10-volt a.c. scale; (4) the ohms scale. The two special a.c.-volt scales can be obtained only by comparison with a dependable a.c. voltmeter. The ohms scale must be calculated.

After the usual checks have been made on filament and plate voltages with the meter movement disconnected, balance V3 by adjusting the panel control R13. It is better to make these adjustments for the first time with a less sensitive meter rather than the 200-microamp movement built into the instrument. The latter can be placed back in the circuit when everything is approximately in line with expected performance. The setting of R13 for meter zero must be changed slightly as the tubes heat up. Always allow sufficient time for the tubes to heat up. Now apply 1 volt d.c. to the d.c. input terminals, as measured by a good d.c. voltmeter and, with S1 at position 1 and S2 at DC, adjust R14 with a screwdriver until the meter reads exactly full scale (200 microamperes). The other d.c.-volts scales should fall in line if the input divider resistors were carefully chosen.

Next throw S2 to A.C. and plug in the a.c.-r.f. probe. Adjust R10 with a screwdriver until the meter reads zero. You can see the amount of contact potential that is being compensated for by setting S2 on D.C. By the same token, when measuring values other than a.c. or r.f. volts, the probe lead must be removed from its panel socket. Here again, if the divider has been set up accurately, the meter will be compensated to zero for each scale with one setting of R10. The 100- and 1,000-volt a.c. scale readings can now be read directly on the basic scale.



This photo shows the meter both before and after alterations have been made.

The ohms scale may be laid out from the formula:

$$V = Rx/(Rn + Rx).$$

V is the meter reading in volts on the 0-1-volt scale, Rx is the unknown resistance, and Rn is the standard resistor.

When reading ohms, connect the unknown resistor to the OHMS terminal and to ground, set S2 at OHMS and S1 to select the appropriate standard resistor. Adjust the voltage across the resistors to 1 volt by setting S3 to 0, pushing in S5, and varying R11 to give full-scale reading on the meter. Then read the value of the unknown resistor on the ohms scale by switching S3 to R and again depressing S5.

Leave S2 set to MA when the instrument is not in use, and do not switch to another function until the tubes have warmed up. This avoids a sharp deflection of the meter pointer when the tubes are unbalanced during warmup.

MATERIALS FOR V.T.V.M.

Resistors: 2—4,700, 4—47,000 ohm, 2—4.7, 2—6.8 megohm, 1/8 watt; 2—2,000, 1—5,000 ohm, 1—5-megohm potentiometer; 14—voltage divider resistors selected as described in text; 4—milliammeter shunts selected on resistance bridge.
Capacitors: 1—.0005, 1—.001, 1—.005-μf mica; 1—.02-μf, 600-volt papers; 2—8-μf, 450-volt electrolytic.
Miscellaneous: 1—250-0-250-v.a.c. power transformer with 6.3-volt winding; 2—4-pole, 4-position switch; 1—d.p.d.t. switch; 1—s.p.s.t. push-button switch; 1—s.p.s.t. toggle switch; tubes, sockets cabinet, 0-200-μa meter, chassis, hookup wire, assorted hardware.

NOISE ISOLATION IN A. C.-D. C. SETS

Were you ever faced with a noisy a.c.-d.c. set which snapped, crackled, and popped whenever any tube, component, or part of the chassis was tapped? Such sets can be headaches, but they can be converted to routine servicing jobs if you use the following method.

Eliminate the possibility of noisy tubes by substituting new ones. If the trouble persists, the search can be narrowed down to under-chassis components or poor soldering.

Assume that the set has the following tube line-up: 12SA7, 12SK7, 12SQ7, 50L6, and 35Z5. Remove the 12SK7 and substitute a dummy tube made by clipping off all pins except 2 and 7 of a tube having a 12.6-volt, 0.15-amp heater. The r.f. and i.f. circuits are now dead as far as the speaker is concerned. If the noise disappears, it originated between the antenna and the i.f. output. If it persists, it starts further along in the circuit. Replace the operative 12SK7 and substitute a dummy 12SQ7. If the noise is gone, it is in the detector or first a.f. circuits. Look in the power supply and output stages if you can still hear it.

This technique, supplemented with an insulated prod and a little brains, will make simple cases out of previous "head-scratchers." Any busy service shop can muster enough used or defective tubes with good heaters to make dummy tubes for substitution. The table shows voltage and current ratings, and heater pin connections for dummies which can be used in most sets having series heater strings. You can add to this list as the vacuum-tube engineers come up with new—and unnecessary—pin terminations.—*R. W. Reid*

Dummy-Tube Table

HEATER			Dummy tube substitutes for
Volts	Amps.	Pins	
OCTAL			
6.3	0.3	2-7	6SA7, 6SK7,
6.3	0.3	7-8	6SQ7, 6SC7.
6.3	0.15	2-7	6SS7, 6T7G,
6.3	0.15	7-8	6ST7, 6SZ7,
6.3	0.45	2-7	6AC7—video use
12.6	0.15	2-7	12SA7, 12SK7,
12.6	0.15	7-8	12SQ7, 12SC7,
1.4	0.05	7-8	1N5, 1H5
LOCTAL			
1.4	0.05	1-8	1LN5, 1LH4,
6.3	0.3	1-8	7B8, 7B6,
6.3	0.15	1-8	7A8, 7C6.
12.6	0.15	1-8	14A7, 14B6.
12.6	0.3	1-8	14N7
MINIATURE			
1.4	0.05	1-7	1T4, 1S5,
6.3	0.3	3-4	6AU6, 6AT6,
6.3	0.15	3-4	6BJ6, 6C4,
12.6	0.15	3-4	12AU6, 12AT6
5-PRONG			
6.3	0.3	1-5	76
6-PRONG			
6.3	0.3	1-6	6D6, 75, etc.
7-PRONG			
6.3	0.3	1-7	6A7, 6B7, 6F7, etc.

Taxi Radio Servicing Has Special Problems

Common faults of Motorola mobile radios and how they can be cured

By C. PALUKA

SERVICING the taxi mobile radio is a different problem from repairing home radios. In these sets, reliability being as important as cost, higher quality parts as used. Because of this, most troubles, other than tube failure, are mechanical.

After about a year of flexing, the microphone cables will break inside near the ends. If one of the control wires is broken, the transmitter either will not turn on or will cut off and on. If the microphone wire is broken, the voice will usually cut in and out. The easiest way to locate the broken wire is to unclamp the wires at the ends and give each wire a firm tug. The broken wire will give like a rubber band. At the microphone end the outer cover may be stripped off, the bad wire spliced, and placed inside the case.

In an emergency this may be done without soldering; but if the break is at the set end, the wires must be cut above the break, stripped, and then soldered to the plug.

The most common fault is breaking of the coil leads. In the Motorola FMRU-30 receiver the tuned lines of the r.f. and multiplier coils break loose from the solder. The coils may be checked with a low-range ohmmeter. They should have a resistance of about .1 ohm. Wiggle or tap the coil to check for intermittents. If the resistance is much higher or varies, apply flux and a little more solder with a very hot iron. Sweat the center wire joint well.

Another source of trouble is the FMTU-30 transmitter phase-modulator coil. It may be repaired by flowing solder with a hot iron down the center hole of the terminals. In the FMTRU-5 sets the coil forms sometimes break loose from the cemented base and change the tuning. Remove the cover and recement them with regular service cement.

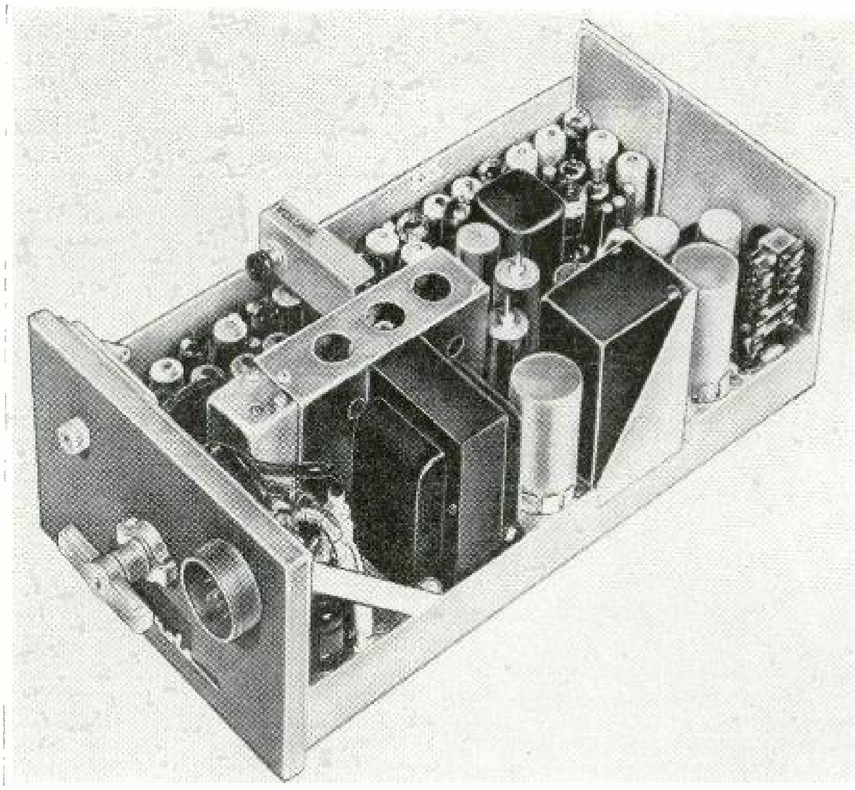


Photo of a typical taxi mobile radio. This set is one of the Motorola series.

One advantage of these sets is the ease with which the essential stages may be metered. Tube life in the receivers is very good with burnouts the chief trouble. Vibrator life is not as dependable, however. A weak vibrator causes loss of sensitivity, although the sets will operate with only 60 volts on the plates. The best sign of a weak vibrator is low oscillator grid current. If it is below 8 microamperes, and replacing the tube and tuning the tank coil has no effect, the vibrator is likely defective. Often a vibrator will stop. This can be caused by a particle between its points. Removal, a sharp blow on the side, and replacement generally will start it operating again.

Intermittent loss of sensitivity usually is caused by bad tube or coil connections. These may be located by tapping the suspected components gently while receiving a signal and metering the stages.

Substitution is the best method of tube checking. Sometimes a tube can be slightly gassy and still operate at the voltages used in a tube tester, but at the higher frequencies it loads the coil and decreases the gain.

Low sensitivity can usually be blamed on the alignment. Constant vibration and changes in temperature cause mechanical movement which changes the tuning. Alignment of the receiver in the cab is not difficult and may be done with no test equipment other than the P-8100 or P-8500 Motorola test meter.

The first step is to zero the discriminator to the master station. Next switch the meter to the oscillator and adjust the oscillator transformer for maximum grid current. Switch the meter to the first limiter. If there is no grid current, switch to the second limiter. With no signal, tune the i.f. transformers for maximum meter deflection, going backward from the first limiter to the first detector. When the first limiter begins to draw grid current, switch to it and continue tuning the i.f.'s.

Switch the meter back to the second limiter and tune it for maximum. Then switch the meter to position 5 and tune the discriminator primary for maximum. All this is done with the noise voltage of the first detector. Check the no-signal zero of the discriminator. If it is off more than 4 microamperes, repeat the alignment. If this does not restore normal sensitivity, the set must be removed for bench alignment.

Tune in the main station. With the meter on the first limiter, tune the multiplier and the r.f. coils for maximum. If one of the coils does not tune, it is probably open and, if repaired properly, will tune with a definite peak. Detailed alignment procedure is covered in the Motorola service manuals for these sets.

Because of the complexity of the transmitter most of the troubles occur in it. *(Note: only an FCC-licensed* *technician, second-class telephone or higher, may make transmitter adjustments.*) The tubes cause less trouble than in the receiver, with gassy tubes being the chief trouble. Usually the tube reads normal at first and then the meter falls slowly.

A good share of trouble is caused by the dynamotor. If the dynamotor runs or starts very slowly, the cause may be the relay points. If one contact is pointed and the other hollowed, file the contacts with a point file until the contacts are clean. Check the low-voltage brushes. If they are shorter than ⅜ inch, replace them. To avoid trouble with the relay points install an automobile starter relay to handle the heavy current. They may be obtained in a modification kit from Motorola or from a supply house.

High mica on the commutator will cause intermittent starting failure and hashy transmissions. The remedy is to undercut the mica. If a groove is cut in the commutator by the brushes, it is a good idea to have the commutator removed and turned down. Corroded connections on the battery terminals or a weak fuse clip will cause the dynamotor to run slowly and the set to lack power. If this is the case, the lights on the control panel will dim when the microphone switch is pressed. Other causes of hashy transmissions are poorly fitting brushes and carbon deposits between the commuator bars of the high-voltage section of the dynamotor.

Poor transmissions are annoying to the dispatcher. The most common cause is low final amplifier output. If that is not the cause, connect headphones to the modulator grid and listen. If the quality is bad, a tap on the side of the microphone may restore the quality. If the quality is good, but the transmission is weak, check the phase shifting network and the balanced modulators. Often the r.f. choke opens at the soldered terminals. If the transmission is buzzy, resolder the connections on the oscillator tank coil.

In cold damp weather frost forms in the base of the antenna and interferes with operation. To check for this, remove the antenna plug from the transmitter and measure the resistance with an ohmmeter. If the value is less than 5 megohms, remove the antenna base, dry it thoroughly, coat it with ignition sealing compound and replace the base. If the coaxial cable is heated too much when it is connected to the antenna base, the insulation will disintegrate or carbonize and form a partial short. The check is the same as for frost. The bad section of the cable will have to be cut off and the cable reconnected.

Most troubles can be narrowed down to a certain part of the set. Study of the schematic and a little thinking will give you an idea of the possible cause. Then an electrical check should be made of the suspected components. A careful inspection should be made for broken connections and cases. This will very often show the faulty part.

Aligning AM Receivers

By W. H. BRAKES

MOST articles on AM receiver alignment do not cover the many difficulties which arise for the beginner. For example: "Peak the antenna trimmer at 1400 kc." This is good advice, but what if it *won't* peak? The beginner may unscrew the trimmer to the end of its thread and not reach a peak. And even many service technicians don't know what to do when that happens.

The i.f. circuits: Connect a short length of insulated wire to the antenna terminal of the set. Wrap this loosely around the hot end of the signal generator lead to provide capacitive coupling. With the receiver tuned to a blank spot on the dial, volume nearly full, and the signal generator set to the i.f. of the set, a weak signal of the intermediate frequency should be heard. *Rotate* the receiver dial to *make sure* the signal in the speaker is i.f. only, and not affected by the r.f. tuning. Adjust the i.f.'s in the usual manner, commencing with the second i.f. stage. Keep the signal generator at minimum possible output. If a vacuum-tube voltmeter is available, connect it from the a.v.c. bus to ground and peak for maximum a.v.c. voltage. Normally, adjustment by ear is satisfactory.

Untuned i.f. output: With this type of circuit, remove the grid lead from the i.f. tube, and connect the grid to ground through a resistor. Clip the signal generator to the grid through a small mica capacitor. Tune the *signal generator* for maximum signal in the receiver. If this signal is very broad, select the mid-point. Leave the signal generator fixed, replace the normal grid lead, then tune the input i.f. transformer to this frequency. This assures maximum gain and selectivity from the untuned stage. If the frequency is more than 10 or 20 kc from the set's nominal i.f., look for trouble in the transformer.

Wave trap: With the signal generator loosely coupled to the antenna lead (and still at the i.f. setting), adjust the wave trap, if any, for minimum response. With some circuits it may be necessary to have an antenna connected.

R.f. and antenna circuits: Remove signal generator and connect an antenna to the receiver. If the set is normally used with a built-in loop only, it should be adjusted that way. The loop must be in its proper location.

Tune in a very weak signal near the high-frequency end of the dial, say 1,400 or 1,600 kc. Peak the r.f. (if any) and then the antenna trimmer. It is important to obtain a definite *peak* in adjusting these trimmers. If unscrewing the trimmers produces a stronger signal until the trimmer has reached the end of its adjustment, there is only one remedy—tighten the adjustment (increase the capacitance) of the oscillator trimmer by a quarter or half turn. Retune the station for strongest signal and again try to peak.

Increase the capacitance of the oscillator trimmer a half or quarter turn at a time until a definite peak is obtained on the antenna trimmer. This is essential for proper gain and selectivity at the high end of the dial. The dial calibration may be off, disregard this for the moment.

Low-frequency padder: Tune the set to approximately 600 kc. Connect a short lead to the antenna terminal of the set, and place it near a fluorescent light or an electric razor. Adjust the 600-kc padder to peak volume.

Calibrating the dial: When these adjustments have been completed, check the dial calibration on several stations. If the set is well designed, moving the pointer (mechanically) a little in one direction or the other will be enough. If this does not produce perfect tracking, set the pointer for correct reading at the middle of the broadcast band, say at 1,000 kc. A slight re-adjustment of the oscillator trimmer, with corresponding re-adjustment of antenna and r.f. trimmers, will often correct the high end of the dial; but be careful not to reduce the oscillator trimmer capacitance to the point where the antenna trimmer no longer peaks. It may be necessary to compromise on the low end of the dial, sacrificing exact dial calibration for efficiency.

Sets using cut oscillator plates in the gang capacitor as a rule have no adjustment for 600 kc. Check tracking if the set is insensitive or broad at this end of the dial. First be sure the high-frequency end of the dial is properly peaked. Tune in a weak station between 500 and 600 kc. Tune the oscillator, r.f., and antenna trimmers. If increasing the capacitance of these trimmers increases volume, the tracking is poor. Change the adjustments of the i.f. transformers to peak at a frequency 5 to 10 kc lower than previously. Repeak the r.f. and antenna trimmers at the high-frequency end of the dial, and again check for sensitivity at 500 to 600 kc.

In some cases it is necessary to change the i.f. frequency by as much as 20 or 30 kc for proper results. If *decreased* capacitance of the r.f. and antenna trimmers produces greater volume at 500 to 600 kc, it is necessary to use a *higher* i.f. Shift the i.f. in steps of 5 to 10 kc for the best frequency.

A RADIO TECHNICIAN LOOKS AT INDUSTRY

Industrial electronics offers many opportunities to radio technicians

By GUY SLAUGHTER

"INDUSTRIAL electronic technician?" he repeated, shaking his head vigorously. "No, not me. I'm just a radioman in a factory." Then his face lighted up in a contented smile. "And you know what?" he continued. "I've got no unreasonable customers to deal with, no deadbeats to collect overdue bills from, no parts to buy, and no rent to pay. I just work on radios and draw my paycheck!"

"Radios?" we said, our eyebrows rising.

"Well," he shrugged. "Practically radios. Controls and gauges and counters and flaw detectors. You know. Glorified amplifiers and Wheatstone bridges, that kind of stuff."

"Yeah," we said solemnly. "See what you mean."

"You just visiting?" he asked.

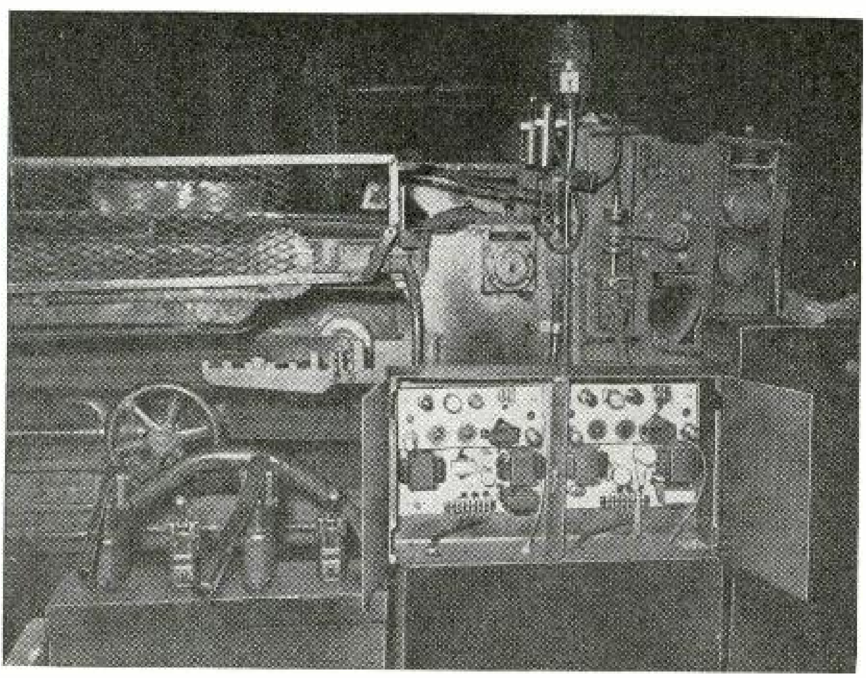
We nodded. "We've been hearing about industrial electronics, and decided to investigate. We figure the steel industry is probably typical. So we're here to look around."

"Fine," he said laconically. "Anything I can do, let me know."

We thanked him and continued our investigation.

We had already learned that the industrial electronic field is a large and still mushrooming business, with steel mills, paper mills, foundries, container manufacturers, even pharmaceutical supply houses using industrialized electronic devices to inspect and control everything from the thickness of the tin coating on a steel tomato can to the number of pills in a bottle. And we had learned too that behind each of these devices and those yet to be developed there is a crew of "radiomen" to make it and another crew to keep it operating.

Now we sated our technical appetites by investigating the types of equipment to be found here in this modern steel plant.



The two chassis shown in the photo are sheet counter amplifiers. The strip of steel approaches from the right and is cut into sheets which are counted by a photocell. Two counters are used; one checks against the other for accuracy.

A huge and impressive-looking metal cabinet bearing the legend DANGER! 50,000 VOLTS! THIS CABINET TO BE OPENED ONLY BY AUTHORIZED PERSONNEL!, and sporting numerous dials, meters, and switches, turned out to be a thickness-indicating X-ray gauge, an electronic micrometer for continuously "miking" moving steel strip. We viewed the thing with awe, and felt a momentary surge of respect for its designers and the supermen who service it.

Then we saw the schematic diagram of it, and the feeling faded. A dual-target X-ray tube beams its energy in two directions at right angles to each other; one beam passes through the strip and thence to an X-ray-sensitive photocell, the other through a sample of similar material and known thickness to another photocell. The respective outputs of the two photocells are fed into identical amplifiers. A milliameter calibrated directly in terms of percentage of difference reads the difference in the outputs of the two amplifiers, and hence the difference in thickness between the sample and the strip.

"Shucks," we thought, "we could fix that. It's just a big 1-tuber plus a couple of d.c. amplifiers!"

Not quite so simple

Another impressive-looking cabinet bore a huge, round dial calibrated in degrees Fahrenheit and the words AUTOMATIC TEMPERATURE CONTROL. We already had the vague impression that certain phases of the steel-making process require critical control of temperature, and that these temperatures range pretty high. Now we were stumped by the contents of this control cabinet. Discreet inquiries were finally rewarded with a schematic that divulged the mysterious innards of the device.

A thermocouple in the heat chamber generates a voltage proportional to its temperature. This voltage is applied to one branch of a Wheatstone-type bridge circuit, and the output of a standard voltaic cell is applied to the opposite branch. A sensitive galvanometer with a mirror attached to its armature is connected across the null legs of the circuit. A light source is beamed at the galvanometer mirror, and is reflected when the galvanometer reading is above zero (at which time the thermocouple output fails to balance the standard cell output) back to a photocell whose output, amplified, triggers a thyratron. The thyratron has a relay in its plate circuit, which closes, switching on the chamber's heating element. When the temperature reaches the proper level again, the thermocouple's output is sufficient to balance that of the standard cell, the galvanometer deflection is zero, the mirror reflects the light *away* from the photocell, and the thyratron ceases to fire, breaking the heating circuit.

"Hunh," we mumbled putting the schematic down. "Nothing to it." Then a thought struck us. Once a thyratron is firing, its grid has no further control; the tube will continue to conduct regardless of the grid potential, unless the plate voltage is cut off or drastically reduced. We picked up the schematic again, expecting to find some sort of plate circuit interrupter that we had probably overlooked. Nope. No auxiliary contacts shown on the switching relay, nor anything else of that nature. Just the relay winding in series with the thyratron plate, and the legend "to anode supply, 230 volts."

We scratched our head, and finally gave up trying to figure out what made that thyratron stop conducting.

"Maybe a special industrial kind of thyratron," we muttered. We shrugged our shoulders, and looked around the factory for another type of equipment that would interest us.

An electronic counter

At the far end of an electrolytic tinning line, where steel strip acquires a coating of shiny tin while traveling along at five or six hundred feet a minute, was a small, unadorned cabinet. Attached to its panel was an electromechanical counter. We watched it for a while. Apparently it was counting the sheets of tinned steel that were being sheared off the moving strip and piled into neat bundles for packaging. The counter consisted of five numbered discs, each bearing the digits one through nine and pivoted side by side on a horizontal axis, an armature, some ratchets, and an energizing coil. The discs were clattering around at a merry rate, for all the world like the mileage-indicating wheels on an ordinary speedometer. We looked further, and found a light source and photocell between which the steel sheets were passing on their way from the shear to the pilers. Tracing the wiring from the photocell into a piece of conduit and following the conduit back to the counter cabinet, led to a little door on the back of the cabinet. Inside there was a power supply and a three-tube amplifier of standard design, and we could guess the rest.

Each time a sheet of steel passed between the light source and the photocell, the change in light level produced a signal which was amplified and applied to the grid of the amplifier's output tube, a conventional 6L6. This tube was normally biased to cutoff, but passed a pulse of plate current as each signal drove its grid positive. The energizing coil of the counter formed the plate load for the 6L6, and attracted the armature at each pulse of plate current. The armature was linked to the ratchet arms, and pulled the numbered discs around one notch for each sheet of steel that cast its shadow on the photocell.

"Well," we mumbled shamelessly. "This stuff is right up our alley."

We decided we'd seen enough equipment for a while, and headed back to the bailiwick of our friend the "radioman-in-a-factory." He was at his bench, making with the prods over the upended chassis of what looked like a 4-foot-long i.f. strip. We noticed a 5-inch scope and a spanking new tube tester on the bench.

"Hi," we greeted. "What the devil's that thing?"

"Pinhole detector," he said laconically. "How you making out?"

"Fine. What's a pinhole detector?"

"This is." He laid down his prods, and waved a casual hand at the long, narrow chassis bearing dozens of octal sockets connected by two spaghetti-covered lengths of bus. He flipped the chassis right side up, and the tubes proved to be photocells. "We call this the scanning tray," he explained, lighting a cigarette. "These photocells are all in parallel, and the steel strip runs between the tray and a bank of light sources. Whenever a hole flits over the tray, one of the photocells passes more current. The signal produced is amplified, and energizes a solenoid that makes a visible mark on the strip; at the same instant, a time-delay device gets a signal, waits until the marked portion of the strip is sheared into sheets, and then trips a solenoid gate down the line a ways. The gate deflects the hole-bearing sheet into a reject bin." He inhaled a lungful of smoke, and gazed at us contemplatively. "Get it?"

"Yeah, but why call it a 'pinhole' detector?"

"Mostly the holes are too tiny to be seen easily. Like what a pinpoint might make."

"You wouldn't think such little holes would hurt anything," we said thoughtfully.

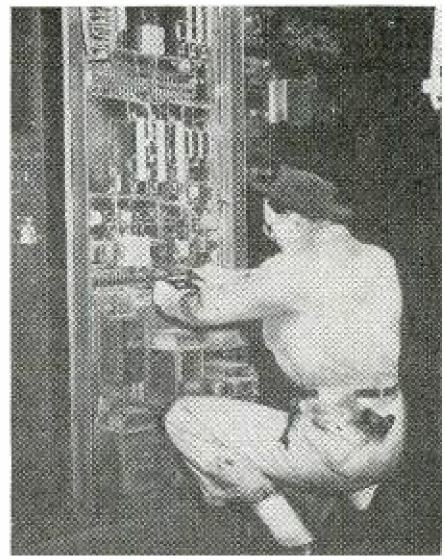
He grinned. "How'd you like to buy a can of tomatuhs with holes in it?"

We changed the subject as tactfully as possible.

Division of labor

"What's your official title around here?"

"Repairman. We've got electricians, repairmen, and lab technicians. The electricians do the dirty work. Besides running motor leads and light lines and that kind of stuff, they have to keep the lines going. There are whole batteries of switches and relays and contactors downstairs on the control panels, and they have to take care of them, too. They don't know much radio, but they get by pretty well even with the electronic stuff. They change tubes sometimes, and that kind of thing. But when a counter or a hole detector or something needs actual repairs, they just pull the chassis and put in a spare."



A factory radioman checking up on the electronic speed controls of a motor.

"Then it's your baby?"

"Yes. I work the chassis over and keep the 'spare cabinet' full of repaired stuff, and apply preventive maintenance measures to the equipment on the lines. You know: look it over from time to time, change tubes, check its operation. I keep a record of what stuff gives what kind of trouble, and how long each piece of equipment is in service between repairs, and all. Like I say, I'm just a radioman in a factory."

"Yes," we said, "and what're the lab technicians you mentioned?"

He picked up his v.t.v.m. prods, and began probing about in the wiring to the preamp built underneath one end of the pinhole detector tray.

"Same as me for more money," he said cheerfully. "Only some departments don't have their own repairmen like ours does, so the lab boys do the work in several departments like I do in this one. Lot of them are graduate engineers, and lot of them aren't. Sometimes they design special equipment that can't be bought outside, but mostly they're just glorified radiomen." He grunted, picked up his diagonal cutters, and snipped a paper capacitor loose from the bowels of the preamp. "Leaky coupler," he said, holding it up for my inspection. He shrugged and laid it down on his bench. "Just like radio work. Same stuff."

(*Continued on page* 44)

"Blown capacitors and open resistors mostly?"

"Not mostly," he said. "All the parts in this industrial equipment are more conservatively rated and heavier duty than in the usual radio. But they do go bad."

"What's the most common type of trouble then?"

"Intermittents," he said with a grin.

"Oh no," we groaned. "Not that."

"Yes. But it's not as bad as you might think. You get used to it and you know what to look for. Matter of fact, aside from shorted or open parts, it's usually one of two things: either a broken wire or soldered joint from the tremendous vibration here in the plant, or false signal pickup, which is usually intermittent too."

"False signal pickup?"

"Yes. This is 'most all high-gain stuff. And if the shielding isn't perfect, an amplifier'll pick up false signals from arcing contactors or commutators either as radiated r.f. or through common primary lines. And since we've got lots of big bus bars carrying several thousand amps around, the whole joint is full of varying magnetic fields, too. So everything has to be shielded three ways: mechanically against vibration, electrostatically against arcing and sparking, and magnetically against shifting fluxes." He grinned again at our look of horror. "But it isn't as bad as you'd think. No worse than the shielding precautions you've got to take in a car or airplane radio installation."

"Some of the equipment out on the lines is made by General Electric," we said, hoping to steer the conversation in a new direction. "We didn't know they made things like pinhole detectors."

"Sure," he said, soldering a new capacitor into the preamp. "They make lots of our stuff. So does Westinghouse and RCA, besides some outfits you probably never heard of."

"Don't they try to monopolize the service work on their stuff?"

"Nope. They don't want any part of it. They like to sell their stuff, and forget it. They supply all the service dope you could want, and a field engineer whenever we need one. But service is our baby. Incidentally, they're good outfits to work for."

"Who?"

"The equipment manufacturers. They hire all kinds of radiomen: designers, model makers, technical literature writers, sales engineers, field service engineers, all kinds."

"How do they pay?"

"Good, I hear. They get a lot of money for their products, so they can afford to pay good salaries. Of course most of the equipment is expensive to build, because it's not assembly line stuff. Practically custom built, you might say."

