RADIO — ELECTRONICS

LATEST IN
TELEVISION
SERVICING
AUDIO

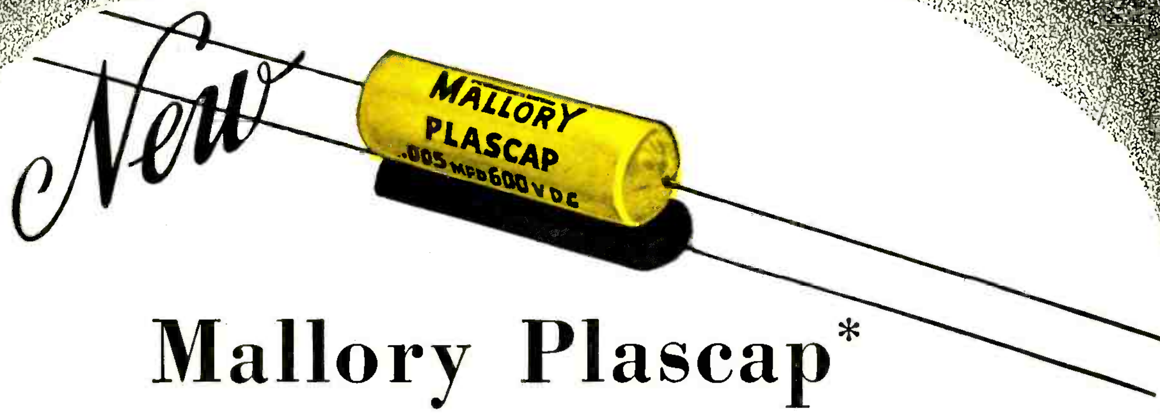
HUGO GERNSBACK, *Editor*

formerly
RADIO CRAFT

JULY
1950

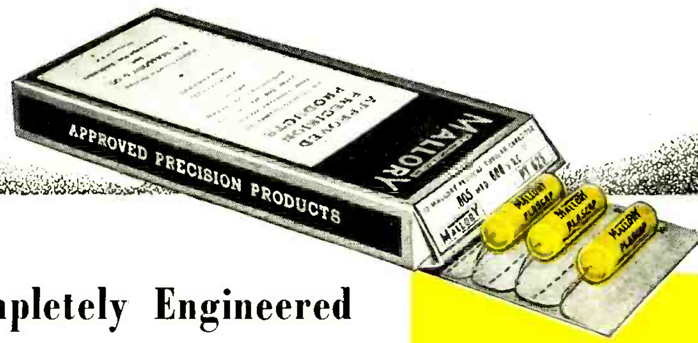
30¢
U. S. and CANADA

MICROWAVE LENSES FOCUS SOUND WAVES — SEE AUDIO SECTION



Mallory Plascap*

...Made with Amazing Mallocene*!



World's First Completely Engineered Plastic Tubular Capacitor

Here's the plastic tubular that's years ahead of its time . . . made possible *now* by Mallocene, amazing Mallory plastic development that gives you *four exclusive* performance firsts, leaves ordinary plastic tubulars far behind!

Gone is the old bugaboo of "call-backs" due to construction weaknesses beyond your control. For the Mallory Plascap is dependable. No oil leakage, no unsoldered leads, no off-center or deformed cartridges, no messy outside wax coating, no insulation problems. The Mallory Plascap makes your service job easier! See your Mallory Distributor.

The Secret of Mallocene . . .

There is only *one* logical way to build a molded type plastic tubular capacitor . . . with a plastic that sticks to the metal leads! But with ordinary construction methods, this has been impossible, for such a plastic would stick to the metal mold!

Here's the secret of the Mallory Plascap. First, an extremely tough plastic shell is molded. The cartridge is carefully centered within this shell. Then, the cartridge is surrounded with Mallocene. When Mallocene hardens, it actually becomes part of the outer plastic shell, and *sticks to the metal leads!* Thus, Mallocene provides a solid plastic tubular capacitor with the *first* moisture-proof construction!

1ST **TRISEAL CONSTRUCTION**—Sealed *three* ways—with moisture-free Mallotrol* . . . tough outer plastic shell . . . exclusive Mallocene!

1ST **FASTITE LEADS**—Permanently fastened . . . sealed with Mallocene . . . unaffected by soldering-iron heat!

1ST **DISTORTION-FREE WINDING** — No flattened cartridges due to molding pressures . . . no failures due to "shorts"!

1ST **TRU-CENTER CARTRIDGE**—Cartridge centered every time . . . uniform insulation guaranteed at all points!

Plus these Top Features: Operates at 85°C . . . . No messy outside wax coating required . . . Great mechanical strength . . . Small in size . . . Light in weight . . . High dielectric strength . . . Lead to outside foil clearly identified . . . Handsome yellow case . . . Legible part-numbers and ratings.

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SWITCHES . . . RESISTORS . . . RECTIFIERS . . .
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*Reg. U. S. Pat. Off.

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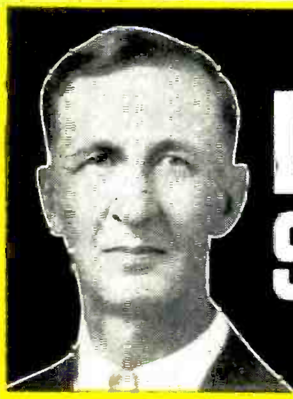
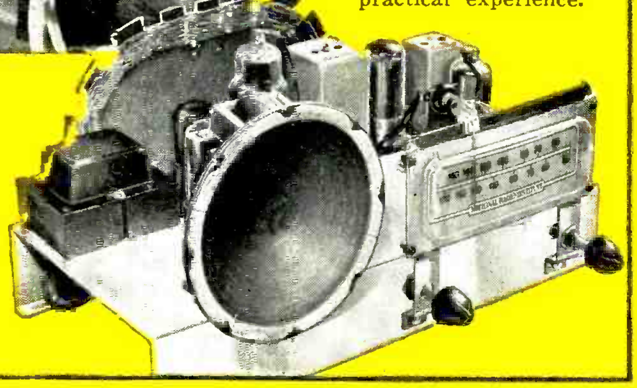


I Will Show You How to
LEARN RADIO-TELEVISION SERVICING OR COMMUNICATIONS
by Practicing in Spare Time

YOU PRACTICE RADIO SERVICING

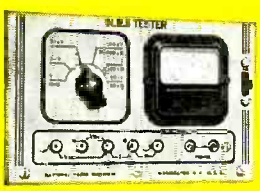
You build the modern Radio shown below as part of my Servicing Course. I send you the speaker, tubes, chassis, transformer, loop antenna, EVERYTHING you need to build this modern Radio Receiver. Use it to make many tests, get practical experience.



YOU PRACTICE RADIO COMMUNICATIONS

I send you parts to build the Transmitter shown below as part of my new Communications Course. Conduct actual procedure of Broadcast Operators, practice interesting experiments, learn how to put a transmitter on the air.

YOU BUILD THIS TESTER



as part of my Servicing Course, with parts N.R.I. sends. It soon helps you EARN EXTRA MONEY fixing neighbors' Radios in spare time.

YOU BUILD THIS WAVEMETER

as part of my NEW Communications Course. Use it with Oscillator you also build that furnishes basic power to transmitter and determines transmitter frequency.

I TRAINED THESE MEN

Good Job In Radio Station

"Am Chief Engineer of Radio Station WORD in charge of four men. Owe all I know about Radio to NRI."—CLYDE J. BURDETTE, Spartanburg, South Carolina.

Has Own Radio Business

"Now have two Radio shops servicing about 200 sets a month. Have largest service establishment in Southeastern Missouri."—ARLEY STUDYVIN, DeSoto, Missouri.

A TESTED WAY TO BETTER PAY

I Will Train You at Home with MANY KITS of Parts I Send

Want a good-pay job in the fast-growing Radio and Television Industries, or your own money-making Radio-Television shop? I've trained hundreds of men WITH NO PREVIOUS TRAINING to be Radio technicians. Or now you can enroll in my NEW practical course in Radio-Television COMMUNICATIONS—learn to be a Broadcasting and Communications technician. You get practical Radio experience with MANY KITS OF PARTS I send you in my train-at-home method. All equipment yours to keep.

MAKE EXTRA MONEY IN SPARE TIME

As part of my Radio Servicing Course, I send SPECIAL BOOKLETS starting the day you enroll. Make EXTRA MONEY fixing Radios in spare time while training. Then start your own Radio sales and service shop or get a good-pay job in Police, Aviation or Marine Radio, Broadcasting, Public Address work, etc. Or think of amazing Television opportunities. Already manufacturers are producing over 100,000 sets a month. New stations going on the air everywhere! Television is America's fastest-growing industry and men who know it will be in demand.

GET ACTUAL LESSON AND BOOK FREE

My DOUBLE FREE OFFER entitles you to actual SAMPLE LESSON and my 64-page book, "HOW TO BE A SUCCESS IN RADIO — TELEVISION — ELECTRONICS," both FREE. Mail coupon now. See how quickly, easily you can start. J. E. SMITH, President, Dept. OGX, National Radio Institute, *Pioneer Home Study Radio School*, Washington 9, D. C.

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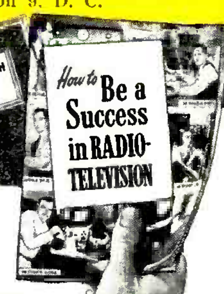

RADIO — ELECTRONICS

Incorporating
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RADIO & TELEVISION
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formerly RADIO-CRAFT

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CONTENTS — JULY, 1950

ON THE COVER: F. K. Harvey of Bell Telephone Laboratories at Murray Hill, N. J., and the audio lens. *Kodachrome by Avery Slack.*

RADIO-ELECTRONICS, July, 1950, Volume XXI, No. 10. Published monthly. Publication Office: Erie Ave., **F to G Streets, Philadelphia 32, Pa. Entered as second class matter September 27, 1948, at the post office at** Philadelphia, Pa., under the Act of March 3, 1879. **SUBSCRIPTION RATES:** In U. S. and Canada, in U. S. possessions, Mexico, South and Central American countries, $3.50; $6.00 for two years; $8.00 for three years; single copies 30c. All other foreign countries $4.50 a year, $8.00 for two years, $11.00 for three years. Allow one month for change of address. When ordering a change please furnish an address stencil impression from a recent wrapper.
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MASS SPECTROMETER which uses velocity rather than magnetic selection has been developed at the National Bureau of Standards by Dr. Willard H. Bennett.

In ordinary mass spectrometers, the ions are separated by passing the ion beam through a strong magnetic field which separates ions of different mass in the beam. The velocity spectrometer has three sets of three tungsten-wire grids spaced along a glass tube to form three stages. A radio frequency is applied to the middle grid of each stage.

The distances between grids and between stages are selected accurately so that for any particular ion mass there is a single radio frequency which can speed up ions of that mass as they pass through each stage. The increased speed of those ions enables them to overcome the opposing potential on the collector while all other ions are turned back.

This new spectrometer will be particularly useful for detecting dangerous radioactive particles in large-scale atomic processes.

SIGNAL CORPS INTRODUCES TELE-PHONE

Video-telephone, demonstrated in this photo by Pfc. Dorothy Burrus and Cpl. James Rheads, permits two-way look as well as two-way conversation. It was shown on Armed Forces Communications Association Day at Ft. Monmouth, N. J.

ULTRASONIC ENERGY rather than surgery or medicine may in the future be used to treat gallstones and kidney stones.

Gallstones can be shattered into tiny fragments by an intense ultrasonic beam, and these can then be excreted through natural elimination. Experiments on dogs have been successful with no apparent ill effects on the animals. The method has not yet been tried on humans because of the lack of suitable equipment.

This possibility was reported by Dr. Harold Lampert of the Yale School of Medicine and Drs. Herbert F. Newman and Ralph Eichhorn of Beth Israel Hospital, New York, at a recent meeting of the Federation of American Societies for Experimental Biology.

TRANSOCEANIC communication advanced another step with the introduction by RCA Communications Inc., of TEX, a two-way radio teleprinter service which now makes direct typed communication possible between business offices equipped with standard teleprinters in the United States and the Netherlands. Material typed by a stenographer in one country becomes visible immediately in the office of the company receiving the message. Though the direct customer-to-customer contact is an important feature of the new service, Tex service will be available at RCA offices for firms not equipped with teleprinters. Charge will be $9 for the first three minutes and $3 for each additional minute.

Developed by Dr. H. C. A. van Duuren, Chief Engineer of the Netherlands Postal and Telecommunications Administration, it converts standard teleprinter code into one in which the characters consist of seven units, and are all the same length. Should static or interference mutilate any character, the machine stops receiving and sends an automatic call for a repeat.

SERVICEMENS' BOYCOTT is alleged by Milton J. Shapp and Jerrold Electronics Corporation of Philadelphia, in a suit filed in the United States District Court in Philadelphia against the Philadelphia Radio Service Men's Association (PRSMA) and the Federation of Radio Service Associations of Pennsylvania (FRSAP). Several individual radio technicians were also named in the complaint.

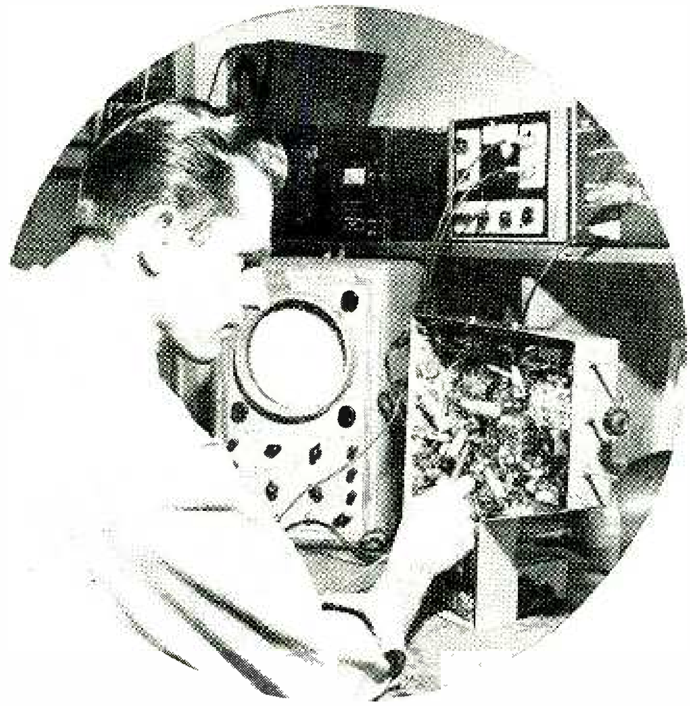
Jerrold claims losses of $20,000 and Shapp $75,000 as a result of the alleged boycott, and claim triple damages under the Clayton Act.

The suit is based on the allegation that the defendants last February put a plan into effect to have all their members refuse to handle any Jerrold products, or any handled by Shapp as an agent for various radio, television, and electronic manufacturers, unless Jerrold agreed to allow only regular dealers to handle its goods, and not sell direct to such consumers as hospitals, apartment houses, and the like.

A telephone call to Dave Krantz of Philadelphia, one of the chief defendants, elicited the opinion that the suit was "nonsense." Krantz claimed that he himself had purchased within the past few weeks several hundred dollars worth of goods manufactured by companies represented by Shapp.

819-LINE TELEVISION station at Lille, France, has commenced regular operation. This is the first time a transmitter of such high definition has worked on regular schedules. The 819-line station at Paris has been broadcasting experimentally for some time. At present practically the complete program of the Lille transmitter consists of movie films, but construction of a series of microwave stations between Paris and Lille is now under way. As soon as they are completed the northern station will rebroadcast the Paris programs.

STOP DREAMING! START PLANNING!



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with practical training in

TELEVISION and FM SERVICING!

Learn Now How to INSTALL and SERVICE All Types of TV & FM Receivers!

LATEST FIGURES show over 2,200,000 TV receivers now in use in the U. S. Twelve million sets are predicted by 1953, and practically every area of the nation will be within range of a TV station! Servicemen will have greater and greater opportunities, and those servicemen with *specialized* Television and FM training will have a bigger advantage over those with knowledge of AM only—both in competing for jobs and in trying to make a go of their own repair businesses.

CREI knows what you need. This specialized servicing course is the practical answer to the technical problems that bother the average serviceman when he faces the job of servicing today's intricate TV and FM equipment. Every lesson in this course is practical and helpful in your daily work. Lessons are revised as new developments become accepted by the industry.

Start your training now and you start applying your new-found knowledge immediately. You will be in demand and can be earning more money as you find yourself handling TV and FM work that only a few months ago looked "impossible."

This can be your big chance! Write today for complete facts.

SAMPLE LESSON **FREE!** **"Television and FM Trouble Shooting"**—this lesson is devoted to live, "dollar-and-cents", practical practice based on day-to-day servicing problems. Read this interesting lesson and see for yourself how CREI training can help you. Mail coupon for this sample lesson, free booklet and details.

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Check Field of Greatest Interest
- ☐ TV, FM & ADVANCED AM SERVICING
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NAME .... AGE ....

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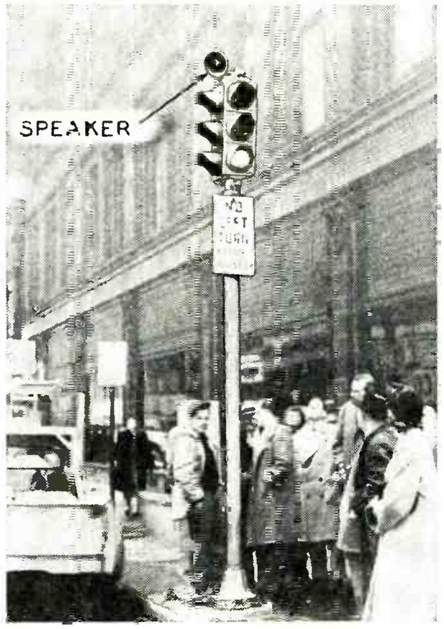
☐ I am interested in Residence School Training.

TRAFFIC LIGHT that talks, the first of its kind, was installed in downtown Syracuse, N. Y. In a joint experiment by G-E, the local police, and the chamber of commerce, an automatic tape recorder was installed to provide the light with a voice that repeats a warning message to pedestrians each time the light changes. The speaker atop the light delivers such slogans as "Look right—look left—it may save your life. Long chances shorten lives."



THREE-COLOR TUBE PATENT was issued to Allen B. Du Mont Laboratories May 16. The patent had been filed October 26, 1945. At that time the inventor, Henry Kasperowicz of Passaic, New Jersey, who is shown below with his tube, was only 27 years old.

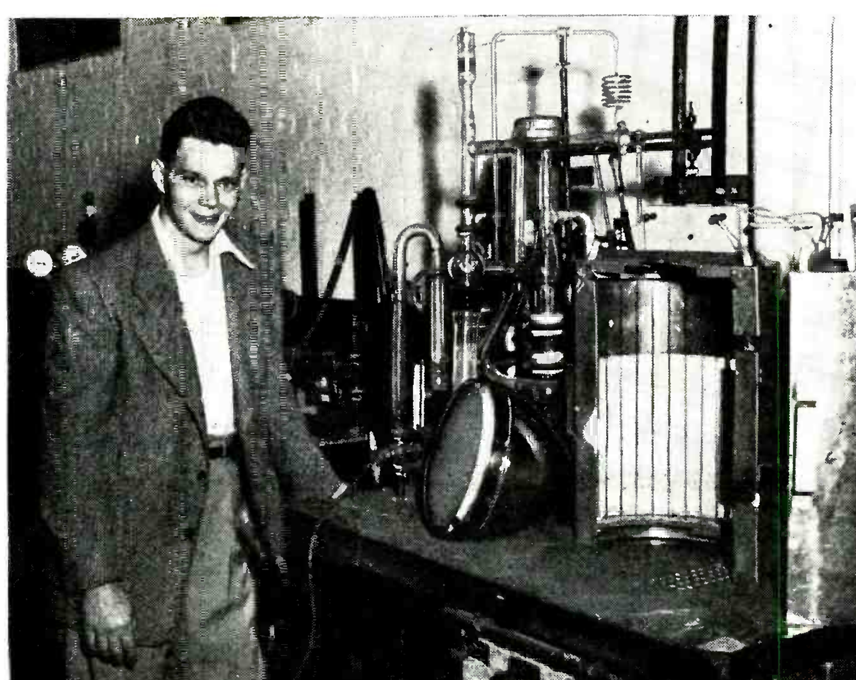
The patent covers both an iconoscope and a kinescope. The screen of the tube is divided into minute squares (roughly a thousand to the vertical height of the picture) which are covered successively with red, blue and green phosphors. The beam is then so modulated that it excites the phosphor of the desired color. In the iconoscope, photoelectric substances which are most strongly excited by the primary colors are disposed in the same checkerboard fashion, thus producing a beam modulated according to the color of the scene scanned.

The new tubes are still in the developmental stage, and their perfection depends to some extent on the setting of standards for color television.

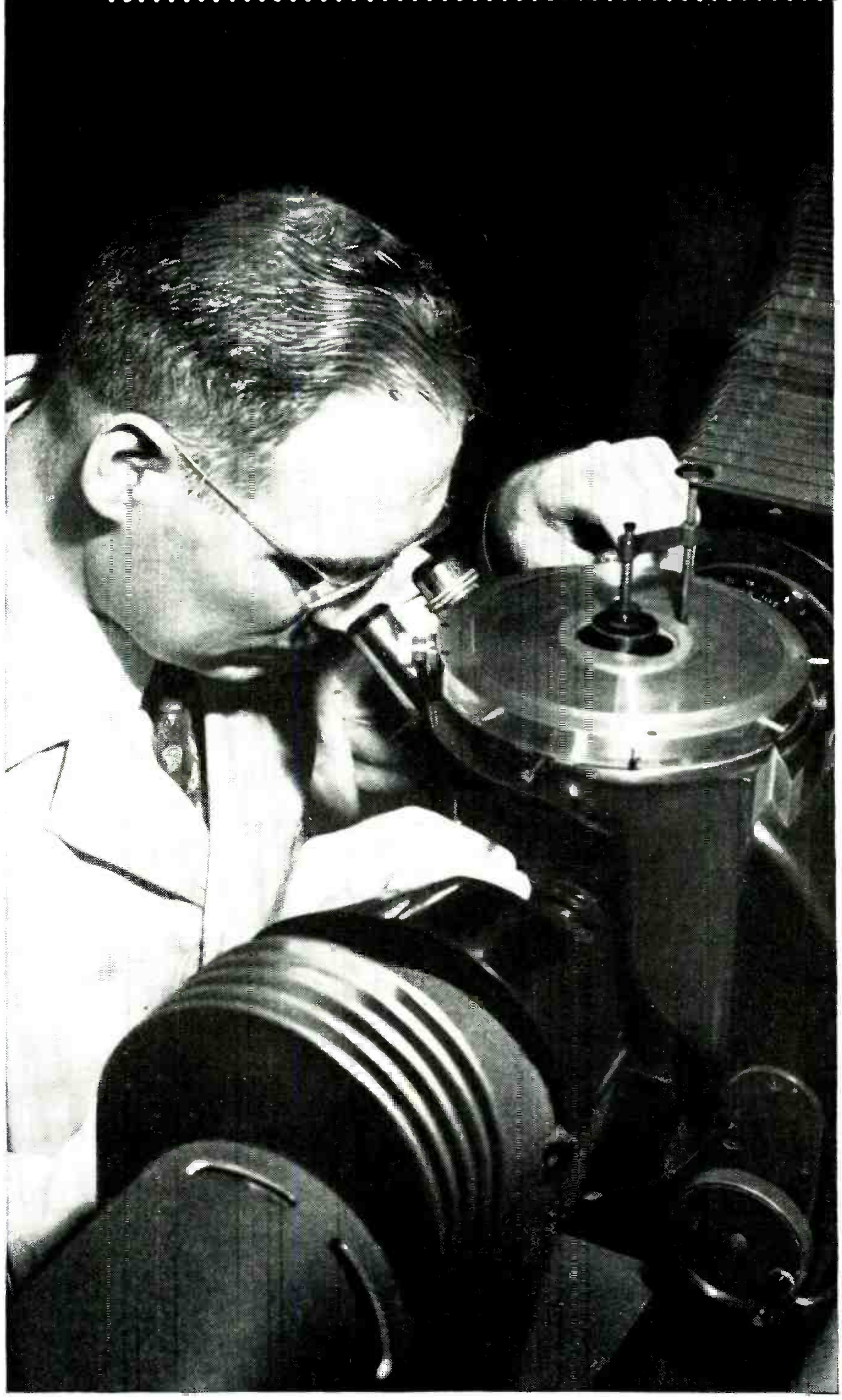
COMPULSORY LICENSING for television servicing concerns, proposed in the New York City Council by a Bronx councilman, was given a cool reception at a public hearing held May 16. Only representatives of the larger television service contracting concerns spoke for the measure, while representatives of radio publishers and service technicians condemned it.

Chief weakness of the proposed bill was that—though it recognized the service contract as the main source of abuses—it was so worded as to practically exclude from business the small technician who does not often work on a contract basis.

Provisions of the proposed local law would have included: $60 annual license fee, $500 financial responsibility bond, $5,000 to $10,000 contractor's insurance; minimum size of establishment to be 500 square feet; minimum personnel three persons (one supervisor, one full-time helper and one full-time office worker). A minimum complement of service instruments — including "sweep generator" (minimum five-inch cycloscope)—was also listed!



The look that keeps telephone costs DOWN



Examining specimen on metallographic microscope at Bell Telephone Laboratories.

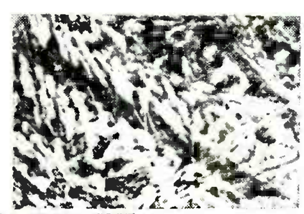
Through his microscope this Bell metallurgist examines a bit of material which is proposed for telephone use. From what he sees of grain structure, he gains insight into performance not provided by spectrum or chemical analysis. He learns how to make telephone parts stand up longer, so that telephone costs can be kept as low as possible.

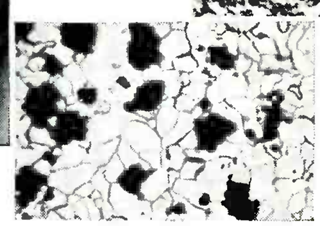
The items which come under scrutiny are many and varied, ranging from manhole covers to hair-thin wires for coils, from linemen's safety buckles to the precious metal on relay contacts.

In joints and connections—soldered or welded, brazed or riveted — photomicrographs reveal flaws which would escape ordinary tests. They show if a batch of steel has the right structure to stand up in service; why a guy wire let go in a high wind or a filament snapped in a vacuum tube; how to make switchboard plugs last longer.

In their exploration of micro-structure, Bell Telephone Laboratories scientists have contributed importantly to the metallographic art. You enjoy the benefits of their thoroughgoing testing and checking in the value and reliability of your telephone system, and the low cost of its service.

Photomicrograph of white cast iron which is hard and brittle.





Same iron rendered malleable by heat treatment. Shows spots of nodular carbon.

BELL TELEPHONE LABORATORIES

WORKING CONTINUALLY TO KEEP YOUR TELEPHONE SERVICE BIG IN VALUE AND LOW IN COST

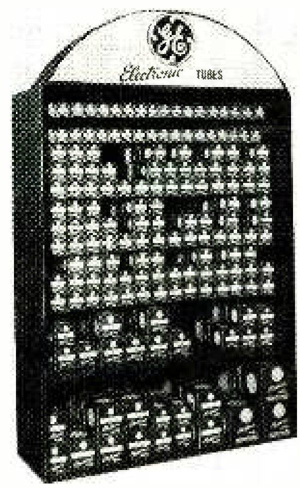
Merchandising News

RCA Victor held the second in its nation-wide series of six Television Service Clinics, beginning May 1. The clinics are sponsored jointly by the RCA Victor Home Instrument Dept., its national distributors and the RCA Service Co.

The second lecture was devoted to the servicing of the r.f. unit, the picture i.f., and the sound channel in RCA receivers. It also covered test methods and equipment. Booklets covering the material discussed in each session were given to the technicians who attended.

Colonial Radio & Television Division of Sylvania Electric Products, Inc., announced a price protection policy on all current Sylvania television models. In the event of a price change, distributors will reimburse dealers for all new and unused models of the receivers reduced.

General Electric Co. is offering an illuminated steel display case for elec-



tronic tubes to all service dealers. Called the "Selector-Salesman", the unit can hold up to 200 tubes.

The unit acts as both a display and a storage cabinet for tubes. Additional units may be attached. It is 34 inches high, 21 inches wide, and 8 inches deep.

Raytheon has announced a one-year guarantee policy on television picture tubes. In making the announcement, the Raytheon Replacement Tube Department stated that it had taken steps to eliminate red tape in processing necessary adjustments.

Centralab Division of Globe-Union, Inc., announced that it has introduced printed electronic circuits to the distributor trade. Until now these circuits were available only in manufacturers' quantities.

The company also announced a new 60-day price protection policy and a comprehensive method of maintaining up-to-date inventories through an inventory exchange plan. Centralab also made known its cooperation with the Sams' **Photofact Service** beginning with folder No. 93.

Insuline Corp. has made a two-color all steel display stand for auto antennas available to dealers. The stand will be sent to dealers who order six antennas.

James B. Lansing Sound, Inc., will start a flying electronics exhibit on

July 10. The exhibit, lasting two weeks, will travel exclusively by airplane.

Lansing speaker systems, **Magnacord** wire recorders, and **MacIntosh** amplifiers will be shown to the trade. Stopovers include Lincoln, Neb., St. Louis, Kansas City, Wichita, and Omaha.

International Resistance Co. has produced a new Concentrikit stock assortment to meet service technicians' increasing need for replacement concentric dual controls. The assortment contains 94 parts.

It is designed to enable technicians to assemble concentric duals in a matter of minutes. Step-by-step instructions are given.

Financial reports

(*First Quarter of year*)

	1950	1949
Admiral Corp.		
Earnings	$ 4,158,449	$ 1,536,217
Sales	$36,291,409	$23,513,097
American Phenolic Corp.		
Earnings	$ 224,906	$ 175,649
Sales	$2,765,336	$2,788,759
Globe-Union (parent co. Centralab Div.)		
Earnings	$ 540,904	$ 259,957
Sales	$7,200,388	$5,414,923

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To Prepare for an Exciting, Profitable Job in...

E. B. De Vry, President DeForest's Training, Inc.

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DeForest's Training, Inc. provides EVERYTHING YOU NEED for real laboratory type training . . . *in your spare time, AT HOME.* No previous experience needed. You learn-by-seeing, learn-by-reading, learn-by-doing as you prepare for a real job or your own business in thrilling Television-Radio-Electronics. This even includes the opportunity to build and keep a big 16 inch rectangular picture tube TELEVISION RECEIVER—an optional feature available at small added cost after completing training described below.

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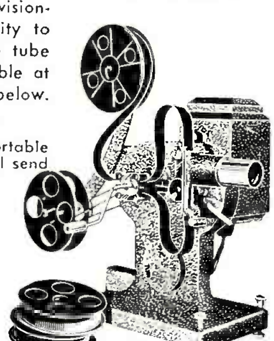
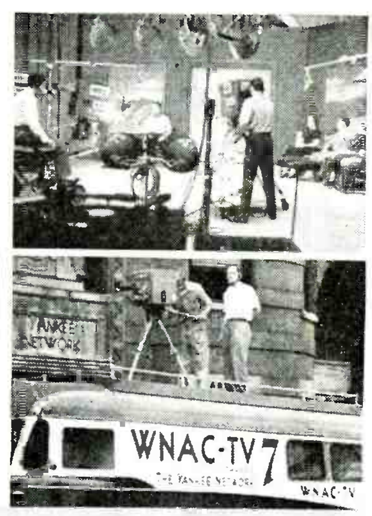
If you choose to come to Chicago, we shall find comfortable living quarters for you. If you train at home, we shall send you modern, practical equipment. In either of these two methods, you will have the supervision of some of the finest instructors in the country. Fill in coupon below and we shall send you, absolutely FREE, full information about our program of building men for better opportunities in TELEVISION-RADIO-ELECTRONICS. DeForest's Training, Inc. also includes instruction in FM Radio and Industrial Electronics.

If you prefer to remain at home, you receive 16 big kits of radio parts and assemblies from which you can work over 300 fascinating experiments . . . including the building of a Multimeter, Signal Generator and Oscilloscope . . . which you keep. In addition, you receive the use of a 16 mm. motion picture projector and 16 information-packed reels of film which help you learn faster . . . easier. You also get modern lessons.





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Chicago 14, Illinois

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Name ______________________ Age ____

Address ______________________ Apt. ____

City ______________ Zone ____ State ______

☐ *If under 16, check here for special information.*

	1950	1949
Hoffman Radio Corp.		
Earnings	$680,595	not reported
Sales	$6,240,660	not reported
Hytron Radio & Electronics		
Earnings	$ 473,705	$ 128,906
Sales	$6,646,046	$3,233,743
Magnavox Co. (estimated)		
Earnings	$ 624,742	not available
Sales	$9,000,000	not available
Motorola, Inc.		
Earnings	not reported	not reported
Sales	$15,200,000	$35,500,000
Noblitt-Sparks Industries, Inc.		
Earnings	$718,496	$502,067
Sales	not reported	
Olympic Radio & Television, Inc.		
Earnings	$ 368,454	$ 79,270
Sales	$4,778,448	$1,531,249
RCA		
Earnings	$11,236,231	$ 5,932,083
Sales	$127,369,550	$92,327,827
Raytheon Mfg. Co.		
Earnings	$ 752,000	$ 419,000
Sales	$16,500,000	$14,100,000
Sylvania Electric Products		
Earnings	$ 1,225,844	$ 1,176,815
Sales	$29,347,911	$27,108,895
Webster Chicago Corp.		
Earnings	$ 364,076	$ 304,076
Sales	$3,708,808	$3,577,779
Weston Electrical Instrument Corp.		
Earnings	$70,127	$146,788
Sales	not reported	not reported

New plants and expansions

The Workshop Associates, Inc., has acquired a new building in Needham Heights, Mass. The additional space will be used for development activities and producing new television antennas.

Centralab Division of Globe-Union, Inc., established its fifth plant devoted to the exclusive manufacture of electronic component parts. Property consists of 42,000 square feet of floor space in two buildings in Milwaukee.

Trio Manufacturing Co., manufacturer of FM and television antennas and accessories, has added 8,000 square feet of space in Griggsville, Ill. . . . **Telrex Inc.** has acquired a new testing site in Belmar, N. J., where it will construct a fully equipped laboratory for antenna design and development. . . . **Crosley Division of AVCO Mfg. Corp.** has leased 160,000 square feet of space in buildings in Cincinnati. The space will be used for warehousing, permitting expanded production at the main plant.

Telequip Radio Co. moved to larger quarters in Chicago which will permit it to triple TV set production. . . . **Noblitt-Sparks Industries, Inc.**, has begun construction on a new factory in Columbus, Ind. It will be devoted exclusively to the manufacture of Arvin television sets. . . . **Air King Products Co., Inc.**, has acquired 40,000 square feet of space in Brooklyn, N. Y.

