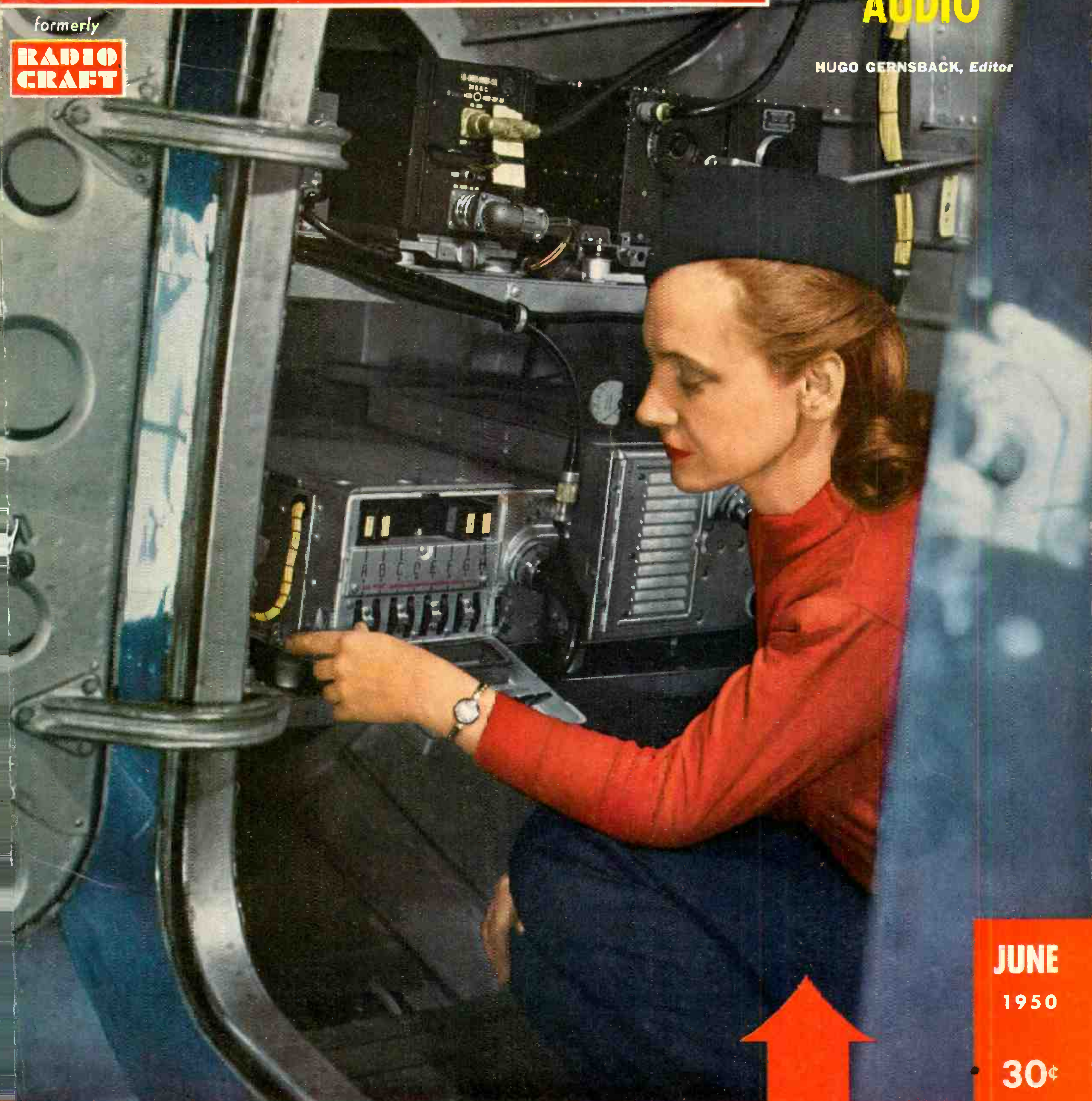
RADIO-ELECTRONICS

formerly RADIO CRAFT

LATEST IN TELEVISION ◆ SERVICING ◆ AUDIO

HUGO GERNSBACK, *Editor*



JUNE 1950

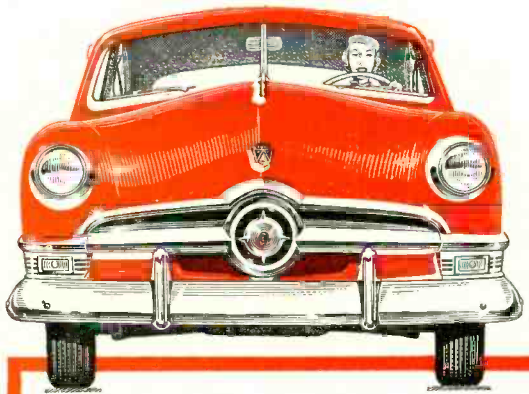
30¢

U. S. and CANADA

SHE SERVICES AIRPLANE RADIO — SEE SERVICING SECTION

$10,000 IN PRIZES

FOR RADIO BATTERY RETAILERS and RCA BATTERY DISTRIBUTOR SALESMEN



YOU CAN WIN A '50 FORD ... OR OTHER VALUABLE PRIZES

IN THE RCA BATTERY "GET THE FACTS" CONTEST

FREE ENTRY... here's how

No purchases required—no sentences to complete! Simply get your FREE copy of the Official RCA "Get The Facts" Contest Booklet . . . from your nearest RCA Battery Distributor. Then, fill out and mail the Free Entry Coupon in the Contest Booklet to the address printed thereon. Contest closes June 30, 1950. All entries must be postmarked on or before that time.

This contest is open to all radio battery retailers within the continental U. S. A. and to full-time personnel whose duties include the selling of radio batteries.

LOOK AT THESE DEALER AWARDS!

FIRST PRIZE — 1950 FORD SEDAN

Factory equipped 8-cyl. Tudor Custom Sedan

2nd Prize $700 Drexel Bedroom Suite
3rd Prize $619 Drexel Dining Rm. Suite
4th Prize $450 Deep Freeze Unit, 12 Cu. Ft.
5th Prize $350 Rogers Sterling (Service for 12)
6th Prize $260 Kaufmann Travel Luggage (4 matched pcs.)
7th Prize $233 Kroydon Golf Clubs & Bag
8th Prize $145 Kaufmann Travel Luggage (2 matched pcs.)
9th to 15th Prizes—$100 Longines Wrist Watches
16th to 25th Prizes—$25 U. S. Savings Bonds

Duplicate Prizes for RCA Battery Distributor Salesmen

Purpose of this contest is to encourage Battery Retailers to *Get The Facts* on why it's best to stock and sell . . . .

RCA The battery for the Radio Trade!

Here's how prizes will be awarded

1. All entry coupons received will be assembled at Contest Headquarters for an impartial drawing to be held July 10, 1950.

2. The retailer whose name appears on the first coupon drawn will be contacted by telephone, person-to-person. He will be asked one of the easy questions about RCA Batteries appearing in the "Get The Facts" Contest Booklet. If this contestant gives the correct answer immediately, he will be awarded first prize.

3. If the contestant fails to give the correct answer immediately, another drawing is held.

4. The above procedure will be followed in awarding all prizes.

DON'T DELAY. Get *your* Contest Booklet from your nearest RCA Battery Distributor. A magnificent prize can be your reward!

Complete Entry and Prize Award Rules can be found in the Official Contest Booklet.

Mail coupon today if you DO NOT know the name of your local RCA Battery Distributor.

RCA Battery Sales
Radio Corporation of America, Harrison, N. J.

Sirs: I am a Radio Battery Retailer, but DO NOT know the name of my local RCA Battery Distributor.

Please forward this request to him for my FREE copy of the RCA Battery "Get The Facts" Official Contest Booklet containing the FREE Entry Coupon.

Signed ______________________

Co. Name ______________________

Street & No. ______________________

City & State ______________________

RADIO BATTERIES

RADIO CORPORATION of AMERICA

HARRISON, N. J.

Incorporating
SHORT WAVE CRAFT* TELEVISION NEWS*
RADIO & TELEVISION
*Trademark registered U. S. Patent Office

RADIO — ELECTRONICS

formerly RADIO-CRAFT

MEMBER
AUDIT BUREAU OF CIRCULATION

CONTENTS — JUNE, 1950

ON THE COVER: Margaret Latham, of Beane Radio Service, Newark, New Jersey, engaged in a typical aircraft servicing operation. *Kodachrome by Avery Slack.*

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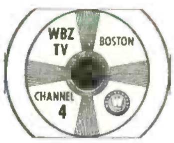
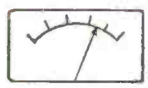
STOP MEASURING "GHOSTS!"

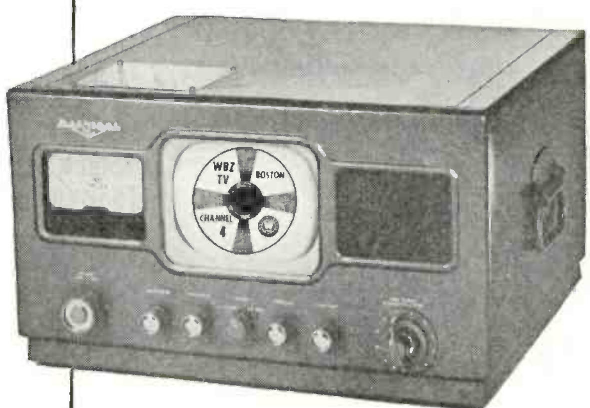




See WHAT YOU *Measure*

NEW NATIONAL VIDEOMETER ENDS ALL TV INSTALLATION GUESSWORK!

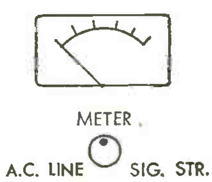
You can't see ghosts or noise on a meter. That's why field strength readings alone are unreliable in making TV installations. Now, the new National Videometer gives you *both* meter readings and a TV picture. You see just what you measure. No more trouble-making initial installations! No more costly call-backs!



$169.95
(Slightly higher west of the Rockies)

Meter Check on Both Field Intensity and Line Voltage

Set the meter switch to A.C. LINE and read the line voltage at the receiver input terminal directly on the 0-150 volt scale. Set the switch to SIG. STR. and read the field intensity on the 0-10 scale. A table is provided to convert directly to microvolts. Reading indicates field intensity at antenna input and is independent of contrast and brightness controls.



National
EST. 1914
NATIONAL COMPANY, Inc.
MALDEN, MASSACHUSETTS

PLATE CHARACTERISTICS of electron tubes can be traced on an oscilloscope screen with an instrument developed at the National Bureau of Standards. The curve generator plots the family of plate current versus plate voltage curves for any receiving tube along with a standard rectangle which provides a direct scale for voltage and current measurements.

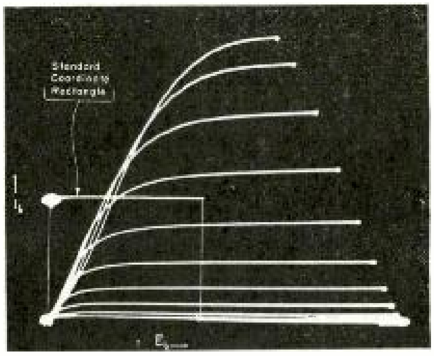


Plate characteristics of a 6AC7 tube.

The plate voltage applied to the tube under test is swept from zero to predetermined positive values. The voltage drop across the plate load resistor is used as a measure of plate current. This voltage drop is applied to the vertical plates of the oscilloscope and the plate voltage itself to the horizontal plates. These two voltages generate a plate current-plate voltage curve on the oscilloscope screen for the entire sweep interval.

The sweep sequence is repeated automatically for several values of grid bias to form a complete family of plate characteristic curves. The instrument also can provide a plate current versus grid voltage curve.

The complete family of curves is retraced sixty times a second; and the image is stationary and free from flicker.

FIELD OF ELECTRON microscope enables its inventor, Dr. Erwin Mueller of the Kaiser Wilhelm Institute of Berlin to see molecules as small as 1-25,000,000 of an inch in diameter. Cost of the instrument is small, about $24.

The microscope—the inventor claims—is simple to make. It has a cold point, usually made of tungsten, on which the subject is mounted. The point is then caused to emit a stream of electrons which is directed to a screen about 10 centimeters away. The screen then shows the image of the molecule.

Only medium size molecules can be observed with the instrument at the present time. Dr. Mueller said he has made single atoms visible, but not with enough detail to be useful for study.

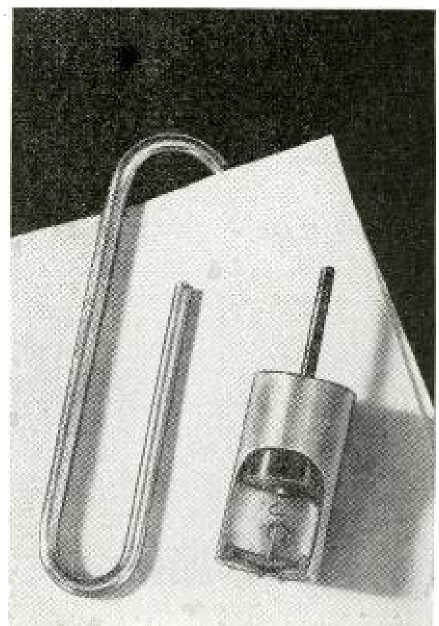
CHILDBIRTH can be made more safe with an electronic apparatus called the electrohysterograph. Three pairs of electrodes are connected to the patient's abdomen, two strain gages are connected to the abdominal wall, and the patient is given a hand switch to signal the beginning and end of each pain. A 6-channel amplifier drives recording apparatus which graphs the signals from the pickup devices.

During normal labor, the apparatus records a characteristic sequence of activity. Any abnormal activity shows up on the graphs, and doctors can detect false labor, early labor or anything going wrong.

TORNADOS are dangerous mainly because they come without warning. Professor H. L. Jones of Oklahoma A & M College is developing a tornado tracking device with which he expects to distinguish a tornado from an electrical storm about thirty minutes before the twister actually forms.

Electrical storms always accompany tornadoes, but the electrical discharge is always of much higher intensity than ordinary lightning. In the warning system, an oscilloscope records the lightning intensity and distinguishes tornado lightning from the less dangerous variety. Once tornado discharges are discovered, directional equipment locates the twister.

PHOTOTRANSISTOR is a new type of photocell developed at the Bell Telephone Laboratories. It is similar in operation to the transistor, having a tiny chip of germanium, but it is controlled by *light* rather than by electric current and has only a collector wire.



The phototransistor, a new photocell.

Light focused on one side of the cell controls the current in the collector wire. The phototransistor has a high power output which in some cases is enough to operate a relay directly without the use of amplifiers. It has good response to rapidly fluctuating light source and is particularly sensitive to wavelengths of light given off by ordinary incandescent light bulbs.

The device is housed in a small cylinder about the size of a .22 calibre rifle cartridge and has no vacuum, no glass envelope, no grid, plate, or hot cathode.

SIX BILLION electron volts will accelerate protons in the new bevatron being built at the California Institute of Technology under plans announced by the Atomic Energy Commission.

The machine is being built from a quarter-scale model now at the University of California. The model is being rebuilt to speed electrons to velocities only one-millionth of one percent less than the speed of light.

DIGITAL COMPUTER 5,000 times faster than a human brain has been developed by the General Electric Company for use within the company.

Unlike some other types of computers, the "Omibac" (Ordinal Memory Inspecting Binary Automatic Calculator) uses the binary system of counting. This is a simplified system which uses only two digits, 1 and 0, rather than the more familiar 10 characters of the decimal system. The decimal numbers 0 and 1 are 0 and 1 in the binary system, but decimal number 2 is 10, and 3 is 11 in binary, 4 is 100, 5 is 101 and so on.

The two digits of the binary system can respond to electronic, electric or mechanical on-off switching, which makes the system readily adaptable for high speed computers.

The computer has two memory devices which can remember more than 1,000 separate instructions and more than 1,000 numbers. The memory devices store the required information on fast spinning cylinders coated with magnetic material (See photo). The instruction cylinder tells the computer what to do and when, and the number cylinder supplies the numbers.

The memory devices of the Omibac make it particularly useful for repetitive problems.

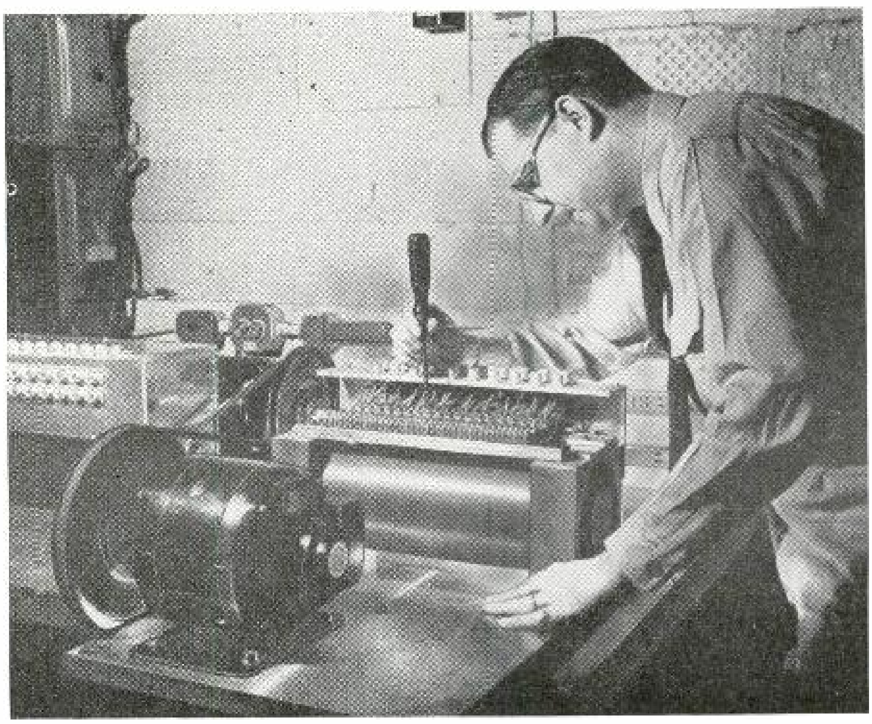
SUPERSONIC AIRCRAFT are being fitted with electronic equipment to avert collisions in midair. The speed of modern fighter planes is so great that if two planes came out of clouds 8,000 feet apart straight toward each other, they would collide before either pilot could do anything about it, Col. Victor Byrnes of the Air Force reported to a scientific meeting last month. If the clouds were only 500 feet apart, the pilots wouldn't even see each other.

Now that faster-than-sound speeds have been reached, engineers are predicting speeds as high as 2,000 miles per hour. At such a speed, a pilot would travel nearly a mile before he could recognize another object and do something about it. Electronic eyes for the aircraft are essential to make them safe for these high speeds.

ROUND-THE-WORLD radio signals on very low frequencies have been detected at the National Bureau of Standards. The signals were transmitted from NSS, the Naval Radio Station at Annapolis, Maryland, on a frequency of 18 kc with a power of 350 kw and were received at a Bureau of Standards field station about 50 miles away.

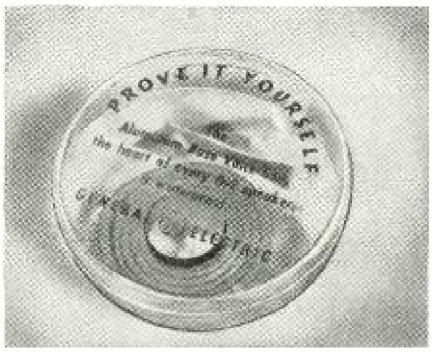
The signals were received with a t.r.f. receiver and a large loop antenna 150 feet high. A dual-beam oscilloscope connected to the receiver showed the unrectified r.f. envelope along with an 18 kc reference voltage. The delay time, normally about one-tenth of a second, was measured by making a film record of the oscilloscope screen.

The test signal was a series of dots with each dot followed by a quiet period equivalent to five dots. The pulse length of each dot was about 40 milliseconds and the repetition rate was four pulses a second.



Engineer G. W. Hobbs makes an adjustment on Omibac's memory cylinders.

General Electric has offered a G-E aluminum-foil base voice coil sealed in a clear plastic case filled with water as proof that excessive moisture will not harm its speakers, as a promotion item for drive-in theater owners.



The company has also developed a three-piece promotion package for G-E speakers. Two streamers and a wall chart giving complete information on each speaker in the G-E line have been sent to all parts distributors.

Radio Corp. of America dedicated its new television picture tube plant at Marion, Ind. Governor Henry F. Schricker of Indiana was a guest of honor. He was accompanied by state and local officials and RCA executives.

It is expected that this plant will become one of the largest producers of picture tubes in the world. The plant's major product is the new short 16-inch metal picture tube recently developed by RCA.

The company announced that the Marion plant is the fourth of thirteen plants to be located in Indiana, which is becoming one of the nation's leading television manufacturing areas.

Allen B. Du Mont Laboratories, Inc., opened its new cathode-ray picture tube manufacturing plant in Clifton, N. J. It is the largest factory in the world devoted exclusively to the manufacture of television picture tubes.

The plant will be devoted to the making of 12-, 12½-, 15-, 16-, 19-, and 20-inch cathode-ray picture tubes for television receivers. Half the production will be devoted to metal tubes. Five hundred-fifty workers will work three shifts daily to meet the current large demand for tubes.

The company also announced it had developed a 30-inch, direct-view TV picture tube with a screen area nearly three times that of the 19-inch tubes now in use. It is meant specifically for hotels, schools, restaurants, and other public places.

R. C. Sprague, chairman of the Town Meetings Committee of the Radio Manufacturers Association, announced a national program by which large television manufacturers will cooperate to help improve sales, merchandising and advertising, and business management practices among dealers in 60 marketing areas.

The program, known as the Town Meetings of Television Dealers, will be modeled after the recent successful two-year program the RMA sponsored to assist radio technicians to adapt themselves to the more complicated techniques demanded by television. Subjects to be covered include sales, merchandising and public relations, store management, and operating a profitable service department. These will be discussed with the aid of slide film presentations.

The initial list of participating television manufacturers includes Raytheon Manufacturing Co.; Crosley Division, Avco Manufacturing Corp.; Allen B. Du Mont Laboratories, Inc.; Emerson Radio & Phonograph Corp.; General Electric Corp.; Hoffman Radio Corp.; Industrial Television, Inc.; Motorola, Inc.; Noblitt-Sparks Industries, Inc.; Packard-Bell Co.; Philco Corp.; RCA-Victor Division; Stromberg-Carlson Co.; Westinghouse Electric Corp.; Zenith Radio Corp.; Other firms are expected to indicate their participation at a later date.

Tendency toward closer cooperation among TV set manufacturers, distributors, and service technicians is noted in the number of service clinics being held recently.

In New York City, Admiral and Zenith distributors held well-attended clinics for service technicians in the metropolitan areas. In Los Angeles, Leo J. Meyberg Co., RCA distributor, held similar meetings. Reports from other sections of the country indicate that other distributors are following suit.

The new action counter display illustrated is being distributed to dealers by ALLIANCE MANUFACTURING COMPANY. It incorporates a miniature antenna which is attached to one

of the rotators. The prospective customer may actually operate the control case right at the counter.

Sylvania Electric Products, Inc., is now guaranteeing all television picture tubes. Previously the company had a warranty which involved a pro-rated charge based on use.

Under the new system, if a picture tube fails because of defects in materials or workmanship within one year of the date of shipment from the factories or warehouses, it will be replaced without charge. A code date stamped on every picture tube will determine whether that tube was shipped within the period during which adjustment is allowed.

To be replaced without charge, the tube must be returned either by the set manufacturer or television service technician to the Sylvania factory for inspection.

This new guarantee plan went into effect March 20, 1950.

Corning Glass Works has begun construction on a new plant in Albion, Mich., for the production of glass bulbs for television picture tubes. The plant, occupying a floor space of 300,000 square feet, will be erected on a 31-acre plot which was recently acquired by the company.

Financial reports released by leading companies in radio, television, and sound reflect a generally optimistic note. Statements of significant companies are listed:

Sprague Electric Co. 1949 net sales $15,335,419 compared with $12,596,620 for 1948. Net earnings for 1949, $1,206,054 as against $831,649 in 1948.

P. R. Mallory & Co. 1949 net sales $24,647,429 against $23,622,144 in 1948. Net income $1,124,090 compared to $1,154,091 in 1948.

Hytron Radio & Electronics Corp. 1949 net sales $16,226,143 compared to $7,937,423 in 1948. Net income $565,171 for 1949 as against $86,121 in 1948.

American Phenolic Corp. 1949 net profit $567,275 compared to $183,141 in 1948.

Maguire Industries (Meissner & Thordarson) net loss for year ending Oct. 31, 1949, $103,508 compared with $895,050 in previous year.

General Electric Co. reported the most profitable year in its history. Net sales of $1,613,563,611 in 1949 were $19,137,995 less than in 1948 but profit increased from $123,835,316 in 1948 to $125,639,051 in 1949.

Sylvania Electric Products, Inc., 1949 sales of $102,539,866 yielded a profit of $3,052,840 contrasted to sales of $99,347,751 and a profit of $3,823,382 in 1948.

Sangamo Electric Co. showed a net profit of $1,392,000 in 1949 as against $1,979,000 the previous year.

Aerovox Corp. 1949 net income $675,000 compared to $357,047 in 1948.

RCA net earnings for 1949 equalled $25,144,279 on a gross income of $397,259,020 compared with $24,022,047 on an income of $357,617,231 in 1948.

Muzak Corp. announced that its transcription division has entered the 45-r.p.m. record field. It has made its facilities available to the trade for recording, processing, and pressing the new discs.

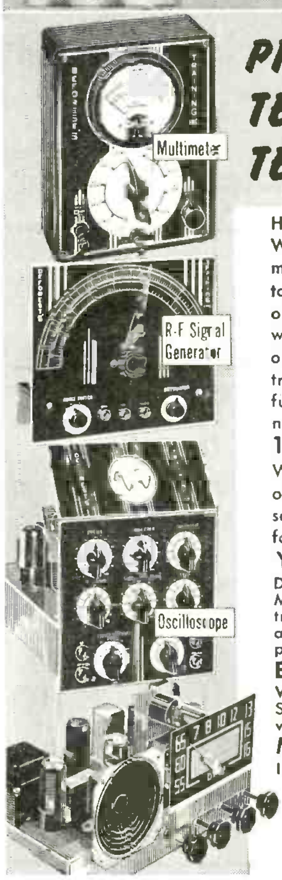
Built-in Television is appearing in new home construction. A Long Island housing development advertised built-in Starrett TV sets last July. More recently, the huge Long Island development of Levittown advertised built-in Admiral sets for 4,000 new homes. Industrial Television, Inc., announced it was installing 16-inch built-in television in a new housing development in Paramus, N. J.

TELEVISION

RADIO *and* ELECTRONICS OFFER YOU

REAL MONEY and REAL JOB OPPORTUNITIES!

OPTIONAL FEATURE — **BUILD AND KEEP FULL-VIEW 16-INCH RECTANGULAR "BLACK" PICTURE TUBE TELEVISION RECEIVER**



PREPARE AT HOME . . . Become a TELEVISION • RADIO • ELECTRONICS TECHNICIAN! *No Previous Experience Necessary*

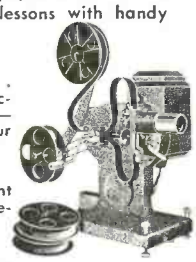
Here is everything you need to prepare you at home for FASCINATING WORK, GOOD MONEY and a THRILLING FUTURE in one of America's most promising fields. This includes the opportunity to build and keep the top-quality 16 inch rectangular picture tube television receiver shown above or a 10 or 12½ inch ROUND picture tube set . . . if you choose. No matter which tube you select, you will get bright, sharp, steady pictures. This is an optional feature—available at slight additional cost when you complete your training described below. Get the complete facts. See how D.T.I.'s wonderfully practical method meets industry's needs. No previous experience needed. Mail coupon today!

16 Big Shipments of Parts — Plus Lessons

Work over 300 electronic experiments and projects from 16 big shipments of parts. This includes building and keeping all test equipment and radio set shown at left side of page. Modern easy-to-read lessons with handy fold-out diagrams simplifies your entire training.

You Also Use Home Movies

D.T.I., alone, includes the modern, visual training aid . . . MOVIES to help you learn faster, easier at home. See electrons on the march and other fascinating "hidden action" — a remarkable home training advantage that speeds your progress.

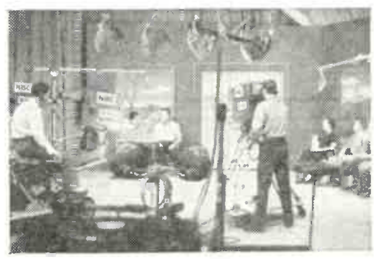


EMPLOYMENT SERVICE

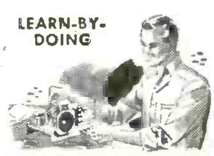
When you complete your training, our effective Employment Service helps you get started toward a real future in Television-Radio-Electronics.

Modern Laboratories

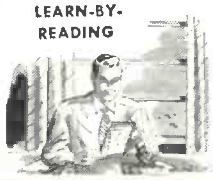
If you prefer, you can get ALL your preparation in our new, Chicago training laboratories . . . one of the finest of its kind. Ample instructors . . . modern equipment. Write for details!



LEARN-BY-DOING



LEARN-BY-READING



LEARN-BY-SEEING

DeForest's Training, Inc.

CHICAGO 14, ILLINOIS

A DeVry Institution

MAIL THIS COUPON TODAY!

DeFOREST'S TRAINING, INC., Dept. RC-G-6
2533 N. Ashland Ave.,
Chicago 14, Illinois

☐ If under 16, check here for special information.

Without obligation, give me complete facts showing how I may make my start in Television-Radio-Electronics.

Name______________________________ Age______

Street______________________________ Apt.______

City____________________ Zone____ State_________

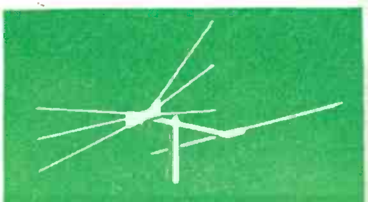
CHANNEL MASTER'S Super-Fan!

BM 313 SERIES

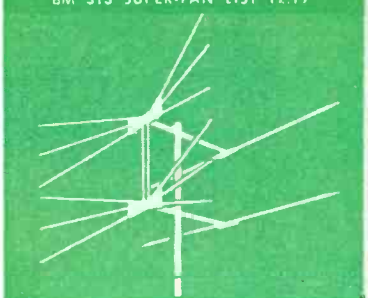
• STRENGTH • RIGIDITY • SENSITIVITY

SUPERSEDES THE BM 312 FAN FLECTOR SERIES

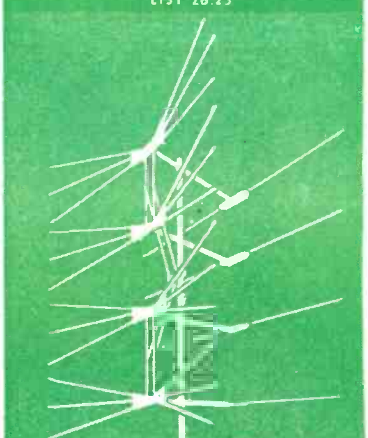
• LOWER PRICES
• SMALLER BOX
• SUPERIOR PREASSEMBLY



BM 313 SUPER-FAN LIST 12.19



BM 313X2 STACKED SUPER-FAN LIST 26.25



BM 313X4 DOUBLE STACKED SUPER FAN LIST 57.10

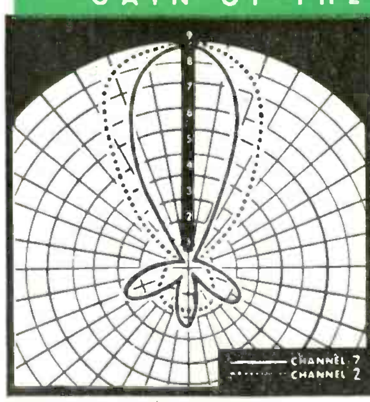
HOWLPROOF BREAKPROOF

The Super-Fan series are the most sensitive broad band antennas, stack for stack, commercially available. Their 150 ohm impedance permits efficient low loss tie-in to all standard transmission lines. Safety engineered with solid aluminum inserts, and howl proof sealed ends, these antennas withstand ice loads and high winds silently and without breakage.

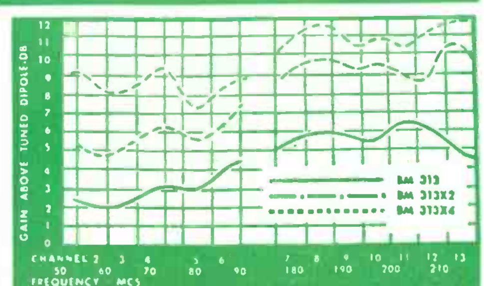
These models also feature *Swing-Lock-Action*, the patented preassembled feature of all Channel Master antennas. Just swing out elements and lock them in place — as easy as that.

A TELEVISION SET IS NO BETTER THAN ITS ANTENNA
THERE IS NO BETTER ANTENNA THAN THE SUPER-FAN

GAIN OF THE SUPER-FAN SERIES



HORIZONTAL POLAR DIAGRAMS



GAIN CURVES

CHANNEL	2	3	4	5	6	7	8	9	10	11	12	13
313	2.1	2.2	3.0	3.0	4.0	5.5	5.8	5.8	5.7	6.5	6.0	4.7
313X2	4.8	5.0	6.1	5.7	6.8	9.0	9.7	9.3	9.4	8.8	9.8	10.8
313X4	9.0	8.2	9.0	7.5	8.5	11.0	11.4	10.6	10.8	10.3	11.3	11.9

GAIN IN DB. ABOVE TUNED DIPOLE

CHANNEL MASTER Corp

FIRST IN PRE-ASSEMBLED ANTENNAS

ELLENVILLE, N. Y.

TO: CHANNEL MASTER CORP., ELLENVILLE, N. Y. 28

Please send me:

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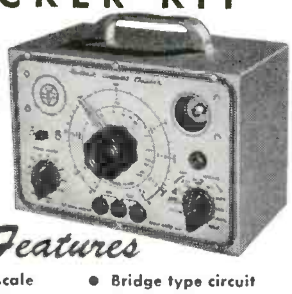

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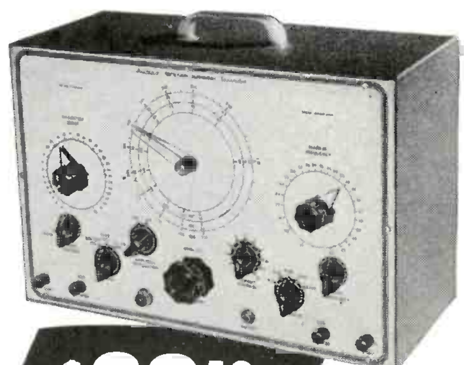

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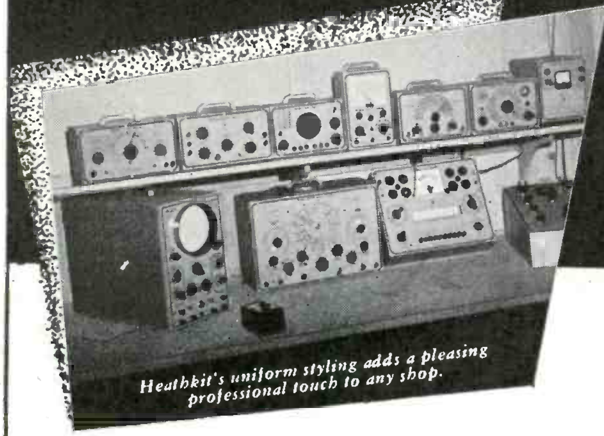

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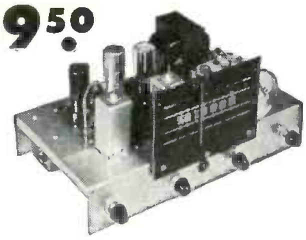

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No. 335 Communications Type Table Model Metal Cabinet..........$4.50
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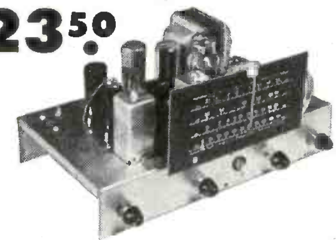

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Whither Radio Servicing?

. . . The future of U. S. radio servicing is in for a boom . . .

By Hugo Gernsback

THE editorial entitled "Unprofessional Servicing" in our April issue, while uncomplimentary to a minority group of service technicians, brought a surprising amount of mail agreeing with our findings. There was little disagreement on the whole.

But one letter, from Mr. Alex Johns, who operates the Johns Radio Shop of Dubuque, Iowa —was caustic in his comments. Yet some of the points that Mr. Johns makes are thought-provoking. His lengthy letter, broken down for simplicity follows:

1. Comparing a disorganized group of fanatics (service technicians) with telephone servicing people is unfair. The telephone company according to Johns, has a complete monopoly on the telephone. Furthermore, the telephone service people are backed by a union.

2. How would we like it if one of the largest radio corporations in the United States were to take complete charge of radio and TV, manufacturing as well as servicing; then give the public a choice of a table model or a console, charge for installation, plus a monthly fee, and if you want the set moved charge for that too. That would be a monopoly similar to that the telephone company has now.

3. Radio service technicians *are* fanatics because if they weren't so in love with their work they would stop working long hours for starvation wages. The radio repairman gets no protection—everyone is out for his scalp. No one goes to bat for him. What is more, what support do the radio magazines give the radio service technician?

4. Mr. Johns complains that the surplus-house advertisers make unfair competition for radio service people who have to pay much higher prices for the components which they buy—sometimes from 5 to 10 times more than the surplus houses get for their merchandise.

He concludes his letter with a pessimistic: "I never have and never will urge men into servicing. It's too rough".

Let us now analyze the four points cited above in their correct order.

Point 1. In the editorial "Unprofessional Servicing" the parallel between the radio service technician and the telephone service men was made purposely to induce radio people to appreciate that the public demands *and is entitled* to good service nowadays.

An obvious and most important point which we did not feel necessary to make was that *it does not cost more to give good, courteous service than sloppy and careless treatment to the customer.* No economics whatsoever is involved in this. Yet that elementary point is frequently missed. It has nothing whatsoever to do with monopoly, as should be readily apparent.

Point 2. The suppositious case cited by Mr. Johns has no reality anywhere in the world, not even in Russia. It would be difficult to imagine it in any country. Nor does even the American Telephone and Telegraph Company—usually thought of as a monopoly—cover the entire country. There are in Continental U. S. A. 5,700 independent telephone companies which have no financial connection with the American Telephone and Telegraph Company. The independents incidentally buy their telephone equipment from various telephone manufacturing companies.

Point 3. Many years ago, in 1930, and for some years thereafter, this magazine—at great expense and effort—tried its best to bring into life a national association for radio service people. We organized the "Official Radio Servicemen's Association", endeavored to have local chapters formed, supplied the technicians with stationery, badges, advertising matter etc. in an attempt to improve their standing. The magazine met with little encouragement by the service people in this effort, because too many of them could not see sufficiently far into the future and resisted all organization. Unfortunately, they are now paying the price for this.

Point 4. We live in a free country, in a free economy. Magazines just cannot lawfully refuse one class of advertising and accept another. This should be obvious. It is also true that merchandise varies in price in *every* line in the United States. You can buy surplus standard telephones and you can buy surplus plumbing and automobile components, too. *Service people in all lines buy where they can.* If they buy standard new merchandise they must charge more money for their work. If they buy surplus merchandise they can charge less—although the customer should be told if new components or surplus parts are to be used. *Then, let the customer choose.*

In the last analysis it resolves itself down to the following:

The service technician must be a good businessman if he wishes to succeed. The American public has been taught to pay for what it gets. We have found, as a rule, that the high-class courteous, careful, and businesslike service technician makes money, that he has the confidence of his customer and that his customer usually refers him to his friends. No service technician worth his salt has to work for starvation wages. *He does not have to compete with cut-price starvation competition if he does not want to.*

We also repeat what we have said in these columns before: Television is now in its ascendency and radio servicing in this country is headed for the greatest prosperity it has ever seen. All signs indicate that this condition will continue at least until 1955 and quite possibly much longer.

Projection Unit for TV

An optical system for custom TV sets

By
DAVID T. ARMSTRONG*

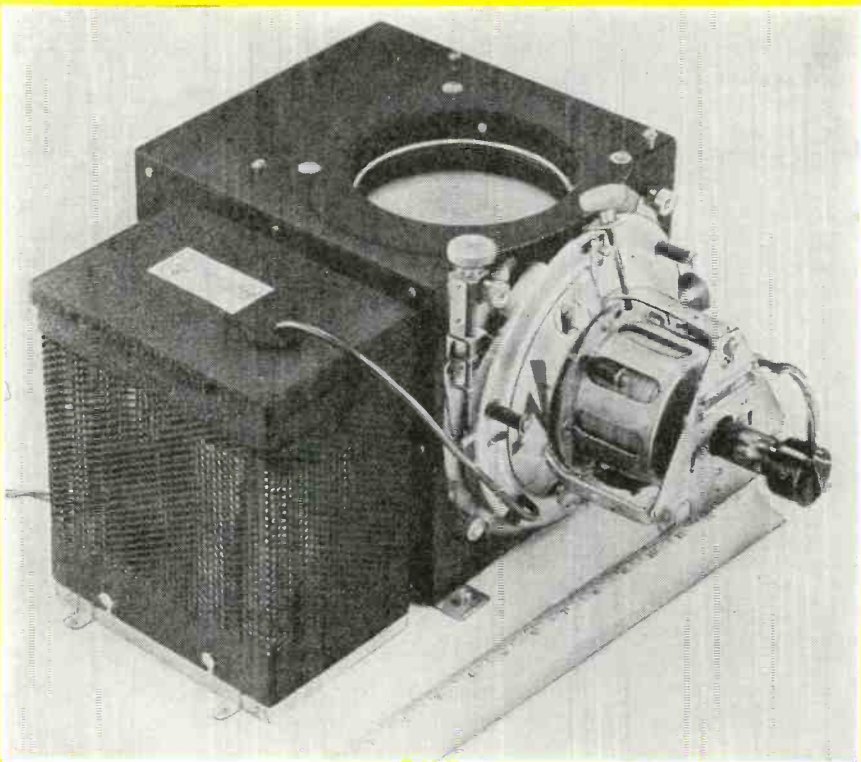
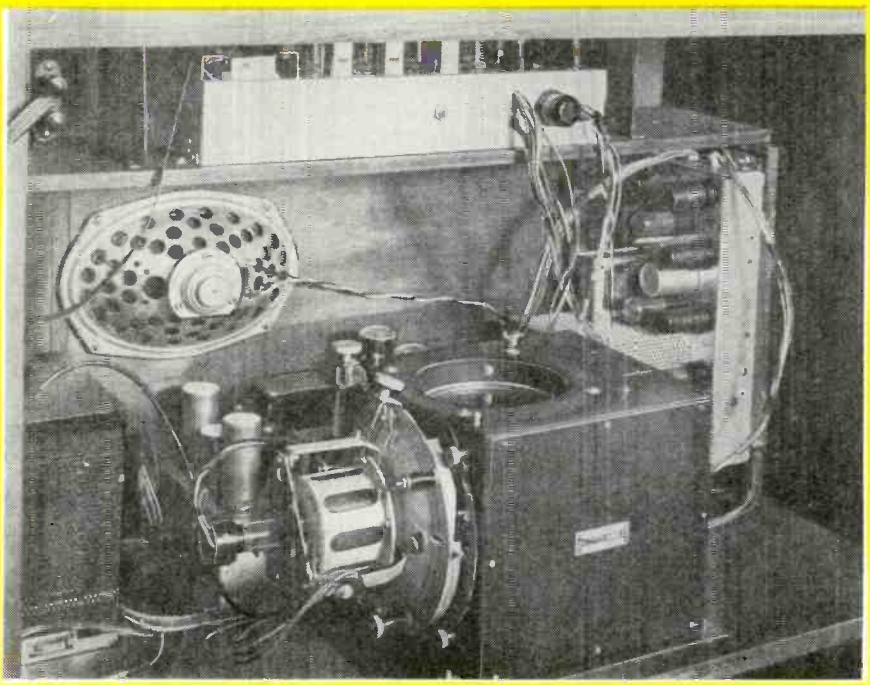


Photo of the television optical system and its high-voltage supply (front). The unit can be adapted to existing sets or built into custom installations.