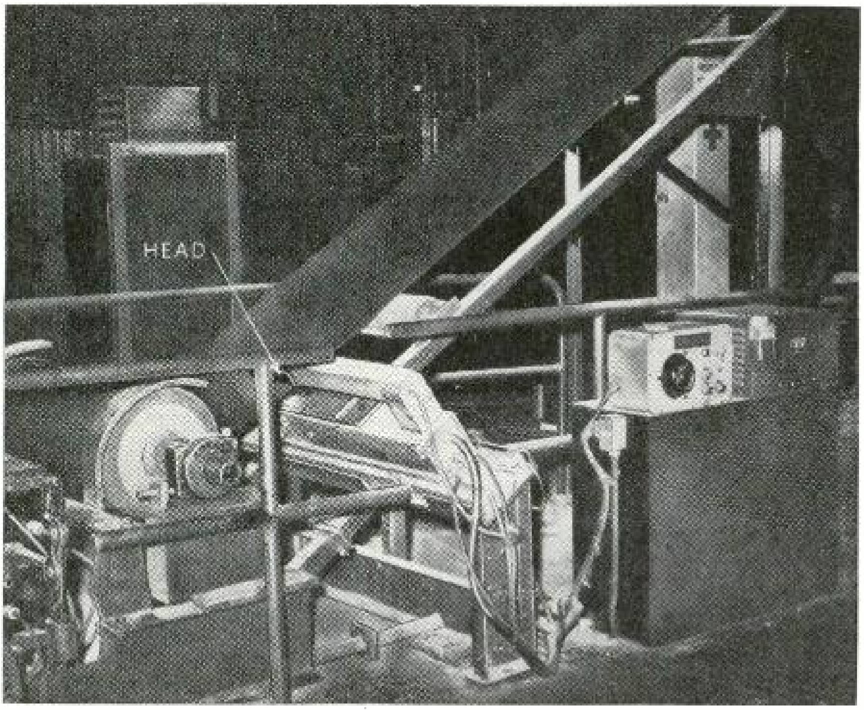
A new thought struck us. "Do you farm any of your service out or do you do it all right here?"

"Nope. When we need something fixed, we need it right now."

"Look, my friend," we said, "we've got two more questions. One is practical, the other technical."

He laid down his soldering iron, pushed the pinhole detector tray away from him, lighted another cigarette, and faced us with a smile.

"Okay," he said. "Shoot."



A typical X-ray gauge setup. The X-ray tube and photocell are in the head at the center. The power supply and controls are in the cabinets at right.

Are jobs obtainable?

"Number one, how does a fellow go about getting a job as an electronic technician in industry?"

He puffed his cigarette thoughtfully for a minute, and then his eyes crinkled up in a good-humored grin.

"If you knew all about running elevators and you wanted a job piloting one," he said softly, "how would you go about getting it?"

We didn't follow him, and said so.

"First," he murmured, "you'd find a building where they've got an elevator, and then you'd ask 'em for a job."

"Yes, but. . . ."

He shrugged his shoulders.

"So in the other case, you find a place where they use radio stuff, and you ask 'em for a job. That's all. Only, don't tell 'em you're a radioman. Tell 'em you're an electronic expert. Some people think there's a difference."

"Yes," we said again. "But. . . ."

"Nearly all manufacturing plants use some electronic equipment nowadays," he went on thoughtfully. "In smaller outfits, they've got a plant engineer in charge of that stuff and he's the guy to see about a job. But in the larger plants, all repair work comes under the heading of 'maintenance' and it's better to wangle an interview with a maintenance supervisor or even a foreman than to go through regular personnel or employment office channels. You see, the front office boys think of potential employees as either laborers, machinists, electricians, or engineers, and you're none of these." He grinned, and dropped his serious manner again. "You're a radioman, period."

"Yes," we said repetitiously. "Well . . . ."

"Number two question, please," he interrupted cheerfully. "Technical, you said?"

"Yes. On that temperature control out on the line. What . . . how come the thyratron stops firing when the galvanometer mirror moves the light off the photocell?"

"The thyratron grid bias falls below the critical voltage, obviously."

"Yes," we said. "But according to the schematic the plate voltage isn't cut off or anything."

"It isn't?" he said, eyeing us gleefully. "Not even periodically?"

"Thyratrons don't cease firing until the anode voltage is interrupted," we insisted, "and that anode supply is wired direct to the plate through the relay winding."

"Right, my friend," the radioman-in-a-factory said, his grin covering his whole face. "Come back and see me again." He turned to his bench, and we started away reluctantly, still wondering about that doggoned thyratron. We had reached the door when he yelled at us.

"Hey," he shouted, and there was a chuckle in his voice. "Ever hear of a.c. anode supplies before?"

"Yes," we mumbled. "Of course."

But actually we hadn't.

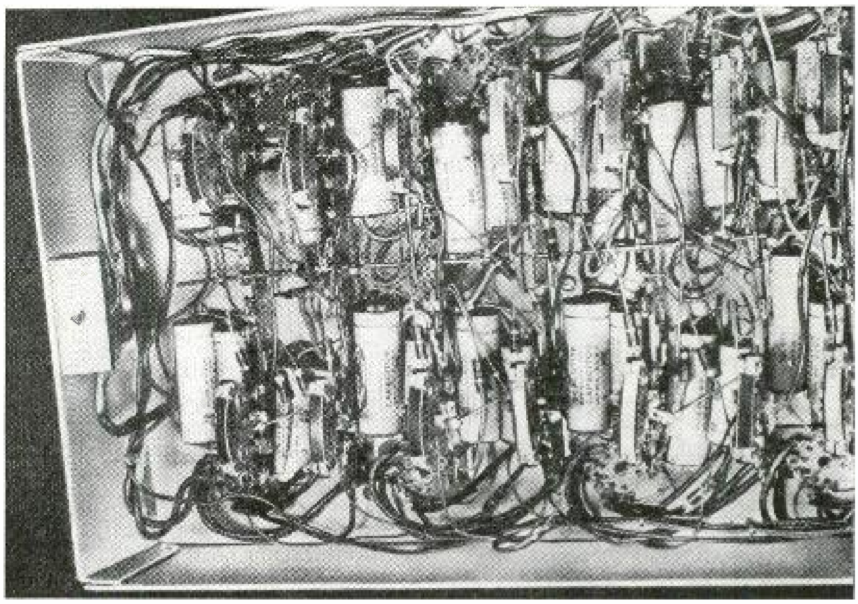
Electronics and Music

Part IV–The vacuum tube oscillator provides flexibility and reliability

BY RICHARD H. DORF

THE types of electronic tone generators discussed in the past two articles of this series are often less expensive and complex than vacuum-tube oscillators, but they are rarely as flexible and reliable. Those may be two reasons why gas-tube (neon or thyratron) oscillators are not used in today's commercial instruments, though they do not seem to be compelling ones.

There are two principal types of instruments—monophonic and polyphonic. In the former, a single oscillator is varied over the entire music range to be covered and only a single tone can be reproduced at a time—no chords. A typical commercial monophonic instrument is the Hammond Solovox. Polyphonic instruments must have at least one tone source for each note of the scale so that chords may be played. Two subclasses of the polyphonic instrument are illustrated by the Baldwin electronic organ, in which both manuals and the pedal clavier operate only one set of generators; and the Connsonata in which each manual and the pedal board has a separate set of tone generators.



Courtesy C. G. Conn, Ltd.

This photo shows a part of the maze of wiring in a Connsonata chassis. This indicates why polyphonic organs are so expensive and require ingenious design.

The monophonic scheme seems the simpler of the two, but unfortunately involves about as many problems as the polyphonic. While there may be only one oscillator, its pitch must be varied over a fairly wide range, at least two-to-one to cover a single octave. Wide-range oscillators are not simple, especially when only simple switching, if any, can be used to vary frequency and each frequency must be held to a very close tolerance (about 0.25% maximum) over a long period of time. Add to this the fact that the waveform of the output must be fairly constant over the entire range.

Variable oscillators

One of the simplest variable tone generators (Fig. 1) is the type often used for code practice. It looks like a Hartley oscillator but does not operate the same way. Basic oscillator theory tells us that a sine-wave output with its frequency determined almost wholly by the L and C of the tank circuit (L and C3 in Fig. 1) is obtained when the signal fed back from plate to grid is just enough to cause oscillation.

In this oscillator, a standard center-tapped inductor is used—usually one winding of an output or interstage transformer. That means that the signal across the grid half of the winding is approximately the same as across the plate half, which is far more than needed to excite the grid and maintain oscillation. The reason, of course, is that the tube amplifies and the output is much larger than the input.

The grid is, therefore, greatly overdriven on each alternation. On the positive half cycle it draws current, creating a voltage across R1 and charging C1. The negative charge given to C1 suddenly swings the grid to cutoff and holds it there until the charge can leak off through R1. The time this takes does not depend much on the values of L and C3, which would normally control the frequency of oscillation.

The frequency of the oscillator therefore depends largely on the time constant of C1 and R1 and the tube acts more or less as a relaxation oscillator. Varying the value of R1 varies the time constant and controls frequency over a fairly wide range. The output waveshape may be any of a number of variations, depending on the setting of R1, the value of C1, and, to a lesser extent, the tank circuit. Instead of being continuously variable, R1 may be a series of resistors selected with keyboard-operated switches.

Actual values for this circuit depend largely on what is in the tank circuit. It is very easy to make the oscillator work over any desired range, however, by a simple experiment. Select the first available inductor and use a 100,000-ohm potentiometer for R1. Any medium-mu triode will do—6J5, 6C5, etc.—and a supply of any voltage between 100 and 300 volts. R2 may be about 50,000 ohms. C2 should be large, at least 0.1 μf. A starting value for C3 is .001 μf. Now experiment with various values for C1, C3, and the setting of R1 to see how much frequency change is possible and in what range. About 15 minutes worth of trying will be sufficient to discover optimum values.

This oscillator will put out a sine wave but not over a wide frequency range. The simplest method to make the output a sine wave is to add a variable cathode resistor. As the cathode resistance increases, it cuts down the tube's gain, and the grid is less overdriven. When output is a sine wave, frequency stability is much better and the L-C3 combination has much greater control of frequency. Sine-wave tone, however, is uninteresting to the ear and in a simple instrument the more complex relaxation waveshapes are considerably better.

Heterodyne oscillators

One of the early electronic musical instruments invented by Leon Theremin in 1924, is called by the inventor's name (sometimes also called the Aetherophon). A monophonic instrument, it can produce the entire musical range.

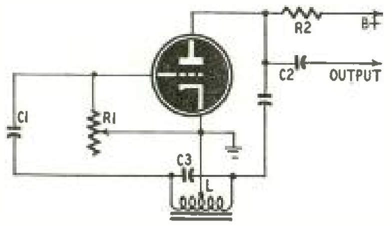


Fig. 1—A simple variable tone generator. It looks like a Hartley oscillator but has much more positive feedback.

It has two radio-frequency oscillators beating to produce an audio note as indicated in Fig. 2. One oscillator frequency is fixed, while the other is varied by the player's hand capacitance as he moves his arm closer to or farther from a rod connected to the oscillator tank. A detector and audio amplifier are used as in a beat-frequency audio test generator. In the original instrument volume was controlled by a third oscillator whose amplitude was varied by capacitance from the player's left hand to a rod connected to its tank. The volume-control oscillator's plate current controlled

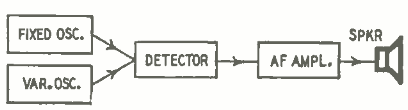


Fig. 2—Block diagram of the Theremin.

the gain of one of the audio tubes.

The Theremin never was particularly popular, for its output waveform is almost pure sine wave and does not interest the ear. Since it is not keyed, it glides from one tone to the next. It does have the advantage that frequency stability is unimportant, since the player need only vary the position of his hand to get whatever frequency he wishes.

Circuits for a Theremin generally follow those of an audio test generator, but have low-C oscillator tanks so that hand capacitance can have great effect. RADIO-CRAFT carried a diagram in the April, 1935, issue (no longer available from the publisher but found in most libraries) and an adaptation to modern tubes and circuits was published in *Radio & Television News* for October, 1949.

Another heterodyne instrument similar electrically to the Theremin is interesting because of the way pitch is varied. The variable oscillator is controlled by varying a tap on the tank inductor. The coil is wound on a form resembling the neck of a violin, as indicated in Fig. 3. Above the coil is stretched a metal wire which the player presses at various points to obtain his pitches. The wire contacts the coil at a point where it puts the right amount of inductance in the circuit for the frequency wanted. Hand capacitance is a problem here which the inventor, N. S. Ananiew (patent No. 1,975,220), does not seem to have solved.

Harmonic synthesis

W. L. Carlson is the holder of a 1931 patent (No. 1,823,724) disclosing an interesting heterodyne instrument which can provide various tone qualities by harmonic synthesis—that is, by adding harmonics to the fundamental tones in calculated proportions as is done in the Hammond Organ. The patent was assigned to General Electric but was never, as far as the writer knows, used in a commercial instrument. Fig. 4 shows how the instrument works.

It has the usual fixed and variable oscillators, the fixed operating, for the sake of argument, at 100 kc. It is coupled to the following tube by three

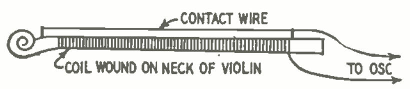


Fig. 3—One tone generator has the variable oscillator coil wound on a violin neck. The pitch is varied when the contact wire above this coil is pressed.

separate secondaries on the tank coil. One secondary is tuned to the fundamental frequency and the others to harmonics—200, 300 kc, and so on. (Only three secondaries are shown but more can be used for additional harmonics.) Each secondary is so spaced from the primary winding that all secondaries pick up approximately equal voltages. Naturally, the fundamental-frequency secondary has the least coupling.

All three secondaries in series are coupled to the amplifier grid, so that fundamental and harmonics appear with equal amplitudes at the output. Three series-tuned circuits are shunted across the amplifier output. A variable resistor in series with each series-tuned circuit enables the circuit either to short out the frequency to which it is tuned or to pass it at the desired amplitude. Thus the stage fed by this amplifier may contain 100, 200, or 300 kc or any combination with any mixture of amplitudes.

The variable oscillator is set so that either its highest or lowest frequency is 100 kc. A series of capacitors, one for each note of the instrument, may be shunted across the oscillator coil by the playing keys. (Only one key at a time is to be pressed.) This oscillator also is coupled to a following amplifier by three harmonic-tuned secondaries. The r.f. from the two oscillators is combined in the variable-oscillator amplifier's plate circuit and the whole is fed to a mixer, amplifiers, and loudspeaker.

Let us assume that middle A, 440 cycles, is to be played. The A key is pressed, shunting the variable-oscillator coil with the correct capacitor to produce a frequency of 100,000 plus 440 or 100,440 cycles. The variable oscillator is then also producing twice and three times that frequency or 200,880 and 301,320 cycles.

If, in the output circuit of the fixed-oscillator amplifier, there is no resistance in the second- and third-harmonic shunt-tuned circuits, only the 100-kc fundamental passes to the mixer and only 440 cycles of audio appears. But if the 200-kc shunt has resistance, it no longer shunts out all the 200 kc, which mixes with the variable's 20,880 to produce 880 cycles, the second harmonic of middle A. The third harmonic is produced similarly by moving the slider of the resistor in the 300-kc shunt circuit in the direction of its maximum resistance.

The single set of harmonic shunts will take care of the entire musical range. The highest musical fundamental frequency usually used is about 4,000 cycles, which means a variation in the fixed oscillator of 100,000 to 104,000 cycles (fundamental), 200,000 to 208,000 (second harmonic), and 300,000 to 312,000 cycles (third harmonic). It is only necessary to design the secondaries of the variable-oscillator transformer so that they will tune broadly over these ranges. That is very easy, as the range in each case is only four per cent of the lowest frequency.

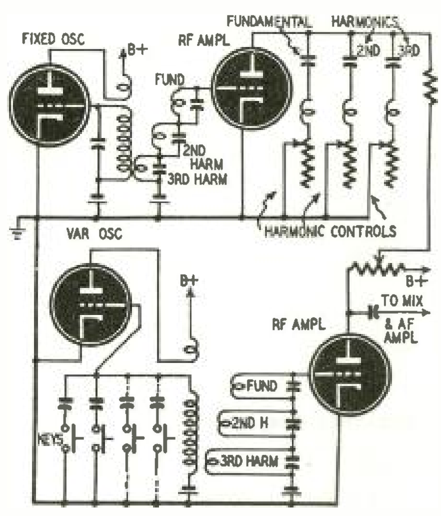


Fig. 4—The heterodyne tone generator shown in this diagram produces various tone qualities by controlling the proportions of harmonics in the output.

In the next installment we shall see how a monophonic instrument may cover a large range without a very wide range oscillator.

An All-Triode Amplifier

Built at relatively low cost, this audio system gives excellent results

By NORMAN BLAKE

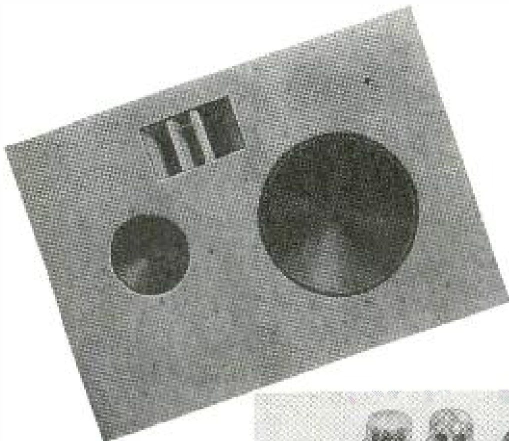


Photo of the baffle, above, with grill cloth removed to show the arrangement of the three speakers. At right is a rear view of the amplifier. As a matter of personal preference, the author did not include variable tone controls.

DESIGNED for FM as well as the variable reluctance phonograph pickups, the cost of this high-quality reproducing system is low compared to the quality of reproduction. Triode tubes are used in the amplifier because of their low distortion and their stability. They also simplify the design of the amplifier without sacrificing performance. The reproducing system has three separate loudspeakers to cover the entire audio range.

The tube line-up consists of a 6SC7 as a two-stage preamplifier, a 6N7 phase inverter, followed by pushpull 6C5's driving a pair of 6A3's as a power output stage. The circuit is shown in Fig. 1. The straightforward amplifier presents no particular problems in construction. Its response, not including the preamplifier, is flat within 3 db from 50 to 15,000 cycles without compensation.

The audio output measured at 1,000 cycles is 10 watts before noticeable amplitude distortion is observed on an oscilloscope. This is about the maximum undistorted output that can be expected from a pair of 6A3's with resistance-coupled drivers and self-bias. Distortion is more noticeable below 100 cycles but this is normal for medium-grade output transformers. The preamplifier is conventional as used with the G-E pickup. Further low- and high-frequency accentuation is necessary with this circuit and is accomplished with a bridged-T network on the amplifier input. This network accentuates the bass about 10 db below 400 cycles and produces a gradual rise in the high frequencies starting around 1,500 cycles. This compensates for the low-frequency characteristics of recordings.

The higher frequencies are attenuated somewhat unless the volume control is full on, due to shunting effect of stray capacitance to ground and the Miller effect. A 100-μμf capacitor on the volume control compensates for these effects. Since the attenuation is a function of the setting of this control, the 100-μμf capacitor automatically corrects the condition as the volume control is varied.

The over-all gain of the amplifier is fairly high and the usual precautions should be observed as with any high-gain wide-range amplifier, such as shielding, decoupling, and power supply filtering. Resistors and capacitors in high-impedance circuits must be carefully located to avoid hum pickup and undesirable feedback. Some objectionable 60-cycle hum in the preamplifier, caused by a.c. currents in the chassis ground, was eliminated by not using the chassis as a conducting ground for the input to the preamplifier. One side of the phonograph pickup lead was grounded directly to the socket of the preamplifier tube.

Good reproduction of the entire audio range is best accomplished with more than one loudspeaker. This requires some means of coupling the speakers to an amplifier to allow each speaker to reproduce only that portion of the audio spectrum in which it operates

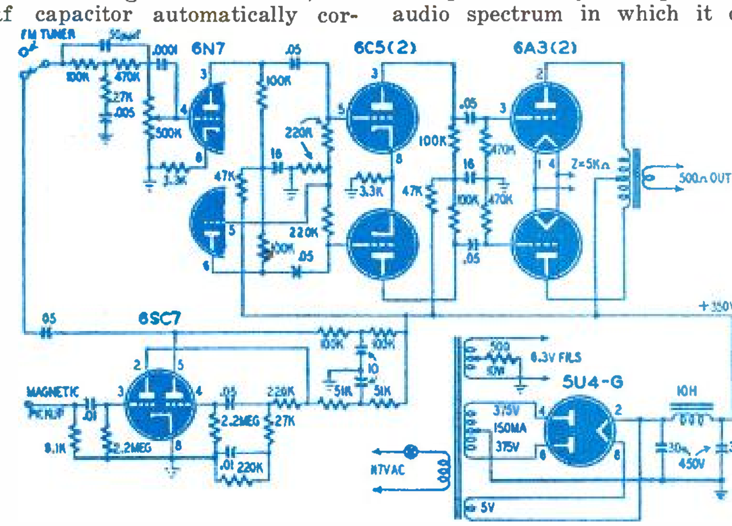


Fig. 1—Circuit of the amplifier. Both high and low frequencies are boosted by the bridged T network in the input. No variable tone controls are provided.

most effectively. Such a frequency-dividing network consists of low- and highpass filters connected to the amplifier with the speakers acting as loads on filter outputs. Filters used for this purpose are relatively simple since sharp frequency characteristics are not necessary or desirable.

When using two speakers, one of the most common and economical methods is to mount the high-frequency unit coaxially in front of the low-frequency unit. The high-frequency speaker is comparatively small and will not seriously interfere with the operation of the larger low-frequency speaker. In a coaxial arrangement the crossover frequency is generally well above 1,000 cycles.

Larger and more expensive dual systems use separate units with the woofer mounted in a suitable baffle and the tweeter mounted externally on the baffle cabinet. The higher audio frequencies reproduced by the tweeter have more directional characteristics and a wide-angle cellular-type horn is used to disperse the radiation.

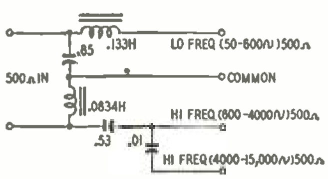


Fig. 2—The frequency dividing network for the speakers. The inductors can be wound on cores from old transformers.

The more expensive systems favor a comparatively low crossover frequency (below 1,000 cycles) while less expensive ones use a much higher crossover frequency. The lower frequency is more desirable when performance in the governing factor: the greatest amount of acoustical energy developed by a full symphony orchestra is below 600 cycles and is readily handled by the larger speaker. If the crossover frequency is high (above 1,000 cycles), the 12- or 15-inch speaker must reproduce sound which is too high for its physical size and will introduce frequency, amplitude, and intermodulation distortion.

If the crossover is much below 1,000 cycles, the relatively small high-frequency unit must withstand the larger amplitude movement of the voice coil caused by the lower frequencies. While other factors are involved in loudspeaker design, these are the most important. Three speakers with the audio spectrum divided among them will correct at least some of these difficulties.

The three units used in this system are a 15-inch PM dynamic to cover the low-frequency range from 50 to 600 cycles. An 8-inch PM dynamic works in the middle range from 600 to the speaker's upper frequency limit. For the upper audio range from 4,000 to 15,000 cycles a small horn-type (University), metal-diaphram tweeter is used with a dispersing horn. These three units are mounted in the front of a complete enclosure of 9 cubic feet lined with a sound-absorbing material.

The dividing network

An ideal three-way dividing network for this arrangement would be a lowpass, bandpass, and a highpass filter fed by an amplifier with each speaker driven from the output of its appropriate filter. A much simpler and satisfactory crossover network shown in Fig. 2 consists of a complementary low- and highpass filter arranged as a two-way dividing network with a crossover frequency of 600 cycles according to conventional filter design. This filter provides an attenuation of 10 db per octave above the cutoff frequency of 600 cycles, which is sufficient to prevent the low-frequency speaker from absorbing power at the higher frequencies. The highpass section feeds the 8-inch speaker and, while this section of the network does not attenuate above 600 cycles, the high-frequency characteristics of the speaker itself provide gradual sloping of the frequencies above 3,000 or 4,000 cycles. Energy for the high-frequency tweeter is also obtained from the highpass section of the dividing network with a .01-μf capacitor in series with the primary of the speaker matching transformer (500 to 8 ohms). The crossover frequency of the two high-frequency speakers is not clearly defined and their ranges overlap.

Voice-coil-to-500-ohm transformers are used on all three speakers because the dividing network is designed for 500-ohm termination. The network can be designed for voice-coil impedance but the large values of capacitors required are impractical and 500 ohms is a good compromise, transformers of this impedance being readily available.

(Constructors who do not wish to use the three additional output transformers at the speakers will find crossover network data for voice-coil impedances on page 83 of RADIO-ELECTRONICS for April, 1950. Connect the midrange speaker to the terminals marked tweeter in that data and connect the high-frequency tweeter as shown in this article through a capacitor whose value is 20% of Cl. Thus for a 16-ohm tweeter this capacitor would be 1.6 μf.—*Editor*)

Winding the inductors

The inductances used in the dividing network can be made by winding the proper number of turns of wire on the I section of an EI-type laminated iron core such as used in small power or audio transformers. Only the I section of the core is used in this case since the inductance is small. If a closed-core type is used, considerably fewer turns will be required for a given value of inductance, but the Q of the resulting coil will be reduced because of losses in the core material. If no iron is used, a much larger number of turns of wire are needed to get the same value of inductance. The Q in this case will be reduced because of losses (d.c. resistance) in the copper.

The I section of core consists of laminations 4 inches long, 11/16 inch wide, and .014 inch thick, stacked to 3/8 inch. The winding uses 2 inches of core space, leaving 1 inch of core extending beyond each end of the winding.

For an inductance of 0.133 henry, use 1,200 turns of No. 26 enameled wire random-wound over 2 inches of core space. For an inductance of .0834 henry wind 1,050 turns of No. 26 enameled wire the same way. This gives an approximate value of inductance but will be satisfactory because the value is not critical.

For greater accuracy, the inductance of these coils can be adjusted by spreading the laminations which extend beyond the winding. This increases the inductance considerably because it tends to close the magnetic circuit around the coil. Up to a point the Q is improved somewhat. Some means of measuring the inductance must be used with this method. If an inductance bridge is not available, a fairly accurate method is to measure the maximum voltage developed across the inductance when it resonates with a known capacitance.

For a coil of 0.133 henry wind about 900 turns on a core as previously explained and connect as shown in Fig. 3 with C equal to 0.19 μf. Set the generator to 1,000 cycles and spread the core laminations on each end of the coil until the voltmeter reads maximum. This indicates resonance. It is important that the output impedance of the signal generator be approximately equal to the resistance of the resonant circuit which is 46 ohms, otherwise it may be difficult to find resonance. With 0.5 volt from the signal generator, there will be between 8 and 10 volts across the coil at resonance.

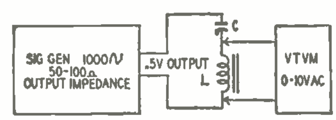


Fig. 3—Simple hookup for measuring L.

The same procedure is used to adjust the other coil to 0.0834 henry. Start with about 700 turns and use 0.3 μf for C.

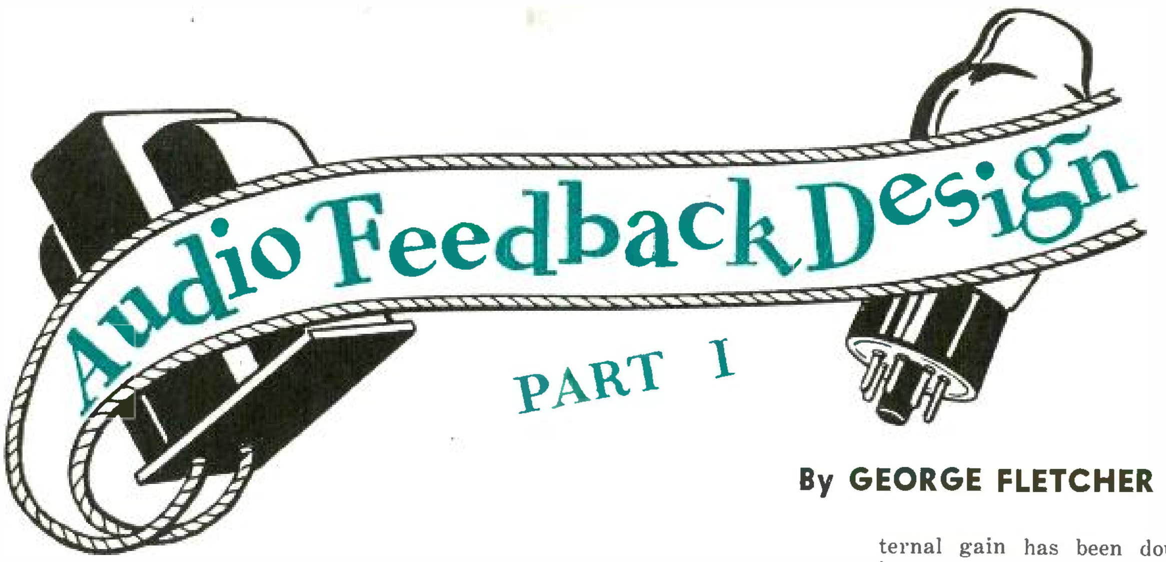
No variable tone controls are used in this amplifier simply as a matter of personal preference. The fixed accentuation of bass and treble provided by the compensating bridged T network is both desirable and sufficient with the flat characteristics of the amplifier and the speaker system. Many brands of recordings were tried and, while the different characteristics were noticeable, they were not extreme and no variable bass or treble controls were thought necessary.

Materials for Amplifier

Resistors: 2—3,300, 1—9-100, 2—27,000, 1—47,000, 2—51,000, 7—100,000, 5—220,000, 3—470,000 ohm; 2—2,2 megohm, 1/2-watt resistors; 1—500 ohm, 10 watt, resistor; 1—500,000-ohm potentiometer.

Capacitors: 1—50, 1—100 μμf mica; 1—.005, 2—.01, 4—.05, 600-volt paper; 2—10, 2—16, 2—30 μf, 450 volt, electrolytic.

Miscellaneous: 375-0-375-volt, 150-ma, power transformer with 6.3-volt and 5-volt filament windings; 10-henry, 150-ma choke; 5,000 ohms to 500 ohms output transformer; tubes, sockets chassis, switches, hookup wire, and assorted hardware.



By GEORGE FLETCHER COOPER

Audio fans, frequently in the dark about the how and why of feedback, can find the answer in this series

"BOIL water and butter together. Add the flavor. Cook till it forms a ball. Season and beat in an egg."

This is not an article on cookery, nor is it one of those articles with the cook book approach on how to build the perfect amplifier. "Take a ripe output transformer, about four pounds," he says, "two large well-matched tubes and an assortment of smaller tubes, capacitors and resistors. Connect as shown. Add feedback to taste." The trouble is that the amplifier described in such articles is never just what I want, and nothing in the article tells me how I can alter it without ruining the performance completely. Consequently, when I need an amplifier, or rather when my employer, who gives me money for doing this, needs an amplifier, I have to design it from scratch. Amplifiers without negative feedback are no problem, but the addition of a reasonable amount of feedback to an amplifier with more than two stages usually leads to instability unless the circuit is carefully designed.

To begin with, why do we want to use negative feedback in amplifiers at all? There are three reasons, depending on the function of the amplifier. If the amplifier is part of an a.c. voltmeter, the gain must be constant in spite of changes in supply voltages and aging of tubes. A voltmeter with a drift of 10% would be a thorough nuisance in any laboratory. After all, unless you are a politician, you must trust something. By using negative feedback, the overall gain can be made almost independent of the internal gain of the amplifier, so that once it is adjusted, the gain will be the same even if the tubes are changed or the line voltage drops 5%.

If the gain is independent of the plate supply voltage, ripple due to inadequate smoothing will not modulate the signal. This is especially important for ordinary program amplifiers. The second and third reasons for using feedback are also important in audio amplifiers. By using negative feedback we can flatten the frequency response; and we can reduce the harmonic and intermodulation distortion.

Feedback improves response

Let us first consider how negative feedback keeps the gain of an amplifier constant. A particular amplifier has a gain of 80 decibels: an input of 1 mv between the first grid and cathode gives an output of 10 volts.[1] We now connect across the output a network which gives exactly 1/1,000 of the output voltage. This network has a loss of 60 db, and when the input to the amplifier is 1 mv the amplifier output is 10 v and the network output 10 mv. The output of this network is now connected in series with the input so that the voltage appearing between grid and cathode of the first tube is the difference between the applied input between grid and ground and the voltage fed back through the network. Working backwards we can see that if the output is to be 10 v, the fed-back voltage is 10 mv, the grid-cathode voltage 1 mv so that the total input must be 11 mv. The overall gain is now 10v/11 mv, which equals 59.17 db.

Suppose now that we make some change in the amplifier, so that for 1 mv between grid and cathode we obtain 20 v out. The voltage fed-back will be 20 mv, so that this 20 v output requires an input of 21 mv and the gain is 20 v/21 mv = 59.58 db. Although the internal gain has been doubled (6 db increase) the overall gain has increased only by about 5%, or 0.41 db.