Business briefs

Sylvania Electric Products is completing a new cathode-ray exhaust machine which will speed up and reduce the cost of TV tube production. . . . **Allen B. DuMont** Laboratories is now marketing its industrial color TV system. . . . Mexico's first TV station will go on the air this Summer.

NEW 1950 Heathkits have all the Features

New 1950 Heathkit

PUSH-PULL EXTENDED RANGE 5" OSCILLOSCOPE KIT

Features

- The first truly television oscilloscope.
- Tremendous sensitivity .06 Volt RMS per inch deflection.
- Push-pull *vertical and horizontal* amplifiers.
- Useful frequency range to 2½ Megacycles.
- Extended sweep range 15 cycles to 70,000 cycles.
- New television type multivibrator sweep generator.
- New magnetic alloy shield included.
- Still the amazing price of $39.50.

The new 1950 Push-Pull 5" Oscilloscope has features that seem impossible in a $39.50 oscilloscope. Think of it—push-pull vertical and horizontal amplifiers with tremendous sensitivity only six one hundredths of a volt required for full inch of deflection. The weak impulses of television can be boosted to full size on the five inch screen. Traces you couldn't see before. Amazing frequency range clear useful response at 2½ Megacycles made possible by improved push-pull amplifiers. Only Heathkit Oscilloscopes have the frequency range required for television. New type multi-vibrator sweep generator with more than twice the frequency range. 15 cycles to 70,000 cycles will actually synchronize with 250,000 cycle signal. Dual positioning controls will move trace over any section of the screen for observation of any part. New magnetic alloy CR tube shield protects the instrument from outside fields. All the same high quality parts, cased electrostatically shielded power transformer, aluminum cabinet, all tubes and parts. New instruction manual now has complete step by step pictorials for easiest assembly. Shipping Weight 30 lbs. Order now for this winter's use.

$39.50

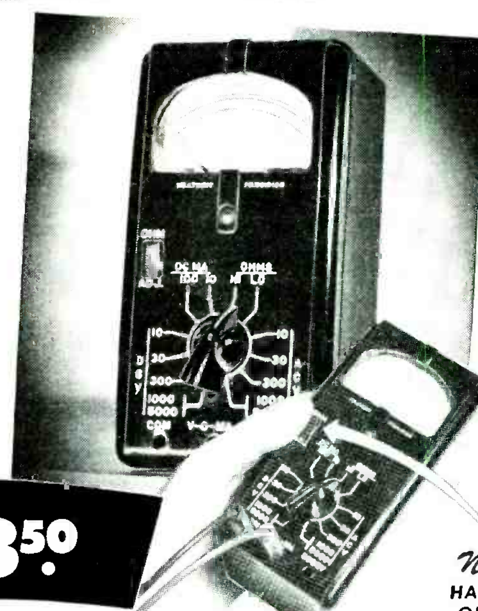
CONVERSION FOR OTHER MODEL HEATHKIT OSCILLOSCOPES

A conversion for all 03 and 04 scopes is available changing them to the new push-pull amplifiers (does not change the sweep generator). Complete kit includes new chassis, tubes and all parts. For a small investment, add the latest improvements to your present oscilloscope (Except C.R. Tube Shield). Shipping weight 10 lbs.
Order 05 Conversion Kit No. 315 .... **$12.50**

THE NEW *Heathkit* HANDITESTER KIT

MORE *Features* THAN EVER BEFORE

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



Note HANDY OHMS ADJUST.

The instrument for all—the ranges you need—beauty you'll enjoy for years and you can assemble it in a matter of minutes—an instrument for everyone. The handiest quality voltohmeter of all. Small enough to put in your pocket yet a full 3" meter. Easy pictorial wiring diagrams eliminate all assembly problems. Uses only 1% precision ceramic divider resistors and wire wound shunts. Twelve different ranges. AC and DC ranges of 10 30 300 1,000 5,000 Volts. Ohms ranges of 0–3,000 ohms and 0–300,000 ohms. Milliampere ranges of 10MA and 100MA. Hearing aid type ohms adjust control fits conveniently under thumb for one hand adjustment. Banana type jacks for positive low resistance connections. Quality test leads included. The high quality Bradley instrument rectifier was especially chosen for linear scales on AC. The modern case was styled by Harrah Engineering for this instrument. The 400 microampere meter movement comes already mounted in the case protected from dust during assembly. An ideal classroom assembly instrument useful for a lifetime. Perfect for radio service calls, electricians, garage mechanics, students, amateurs and beginners in radio. The only quality voltohmeter under $20.00. An hour of assembly saves you one-half the cost and quality parts give you a better instrument. Order today. Shipping weight 2 lbs.

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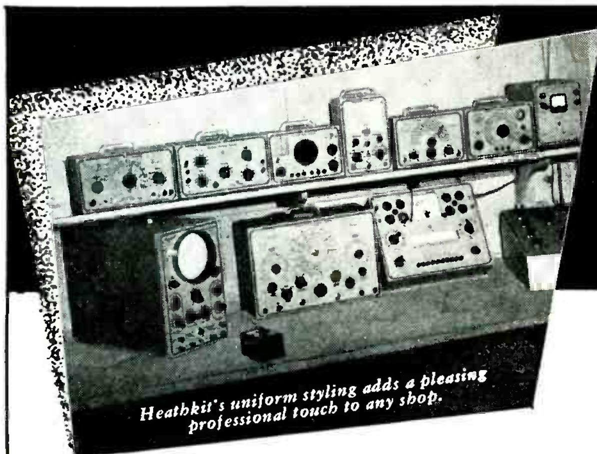


Heathkit's uniform styling adds a pleasing professional touch to any shop.

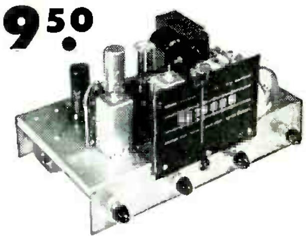
Heathkits PROVIDE PROFESSIONAL LABORATORY APPEARANCE

New Heathkit BROADCAST AND 3 BAND SUPERHETERODYNE RECEIVER KIT

BROADCAST MODEL BR-1

550 to 1600 Kc.

$19.50

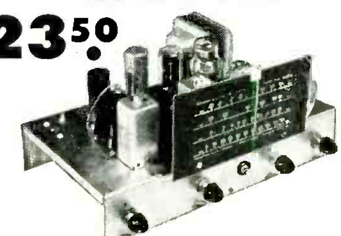


Two new Heathkit Superheterodynes featuring the best of design and material. Beautiful six inch slide rule dials — 110 V. 60 cy. AC power transformer operated—metal cased filters—quality output transformers, dual iron core metal can IF transformers — two gang tuning condenser. The chassis is provided with phono-radio switch—110 V. outlet for changer motor and phono pickup jack. Each kit is complete with all parts and detailed instruction booklet. Pictorial diagrams and step-by-step instructions make assembly quick and easy.

3 BAND MODEL AR-1

550 Kc. to 20 Mc.

$23.50



Ideal AC operated superheterodyne receiver for home use or replacement in console cabinet. Comes complete with attractive metal panel for cabinet mounting. Modern circuit uses 12K8 converter, 12SH7 input IF stage, 12C8 output IF stage and first audio 12A6 beam power output stage. 5Y3 rectifier. Excellent sensitivity for distant reception with selectivity which effectively separates adjacent stations.

The husky 110 V. cased power transformer is conservatively rated for long life.

The illuminated six inch slide rule dial is accurately calibrated for DX reception. Enjoy the pleasure of assembling your own fine home receiver. Has tone, volume, tuning and phono-radio controls. Chassis size 2¼" x 7" x 12½" Comes complete with all parts including quality output transformer to 3-4 ohm voice coil, tubes, instruction manual, etc. (less speaker). Shipping Wt., 10 lbs. No. BR-1 Receiver $19.50.

No. 335 Communications Type Table Model Metal Cabinet.................$4.50
No. 320 High Quality 5" PM Speaker for above.................................. 2.75

Enjoy the thrill of world wide short wave reception with this fine new AC operated Heathkit 3 band superheterodyne — amazing sensitivity 15 microvolt or better on all bands. Continuous coverage 550 Kc. to over 20 Mc. Easy to build with complete step-by-step instructions and pictorial diagram. Attractive accurately calibrated six inch slide rule dial for easy tuning. Six tubes with one dual purpose tube gives seven tube performance. Beam power output tube gives over 3 watts output.

Separately assembled coil turret with band switch eliminates difficult construction. Conservatively rated 110 V. power transformer supplies full operating voltages to all tubes for maximum reception. Has band switch, tuning, volume, tone and phono-radio controls. Chassis size 2¼" x 7" x 12½" — supplied complete — punched chassis — tubes — controls — transformers (quality output to 3-4 ohm voice coil) — all small parts — hardware and instructions (less speaker). Shipping Wt., 10 lbs. No. AR-1 Receiver $23.50.

No. 335 Communications Type Table Model Metal Cabinet.................$4.50
No. 320 High Quality 5" PM Speaker for above.................................. 2.75

Heathkit PUSH-PULL HIGH FIDELITY AMPLIFIER KIT

$12.50

Build this high fidelity push-pull amplifier and save two-thirds the cost—has two pre-amplifier stages, phase inverter stage and push-pull beam power output stage. Comes complete with six tubes—quality output transformer (to 3-4 ohm voice coil) tone and volume controls—varnish impregnated cased 110V. power transformer and detailed instruction manual and all small parts. Six watt output with output flat within 1½ db between 50 and 15000 cycles.

Build this amplifier now and enjoy it for years.

Shipping Wt. 7| lbs. Model A-4

12" PM Speaker for above..........$6.95

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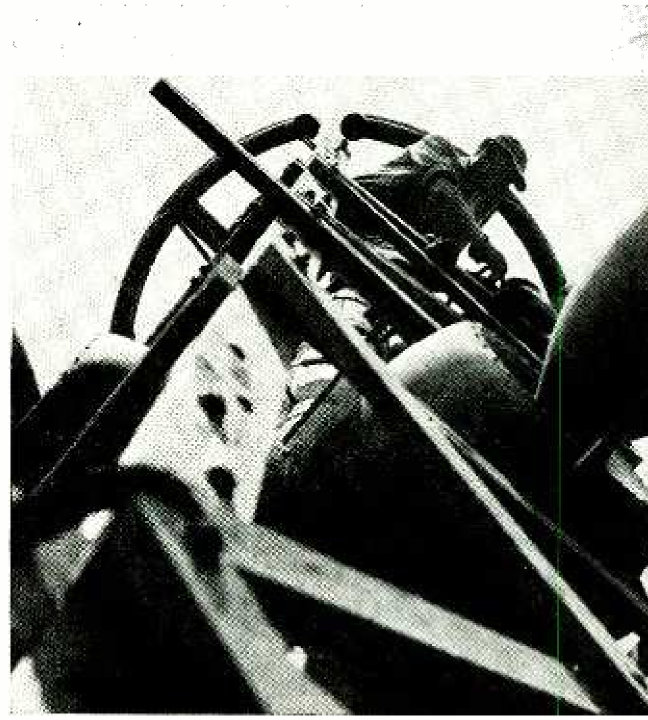
They climbed the world's tallest tower so you could see farther



Steeplejacks at work *on an NBC television antenna—1250 feet above the sidewalks of New York. Its height gives telecasts a wider range in the New York and New Jersey area.*

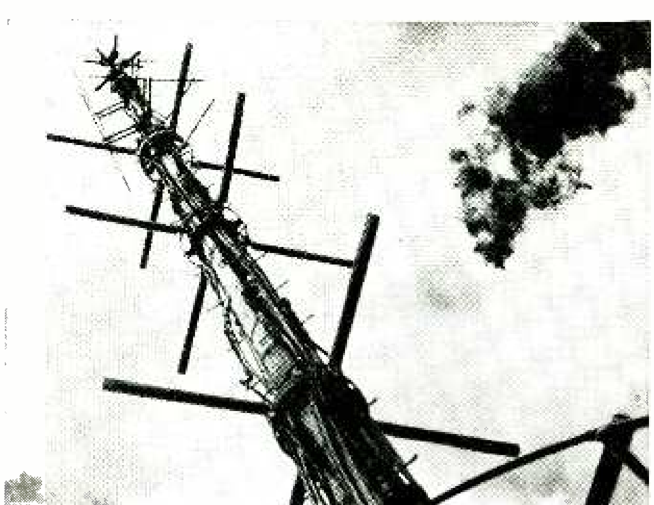
Installation of NBC's television antennas has been a job for daring steeplejacks!

No. 6 in a series outlining high points in television history

Photos from the historical collection of RCA

● Dwarfed ant-small by their height above Manhattan's streets, skilled and daring workmen—in 1931—offered New Yorkers a sight as exciting as the highwire act at a circus . . . but much more significant.

Task of these men, as they clambered about atop the tower of the Empire State Building—1250 feet in the air—was to install an antenna for experimental telecasts from NBC's television station. "Why did it have to be so high?" was a question on thousands of watchers' lips.



A familiar sight *on the New York skyline, NBC's television antenna—installed in 1946—was the successor to those erected in 1931, 1936 and 1938, and used by RCA and NBC to perfect television.*

As might have been expected, with television an unfamiliar art, the average layman thought of it in relation to radio broadcasts, whose waves he knew could circle the globe. That telecasts were fundamentally limited by the line of the horizon was little known. To increase this limiting range, scientists, engineers, and technicians, sought the highest available vantage point.

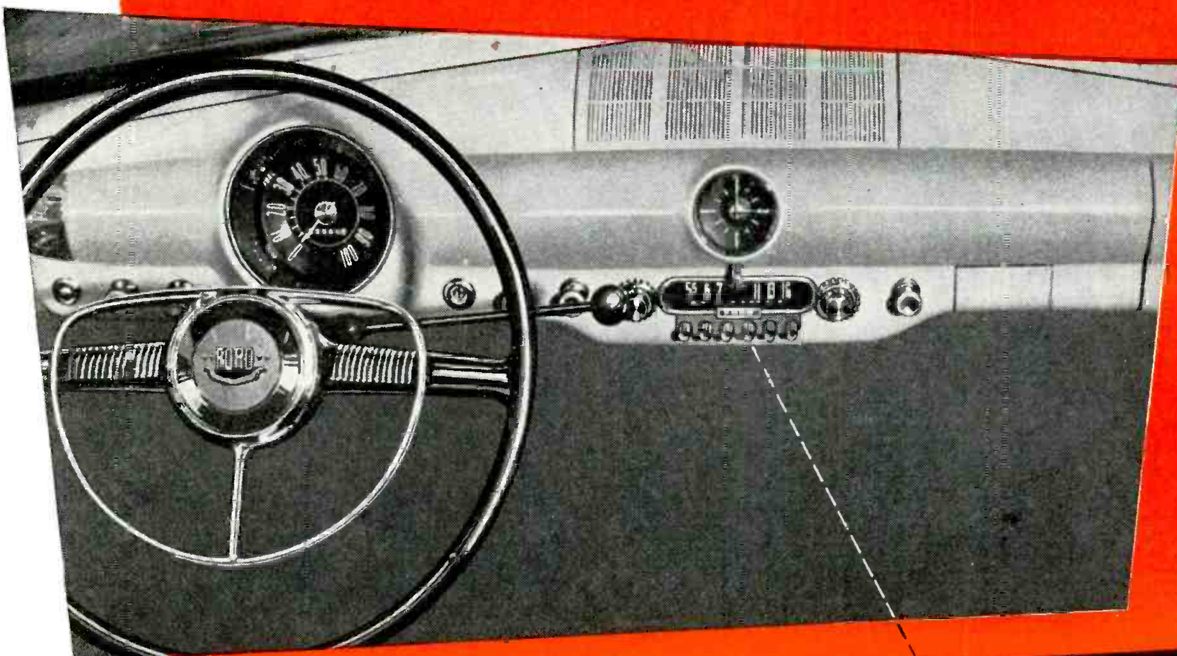
With its antenna installed, this experimental television station was able to transmit pictures a distance of about 42 miles, and farther under highly favorable conditions. Receivers dotted around the New York area picked up the first telecasts, providing encouraging and instructive information to be studied by RCA's scientists.

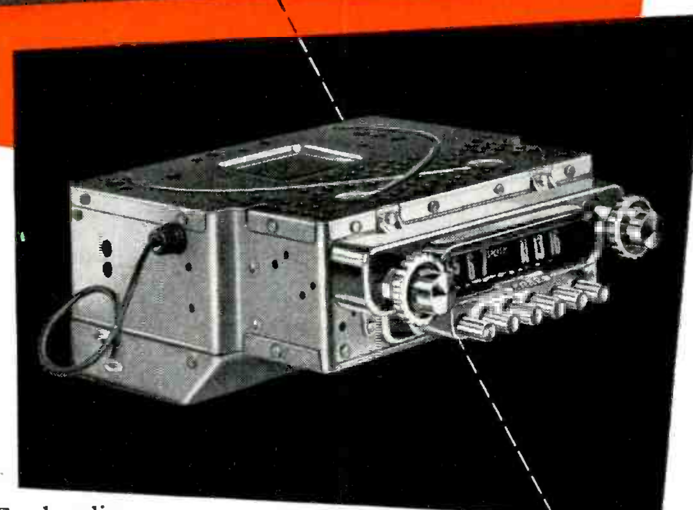
Facts gathered in this period included new data on the behavior of very short waves, as well as how to handle them. New knowledge about interference was acquired, including the fact *that much of it was man-made* and therefore could be eliminated.

Other studies undertaken at the time included basic work on the "definition" most suitable for regular commercial telecasts. Definition as coarse as 60-lines was used in early days. Then came 341-line, and 441, until today's standard of 525-line definition was finally adopted.

That we may now, as a matter of course, see sharp, clear pictures on the screens of our home television receivers is in good part the result of experimental work initiated by RCA scientists, and carried out by NBC engineers since the erection of the first station in the Empire State Building. A share should also be credited to the steeplejacks who climbed to dizzy heights so that you could see farther!

Radio Corporation of America
WORLD LEADER IN RADIO—FIRST IN TELEVISION





FORD for '50
HYTRON for '50

Thrifty, nifty fifty Ford. On the dash a fine new Ford radio receiver. And again tubes by Hytron. Hytron continues as a major supplier of Ford auto radio tubes. Because Hytron *specializes* in auto radio tubes. Engineered for leaders like Ford, these Hytron tubes are leaders too. 'Nuff said! Buying auto radio tubes? Buy wise . . . like Ford. Buy Hytron!

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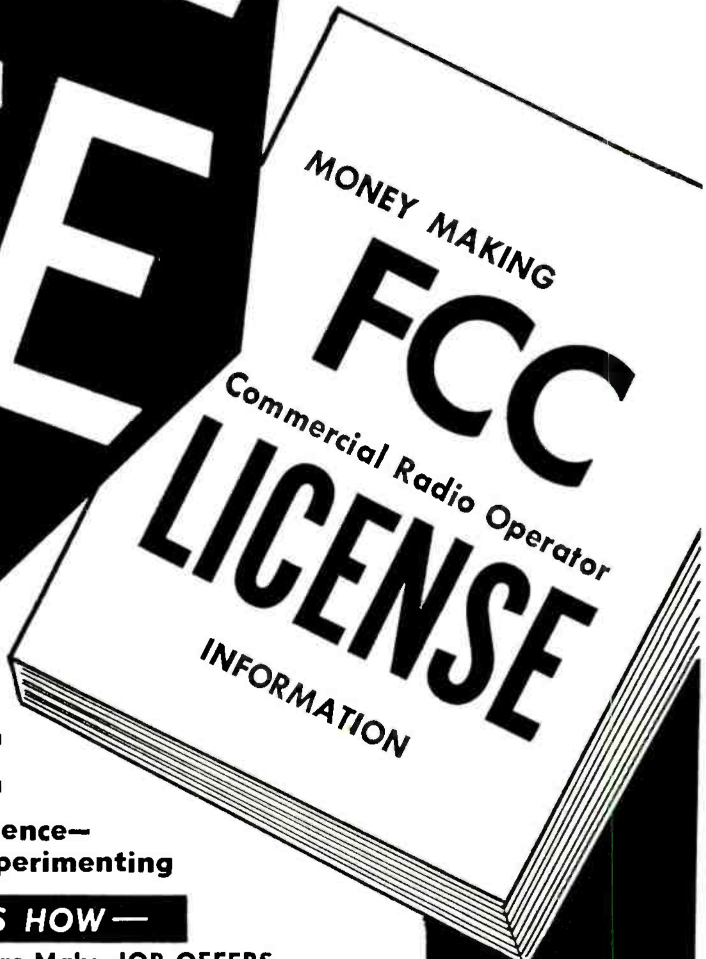

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if you have had any practical radio experience—amateur, Army, Navy, radio repair, or experimenting

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Amazingly Effective Job-Finding Service Helps CIRE Students Get Better Jobs. Here are just a few recent examples of Job-Finding results:

GETS JOB WITH CAA

"I have had a half dozen or so offers since I mailed some fifty of the two hundred employment applications your school forwarded me. I accepted a position with the Civil Aeronautics Administration as a Maintenance Technician. Thank you very much for the fine cooperation and help your organization has given me in finding a job in the radio field."
Dale E. Young, 122 Robbins St., Owosso, Mich.

GETS JOB IN PUBLIC UTILITIES

"I have secured the position of Radio Technician with the Toledo Edison Company. I want to thank you once more. The help you gave me was much more than would ordinarily be expected—both in obtaining my license and in finding employment."
Norman W. Stokes, Jr., Rt. 11, Box 612, Toledo 7, Ohio

GETS JOB AS DEVELOPMENT ENGINEER

"I wish to express my thanks for the Applications-For-Employment you recently prepared for me. I received 3 telephone calls and one letter. As a result I am now employed in a development engineering capacity."
K. E. Forsberg, 26 Soley St., Charlestown, Mass.

GETS JOB IN BROADCASTING

"I have accepted a position with KWAD. I secured this position through the help of your Job-Finding Service and I had at least six other offers. I am sincerely under obligation to you."
Fred W. Kincaid, Box 241, Wadena, Minn.

TELLS HOW—

Employers Make JOB OFFERS Like These to Our Graduates Every Month!

Telegram, Apr. 7, 1950 from Chief Engineer, Broadcast Station, Pennsylvania. "Immediate opening for engineer. Automobile and First Phone a must. If graduate available, please forward name and address."

Letter, Apr. 14, 1950 from Chief Engineer, Broadcast Station, Montana: "Immediate opening for Engineer-Announcer. Basic salary $62.50 . . . real future for right man."

Letter, January 30, 1950 from Chief Engineer, Broadcast Station, Tennessee: "Have opening for operators. If you have men, please have them contact us."

These are just a few examples of the job offers that come to our office periodically. Some licensed radioman filled each of these jobs; it might have been you!

Ours is the only home study course which supplies FCC-type examinations with all lessons and final tests.

ACT NOW!

Get All 3 FREE

Your FCC Ticket is Always Recognized in All Radio Fields as Proof of Your Technical Ability.

HERE'S PROOF FCC LICENSES ARE OFTEN SECURED IN A FEW HOURS OF STUDY With OUR Coaching AT HOME in Spare Time:

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James A. Gram, 11 West Main St., Cuba, New York	1st class telephone	34
Ernest K. Hodson, Box 1001, Caldwell, Idaho	1st class telephone	71
Howard J. Kischassey, Rt. 2. Box 736. El Cajon. California	2nd class telephone	49
Ralph I. Nichols, 510 Elm St., Kerrville, Texas	2nd class telephone	34
Elbert L. Risinger, P. O. Box 122, Bedias, Texas	1st class telephone 2nd class telegraph	34
Harry R. Rogers, R. R. 6, Lafayette, Ind.	2nd class telephone	50

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MEDICAL ELECTRONICS

. . . An immense field beckons the researcher . . .

By Hugo Gernsback

There is perhaps no field today which requires electronic applications more urgently than medicine. The reason for this is that medicine is as yet not an exact science, but rather an art. The medical man still falls back upon most of his five senses when he makes a diagnosis. His trained eyes see many tell-tale signs, his touch interprets temperature, pulse beat, etc., his ear evaluates heart, chest and lung sounds, his nose can often recognize certain diseases, such as measles, scarlet fever and others that have characteristic odors. Old-time practitioners touched the back of their patient's hands with the tip of their tongue—the salinity, the acidity, etc., of the skin frequently was a good index of certain diseases.

Methods such as these seem crude and archaic in the electronic age. The human body is a most complex machine, with most of its machinery hidden and inaccessible. Its electric organs are delicate and deep-seated. Its chemical plants are distributed widely throughout the body and are often difficult to contact. The body's heating and cooling plants are still little understood. The blood circulatory system—while better explored—still holds many unsolved problems.

Thousands of medical books covering every part and function of the human body cannot begin to more than scratch the surface of the subject. This is particularly true of the vast field of diagnosis.

Electronically the human body can be compared to a sealed up radio or television receiver, with only a few exposed connections. The service technician parallels the physician who now is called upon to locate the hidden defect. But the physician today has no universal "analyzer" that can locate faults or troubles throughout the vast and complex domain of the "sealed-unit" human machine.

But there no longer remains any valid reason why electronic science should not give the medical practitioner a biological-electronic analyzer that could in time diagnose *any* disease, *any* dysfunction. The oscilloscope, the amplifier, the millivoltmeter and ammeter, the sensitive thermo-couple and dozens of other electronic instruments can all be combined into a portable *bio-analyzer*.

Even now, medical science uses thermionic amplification plus a graphic galvanometer for recording heart impulses, brain waves and uterine contractions. The photoelectric cell has already been made an indispensable part of bio-chemical technique; the colorimeter is calibrated to read grams of haemoglobin per hundred cubic centimeters of blood directly, or milligrams of nitrogen . . . . or creatine or uric acid. Heart sounds are accurately analyzed on a tape; murmurs are measured to a hundredth of a second. It is only a question of time until these present uses and others added are all integrated into one portable unit.

Once such an instrument has been evolved and perfected and the practicing physician has learned how to master its complexities, medicine will have a valuable tool to combat disease effectually. There will then no longer be any guesswork as to diagnosis.

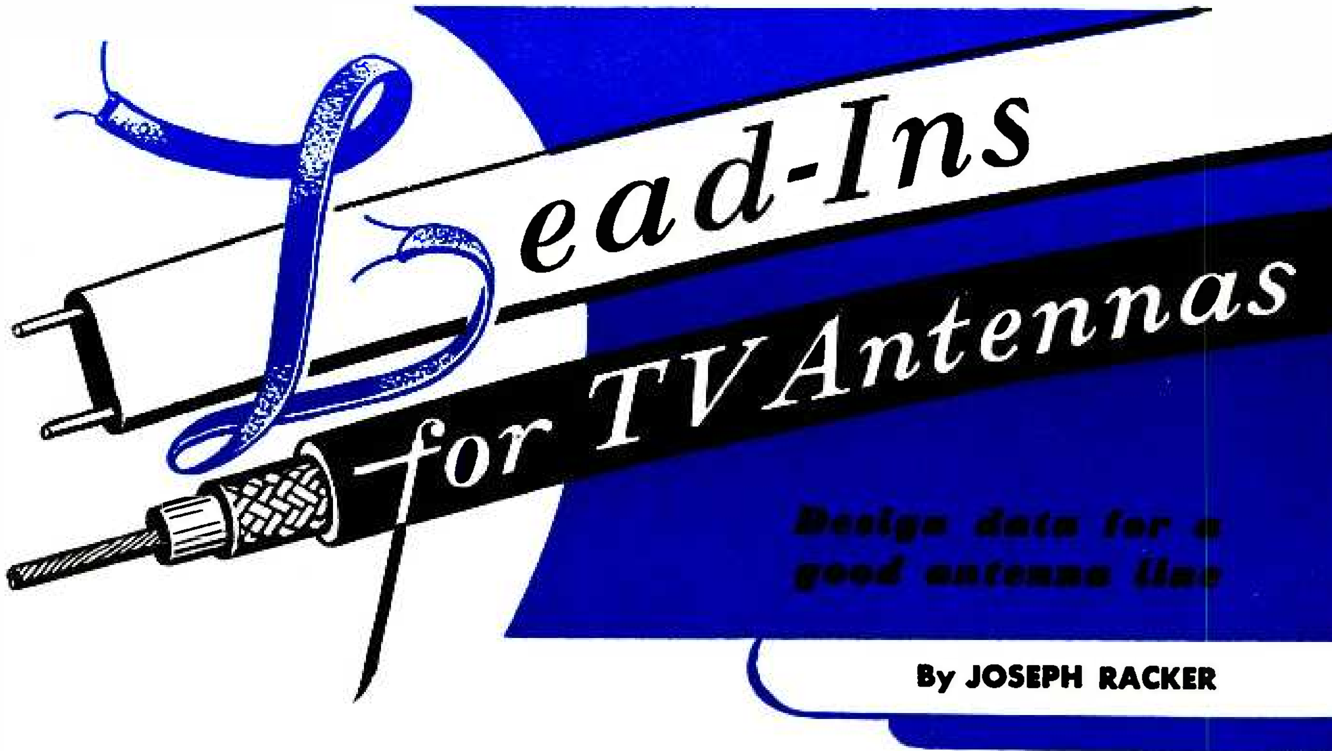
The doctor then can make his blood tests, his blood count on the spot—without puncturing the patient's skin—and without the necessity of going to a technician who specializes in such work. He will take his cardiogram on the spot. He will know the *exact* status of an appendix and will know if it is to be excised or if it can be treated. Puzzling rises of temperature of a patient can be tracked down fast—hidden abcesses for instance can be located by local temperature variations. Usually the site of an internal abcess has a higher temperature index than other parts of the body. Hundreds of similar examples could be cited to prove that bio-electronic diagnosis *is* possible and that undoubtedly it will be commonplace in the not too distant future.

Much research will have to be done in the meanwhile to make it an accomplished fact. Electronic and medical research teams will have to pool their joint talents and knowledge in collaboration with instrument technicians to evolve a medically acceptable bio-analyzer. Finally doctors will have to be trained to use the instrument and to evaluate all its ramifications. Admittedly this will take time, effort and money but it *will* be done.

I am not unmindful of the fact that as early as 1916 the notorious Dr. Albert Abrams sold an electric gadget to medical doctors that was supposed to analyze any disease from a cold to a hidden cancer. He was exposed in due time because his gadget was a palpable fraud—made to sell to gullible medical men, who did not know that the gadget was not a scientific instrument. Similar fakes have been sold by other unscrupulous promoters—indeed this magazine exposed one of the most flagrant ones in the February 1944 issue.

If this proves anything, it indicates that there is a wide demand for a bio-analyzer—even if false starts were made in developing some worthless ones. Television, too made a great many false starts (albeit no fraudulent ones) during the past 30 years, before it became a resounding success.

Incidentally, the bio-analyzer will, in time be big business. There are today some 200,000 physicians in the United States. If only 60% of these physicians were to buy a bio-analyzer set at a projected price of $1,500 each, this would then represent a total of $180,000,000. This appears a very interesting figure for analyzer people to contemplate.



Lead-Ins for TV Antennas

Design data for a good antenna line

By JOSEPH RACKER

WITH customers more critical than ever because of increased competition and many demonstrations, the responsibility of the television installer has become greater than ever. The customer—or the technician who installs his own set—won't be satisfied until his picture quality is at least as good as that obtained on the best "neighbor" receiver.

In many cases this attitude is justified because of the improved design of virtually all receivers, and the development of new types of antennas and transmission lines, which overcome difficulties encountered in many previously adverse locations. In this article we will consider the selection of the best transmission line system.

Little importance has been attached to the type of transmission line used in most installations. The attitude has been to use 300-ohm flat ribbon line for receivers with 300-ohm inputs, and 70-ohm coaxial cable for 70-ohm sets. Alternative lines are rarely considered though—for 300-ohm units in particular—an appropriate choice of transmission line can greatly improve reception.

The term picture "quality" has little specific meaning in judging the performance of transmission lines. To overcome this difficulty we shall define "quality" in terms of signal-to-noise (S/N) ratio. A signal-to-noise ratio of at least three at the input to the receiver is necessary for a picture of passable quality. As the S/N ratio is increased, the picture quality improves until a point is reached where further improvement in this ratio cannot be seen on the screen. This point (usually about 6:1) varies for different sets and there is no reason to try to exceed it. We will refer to it as the optimum S/N.

Transmission line systems that provide the optimum signal-to-noise ratios should be used, if possible. Two characteristics of any line are of interest. The first is its ability to deliver maximum signal to the receiver input, and the second its ability to pick up a minimum of noise. Noise in this article is defined as any type of interference, including "ghosts". These two characteristics are independent of each other, and will be considered separately.

A transmission line should transmit the signal picked up at the antenna to the receiver input as efficiently as possible. An ideal transmission line would do this with no loss of signal at all, but in practice it is impossible to design such a line. Losses in signal strength may be caused by the line for two reasons. One is the attenuation of the line and the other is possible mismatch between line and receiver input.

The attenuation of a transmission line is usually given in decibels of power. To review briefly, the decibel (db) is a way of expressing the ratio of two compared powers. This relationship is expressed by the equation:

$$db = 10 \log P1/P2,$$

where P1 and P2 are the powers compared. When voltage ratios are used, the db (in power) is equal to 20 log (V1/V2), if both voltages are measured across the same impedance.

For example, if an antenna picks up a 10-microvolt signal and only 1 microvolt is delivered to the receiver, the loss in the transmission line in db is 20 log 10, or 20 db.

To simplify the calculation of decibels gained or lost, see the conversion table (Table 1). From this table the reader can convert db into power or voltage ratios or the ratios to db without logarithm tables or a slide rule.

Many technicians have an exaggerated view of the losses caused by mismatch between the characteristic impedance Z_0 of the cable and the input impedance Z_L of the receiver. It is true

TABLE 1

LOSS		DB	GAIN	
Power Ratio	Voltage Ratio		Power Ratio	Voltage Ratio
1.000	1.000	0	1.000	1.000
0.977	0.988	0.1	1.023	1.011
0.955	0.977	0.2	1.047	1.023
0.891	0.944	0.5	1.122	1.059
0.794	0.891	1.0	1.259	1.122
0.631	0.794	2.0	1.585	1.259
0.501	0.708	3.0	1.995	1.413
0.398	0.631	4.0	2.512	1.585
0.316	0.562	5.0	3.162	1.778
0.251	0.501	6.0	3.981	1.995
0.199	0.447	7.0	5.012	2.239
0.158	0.398	8.0	6.310	2.512
0.126	0.355	9.0	7.943	2.818
0.100	0.316	10.0	10.000	3.162
.010	0.100	20.0	100.00	10.00
.001	0.0316	30.0	1000.00	31.62

that no power will be lost because of mismatch when a 300-ohm line is used to feed a 300-ohm receiver. However, in evaluating the over-all efficiency of the cable, it is important to know what the loss is when a cable with a different characteristic impedance is used. The losses due to mismatch, shown graphically in Fig. 1, are a function of impedance ratio. It is conventional to express the impedance ratio with a number greater than 1: if Z_o is larger than Z_L, the ratio of Z_o/Z_L is used; and if Z_L is larger, the ratio is Z_L/Z_o. Fig. 1 shows an important fact: for impedance ratios less than 2:1 the power loss is less than 1 db.