A typical installation. Chassis at top contains front end, sound, and video i.f.'s. Chassis at right houses the sweeps. High-voltage power supply is at left.

UNTIL recently projection TV has been a luxury product for the carriage trade. Now, it is possible to manufacture compact projection sets at prices comparable to those of 16- and 20-inch direct view receivers. The Norelco Protelgram is such a unit which can be adapted to existing sets or used with specially designed circuits.

Several picture sizes are available with the basic Protelgram unit. The size of the picture depends upon the "throw distance" which is measured from the top of the corrector lens to the viewing screen. The throw distance may be straight-line distance, or it may be the sum of two or three straight-line distances bent to any convenient angle by plane surface mirrors. See Fig. 1 for illustrations of three common throw distance designs in receivers.

The throw distance varies according to the lens used. All the optical parts of the projection system are the same for all units; the corrector lens is the only part that requires changing when the projection throw distance is changed. This operation must be performed at the factory. Three models with the indicated throw distances are now available; for data study the figures in the table.

A high voltage unit

The high-voltage supply now used with the unit operates with a divided type of plate power supply of the type popularized in the 630 TS chassis. The negative side of the plate power input is insulated from the chassis. (See Fig. 2.) Since the maximum permissible B-minus voltage is determined by the heater-cathode rating of the 6BG6-G tube, this voltage must be limited to 135 volts. The 100 volts B-minus provided is well within this limit.

The output of this high voltage unit varies with the d.c. input supply voltage. The high voltage output is rated at 25 kv ± 2 kv at no load with an input supply voltage of 350 volts. As little as a 10-volt change, plus or minus, of the input voltage will show up as approxi-

* *Vice President* Electronics Research.

mately 750 volts change in the output potential.

The receiver power supply should provide an input potential of 350 volts maximum during projection, with a beam current of approximately 100 μa. When the line voltage varies between the normal RMA limits of 105 to 125

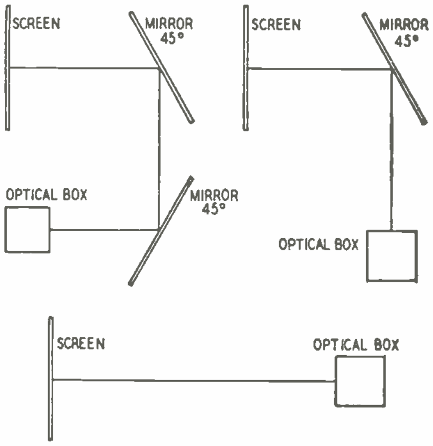


Fig. 1—Three methods of getting throw distance. Mirrors decrease efficiency.

volts the input supply voltage should not exceed 380 volts, nor be less than 320 volts.

When the beam current is varied from 0 to 100 μa, the input current changes by approximately 12 ma. Any receiver that is to operate under abnormal line voltage conditions must have a regulated input supply. This is important because the quality of the picture depends on the performance characteristics of the high voltage which supplies the second anode of the picture tube.

Dust and spurious light

Dust accumulation on the surface of the corrector plate of the optical box is undesirable because it affects the brightness and contrast of the projected image. There is loss of illumination and the tiny dust particles cause dispersion of the light emanating from the projection box.

Two possible remedies are dust proofing the optical path from the projection box to the screen and eliminating or shielding reflecting surfaces close to the optical path. Fig. 3 suggests an effective type of dust proof enclosure. The black buckram shroud should not sag into the optical path. This can be avoided by drawing it up tightly and fixing it firmly about the corrector lens with a rubber band.

Mounting the projection box in a position which puts the corrector plate in a vertical plane minimizes dust accumulation.

The optical system

The correct adjustment of the optical system requires that the center of the correction lens be exactly at the center of the curvature of the concave mirror. Adjusting screws facilitate this correction and two v shaped marks are brought together apex to apex to form a cross.

Because the projection tube is small, only 2.5 inches in diameter, the focal length may be as little as 4 inches. This makes possible the projection of a 13.5 x 18-inch picture with a straight line throw distance of 32 inches from the correction plate to the viewing screen, or a total of 40.5 inches from the base of the optical box.

The optical system has a numerical aperture (the sine of the semi-apex angle of the cone of gathered light) of 0.64. The optical efficiency of the mirror is the square of the numerical aperture, or 41%. Masking, absorption, transmission, and reflection losses reduce the overall optical efficiency to approximately 20%. This 20% optical efficiency assumes straight-line projection from the correction plate to the viewing screen.

In most projection receivers there is an additional plane mirror set about 45 degrees to bend the light beam from a vertical to a horizontal plane. The use of this one mirror decreases the overall optical efficiency to approximately 17%.

The sharpness of the images produced by this optical system is extremely good, for the system can easily render a definition of 1,000 lines, and will readily reproduce the 525 lines now used.

Although you get the best projection picture with straight-line horizontal projection, most installations do not permit a total of 40½ inches overall distance in a horizontal plane (32 inches for the throw distance and 8½ inches depth from the correction lens to the end of the optical box). Most projection receivers using Protelgram require one or more cabinet mirrors to fold the light beam. Any such projection receiver cabinet mirror must be a first surface or plane surface mirror. of good quality.

Any deviation of the reflecting surface from a perfect plane will cause optical distortion. Further, the closer the mirror is positioned to the projection box the more critical it is with respect to its flatness characteristic. Therefore, in any two-mirror system special attention must be given to the

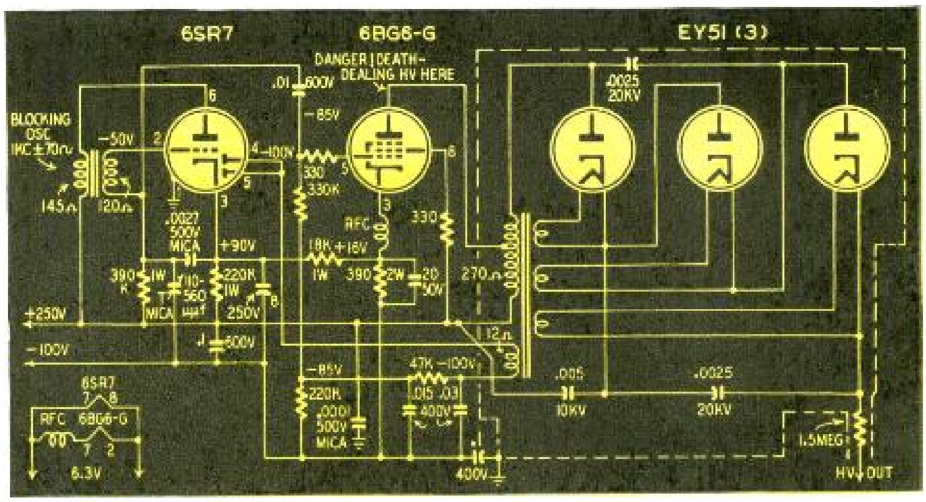


Fig. 2—Circuit of high-voltage supply. The rated output is 25 kv at no load.

quality, selection, and mounting of the mirror adjacent to the optical projection box.

The optical quality of mirrors made from standard 13/64 or ¼-inch polished plate glass is satisfactory for most projection receiver installations.

Protecting the picture tube

In direct view television receivers, comparatively little attention is given to protection of the expensive picture tubes against the possibilities of screen burns if the sweep circuit fails.

Where the second anode voltage is developed by the flyback method there is automatic protection against horizontal sweep failure, and even against a combination failure of both the horizontal and vertical sweep circuits. But for a simple and single vertical sweep failure no protection is provided. This is not so careless as it seems, for the electron beam is not likely to be strong enough to produce any fixed line burn if the vertical sweep circuit fails. Furthermore, the majority of sweep failures occur in the horizontal sweep circuit.

The separate high voltage unit in the Protelgram does not depend upon the sweep circuit for its operation. The electron beam energies of 90 μa, with highlight peaks of more than 500 μa, in the 3NP4 are sufficiently great to

Fig. 3—The optical system is shielded from stray light and dust by a shroud.

destroy the screen face in a few seconds if any part of the sweep fails.

Bitter and costly field experience has

revealed that of sweep failure may occur often enough to warrant simple precautions to prevent tube face burns. Sweep burns, either line burns or spot burns, usually destroy the usefulness of the tube.

The diagram in Fig. 4 suggests a simple protection circuit. The video drive is applied to the grid of the cathode ray tube and the direct current brightness control is supplied by a positive voltage on the cathode of the picture tube. Positive horizontal pulses are taken from the secondary winding of the horizontal output transformer and applied to the grid of one triode section of the 6SC7 protection tube through the .001-µf capacitor. This grid-cathode circuit then operates as a diode and forms a grid leak bias which cuts off this triode section whenever horizontal sweep output voltage is present. In a like manner, positive vertical pulses cut off the other section of the 6SC7 dual triode protection tube when vertical sweep output voltage exists.

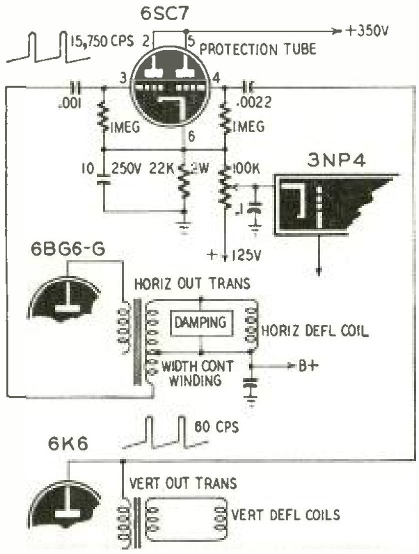


Fig. 4—This circuit protects the 3NP4 if either of the sweep circuits fails.

If the signals from the horizontal or vertical sweep disappear, either or both of the triode sections of the 6SC7 control tube will begin to draw large plate currents which will increase the potential at the cathode. Such cathode voltage will bias the picture tube as it is also applied to the cathode of the picture tube.

The plate voltage applied to the 6SC7 must be obtained from the same source that supplies input potential for the high voltage unit to insure protection if the sweep power fails.

A video amplifier

A cathode compensated video output stage will supply all the Protelgram requirements and requires far less power. For the same bandwidth the plate load is larger than in the conventional type amplifier. More output voltage can be obtained for the same current swing, or, better still, a specified output voltage can be developed with much less current swing. The lower average current reduces the drain on the power supply by as much as 30 ma. It is also possible to use a wider selection of tubes for the video output.

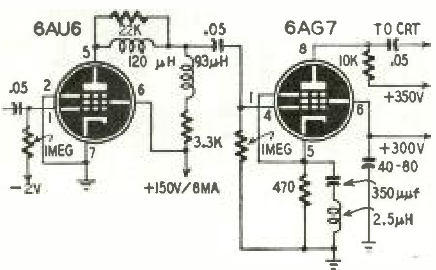


Fig. 5—A video amplifier with cathode compensation for use with Protelgram.

One disadvantage is that at the high frequencies the maximum output of the amplifier is somewhat reduced as a result of the shunting effect of the output capacitance across the relatively large plate load.

Fig. 5 shows a cathode-compensated video amplifier which has worked out well. The total output capacitance of this amplifier is about 45 µµf. This is made up of the output capacitance of the 6AG7 tube, the input capacitance of the 3NP4 projection kinescope, the wiring capacitance, and the capacitance of the three-foot lead to the projection tube.

The 6AU6 driver stage uses the conventional shunt-series peaking and provides for noise clipping at the cut-off in its grid circuit. The 6AG7 uses cathode compensation. Bandwidth is 4.5 mc at 3-db points.

The cathode compensation cannot be given theoretically, but must be determined by experiment in each case, for it depends upon the individual chassis arrangements and choice of components. Values shown may be used as starting points. Decrease inductance as capacitance is increased. Cathode bias is 11 volts at low frequencies.

	Throw Distance (inches)	Width (inches)	Height (inches)
Model 161A For table models	23⅛ to 23⅞	13½	10
Model 160A For consoles	31 32	16 18	12 13½
Model 162A For large scale projection.	70 90 110	32 48 64	24 36 52

Table shows the picture size and throw distance of the three different models.

An adaptor and power supply

The Protelgram system may be added to existing chassis and an adaptor circuit with its plug in possibilities is illustrated in Fig. 6. This adaptor circuit requires the addition of two Amphenol sockets to an existing chassis and another small power supply unit with the protection tube circuit built in. The power supply may be added to the existing chassis if there is room or it may be built on another small chassis of its own. This adaptor circuit offers intriguing possibilities to the experimenter since it is an attachable-detachable package unit.

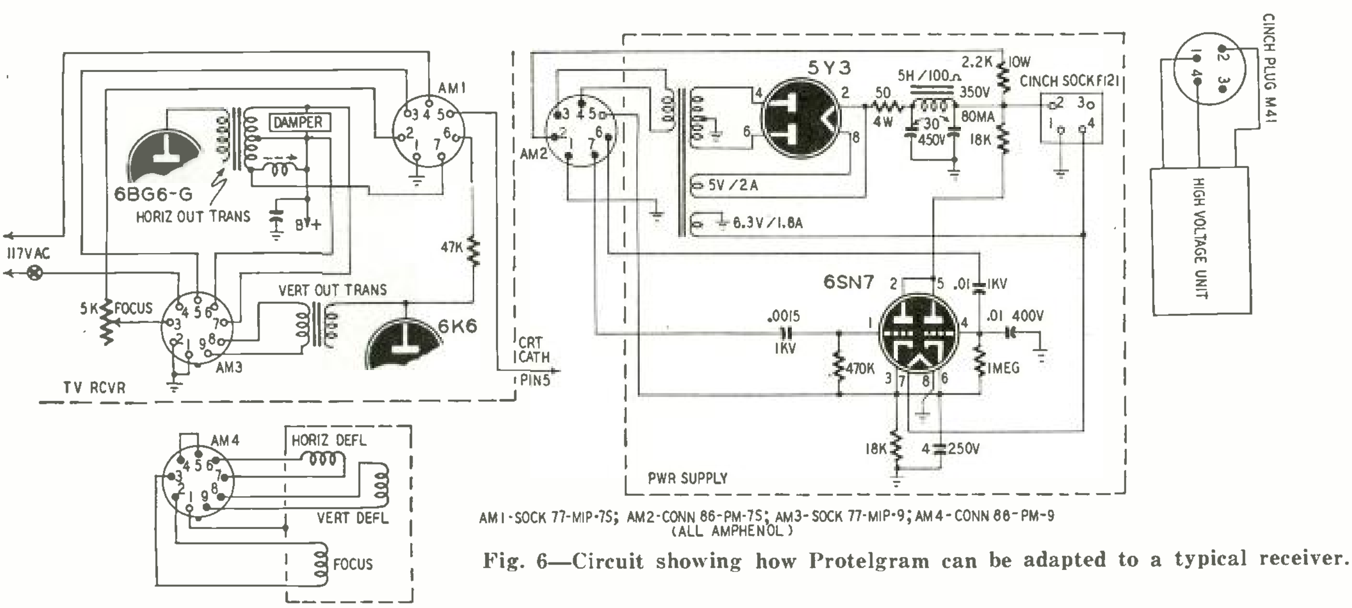


Fig. 6—Circuit showing how Protelgram can be adapted to a typical receiver.

New Picture Tube for Color TV

COLOR television for the general public is now one step nearer, because of a new color viewing tube just developed by RCA. The new kinescope is based on a different principle from any previously described, though it has some resemblance to the Geer tube or Du Mont Trichromoscope.

The new tube may be built with either one or three electron guns, with no change in the principle of operation, though of course with some variation in the details of circuitry and construction. It has been demonstrated with RCA 525-line dot-sequential color transmissions, but could be used with other systems if desired.

The screen of the new kinescope is made up of a vast number of dots of color phosphors, arranged in triangular groups of one green, one red and one blue dot. There are 117,000 of these triangles in the present developmental tubes, or 351,000 dots in an approximately 15-inch tube.

Directly behind the fluorescent screen is a metal mask which contains 117,000 holes of approximately the same size as the dots of color phosphor. The holes are opposite the center of each triangle, so they overlap equally the green, red and blue dot of the group. The angle at which the beam comes through the hole then determines which color dot will be excited (See Fig. 1).

Positioning of the guns in the three-gun tube of course determines the angle at which the beam will be projected through the holes at the fluorescent screen. Each gun takes the place of one of the tubes in the RCA three-tube system (RADIO-ELECTRONICS, January, 1950, page 28). When the red dot is being received, the beam from the red gun is modulated, being strengthened or weakened in proportion to the amount of red at that point in the scene being scanned. The blue gun takes over as the blue dot is received, and since its beam reaches only the blue dot on the screen, the blue phosphor is excited in proportion to the amount of blue in the point of the scene being scanned. Thus each color in the transmission is reproduced.

A means for converging the three beams at the same point is required. This is an additional electrode in the three-gun tube. The degree of convergence should vary during the line scan, on account of the varying angle which the sweeping beam makes with the practically flat screen. This is provided for by varying the voltage on the convergence electrode.

An ingenious dodge makes the single-gun tube the practical equivalent of three guns. The beam from the single gun is magnetically rotated, so that it occupies in quick succession the positions of the guns in the three-gun kinescope. The beam is rotated by a special deflection yoke (Fig. 2) which can be adjusted on installation so that it is in the position of the green gun when the green dot is being received, then moves to the positions of the red and blue guns at the correct instant.

Convergence, which is controlled electrostatically in the three-gun tube, is controlled magnetically in this tube. The variation in convergence as the beam swings farther from the center of the tube is provided for by a dynamic convergence circuit, output from which is applied through a yoke shown just inside the convergence yoke in Fig. 2.

At least two research receivers have been built for the new color kinescopes. Both include a 27-tube standard black-and-white chassis. One has 19 additional tubes for color synchronization, sampling, additional power supply, etc. The other, a simplified circuit, uses 10 extra tubes for these purposes.

Both the one- and three-gun tubes operate with a final anode voltage of 18,000. The convergence electrode of the three-beam tube operates at 9,000 volts and focussing voltages are in the order of 3,000 volts.

A new circuit on these receivers—not developed at the time of the January article—is that for *color synchronization.* Not only must lines and frames be kept in perfect synchronization with those of the transmitter, but in the color receiver synchronization of the color dots is essential. In early models, there was a tendency for the receiver to drift, with the result that the transmitter might be sending out a red dot while the receiver was only half way between blue and red. The result was that part of the red dot would be interpreted as blue and the rest of it as red, causing a mixture of the two colors on the screen.

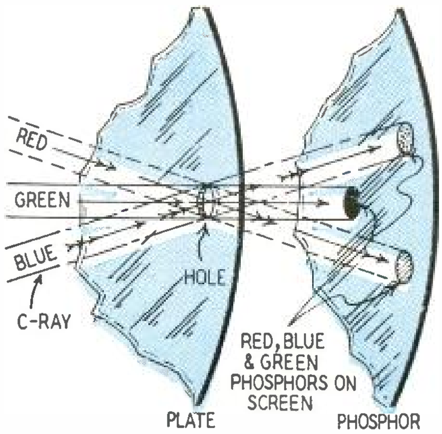


Fig. 1—Angle of beam determines color.

Additional pulses sent by the transmitter during the blanking period after each line are picked up from the video amplifier just as are the other sync signals. They are made to control the sampling so that the receiver is locked into step with the transmitter colorwise as it is for line and frame scan.

Additional improvements are in progress on these tubes and circuits, but enough has already been demonstrated to prove that an electronic color television system with a single viewing tube is possible today, and should be economically and technically practical within the next couple of years.

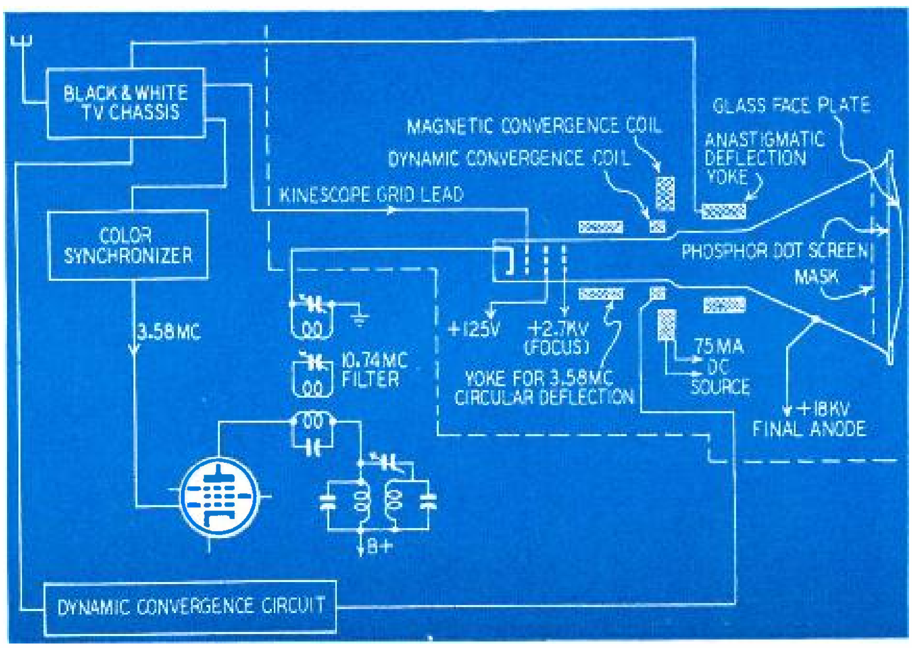


Fig. 2—Diagram of the single gun system adapted to a black-and-white TV set.

Electronic TV Magnifier

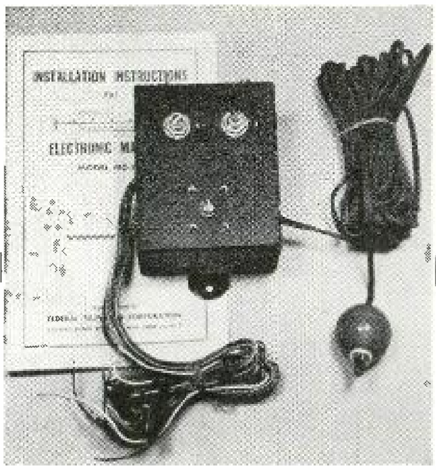


Photo 1—Complete kit includes metal box with relay, resistors, and capacitor inside, and booklet showing connection diagrams for use with any TV receiver.

Adapter unit provides blown-up images on electromagnetic sets.

By RICHARD H. DORF

NOWADAYS anyone can add electronic enlargement to almost any television receiver with the aid of a little device put out by Federal Television Corp., New York—the electronic magnifier, model MD-100. The effect is the same as that of the Garod Tele-zoom introduced some time ago and since incorporated in other manufacturers' models. At the press of a hand-held button, the picture enlarges as if the camera had suddenly moved closer to the performer. Another press and it returns to normal.

The actual effect on the eye varies considerably with the particular picture. For some psychological reason, some enlarged scenes give a tremendous effect of greater nearness while others seem to change hardly at all.

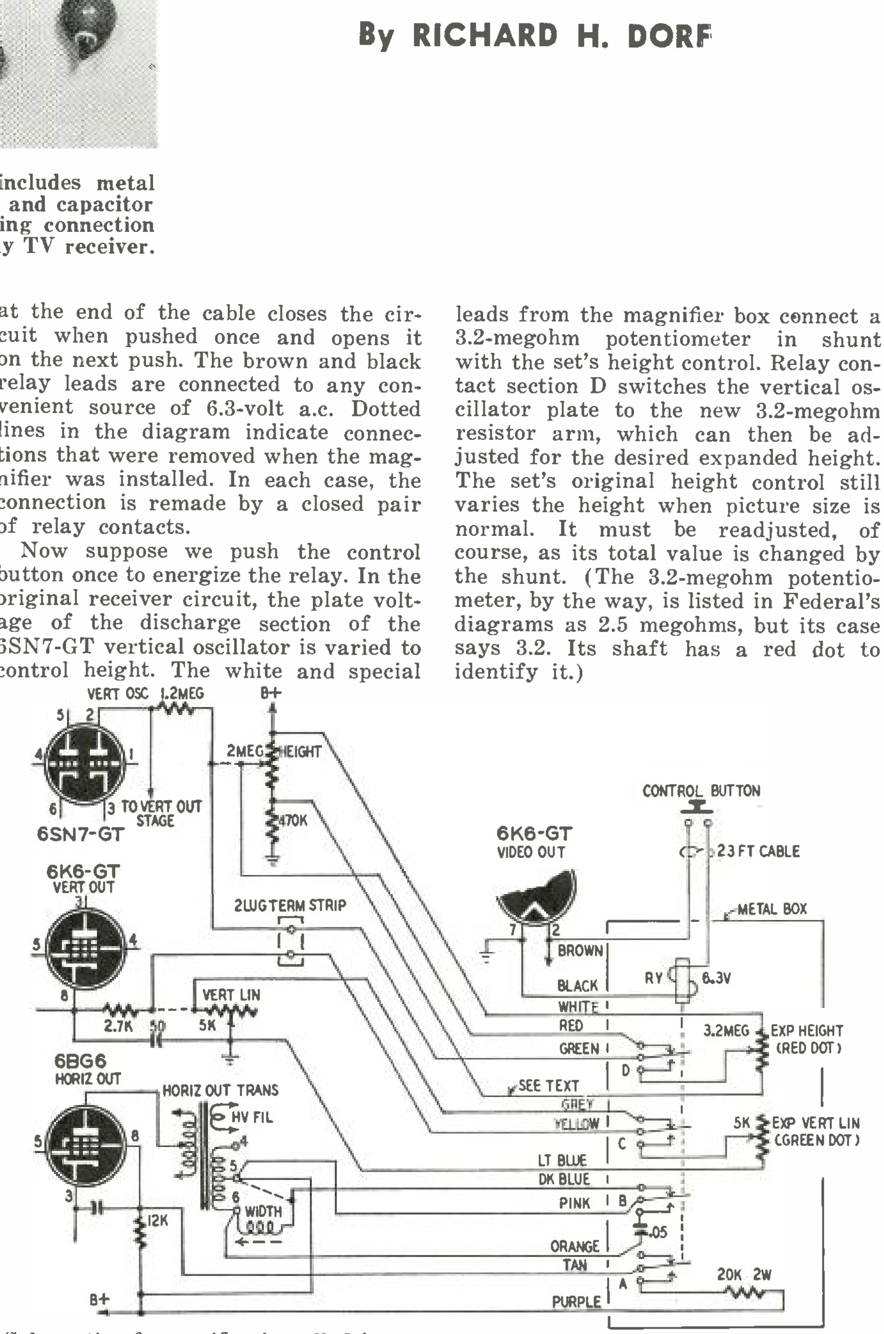
The entire magnifier consists of the little black steel box shown in photo 1. Inside it are one fixed and two variable resistors, a capacitor and a 6.3-volt relay with four s.p.d.t. contact assemblies. Leads from the contacts and components come out through one hole and a 23-foot cable comes out of another. On the end of the cable is a small hollow plastic sphere in which a push-button switch is mounted.

The magnifier is diagrammed in the figure and the inside appears in Photo 2. It was installed on an Admiral 30A1 chassis, as the diagram indicates. The instruction book that comes with the unit has 33 separate installation diagrams covering almost all electromagnetically deflected models of 62 manufacturers.

How it works

In the diagram the relay contacts are shown in their normal position, the relay unenergized. The control button at the end of the cable closes the circuit when pushed once and opens it on the next push. The brown and black relay leads are connected to any convenient source of 6.3-volt a.c. Dotted lines in the diagram indicate connections that were removed when the magnifier was installed. In each case, the connection is remade by a closed pair of relay contacts.

Now suppose we push the control button once to energize the relay. In the original receiver circuit, the plate voltage of the discharge section of the 6SN7-GT vertical oscillator is varied to control height. The white and special leads from the magnifier box connect a 3.2-megohm potentiometer in shunt with the set's height control. Relay contact section D switches the vertical oscillator plate to the new 3.2-megohm resistor arm, which can then be adjusted for the desired expanded height. The set's original height control still varies the height when picture size is normal. It must be readjusted, of course, as its total value is changed by the shunt. (The 3.2-megohm potentiometer, by the way, is listed in Federal's diagrams as 2.5 megohms, but its case says 3.2. Its shaft has a red dot to identify it.)



Schematic of magnifier installed in Admiral 30A1 chassis. Other diagrams come with the unit. Use tie lugs where possible to join long wires under chassis.

The special lead is not in place when the magnifier is bought. Some receivers use a voltage-dropping rather than a voltage-dividing arrangement for height control, in which case only the B-plus connection is needed. The diagrams in the instruction book indicate when the special lead must be added.

Vertical linearity is controlled in the Admiral by varying the cathode resistance of the 6K6-GT vertical output stage. The original circuit, as shown, varies slightly from the expanded circuit. In the original, both end connections of the 5,000-ohm potentiometer are used, while in the magnifier circuit only the arm and one end are connected. The advantage in the original is that, if the arm fails to make contact due to dirt or age, the vertical deflection will not fail entirely. That can be duplicated in the magnifier, but the writer did not think it worth while to bother adding the extra lead.

Two long wires in the chassis must be connected to wires from the magnifier—those from the vertical oscillator plate and the vertical output cathode. Rather than taping them and leaving them hanging, install a two-terminal strip inside the rear chassis apron between the height and vertical linearity controls.

To increase the horizontal deflection two things are changed. First, a 20,000-ohm resistor is shunted across the 12,000-ohm screen resistor of the 6BG6 horizontal output stage. That increases the screen voltage and the output, which raises both secondary outputs of the horizontal output transformer. The width control is replaced by a .05-μf capacitor. The capacitance is reflected into the high-voltage winding, reducing the voltage to something slightly below normal and making the beam less stiff so that the deflection current has greater effect. The reflected effect on the high-voltage winding reduces high voltage to a greater degree than it reduces deflection current because the high-voltage winding is of much higher impedance. The net result is more deflection current and less high voltage which gives a boost to the picture width.

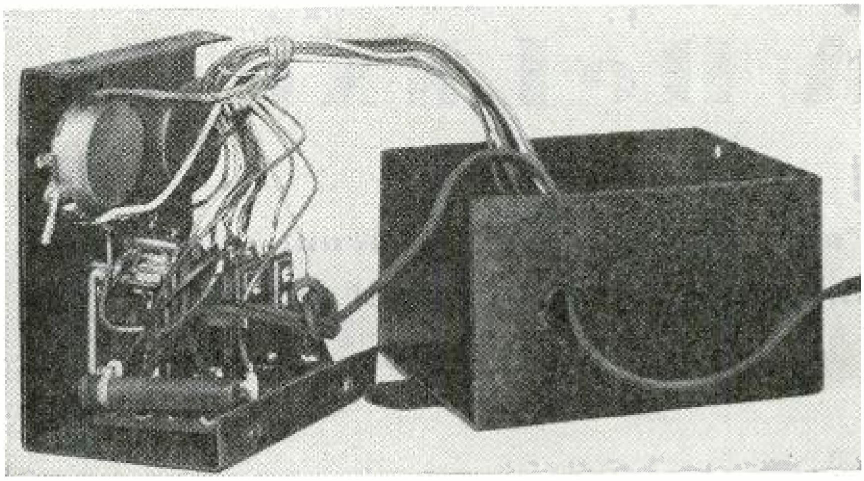


Photo 2—All the parts are mounted in the box, held together with four screws.

Installation

Installing the magnifier is easy. The only thing to be careful about is the C-R tube—don't let anything fall on it and don't drop the chassis when you're carrying it.

The instructions suggest mounting the black metal box in the cabinet. Two wood screws are provided for the purpose. The writer did not like that idea, as the box would have to be detached and dangled every time the chassis came out. First thought was to hang it like a rumble seat on the rear chassis apron, but a better place was found on top of the high-voltage cover. It was mounted far enough forward to leave the ventilating grill almost completely clear. Very short self-tapping screws avoid having anything stick down near the high voltage.

To make the job look shipshape, all the colored leads were laced together with waxed cord to the point where they enter the chassis. All the leads for vertical circuits were pushed through the hole provided for the C-R tube socket connections. The rest were led back about 4 inches to the hole through which the deflection—and focus—coil leads come.

The brown and black leads for the relay coil were soldered to pins 2 and 7 of the 6K6-GT video output tube, which happens to be the most convenient. The white and gray leads were attached directly to the controls, and the other two were brought to the two-terminal strip installed for the purpose.

The color code is clear—but watch the brown and light blue leads (the word "light" is not used in the instruction book) to avoid confusing them with the tan and dark blue ones. If in doubt, use an ohmeter. In addition, most of the colors agree with those used in the set's own wiring.

The tan and purple leads go directly across the 12,000-ohm resistor in the 6BG6 screen circuit—no trouble there. Lead the orange, dark blue, and pink wires over to the high-voltage compartment, then up again through one of the holes. The transformer terminals are marked clearly (though upside down).

Clip the width-control connection away from terminal 5, leaving enough wire hanging out of the spaghetti for connection. Scrape it with steel wool, as it is enameled. Then tie the dark blue lead to it. The writer wanted to use a terminal but couldn't find a place to mount it without more drilling, so the connection was simply wrapped with Scotch electrical tape and left alone. The leads are all laced and there is no strain, but when taking off the high-voltage cover with the magnifier box mounted on it, it won't be a good idea to tug too hard on the leads.

Putting the chassis back in the cabinet is the next step, followed by adjustment. Push the button once or twice to see that the relay clicks, then, with size normal, readjust all the set's controls in the usual way. Push the button for enlargement, then adjust the two control shafts on the magnifier box for the desired magnification. Set the horizontal drive on the receiver to maximum, adjust width in normal condition with the width control, and you'll have all the expanded width you want.

TELEVISION DX

Long-distance television reception is a seasonal thing, with the summer months a little more favorable than the winter. With this in mind, we hope to be getting more reports before long.

J. F. Hunnicult, West Hartford, Conn., reports having received WTMJ-TV, Milwaukee, on channel 3 last July with perfect picture and sound. He uses a 7-inch Teletone with a Transvision booster. Antennas are a stacked conical, a modified Yagi array, a stacked folded dipole, and a reflector high-band array which is used for dx-ing. These are all homemade. Mr. Hunnicult has also received Stratovision station W10XWB.

G. F. Early, Topeka, Kansas, reports receiving WKY-TV, Oklahoma City, some 290 miles away. The unusual feature of this reception is that his antenna was at all times oriented on WDAF-TV in Kansas City. A look at the map tells the story. Receiver was a Motorola 12VT13, and the antenna a Ward T-49.

William Bashta of Los Alamos, N. Mex. reports receiving KOB-TV, channel 4, Albuquerque, N. Mex.; WBKB, channel 4, Chicago; and WTMJ-TV, channel 3, Milwaukee, Wis.

R. Ulbrich of Erie, Pa. received with very good picture and sound on March 6: WNBK, channel 4, Cleveland, Ohio; WBEN-TV, channel 4, Buffalo, N. Y.; WXYZ-TV, channel 7, Detroit, Mich.; WWJ-TV, channel 4, Detroit; WJKB-TV, channel 2, Detroit; and WHAM-TV, channel 6, Rochester, N. Y. The receiver is a Motorola Model 9L1 and the antenna a BM312X2 stacked fan Flecton.

A DeLuxe Televiser

Part VI—Aligning the front end and checking with visual method

By
CHARLES A. VACCARO

IF you have followed closely the construction of this televiser since the series began in the January issue, you will probably have completed the set and will have aligned the i.f.'s with AM-type test equipment. In this installment, we will discuss the alignment of the tuner and will show how alignment can be done or checked with a sweep generator and scope.

It is difficult to completely align the front end or tuner when it is in position on the chassis because some of the high-frequency coils are hard to reach. Adjusting these is made easier by using a special bracket made of .064-inch or heavier 1-inch aluminum. The bracket is bent as shown in the photo and drilled for mounting holes. It should be long enough to hold the tuner chassis at an angle where the high-band coils and antenna terminals can be reached. Remove the extension shafts and nuts and bolts which hold the tuner to the main chassis. Fasten the tuner to the bracket as shown.

The Oscillator Coils

The oscillator coils can be aligned when stations in your area are on the air. The picture need not be a test pattern.

Switch to the different channels. If the audio from the station can be heard around the middle range of the fine tuning capacitor, leave that oscillator coil and proceed to another channel. If the audio comes in near minimum capacitance or if the picture is seen but the audio cannot be heard at all at the minimum-capacitance setting, then leave the capacitor at about half capacitance and decrease the inductance by spreading the turns on the coil until the audio is heard. If the audio comes in near maximum capacitance or if neither picture or sound is received and it is known that the station is on the air then proceed to increase the inductance by squeezing the turns of the oscillator coil until the sound and picture come in. The only exception to the above is for U-shaped coils for channels 10 to 13 inclusive. In this case, squeezing the two sides together will decrease the inductance thereby increasing the frequency while spreading the sides out or making the coil more circular will increase the inductance and therefore decrease the oscillator frequency.

One end of a high-frequency oscillator coil can be unsoldered and the coil lengthened or shortened slightly to increase or decrease its inductance. This applies to the r.f. and mixer coils as well. If it is necessary to do this in more than one or two cases, check the wiring of the entire tuner before proceeding. Make sure that the switch, components, wires etc. to and from the switch do not differ from the layout. If the layout is followed, you need not do more than squeeze or spread the coil turns. Insulated rods and pliers will be handy for these coil adjustments.

The r. f. and mixer coils

These coils are coupled together and their adjustments are similar. Adjustments must be made with a test pattern on the screen and the audio carefully tuned in. Squeeze the plate coil turns together. If the signal gain decreases, spread the coil turns apart until the picture gain becomes maximum or the test pattern begins to tear. Then squeeze the turns together until the picture just starts to get weaker. At this point the picture quality improves. Repeat the procedure for the mixer grid coil. Retouch each coil in turn until the lines in the vertical wedges are as distinct as possible. It will be possible to see these lines clearly all the way in—or nearly—in to the most narrow part of the wedge.

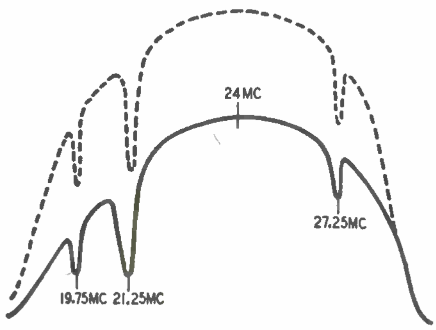


Fig. 22—Response of the loaded i.f.'s.

If you have succeeded with other channels but one cannot be brought up to the same quality, skip over it for a day or two and hope the quality of the transmission will improve. This occurs at times when adjustments are being made to the transmitting equipment and quite often an improvement is made within a few hours.

After all the transformer coils for each active station are adjusted, the oscillator coils can be touched up so the fine tuning control will bring in the different channels at approximately the same position of its range. Set it to the middle of its range and leave it there. Switch to the various channels and adjust each oscillator coil slightly so the sound can be heard for each. The only occasion where you may not want each channel to fall on the same fine tuning control position is if you are located where signals can be received on two adjacent high-band channels such as 8 and 9, 10 and 11 or 12 and 13. In this case, the higher of the two must tune as closely as possible to minimum capacitance so the lower channel can be tuned near maximum capacitance. This will usually be an exception so in most cases you will be able to set the osc. coils so the channels in the area will fall in at the same tuning position when the selector switch is rotated.

After the high channels have been aligned and the tuner is fastened back down to the main chassis, it may be necessary to touch up the coil adjustments slightly. This is due to the reduced inductance to ground after adding the other two ground leads.

The tuning of the r.f. and mixer coils is usually unaffected and that of the oscillator coils will be slight if at all.

After the front end alignment has been completed, an additional improvement can usually be gained in picture quality by touching up three of the cores in the i.f. strip. Tune in the channel displaying the best test pattern. Touch up the 25.0-, 25.3-, and 25.4-mc adjusting screws. These will not require more than one and usually not more than ⅛ of a turn. Turn the screw slowly clockwise and note if an improvement is apparent. If no improvement is noted, return the screw to its former position and move up to the next one in the order listed. The trailing edges of the shaded circles of the test pattern will appear to stand out or have a third dimension as the core is turned in. Back off the adjustment to the point where this effect just disappears. If the screw is backed off too much, the whites will become streaked with gray and the sharp portions of the picture will smear. Do not touch any adjustments other than the three that have been mentioned.

Place the sync selector switch in the ASC position and readjust focus and contrast controls.

Decrease the width of the raster if necessary by turning the core out of the width control. Turn down the contrast control slightly so the blanking bars can be seen on the edges of the raster. Turn the ASC horizontal hold control to the middle of its range. Adjust the horizontal discriminator adjustment screw protruding from the rear panel while switching the station selector switch off and on the channel being viewed. Adjust the screw so the picture is in sync the instant the channel is switched on. Then adjust the phasing screw at the opposite end of the discriminator transformer so the blanking bars are equal on each side of the picture. If this latter adjustment has to be changed very much the procedure should be repeated. The adjustment can be checked by rotating the ASC horizontal hold control to full clockwise and counter-clockwise positions. The picture should not go out of sync in either direction.

It is a good time now to become familiar with the proper vertical hold position for interlacing. The picture may or may not slip out of sync at the extreme ends of the vertical hold control. However near both ends of the control the space between the horizontal lines will be wide and appear stationary. At a position about half way between these two limits the lines will appear to be moving and the space between lines will be very thin. This is the proper position for the vertical hold control.

Using sweep gen. and scope

Although not entirely necessary, an oscilloscope and sweep generator are useful for checking the passband and response of the various circuits.

To check the alignment of the video i.f.'s, set the sweep generator at 24 mc, adjust it to sweep through 10 mc, then connect it to the mixer grid. Connect the scope between the junction of the 6AC7 video peaking coils and ground. Keep the output low so the amplifiers are not overloaded. Use an accurate signal generator or marker generator to check the response at points shown on Fig. 20. Be sure that the 25.75-mc marker is half way down the slope. If the curve differs from Fig. 20, repeat the alignment as described in the May issue. Complete the check with the marker generator set at 21.25 mc.

Connect the sweep generator between the grid and ground of the 6SH7 limiter on the sound i.f. strip. With the marker still set to 21.25 mc, tune the sweep generator to this frequency and set it to sweep approximately 2 mc. Connect the scope to the grid of the 6SF5 or 6V6 a.f. amplifiers. Advance the gain on the scope and keep the generator output just high enough to produce a fair-sized pattern on the scope.