This example shows immediately how negative feedback improves the performance of a voltmeter amplifier. By using more feedback, ever greater constancy of gain can be obtained. A little thought will show that the other properties of negative feedback can also be obtained in this example. Suppose that the change of gain was the result of changing the test frequency; for example the gain might increase by 6 db when the frequency is increased from 50 c.p.s. to 400 c.p.s. The feedback keeps the gain the same within 0.4 db for this change of frequency.

The reduction in distortion is not as simple. In the normal working range of the amplifier the gain is not quite constant at all points in the voltage wave. This can be seen by looking at a graph showing mutual conductance plotted against grid bias. These variations in gain *during a single cycle* cause distortion, but obviously since negative feedback keeps the gain nearly constant, the distortion must also be reduced.

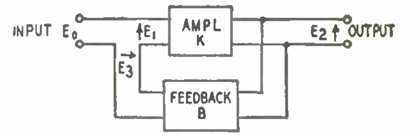


Fig. 1—Basic feedback amplifier circuit. The feedback network feeds part of the output signal back to the input.

At this point the reader is warned not to open up the amplifier to connect a simple potential divider from loudspeaker terminals to input grid. By a well-known law of Nature (the *law of the cussedness of inanimate things*—Editor) you will be certain to add positive feedback, and will produce an excellent oscillator. Relax in your armchair and continue to read this article.

Oscillation troubles

The problem which really causes trouble in negative feedback amplifiers is oscillation at the extremes of the frequency range. When feedback is applied to an amplifier with more than one stage, oscillations may occur either at very low frequencies or at very high frequencies. Fairly typical values would be 2 c.p.s. and 30 kc. It is difficult to detect the high-frequency oscillations just by looking. The amplifier appears to have no gain, but lots of distortion. With an oscilloscope, of course, the trouble is easily found. There are no certain cures which can be applied to all amplifiers: one man's meat is another's poison. In my view, the only safe way to proceed is to draw the amplitude and phase responses, and later in this series I shall show how this can be done easily.

A little mathematics

Before discussing the specific problems of design, let us look at the basic mathematics. The generalized circuit of a feedback amplifier is shown in Fig. 1. It consists of an amplifier having a gain of K and a feedback networking having a gain (actually a small fraction) of β. The two equations are:

$$E_2/E_1 = K$$
$$E_3/E_2 = \beta$$

Suppose we call the gain of the amplifier including feedback K^1 to distinguish it from the gain K of the amplifier without feedback. The overall gain is:

$$K^1 = \frac{E_2}{E_0} \qquad (1)$$

Since the feedback is negative the feedback voltage must subtract from the input voltage to give the voltage E_1 actually applied to the grid, or:

$$E_1 = E_0 - E_3$$

For convenience we can rearrange this equation to read:

$$E_0 = E_1 + E_3$$

Suppose we substitute $(E_1 + E_3)$ for E_0 in equation 1 (which we can easily do because the two quantities are equal to each other). We then get:

$$K^1 = \frac{E_2}{E_1 + E_3} \qquad (2)$$

So far nothing spectacular has happened, but from the first two equations we know that:

$$E_1 = \frac{E_2}{K} \text{ and } E_3 = \beta E_2$$

so we can put these values for E_1 and E_2 in equation 2.

If you can recall a little algebra, you will see immediately that all the E_2's in this equation will drop out and we have left:

$$K^1 = \frac{1}{1/K + \beta}$$

This equation we can rearrange to suit ourselves (as long as we follow the rules of algebra), so let's make it read:

$$K^1 = \frac{K}{1 + \beta K}$$

The term βK in this equation is called the feedback factor. In terms of numbers we can make this factor have practically any value we want by adjusting the gain of the amplifier and the amount of feedback voltage. Suppose we make βK much larger than 1. In that case, the quantity $(1 + \beta K)$ in equation 3 is very nearly equal to just βK and for all practical purposes we can write equation 3 as:

$$K^1 = \frac{K}{\beta K}$$

and the gain of the amplifier with feedback is:

$$K^1 = \frac{1}{\beta}$$

Since the K drops out, the gain K^1 of the amplifier with feedback is independent of the gain without feedback as long as the feedback factor βK is fairly large compared with 1. To meet this condition, βK would usually have to have a value of at least 10.

Without feedback, the gain of the amplifier in decibels is 20logK. The effect of the feedback is to reduce the gain by 20logK decibels.

Effects of phase shift

So far we have assumed that β and K are just ordinary numbers. If the feedback network is just a couple of resistors, this is all right as far as β is concerned. But the amplifier gain K has a phase angle which depends on the interstage coupling networks and transformers if any are used.

Fig. 2 shows a typical resistance-capacitance coupling circuit. At some frequency the reactance of C will be equal to the resistance R and at this

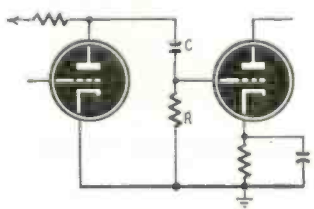


Fig. 2—A typical R-C coupling network.

frequency the phase shift is 45° and the response has fallen by 3 db. At still lower frequencies the phase shift gets larger until it approaches 90°.

In a three-stage amplifier there will be two coupling circuits of this kind plus a third to keep the plate d.c. from the feedback network. If the C-R products of these three networks are equal, each will have a phase shift of 60° at some frequency and the total phase shift will be 180° The correct value for the gain at this point is then not K but —K. The gain with feedback is then equal to:

$$K^1 = \frac{-K}{1 - \beta K}$$

If βK happens to equal 1 at this frequency, the bottom of this equation is equal to 0 and the gain is infinite. Obviously this will not do because we want an amplifier and not an oscillator, so we must arrange for βK to be less than 1 if the phase shift is 180°.

The negative feedback can cause trouble even before the amplifier becomes unstable. If the phase shift is large, the gain can increase, [...] bumps in the response at eac[...] the amplifier is well desig[...] bumps will not appear.

If we apply a little highe[...] matics to equation 3 (we wo[...] to go into the details) we [...] another important equation:

$$\frac{dK^1}{K^1} = \frac{dK}{K} \cdot \frac{1}{1 + \beta K}$$

In this equation, the terms [...] dK represent the *change* of ga[...] amplifier with and without [...] If variations of supply voltag[...] cuit components produce a [...] the gain of the amplifier wi[...] back (dK), then this chan[...] a fraction dK/K of the to[...] The change of gain with [...] (dK^1). In other words, any [...] in gain of the amplifier will [...] by the fraction $1/(1+\beta K)$ [...] circuit has a feedback facto[...]

A sample problem

This equation is very usef[...] signing amplifiers to rigid [...] tions. For example, suppose [...] an amplifier with a gain of 1[...] (60 db±0.2 db). The ampl[...] need three stages (this is a gu[...] on experience), and we must [...] if we can meet the require[...] three-stage amplifier may ha[...] variation of about ±6 db. H[...] gain and how much feedback [...] have?

If we have +6 db, the gain [...] to twice its normal value so t[...] K and dK/K = 1. But we require that dK^1/K^1 be 2% so that:

$$.02 = 1 \cdot \frac{1}{1 + \beta K} \quad \text{or} \quad 1 + \beta K = 50$$

In addition, $K^1 = 1{,}000$, and since

$$K^1 = \frac{K}{1 + \beta K}$$

we can find the value needed for K from this equation:

$$K = K^1(1 + \beta K) = 50{,}000, \text{ or } 94 \text{ db.}$$

This is a reasonable figure for a three-stage audio amplifier, so the basic assumption was in order.

Most people do not use negative feedback to provide constant gain, but to reduce the distortion. Usually most of the distortion originates in the output stage. Suppose we have 5% distortion at the required maximum output. If we want to reduce the distortion to ½%, we must provide 20 db of feedback, and we must increase the gain without feedback by 20 db to give the same overall gain.

In the articles which follow, charts will be given so the reader can calculate easily, with no more mathematics than working out what $1/2\pi RC$ equals, the phase and amplitude response and hence the stability conditions of any amplifier circuit.

[1]These are not true decibels, as the impedances are not necessarily the same. "The question is", said Alice, "whether you *can* make words mean different things."

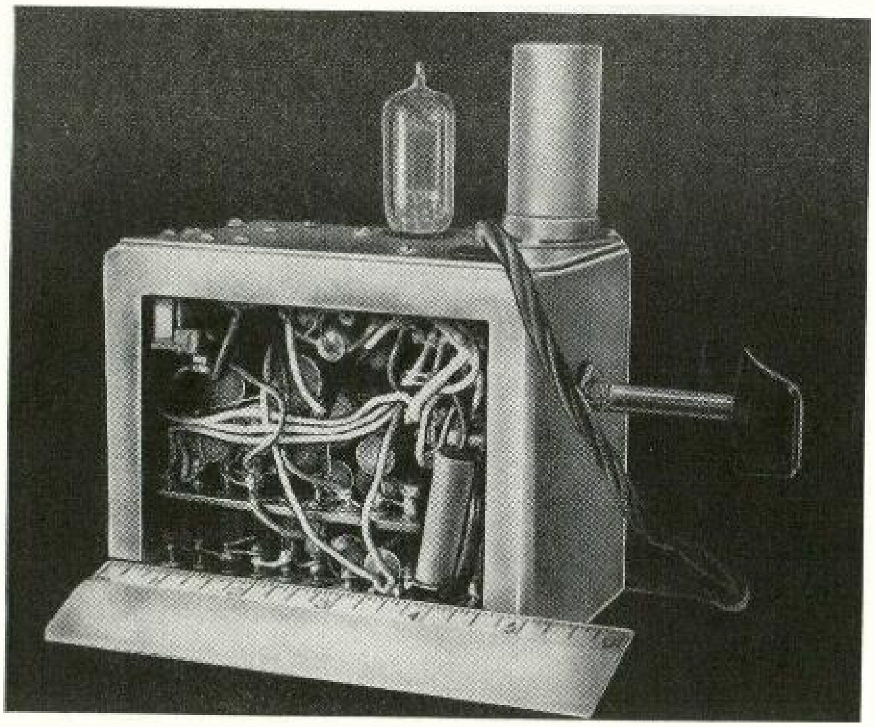
"The question is", said Humpty Dumpty, "which is to be master—that's all".

(*Through the Looking Glass*—Lewis Carroll).

Tunable Audio Filter Reduces QRM

C.w. tuning is easier and audio selectivity better with this compact audio filter. It easily fits in almost any communication set

By W. H. ANDERSON



The tunable audio filter is built into a small shield can that can be mounted in almost any communications receiver. It has a selection of nine frequencies.

WITH the QRM on the c.w. bands what it is today, the question of audio selectivity is not "whether" but "how." The two basic approaches to the problem are filters with lowpass (one-slope) and bandpass (two-slope) characteristics.

In normal operation it is not always possible to maneuver the desired signal into a fixed filter because the b.f.o. and crystal phasing controls are probably set for best single-signal response, and the main tuning may be positioned to zero-beat a strong station. Obviously what is required is a *variable* peaked filter. Continuous variation was ruled out because no variable capacitors or inductors are practical that would tune the rather large frequency range (1,300:150 or about 9:1) requiring a maximum to minimum capacitance or inductance range of 80:1. This range was chosen because 1,300 cycles would catch most of the frequencies that would get by a Q5'er or similar selectivity, and 150 cycles would be about the lowest usuable.

Fig. 1 is schematic of the unit as finally assembled and built into a receiver. It consists of a cathode follower to get down from a high impedance source such as is normally found at some convenient point in the audio system, often the phone jack. The filter itself consists of three series-resonant circuits in cascade which feed a conventional triode voltage-amplifier, coming out in medium-high impedance. On any one switch position, the three resonant circuits are centered on the same frequency. Moving S1 simultaneously switches capacitors in each circuit to change the resonant frequency. A total of nine selected frequencies is provided —170, 290, 420, 550, 680, 820, 970, 1,130 and 1,290 c.p.s. A straight-through connection (through C4 and R4) is provided on points 1 and 11 of the rotary switch, and the switch turns counterclockwise to select lower frequencies, in the same manner as a tone control. R4 can be proportioned until the net headphone level sounds approximately the same in the select and straight-through positions.

If the filter unit can be fed from a low-impedance source by tapping onto the speaker terminals or some such means, the cathode follower may be omitted. In any case, take care not to overdrive the filter and distort the output.

The voltage output characteristics for a constant input voltage are shown in Fig. 2. Two beat notes 250 cycles apart in frequency may be altered about 30 db (5 S points) in respect to each other by moving the switch through two positions. This imposes a rather rigorous requirement on the stability of the received signal and the receiver h.f. oscillator.

The fact that the passbands are wider and higher in output at the lower frequencies is due to the lower Q of the inductors and to the tendency for the filter to operate right through, disregarding R1, R2, and R3. Consequently the noise levels will be higher on the low-frequency positions but still very much below the straight-through conditions. The unit does not quite break even in volts input to output, and the output impedance is somewhat too high for direct connection even to high-impedance phones—in the writer's case it feeds back into the receiver audio channel and the phones are taken off one stage later.

When using headphones on any single tone, a 10-to-15-times change in termi-

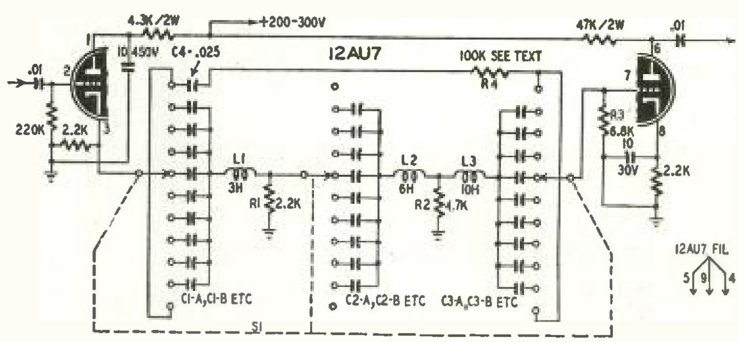


Fig. 1—Schematic of the audio filter. It can be inserted at any convenient point in the receiver's audio stage. The cathode follower may not be needed.

nal voltage (20 to 30 db) is required to make a significant change to the ear. With two or more tones, these ratios are less, but in any event two times in volts (6 db), which is one S point, may look like a lot on a voltmeter but is scarcely noticeable in the phones. The filter center frequencies were accordingly chosen to cross over at points about 6 db down.

The question now is: What about the chokes L1, L2, and L3? These are the heart of the unit and its principal procurement problem. The ones in this unit, though very small physically, have a Q of around 20 at 1,000 c.p.s., but they are not standard catalog items. The chokes were put in ascending inductance, for the higher the reactance the higher the permissible source and load impedances; and these increase as one proceeds through the filter. Incidentally, R1, R2, and R3 were chosen to be about 1/10 the reactance of L at 1,000 c.p.s. which seems a good compromise between selectivity which calls for low resistance and low insertion loss which calls for high resistance. If identical chokes are used, R1, R2, and R3 should still be in ascending order of resistance.

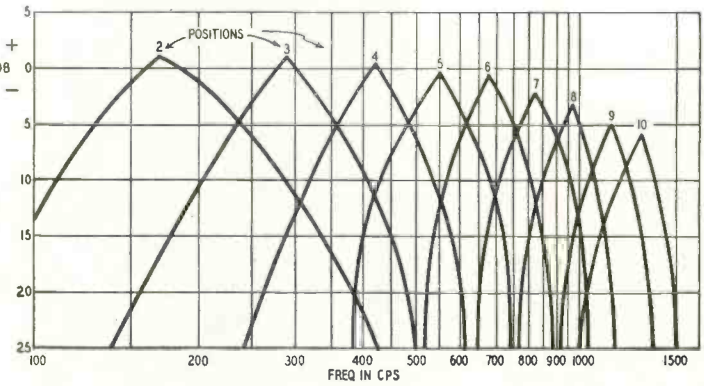


Fig. 2—The frequency characteristics of the filter. The crossover points are 6 db down from the peaks to eliminate effects of apparent volume difference.

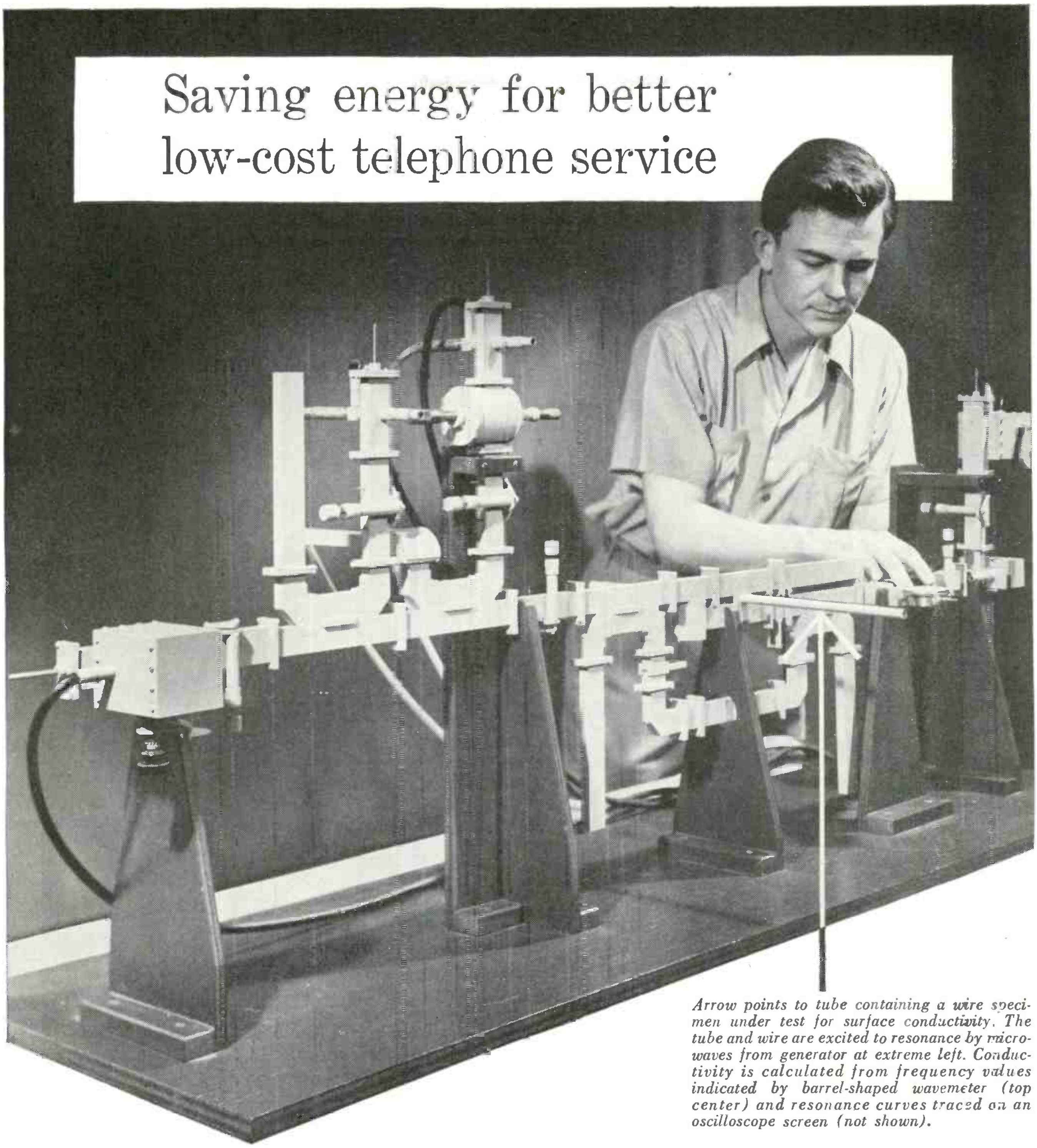
Chokes from the surplus FL8 filters now available might be used successfully. The resonating capacitors become very cumbersome with inductance of less than 3 henries or so, and an FL8B recently dismantled contained only two 2-henry chokes and several of less than 1 henry—the Q being about 12.

Very high-Q (and rather expensive) toroids are available—in which case two tuned circuits might be all that would be usable. The most intriguing possibilities lie in dismantling the PD52010-1 and 70473 filter units, and particularly the 90-150-cycle filters in the R89/ARN5A glide path and B0-733-D localizer receivers. Apparently these are quite common and inexpensive on the surplus market in the U.S.A., but unfortunately not in Canada and no tests could be made.

If you run across some high-quality cores with windings unusable for some reason or other, don't be afraid to tackle rewinding them. Nothing is guaranteed of course, but L2 was home-rewound with No. 40 wire—the inductance was 6 henries and the Q 16 as against the 10 henries and Q of 22 that the manufacturer was able to obtain on the same sized core.

Both the reactance and Q of the coils are easy to measure. Find the frequency upon which WWV is steadiest, tighten up the selectivity to a moderate degree until only the 440-c.p.s. modulation component is getting through (the 4,000-c.p.s. modulation would be lost in any modern communications receiver under such circumstances) and use the low-impedance speaker terminals as you would an audio signal generator. Connect the unknown inductance, a convenient value of capacitance, and a resistor of the order of 100 ohms all in

(*Continued on page* 56)



Arrow points to tube containing a wire specimen under test for surface conductivity. The tube and wire are excited to resonance by microwaves from generator at extreme left. Conductivity is calculated from frequency values indicated by barrel-shaped wavemeter (top center) and resonance curves traced on an oscilloscope screen (not shown).

In the waveguides which conduct microwaves to and from the antennas of radio relay systems, current is concentrated in a surface layer less than 1/10,000 inch thick, on the inner surface of the waveguide. When these surfaces conduct poorly, energy is lost.

To investigate, Bell radio scientists devised exact methods to explore this skin effect at microwave frequencies.

Scratches and corrosion, they found, increase losses by 50 per cent or more. Even silver plating, smooth to the eye, can more than double the losses of a polished metal. Very smooth conductors, like electropolished copper, are best. An inexpensive coat of clear lacquer preserves initial high conductivity for many months.

Energy saved *inside* a microwave station is available for use in the radio-relay path *outside*. So stations can sometimes be spaced farther apart, and there will always be more of a margin against fading. Here is another example of the practical value of research at Bell Telephone Laboratories.

BELL TELEPHONE LABORATORIES

WORKING CONTINUALLY TO KEEP YOUR TELEPHONE SERVICE BIG IN VALUE AND LOW IN COST series across these speaker terminals. The idea is to get a small reading of a.c. voltage across the resistor—100 ohms may be too small or too great, depending on many factors. Vary the capacitance to obtain a greater a.c. voltage, reducing the resistor value as resonance is approached, until a point is reached where either adding or subtracting capacitance will cause the voltage to fall off. This maximum voltage should not exceed one-half the receiver output voltage at any time, and is preferably less, to obtain greater sharpness of resonance.

This is now a simple series-resonant circuit at 440 c.p.s. and the inductance can be calculated from the familiar impedance nomographs or from the expression $L = \frac{1}{4\pi^2 f^2 c}$, where L is in henries, C in farads, and F (in this case) 440.

To find Q, vary the resistance until the voltage across it is half the receiver output voltage. The Q at 440 cycles will then be $\frac{2\pi f L}{R}$. For example, one choke was checked in the above manner and resonated with a 100-ohm resistor and a 0.6-μf capacitor in series. L works out to be .22 henries. The resistance had to be reduced to 70 ohms to have 4 volts across it when the receiver output voltage was 8 volts. The Q at 440 cycles was therefore $\frac{610}{70} = 8.7$. This inductor on a standard bridge measured 205 millihenries at Q of 13 at 1,000 cycles, which bears out the above inductance calculation.

If both measurements are equally correct, the Q change is roughly proportional to the square root of the frequency ratio. That is—$8.7\sqrt{\frac{1000}{440}} = 13$. This is by no means a rule, but illustrates that Q is not linear with frequency as might be assumed by glancing at the formula.

In any event, this method will provide a general idea as to whether the inductor is low, medium, or high Q in the range up to 1,000 c.p.s. or so.

No values have been assigned to the resonating capacitors C1, C2, and C3 as these will have to be worked out for each frequency and for each choke. This unit has about all the selectivity that can be used without ringing, and the nine center frequencies employed should be a useful pattern.

The unit is best tested in actual practice. First of all, no serious ringing should be present. Raising the values of R1, R2, and R3 may minimize the ringing by broadening the passbands. Conversely these may be lowered to sharpen the response. It should be possible to separate the two audio tones present on radio teletype signals if such a station can be identified on the commercial bands. Speech will be readable with considerable difficulty on some of the higher frequency positions. With c.w. it is best to tune the receiver operating the filter straight-through (or the tuning will be too touchy), then run the filter through its range, stopping on the position which peaks the desired signal.

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STANDARD OF COMPARISON
RADIART

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CORNELL-DUBILIER ELECTRIC CORP.

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with a Startling Consumer Campaign on Key TV Stations *In The Major TV Markets!*

NOW! Your Customers See TELE-ROTOR Film Demonstrations In Their Own Homes of the

Here are more and bigger profits for everybody in the TV field! Setting sensational sales records everywhere on merit alone . . . NOW —watch for even BIGGER sales starting with our NEW series of announcements on key TV stations in all the important markets. These film demonstrations will reach into millions of homes . . . ALL YOUR POTENTIAL CUSTOMERS . . . telling them of the advantages and superiority of the TELE-ROTOR! These will do a PRE-SELLING job for YOU . . . so get set NOW . . . for this big business ahead . . . by featuring the BEST . . . the TELE-ROTOR.

ONLY Rotator with ALL the Important Features

FEATURES	TELE-ROTOR		Rotator A		Rotator B	Rotator C	Rotaror D	Rotator E	Rotator F
	TR-1	TR-2	Type 1	2					
TORQUE FT. LBS.	36	36	5½		4.5	6.75	2.25	4.5	6.00
TORQUE PER POUND OF ROTATOR	3.13	3.13	0.91		0.55	1.08	0.35	0.58	0.86
SIDE THRUST OVERLOAD (FT. LBS.) TO STOP ROTATION	525	525	94		50	83	88	110	160
WEATHER PROOFING	One piece "Water Shed" Dome Housing		Rubber Gasket		Metal Ring	Felt Washers	Rubber Gasket	Rubber Gasket	Rubber Gasket
ELECTRICAL TO MECHANICAL EFFICIENCY TORQUE PER WATTS CONSUMED	72%	58%	16.4%	16.3%	13%	11%	4%	11%	11%
TYPE OF LOAD BEARING	Two 6½ in. dia. Ball Races		Double Sleeve		Sleeve & Ball 2 in. dia. Ball Race	Sleeve	Sleeve	Double Ball Race 1 in. dia. Ball Race	Double Sleeve
MAST CAPACITY	2"	2"	1⅜"		1¾"	2"	1¾"	2"	1½"
ALIGNMENT OF ROTATOR SUPPORT MAST AND ANTENNA MAST	In Line	In Line	Off Set		Off Set	Off Set	In Line	Off Set	In Line
MOUNTING VERSATILITY	Mast or Platform		Mast Only		Mast Only	Mast Only	Mast Only	Mast Only	Mast or Side Plate
TYPE OF DIRECTIONAL INDICATION	End of Rotation Light	Dial lights 8 Positions and end	End of Rotation Light	Meter	Meter	Meter	End of Rotation Light	Meter	Meter

Logarithmic Compressor Has Low Distortion

PEAK limiters or clippers are widely used to prevent overmodulation of transmitters in amateur and other communication circuits. These devices abruptly clip the audio signal when it exceeds a predetermined level. This process produces high-order harmonics which must be removed by well-designed low-pass filters.

Designed to *compress* the signal above given levels without generating so much distortion is a logarithmic compressor circuit described in *G-E* impedance compression circuit. It may be almost any standard push-pull output transformer. The instrument rectifier may be two half-wave units connected as shown. A bridge rectifier may be used if the proper terminals are used.

R2, R3, C1, and C2 make up a simple low-pass filter which removes high-order harmonics generated by nonlinearity in the rectifier unit. Coupling and bypass capacitors and other response-determining components are

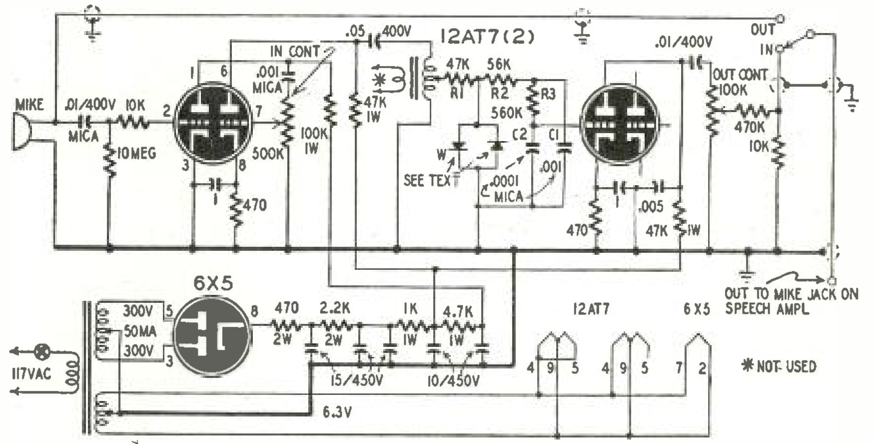

Fig. 1—Circuit of the compressor. Two meter rectifiers do the compressing.

Ham News. Because it generates less distortion and fewer harmonics, filtering is simplified. The circuit shown in Fig. 1 permits higher input levels to the speech circuits without overmodulating the transmitter. The compression takes place in a pair of copper-oxide meter rectifiers connected back-to-back in a circuit which looks like the conventional diode clipper. Figs. 2 and 3 show the transfer characteristics of copper-oxide instrument rectifiers and diode clippers, respectively.

The compressor is inserted between the microphone and speech amplifier in the transmitter. The first section of the 12AT7 brings the microphone voltage up to the level required at the compressor. The output of its second triode is connected through the primary of a push-pull output transformer to the compression circuit consisting of R1 and the instrument rectifier W.

The transformer matches the high-impedance plate circuit to the low-

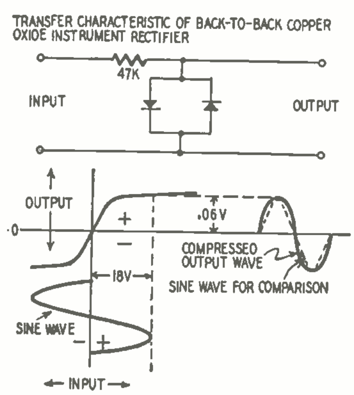

Fig. 2—Action of the meter rectifiers.

selected to develop response-curve characteristics which are best for voice communication circuits.

Connect the output of the compres-

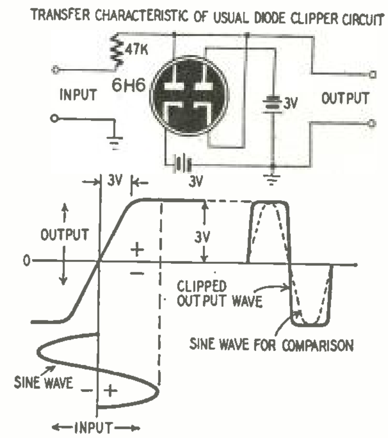

Fig. 3—The action of a diode clipper.

sor to the input of the transmitter. Throw the output switch to OUT and adust the transmitter's gain control to the normal input level while checking the modulation percentage with a scope or other means. Set the compressor's output control to zero and the compression control to half way on. Throw the switch to IN and adjust the output control until the modulation level is the same with the compressor out of the circuit. Whistle a sustained note or sound a sustained OOOOO——O into the microphone while setting the compression control to make the average modulator plate current no more than twice that obtained with the compressor OUT. Make final adjustments of the compression control while on the air.

4 Pages of TEST EQUIPMENT at prices every serviceman can afford!

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Every single unit described on this and the following pages is offered on a strict "money-back-if-not-satisfied-basis." No if's—no but's—no maybe's. Simply send your order for any unit or units you select and try them out for 10 days. If not completely satisfied—return for refund in full. No explanation necessary. You are sole judge.

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TUBE TESTERS

THE NEW MODEL 247

Check octals, loctals, bantam jr., peanuts, television miniatures, magic eye, hearing aids, thyratrons, the new type H.F. miniatures, etc.

Features:

★ A newly designed element selector switch reduces the possibility of obsolescence to an absolute minimum.

★ When checking Diode, Triode and Pentode sections of multi-purpose tubes, sections can be tested individually. A special isolating circuit allows each section to be tested as if it were in a separate envelope.

★ The Model 247 provides a supersensitive method of checking for shorts and leakages up to 5 Megohms between any and all of the terminals.

★ One of the most important improvements, we believe, is the fact that the 4-position fast-action snap switches are all numbered in exact accordance with the standard R.M.A. numbering system. Thus, if the element terminating in pin No. 7 of a tube is under test, button No. 7 is used for that test.