Let us consider a typical problem. A 100-foot line must be used to connect an antenna to a receiver in an area where maximum possible signal strength must go to the 300-ohm input receiver. Table 2 lists the available cables and their characteristics.

Obviously the choice is between the two unshielded cables. The 300-ohm line will not introduce mismatch but will attenuate the signal 1.85 db at 200 mc. The 200-ohm cable, with an attenuation of 0.66 db (at 200 mc) and a mismatch loss of 0.2 db (from Fig. 1), has a total attenuation of only 0.86 db. Therefore, the 200-ohm cable is better.

This may come as a surprise to the reader. Practice proves that in low-signal-strength (and low-noise) areas, where the antenna must be high and needs a long lead-in, the 200-ohm cable is far superior.

Another fact to consider is the actual loss versus the calculated loss. Manufacturers figures for attenuation and characteristic impedance of unshielded lines assume that the cable is dry and completely isolated from ground. This is not true for many installations and both the attenuation and characteristic impedance of the cable may vary from the figures given. In the extreme cases of a wet line touching a metallic ground, the lead-in may short-circuit the signal.

Two measures are necessary to minimize this effect. Keep the cable away from metallic grounds such as radiators and water pipes, and keep horizontal runs of cable on roof top to a minimum. With the lead-in lying on the roof, the likelihood of water seeping into the cable is far greater than if the cable were vertical. Of course shielded lines with a waterproof jacket will maintain a constant characteristic impedance and attenuation regardless of cable position or weather conditions.

Noise introduced by lead-in

In many locations the problem is not lack of signal as much as it is too much noise. Noise introduced into the system by the antenna or receiver cannot be eliminated by choice of transmission line. But noise picked up by unshielded lines can be reduced. Tests in noisy areas have shown that a large percentage of the noise picked up by a receiver is traceable to unshielded line.

An unshielded cable acts as an antenna for all signals in the atmosphere from very low frequency to v.h.f. and u.h.f. In contrast, the antenna is a highly selective circuit choosing only signals in the TV band. The harmonics of any one of the signals picked up by the unshielded line, or the sidebands of two such signals, could easily fall within the television frequency range and be introduced to the receiver as noise.

The unshielded lead-in also acts as an antenna for ghosts. A ghost is the result of a multiple path signal mixing with a direct path signal. A 100-foot unshielded lead-in is far more likely to pick up ghosts than the approximately 4-foot antenna. (The efficiency of a "balanced" transmission line as an antenna is often underestimated. Try a piece a few feet long, connected to the input posts of a television receiver.)

Ghosts also may be caused by impedance mismatch between cable and receiver, but this effect is not serious until mismatch is of the order of 3:1. A mismatch of this magnitude may occur if the weather conditions radically change the characteristic impedance of an unshielded line.

A shielded line can be used to minimize these effects. Recent development of shielded 300-ohm balanced lines makes good picture quality possible in noisy areas. A shielded line delivers to the receiver only the signal picked up by the antenna. If the antenna is shielded from the source of noise, high signal-to-noise ratio is possible even in industrial areas.

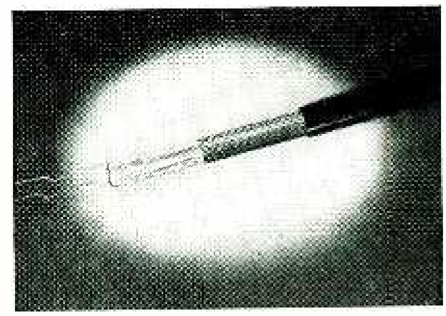
However, the attenuation of shielded lines is greater than that of unshielded lines and the reduction in noise obtained through their use should be large enough to overcome the increased signal attenuation. The technician should always remember that improvement in signal-to-noise ratio is the ultimate objective.

A short length of unshielded cable between the input and r-f stage within the receiver itself may be picking up noise. It is usually advisable to replace this cable with shielded line if a shielded line is required between antenna and receiver.

Installation procedure

To select the most economical transmission line system that will provide the optimum signal-to-noise ratio, some means of measuring signal strength must be available. In the absence of a better instrument, the author suggests one of the relatively inexpensive portable 3-inch television sets with the following modification: place a v.t. voltmeter across the output of the final i-f stage. With a signal generator, calibrate this meter to read directly in power or voltage input. To use this test set to measure r-f signal strength, determine the minimum signal necessary for a good picture on the different models of receivers that you install. Mark these directly on the meter. You have now established reference levels for your installations.

At the customer's house the following procedure can be used to determine the best transmission line system:



The new balanced 300-ohm shielded line.

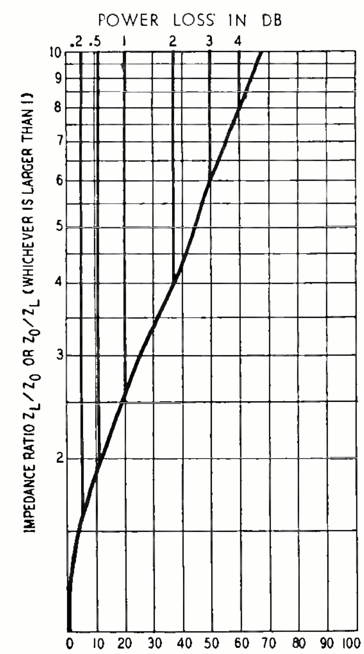


Fig. 1—Graph showing mismatch losses.

TABLE 2

TYPE	Characteristic Impedance (ohms)	Attenuation in DB/100 ft. 40 mc	100 mc	200 mc
Unshielded	300*	0.75*	1.27*	1.85*
Unshielded	200*	0.43*	0.55*	0.66*
Shielded	300	2.2	3.4	5.0
Shielded (Low Loss)	300	1.55	2.65	3.9

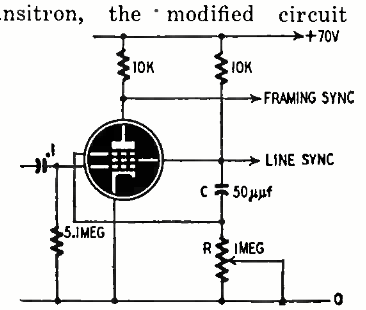
* Measured with cable isolated from ground.

Transitron as Sync Separator

By KERRISON JONES

USED under certain bias conditions, the transitron has proved to be capable of fulfilling all the major requirements for an economical and yet efficient sync separator—a prerequisite for good interlocking and effective interlacing.

In operation there are two distinct actions which occur in this "see-saw" transitron, the modified circuit of



The transitron sync separator circuit.

which is shown in the diagram. The "see" occurs when the screen grid, drawing current, drives the suppressor grid sufficiently negative to cut off plate current completely. When this happens C gradually charges at a rate which is dependent upon the time constant of R and C, and the suppressor potential rises until plate current, as well as screen current, is permitted to flow. The latter action represents the "saw" in the transitron circuit.

The above actions form the basis of the arrangement utilized in the separation of two pulses which have similar amplitudes and similar shape but whose durations differ, such as the sync signals of a television transmission. For that purpose, the tube is biased so that it conducts only during the period when sync signals are being transmitted. D.c. restoration occurs at the grid of the tube. On the arrival of a line pulse the tube conducts and the suppressor grid is immediately driven negative, thus effectively preventing plate current from rising. The time constant of R-C is such that the horizontal pulse has ceased before the capacitor is sufficiently charged to permit plate current to flow. Thus, while a steep-front pulse is produced at the screen grid and is utilized to trigger the horizontal time base, no signal appears at the anode, which is operating at maximum plate voltage throughout the whole operation.

The vertical pulse however, is much longer in duration. Its arrival at the grid of the tube results in a similar action to that described above for the horizontal pulse, but there is a difference in that the time constant of R-C is shorter than the duration of the vertical pulse. As a result, the capacitor has sufficient time to charge fully and to permit the flow of plate as well as screen current. The result is a large, steep-front pulse at the screen of the tube and a similar pulse at the anode, the latter being used to trigger the vertical time base.

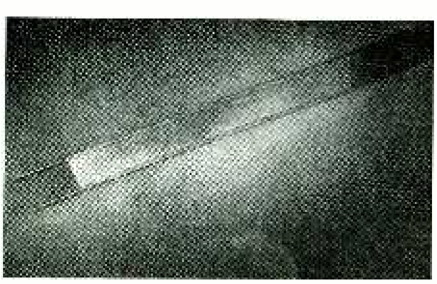
The requisite for correct operation is that the time constant of R-C should be such that it is longer than the horizontal pulse duration but shorter than that of the vertical sync pulse. This assures that the line pulse will not have time to trigger the vertical time base while the longer vertical pulse has ample time to charge the capacitor sufficiently.

Adjustment of the circuit is made relatively simple by observation of the vertical pulse at the plate of the tube. In practice, R should be slowly increased until practically all the horizontal pulse is eliminated in the circuit connected to the vertical time base.

LEAD-INS FOR TV ANTENNAS (*Continued from page* 25)

Note the signal in the calibrated receiver for the worst station at the position where the set is to be installed. If signal strength at this point exceeds the minimum calibrated value, an indoor installation will be sufficient. Otherwise an outdoor installation is necessary.

Connect a long piece of unshielded lead-in to the calibrated receiver and tune the receiver to a channel that is



A 200-ohm twin-lead transmission line.

not broadcasting. Note the amount of noise in the receiver. To get a signal-to-noise ratio better than 6:1, the signal must be 16 db greater than the noise level. If this is greater than the reference level on the meter, use this higher value as the new reference level.

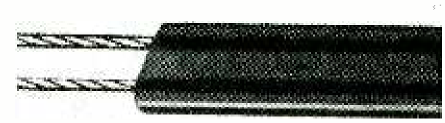
At this point it may become obvious that a shielded cable should be used. In this case note the noise in the receiver with shielded cable.

Check signal strength at a number of convenient locations (usually on roof) until a point is found where signal strength exceeds the minimum required. When determining the best location for the antenna be sure to consider the length of transmission line necessary from the antenna to receiver. For example, if a 2-db advantage is obtained at a location requiring 100 feet of additional lead-in—resulting in a 3-db loss in signal—nothing is gained by using this location, in fact there is a loss of 1 db.

Erect the antenna at the point selected and connect it to the calibrated receiver. Evaluate the excess signal in terms of db. For example, if the minimum signal required is 10 millivolts, and a signal strength of 50 millivolts is recorded, the excess signal is 20 log 5, or about 14 db. This means that the maximum tolerable loss in the transmission system is 14 db.

Starting with the most economical transmission line (300-ohm unshielded line), determine whether adequate signal can be obtained. The lowest cost line that meets signal requirements should be used.

Another factor to be checked before making final installation are ghosts on the calibrated receiver at both antenna and receiver locations. If they are excessive, a shielded line may be necessary even though signal-to-noise ratio is otherwise sufficient. Determine also if there are any noise sources in the neighborhood that were not present during these tests but which might disturb reception during certain times of the day. These might be such things as diathermy machines, sparking motors, etc.

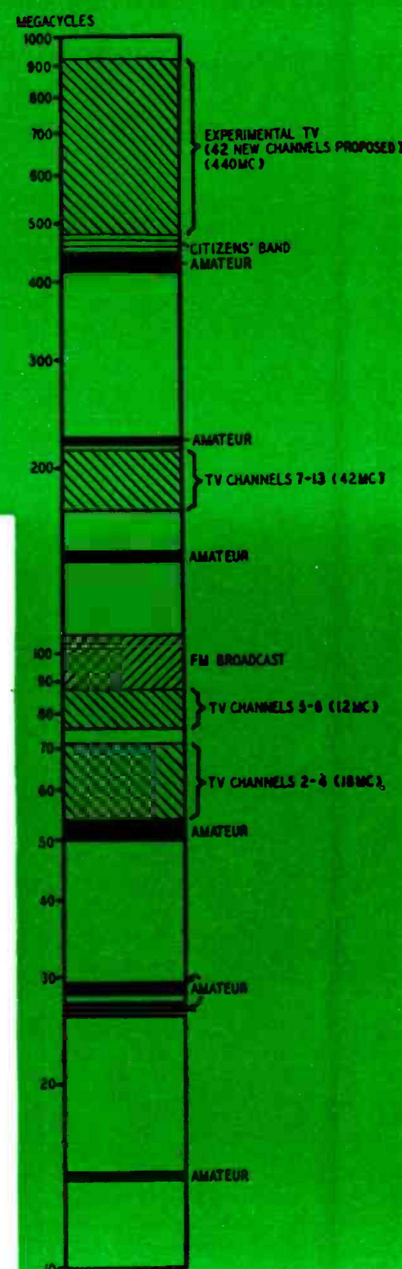


This 300-ohm line is most economical.

The 70-ohm coaxial transmission line.

TV Deep Freeze Stumps the FCC

Station allocation, color and interference are some of the worst difficulties



The present frequency allocations for TV, FM, amateur and citizens' band are shown in this chart. The rest of the spectrum is used up by other services.

By MANFRED G. WENTZEL

IN THE Fall of 1948 the Federal Communications Commission announced that it was suspending action on all pending applications for television stations. For over a year and a half television broadcasting has been beset by the "freeze" imposed by that order.

At that time there were 37 stations in operation, 86 more had been granted construction permits, and there were 303 applications pending. At the time of the freeze it was made clear that stations holding construction permits would be allowed to go ahead with their plans. Many of these stations have since gone on the air.

The freeze was imposed because it became alarmingly apparent by the middle of 1948 that the allocation of television channels was completely inadequate. There were then, as now, 12 channels in the very-high-frequency range with channels 2 to 6 covering the 54- to 88-mc band, and channels 7 to 13 the 174- to 216-mc band. In addition, a large band from 480 to 920 mc in the ultra-high-frequency range was reserved for experimental television.

Little was known about tropospheric effects on adjacent channel and co-channel interference, but it was obvious by that time that this interference was becoming a major factor in television transmission. The freeze was called to allow time for a study of the tropospheric effects.

The freeze was expected to last for about six months, but new issues have so beclouded the problem that now it is not likely that the final solution will be forthcoming until this fall or early next year. Some of the more important of these issues are a priority system for station allocation which emphasizes area rather than population coverage, a plan to use the ultra high frequencies for television broadcast, and possible revision of standards to include color television.

History of the freeze

Shortly before the war the FCC had adopted a set of television standards which provided for 18 commercial channels in the very high frequencies. By the time the war stopped construction, five stations had managed to get on the air. These kept television alive during the war.

Before the war ended, the FCC held a long series of hearings to determine where to fit television into the spectrum of frequencies. This was a great opportunity to reorganize the entire spectrum for all services and to expand into the new ultra-high-frequency range which had been opened as a result of war developments.

The television industry was split into two factions. One group was anxious to get a quick start in the very high frequencies immediately after the war. The other wanted television assigned to the ultra highs where there would be room for hundreds of television stations in a continuous band with no interference from each other or from other services.

The latter plan would have caused a delay of perhaps two years in getting television to the public because wartime restrictions were still in effect and there had yet been no field operations in these frequencies.

In the fall of 1944 the Commission established the Radio Technical Planning Board which was to give hearing to the various viewpoints on the subject. After one of the most comprehensive proceedings of its kind, the Board presented the Commission with a plan recommending 18 channels in the very high frequencies.

The commission took action on this recommendation, but could only jam 13 channels, each 6 mc wide, into the already crowded very high frequencies (Some of these were to be shared with other services.) One of these, channel 1, was later withdrawn from television. An allocation chart was drawn up which allowed for television channels in 140 metropolitan districts throughout the country.

This chart was adopted by the Commission in 1945, and the process of parceling out broadcasting licenses began. FCC engineers were instructed to allow a minimum separation of 200 miles between co-channel stations and 85 miles between adjacent-channel stations.

This plan allowed only four stations in the New York City area and therefore was opposed strongly by the broadcasters who wanted co-channel station separation reduced to as low as 60 miles. The Commission reduced its safety factor to a 150-mile separation for co-channel stations and 75 miles for adjacent-channel stations. These station allocations were based on ground wave calculations.

It was known then that the effects of the troposphere might cause more interference than the ground wave calculations predicted, but no one knew how much. Not until a number of stations got on the air did the Commission realize that such interference could not be ignored.

In 1948 the Commission proposed a revision that would provide television outlets to many communities not originally covered, but the new service areas would be much smaller because of tropospheric interference.

In June of that year a hearing was begun, and that hearing is still in progress.

An engineering conference called to investigate the situation soon concluded that there was not much available information on tropospheric interference.

The Commission realized that it could not safely proceed with further allocations until a more detailed study could be made, and late in September it announced the freeze on station applications.

As soon as the freeze was put in effect, the Commission appointed a committee to study the tropospheric problem. This committee, with the cooperation of the Bureau of Standards, FCC engineers, and the industry, spent several months digging up information on the problem and making a report to the Commission.

In the meantime, two other issues were brought up that complicated the problem. The first was a new proposal to move television into the ultra highs. The other was a proposal that any new rules should include provisions for color television.

If moved into the ultra-high-frequency range, television could have a continuous band of channels, with the bandwidth of each increased to allow transmission of a better picture. The ultra highs would allow room for more and better television, both color and black-and-white.

On the other hand, this move would make obsolete practically all receiving equipment now in the hands of the public. Possibly converters could be made to adapt present sets to the new frequencies, but this would mean additional investment for the set owner. It has yet to be demonstrated that mass-produced television sets can be made to work on frequencies from 480 to 920 mc.

And color, too!

The color problem adds to the dilemma. The ideal which the FCC is looking for is a color system which can use the present 6-mc bandwidth and 525 scanning lines. It also must be fully compatible with black-and-white television. That is, a black-and-white set must be capable of receiving color transmission (with a black-and-white picture, of course).

Three major proposals have been made so far. CBS has offered a system that will fit into the 6-mc bandwidth, but it requires a mechanical color wheel and it is not fully compatible.

RCA has a 6-mc color system, but until recently it required three kinescopes and an elaborate system of mirrors to bring the colors together. Now RCA has developed a new all-electronic single tube for color reception. The system is fully compatible.

Another compatible system is that demonstrated by CTI (Color Television Incorporated). This is also all-electronic with a line sequential color interlace.

Whatever decision the FCC makes, provisions must be made for color. Furthermore, there is no room for color except in the ultra high frequencies. If these ranges are opened for television, the Commission must take great care not to render millions of present sets obsolete.

The proposed allocation table is another problem that must be clarified. The present proposal gives first priority of allocation to provide at least one television service to all parts of the United States, giving priority to square miles over people. The peculiar situation has come up that some villages of less than 1,000 persons would be authorized television stations, while some cities with populations as large as 10,000 would not.

If these decisions were purely technical they would not be so difficult because they could be made on the basis of technical research. The trouble is that the issues are just as much political as technical.

The FCC is in the unpleasant position of having to please several factions within the industry as well as fulfill its avowed purpose of providing the best possible standards for the public. At the same time the growing demands of television must not be allowed to crowd out the host of other services, both military and civilian, which are vital to the safety and welfare of the country.

All of these issues are tightly interwoven. Whatever the final ruling of the FCC will be cannot be predicted at this time. The only thing that is certain is that whatever decision is made will not please everyone. Perhaps the best decision will be the one which displeases everyone about equally.

Picture Tube Safety Precautions

TELEVISION picture tube manufacturers recommend the use of protective goggles and gloves when replacing such tubes in a receiver and when handling them for any other reason. Too many technicians neglect these precautions and run the risk of being severely cut by flying chips of glass should the tube break.

All cathode-ray tubes, from the smallest 3-inch tube in an oscilloscope to the largest direct-view tube in a TV receiver, have an extremely high vacuum. The air pressure around such a tube is enormous, and a 10-inch TV receiving tube has as much as ¾ ton of pressure on the tube face. When such a tube is dropped or hit sharply with another object, it can easily shatter, scattering glass in all directions at high velocity. Many tubes have been dropped without breaking, but breakage depends on the distance dropped, how hard the material is upon which it falls, and how the tube itself falls. Falling neck first invariably breaks a tube. The manner in which it breaks may not always result in excessive flying glass.

The very fact that results are unpredictable indicates the need for constant precaution. It is better to put up with the inconvenience of goggles and other handling precautions than to suffer severe cuts around face and arms when something does happen—particularly when the danger to eyesight is so great.

When installing a new tube of the 10-inch size or larger, it should be handled by the flared sides, and not the neck. Care must be taken that the neck does not strike the bench or chassis, because this thinner section is more easily broken than the rest of the tube. Insert the tube neck into the yoke and focus coil assemblies with great care, using no force if it should stick.

After the tube has been properly set, the tube ring tension should be increased until the tube is held firmly on the chassis. Some sets use flexible cloth straps while others use metal rings with a soft material such as rubber between them and the tube rim. The photograph shows a typical tube mounting.

With any of these methods the tension should be increased only to the point at which the tube is held with satisfactory rigidity. If the draw bolts of a metal ring, for instance, are pulled up too tightly, it will exert an excessive pressure on the tube and increase breakage danger. Any glass tube will break more easily when under excessive pressure and this means that accidentally hitting the tube under such a condition may cause it to shatter when ordinarily it would have withstood the blow. The fact that the rings are often mounted with a soft material between them and the tube rim does not mean excessive pressure cannot be applied. The ring can be tightened until the flexibility of the material has reached its limit, and the pressure increases as the draw bolt is tightened further.—*Matthew Mandl*

A DeLuxe Televiser

Part VII—Trouble shooting and possible changes are discussed

By
CHARLES A. VACCARO

THIS is the concluding installment of a series which began in the January issue. In it we will discuss trouble-shooting and possible circuit modifications in this televiser.

Circuit voltages as measured with a 1,000 ohms-per-volt meter and with a v.t.v.m. are shown on the main schematic in Fig. 17. These voltages and the patterns in Fig. 23 are to facilitate trouble shooting and to allow the constructor to make a complete check on the operation of the various circuits. The patterns were recorded on a DuMont 241 scope. The captions show the settings of the vertical attenuator and vertical gain control. The attenuator ratios of 1 to 1, 10 to 1, and 100 to 1 correspond to low, medium, and high settings as recorded on the patterns. In some tests, a 10,000-ohm isolating resistor was inserted in series with the probe or hot test lead.

Do not attempt to measure the voltage on the plate of the 6BG6-G horizontal output tube or across the kickback power supply.

A safe way of measuring the high voltage output is to connect the voltmeter across the grounded 20-megohm resistor in the high-voltage bleeder. If the 15 bleeder resistors were purchased at one time, their tolerances are likely in the same direction and the output high voltage will be 15 times the measured voltage.

After the receiver has been in operation for some time it may become necessary to replace tubes in the i.f. amplifiers or front end. When one of the tuner or i.f. amplifier tubes is replaced, slight readjustment of the coil cores in the associated circuits may be necessary.

When the 6AG5 is replaced only the .25-3-μμf trimmer in its plate circuit requires adjustment. When the 7F8 is replaced, the trimmer in the mixer grid circuit and the one across the fine tuning control may require readjustment and the i.f. transformer in the mixer plate may require slight retuning. Switch to one of the high-frequency channels—preferably channel 13—and adjust the trimmers for proper alignment on that channel only. The other channels will automatically fall into proper alignment.

Circuit Variations

It is strongly recommended that no changes or variations be made in the circuits until after the receiver has been built according to instructions and is operating properly. A few variations will be described for which provisions have been made.

1—The blank position on the selector switch provides a convenient means of making the r.f. amplifier and oscillator inoperative during i.f. alignment. This position can be used for other functions if desired. In a 7-inch model of this receiver coils were added to allow a portion of the 88-108 mc FM band to be heard. This provided a convenient check on the operation of the receiver in an area where it is not known that a TV station is on the air. It has been used to advantage in various parts of the country where the receiver has been set up and operated. When the blank position is used for FM stations, it is essential to make the oscillator inoperative by other means when the audio or video i.f. amplifiers are being aligned. This can be done by shorting the grid of the oscillator ground with a jumper.

2—The unused section of the station selector switch can be used to cut off B-plus voltages from sweep circuits etc. when the blank position of the same switch is used for FM. This section was included for possible uses which may arise in the future such as the addition of another r.f. stage, switching of antennas, switching of converter for u.h.f. television, etc.

3—Other 10 or 12-inch picture tubes can be used instead of the 10FP4. The circuits require no changes but the diameter of the tube mounting ring must be increased by approximately 2 inches for 12-inch types. The 10FP4 has an aluminized screen which reduces internal reflections and also eliminates the need for an ion trap. For other tube types requiring an ion trap, a permanent magnet or an electromagnet type can be used. Connect the red lead to the end of the 20-ohm resistor towards the horizontal centering control and the black lead to the end towards the focus control. The 20-ohm resistor is replaced by two parallel 100-ohm, 1-watt resistors. (See Fig. 17.)

4—Another change that can be made if there is certainty that the extra AM, FM, etc. functions are not going to be desired in the future, is that of omitting the selector switch and two jacks. This can be done by connecting the wires directly so the circuits are the same as they would be when the switch is the TV position and by adding the on-off switch to the volume control or preferably to the tone control.

5—Another change that can be made is the omission of either of the horizontal sync control systems. However both systems have definite advantages and it has been found very convenient to have both incorporated. The a.s.c. system has the advantage of staying in sync better with rapid types of interference such as interfering r.f., spurious oscillations in the transmitted signal, diathermy interference, etc. However, its disadvantage is that it requires much more signal to pull it into synchronization than the other system. Furthermore; phase shift in the transmitted sync signals shows up as distortion on the sweep. This becomes visible as curved posts, doors, etc. Throwing the switch to the other system when this becomes annoying immediately restores the linearity.

The directly driven sync (d.s.c.) system, besides having the above advantage, is simple, has few components to cause trouble, and pulls the oscillator into sync with a small amount of signal. This is important if you are interested in pulling in some of those weak dx signals. This latter system has a slight disadvantage when receiving a signal with a severe ghost on it. In the N.Y.C. area a TV transmitter located about one half mile north of the Empire State building sends out a signal. At the same time some of the signal goes back, hits the Empire State and is reflected back to arrive at receivers north of the city a few microseconds later. Two sets of sync signals with nearly equal amplitudes arrive at the grid of the syncronized horizontal multivibrator and the tube has a tough time deciding which one to sync on. Although this situation was considered in the design of the horizontal sync circuits, the only complete remedy at the receiver is to switch to some other channel.

6—Placing the focus control on the rear panel or front panel is a matter of choice. Once set it does not require adjustment for quite some time. However for those who wish to have this control on the front panel, the potentiometer bracket is located so the potentiometer can be mounted with the shaft facing the front panel.

7—A spare socket has been included on the chassis to change from single to push-pull audio ouput if desired. The added 6V6 can be driven by a portion of the output of the existing output amplifier or from a dual-triode phase inverter substituted for the 6SF5 audio amplifier. *Be prepared to redesign and make changes to the focus, horizontal centering and bias circuits in the negative side of the supply before starting this or any other change that will increase the current requirements from the power supply.*

8—A.g.c. was left out of the receiver because up until about a year ago, when it was decided to make no further changes to the receiver design, no suitable system had been devised. All the available systems affected either the quality of the receiver or its immunity to noise bursts and static interference. Some were so complicated that the results were not worth the additional tubes and components. For those who wish to experiment with a.g.c., the bias for it can be taken from the negative side of the power supply. This leaves the half of the 6H6 that is now being used as a bias rectifier free to be used as an a.g.c. detector.

9—Although this receiver was designed for a console model it can be made as a table model if several factors are carefully considered. There is probably sufficient room around the picture tube and below the chassis for the power supply. With the weight distributed as the receiver is now designed it is safe to operate the receiver on its side with the picture tube mounted. With the extra weight of the power supply on the chassis this would be dangerous. The additional weight on the chassis would also make it difficult to handle during construction, alignment and experimenting. Another disadvantage in having the power supply on the main chassis is that additional heat that would be generated. This one factor is so important to the stability of circuits and components that a large part of the design time of the receiver circuits was spent in minimizing heat from components underneath the chassis.

Probably the best solution to converting to a table model would be to build the power supply on a separate chassis that would fit in the space above the tubes and to the right of the picture tube over the main chassis. This would have to be mounted by brackets to either the main chassis or to the cabinet itself and should be easily removable to allow access to tubes and adjustments underneath. It should also be kept back far enough to allow for mounting of the speaker.

There are many advantages to having the separate and larger power supply chassis which the console model permits. One advantage which has not been previously mentioned is that the larger space permits larger and overrated components to be used thus mini-

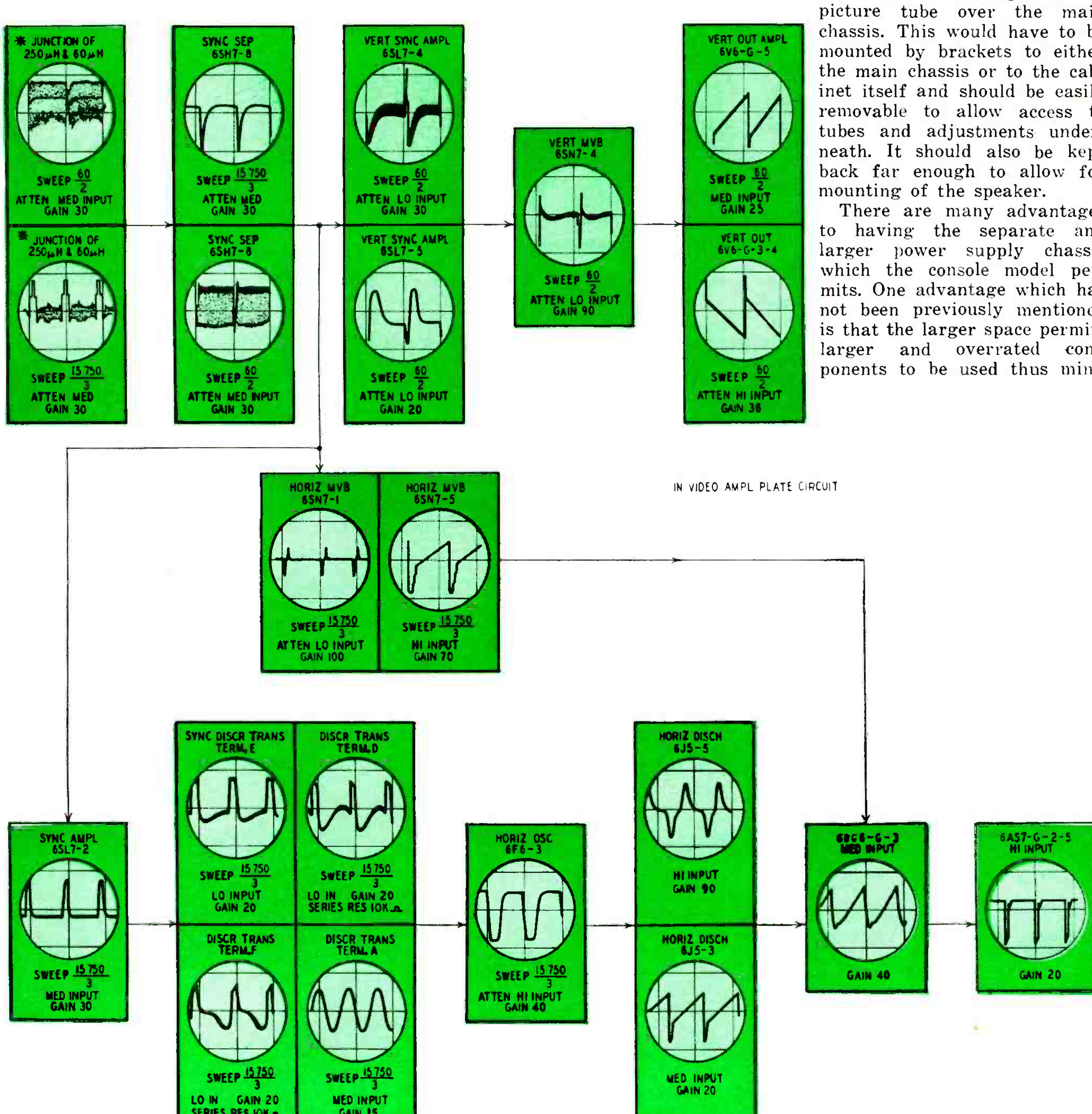


Fig. 23—The patterns above will help the constructor make a complete circuit check and will aid in trouble shooting.

mizing replacements. It also permits a combination of transformers to be used in place of one large one which may be harder to obtain.

The receiver may be mounted in a wall if precautions are observed to allow for adequate ventilation. Note that in all cases either felt or rubber feet should be fastened to the bottom of the perforated chassis bottom plate to allow air to enter the bottom of the chassis.

During more than two years of operation of the experimental model and a year of operation of the final model the replacement of only one item has been necessary. This was a surplus 6SN7 tube.

It is hoped that the builders and users of this receiver have as many enjoyable and trouble-free hours of entertainment.

Editor's Note

Several additional errors and omissions have been called to our attention by Mr. Vaccaro and by readers. These can be seen in Fig. 17 in the March issue.

The 10,000-ohm grid resistor in the second video stage is shown floating. This resistor should continue down to the .001-μf bypass capacitor and to the junction of the 1,000-ohm resistors in the line between the grid returns of the first and third video i.f. stages.

The shaping resistor ahead of the horizontal discharge tube is shown as 680,000 ohms. Its correct value is 6,800 ohms. The charging resistor in the plate circuit of the 6SN7 horizontal multivibrator is shown as 160,000 ohms. It should be 150,000 ohms.

The 15-μf capacitor in the B-plus side of the height control and the 30-μf plate decoupling capacitor for the 6V6-G vertical output tube are shown with 300-volt ratings. These should be rated at 450 volts. The 50-μf capacitor in the 225-volt lead from pin 4 of the power supply plug is shown to have a 600-volt rating. The rating need not be higher than 300 volts.

Pins 2 and 4 of the 6H6 video detector and bias rectifier are shown as being connected to heater lead X1. They are actually connected to heater lead X as shown in the heater hook-up diagram in the lower right-hand corner of Fig. 17.

The schematic shows a common heater ground lead for the tubes in the tuner and another for the heaters in the video i.f. amplifier. Actually, there are separate grounds for each heater in these circuits. Correct connections are shown in Figs. 1 and 7.

The vertical output tube is shown as a 6Y6-G in Figs. 17 and 20. This tube should be a 6V6-G.

Type numbers for the focus coil and horizontal output transformer are RCA 202D1 and RCA 211T1 respectively.

The sound detector is called a ratio detector in the text. It is a standard discriminator which was modified for a common cathode connection.

Antennas For Fringe Reception

YAGI-type beams used in TV-dx and fringe-area reception experiments conducted by the Commercial Engineering Dept. of Sylvania Electric Products, Inc. are described in *Sylvania News*.