Adjust the *bottom* screw of the a.f. discriminator transformer for maximum deflection on the scope and adjust the *top* one for the typical discriminator response curve. Continue the adjustments until the center portion of the trace is as straight as possible between peaks, and the peaks have maximum and equal amplitudes above and below the 21.25-mc marker. See Fig. 21. The *bottom* adjustment affects the amplitude of the trace while the *top* shifts the response about the center or marker frequency.

Move the signal generator to the mixer grid and adjust both cores of the sound i.f. transformer so the response is maximum and the linearity is as shown in Fig. 21. Check this by moving the marker to 21.15 and 21.35 mc. These points should be equidistant from the peaks.

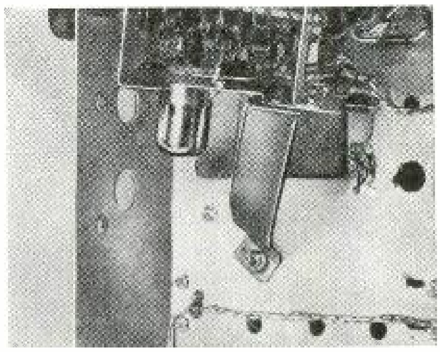
Unless the sweep generator has crystal-controlled frequencies for the r.f. sound carrier for each channel, use the station's sound carrier to adjust the oscillator coil as described in the beginning of *this* installment. Just be sure that the stations all come in at approximately the same position on the fine tuning control.

Remove the 300-ohm line between the antenna terminals and the tuner. Connect the generator to the tuner, using a non-inductive resistor—usually 100 or 200 ohms—to match the tuner to the generator. Shunt the 22-mc mixer plate coil with approximately 350 ohms and connect the scope between ground and the junction of this coil, the .0047-μf capacitor, and 36,000-ohm resistor. Turn down the contrast control and leave it until the preliminary adjustment of the front end is completed.

Switch the tuner to the lowest channel and adjust the generator as closely as possible to the center of the channel. Adjust the sweep to 10 mc. Set the scope and generator gain controls so the trace is visible. Adjust the mixer grid and r.f. plate coils to obtain a nearly-flat, maximum-response curve. Sacrifice some gain for a nearly-flat curve if it droops in the center. Spreading and squeezing the turns on the coils will increase and decrease their resonant frequencies, respectively. Separating the two coils will decrease the bandwidth. Moving them together increases the bandwidth and reduces the amplification. Coil changes will be minor if they are reset as shown in Fig. 14. Crystal-controlled markers can be used to mark the edges of the band.

For the dual-channel positions 8-9, 10-11, and 12-13, select stations which are or will be in your area and adjust the coils for maximum response. To cover the six highest channels, adjust the oscillator coils so the sound for the higher of each pair comes in at minimum setting of the fine tuning control. The r.f. and mixer coils are adjusted wide enough to cover both channels. For example; a range of 180 to 192 mc is required to admit both channels 8 and 9.

Set the sweep generator to the *upper* limit of the *lower* channel and sweep it over 15 mc. Adjust the coils for as flat a response as possible over approximately 12 mc. If crystal markers are not available, shunt the five video i.f. coils with non-inductive resistors of about 350 ohms. Connect the generator and scope as described for video i.f. alignment. Use a 10,000-ohm resistor in series with the scope. Adjust the sweep to 15 mc. The pattern of the loaded i.f.'s will be similar to the solid curve shown in Fig. 22.



Bracket holds tuner during alignment

Reconnect the generator to the tuner antenna terminals to check the overall video response. Advance the contrast control to nearly maximum and set the fine tuning control for the sound on the *lower* channel. Adjust the generator to sweep 15 mc centered on the *upper* limit of the upper channel. The response will be similar to the broken curve in Fig. 22. However, it should not drop too sharply at 19.75 mc. Swing the fine tuning control to minimum or to the best tuning point for the *upper* channel. The response curve will be the same but it should not drop too sharply at the 25.75-mc end of the curve.

The table shows the TV channels with band-edge, carrier, and receiver oscillator frequencies. Refer to it when setting the sweep and marker generator frequencies and when making calculations.

Table of the Important TV Frequencies

Channel No.	Band	Video Carrier	Audio Carrier	Rcvr. Osc.
2	54-60	55.25	59.75	81
3	60-66	61.25	65.75	87
4	66-72	67.25	71.25	93
5	76-82	77.25	81.75	103
6	82-88	83.25	87.75	109
7	174-180	175.25	179.75	201
8	180-186	181.25	185.75	207
9	186-192	187.25	191.75	213
10	192-198	193.25	197.75	219
11	198-204	199.25	203.75	225
12	204-210	205.25	209.75	231
13	210-216	211.25	215.75	237

Note: Band, carrier, and oscillator frequencies are in megacycles.

This completes the front-end alignment, so touch up the video i.f. and sync discriminator adjustments as previously outlined in *this* installment.

Television Dictionary

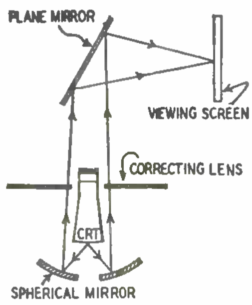
(Continued from page 38 of the May issue)

By ED BUKSTEIN

Scanning
The process of exploring an image, usually with an electron beam, in a predetermined pattern. In standard television practice, scanning of an image is accomplished in 525 horizontal lines.

Scattering
The tendency of an electron stream to spread out or diverge due to the repelling influence exerted on every electron in the stream by every other electron.

Schmidt optical system
A method of projecting the im-



age from the screen of a cathode-ray to a larger viewing screen. The system uses a spherical mirror and a correcting lens to compensate for spherical aberration.

Separator
A clipping circuit used to remove a portion of a waveform by virtue of its amplitude. In the television receiver, a separator circuit is used to extract the synchronizing pulses from the composite signal. (See Amplitude separation.)

Sequential color transmission
A system of color television in which picture elements of the same color are transmitted as an individual field. (See Color sequence.)

Sequential interlace
A system of interlacing in which the fields are scanned in a progressive order. (See Progressive interlace.)

Serrated Vertical Pulses
The wide vertical synchronizing pulse is divided into a number of narrower pulses in order to prevent loss of horizontal synchronization during vertical flyback.

Shading
An undesired reduction of background illumination of the image, caused by secondary electrons returning to the mosaic. In the iconoscope, the impact of the scanning beam knocks secondary electrons out of the mosaic. Such secondary electrons may return to other globules and reduce the charge of the globule capacitance.

Shading generator
A device for reducing shading by generating waveforms which are 180 degrees out of phase with the shading signals produced by the return of secondary electrons to the mosaic.

Spectral response
The same as spectral sensitivity.

Spectral sensitivity
The relative response of a photosensitive device to the different wavelengths within its range of response. For instance, some phototubes have a spectral sensitivity which is high in the blue region, while other tubes are more sensitive to red.

Spherical aberration
A defect of a spherical mirror which prevents the light from coming to a sharp focus on the principal axis.

Spherical mirror
A curved reflecting surface of such shape that it causes the rays of light striking it to focus upon a point on the principal axis. (See Concave mirror.)

Spurious signals
The shading signals produced by the return of secondary electrons to the mosaic of a pickup tube. (See Shading.)

Staggered interlace
A system of interlace in which the fields do not follow in a progressive order. (See Quadruple staggered interlace.)

Staggered tuning
Alignment of successive tuned circuits to slightly different frequencies in order to widen the over-all response.

Stratovision
A proposed system of increasing the range of television coverage by transmitting the signal from an airplane.

Sweep
Movement of the spot across the screen of a cathode-ray tube. Sweep is normally accomplished either by applying a sawtooth voltage to the deflection plates (electrostatic deflection) or by passing a sawtooth current through the deflection coils. (electromagnetic deflection).

Synchronization
Timing of an electrical action or waveform. In the television receiver, the horizontal and vertical sweep oscillators are synchronized or locked-in by the synchronizing pulses which accompany the transmitted signal.

Synchronization clipper
A circuit designed to remove the synchronizing pulses from the composite signal. (See Separator and Amplitude separation.)

Synchronization pulses
Pulses transmitted along with the picture information and used to lock-in the frequency of the sweep generators in the receiver.

Synchronization separator
Same as synchronization clipper.

T

Tearing
Splitting of the television picture due to improper synchronization.

Telecast
A television broadcast.

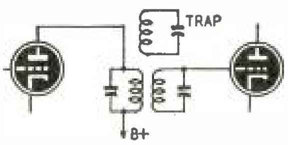
Televise
The process of converting an optical image into an electrical image for transmission.

Test pattern
A fixed television image used to determine the quality and correctness of adjustment of a television system. (See Resolution chart.)

Tilt
Scanning a field of view by moving the camera in a vertical plane.

Trace
The path followed by the spot as it moves across the screen of a cathode-ray tube.

Trap
A tuned circuit used to eliminate a given signal or to keep it out of a given circuit. For instance,



in the television receiver, traps in the video circuits keep the sound signal out of the picture channel. One type of trap is simply a tuned circuit which absorbs the energy of the signal to be eliminated.

TV
A commonly used abbreviation for television.

V

Vertical blanking
The application of cutoff bias to the cathode-ray tube during the vertical retrace.

Vertical centering control
The adjustment which shifts the image in the vertical direction so that it may be centered on the screen.

Vertical hold
The adjustment which varies the free-running frequency of the vertical sweep oscillator in the television receiver. When this adjustment is properly set, the incoming synchronizing pulses will "lock-in" the frequency of the vertical oscillator.

Vertical retrace
The movement of the spot from the bottom of the image to the top after each vertical sweep. The cathode-ray tube is biased beyond cutoff during this time.

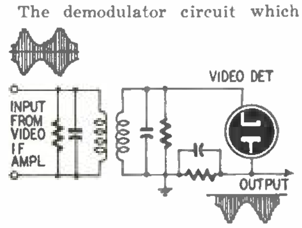
Vertical synchronization
Locking-in of the vertical sweep oscillator by the incoming vertical synchronizing pulses. (See Vertical hold.)

Vestigial sideband transmission
A method of transmission in which one set of sidebands is largely, but not completely, eliminated. This system is employed in commercial television practice.

Video
Pertaining to television signals or equipment.

Video amplifier
The amplifier stages following the video detector in a television receiver. They are designed to have a flat response up to several megacycles.

Video detector
The demodulator circuit which



extracts the picture information from the modulated carrier.

W

Width
The horizontal dimension of the television image.

Width control
The adjustment which varies the horizontal size of the television picture. This is accomplished by controlling the amplitude of the horizontal sawtooth.

Y

Yoke
The assembly containing the deflection coils used for electromagnetic deflection. (See electromagnetic deflection.)

(This concludes the Television Dictionary, which began in the January 1950 issue, and continued through every issue thereafter.)

Using the VR Tube

How to use voltage regulator tubes in designing power supply circuits

By CARL W. SHIPMAN

SOME types of circuits, such as oscillators and unbalanced amplifiers, are adversely affected by changes in supply voltages. A voltage regulator tube in the power supply circuit may improve their operation greatly.

Voltage changes may be due to variations in the a.c. supply or to variations in the load current acting through the resistance of the power supply. A voltage regulator tends to isolate its output from changes of either type.

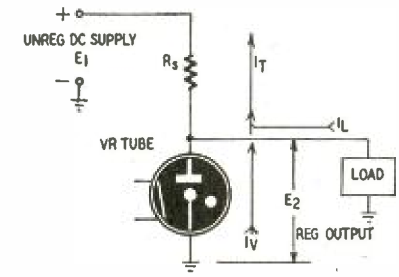


Fig. 1—Typical circuit using a VR tube.

Voltage regulator tubes are cold-cathode, gaseous-discharge diodes. A characteristic of gas-filled tubes is a relatively constant internal voltage drop within wide limits of current. In these tubes, a current variation of 600% will produce a voltage change from plate to cathode of less than 5%.

Gas-filled diodes have three characteristic voltages, determined by the gas or gases used and the construction of the tube. The starting or ionization potential is the voltage which must be impressed to start the initial ionization and current flow. When the gas becomes ionized, the voltage across the tube falls to a lower value, called the operating potential. This operating potential is maintained over a large range of current values. If the voltage is reduced below the operating potential, a point is reached where conduction stops. This is the de-ionizing voltage.

The first two of these constants are important in voltage regulation and are specified by the manufacturer for each tube type.

The regulator tubes most commonly used are the OA3, OC3, and OD3, which are also designated VR75, VR-105, and VR150, respectively. In the latter designations, VR stands for voltage regulator and the 75, 105, or 150 is the operating voltage drop across the tube. These tubes have a maximum current rating of 40 milliamperes. Regulation is somewhat better if the current does not exceed 30 ma. In these three types the minimum current at which the voltage is stable is 5 ma.

A filtered but unregulated voltage considerably higher than the operating potential for the tube must be supplied to the regulator circuit. Operating voltages and currents for these three types are shown in the table below.

The VR tube is placed in series with a resistor R_s across the higher, unregulated voltage E1, and the regulated output E2. The load is connected in parallel with the regulator tube.

The total current I_T which flows through Rs consists of the load current I_L plus the regulator tube current I_V. R_s is chosen so that the total current causes a voltage drop across it equal to the difference between the d.c. applied voltage and the desired regulated output.

If the supply voltage increases, the voltage across the VR tube and the load begins to increase. However, a very small change in voltage across the VR tube produces a large change in current. This increase in current increases the voltage drop across R_s. The result is that the voltage across the tube and the load remains practically constant. This same reasoning applies to a decrease in supply voltage.

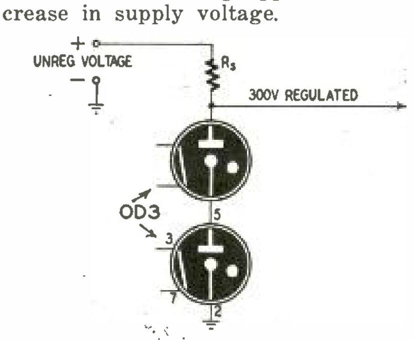


Fig. 2—A 300-volt VR regulated supply.

If the load current increases, it tends to reduce the voltage across the VR tube, due to the increased voltage drop across R_s. The tube responds by reducing its current flow so that the total current through R_s is virtually the same, with the result that the regulated voltage undergoes only a slight variation. If the load current decreases, the tube current then increases a corresponding amount.

The value of the series resistor R_s is found by dividing the current which flows through it into the voltage across the resistor. This voltage is equal to the difference between the unregulated d.c. voltage and the regulated d.c. voltage. In Fig. 1, this voltage is E1 minus E2. The current through the series resistor is taken to be the maximum rated current of the VR tube. In the following example, this is 40 ma.

Suppose it were desired to supply a regulated 150 volts to a small load. An OD3 would be placed in the circuit of Fig. 1. The unregulated supply voltage must exceed 160 volts to ionize the tube, and should be considerably higher to allow drop across R_s. If 250 volts were available, the required voltage drop across the series resistor would be 250 minus 150 volts, or 100 volts. The value of R_s is calculated by dividing 100 volts by 40 ma, resulting in 2,500 ohms. The power dissipation in the resistor is 100 volts multiplied by 40 ma, or 4 watts. A value at least twice as large as this would be used to allow a safety factor.

If the load current in this circuit is zero, the tube will draw 40 ma and the output voltage will be 150 volts. If the load current increases, the VR tube current will decrease correspondingly, maintaining a relatively constant output voltage. If the load current rises to 35 ma, the current through the VR tube will then be 5 ma, which is its minimum value. Therefore this circuit will provide regulation for any value of load current between zero and 35 ma.

Two or more voltage regulator tubes may be connected in series to provide higher values of output voltage as shown in Fig. 2.

A jumper within the tube is connected to two of the socket pins. The power supply may be wired so that removal of the VR tube will disconnect the load. This is an excellent safety and alarm device and should not be overlooked in circuits where application of unregulated voltage is undesirable.

Tube type	Operating voltage	Starting voltage	Supply voltage
OA3	75	100	105
OC3	105	115	133
OD3	150	160	185

Fundamentals of Radio Servicing

Part XV—The Power Output Stage

By JOHN T. FRYE

"Tinker to Evers to Chance!"

THAT hallowed phrase from the world of baseball is a classic description of split-second, three-way co-operation. In a radio receiver, though, we have another example of one-two-three team play that might well be paraphrased: "output stage to transformer to speaker."

Let us examine this trio, starting with that familiar member, the speaker. In the last chapter we learned that to make a speaker "work," we must have a varying current flowing through the voice coil. This voice coil cannot contain many turns of wire for two good reasons: first, there simply is not room for a large coil in the restricted space in which the voice coil moves, and this space cannot be increased without weakening the strong magnetic field needed in the air gap.

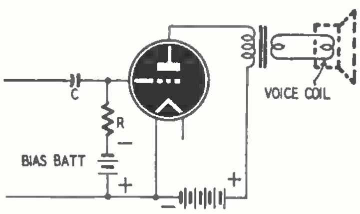


Fig. 1—A single triode output stage.

Second, more turns of wire would increase the inductance, and inductance is something we do *not* need in a voice coil. The reason is that inductive reactance—unlike pure resistance— plays favorites with frequencies, and it has low-down tastes. It will allow a low frequency to pass with comparatively little hinderance, but its opposition grows stronger and stronger as the frequency becomes higher and higher. Such partiality would mean that a speaker with a highly inductive voice coil would unduly accent some audio frequencies and play down others. The sounds coming from such a speaker would not be a true reproduction of the sound originally heard in the broadcasting studio.

Voice-coil inductances are like whiskers: we cannot get rid of them entirely, but we can keep them whittled down. The way to keep inductance small is simply to keep the number of turns low. Unfortunately this solution, like the solution of nearly every other problem in this wacky radio business, gives birth to a new problem. The strength of the magnetic field produced by currents in the voice coil depends on two things—the number of turns in the coil and the strength of the current. If we are going to have few turns, we are going to have to have lots of current. Heavy current means large wire. Large wire means low resistance—and that is what our voice coil has. You will soon see why this low resistance complicates coupling a speaker to the radio receiver.

Usually the d.c. resistance of a dynamic speaker voice coil lies somewhere between 1 and 20 ohms, the average being in the neighborhood of 5 ohms. The impedance of the coil—resistance plus inductive reactance—is roughly 25% higher than the pure resistance. For example, a voice coil that has 4 ohms of resistance will present approximately a 5-ohm impedance to a frequency of 400 cycles per second, this being the frequency at which voice coil impedances are usually measured. This is good, for the impedance of our coil consists chiefly of resistance and will present a fairly uniform impedance to all audio frequencies.

The output stage

Now let us go to the other end of this triple-play combination and consider the *output stage* of the receiver. By "stage" we mean a tube or combination of tubes, together with proper input and output circuits, that performs a single operation on the signal passing through the receiver. The output stage is the one that handles the signal just before it is delivered to the speaker. For the purpose of our study, we shall assume that our output stage consists of a single triode tube connected as shown in Fig. 1.

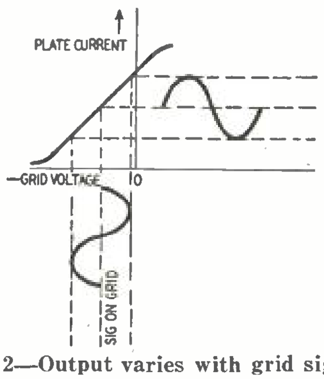


Fig. 2—Output varies with grid signal.

An alternating, audio-frequency voltage is delivered through capacitor C from the preceding stage to the grid of our output tube and appears across resistor R. This means that the alternating voltage is really in series with the fixed negative voltage that the bias battery delivers to the grid. Voltages in series can be added like positive and negative numbers in algebra. That means that when the audio voltage is on the negative half of the cycle, its value is added to the bias voltage and makes the grid more negative. During the positive half of the cycle, its value is subtracted from the negative bias voltage and the grid becomes less negative.

Fig. 2 shows what happens to the plate current while the grid voltage is waltzing around in this dizzy fashion. As might be predicted from our study of triode action, the plate current rises and falls right in step as the voltage on the grid becomes less and more negative. As is evident from Fig. 2, the pattern of the plate current is a reproduction of the audio voltage applied to the grid.

"Eureka!" you are probably shouting in your best Greek accent. "Here we have exactly what we need to make our speaker do its stuff: a varying current that follows curves better than a lastex suit! All we have to do now is to place our voice coil in the plate lead of the output tube and sit back and listen to the program rolling in loud and clear."

Not so fast, my friend! You are forgetting something—or several somethings. Remember we said few turns on the voice coil meant heavier currents—or rather excursions of current, for it is variation in current that makes our voice coil move back and forth. Well, the plate current swings of our triode are not likely to exceed 100 milliamperes, and that is far too small a current to get much action out of our speaker.

And there is another point. You will recall that when we talked about characteristics of vacuum tubes we found that every tube has a *plate resistance*. If we consider our output tube a generator of power—and it really is—this plate resistance reperesents the internal resistance of our generator. It is an easily demonstrated fact that a maximum transfer of energy takes place between a generator of power and the thing receiving the power when the "giver" exactly matches that of the "givee." (I'm haunted by the feeling that there is some sort of an analogy in there to a playboy trying to give a mink coat to a chorus girl, but I can't quite pin it down.)

To demonstrate this "easily demonstrated fact," suppose we consider Fig. 3. Here we have a 100-volt generator with an internal resistance Ri of 10 ohms and a variable external resistance Re that is used as the load. The table shows what happens to the current,

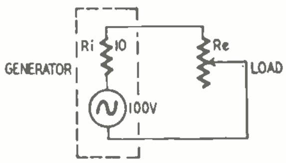


Fig. 3—Output varies as Re is changed.

I Re (Ohms)	II Current (Amperes)	III Voltage across Re	IV Power in Watts II×III
1	9.09	9.09	82.6
5	6.66	33.3	222.0
10	5	50.0	250.0
40	2	80.0	160.0
100	0.909	90.9	82.6

rent, the voltage drop across Re, and the power dissipated by Re as its resistance is set at various values. It is readily seen that the *maximum power* is delivered to the load when its resistance is 10 ohms, the same as the internal resistance of the generator. Either increasing or decreasing this load resistance results in a loss of power. You might also note, for future reference, that the *maximum voltage* across the load resistance does *not* appear at this point but goes up as the load resistance increases.

This is easy to see if you will consider that when Re is made smaller, the output voltage gets smaller, until Re gets to zero and there is no output voltage. With no output voltage there can't be any power because the power is equal to voltage × current.

Going the other way, if Re is made larger, the current keeps getting smaller until there isn't enough current to have any output power.

If our output tube is a 45 with 250 volts on the plate, its plate resistance is 1,610 ohms; and it will deliver the most power to a load in its plate circuit if the impedance of this load is also 1,610 ohms. But, when a tube is thus putting out its maximum amount of power, the plate current variations do not exactly follow the grid voltage current changes, and we have some *distortion* of the signal. (More about this distortion subject in the next chapter.)

This distortion can be reduced by increasing the load resistance to something more than twice the plate resistance. This means a reduction from the maximum power output of our tube, but the loss is so small the ear cannot detect it. For obtaining maximum "undistorted power output" from our 45 tube, the manufacturer recommends a load resistance of 3,900 ohms.

And now we see why the low resistance of our voice coil presents a problem. There is a lot of difference between the 3,900 ohms needed in series with our output tube's plate lead and the 5 ohms or so of impedance in our voice coil. If we placed the voice coil in the plate lead, practically no power would be delivered to the speaker. What we need is some dingus that will allow us to "match" the high plate resistance of the output tube to the low voice-coil impedance of the speaker in the same way that a plumber uses a reducing coupling when he wants to connect a large pipe and a small one together.

Output transformer

In discussing the transformer (October, 1949, issue of RADIO-ELECTRONICS), we said it provided a method of changing high voltage at low current into low voltage at high current. Suppose we place a transformer between the output tube and the speaker as is shown in Fig. 1. Let the primary winding placed in series with the plate lead consist of many turns of fine wire, while the secondary connecting across the voice coil is made up of a few turns of heavy wire.

A review of the transformer action story will help us understand exactly what takes place when an audio signal appears on the grid of the output tube. First, this causes the plate current to rise and fall. The surging of this varying current through the primary of the transformer sets up an expanding and contracting magnetic field that, in turn, produces an alternating current in the secondary winding. The flow of this current through the voice coil makes the cone move back and forth and produce sound from the loudspeaker.

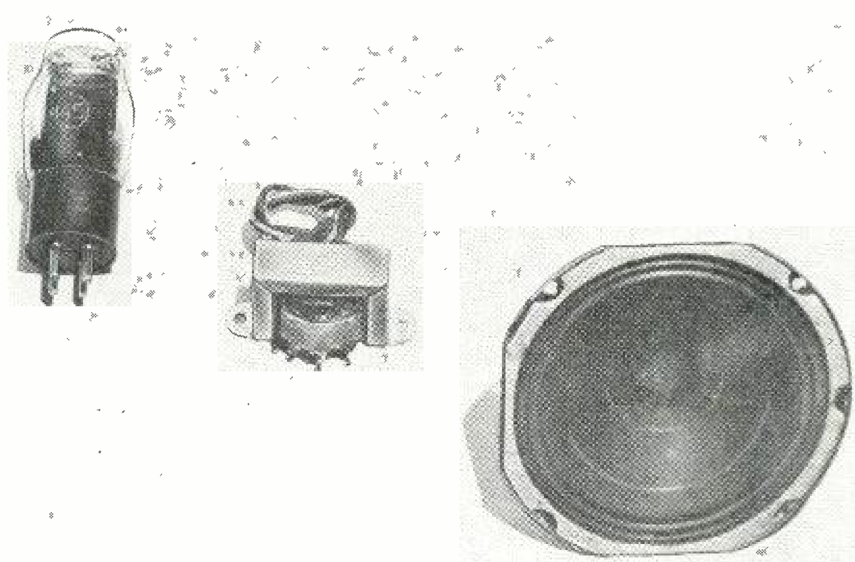
Because of the high inductance of the primary, a considerable voltage appears across this winding. Since our transformer is of the "step-down" type, much less voltage appears across the secondary, but the current in the secondary is accordingly much heavier than in the primary.

As explained before, when a low resistance is placed across the secondary of a transformer, the heavy current that this causes to flow in that winding produces a magnetic field that weakens the back-electromotive-force or impedance of the primary. If we increase the value of this load resistance and so reduce the current in the secondary, more "bucking voltage" is available to the primary and its impedance to the flow of a variable current rises. It follows then that we can make the primary impedance anything we wish simply by varying the load across the secondary. The whole thing works like a pair of long-bladed scissors in which a ¼-inch opening of the handles results in a couple of inches of separation of the points.

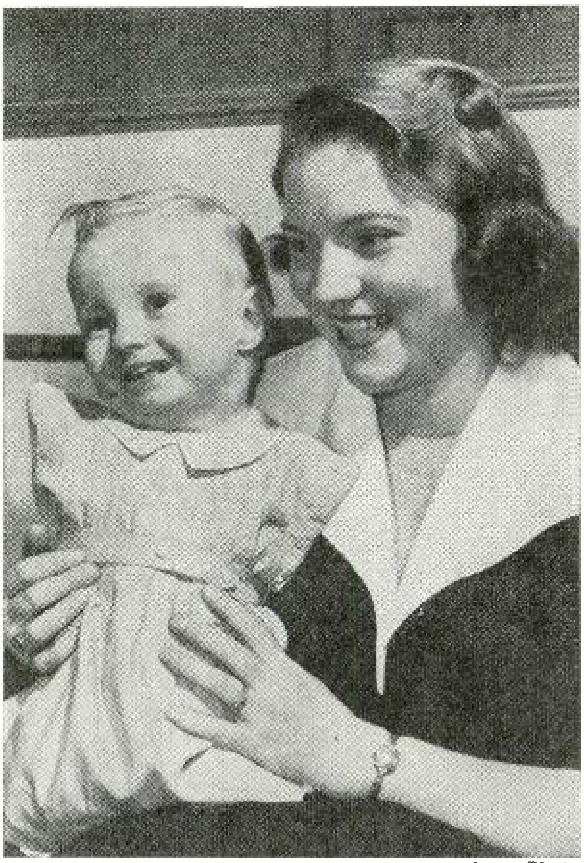
Just as the amount of control that the handles have over the blades of the shears depends upon the ratio of the lengths of these two elements, so does the effect of secondary load upon the primary impedance of our output transformer depend upon the ratio between the number of turns of wire on each of these two windings. This relationship has been neatly expressed in one of those formulas so dear to the heart of the engineer:

$$N = \sqrt{\frac{Zs}{Zp}}$$

In this formula N is the turns ratio, secondary to primary; Zs is the impedance of the load connected to the secondary; and Zp is the impedance presented by the primary. Let's see if we can use this simple-looking critter to



Three essentials of the output stage are tube, transformer, and loudspeaker.



Acme Photo

Service for FREDDIE

Freddie Thomason, 2-year-old son of a radio service technician, gives a big smile for his mom.

BORN without arms and legs is the extreme misfortune that befell Freddie, son of service technician Herschel Thomason of Arkansas. This unusual freak of nature is a continuous disaster for the parents. It will cost a fortune to equip Freddie with artificial arms and legs throughout the years.

With this issue we are putting Freddie's plight up to our readers and RADIO-ELECTRONICS is starting a collection for him. Every service technician knows full well how *he* would feel if such a terrible misfortune would befall his family.

As Freddie's father is a service technician himself, we trust that every reader of RADIO-ELECTRONICS will contribute handsomely to the "Help - Freddie - Walk-Fund."

The publisher of RADIO-ELECTRONICS has already sent out an appeal to the trade and we are happy to announce a number of contributions received up to the time we went to press.

No contribution is too small to help in this worthwhile effort to make the lot of Freddie's parents easier.

Make checks, money orders, etc., payable to Herschel Thomason and send remittances to:

Help-Freddie-Walk-Fund
% RADIO-ELECTRONICS
25 West Broadway
New York 7, N. Y.

Contributions received up to April 26:

Anonymous—Akron, Ohio	$25.00
S. B. Darmstader—Chicago, Ill.	10.00
De Forest's Training, Inc.—Chicago, Ill.	50.00
Allan W. Fritzsche, The General Industries Co.—Elyria, Ohio	50.00
Hugo Gernsback—New York	100.00
S. Gernsback—Chicago, Ill.	10.00
Charles Golenpaul, Aerovox Corp.—New Bedford, Mass.	5.00
W. S. Halligan—Hallicrafters, Inc., Chicago, Ill.	50.00
Heath Co.—Benton Harbor, Mich.	50.00
L. M. Heineman, Permoflux Corp.—Chicago, Ill.	5.00
National Union Radio Corporation—Newark, N. J.	50.00
National Radio Institute—Washington, D.C.	25.00
E. G. Perkins, Supreme, Inc.—Greenwood, Miss.	10.00
Mrs. Helen S. Quam, Quam-Nichols Company—Chicago, Ill.	5.00
Ray Sparrow, P. R. Mallory—Indianapolis, Ind.	10.00
Sprague Electric Company—North Adams, Mass.	100.00
Sprayberry Academy of Radio—Chicago, Ill.	25.00
Standard Transformer Corp.—Chicago, Ill.	10.00
Superior Instruments Company—New York, N. Y.	50.00
Supreme Publications—Chicago, Ill.	4.00
Telrex, Inc.—Asbury Park, N. J.	25.00
The Astatic Corp.—Conneaut, Ohio	10.00
The Muter Co.—Chicago, Ill.	50.00
University Loudspeakers, Inc.—White Plains, N. Y.	5.00
Weller Mfg. Co.—Easton, Pa.	20.00
Wholesale Radio Parts Co., Inc.—Baltimore, Md.	15.00
TOTAL	$769.00

FUNDAMENTALS OF RADIO SERVICING (*Continued from page 35*)

figure out the turns ratio needed:

Zs is 5 ohms; Zp is 3,900 ohms; so N must equal $\frac{\sqrt{5}}{3{,}900}$ or $\frac{\sqrt{1}}{780}$. Unless my slide rule has slipped, that means that our turns ratio will be just about 1/28. If our primary contains 280 turns, our secondary should have 10 turns.

In practical radio servicing it would be most inconvenient to have to obtain an exact duplicate unit for each output transformer replacement job, and it isn't necessary. "Universal" output transformers, of the type diagrammed in Fig. 4 are provided for this purpose. A tapped secondary allows you to have any turns ratio needed. Either the primary or the secondary *could* be tapped to secure the proper turns ratios needed for matching various output tubes to a wide variety of voice coils, but it is easier to tap the secondary.

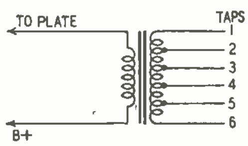


Fig. 4—Taps allow variety of matching.

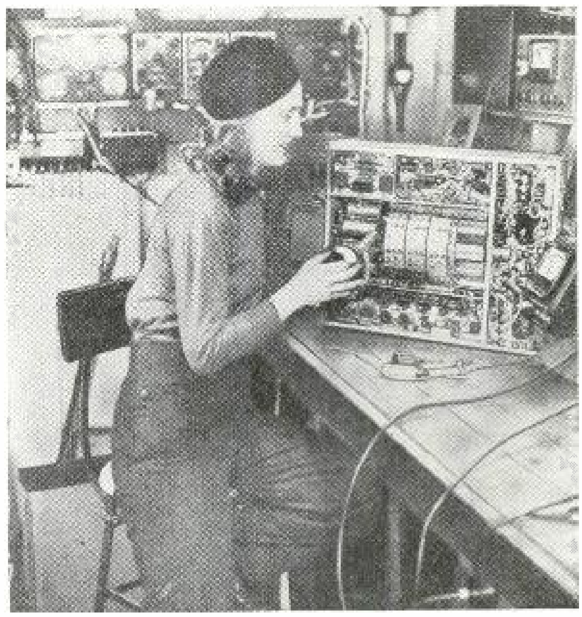
You do not have to use your adding machine, slide rule, or abacus to figure out just which taps to use for matching a certain tube to a certain voice coil. A chart furnished with the transformer tells exactly what taps are needed to do any job you may encounter. For example, one such chart shows that if a single 45 is connected across the primary, a 1-ohm voice coil should be connected across taps 5-6 of the secondary; a 6-ohm coil across taps 1-5; a 12-ohm coil across taps 1-6, etc.

If the proper match is not made, the quality of reproduction will suffer, although the average ear may not notice the distortion until the mismatch is quite serious. In general, the distortion will be worse if the tube is forced to work into a load that is below its plate resistance than if it works into a load that is higher than the recommended value. Usually the low frequencies are accented if the output tube is made to work into a too-high impedance, while the high frequencies are pushed up when the output impedance is too low.

Many output stages consist of two tubes working in a *push-pull* circuit, but this will be taken up in the next chapter in which we really delve into the *Care, Feeding, and Love-Life of the Audio Amplifier.*

Radio Repair For Aircraft

By MARGARET LATHAM*



The author checking frequencies in a set from a small aircraft.

PRIVATE aircraft radio servicing, one of the most fascinating branches of the radio field, is certainly not one of the easiest. The service technician must have a genuine interest in aircraft and the people who fly them, as well as a thorough knowledge of the principles of radio, because as often as not he is called upon to cancel his own personal plans to complete repairs on an aircraft radio.

In scheduled airline work "Sparks" gives the equipment an operational check and simply removes and replaces any defective unit, sending it to the shop for repair. The private operator seldom has stand-by equipment—it is necessary to service the set on the spot.

In our business at Newark Airport, we service aircraft of all sizes and all kinds. Our customers are divided into three main types: executive aircraft, non-scheduled air carriers, and small private planes.

The average executive aircraft—an airplane owned and operated by a corporation head or a bank president—usually has the very best of radio equipment. It carries a 50- or 100-watt m.h.f. transceiver, often equipped with radio-telephone channels; a range receiver; one or two automatic direction finders; a marker beacon receiver; two-way v.h.f. equipment; and either a blind landing system or complete omnidirectional equipment. The audios from the various sets are selected by toggle switches on a control panel, and every set is controlled from the cockpit.

We have built mock-ups of all the more popular types of radio equipment used in aircraft so that we may properly bench check sets. Our customers often have a definite schedule to follow, and we have a limited time to service the radio. Normal procedure is to remove the equipment from the aircraft and completely bench check. If the set functions normally, we must then check the various circuits in the aircraft itself.

Often intermittent conditions show up only at given speeds in flight. One of our very good customers kept complaining of a ticking noise in his range receiver. We gave the set an exhaustive bench check—traced and checked every connection in every junction box and on every antenna fitting. Still the noise persisted. Finally, we checked the radios with the engines running, and found a vibrating shackle on an antenna support. Securely bonding the shackle to ground eliminated the noise. Although the support was not actually a part of the antenna, the receiver was so sensitive that it picked up the noise.

Sometimes radio trouble is definitely pilot error. We made a routine preflight check on a carrier one afternoon, and found everything satisfactory. The plane was scheduled to depart at eleven that night. The weather was very bad, with snow and cold. About ten-thirty in the evening, we were called to rush to the airport—the radio on the aircraft was out of commission and the flight couldn't depart until it was working. We wondered what could have gone wrong as we dashed back to the hangar. But the trouble wasn't too hard to locate—the transmitter was in a constant keyed position, throwing the antenna relay to the transmitter so that the receiver appeared not to be working. The manual key on the transmitter control was screwed down securely, and as soon as we released it the equipment functioned satisfactorily. Sometime much later, the pilot admitted to us that he had screwed the key down, hoping the flight would be cancelled because of radio failure, and he could stay home.

Installation problems

Private operators like ourselves usually do a lot of installation of new radios. This kind of work calls for a great many more skills than merely a knowledge of radio. To begin with, an aircraft is a very carefully balanced device, divided into two "arms" by a central point or "datum line", and any added equipment must be carefully checked as to weight and distance on the arm, and whether the craft can "carry" the addition. Then a shelf or shelves must be fabricated for mounting the equipment. External antennas must be attached in a manner which will meet CAA approval.

All cables must be attached to the connectors carefully, every soldered joint made so that it will stand up under constant vibration. Wiring must be run so that it will not be subjected to any rubbing that may damage the insulation, and so that it will not interfere with any control cables. Most executive aircraft have a very "plush" interior, and all wiring must go out of sight behind the upholstery. It often takes hours to remove and replace trim to complete a job that ordinarily would take minutes.

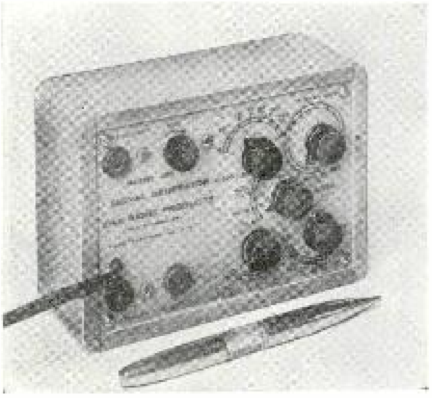
A special job

One of the most ticklish installations we ever had was a pleasure radio installed in the cabin for the entertainment of the passengers. We selected a small receiver designed for light aircraft, which usually performs very well as a cabin radio. Speaker and receiver were mounted on the inner side of the doors of an ornate wooden cabinet, so that the interior of the cabinet could still be utilized for glasses and bottles. The doors required a lot of special woodwork to make the installation blend with the aircraft interior. However, the cabin was so effectively sound-proofed that, potent as the receiver was, the volume was not sufficient to carry properly in the "dead" cabin. We had to redesign the audio section of the receiver and build an additional amplifier stage before the set could be heard.

*Beane Radio Service, Newark Airport, Newark, N. J.

Set and Service Review

Useful testers for outside servicing



Model 103 is less than six inches long.

THE lack of truly portable signal generators and allied test equipment has been a major drawback to TV servicing and troubleshooting in the field. Smaller than most multimeters are the new Oak Ridge model 103 and 104 signal generators which were developed for signal tracing in the customer's home and facilitate on-the-spot servicing.

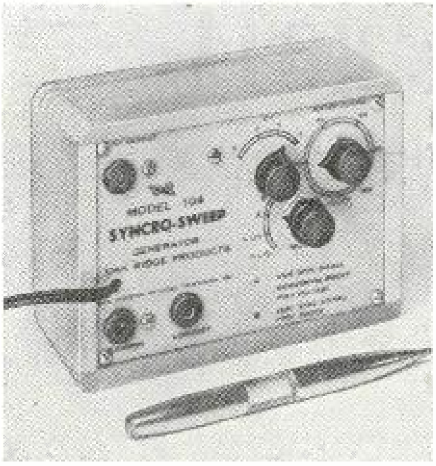
The model 103 generates modulated or unmodulated signals at TV video and sound carrier frequencies, at FM carrier frequencies, at TV sound and picture intermediate frequencies, and supplies a 500-cycle note for testing a.f. systems of FM and TV receivers.

A diagram of the 103 is shown. The circuit consists of a 6C4 operating as a grounded-plate oscillator on bands A, B, and C, and a Hartley oscillator on band D; and a 6J6 multivibrator-type a.f. oscillator. When it is turned on by opening the switch across one of its grid resistors, the r.f. oscillator is modulated by the 500-cycle signal which is also available at the AUDIO-VIDEO output jack.

Bands A, B, and C have separate tuning controls. Band A tunes from 55 to 83 mc and C tunes from 84 to 109 mc. The fundamentals of A and C cover the low TV and FM bands respectively. The second harmonics of C tune across the high TV band. Band A is marked with settings for the sound carrier frequencies of channels 2, 3, 4, and 5; and C is calibrated in megacycles and has settings for sound carrier frequencies of the high-band TV stations. Band B tunes from 20 to 28 mc. The fundamental and second harmonic are used when working with video and sound i.f.'s between 20 and 28, and 40 and 56 mc.

When the SELECTOR switch is on AUDIO-VIDEO, the 6C4 is converted to a Hartley oscillator fixed at 4.5 mc. Its signal is used to check the sound i.f.'s of intercarrier receivers, video amplifiers, and 4.5-mc traps.

Signals from the 103 make it easy to locate a defective stage in a TV receiver by signal injection. To check the front-end of a TV or FM receiver,



The Syncro-Sweep is a twin to the 103.

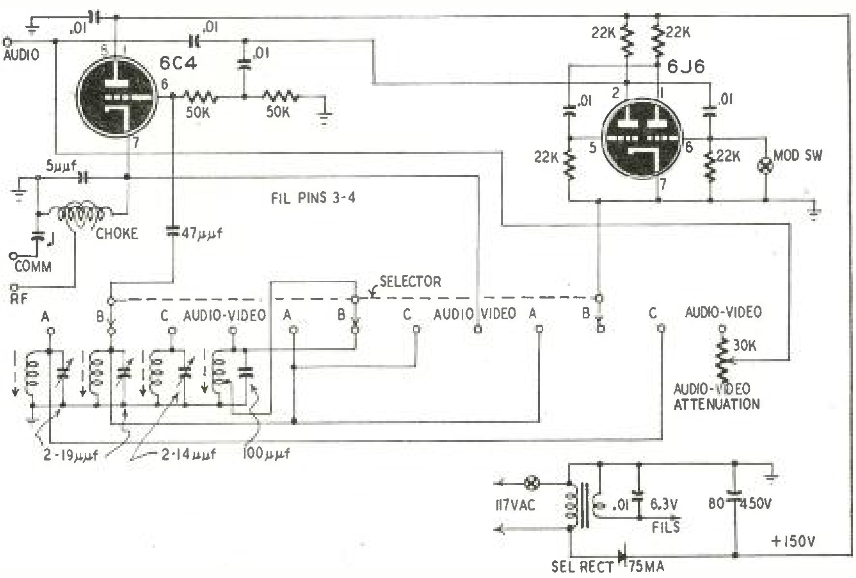
set the generator to deliver a modulated signal at the TV sound or FM broadcast frequency. Connect the test leads to the RF OUTPUT and COMMON jacks. Allow the r.f. output lead to lay near the receiver, or clip it to the lead-in or to the receiver antenna terminals and clip the common lead to the receiver chassis. The connection depends on the strength of the desired test signal. If the 500-cycle note is heard, it indicates that the set is operating OK from antenna to speaker. When testing a TV set, rotate the generator's frequency control to a point approximately halfway between the desired channel and the channel below it. Bars on the screen indicate that the set is working properly from antenna to the C-R tube.