Model 247 comes complete with new speed-read chart. Comes housed in handsome hand-rubbed oak cabinet sloped for bench use. A slip-on portable hinged cover is indicated for outside use. Size: 10¾"x8¾"x5¾".

ONLY

$29.90 NET

SUPERIOR'S NEW MODEL TV-10

Specifications:

★ Tests all tubes including 4, 5, 6, 7, Octal, Lock-in, Peanut, Bantam, Hearing-aid, Thyratron, Miniatures, Sub-Miniatures, Novals, etc. Will also test Pilot Lights.

★ Tests by the well-established emission method for tube quality, directly read on the scale of the meter.

★ Tests for "shorts" and "Leakages" up to 5 Megohms.

★ Uses the new self-cleaning Lever Actian Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TV-10 as any of the pins may be placed in the neutral position when necessary.

★ 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.

★ Free-moving built-in roll chart provides complete data for all tubes.

★ Newly designed Line Voltage Control compensates for variation of any line voltage between 105 Volts and 130 Volts.

The Model TV-10 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a beautiful hand-rubbed oak cabinet complete with portable cover.

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Superior's model 770 **AN ACCURATE POCKET-SIZE**

VOLT-OHM MILLIAMMETER

(SENSITIVITY—1000 OHMS PER VOLT)

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★ Compact-measures 3⅛" x 5⅞" x 2¼".

★ Uses latest design 2% accurate 1 Mil. D'Arsonval type meter.

★ Same zero adjustment holds for both resistance ranges. It is not necessary to readjust when switching from one resistance range to another. This is an important time-saving feature never before included in a V.O.M. in this price range.

★ Housed in round-cornered, molded case.

★ Beautiful black etched panel. Depressed letters filled with permanent white, insures long-life even with constant use.

The Model 770 comes complete with self-contained batteries, test leads and all operating instructions.

SPECIFICATIONS

6 A.C. VOLTAGE RANGES: 0—15/30/150/300/1500/3000 VOLTS

6 D.C. VOLTAGE RANGES: 0—7.5/15/75/150/750/1500 VOLTS

4 D.C. CURRENT RANGES: 0—1.5/15/150 MA. 0—1.5 AMPS.

2 RESISTANCE RANGES: 0—500 OHMS 0—1 MEGOHM

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SUPER-METER

***A COMBINATION* VOLT-OHM MILLIAMMETER PLUS CAPACITY REACTANCE INDUCTANCE AND DECIBEL MEASUREMENTS**

SPECIFICATIONS:

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500/7,500 Volts
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
OUTPUT VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5 Amperes
RESISTANCE: 0 to 500/100,000 Ohms 0 to 10 Megohms
CAPACITY: .001 to .2 Mfd. .1 to 4 Mfd. (Quality test for electrolytics)
REACTANCE: 700 to 27,000 Ohms 13,000 Ohms to 3 Megohms
INDUCTANCE: 1.75 to 70 Henries 35 to 8,000 Henries
DECIBELS: —10 to +18 +10 to +38 +30 to +58

ADDED FEATURE:

The Model 670 includes a special GOOD-BAD scale for checking the quality of electrolytic condensers at a test potential of 150 Volts.

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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Superior's new model TV-20

20,000 OHMS PER VOLT MULTI-METER and TELEVISION KILOVOLTMETER

SPECIFICATIONS

- 9 D. C. VOLTAGE RANGES. (at 20,000 ohms per Volt) 0-2.5/10/50/100/250/500/1,000/5,000/50,000 Volts
- 8 A. C. VOLTAGE RANGES: (At 1,000 ohms per Volt) 0-2.5/10/50/100/250/500/1,000/5,000 Volts
- 5 D. C. CURRENT RANGES
  0-50 Microamperes
  0-5/50/500 Milliamperes
  0-5 Amperes
- 4 RESISTANCE RANGES:
  0-2,000/20,000 ohms 0-2/20 Megohms
- 7 D. B. RANGES: (All D. B. ranges based on ODb = 1 Mv. into a 600 ohm line)
  — 4 to + 10 db
  + 8 to + 22 db
  + 22 to + 36 db
  + 28 to + 42 db
  + 36 to + 50 db
  + 42 to + 56 db
  + 48 to + 62 db
- 7 OUTPUT VOLTAGE RANGES:
  0 to 2.5/10/50/100/250/500/1,000 Volts

ADDED FEATURE:

The Model TV-20 includes an Ultra High Frequency Voltmeter Probe. A Silicon V. H. F. Diode together with a resistance capacity network provides a frequency range up to 1,000 MEGACYCLES. When plugged into the Model TV-20, the V. H. Probe converts the unit into a Negative Peak-Reading H. F. Voltmeter which will measure gain and loss in all circuits including F. M. and T. V.; check capacity and impedance; test efficiency of all oscillator circuits; measure band-width of F. M. and T. V.; etc.

The Model TV-20 operates on self-contained batteries. Comes housed in beautiful hand-rubbed oak cabinet complete with portable cover, Built-In High Voltage Probe, H. F. Probe, Test Leads and all operating instructions. Measures 4½" x 10¼" x 11½". Shipping Weight 10 lbs.

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THE WELL KNOWN MODEL CA-12 IS THE ONLY SIGNAL TRACER IN THE LOW PRICE RANGE INCLUDING BOTH METER AND SPEAKER!!!

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- ★ Comparative Intensity of the signal is read directly on the meter—quality of the signal is heard in the speaker.
- ★ Simple to Operate—only one connecting cable—no tuning controls.
- ★ Highly Sensitive—uses an improved vacuum-tube voltmeter circuit.
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- ★ Built-In High Gain Amplifier—Alnico V Speaker.
- ★ Completely Portable—weighs 8 pounds—measures 5½" x 6½" x 9".

Model CA-12 comes complete with all leads and operating instructions...... **$29.95 NET**

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TELEVISION SIGNAL GENERATOR

ENABLES ALIGNMENT OF TELEVISION I. F. AND FRONT ENDS WITHOUT THE USE OF AN OSCILLOSCOPE!

FEATURES

Built-in modulator may be used to modulate the R. F. Frequency also to localize the cause of trouble in the audio circuits of T. V. Receivers.

Double shielding of oscillatory circuit assures stability and reduces radiation to absolute minimum.

Provision made for external modulation by A. F. or R. F. source to provide frequency modulation.

All I. F. frequencies and 2 to 13 channel frequencies are calibrated direct in Megacycles on the Vernier dial. Markers for the Video and Audio carriers within their respective channels are also calibrated on the dial.

Linear calibrations throughout are achieved by the use of a Straight Line Frequency Variable Condenser together with a permeability trimmed coil.

Stability assured by cathode follower buffer tube and double shielding of component parts.

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. Oscillator. 6SN7 as Audio Oscillator and power rectifier.

Model TV-30 comes complete with shielded co-axial lead and all operating instructions. Measures 6" x 7" x 9". Shipping Weight 10 lbs.

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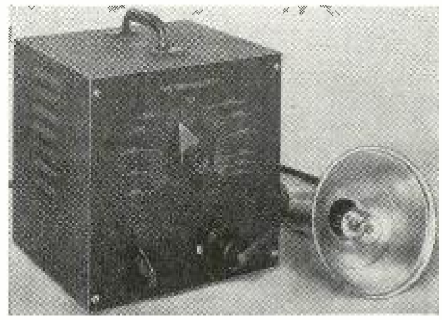
Simple Stroboscope has Many Uses

Here is an easy-to-build instrument that simplifies trouble shooting of any rotating or reciprocating parts

By ROBERT F. SCOTT



The stroboscope has only two controls and is easy to operate. Experimenters will find it a very useful instrument.

STROBOSCOPES or motion analyzers are sources of pulsed light used to study high-speed rotating and reciprocating machine parts and to photograph high-speed motion which cannot be stopped with ordinary photographic equipment. They can be used for numerous jobs in machine shops, garages, and in developmental and experimental work, but are seldom found outside of large plants and laboratories because of the relatively high cost of commercial models.

The stroboscope shown in the diagram and photographs was constructed from a semi-assembled kit purchased on the surplus market. It consists of a 400-volt, 100-ma power supply, thyratron relaxation oscillator, and a Sylvania 1D21 Strobotron which provides short-duration neon-red light pulses at a rate determined by the frequency of the driving oscillator.

Although the kit is no longer generally available, all its components except the reflector can be obtained at radio supply houses. The reflector unit can be made by mounting an Amphenol type 78S4 four-prong tube socket in the brass shell of a standard light socket. Remove the insides of the socket, leaving the fiber insulation in place. Solder leads of a four-conductor cable to prongs on the tube socket. Force the socket into the shell. File or grind the socket so its edges are flush with the sides of the shell. Obtain an aluminum floodlight reflector from a photographic supply house and screw it onto the brass shell.

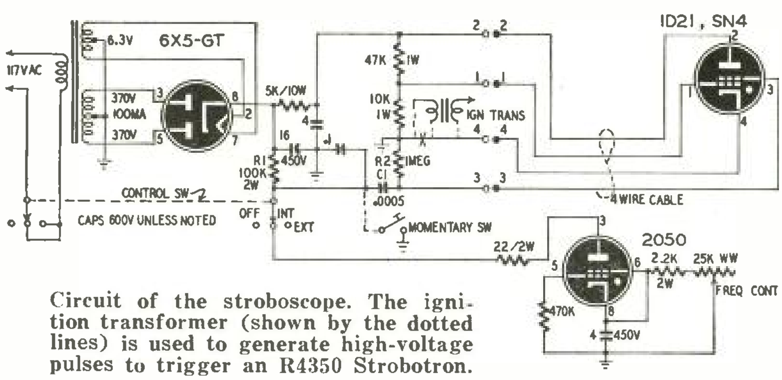
The Strobotron may be fired by applying a voltage pulse between the grids or between either grid and the cathode. In this circuit, the shield grid (pin 3) is biased by the charge on the .0005-μf, 600-volt capacitor C1 connected to B-plus through R1 and to B-minus through R2. Each time the 2050 relaxation oscillator conducts, its internal resistance drops to a low value and C1 discharges through it. The sudden drop in bias on the shield grid fires the Strobotron which produces a light pulse. One pulse is produced during each oscillator cycle.

When the CONTROL SWITCH is on EXTERNAL, oscillator plate voltage is removed and the 1D21 may be triggered from an external source. A momentary switch, connected as shown by the dotted lines, can be used to trigger the lamp manually. This switch can be one of the microswitch variety with a roller arm. It can be positioned so the roller rests on a cam, rotating shaft, or even an automobile tire which has been mounted on a rack for balancing. Any vibration or unevenness will close the switch and trigger the light. If the light is played on the tire, it will appear motionless and the high point will be directly under the roller.

The 1D21 can also be triggered by a sharp audio pulse if R1 is used as the load resistor of a high-gain a.f. amplifier which is biased almost to cutoff. The sound of a gunshot can be made to produce a positive pulse, which will cause the amplifier to conduct heavily and fire the 1D21. If a model airplane ignition transformer or photoflash transformer is connected between cathode and ground of the 1D21, as shown by dotted lines, a high-voltage pulse will be generated in the secondary. This pulse can be used to ignite flash powder or to trigger an R4350 white-light Strobotron which can be used as a light source for photographing a bullet in flight.

We used this stroboscope to track down an erratic phono motor. By playing the stroboscopic light over the motor and adjusting the oscillator until the governor seemed to stand still, we were able to see that one of the governor arms was more flexible than the other. Since new arms were not immediately available, we cured the trouble by filing metal off the stronger spring until both of them balanced.

When the light was focused on the blades of a particularly noisy electric fan, it showed that one blade was bent much more than the others. When this blade was lined up, a troublesome vibration was eliminated.



Circuit of the stroboscope. The ignition transformer (shown by the dotted lines) is used to generate high-voltage pulses to trigger an R4350 Strobotron.

Calibration

The oscillator FREQUENCY CONTROL can be calibrated directly in revolutions per minute so the stroboscope can be used as a tachometer to determine the speed of revolving or reciprocating movements. This model is calibrated from 500 to 3,600 r.p.m., which corresponds to oscillator speeds from 8⅓ to 60 cycles per second. The oscillator can be changed to have maximum frequency 240 cycles per second (the maximum flashing rate of the 1D21) so the dial can be calibrated to read directly speeds as high as 14,400 r.p.m.

(*Continued on page* 66)

SIMPLE STROBOSCOPE HAS MANY USES (*Continued from page* 65)

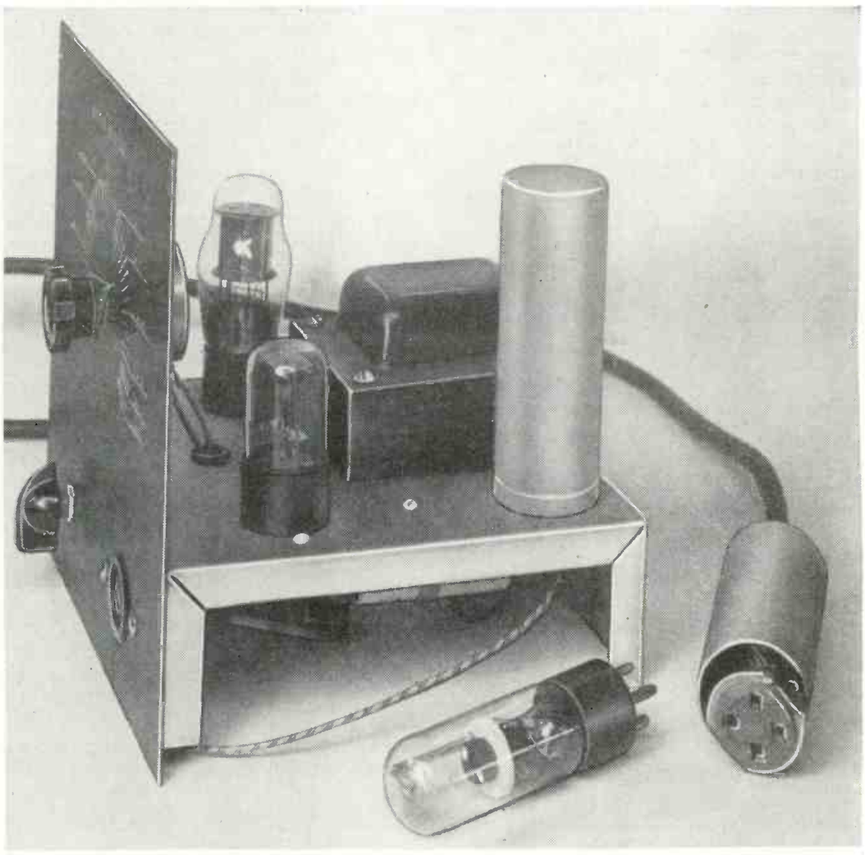
The oscillator can be calibrated with an oscilloscope, applying the method used in calibrating an audio oscillator.

Tachometer applications

In using the stroboscope as a tachometer, the shaft or moving part should be marked with a spot of chalk or paint. This spot serves as an index point. Set the part in motion and turn on the stroboscope. Begin with the FREQUENCY CONTROL set at the lowest frequency (slowest speed) and advance it until the index mark appears to stand still. This is an optical illusion created when the flashing rate is adjusted so the lamp always flashes when the index point is in the same place. If the control is set at 600 r.p.m., the part may be moving at 600 r.p.m. or it may actually be moving at 1,200, 1,800, 2,400 r.p.m. or even faster, in which case, the lamp is flashing during each second, third, fourth, or *n*th revolution. Make sure of the actual speed by advancing the control until the index stands still again. The difference in speeds indicated by the control will be the actual speed of the part. Verify this by advancing the FREQUENCY CONTROL to twice the actual speed. If your measurements are correct, the index can be made to appear at two points because the lamp is now flashing twice per revolution.

Besides being a very useful instrument, the stroboscope can also produce a number of "trick" effects that are very amusing. For example, make a disc with twelve equally-spaced dots arranged in a circle near the outer edge of the disc with the center of the circle at the center of the disc. Inside this circle put another set of nine dots concentric with the larger circle of dots. Put the disc on a motor or other rotating device and start it turning.

Under the stroboscopic light at various frequencies the entire pattern of dots can be made to appear stationary; both circles can be made to rotate at the same speed in the direction of disc revolution; both can be made to rotate at the same speed opposite to the direction of revolution; both circles can be made to appear as if rotating in opposite directions; or they can be made to rotate in the same direction at different speeds.



The stroboscope removed from its case. The strobotron is in the foreground.

Materials for Stroboscope

Resistors: 1—1 megohm, 1—470,000 ohms, ½ watt; 1—47,000, 1—10,000, 1—2,200 ohms, 1-watt; 1—100,000, 1—22 ohms, 2 watts; 1—5,000 ohms, 10 watts; 1—potentiometer, 25,000 ohms, wire-wound.
Capacitors: 1—16, 1—4 μf, 450 volts, electrolytic; 1—4, 1—0.1, 1—.0005 μf, 600 volts, paper.
Miscellaneous: 1—6X5, 1—2050, 1—1D21 or SN4; 1—power transformer 740 volts center trapped, 100 ma, with 6.3-volt, 2-ompere filament winding; 2—octal sockets; 2—four-prong sockets, Amphenol type 78S4; 1—four-prong male plug; 1—double-pole, three-position rotary switch; 1—7 x 8 x 9-inch utility box with chassis; 1—reflector; 1—connector, male, Amphenol 06-PM4

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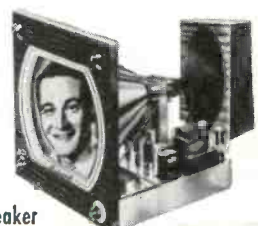

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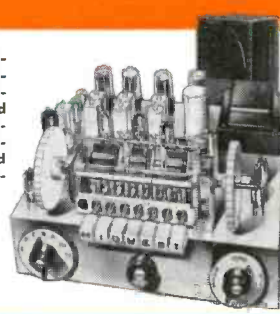

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SURPLUS REFERENCE SHELF FOR THE CONSTRUCTOR

THE surplus radio-electronic market is one of perpetual surprises. Not the least of these is its longevity.

Even the slightly initiated knows that often not even the jobbers are aware of the value and nature of surplus material. The beautifully descriptive paragraphs in the ads lend a sort of holiday grab-bag spirit to the business and add to the fun. But the time comes when we want to know what we are buying and what it is worth.

The difference between a buyer and an expert buyer may be just a small set of books. Each item in this set is chosen for a particular use and the whole collection should pay for itself in the first $75 worth of surplus equipment bought with its guidance.

First on the list is *The Radio Amateur's Handbook* (The A.R.R.L., Hartford, yearly, $2). Besides containing quantities of useful radio lore, it has an extensive but convenient catalog of tubes and their operating characteristics. A quick check, just as a sample, indicates that the E1148, recently advertised for 15¢, is the same tube as the HY615, in the same ad for 29¢.

Next is a luxury piece on the bookshelf, the *Components Handbook*, Volume 17 of the M.I.T. Radiation Laboratory Series (McGraw-Hill, New York, 1949, $8). This book contains 14 chapters, each written by one or more specialists, and each covering a restricted class of components. Separate chapters cover wires and cables, resistors, potentiometers, delay lines, inductors, motors, power supplies, relays, receiving tubes, and other components used in electronic equipment.

This book must be used to be appreciated. It provides instructive reading on the various components and also has lots of *practical* advice on tolerances, nominal values, and interchangeability. With the assistance of the chapter on tubes I have found that often a 15¢ surplus tube will do a job as well or better than a more popular 90¢ tube.

The *Schematic Manual for Surplus Electronic Equipment* (Department of Commerce, Office of Technical Services, Washington, $1 per volume) is a collection of schematic diagrams, parts lists, and test voltage and resistance charts for selected electronic surplus units. Volumes I, II, and III are currently available and others will be made available.

The data in this manual is reproduced from appropriate manuals and tech orders now out of print and has information which will prove helpful in converting equipment or putting it into operation as is. It makes a good parts inventory for gear to be torn down for components.

Two more items, *A Bibliography of Sources of Information on the Conversion of Surplus Electronic Equipment* (Department of Commerce, Office of Technical Services, Washington, free) and *Adapting War Surplus to Educa-*

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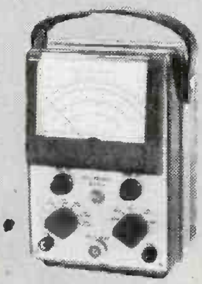

The WV-97A has a range of usefulness extending beyond that of any other instrument in the field. The new Senior VoltOhmyst measures dc voltages in high-impedance circuits, even with ac present. It reads the rms values of sine waves or recurrent pulses, even in the presence of dc. Its electronic ohmmeter has a range of ten billion to one. Like all RCA VoltOhmysts, it features high input resistance, electronic protection from meter burn-out, zero-center scale for discriminator alignment, molded-plastic meter case, a 1-megohm isolating resistor in the dc probe, and sturdy metal case for good rf shielding. 25P21527, Wt. 12 lbs..... $62.50

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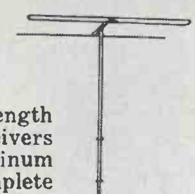

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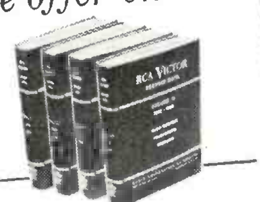

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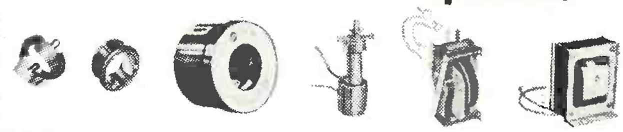

Stock No.	RCA No.	Description	Price ea.
6F5977	201D1	Deflecting Yoke	4.41
6F5978	201D2	Deflecting Yoke	7.64
6F6002	201D3	Deflecting Yoke	8.76
6F6003	201D12**	Deflecting Yoke	4.41
6F5979	201R1	Width Control	.41
6F5980	201R2	Width Control	1.29
6F5981	201R3	Horizontal Linearity Control	.47
6F5877	201R4*	Width Control	.59
6F5878	201R5*	Horizontal Linearity Control	.71
6F6004	201T6**	Power Transformer (30-tube)	15.29
6F6005	201T7**	Power Transformer (24-tube)	12.35
6F6006	201T8**	Power Transformer (21-tube)	11.17
6F6007	201T9*	Power Transformer (27-tube)	12.35
6F6008	201T10*	Power Transformer (27-tube)	12.35
6F5982	201X1	Yoke Mounting Hood	.76
6F5983	202D1	Focus Coil	4.41
6F5876	202D2*	Focus Coil	6.47
6F5984	203D1	Ion-Trap Magnet	3.82
6F6009	203D3**	Ion-Trap Magnet (PM type)	1.23
6F6010	203R1**	Hor. Osc. & Sync. Control Coil	1.06
12F10168	204L1	Filament Choke	.12
6F5986	204T2**	Vertical Output Transformer	2.94
6F5970	204T3	Horizontal Output	7.06
6F6011	204T9**	Vertical Defl. Output Transf.	2.65
6F5971	208T1**	Horizontal Block, Osc. Transf.	2.29
6F5972	208T2**	Vertical Block, Osc. Transf.	1.62
6F5973	208T3	Horizontal Block, Osc. Transf.	1.62
6F5974	208T8**	Horizontal Sync-Disc. Transf.	1.35
6F6012	208T9**	Ver. Blocking Osc. Transformer	1.47
6F5975	211T1	Horizontal Output Transformer	3.29
6F5976	211T2	Horizontal Output Transformer	11.17
6F6013	211T3	Hor. Defl. Output & HV Transf.	3.29
6F5875	211T5*	Hor. Defl. Output & HV Transf.	5.59

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6N5884	71446	10,000	1 meg.	2.50
6N5885	71784	500,000	10,000	2.53
6N5886	71971	1,000	50,000	1.47
6N5887	72758	1 meg.	50,000	1.47
6N5890	73193	10,000	500,000	1.82

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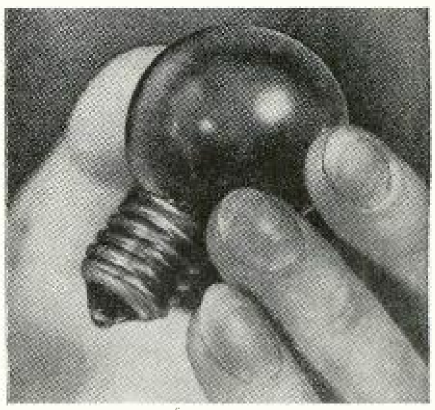
tional Use, (Federal Security Agency, Office of Education, Washington, free), should be included. The first has a list of most of the conversion articles that have appeared in radio and other magazines since the war. The second is a list, with sources and illustrations, of several hundred conversion projects actually accomplished at schools and colleges. Even a casual scanning of these pamphlets is sure to suggest new and interesting ideas.

Another very useful book is the *Surplus Radio Conversion Manual* (Editors and Engineers, Santa Barbara, $2.50 per volume). The two volumes of this set have conversion data for many of the popular receivers, transmitters, frequency meters, and other equipment. The first volume also has an electronic surplus index listing most of the material available on the market and a cross-index of military VT tube numbers to commercial numbers.

These books and pamphlets by no means make up a complete technical library (a few other sources were referred to in the Question Box; page 90, July RADIO-ELECTRONICS.—*Editor*) but they cover the needs of the surplus buyer completely and each will justify its place on the experimeter's bookshelf. —*Dr. L. B. Hedge.*

OZONE LAMP

Odors, not darkness, are dispelled by a new lamp developed by General Electric's lamp department. Designated as the OZ4S11, the lamp has a radiation that produces ozone, the form of oxygen created during an electrical storm and which causes the characteristic after-storm clean, fresh smell. One such bulb which will mask odors in rooms up to 1,000 cubic feet is being built into such devices as refrigerators, clothes dryers, and beverage vending machines.

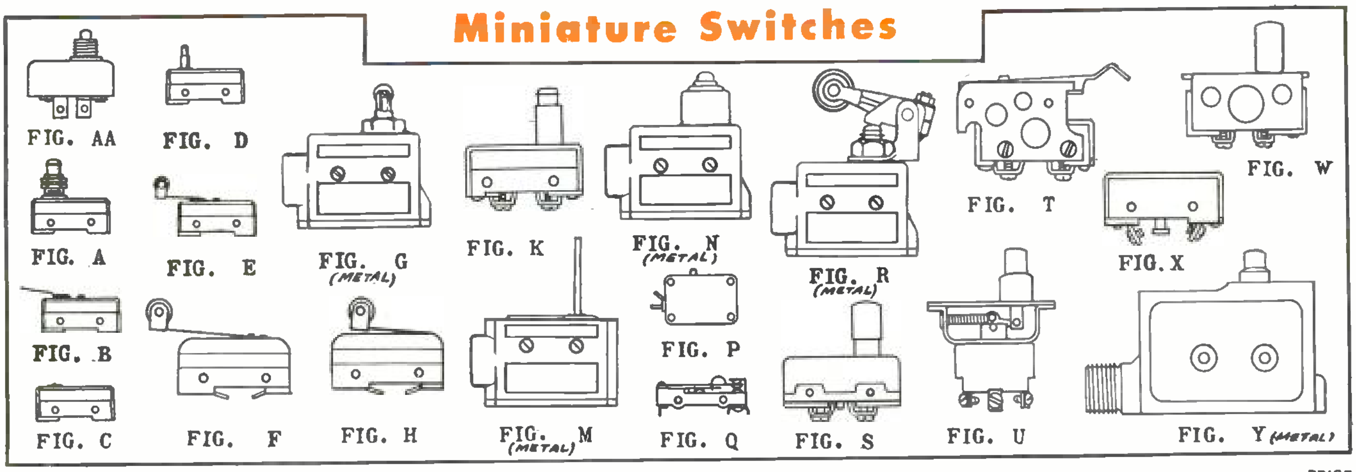


The OZ4S11 requires 25 volts a.c. for operation, about half of this being absorbed in a series resistance. Because the lamp itself only uses 4 watts, it is practical to ballast it with a series resistance even when the supply voltage is as high as 115 volts. It has a life of about 6 months of continuous operation.

A complete deodorizing unit using this bulb, called Air-Tron, is being manufactured by the Roy C. Stove Co. This unit comes complete with a self-contained transformer and ballast resistor and it can be plugged directly into a 117-volt a.c. wall outlet.

SAVE on Miniature and Toggle Switches at WELLS

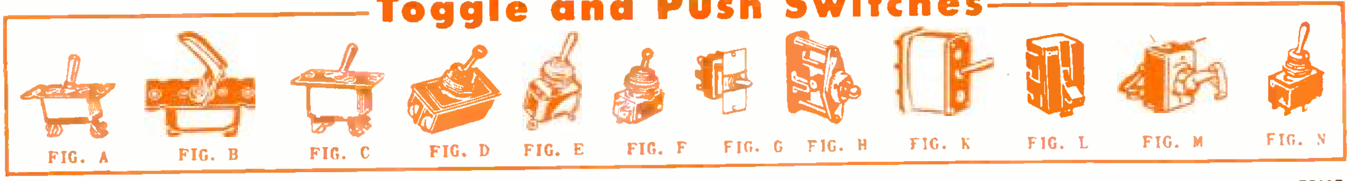
Miniature Switches



STOCK NUMBER	MANUFACTURER	MFR. TYPE NO.	CONTACTS	ILLUSTRATION	PRICE EACH
305-10	Microswitch	WP3M5	N.C.	FIG. AA	$0.40
305-160	Microswitch	WP-5M3	N.C.	FIG. AA	.40
307-210	Microswitch	YP3A	N.O.	FIG. AA	.50
303-67	Microswitch	YZ7RA6	N.O.	FIG. A	.71
PH-100	Acro	R0182T	N.O.	FIG. A	.71
301-46	MU-Switch	MLB-321	SPDT	FIB. B	.85
301-93	Microswitch	YZ-2YLTC1	SPDT	FIG. B	1.01
301-30	MU-Switch	R02M	SPDT	FIG. B	.95
301-78	MU-Switch	Green Dot	SPDT	FIG. B	.75
303-79	Microswitch	BZ-RL32	SPDT	FIG. B	.75
303-85	MU-Switch	MLB329	SPDT	FIG. B	.67
305-154	Acro	XD4-5L	SPDT	FIG. B	.78
311-130	Acro	— —	SPDT	FIG. B	.70
PH-101	Microswitch	BRL18	SPDT	FIG. B	.78
PH-102	Microswitch	YZRL812	N.O.	FIG. B	.65
PH-104	Microswitch	YZ3RLTC2	N.O.	FIG. B	.64
PH-105	Microswitch	YZR31	N.O.	FIG. C	.53
PH-106	Microswitch	R-R36	N.C.	FIG. C	.50
PH-107	Microswitch	BR-26	N.C.	FIG. C	.53
PH-108	Microswitch	WZ-2RT	N.C.	FIG. C	.50
305-161	Microswitch	YZ3R3	N.O.	FIG. C	.71
311-115	Microswitch	WZR31	N.C.	FIG. C	.71
311-123	Microswitch	WZ-7R	N.C.	FIG. C	.60
311-126	Acro	HRRC7.1A	N.C.	FIG. C	50
311-125	Acro	HRR07.1A	N.O.	FIG. C	.53
311-121	Microswitch	WZ7RTC	N.C.	FIG. C	.50
311-128B	Microswitch	YZ	N.O.	FIG. C	.53
370-6	Microswitch	X757	N.C.	FIG. C	.45
PH-119	Microswitch	WZR-8X	N.C.	FIG. C	.45
PH-109	Microswitch	RRS13	N.C.	FIG. D	.45
PH-110	Microswitch	BRS36	SPDT	FIG. D	.53

STOCK NUMBER	MANUFACTURER	MFR. TYPE NO.	CONTACTS	ILLUSTRATION	PRICE EACH
PH-111	Microswitch	GRS	N.O.	FIG. D	$0.49
311-116	Microswitch	SW-186	N.C.	FIG. D	.63
303-49	Microswitch	YZ2YST	SPDT	FIG. D	.68
309-93	Microswitch	BRS36	SPDT	FIG. D	.68
370-17	MU-Switch	QRS	SPDT	FIG. D	.75
PH-112	MU-Switch	MBW	SPDT	FIG. E	.72
311-25	MU-Switch	CUN24155	N.C.	FIG. E	.85
370-10	Acro	R02M12T	N.O.	FIG. E	.70
303-32	Microswitch	YZ-3RW2T	N.O.	FIG. F	.65
306-10	Microswitch	BZE-2RQ9TM1	SPDT	FIG. G	2.48
PH-120	Microswitch	YZ7RQ9T6	N.O.	FIG. G	.75
309-101	Microswitch	BZ-2FW221	SPDT	FIG. H	.95
PH-113	Microswitch	RZBQT	SPDT	FIG. K	.58
L306-1010	Acro	R07-8586	N.O.	FIG. K	.55
370-18	Acro	HR071P2TSF1	N.O.	FIG. K	.60
370-19	Microswitch	YZRQ41	N.O.	FIG. K	.65
370-8	Microswitch	RN-11-H03	SPDT	FIG. M	1.50
309-157	MU-Switch	— —	N.C.	FIG. N	1.15
370-15	MU-Switch	AHB203	SPDT	FIG. N	1.25
370-7	Microswitch	WZE-7RQTN	N.C.	FIG. N	1.35
305-11	Acro	2M031A	N.O.	FIG. P	.37
305-50	Microswitch	Open Type	SPDT	FIG. Q	.35
303-84	Acro	HR07-4PST	N.O.	FIG. S	.50
303-83	Microswitch	YZ-RQ4	N.O.	FIG. S	.50
PH-114	Microswitch	WZR-31	N.C.	FIG. T	.65
PH-115	Cutler Hammer	8905K564	DPDT	FIG. U	.65
PH-116	Microswitch	WZRQ41	N.O.	FIG. W	.60
PH-118	Microswitch	BZRQ41	SPDT	FIG. W	.60
311-128A	Microswitch	YZ-RTX1	N.O.	FIG. X	.90
PH-117	MU-Switch	Z	N.C.	FIG. Y	1.35

Toggle and Push Switches



STOCK NUMBER	FIG.	CONTACT ARRANGEMENT	MANUFACTURER & NUMBER	PRICE EACH
PH-500	A	SPDT	B1B	$0.35
PH-501	A	SPDT	AN3022-3B	$.35
PH-503	A	SPDT CENTER OFF MOM EACH SIDE	B11	.32
PH-505A	A	SPDT MOMENTARY	B21	.30
PH-505	A	SPST	AN-3022-2B	.30
PH-506	A	SPDT CENTER OFF	AN-3022-1	.35
PH-507	A	SPDT CENTER OFF MOM EACH SIDE	AN-3022-7B	.32
PH-508	A	SPST MOMENTARY	AN-3022-8	.28
PH-513	A	SPDT CENTER OFF	CH AN-3022-1B	.38
PH-514	A	SPST	CH B-5 A	.35
PH-516	A	SPST	B5	.35
LT-104	A	SPDT 1 SIDE MOMENTARY	CH 8905K568	.35
309-168	A	SPST	168553	.30
370-1	A	SPST MOMENTARY	CH AN-3022-8B	.25
370-4	A	SPDT CENTER OFF	CH B-9A	.35
370-14	A	SPDT CENTER OFF 1 SIDE MOM.	CH B-7A	.30
370-25	A	SPST MOMENTARY	CH B-6B	.25
305-171	A	SPDT CENTER OFF MOM 1 SIDE	8209K5	.32
309-169	B	SPST MOMENTARY	CH B-19	.35
PH-509	C	DPST	AN-3023-2B	.45
PH-510	C	DPDT MOMENTARY	CH 8715K2	.50
PH-511	C	DPDT MOMENTARY	CH 8715K3	.50
PH-512	C	DPST CENTER OFF	CH 8720K1	.55
PH-515	C	DPDT CENTER OFF	C-9A-8700K2	.55
PH-517	C	DPDT	C-5A-8701K2	.55
303-65	C	DPST	CH AN-3023-2	.45

Distributors: Our standard distributor arrangement applies on these items.