The upper part of Fig. 1 shows the construction of a four-element beam for channel 4. The directors and reflectors were made from ⅜-inch aluminum tubing. The conductors of the folded dipole are made from 1-inch and ¼-inch tubes spaced 1¼ inches center-to-center to step up the impedance to 300 ohms. The dipole conductors are cut 1 inch longer than is necessary and are shorted together ½ inch from the ends. A ¾-inch gap is left in the center of the smaller conductor to permit connection of the transmission line.

Two of these four-element units may be stacked 0.475 wavelength apart if the dipoles are made from ¾- and ⅜-inch tubes spaced 1¾ inches center-to-center. The stacked sections are connected by 300-ohm line, and a 300-ohm line is connected to the center of the phasing line as shown in the figure.

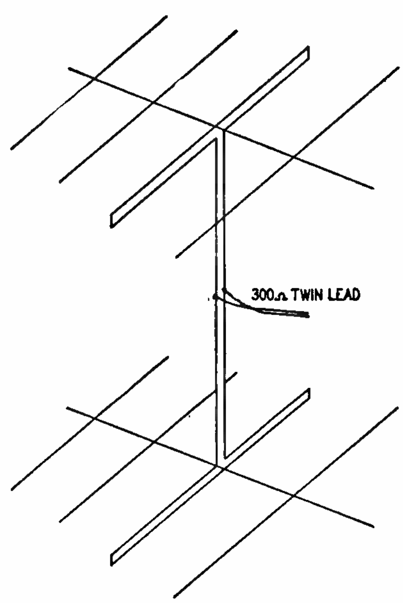


Fig. 1—Two 4-element Yagis stacked vertically form a highly directional and sensitive antenna. One 4-element beam is satisfactory in many areas.

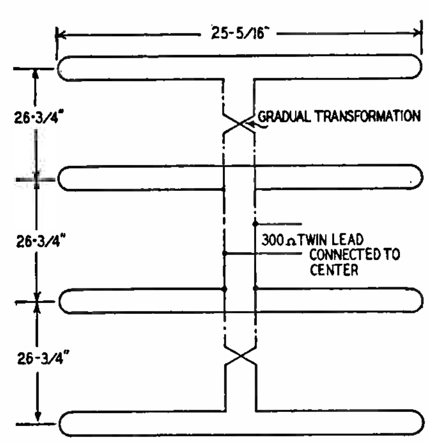


Fig. 2—Where maximum signal pickup is needed, 4 elements may be stacked.

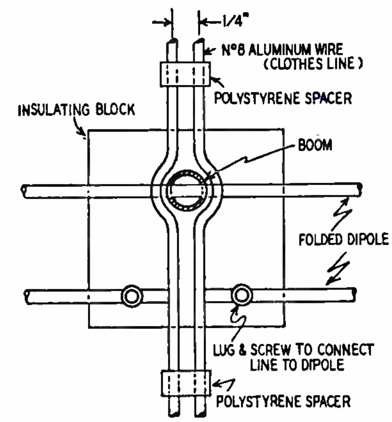


Fig. 3—Detail of the insulating block where the line is led around the boom.

Fig. 2 shows the connections for the dipoles of a 16-element stacked array. Dimensions are for channel 13. The four-element sections are 0.475 wavelength apart. The elements are all made of No. 8 aluminum wire (clothesline) and the boom is ⅜-inch tubing. The dipole is cut in one piece, folded to place the conductors ¾ inch apart. Fig. 3 shows how the phasing line crosses over the two booms.

The length of the elements and spacing between them—in wavelength—is the same as for the channel-4 antenna in Fig. 1.

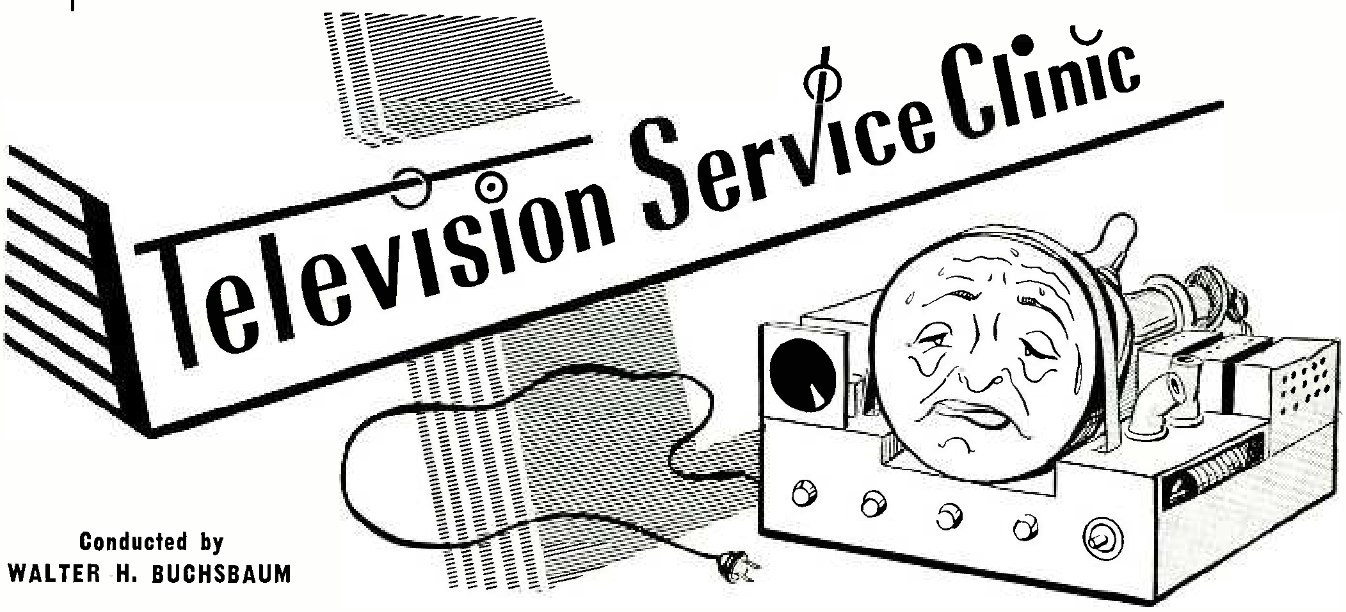
The antennas were designed for the low-frequency end of the channels; therefore, the maximum gain is centered on the video-carrier frequency. To convert frequency to wavelength in meters, divide 300 by the frequency in megacycles. Convert meters to inches by multiplying by 39.37.

All tubing in these arrays should be 3SH14 grade or harder.

COLOR-BLIND TECHNICIANS?

The advent of color television, when it comes, will pose new problems for service technicians, according to the *Dallas Radio and Television News*, published by the Dallas Radio Sales and Service Association, Inc. Not only must the test pattern be correct but the colors will have to be just right. If you ever went shopping for yarn for the little woman, you'll know what that means. And if Mrs. Doe calls up to say that Senator Blank has a green face, red arms, and blue feet, you won't be able to say it probably is something he ate.

And what's going to happen to the black-and-white television technician who suddenly finds out that he's color-blind?



Conducted by
WALTER H. BUCHSBAUM

Several letters concerned with television reception at distances of 100 miles and over have been received. To answer all questions on DX television would require more space than is available and we are therefore limited to a summary of measures which will improve reception from distant stations, in fringe areas or wherever weak signals are received.

Three different methods are practicable. The first and most obvious is to increase the pickup of the antenna. If this is impractical or not sufficient, the next step is to improve the gain of the r.f. stage. The third method is to increase the i.f. amplification.

Raising the antenna

Increasing the height of the antenna is often effective, especially in near-fringe areas, but the expense of constructing a suitable tower and the difficulty of finding a strong enough base for it limit the practical use of this step. When an antenna is raised, not only does it pick up more signal, but it also introduces more noise. In some areas, the distant signal may come down at an angle, and raising the antenna is not effective.

The larger the number of individual antennas, the greater will be the signal strength. Arranging dipoles or conical antennas in arrays doubles and quadruples the r.f. signal going to the receiver although it also increases vertical directivity, a disadvantage if the signal does not arrive horizontally. The limitations of this method again are mechanical. While 1-inch steel pipe might be strong enough for a single dipole with a reflector, it is not advisable to mount a four-section array on such a mast. The size, weight, and cost of the mast and antenna structure usually limits an array to about four sections.

If only a single station is to be received, it is possible to increase the signal pickup by using an antenna tuned exactly to the desired channel. The Yagi antenna is widely used for this purpose. In addition to increased pickup of the desired station, this antenna is very directive and can be beamed accurately toward a station. For best results the Yagi should be cut to resonate in the center of the 6-mc television channel of the desired station.

$$\text{length (feet)} = \frac{234}{\text{frequency (mc)}}.$$

Increasing r.f. gain

The most obvious method of increasing r.f. gain is to add another r.f. amplifier. If only a single station is received, it is not too difficult to design and build an additional stage right on the receiver. When it is desired to receive several channels, the extra r.f. stage must be tunable to all these stations. Since this complicates the design greatly, the majority of cases warrant the purchase of a finished preamplifier or booster. The manufacturer's instructions regarding matching the booster to the antenna and to the receiver should be followed carefully. Mismatch between the different impedances can nullify the amplification of the booster. Another method of increasing r.f. gain is to change the design of the r.f. amplifier slightly.

Increase B-plus voltage up to 200 volts if a 6AG5, 6AU6, 6CB6, or 6BC5 is used.

Remove r.f. amplifier grid bias lead from a.g.c. bias line and return it to ground. For best noise characteristic the above-mentioned tubes should have about 0.8 volt of bias (if a 6CB6, -1.5 volts).

Substitute a 6AK5 for any of the above tubes. Do not increase the plate voltage beyond 180 volts for the 6AK5, but ground the grid return lead. This tube works wonders on channels 7 to 13.

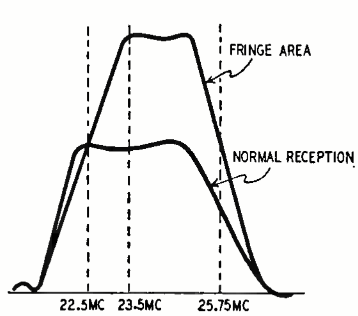


Fig. 1—Stagger-tuned i.f.'s can be re-aligned for less width but higher gain.

Increasing i.f. gain

Several possibilities exist in the i.f. stages. In stagger-tuned i.f. amplifiers it is possible to align the individual stages to give less bandwidth but increased gain. To avoid regeneration subsequent coils should be tuned to different frequencies. For instance the first, third, and fifth coils can be tuned to 25.2 mc and the second and fourth coils to 22.7 mc. This will result in an over-all width of about 3 to 3.5 mc at the 70% points. To keep the over-all response curve even, it may be advisable to peak one of the odd-numbered coils to about 24 mc or shunt it with a resistor lower than any of the others. Some technicians peak i.f. stages to 23.5 and 25 mc, respectively, to get about 2-mc bandwidth as shown in Fig. 1.

Adding a small positive voltage in series with the a.g.c. bias increases the gain at low signal levels. The positive voltage, about 1.5 volts, overcomes the usual residual bias due to noise and some diode current. Increasing the B-plus voltage on the i.f. amplifiers also helps to increase the gain.

Substituting the new type 6CB6 miniature pentodes is another way of obtaining more i.f. amplification. The transconductance of this tube is about 15% greater than a 6AG5 and this increase is multiplied by the number of i.f. stages. When these tubes are substituted for the 6AU6's or 6AG5's already in the set, the entire i.f. section should be re-aligned, since the new tubes have different interelectrode capacitance. In an actual experiment it was found that substituting a 6CB6 for a 6AG5 in a four-stage i.f. section increased the over-all sensitivity of the receiver by a factor of two. Pins 2 and 7 on 6AG5 sockets must be tied together for the 6CB6.

Arcing and corona

Several readers have inquired about locating the source of arcing or corona in the high-voltage compartment.

In many cases the arc can be seen clearly or, when the compartment is darkened, the bluish glow of a corona discharge is visible. The cure for this is simply to smooth out all sharp points in the wiring and clean the insulating surfaces. The application of a little polystyrene coil dope often works wonders.

Very often the discharge is so fine that it cannot be seen and the sharp point or leaky insulation is hard to find. A good way to locate such a defect is to use a rod of good insulating material such as polystyrene, lucite, or Plexiglas about a foot long. By touching the tip of this rod to different solder joints, wires, tube pins, etc., it will be possible to find one where the rod will stop the discharge.

Insufficient width

Insufficient width with poor linearity or foldover on the right appear on the Hallicrafters T54. In addition horizontal sychronization is unstable with occasional vertical instability.—J. K., Chicago, Ill.

The defect is either in the horizontal oscillator or the sync pulse separator preceding it. The circuit is shown in Fig. 2.

Interchange the 12SN7 tubes used as V12, V17, and V19. If this does not clear up the trouble, check the choke in the grid of V17. A short or open in this grid circuit causes a loss of horizontal sync pulse and unbalance in the multivibrator circuit. Check the grid and cathode circuits of both sections of V12 with an ohmmeter.

If an oscilloscope is available, connect the scope to the grids of V19, pins 1 and 4. The waveform should be a linear sawtooth of constant amplitude. If it is not linear, the defect is in the output half of V17; if the amplitudes are not equal, the defect lies in either half of V19. Sync pulses should be observed clearly at pin 5 of V12 if the tube is operating properly.

Picture shift

In the Motorola 7VT2 the picture shifted about 1½ inches to the left and cannot be brought back with the horizontal centering control.—E.S.F., Nellsville, N. Y.

The manufacturer's data gives the following possible remedies for this defect:

Carefully readjust the horizontal hold and size controls. Reduce the contrast and increase the brightness until the retrace lines are visible. If the hold and size are adjusted properly, a blanked-out space should be visible both on the left and right edges of the picture. Now adjust the centering control again. If it still does not function properly, the defect lies in the centering circuit alone.

Turn the set off and open the back of the cabinet. Remove the kinescope socket. Interchange the connections between pins 7 and 8 and between 10 and 11. Loosen the picture tube mounting strap and rotate the tube 180 degrees. Plug the picture tube in, turn on the set, and rotate the picture tube until the raster edges are parallel with the cutout in the cabinet. Adjust the centering control again. The picture now will center as it should.

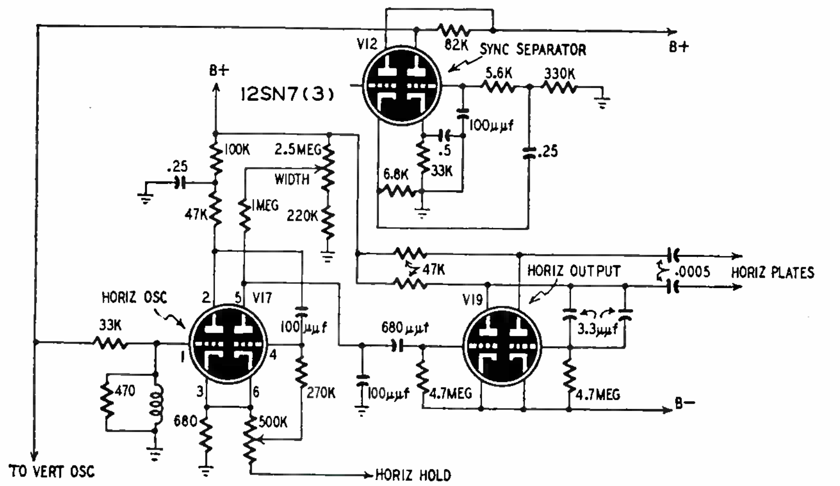


Fig. 2—The sync separator and horizontal oscillator of the Hallicrafters T54.

All-Electronic Color TV By CBS

An all-electronic color television receiver was demonstrated by CBS to the FCC recently. The receiver, a projection type with a picture size equivalent to that of a 22-inch tube, was demonstrated to show that all-electronic receivers can be used with the CBS system. However, CBS does not yet consider the receiver suitable for commercial use.

The receiver has a single tube with a single gun. Three images are produced on the face of the tube and these are combined optically.

CBS also demonstrated a new compact color television camera chain for industrial and surgical uses. The chain has two units, a camera and a control unit. The camera occupies less than ½ cubic foot as compared with about 3 cubic feet of a standard black-and-white camera and weighs 29 pounds.

Photo courtesy CBS

Dr. Peter C. Goldmark (right), research director of CBS, and James J. Reeves, a CBS engineer, inspecting the new 29-pound compact color television camera.

Prize Contest Winners

Uses for radio-electronics in the home

RESULTS of the first month's RADIO-ELECTRONICS IN THE HOME contest have not been particularly gratifying. We are not sure whether readers did not fully grasp the idea of the contest or whether they have not been able to think of any good electronic devices to use in the home.

To repeat: the purpose of the contest is to turn up ways in which electronics may be used to lighten the burden for the tired housewife or the equally tired husband home from a hard day's work —any electronic means whatever to make home work lighter and home life happier.

Despite the relatively weak entries, we have decided to allot the three main prizes and publish the ideas to give other readers something to improve on in future contests. No entry could be found worthy of the fourth prize.

First prize was awarded to a simple intercom built from an old radio.

Second prize goes to an automatic rain indicator. This entry was excellently and carefully worked up and would have received first prize were it not that it does not depend entirely on electronics. The same thing can be done electrically.

Third award is an automatic radio silencer which cuts the volume of the radio receiver when the telephone receiver is lifted.

Perhaps some would-be contestants have been a little timid about entering their ideas for fear of competition. Such timidity is unfounded. Send in your entries! And remember that any ideas used as the subject of a full-size article will be paid for as articles as well as winning the cash prize.

First Prize, $50, Charles J. Spaid, Lewisburg, Pa. A Two-Way radio intercom.

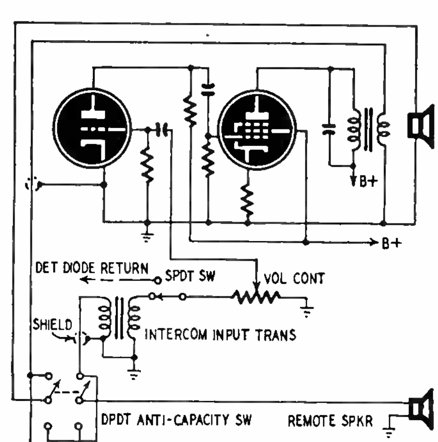


Fig. 1—A speaker, a d.p.d.t. switch, and a transformer can be used to convert almost any radio to a two-way intercom.

The Winners

Two-way Radio Intercom

Charles J. Spaid $50

Rain Indicator

Otto von Guericke $25

Radio Silencer

John W. Cook $15

With only a standard output or intercom input transformer, a d.p.d.t. switch, and a small PM speaker, any radio set can be converted into a two-way intercom, as Fig. 1 shows. While the intercom is not a new device, it has not often been used to advantage around the house where it can be a great step saver for the busy housewife.

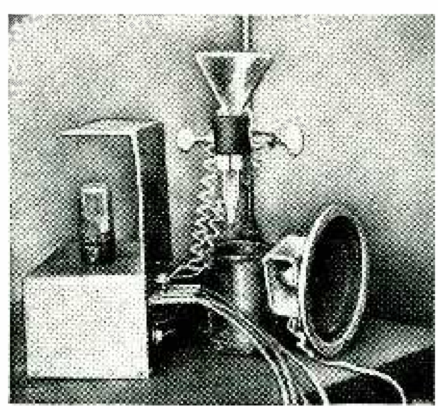


Fig. 2—The complete rain indicator. Sensitivity depends on the funnel size.

The a.f. amplifier shown in the schematic is typical of those used in small receivers. In most cases it is necessary to ground the secondary of the output transformer and the speaker voice coil of the master station with two separate leads. This is important, because a common ground lead will usually cause oscillation.

Another d.p.d.t. switch on the remote station makes possible control from either station, and more stations can be added if each is equipped with a d.p.d.t. switch.

If it is desired to use the radio as well as intercom, the s.p.d.t. switch is installed. With it hooked up, the distant speaker cannot call when the s.p.d.t. is in radio position. Should this be a disadvantage, the input transformer secondary should be connected permanently to the hot end of the volume control.

Second Prize, $25, Otto von Guericke, Göttingen, Germany. Rain Indicator.

This unique device sounds an alarm when a small container is filled with water. Further, after throwing a

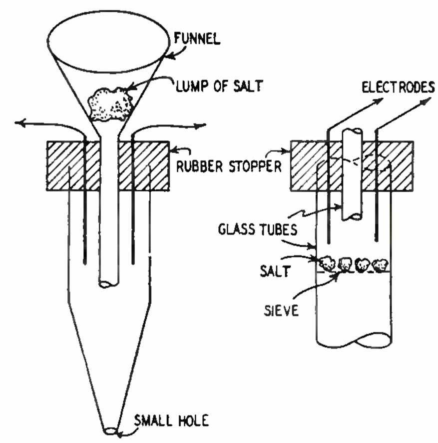


Fig. 3—"Water switch" for the rain indicator (a) and the level indicator (b).

switch, it gives a warning when the water level has dropped below a certain point. It can be used to signal when the bathtub is full or to let the housewife know when it is raining outside so she can get her laundry off the line before it gets soaked. Fig. 2 is a photo of the complete unit.

The heart of the device is a "water switch" which consists of two electrodes separated from each other in a glass tube as shown in Figs. 3a and 3b. When water fills the switch, the salt dissolves and current flows between the electrodes.

The tube in Fig. 3-a is for rain indication. The size of the funnel of course determines the sensitivity, and the small hole at the bottom allows the water to flow off and open the switch when the rain has stopped. The tube in Fig. 3-b is for water level indication. The resistance of the water switch is about 100 ohms when filled with water, and about 30,000 ohms after the water has trickled out but the electrodes and walls of the tube are still wet.

The electronic circuit, Fig. 4, consists of a 6SN7, one half used as a voltage amplifier and the other as a power amplifier, and a neon tube relaxation oscillator which supplies an audio signal of about 1,000 cycles.

With the d.p.d.t. switch in the position shown, the amplifier is cut off by 15 volts positive on the cathode. When the water switch conducts, the grid is shorted to cathode potential and the amplifier tube conducts. If the d.p.d.t.

switch is thrown to the other position, the amplifier tube is cut off when the water switch is shorted and conducts when the switch is open. With this arrangement, the warning can be made to sound either when the water switch opens or when it closes.

Third prize, $15, John W. Cook, Waynesboro, Va. Radio silencer.

If the radio or phonograph is on when the phone rings, it is often necessary to detour to the telephone to turn down the radio's volume before answering. The radio silencer automatically does this whenever the telephone receiver is lifted from its cradle.

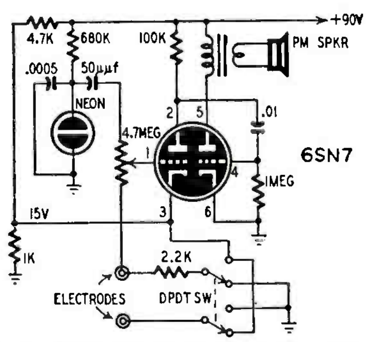


Fig. 4—The circuit of the water alarm.

A small s.p.s.t. microswitch is installed on the phone base directly below the center of the handset of the telephone (see Fig. 5). The switch must be of the normally closed type. When the receiver is in its cradle, its weight keeps the switch open. Raising the receiver closes the switch to short out the voice coil of the speaker on the radio as shown in Fig. 6.

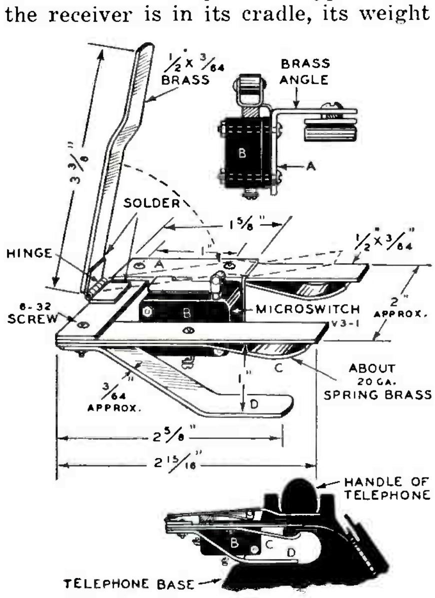


Fig. 5—The radio silencing switch is mounted under the telephone receiver.

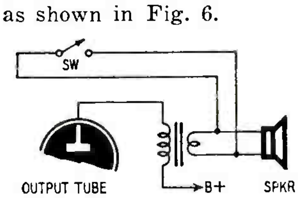


Fig. 6—When the receiver is lifted off the cradle, the speaker is shorted out.

Continuing

$1,200.00 PRIZE CONTEST
RADIO-ELECTRONICS IN THE HOME

DESPITE the amazing and extraordinary progress made in radio-electronics during the past two decades, one phase seems to have been neglected completely. We refer to radio-electronic applications IN THE HOME.

Practically all present-day inventions and patents concern themselves with industrial applications. Even such obvious applications as automatic electronic door openers are used chiefly in railroad terminals, restaurants, and other public places.

The home is the place where radio-electronic devices are really needed today. There are potentially thousands of ingenious ideas that can be used in the modern home, not only to lighten our work, but to make life safer, to give us more leisure, to safeguard our health, and to give us conveniences which are often urgently needed.

These applications need not necessarily be new inventions. It is simply a matter of applying ourselves to adapt the innumerable radio-electronic devices and instruments available. Most of our readers can solve these various problems at not too great a cost in their spare time.

There are literally hundreds of potential applications of radio-electronics that will fulfill serious needs in every American home.

We are sure that readers of RADIO-ELECTRONICS have many worth-while ideas for applying radio-electronics in the home.

We therefore invite you to contribute to this monthly Prize Contest, which will run for a total time of one year.

Monthly prizes totaling $100 will be given for the best ideas submitted during the month. These are cash prizes as follows:

FIRST PRIZE $50
SECOND PRIZE $25
THIRD PRIZE $15
FOURTH PRIZE $10

Please Note the Following Rules

1. This is a monthly cash Prize Contest for the best idea submitted during the month for a practical new radio-electronic application in the home.

2. The highest prizes will go to those contestants who have *actually built* the devices they describe and who submit photographs to prove it. Lesser prizes may be given for "ideas" not reduced to practice and for entries unaccompanied by photographs.

Entries of constructed devices must be accompanied by photographs, full description, and complete circuit diagrams.

3. Ideas for new devices which have not actually been built must be stated in complete detail and accompanied by complete diagrams, drawings, and all other possible descriptive material.

4. All the descriptions and photographs of the prize-winning devices or ideas will become the property of RADIO-ELECTRONICS, which will publish a descriptive article on each device or application. The prize winners will be paid regular rates for their articles, in addition to the prize money. Entries not winning prizes will be returned.

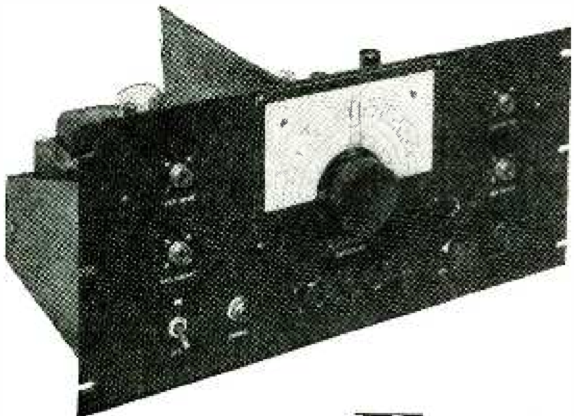
5. If two or more entries submitted during the same month are judged to be of equal worth, identical prize awards will be made for both entries. Devices which have been awarded prizes in previous contests will not be considered unless they show marked improvement on earlier entries.

6. All entries will be judged by the Board of Editors of RADIO-ELECTRONICS. Prizes will be awarded in accordance with novelty, general importance of the application or device, smallness of cost involved in building it, and practicability. The decisions of the Board of Editors of RADIO-ELECTRONICS will be final.

7. Excluded from this contest are RADIO-ELECTRONICS employees and their relatives.

8. The fourth monthly contest closes July 31 at midnight, Eastern Standard Time. All entries postmarked not later than July 31 will be judged in the fourth month's contest.

9. Announcement of the second monthly prize award will be made in the August issue of RADIO-ELECTRONICS. The second month's prizes will be paid on the publication date of the August issue of RADIO-ELECTRONICS.



An extended range covering 20 cycles to 700 kc with a clean waveform makes the oscillator at left a valuable instrument

Extended-Range Test Oscillator

By

HAROLD PALLATZ

RADIO shop and laboratory measurements are simplified if a wide-range oscillator is available. The unit shown in Fig. 1 will not only provide the technician with a valuable audio oscillator, but will also supply any intermediate frequency as well. It has a range from 20 cycles to 700 kc covered in five bands. Band 1 covers 20-200 cycles; band 2, 200-2,000 cycles; band 3, 2-20 kc; band 4, 20-200 kc; and band 5, 150-700 kc. The total harmonic distortion of this oscillator is less than 0.5% on all audio frequencies. This clean waveshape permits quicker and more dependable measurements on amplifiers or test equipment. The purity of waveform is obtained by using a variable capacitor for changing frequency. A good capacitor will track closer over longer periods of time than a dual potentiometer of the same cost.

This circuit is a modification of the famous Hewlett-Packard audio oscillator. The design uses the resistance-capacitance principle and eliminates the need for tuned coils (See Fig. 1).

A video amplifier incorporated in the unit has a response to 2.5 mc and is very useful for increasing the strength of weak signals. It can serve as an oscilloscope preamplifier, a signal tracing aid, and a v.t.v.m. adapter or bridge null amplifier. A series circuit consisting of a meter (1 ma), a crystal rectifier, and 2-μf capacitor connected to the output jack makes it a sensitive a.c. voltmeter (see Fig. 2).

Two impedance and voltage levels are available separately or simultaneously, from the oscillator. The low-impedance output jack is used with circuits up to 100 ohms. Higher circuit impedances are more closely matched with the high-impedance output. At the high-impedance jack 10 volts output is obtained and ½-volt output at low impedance. Output on band 5 is in the order of 2 volts at high impedance.

Flat output of the oscillator is maintained with a 3-watt bulb and two balancing capacitors. The first four ranges are kept at a constant level and the fifth band, while at a lower level, also has a constant output.

For adequate shielding at all frequencies, coaxial cable and associated hardware are used. A number of convenient binding post adapters were made for the lower frequency measurements. Hum pickup was reduced by installing a soft-iron partition to isolate the power supply from the oscillator circuits. Two partitions are used: one above, the other below the chassis.

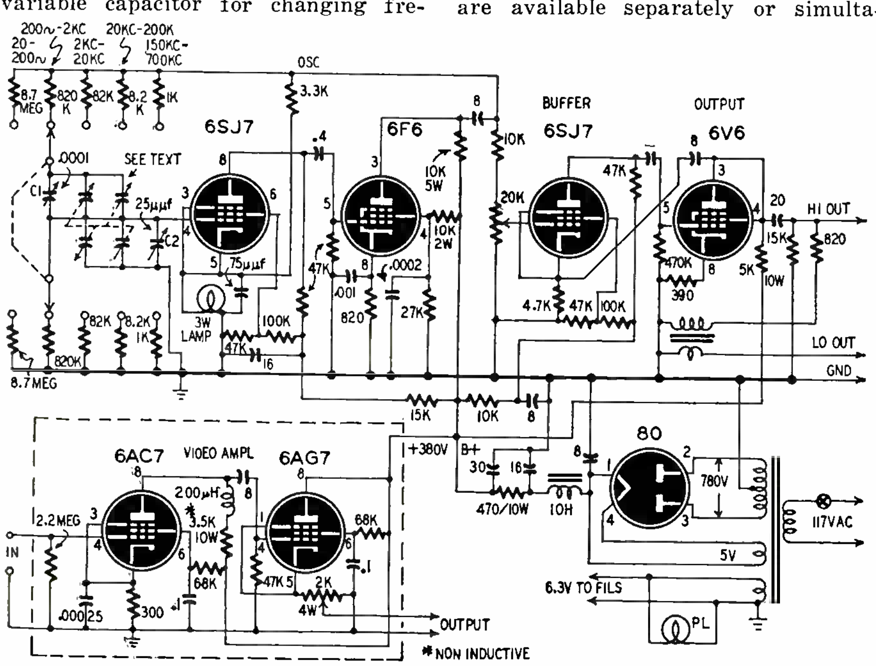


Fig. 1—Tuned coils and transformers are eliminated in the oscillator circuit.

Components and construction

A 4-gang 500-μμf variable capacitor is used for tuning. This item requires a little diligent searching for, but is obtainable. The minimum capacitance should be around 15 μμf. A 465-μμf unit will serve as a substitute, but the range will be reduced slightly.

The low-impedance output transformer is of the "Ouncer" variety. This is rated for the audio frequencies, but it does give a flat output on the high bands in this circuit, although the output is somewhat lower on band 5. The 3-watt bulb (115 v) supplies the required current-vs-resistance characteristics to keep the oscillator output constant. The power transformer is a standard type with 100-ma current rating.

A plate choke for the video amplifier may be wound on ⅜-inch-diameter Bakelite rod, or it may be purchased ready made. The rod should be cut to a length of 1½ inches, and wound with 100 turns of No. 30 enameled copper.

The front panel may be either aluminum or steel. The partition for power supply isolation is galvanized iron covered with wrinkle paint.

The body of the variable capacitor is insulated from ground by rubber washers. Fiber washers also can be used. Hum pickup by the floating variable capacitor is eliminated by mounting it next to the power supply partition.

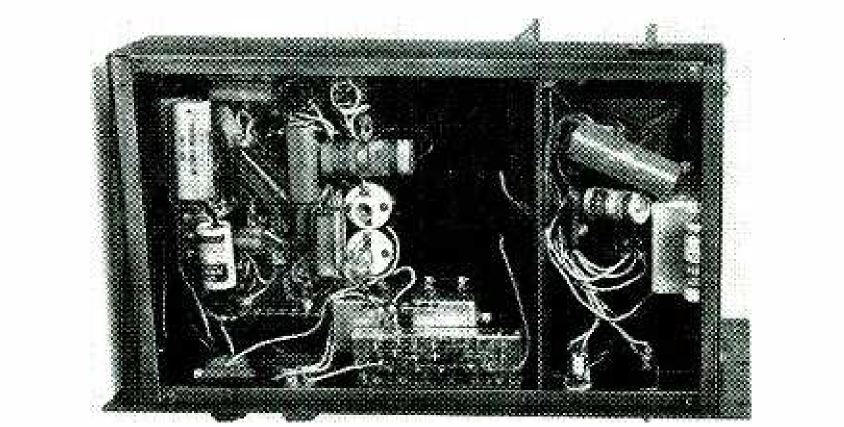
Calibration and operation

The coaxial jacks on the left are for the video amplifier input and output, and the high- and low-impedance oscillator output jacks are on the right. Separate controls vary the output level of the oscillator and the video amplifier.

Before calibration, the unit should be checked for proper output on all bands. C1 and C2 should then be balanced until turning the variable capacitor (while on band 2) gives no change in output level. This will be the approximate calibration of the audio oscillator. Final calibration should be made only after the unit is aged by leaving the set on for at least 12 (preferably 24) hours at normal line voltage.