If no signal is seen or heard, check the high-frequency oscillator. Set the receiver and generator to a specific channel. Turn off the modulation, clip the r.f. test lead to the mixer grid and tune the generator toward the next higher channel until you can tune in a station by tuning the generator. If a station comes in, the receiver's oscillator is defective.

I.f. amplifiers are checked by applying a modulated signal to the plate of the mixer and tuning the generator to the intermediate frequency. The presence of bars on the picture or sound from the speaker indicates that the video, i.f., and a.f. amplifiers are working properly. If sound or video is missing, advance the r.f. lead to grid then plate of successive audio or video i.f. amplifiers until the signal comes through. This procedure is the same as when testing AM receivers by signal injection—the only difference being in the injected frequencies.

Video and a.f. amplifier stages are checked applying 4.5-mc or 500-cycle signals from the AUDIO-VIDEO jack to the grid of the first amplifier and looking or listening for the signal in the output. The AUDIO-VIDEO attenuator should be set for maximum output during these tests. If the signal is not evident, advance the test lead to each plate and grid right up to the speaker or C-R tube.

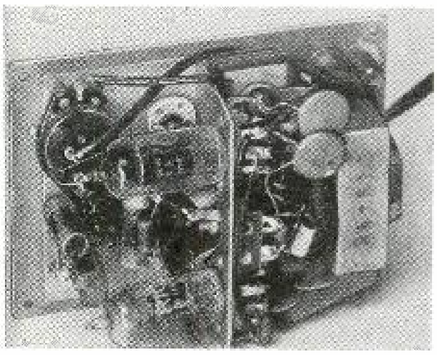
If the signal is not reproduced when fed into the plate of the last i.f. stage



Schematic of the 103 multi-signal generator for television and FM testing.

but can be fed through the video or a. f. amplifiers, the trouble is in the FM or video detector circuits.

Adjust sound traps in the video i.f. amplifier by turning the contrast and volume controls to maximum and feeding the modulated signal into the mixer



Behind-the-scenes photo of model 103.

plate. Adjust the tuning control of band B for maximum sound output. If the sound traps are detuned, bars will appear on the raster. Tune the sound traps for minimum intensity of the bars. Note the generator setting which produces the maximum sound from the receiver. Tune the generator 6 mc higher and adjust the adjacent-channel traps so the bars are reduced to minimum.

The Syncro-Sweep

The model 104 Syncro-Sweep generator is designed for checking the horizontal and vertical deflection circuits. It contains an r.f. oscillator tunable between channels 2 and 5 and a modulator which supplies frequencies several times the horizontal and vertical sweep rates to generate bars used when adjusting the set's linearity, size, and position controls. The number of vertical bars is variable between five and nine and the horizontal bars between seven and fifteen.

The r.f. oscillator can be modulated with sync signals which are used to check the sync circuits in the receiver. The modulating signals are available as sawtooth voltages at a separate output terminal.

If the set does not produce a raster, the sawtooth waveforms may be injected into the deflection and output circuits to produce one. In sets having fly-back high-voltage supplies, the high-voltage fails when the horizontal oscillator or any of the horizontal deflection circuits fail. The faulty circuit is located by injecting the sawtooth into horizontal grid and plate circuits until high voltage appears.

When these instruments are used with a multimeter and tube tester, it is possible to isolate the trouble in a receiver without returning it to the service shop. In many cases, the trouble is caused by a capacitor or resistor which can be replaced on the spot. Without such equipment, it would be necessary to take the set to the shop in order to locate a faulty component which could have been spotted and replaced in the field.

Philco Service Hints

By HARRY ASHBY

INFORMATION in this article will enable you to improve the performance of many 1948-49 models of Philco television receivers. Also included are service hints which should be beneficial to anyone servicing these receivers.

One of the difficulties encountered, especially in weak-signal areas, is drift. This is due to failure of the a.f.c. to overcome the combination of oscillator and discriminator drift. You have this trouble if you have to readjust the oscillator coil continually.

Discriminator drift can be reduced considerably by installing a new-type discriminator transformer, available from Philco as part No. 32-4317. After the transformer has been installed, change the discriminator balancing choke to a 47-ohm resistor. The 5-μμf capacitor from the second sound i.f. plate to ground should also be removed.

To reduce oscillator drift, the oscillator grid-tank capacitor should be replaced with a special capacitor of the proper temperature coefficient, available as part No. 30-1224-51. This capacitor should not be changed, however, unless the new-type discriminator is installed. After making the changes, allow the set to warm up for 15 or 20 minutes before making any adjustments.

If you have had the above trouble, no doubt you have made several adjustments on the oscillator coils, especially on the higher channels. Since the adjustment screws on the oscillator coils are brass, several adjustments will cause the threads to wear, resulting in a loose fit. Unless this is corrected, the set will still get out of adjustment due to turning of the channel selector. The continual turning from channel to channel will cause the screw to loosen of its own accord. Tension on the screw can be increased in several ways.

Fig. 1 is a drawing of the oscillator coil with its adjustment screw. To increase tension, remove the coil from the turret by depressing the spring clip at the rear of the coil and lifting out. If the coil does not come out freely, it may be necessary to turn the adjusting screw in a few turns until it clears the front of turret. After removing the coil, note the position of the screw and then turn it all the way out.

Apply solder to the threads. When the screw is entirely coated, remove the soldering iron and shake off the excess solder. Turn the screw back to where it was. Take a short length of wire, approximately No. 20, and solder one end to the front of the coil at point A, as indicated in Fig. 1. Run the wire up and around the screw and pull it fairly tight. Solder the other end of the wire to point B. These two things will keep the screw tight and eliminate some return service calls. After the coil is reinserted in the turret, make the final adjustment after the set has warmed up.

The current models of Philco television have wire clips already attached to the coil to help hold the screw in place. If a new model is available, simply remove the clip from the oscillator coil of an unused channel and place it on the one that is loose.

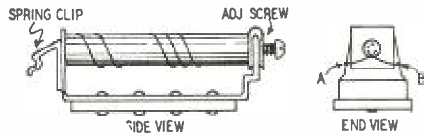


Fig. 1—The coil and adjusting screw.

Another method which is quicker but not quite as effective is to remove the coil and turn the screw out a few turns. Then apply a small amount of fast-drying cement to the threads. Quickly reinsert the coil and make the adjustment before the cement sets. Be sure the set has been on for 15 or 20 minutes *before* doing this, as no adjustment can be made after the cement hardens.

Fine tuning

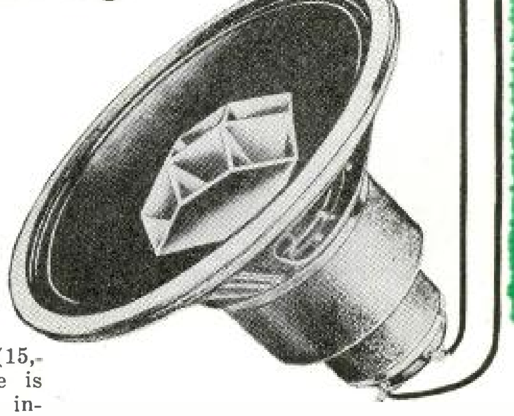
Another improvement which can be made in Philco television receivers is the addition of a channel adjuster or fine tuner. It is particularly suitable for weak-signal areas. The channel adjuster is so constructed so that it makes full use of the a.f.c. incorporated in the receiver. The kit includes a dual potentiometer with on-off switch, necessary components, and complete instructions. Installation consists of removing the contrast control and replacing it with the dual potentiometer, one section of which is reconnected for use as the contrast control. The other section is used as the fine tuner. On a weak signal the on-off switch on the potentiometer is turned on and the station is tuned in manually. On strong signals, the switch is turned off and full use is made of the automatic tuning. This kit, available for all 1949 Philco television receivers, is ordered as part No. 45-1659. For the Philco model 48-700, the part number is 45-1653. For the 48-1000, 48-1001, 48-1050, and the 48-2500, the part number is 45-1654.

Dirty contacts on the oscillator and the antenna-r.f. coils also give rise to trouble but that is easily remedied by removing both coils and cleaning them lightly. Go over the contacts with fine No. 400-A emery paper. If the contacts on the coil are badly worn, the complete coil should be replaced.

Acknowledgment is made to the *Philco Service and Accessory Merchandiser*, in which many of the procedures described above are described.

CONNECTING LOUDSPEAKERS

Know-how on a subject that has puzzled many



By **MELVIN C. SPRINKLE**

An audio amplifier is like a mule—if you don't hitch him to a load, he won't do any work. An audio amplifier is useless unless connected to a load, which is usually one or more loudspeakers. As in the case of a mule, unless the load is properly connected, results are unsatisfactory.

When only one loudspeaker is used with an amplifier, correct connection is relatively simple. The speaker is connected to the amplifier output tap whose impedance as marked most nearly approaches the speaker impedance. Even this simple operation, however, may be beset with problems if the speaker is located far from the amplifier.

When a number of loudspeakers are operated from an amplifier, as in a large sound system, and the power fed to each speaker is different, the fun starts! This article is intended to present a few simple rules to help the sound technician to do a properly engineered job with preassured results.

The term "transmission line" brings to mind high mathematics, nepers, and surge impedance, especially if associated with television. In audio, things are simpler. An audio transmission line is just a pair of wires that connect one audio device to another, as, for example, an amplifier to its loudspeakers. Surge impedance, propagation constant, etc., don't bother us until the line gets pretty long, say a good fraction of a wavelength. At audio frequencies (15,000 cycles) a ¼-wavelength line is some 3 *miles* long, and the length increases as the frequency gets lower.

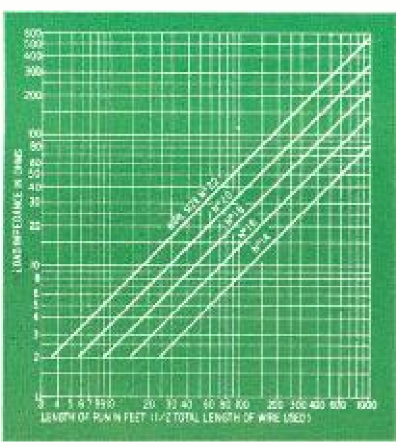


Fig. 1—Chart of maximum line length for given wire size and line impedance.

Two things plague the audio man: conductor resistance and shunt capacitance. The former causes power losses as heat and the latter limits high-frequency performance. Their effects depend on the line impedance.

The impedance of a line is the nominal value (magnitude) of the impedance across the receiving end of that line. The definition is so stated because in high-quality audio amplifiers, the source impedance, looking back into the amplifier, may be but a fraction of the load impedance. Thus the *same* pair of wires can be a 4-ohm line, a 16-ohm line, or a 500-ohm line, depending on the load.

Selecting a speaker line

All conductors have resistance. Accordingly, when current flows in the line, there is a loss of power, the energy being converted into heat. Resistance losses—or copper losses as they are sometimes called—may be minimized by using larger diameter conductors and by making the line as short as possible. Copper losses are most important on low-impedance (16 ohms or less) lines since the lower the impedance, the more current flows for a given power, and there is greater I^2R power loss as heat.

Commercial sound engineers usually like to use the smallest possible wire size because the smaller sizes are less expensive and are easier to install and conceal in existing buildings. The smaller the wire size, the greater the resistance per foot and the greater the power loss, so a compromise must be made. Sound engineers allow 0.25-db loss (about 5% power loss) in the wiring to speakers.

To eliminate calculations, Fig. 1 has been prepared to show the maximum length of line which can be used for various line impedances and wire sizes. The chart is simple to use. For example, a single 16-ohm loudspeaker can be connected to an amplifier with No. 18 wire and can be *any* distance up to 75 feet from the amplifier. For No. 14 gage, the distance may be up to 190 feet.

Three conditions may occur when using the chart:

1. If the point of intersection of the line length and load impedance falls *above* the line labeled No. 22 gage, No. 22 wire or any *larger* size may be used. Smaller wires are not recommended.
2. If the point falls *between* two curves for wire size, the *larger* size should be used.
3. If the point falls *below* the curve for No. 14 wire, the load impedance is unreasonably low for the length of line required and matching transformers to make the line impedance higher must be used. This point will be considered a little later.

Multiple speaker installations

Installing a single loudspeaker involves no problems since its impedance may be used directly in finding the wire size from the chart. When two or more loudspeakers are used, there are two methods of connection: series and parallel. The series connection is often attractive but is not recommended except as an emergency measure. There are two reasons for this: the series connection is unreliable because if one speaker fails the entire series group is silenced. At some frequency a loudspeaker goes through cone resonance and its impedance becomes much greater than its nominal impedance value. Where several speakers are used, especially several makes or several sizes, their resonant frequencies may be different. When one speaker in a series string goes through resonance, the sound volume from the others changes. This effect can be very annoying, and is almost entirely absent in parallel-connected speakers.

Fig. 2—One speaker on a 500-ohm line.

When two or more speakers are connected in parallel, their impedances are combined in the same way as parallel resistances. The *equivalent* impedance of the total speaker system is used in the line chart, Fig. 1, in the same way as that of one speaker. The group is

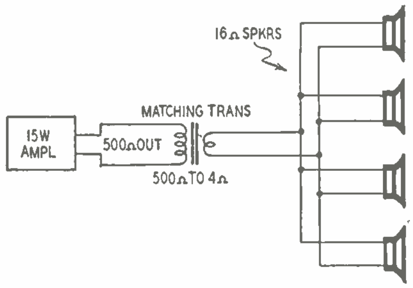


Fig. 3—Power per speaker is 3.75 watts.

connected to the amplifier tap which corresponds to the *equivalent* impedance of the system. If an exact tap is not available, connect to the next *lower* amplifier output tap.

Assume that we have three speakers, each with a voice coil impedance of 16 ohms, and that the group is to be 30 feet from the amplifier. The equivalent impedance of the speaker load is 16/3 or 5⅓ ohms. On the chart the point of

runs or big wire or both. The best method is to use equal impedance and power distribution for these voice coil lines, and keep the line impedance 4 ohms or higher.

Matching transformers

In discussing the speaker line chart, Fig. 1, it was pointed out that in some cases the length of line is great for the load impedance, and the line loss is greater than 0.25 db unless very heavy conductors are used. For such cases we borrow a trick from the power engineers who deal with power transmissions over long distances. The power boys get around the problem of line loss by stepping up the voltage at the sending end and stepping it down at the receiving end.

Audio engineers use a similar stunt with an output transformer at the amplifier that has a different turns ratio (gives higher voltage) than those ordinarily used with voice coils. Sometimes both voice coil and line impedances are present on the output taps. The usual line impedance is 500 ohms although 250 and 125 ohms are used. Broadcast engineers usually use 600 ohms as a line impedance because tele-

step 2 by the power desired in the first speaker or group of speakers. This quotient is the primary impedance of the matching transformer for the speaker(s).

4. Repeat step 3 for each speaker or group of speakers.

Some typical cases

The use of the rule is best shown by examples of several types of matching situations.

Fig. 2 shows a single speaker fed by a 15-watt amplifier through a 500-ohm line. The power capacity of the speaker is 30 watts and its nominal impedance is 16 ohms. Here the limiting factor is amplifier power and we proceed to step 2: 15 x 500 is 7500. Dividing by 15 (as all the power goes to the one speaker) gives us 500 ohms as the correct primary impedance for the matching transformer. The secondary impedance is 16 ohms.

Had there been four speakers to be fed from one transformer, the primary impedance would have been the same, but the secondary would be set for four ohms. In this case the total power for the group is still 15 watts (used in step 3) but the power per speaker is 15/4 or 3.75 watts. The case is shown in Fig. 3.

Fig. 4 shows four speakers strung along a 500-ohm line. If there is considerable separation between speakers, it is best to use a separate matching transformer at each speaker. Let us say that we have a 20-watt amplifier

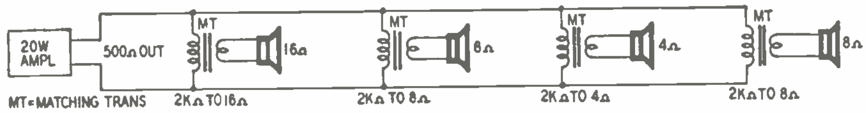


Fig. 4—Each speaker needs a matching transformer if the lines are long.

intersection of 5 ohms and 30 feet falls between the curves for No. 18 and No. 16 wire. Thus No. 16 wire is the smallest wire that can be used.

The speaker line should be connected to a 5-ohm tap, but most amplifiers do not have a 5-ohm tap, so the line should be connected to the 4-ohm tap, a common value. The reason for using a lower tap is that an output transformer reflects to its primary an impedance which is the load for the output stage. Connecting a slightly higher load to a tap, as in this case, causes the reflected impedance to be higher in the same proportion, which is better for an amplifier than having a slightly lower load.

When several speakers have their voice coils in parallel, the impedance of each voice coil should be the same. Any parallel system is a constant-voltage system and the voltage across each speaker is the same. Each speaker will draw the same power, and, assuming equal efficiency, will deliver the same sound level.

If several values of impedance are used in parallel, as two speakers of 8 ohms and one of 4 ohms, each 8-ohm speaker draws only half the power of the 4-ohm speaker. This unequal power distribution may be useful at times to provide different power levels in speakers. However, unequal amounts of power distribution are best distributed with matching transformers and higher impedance lines. Parallel combinations often give nasty combinations of impedances; the line impedance gets below 4 ohms and that makes for short

phone lines (used for low levels only) have about 600 ohms characteristic impedance.

Impendances greater than 500 ohms are not used because shunt capacitance in long lines causes rolloff in response at the higher audio frequencies. When using a 500-ohm line, a matching transformer is used at each speaker (or group of speakers) to step down the line voltage to values suitable for voice coils. The speaker matching transformer reflects the voice coil impedance to 500 ohms (or other value depending on the line impedance).

This fundamental axiom is often overlooked, but should be stated for the sake of completeness. The rated power of the speaker or speakers should be at least equal to the rated power output of the amplifier; and the rated power of the amplifier should be equal to the total power desired in the speakers. The first proposition assures that the speakers will not be overloaded, and the second that they will provide adequate sound. Not all amplifiers will put out their rated power even at midrange frequencies, but following this simple rule and using good amplifiers will assure success.

In laying out a 500-ohm distribution system one rule covers all cases of equal or unequal power distribution:

1. Determine the power to be fed to each speaker or group of speakers.

2. Select an amplifier capable of this power, and multiply the amplifier power by the desired line impedance.

3. Divide the number obtained in

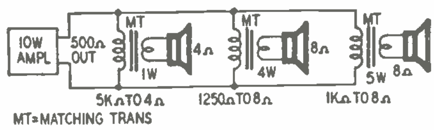


Fig. 5—If power distribution is unequal, each speaker needs transformer.

and the desired power per speaker is 5 watts. The rated power of each speaker being 10 watts, we are safe. In step 2: 20 x 500 is 10,000. In step 3: we divide 10,000 by 5, giving us 2,000 ohms as the primary impedance for each transformer. Since each speaker has the same power, we need calculate but once. The secondary of each matching transformer is set to the impedance of each voice coil which need not be the same for all speakers.

Let us proceed to a problem shown in Fig. 5 where we have unequal power distribution. A 10-watt amplifier with 500-ohm output is to feed three speakers. The first is to be fed 1 watt, the second 4 watts and the third 5 watts. For this type of circuit each speaker must be equipped with a matching transformer even though they are near each other. In step 2 we multiply 500 x 10 to get 5,000. Dividing by 1 in step 3 gives us 5,000 ohms for the primary impedance of the matching transformer for the first speaker. The secondary is set for the correct voice coil impedance. For the second speaker, (step 4), we divide 5,000 by 4 to get 1,250 ohms for the matching trans-

(*Continued on page* 42) ▶

Automatic Intercom Switch

By E. AISBERG*

ONE of the greatest inconveniences of practically all intercommunicators is the necessity of switching from "talk" to "listen" and back again, as the conversation changes. The "talk-listen" switch

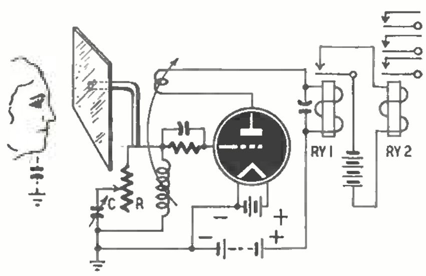
Body capacitance switches the intercom.

is almost invariably on the speaker, connecting it either to the input of the amplifier, where it acts as a microphone, or—when the set is acting as a receiver—to the output in its own proper character of speaker.

At the recent radio exhibition at Brussels, we saw an intercom with an automatic switching which was exceptionally ingenious and absolutely reliable. The equipment looked like a normal intercom, with the exception that a curved arm supporting a plate of chromium-plated copper rose out of the cabinet. (See photo.)

When the person using the apparatus moves his head toward the plate (without touching it, of course), the interphone automatically assumes the "talk" position. Drawing the head away turns it to "listen." The important point is that the movement of the head toward the intercom as one begins to speak is entirely instinctive. One can use this intercom without any practice and without risk of error.

Any radioman will have guessed that the unit is capacitance-actuated. The capacitance between the head and the metal plate is, as the schematic reveals, in parallel with that of a variable capacitor C, which tunes an oscillating circuit in the plate circuit of which there is a sensitive relay RY1. The capacitor C is adjusted to the point where the least increase in capacitance will cause the circuit to stop oscillating. A small variable resistor R (variable from zero to 50 or 100 ohms) reduces

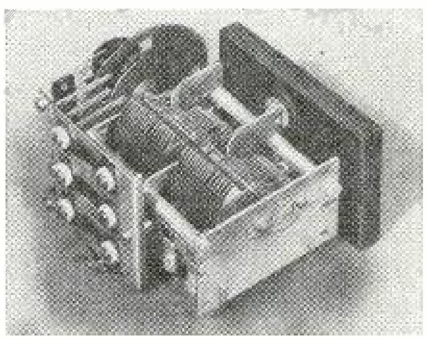


Oscillation stops at approach of head.

the Q of the circuit to render the adjustment uncritical. Now the least increase in capacitance—such as might be caused by the user's head approaching the metal plate—stops the oscillations. The tube's plate current stops and the relay is thrown to "talk." In the Brussels equipment a second relay RY2 operating on a low-voltage battery, operated the "talk-listen" switch.

The idea of a capacitive relay is by no means new, but its use in an intercom is a particularly happy and rather a novel application.

Another interesting new idea (seen at the French Radio Parts Exhibition in Paris,) was a variable capacitor with automatic bandspread. The slotted metal disc just behind the dial switches three semifixed padders into the circuit. Most of the capacitance normally required for a given band is contained in the padder, making it possible to have bandspread on three bands without any other switching. Each band covers approximately 60 degrees on the dial. The padders are connected successively in parallel for lower frequen-



The slotted disc switches in padders.

cies as the capacitor meshes; thus either international shortwave (such as the popular 25, 31, and 49-meter combination), amateur, or other bands can be received by proper adjustment of each padding capacitor.

* Editor, *Toute la Radio*, Paris.

▶ CONNECTING LOUDSPEAKERS

(*Continued from page* 41)

former primary. Repeating for the third speaker we get 1000 ohms as the impedance for the third matching transformer. To check the calculations, we can combine the three impedances as parallel resistors. We get 500 ohms, which show that we have a matched system.

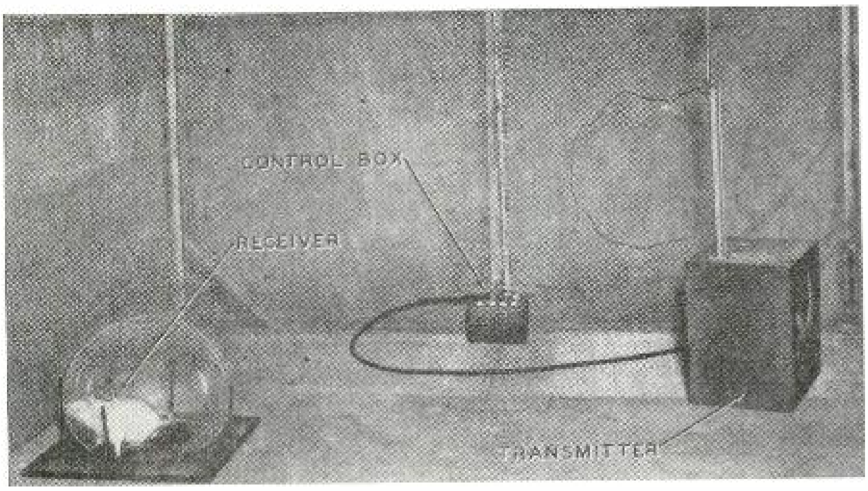
The 500-ohm line is not a sacred cow. Lower impedances such as 250 ohms will work equally well if larger wires are used for runs over 400 feet. This information is obtained from Fig. 1. A lower impedance sometimes may be required. For high power amplifiers with many speakers the required primary impedance of some of the matching transformers may be greater than 10,000 ohms. In this case the line impedance should be lowered to say 250 ohms, as high quality matching transformers are generally not made with primary impedances higher than 10,000 ohms.

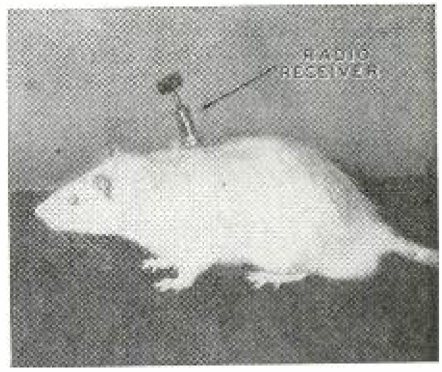
If there are several speakers to be fed from a single matching transformer, the speakers need not be adjacent to each other. For example, one of the speakers of Fig. 3 could be up to 30 feet from the matching transformer, if it is connected with No. 16 gage wire or larger. Fig. 1 should be consulted to find out if such a scheme (which reduces cost because wire is cheaper than good matching transformers) is practicable.

The maximum recommended length for speaker lines, even at 500 ohms, is 1,000 feet. One reason is that the shunt capacitance in a 1,000-foot line may build up to the point where it is severe restriction on quality. In high-fidelity work loss of high frequencies is disastrous. In public address work loss of high frequencies causes a reduction in intelligibility and a decrease in the usefulness of the system.

Another reason is power loss. If kept to 0.25 db, that is a 10% power loss. In a 50-watt system it means 5 watts lost. The cost per watt in amplifiers is high, so losses mean money. If a speaker line must be run much over 1,000 feet, it is better to put a booster power amplifier nearer the speakers and feed it on a 500-ohm line at lower power level where a 10% loss means fewer watts. Such a scheme permits equalization to counteract loss of high frequencies. Speaker lines *can* be run over 1,000 feet if the limitations are known and efforts are made to minimize their effects.

In another article, we will cover the new RMA standard 70-volt distribution system, high-fidelity speaker connections and selection of matching transformers.





Interior of shielded cage showing the transmitter. Rat is kept under Lucite bubble during field strength tests.

Radio Pulses Control Rats

By VERNE KALLEJIAN and J. A. GENGERELLI

THE relative lack of knowledge about the functioning of the central nervous system is due in part to the enormous complexity of the system on the one hand, and to a lack of adequate methods with which to study it in the intact organism on the other. Many investigators have been hampered by the lack of a technique which would permit the controlled stimulation of a normal healthy unencumbered animal while it was actually in the process of performing normal functions, such as learning, problem solving, eating, etc. For the psychologist who is studying the learning process the problem is one of stimulating some portion of the brain of an animal with a controlled stimulus, while it is in a learning situation.

Learning is assumed to be associated with complex physical changes within the central nervous system, in particular the brain, and some of these changes are brought about by electrical impulses which are sent to the brain from the receptorial system of the animal. The characteristics of the impulses which might account for these changes are the frequency, pulse duration, intensity and wave form.

If this is true it might be possible to test this and other hypotheses if a technique could be devised which permits the systematic variation of these variables in stimulating different portions of the brain of an animal in controlled situations.

The radio equipped rat is an attempt to solve this problem. The laboratory animal becomes a mobile receiving station with the output of a receiver coupled to his brain.

The receiver shown schematically in Fig. 1 is a small crystal detector built in two parts. The receiver mounting (Fig. 2a) which the rat carries with him at all times is a silver frame (⅞ x ¼ inches) surgically mounted under his skin on the back of his neck so that the threaded stub protrudes about one-half inch above his back. This stub is fitted with a small hole in its center which accommodates the insulated lead from the electrode. This lead terminates at the top of the stub in a solder bubble. The bubble is insulated from the stub by a lucite washer.

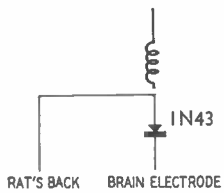
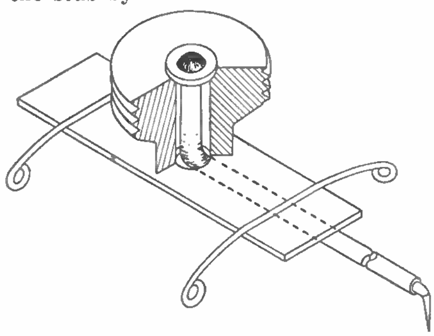


Fig. 1—Schematic diagram of receiver.

The needle electrode is inserted into the brain so that the exposed tip makes contact with the desired cortical area. Within a few days after the operation the animal recovers completely with no apparent ill-effects and it is impossible to distinguish him from other laboratory animals except for the small stub protruding from his back.

The receiver (Fig. 2b) is a plastic cylinder about three-fourths an inch long which holds the 400A (1N43) crystal. It has a threaded magnesium sleeve on the bottom and a small threaded pin on the top which contacts the crystal on the inside of the cylinder. The antenna is coupled to the top of this pin.

When the holder is screwed onto the mounting stub on the rat, one leg of the circuit is from the antenna to the sleeve, to the stub which is part of the mounting attached to the animal's body. The other leg is from the exposed end of the crystal to the bubble of solder in the center of the stub along the wire to the electrode in the brain. The return circuit is through the body of the animal. The receiver unit can thus be removed when the animals are in



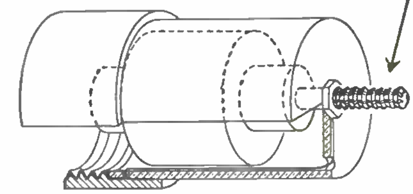


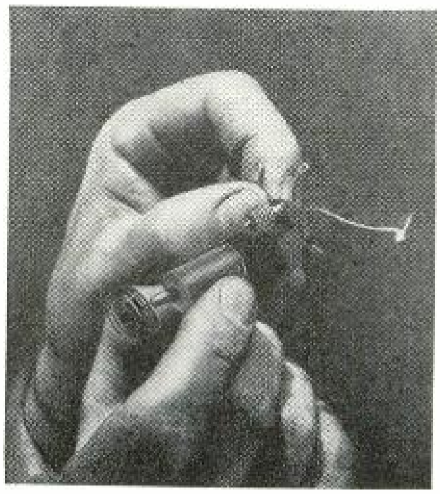
Fig. 2a, left—The receiver mounting.
Fig. 2b, above—The receiver housing.

[1]This article is based on research now under way at the University of California at Los Angeles, under the direction of J. A. Gengerelli, Professor of Psychology.

the cages and the same unit can be used on all animals which insures constancy in the output for each rat.

The antenna attached to the top of the receiver is bottom loaded with a ⅜-inch diameter coil of 9½ turns to bring it into resonance at 250 megacycles. The overall length of the antenna is 2 inches. The entire system is so light that the animal can carry it comfortably for short periods.

In certain experiments in which the animal is required to maneuver in confined quarters a smaller antenna is used which consists of a coil of 8 turns of wire approximately ½-inch in diameter.


Closeup of the receiver and mounting.

The signal which the rat receives is generated by a pulse-modulated transmitter (Fig. 3). The oscillator is a pair of 8012's in a t.p.t.g. circuit operating at 250 megacycles. This unit is housed in a small box and coupled to a vertically oriented dipole mounted about 2 feet above the floor surface. The grid return of the oscillator is to the plates of two 6L6's in parallel. The grids of these tubes are pulsed by a square wave generated by a conventional multivibrator and negative clipper. The pulse generator is designed so the pulse frequency and pulse duration controls are virtually independent and thus the output of the oscillator is a square wave pulse whose frequency and width can be varied. Signal strength is controlled by a variac in the primary of the power transformer. Using a 50 percent pulse with a frequency of 30 cycles per second this unit draws about 100 watts average power.

In order to prevent spurious radiations from the laboratory as well as to keep extraneous signals from disturbing the animal a 10x6x6-foot double shielded cage is used to house the experimental area and the oscillator. A short cable connects the oscillator to the power source outside the cage. A receiver unit suspended in the cage is connected by a shielded lead to the vertical plates of an oscilloscope which serves as a monitor for the signal.

When the animal is placed in the cage for an experimental run the receiver unit is attached to the stub on its back and the transmitter is turned on at low power. As there are no pain receptors in the brain, very weak stimulation causes no apparent discomfort to the animal. If the electrode is embedded in a "motor" area, a strong stimulus will cause the animal's whiskers to vibrate back and forth syncronously with the pulse frequency. A brief shock at full power will cause permanent damage to the animal while a mild shock is adequate to keep an animal out of an area in which the shock was received.

It is impossible to predict how fruitful the application of this technique will be in enhancing the present understanding of animal or human behavior. It is hoped that a wide variety of problems and theories can now be explored which have hitherto resisted experimental attack. It may be possible to gain new insights into brain function, for by using appropriate techniques and sufficient power certain areas of the brain can be destroyed and the behavior of the animal photographed during the process. In the study of learning, an approach of this nature may supply part of the answer as to how learning takes place at the physiological level.

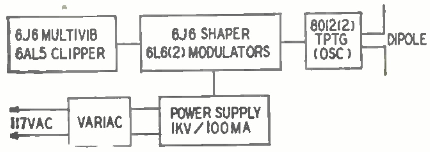


Fig. 3—Diagram of pulse transmitter.

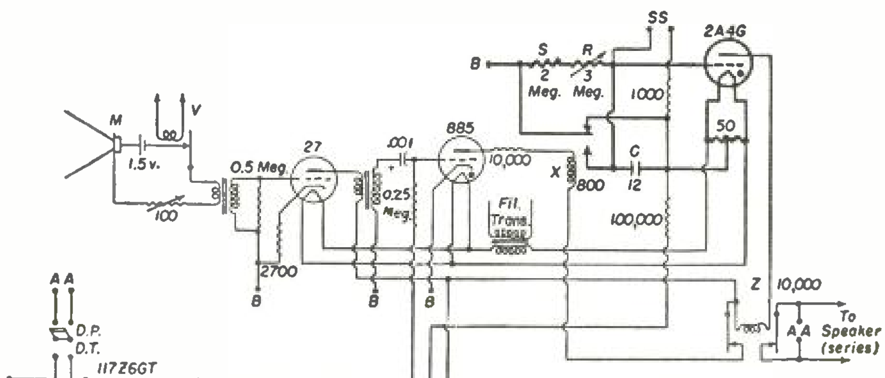
Commercial-killer Improves Programs

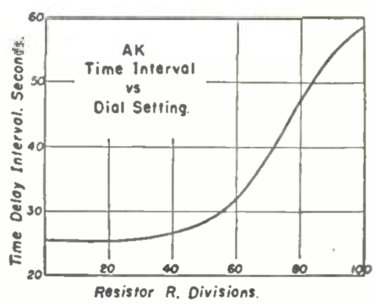
RELIEF for the harried radio listener is promised in a new "commercial-killer" devised by Dr. I. Clyde Cornog of the University of Pennsylvania and described in the *American Journal of Physics*, February 1950.

The "commercial-killer" is a special time-delay using thyratrons, which opens the loudspeaker circuit when "ordered" to do so by any sharp sound, such as a hand-clap. The length of time the radio remains off the air can be adjusted by R, a 3-megohm potentiometer. The time interval for different settings of R appears on the insert chart. Most radio commercials last about 60 seconds.

The schematic shows the equipment in its non-active position. When the set is turned on current from the power supply closes relay V, connecting the dry cell to the carbon microphone M. Potentiometer P is so adjusted that current through the 885 is just below that required to close relay X. Thus the 2A4G grid is connected to its cathode through S and R. Operating practically at zero bias, it conducts normally and keeps the relay Z closed, closing both the speaker circuit and the plate circuit of the 885.

Any loud sound will cause the current through the 885 to rise, closing relay X. This breaks the circuit between grid and cathode of the 2A4G and connects the grid direct to point B. The cathode is now connected (through a 100,000-ohm resistor) to a point 105 volts more positive than B. The 105-volt negative charge is also placed across C. The 2A4G tube cuts off and relay Z opens, stopping the program and opening the circuit of the 885. Relay X immediately opens and the charge on C leaks off to cathode through the resistors S and R, again closing relay Z. Pushbutton switch SS may be pressed to discharge the capacitor and bring the set back into action immediately if desired.





18-Tube High-Performance Communications Receiver

By FRANCIS O. DAVIS*

SO MANY amateurs use factory-made communications receivers today that the ham who wishes to construct his own finds little or no up-to-date design information available. But the amateur who lacks funds to buy or wishes to build a communications receiver with his own hands can construct a piece of equipment that will equal the best commercial jobs.

The cost of this receiver depends on the varying surplus market, but should not run much over $100. A v.t.v.m.-analyzer, BC-221 frequency meter or signal generator, and a simple calibrated grid-dip meter are needed to test and calibrate the set.

It receives the 6-, 10-, 20-, 40-, and 80-meter bands with high frequency stability and high signal-to-noise ratio, has variable selectivity without a crystal filter, and also receives WWV on 5 mc.

To obtain these results, double conversion and some unconventional principles were used. For example, the oscillator operates at all times in the vicinity of 5 to 7 mc, and is temperature-compensated. Doublers multiply the frequency for the other bands. There are absolutely no tracking problems. The cathode-coupled 6J6 r.f. stage has the best signal-to-noise ratio the writer has seen. The 6J6 output tube and the 6AK5 mixer input use the same tuned circuit. Oscillator signal injection is kept very low.

In the BROAD i.f. position, the signal from the first (1425-kc) i.f. amplifier goes to the diode-detector-a.v.c. In the SHARP i.f. position, it is converted to 85 kc and further amplified. A 1-μμf capacitor prevents the large signal from the last 1425-kc stage from overloading the 6SA7 second converter grid. The 85-kc stage is designed for unity gain—there should be no change in signal strength in going from BROAD to SHARP position.

A 1N34 serves as a shunt noise limiter. A 1,000-cycle c.w. filter is provided. When it is switched in, one section of a 6SN7 amplifies the signal leaving the filter, making up the 14-db insertion loss.

Two potentiometers are associated with the 0-1-ma signal strength meter: one to zero-set it, the other to adjust the full-scale sensitivity. A switch on the panel below the meter cuts it off for c.w. operation.

WWV is received by turning on the plate voltage, to a separate front end with a crystal oscillator. A 6SJ7 r.f.

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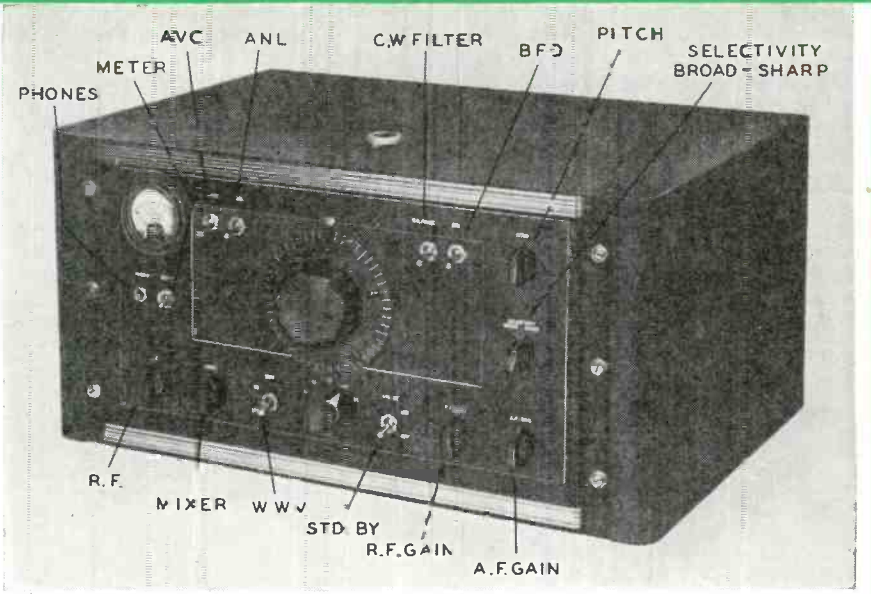


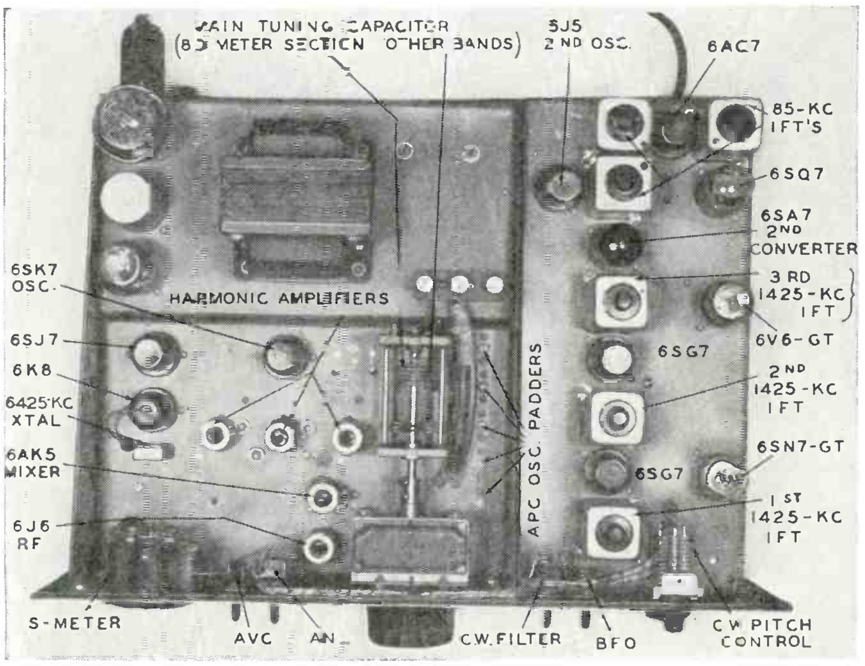
In appearance and performance, this receiver rivals the better commercial jobs.

stage and 6K8 converter is fixed-tuned to 5 mc while the converter's oscillator section is operated as a Pierce crystal oscillator on 6425 kc. The 1425-kc conversion signal is coupled to the first 1425-kc. i.f. transformer through a small variable capacitor.