STOCK NUMBER	FIG.	CONTACT ARRANGEMENT	MANUFACTURER & NUMBER	PRICE EACH
305-174	C	DPDT CENTER OFF MOM 1 SIDE	AN-3023-5	$0.50
305-177	C	DPDT CENTER OFF MOM EACH SIDE	C-3	.50
305-176	C	DPDT CENTER OFF MOM EACH SIDE	AN-3023-7	.50
305-173	C	DPDT	8710K3	.55
305-175	C	DPDT CENTER OFF MOM EACH SIDE	3712K3	.50
305-179	C	DPDT CENTER OFF MOM EACH SIDE	8732-K2	.50
309-163	C	DPDT CENTER OFF MOMENTARY	CH C-11	.55
309-162	C	DPST	CH C-1	.45
309-164	C	DPST MOMENTARY	CH 8711K3	.40
370-31	C	DPDT	CH C-1B	.55
305-87	D	1 SIDE DPST MOM 1 SIDE SPST	AH & H	.95
LT-100	F	SPST	CH	.22
LT-101	F	SPST MOMENTARY	AH & H w/LEADS	.20
301-51	G	4PDT MOMENTARY	CH 8905K12	.75
305-140	H	DT NO MAKE EACH SIDE	OPEN FRAME	.25
309-161	K	SPST	CH 8781K3	1.95
305-76	L	DPST	AH & H OPEN FRAME	.75
301-12	M	DPST	AH & H SPECIAL FOR HANDY	.40
LT-107	N	DPST	AH & H TALKIE	.25

Many More Types in Stock. Send Us Your Requirements.

JUST OUT: CATALOG H500 Manufacturers, Distributors and Amateurs write for the brand new Wells Electronic Catalog H500. Full of tremendous values in highest quality components.

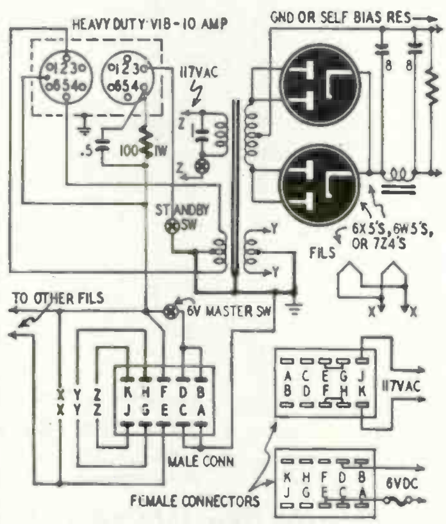
WELLS SALES, INC.

Order directly from this ad or through your local parts jobber—

320 N. LA SALLE ST. DEPT. Y, CHICAGO 10, ILL.

DUAL POWER SUPPLY

Amateurs, service technicians, and emergency workers often must operate receivers, transmitters, public address amplifiers, and allied equipment when primary power sources have failed. Such problems are usually met by portable gasoline-powered a.c. generators. Because such devices are bulky and relatively expensive, they may not be available when there is most need for them. On the other hand, 6-volt storage batteries are universally available and in most emergencies can be commandeered or borrowed from the nearest automobile. Under such circumstances, it is always advisable that emergency equipment be designed to operate both from 115-volt a.c. and 6-volt d.c. sources.

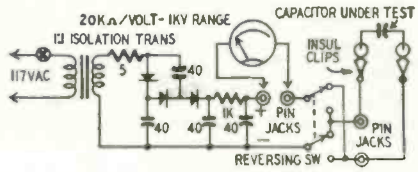


A dual power supply which delivers 325 volts d.c. at 135 ma from 60-cycle a.c. lines or 6-volt storage batteries is described in Thordarson's general catalog. The circuit is shown. The unit is switched from one type of power to the other merely by plugging in the correct power connector. Make sure that the 6-volt d.c. leads are sufficiently heavy to carry the current without excessive voltage drop. The vibrator, an Electronic type 490 or equivalent, should be capable of carrying 10 amperes or more. Before wiring the supply, check the base connections of the vibrator you plan to use. The power connectors should have at least four heavy contacts which are used for the 6-volt d.c. primary circuits. The filter choke and bleeder resistor depend on the demands of the device being powered.

If the current drain exceeds the demands of a single Thordarson T-22R24 transformer, two of these can be connected in parallel as described in the article "Portarig Ham Station" in the June 1946 issue.

NOVEL CAPACITOR TESTER

This tester and a 20,000-ohm-per-volt 1-kv voltmeter are used to measure leakage resistance of a paper capacitor and to compare its capacitance with a standard. The instrument consists of a 450-volt, transformerless power supply and a circuit-reversing switch.



To measure leakage resistance, short the test leads and read the supply voltage on the 1-kv scale of the meter. Record this voltage as E1. Connect the capacitor to the test leads and allow it to become fully charged—the needle comes to rest. Read the new voltage on the meter as E2. Because the meter resistance is 20 megohms on the 1-kv range, the leakage resistance is equal to:

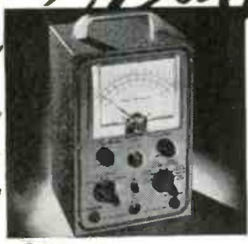
$$20{,}000{,}000 \times \frac{E1 - E2}{E1}$$

To measure capacitance, allow the capacitor to charge, then press the reversing switch. The meter will kick to nearly twice the supply voltage E1. Compare the kick with that delivered by a standard capacitor.

The isolation transformer is necessary in this circuit. It insures that the user will not be caught between ground and the hot side of the a.c. line. It also prevents fireworks which would otherwise occur if the tester were used to check capacitors in the a.c.-d.c. equipment by unsoldering one lead, as is common practice with all skilled radio technicians.—*Wm. E. Wadsworth*

Heathkits are the Quality Line of TEST INSTRUMENT KITS

You GET THE BEST IN *Heathkits*



Modern STYLING KITS THAT MATCH

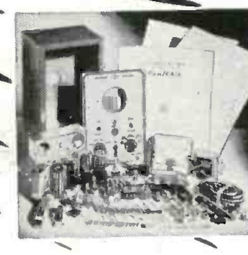
Heathkits are styled in the most modern manner by leading industrial stylists. They add beauty and utility to any laboratory or service bench. There is a complete line of Heathkit instruments allowing a uniformity of appearance.

An attractive service shop builds a feeling of confidence. Many organizations have standardized on Heathkits providing uniform service departments.

There is no waste space or false effort to appear large in Heathkits — space on service benches is limited and the size of Heathkit instruments is kept as small as is consistent with good engineering practice.

Famous HEATHKIT PARTS

- MALLORY FILTER CONDENSERS
- WILKOR PRECISION RESISTORS
- GRIGSBY ALLISON SWITCHES
- ALLEN-BRADLEY RESISTORS
- GENERAL ELECTRIC TUBES
- CHICAGO TRANSFORMER
- CENTRALAB CONTROLS
- SIMPSON METERS
- CINCH SOCKETS



Complete KITS WITH PARTS THAT FIT . . .

When you receive your Heathkit, you are assured of every necessary part for the proper operation of the instrument.

Beautiful cabinets, handles, two-color panels, all tubes, test leads where they are a necessary part of the instrument, quality rubber line cords and plugs, rubber feet for each instrument, all scales and dials ready printed and calibrated. Every Heathkit is 110 V 60 Cy. power tranformer operated by a husky transformer especially designed for the job. Heathkit chassis are precision punched for ease of assembly. Special engineering for simplicity of assembly is carefully considered.

Accuracy ASSURED BY PRECISION PARTS

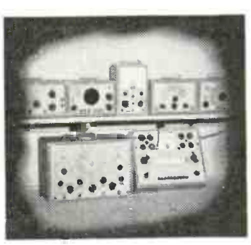
Wherever required, the finest quality 1% ceramic resistors are supplied. These require no aging and do not shift. No matching of common resistors is required. You find in Heathkit the same quality voltage divider resistors as in the most expensive equipment.

The transformers are designed especially for the Heathkit unit. The scope transformer has two electrostatic shields to prevent interaction of AC fields.

These transformers are built by several of the finest transformer companies in the United States.

Complete INSTRUCTION MANUALS

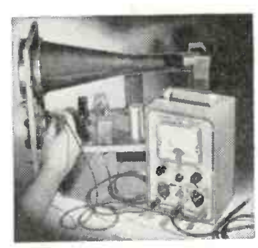
Heathkit instruction manuals contain complete assembly data arranged in a step-by-step manner. There are pictorials of each phase of the assembly drawn by competent artists with detail allowing the actual identification of parts. Where necessary, a separate section is devoted to the use of the instrument. Actual photos are included to aid in the proper location of wiring.



Used BY LEADING MANUFACTURERS

Leading TV and radio manufacturers use hundreds of Heathkits on the assembly lines. Heathkit scopes are used in the alignment of TV tuners. Impedance bridges are serving every day in the manufacture of transformers. Heathkit VTVM's are built into the production lines and test benches. Many manufacturers assemble Heathkits in quantity for their own use thus keeping purchase cost down.

Used BY LEADING UNIVERSITIES



Heathkits are found in every leading university from Massachusetts to California. Students learn much more when they actually assemble the instrument they use. Technical schools often include Heathkits in their course and these become the property of the students. High schools, too, find that the purchase of inexpensive Heathkits allows their budget to go much further and provides much more complete laboratories.

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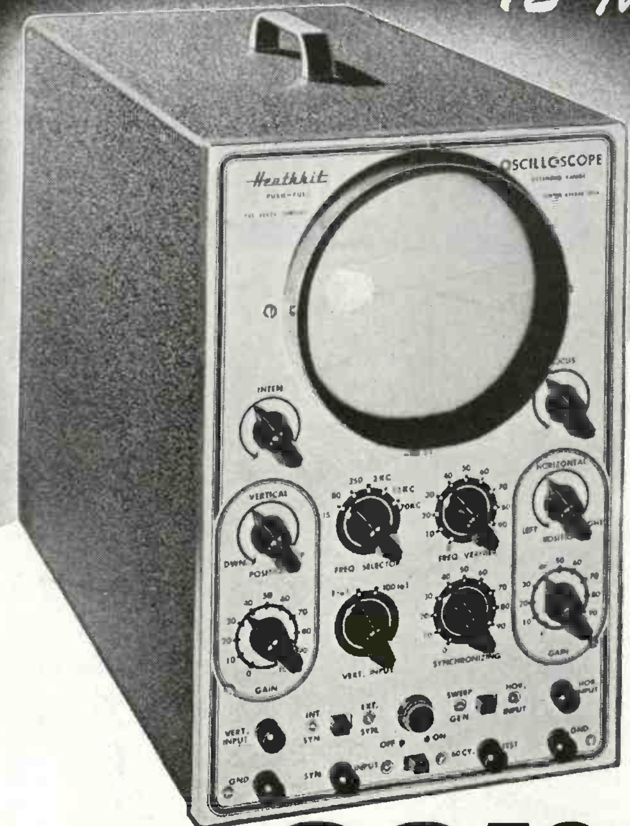
12 *Improvements* IN NEW 1951

MODEL O-6 PUSH-PULL

Heathkit OSCILLOSCOPE KIT



- ★ New AC and DC push-pull amplifier.
- ★ New step attenuator frequency compensated input.
- ★ New non frequency discriminating input control.
- ★ New heavy duty power transformer has 68% less magnetic field.
- ★ New filter condenser has separate vertical and horizontal sections.
- ★ New intensity circuit gives greater brilliance.
- ★ Improved amplifiers for better response useful to 2 megacycles.
- ★ High gain amplifiers .04 Volts RMS per inch deflection.
- ★ Improved Allegheny Ludlum magnetic metal CR tube shield.
- ★ New synchronization circuit works with either positive or negative peaks of signal.
- ★ New extended range sweep circuit 15 cycles to over 100,000 cycles.
- ★ Both vertical and horizontal amplifier use push-pull pentodes for maximum gain.

Only $39.50

The new 1951 Heathkit Push-Pull Oscilloscope Kit is again the best buy. No other kit offers half the features — check them.

Measure either AC or DC on this new scope — the first oscilloscope under $100.00 with a DC amplifier.

The vertical amplifier has frequency compensated step attenuator input into a cathode follower stage. The gain control is of the non frequency discriminating type — accurate response at any setting. A push-pull pentode stage feeds the C.R. tube. New type positioning control has wide range for observing any portion of the trace.

The horizontal amplifiers are direct coupled to the C.R. tube and may be used as either AC or DC amplifiers. Separate binding posts are provided for AC or DC.

The multivibrator type sweep generator has new frequency compensation for the high range it covers; 15 cycles to cover 100,000 cycles.

The new model 0-6 Scope uses 10 tubes in all — several more than any other. Only Heathkit Scopes have all the features.

New husky heavy duty power transformer has 50% more laminations. It runs cool and has the lowest possible magnetic field. A complete electrostatic shield covers primary and other necessary windings and has lead brought out for proper grounding.

The new filter condenser has separate filters for the vertical and horizontal screen grids and prevents interaction between them.

An improved intensity circuit provides almost double previous brilliance and better intensity modulation.

A new synchronization circuit allows the trace to be synchronized with either the positive or negative pulse, an important feature in observing the complex pulses encountered in television servicing.

The magnetic alloy shield supplied for the C.R. tube is of new design and uses a special metal developed by Allegheny Ludlum for such applications.

The Heathkit scope cabinet is of aluminum alloy for lightness of portability.

The kit is complete, all tubes, cabinet, transformer, controls, grid screen, tube shield, etc. The instruction manual has complete step-by-step assembly and pictorials of every section. Compare it with all others and you will buy a Heathkit. Model 0-6. Shipping Wt., 30 lbs.

New INEXPENSIVE MODEL S-2

ELECTRONIC SWITCH KIT

Twice as much fun with your oscilloscope — observe two traces at once — see both the input and output traces of an amplifier, and amazingly you can control the size and position of each trace separately — superimpose them for comparison or separate for observation — no connections inside scope. All operation electronic, nothing mechanical — ideal for classroom demonstrations — checking for intermittents, etc. Distortion, phase shift and other defects show up instantly. Can be used with any type or make of oscilloscope. So inexpensive you can't afford to be without one.

Has individual gain controls, positioning control and coarse and fine switching rate controls — can also be used as square wave generator over limited range. 110 Volt transformer operated comes complete with tubes, cabinet and all parts. Occupies very little space beside the scope. Better get one. You'll enjoy it immensely. Model S-2. Shipping Wt., 11 lbs.

Only $19.50

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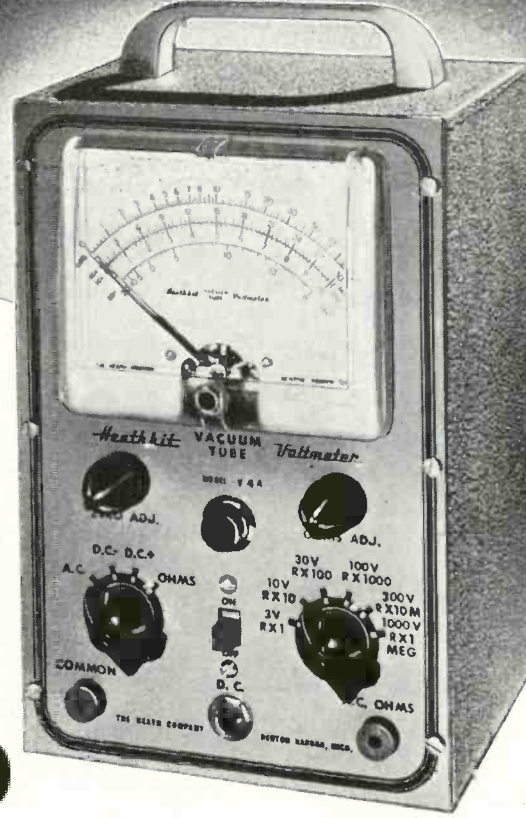
... BENTON HARBOR 20, MICHIGAN

New 1951 • • MODEL V-4A

Heathkit VTVM KIT

HAS EVERY EXPENSIVE *Feature*



★ Higher AC input impedance, (greater than 1 megohm at 1000 cycles).
★ New AC voltmeter flat within 1 db 20 cycles to 2 megacycles (600 ohm source).
★ New accessory probe (extra) extends DC range to 30,000 Volts.
★ New high quality Simpson 200 microampere meter.
★ New ½% voltage divider resistors (finest available).
★ 24 Complete ranges.
★ Low voltage range 3 Volts full scale (⅓ of scale per volt).
★ Crystal probe (extra) extends RF range to 250 megacycles.
★ Modern push-pull electronic voltmeter on both AC and DC.
★ Completely transformer operated isolated from line for safety.
★ Largest scale available on streamline 4½ inch meter.
★ Burn-out proof meter circuit.
★ Isolated probe for dynamic testing no circuit loading.
★ New simplified switches for easy assembly.

New LOW PRICE $23.50

The new Heathkit Model V-4A VTVM Kit measures to 30,000 Volts DC and 250 megacycles with accessory probes — think of it, all in one electronic instrument more useful than ever before. The AC voltmeter is so flat and extended in its response it eliminates the need for separate expensive AC VTVM's. + or − db from 20 cycles to 2 megacycles. Meter has decibel ranges for direct reading. New zero center on meter scale for quick FM alignment.

There are six complete ranges for each function. Four functions give total of 24 ranges. The 3 Volt range allows 33⅓% of the scale for reading one volt as against only 20% of the scale on 5 Volt types.

The ranges decade for quick reading.

New ½% ceramic precision are the most accurate commercial resistors available — you find the same make and quality in the finest laboratory equipment selling for thousands of dollars. The entire voltage divider decade uses these ½% resistors.

New 200 microampere 4½" streamline meter with Simpson quality movement. Five times as sensitive as commonly used 1 MA meters.

Shatterproof plastic meter face for maximum protection.

Both AC and DC voltmeter use push-pull electronic voltmeter circuit with *burn-out* proof meter circuit.

Electronic ohmmeter circuit measures resistance over the amazing range of 1/10 ohm to one billion ohms all with internal 3 Volt battery. Ohmmeter batteries mount on the chassis in snap-in mounting for easy replacement.

Voltage ranges are full scale 3 Volts, 10 Volts, 30 Volts, 100 Volts, 300 Volts, 1000 Volts. Complete decading coverage without gaps.

The DC probe is isolated for dynamic measurements. Negligible circuit loading. Gets the accurate reading without disturbing the operation of the instrument under test. Kit comes complete, cabinet, transformer, Simpson meter, test leads, complete assembly and instruction manual. Compare it with all others and you will buy a Heathkit. Model V-4A. Shipping Wt., 8 lbs. Note new low price, $23.50

New 30,000 VOLT DC PROBE KIT

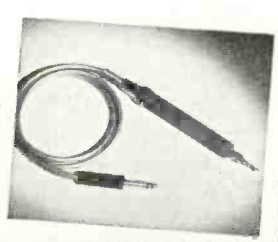
Beautiful new red and black plastic high voltage probe. Increases input resistance to 1100 megohms, reads 30,000 Volts on 300 Volt range. High input impedance for minimum loading of weak television voltages. Has large plastic insulator rings between handle and point for maximum safety. Comes complete with PL55 type plug.

No. 3366 High Voltage Probe Kit. Shipping Wt., 2 pounds. **$5.50**

Heathkit RF PROBE KIT

Crystal diode probe kit extends range to 250 megacycles = 10% comes complete with all parts, crystal, cable and PL55 type plug.

No. 309 RF Probe Kit Shipping Wt., 1 lb. **$5.50**



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The HEATH COMPANY
... BENTON HARBOR 20, MICHIGAN

NEW *Heathkit* T. V. ALIGNMENT GENERATOR KIT

Shipping Wt., 16 lbs.

$39.50

- ★ New simplified circuit for easy calibration and assembly.
- ★ New 2 band built-in marker covers 19 to 75 Mc.
- ★ New dual spider sweep motor for long life.
- ★ New blanking circuit gives base line for better alignment.
- ★ New variable oscillator gives high output fundamentals on high TV band.
- ★ New standby switch keeps instrument ready for instant use.
- ★ New 6 to 1 slow speed drive on both master oscillator and marker tuners.

The new Heathkit TV Alignment Generator incorporates the new developments required for modern TV servicing. An absorption marker circuit covering all possible IF bands and even several of the RF bands. The new blanking circuit provides a base reference line which is invaluable in establishing proper traces. The new sweep motor incorporates dual spiders in the speaker frame assuring better alignment and long life. The mounting of the speaker sweep motor has been simplified for easy alignment.

The variable master oscillator covers 140 to 230 Mc. thus giving high output fundamentals where they are most needed. Low band coverage 2 Mc. to 90 Mc.

A new step attenuator provides excellent control of output.

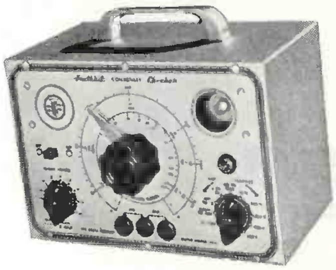
Planetary 6 to 1 drives on both oscillator and marker provides smooth easy control settings.

A standby position is provided making the instrument always instantly available.

Horizontal sweep voltage with phasing control is provided. No other sweep generator under $100.00 provides all these features — comes complete with instruction manual. Model TS-2.

Heathkit CONDENSER CHECKER KIT

Only **$19.50**



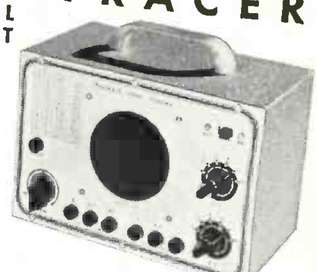
Features

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

Checks all types of condensers over a range of .00001 MFD to 1,000 MFD. All on readable scales that are read direct from the panel. NO CHARTS OR MULTIPLIERS NECESSARY. A condenser checker anyone can read. A leakage test and polarizing voltage for 20 to 500 Volts provided. Measures power factor of electrolytics between 0% and 50%. 110 V. 60 cycle transformer operated complete with rectifier and magic eye tube, cabinet, calibrated panel, test leads and all other parts. Clear detailed instructions for assembly and use. Model C-2. Shipping Wt., 7 lbs.

NEW *Heathkit* SIGNAL TRACER AND UNIVERSAL TEST SPEAKER KIT

$19.50



Features

- High sensitivity
- Complete set of speaker impedances
- Tests microphones and PA systems
- Tests both single and push-pull speaker circuits

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 test microphones, pickups, PA systems — comes complete — cabinet, 110 V. 60 cycle power transformer — tubes, test probe, all parts and detailed instructions for assembly and use. Model T-2. Shipping Wt., 8 lbs.

Heathkit TUBE CHECKER KIT

Features

- Sockets for every modern tube — blank for new types.
- Fastest method of testing tubes — saves time — makes more profit.
- Rugged counter type birch cabinet.
- Gear driven roller chart gives instant setup for all types.
- Tests each element separately for open or short and quality.
- Beautiful 3 color meter — reads good-bad and line set point.

Test your tubes the modern way — dynamically — the simplest, yet fastest and surest method — your Heathkit has a switch for each tube element and measures that element — no chance for open or shorted elements slipping by, all the advantages of the mutual conductance type without the slow cumbersome time consuming setups.

Your Heathkit Tube Checker has all the features — beautiful 3 color BAD-GOOD meter — complete selection of voltages — roller chart listing hundreds of tubes including the new 9 pin miniatures — finest quality Centralab lever switches for each element — high grade birch counter type cabinet — continuously variable line adjust control — every feature you need to sell tubes properly. The most modern type tube checker with complete protection against obsolescence. The best of parts — rugged oversize 110 V. 60 cycle power transformer — finest of Mallory and Centralab switches and controls, complete set of sockets for all type tubes with blank spare for future types. Fast action brass gear driven roller chart quickly locates the settings for any type tube. Simplified switching cuts necessary testing time to minimum and saves valuable service time. Short and open element check. Simple method allows instant setup of new tube types without waiting for factory data. No matter what the arrangements of tube elements, the Heathkit flexible switching arrangement easily handles it. Order your Heathkit Tube Checker Kit today. See for yourself that Heath again saves you two-thirds and yet retains all the quality — this tube checker will pay for itself in a few weeks — better assemble it now. Complete with instructions — pictorial diagrams — all parts — cabinet — ready to wire up and operate. Model TC-1 Shipping Wt., 12 lbs.

$29.50

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The HEATH COMPANY
. . . BENTON HARBOR 20, MICHIGAN

NEW 1951 *Heathkit* SIGNAL GENERATOR KIT

Features

- Sine wave audio modulation.
- Extended range 160 Kc. to 50 megacycles fundamentals.
- New step attenuator output.
- New miniature HF tubes.
- Transformer operated for safety.
- Calibrated harmonics to 150 megacycles.
- New external modulation switch.
- 5 to 1 vernier tuning for accurate settings.

A completely new Heathkit Signal Generator Kit. Dozens of improvements. The range on fundamentals has been extended to over 50 megacycles; makes this Heathkit ideal as a marker oscillator for T.V. New step attenuator gives controlled outputs from very low values to high output. A continuously variable control is used with each step. New miniature HF tubes are required for the high frequencies covered.

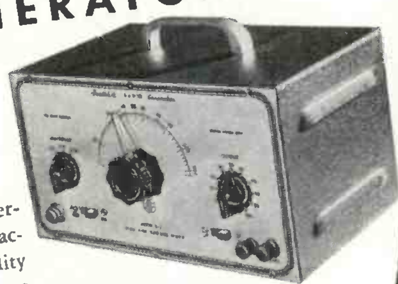
Uses 6C4 master oscillator and 6C4 sine wave audio oscillator. The set is transformer operated and a husky selenium rectifier is used in the power supply. The coils are precision wound and checked for calibration making only one adjustment necessary for all bands.

New sine wave audio oscillator provides internal modulation and is also available for external audio testing. Switch provided allows the oscillator to be modulated by an external audio oscillator for fidelity testing of receivers.

A best buy — think of all the features for less than $20.00. The entire coil and tuning assembly are assembled on a separate turret for quick assembly — comes complete — all tubes — cabinet — test leads — every part. The instruction manual has step-by-step instructions and pictorials. It's easy and fun to build a Heathkit Model SG-6 Signal Generator. Shipping Wt., 7 lbs.

$19.50

Heathkit SINE AND SQUARE WAVE AUDIO GENERATOR KIT



Either sine or square wave.
Stable RC bridge circuit.
Covers 20 to 20,000 cycles.
Less than 1% distortion.

Hundreds of Heathkit Audio Generators are used by speaker manufacturers—definite proof of their quality and dependability. The added feature of square wave opens up an entirely new field of amplifier testing. Uses the best of parts, 4 gang condenser, 1% calibrating resistors, metal cased filter condensers, 5 tubes, completely calibrated panel and detailed instruction manual. One of our best and most useful kits. Model G-2. Shipping Wt., 12 lbs.

$34.50

THE NEW *Heathkit* HANDITESTER KIT

- 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.

$13.50

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 Wt., 2 lbs.

NEW *Heathkit* BATTERY ELIMINATOR KIT

Features

- Provides variable DC voltage for all checks.
- Locates sticky vibrators-intermittents.
- Voltmeter for accurate check.
- Has 4000 MFD Mallory filter for ripple-free voltage.

Even the smallest shop can afford the Heathkit Battery Eliminator Kit. A few auto radio repair jobs will pay for it. It's fast for service, the voltage can be lowered to find sticky vibrators or raised to ferret out intermittents. Provides variable DC voltage 5 to 7½ Volts at 10 Amperes continuous or 15 Amperes intermittent. Also serves as storage battery charger. Ideal for all auto radio testing and demonstrating.

$22.50

A well filtered rugged power supply uses heavy duty selenium rectifier, choke input filter with 4,000 MFD of electrolytic filter for clean DC. 0-15 V. voltmeter indicates output which is variable in eight steps. Easily constructed in a few hours from our instructions and diagrams — better be equipped for all types of service — it means more income. Model BE-2. Shipping Wt., 19 lbs.

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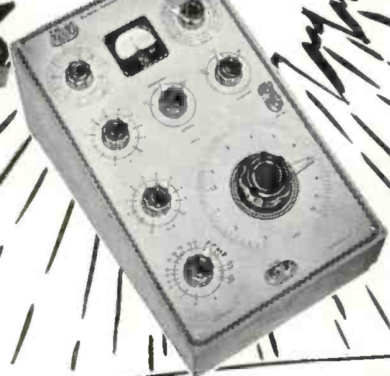
New LABORATORY INSTRUMENT KITS

HUNDREDS OF LABORATORIES USE

Heathkit IMPEDANCE BRIDGE *as Standard*



Features

• Measures inductance 10 microhenries to 100 henries • Measures resistance .01 ohms to 10 megohms • Measures capacitance .00001 MFD to 100 MFD • Measures "Q" and power factor.