The set should be calibrated while it is still warm. Two scale calibrations are necessary: one for bands 1 to 4. and a separate one for band 5. If it is impossible to get tracking on any of the first 4 bands, vary the values of the pair of frequency-determining resistors of that band. Tracking at the lower frequencies within 5% or better is sufficient.

In selecting the frequency-determining resistors, it must be remembered that the harmonic content of the signal (percent of distortion) depends on how well the resistors are matched. Precision-built film-type resistors are best.



Underside of the test oscillator. A push-button switch selects the ranges

Do not use inductively wound units.

The oscillator scale is best calibrated with the help of an oscilloscope. A good method for doing this is described in RADIO-ELECTRONICS for October, 1948.

Band 5 is calibrated in the same way as an r.f. signal generator. This unit was checked with hetrodyne frequency meter on band 5. Calibration with a broadcast receiver tuned to the harmonics of band 5 will do in the absence of a good frequency standard.

The low-impedance output is obtained through an output transformer. This transformer tends to introduce waveform distortion if used below its rated range. Therefore, when very low distortion is required of a low-frequency signal, use the high-impedance jack. The 820-ohm resistor in the high-impedance output broadens the response.

Frequency response of the video amplifier may be checked up to 700 kc by applying the output of the oscillator to the video input. Wide-response a.c. voltmeters should be connected to the input and output of the amplifier. A s.p.d.t. switch may be used to permit measurements with one meter. Response should remain flat throughout this range. Higher frequency response may be checked with any reliable metered r.f. signal generator.

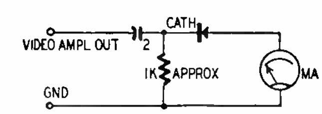
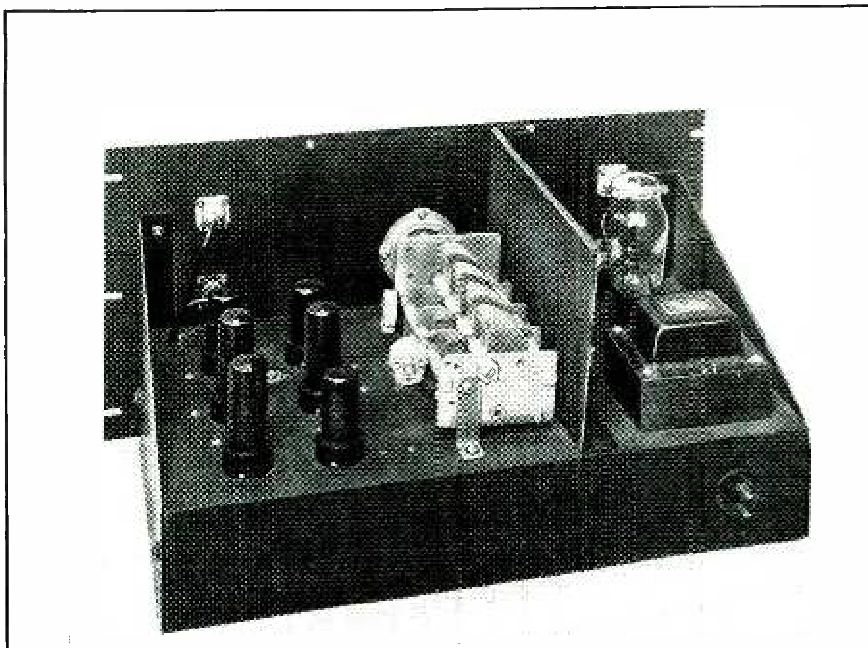


Fig. 2—Adaption circuit for v.t.v.m.



The chassis layout is neat. Note that the power supply is carefully shielded.

Practical applications

The response of any amplifier may be checked by the method previously described (video amplifier response test). Measurements on audio amplifiers should be made with the speaker or its equivalent load across the output. The volume, gain, and tone controls will affect results; therefore take several readings. The response of typical audio amplifiers will fall between 10 and 50 cycles for the lower limit and 5 to 20 kc for the upper limits.

Phase shift of amplifiers is easily checked by using this oscillator with a good oscilloscope. The method consists of feeding the oscillator to both the input of the amplifier under test and to the vertical scope amplifier. The output of the amplifier is then fed to the horizontal scope amplifiers. Any phase

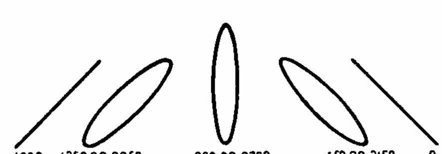


Fig. 3—Scope patterns for phase check.

shift occurring in the amplifier will cause a rotation of the scope pattern. The scope gain controls should be set to develop a pattern like that in Fig. 3 at 400 cycles. Varying the oscillator frequency through the usable response range of the amplifier will instantly show any phase shifts. This method assumes no phase shift in the scope amplifier.

Vacuum-Tube Voltmeter Kit Has Interesting Features

Popular v.t.v.m. kits have many features found in costlier commercial instruments

By RUFUS P. TURNER

A closeup view of the completed meter.

TO design a trouble-free, wide-range, stable vacuum tube voltmeter-ohmmeter "from scratch" with the hope of beating the price of factory-built instruments is a tough job. It demands a stiffer back-ground of engineering skill and much more time than most experimenters and servicemen have. Even when skill and time are available, the home-built instrument seldom approaches a factory-built job in appearance. Furthermore, the final cost of a home-made model is apt to equal the price of the manufactured article, especially if much cutting and trying is involved. Thus the technician with a limited instrument budget finds the popular kit-type instruments well suited to his situation.

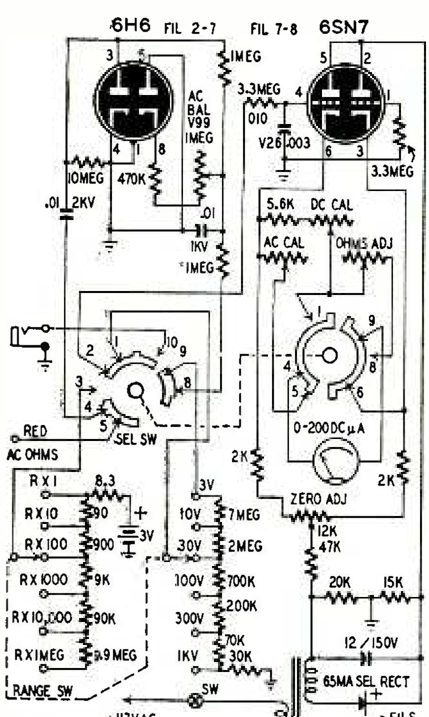


Fig. 1—Schematic of the v.t.v.m. The basic circuit is of the bridge type.

The new Heathkit model V-4 vacuum-tube voltmeter is an excellent example of these. An improved version of an earlier model, it is an inexpensive instrument having features of more costly electronic meters. The average radioman can assemble and adjust it in a few hours. Its construction is an excellent project for students.

Electrical characteristics

The unit measures a.c. and d.c. voltages, d.c. resistance, and decibels. Six a.c. and d.c. voltage ranges are provided: 0-3, 0-10, 0-30, 0-100, 0-300, and 0-1,000 volts. The lowest dial-marked voltage is 0.05 volt, while 0.025 volt can be estimated with good accuracy. A high-voltage d.c. test probe is available as a separate kit for measuring voltages as high as 10,000.

The input resistance of the instrument is constant at 11 megohms on all d.c. voltage ranges. One megohm of this resistance is an isolating resistor in the handle of the shielded d.c. test probe. The isolating resistor, together with the shielding of the d.c. probe and cable, minimizes hand capacitance.

Sensitivity of the model V-4 is approximately 3.7 megohms per volt on the 3-volt range—approximately 183 times the sensitivity of the popular 20,000-ohm-per-volt nonelectronic meters. The selector switch includes both positive and negative d.c. positions.

The a.c. voltage ranges are the same as the d.c. ranges, and are read on the same scales. There are no special scales for any a.c. ranges. R.m.s. voltage values are indicated. The a.c. portion of the instrument is essentially a negative-peak indicator. The meter indications are r.m.s. values of a sine wave, or 0.707 of the peak value of complex waves.

The a.c. circuit is fully electronic (see Fig. 1), consisting of a shunt diode 6H6 signal rectifier. One diode section of the tube acts as the rectifier, while the other half supplies d.c. contact potential for balancing out the contact potential of the first section. A.c. voltage may be measured throughout the audio-frequency spectrum. At higher frequencies, up to a maximum of 200 megacycles, an external crystal-type probe is available as a separate kit, and plugs into the d.c. input jack.

Six resistance ranges are provided when the selector switch is thrown to its OHMS position: 0.1 to 1,000 ohms, 1 to 10,000 ohms, 10 to 100,000 ohms, 100 ohms to 1 megohm, 1,000 ohms to 10 megohms, and 100,000 ohms to 1,000 megohms. The ohmmeter circuit is powered by two self-contained 1.5-volt jumbo flashlight cells.

For direct testing of audio equipment, six decibel ranges are provided: –10 to +5, –20 to + 15, –30 to +25, –40 to +35, –50 to +45, and –60 to +55 db. The decibel scale is based on a standard zero level of 6 milliwatts into a 500-ohm load. This places zero db at 1.73 volts on the 10-volt a.c. scale.

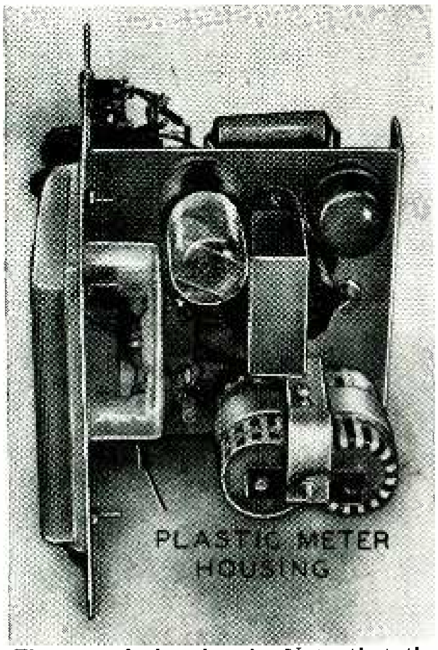
Test probes are the shielded D.C. test probe which contains the 1-megohm isolating resistor, connected to a shielded cable, and terminated by a phone plug; the COMMON (black) lead terminated by a crocodile clip, normally fastened to the chassis (B-minus) of the device under test; and the A.C.-OHMS (red) lead, terminated by a pencil-type test prod.

Fig. 1 is the complete circuit of the instrument. The basic electronic d.c. voltmeter section is a highly stable bridge circuit using the two triode sections of a 6SN7 tube. The indicating meter is a 0-200 d.c. microammeter.

The 12,000-ohm zero-adjust potentiometer has a 2,000-ohm limiting resistor connected to each end of its winding. The range of adjustment is sufficient to allow close setting of the meter to zero and the maximum swing of the meter with this adjustment is sufficient to permit setting the pointer to half-scale when a center-zero instrument is desired. There is no zero shift when switching from one voltage range to another, from A.C. to D.C., or from positive to minus volts.

Separate potentiometers are provided for initial standardization of the a.c. and d.c. voltage ranges. Only one adjustment is needed in each case to standardize *all* of the scales.

A 3.3-megohm resistor (010 in Fig. 1) and 0.003-μf capacitor V26 form a low-pass filter to remove any



The top of the chassis. Note that the meter housing is transparent plastic.

fluctuating component from d.c. voltages on the active grid of the 6SN7 tube.

The input coupling capacitor for the a.c. voltage ranges is a 2,000-volt, 0.01-μf unit. This is a decided improvement over other models having lower-voltage capacitors in this position. One half of the 6H6 tube acts as the signal rectifier which delivers d.c. (corresponding to the a.c. signal voltage) to the active grid of the 6SN7 tube. Since the 6H6 has an appreciable contact potential which deflects the microammeter continuously, giving a false indication of voltage, the second half of the 6H6 acts as a contact potential generator whose voltage bucks out the contact potential of the first section. A 1-megohm potentiometer V99 is used to set this bucking voltage to the exact value required to reduce the false deflection to zero.

Mechanical features

The instrument is contained in a lightweight aluminum cabinet, 10 x 6 x 5⅞ inches. The complete kit weighs about 8 pounds.

The microammeter is a new Triplett unit with a fine knife-edge pointer, enclosed in a completely transparent shatter-proof plastic case. Volt and ohm scales are inscribed in black; the decibel scales in red.

The chassis, front panel, and cabinet are supplied with all holes punched. No mechanical work other than bolting the parts together is necessary. Wire is furnished for electrical work.

Preliminary adjustment

After the instrument has been assembled and the wiring carefully checked, plug into the power line, set the selector switch to D.C.+, range switch to 3 volts, throw the power switch to its ON position, and allow about 15 minutes for the initial warmup.

D.c. voltage: The voltage of one of the ohmmeter cells supplied with the kit is measured accurately by the Heath laboratories and the exact voltage value is marked on the jacket of the cell. Remove this cell temporarily from the instrument. Set the meter to zero on the 3-volt range with the zero-adjust potentiometer. Connect the d.c. test leads to the calibrated cell (black COMMON lead to the negative terminal; shielded d.c. test probe to the positive terminal), noting that the meter reads upscale. Now, adjust the d.c. calibration potentiometer to bring the pointer of the meter to the voltage indicated on the calibrated cell. The meter now is standardized on all of the d.c. ranges. Replace the calibrated cell in the ohmmeter battery bracket.

A.c. voltage: With no test leads plugged into the jacks, set the range switch to 3 v and the selector switch to its A.C. position. The meter will be deflected. Adjust the screwdriver-adjusted a.c. balance control potentiometer to bring the meter pointer to zero. No meter movement should now be noticed when the selector switch is moved through its +D.C., –D.C. and A.C. positions. If there is any movement of the pointer during switching, the a.c. balance control potentiometer must be more closely set. Plug in the A.C. and COMMON test leads, set the range switch to 300 v, and connect the test leads to the power line. (The power line voltage must be checked with a known correct a.c. voltmeter; and the operator must be careful in making this test, since this voltage is dangerous.) Adjust the a.c. calibration control potentiometer to bring the pointer of the meter exactly to the line voltage value.

Ohms: When the selector switch is set to its OHMS position, the meter will be deflected upward. Adjust the OHMS ADJUST panel knob to bring the pointer exactly to full scale. This adjustment must be made at each setting of the range switch.

Conversion Table for Decibel Readings

A.C. Scale (volts)	Decibel Scale
0-3	subtract 10 db from reading
0-10	read direct
0-30	add 10 db to reading
0-100	add 20 db to reading
0-300	add 30 db to reading
0-1,000	add 40 db to reading

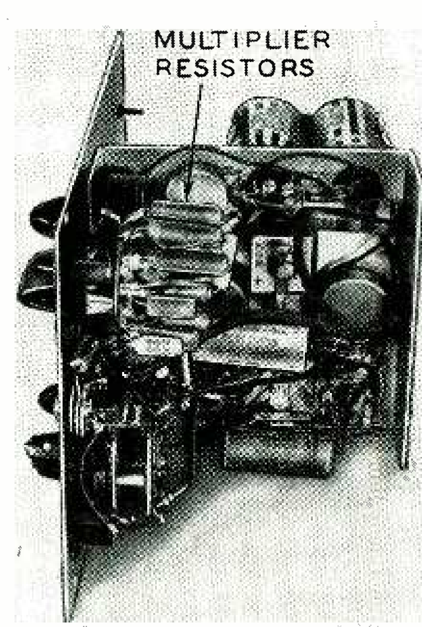
Using the instrument

Voltage measurements: Check d.c. voltages with the selector switch in its +D.C. or –D.C. position, whichever will give upscale deflection of the meter with the test leads properly connected to the circuit under test. In normal operation, the shielded test probe will be in contact with the positive terminal of the voltage source. Use the COMMON (black) and shielded D.C. test probe. Always check an unknown voltage (a.c. or d.c.) first on the highest (1,000-v) range, switching successively to lower ranges until the reading is obtained in the upper part of the meter scale. This procedure prevents slamming the pointer, and reading near the top of the scale gives best accuracy.

Check a.c. voltages with the selector switch in its A.C. position, and with the COMMON (black) lead plugged into the COMMON jack and the red lead into the A.C.-OHMS jack. Sensitivity of the instrument on the 3-volt a.c. range is great and may result in a small deflection of the meter due to pickup of a.c. fields in the room. For this reason, the operator should keep his fingers near the end of the a.c. test probe to minimize body capacitance.

Resistance measurements: For resistance measurements, plug the COMMON (black) test lead into the COMMON jack, and the red lead into the A.C.-OHMS jack. Set the selector switch to its OHMS position, and the range switch to its R × 1 MEG position. Set the pointer of the meter to full scale by means of the OHMS ADJUST knob. Touch the two test prods together, noting that the meter is deflected toward zero. Touch the test prods firmly to the resistor under test and read the resistance value on the meter scale. Switch to another range, if required, for closer reading. When switching to a new range, disconnect the unknown resistor and, with the test prods out of contact with each other, reset the pointer to full scale with the OHMS ADJUST knob.

Decibel measurements: The a.c. meter is used also to check decibels. The red db scale is direct-reading on the 10-volt a.c. range.



The precision multiplier resistors are mounted directly on the range switch.

Selenium Rectifiers Simplify Fixed Bias

By J. T. CATALDO

FIXED grid bias offers several advantages over the conventional cathode bias in amplifiers and receivers, provided that the cathode resistor is not intended to obtain degeneration. The greatest advantage of fixed bias is for class-AB1 push-pull amplifiers. When used in this type of circuit, fixed bias provides higher power output, increased stability, and less distortion for a given plate current. For example, when fixed bias is used on 2A3, or 6B4 tubes, the power output is increased by about 50% and the distortion is decreased by about 50% for the same current rating.

Although cathode bias has eliminated the disadvantages of batteries and bias cells, it presents another problem because the bias supply voltage subtracts from the available B-plus voltage. In the usual a.c.-d.c. receiver, where the B-plus voltage is at a premium, the available plate voltage for the biased tube is lowered by the amount of its bias and the output is less. Contact bias does not have this disadvantage, but it cannot be used for more than 1 or 2 volts bias.

The selenium rectifier as a replacement for vacuum-tube rectifiers has found many uses in radio and television receivers. One application is for grid bias supply. eliminating the disadvantage of cathode bias. Since selenium rectifiers can be made with a wide range of voltage and current ratings, they can be used to supply grid bias to tubes that draw large grid currents as well as those that draw negligible current.

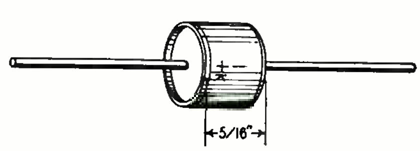


Fig. 1, 3, and 4 Courtesy Radio Receptor Co., Inc.

Fig. 1—A small-sized selenium rectifier for use in fixed bias supplies.

Selenium rectifiers with large plates are used for tubes drawing large grid currents. However, where the grid current is in the order of a few milliamperes, smaller compact half-wave, low-current selenium rectifiers may be used. At the present writing, a number of companies, are producing such a compact selenium rectifier in limited quantities. (See Fig. 1.) Because of its two pigtail leads and completely insulated, compact construction, installation in a crowded chassis is not difficult.

Many bias supplies have been devised using the selenium rectifier. The simplest one that the service technician or experimenter can try in his workshop is supplying fixed bias to the power output tube of a conventional five-tube a.c.-d.c. superheterodyne receiver.

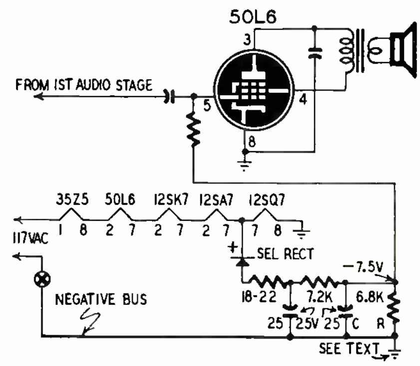


Fig. 2—A circuit for supplying fixed bias to the output tube of a receiver.

The only components required are a selenium rectifier, three ¼-watt resistors, and two electrolytic capacitors. These components are wired as shown in Fig. 2. A dual electrolytic with a common negative lead cannot be used. Instead, two single capacitors or a dual with a common positive lead must be used.

To make the change, remove the cathode resistor from pin 8 of the 50L6 and solder a wire from this pin to ground. In some sets, ground is the chassis while in others, ground is the B-minus line or one side of the a.c. line, usually the one in which the on-off switch is wired. (Caution: *do not play the radio with only this connection made.* The 50L6 now has zero bias and, if the set is operated, will draw a large current which may damage the tube and the output transformer.)

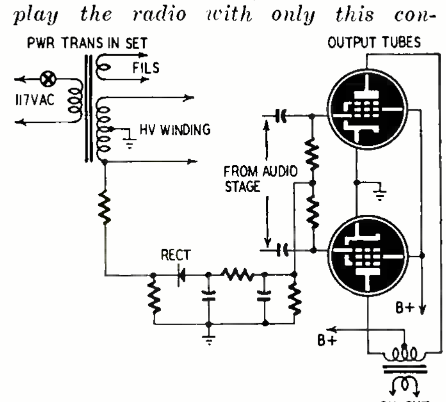


Fig. 3—Fixed bias for push-pull stage.

The cathode of the selenium rectifier (equivalent to the cathode of a vacuum diode) is usually marked with a K, +, or a red mark, depending on its manufacturer. Solder this terminal to the high side of the filament of the 12SQ7. The rest of the components can be wired in the most convenient place for the particular receiver.

Disconnect the grid resistor of the 50L6 from ground (same ground mentioned above) and solder it to the junction of C and R in Fig. 2. With this connection made, the power output tube has been converted for fixed bias. This will provide additional power output because the output tube plate voltage has been raised by approximately 7.5 volts.

Fig. 3 shows the output stage of a push-pull receiver or amplifier in which fixed bias for the output tubes is obtained from the high-voltage winding of the transformer with a voltage divider, a selenium rectifier, and a filter network. There is no need to consider the loading effect on the transformer as the additional current is negligible.

A bias supply for the output and r.f. stages of an a.c. receiver is shown in Fig. 4. This circuit is essentially the same as for the a.c.-d.c. set except that

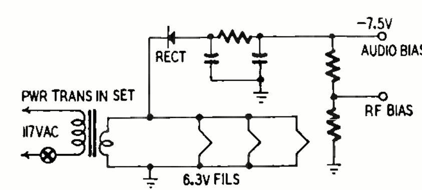


Fig. 4—A bias supply circuit for the audio and r.f. stages of an a.c. set.

the a.c. input to the selenium rectifier is obtained from the filament winding of the transformer.

Fig. 5 is a circuit for a TV receiver bias supply. This supply can be used to supply bias to the synchronization amplifiers, audio stages, and r.f. and i.f. stages of the set. The variable r.f. and i.f. bias can be used as the contrast control for the picture tube. This is desirable as it eliminates the problem of current changes in one circuit affecting the other circuits as when obtaining bias from a bleeder circuit. The action of the a.v.c. and the contrast control and tube aging, each of which changes the total bleeder current, can defocus the set and change picture brightness level and important bias voltages.

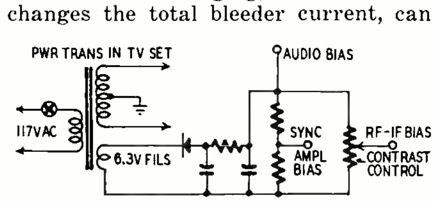


Fig. 5—Variable r.f. and i.f. bias is used for contrast control on a TV set.

Fundamentals of Radio Servicing

Part XVII—The Voltage Amplifier

By JOHN T. FRYE

IN OUR crablike method of progressing backward through a radio receiver, we always assume that each stage will receive just the right kind of a signal from the stage before it. When we discussed power amplifiers last month, we found that we need an audio-frequency signal on the grid of that amplifier to make it work.

This audio voltage must be pretty husky if the output tube is to be worked at full power. A little reflection shows why this is so: a power output tube must have a relatively heavy plate current to develop much power (power is always the product of voltage *and current*) in its plate circuit. This means that the plate resistance of the tube must be low. The way to lower the plate resistance of a triode is to move the plate closer to the filament, thus (December 1949 issue) reducing the amplification factor of the triode. A low amplification factor makes it necessary to have large swings of grid voltage to produce large swings of plate current.

In a triode power amplifier, the peak-to-peak voltage required on the grid for full power output may be as high as 70 to 80. Screen grid and beam tubes can deliver high power outputs with much lower grid voltage swings, but even they require audio voltages of several volts on their grids.

But the audio voltage that results when the audio portion is peeled off the carrier by the detector is often only a small fraction of a volt. Before this puny voltage can swing the grid of our power amplifier back and forth as it should be swung, it must be given a shot of spinach juice or something that will make it many times more powerful.

The "builder-upper" that does this trick is called an *audio-frequency amplifier* or simply an *audio amplifier*. Its job is to take the little audio voltage delivered to it by the detector and consisting of frequencies from 50 to 15,000 cycles per second and amplify this voltage many times, being careful to play no favorites and to boost all of the frequencies exactly in proportion to the amplitude they had before the boosting operation started. If all of the frequencies are not uniformly boosted, we have what is called *distortion*. The voice or music that comes out of the amplifier no longer sounds like what went into it. The result is about the same aurally as the visual experience of peering into one of those magnifying shaving mirrors: there is plenty of enlargement, but the perceived result does not bear much resemblance to the original! If necessary, two or more stages of audio amplification can be used between the detector and the power amplifier; but this is usually not necessary, at least in small receivers; a single pentode can amplify a signal 150 times or more.

Fig. 1 shows the basic circuit of an audio amplifier stage. A triode is used

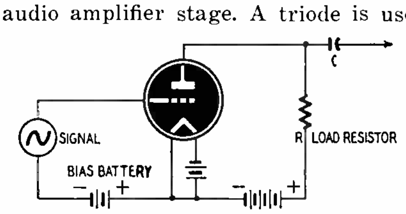


Fig. 1—Basic audio amplifier circuit.

for simplicity. This should look familiar to you for it is nearly the same circuit as that of the power amplifier studied in the last chapter. The only difference is that we have a resistor in the plate lead instead of an output transformer primary.

A power amplifier and a voltage amplifier are really first cousins. The big difference lies in what we want them to deliver. Last month we wanted *power* (volts × amperes) to drive our speaker; so we selected a tube with a husky plate current and adjusted our plate load for very nearly maximum power output. You will recall that this load was raised from the one that would give the most power output (equal to the plate resistance) to about twice this figure in order to reduce distortion.

Now we are not interested in power. No power is used in the grid circuit of the power amplifier because no current flows in this circuit. Only voltage is needed; therefore, all our audio amplifier stage need do is amplify voltage. With that in mind, we select a tube with a high amplification factor, such as a pentode or a high-mu triode, and we use a plate-loading resistor with a value several times the plate resistance of the tube. Fig. 2 shows how the actual amplification of the tube approaches its amplification factor as the plate load resistance is increased.

Remember the discussion of the dynamic characteristics of vacuum tubes? If you don't, go back and look it up in the February, 1950, issue. These dynamic characteristics revealed exactly how the plate current varied in accordance with the grid voltage when various values of plate resistance were used. Fig. 3 shows a whole family of dynamic-characteristic curves for a small triode. Each curve represents a different plate resistance.

Fig. 4 is a close-up study of what happens when we select one of these curves, the one with the 50,000-ohm plate resistor, and apply an audio voltage that swings 2 volts either side of zero center to the grid. This audio voltage is applied in series with −5 volts of bias on the grid.

Notice that if you read along the left side, of the graph, the vertical divi-

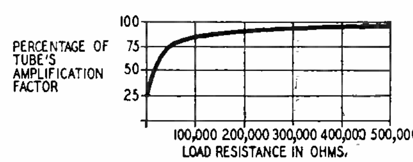


Fig. 2—Curve showing voltage amplification vs load resistance for a triode with a plate resistance of 10,000 ohms.

An audio amplifier having two voltage amplifier stages and push-pull output.

sions represent plate current in milliamperes; while if you read along the right side, they stand for the actual voltage on the plate after the voltage drop across R has been subtracted from the 300-volt plate supply.

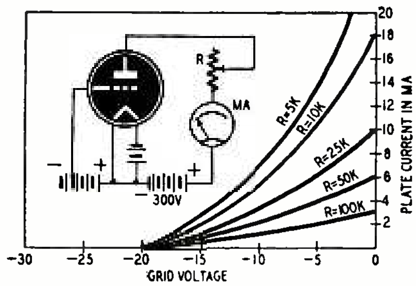


Fig. 3—Triode dynamic characteristics.

Before the audio signal is applied to the grid, our −5 volts of bias causes the tube to draw 2 milliamperes of plate current. The drop through R (.002 × 50,000) is 100 volts, leaving 200 volts on the plate. When the audio grid swings to its maximum negative value of 2 volts, the total grid voltage is −5 + −2, or −7 volts. At this point our plate current falls to about 1⅓ milliamperes, the drop across R (.0013 × 50,000) is only about 65 volts, and the voltage on the plate rises to 235 volts.

On the other hand, when the audio voltage swings to its most positive value, the total grid voltage becomes −5 + +2, or −3 volts; and the plate current rises to the vicinity of 2⅔ milliamperes. This makes the voltage

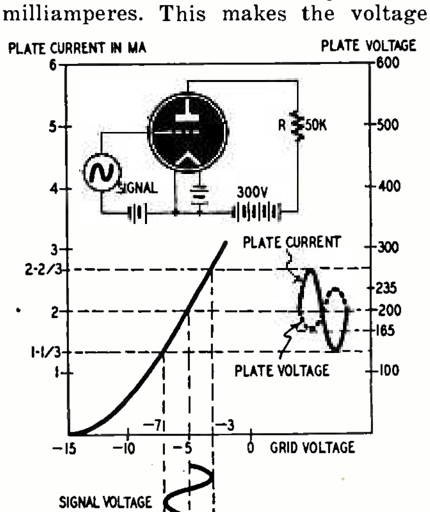


Fig. 4—Curve showing how grid signal varies both plate current and voltage.

drop across R (.00266 × 50,000) approximately 135, and the plate voltage falls to 165.

Keep in mind that for *every* value of grid voltage lying between these extremes there is a corresponding different plate current value and consequently a different plate voltage value. Any movement of the grid voltage in a positive direction immediately produces a proportionate *increase* in the voltage drop across R and an accompanying *decrease* in actual voltage on the plate of the tube. By the same token an increase of the grid voltage in the negative direction produces an increase in the positive plate voltage on the plate for the reasons just mentioned. Since a negative-going grid voltage results in a positive-going plate voltage, we say the grid and plate voltages are 180 degrees out of phase.

If we concern ourselves only with the voltage actually appearing across R—and we can separate this varying voltage from the d.c. voltage by leading it off with a capacitor C—we find that we have a king-size replica of the voltage on the grid of our audio amplifier. In the example we have been studying we know that our actual plate voltage varied from 165 to 235, or a total range of 70. Since this was produced by a peak-to-peak grid voltage of 4, we can see that our amplifier has amplified the grid voltage about 17½ times.

Yes, a radioman has to be as familiar with curves as beauty contest judge.

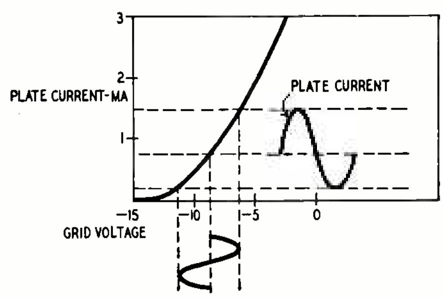


Fig. 5—Incorrect biasing of the tube will cause the output to be distorted.

Not only must he know which curve to select but he must also know what portion of that curve to use. Fig. 5 shows what happens if the fixed bias is set so that the curved instead of the straight portion of the "curve" is used. No longer is the plate current pattern a faithful reproduction of the audio voltage presented to the grid. It is nonsymmetrical or lopsided. Under such conditions the audio signals being amplified by the tube are certain to be distorted and will not sound true to the ear.

In the same way too large a signal on the grid of the tube will result in distortion as shown by Fig. 6. If the audio signal is too great, the extremes of its swing cannot be kept on the straight portion of the curve, even though the bias is correctly set for the middle of this straight part. In this case the tips of the sine wave are flattened by this "overloading" of the audio amplifier.

By using two tubes in a push-pull circuit such as the one shown in Fig. 7, we can have an exciting voltage for our amplifier that is twice that of a single tube. In this circuit the audio voltage is delivered to the grids by means of the input transformer. When one end of the secondary of T1 is positive, the opposite end is negative; so only half of this total audio grid voltage can appear between the negative terminal of the bias battery and either grid. In the same way, while the plate current of one tube is rising that of the other tube is falling. Because of the way they pass through the two halves of the primary of T2, these opposite-going currents produce voltages in the transformer that are in the *same* direction and so add together. This means that a push-pull stage has twice the power output of a single stage. As a matter of fact, it has more than twice the power output because a push-pull amplifier has less distortion and so can be made to put out increased power without exceeding the usual 5% permissible distortion figure.

To understand *why* a push-pull stage has less distortion, you must realize that an audio signal is like a pretty girl: it is seldom seen by itself. Accompanying it are other lesser audio voltages called *harmonics*. A harmonic is an audio voltage that is some multiple of the fundamental audio frequency. For example, if our fundamental frequency is 400 cycles, the second harmonic is 800 cycles; the third, 1,200; the fourth, 1,600, etc. Unfortunately the voltages of these harmonics combine with the voltage of the fundamental and produce changes in the waveshape of that fundamental that spell distortion. Fig. 8 shows how the presence of a second-harmonic voltage wave can foul up a nicely shaped fundamental wave.

In a push-pull amplifier, the even-numbered harmonics are made to cancel out their distorting effects on a signal passing through a single tube by combining the output of both tubes in the transformer in the plate circuit. Fig. 9 shows exactly how this takes place. At A the solid line shows the harmonic-distorted wave produced by tube No. 1 of the push-pull stage. The dotted line portrays the similarly distorted output of tube No. 2, but notice that here the higher peaks appear on the opposite side of the line than they

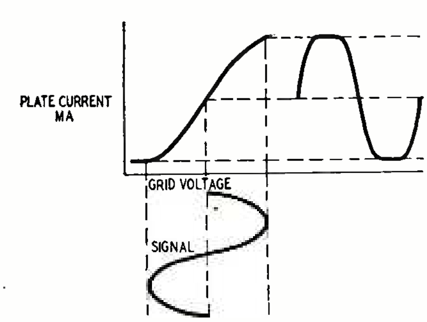


Fig. 6—Too large a signal on the grid causes distortion of the output signal.

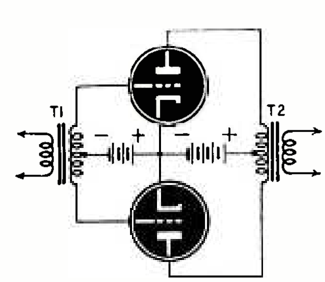


Fig. 7—Diagram of push-pull amplifier.

did for tube No. 1. At B is shown the amplified distortion-free wave that results from the combination of these two waves.