A three-chassis receiver

The receiver is constructed on three separate chassis. The power supply is on an 11x6x3½-inch chassis, the high-frequency r.f. stages are on an 11x7x3-inch chassis, while the i.f. and audio stages are on a 13x6x2-inch chassis.

Mounted on the power supply chassis are an 0D3 regulator tube, the transformer, the dual filter capacitor, and the 5Z3 rectifier tube. Under it are the filter choke, two potentiometers used in the S-meter circuit, a terminal strip,



The receiver is built on three separate chassis. The i.f. and audio section is at right, power supply at left rear and the high-frequency section left front.

and miscellaneous small parts. The power input cable plug, the power fuse, and pin jacks for the speaker voice coil leads are on the back apron of this chassis.

Tie points should be provided on the terminal strip for leads that go to other parts of the set. These are +250 volts, plate voltage from the meter circuit, 150 volts regulated, two meter leads, two leads to line switch (on back of audio gain control) and 6.3 volts a.c. for the filaments.

Two grommets connect the power chassis to the high-frequency chassis. Some of the interconnecting wires go along the right side of the high-frequency chassis. Others leave at the left end of the power supply and are out of sight under the left end of the high-frequency chassis lip.

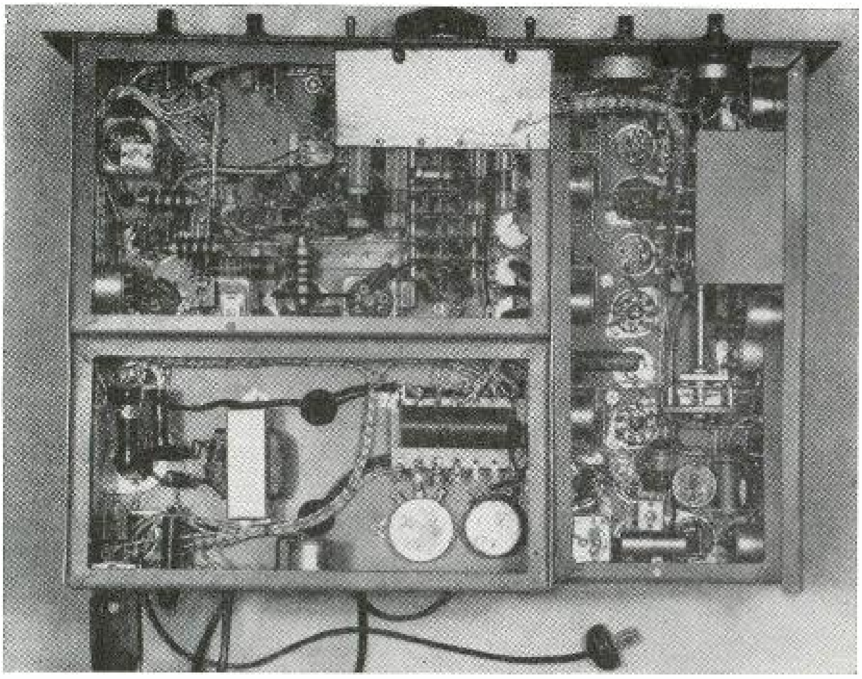
After the power supply has been checked, the i.f. and audio chassis should be built.

First procure on the surplus market a BC-453 and a BC-454 receiver (part of the 274-N aircraft command set). The BC-453 has a range of 190 to 550 kc, and the BC-454 one of 3 to 6 mc. Remove from them all the i.f. transformers, the b.f.o. transformer (located under the chassis), all the bypass capacitors, and all the mica insulated tie-point strips. Also remove from the BC-454 the three cans under the three-gang tuning capacitor.

The layout of the i.f. amplifiers is shown in the photo of the top of the chassis. The position of the switches for the i.f. system may be observed in the front-panel photo. The off-on switches for the a.v.c. and a.n.l. are to the left of the tuning dial while the c.w. filter and b.f.o. switches are on the right.

The i.f. chassis is mounted with its bottom 3½ inches above the base of the panel. Extending down the outside of this chassis is a protective apron. Below this chassis are mounted the r.f. and a.f. gain controls. On the apron is mounted the 1,000-cycle-pass c.w. "range filter" obtained on the surplus market for about $1.00. It is marked "voice in," "ground," "voice out," "range in," and "range out." The "ground" is wired to the chassis, and the "range in" and "range out" are the 1,000-cycle filter, in and out. The "voice" connections are not used.

About two-thirds of the way back, bottom view, is the three-pole, two-position ceramic wafer selectivity switch, with its shaft passing under the c.w. filter and extended to the front panel above the a.f. gain control. In the back corner of the chassis is the 1340-kc transformer, L 13. The 85-kc b.f.o. transformer L 14 is in the front corner. The 1340-kc unit is the 1415-kc b.f.o. transformer from the BC-454. A 25-μμf silver mica capacitor is shunted across the tuning capacitor in this unit to make it tune to 1340 kc.



Judicious cabling of wires helps to keep the receiver's underchassis clear.

The 1415-kc i.f. transformers from the BC-454 will tune to 1425 kc without modification. The first transformer must have the 170-μμf ceramic button capacitor which goes from the plate to B-plus removed. This is placed at the plate of the 6AK5 mixer later. The 6V6 plate-to-voice coil transformer is out of sight under the c.w. filter.

The bypass capacitors from the BC-453 and BC-454 are spaced around the chassis as shown. The mica insulated resistor mounts are used between the bypass capacitors. These tie points are used to mount various cathode, screen, a.v.c., and plate decoupling resistors. The resistors on them are removed and saved.

Use care in wiring the i.f. section, keeping leads as short and direct as possible. Shield the following: the lead from the audio coupling capacitor to the top end of the audio volume control, the lead from the arm of the volume control to the grid of the 6SQ7, and all the audio leads going to the c.w. filter switch.

When this section is wired and checked, hook it to the power supply with temporary leads and tune up. Turn the selectivity switch to the BROAD position with the r.f. gain on full. Put a 1425-kc signal on the grid of the last 6SG7 tube, through a capacitor, and peak this stage, using a vacuum-tube voltmeter on the a.v.c. Attach the signal generator to the grid of the first 6SG7 tube and repeat this adjustment, as well as tuning the middle 1425-kc i.f. transformer. The first i.f. transformer cannot be tuned at this time, due to the removal of the 170-μμf capacitor from its input.

Place the d.c. probe of the vacuum-tube voltmeter on the 6J5 1340-kc oscillator grid. If it is oscillating, about 10 volts or more of self-rectified grid voltage will be measured. Using the frequency meter, tune this oscillator to 1340 kc. Adjust the oscillator injection capacitor until 10 volts are measured on the control grid (pin 5) of the 6SA7. Then retune the oscillator until the frequency is exactly 1340 kc.

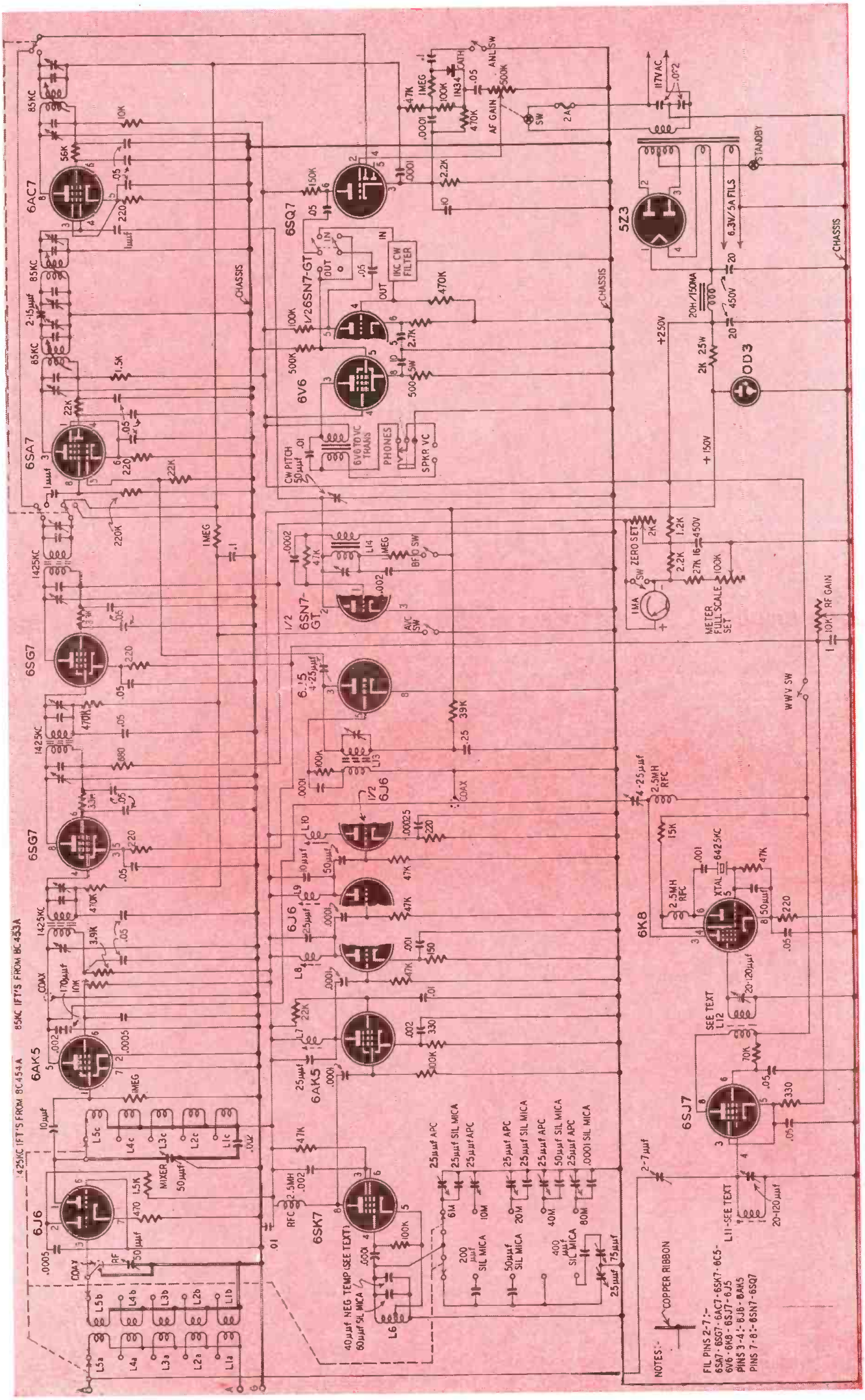
Turn the selectivity switch to SHARP and tune the 85-kc transformers. The 85-kc transformers have a variable coupling adjustment. Pull the little fiber rod in the center of each transformer all the way out. If it is cemented, loosen it with coil cement thinner or nail polish remover.

Apply a 1425-kc signal to the first 6SG7 grid; a.v.c. voltage should result. Peak the 85-kc transformers for maximum a.v.c. voltage. The little padding capacitor between the back-to-back 85-kc transformers, should be at minimum capacitance for this adjustment.

Now switch the selectivity control to BROAD and note the value of a.v.c. voltage. Adjust the input coupling from the signal source until about 6 or 8 volts of a.v.c. are measured. Note this value and switch to sharp selectivity. The a.v.c. voltage may be slightly less now. If it is, adjust the coupling capacitor between the two 85-kc transformers until the a.v.c. voltage is the same as on broad selectivity. If the a.v.c. voltage is slightly more, the value of the 6AC7 cathode resistor can be increased until unity gain is obtained. But if it is much greater, the grid coupling capacitance on the 6SA7 tube must be reduced.

Now turn on the b.f.o., making sure the selectivity switch is at SHARP. With the pitch control half way in, the b.f.o. is set to zero-beat by adjusting the tuning screw in the center of the b.f.o. transformer. With the b.f.o. on, turn on the c.w. filter switch. If everything is connected right, the c.w. tone can be peaked very sharply at 1,000 cycles with the pitch control.

At this point you are ready to start on the high-frequency section. Its lay-



Schematic of the high-performance communications receiver. Constructed almost entirely from surplus materials, this set owes its outstanding performance to a number of features not commonly found in home-constructed receivers. Double conversion provides either narrow or broad tuning with no change in volume. Oscillator problems are minimized with a low-frequency oscillator and doublers for the higher bands. A special receiver for WWV is included for frequency checks. All the amenities, including a signal-strength meter, noise silencer and 1,000-cycle filter for c.w. are provided. Selectivity at ten times down can be varied from 10 kc to 200 cycles, plus the extra selectivity obtained on c.w. with the 1,000-cycle filter. An excellent receiver for the advanced amateur who prefers to construct his own equipment as well as for the man with a cellar full of surplus he wants to put to use.

out is shown in the top view of the chassis. At the extreme right are the APC-type padding capacitors for the oscillator. The rear one is for 80 meters with 40, 20, 10, and 6 meters proceeding in that order toward the front.

After all holes are cut in this chassis, the three chassis can be assembled. Panel brackets at each end of the r.f. and power supply and on one side of the i.f. chassis hold these together. The other side of the i.f. unit is supported by the protective apron as shown, looking at the bottom view. With the chassis assembled in this manner, the top caps on the i.f. transformers are just even with the top of the 8¾x19-inch panel.

The first thing to wire on the r.f. chassis is the WWV section. The coils for this section are obtained from the BC-454. Remove the three cans under the main tuning capacitor on the BC-454 and open them. One contains a coil wound on a ceramic form. Set this aside for the h.f. oscillator. The other two (designated L11 and L12 in the diagram) are tuned to 5 mc.

All the interconnecting wires between the i.f. chassis and the power supply can now be run in. They come through the r.f. chassis and go along the left side through to the power supply. Other wires from the i.f. chassis come along the front of the r.f. chassis where they terminate at various points or go up to the phone jack or a.v.c. disabling switch. The S-meter wires, together with power wires for the high-frequency section, go along the right side, looking at the bottom, of the r.f. chassis into the power supply.

The connection between the 6AK5 mixer plate and the first 1425-kc i.f. transformer is made with low-capacitance coax (capacitance 13 µµf per foot). The reason for removing the 170-µµf capacitor from the first i.f. transformer now becomes apparent. By placing it at the plate of the mixer, the inductance and capacitance of the long coax lead becomes a part of the i.f. tuned circuit. Because of the added capacitance of the coax, a .002-µµf capacitor is placed in series with the 170-µµf button capacitor at the plate of the mixer to reduce its capacitance.

The lead from the 6K8 WWV converter tube to the plate of the 6AK5 mixer is now put in. It is the short piece of low-capacitance coax shown in the bottom view near the right center of the high-frequency chassis. At the junction of this lead and the 6AK5 plate is the 4—25-µµf padding capacitor which couples the converted signal from the WWV section to the first i.f. transformer lead, and is set at about 4—7 µµf.

COIL DATA TABLE

	Ant.			R.F.			Mixer			form dia. (in.)	remarks
	coil	turns	wire size	coil	turns	wire size	coil	turns	wire size		
80 mtr.	L1A	16	35	L1B	77	35	L1C	85	35	½	close-wound
40 mtr.	L2A	9	30	L2B	45	30	L2C	48	30	½	close-wound
20 mtr.	L3A	7	30	L3B	28	26	L3C	30	26	⅜	close-wound
10 mtr.	L4A	4	30	L4B	14	26	L4C	15	26	⅜	L4A close-wound L4B, L4C spaced wire dia.
6 mtr.	L5A	3	18	L5B	6	18	L5C	7	18	⅜	L5A close-wound, L5B, L5C spaced for ½-in. length.

OSCILLATOR CIRCUITS

coil	turns	wire size	form dia (in.)	remarks
L6	20	26	⅝	spaced wire dia.
L7	34	30	½	close-wound, slug-tuned
L8	16	24	½	close-wound, slug-tuned
L9	12	22	½	close-wound, slug-tuned
L10	8	24	½	spaced wire dia., slug-tuned

L11 and L12 are r.f. and mixer coils from 3–6-mc BC-454-A.

L13 is b.f.o. transformer from BC-454-A.

L14 is b.f.o. transformer from BC-453-A.

L1A and L2A are spaced ⅛ inch from cold end of L1B and L2B, respectively.

L3A, L4A, L5A are each spaced 1/16 inch from cold end of their respective B-coils.

All coils wound with enameled wire.

The WWV section can now be turned on and the first 1425-kc i.f. transformer tuned. Be sure the 6AK5 mixer tube is in its socket. Adjust the trimmers on the 5-mc r.f. and mixer while feeding in a 5-mc signal.

The next step is the oscillator section. The main tuning capacitor was made from a dual 100–100-µµf capacitor found on the surplus market. The plates were removed with a pair of long-nose pliers until one section measured about 25 to 30 µµf and the other about 75 µµf. The 75-µµf section is used for 80 meters and the 25-µµf section for the remaining bands.

Wind the oscillator coil L6 very carefully on the ceramic coil form set aside when the coils were removed from the BC-454. Dope it well and let it dry. The negative-temperature-coefficient capacitor shown on the diagram is placed close to the oscillator coil and cemented in place. This assembly is then placed inside the shield can and mounted near the back of the band switch.

The negative-temperature-coefficient capacitor is actually a 50-µµf capacitor. One end is connected to the hot end of the coil inside the can. The other is brought to one of the unused terminals on the bottom of the can and a 200-µµf silver mica capacitor is connected there to ground, to adjust the compensation to fit any given temperature condition.

Wire the band switch as shown on the diagram using stiff wire.

When the oscillator is finished, turn it on and adjust the trimmers. Switch to the 10-meter position and turn the main tuning capacitor all the way out. Adjust the 10-meter trimmer until the frequency of the oscillator measures approximately 7070 kc.

If the specifications are carefully followed, the APC capacitor will be approximately half-way meshed. If the oscillator will not tune to 7070 kc with the APC at about half capacitance, the size of the 60-µµf silver mica across L6 can be changed slightly. If more than 10-µµf change in this capacitor is needed, L6 is probably not right or else a mistake has been made in choosing some other circuit component. Now run the main tuning capacitor in until 6650 kc is reached. This should occur with the main tuning capacitor nearly at maximum capacitance.

Switch to the 6-meter position and set the main tuning capacitor near maximum capacitance. Adjust the 6-meter APC padder until the oscillator frequency is 6070 kc. The main tuning capacitor should tune the oscillator to 6575 kc at near minimum capacitance.

The same procedure is followed on 20, 40, and 80 meters where the maximum and minimum frequencies are 6990 and 6280, 5880, and 5570 kc and 5430 and 4920 kc, respectively.

The oscillator frequency or its harmonic is always 1425 kc lower than the corresponding amateur band, with the exception of the 80-meter band where it is 1425 kc higher.

Next wire the 6AK5 isolation amplifier and the 6J6 harmonic amplifiers. When they are completed, use a grid dip meter and adjust L7 to 5.5 mc, L8 to 12.8 mc, L9 to 27.3 mc and L10 to 50.5 mc. This is done by adjusting the tuning slugs in the inductances with the power off, but with the 6AK5 and 6J6 tubes in their sockets. The coil forms used for L7, L8, L9, and L10 are the type used in the oscillator of an SCR-522. National Manufacturing Co., however, makes a slug-tuned coil form which is ideal for this purpose.

The isolation amplifier and harmonic amplifiers are broad enough to give ample output on all bands even though they are not exactly harmonically related.

The r.f. and mixer stages are straightforward. All bypass capacitors used in these stages are the button type mounted for minimum lead length.

The lead from the r.f. stage tuning capacitor to the band switch being relatively long, it is made part of the tuned circuit by using a short piece of low-capacitance coax. The ground lead on the r.f. tuning capacitor is heavy ¼-inch copper ribbon which furnishes the return for the tuned circuit. Copper ribbon is also used in the mixer tuned circuit for the tuning capacitor lead to the switch as well as the coil return to the capacitor. A .002-µf capacitor

(*Continued on page* 50)

(*Continued from page* 48)

blocks direct current at this point.

This direct and heavy construction is important! The copper ribbon reduces the inductance in the leads and puts it in the coupled circuits where it can do some good. Performance on 6 meters was very poor until this refinement was made. The heavy lines in the diagram show the leads referred to.

Take care to prevent oscillation in the 6J6 r.f. stage. If the 6J6 plate-6AK5 mixer tuned circuit is coupled back in any way to the first 6J6 grid, instability will result. This can be prevented by the partition shield between the r.f. and mixer coils. It is made of 3/16-inch aluminum, held by putting it in place of one of the wafers in the band switch. The edges are drilled and tapped so they can be bolted to the chassis. The r.f. coils have a thin copper shield over them between this partition and the front of the chassis.

The partition has four holes for the coil forms cut in it, two ½-inch and two ⅜-inch, and is slotted lengthwise so the forms can be clamped in place.

The 80- and 40-meter mixer coils are on the right side of the switch while the 20- and 10-meter coils are on the left (viewed from the front with the set upside down). The r.f. coils are on the other end of the same forms under the copper shield. The 6-meter coils are self-supporting and are mounted on the switch below the 20-meter coils. There are more wafers on the switch than are used because several front ends were tried and it would have been inconvenient to add wafers for experiment.

The oscillator injection to the mixer should provide about ½ volt on the 6AK5 grid. Any more raises the noise from the mixer without increasing the signal. The mixer grid voltage on all bands was between 4/10 and 6/10 volt with no coupling other than stray capacitance between the mixer circuits and the harmonic amplifiers. If there isn't enough coupling, some could be provided by a very small capacitor from the hot end of the mixer coil to the hot end of the harmonic amplifier coil on the band where more coupling is needed.

All bands on this receiver start with the low-frequency end at 20 on a 0-500 division dial. All the bands end at about 425 to 450 on the dial, giving over 400 divisions of bandspread.

This receiver was tested with a Measurements Corp. model 80 signal generator and was found to have 4 microvolts absolute sensitivity on 6 meters, 1.8 microvolts on 10 meters, and 1 microvolt on 20, 40, and 80.

The selectivity is the number of cycles off resonance when the signal is 10 times down. On broad selectivity it measured 10 kc; on sharp it measured 1.8 kc; and on c.w. with filter in, it measured 200 cycles.

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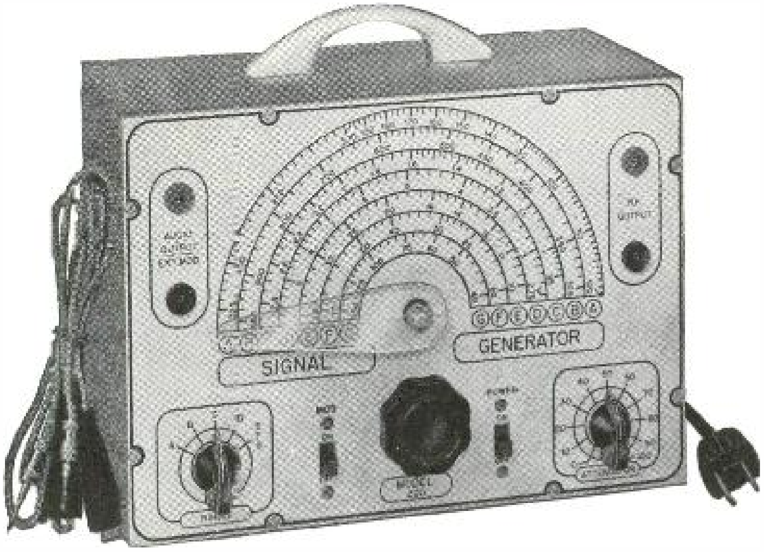

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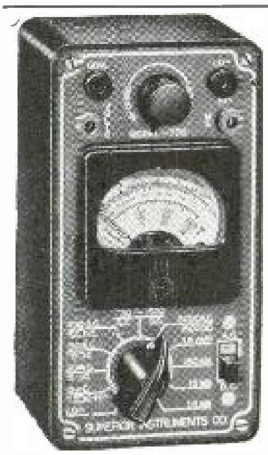

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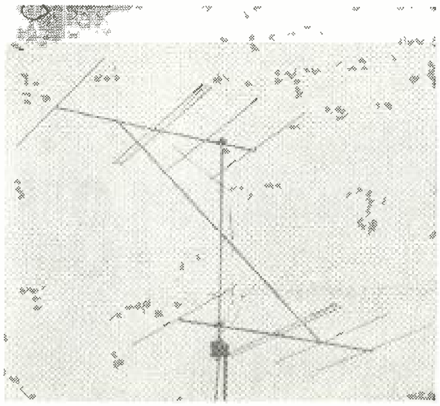
TV Antenna Phase Control

Co-channel interference is reduced and signal strength increased with a variable phasing control antenna

By G. N. CARMICHAEL



The antenna as viewed from the ground. The two Yagis are offset so that a wave front intercepts the two antennas with a phase difference of about 90 degrees.

As the number of television stations has increased in recent months, co-channel interference has become a serious problem in fringe areas. Few fringe areas are completely free from this difficulty.

Before this situation actually occurred at the author's location, much thought was given possible solutions. The advent of WOC-TV in Davenport, Iowa at a distance of 120 miles north, on the same channel as KSD-TV in St. Louis, Mo., at a distance of 90 miles south by south-east, provided the necessary signals for a series of antenna experiments.

The author has felt that the Yagi type of antenna, even when tuned for maximum front to back ratio, would not be 100 percent effective. This proved to be the case, though a sharply directive Yagi was sufficient in many installations. Screen reflectors and multi-reflector parasitic elements gave some improvement but added so much to the bulk and wind resistance of the antenna, that this line of experiment was dropped.

The final solution was found by using a variable phasing control to add the voltages from two antennas in a way that nearly completely suppressed the undesired signal. At the same time, this method greatly added to the signal gain from the desired direction.

For a complete understanding of the operation of this antenna system, it will be necessary to review some simple cases.

Let us consider two half-wave antennas A and B, with a horizontal spacing of one-quarter wavelength, and with independent feed-lines to the receiver. Fig. 1 shows voltages and phases of signals from opposite directions.

A signal from one direction produces a voltage in antenna A (curve 1) which leads the corresponding voltage in antenna B (curve 2) by 90 degrees. At the same time, the signal from the opposite direction produces a voltage in antenna A (curve 3) which lags the corresponding voltage in antenna B (curve 4) by 90 degrees.

If the feed-lines to the receiver are of the same length, there is neither complete addition of the desired signal nor complete cancellation of the undesired signal. However, if we shift the voltage phase by 90 degrees, for example, by lengthening one feed line by a quarter wavelength, both of these results can be obtained; that is, addition of the desired voltages and cancellation of the undesired voltages.

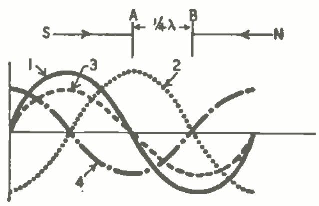


Fig. 1—Diagram of phase difference of two signals from opposite directions.

The above discussion assumes that both signals intercept the antennas from a horizontal direction. In practice this is not the case. The vertical wave angle is not constant from day to day, nor is it the same for signals from different distances. Fig. 2 shows an end view of the two half-wave antennas, indicating the horizontal wave and one with a different vertical wave angle.

The perpendicular distance between the wave fronts through each antenna represents the difference in phase of the voltages induced in these. If the desired signal from one direction has a vertical wave angle of 15 degrees, for example, and the undesired signal from the opposite direction has a vertical wave angle of 12 degrees, then the desired results can not be obtained by a shift of phase of 90 degrees for one of the voltages.

If the difference in horizontal direction between the desired and undesired signal is not 180 degrees, the situation is similar, as can be seen from Fig. 3. However, in both these cases, we can still obtain either maximum signal or maximum cancellation, or, in some cases, both, by properly phasing the voltages.

For complete flexibility, it is necessary to have controllable phase shift of one of the voltages. This control can then be used to get either maximum suppression or maximum forward gain.

The next step in developing a useful antenna system is to provide a better source of signal voltage than a half-wave antenna.

The complete antenna as designed by the author and produced by Trio Manufacturing Co., Griggsville, Illinois, consists of two Yagis with double dipole antennas mounted on one mast with the dipoles offset so that the wave front will intercept the two antennas with an approximate 90-degree phase difference for the vertical angles commonly encountered in fringe area reception. The vertical spacing between the two antenna bays is a compromise between minimum interaction of the antenna elements and difficulty of installation.

The feed lines from each of the Yagis are brought down separately to the phasing control. A schematic of the phasing control is shown in Fig. 4. The inductance and capacitance in the phasing control are carefully chosen for minimum variation in input impedance.

The Yagi antennas used for the voltage pick-up are 4-element arrays, consisting of an active element, one reflector and two directors.

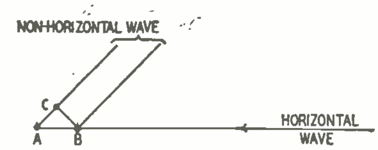
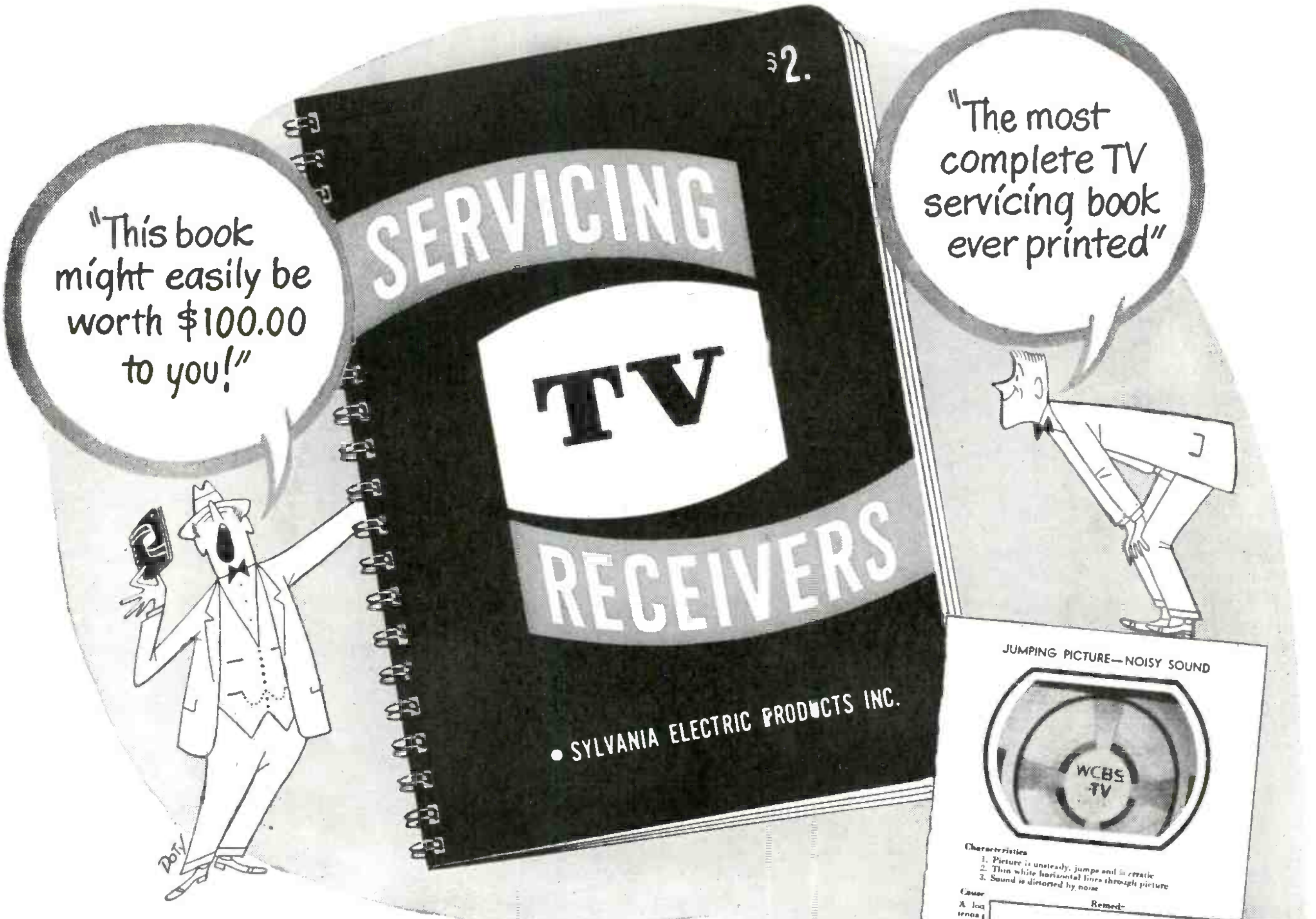


Fig. 2—End view of the dipoles. AB is the phase difference for the horizontal wave, AC for the non-horizontal wave.

The active element is a double folded dipole with a ⅜" driven element paralleled by two ⅝" elements to give the desired impedance. This is a simple method of obtaining a large increase in impedance without adding greatly



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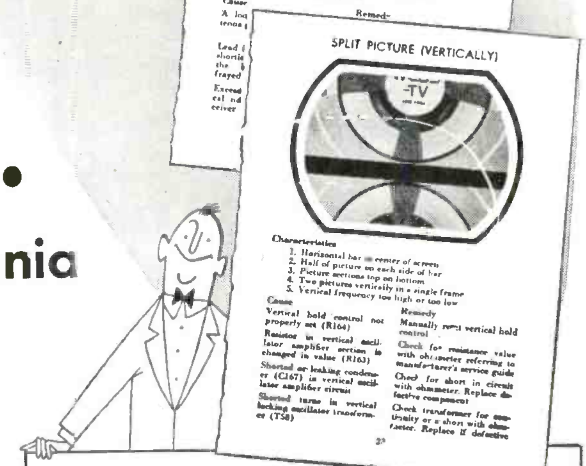

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Fig. 3—A top view. AB represents the phase difference of undesired signal.

To understand the operation of the phasing control, it is convenient to analyse the phase shift obtainable by manipulating the lengths of the feed-lines. If we could continuously vary the length of the feed line from one of the antenna bays by as much as a quarter wavelength, we could get a phase shift of 90 degrees. If one lead-in is equipped with a d.p.d.t. polarity reversing switch, an additional 180 degree shift could be obtained.

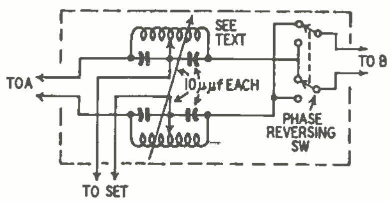


Fig. 4—Circuit of the phasing control.

Let us consider an arrangement such as that in Fig. 5. The lead-ins from the two antenna bays are connected to the two ends of a quarter-wave two-wire line, and the lead-in to the set is tapped on this quarter-wave section. As the position of the tap is varied, the total length to the set, of one line becomes longer, while the other is shortened. The total phase shift available in one is 90 degrees in one direction, while the other varies 90 degrees in the other direction. This 180 degree variation, together with a polarity reversing switch will then give complete control.

The phase control itself consists of two solenoid coils mounted on a rotatable shaft, and each provided with a wiping contact which is continuously variable from one end of the coil to the other as the shaft is rotated. Each coil consists of 10 turns of silver wire on

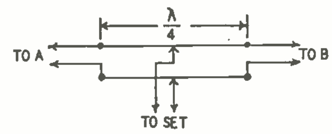


Fig. 5—A ¼-wave line phasing control.

a grooved form of 1-inch diameter, with silver wiping contacts to provide the end terminals. Small fixed capacitors, each 10-μμf are connected from each end terminal to the variable contact. This phasing control gives results precisely the same as that obtained by varying the tap on the quarter-wave section of two-wire line.

The combination of the sharp pattern of the Yagi, together with the phasing control, provides adequate rejection of the interfering signal in nearly all cases. Of course, very little can be done when the interfering signal is from the same direction as the desired signal. This situation is very uncommon, however, because of frequency allocations.

If the direction of the interfering signal is less than 135 degrees from the direction of the desired signal, the directivity of the Yagis provides the necessary rejection, and the phasing can then be set for maximum forward gain. A rotator is practically a necessity because the pattern of the Yagi is quite sharp.

If the interference is coming from one of the back lobes, the adjustment of the phasing control for maximum rejection eliminates the unwanted signal while still giving gain in the desired direction. Front to back, or rejection, ratios of 35 to 40 db. can be obtained while maintaining a gain of 15 db as compared with a reference dipole oriented in the desired signal direction.

Since the video and audio carriers are not on the same frequency it is sometimes impossible to eliminate completely interference on both picture and sound. In such cases, the phasing control is set to provide a clear sound carrier, free from chatter, and the picture interference is then slight enough to be scarcely noticeable.

A certain amount of retuning of the phasing control is necessary to compensate for shift in the vertical wave angles. This is especially true when the signals are subject to heavy fading, an indication of large changes in the vertical wave angle.

This antenna system gives adequate reception in areas where other types of antenna will not.

[1] G. N. Carmichael, "Impedance Considerations in TV Antenna Design", Radio and Television Retailing, p. 86 Feb. 1950. The formula for the impedance step-up of such a dipole is

$$\left[1+\frac{2\log D/R_1}{\log D/R_2}\right]^2$$

where R_1 is the radius of the driven element of the dipole, R_2 the radius of the paralleled elements, and D is the center-to-center spacing between driven element and paralleled elements.

"Please have a seat—the doctor will see you in a moment"

VEE-D-X

LOW PRICED

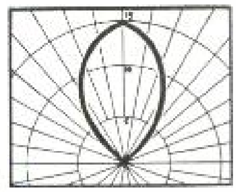
Yagi Arrays

- Transformer ratio of *stepped-up* driven element provides perfect match to 300 ohm line.
- *Lowest* standing wave ratio insures maximum transfer of signal.
- High front to back ratio prevents co-channel interference.
- Sharp horizontal pattern helps reject unwanted interference of all types.
- Extra high forward gain makes this the ideal antenna for single channel fringe reception.
- Not designed to replace the famous heavy-duty RLY and EC series.

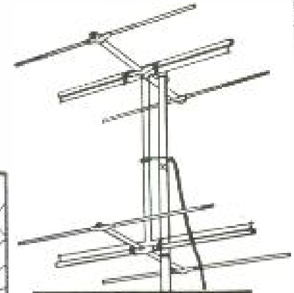
J SERIES

JA

V. S. W. R. = 1.34
Z = 335 ohms



Gain in decibels



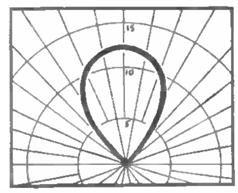
LOW CHANNEL $17.35 list
HIGH CHANNEL 12.50 list
For double stack as shown

Including phasing rods

LOW CHANNEL $13.20 list
HIGH CHANNEL 6.95 list

JB

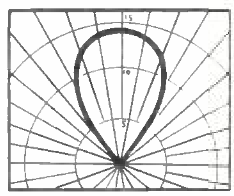
V. S. W. R. = 1.26
Z = 315 ohms



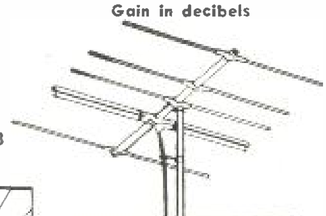
Gain in decibels

JC

V. S. W. R. = 1.28
Z = 317 ohms



Gain in decibels



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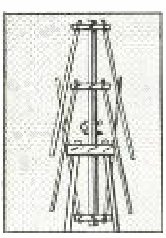
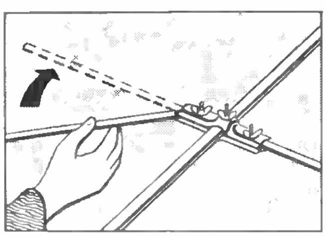
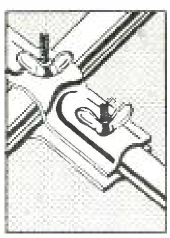
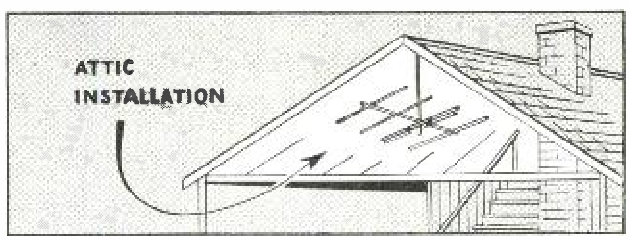






All the parts are in one package ready for assembly. The new clamp type construction makes it easy to swing each element in place and secure it firmly with the wing nut. No bag of hardware to fuss with — no bolts or screws to lose.



Because of the high gain of this antenna, many people have found that they can obtain excellent results with a single bay attic installation.

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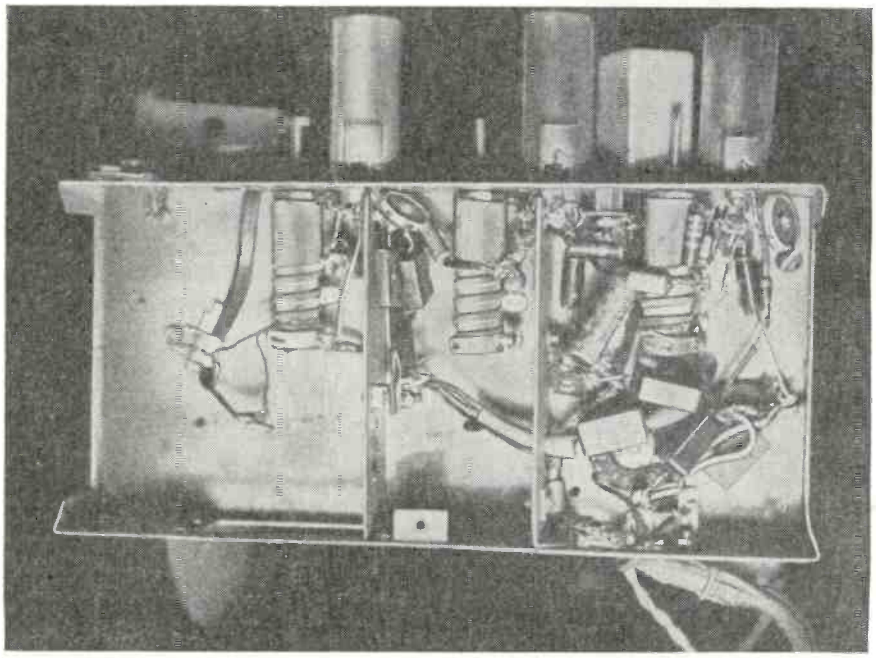
Low-Noise FM Front End



An underchassis view of the front end before addition of the first r.f. stage.

The front end for a high-gain tuner

By JOSEPH MARSHALL

THE design of front ends for television, FM and v.h.f. is more complicated than other high-frequency circuits because the front end must provide a high signal-to-noise ratio as well as considerable gain. It is difficult to design and construct a conventional i.f. amplifier for FM with a gain of more than 80 db, and the usual FM i.f. channel does not have more than 60 db gain up to the limiter. To get sensitivity better than 50 microvolts, the front end must provide high gain. Since gain and noise level rise together a really sensitive, low-noise front end requires careful design.