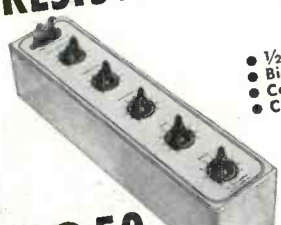
Measures inductance from 10 microhenries to 100 henries, capacitance from .00001 MFD to 100 MFD. Resistance from .01 ohms to 10 megohms. Dissipation factor from .001 to 1. "Q" from 1 to 1,000. Ideal for schools, laboratories, service shops, serious experimenters. An impedance bridge for everyone — the 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 1,000 cycle hummer. Mallory ceramic switches with 60 degree indexing — 200 microamp type binding posts with standard ¾" centers. Beautiful birch cabinet. Directly calibrated "Q" and dissipation factor scales. Ready calibrated 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.

$69.50

Internal 6 Volt battery for resistance and hummer operations. Circuit utilizes Wheatstone, Hay and Maxwell circuits for different measurements. Supplied complete with every quality part — all calibrations completed and instruction manual for assembly and use. Deliveries are limited. Model IB-1. Shipping Wt., 15 lbs.

NEW *Heathkit* LABORATORY RESISTANCE DECADE KIT

Features



- ½% Accuracy
- Birch Cabinet
- Ceramic Switches
- Covers 1 ohm to 99,999 ohms

The new Heathkit Resistance Decade is a handy tool for laboratory, school and service shop. Ideal for test setups, calibrating instruments, bridge measurements, selecting multipliers, etc.

$19.50

Uses the finest Centralab ceramic switches, ½% ceramic decade resistors and heavy birch cabinet matching other laboratory equipment. The range is 1 ohm to 99,999 ohms in one ohm steps.

Finest quality throughout to withstand school usage — heavy aluminum panel — laboratory type binding posts — the fine decades are extremely simple to assemble — complete kit. Model RD-1. Shipping Wt., 4 lbs.

NEW *Heathkit* LABORATORY POWER SUPPLY KIT

Features

- Supplies 6.3 V. AC at 4.5 Amps.
- Heavy duty construction.
- Handy for schools, labs., and service shops.
- Supplies variable DC 50-300 Volts.
- Shows voltage or current on 3½" meter.

This new Heathkit Variable Power Supply Kit fills hundreds of needs — use it for experimental circuits — no need to build a separate power supply — use it for a test voltage to determine proper coefficients in unknown circuits — calibrate instruments with its variable voltage, etc. This new Heathkit supplies 50 to 300 Volts continuously variable DC together with an AC filament voltage of 6.3 Volts at 4.5 Amperes. A built-in 1 MA 3½" meter has proper shunts to read 0-500 Volts and 0-200 Milliamperes. The circuit uses a 5Y3 rectifier, two 1619 tubes as electronic control tubes to vary the output voltage with a single potentiometer. Case measures 7⅛" x 13" x 7⅛". Has instruction manual for assembly and use. Model PS-1. Shipping Wt., 18 lbs.

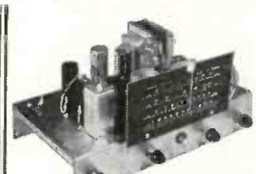
$29.50

Heathkit RECEIVER & TUNER KITS for AM and FM

TWO HIGH QUALITY *Heathkit* SUPERHETERODYNE RECEIVER KITS

Model BR-1 Broadcast Model Kit covers 550 to 1600 Kc. Shipping Wt., 10 pounds.

$19.50



Model AR-1 3 Band Receiver Kit covers 550 Kc. to over 20 Mc. continuous. Extremely high sensitivity. Shipping Wt., 10 lbs.

$23.50

Two new Heathkits. Ideal for schools, replacement of worn out receivers, amateurs and custom installations.

Both are transformer operated quality units. The best of materials are used throughout — six inch calibrated slide rule dial — quality power and output transformers — dual iron core shielded I.F. coils — metal filter condensers and all other parts. The chassis has phono input jack — 110 Volt outlet for phono motor and there is a phono-radio switch on panel. A large metal panel simplifying installation in used console cabinets is included. Comes complete with tubes and instruction manual incorporating pictorials and step-by-step instructions (less speaker and cabinet). The three band model has simple coil turret which is assembled separately for ease of construction.

TRUE FM FROM *Heathkit* FM TUNER KIT

$22.50

The Heathkit FM Tuner Model FM-2 was designed for besr possible tonal reproduction. The circuit incorporates the most desirable FM features — true FM — ready wound and adjusted coils — 3 stages of 10.7 Mc. I.F. (including limiter).

Tube lineup: 7E5 oscillator, 6SH7 mixer, two 6SH7 I.F. stages, 6SH7 limiter, two 7C4 diodes as discriminator, 6X5 rectifier.

The instrument is transformer operated making it safe for connection to any type receiver or amplifier. The R.F. coils are ready wound — mounted on the tuning condenser and the condenser is adjusted — no R.F. coils to wind or adjust.

A calibrated six inch slide rule dial has vernier drive for easy tuning. The finest parts are provided with all tubes, punched and formed chassis, transformers, condensers and complete instruction manual. Model FM-2. Shipping Wt., 10 lbs.

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ENJOY MUSIC AT ITS *Finest* WITH *Heathkit* AMPLIFIERS

NEW *Heathkit* HIGH FIDELITY 20 WATT AMPLIFIER KIT

$21.50

Features

- Push-pull 6L6's.
- Full 20 Watts output.
- Fully enclosed chassis.
- Provisions for reluctance pickup compensation stage.
- Cased high fidelity output transformer.
- Treble and bass boost tone controls.
- Full range of output impedances 3.2 ohms to 500 ohms.

The finest amplifier kit we have ever offered — check the features. This inexpensive amplifier compares favorably with instruments costing five times as much. Nothing has been spared to provide the best reproduction — an ideal amplier for the new Heathkit FM Tuner listed below.

Dual tone controls for control of both treble and bass. Bass control is of the boost type for maximum listening pleasure. Optional preamplifier stage for use with G. E. reluctance pickup or microphone. Uses inverse feedback to give excellent response over entire range. Tube lineup: 6SJ7 preamplifier stage, 6J5 phase splitter stage, two 6L6's in push-pull and 5Y3 rectifier. (6SC7 as optional compensation stage).

Uses highest quality Chicago Transformer Corporation cased output transformer with taps of 3.2, 8, 15, 60 and 500 ohms to match any speaker combination. Power transformer is conservatively rated for continuous operation in sound systems. Tone control gives maximum bass boost of 6 db at 70 cycles. Amplifier has maximum gain of 75 db. Response within 3 db 20 to 20,000 cycles. Shipping Wt., 17 lbs. Complete with all parts, tubes and instruction manual.

Model A-5A Amplifier with preamplifier for G. E. cartridges or microphone $23.50
12" 20 Watt Speaker, No. 326 .... 7.50

Heathkit ECONOMY 6 WATT PUSH-PULL AMPLIFIER KIT

$12.50

No. 304, 12-inch Speaker... $6.95

This new Heathkit Amplifier was designed to give quality reproduction at a very low price. Has two preamp stages, phase inverter stage and push-pull beam power output. Comes complete with six tubes, quality output transformer (to 3-4 ohm voice coil), husky cased power transformer and all other parts. Has tone and volume controls. Instruction manual has pictorial for easy assembly. Six watt output with response flat ± 1½ db from 50 to 15,000 cycles. A quality amplifier kit at new low price. Better build one. Model A-4. Shipping Wt., 7 lbs.

Heathkit RECEIVERS and TUNER CABINETS

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Order No. 350 for FM tuner.

Blonde birch veneer cabinet for either the receivers or tuner. Modern styling is an asset to any room. 5" speaker fits in end of cabinet when used with receivers. Size 7 x 13½ x 8¼ inches. Shipping Wt., 5 lbs.
Order No. 345 for either receiver

Metal professional type communications receiver cabinet. Finished in deep grey to fit the panel supplied with Heathkit BR-1 and AR-1 Receivers (panel shown not included with cabinet). 5" speaker mounts in end of cabinet. Gives professional appearance to Heathkit receivers. Size 7 x 14 x 7¾ inches. Shipping Wt., 6 lbs.

5" Permoflux Speaker for either cabinet for use with either Heathkit Receiver
No. 320 5" Speaker $2.75

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No. 335 Cabinet for receivers only.

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	Heathkit FM Tuner Kit — FM-2			Heathkit H.V. Probe Kit — No. 336	
	Heathkit Broadcast Receiver Kit — Model BR-1			Heathkit R.F. Signal Gen. Kit — Model SG-6	
	Heathkit Three Band Receiver Kit — Model AR-1			Heathkit Condenser Checker Kit — Model C-2	
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	Heathkit Audio Generator Kit — Model G-2			Heathkit Impedance Bridge Kit — Model IB-1	
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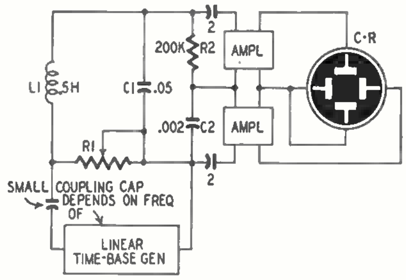
SPIRAL TRACE GENERATOR

Most oscillographic studies are made by applying known and unknown signals to the horizontal and vertical plates of a C-R tube to obtain Lissajous figures or a trace which deviates about the horizontal and vertical axes. Measurements involving time intervals, duration, or frequency are difficult when there is a considerable difference in the frequency or duration of the known and unknown signals.



Spiral and circular time-base generators are frequently used in radar and other electronic navigation systems to permit accurate measurement of the duration or frequency of an event. The spiral time-base generator shown in the diagram was described in *Wireless Engineer* (London).

Voltage from a linear time-base generator—the sawtooth generator in the scope will do—is applied to an oscillatory circuit consisting of R1, C1, and L1. A phase-shift network in which the resistance of R2 equals the capacitive reactance of C2 at the resonant frequency of the tuned circuit is shunted across C1. The voltage across C2 is applied to the horizontal plates and the voltage across R2 to the vertical.

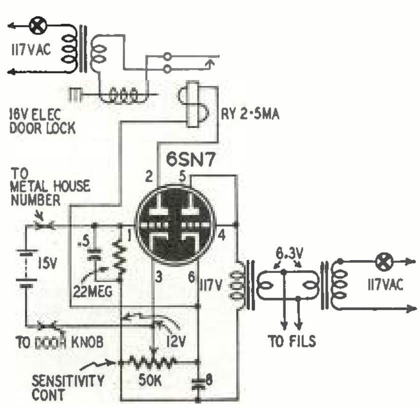
The number of traces in the spiral is determined by the relationship between the frequency of the sawtooth generator and the resonant frequency of L1-C1. The natural frequency of the resonant network should be several times the frequency of the sawtooth.

The signal to be studied or measured can be made to modulate the anode or grid of the C-R tube or the grid voltage on the amplifiers feeding the deflection plates.

ELECTRONIC DOOR OPENER

Devised to permit any authorized person to open an electric door lock from outside a building, this circuit uses a 6SN7 with one triode connected as a half-wave rectifier and the other as a relay control tube. Leads are run from the cathode and grid of the relay tube to a metal door knob and a metal house number or ornament on or beside the door. The 50,000-ohm sensitivity control is adjusted so the grid is biased to plate-current cutoff—approximately 12 volts.

To open the door, a person must have a 15-volt hearing-aid battery. He holds the battery with one hand touching the negative terminal. While holding the door knob in the other hand, he touches the positive terminal of the battery to the metal house number. This places 15 volts positive on the grid of the relay tube and on the 0.5-μf capacitor. The battery circuit is shown in dotted lines on the diagram. The triode conducts and closes the circuit to the door lock. The capacitor holds its charge for approximately 5 seconds after the battery is removed from contact with the house number. This is ample time for the person to open the door before the locking circuit is broken.



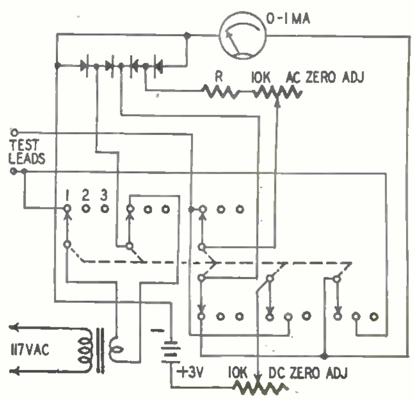
The relay used in this circuit should have a high-resistance coil, normally open contacts, and should pull in at 2 to 5 ma. Two 6.3-volt filament transformers are connected back-to-back to isolate the relay circuit from the line and thus prevent you from getting a shock if you should touch the door knob while standing on a wet surface. You can get the same result by using a small power transformer. The rectifier should be connected across half of the high-voltage secondary.

This system can be modified to deactivate a burglar alarm before entering a house or building.—*Llewellyn Jones*, REC-33

NOVEL CAPACITOR CHECKER

Checking capacitors in receiver or other electronic circuits can be a tiresome task because the usual methods require that at least one of the capacitor leads be disconnected from the circuit—a trying task in some midget sets. If the capacitor values are not too low, the instrument diagrammed checks them while they are in parallel with resistors, as in cathode-bypass circuits.

The tester in Fig. 1 is an ohmmeter which has a.c. and d.c. voltage sources. The meter is a navy surplus 0-1-ma unit calibrated —10 to +5 db. The rectifier and resistor R are built into the meter.



We replaced the scale and used known resistors to calibrate it from 0 to 500,000 ohms. Separate scales are used for the a.c. and d.c. measurements. When checking pure resistance, the a.c. and d.c. readings are equal. Any circuit component which has reactance will

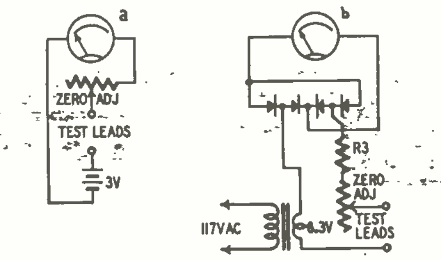


Fig. 2—Basic d.c. and a.c. circuits.

have a difference in the d.c. and a.c. readings. Thus, the readings will be equal if the capacitor is open or shorted. The test leads must be shorted and the meter adjusted to zero before taking measurements.

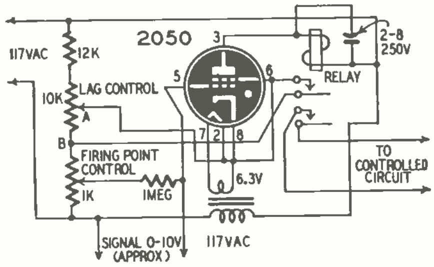
The full schematic of the instrument is shown in Fig. 1. Breakdowns of the d.c. and a.c. ohmmeter circuits are shown in Figs. 2-a and 2-b, respectively.

You can get the hang of using the instrument by experimenting with various combinations of resistance and capacitance.—*Morris Lieberman.*

ANTI-HUNT CONTROL

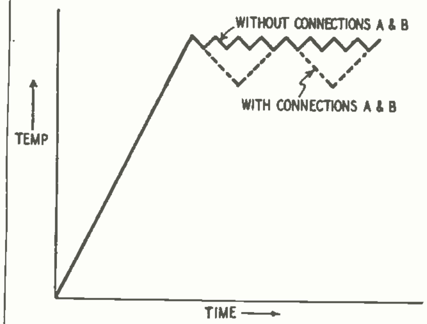
Simple control circuits using highly responsive elements such as thermistors and phototubes as signal sources frequently display a tendence to *hunt*—oscillate or become unstable—unnecessarily.

When precise regulation is not required, such as when controlling oven



temperatures within + or − 25° F as compared with + or − 2° F, hunting can be eliminated by using this circuit.

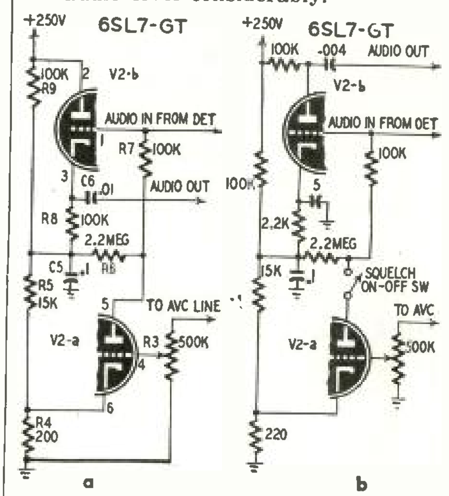
The circuit is conventional except for connections A and B. The constants depend on the available signal voltage. Those on the diagram are for a 2050 or 1D21 and signals up to about 10 volts.



When a signal is applied to the circuit, it bucks the bias voltage until the latter is reduced to the point at which the tube fires and closes the relay. Auxiliary contacts on the relay short A to B and further reduce the bias. Consequently, for the thyratron to extinguish, the signal must drop much more than it would without connections A and B. The amount of signal voltage lag is determined by the setting of R1. In this circuit, the lag is approximately 3.3 volts. The graph above shows the effect of using this modified circuit in temperature control applications.—*R. C. Roetger*

IMPROVED SQUELCH CIRCUIT

An audio squelch was described on page 32 of the December, 1949, issue. I installed this circuit in my 14-tube home-built superhet and found that it worked very well, although it reduced the audio level considerably.



I improved the circuit by placing the load resistance in plate circuit of V2-b and using a 2,200-ohm resistor and a 5-μf bypass capacitor in the cathode return, thus converting the V2-b from a cathode follower (see Fig. a) to a conventional amplifier as shown in Fig. b. This circuit has the added advantage that V2-b may be used as the first a. f. stage, thus making it possible to install the squelch in many receivers without drilling an extra socket hole. —*Arthur H. Bryant*

ESSE RADIO COMPANY
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COMMAND SET MODULATOR

BC-456 and Navy CBY50083. Contains dynamotor; however, no guarantee can be made on condition at this price. . . $1.95

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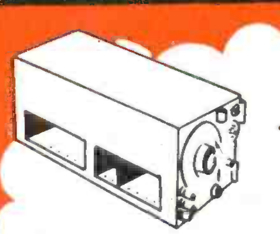

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Attention CAR AND BOAT OWNERS
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Tuning range 200-12,700 Kc. Tubes contained and included as follows: 4—39/44: 1—37: 1—38. One new Dual Coil set C-379 supplied with each set. Tunes range 201-398 Kc. and 2500-4700 Kc. Ideal for reception for CAP and boat frequencies. Power supply only necessary. Please—no technical inquiries on this item.
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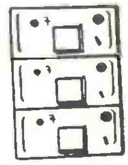
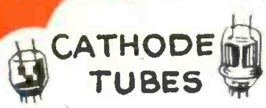
BC-375 TUNING UNITS

TU-26-B, TU-9-B, TU-7 — Used
TU-10-B — New
PRICE. . $1.25 each





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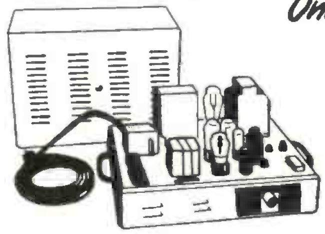


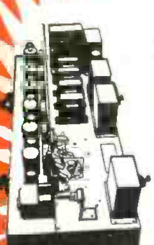
CLOSE OUT

Model F. Power Amplifier Unit manufactured by Personal Music Co., Newark, New Jersey. Formerly sold to jobbers at $129.50 each. Chassis size 11½" x 17½" x 2½" high (with cover 11½" x 17½" x 7½" high). Net weight about 50 lbs. Gray crackle finish. This amplifier delivers 15 watts of undistorted audio power with excellent frequency response. The tube line-up is 1—2D21, 1—6AL5, 1—6SJ7, 1—6SN7, 2—6L6G's, 1—5U4G. The total power drain is 300 watts from the 110 V. 60 cycle AC power source. Treble, bass, vernier volume and master volume controls are provided. This amplifier is beautifully designed and is sturdily constructed with the best of components. It can be used for continuous day and night service. Deluxe features such as high-low AC line switch, AC line fuse, good ventilation of chassis and cover, external carrying handles, lock and key, and heavy duty AC line cord are provided.

You can use this unit. It will make an excellent fool-proof and trouble-free unit for dance bands, lecture halls, schools, sports events, for rental purposes, for inner-office communication. It will handle a number of loudspeakers. Originally sold for $129.50.
OUR PRICE, BRAND NEW COMPLETE $24.95

NEW LOW PRICE! $2.50
ANTENNA KIT

Here is a deal you all can use. This versatile kit was made for the Army to hastily construct any type of antenna desired from an 'L' to a 'T' or umbrella. The kit comes in original moisture-proof wood box containing a canvas bag with 20 ceramic 3" strain insulators, covered wires in various lengths from 5 ft. to 150 ft., approx. 300 ft. or more total. All wires have connectors or snaps for quick and positive erection. Ideal for emergency or field work.
BRAND NEW $2.50 ea. kit



NEW!
BC-406A RECEIVER

This receiver made for radar use on frequency of 165 to 205 Mc. by W.E. Contains 19.5 Mc. IF strip with a .7 Mc. band width. Easily converted for other high frequency uses. Power supply is 110 V. AC 60 cycle containing Thordarson power transformer and 3 filter chokes with oil-filled capacitors. You have a bargain for parts alone. Tubes removed.
NEW—CLOSE OUT

ONLY $8.50

FIELD TELEPHONE WIRE
525'—$2.95

3-conductor stranded (4 steel, 4 copper). Insulated and weather-proofed. Ideal for inter-communication, telephones, burglar alarms, etc. Use it inside or out of doors. NEW

6V STORAGE BATTERY

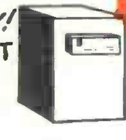
Willard plastic storage battery. Shipped dry-charged. Add only 1.265 sp.g. sulphuric acid. Size overall 7½" w. x 6⅜" x 2½" deep. Useful for portable electronic equipment, motorcycles, aircraft, etc. 17 A.H. cap.
BRAND NEW . . . . $2.50 ea.

$6.50

RT7/APN-1 RADIO ALTIMETER

This is a complete radio receiver and transmitter which may be converted or used commercially. All tubes are included consisting of 4—12SH7's; 3—12SJ7's; 2—6H6's; 1—VR150; 2—955's; 2—9004's. Other components such as relays, dynamotor, condensers, etc. make this a buy on which you cannot afford to pass up at the low close out price of ONLY $6.50 each.

BRAND NEW!
12 V AIRCRAFT BATTERY
$8.95



This is an ideal emergency power source or source for your operation of surplus equipment. Place battery in service by filling with mixture of sulphuric acid and water of 1.265 sp.g. These batteries are housed in corrosion-proof cases to protect other surrounding equipment. Size 1¼" wide x 10" high x 5½" deep.
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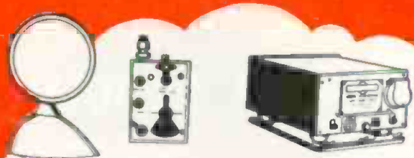
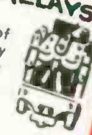


BRAND NEW MN-26 RADIO COMPASS

Here's an item for any ham, boat owner, or aircraft use. These units were made by Bendix Aircraft Company and sold for hundreds of dollars. They are brand new surplus and a nicer looking piece of equipment cannot be found at any price. Two models available. MN-26-C operates from 150 to 1500 Kc.

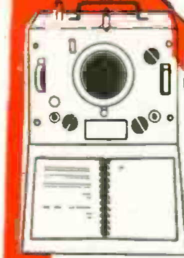
MN-26-Y operates from 150 to 695 Kc. and 3.4-7 Mc. All made to operate from 28 V. DC source but may be converted by good technician for any supply source. I repeat—these are brand new—complete with instruction book, remote control and loop.

$32.50



BRAND NEW RELAYS

Here is an assortment of miscellaneous relays any one of which is worth the price of the lot. The assortment includes 6 V. DC SPDT, 24 V. DPDT sensitive, etc. We are closing out our stock on these so take advantage of this offer.
12 for $2.95



BC-221 FREQ. METER

$59.50

Just received a nice lot of these at a price which we can pass along to our customers. Covers the range from 125 to 20,000 Kc. Accuracy of .01%. Furnished complete with calibration charts and ready to operate by connection of batteries or an AC power supply (not furnished).
Guaranteed good $59.50
Above model with audio modulation $15.00 extra

FILAMENT TRANSFORMER

5 V. CT. 7.5 amp. 110 V. 60 cycle pri.
Size 3" x 3½" x 2½".
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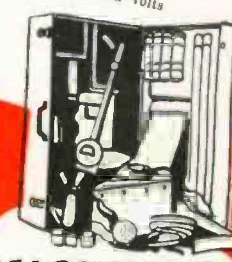
52 ohm impedance. Black vinyl cover over outer conductor. Maximum operating volts 4000 RMS. Only 2.1 DB attenuation per 100 ft. at 100 Mc.
This is an item getting scarce on the surplus market. New—Lengths to 500'—$5.95 per 100 ft.



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CENTRIFUGAL BLOWER

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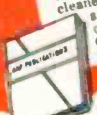
Has 1/4 Hp. 6000 Rpm motor AC or DC, with approx. 2" air openings. Many interesting and useful items have been made from these such as vacuum cleaners, organ conversions, transmitter cooling, forges, etc. Good condition.
PRICE $3.75



AAF PUBLICATIONS BINDER

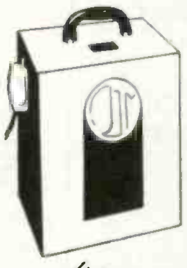
Made of heavy material fabric covered. Has three post clamps for holding your technical manuals or may be used for loose-leaf or magazine binder. Keep each year's copies of your various radio publications intact. Size 9½" x 11½". Holds thicknesses up to 2¾ inches.
BRAND NEW .... 29c ea.

6 VOLT STEWART WARNER HEATER FAN MOTOR

59¢ ea.

This motor was made for Stewart-Warner auto heaters but may be adapted to many other uses. New but some are dirty, guaranteed operation. Size 2¼" dia. x 2½" length with ½" of ¼" shaft extension.

A TALL BARGAIN!



JEFFERSON-TRAVIS MARINE RADIO TELEPHONE

$79.50

The Jefferson-Travis Model 52, 5 watt Marine Radio Telephone, has been specifically designed to provide radio telephone service on sail boats, small power boats and other craft with no electrical installation or where it is not desirable to use existing power. This unit would also be desirable for the amateur 75 meter band for mobile or portable operation.

The model 52 has two channels designed to operate in the frequency range of 2 to 3 mc., is crystal controlled in both receiver and transmitter and can operate with a self-contained rechargeable battery pack, sold as optional equipment, on an external 6V. DC power source. Battery drain is very slight for this equipment and approximately 10 hours of operation may be obtained from the self-contained battery listed below. The cabinet is made of sheet steel finished in Copen blue wrinkle inside and outside and is protected from corrosion by an inter-coating of zinc chromate. The control panel is equipped with a horizontal key type switch to select either two of crystal controlled channels. The vertical push-to-talk key type switch in a combination on/off and volume control knob. A hand type microphone of rugged construction is included and conveniently mounted on the left side of the unit. Speaker is self-contained. Weight of unit, less battery, is approx. 12 lbs.

These units were manufactured and made to sell for much more than our asking price. From reports and information obtained by E R C. before the purchase of these sets, we were told that they are operating from 35 to 50 miles of the coast to shore stations or between other aircraft. We were not fortunate enough to obtain a large quantity of these units; therefore, rush your order to assure your purchase of one of these excellent bargains. This is brand new factory-packed merchandise.

OUR PRICE $79.50

BATTERIES, suitable for above equipment Willard rechargeable storage batteries, brand new. Shipped dry, 6 V. battery in spill-proof clear plastic case. Uses standard battery electrolyte available at any drugstore. 1.265 specific gravity.

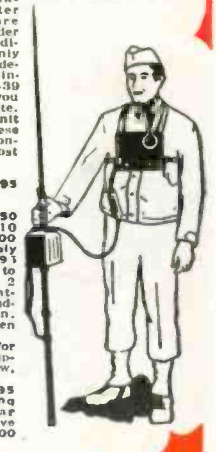
PRICE $3.00

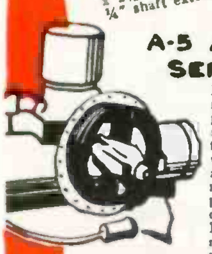
BC-745 HORSIE TALKIE

$3.95

Here's a swell portable transmitter and receiver operating on 75 meters. Total range 2-6 Mc. These were made for operational distances of five miles; however, greater distances are obtained under favorable conditions. Add only tuning unit desired (not included), chest unit T-39 and batteries and you are ready to operate. Wgt. of entire unit approx. 13 lbs. These units are all good condition; in fact, most are brand new.
PRICE, less tubes $3.95

T-39 Chest Unit. New $2.50
TU-BC-746 Chan. 10 Freq. 3735 Kc. . $1.00
PE-157 Power Supply Unit $4.93
These units used to power BC-745 from 2 V. to 6 V. storage battery to give loudspeaker operation. (Loudspeaker has been removed.)
BB-54 2 V. Battery for enclosing in above supply and operation (New, dry-charged).
Price $2.95
FT-338-A Mounting Rack for vehicular mounting of above supply. Prcie. . $1.00





A-5 AUTO PILOT SERVO-M-1

Has ¼ Hp. 24 V. DC motor speed 6000 Rpm to pump hydraulic fluid to selected cylinder for rotation of cable drum. A ham with a little mechanical ability can convert this to rotate his beam by wrapping cable around the drum and his beam mast. Dog included for disconnect of drum for free rotation.

BRAND NEW $4.25

NEW PANEL METER

2" ROUND .... $1.50 each
0-3 Volts DC Weston
0-60 Amps DC G.E.
*0-150 Amps. DC Westinghouse
*0-240 Amps. DC G.E. or Weston
*0-480 Amps. DC G.E. or Weston
*Combination 0-30 V. and 0-120 amps. Weston

3" PANEL METERS

$2.00

0-30 V. DC Westinghouse
0-40 V. DC Hoyt
0-30 Amps DC Hoyt
*0-600 Amps. DC Hoyt
0-500 Ma. DC Westinghouse
0-5 Amps. RF Westinghouse
*Uses external shunt, not included. Shunt. . $1.50 extra

PE-101C DYNOMOTOR

New—Original Packing Made for the BC-645-A 420 Mc. Trans.-Rec. Input 13 or 26 V. DC. Output 400 and 800 V. DC and 9 V. AC. Will operate on 6 V. DC at reduced ⅛ voltage. Size approx. 4 in. dia. x 14 in. long. Shipping wgt. approx. 15 lbs.
CLOSE OUT PRICE $1.95


COMMAND SET
RECEIVER-XMITTER
CLOSE OUT
We are clearing our stock of command set 3-6 Mc. BC-454 and Navy CBY46105 receivers and BC-457-A 4-5.3 Mc. transmitters. These are removed from aircraft and are complete with tubes and receiver dynamotors.
TAKE YOUR PICK .... $3.75 ea.
Racks for above .... 75¢ ea.
Rec. triple or Trans. dual.
CHOICE $ 3.75 ea.
RADIO MODULATOR
BC-423, BC-424
110 V. AC. operated. May be readily placed into ham use by changing frequency of existing 206 Mc. osc. Contains speech modulator with audio tone osc. The National vernier dial alone is worth the price. Comes complete with all tubes such as 2—6J7's; 1—6F6; 1—5W4 and 1—955. Thordarson power transformer T70R61. Housed in heavy steel cabinet 14¼ x 9 x 8".
NEW CONDITION—CLOSE OUT
$6.50 ea.
Miss ESSE
presents
THE BIGGEST
STRIP ACT
in
HAM HISTORY
(HRU) DC POWER SUPPLY
$69.50 EA.
24-28 V. at 70 amp. 2000 watts gasoline engine generator with electric starter. Power supply which can be used to operate 24-28 V. equipment, start airplane engines, charge batteries, as a welding machine, lighting system, or for amateur radio station. 21½" x 17½" x 24⅝". Wgt., 115 lbs.
PRICE $69.50
HEADPHONES
BRAND NEW 79¢
Dual with cloth covered headband. Trimm Rex type low Z.
T-17-B CARBON MIKES
New $1.75
Used .... .75
LP-21A LOOPS
$4.95
Used with radio compass SCP-269. Used, removed from aircraft.
PRICE .... $4.95 ea.
PP 2/APQ-5 POWER UNIT
Contains many useful parts such as condensers, resistors, tube sockets, transformers, etc. Made to operate from 115 V. DC 400 cycle. Size 21" L x 5¼" W. x 7¾" H. Complete with dustproof cover. Worth the price alone for the chassis and cabinet.
CLOSE OUT PRICE (less tubes) .... 95¢ ea.
A STEAL FOR THE PRICE
T-39/APQ-9 RADAR XMITTER
This is the transmitter described in the February "CQ" for conversion for the 420-450 Mc. Amateur band and is now being subjected to approval by the F.C.C. for the 465 Mc. Citizen's band. The oscillator has excellent frequency stability. Two-way communications for distances of 22 miles have been reported.
If conversion is not desired, the transmitter contains many excellent parts for the VHF experimenter such as a cavity oscillator using 2-RCA 8012 tubes rated at full output to 500 Mc. Tubes are forced air cooled by 24 V. DC motor which is easily converted for 110 V AC operation. 8012 tubes only supplied. Other valuable parts such as switches, potentiometers, gears, revolution counter, etc. make this an offer not to be repeated.
PRICE .... $5.00 ea.
PP-51/APQ-0 POWER UNIT $1.50 ea.
Used for operation of above unit. Contains 2—4 mfd. 1000 V. Condensers, 2—1 mfd. 1500 V. Condensers, transformers, power resistors, etc. A useful item for parts or in conversion of above unit for amateur use. Unit complete except tubes. Price $1.50 ea.
SCR-269 RADIO COMPASS
Brand new complete, ready for installation on your plane or boat, except for electrical cables.
PRICE . $99.00
I-82 SELSYN INDICATOR
BRAND NEW
$4.95 ea.
Use for beam position indicator or with your SCR-269 ADF.
PRICE NEW .... $4.95 ea.
PL-118 PLUG for above I-82 Indicator .. 50¢ ea.
C-1 AUTO PILOT CONTROL BOX
Contains many useful parts such as numerous toggle switches, potentiometers instrument lights, etc.
CLOSE OUT $2.75 EACH
MY TERMS ARE Easy!
Cash with order for quick shipment or 1/3 cash with order, balance C.O.D.
No order under $2.00 accepted due to these special price concessions.
Brand New
STEWART WARNER- GAS HEATER
These heaters are similar to those manufactured for your car except made for aircraft use. Model 794-850 BTU output 24 V. Contains 6800 Rpm motor with fan blade. Motor will operate on 6 V. DC or 24 V. AC. Brand new $3.95

BALANCED DETECTOR

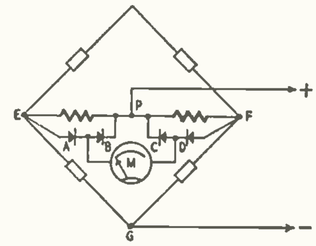
Patent No. 2,498,103

Bogumil M. Wojciechowski, New York City

(assigned to Western Electric Co.)