Incidentally, this same cancellation process also takes out any power supply hum that may be impressed directly on the plates of the push-pull output

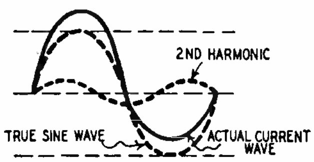


Fig. 8—The second harmonic adds to the sine wave and distorts the output.

tubes; it does not, however, remove any hum that may be introduced into the amplifier from preceding stages. Neither does a push-pull amplifier reduce the distortion produced by odd-numbered harmonics, such as the third, fifth, seventh, etc.; but since the amplitude of the harmonic usually diminishes as its frequency departs farther from that of the fundamental, getting rid of the second harmonic is very much worth while.

Let us summarize what we have said about audio amplifiers in this installment. The job of this part of the radio receiver is to build up the small signal that is put out by the detector so it will be big enough to drive the power output stage. The audio amplifier looks like the power amplifier except that it has a resistor in its plate lead instead of a transformer primary.

It must boost all the frequencies from 50 to 15,000 cycles in the same proportion, otherwise we get distortion. Sometimes a receiver needs two or more stages of audio frequency amplification.

Related to the voltage amplifier is the push-pull amplifier, which is a power amplifier using two tubes to put out twice as much power as one tube will. It also improves the output stage by canceling out even harmonics which are introduced by the tubes.

Push-pull stages are found more often in the power output portion of a receiver than they are in the voltage

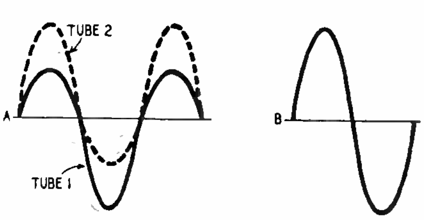


Fig. 9—Distortion from even harmonics cancels out in a push-pull amplifier.

amplifier section. As you will discover, push-pull action can be had without using an input transformer, but that is a refinement that will be taken up later. Right now, Watson, slip your service revolver into the pocket of your great-coat, bring me my fore-and-aft cap and my magnifying glass, for we are about to start studying *detection!*

Audio Freqmeter Has A Tubeless Indicator

By I. QUEEN

THE experimenter who wants to find the value of unknown audio frequencies quickly and simply will find the audio-frequency meter described in this article a useful instrument. In spite of its simplicity and the ease with which it may be built, this instrument is accurate for all audio frequencies.

The audio-frequency meter uses the standard Wien bridge circuit, the basis of most meters of this type. An unusual feature of this particular instrument is the built-in tubeless indicator, consisting of a 1N34 crystal diode and a d.c. microammeter. This capacitance-coupled indicator gives good sensitivity even at the low frequencies.

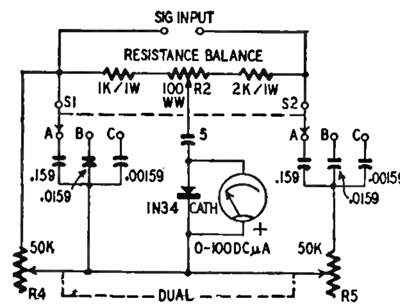
The instrument has three ranges: 20 to 200 cycles, 200 to 2,000 cycles, and 2,000 to 20,000 cycles. A ganged selector switch S1-S2 switches in pairs of identical capacitors to set these ranges. The ganged 50,000-ohm dual potentiometer R4-R5 is the main adjustable control, and a dial reading directly in cycles per second is attached to this potentiometer.

In use, the instrument is tuned in the following way: The unknown signal is fed into the input terminals, and the dial of R4-R5 is adjusted for a sharp downward dip of the microammeter pointer. When the lowest dip is obtained, adjustment of potentiometer R2 will make this null point sharper and therefore more closely readable on the R4-R5 dial. Adjustment of R2 will not affect the setting or calibration of the main tuning dial. For that reason, no dial is needed for R2.

If an audio oscillator is available, it may be used to feed various spot frequencies between 20 and 20,000 cycles into the audio-frequency meter. As the meter is set to null for each frequency, the corresponding point may be marked on the dial of potentiometer R4-R5. Only one dial scale is required.

If a calibrated oscillator is not available, the dial may be calibrated closely enough for most practical purposes by checking resistance settings of potentiometer R4-R5. The chart gives resistance readings corresponding to frequencies between 20 and 20,000 cycles. A resistance bridge or good ohmmeter may be used for the measurements. The values in the chart assume the range switch is in position C. When it is in position B, drop the last zero from the frequency figure (200-2,000 cycles); when in position A, drop two zeros (20-200 cycles).

The matched capacitors are made by paralleling combinations of oil-filled and mica capacitors to the correct value. If only one dial scale is used, the accuracy of tracking depends on the accuracy of the capacitors. The 5-μf coupling capacitor can be made by paralleling several large paper capacitors. Do not use electrolytics.



CALIBRATION TABLE

FREQUENCY (cycles)	RESISTANCE (ohms)
2000	50,000
2500	40,000
3000	33,300
3500	28,500
4000	25,000
4500	22,200
5000	20.000
5500	18,200
6000	16,700
6500	15,400
7000	14,300
7500	13,400
8000	12,500
8500	11,800
9000	11,100
9500	10,500
10,000	10,000
11,000	9100
12,000	8300
13,000	7700
14,000	7150
15,000	6660
16,000	6250
17,000	5900
18,000	5550
19,000	5250
20,000	5000

The values in the table are calculated from the standard formula for the Wien bridge:

$$f = \frac{1}{2\pi\ RC}$$

In this case R is the measured resistance of one of the dual pots and C is the value of one of the matched capacitors. A calibration point for any frequency can be found with this formula.

A Midget Double-Trace Scope

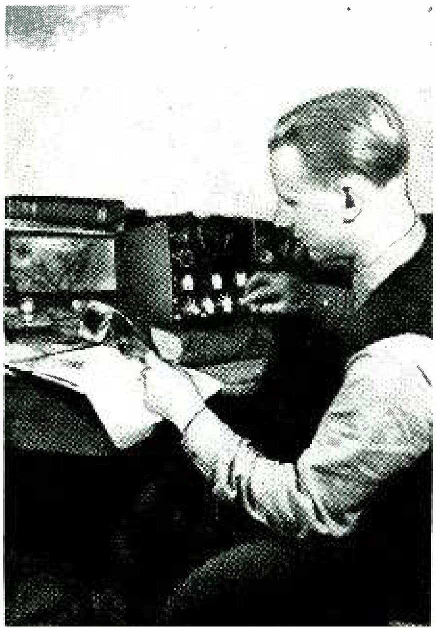


Fig. 1—The scope takes up little room.

By OTTO VON GUERICKE

FOR my work I needed an oscilloscope with the following qualities: it must have all the features of the lower-priced oscilloscopes and should contain them in a small case that could be handled easily and always be placed in the position most convenient for observation.

In addition, the scope should be double-traced with a built-in electronic switch to connect the vertical deflection plates alternately to two different inputs. The switching frequency must be high enough to make simultaneous observation of both inputs possible.

To reduce the size of the apparatus, I selected the 2AP1 cathode-ray tube, although friends had warned me that counting waves in frequency measurements was very difficult on a 2-inch screen. When I first tried out the tube, I found the focusing much sharper than on a 5-inch tube, and this compensated for the loss in size.

Using this tube enabled me to keep the dimensions of the cabinet down to 7¼ x 7¼ x 9¼ inches with enough room left to accommodate two rectifier tubes, three 6J7 amplifiers, a 6N7 multivibrator, an 884 sweep oscillator, transformers, and other components.

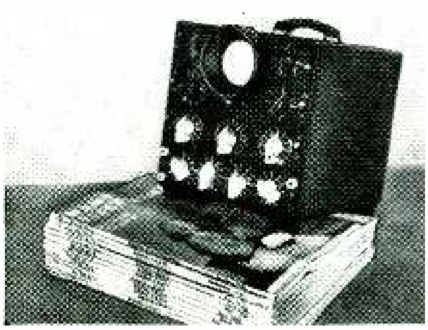


Fig. 2—A front view of the instrument.

Fig. 1 indicates how little room is taken by the oscilloscope as I work at my table. Fig. 2 shows the completed instrument.

The small dimensions caused some trouble with magnetic hum from the stray fields of the transformers. I cured this in two steps. First I connected the primaries of two transformers mounted side by side so that the instantaneous fields had opposite polarities. This reduced the stray magnetic field as indicated in Fig. 3 and helped a great deal.

The 2-mm iron tubing around the cathode-ray tube still was unable to keep out the remaining magnetic field completely. Adding another iron tube 6 mm thick, with air gap between the two shields, completely eliminated the magnetic hum. Thus it is not impossible to operate a C-R tube and line transformers at close quarters if some precautions are taken.

The 6J7 amplifiers, the C-R tube circuits, the flyback blanking, and the 884 sweep generator were copied from issues of RADIO-ELECTRONICS and worked satisfactorily, so nothing more need be said about them. I did work out some special circuits myself. (See Fig. 4.)

I center-tapped the high-voltage transformer and provided a switch, S1, on the front panel (just below the C-R tube) to connect either 1,000 or 500 volts to the rectifier. The power supply then furnishes two different d.c. potentials to the C-R tube. To observe a weak signal, I apply the lower voltage to get a higher deflection sensitivity. To view a quick phenomenon, I use the higher voltage which gives a brighter trace. This simple trick is very useful and to be recommended highly.

The intensity grid of the C-R tube is brought out to the panel across an RC network. The horizontal amplifier (when not used for double tracing) is connected to this same terminal when the sweep is switched to the horizontal deflection plates with S5. In this position of the switches, the horizontal amplifier acts as an intensity amplifier.

Another advantage of this arrangement is that this terminal may be connected to the *vertical* input with a shielded wire so that the signal fed to the horizontal amplier input is amplified by both amplifiers in series. The gain is about 500 at 50 cycles. In most cases this has no effect on the intensity grid because this arrangement is used only for very small signal voltages.

To get double tracing, the vertical and horizontal ampliers are connected to the vertical deflection plates and blocked alternately with the square-wave output of a multivibrator. A multivibrator is most convenient because it provides the two necessary signals 180° out of phase at the two plates of this circuit.

I tried all three grids of the 6J7 to find that most suitable for injecting the blanking pulses. The best results were had from the suppressor grid. This was also convenient for switching from normal operation to double tracing because the pulses can be supplied through an RC network, leaving the suppressor at ground potential when the multivibrator is not working.

Experimentation with the plates of the 6J7's, which had to be connected to the vertical deflection plates, showed it best to use a common load resistor. Thus all that I needed to go from normal to double-trace operation was a d.p.d.t. switch S6.

To get square waves with steep sides, the capacitors in the multivibrator circuit must be made as small as possible (I used 20-μμf air padders) and the grid resistors relatively large. For the latter I used 2.2-megohms with d.p.d.t. switch S7 to add 1-megohm resistors in parallel to raise the frequency about four times. The frequency is about 3,000 c.p.s. with the 2.2-megohm resistors and adding the 1-megohm shunt across each raises the frequency to about 10,000 c.p.s.

The position of the two traces is controlled by the 5,000-ohm potentiometer in the cathode circuit of one of the amplifiers. Fig. 5 shows how it looks when there are no input signals and

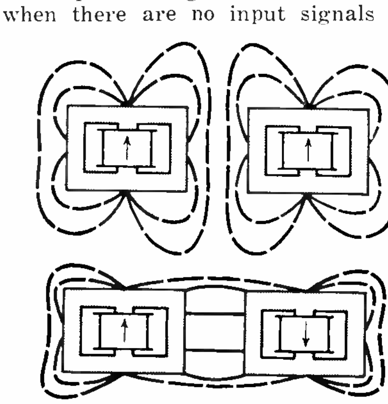


Fig. 3—Transformers are connected so that stray fields oppose each other.

the sweep frequency is so high that the switching cycle is visible. If the sweep frequency is lowered, only two parallel lines with a thin veil between them are visible.

The two lines can be made to coincide by adjusting the cathode potentiometer and, if there is no signal on one input, an x axis is formed for the signal on the other (Fig. 6).

There are so many applications for an oscilloscope, especially one with a double trace, that it seems worth while to mention a few less common ones.

A pulse of very short duration may easily pass the attention of the observer because the quicker the movement of the beam, the less the screen is illuminated. In such cases, intensity modulation is very useful. The pulse is fed to the vertical input *and* to the intensity terminal at the same time.

If the pulse voltage is small, the horizontal amplifier can be used as long as the sweep is used also. The result is a bright trace instead of a nearly invisible one. If the signal also includes a sine voltage, it is advisable to pass it through an R-C network to attenuate the sine voltage but not the pulse.

If it were of interest to observe the parts of a signal voltage which rise most quickly, the same connections can be used. The quickest rise is indicated by the brightest trace, while a drop in voltage makes the trace less bright.

Lissajous figures are formed when sinusoidal voltages are applied to both the horizontal and vertical deflection plates. Interpretation of these patterns is a method of frequency measurement. An easier way is to connect one frequency to the intensity grid instead of the horizontal deflection plates (with the sweep on). The number of dark *or* bright spots on one cycle of the curve shows the frequency of the signal on the intensity grid compared with that on the vertical plates. Of course the higher frequency must be connected to the intensity terminal.

The advantage of this method is that the voltages need not be sinusoidal. It is also easier to count the spots than to examine the circumference of a Lissajous pattern.

A sinusoidal voltage may be used as a time base. The sine wave is applied to both the horizontal input and to the intensity terminal. Only half of the sine wave becomes visible and a sawtooth wave is formed. The sawtooth is by no means ideal, but for many applications it is sufficiently linear.

The advantage of using a double trace can be stated simply: comparison of two periodic waves as to shape, amplitude, frequency, and phase can be made at a glance.

In Fig. 7, one trace is left with no signal and is so shifted that it just touches the negative peaks of a sine wave on the other trace. This is a quick and simple way to compare peak amplitudes no matter what the shapes of the voltages are.

Fig. 8 shows an easy way to check the frequency response of an amplifier. The upper trace is the signal at the amplifier input, and the lower trace the signal at the output. The pattern shows that the amplification of the fundamental frequency is about 1, while the harmonic in the signal is amplified about 10 times. Phase shift also can be detected at a glance.

The frequency response of an amplifier can be checked quickly with a square wave. As the multivibrator used to generate the square wave may not have an ideal waveform, reliable results are possible only when the square wave is viewed both at the input and the output of the amplifier—another use for double tracing.

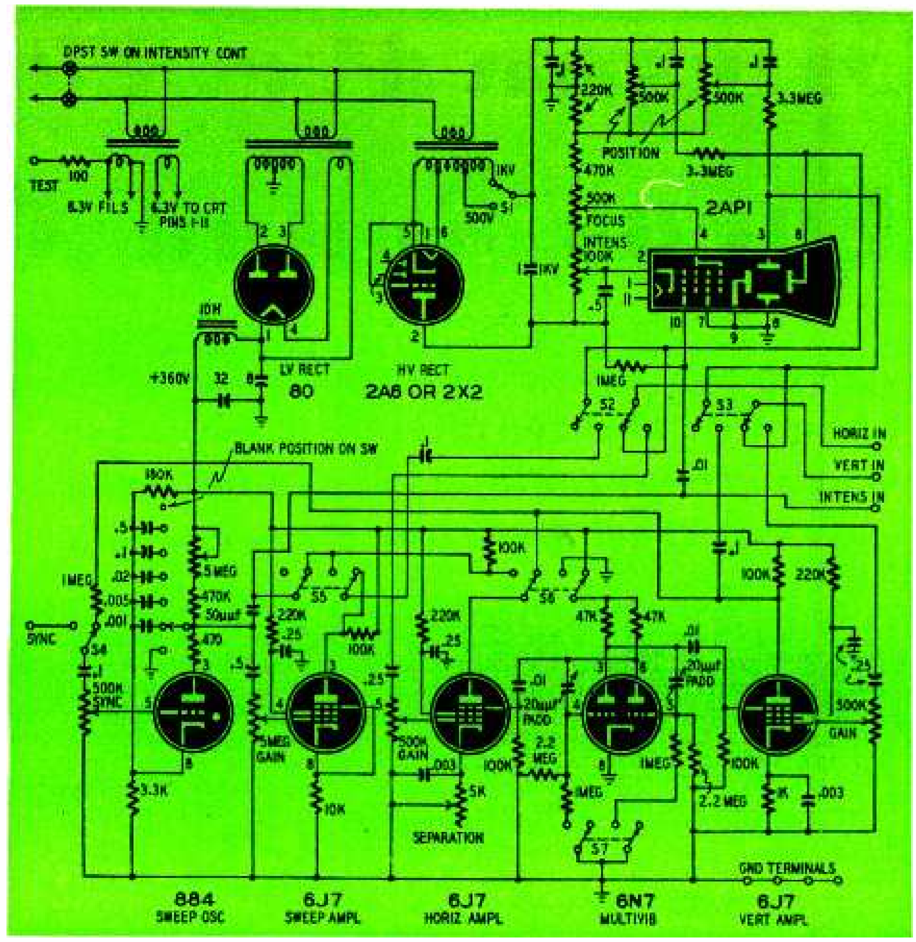


Fig. 4—Schematic of the oscilloscope. The built-in multivibrator provides for double tracing. The tapped high-voltage supply gives two sensitivities.

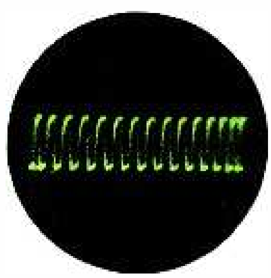


FIG. 5

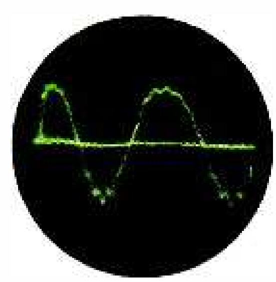


FIG. 6

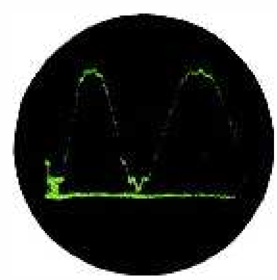


FIG. 7

Fig. 5—The switching cycle as it appears when the sweep frequency is too high with no signal input.

Fig. 6—The horizontal amplifier cathode potentiometer adjustment makes the sweeps coincide. One may be used as an x-axis for a trace on the other.

Fig. 7—Rapid peak amplitude comparison of two signals can be made if one trace is positioned at the negative peak of a signal on the other trace.

Fig. 8—The double trace simplifies amplifier response check. The input signal is applied to the upper trace and the output to the lower trace.

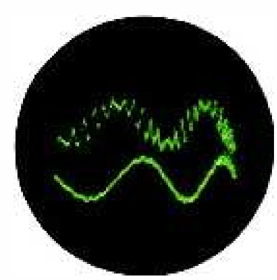


FIG. 8

Microwave Lenses Focus Sound Waves

The artificial-dielectric lens is useful for beaming u-h-f radio waves and for audio waves of roughly the same wave length

By FRED SHUNAMAN

HERTZ was the first to prove that radio waves could be reflected and refracted with lenses like light waves. His discovery was for many years one of the well known but unused facts of radio. It was not until microwaves came into use that the lens idea was applied to bending or beaming radio waves.

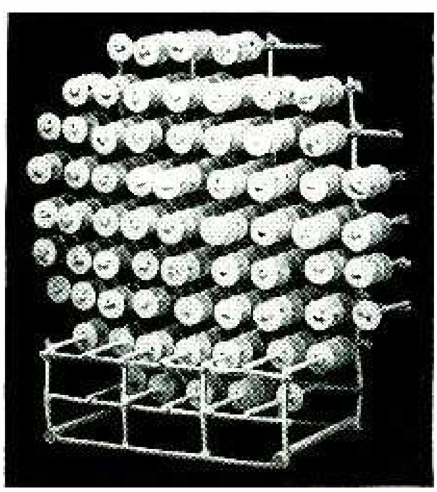


Fig. 1—An early type of artificial-dielectric lens made of metal discs.

The first of the modern electro-magnetic lenses was patterned on wave-guide principles. It was developed at the Bell Telephone laboratories and described in this magazine July, 1947. The waveguide type of lens was highly directive and could focus radio waves in a narrow beam. It had one disadvantage—a given lens was confined to a narrow band of frequencies.

A later lens, also developed by scientists of the Bell Telephone Laboratories, overcame this drawback. It was composed of small spheres or discs of conducting material, and slowed the radio waves down as a lens of glass slows down a ray of light. Fig. 1 is a lens of this type. It can be used over a very wide band of frequencies, yet is capable of focusing microwaves in a narrow beam. Discs or spheres are replaceable by metal strips, making the lens relatively simple to construct. Such strip lenses are the ones now used in the New York-Chicago microwave relay circuits of the Bell System for telephone and television network use.

A most interesting development—and the one that forms the subject for our cover this month—is the adaption of the microwave lens for use with sound waves of approximately the same wavelength as the radio waves for which the lens was designed originally. This is an important step in the microwave field as well as in audio, for the lens can not only be used to beam sound waves, but the characteristics of a lens intended for microwave frequencies can be determined with the simpler and cheaper equipment which can be used to produce sound waves rather than the more costly microwave equipment.

How a lens works

A lens of the obstacle type consists of a collection of objects which are small compared to the wavelength of the radiation being focused. W. E. Kock, who invented the waveguide lens and the obstacle lens, reasoned that in a glass lens for refracting light, the molecules of glass are so small as to give the impression (even under a microscope) of a perfectly smooth and homogeneous medium. As the wavelength is increased, the size of the obstacles and their spacing can be increased till, for sound waves in the order of several thousand kilocycles (or microwaves in the centimeter region), they look like the lens of Fig. 1 or the cover photo.

According to the commonly accepted theory of lens action, a lens slows down the waves transmitted through it because of reflections from the small elements that make up the lens. Thus the

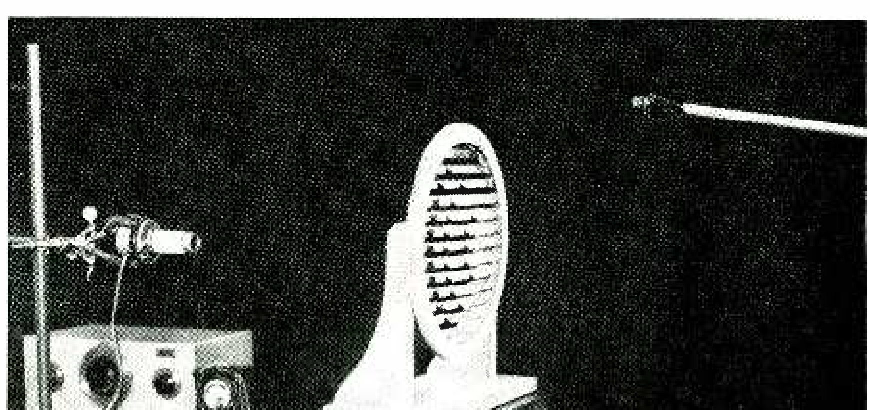


Fig. 2—This is the setup used to produce the pattern shown on the cover.

molecules of glass reflect back part of the light that impinges on them, and the beam which finally emerges from the lens is a resultant of the original wave which entered it and all the small reflections from the molecules of glass.

In an electric lens, the "molecules" should be perfectly conducting to make a perfect lens—in an acoustic or audio lens they should be perfectly rigid. Although perfection is not often found in the field of physical experiment, the metal of which the lenses are made is a sufficiently good conductor and also mechanically rigid enough to make an efficient lens. The focus pattern can be seen on the front cover. (A "perfect" photograph would have shown a sharper focus at the point of greatest light intensity.)

The equipment which plotted the field has the simplicity of genius. A neon bulb and a microphone are mounted on the end of a rod (Fig. 2) which is attached to a carriage. The rod swings slowly up and down, at the same time backing away from the lens at a rate that makes each swing one-tenth of an inch further from the lens than the last one. The microphone is connected to the input of an audio amplifier and the neon bulb to the output. The lamp therefore lights brightest in regions of maximum signal. The sound is produced by a standard audio oscillator and is beamed at the lens by a high-frequency horn or transducer, like the one on the cover or in Fig. 2.

The above explanation is a simplification, as a second signal of the same frequency must be mixed with the wave to produce the interference pattern which gives the standing waves shown in the photograph, but is correct in the fundamentals. A camera takes a time exposure of the flickering neon lamp in complete darkness to make a permanent record of the pattern.

One of the simplest types of lenses is that illustrated on the cover. Originally developed for microwaves by Dr. Winston E. Kock and later used with sound waves by Kock and F. K. Harvey of the Bell Telephone Laboratories, it consists of a simple array of metal strips. Aluminum is used in the lens portrayed here, though there is no good reason why copper or any other metal with the necessary requirements of rigidity and conductivity should not be used. Fig. 3 gives the details and dimensions of the lens. This lens cuts off at around 10,000 cycles (audio waves) or with radio waves at a little longer than 3 centimeters. Waves of lower frequencies (longer wavelengths) are refracted over a wide band, though the efficiency of the lens is greater for wavelengths of less than twice the lens diameter.

Metal arrays can be used for diffusing as well as focusing sound waves. One use is broadening the usually very directive field of high-frequency horns. Although a wide-angle lens of the strip type described above could be used, the slant plate type of lens illustrated in Fig. 4 is preferred. Instead of slowing down the wave by partial reflections, it leads portions of the wave along a longer path than they would normally travel, slowing them down by detouring them. The focusing (or rather diffusion) pattern can be changed by varying the shape of the lens. Those portions of the sound wave that are detoured farthest can be compared to those which go through the thickest part of the obstacle lens.

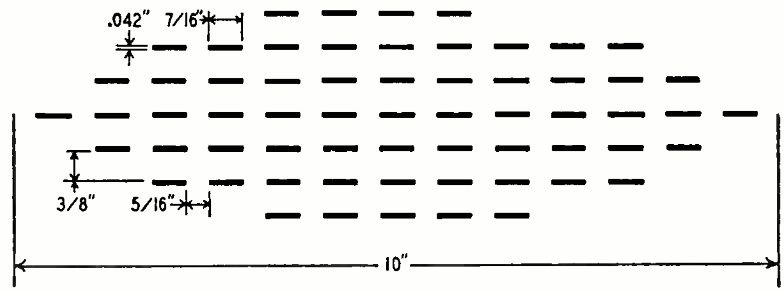


Fig. 3—Cross-section of the 10-inch lens. Drawing is 40% actual size. The individual strips of which the lens is made are cut to such lengths that their ends fall on circles which are ten, eight, six and three inches in diameter.

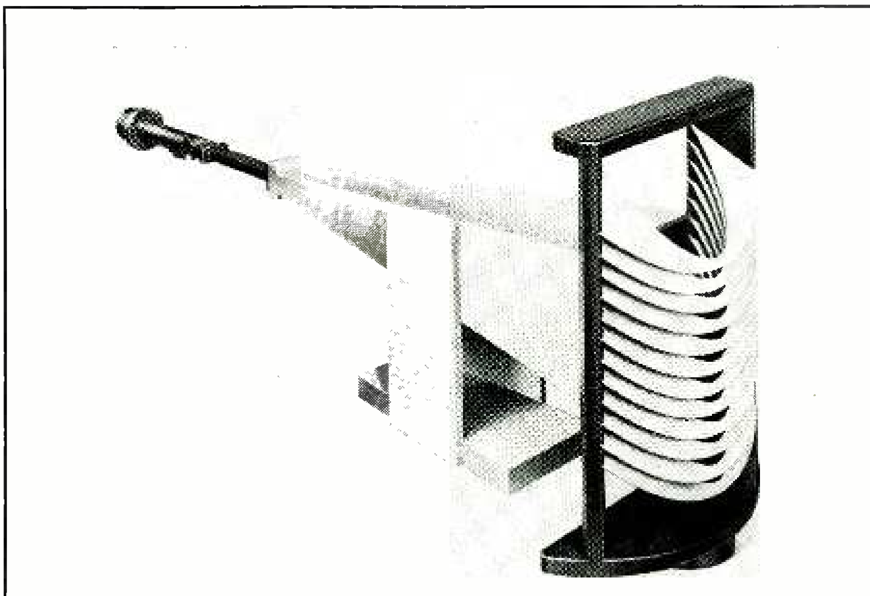


Fig. 4—Slant-plate type of lens used where diffusion is desired.

Audio lenses may well have a number of future applications other than those discussed in this article. Meanwhile they can shed a great deal of information on the behavior of microwave lenses at frequencies where performance of electronic equipment is not always invariable.

The experimenter may be interested in constructing a lens like that shown in Fig. 3, either for audio or radio waves of 3 to 10 centimeters and longer wave lengths. The necessary dimensions are given in the figure.

TELEPHONE AID FOR HARD-OF-HEARING

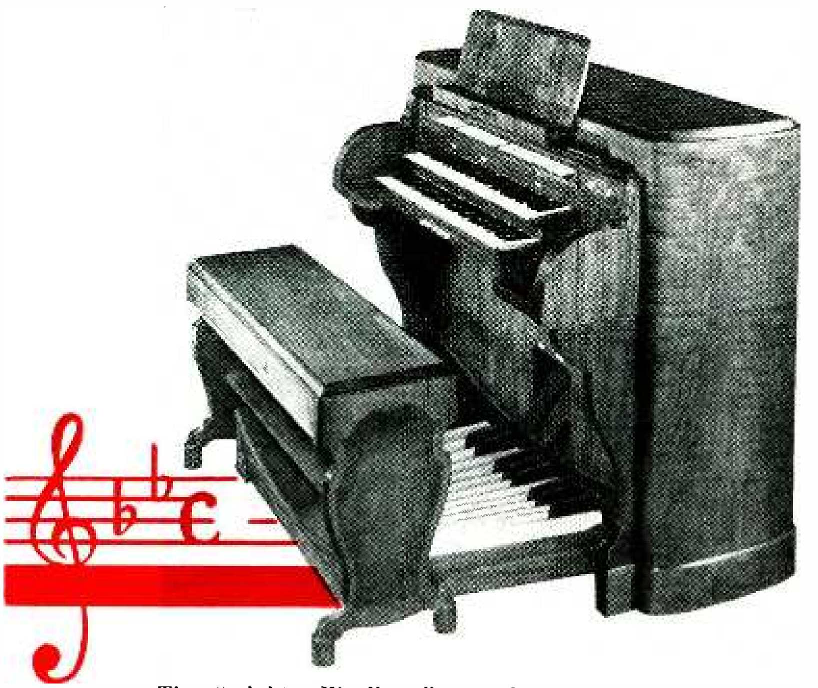
Telephone conversations for the hard of hearing or in noisy surroundings are often difficult if not impossible. A recent invention to overcome this difficulty is a pocket-size portable induction coil pickup and amplifier that slips under a telephone and amplifies the conversation. A supplementary headphone is used with the device.

For those who wear their own individual hearing aids, only the pickup will be provided. A jack fitted to the hearing aid will cut out the microphone when the telephone pickup coil is in use. Patent applications have been made for this device by Erich Hausdorf of Ottowa, Canada.

Electronics and Music

PART I

Beginning a series on practical electronic instruments



The "mighty Wurlitzer" console looks conventional but today's model speaks from loudspeakers, not organ chamber.

By RICHARD H. DORF

NOT a week passes that the editors of RADIO-ELECTRONICS do not receive from three to a dozen letters asking for information on electronic music. The letters are interesting from other standpoints than mere volume. They indicate that, while there is much evidence of burning ambition, there is a striking lack of information on the problems involved.

Most letter writers assume that the main problem is to get together some sort of system that will produce the notes of the scale. Magazine articles describing home-built organs and solo instruments show exactly the same thing. It's too bad—because it simply isn't so! The classic example is the Theremin, which can produce any note in the scale (and any note *not* in the scale, too), but which is still unacceptable as a musical instrument—because of its monotony of tone color, difficulty of control, and sharp attack and decay.

What is music?

Music is a succession of tones of various frequencies and characteristics, sounded sometimes simultaneously and sometimes consecutively, in such a way that the result is pleasing to the ear. That seems a pretty poor definition but it's about as good a one as you can expect. Music is not a science but an *art*, which means that its effect is almost entirely subjective. What sounds good to you may not sound good to me. What a Chinese would call beautiful melody might sound to you like a horrible noise, and vice versa.

What people mean when they refer to "the science of music" is that the *tools* of music have been artificially conventionalized for the sake of convenience. For example, all of the tones in the musical range are divided into units called octaves. The highest tone of each octave is twice the frequency of the lowest. The octave is further divided into twelve tones, each of which is said to be one half step higher than the preceding one. The ratio between any pair of half tones is equal to the twelfth root of 2 or 1.05946309.

A major scale consists of eight notes, with a half-tone separation between the third and the fourth and the seventh and eighth notes, and the rest are separated by two half tones or a full tone. Minor and other types of scales are made by putting the two half-tone intervals between different notes of the scale.

There is nothing particularly "natural" about this arrangement, but it is convenient. And we are so used to it that music played with other intervals sounds "unnatural." That is why oriental music sounds strange, even unbearable. Some occidental composers have tried to break the convention but have had difficulty in getting public acceptance.

We can further "scientize" the tools of music by showing on an oscilloscope that the tones produced by any instrument are far from pure. Each tone consists of the fundamental plus a number of harmonics. That is one of the most important aspects of electronic music synthesis. If the tone were pure sine wave, it would be devoid of interest—no audience would listen to it. Probably the closest approach to that kind of sound in music is the lower register of the flute when played softly. It is very effective for short periods but the flute would hardly be much good if that were the only tone it could produce. As it is, the flute is at its best when part of an ensemble.

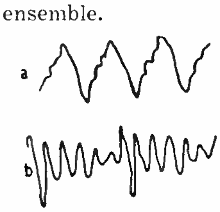


Fig. 1—Waveforms of violin (a) and French Horn (b). At different pitches the oscillograms will look different.

The type of harmonics (whether predominantly odd or even) and the relative strength of each at each fundamental frequency, largely determine the tone quality—whether the tone sounds like a trumpet or a fiddle. Fig. 1-a, for example shows a cycle of the tone produced by a violin; at b is the waveform of a French horn. Every electronic music enthusiast should find an opportunity to examine the traces of several different instruments (one at a time) on a scope. Even without calculations, he will be able to recognize each one after a while.

But no instrument is worth its salt unless it can generate tones of *varying* quality. Most reed instruments vary somewhat from upper to lower register. Additional tonal effects are produced when the player blows harder. Stringed instruments like the violin family can produce an infinite variety, brought about by changes in bowing angle, bowing speed, use of mutes, and in other ways. The percussive and plucked strings—piano, guitar, etc.—vary in tone quality with touch. And so on. An organ produces a wide variety by using many ranks of pipes, each rank sounding a complete frequency range with a distinctive tone quality. It is really several instruments in one. Music would not be music without this variety.