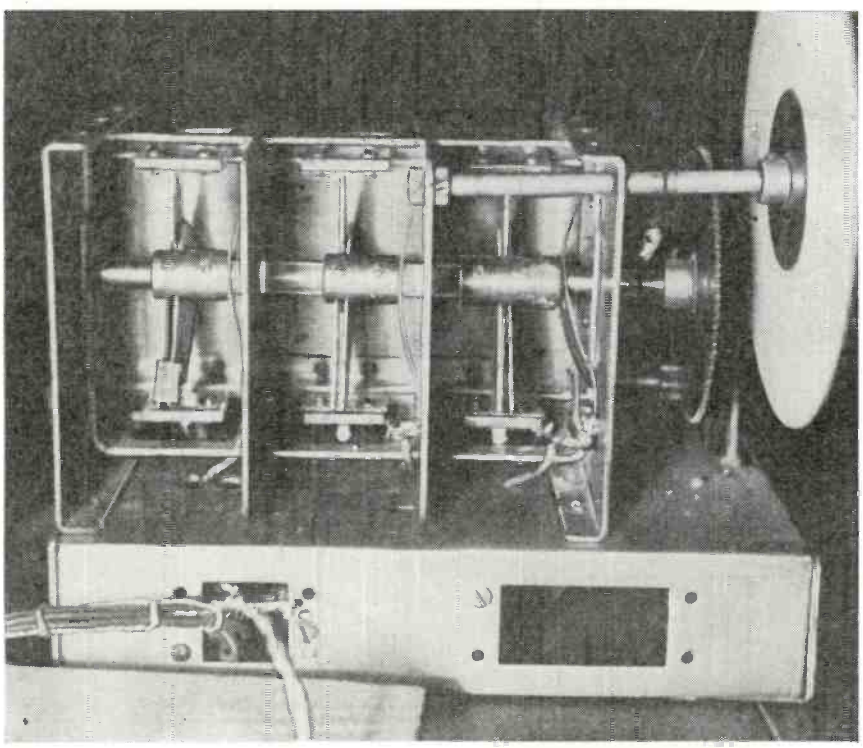


Photo of the modified broadcast set capacitor. Note the polystyrene shaft.

By using an i.f. amplifier of very high gain, it is possible to achieve a low noise level in the front end. One such amplifier, using double conversion, two stages of 10.7-mc amplification, a second converter, one stage of 200-kc amplification, two limiters, and a frequency-counting detector, provides nearly 120 db of gain and will be described in a following article. Only normal gain is then needed at the front end to get better than 5 microvolts sensitivity on the FM band; and if the noise is really low, the usable sensitivity can be brought to 1 microvolt. A front end for the FM band which, if used with the i.f. amplifier mentioned, provides 1-microvolt sensitivity on the FM band, is described here. The circuit can be modified easily by changes in the coils and capacitors for use on v.h.f. ham bands or communications bands.

The front end uses triodes throughout: four 6J6 s—two as r.f. amplifiers, one as a converter, and one as an oscillator. It is tuned with a home-made ganged capacitor. Because of the high losses and uneven gain, this is not the best method of tuning a v.h.f. front end when high efficiency is desired. It also may cause regeneration through coupling in the common shaft. The capacitor was used for the simple reason that no better tuning unit was available, and we had a capacitor which seemed well suited for such use.

In this case the performance has been highly satisfactory because the front end does not need to give very high gain. Very good capacitors for FM are available for about $1.50 and one of these will save the trouble of improvising from the junk-box. On the other hand, the home-made capacitor using parts from the junk box, can equal it in performance.

The capacitor started as a three-gang unit in an ancient Scott receiver. It had three plates in two of the sections and a number in the third. What made the condenser attractive was the spacing of the sections which was wide enough for good placement of components in the various stages and low capacitance between sections. The rotor of each section was a heavy brass sleeve sliding independently on the

(Continued on page 60)

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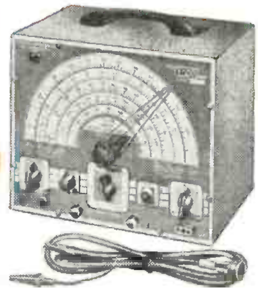

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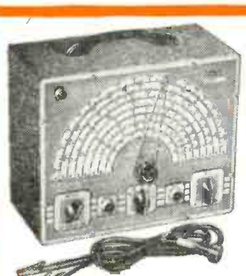

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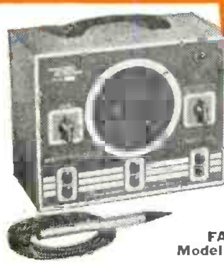

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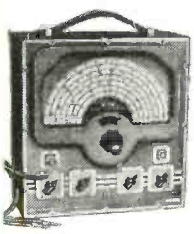

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⅜-inch steel shaft, and each sleeve was wiped independently by a heavy brass grounding strap. The capacitor had a chromed cover which completely shielded it, not only electrically, but also from dust and grime. It occurred to us that if the steel shaft were replaced by a low-loss dielectric shaft, each section would be electrically isolated and this would reduce the common coupling effects. The steel shaft was removed and cut in two places, leaving just enough at the two bearing ends to fit the sleeves solidly. The remainder was replaced with a length of polystyrene rod of the same diameter. The bakelite insulation was replaced with polystyrene strips, and the third section was cut down to three plates. The whole thing was then checked and adjusted until it operated smoothly.

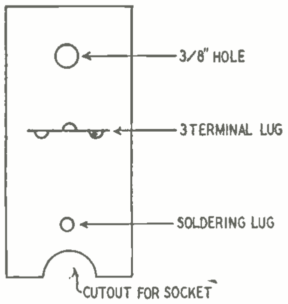

Fig. 1—Sketch of the partition shield.

The capacitors are connected to the coils with series ceramic capacitors of 25 μμf for the r.f. sections and of 20 μμf for the oscillator section. This reduces the minimum capacitance and gives a bandspread covering the FM band plus a megacycle or two on each end. The series capacitor also replaced what would have been a 2-inch lead.

If a commercial FM capacitor is used, the series capacitor is not needed to reduce the tuning range. If leads longer than 1 inch or so are necessary, it might be advisable to use a 50-μμf coupling capacitor instead of the leads. If the capacitor leads are kept within a total of 1½ inches or less, the result should be good.

The rotors of each section are grounded to the capacitor frame at a single point. A length of shielded braid, stretched to its thinnest diameter, connects this point to the socket ground. The braid has a relatively low inductance for a given length.

Before going into construction, a few words about the circuit. One of the big problems at these frequencies is getting a stable oscillator with an adequate signal over the whole band. This oscillator uses a 6J6 with the two sections in parallel. It works at a frequency higher than the r.f. because it is more difficult to track at the lower frequency with equal-section capacitors. The oscillator coil is identical to the r.f. coils, and all are standard National AR-5 coils without modification. No difficulty was experienced in tracking because, the series capacitor for the oscillator being the smaller, the total capacitance is less and because the coil slug permits plenty of leeway in inductance. The total minimum capacitance is less than 12 μμf, including circuit and tube capacitance. The two tube sections in parallel give an adequate and uniform carrier with good stability.

When this front end is used with the i.f. amplifier mentioned previously, there is no need for retuning after the initial few minutes. The i.f. amplifier and its detector are not affected as much by slight detuning as discriminator-and-ratio-type detectors. The front end is fed by a power supply without electronic regulation, but the supply has a heavy bleeder and the front end is fed through a 5,000-ohm series resistance which contributes to regulation. Changes of line voltage as great as 15 volts will not make retuning necessary.

The hot side of the oscillator filament is fed through a choke, and the other side is connected to the cathode so the filament current travels through the oscillator coil to insure hum-free performance of the oscillator. The only precaution necessary with this oscillator is to keep the leads to the grid, coil, and cathode as short as possible—less than an inch in any case.

The converter is another 6J6 with the sections in parallel. This reduces noise and increases gain. Aside from the arrangement of the components which will be discussed later, only one little trick is necessary with this converter. The capacitor across the i.f. coil must be removed from the shield can and placed near enough to the socket to keep the lead from plate to capacitor exactly 1 inch long. This gives just enough inductance to overcome degenerative effects. The inductance introduces a negative resistance component into the grid circuit which reduces the loading at input frequencies. Be careful not to make the lead longer, for a greater inductance might result in a negative input resistance and regeneration or even oscillation.

The converter is quite free of pulling effect, and the sensitivity is extremely good because of the high grid leak. All in all, it is a highly satisfactory converter with a good deal less noise than a 6AK5 r.f. stage and many times less than pentode or pentagrid mixers.

The converter is preceded by a cathode-coupled r.f. stage. If the specified layout or a close approximation of it is used, this is an uncritical type of r.f. amplifier to construct and adjust. There is a cathode choke in addition to the resistor. This choke is broadly resonant at about 100 mc with circuit capacitance and increases the gain. The filament, as all the others, is fed through a choke and has plenty of decoupling and bypassing. Button-type silver mica capacitors are used close to the chassis and the smallest size of 1,000-μμf mica capacitors are used where spacing between element and ground is too great for button capacitors. All ground returns are to a single point. The use of the tuning capacitor with insulated shaft no doubt accounts for part of the stability, but an ordinary capacitor would probably work very well if the same or similar layout were used.

The noise of this stage, though very low, is not optimum because the noise contributed by the parallel tube sections is twice that of a single section. However, the gain is more than enough to override the noise contributed by the converter.

To reduce the noise still further, a grounded-grid amplifier is used as an antenna stage, again with the 2 sections of a 6J6 in parallel. Thus connected, the 6J6 has about the same transconductance and less noise than the much more expensive 6J4, which has the lowest noise figure of all available tubes. The filament is kept at cathode potential by a simple bifilar choke.

The cathode input circuit uses a self-supporting coil wound of surplus silver-plated wire. A piece of No. 18 hookup wire stripped of its insulation will do. This coil is not very critical and need not have a very high Q. The exact inductance is not critical either because the stage is very broad; and if the circuit resonates with tube and stray capacitance anywhere from 80 to 150 mc, nearly maximum and uniform gain will be obtained over the whole FM band. The input impedance of this stage matches a 150-ohm line almost exactly but a mismatch to a 300-ohm line will not make any appreciable difference unless the front end is on the verge of regeneration. In this case, the standing waves on the line might throw the stages into regeneration. If a coaxial cable of 50 or 75 ohms is to be used, the coil can be tapped halfway for the input.

There is an input balancing coil, or elevator, between the cathode and the transmission line input to preserve the line balance and prevent the line from acting as an antenna. This is very important if the front end is used with the i.f. amplifier described previously because an unbalanced line would pick up c.w. interference and harmonics of the oscillator.

The decoupling and filter networks in the power leads are quite elaborate. The B-plus lead is filtered where it enters the chassis. This keeps 10.7- or 10.9-mc signals from the i.f. and helps keep the r.f.'s from the i.f.'s where they may be re-radiated and picked up by the front end to cause regeneration. The filament is also filtered and bypassed for the same reasons. There is a parallel resonant circuit in the B-plus line between the oscillator section and the r.f. sections. This consists of a 3.5-μh choke and a 50-μμf capacitor which resonate at about 11 mc and offer a high impedance to the i.f.'s. These measures are necessary to real-

(*Continued on page* 62)

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HRU DU Power Supply 24-28 V. at 70 amps. 2000 watt gasoline generator with electric starter, thoroughly checked 70.00
GE-Argon Glow Lamps. 2 watts. Box of 10. New 1.20
Blasting Machines. Originally manufactured for United States Army by White-Rodgers Electric Co. Detonate electric blasting caps. 10 Cap capacity. 3.00
Sound-powered Microphone. Chest type. Complete with bracket and long cord. Brand new 5.00
PE-103 Dynamotor 17.50
Tuning units for BC-375 Transmitter. TU-10B. brand new 2.00
TU-7B, TU-26B, TU 9B, TU8B, choice 2.00
Sperry A-5 Autopilot Amplifier rack. Contains 115 V. AC voltmeter and 350-450 cycle frequency meter. A total of 4 amplifier chassis, complete with tubes in each rack. 2—1631, 6—1632's, 3—1633's, 3—1634's and 2—1644's. Numerous transformers. A very hot parts item that you can't afford to pass up at 5.00
Ratchet Motor. Operated from 12-24 V. Similar to motor used for automatic tuning of SCR-522 transmitter and receiver. Ideal for remote tuning of mobile and other equipment. Rotates approx. 1 revolution per second. Brand new .... .35
Command set modulator BC-456A, Complete with tubes 3.00
FL-5C Radio Range Filter. Similar to FL-8 except used with remote range voice switch. 1.25
Navy Type RAK-8 Radio Receiver, complete with power supply. Frequency 15-1600 Kc. New 60.00
HS-23 Headsets. Excellent condition. .... pr. 1.50
HS-33 Headsets. Excellent condition. .... pr. $1.50
Stanley No. 4001 5" Navy type screwdriver. New .... .25
Phillips Cross-point size #1 screwdriver. New .... doz. 1.25
SCR-274N Mounting Racks Single, double or triple. Choice 1.00
Indicator Scope ID-41/APQ-13. Contains 1—5FP7, 1—6AK5 tubes, 5 grain-of-wheat 3 V. pilot lights, magnetic deflection yoke, condensers, resistors, potentiometers, sockets. 3.95
Tuning heads for command sets. Single, double or triple. Choice .... .75
BC-1158-A Radio Modulator, complete with tubes and tuning meters 17.50
Detrola Aircraft Receiver. Badly used but complete 2.50
BC-357 Marker Beacon Receiver. You know what it is. Here's our price 1.50
BC-1033B Marker Beacon Receiver. Again you know. 2.50
BC-457 Command Set Transmitter. 4-5.3 Mc. with tubes. 4.95
BC-458 Command Set Transmitter. 5.3-7 Mc. 6.00
RT-19/ARC-4 Western Electric Transmitter-Receiver for 110-152 Mc. operation. Similar to 522 except more compact. Complete, while they last 24.95
BC-314 Radio Receiver 50.00
C-1 Auto Pilot Amplifier. Convert one of these for radio controlled models, doors, etc. 24 V. operation, complete. 5.00
BC-312 Receiver. 1500-18,000 Kc. operation. 110 V. operated. 69.50
BC-344 Radio Receiver. 150-1500 Kc. 110 V. AC 69.50
BC-322 Walkie-Talkie (52-65 Mc. operation). Complete with antenna. Used, as is, serviceable condition 12.50
BC-222 Walkie-Talkie (28-52 Mc. operation). Complete with antenna. Used, as is, serviceable condition 12.50
Scoop! Scoop! Scoop! BC-221 Frequency meter. Covers 125-20,000 Kc. Battery operated. These are beauties 60.00
With modulation 80.00
T-17 Microphones. Brand new 2.00
T-17-B Microphones. Brand new 2.50
Relays. 18-30 V. DC. Pick-up voltage 14 V. maximum DC. RBM Manufacturing Company .... .25
Intervalometer. Electric timing device. Contains relays, switches, pilot lights, resistors, knobs, etc. 2.00
C-1 Auto Pilot Assembly. New. Contains 3 servo units, 1 gyro unit and 1 dashpot. Housed in metal container. 24.50
BL-Selenium Rectifier. Type 23751. 110-120 V. AC input. 110-135 V. DC output at .75 amps. Connect in parallel for higher current requirements. We have sold thousands of these. Use to convert AC to DC. New 1.25
Turbo amplifiers. We have had them advertised ever since we have been in business. Now we sell them to you without tubes .... 10 for 2.50
AN/PRS-1 Mine Detectors. If you need something to find pipes or metal buried underground or in a log, here it is. Close out price 9.75
Mine Detector SCR-625. There are but a few of these in the country. Esse has about 700 of them. Here's the finest detector that we know of that was ever built. When we price them the way we do within this ad, frankly, we are looking for dealers, exporters—in other words, quantity buyers. Yes, we will sell singly. Brand new, export packed. 49.50
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Quick-set vise. 3" adjustable jaws. Clamp for bench mounting. Does your bench need a vise? New. 3.50
Field telephone wire. 3-conductor stranded. Ideal for inter-communication systems, telephones, selsyn indicators. Use it inside or outside. 525 ft. roll. new 4.25
Collins AN/ART-13 Transmitter. We have been selling them previously at $234.50. These are tops, especially fine. Without 24 V. dynamotor 150.00
With 24 V. dynamotor 180.00
Wire-wound Resistors. Do you need them? We had them advertised in March issue of "CQ" and "Radio-Electronics" magazines. Although we are not using the name of the manufacturer, they are standard brands. We have thousands and thousands. 10 watt, 20 watt, 25 watt, 50 watt, 80 watt, 100 watt, 200 watt, fixed and variable. Assorted resistance ohms. Look them up. This month, if you can use quantity on any of them, we will give you terrific discounts. Write us.
Surplus Radio Conversion Manual. Printed by Technographic Publications. 115 pages. Articles on BC-221 Frequency Meter, BC-342, BC-312, BC-348, BC-946, SCR-274N, SCR-522, etc. Have one of these in your library. It is indispensable. 1.25
Did you see those Navy Model ATD Aircraft Radio Transmitters, manufactured by Bendix, advertised on page 44 in March 1950 "CQ" magazine at $225.00. The complete unit contained one CRR52253 transmitter, 4 tuning units covering 200-540 Kc., 540-1500 Kc., 3000-9050 Kc., one dynamotor assembly, one remote indicator unit, one remote control unit, one set of operating spares such as tubes, condensers, motor brushes, etc., necessary plugs and attaching cables, one instruction book. Be one of the lucky fellows that gets one of these. We have never before seen them advertised and boy would we like to have a store full of these. For this month only, we are cutting the price on them to 99.50
They are brand new
Buy your Television tubes at Esse during Esse's inventory reduction sale. We're too fat. Help reduce us. Can you beat it. 10BP4—New 16.00
12LP4—New 18.00

Don't think, because of these prices, that Esse is going out of the surplus electronic business. What have you to sell? Describe it in a letter with full details and Esse will try to buy.

ESSE RADIO CO., 40 W. SOUTH ST., INDIANAPOLIS, INDIANA

ize the full value of the low noise and high gain of the front end and i.f. stage. Any interference picked up at the intermediate frequencies will be amplified to some degree in spite of the two tuned r.f. circuits and may add enough additional noise to reduce the sensitivity.

No claim is advanced that this front end has the best possible noise figure. There may well be other combinations of r.f. amplifiers and converters which give better results. Additional work on the input stage and its coupling to the r.f. stage may reduce the noise somewhat; but, as it stands, this combination is about as good as possible with ordinary measuring and testing equipment. The sensitivity is well below 1 microvolt. As a matter of fact, any signal distinguishable from the background noise is readable, although that does not mean it would provide good listening. This seems to be about all one can expect. It is difficult to measure gain accurately at these frequencies with ordinary service-type equipment and no great effort was made to attain high gain, but the amplifier provides a gain of at least 40 db at the high-capacitance end.

Construction details

At these frequencies the mechanics of construction are extremely important. Great care in placement, shielding, dressing of components and wiring, and other such details is essential. The layout used in this front end should be duplicated as closely as possible unless previous experience at these frequencies indicates otherwise.

The chassis used is from one of the tuning units of a BC-610 transmitter. This chassis is well suited for this amplifier and will greatly reduce construction work; if one can be obtained at a reasonable price, it is well worth getting. However, a regular 4 x 8 x 1½-inch aluminum chassis with a cover plate will make nearly exact duplication possible.

The arrangement of components and shields is quite simple and is the same for the two r.f. stages and the converter. The tube sockets and coils are mounted along the center line of one of the long narrow edges of the chassis. In the tuning unit chassis, the sockets were mounted in holes already present. Three of these are exactly right to take a shielded mica-filled socket, and the fourth needs only slight enlargement. If a new chassis is used, the tube sockets can be spaced 2 inches apart, with the coils in the middle of the intervening space. Better yet, the sockets can be spaced to match the tuning capacitor used, so that the leads from capacitor to coil will be as short as possible.

The partition shields are cut from aluminum or copper sheet in the shape indicated in Fig. 1. The shields are fastened to the chassis only at the rear, and are grounded at the front to the middle of the tube socket. The semicircular cutout along the edge fits over the socket and must clear the socket terminals. The shield is mounted to bisect the socket, leaving the grid and cathode leads on one side and the plate and one filament lead on the other. The other filament lead, pin 4, will be exactly in the middle under the shield; and, when oriented this way, the socket mounting screws will be placed so that one is on one side of the shield and the other on the other. Do not drill the mounting holes for the sockets until you have checked this orientation.

Before the shield is put in place, the sockets are mounted, with a soldering lug under the mounting screw between the plate and cathode leads. A short length of bare hookup wire is worked through the hole in the center shield of the socket to pin 4 and through the soldering lug to make a grounded bus bar. The filament choke and its button capacitor are wired in, and the ground side of the capacitor is soldered to pin 4. The socket ends of all the chokes, resistors, and capacitors are then wired in and the ground ends of the bypass capacitors are wired to the common ground.

The shield has a 3-terminal lug mounted about 2 inches above the cutout and a soldering lug just above the cutout. There are also one or more small holes at the back to pass the power supply leads from one stage to another. The shield is fastened in place and the soldering lug above the cutout is soldered to the center post of the socket. The plate circuit components can now be wired to the terminal strips. Before the coil is put in place, a short lead should be soldered to the grid terminal of the socket and the lead from the tuning capacitor (actually the 20-μμf ceramic capacitor) arranged to connect to the grid tap of the coil with the shortest possible lead. When the coil is put in place, it is necessary only to connect the leads to the coil and the coupling capacitor from the previous stage.

The same arrangement, with only slight changes, is used in the two r.f. stages and the converter. The arrangement within the oscillator compartment is not critical except that the lead of the coupling capacitor between converter and oscillator should not exceed 1½ inches, and the leads to the coil, grid and cathode should be as short as possible. No dividing shield is needed for the oscillator socket.

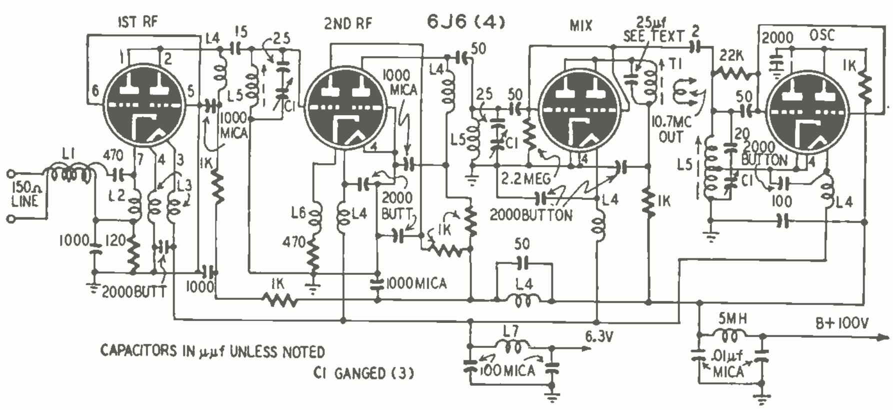
The input filters are now arranged in the oscillator compartment. Do not ground any supply line bypass to the shield between oscillator and converter. Use a single, separate ground point for these bypasses. Mica capacitors are specified for the filters. Paper capacitors will do, but micas are more reliable and efficient. This arrangement is simple and effective, and it makes a good-looking job.

Alignment and adjustment

If the specified coils and a capacitor with a minimum capacitance of 5 μμf per section or less is used, there should be no difficulty in putting this front end into operation. With a 100-mc signal fed through a 1-turn loop of hookup wire wrapped around the ground end of the converter coil, the oscillator and converter can be tracked by adjusting the coil inductance. Then the hookup wire loop can be moved to the r.f. coil and this stage adjusted. Finally, the signal can be fed to the antenna input, and the whole front end peaked. Be sure to check each stage several times.

If the layout has been followed carefully with good workmanship, and the plate supply voltage is not much over 100, there should be no oscillation. If there is oscillation, check the partition shields for grounding and for undesired grounding of tube contacts to the shield. If the oscillation is sporadic and occurs suddenly at any point in the tuning range, check the capacitor wipers for good contact and the circuit for loose connections, especially ground connections. If one part of the range is hotter than the rest, check the filters in the plate and filament leads.

Much trouble will be saved if great care is used in the initial wiring, especially in making every joint mechanically strong and well soldered. Be sure to make the right connection to the cathode-coupled stage. It is easy to confuse the various socket contacts and get the wiring of the two sections mixed up. Finally, be sure to avoid radiation by both front end and i.f. This model is completely shielded, capacitor and all, so there is not much



Schematic of the front end. It is designed for a high-gain i.f. amplifier.

stray pickup except of the harmonics of the second oscillator in the i.f., and this amounts to about 1 microvolt.

Tuning mechanism and dial

There are a number of dials and drives available commercially and the constructor has his choice. The tuning knob should have a ratio of at least 8 to 1, preferably more. In this model, the arrangement is entirely improvised. The drive is a 50-1 gear train made from an old-fashioned hand-wound phonograph. It works smoothly and the high ratio makes tuning very simple. A crank knob is used for fast tuning.

The scale and escutcheon match the SX-32 receiver and are made of surplus parts from these receivers. A ¼-inch shaft and coupling were mounted in one corner of the capacitor frame to take the dial. This shaft was coupled to the capacitor shaft with fishline held taut by a spring. The difference in diameters provides a 270-degree rotation of the dial for a 180-degree rotation of the capacitor. The dial is of translucent plastic originally intended for another receiver. The old scales were removed by rubbing it with a wet stick of white rouge and new ones re-inked with india ink. A pilot light was mounted behind the scale to light it. The escutcheon is a replacement for the SX-32 receiver.

It is improbable that this arrangement can be duplicated exactly. However, old broadcast receivers provide a variety of excellent drives and dials which can be modified to fit the need nicely. A little searching and a little head-scratching should produce a system at least as good as this one.

	Coil Data
L1	15 double turns No. 28 d.c.c. wound side-by-side (bifilar) on ⅜-inch form.
L2	No. 18 bare tinned or copper, double-spaced on ⅜-inch form, ¾ inches long or 10 turns. Removed from form and self-supporting. (See text.)
L3	15 double turns No. 28 d.c.c. twisted together on ¼-inch ceramic form.
L4	3.5-μh choke of No. 28 enamel close-wound on ¼-inch form to ¾-inch length. 6 required.
L5	National AR-5. 3 required.
L6	1.7-μh choke or No. 28 enamel, wound double-spaced to ⅜-inch length on ¼-inch form.
T1	10.7-mc midget i.f. with secondary removed. 4 turns of No. 28 enamel wound below B+ end of primary.
L7	15-20 turns No. 16 enamel wound to 1-inch length on ⅜-inch form.

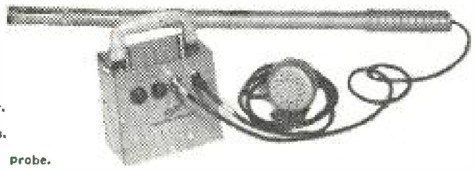
The performance of the front end with the i.f. amplifier mentioned has been unusually good. It has given regular daily reception with full limiting of FM stations up to 150 miles distant, and almost every FM station within a radius of 300 miles has been logged. The combination provides almost complete quieting on a 1-microvolt signal; and every signal which can be recognized as a signal amid the background noise is readable, although not of entertainment value.

BARGAINS AT HERSHEL RADIO CO

● DETROIT 8. MICHIGAN

THE "FORTY-NINER" GEIGER COUNTER

$89.50

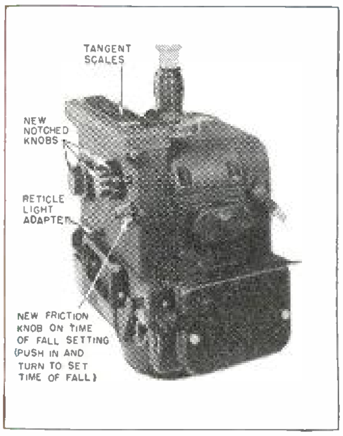


- Light weight uranium detector.
- Detects beta and gamma rays.
- Equipped with 36 inch search probe.
- Contains two 67½ volt Minimax batteries in the well-known type of relaxation oscillator supply.

Weight 4½ lbs. complete; size 4"x5"x6". Beautifully finished case with handle.

Complete with four tubes, including Geiger tube, batteries, search probe and ear-phone.

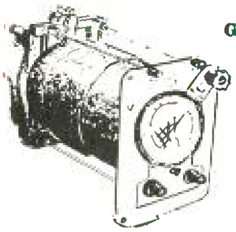
S-1 BOMBSIGHT WITH M2 MODIFICATIONS



Contains many precision gears, cams—planetary assemblies gyros—switches, motors, slide rule, tangent scale, adjustable coated optic system, outside silvered mirrors. Comes in heavy, metal, safe-like container.

Brand new and complete.

Shipping weight 150 lb. $69.95



BANK - CLIMB GYRO - - CONTROL

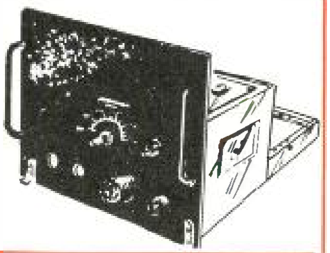
For Mark 4 Automatic Pilot

$4.95

ALL-PURPOSE CHASSIS

Contains' 3 plugs. 2 vol. controls, 1 25 wt. resistor 2600 ohms, 250.000 ohms 10 wt. resistors. 13,-500 ohms. 10 wt. resistors. 3 ½ mmfds. 3 bathtub condensors 600V. 3 sockets. 4 shock mounts and many other parts in a blank top chassis.

95¢



POTTER AND BRUMFIELD OVERLOAD RELAYS

1, 5000 ohms, coil current 10 Ma., Relay 2, 110 V, 60 cy. AC. coil S.P.D.T. F236 $1.95

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Approx. 50 MMFD. per section with individual air tuned padders. . . . 18 to 1 vernier drive. F-243 $1.95

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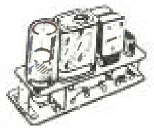
Just the tube for that 1KW final—typical operation 2500 volts at 400 MA. An ideal tube for that induction heater or dielectric heater. Efficient operation at 1500 V. to 3000 V.

BC-746 Tuning Unit



Plug in transmitter tuning unit from army Walkie Talkie. Contains antenna and tank coils, tuning condenser, transmitting and receiving crystals. Ideal transmitter foundation. Shipping Wgt. 1 lb. Each.......... 95c

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5-TUBE SUPERHET AC-DC KIT

Full-sized 5 Tube Superhet Kit with automatic Volume Control, Built-in Antenna, Dynamic Speaker, Brown Plastic Cabinet. Build it yourself and enjoy fine performance! Uses 12SA7, 12SK7, 12SQ7, 50L6, 35Z5. For 110 volt AC or DC. Complete..........$12.95

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Lowest Price Ever! Slightly used, guaranteed perfect and clean. Single button carbon handmike. Light, efficient. 200 ohms. Press-to-talk switch. 5-ft. rubber cord with PL-68 plug attached.

Special.................. 69c

ULTRA HIGH-FREQUENCY TRANSMITTER T-85/APT-5

BRANO NEW! ONLY $95.00

1500 Megacycle Transmitter. made for U.S. Government, complete with the following tubes: 2-6AC7, 1-6L6, 2-829, 1-931A; 1-6AG7, 1-522 Ultra high freq. tube. Complete with high freq. cavity. 1 Blower to cool the 522, 1 time delay relay, 2 filament trans. cond. and many other component parts for ultra high frequency work. It has a frequency checker, complete Lecher wires, with slider and sensitive bulb for checking the wave length. The Lecher wires are so calibrated that the setting of the slider may be read directly in Centimeters. Operates on 115V. AC for filaments only. Does not include any plate supply. The tubes alone are worth many times more than what we are selling the complete transmitter for. Packed in original case—contains instruction book. Wgt 118 lbs.

G.E. PHOTOCELL . . 95¢

Type used in movie projectors, burglar alarms, etc.

Butterfly Condensers

Oscillator assembly 76 to 300 MC with acorn tube socket mounted on condenser $3.95

Type B Frequency range 300-1000 megacycles 2.95

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STANDARD MAKE CAPACITORS

2000 MFD, 50 V..............F309 $1.29

(W.P.) 2000 MMFD at 15V......F308 95¢

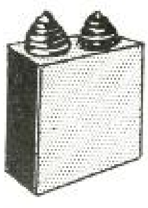
STANDARD MAKE MICA CAPACITORS

.0004 MFD .002 MFD, 3000 VDC.....49¢

COAXIAL FITTINGS

5c	25c	35c	20c
HOOD	SOCKET SO-239 83-1R	PLUG PL-259 83-1SP	ANGLE-ADAPTER M-359 83-1AD

INDUSTRIAL PAPER OIL CAPACITATORS



1. MFD 5000 V. $2.95

1. MFD 6000 V. $4.95

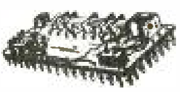
2. MFD 6000 V. $8.95

2 MFD. 1000 V. 95c

OUTPUT TRANSFORMER

No. 227. Push pull 6V6's to 6-8 ohm voice coil, excellent characteristics.....49¢ each

BK 22 K RELAY



$2.95 Used in conjunction with SCR-269F, changeover contains 28V. step relay 5 deck. 6 position switch. 12V. DPST.

Banana Jack and Plug

75¢ Dozen Sets

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Normally opens at 95° F85-1 H5 49¢

MODULATION TRANSFORMER AND DRIVER TRANSFORMER

RC 1206 modulation transformer. 815 Class AB2. 56W. audio. RC 1205 driver transformer. 6SN7 to 815, Class AB2—Companion to RC 1206.

ONLY $4.95 FOR BOTH UNITS

FILAMENT TRANSFORMER

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For High Voltage Rectifiers. PRI. 115V., 50/60 Cycle.

SEC. 5V., C/T @ 10 Amp.

35 KV R.M.S. Test 12 KV D.C. Operating. Uses 872A Tube or other tubes.

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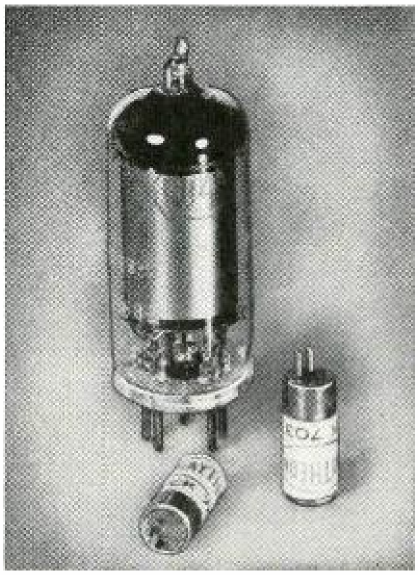
872-A....$1.75

Experimental Circuits For Crystal Triodes

By RUFUS P. TURNER, K6AI



Two CK703 germanium crystal triodes shown with a 1U4 tube for size comparison.

THE germanium crystal triode, also known as the *transistor,* can be applied in a variety of ways to experimental electronic circuits. Much interesting and valuable work can be done with these new components by experimental-minded radio technicians who are interested in crystal devices. Small in size and having no filament, the crystal triode offers attractive possibilities in circuit miniaturization. The Raytheon CK703 crystal triode is only 0.225 inch in diameter or slightly more than ¼ inch and has an over-all length, including its tiny base pins, of 0.775 inch (slightly more than ¾ inch). See Fig. 1.

Operating data for the CK703 and base connections are given in the accompanying table. The crystal triode has two whiskers (emitter and collector) in contact with the germanium crystal. In the CK703 the two whiskers are connected to the base pins. The crystal is connected to the brass shell which encloses the device. The photo shows two CK703 transistors beside a 1U4 miniature tube for size comparison.

Contrary to vacuum-tube practice, a *positive* bias voltage is applied to the emitter whisker (grid) and a *negative* voltage to the collector whisker (plate). Unlike the vacuum tube, the transistor has a low input impedance and high output impedance. Input (emitter) impedance of the CK703 is 500 ohms; output impedance (collector) is 10,000 ohms. Aside from these features, transistor circuits resemble triode tube circuits.

In about three months of experimenting, the author assembled and tested several dozen breadboard circuits either worked out entirely by himself or suggested by his associates. The circuits given in this article are the ones which performed best and seem most satisfactory for amateur experimenters.

Audio amplifiers

The author had no success with resistance-coupled transistor audio amplifier circuits. In the resistance-coupled circuit, the 10,000-ohm output of one crystal triode must feed into the 500-ohm input of a second triode. This results in considerable signal voltage reduction, and a prohibitive number of stages is necessary for enough voltage gain. Also, the collector resistance of one stage, interstage coupling capacitor, and lower emitter resistance of the following stage constitute a high-pass filter which spoils frequency response.

Best results are obtained with transformer coupling. However, the transformers must be connected backward from conventional practice—that is, the high-impedance winding must be connected to the output of one transistor and the low-impedance winding to the input of the following transistor.

(*Continued on page* 68)

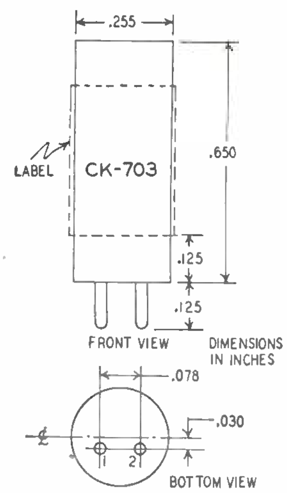


Fig. 1—Dimensions of the CK703 triode.

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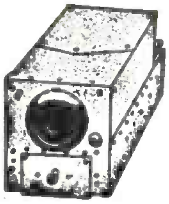
ARMY AIRCRAFT RECEIVER—BC-946-B



Covers 520 Kc to 1500 Kc Broadcast Band. 6 Tubes: 3—12SK7, 1—12SR7, 1—12A6, 1—12K8. Designed for dynamotor operation; can be easily converted to 110 volt or 32 volt use. Two IF Stages. Three-gang tuning con. BRAND NEW, in sealed carton, with tubes and instruction manual, less dynamotor **$29.50**

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BC-454 RCVR.	$4.95	7.95
BC-455 RCVR.	6.95	9.95
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BC-457 XMTR.	6.95	8.95
BC-458 XMTR.	6.95	8.95
BC-459 XMTR.	...	23.95
BC-696	14.95	24.95

BC-348 Receiver, New	$149.50
BC-348 Receiver, Used, good as new	129.00
BC-221 Freq. Meter, Exc. Cond.	77.50
MN-26C Compass Rcvr. New	28.50

BC-645 XMTR RECEIVER
15 Tubes 435 To 500 MC

BRAND NEW!

$16.95 each

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PE-101C DYNAMOTOR for above BC-645 .... **$2.95**

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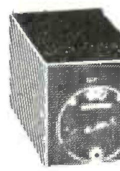

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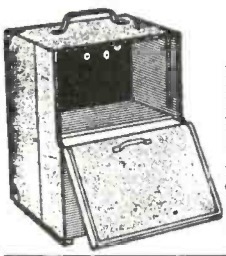

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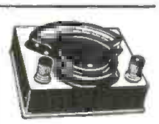

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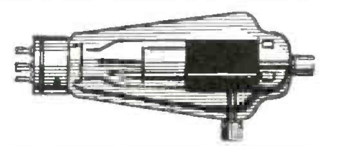

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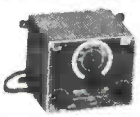

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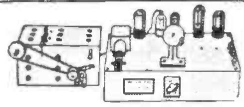

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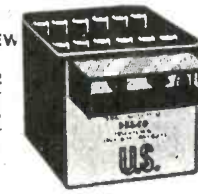

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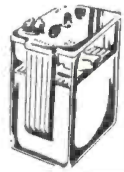

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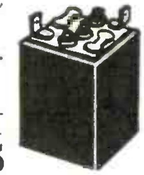

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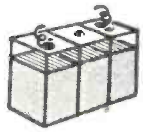

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Operates over a frq. range of 300-1400 MCPC with nominal output of from 10-30 watts. Comes equipped with 110 V. 50 CPS filament transformer; blower: lecher wire test freq. set and 8 tubes: 1—931A, 2—6AC7, 2—6AG7, 1—6L6G, 2—829B and 1—3C22 (GL522 Oscillator). Brand new in original box, operating instructions. Manual included................. **$69.50**

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.5 mf 600V....17c	3-3 mf 600V...88c
2.0 mf 600V...34c	.25 mf 6000V.$1.79
1.0 mf 1000V..49c	8 mf 1000V.. 2.25
1.0 mf 1500V..69c	

Figs. 2, 3, and 4 show three transformer-coupled audio amplifiers using crystal triodes.

The circuit in Fig. 2 uses a "cathode" resistor to obtain the required 0.2-volt d.c. bias required by the emitter electrode. This resistance will be between 500 and 1,000 ohms, the exact

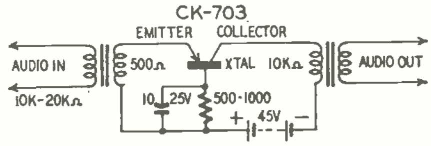


Fig. 2—Self-biased audio amplifier.

value for best output and stable operation is being determined experimentally for individual crystal triodes.

The author's procedure was to connect a 1,000-ohm wire-wound rheostat (volume control type) in each "cathode" lead and to adjust it for best operation. The rheostat then was removed from the circuit without disturbing its setting, and its resistance was measured with an ohmmeter. The rheostat then was replaced with a series-connected combination of ½-watt fixed resistors giving the same total resistance.

This single stage gives an output of 2 milliwatts or slightly better for a signal input power of 50 microwatts. Several stages may be operated in cascade, as in Fig. 3, with a maximum power gain of 16 db per stage.

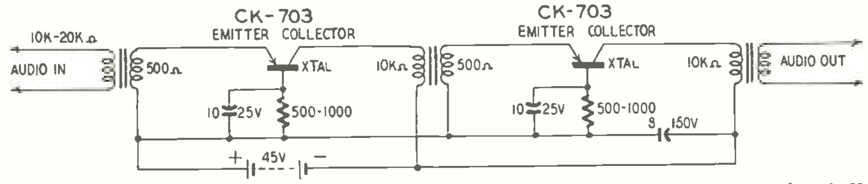


Fig. 3—Two transformer-coupled stages in cascade. The gain per stage is 16 db.

Fig. 4 is a circuit for operating the crystal triode at fixed bias. Both emitter and collector voltages are adjusted with 5,000-ohm potentiometers in series across the single 45-volt battery. Potentiometer R_1 is set for a positive voltage of 0.2 volt between emitter and crystal terminals; R_2 for a negative voltage of 30 volts between collector and crystal terminals. Make all voltage measurements with a d.c. vacuum-tube voltmeter. Remove the input signal from the amplifier while making voltage adjustments.

This circuit gives somewhat higher output power than the self-biased arrangement. It also permits grounding of the metal shell (crystal terminal) of the CK703 to chassis, an advantage in some constructions.

The author's three-stage amplifier of this type, feeding into 2,000-ohm headphones, gave a small amount of steady noise hiss, which is characteristic of transistor operation. This noise is not severe, however, and is not noticed at all with a full-output or half output signal. The inherent noise level of the transistor will, at least for the present, limit the number of maximum-gain stages which can be used in audio service. With the relatively low power output of the CK703, we did not get loudspeaker operation with any audio amplifier circuit.

Interstage transformers used in these audio amplifier circuits must provide a 10,000-to-500-ohm impedance ratio. This corresponds to a 4.47:1 turns ratio. A satisfactory miniature transformer for this purpose is the U. T. C. Ouncer type 0-9. A somewhat larger small-size transformer is the tube-base Kenyon A-40. Larger-size transformers which can be used where physical dimensions are of no consequence include Stancor A-3250, Utah 8316, and U. T. C. S11 and S14.