In circuits which carry only weak signals, random noise voltages may be an important factor. This noise may result in fluctuations on both sides of zero-center of a bridge galvanometer when the bridge is at or near balance. To remove this source of annoyance the circuit may be blocked if unbalance drops below a predetermined level. At greater unbalance the bridge functions normally.

The diagram shown here may be that of a Wheatstone bridge, balanced v.t.v.m., or similar



circuit. A d.c. is applied between point P and the lower corner G. When the bridge is at or near balance, this voltage is the only one of importance in the circuit. Therefore, P is positive and both E and F negative. The polarity of the rectifiers (germanium crystals, for example) is such that each pair is blocked by this voltage. The galvanometer cannot deflect under this condition.

When the bridge is sufficiently unbalanced, a d.c. signal appears between E and F. Assume that E is positive. A path may be traced from E through rectifier A, meter M, rectifier C and point P. The polarity of this signal unblocks rectifiers A and C, permitting the meter to indicate.

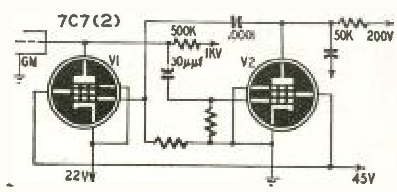
QUENCH-AMPLIFIER for G-M DETECTOR

Patent No. 2,503,730

Donald G. C. Hare, Roslyn, N. Y.

(assigned to Taxaco Development Corp.)

Improvement in Geiger-Muller radiation detection is the object of this invention. The rate of count varies with the intensity of the radiation. At high counting rates amplitude of the pulses tend to drop off, which is a disadvantage where the pulses are used for recording or other purposes. This inventor uses the G-M detector to



control a multivibrator. Pulse output from the multivibrator depends mainly on the tubes and voltages used, therefore the pulses are constant. The circuit described here also quenches the G-M detector.

Normally V2 conducts because it is biased at or near zero, and V1 is blocked by the 22-volt cathode bias. When radiation falls on the G-M detector, it discharges. Current flows through the 0.5-megohm resister and a negative pulse is transmitted to the V2 grid (through a capacitor), blocking the tube. As a result, a positive pulse is transmitted to the V1 grid, permitting momentary heavy conduction. This lowers the plate voltage to V1 and the detector so the latter is quenched at once. The circuit returns to its original condition with V1 blocked and V2 conducting.

The pulses obtained from the multivibrator have equal amplitude and width over a wide rate of counting.

MUSICAL INSTRUMENT

Patent No. 2,497,661

Robert B. Dome, Geddes Township, N. Y.

(assigned to General Electric Co.)

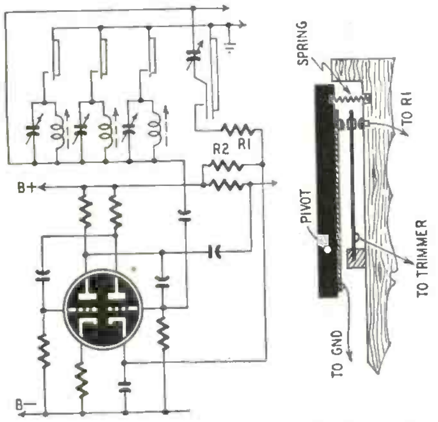
Although this instrument has only 15 keys, any note can be played on three consecutive octaves. Three keys are selectors to choose a desired octave. The other 12 correspond to the 12 keys (seven white and five black) of a piano octave.

A simplified version of the instrument is shown in the figure. The dual triode is a multivibrator oscillator. Frequency depends upon the capacitor and coil values in the grid circuit of triode on the right. The keys at the left are octave selectors. Only one key is shown at the right but actually 12 are needed, each wired just like the one shown.

Normally the triode on the right is blocked and no plate current flows. Note that its cathode is returned to a point of high positive voltage through R2. When one of the 12 keys is depressed, however, the cathode is grounded through R1 and oscillations begin.

When an octave selector is operated, one of three audio tank circuits is connected in the multivibrator circuit. Each of the other 12 adds a trimmer capacitor to tune to the desired frequency. This is shown better in the insert. Depressing the key halfway grounds the trimmer, connecting it across one of the audio tank circuits (provided one of the selectors is also operated). When the key is fully depressed, it also grounds R1 and unblocks the oscillator triode. Therefore, to play a note it is necessary to operate the desired octave selector simultaneously with one of the 12 piano keys.

The three coils in the octave selectors must be adjusted for inductance ratios of 16:4:1. Since frequency is inversely proportional to the square



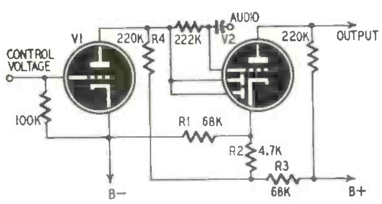
root of the inductance, these coils determine which octave will be played. The capacitors across the coils are needed to overcome the distributed capacitance of the windings, which might otherwise cause error. For any octave selector, the 12 piano keys are operated in turn, and each trimmer tuned to produce the notes of an octave. Then the other two selector circuits are adjusted by tuning the trimmers across the coils.

SQUELCH CIRCUIT

Patent No. 2,507,432
Harland A. Bass, Mt. Healthy, Ohio
(assigned to United States of America as represented by Secy. of War)

This squelch circuit blocks the audio amplifier of a receiver until a predetermined minimum signal is picked up.

The squelch triode may be a 6SF5, and the audio amplifier diode-triode may be a 6SQ7. Suggested component values are shown. If there is no a.v.c. control voltage to V1, it conducts. A voltage drop across R4 places a negative bias on the V2 grid to block the tube.

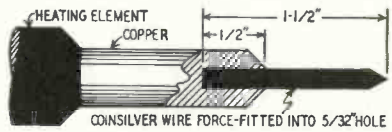


When a strong enough signal is intercepted, the a.v.c. voltage blocks V1, thus reducing the voltage drop across R3 and permitting V2 to conduct.

R1, R2, and R3 form a divider to supply plate voltage to V1. This divider also places a small positive voltage on the grid of V2. Since the grid should be kept negative at all times, the diodes are connected to have their current flow through R4. Even when V1 is blocked there is a voltage drop across R4, which provides the minimum bias to V2.

IMPROVED SOLDERING IRON

A short length of silver wire can very easily improve the heating ability of a small pencil-type soldering iron. Since silver is a much better conductor of heat than is copper, a soldering iron with a silver tip is more efficient than one with a conventional tip. Furthermore, a silver tip does not corrode or oxidize as badly as does a copper one and consequently does not require retinning as often.



To make the silver tip, drill a hole approximately 5/32 inch in diameter about ½ inch deep into one end of the copper. Then force-fit a short length of *coin-silver* wire of the same diameter into the hole, allowing about 1 inch to protrude. File a point onto the end of the wire and the job is done. The drawing shows construction details.

A tight force-fit is most important. If the wire fits loosely, the heat will not be transferred efficiently and most of the advantages of the silver will be nullified.—*Harold Weinfeld*

PRINTED-CIRCUIT GROUNDS

Most amplifier builders have, at one time or another, spent hours tracking down hum or feedback which was eventually traced to a ground loop in a high-gain stage. Because it is often difficult to run all grounds to one point in the low-level stage, I avoid ground loops by using printed-circuit grounds.

I cover the underside of the chassis with a piece of insulating paper, then drill through it and mount all components. All grounds are painted on this sheet with regular silver paint used in making or repairing printed circuits.

When connections are to be made, cut out a tab, lift it up, paint it with a heavy coat of silver, then squeeze a soldering lug onto it and let it dry. Solder connections to the lug.

If the spot selected for a common ground is not satisfactory, it can be moved to another. We have not been successful in deliberate attempts to create ground loops while using this method of grounding.—*Irving Sperling*

TOUCH UP SCRATCHED PARTS

When black panels, smooth or crackle-finished, are scratched, try this trick.

Rub a piece of black wax crayon over the scratch with a circular motion. Dip a piece of soft cloth in linseed oil and rub over the spot, using the same circular motion. Finish the job by rubbing with a polish cloth. If you get too much oil on the surface, remove the excess with a little turpentine on a rag. This method of removing scratches can be applied to other colors by using wax crayons of matching colors.—*G. Samkofsky, W2YSF*

AUTO RADIO KINK

Sometimes it is desirable to do preliminary troubleshooting before removing a defective auto receiver. It is not necessary to bring out the portable signal generator. Simply remove the cover from the hash filter in the power supply section of the set. Use a capacitor to couple the vibrator hash into the suspected circuit or component under test. The coupling capacitor should be large enough to pass the hash and have a working voltage rating high enough to protect parts and tubes from d.c.

This system will prove useful in isolating an intermittent stage and for signal tracing by the signal-injection method. Do not attempt to use it to align r.f. or i.f. stages because the output of the vibrator is a wide-band signal which is not constant in amplitude or in frequency. Consequently, such signals are useful only for simple signal tracing.—*E. B. Davis*

TIGHTENING DIAL CORDS

A number of suggestions have been advanced for tightening dial cords so they won't slip. My method is to loosen one end of the cord, twist it a number of times, then replace it. Twisting shortens the cord, thus causing it to exert greater pull on the spring throughout the drive mechanism.—*Joseph A. Fiederer, AT3, U. S. N.*

REDUCING IGNITION TVI

Automobile ignition systems and arcs from trolley cars tend to interfere with TV receivers.

I have eliminated several cases of interference of this type by elevating the TV antenna and moving it to the rear or remote side of a building. Shielded or coaxial transmission line prevents noise pickup on the lead-in. A false ground or reflector made of fine wire mesh will often prevent interference from reaching the antenna proper if it is installed in a horizontal plane below the antenna.

Interference from oil burners, refrigerators, washing machines, etc., can be reduced or eliminated in some cases by grounding the cabinet or case housing the motor or by grounding the motor frame itself through a .05-μf, 600-volt paper capacitor.—*John L. Johnson*

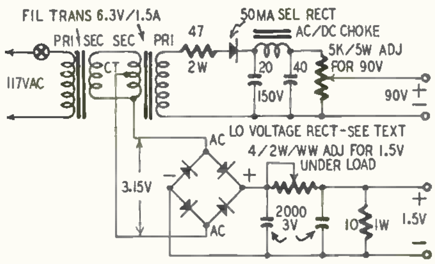
630-TYPE TV SETS

Replacing the 6K6-GT vertical output tube with type 6Y6-G in 630 TS-type television receivers, or receivers with similar circuit design, will provide increased picture height with good vertical linearity. This change is especially applicable to sets that have been converted from 10- to 12- or 16-inch picture tubes. No other modification is required for expanded height.—*Olaf W. Bailey*

(Better make sure that the heater winding on the power transformer can take the added drain. The 6Y6-G draws 1.25 amperes—slightly more than three times the current of the 6K6-GT.—Editor)

SIGNAL TRACER SUPPLY

? *Please print a diagram of a compact a.c. power supply to replace the 1.5- and 90-volt batteries in my portable signal tracer. It has one 1T4 and one 3S4 tube.—W.A., El Dorado, Ark.*

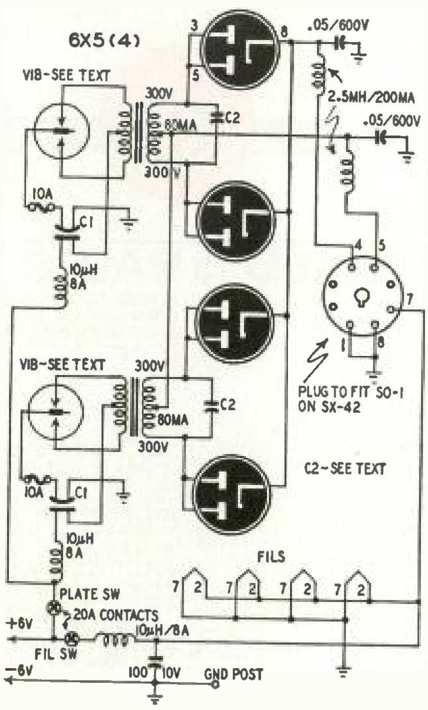


A. This supply is designed to deliver the voltages required for your tracer. The two filament transformers isolate the B-supply from the a.c. line to avoid shock and hum when the instrument is in use. One of the transformers should have a center tapped secondary to supply voltage for the low-voltage rectifier, which may be a Mallory type 1B4R or equivalent. The output voltages should be adjusted under load. The 5,000-ohm, 5-watt variable resistor adjusts high-voltage output and the 4-ohm, 2-watt resistor adjusts filament voltage.

VIBRATOR POWER SUPPLY

? *Please print a circuit of a vibrator power supply which will enable me to operate my SX-42 receiver from a 6-volt storage battery. The supply should deliver 250 to 270 volts at 150 ma. Also please show how the supply can be connected to the receiver.—E. S., Toronto, Ont., Canada.*

A. Because vibrator transformers delivering more than 135 ma are not



readily available, two 80-ma, 600-volt transformers are used. They have separate vibrators, hash filters, and rectifier tubes. The high current makes it necessary to use two 6X5's in each circuit as shown. The outputs of the two supplies are connected in parallel before being fed to the receiver. Low-frequency filtering is not required because the current flows through the filter in the receiver.

The buffer capacitors C2 are critical; select them carefully. Use values which result in the lowest primary current for a given output voltage from the supply. These capacitors will probably be between .05 and .003 µf. They should be rated at 2,000 volts.

The supply should be mounted in a metal box having ventilating holes covered with ventilating hole plugs or fine metal screen. Ground the case directly whenever possible.

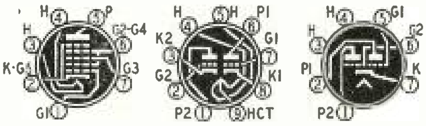
Wire an octal plug as shown to fit into socket SO-1 on the rear of the receiver. Use No. 18 wire for leads to pins 4 and 5, and No. 12 or larger for leads to pins 1, 7, and 8.

The vibrators may be Radiart type 5503, Mallory type 825 or 826, or equivalent. Capacitors C1 should be designed for hash-suppression circuits. They may be Mallory type RF481 or equivalent.

This supply can be used for public address systems, other receivers, and various electronic equipment having 6-volt filaments and plate voltage and current requirements not exceeding those of the SX-42.

TUBES OF THE MONTH

Three miniature tubes designed especially for electronic computer service are part of RCA's contribution to the month's new tubes. These are the 5915, 5963, and 5964.



5915 5963 5964

The 5915 is a pentagrid control tube for on-off applications involving long periods of operation under cutoff conditions. Grids No. 1 and No. 3 can each be used as independent control electrodes. When used as a class-A amplifier with 67.5 volts on the plate and on grids No. 2 and No. 4, the tube has a grid No. 1-to-plate transconductance of 2,000 μmhos and a grid No. 3-to-plate transconductance of 1,100 μmhos.

The 5963 is a medium-mu twin triode also for on-off control applications involving long periods of operation under cutoff conditions. It has separate terminals for each cathode and a center-tapped heater for either 6.3- or 12.6-volt operation. The class-A characteristics of this tube with 67.5 volts on the plate and zero bias are: amplification factor, 22; plate resistance 7,850 ohms; transconductance, 2,800 μmhos; and plate current, 7 ma.

The three new RCA tubes for computers.

The 5964 is also a twin triode and its characteristics are similar to those of the 5963, but it has only one cathode and its heater is only for 6.3-volts.

Another RCA tube is the 5876 high-mu triode intended for use as a grounded-grid r.f. amplifier or mixer tube in receivers operating at frequencies up to 1,000 mc. It can also be used as an oscillator up to about 1,700 mc. This tube has the pencil type construction with a coaxial electrode structure. Its class-A characteristics with 250 volts on the plate and a 75-ohm cathode resistor are: amplification factor, 56; plate resistance, 8,625 ohms; transconductance, 6,500 μmhos; and plate current, 18 ma.

G-E announces two new TV picture tubes. One is the 17BP4-A, a 17-inch rectangular tube with a neutral-density faceplate and magnetic focus and deflection. This tube also has an electron gun designed for use with an external, single-field ion trap magnet and its external conductive coating serves as a filter capacitor when grounded. It has a 6.3-volt heater which takes 0.6 amps.

The other picture tube is the 16KP4-A, a 16-inch rectangular tube. It is like the 16KP4, but has an aluminum-backed screen with dark faceplate to increase picture clarity and brightness. This represents G-E's first step towards aluminizing large picture tubes.

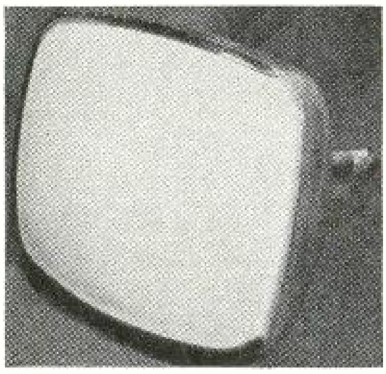


Photo of G-E's 17BP4-A picture tube.

Eitel-McCullough has two new transmitting tubes. The 2C39A is a high-mu, forced-air cooled triode for use as a power amplifier, oscillator, or frequency multiplier for frequencies up to 2,500 mc. As a power amplifier its power output is 27 watts under typical operating conditions. The other Eimac tube is the 4E27A/5-125B. This tube is a power pentode with a maximum plate dissipation rating of 125 watts.

MASTER ANTENNAS

Television reception in congested areas will depend eventually on the multiple master antenna system, according to the president and the chief service engineer of the Lance Television Laboratories in Bronx, New York, which has installed and serviced up to 2,000 TV receivers a week during the past two years. They have found that many of the service calls are for reception complaints due to faulty antennas. In many cases reception is poor even with good antennas when there are several on the same roof because they interfere with each other.

In addition many landlords who are anxious to serve their tenants but who are conscious of the disfigurement, increased cost of maintenance, and financial liability for possible accidents from roof-top antennas, have also inquired about the possibilities of master-antenna systems.

Many new set-owners, according to Lance engineers, first have built-in antennas or indoor aerials. "We service these and try to obtain the best possible pictures for them. Usually we have to compromise on clarity to get them full channel coverage. Then they ask for a window-sill antenna. Finally, if and when the landlord permits it, they get a roof-top antenna, but even then, they are not getting perfect reception. Only a master antenna can give this, unless the individual set-owner erects a separate antenna to receive each channel."

Many TV installation companies in the larger cities are now equipping buildings with master antenna systems and many new construction jobs have provisions for multiple TV.

SAFETY FOR TV SET OWNERS

Owners of television receivers should not tamper with the insides of their sets, warned the RMA last month. "The picture tube is harmless as long as it is left intact in the receiver and not tampered with," the Association said. "It becomes hazardous when removed from the set or when an untrained person attempts to repair his receiver. Consequently, it is always essential for a television receiver owner to call a serviceman when trouble develops and never to attempt repairs himself."

The danger, RMA pointed out, comes from the high degree of vacuum in the large tube envelope. A crack in the glass may cause a highly dangerous implosion, with glass and tube elements flying at high velocity.

Five rules were formulated by the Association:

1. Read the operating manual!
2. Don't tinker with the inside of the set. Call a repair technician.
3. Don't let members of the family gather around the technician while he is working with the tube exposed.
4. Request the technician who has replaced a picture tube to put it in its protective container immediately and to take it with him when he goes.
5. Don't clean or dust inside the set. The technician should do that when he services it.

A TABLE-SIZE MODEL

Courtesy Radio Corporation of America

A new table model electron microscope that magnifies 5,000 times. While not as powerful as larger models, its cost will be only about one third as much.

ULTRASONIC MUTATIONS

Plant mutations similar to those caused by atomic radiation are caused by exposure to ultrasonic radiation. In experiments described by Professor Raymond H. Wallace of the University of Connecticut it was found that exposing plants to such radiation for 1 to 25 seconds will cause a wide variation in the seedlings of the plant.

The radiation does not affect the parent plant, but its children and grandchildren have unusual leaf and flower forms, greater or lesser vigor, and changed color or size. In some lines the mutation disappears after the fourth or fifth generation is reached; in others they do not appear in the first or second generation but appear in later generations.

THAT SPEEDY C-R SPOT

Here is an interesting point not often realized even by engineers:

Let's look at an average receiver—having a 10-inch cathode-ray tube. What you see on its 8½ x 6½-inch face—the screen—is an image "painted" by an electron ray. The ray swings backward and forward 15,750 times each second, from top to bottom of the screen. This speed is so great that you see only the result—the television image.

Now, the electron ray travels a distance of 8½ inches across the screen with each swing. It does so 15,750 times a second. Therefore, the ray travels 8½ times 945,000 or 8,032,500 inches per minute. That is 126.77 miles. In 1 hour the ray travels 7,606 miles or almost one-third the circumference of the earth!

TV EYESTRAIN

"Television does not harm the eyes," declared Dr. Carl F. Shepard, Chicago optometrist, speaking at the 52nd annual meeting of the American Optometric Association. But he added that it may bring out visual problems that otherwise might not have been discovered until later; television makes people conscious of problems that already needed attention.

The American Optometric Association has issued a list of suggestions for added pleasure and visual comfort when viewing television:

1. Make sure your set is properly installed, especially the antenna, for clearest possible reception.
2. In tuning, adjust the contrast setting before turning up the picture to the desired brilliance. Strike a comfortable balance between steadiness of image and brilliance. An unsteady image or too much light, or both, will cause visual discomfort.
3. Avoid both intense darkness and bright light in the room. A mild indirect light is preferable.
4. Do not wear sunglasses for televiewing because they adapt the vision to unnatural conditions.
5. Avoid excessively long periods of close concentration on the screen.
6. Do not sit too close to the screen. Usually a distance of 6 to 12 feet from the typical home receiver will be least tiring.
7. In case of discomfort, have your vision examined by a specialist and follow his advice. Many older persons who wear bifocals may find neither segment suited to television. They may be helped by special lenses prescribed for the proper distance.

SMART SERVICE CONTEST

To improve shop appearance, personnel neatness and customer relations, the British Columbia chapter of the Radio Electronic Technicians Association has announced an annual competition for the smartest service shop. The cooperation of jobbers in the area has made possible awards of a shield for the best shop in the province as a whole, and certificates and $25 cash awards for each of the four areas into which the province will be divided.

Awards will be based on general appearance of the shop, neatness of personnel and service areas, and customer relations. No distinction will be made between large and small shops, so the smallest shop has as good a chance as the largest. The judges will be a committee of RETA and Jobbers Association members, and judging will be based on reports sent in by impartial observers. It is hoped that the first awards will be given in June 1951.

1750-KC DISASTER NETWORK

Disaster chain to facilitate communications during such national emergencies as floods, earthquakes, or armed attack is being set up by the Federal Communications Commission. Several thousand hams, along with commercial broadcasting stations and armed forces outlets will be licensed on the 1750- to 1800-kc emergency band. The network will be designed to operate on either a local or a nation-wide basis.

FREDDIE GETS FIRST LEGS

Freddie is learning to walk! The Arkansas radio technician's two-year-

George Van Photo

Freddie tries to take his first steps.

old son, born without arms or legs, has already learned to balance himself on his first pair of simple "stumpies." Now he is being trained to use them in walking—a feat doubly difficult as he has no arms and cannot use crutches.

The expense for Freddie's treatment is being borne by his numerous friends and sympathizers, not the least of whom are the readers of RADIO-ELECTRONICS, who have already contributed $2725.51 toward Freddie's complete rehabilitation. A trust fund has been set up so that not only his immediate needs are covered but money is being set aside to supply him with arms and the training to use them, and to replace his present "stumpies" with longer and more usable legs as he grows bigger and able to walk better.

The generosity of our readers will make it possible for this Arkansas radioman's child to become a normal and useful member of society. Each contribution is a mighty step in that direction. No amount is too large or too small! *Make all checks, money orders, etc., payable to Herschel Thomason.* Please address all your letters to:

Help-Freddie-Walk-Fund
% RADIO-ELECTRONICS
25 West Broadway
New York 7, N. Y.

Balance as of July 24	$2,435.01
New Contributions:	
Anonymous—Los Angeles, Calif.	$10.00
Anonymous—Baltimore, Md.	2.00
Anonymous—Syracuse, N.Y.	5.00
Blair County Association of Radio Service Engineers—Altoona, Pa.	10.00
Edward J. Blatt—St. Petersburg, Fla.	3.00

George J. Burza—Alhambra, Calif. ..	5.00
P. J. C.—Seattle, Wash.	5.00
Michael D'Alesio—Hackensack, N. J. .	2.00
John B. Dewey—Florence, Mass.	1.00
Ellsworth J. Emerick—Cumberland, Md.	1.00
Timothy and Bambi Gray—Middletown, N. Y.	2.00
R. L. Halliburton—Arlington, Va.	1.00
Commdr. J. F. B. Johnston—San Francisco, Calif.	3.00
H. C. Matzinger—Wyandotte, Mich. .	2.00
Victor H. Meyer—Brooklyn, N. Y.	10.00
J. Nehring—Copiague, N. Y.	5.00
Frank E. Olsson—Guam City, Guam ..	10.00
Pace's Radio Service—Vicksburg, Miss.	5.00
Philadelphia Radio Service Men's Association—Philadelphia, Pa.	100.00
Radio Maintenance Drs.—Los Angeles, Calif.	5.00
Radio Shop, Topeka Trade School—Topeka, Kansas	7.00
Norwood Richardson, Woodbury, N. J.	1.00
Lowell Russell—Toledo, Ohio	2.50
John G. Trainor—College Point, N. Y.	5.00
Neil J. Trotta—Brooklyn, N. Y.	5.00
Adolph J. Uryniak—Utica, N. Y.	2.00
Employees of WABD—New York, N. Y.	71.00
W2HCJ—Watertown, N. Y.	10.00
Total to Aug. 22	**$2725.51**

Radio Thirty-Five Years Ago
In Gernsback Publications

HUGO GERNSBACK
Founder

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

ELECTRICAL EXPERIMENTER OCTOBER 1916

The Feminine Wireless Amateur
Intensifying Radio Signals with Radium
President Wilson Opens Centennial by Radio, by W. H. Kirwan
Some Interesting New Radio Apparatus
New System of Radio Telephony
Novel Radio Apparatus
Lead-in of the Eiffel Tower
Rotary Spark Gaps
Hints on the Crystaloi Detector, by Erney T. Tugene
An Inexpensive High-Frequency Alternator for Testing Crystal Detectors, by Raymond Francis Yates

Canadian radio service technicians held a national convention in July. The Manitoba, Saskatchewan, Alberta and British Columbia Radio Electronic Technicians Associations were represented.

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. Send coin or stamps where cash is required. We will forward the request to the manufacturers, who in turn will send the literature directly to you. This offer void after six months.

OC-1—TV CATALOG, REPLACEMENT GUIDE

The Seventh edition of the Stancor Television Catalog and replacement Guide lists complete specifications and list prices of all Stancor transformers and related components for television replacement or conversion. Indexed for use in 618 TV chassis and receiver models by 64 different manufacturers. —*Gratis*

OC-2—HIGH FIDELITY EQUIPMENT

A 6-page folder issued by University Loudspeakers, Inc., describing cone speakers, tweeters, tweeter adapters, cross-over networks and coaxial speaker systems. Includes installation instructions for each item listed in the folder.—*Gratis*

OC-3—LOUDSPEAKERS

A 10-page catalog issued by Racon Electric Co., describing their line of mostly heavy-duty, all-weather speakers, drivers, reentrant and straight trumpets, cobra-type and paging speakers.—*Gratis*

OC-4—POWER POINTS

A magazine published by Onan & Sons Inc., largely devoted to articles describing interesting and unusual applications of electric plants.—*Gratis*

OC-5—C-D POWERCONS

Cornell-Dubilier's catalog No. 410 on its line of Powercon vibrator convertors also contains a number of pages of explanatory material and is described by the publisher as a combination catalog and manual.—*Gratis*

OC-6—TV PICTURE TUBE GUIDE

An 11 x 24-inch folder issued by National Union, provided with punched holes for wall hanging. It lists most of the existing television tubes, with dimensions and basing diagrams.—*Gratis*

OC-7—ANTENNAS AND ACCESSORIES

A catalog issued by the JFD Manufacturing Co., describing its line of antennas, mounts, screw eyes and other accessories. The number of small accessories and variety of TV antenna hardware are impressive.—*Gratis*

OC-8—MICROPHONE CATALOG

A complete line of microphones is described in a 23-page catalog issued by the Electro-Voice company. Also included are several phono pickups and technical information on the operation of various types of microphones. A chart in the front cover is a guide for selecting the correct microphone for any particular purpose.—*Gratis*

New Devices

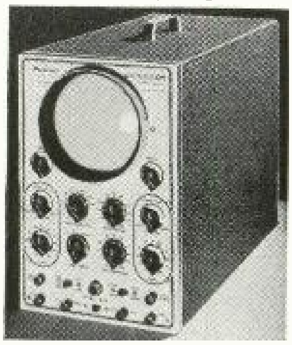
OSCILLOSCOPE KIT

Heath Company
Benton Harbor, Mich.

The new Heathkit oscilloscope kit model 0-6 has some added features to make it more useful for television repair.

A synchronizing circuit operates on either positive or negative peaks of the input signal to better lock in TV signals as they appear in the various stages of a television receiver. Steep wavefronts encountered in TV alignment are easily handled by this scope.

The multivibrator type sweep circuit covers from 15 cycles to over 100,000 cycles, and both vertical and horizontal deflection plates are operated in push-pull by high gain pentodes. A step-attenuated frequency - compensated vertical input amplifier circuit permits examination of nonsinusoidal and high harmonic content input signals.



Other new features include a d.c. amplifier arrangement, a specially designed power transformer which has a greatly reduced external electromagnetic field, and an improved Allegheny Ludlum metal C-R tube shield.

The kit comes complete with a punched and formed chassis, all parts and tubes including the C-R tube, an aluminum cabinet with crackle finish, and a detailed instruction manual with a step-by-step wiring description, pictorials, and photoprints.

CERAMIC CAPACITORS

Centralab Div.
Milwaukee, Wisc.

Ceramic flat-plate capacitors with higher capacitance are now made available. Their unusual thinness makes them useful for many special applications and they are available in .02, .05 and .1 µf, all rated at 600 working volts d.c.