The electronic approach

Theoretically, electronics allows us to reproduce any natural harmonic structure and even make up new ones. The process is essentially a simple one (until you try to reduce it to practice). If a certain tone shows that it is made up of the fundamental plus certain harmonics, each harmonic having a certain relative amplitude, you can synthesize the tone by mixing together sine-wave tones corresponding to the fundamental and the harmonics, and regulating the amplitude of each harmonic correctly. That method is used in the Hammond organ.

Approaching the same problem from the other end, you can begin by generating a very complex wave, sawtooth, for instance, and synthesize the waveform you want by removing, with filters, the undesired harmonics and regulating the attenuation of each. That is the basis of the Baldwin electronic organ. Whichever you choose, a very formidable problem is how to do it without running costs and space requirements sky-high.

Not all electronic instruments are intended to duplicate the tones of standard instruments, and simpler ways of varying tone color are used. Clippers may add odd or even harmonics to a sine wave, depending on whether one or both of the peaks of each wave are clipped and the degree of clipping of each. Driving a tube into the grid-current region produces a certain type of distortion that results in even harmonics unless two such stages are used in cascade, in which case the harmonics may be odd or even or both. Simple tone controls—high-, low-, or bandpass—alter not only the over-all balance of an instrument but also the harmonic structure of the individual tones.

All acoustical instruments, particularly those of the string family, have *formants*. The body of the instrument is naturally resonant at some frequency above the normal range of pitches played; each time the body is "hit" or shock-excited by a transient in the primary tones, it generates a damped-wave train at its resonant frequency. This gives a distinctive quality to the instrument and is one reason why some violins are superior to others. The same thing happens to the human voice in the oral cavity, the

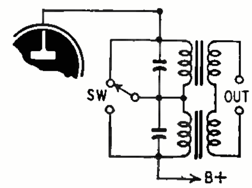


Fig. 2—Selectable resonant circuits simulate resonance of instrument body.

shape of which we adjust to produce the various vowel sounds. The natural frequency of the cavity is a formant. Formants can be produced electronically by passing the audio through a transformer tuned to the formant frequency. The circuit of Fig. 2 produces one of two formants, depending on the position of the switch.

Tremolo or vibrato is characteristic of almost all instruments, including the voice. Tremolo is a small change in *volume* that occurs about six times a second. Vibrato is a change in *pitch* at the same rate. Too much of either is very annoying, but none at all yields an uninteresting musical tone. Whether vibrato or tremolo is preferable is a matter of opinion. Vibrato can be produced electronically by connecting a reactance tube across the tone oscillator and feeding a 5-8-cycle sine signal to its control grid. A tremulant can be made by inserting a variable-mu tube in the audio amplifier and varying its gain with a 5-8-cycle oscillator. (There are, of course, other ways, which will be described in this series.) Fig. 3 shows that tremolo is really amplitude modulation at the 5-8-cycle rate, while vibrato is FM.

Another highly important point is the rate of *attack* and *decay*—the shape of the keying envelope. If you connect an audio oscillator to a loudspeaker and put a switch in the line, closing the switch produces the tone much too abruptly. It doesn't sound like music because in every real instrument (including the percussive piano, guitar, celeste, etc.) tone buildup or *attack* takes an appreciable time. Opening the switch shuts off the sound abruptly, which, again, is unnatural. When the player of an acoustical instrument stops blowing or lets go his key, the tone takes a certain time to die away or *decay*. Fig. 4 shows the difference between the keying envelopes. Instruments other than the piano have much longer attack times and shorter decay. Electronic instruments that have no at-

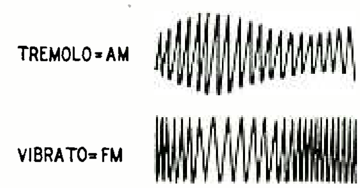
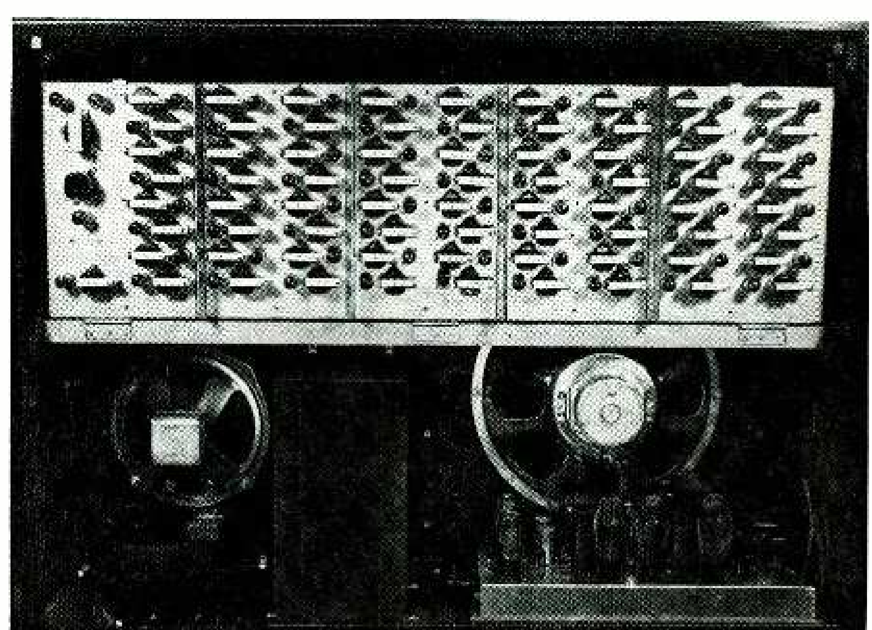


Fig. 3—Tremolo varies the amplitude and vibrato varies the frequency or pitch. Vibrato is generally preferred.

tack and decay control sound very much like code-practice oscillators.

The delay can easily be brought in by using R-C time-constant circuits (among other methods) though again the story may not be so simple in practice, for a harmonic-synthesis instrument like the Hammond organ, for instance, would need a separate delay circuit for each harmonic of each note.

There is one more musical quality, that accounts for the peculiar beauty



In this one-manual-and-pedal Consonette, 73 vacuum-tube oscillators generate the tones. Three more shape the tones and six others amplify the music for the two speakers. This is rear of console, which contains everything.

A 3-Channel Hi-Fi Amplifier

Wanted: An audio amplifier for phonograph and AM-FM radio in the average home. Said amplifier must be so faithful in its reproduction that the most critical ear cannot detect any distortion, and anyone should be able to adjust its response so that the balance of frequencies is right for his or her ear. All this to be built by any radio experimenter in his own shop in spare time and at low cost.

An amplifier designed for low distortion and a versatile frequency balance system

By R. L. EARDLEY-WILMOT

IN the *Radio-Electronics Reference Annual* for 1947 there appeared an article by M. Contassot on a high-fidelity 3-channel amplifier. The writer was impressed with the idea and determined to construct a similar set at the earliest opportunity. The two big snags were, as usual, time and money for experimentation.

The first step was to get "wealthy chum" interested in the job. That took a bit of time, but one day WC said, "Bob, I've decided that amplifier is to good to remain on paper. Let's build it."

"O.K." I replied, "let's start modifying the circuit."

"Oh, no," he said, "there is one condition: we build it just like the man says."

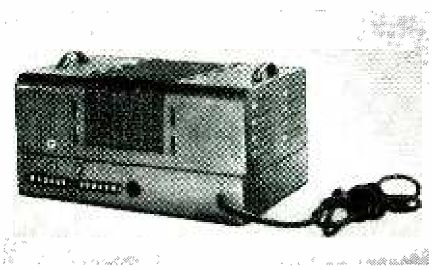
(WC knew little about radio, but had previous experience with my destruction of other people's circuits.)

The next thing was to explain that certain things had to be changed because of parts that were not available, and also that such modern things as single-ended tubes would improve the design. As long as I was able to give very convincing reasons for changes they were accepted by WC. Then I discovered a better way to get the changes I wanted. That was to educate him in the intricacies of amplifiers. He is a quick learner and after a while I was able to make him think that the changes were his idea. Eventually he came out with original ideas such as,

"That point-one has got to come out of the cathode of the 6SJ7 and be replaced by a 25 μf. The guy didn't know what he was about!"

I was amazed and delighted. With due apologies to M. Contassot, the 0.1 *was* quite inadequate in the final product.

The first step in redesigning was to choose tubes to use. No very serious changes here, except to put in single-ended tubes: 6SF5's, 6SJ7, 6F6-G, 5V4-



Rear view of the completed amplifier.

The same view with the cover removed.

◀ **ELECTRONICS AND MUSIC** *(Continued from page 49)*

of the sound heard when several similar instruments play in unison. In the first-violin section of an orchestra, for example, all the instruments may sound the same notes; but since the vibrato is produced separately by each player, it not only varies somewhat in rate among the players, but also in phase. At any instant one violin may be sounding a frequency slightly high, another slightly low, and the others anywhere between the maximum and minimum frequency produced by the vibrato swing. Fig. 5 is a graph showing how the frequencies of two violins shift up and down slightly with vibrato. D is the instantaneous frequency difference between the two caused by the independent vibratos. The slight frequency differences make for a *choir* effect. The most impressive proof of its importance is a choir of voices. Each individual voice may be far from good but the ensemble sound (provided the singers at least hit the right pitch) is invariably very acceptable.

Choir effect is one of the hardest things to duplicate on an electronic instrument. I know of only one that attempts it (though there may be others), the Hammond organ, in which a complete duplicate set of tone generators is switched in, with the pitches a

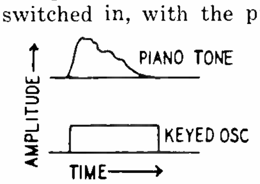


Fig. 4—Manner in which tones build up (attack) and die away (decay) is an important factor in determining character of instrument. Abrupt start and stop of keyed oscillator appears unmusical to the ear, so some way of preventing the tones from "spitting" is always needed.

shade different from those of the main generators. Even so, the sound is not as good as when the variations are random. Besides being difficult to get, this random effect requires a large number of tone generators to give the effect of a large orchestra or choir.

The purpose of this introductory article is to convince the enthusiast that just producing the right frequencies is not enough to make music. There are many other considerations, and more than those discussed here. Beginning next month, we'll give actual, practical circuits. We will show several ways of obtaining each of the necessary effects. Some of the circuits will be commercial, some experimental, with development up to you. We'll give complete analyses, too, of several of the more important commercial instruments, including schematics and all specifications.

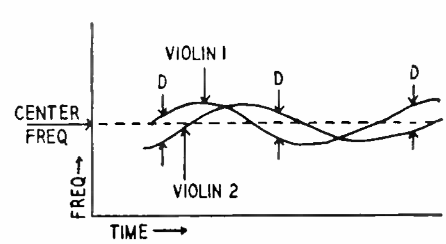


Fig. 5—Differences in instantaneous frequency between instruments in ensemble creates the pleasing "chorus" effect so hard to do electronically.

G being obvious substitutions. We left the 6C5 unchanged. For the other power rectifiers we decided on 6X5-GT's, and for the push-pull amplifiers we were able to get 6B4-G's which are a direct substitution for the 6A5's except that they have directly heated cathodes.

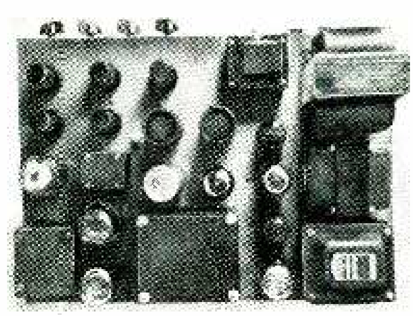
The next items were the power transformers. This reduced to determining what currents the tubes would draw at arbitrary voltages. Let us consider them one at a time.

The power supply for the output tubes required 350-0-350 volts and a 5-volt filament winding. The one we used had a center-tapped 6.3 volt winding at 4.0 amp which was more than enough for the filaments of the 6B4-G's. Then we allowed for two 40-µf filter capacitors and a 30-henry, 150-ma, 190-ohm choke. That is a huge one, and in another set I should probably use three capacitors and two 10-henry chokes instead. We used 30 µf in the plate circuit of the 6F6-G and 6SF5 which are also fed from this supply. The current drawn here is about 112 ma.

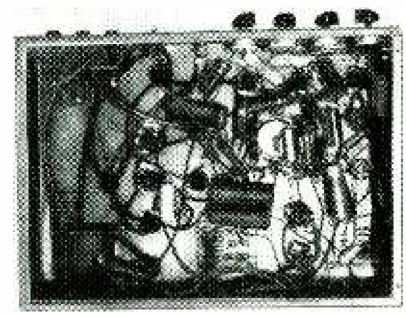
Next was the grid bias supply. Here we used a 6X5-GT and a transformer having 200-0-200 volts and a 6.3-volt, 2 amp. filament winding. The latter feeds the first five tubes. One side must be grounded to reduce hum. In the filtering of this supply we again used 40-µf capacitors. The original bleeder was not correctly proportioned for the voltage we were applying, so we put 10,000 ohms on the high side and 3,000 ohms on the low side of the 5,000-ohm potentiometers. That gave plenty of leeway on both sides of the proper bias point.

The last power supply really took a beating, but mostly because we added voltage regulators. We got a transformer with 310-0-310 volts and 6.3 volts at 2.4 amp. The latter was used for the two 6X5-GT's. There being a 5-volt winding on this transformer, we supplied the pilot light from it to insure long life for that piece of finery. For filtering here, we again used two 40-µf capacitors and a single 7-henry, 40-ma, 340-ohm choke. A 3,000-ohm, 10-watt resistor served where the 25,-000-ohm adjustable was shown in the original diagram, and the two OD3's were connected in series causing the current from this supply to be 30 ma.

The next thing was the other transformers and here there is no point in trying to save money. The best, and only the best, is the rule. Hammond, of Canada, puts out one (the 1713) that suits the push-pull output to perfection. Its full range is 30 to 12,000 c.p.s. ± 1 decibel, and it is free from core saturation down to 30 cycles at full rated output of 15 watts. Primary impedance is 3,000 ohms center-tapped, and output taps are 4, 8, 15, 30, 125, 250, and 500 ohms. Its feedback winding was not used. The original feedback seems quite satisfactory; and because the tubes are running class A1, you can't use current feedback. This transformer's cost of just over $10



A top chassis photo of the amplifier.



A look at the underside of the chassis.

made it the most expensive part of the amplifier. United States constructors may get an American brand for slightly less or more, depending on quality.

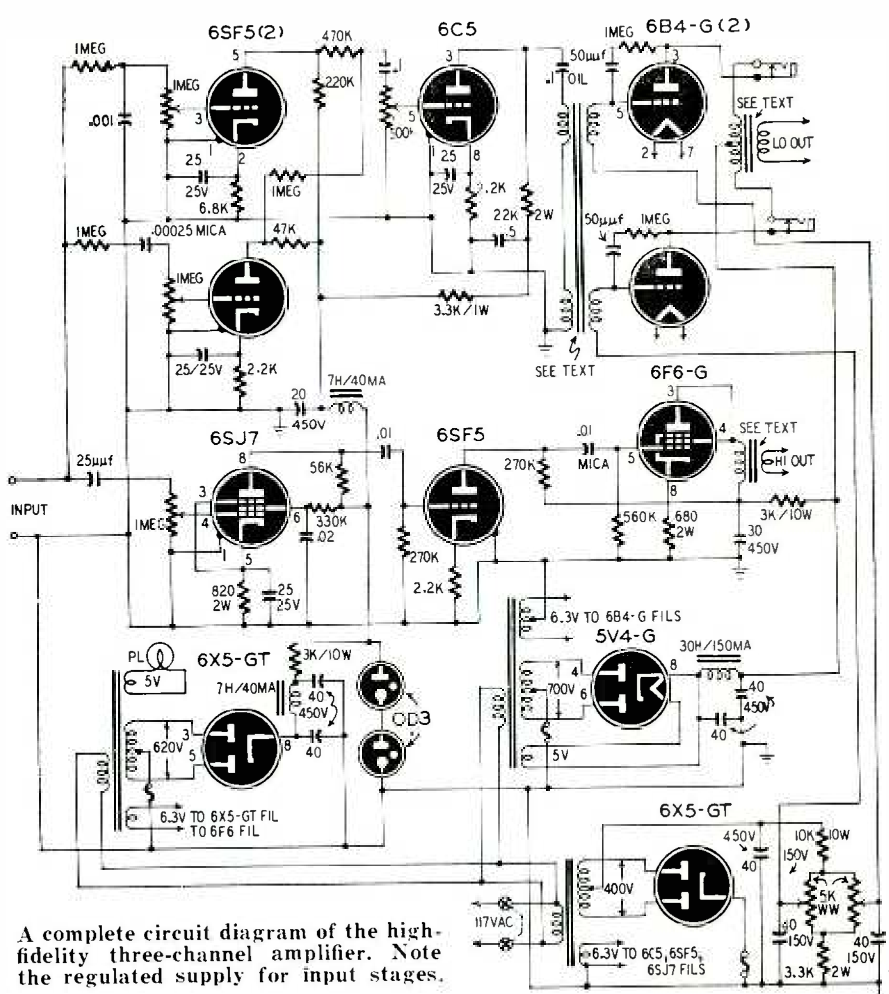
Hammond had a tiny transformer (the 834) for the input coupling in this channel. It has a frequency range of 30 to 15,000 c.p.s., a primary impedance of 20,000 ohms, and a secondary impedance of 10,000 40,000 ohms.

Finally, the other output transformer (Hammond 954) is also flat from 30 to 15,000 c.p.s. and has a primary impedance of 4,000 ohms. Secondary taps provide for 1.5-, 3.75-, 6-, 7.5-, 10-, and 15-ohm voice coils. The maximum output level is rated at 10 watts which is quite satisfactory for a tweeter.

The last question, and one that has never been settled, is the proper value for the blocking capacitor between the 6C5 and the coupling transformer. By all the rules it should be dependent on the transformer primary inductance, running from 4.0 µf, if the inductance is 10 henries, to 0.5 µf if the inductance is as high as 150 henries. We used 0.1 µf and it seems O.K., but the original circuit called for 0.02 µf which just doesn't work out, at least mathematically.

The total cost of the amplifier was around $100 in Canada, including the cost of a specially made chassis; it should be well under that figure in the States. At any price it would be a bargain, for its performance is out of this world.

The photographs and diagrams tell the rest of the story.



A complete circuit diagram of the high-fidelity three-channel amplifier. Note the regulated supply for input stages.

Square Wave Analysis For Audio Amplifiers

One of the essentials of successful square wave analysis is a reliable wideband cathode-ray oscilloscope.

Part I — Simplified test procedures make use of the complex square wave and require fewer test instruments

By EUGENE J. THOMPSON

SQUARE-WAVE analysis is a comparatively new and more efficient method for determining frequency characteristics and certain other properties of electronic circuits. It is more rapid and requires less equipment than older test procedures. Although used chiefly for audio work, it has many other applications, some of which will be discussed in these articles.

Fig. 1 is a schematic of a general-purpose audio amplifier whose frequency response must be checked. This particular amplifier circuit is shown only for the purpose of illustration. All of the test procedures described in this article can be applied just as well to any other audio amplifier.

Fig. 2 shows the test setup for obtaining this information by the older *amplitude-vs-frequency* method. The output of the amplifier is measured with the v.t.v.m. and recorded on graph paper, while a series of signals of different frequencies but the same amplitude are fed into it. A response curve is drawn through the points marked on the graph paper, plotting the output amplitude against frequency (Fig. 3).

This curve indicates that the frequency response starts to drop off above 8,000 cycles. Therefore, the test must be repeated, stage by stage, and new curves drawn up, to determine the stage or stages at fault. The circuit constants for that stage must then be changed, and the entire test procedure repeated after each substitution until a satisfactory response curve is obtained.

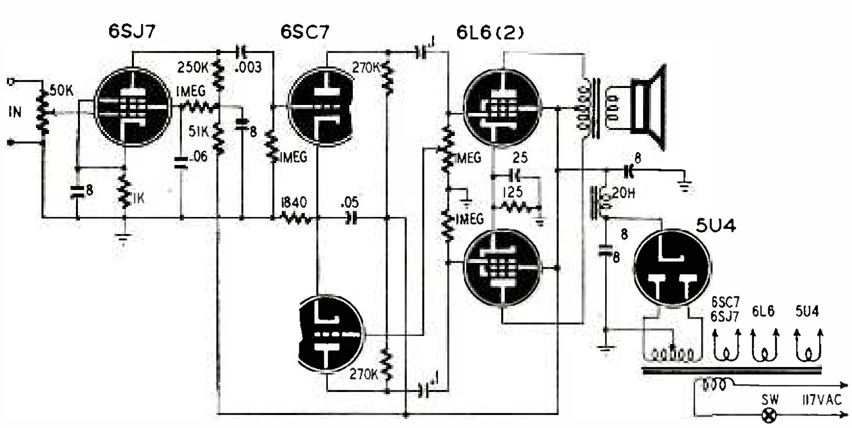


Fig. 1—Circuit of the audio amplifier to be checked with square-wave analysis.

Because of the phase inversion which occurs when a signal passes through an odd number of stages, the output of the signal generator must be absolutely sinusoidal when using this method. The reason for this is that the v.t.v.m. records the amplitude of only the positive half-cycle of the input or output signals; and if both half-cycles are not perfectly symmetrical, the amplitude measurements are erroneous.

The frequency response can also be determined by measuring the *phase shift* which a signal undergoes in passing through the amplifier. The testing arrangement is illustrated in Fig. 4. This method is more sensitive than the previous one because even minute changes in amplitude are accompanied by large shifts in phase. The test procedure is the same as that for the amplitude-vs-frequency method except that the input and output signals are compared as to phase by applying them to the vertical and horizontal plates of a cathode-ray oscilloscope. Depending upon the degree of phase shift, the resulting pattern, called a Lissajou figure, will be a straight line, a circle, or an ellipse, as shown in Fig. 5. The phase shift may be estimated from the shape of the figure, but is best calculated from the formula, $\varnothing = 2 \tan^{-1} (b/a)$, where $\varnothing$ is the phase-shift angle in degrees, b is the length of the shorter axis, and a is the length of the longer axis. See Fig. 5 for an illustration of axes a and b.

As an example, in Fig. 6, the short axis b is 6 units long and the long axis a is 10 units long. Therefore, $b/a = 6/10 = 0.6$. Looking in a table of tangents to find the angle whose tangent is 0.6000, we find that the closest one is 0.6009, which is the tangent of 31 degrees or 149 degrees. Multiplying these angles by 2 as the formula states, the phase shift is $31 \times 2 = 62$ degrees or $149 \times 2 = 298$ degrees. To determine which of the two is the correct phase

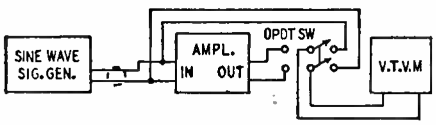


Fig. 2—Test setup for frequency check.

angle, note that the Lissajou figure in Fig. 6 is tipped over to the left. Hence, the phase shift is approximately 62°. Had it been tipped over to the right, the phase angle would be about 298°.

The calculation is made for every frequency fed into the amplifier, from 500 to 15,000 cycles. However, in drawing up the response curve, phase shift, instead of amplitude, is plotted against frequency. If the curve is not sufficiently flat, the faulty stage or stages must be located by point-to-point testing, substitutions made, and the entire procedure repeated as before.

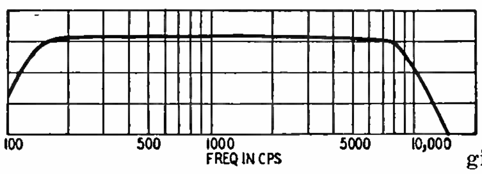


Fig. 3—Response curve of the amplifier.

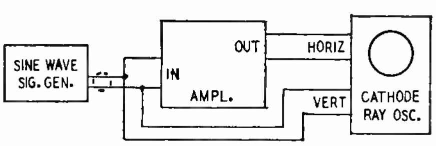


Fig. 4—Hookup for phase shift check.

Compared to these procedures, square-wave analysis (Fig. 7) is simplicity itself. To apply it, set the fundamental frequency of the square-wave generator at 500 cycles. The input signal to the amplifier is viewed on the wideband oscilloscope to make sure that it is square. A slight adjustment in the coupling capacitor between the generator and the amplifier input may be necessary to compensate for loading effects which distort the square wave-shape. The scope is then switched to the output of the amplifier and the waveform viewed to see if it is square. If it is, the frequency response is satisfactory from 500 to 15,000 cycles. If the output waveform is distorted, the amplifier needs adjustment. The scope is then switched to the output of the next to the last stage, then the stage before that, and so on, until the wave-shape becomes square. This localizes the difficulty to the following stage.

Adjustments are made in the amplifier until the waveform assumes a square shape. The amplifier is then passing all frequencies between 500 and 15,000 cycles. There are no multiple-frequency checks, no calculations, and no curves to be drawn!

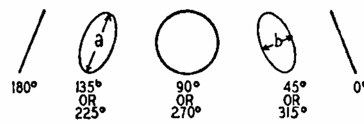


Fig. 5—The patterns show phase shift.

Strangely enough, square-wave analysis is so simple because square waves are so complex. Theoretically, a square wave is the algebraic sum of a fundamental frequency and an infinite number of its harmonics, all sinusoidal in shape and all having a common time of origin. In practice, however, the 30th harmonic is the highest order of sufficient amplitude to be of consequence. Fig. 8 suggests how the fundamental and its harmonics combine to produce a square wave by flattening the top and steepening the sides of the original sinusoidal waveform.

Not all square waves are alike. They may differ in period or repetition rate, frequency, amplitude, and percentage width. The *period* or *repetition rate* is the reciprocal of the frequency of the fundamental and is defined as the time between the beginning of any two successive pulses. The time duration of the pulse t_1 is called the *pulse width*. These characteristics of the square wave are illustrated in Fig. 9.

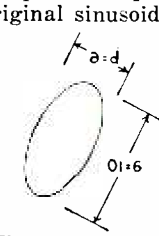


Fig. 6—b/a is tangent of angle.

The ratio of the pulse width t_1 to the period t, when multiplied by 100, is known as the *percentage width:* $t_1/t \times 100$ = percentage width. The percentage width depends upon the harmonic content of the particular square wave. It is possible to prove this by a complex mathematical procedure known as a Fourier expansion. This operation is used to analyze complex wave-shapes and to determine the amplitudes and natures of their components. A tabulation of the amplitudes of the fundamental and all its harmonics up to the 30th of square waves

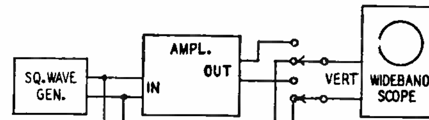


Fig. 7—Square wave amplifier check.

of different percentage widths is given in the table of square-wave components. This table lists percentage widths in steps of 10%, from 10% to 90%. The figures in it were obtained by using a Fourier expansion.

The next and concluding article of this series will describe various types of circuits for producing square waves and the practical applications of square-wave analysis.

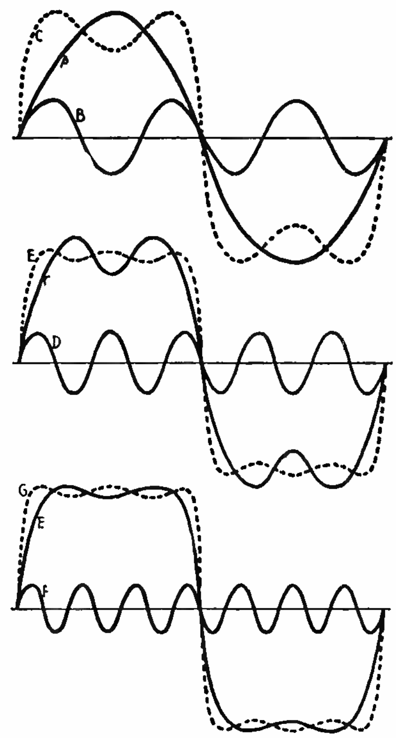


Fig. 8—These curves indicate how the harmonics add to form the square wave.

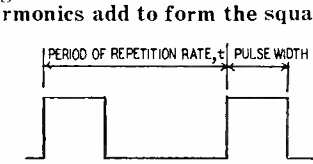


Fig. 9—Square wave time definitions.

SQUARE-WAVE COMPONENT TABLE

Percentage width	Harmonic 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
10% or 90%*	.20	.19	.17	.15	.13	.10	.07	.05	.02	0	-.02	-.03	-.04	-.04	-.04
20% or 80%*	.37	.30	.20	.09	0	-.06	-.09	-.08	-.04	-0	.03	.05	.03	.03	0
30% or 70%*	.52	.30	.07	-.09	-.13	-.06	.03	.08	.06	0	-.05	-.05	-.02	.03	.04
40% or 60%*	.61	.19	-.13	-.15	0	.10	.05	-.05	-.07	0	.06	.03	-.03	-.04	0
50%	.64	0	-.21	0	.13	0	-.09	0	.07	0	-.06	0	.05	0	-.04

Percentage width	Harmonic 16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
10% or 90%*	-.04	-.03	-.02	-.01	0	.01	.02	.02	.03	.03	.02	.02	.01	.01	0
20% or 80%*	-.02	-.04	-.03	-.02	0	.02	.03	.03	.02	0	-.01	-.02	-.02	-.01	0
30% or 70%*	.02	-.01	-.03	-.03	0	.02	.03	.01	-.02	-.03	-.01	.01	.02	.02	0
40% or 60%*	.04	.02	-.02	-.03	0	.03	.02	-.02	-.03	0	.02	.01	-.01	-.02	0
50%	0	.04	0	-.03	0	.03	0	-.03	0	.03	0	-.02	0	.02	0

*Reverse signs given in table for pulse percentages over 50%

The author (rear left) gives weekly instruction to a naval reserve unit, whose members later applied their training on the Murmansk run and in the Pacific.

Code teaching experience of the author has led to a break-down of the code that makes learning easy

Seven Basic Steps To Learn The Code

By SAMUEL FREEDMAN

THIRTY years ago I learned the continental or international code. Since that time, I have been rated on sounder or buzzer or on actual signals at such typical speeds as 38 words per minute for coded material containing many consonants and 55 words per minute for plain language containing many vowels.

I have repeatedly seen men flunk their code tests for amateur radio license even though they definitely were able to copy well in excess of the required speed (13 words per minute) before reporting for FCC examination. The reason is always the same: over-practice in the letters which appear most often in common English, such as newspaper text. These letters generally have the simplest and shortest dot-and-dash combinations to remember. The most practice is needed in these letters which appear least often in plain English text and which have the more complex or longer dot-and-dash combinations.

This very thing which flunks them is just what makes possible the art of cryptography or the breaking down of a coded message. For example, the letter E appears 128 times more frequently than the letter Q in English. The letter E is one dot and very easy to remember as well as quick to transmit. The letter Q is dash-dash-dot-dash, which is more difficult to remember and actually requires about 13 times longer to transmit or receive than the letter E.

Telegraphy appears either easy or difficult to master, depending on the student's viewpoint and introduction. The difficult approach is to say that learning the code is equivalent to learning a foreign language. *But*, where could a student ever hope to find a language that contained only 26 symbols to learn, plus 10 numerals and a few punctuation marks and procedure signals? The English language has approximately 380,000 words in its vocabulary. The language of the code has only 40 to 50 characters. (The higher figure includes abbreviations and foreign accented letters not used in English.) Knowing these 40 to 50 characters, the telegrapher can converse with no trace of accent or eccentricity with a telegrapher of any other nation in the world, whether German, Japanese, Scandinavian, Russian, South American, or anyone else. Even an infant can learn that many words or details in its repertoire.

The telegraph code as required for radio license and radio telegraphy throughout the world is made up entirely of dots and dashes. The dots are called or sounded like "dits" and the dashes each sound like "dah". The letter A sounds dit-dah; B, dah-dit-dit-dit; etc.

Telegraphy code units

The *dot* is the unit of size. The time required to send a dot regulates the length of the dash and the interval spacings. The over-all code speed is dependent on the size of the dot used. A short dot is therefore associated with a high telegraphic speed while a longer dot is associated with a reduced telegraphic speed.

The *dash* is three times longer in duration than the dot.

The *space* between dots, or dashes, or dots and dashes, within a single letter is usually said to be the duration of one dot. It should be long enough to make the separation obvious but not long enough to make it appear detached in the letter being formed. For example, A is dot-dash (sounded dit-dah). If the interval between the dot and dash is too long, the listener will think it is a letter of one dot (E) plus another letter of one dash (T).

The spaces between letters or numerals should be equal to a dash or three dots in duration. In practice, it may be a little more for beginners learning the code and a little less for speed demons trying to get maximum code speed.

The spaces between words should be equal to about five dots (more or less, as in the case above).

Just as a typewriter has the most commonly used letters conveniently located, so does the telegraph code have the more commonly used letters (based on all languages rather than on the English language alone) provided with the shortest dot and dash combinations. It is done to save time in transmission. Whether by design or by accident, the fact remains that the letters used least often in the common languages of the world have the longer combinations of dots and dashes while those used the most often (particularly some of the vowels) have the shortest combinations. If one were to catalogue the letters of all the words in a lengthy normal

(*Continued on page* 56)

newspaper article, it would average up approximately as indicated below.

LETTER	FREQUENCY PER THOUSAND LETTERS	MAKEUP	TIME REQUIRED TO HANDLE (Dot Units)
E	128	· dit	1
T	86	– dah	3
O	81	––– dah-dah-dah	11
A	78	·– dit-dah	5
N	69	–· dah-dit	5
I	68	·· dit-dit	3
R	65	·–· dit-dah-dit	7
S	62	··· dit-dit-dit	5
H	60	···· dit-dit-dit-dit	7
D	40	–·· dah-dit-dit	7
L	37	·–·· dit-dah-dit-dit	9
U	31	··– dit-dit-dah	7
C	30	–·–· dah-dit-dah-dit	11
M	29	–– dah-dah	7
P	22	·––· dit-dah-dah-dit	11
F	20	··–· dit-dit-dah-dit	9
Y	19	–·–– dah-dit-dah-dah	13
W	18	·–– dit-dah-dah	9
G	17	––· dah-dah-dit	9
B	14	–··· dah-dit-dit-dit	9
V	11	···– dit-dit-dit-dah	9
K	8	–·– dah-dit-dah	9
J	5	·––– dit-dah-dah-dah	13
X	3	–··– dah-dit-dit-dah	11
Z	2	––·· dah-dah-dit-dit	11
Q	1	––·– dah-dah-dit-dah	13

The letters which are among the ten lowest in frequency while at the same time being among the fifteen requiring the longest time to transmit are Q, Z, X, J, K, V, B, G, W, and Y. *They should be given heavy inclusion in practice texts for code instruction.*

The letters which are among the ten highest in frequency of occurrence and among the fifteen requiring the shortest time to transmit—are least complex in makeup—are E, T, A, N, I, R, S, H, D, and O. *These should get lighter treatment* in practice texts. The remaining letters C, P, L, F, U, and M should get moderate inclusion.