Unless the "cathode" resistors in circuits Figs. 2 and 3 are adequately bypassed, the circuit will tend to oscillate because the resistance is common to both emitter and collector circuits.

This oscillation starts off as a slight rise in the normal noise level and the ordinarily light hiss takes on a sharp, brittle characteristic similar to the frying noise of a superregenerative receiver. In severe cases, the hiss breaks into a ragged singing or whining sound.

D.c. voltage amplifier

Fig. 5 is the circuit for a d.c. voltage amplifier with a voltage gain of 10. Maximum d.c. signal input voltage is 0.1 v. At zero signal voltage input, the d.c. voltage across the output is 15 volts. With a signal input of 0.1 volt, the voltage output increases to 16 volts as measured with a d.c. vacuum-tube voltmeter. This 1-volt increase represents a voltage gain of 10 through the amplifier. The initial 15 volts output can be bucked out of an external high-resistance voltmeter circuit with an external voltage of the same amount. This will reduce the initial meter reading to zero. The meter then will be deflected upward proportionally to applied d.c. signal voltages applied to the amplifier input terminals.

For higher gains, several such amplifier stages may be cascaded in the same way as conventional d.c. amplifiers of the tube type. Three CK703 stages, for example, will provide a d.c. voltage gain of 1,000.

The single d.c. amplifier stage gave no noticeable drift effects. However, in several cascaded stages, the drift troubles of tube-type direct-coupled d.c. amplifiers were found. That is, small current or voltage shifts in the first stage showed up as rather sizeable changes in the output meter reading.

Signal tracer

In Fig. 6, a shunt-diode crystal rectifier probe is followed by a CK703 d.c. amplifier stage. This unit may be used for signal tracing in either a.f. or r.f. circuits. It will operate equally well with modulated or unmodulated signals.

The amplifier allows higher sensitivity than ordinarily can be obtained with the shunt-diode crystal circuit. The shunt-diode arrangement is desirable, since the input capacitors isolate the instrument circuit from any harmful d.c. component in the circuit under test. Also, the circuit under test is not required to complete the d.c. return path of the crystal rectifier.

An a.f. or r.f. input signal of 0.1 volt

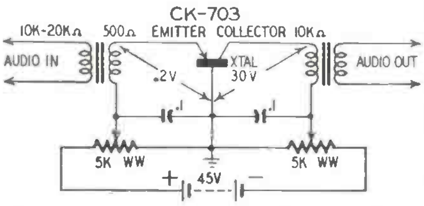


Fig. 4—A fixed-bias audio amplifier.

r.m.s. will deflect the indicating meter to full scale. Stronger signals should be reduced by turning down the output control of the generator which supplies the signal.

Regenerative broadcast receiver

Fig. 7 shows the circuit of a simple regenerative broadcast-band receiver with CK703 detector. If desired, this detector circuit can be followed with a transformer-coupled CK703 audio amplifier, such as the ones given in Figs. 2 and 3.

In this circuit, regeneration (and

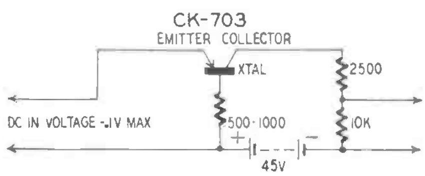


Fig. 5—D.c. amplifier with gain of 10.

also oscillation) is obtained through coil L2, which is a common impedance to both input and output circuits. L1 and L2 are primary and secondary windings, respectively, of a standard, factory-made broadcast antenna coil. Regeneration is controlled with the 5,000-ohm rheostat in the emitter circuit.

This simple circuit gave much pleasure to the author, who has worked with

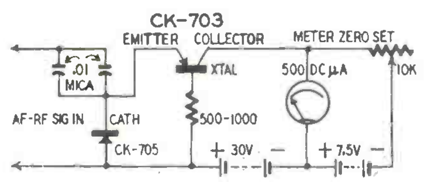


Fig. 6—A CK703 signal tracer circuit.

crystals since the early 1920's and often despaired of their inability to make straight c.w. signals audible. It was exhilarating to hear this little detector whistle when it is tuned in on a carrier with the regeneration control advanced.

R.f. oscillator

The radio-frequency oscillator circuit shown in Fig. 8 follows the design suggested by Dr. T. Stuart Martin and

Harold Heins in their paper "*Germanium Crystal Diode and Triode Development*" in Proceedings of the Radio Club of America (Vol. 26, No. 2, 1949).

The frequency is determined by the

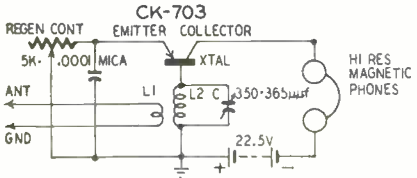


Fig. 7—A broadcast receiver hookup.

values of L1 and C3. Tuning capacitor C3 may be a 350- or 365-μμf midget unit. For low frequencies, L1 and L2 are the two coils of an i.f. transformer. For higher frequencies, factory-made test oscillator coils may be used, or satisfactory coils may be wound, using the tables given in the various radio handbooks.

A 2½-millihenry pi-wound r.f. choke as L1 and a 0.001-μf silvered mica capacitor as C3 gave a frequency close to 100 kc. The r.f. output was checked at 2 volts r.m.s. with a high-impedance r.f. vacuum-tube voltmeter.

The 5,000-ohm "cathode" rheostat is adjusted to start oscillation and also to control oscillator output amplitude. Output will be highest at the low frequencies, decreasing rather rapidly above the standard broadcast band. This circuit gave more stable performance than one using tickler feedback.

At 1500 kc, the output signal voltage could not be detected on the 0-3-volt scale of an r.f. vacuum-tube voltmeter, but a beat note could be obtained in a receiver tuned to a 1500-kc broadcast station.

The r.f. oscillator may be modulated by the transistor audio oscillator shown in Fig. 9.

Audio oscillator

The CK703 audio oscillator circuit shown in Fig. 9 uses an Ouncer trans-

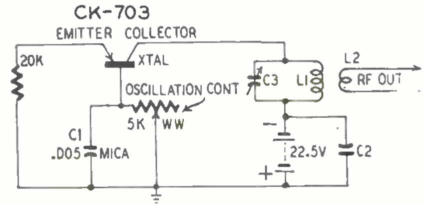


Fig. 8—An oscillator circuit using the triode. Output is 2 volts at 100 kc.

former to provide tickler-type feedback. Maximum output of this circuit is approximately 10 volts r.m.s. across 10,000 ohms resistance.

The frequency of oscillation is determined by the fixed capacitor C1 and

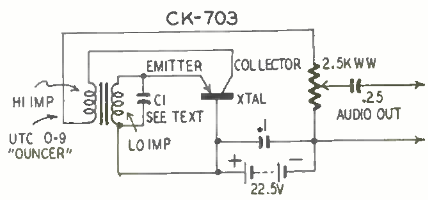


Fig. 9—An audio oscillator circuit.

inductance of the low-impedance winding of the transformer. A capacitance of 0.1 μf will give a frequency of approximately 600 cycles. Other frequencies may be obtained by switching in other capacitances.

The circuits described in this article are only some of the possible uses to which the germanium crystal triode can be put. The experimenter can use these as a starting point from which to work out new circuits. Besides adapting it to standard circuits, the crystal triode has many interesting possibilities such as using it with printed circuits for greater space saving or with the new light-sensitive germanium crystal known as the phototransistron in photoelectric control circuits.

Germanium Crystal Triode Type CK703

Terminal Connections:

Lead 1	Emitter
Lead 2	Collector
Case	Crystal Connection

Maximum Ratings:

Collector voltage	–70 volts
Collector current	4 ma
Collector dissipation	200 mw
Emitter current	10 ma

Characteristics and Typical Operation:

Collector voltage	–30 volts
Emitter voltage	0.2 volts
Collector current	2 ma
Emitter current	0.75 ma
Transconductance	5000 μmhos
Collector impedance	10,000 ohms
Emitter impedance	500 ohms
Average power output*	2 mw
Average power gain*	16 db

*Measured at 50 μw input power to emitter

Mobile Radio Service

Two-way radiotelephone service offers an important field for technicians

By I. QUEEN

MANY radio technicians are taking advantage of opportunities in the widening field of two-way radiotelephone communications. Numerous mobile and fixed stations are now owned and operated by public utilities, transportation lines, public telephone companies, taxicabs, trucking fleets, and other groups. Channels are assigned in the 152-162-mc band for this type of communication.

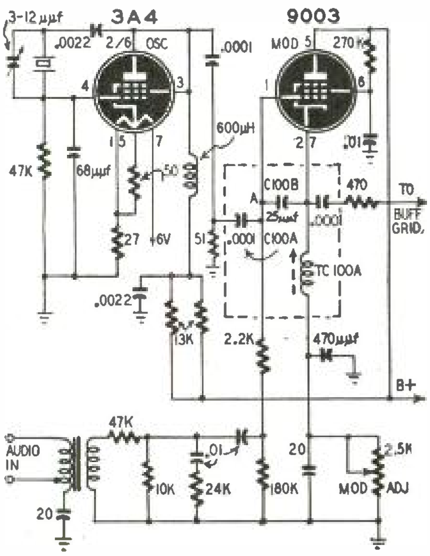


Fig. 1—Modulator circuit of PRT 150GT

Mobile and fixed radiotelephone equipment requires expert installation and maintenance. Adjustments to a transmitter may be made only by a licensed (second-class telephone or higher) technician. However, an unlicensed person also may do the work under direct supervision of a licensed person.

The transmitters are all crystal-controlled and phase-modulated. Phase modulation is one of the simplest possible means of superimposing intelligence on a carrier and requires practically no audio equipment. Its effects as far as the receiver is concerned are exactly the same as FM.

Two practical methods of making the phase of a signal change at an audio rate are used in mobile transmitters. The most common is to combine two signals from the oscillator. One is a direct feed and is in phase with the oscillations; the other is fed through a phase-shifting network and leads or lags the oscillator voltage about 90 degrees. Varying the gain of one path relative to the other varies the proportions in which the two quadrature (90-degree-apart) components are mixed. The phase of the resultant varies accordingly.

A less common method takes advantage of the fact that a reactance shunted across a signal source changes the phase of the signal. A fixed reactor would produce no modulation (though it may be used to produce the 90-degree-out-of-phase voltage needed for the "mixture" method). The change in phase is proportional to the value of the reactance; thus if that is *varied* at an audio rate, the phase will vary with it. The practical way to produce this effect is to shunt a reactance tube across the oscillator output. While the frequency of the crystal oscillator cannot be changed, the phase of its output varies in step with the audio at the reactance-tube grid.

Philco PRT 150GT

This transmitter uses a Pierce oscillator (Fig. 1). The modulator is excited by two signals at point A, r.f. from the oscillator and a.f. from a single-button carbon mike. During negative audio peaks the modulator tube is cut off, leaving only an L-C series network between point A and ground. The reactance of coil TC100A at the oscillator frequency is half that of the capacitor C100B. If, therefore, the voltage across the coil measures 1 unit, that across the capacitor measures —2 units. The r.f. input to the combination must be the vector sum of these two voltages, or —1. Since the +1 volt across the coil is the output and the input is at —1, input equals output but has opposite phase.

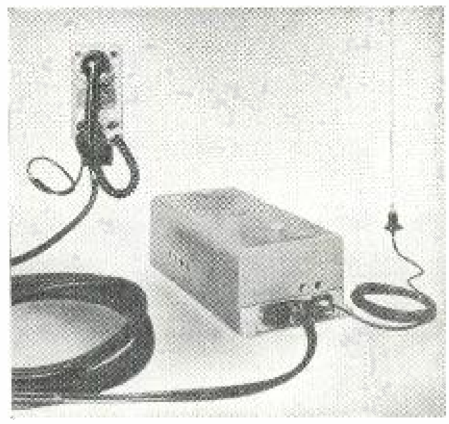


Photo of the Link radiotelephone unit.

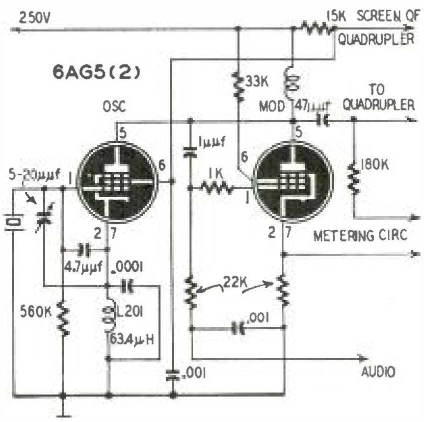


Fig. 2—The G-E set has reactance tube.

During positive peaks the modulator tube, a cathode follower with a gain of 1, is fully conductive. The cathode load is the coil TC100A, the output of which, as in any cathode follower, is in phase with the input.

At full tube conduction, the input

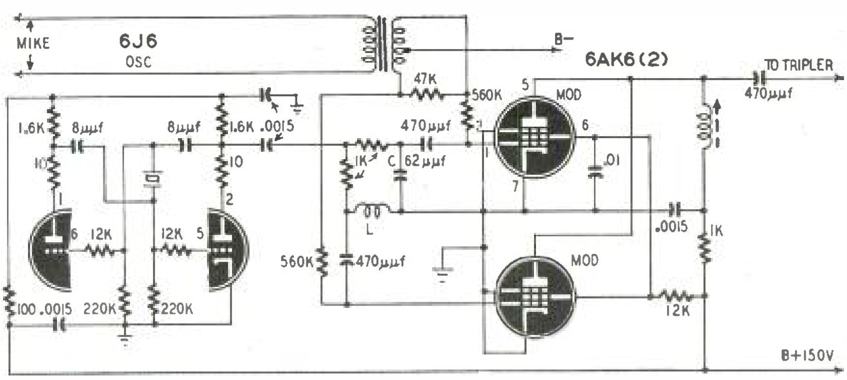
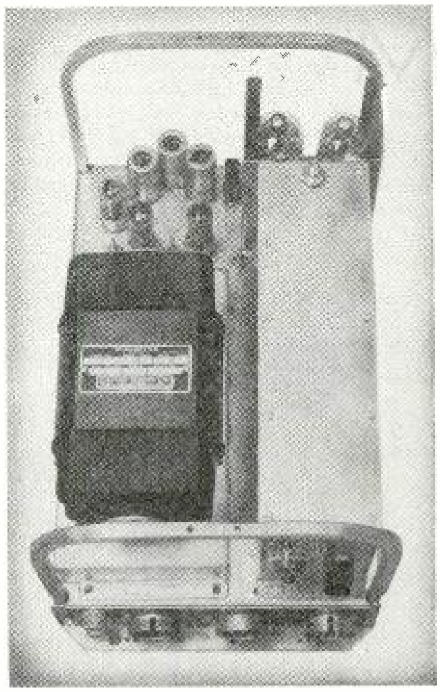


Fig. 3—The modulator output is shifted in phase by varying output of each tube.

(grid) and output (cathode) voltages are equal and in phase. At intermediate audio voltages, when the tube is partially conducting, the phase of the output varies in accordance with the audio. There is some AM, as in all these modulator circuits, but it is swamped out by the following class-C stages.

General Electric ES1B

This model is a single unit comprising mobile transmitter, receiver, power supply, and controls. The harmonics of the crystal oscillator (Fig. 2) are accentuated by coil L201. The second tube behaves like a reactance because of



A top view of the Harvey transmitter.

capacitive feedback from its plate to grid, the reactance value being controlled by the audio signal. This reactance across the r.f. source varies the phase of the signal.

Raytheon UM15-1

This mobile unit includes receiver and transmitter.

The 6J6 used as a push-pull crystal oscillator (Fig. 3) feeds the two 6AK6 modulator tubes separately. The upper tube receives an r.f. voltage which lags the oscillator voltage due to C. The other tube receives voltage which leads because of L. The modulator output voltage may be shifted in phase by varying the output of each tube. Speech is applied to the modulators in push-pull. During modulation, the gain of one tube is increased and the other decreased at an audio rate.

Link Type 2210

In this single unit which contains transmitter, receiver, and power supply, the modulator circuit (Fig. 4) is similar to an amateur NBFM method described on page 60 of the December, 1948, issue of RADIO-ELECTRONICS.

Because of its large cathode resistor, the modulator triode has extremely low gain. Its "amplified" output, in fact, compares with the voltage appearing across the load due to the path through the internal plate-to-grid capacitance of the tube.

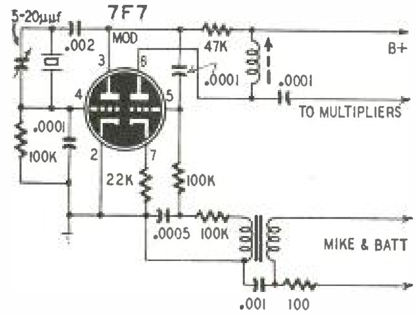


Fig. 4—Circuit of the Link modulator.

The r.f. reaching the load through the interelectrode capacitance is fixed in amplitude and is about 90 degrees out of phase with the input. The output produced by the amplifying action of the tube is 180 degrees out of phase with the input and varies in amplitude according to the audio applied to the grid. The mixture produces a resultant phase shift varying from 90 to 180 degrees.

Harvey Model 542

This transmitter can be used with a plug-in power supply for either 6 volts d.c. or 117 volts a.c. The type of power determines the tube complement.

The output of the Pierce oscillator (Fig. 5) is connected across R1 and R2.

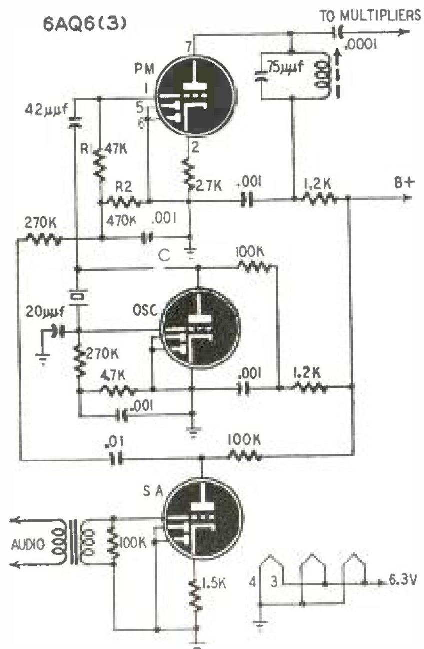


Fig. 5—The Harvey modulator circuit.

R2 is shunted by C, which shifts the phase of the r.f. voltage across it. The grid of the modulator therefore receives an r.f. voltage whose phase is the resultant of the unshifted voltage across R1 and the shifted voltage across R2.

The output of the speech amplifier appears across R2. The level of r.f.

across R2 rises and falls with the audio wave, which amplitude-modulates it. The proportion of shifted to unshifted r.f. voltage across the R1-R2 combination varies with audio, and the resultant phase of the r.f. reaching the modulator grid also varies.

Bendix MRT-1G and MRT-1H

These mobile transmitters have a very simple modulation system which makes use of an effect amateurs find undesirable and make every effort to avoid.

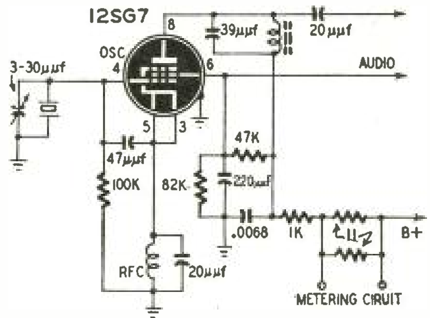


Fig. 6—Hookup of the Bendix modulator.

The signal from the microphone is fed to the screen of the oscillator tube (Fig. 6) to vary the transconductance of the tube. Amplitude modulation is produced, of course, but it is swamped out in the following multipliers. More important, the audio-rate changes in tube characteristics affect the input and output capacitances, which varies the phase of the output r.f., producing the desired phase modulation.

WIRELESS CURIOSITY

Mysterious interference in aircraft radio began last September at Essenden in Victoria, Australia. Pilots reported hearing broadcast stations when they tuned to the control tower frequency of 118.1 mc at Essenden Airport. Reports were sporadic at first, but by the end of the year, the interfering signal was being heard daily with such strength that it became a hazard to flying.

The interference was heard in all types of v.h.f. equipment and in all kinds of aircraft from Tiger Moths to DC-6's, but it was confined to the Melbourne area and one station seemed to appear most often, although other stations were heard occasionally. Capt. Doug Secomb, a pilot who had a v.h.f. receiver in his home, also received the interference regularly.

The fact that all types of aircraft, both in the air and on the ground, were getting the interference showed that the v.h.f. receivers were not at fault. Experts thought that cross-modulation might be the cause. A carrier from one transmitter might be interfering with another transmitter to create a new signal that happened to be on the airport frequency. They tried to calculate the possible frequencies of the unknown transmitter and through *Amateur Radio*, they got the cooperation of amateurs. Every transmitter in the area was switched off in turn to see which was the culprit. The local radio station also cooperated and changed from its main transmitter at nearby Alphington to an emergency station in the city. During the changeover a delay occurred and the station was off the air for a few seconds. At the time of the blackout, the carrier of the interfering signal was still heard, thus eliminating the cross-modulation idea.

The next step was to use mobile direction-finding equipment to locate the source. The trouble was traced to a small group of houses in West Preston. Eventually it was run down to a 14-year-old, homemade, five-tube superhet receiver. When it was turned off, the interference stopped.

The set had deteriorated with age and become a very efficient v.h.f. transmitter which rebroadcast whatever program it happened to be receiving. It received only one station well, and that is why one station was heard most often by the pilots.

Radio experts are now investigating the unique behavior of this set with the hope of finding out what makes it act the way it does.

ECHOLESS ROOM

Anechoic room at the Naval Ordnance Laboratory, White Oak, Md., has recently been completed. Floor, ceiling, and walls of the 50 x 53 x 35-foot room are covered with fibre glass wedges designed to absorb all noise from a sound source within the room.

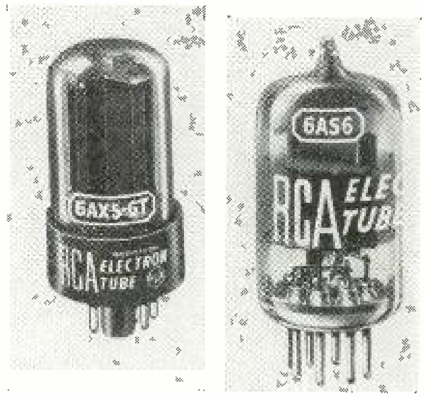
In contrast to the almost 100% echo reflection in an ordinary room, with hard surfaced walls, the echo in this room is only a few tenths of a percent. Any noise produced in the room can be studied by scientists in its original form without distortion or disturbance caused by echos.

Transducers are hung from pulleys on remotely-controlled overhead cranes and sound emitting and receiving devices can be positioned any place in the room. A catwalk allows access to the test equipment.

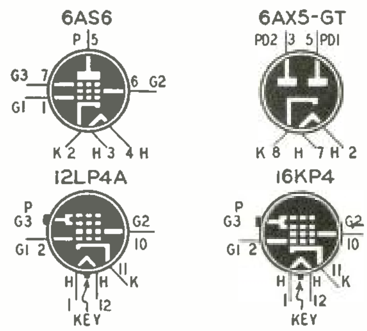
The fibre glass wedges which line the interior of the room are 40 inches long and 12 x 4½ inches at the base.

Review of New Tubes

AMONG the new tubes recently issued are RCA's type 6AS6 pentode and the type 6AX5-GT full-wave rectifier.



The 6AS6 is a sharp-cutoff pentode of the 7-pin miniature type. The Grids 1 and 3 can each be used as independent control grids to make the tube especially useful for gated amplifier circuits, delay circuits, gain-controlled amplifiers, and mixer circuits. It is usable for frequencies up to about 400 mc.



The 6AX5-GT is a full-wave vacuum rectifier of the heater-cathode type designed for economy in a.c. receivers and automobile radios having high power output.

Peak inverse plate voltage rating is 1250 volts maximum, and the peak plate current rating is 375 ma per plate.

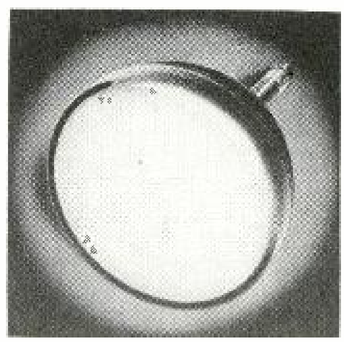
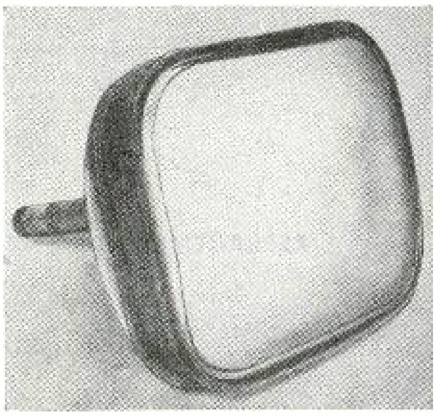


Photo of the new Du Mont picture tube.

Du Mont has released the type 12LP-4A, a 12-inch magnetic focus and deflection television picture tube. The tube has a gray filter face plate to increase contrast in lighted rooms. The electron gun has a bent electrode structure to be used with an external magnet to eliminate ion spot.

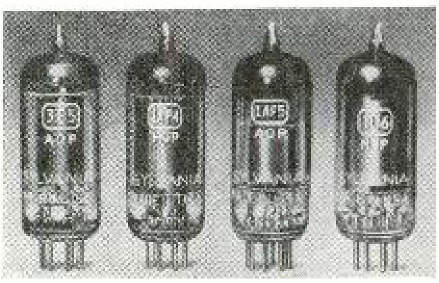
A rectangular television picture tube, the 16KP4, is now being produced by General Electric. The tube has a useful picture area of about 136 square



The 16KP4, a new G-E rectangular tube.

inches and an offset gun structure for use with an external ion trap magnet. The neutral-density face plate is designed to increase picture contrast and detail under high ambient light conditions.

Other new tubes include a set of miniature tubes for portable radios announced by Sylvania. These tubes, type 1U6, a heptode converter with a separate oscillator anode; type 1AF4,



a sharp cutoff r.f. pentode; type 1AF5, a diode pentode; and type 3E5, a beam power output tube require a filament current of only 25 ma. Performance of these tubes compares to other battery types.

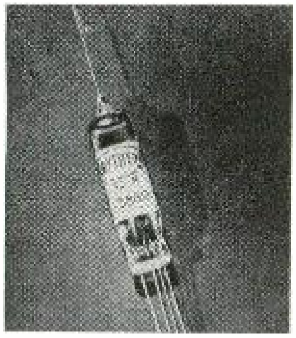
G-E has three new tubes for television receivers, the type 6AS5, type 6AV5-GT, and type 25AV5-GT. The 6AS5 is a miniature beam power amplifier intended for audio output in television receivers and small radios. The 6AV5-GT and 25AV5-GT feature compact design and power economy for magnetically deflected television tubes. They can operate from a power supply of 125 volts. Maximum d.c. plate voltage is 250 volts and maximum plate current is 100 ma.

Two new Sylvania subminiatures are the type 5645 medium-mu triode having a transconductance of 2700 μmhos and an amplification factor of 20, and type 5646 high-mu triode having a transconductance of 2400 μmhos and an amplification factor of 70. These tubes are 1.3 inches long and 0.3 inches in diameter.

ELECTROMETER PENTODE

Raytheon Manufacturing Co.
Newton, Mass.

The CK5889 is a new subminiature electrometer pentode featuring a low filament current of 7.5 ma. In single stage circuits where the tube must actuate indicating or recording devices, the tube has sufficient reserve emission to provide operation for several thousand hours. The filament power may be reduced in multistage circuits. Other electrical characteristics are similar to those of the CK5886.



SOLDER ALLOYS

Division Lead Co.
Chicago, Ill.

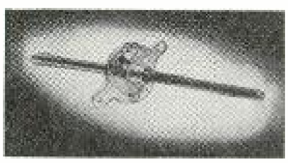
The new solder alloys have been developed for use with silver printed circuits and plated conducting mediums. They work equally well on ceramic, plastic, bakelite, and other base materials which have been coated with silver.

These solders have two melting ranges. DIVCO no. 233 solder is recommended where abnormally high temperatures are not encountered, and no. 276 should be used with assemblies operating above 350 degrees Fahrenheit. The solders are available in bar, solid wire, or rosin core shapes.

DETENT SWITCH CONTROLS

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

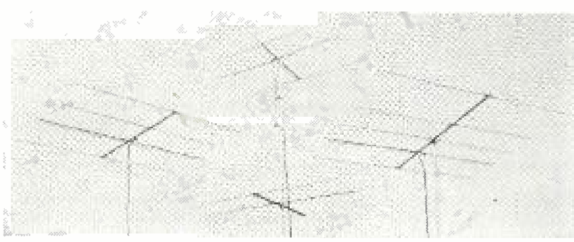
Four detent switch controls for use as replacements in a large number of standard television receivers are announced. Made with brass and phenolic shafts, they are engineered to fit most television tuner units in use today.



YAGI ANTENNAS

LaPointe-Plascomold Corp.
Unionville, Conn.

Three new low-price Yagis have been added to the VEE-D-X line of TV antennas. Known as the "J" series, the antennas are the JA with 2 bays and 3 elements, the JB with 4 elements, and the JC with 5 elements. Each antenna has a clamp type construction and is shipped completely assembled with all elements folded against the boom to eliminate assembly difficulties.



D.C. POWER SUPPLY

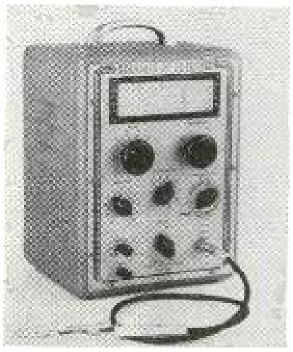
Electro Products Laboratories
Chicago, Ill.

The new model BJ low voltage d.c. power supply supplies 1 to 12.5 amps at 6 volts in continuous duty and up to 25 amps in intermittent duty. It supplies 3 to 9 volts at other ratings and operates from 115 volts 50-60 cycles. The supply is well filtered and has a 0-10 voltmeter and 0-25 ammeter. It is housed in a steel cabinet with a blue hammerloid finish.

SWEEP GENERATOR

Sylvania Electric Products Inc.
New York, N. Y.

This new sweep signal generator, specially designed for servicing FM and television receivers, incorporates electronically controlled sweep circuits. FM sweep range is from 0 to 600 kc, television sweep 0 to 15 mc. Fundamental output frequencies of the generator range from 2 to 230 megacycles, which are covered in four bands.



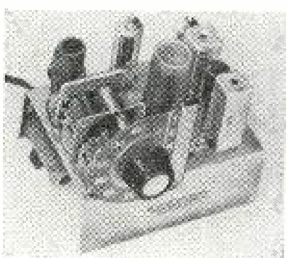
Output is at least 100 millivolts on all bands controlled by a smooth attenuator. Double shielding prevents signal leakage and frequency stability is assured by voltage regulated power supply. Wide range phasing control permits adequate adjustment for single oscilloscope response curve. Voltage for driving or synchronizing horizontal oscilloscope deflection is provided.

SUPERHET TUNER

Approved Electronic Instrument Corp.
New York, N. Y.

This tuner, adapted for use with public address systems, portable amplifiers, record players, tape or wire recorders, etc., uses a 12BE6 converter, 12BA6 i.f., 12AT6 detector-first audio and 35W4 rectifier.

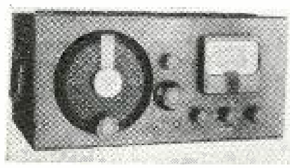
Specifications: Maximum output approximately 10 volts (high impedance) adjustable in three steps of 1 volt, 3 volts or 10 volts; a.c.-d.c. self-contained power supply for 115-volt line; 2½-foot shielded output cable; attached 5-foot antenna. Size is 4 x 4 x 5 inches. A model with isolating transformer is also available.



FM MONITOR

Browning Laboratories Inc.
Winchester, Mass.

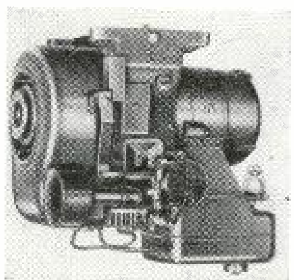
The new Model MD-25 F.M. modulation monitor is designed to continuously cover 30 to 50 mc, 72 to 76 mc, and 152 to 162 mc in four bands, making it possible for the one instrument to be used in checking transmitters on widely separated frequencies or on different bands. Coarse and fine tuning controls permit precise adjustment to the carrier frequency. Either upward or downward swing can be measured up to 20 kc with an accuracy of better than 1 kc on an easily read 4 inch meter, which is also used as a tuning indicator. An audio output is provided so that the instrument may be used as an aural monitor or a visual monitor when used in conjunction with an oscilloscope. The sensitivity of the instrument makes possible measurements with less than 1 millivolt on the antenna terminals. This permits checking mobile transmitters without bringing the transmitter to the monitor.



ELECTRIC PLANT

D. W. Onan & Sons Inc.
Minneapolis, Minn.

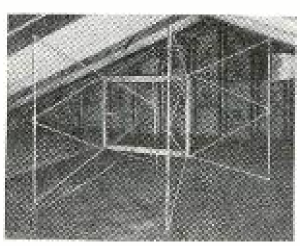
Designed for applications needing a portable source of electric power, this is a 400-watt, 60-cycle, a. c. electric generating plant that will operate for five hours on a single gallon of gasoline. Only 19 inches long, with a width of 14¼ inches and a height of 16¼ inches, this little generating plant produces ample power for amateur radio operations, emergency floodlights, public address systems, sound recorders and geophysical instruments.



ATTIC TV ANTENNA

Telrex Inc.
Asbury Park, N. J.

Attic V Beam folds into a compact package for easy handling and placement, and opens up completely assembled, into a full two-bay conical V beam array, complete with transmission line. The array is extremely light and entirely self supporting. It may be suspended or rested on flooring, beams, or rafters.



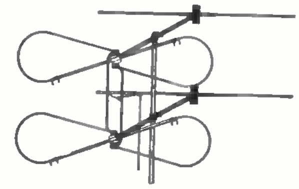
The new antenna is suited for private homes, garden apartments and other multiple dwellings, clubs, churches and other places in which conventional outdoor antennas are impractical or prohibited. It will be especially welcome to TV viewers who are now forced to get along on ineffective built-in or indoor antennas because of local zoning regulations or landlord opposition.

TV ANTENNA

Walter E. Peek, Inc.
Indianapolis, Ind.

The Wepco Model V 88 double stack antenna is designed to provide high gain over the entire television and FM bands from 40 to 260 megacycles.

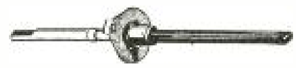
The co-linear dipoles are positioned as illustrated. Transmission line is connected directly to the dipole terminal screws—no matching bars are required.



REPLACEMENT DETENT

Tele-Matic Industries Ltd.
Brooklyn 2, N. Y.

This replacement part, known as the Sturdy-Tune detent, is especially designed to fit the RCA tuner as used in the 630-TS and many other TV chassis. It is available for use with the original locating plate.



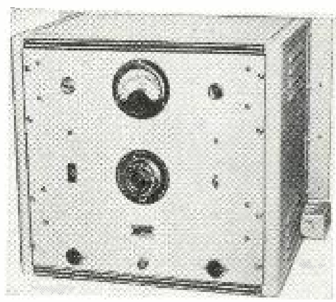
POWER SUPPLIES

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

A new series of electronically regulated and stabilized power supplies, utilizing a new type of direct-coupled amplifier to control a pair of thyratron rectifier tubes, is now in production.

Two separate series of 250 watt (output power) supplies are available. The Standard Series is stabilized against line changes of 90 to 130 volts within ± 0.5%, and load regulated within ± 0.5% from no load to full load. The Super Series, with a more sensitive error control circuit, is line-stabilized and load-regulated to within ± 0.1%.

The following power supplies comprise each series: 0 to 25 volts up to 10 amperes; 0 to 50 volts up to 5 amperes; 0 to 125 volts to 2 amperes; 0 to 250 volts to 1 ampere; 0 to 500 volts to 500 milliamperes. Each of the ten units has a continuously adjustable and smoothly controlled d.c. output to full voltage and current rating.

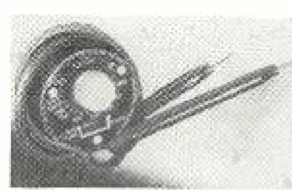


MINI-VOLT METER

Industrial Devices, Inc.
Edgewater, N. J.

A new model of the Mini-Volt Voltmeter features an expanded scale centered on 110 and 220 volts.

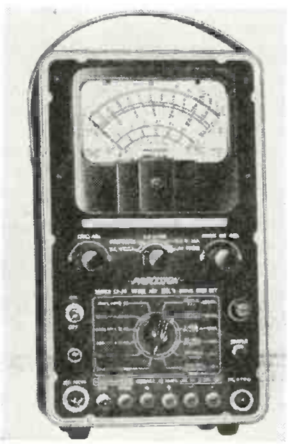
This new Model 410A is accurate to within 2 volts at 110 volts a.c. Practically burnout proof operation is assured by the glow-lamp indicator which is guaranteed for 25,000 hours' operation minimum. 12-inch flexible test leads are tipped with heavily insulated test prods, assuring user maximum safety.



V. T. V. M. TEST SET

Precision Apparatus Co.
Elmhurst, N. Y.

The Series EV-20 affords 48 ranges to 1,200 volts, 2,000 megohms, 12 amperes, +63db and d.c. v.t.v.m. ranges to 12,000 and 30,000 volts when used with the Precision TV super-high voltage test probe.



Important features include direct-reading, all-zero center v.t.v.m. which indicates both polarity and magnitude without switching or test lead reversal; voltage-regulated bridge circuit; master range and function selectors to eliminate frequent and inefficient shifting of test loads; shielded connectors which permit simultaneous and non-interfering connection of both the d.c. circuit isolating test probe and optional high frequency vacuum-tube probe.

Direct reading high frequency voltage scales are incorporated in this instrument. The dual-balanced electronic bridge ohmmeter-megohmmeter circuit uses only two 1.5-volt flashlight cells, easily replaceable at rear of cabinet. The 1,000 ohms/volt functions permits simple a.c.-d.c. voltage, db and current measurement free of power line requirements.

MIDGET BATTERIES

General Dry Batteries, Inc.
Cleveland, Ohio

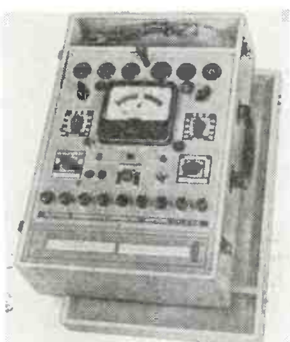
The K-cell is a new midget dry battery only 3/8 inch in diameter. Besides making possible actual pen-size flashlights, the new batteries will be useful in electronic equipment in which space and weight are important factors.

TUBE TESTER

Electronic Measurements Corp.
New York, N. Y.

The Model 201 is a mutual conductance tube tester that does checking on a calibrated micromho scale as well as on a REJECT-GOOD scale.

It also checks tubes for gas content and checks all tubes from .75 to 117 filament volts as well as all loctal, octal, 9-prong miniature and sub-miniature tubes. Cold cathode, magic eye, voltage regulator and ballast resistor tubes can also be tested. Individual sockets for each type tube base eliminates possible errors.



ISOTAP TRANSFORMER

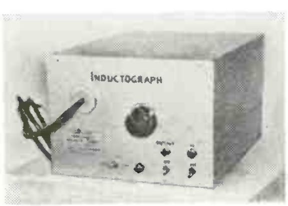
RCA Victor Division
Radio Corporation of America
Camden, N. J.

This unique test instrument combines an auto-transformer and an isolation transformer. It is designed to bring a new degree of safety and efficiency to the testing and servicing of TV receivers and other electrical equipment.

VARIABLE H-V SUPPLY

Inductograph Products
New York, N. Y.

The variable high voltage r.f. power supply Model 99 delivers from 1 to 40 kv, either negative or positive polarity. The output voltage is obtained from an r.f. transformer and rectified by a half-

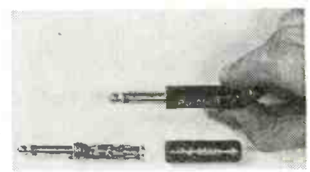


wave voltage tripler rectifying system. Rectifier filaments are heated by a second r.f. transformer to maintain constant filament current.

NEW PHONE PLUG

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

The PJ-055B is a precision-made phone plug manufactured to meet JAN speci-



fications. The metal members are highly polished brass. High compression-molded Resinox insulation provides durability with high dielectric and tensile strengths and low moisture absorption.

TUBE TESTER ADAPTER

VHF Labs
Boonton, N. J.

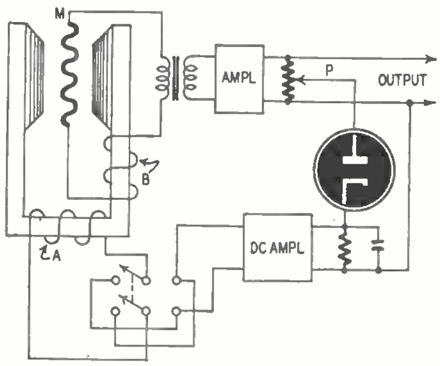
This adapter is for testing the 832A and 829B tubes used in v.h.f. communication equipment ARC/1, ARC/3, ARC/5 and SCR 522 as well as the

new commercial models of ground station, marine, mobile and airborne equipment. It indicates output, shorts and balance between sections, and eliminates time-consuming substitution of questionable tubes.

MICROPHONE COMPRESSION AND EXPANSION

Patent No. 2,495,809
George K. Graham, Oceanside, N. Y.
(Assigned to Radio Corp. of America)

Sound compression is necessary in broadcasting and sound recording to prevent overloading of the equipment and to keep the level sufficiently high above the noise. To regain the original fidelity the sound must be expanded during reproduction. This circuit expands or compresses the sound picked up by a dynamic or ribbon microphone. The control takes place at the microphone itself.



The figure shows a ribbon microphone M. The ribbon vibrates in accordance with the sound wave velocity. This induces an e.m.f. in the ribbon by cutting the magnetic field. A matching transformer couples the microphone to the amplifier.

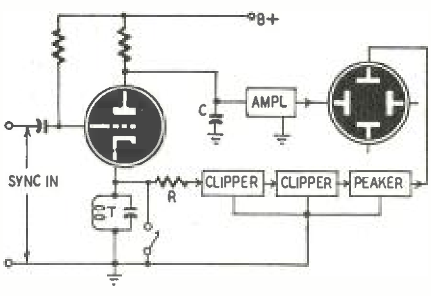
A portion of the microphone output (as determined by P) is rectified and filtered. The d.c. amplifier feeds winding A to control the magnetic field. The switch reverses the current so that A either aids or opposes the field as desired. In the first case more microphone output strengthens the magnet and results in still greater output. In the second case more microphone output weakens the field and makes the microphone less sensitive. These are the conditions of expansion and compression, respectively.

The ribbon e.m.f. should be the result of flux cutting only. The variations in the field (due to changes in A) should not contribute to this e.m.f. Winding B is added to cancel out any such induced voltage.

RANGE MARKER GENERATION

Patent No. 2,496,283
James E. Gall, Washington, D. C.
(May be used by the United States Government without royalty payments)

Radar receivers use range markers to indicate distance from the station. The markers are pips which appear spaced regularly across the CRO screen. To simplify the equipment, the markers may be generated in the same circuit which develops the horizontal sweep voltage.