Centralab now also has ceramic Min-Kaps, which are lower voltage flat-

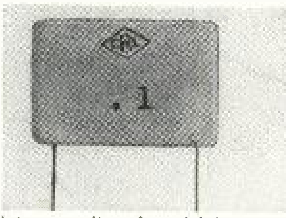
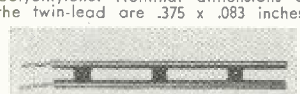


plate capacitors for miniature applications where space is at a premium. The Min-Kaps are rated at 150 working volts d.c. and are flash-tested at 300 volts. Capacitance tolerances are maintained from 10° to 50° C. These units are insulated with a phenolic coating and have 1¾-inch No. 26 tinned copper leads. Their size is 17/32 x 7/32 x 7/64 inch.

LOW-LOSS LEAD-IN

Don Good, Inc.
South Pasadena, Cal.

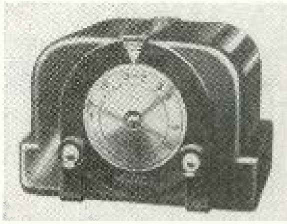
The Goodline Airlead is a ribbon line with 80% of the dielectric web between the wires removed to reduce losses in the dielectric. Its impedance is 300 ohms. Its two 7 x 28 conductors are insulated with weather resistant polyethylene. Nominal dimensions of the twin-lead are .375 x .083 inches.



TV BOOSTERS

Astatic Corp.
Conneaut, Ohio

Two new boosters for TV and FM bring the total Astatic line up to four. The new models, the BT-1 and the BT-2,



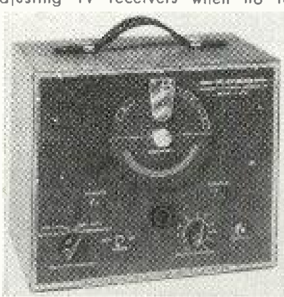
both use the Mallory Inductuner for continuous one-knob tuning through both TV and FM bands. They have a single 6AK5 with a selenium rectifier and provision for either 72- or 300-ohm input and output impedance. They present no shock hazard to the user and have an on-off switch for easy cutting in and out of the circuit.

The BT-1 is encased in a metal cabinet of simple design with a mahogany woodgrain finish and gold dial facing and numerals. The BT-2, shown in the photo, is slightly higher priced and comes in a modernistic dark brown plastic cabinet. The entire dial revolves below a fixed pointer and a recessed pilot light shows if the booster is on or off.

LINEARITY GENERATOR

Approved Electronic Instrument Corp. New York, N. Y.

The model A-470 is a crystal-controlled linearity pattern generator for adjusting TV receivers when no test



pattern is available. It has vertical, horizontal, and crosshatch patterns; a shielded attenuator control; 100 to 6,000 microvolt output; and an output impedance of approximately 50 ohms. It can be used for adjusting vertical and horizontal linearity, setting of hold control, checking for hum in deflection circuits, relative sensitivity measurements, and troubleshooting without station pattern.

The instrument is housed in a battleship gray steel cabinet. It has a 7-tube circuit with a 1N34 crystal and a high-stability oscillator crystal.

MOLDED CAPACITORS

Cornell-Dubilier Electric Corp.
South Plainfield, N. J.

A new line of compact molded paper capacitors, types 5MC, 1MC, and 1DMC, is intended for use where unusually high reliability is needed.

Characteristics of this series are: Type 5MC is 7/16 x 11/16 x 3/16 inches and available from 0.001 to 0.01 µf at voltages—depending upon capacitance —from 120 to 400 v.d.c.w. Type 1MC is 13/16 x 13/16 x 1/4 inches on a capacitance range from 0.001 to 0.02 µf at voltages—again depending upon capacitance—from 120 to 800 v.d.c.w. Type 1DMC is 13/16 x 13/16 x 5/16 inches in capacitance range from 0.003 to 0.02 µf at 300 to 800 v.d.c.w.

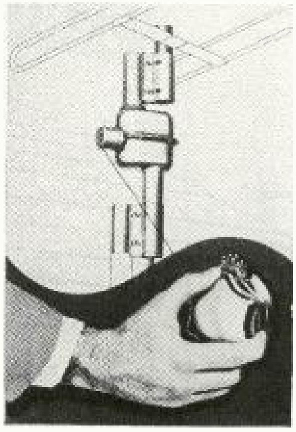
These capacitors are supplied with No. 20 tinned wire leads on 5MC and No. 18 tinned on 1MC and 1DMC, all 1⅜ inches long. They meet JAN-C-91 quality characteristic E.

Impregnated with Dykanol C, wound with kraft paper dielectric and aluminum foil, this series is designed for service at temperatures from —55° to +85° C. Insulation resistance exceeds 10,000 megohms at 25° C; average power is factor 0.3 per cent.

ANTENNA ROTATOR

Joseph Shaw Co.
Toledo, Ohio

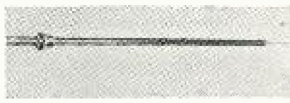
The Tele-Turner is a mechanically operated TV antenna rotator. It comes complete with directional indicator, inside manual control, and all necessary hardware.



BEACON ANTENNA

Workshop Associates, Inc.
Needham Heights, Mass.

The model 2HW is a high-gain beacon antenna for aircraft frequencies.

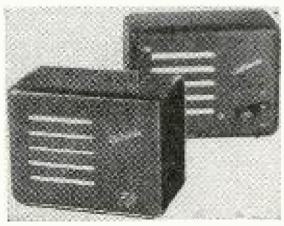


It has an omnidirectional radiation pattern and a gain of about 3 db. A special side lobe permits communication with aircraft while aloft. The antenna has a low standing wave ratio, and each unit can be matched to the operating frequency. It has built-in lightning protection and single-unit construction to reduce maintenance.

INTERCOM

Wm. M. Smith Co.
Broomall, Pa.

A new electronic communicator, the Callmaster, is designed for the low



price field. It operates on 110 volts a.c. or d.c. and has two watts power output. The tube complement is 50L6, 35Z5, and 12SJ7; and it has a 4-inch, 15-ohm speaker. It operates at full volume at up to 2,000 feet between stations. The cabinet is molded plastic and control knobs are of bakelite to make the unit shockproof. Model CM-10 of this intercom consists of a master and sub-station complete with 50 feet of cable. Other equipment is the model CM-20 multi-sub-station systems; and model CM-30 all master systems.

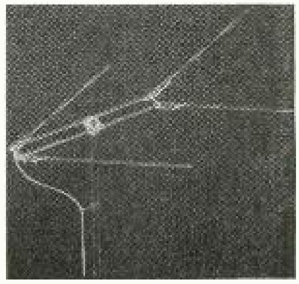
TV ANTENNAS

Ward Products, Inc.
Cleveland, Ohio

The Flying Arrow model TV-72 is a new antenna for improved high-band reception. It has sharp directivity and matches a 300-ohm line. The antenna, shown in the drawing, is rigidly built of ⅜-inch aluminum tubing. Model TVS-75 is a stacked array consisting of two single bay Flying Arrows.

Ward also announces a new Airflight conical antenna for all-band reception. A universal insulator permits any desired element arrangement to suit local conditions. The Airflight conicals are available in single or in 2-bay arrays and both are constructed either of ⅜-inch butt seam tubing or ½-inch seamless tubing. Harness kits permit stacking of two single bays into a 2-bay array or two 2-bay arrays into a 4-bay stacked array.

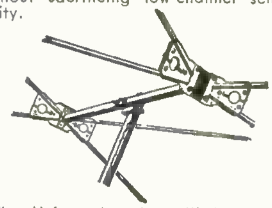
A third new antenna is the attic model TVH-52 which is a 3-element array especially designed for installation in attics.



CONICAL ANTENNA

Telrex, Inc.
Asbury Park, N. J.

The new Universal series of conical V beams has 3-slot element clamps in both driven and reflector "butterflies" to allow flexibility in arranging the elements to suit various operating conditions. Increased V beam action gives a stepped up high-channel response without sacrificing low-channel sensitivity.



The Universal series will be available as model U2X-TV (singe bay) and model U4X-TV (two-bay stacked array).

OUTDOOR TRANSFORMERS

Standard Transformer Corp.
Chicago, Ill.

Two new outdoor type line to voice coil output transformers have been added to the Stancor line. These new units have primary impedances of 3,000/2,000/1,500/1,000/500 ohms and secondary impedances of 16/8/4 ohms. Part No. A-333 is rated at 14 watts, Part No. A-3334 at 25 watts. Both units were designed to fit the most needed outdoor applications. An adapter hardware kit is also available for use where lack of usual mounting space requires that the transformer be clamped to the bracket of a trumpet projector.

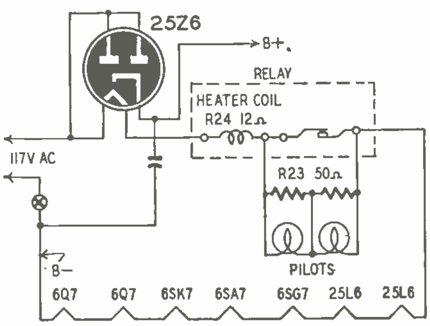
INDOOR TV ANTENNA

Radion Corp.
Chicago, Ill.

A new departure in indoor antennas is the model TA55 Foto-Tenna. To blend with the interior of any home, the antenna is built into a brown leatherette photograph album. The antenna itself will provide good reception in many metropolitan areas.

RCA 28X5 RECEIVER

The thermal relay burned out and a replacement was not immediately available. To protect the tube heaters and pilot lamps against warm-up surges, I replaced the 12-ohm relay coil with a



negative-coefficient resistor having a resistance of 12 ohms when hot. The diagram shows the relay connections before modification.—*L. Furth*

RCA 612V1 AND 612V3

Several of these sets have come in with complaints of a frying sound in the background of AM stations. In each case the trouble has been traced to leakage in the 18-μμf capacitor C17 in the grid circuit of the 6BE6 oscillator. This capacitor is located behind the oscillator tube where tweezers, delicate handling, and patience are required to get at it. Replace it with a high-quality ceramic unit.—*Leo Beckerman*

MOTOROLA TS-9 CHASSIS

Low brilliance on these and similar chassis may be caused by an increase in value of the high-voltage filter resistor R-108 (820,000 ohms). When the resistance of this unit increases, picture brightness will fall off because of a substantial decrease in accelerating voltage.—*Ralph Lombardi*

CROSLEY MODEL 11-100U, ETC.

Slippage of dial drive cords on this model and on the 11-101U, 11-102U, 11-103U, 11-104U, and 11-105U can be corrected by replacing the drive cord with one long enough to be wrapped around the drive shaft four turns instead of three.

If necessary, place a 1/16-inch thick No. 6 flat washer on each screw that mounts the tuning capacitor. The washer should be placed between the rubber grommer eyelet and the capacitor frame. When the mounting screws are drawn tight, the eyelet will then flatten enough to reduce the flexibility of the grommet. This holds the capacitor rigid and prevents the cord from becoming loose when the drive shaft is rotated.—*Crosley Service Instructions*

ADMIRAL 24D1 CHASSIS

Arcing between pin 9 of the 6S4 vertical output tube and ground sometimes damages the socket and resistor R417 (2,200 ohms) in the Admiral 24D1, 24E1, 24F1, 24G1, and 24H1 chassis.

A new socket, part No. 87A25-3, is now being used to prevent arcing. This should be used whenever replacement is necessary. The excessive current drawn by the arc will probably damage R417. Although this resistor may check good on an ohmmeter, it should always be replaced when the socket is changed.—*Admiral Radio and Television Service Bulletin.*

INCREASE WIDTH ON G-E 801

The maximum available width on G-E 801 receivers can be increased by 1 inch when you replace the 5Y3-GT (V23) rectifier with a 5V4-GT and add an extra 30-μf capacitor in parallel with the 30-μf filter capacitor C63.—*Christie Urback*

PEST-PROOFING RECEIVERS

Many cases of radio failure are caused by mice which eat away the wax coating sometimes used on coils and capacitors. As a preventive measure, cut brass or galvanized screen wire to fit the back and possibly the bottom of the set. Solder a ⅛-inch border around the edge of the screen and mount it over the rear of the cabinet.

This method can be used to good advantage in mobile communications equipment and standard auto receivers. Some speakers have a thin grille cloth over the back of the speaker case and others have no protection at all. In areas where dirt daubers are as plentiful as they are here in Florida, these pests will build their mud huts in a speaker or control head and ruin it in a short time.

Always protect the speaker by enclosing it in metal screen wire. Prevent them from entering control heads by taping the small holes and then coating the tape with service cement.—*Lyman E. Gray*

REPAIRING FUSE CONNECTORS

When repairing auto radios, we often find that the fuse connector has been disconnected and the insulated sleeve has been lost. If a new one is not immediately available, make a new one of the same size from a piece of spaghetti tubing. Insert the fuse into the sleeve before putting it in the connector. This gadget works well. There is no danger of shorts between the connector and the body of the car itself.

SOLVING THE ANTENNA PROBLEM

When a large increase in rent was asked by the landlord in return for permission to erect an outdoor TV antenna, one set owner tried all sorts of indoor TV antennas with poor results. Finally, a piece of 300-ohm ribbon line was run up to the floor above where a friendly tenant had an outdoor antenna. The ribbon line was run parallel to the friend's lead-in and taped to it. There was no electrical connection between them. The two sets worked fine with no ill effects on the picture on either receiver.

A service technician can waste a lot of time on a set which is apparently O.K. but will not produce a stable picture on any channel. Before going into such a set, always check the antenna. If stations are on the air, make a temporary antenna from 300-ohm line and connect it to the set. If the set performs with fair results, check the lead-in and connections to the original antenna until you locate the fault.—*Jacob Dubinsky*, TEC-194

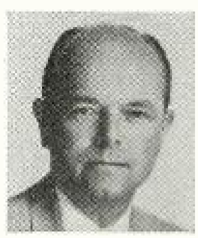
E. H. Ulm has been appointed merchandising manager of the Electronics Division, SYLVANIA ELECTRIC PRODUCTS.

Ulm joined the staff of the Electronics Division of Sylvania Electric in 1945 as a sales engineer. Prior to that time he was instructor in radar and sonar with the field engineering force of Radio Division of the Western Electric Company. During 1943 he served as an anti-submarine warfare field engineer for the Division of War Research at New York's Columbia Univ.

Sanford B. Cousins was elected vice-president and director of BELL TELEPHONE LABORATORIES effective August 1. Mr. Cousins was formerly vice-president and general manager of the New England Telephone and Telegraph Company.

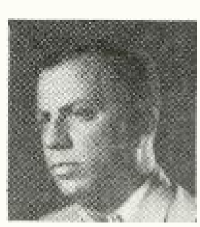
Ralph R. Batcher, New York electronic consultant, succeeded L. C. F. Horle as chief engineer of the Engineering Department of the RADIO-TELEVISION MANUFACTURERS ASSOCIATION and manager of the RTMA Data Bureau. Mr. Horle retired after 15 years of service with the RTMA.

Cecil S. Allen was elected executive vice-president and general manager of the Russell Electric Company Division of the RAYTHEON MANUFACTURING CO. Before joining Russell Electric, Mr. Allen held executive engineering positions with the A. O. Smith Corp. and with the General Electric Company's engineering staff.



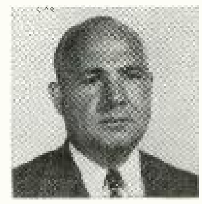
Dr. George W. Vinal, chief of the Electro-chemistry section of the NATIONAL BUREAU OF STANDARDS and author of *Storage Batteries*, retired after more than forty-two years of service.

Ira Kamen, authority on TV antennas, was named director of TV development and TV promotion for the BRACH MANUFACTURING CO., a subsidiary of the General Bronze Corporation. Before joining Brach, Mr. Kamen was manager of the TV department for the RCA Commercial Sound Distributors in New York and surrounding states. He is the author of two books and his articles have appeared in RADIO-ELECTRONICS.



C. J. Biver was appointed commercial engineer of the central region for the GENERAL ELECTRIC COMPANY'S Tube Divisions and **J. H. Chrysler** was made district representative. Other G-E appointments include **Joseph A. Kerr**, New York district manager of the Receiver Division; **William J. Morlock**, assistant manager of the Commercial Equipment Division and **Howard K. Smith**, manager of marketing services for the Commercial Equipment Div.

Francis X. Rettenmeyer, veteran electronics engineer, has joined the PHILCO CORP. as executive engineer to assist in the company's government and industrial electronics program. Mr. Rettenmeyer was previously with the Bell Telephone Laboratories, RCA and the Federal Radio and Telegraph Company.



James D. Walker and **Charles F. Gill** were named managers of CAPEHART-FARNSWORTH'S Detroit and Washington D. C. regions, respectively.

Jack L. Hobby joined the ANDREA RADIO CORP. as advertising and sales promotion manager. The Andrea Company also announced the appointment of **Charles F. Watts** as assistant purchasing agent for TV cabinets.

C. Arthur Robson has joined the engineering staff of the TURNER CO. He came to Turner from the engineering department of the Crosley Broadcasting Corp. Mr. Robson is currently conducting tests on the Turner Company's recently developed television booster.

Personnel Notes

Donald E. Smith, formerly an engineer for the Electronics Division of SYLVANIA ELECTRIC PRODUCTS INC., has been transferred to the renewal sales department of the Radio Tube Division. . . . **Samuel J. Spector**, president of the INSULINE CORP. OF AMERICA, has been elected to the board of directors of the Radio Parts and Electronic Equipment Shows, Inc. . . . **Nelson W. Wells** has been appointed sales manager for the TELEVISION EQUIPMENT CORP. . . . **George F. Bart** was named advertising manager of OLYMPIC RADIO & TELEVISION INC. . . . **Joseph B. Zetka**, vice-president and general manager of ZETKA TELEVISION TUBE, INC., died recently after a six months illness. . . . **Jack Stevens** was elected vice-president of GEO. STEVENS MFG. CO., INC., manufacturer of coil winding machines. . . . **Myles Spector** has joined the NATIONAL ELECTRONIC MFG. CO. as sales engineer. He is the son of Samuel J. Spector, president of the firm.

SERVICING EVOLUTION

Dear Editor:

I have read your editorials "Whither Radio Servicing?" in the June issue and "Unprofessional Servicing" in the April issue. Mr. Gernsback knows better than anyone the history and evolution of the serviceman of the past, but he may not be so well cognizant of the transition or evolution that has taken place in the service technician of today, especially since television.

The slogan of the vast majority of radio and television dealers today is "We Service What We Sell." This slogan cuts the rug out from under the feet of the independent service technician and he is obliged to go back to the dressing room and put on new "make-up" if he wishes to continue in the act. In other words, he must get a job if he can with one of the "We Service What We Sell" dealers and become an hourly rate worker. The responsibility of keeping his clothes neat, of seeing that he has the right tools to work with, of checking on him to see that he does not litter or dirty up the customer's rugs and furniture, lies with his boss, the fellow who juggles the balance sheet and who is concerned primarily with the sales records. The service technician knows he is a hireling. He is concerned with his $1.50 per hour; his mind is as a rule centered on it, especially if he is a married man who needs to "bring home the bacon."

One factor that discourages the independent service man is the rebuff he gets from the television manufacturer and the television jobber. They favor the larger television dealers and their service departments. The television customer is likewise bound up to the television dealer in his contract. Only a few straggler television customers, are available to the independent service man. The income from this limited business is not sufficient to warrant the large capital expenditures required to set him up for first class television service. He, however, as a rule keeps himself informed on television through technical magazines and service meetings, and accomplishes television service with the limited radio instruments he has on hand.

HARRY FORBES

Forbes Radio Service
Erie, Penna.

(The real workman, whether independent or employed, has a responsibility *to himself* to keep neat and to do clean, tidy work. Otherwise we agree whole-heartedly with Mr. Forbes, though we feel that the present set-up in favor of the large service establishment and the dealer-service organization may be temporary. Radio went through much the same evolution in the '20's, and the superior efficiency and flexibility of the small establishment was some years in proving itself. Television may well follow the same course, probably with a little larger unit appearing as the most efficient one. *—Editor*)

LIKES THE MAGAZINE

Dear Editor:

Your magazine is my idea of a really fine radio paper.

Too many of the current magazines on radio have suddenly turned in the direction of television topics. Now don't get me wrong, I don't have any thing against television, but—I don't like to hunt all through a radio magazine and just find television—plus more television. I like the part of the magazine that devotes some time to the radio experimenter.

Not everyone can afford to build a TV set. *I* can't, and a lot of others are probably like me. That is my reason for writing you this letter, to tell you what a fine magazine you have and to keep up the good work, and I don't believe that I am the only reader who feels this way.

JEROME ANDERSON
San Diego, Calif.

COSTS OF FIXED BIAS

Dear Editor:

The article "Selenium Rectifiers Simplify Fixed Bias" in the July issue of RADIO-ELECTRONICS is timely and informative.

The additional components required to change from cathode bias to fixed bias as indicated by Mr. Cataldo, represent an expense worthy of consideration.

In view of that expense, two other changes are justified, to satisfy the requirements of practical audio design.

The grid resistor for the output tube must be replaced by a resistor with a value of 100,000 ohms. This is the maximum permissible resistance for fixed-bias operation.

The coupling condenser between first audio plate and output tube grid must be changed to one of greater capacitance to bring the low frequency response back in line with original performance. A value of .03 μf will be satisfactory.

JOHN E. HAZELRIGG
Holden, West Virginia

LIKES USEFUL ARTICLES

Dear Editor

I, like Mr. H. D. Thompson, have read *Short-Wave Craft* and *Radio Craft* for a long, long time. The first signals I ever listened to on short waves came from a Gernsback-inspired circuit, and I've been going along with the magazine through the years ever since. And let's say that I am interested in TV—not interested enough to build a set, but I do read the articles about TV appearing in the magazine. I probably will never build or service any TV set—but first and foremost, it is a mighty important part of my beloved radio hobby.

The things that I actively concern myself with in the magazine are the "How To Build It" articles, tuners, amplifiers, and at the present moment, the conversion of the R89/ARN5 receiver to an FM tuner. So granted that TV will never be much closer to me than the set in my living room, I feel that because it is the latest and greatest development in the field, I owe it to myself to at least read about it and find out at least something about it.

Certainly, for my own benefit, I'd like to see RADIO-ELECTRONICS devoted exclusively to experimenting and FM-AM set construction every month. But as there is enough of it in the magazine, I don't feel as though I should foam at the mouth because TV articles appear therein.

R-E is not the only radio or electronics magazine I buy—but I sincerely believe that it is the only one which has kept faith with the radio hobbyist and given him a good portion of articles that he can utilize with his limited equipment and knowledge. When it ceases to do that, I probably will continue to buy it for its technical content—but it will have lost its greatest value for me as an individual.

FRANCIS D. DONOVAN
West Medway, Mass.

Suggested by Albert Margo, Munhall, Pa.

Extremely fine wire, less than one-tenth the thickness of human hair, has been made at the Illinois Institute of Technology by an electrochemical process which "eats" down a wire of larger size to the thickness desired.

FREQUENCY MODULATED RADAR, by David G. C. Luck. Published by McGraw-Hill Book Co., New York. 6¼ x 9¼ inches, 466 pages. Price $4.00.

Since the close of the war, a number of books and articles have been published on radar and radar techniques. These were almost invariably devoted to pulse-type radar systems. The author of this book, by dealing exclusively with FM systems, has made a place for his book in this crowded field.

After discussing the underlying principles of determining speed and position by FM radar, the author then describes circuits and apparatus which have been developed for this purpose. Such elements of the systems as antennas, oscillators, modulators, limiters, and counters are described.

The major portion of the book is devoted to single-target FM systems. Multiple-target systems are covered with much less detail. Much of the discussions of FM radar sets are confined to the AN/APN-1—a popular surplus item—and the AN/APG-4 system for low-altitude bombing.—*RFS*

LEARNING ELECTRICITY AND ELECTRONICS EXPERIMENTALLY, by Leonard R. Crow. Published by The Scientific Book Publishing Co., Vincennes, Indiana. 5½ x 5¾ inches, 525 pages. Price $4.40.

Fundamentals of electricity, magnetism and electronics are taught with approximately 135 experiments which can be performed with simple, inexpensive equipment found in high-school or home laboratories. Most of the experiments are designed to be entertaining as well as instructive. Such attention-holding effects as jumping rings, spinning balls, powerful electromagnets, and miniature motors are presented. The experiments are described with line drawings and photographs of actual setups.

The book also contains 300 pages of basic theory on a.c. circuits, magnetic circuits, magnetic frequency multipliers and amplifiers, d.c. saturable reactors, peaking transformers, dry rectifiers, vacuum tubes, and electric arcs. This section is also well illustrated with drawings and photos. Errors were noted in four diagrams in the section on amplifiers. Tubes were marked as 6AG5's while it is obvious from the circuits that they are actually 6A5-G's. —*RFS*

MANUAL OF ELECTRIC INSTRUMENTS. Published by Meter & Instrument Divisions, General Electric Company, Schenectady, N. Y. 8½ x 11 inches, 140 pages. Price $1.

This manual explains the operating principles and illustrate the application of these principles in the instruments commonly used for electrical measurements. It is not intended as a guide to instrument design or to instrument application. Most of the basic instruments are described, but electronic instruments are not included because these represent circuit developments rather than electro-mechanical structures. The book has many illustrations, both photographs and drawings, to aid in presenting a clear and understandable discussion of how these instruments work.

ESSENTIALS OF ELECTRICITY FOR RADIO AND TELEVISION, Second Edition, by Morris Slurzberg and William Osterheld. Published by McGraw-Hill Book Co. 6¼ x 9¼ inches, 533 pages. Price $5.

The beginner in radio who is serious about learning more of this art will find this book a valuable starting point from which to go deeper into such things as FM, TV, high-fidelity, and high-frequency circuits. It deals with basic theory of electricity, electrical power apparatus, alternating current circuits, and basic electronic circuits in a very simple manner slanted toward radio and television applications rather than power circuits.

Each chapter ends with a number of questions and problems dealing with the subject covered. About 50% of the answers to the problems are given. The appendix has a pictorial chart of common radio symbols, together with photographs of the elements the symbols represent, to help the beginner correlate schematics with actual circuits. The appendix also contains useful formulas, mathematical tables, wire tables, and standard color coding charts.—*MW*

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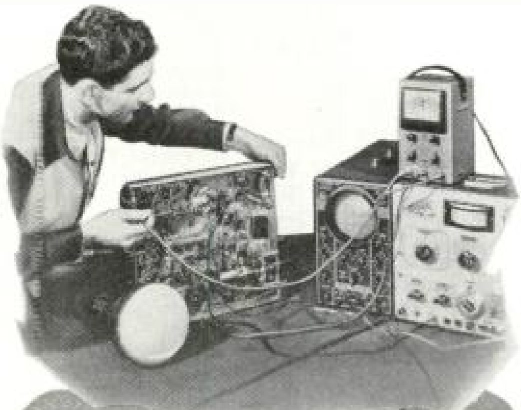

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ADVERTISING INDEX

RADIO SCHOOL DIRECTORY
(Pages 110-111)

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RADAR SYSTEMS AND COMPONENTS, by members of the technical staff of Bell Telephone Laboratories. Published by D. Van Nostrand Co., New York. 6¼ x 9¼ inches, 1042 pages. Price $7.50.

The development of radar during World War II made such striking advances that there was a real need to record these developments in detail as far as security regulations would permit. This was first done in a series of papers published in the Bell System Technical Journal. This book puts all these papers in one cover.

No attempt is made to describe in detail the hundreds of different radar units ranging in size from small aircraft sets weighing only a few hundred pounds to giant battleship models of several tons; but all these radars are governed by the same principles and use the same circuits and electronic techniques. These techniques are described in detail. This book should be a useful tool for those working with microwaves.—*MW*

JOSEPH HENRY, His Life and Work, by Thomas Coulston. Published by Princeton University Press, Princeton, N. J. 6 x 8½ inches, 352 pages. Price $5.00.

The only American to give his name to one of the standard units of electricity, Joseph Henry is a far more obscure figure than many whose work has been of far less importance. A well written and sympathetic biography such as this one will do much to put him in his proper place in the mind of the technical reader.

Dealing with Henry as a human being as well as with his scientific discoveries, the book is very readable. Nor does it neglect the scientific side: students will find the chapter "Henry's Place in Science" an excellent and concise summary of the discoveries and developments described at length in the body of the book.

THE RADIO MANUAL, by George E. Sterling and Robert B. Monroe. Published by D. Van Nostrand Co., New York. 8 x 10½ inches, 890 pages. Price $12.00

The new edition is much larger than its predecessors, and contains new chapters on frequency modulation, radio wave propagation, antennas, emergency equipment, FM broadcast equipment and lifeboat radio.

In other respects it follows the line of the older editions, covering (but more completely) the whole field of radio, from broadcasting through commercial and marine radio to navigational aids, including loran and radar. State as well as federal regulations covering radio operation and use are given in three final chapters. The section on television is written by T. T. Goldsmith Jr., director of research of the Allen B. Du Mont Laboratories.

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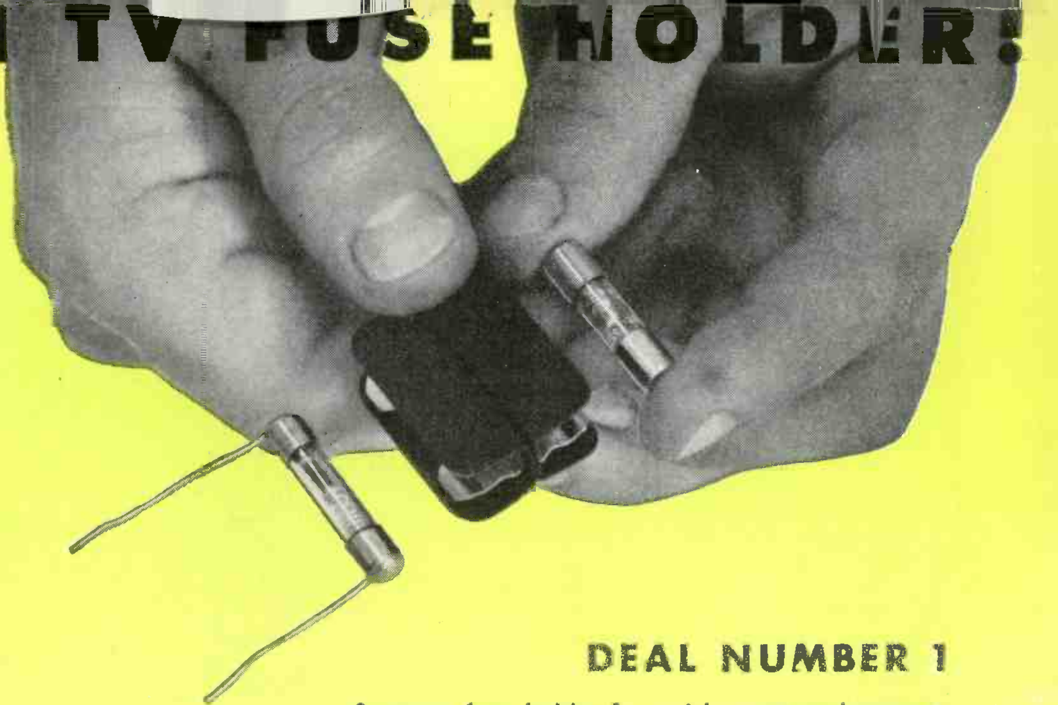

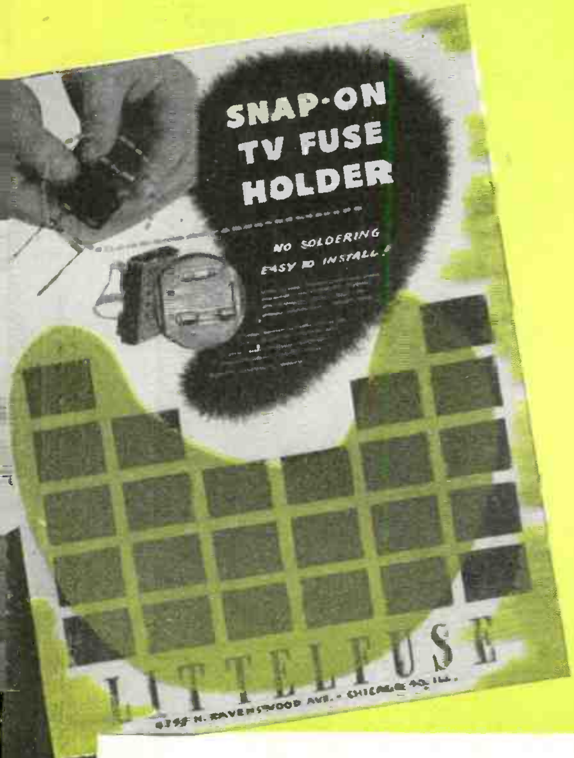

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