The triode shown here is a conventional sweep generator. Normally it is conducting and its plate voltage is low. A negative pulse cuts off plate current and allows the plate voltage to rise to the value of the power supply, thus charging the plate capacitor. When the tube returns to its normal conducting state, the capacitor is quickly discharged. The sawtooth voltage across C is amplified and connected across the horizontal plates of the CRO.

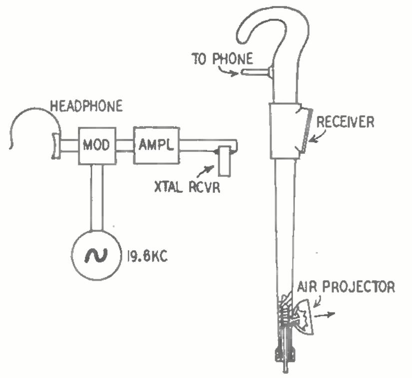
When the plate current drops abruptly to cutoff, the tank T is shocked into oscillation. A train of damped waves passes through the isolating resistor R to the clippers. These square off the waves and the peaker sharpens the leading edge. The sharp pulses have a frequency equal to the resonant frequency of circuit T. They are used to measure equivalent distances from the radar antenna.

OBSTACLE DETECTION FOR THE BLIND

Patent No. 2,496,639
John W. Richardt, Jr., Terre Haute, Ind., and Oscar A. Shann, Short Hills, N. J.
(Assigned to Bell Telephone Labs, Inc.)

Blind people can detect obstacles in their path by tapping a cane and noting from which directions the sound is reflected. This invention is a distinct improvement because it relies upon supersonic waves, which are more directional and are not objectionable to nearby persons.

The supersonic energy is projected into space from an air whistle or a crystal transmitter located at the bottom of a cane. A frequency of about 20 kc is satisfactory. Echoes are reflected from nearby obstacles. These high-frequency signals are picked up by a crystal receiver, amplified and modulated by an oscillator (19.6 kc in this example). An a.f. beat of 400 cycles is reproduced in the headphone.



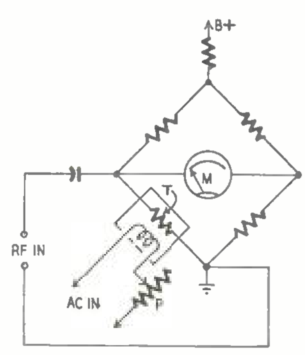
All receiving equipment may be located within the upper part of the cane. Leads connect it to the headphone. The transmitter may be controlled by the blind individual, who operates it by pressing down on the cane.

R.F. MEASUREMENT

Patent No. 2,495,268
John P. Leiphart, U.S. Navy
(May be used by the U.S. Government without royalty payment)

A thermistor can be used to measure r.f. current. The current flows through the thermistor, heating it and causing a change in its resistance. The resistance may be measured on a bridge calibrated in terms of current. In the absence of r.f. the bridge is balanced. Unfortunately, the thermistor resistance varies with ambient temperature as well as r.f. current, so the calibration can be correct at only one value of room temperature.

This circuit compensates for changes in ambient temperature. An a.c. coil warms the



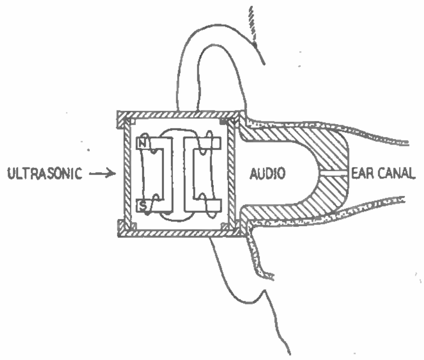
thermistor T to some temperature above normal ambient, and the bridge is calibrated at that temperature. A rise or fall in the ambient tends to introduce error, but this can be cancelled out by adjusting P. The adjustment is correct if the bridge balances when the r.f. is shut off.

ULTRASONIC CARRIER SYSTEM

Patent No. 2,461,344

Harry F. Olson, Princeton, N. J.
(Assigned to Radio Corp. of America)

There are occasions when some people desire to listen to a radio or phonograph while others in the same room do not. This can be done by reproducing the sound on an ultrasonic carrier so it remains inaudible except to those equipped with a special receiver. The figure shows a special



receiver adapted to be worn in the ear. The unit has a diaphragm at each end. At the input end is a permanent magnet and at the output an unpolarized magnet. Each magnet has a coil and these are connected in series.

An incoming ultrasonic carrier forces vibration of the input diaphragm (at the left). A voltage is induced in the coil wound on the permanent magnet and is transferred to the electromagnet coil. Since its magnet is not polarized, it attracts the output diaphragm on both positive and negative alternations. This distorts the wave.

The combination of polarized and unpolarized transducers demodulates the carrier and the a.f. is projected into the ear canal.

WIDE RANGE COUPLING

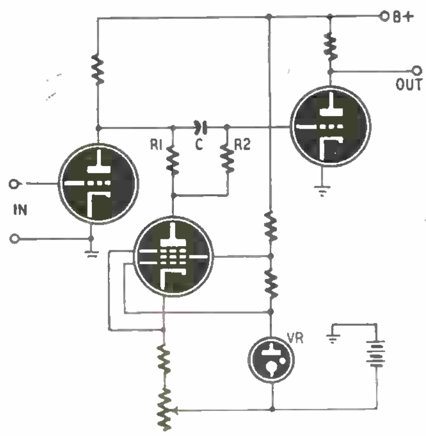
Patent No. 2,499,443

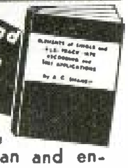
Norman H. Young, Jr. and Louis W. Parker
Jackson Heights, N.Y.
(assigned to Federal Telecommunication Labs.)

This circuit can pass a wide frequency range from video signals down to d.c. The amplifying tubes (shown as triodes in the figure) are coupled by a capacitor C and by the resistors R1 and R2.

The pentode plate current is maintained constant because of the VR tube in the grid circuit and the negative feedback (unbypassed) resistors in the cathode circuit. This current flows through R1, producing a negative voltage at the lower end. Since the drop across R1 is constant, the bias on the second tube is also fixed.

Slow fluctuations pass from the plate of the first triode to the grid of the second through R1 and R2. Higher frequencies pass through C as usual since its reactance is much lower than the total resistance R1 and R2.





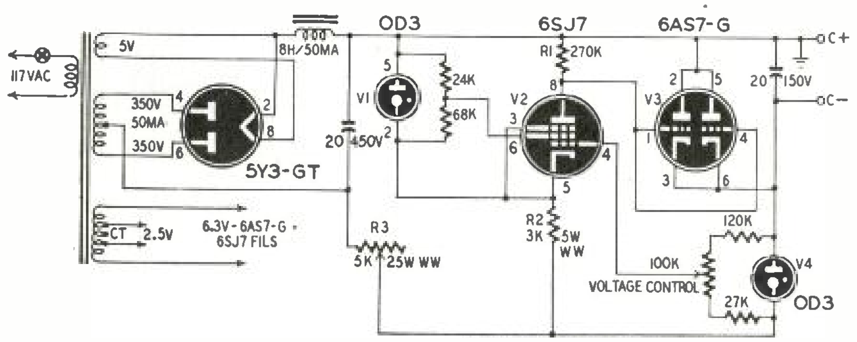
ELECTRONIC VOLTAGE-REGULATED BIAS SUPPLY

Bias voltages for class B and C amplifiers should be obtained from sources having good regulation. Many amateurs use power supplies delivering current 15 or 20 times the rectified grid current of the amplifier, the excess current being wasted in the form of heat in a heavy bleeder resistor. Besides wasting power, this type of supply does not have the regulation required for class B service. An electronic bias supply having regulation of 1 μv per ma is described in RCA *Ham Tips*.

The circuit shown in the diagram can handle rectified grid currents to 200 ma when delivering bias between 20 and 80 volts. Voltage can be reduced to 20 volts when grid current does not exceed 100 ma.

V1 and R2 and V3 and V4 are in parallel across the output of the supply. Because V1 and V4 are voltage-regulator tubes, the voltage drops across them will be constant. Therefore, a change in voltage across V3 will also appear across R2, the cathode bias resistor of V2. Any change in cathode bias on this tube will be amplified and will appear across R1 which is connected between plate and grid of the 6AS7-G output tube. The change in voltage across R1 swings the grid of V3 to keep its output constant. For voltages between 30 and 80, the output voltage changes 200 mv when the rectified grid current varies from zero to 200 ma.

Resistor R3 is set so the current through it is approximately 40 ma when the 100,000-ohm voltage control is set for approximately 75 volts output.



MULTIPLE TELEVISION RECEIVING ANTENNAS

Several methods of connecting two or more receivers to a common TV antenna or booster were described in *Wireless World* (England) recently. Because the resistive matching networks have insertion loss, these systems are suitable only where the signal level is unusually high or where boosters are used to bring the signal to an acceptable level.

The circuit in Fig. 1 can be used to feed any number of receivers having the same input impedance. The value of each resistor R is $Z \times n - 1/n + 1$, where Z is the impedance of the transmission lines and receiver input terminals and n is the number of receivers. Because the power divides equally between the receivers, the input to each is 20 log n decibels below the antenna output.

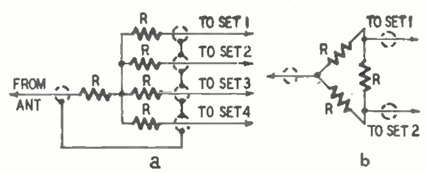


Fig. 1—Circuit for several receivers.

Fig. 2 shows an alternate method of connecting two receivers to a common antenna. In this circuit, R is equal to the impedance of the transmission lines. In Fig. 2, two of the resistors have been replaced by ribbon-type transmission lines, making it possible to feed four receivers. One resistor is left in the circuit to make each receiver input see its correct terminating impedance.

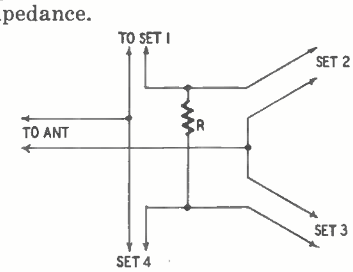


Fig. 2—A two-receiver antenna system.

NOTES ON CLAPP OSCILLATORS

The stability of a well-designed Clapp oscillator can approach that of the average crystal oscillator, but its output changes considerably if the frequency is varied over a wide range. Furthermore, bandspreading this circuit usually results in increasing the minimum capacitance of the tuning capacitor and reducing the stability. Two circuits for improving performance of Clapp oscillators are described in *Short Wave Magazine* (London).

Fig. 1, developed by G2DC1, provides constant output over the entire tuning range by shunting the series-tuned network with a variable capacitor C2 having a maximum-to-minimum capacitance ratio equal to that of the main tuning capacitor C1. C1 and C2 are ganged so the ratio between the series and parallel capacitors will be constant throughout the tuning range.

The circuit in Fig. 2 was developed by G2RX to provide better bandspread performance. C1 is the bandset capacitor. It is tapped at a point on the

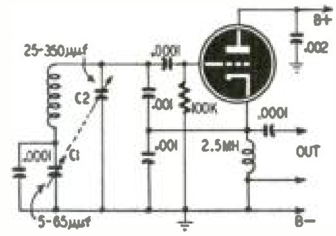


Fig. 1—Series-parallel tuning system.

ground end of the coil which will result in the desired bandspread. C2 is the bandspread capacitor and C3 is the minimum value needed to maintain oscillation when C2 is reduced to a low value. C4 and C5 are made as large as

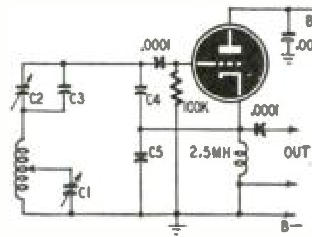


Fig. 2—Clapp circuit with bandspread.

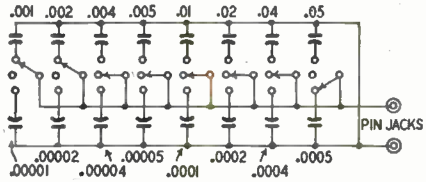
possible. Their maximum value will depend on the Q and inductance of the coil and will be approximately .001 μf for most 160- and 80-meter coils.

SPEAKER SERVICING KINK

Before drilling a hole on or near a loudspeaker, coat the area with a layer of service cement at least 2 inches in diameter. Drill the hole before the cement dries. The cement will catch and hold any chips and prevent them from entering the gap between the loudspeaker's pole piece and voice coil.
—*Marty Arslan*

CAPACITOR DECADE

A capacitor decade box having a range of 10 μμf to 0.1 μf can be made from 16 capacitors and eight toggle or slide-type s.p.d.t. switches connected



as shown in the diagram. The switches should have a "dead" or off position so capacitors not in use are out of the circuit. The decade box is set at .0035 μf in the diagram.—*Horace Shafer*

ELECTRICAL WIRING HINT

Solder all splices and connections and avoid solderless connectors when installing power and light wiring on or near radio and TV service benches or sensitive electrical and electronic instruments.

A solderless connector is not likely to cause power loss, but oxidation and corrosion may result in small transient currents in the joint. Such currents can cause noise and spurious responses in sensitive equipment connected to the line.—*R. C. Roetger*

INTERFERENCE ELIMINATION

TV and FM receiving antennas frequently take on a heavy charge of static electricity which produces interference as it leaks off in a corona discharge. This can be eliminated by placing plastic beads or a coating of tar on the ends of the antenna elements and other sharp projections on the assembly.—*G. W. Deuchler*

NOTE TO CONSTRUCTORS

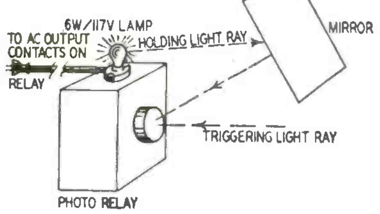
It has been suggested that iron or steel nuts and bolts can be installed in hard-to-reach places by using the magnetic field surrounding the tip of a Weller-type soldering gun. This method has several disadvantages: the heat from the gun may damage other components, the magnetic field at the tip will not hold the fitting rigid, brass fittings cannot be installed by this method.

Positioning *brass or iron* fittings is made easy by *soldering* the fitting to the tip of the gun and allowing it to cool. After the fitting is secured in position, heat the gun to melt the solder. This operation takes less than a minute and does not have the disadvantages of the magnetic method.—*Walter Blazek*

SELF-LOCKING PHOTO RELAY

Some photoelectric relays close an external circuit when light falls on the phototube and open the circuit when light fails. By adding a few simple parts, the external circuit can be locked on until opened manually. Locking-type relays or internal circuit changes are not required.

Mount a 6-watt, 117-volt lamp on or near the control unit and reflect its light into the phototube with a small mirror as shown in the diagram. Connect the lamp to the a.c. output contacts in parallel with the external circuit. When a light pulse falls on the



phototube, the external circuit is closed and the 6-watt lamp comes on. Its light will be reflected into the phototube so the relay remains closed. Turn off the 6-watt lamp to open the external circuit or to restore the relay to momentary-type operation.—*O. C. Vidden*

ANCHORING RADIO PARTS

The conventional method of mounting such components as extractor fuse posts, spring-mounted sockets, grommets, etc., may permit them to be turned enough to break the leads or cause a short circuit. This may be prevented by applying a cement such as EC-847 (Minnesota Mining & Mfg. Co.) to the components which must be anchored securely.

This cement can be used to make outdoor PA equipment water- and weatherproof. Apply a coat of the cement to junctions between cables and plugs and to other joints where water and moisture may enter.—*H. Zave*

NEW YORK RADIO TECHNICIANS CONVENE

The 1950 annual meeting of the Empire State Federation of Electronic Technicians Associations (ESFETA) was held April 23 at the Hotel Arlington in Binghamton, N. Y. Seven of New York State's nine radio technicians' associations were represented: Long Island, New York City, Southern Tier, Endicott, Corning, Central New York and Rochester. Hudson Valley and Kingston were not present.

Officers elected for the 1950-51 term are: Max Liebowitz, ARSNY, president; Larry Raymo, Rochester Radio Technicians Guild, vice-president; Wayne Shaw, Southern Tier Radio Servicemens Association, secretary; Ben de Young, Central New York RTG, treasurer; and Ed Fisk, Rochester RTG, sergeant-at-arms. This is a re-election of the 1949-50 chief officials, excepting that Larry Raymo replaces vice-president Margaret Snyder, who withdrew her name from nomination because of preparations for her expected forthcoming marriage June 28.

Most important subject of general discussion was the winter series of technical lectures. Methods of better co-ordination between local associations and speakers were worked out, with the object of having smoother meetings and avoiding mistakes and accidents of the type which caused a 3-week run of speakerless meetings both at Binghamton and Rochester.

Also discussed was the question of ethical advertising of television sales and service, a sore problem with many technicians who are called upon to make good the dealer's claims, whether exaggerated or otherwise. On this point Max Liebowitz gave a short report of the conferences sponsored by the New York City Better Business Bureau with the aim of setting up standards for advertising claims.

SOCIAL AND DANCE HELD BY N. Y. C. TECHNICIANS

ARSNY, the Associated Radio-television Servicemen of New York, N. Y., held their first annual social and dance at the Hotel Diplomat, New York City, on March third. Attendance was well over 200.

The dance was accompanied by an excellent floor show, and a large number of door prizes were distributed, including a Motorola radio, a Philco Pocketscope and late Rider Manuals.

SERVICE TECHNICIAN SURVEY

The editors wish to thank the service technicians who replied to the Service Technicians' Survey questionnaire which appeared in the November issue of RADIO-ELECTRONICS, especially the many who supplemented their answers with interesting explanatory letters.

Here is a summary of the most generally interesting and pertinent results of this survey:

1) The technicians who replied definitely indicated their preference for a greater percentage of articles on TV servicing. For more TV servicing articles: 79%; against: 14%.

2) Approximately 38% of the replying technicians service radio receivers only, 2% TV only and 54% both. About 40% of those who serviced only radio indicated that they were in non-TV areas and that their specialization in radio was only temporary.

3) A large majority (73%) said that they were asked to recommend various makes of TV receivers. Of the 21% who were not asked for such endorsements, roughly 30% were in non-TV areas.

CORRECTION

There is an discrepancy in the text of the article "A Ten-Tube FM Receiver for Only $10." in the March issue. The paired capacitors across the secondary of the discriminator transformer are listed as 40 μμf each. The values are 50 μμf as shown on the diagram.

We thank Mr. Ray Appechaws, of Pen Mar, Pa. for this correction.

Radio Thirty-Five Years Ago
In Gernsback Publications

HUGO GERNSBACK
Founder

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

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

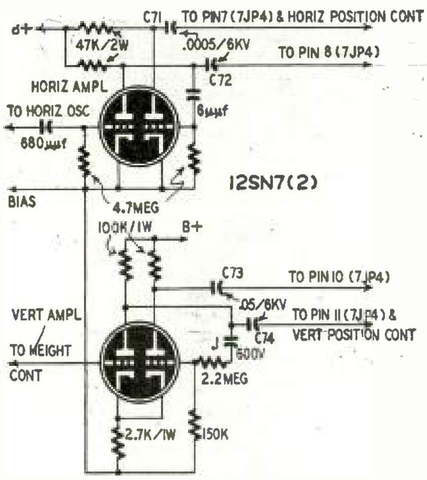
June, 1916, ELECTRICAL EXPERIMENTER

Electricity and Wireless Solve Secret Service problems
Wireless Music with Your Meals, by Albert Marple
Tesla's Early Work with Radio Controlled Vessels
Radio League of America News
United States Signal Corps Use Radio In Mexico
High Speed Radio Telegraphy, by C. V. Logwood
Hook-Up for Undamped and Damped Oscillations, by Harry Y. Higgs, R.E.
Emergency Telephone Headband, by Cecil H. Ostermerer
Pocket Radio Receptor with 60 Mile Range, by Earl H. Swanson
High-Voltage Battery for Audions, by Francis R. Pray
Variable Inductance for Transformers, by Chase Hutchinson
A Practical Portable Wireless Set, by Milton B. Sleeper

SERVICING HALLICRAFTERS 505

? I have a Hallicrafters model 505 TV receiver. After it warms up, the picture slides downward to the extent that it cannot be centered with the vertical position control. How can I cure this trouble?—E.R.McC., Gunter, Texas

A. When the picture slides in any direction and cannot be centered with the positioning controls, it is likely that one of the high-voltage coupling capacitors between the deflection amplifiers



$1,200.00 PRIZE CONTEST RADIO-ELECTRONICS IN THE HOME

Midnight of July 1, Eastern Standard Time marks the closing of the third month's *Radio-Electronics in the Home* contest. Entries for the July contest must be postmarked before this date. *The closing date for the June contest is midnight, June 1.*

FIRST PRIZE $50
SECOND PRIZE $25
THIRD PRIZE $15
FOURTH PRIZE $10

Monthly prizes totaling $100 are given for the best ideas on applications of radio-electronics in the home.

Prizes will be awarded in accordance with novelty, general importance of the application or device, smallness of cost involved in building it, and practicability.

Any ideas may be submitted. Highest prizes will be awarded to contestants who have actually built the device and submit photographs to prove it. Lesser prizes will be given for "ideas" and entries not accompanied by photographs.

For complete details and rules of the contest see page 35 of RADIO-ELECTRONICS for March.

and the C-R tube is leaky. The deflection amplifiers and coupling capacitors are shown in the diagram.

Replace capacitor C74 if the picture moves downward or C73 if it moves upward. When the picture moves right or left, replace capacitor C72 or C71.

OPEN-WIRE FEEDERS FOR TV

? *My TV antenna is over 100 feet from the house and is connected to the receiver by 300-ohm ribbon-type transmission line. A combination of salt air and bright sunlight causes the transmission line to deteriorate within a comparatively short time. Can I use No. 12 wire in an open line?—F. M., Erma Park, N. J.*

A. Open-wire line can be used. Because 2-inch spreaders are the smallest generally available, it is advisable to use these. Two No. 12 conductors spaced 2 inches gives the line a characteristic impedance of approximately 465 ohms. A 375-ohm matching stub should be used on each end of the 465-ohm line. Each stub should be a quarter-wavelength long. They may be made from No. 6 wire spaced 1¾ inches or ⅜-inch tubing spaced 4 inches.

9LP7 BASE CONNECTIONS

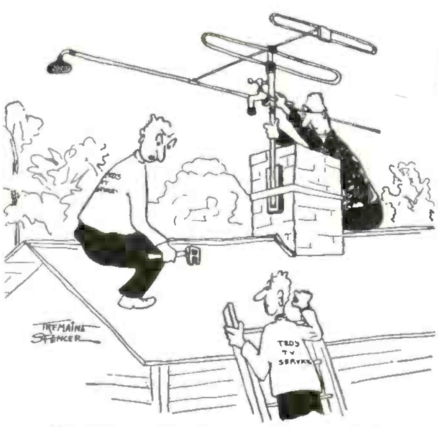
? *Please print the socket connections for a 9LP7 cathode-ray tube.—F. D., Baltimore, Md.*

A. Connections for the elements of a 9LP7 are: pin No. 2, heater; No. 3, grid No. 2; No. 5, control grid; No. 7, cathode; and No. 8, heater. The high-voltage supply connects to the button on the cone of the tube.

TROUBLE IN TV RECEIVER

? *There is a continuous ripple in the picture on my Admiral 24D1 chassis when it is powered by a 117-volt, gasoline generator. What causes the trouble? How can I eliminate it?—E. K. W. Grand Rapids, Mich.*

A. A strong field around the power transformer causes the ripple when transmitter and receiver power sources are not synchronized. Admiral's Service Division, 201 E. North Water St., Chicago, Ill., has a special replacement transformer which does not cause this trouble. Their bulletin TV-85 describes in detail the trouble and its cure.



"I still say the boss made a mistake by hiring a plumber."

Temperature changes that affect oscillator frequency take place in the tuned circuit, tube, and surrounding air. The first is by far the most important.

ZENITH S-11468 CHANGER

When the tone arm skips grooves and repeats, the vertical hinge on the tone arm may be too tight, thus causing the arm to hang slightly. This prevents the needle from exerting enough pressure on the record to follow the grooves. Use long-nose pliers to bend the horizontal U-shaped bracket until it pivots freely.—*Baron von Huene*

BELMONT MODEL 22A21

No raster, sound OK. Check the .001-µf filter capacitors in the high-voltage rectifier circuit. One of these capacitors has been shorted in several sets. Replace the defective unit with a high-grade .001-µf capacitor having a working voltage of 5,000 or higher.—*Wilbur J. Hantz*

SENTINEL 400-TV and 405-TVM

Shorted or intermittent screen-by-pass capacitors in the 6Y6-G high-voltage oscillator are the cause of no picture or intermittent picture. Replace this unit with a 0.1-µf, 600-volt unit. If the old one was shorted, check the 33,000-ohm screen dropping resistor because it may have been damaged by the overload. Replacement is always safest.—*W. E. Tooney*

WESTINGHOUSE MODEL H-196

Poor vertical sync in older models can be improved by replacing the 12AU7 sync amplifier with a 12AT7. The latter has higher mu and will provide greater sync amplitude. No wiring changes are required.

Insufficient picture width under low line voltages, even though the width control is at maximum, may be caused by the deflection yoke. Check its code number located under the "V" number on the yoke. If the number is 98, 108, or 118, replace the yoke with one carrying any other code number. The old yoke will perform satisfactorily with normal line voltages.

Hum in the a.f. section of this model and the H-207 may be reduced by connecting a 30-µf capacitor across C99 between the screen of the 6AQ5 output tube and ground. This additional capacitor will be found in later models. —*Westinghouse Service Hints*

ZENITH 4G800

Noisy or erratic reception may be caused by a broken antenna lead. First remove the chassis from the case, and then remove the plastic handle. The break, caused by opening and closing the front cover, will probably be found directly under the handle.

—*Frank N. Verni*

ELIMINATING IGNITION NOISE

To cure stubborn cases of ignition noise in auto radios, construct a three- or four-turn, 2-inch loop, using insulated, unshielded wire. Connect this loop in series with the antenna lead-in with shielded wire. Move this noise-pickup coil close to potential sources of noise. Orient the coil for maximum noise cancellation; then fasten the coil in this position.—*Charles Buscombe*

MALTA SHORTWAVE SERVICE

Dear Editor:

We have received a great number of reception reports from your readers. At present our service consists of two 7½-kw high-frequency installations on Malta, and a number of medium-wave stations here, in North Africa and on Cyprus. Our present schedules are:

Frequency (mc)	Time (GMT)
4965	0400-0700
	1330-2200
7270	0400-0700
	1400-2200
11895	0930-1300

It is our intention to start a special Shortwave Listeners hour later on in 1950. This will have to be timed after closedown of our standard schedule. I would suggest about 2200 GMT as a good hour. Perhaps your shortwave listeners would let me know if they think the idea sound, and the time satisfactory?

LESLIE KNIGHT

Chief Broadcasting Officer, MELF Malta Garrison, Malta.

TUBE NUMBERS AGAIN

Dear Editor:

The manufacturers of radio tubes have been very lax about putting the numbers on tubes so they will stay put. Something should be done about it!

JAMES G. SHELLER

Claysville, Pa.

TELE IN THE DEEP FRINGE

Dear Editor:

Like so many fellows who have written you about running too many TV articles, I live in a remote part of the country far from any TV station. But I have been studying it for some time and have learned a lot from your magazine.

With the help of your articles and some home-study courses, I have done what other technicians said would be impossible. One person who complained to you last summer about too much TV lives only 12 miles from me in Baxter Springs, Kansas. I have already installed two sets in that town and nine in this area, where they said TV wouldn't arrive for 10 years.

We receive three stations here: WKY-TV, Oklahoma City, 200 miles; WDAF-TV, Kansas City, 130 miles; and KOTV, Tulsa, Oklahoma.

ALBERT DUNIVIN
Galena, Kansas

VALUABLE ARTICLES

Dear Editor:

Being only a novice, I find the "Fundamentals of Radio Servicing" of great value to me and I now feel that I thoroughly understand some of the things which were unfathomable mysteries before I began studying his articles.

Another article which received much of my attention is "How to Become a Ham" by George Shuart. I expect to construct a code oscillator soon and get a license before long.

JEROME VRIESMAN
Whitehall, Michigan

TV AND FLYING SAUCERS

Dear Editor:

What's wrong with the readers? Where is the American spirit? They seem to think a magazine must cater to a particular group. A large part of our good old U.S.A. has television and another large part is fringe area, so I'd guess that more than not readers are interested in TV. Your policy is to cover the field; and while TV is the newest and biggest thing, it's only natural that TV should be given more space.

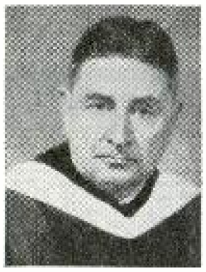
If and when (I said *if*) a flying saucer crashes to earth (a possibility, as two magazines on the market would have us believe), I will look to RADIO-ELECTRONICS to bring us all the electronic data and theories of the story if our government will permit them to be released. I have that much faith in the magazine.

There are many electronic devices which most radio men never see, but it is interesting to know something about them; so please give us a few articles from time to time about such things as the electronic microscope, the electric brain, etc.

W. G. ESLICK
Wichita, Kansas

Austin C. Lescarboura, journalist and industrial advertising consultant in the electronics field, was given the Cross of Chevalier of the Legion of Honor by the French government.

The award was made in recognition of Mr. Lescarboura's long-time technical service to the French cause and especially for recent assistance to industrial missions sent to the United States to aid in the rehabilitation of industry in post-war France.



This is the third decoration Mr. Lescarboura, a New Yorker of French ancestry, has received from the government of France. In 1919 he received the Officer d'Academie decoration, followed in 1947 by promotion to Officier de l'Instruction Publique.

Walter E. Poor, chairman of the board of SYLVANIA ELECTRIC PRODUCTS INC. died in New York City.

Born in Salem, Mass., Mr. Poor graduated from Massachusetts Institute of Technology in 1908. After a short period as electrical engineer for the Boston Elevated Railway, Mr. Poor joined his brothers in the manufacture of electric lamps at Danvers, Mass., at the Hygrade Lamp Co., the predecessor of Sylvania Electric Products. Mr. Poor became executive vice president in 1940, president in 1943, and chairman of the board in 1946.

Besides heading the board of Sylvania, Mr. Poor was a director of the Sound-Scriber Corp.

Norman A. Woodford has been appointed Sales Manager, Television Division of NORTH AMERICAN PHILIPS Co.

Mr. Woodford has been active in the radio and television business for the past 27 years. Since 1940 he has been associated with the Philips organization in various capacities. In his new capacity, Mr. Woodford will have charge of building a distributor and dealer organization on the firm's new Duo-Vue television unit which enables the customer's own table model to offer a choice of direct viewing or a 3 x 4 foot picture projected on a home movie screen. He will also handle sales of Protelgram Television systems.

Josua Sieger was elected vice president in charge of engineering by the Board of Directors of the FREED RADIO CORP. He will direct Freed Radio's new research laboratories.

Peoria Amateur Radio Association is holding its annual hamfest June 11 at Pleasant Valley Park, 1½ miles south of Dunlap and 10½ miles from Peoria, Illinois.

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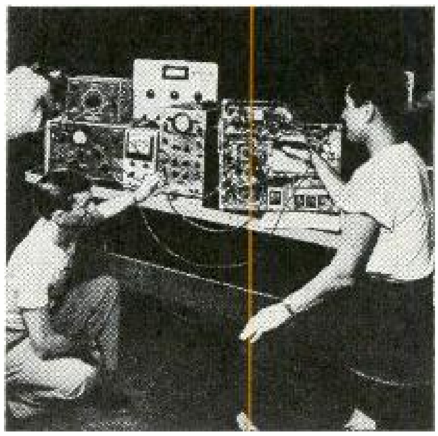

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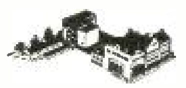

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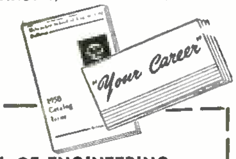

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RAPID RADIO REPAIR, by John D. Burke. Published by the John D. Burke Co., Jamaica, N. Y. 5¼ x 8½ inches, 100 pages. Price $1.25.

This is an unusually hard book to review; it can be judged by no conventional standards. The author is a radio service technician who has achieved success with his own methods, some of which are unconventional and controversial.

His writing style is equally unconventional. As impatient with methods of writing radio books as he is with some servicing procedures, he makes a conscious attempt to represent in his writing the repairman who "must approach his work from many angles." The result looks disorganized at a first glance, but may be as effective as the textbook approach.

Whether the radio technician agrees with all Mr. Burke's servicing methods or not, he will find this little work—which seems to have been written right on a service bench—a refreshing change from the standard type of book on radio servicing.

MOST-OFTEN-NEEDED 1950 TELEVISION SERVICING INFORMATION, compiled by M. N. Beitman. Published by Supreme Publications, Chicago. 8¼ x 10½ inches, 144 pages plus 10 fold-ins. Price $3.00.

Prepared in the same familiar style as other editions of the Most-Often-Needed series, this manual is a compilation of diagrams and service data for approximately 100 television receiver models or chassis. Alignment data, response curves, chassis drawings, and other pertinent servicing information is included on most sets. —*R.F.S.*

THE MATHEMATICS OF CIRCUIT ANALYSIS, by Ernst A. Guillemin. Published by John Wiley & Sons, Inc., N. Y. 6½ x 9½ inches, 590 pages. Price $5.00.

As one of the MIT *Principles of Electrical Engineering* series, this book is intended to present a variety of mathematical principles and methods essential to a thorough understanding of electrical network theory. The topics covered are advanced algebra, vector analysis, functions of a complex variable, and Fourier series and integrals.—*M.W.*

THEORY AND DESIGN OF ELECTRON BEAMS, by J. R. Pierce. Published by D. Van Nostrand Company, Inc., N. Y. 6½ x 9½ inches, 197 pages. Price $3.50.

This book presents an advanced treatment of the theory of electron beams and electron focusing in devices other than electron microscopes and image tubes. The material is presented completely enough so that it can be understood without reference to other sources and much material on electron optics is included. A knowledge of calculus is assumed.—*M.W.*

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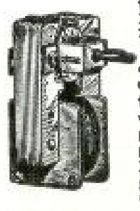

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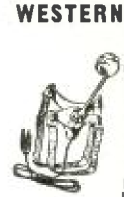

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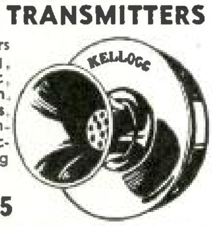

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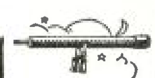

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SCHEMATIC MANUAL FOR SURPLUS ELECTRONIC EQUIPMENT, Volumes I and II. Prepared by Department of Commerce, Office of Technical Services, Washington, D. C. 8 x 10½ inches. Price $1.00 each.

These two volumes of schematics, wiring diagrams, and other pertinent data on surplus electronic equipment, are reprinted from technical manuals and bulletins on the equipment. Volume I, designated PB No. 98487, has schematics of the following units: ARC-4, -5; BC-191, -222, -223, -312, -314, -342, -344, -610, -614; DY-8; MD-7; PE-49; R-24 through R-28; RT-19; SCR-177-B, -188-A, -193, -210, -245, -299; and T-18 through T-23.

Volume II (PB No. 99539) contains the following schematics: AN/TRC-2; BC-453 through BC-459, BC-474, -652-A, -653-A, -654, -696-A, -946-B, -1306; DM-40-A through DM-43-A; GN-44-A; SCR-274-N, -284-A, -288, -506, and SCR-694.

TELEVISION COMPONENTS HANDBOOK. Published by Technical Advertising Associates, Cheltenham, Penna. (Handled through Philco distributors.) 6 x 9¼ inches, 160 pages. Price $2.50.

A data book on characteristics of major television receiver components and common TV circuits, this handbook fills the gap between most television text and engineering workbooks and manuals. Diagrams of various TV circuits are presented and specifications for such components as deflection coils, output transformers, switches, resistors, and capacitors are given. This book is a companion to the *Radio Component Handbook* which was reviewed in our December 1949 issue.—*R.F.S.*

ELECTRONIC ENGINEERING MASTER INDEX (1947-1948). Published by Electronics Research Publishing Co., Inc., New York. 7 x 9¾ inches, 339 pages. Price $19.50.

The 1947-1948 edition of the index is a recent addition to the bibliographical series which lists references to electronic and allied literature published throughout the world since 1925.

In addition to listing material in approximately 250 publications, the index also includes references to declassified documents published by the U.S., Canadian, and British governments; and patents issued during 1947-1948 by the U.S. Patent Office. The book concludes with a bibliography of engineering books published during 1947-1948 and an 11-page cumulative cross index of subjects which appear in the 1925-1945, 1946, and 1947-1948 issues.—*R.F.S.*

BBC YEAR BOOK FOR 1950. Published by the British Broadcasting Corp., London, England. 5 x 7½ inches, 176 pages. Price 3 shillings sixpence.

As with past editions, this Year Book contains accounts of the past year's accomplishments by the BBC and discussions of radio subjects in general, each written by a well-qualified person. Photographs of prominent personalities abound.

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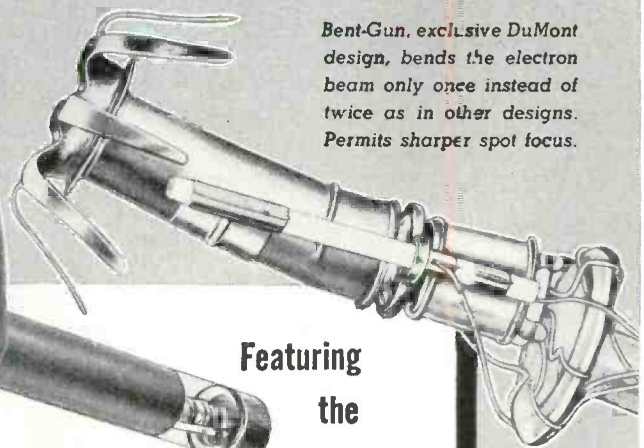

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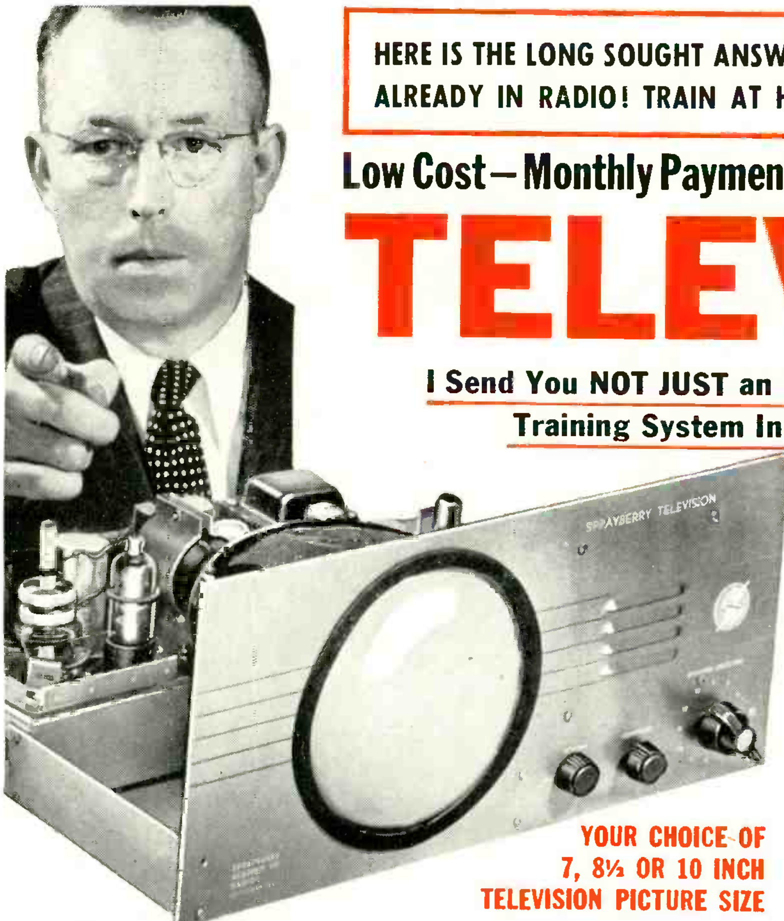

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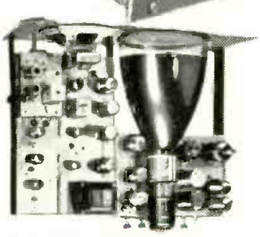

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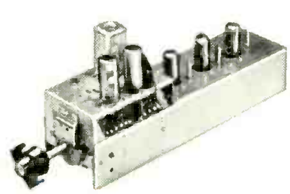
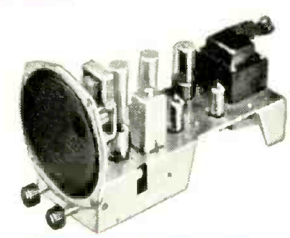


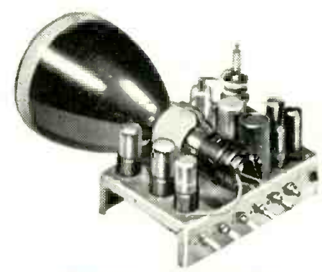
TV Tuner—I. F. Unit

Contains the RF amplified local oscillator, mixer and three stages of broad band IF amplification and the video second dector. The output constitutes the video signal and audio IF signal. For training, it is used to build and test video second detector, and stagger tuned IF amplifier obtaining 4.5 mc band pass. For TV servicing, it becomes a TV calibrator for IF alignment, substitute tuner, IF signal injector and second detector.



Video-Audio Amplifier Unit

Provides 4.5 mc IF ratio detector, low voltage power supply. For TV, it becomes the audio output, including speaker, video output and low voltage power supply for RF and IF stages. For training, it is used to build and test transformer type power supplies, audio, video, IF amplification and FM detection. For TV servicing, it is an audio signal tracer, IF signal tracer, video signal tracer and low voltage power supply.



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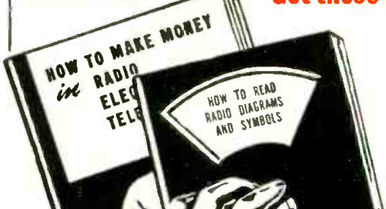

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Seven of the Top Ten **are RCA**

...**pioneered** for AM, FM, and TV

AMONG THE RECEIVING TUBES used *industry-wide* during 1949, seven of the top ten volume types were RCA pioneered. Of the remaining three, two were of basic RCA design. Almost one-half of these industry-wide leaders were also among the top ten volume types used in the radio and television *service business* during 1949.

Only tubes of unquestionable quality—both as to design and manufacture—could merit acceptance by the industry. Here are leaders designed by the Leader—familiar types, such as the RCA 6SN7-GT and 6AG5 . . . and more recently the 1B3-GT, 6BA6, 6J6, 6AU6, and 6AL5. Their wide-spread application has permitted production to be concentrated on fewer types . . . which, in turn, has accounted for lower costs, improved quality, and greater uniformity.

* * *

This is but one instance of how RCA's engineering leadership adds *value beyond price* to the RCA tubes you sell. It is a value shared alike by you and your customers.

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RCA

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ELECTRON TUBES **HARRISON, N. J.**