Numerals are very easy to remember because they follow a simple pattern of construction, but are confusing when used in a mixed text of letters and numerals. Use heavy practice texts of mixed letters and numerals, particularly consonants or low-frequency letters with the numerals. Table 1 lists the code classifications as used in the continental code throughout the world.

The Seven Steps

Starting with no knowledge of the code, it can be learned in a series of steps. An hour of instruction (plus the review of previously studied steps) should cover each step until all have been covered and reviewed. Thereafter, the student should work the entire code on lengthy practice texts made up of a small amount of plain language, a medium amount of coded texts, *and a large amount of mixed letters and numeral groups.* The usual practice is to use five-character groups although deviations from this are permissible and even desirable for part of the practice.

1. Dots alone and dashes alone

(total 7 letters)

· (dit) E
·· (dit-dit) I
··· (dit-dit-dit) S
···· (dit-dit-dit-dit) H
– (dah) T
–– (dah-dah) M
––– (dah-dah-dah) O

Practice Text:

SHIEH TOTOM TOMME ESEIS OMTTO
TIEHO IEHSI MTMOO HESMT SISHE
MOOTM MOHSI SSHIE TOMMO SITOH
SEHIS OTMTO EMOTS IHSEH OTOMT
IHMTO ISEHS MMTOT OSHOM OHETE
ETIES EIHIH MTMMT ISMIH EHIES
SHIEM EHTHI.

The above text has averaged groups of dots alone, dashes alone, and of dots and dashes together.

2. Combination dot-dash letters

Plus those in step 1 (total 12 letters).

·– (dit-dah) A
··– (dit-dit-dah) U
···– (dit-dit-dit-dah) V
·– (dit-dah) A
·–– (dit-dah-dah) W
·––– (dit-dah-dah-dah) J

Practice Text:

VAUJW JTEMU AVJJU EIJWJ WUAVJ
IMVJW UAVJV WEMAV JWUWA VSTUM
JVWAV SASVA UAJVW HVITO WUAAU
UWHOH AWVWJ TJOST VJWUA AHUIS
OUAHE MOWEI AOHMW TEJAU.

3. Combination dash-dot letters

Plus those in steps 1 and 2 (total 16 letters).

–· (dah-dit) N
–·· (dah-dit-dit) D
–··· (dah-dit-dit-dit) B
–· (dah-dit) N
––· (dah-dah-dit) G

Practice Text:

NGBDG JNDWB BNDNB VGUEA DGBDB
MIOST HBNWM GNDBN DEHAV BDGGD
UJTIS GOAWU NBNND VJMHG BNSTI
DNGBG DIHOA UWSEG GBNDG EDMTN
WJETS INBJG AWMDO GBJND.

4. Combination dot-dash-dot letters

Plus those in steps 1 to 3 inclusive (total 20 letters).

·–· (dit-dah-dit) R
·–·· (dit-dah-dit-dit) L
··–· (dit-dit-dah-dit) F
·––· (dit-dah-dah-dit) P

Practice Text:

F[illegible]PRR JLETM LFRPL VRWHI FAUSP
[illegible]RFLP NPBGO LESTI RPLFF RMVJN
RRPLF GBPDF WAOUL LPFRL VRWLJ
MALHU PFRPL DJBIG FRLPF BREPL.

5. Combination dash-dot-dash letters

Plus rest of alphabet steps 1 to 4, inclusive (total 26 letters).

–·– (dah-dit-dah) K
–··– (dah-dit-dit-dah) X
–·–– (dah-dit-dah-dah) Y
–·–· (dah-dit-dah-dit) C
––·· (dah-dah-dit-dit) Z
––·– (dah-dah-dit-dah) Q

Practice Text:

This practice text material heeds the frequency table but favors the lower-frequency letters with the longer and more complex makeups.

HNRVQ JYQPC MXZWF LOSER GAITU
DUNCE BEAST WOMAN KGFHK LONEC
BJQYX UNITE DBQVZ HURTS PURER
FOUND GLADY JINXY COMET SVQZK
PFGBH LIVID WALKS YOUNG QUACK
BFHMJ QPXZJ RAILS XHPYC MVZYQ
WBDFE GHJIK NMLOP QTVZW XJLRT
VZYKG CHIMP BEDOX FQWCY JQCYZ

6. Numerals

·–––– (dit-dah-dah-dah-dah) 1
··––– (dit-dit-dah-dah-dah) 2
···–– (dit-dit-dit-dah-dah) 3
····– (dit-dit-dit-dit-dah) 4
····· (dit-dit-dit-dit-dit) 5
–···· (dah-dit-dit-dit-dit) 6
––··· (dah-dah-dit-dit-dit) 7
–––·· (dah-dah-dah-dit-dit) 8
––––· (dah-dah-dah-dah-dit) 9
––––– (dah-dah-dah-dah-dah) 0

Numerals are easy to learn by themselves since they follow a simple and obvious pattern. The number 1 has one dot and four dashes; 2 has one more dot and one less dash, etc. By the time 5 is reached, all the dashes have been used and the number is all dots. Then the reverse takes place: 6 is one dash and four dots; 7 is one more dash and one less dot. By the time zero (after 9) has been reached, the character is all dashes. In practice, a very long dash is sometimes sent instead of five dashes for the numeral zero (although this is not theoretically correct). In every case, a numeral has five dots or dashes or combination of the two. To avoid confusion between letter "O" and numeral "O" (zero), it is customary to indicate zero with a slant, thus "Ø", when used in mixed makeups of letters and numerals.

Practice Text:

15643 Ø5876 29842 317Ø5 96318 27Ø27 4Ø194
58623 61738 59Ø54 81369 45Ø95 5Ø713 83716
24892 32685 7865Ø 491Ø4 34651 72Ø72 53641
5Ø768 48922 17Ø35 68139 7Ø227 4Ø491 85632
78613 Ø9554 84582 37437 21455 26359 15Ø34
28942 69119 85Ø57 43217 95281

7. Mixed letters and numerals

(26 letters and 10 numerals)

Practice Texts: These should be made up in random combinations of letters alone, numerals alone, and letters and numerals, but in every case should be so averaged as to give equal familiarity with all letters and numerals. It is also desirable to favor the harder-to-remember combinations in the ratio of three to two or even two to one. Typical examples are:

B6 H5 SI QY CK WJ 4V X7 82 OØ DA E3
Z1 UT FM GL RP N9 CBØ DG5 JP2 E4A
3VK FH6 IS9 MLQ WXY UZ1 87Ø NRT X4UD
YQ6J VLNP RCA7 KOTE GFH3 IMOS BW5Z
2189 JA5U8 YP21C FNQ9L 4RKHT SIOMW
BG4D7 X6JVE 3ZCJQ ZXKØ5

Do not worry about learning plain language texts. That will be acquired automatically with the use of coded or cipher text material.

General rules to remember

1. Frequent short practice periods are much better than infrequent long practice periods. Daily periods of 30 minutes each are many times more effective than 7 hours once a week.

2. Skip about the alphabet rather than using alphabetical or numeral sequences.

3. Memorize each letter and numeral as an audible dit or dah combination. Do not make things hard for yourself by going through a double conversion (visual conception as laid out on paper and aural conception as it is heard on headphones or from a buzzer).

4. When two persons are practicing, the one doing the sending will be less competent than the one doing the receiving. Receiving should be 90% (not 50%) in acquiring a knowledge of the code. It is always easy to learn how to send if you know the code and can receive it.

5. Plain language text does not make for good instruction. It is too easy to guess missing letters or the last part of words.

6. In sending practice, make sure that parts of a letter are not disengaged. Do not separate the dash from the three dots in B so it sounds like T and S. Likewise, do not let C sound like

NN, F like IN, Q like MA, V like ST, X like TU, Y like NM or TW, G like ME, J like AM, L like AI, P like AN, U like IT, or Z like MI. This *always* happens during initial code instruction and must be avoided by proper formation and spacing of the characters.

7. *Win the battle!* Don't linger or ponder when one letter is missed. Leave a blank space and *keep going.* Otherwise you get out of the groove and lose a whole chunk of text before being able to resume again. *Stay in the groove* even if you miss an occasional letter.

8. You have not really learned the code until you can hold part of it in your mind and copy behind. I, like other professional telegraphers, can stay several words behind on plain language and a word or two behind on code and cipher. This ability is very useful so a man can light a pipe or cigarette while telegraphing, hop over to the water cooler for a cold drink, or munch a sandwich while on watch if no relief is available and traffic will not end. At speeds of 25 words per minute or less this is not too difficult.

9. Too slow telegraphing will put anyone to sleep. Regardless of code speed ability, *make the characters fairly fast* and allow any length interval between letters and words that may be necessary. In the beginning the interval will be long. Later this is reduced until it becomes normal or the minimum necessary to permit intelligible reception. Make your characters smart and sharp. Make A as "dit-dah" not "deeeeeeeeet-dahhhhhhhhhhhhhhhhhh".

10. Speed is a very relative thing. It depends largely on the exact letters used to make up the words. Letters made up of several dashes are going to come through much slower than those made up of few dots. It takes 13 times longer to handle Y, J, or Q than it does E. Raise your speed on an average of all characters used to make up five-word groups. If you base it on newspaper text, chop off a third of the computed speed.

How elaborate or modest the equipment for code practice happens to be has little importance so long as the equivalent of a key and buzzer is available. Even prisoners can telegraph prison-wide with surprising efficiency by use of the "Devil's Island" code which may be transmitted by tapping on conducting metal. They simulate dashes by the use of two dots run closely together. B for example is tapped "dit-dit dit dit dit".

The advantage of code is the ease in which intelligence can be conveyed without a specially provided modulation system, making possible the simplest form of radio transmitter. It provides intelligibility under conditions that are unfavorable for voice (conditions of static, signal fluctuations, etc.).

Above all, code is necessary to qualify for an amateur radio license or for any position involving radiotelegraphic operation. All of radio and electronics and much of nucleonics was founded on offshoots of the radiotelegraphic art. Telegraphy will be with us a long time professionally and forever as a hobby.

TABLE I

CLASSIFICATION OF THE CONTINENTAL CODE.

DOTS ONLY

.	E
..	I
...	S
....	H
.....	5

DASHES ONLY

-	T
--	M
---	O
----	CH
----	Zero

NUMERALS

.----	1
..---	2
...--	3
....-	4
.....	5
-....	6
--...	7
---..	8
----.	9
-----	0

DOT-DASH

.-	A
..-	U
...-	V
....-	4
.-	A
.--	W
.---	J
.----	1
.-.	R
.-..	L
.-...	Wait
..-.	F
.--.	P

DASH-DOT

-.	N
-..	D
-...	B
-....	6
-.	N
--.	G
---.	(disregard signal)
----.	9
-.-	K
-..-	X
-...-	Break, equal sign or separation
-....-	Hyphen
-.-.	C
-.--	Y
--.-	Q
--..	Z

ABBREVIATIONS (TYPICAL)

HL	(Hasta Luego. Spanish So Long).
AW	(Auf Weidersehen German).
GM	Good morning.
GN	Good night.
GB	Goodbye.
OM	Old man.
73	Best regards.
88	Love and kisses.
TMW	Tomorrow.
CUL	See you later.
N	No or negative.
Y	Yes or affirmative.
R	Received and understood.
TU	Thank you.
SVC	A service message.

Many other clever abbreviations exist including mischievous and profane.

MISCELLANEOUS

-.-	K or go ahead and send.
.-...	Wait or stop sending.
-.-.-	Starting signal.
----	German dual letter CH.
..-..	French accented letter é.
..--	German accented letter ü.
--.--	Spanish accented letter ñ.
....	Error signal. Start word again.
.-.-.	End of a message.
...-.-	End of entire transmission.
---.	Dutch accented letter ö.
.-.-	Scandinavian accented letter ä.
.--.-	French accented letter á.
-.--.-	Parenthesis sign. One each end.
.-..-.	Quotation mark sign. One each end.
-..-.	Fraction mark or slant sign.
...-..-	SX or dollar sign.
.-..	L or English pound (sterling) sign.

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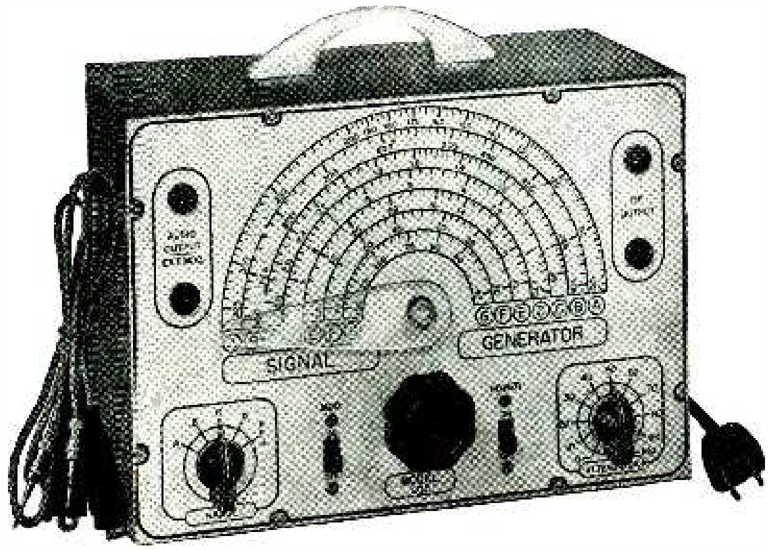

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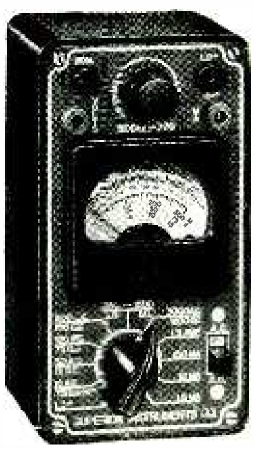

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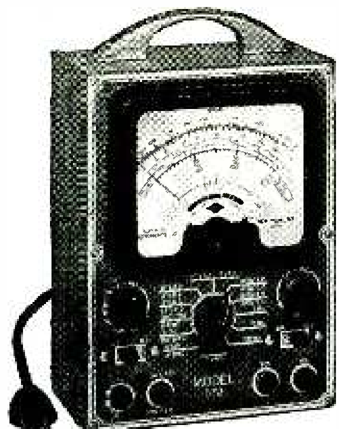

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BRITISH TEST AM AND FM FOR HI-FI BROADCASTING

By R. W. HALLOWS

THOUGH Britain has not yet a nation-wide v.h.f. high-fidelity service, do not think we are doing nothing in the way of FM—and wideband AM too. At the moment there are two brakes on the wheels of progress in high-fidelity transmission: the B.B.C. (quite rightly) regards the provision of a nationwide television service as top priority and spends the bulk of its available money on that; and owing to our need to export all that we can, electrical and radio equipment is in short supply.

There is also a third reason of no small importance. There are no politics behind FM here and, having been subjected to no propaganda drives, we can take an entirely dispassionate view of the claims made for it. Experts in this country are by no means convinced that wideband AM can't do everything that FM can—and do it rather better.

At the moment our only FM broadcast transmitter is at the Alexandra Palace, on the outskirts of London, which is also the home of the metropolitan TV station. This radiates items of various broadcast-band programs from 11 am till noon, from 2.30 to 4.30 pm and from 6 pm until about 11.30 pm. All times are GMT. The carrier frequency is 90.3 mc, the deviation ±75kc, and the modulator characteristic almost flat up to 12 kc.

Other details are: power output 0.5 kw; polarization, vertical; antenna, a dipole near the top of the Alexandra Palace TV mast. The service area of this small station is remarkably large, consistently good reception being obtained in places up to 80 miles distant.

This transmitter, however, is a mere stop-gap. A twin AM and FM station is now being built at Wrotham some 15 miles south of London. From this the same programs will be radiated simultaneously by a 25-kw FM transmitter and an 18-kw AM transmitter. A number of observers will be appointed in various parts of a wide area. These will render reports showing which of the two systems regularly gives them the better results. Future high-fidelity policy will be based on the outcome of these powerful experimental transmissions.

What it boils down to is that Britain will have within the next 5 years a country-wide high-fidelity service with a modulation frequency range of not less than 12-15 kc. The results of practical experience under conditions devoid of pro-AM or pro-FM propaganda should be of value not only to us but to the rest of the world as well, for they will give an unbiased answer to the exceedingly vexed AM versus FM question.

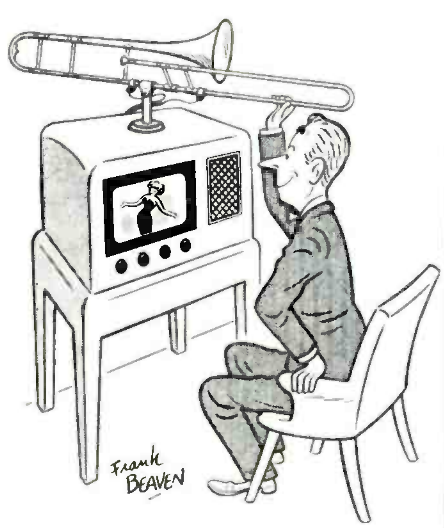
Meantime, neither FM nor any other kind of high-fidelity broadcasting mean very much to John Bull and his wife, for the simple reason that they have never had any opportunity of hearing really wideband reproduction and judging for themselves what it can do.

The sound which accompanies the London TV transmissions is genuine high-fidelity stuff; but, since manufacturers have long been vying with one another to produce cheaper televisers, few receivers outside the luxury class can do anything like justice to it.

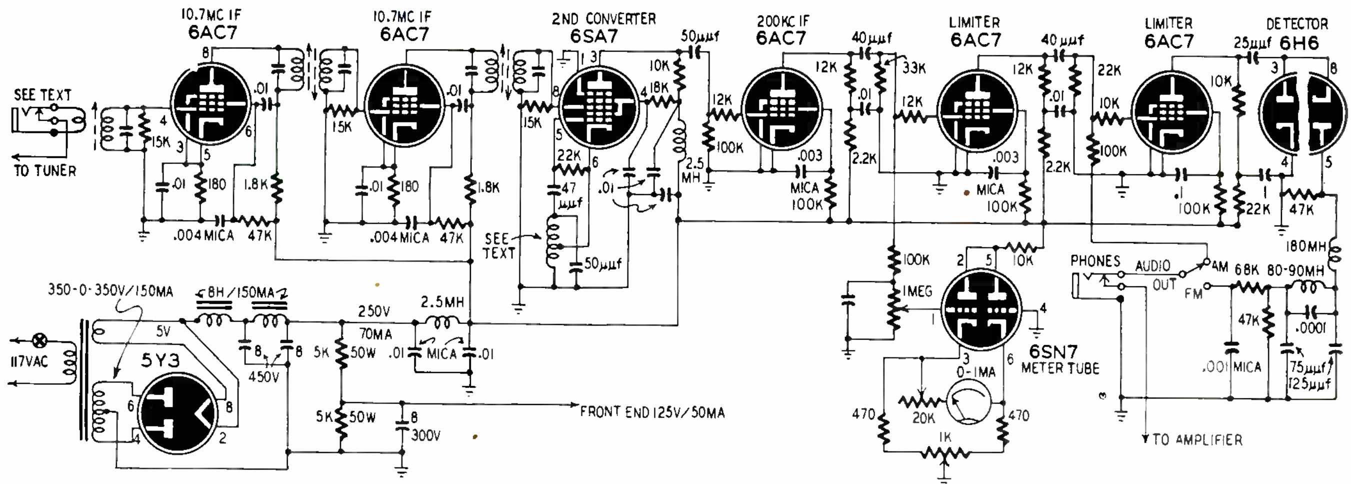
As for FM, I know hardly any radio receiver made in this country, outside the super-super-luxury class, which can be switched over to deal with this kind of modulation. FM reception is thus almost entirely confined at present to radio engineers engaged in experiments and to a comparatively small band of hams who have built their own sets. There will probably be a big change when the Wrotham stations get going, for manufacturers will quickly wake up to the powerful selling points offered by high-fidelity radio.

There are some who hold that the task of the manufacturers won't be an easy one. The public, they say, has become so used to the 4.5 kc modulation bandwidth (European channels are 9 kc apart) that it wants nothing better. That's not my view. I believe that, whether we eventually decide on AM or FM for our v.h.f. fidelity service, the new standards of reception made possible will have an even more popular welcome than that accorded five and twenty years ago to the then new kind of phonograph records, when electrical recording and reproduction began to replace the original mechanical methods.

Whichever is decided on, we feel certain it will be the best and most practical for our needs. In the meantime we can't get much in the way of good high-fidelity radio equipment at reasonable prices anyway. This, rather than being a drawback,—even though we would like to get started—gives us at least some assurance that care will be taken in the final decision, and it will be based on several years of actual field tests.



Suggested by Angelo Manuri, Marseilles, Ill.



Schematic of the supersensitive i.f. amplifier. The power supply (on a separate chassis) also supplies the front end.

Supersensitive FM I. F. Unit

By JOSEPH MARSHALL

THE QTH here is in the mountains of Tennessee, 50 airline miles from Knoxville, 65 from Chattanooga, 120 from Nashville, and more than 150 from Atlanta and Louisville. The elevation of 1,700 feet increases the effective antenna height and the theoretical line of sight greatly.

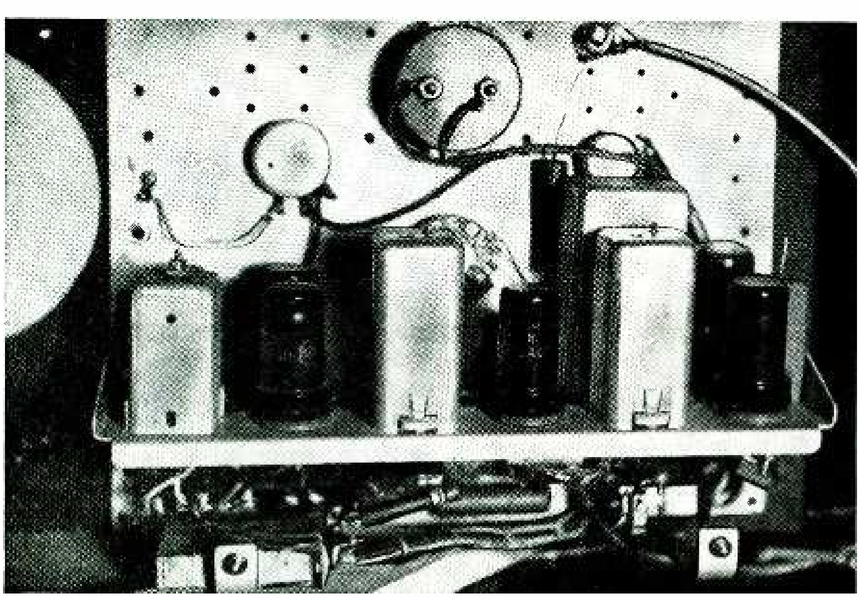
On the other hand, the site is the bottom of a bowl, surrounded within 4 miles in every direction by mountains 500 to 1,000 feet higher which definitely put the location out of direct line of sight. The house is on the reverse slope of a mountain in the immediate shadow of a mountain to the west and north; finally, it is in the middle of a forest where any antenna lower than 70 feet is screened by trees in every direction. In short, with the exception of the elevation, the site has almost everything against it for receiving v.h.f. dx.

Satisfactory reception was possible only from the Knoxville stations with a good commercial FM receiver; signals from more distant points were too far down in the noise for entertainment value. It was obvious that satisfactory reception of FM stations would require something heroic in the way of a receiver—an outfit which would provide full limiting on input signals of 5 microvolts or less.

Disregarding the antenna, the problem had two parts. The first was to provide an i.f. amplifier capable of very high gain; the second, to provide an r.f. front end with the best possible signal-to-noise ratio or noise figure. The r.f. front end was described in the June issue of RADIO-ELECTRONICS; the i.f. amplifier is described here.

This amplifier being an independent unit, it can not only be used for FM reception but also makes an ideal i.f. channel for v.h.f. ham-band receivers with separate converters for the various bands. It provides for AM as well as FM reception at the turn of a switch. Aside from its extreme sensitivity, the amplifier has other qualities to recommend it. It is very simple to align; it uses a frequency-counting detector which is linear and free of distortion; the detector is very unresponsive to AM and therefore has good noise-suppression characteristics; the receiver can be tuned by ear with good results—in fact, it is no more difficult to tune correctly than an AM broadcast receiver.

The design, while novel, is not as complicated as a casual glance at the diagram might indicate, and has no critical elements. If the design is followed exactly, it should give no trouble in adjustment or operation. The i.f., with a front end, constitutes a double superheterodyne with two high-gain i.f. stages at 10.7 mc, followed by a second converter which converts the signal to 200 kc. This is followed by one resistance-couple stage at 200 kc, then by two cascaded limiters and a frequency-counting detector.* This detector has exceptionally low distortion.



The 200-kc channel is next to the panel, 10.7-mc channel is on rear of chassis.

The i.f. stages

The input to the amplifier is link-coupled. The front end is connected to the input through a length of coaxial cable; and a circuit-opening phone jack on the panel connects the amplifier with

*This circuit was first developed by W. W. Moe, W1JKC (QST—Sept. 1946).

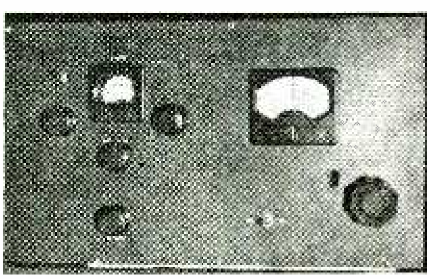
other front ends—insertion of a plug disconnects the FM input.

This type of input makes the i.f. amplifier an independent unit and improves the over-all performance. At v.h.f. frequencies, the connection from the converter plate to the input transformer should be critically dimensioned. On the other hand, it is difficult to lay out a receiver, even on a single chassis, so that the input transformer is close enough to both the converter plate and the first i.f. grid for best performance at both r.f. and i.f. frequencies. With link coupling, the layout can be arranged for optimum performance.

The input transformer is a homemade job, using a surplus slug-tuned form and a small shield can. A commercial i.f. transformer, especially the midget type, is easily modified for link-coupling and the small investment would avoid a great deal of uncertainty and adjustment.

To modify a commercial i.f. transformer, remove the shield can and disconnect the primary coil and capacitor—or remove them entirely. Wind about 4 turns of No. 28 enamel wire just below the ground end of the grid coil, and connect the two ends to the terminals formerly used for the primary winding. The i.f. transformer for the front end is treated similarly, except that the secondary is disconnected and the link is wound just below the B-plus end of the plate coil.

The layout for the amplifier is uncritical except for the usual precautions



Front panel of the complete receiver.

against instability in the 10.7-mc channel. The stages can be put in line or doubled back as in this case. A 7x17-inch chassis would line up the various stages in line and leave room for a power supply or a.f. amplifiers, or both. This model was built on a surplus servo-amplifier chassis because its over-all shield promised more complete isolation. Although the chassis is crowded, there was no difficulty with stability.

The i.f. transformers and the tube sockets are mounted and oriented to have the plate and grid leads 1 inch or less long and on opposite sides of the sockets. The transformers are placed between the tubes to provide short leads and shielding as well. The .01-μf bypass capacitors have leads ½ inch long. With such leads they resonate at about 11 mc and greatly improve the bypassing action. The two 6AC7 tubes are neutralized by returning the plate bypass capacitor to the screen and then bypassing from there to ground with .004-μf mica capacitors. This forms

$1200.00 in prize money is being awarded in the RADIO-ELECTRONICS IN THE HOME contest. Any radio-electronic device that has potential use around the home is eligible for entry and may win a prize. The three best entries are selected each month. For details and rules of the contest, see page 35.

a bridge circuit which effectively neutralizes the plate-to-grid capacitance of the tubes and prevents feedback.

Loading resistors are used across the secondary windings of all transformers to widen the response curve. With these resistors the passband is better than 200 kc and the amplifier will reproduce 100% modulation of a 15,000-cycle tone without distortion. If the amplifier is to be used exclusively for ham-band communication, these resistors can be left out and there will be a considerable increase in the sharpness of tuning. In that case the passband is about 100 kc, which is just about right for ham-band use.

No gain control is used because in this remote location none was necessary. A cathode-bias gain control was tried and the photos show it. It was removed, because, if applied to one stage only, it modifies the response curve and increases distortion, especially on weak signals. If it is applied to both stages, it introduces feedback through common coupling. Where signals approach millivolt strength, it might be well to apply the control to the second stage to prevent overloading of the second converter. The effect on the quality of such strong signals will not be serious.

Second detector and limiter

The second converter is a 6SA7. The oscillator coil is a commercial iron-core item intended as replacement for shortwave receivers. The oscillator operates at 10.9 mc. The oscillator section should be shielded to keep the oscillator frequency from the front end and the previous i.f. stages. The coil should be in a shield, the leads very short and dressed close to the chassis. (A shielded compartment might be put around this converter section to isolate it from the others.) A choke in the plate circuit filters the frequency from the B-plus line, and a choke-capacitor filter is used where the B-plus lead enters the chassis since a separate power supply is used with this amplifier.

The 200-kc amplifier and limiters involve no trouble other than finding room for all the small components. The capacitors and resistors were mounted on a terminal board beforehand and then connected to the tube sockets. We were worried that such crowded placement might result in feedback, but had no trouble whatever. The plate bypass capacitor of the second limiter should be 1 μf or larger to insure proper low frequency response.

The frequency-counting detector is simple and involves no problems either in construction or adjustment. This type of detector is perhaps the most satisfactory of all FM detectors; it certainly has the lowest distortion. It is not used ordinarily because it operates only at frequencies of 200 kc or less. No adjustment is necessary to put it into operation. If there is trouble in getting proper FM detection, it probably will be found in the second limiter which is closely associated with the detector. Regeneration in the i.f. stages is most likely to account for any distortion either by producing too sharp a bandpass or an asymmetrical one. If there is no regeneration and the i.f. is aligned to provide a passband of 200 kc, there should be no trouble.

The detector is followed by an elaborate low-pass filter which attenuates all frequencies above 15,000 cycles. This was made from surplus iron-core coils, intended for low-frequency aircraft receivers, and mounted in a shield can. The filter is desirable when the amplifier is used with a very-wide-band, high-fidelity audio amplifier which may respond to the unfiltered r.f. and cause distortion by driving the audio tubes into the bends of their curves. It can be left out, however, and in that case the cathode resistor should be bypassed by a 0.1-μf capacitor.

The audio output is about 1 volt and can be connected to the crystal-phono input of any amplifier. A single stage or more of audio can be added if desired.

A 6SN7 is used as a meter tube. The circuit is the balanced type used in v.t.v.m.'s. The 1000-ohm potentiometer is for zero-setting. Although it is mounted on the panel in this amplifier, it can be placed on the chassis because it seldom needs readjustment. The meter sensitivity control can also be left out; it was included to provide a more versatile and accurate means of recording field strength of weak signals. The meter was calibrated with a calibrated signal generator, but for ordinary tuning it could be marked with arbitrary S units and tuned only for maximum deflection.

The meter is not necessary for tuning. This is a simple combination to tune correctly and can be tuned by ear alone. Since the detection does not depend on the response curve—as in other FM detectors—it is necessary only to tune for maximum signal or minimum distortion.

Aligning the amplifier

Alignment is no problem if the amplifier is not oscillating or regenerating. Set the oscillator at the second converter to 10.9 mc. This can be done simply by placing a shortwave receiver adjacent to the amplifier, tuning it to 10.9 mc, and then turning the slug on the 10.9-mc oscillator until the carrier is received on the receiver. Set a test oscillator to 10.7 mc, couple it to the link input with a small capacitor, and adjust the i.f. transformers for peak reading on the signal meter. If no signal meter is built in, a v.t.v.m. connected to the grid of the first limiter will serve; and if no v.t.v.m. is available, a microammeter can be put in series with the bottom end of the grid leak of the first limiter and ground; if no meter is available, the signal can be modulated with a tone and the i.f.'s adjusted for maximum volume of the tone. When the 10.7-mc channel is peaked carefully, the 10.9-mc oscillator can be retouched for a peak reading.

If the amplifier is not oscillating or regenerating, it is not necessary to use visual equipment for alignment, although those who have such equipment will find it useful in checking the symmetry of the response curve. The symmetry also can be checked with the signal meter and oscillator; detuning the oscillator on both sides should produce nearly exact deflection slopes on the meter.

Minor irregularities of the curve will not mar reception, though they may reduce sensitivity slightly. Any serious asymmetry or too sharp a bandpass will cause distortion in the FM position on the very high audio tones and the sibilants of voices. FM signals can be received in the AM position of the switch when the carrier is detuned to one side or other of the center. This is the result of slope detection.

The sensitivity of this amplifier alone is below 5 microvolts. Very little amplification is needed from a front end to get 1-microvolt sensitivity, although the best possible signal-to-noise ratio is more difficult to achieve. Any type of FM front end can be used with this amplifier.

The performance of this amplifier has been very satisfactory on FM and in brief tests, on the 50- and 140-mc ham bands. With the front end mentioned, regular reception with complete limiting includes FM stations in Knoxville, Chattanooga, Atlanta, Charlotte, and various intermediate cities; and almost every FM station within a radius of 250-300 miles has been logged at least once.

The amplifier has only one slight drawback. Despite the most heroic measures, one of the harmonics of the 10.9 oscillator appears in the tuning range at about 98 mc. The strength of this pickup is apparently in the order of 1 microvolt and is not serious. If this radiation should fall within a point in the band occupied by a station, the 10.9-mc oscillator frequency should be moved up or down to clear the channel. In that case the 10.7-mc channel will require slight retuning. However, the pickup is not great enough to cause any other interference and it is a slight price to pay for the many benefits.

The FM tuner made up of this i.f. amplifier and the front end described in the June issue not only has an unusually high sensitivity and very low noise, but very good frequency response and low distortion are also claimed for it. For this reason it is recommended that it be used with high-fidelity audio equipment.

Materials for i.f. amplifier

Resistors: 2—180, 2—470, 1—1800, 1—2,200, 4—10,000, 4—12,000, 3—15,000, 1—18,000, 3—22,000, 1—33,000, 4—47,000, 1—68,000, 6—100,000 ohms, 1/2 watt; 2—5,000 ohms, 50 watts, wire-wound; 1—1,000, 1—20,000 ohms, 1—1-megohm potentiometers.

Capacitors: 1—.000025, 2—.000040, 1—.000047, 2—.000050, 1—.000075, 1—.000100, 1—.000125, 1—.001, 2—.003, 2—.004, 2—.01 μf mica; 9—.01, 2—0.1 μf, 250 vlts paper; 1—1.0-μf bathtub type; 3—8 μf, 450 volts, electrolytic.

Transformers and chokes: 3—10.7-mc i.f. transformers; 1—5.3-16.5-mc oscillator coil; 1—80, 1—180-mh choke; 1—2.5-mh r.f. choke; 2—8-h, 150-ma filter chokes; 1—350-0-350 volts at 150 ma power transformer.

Miscellaneous: 5—6AC7, 1—6SA7, 1— 6SN7, 1—6H6, 1—5Y3 tube types; switches, sockets, Jacks, chassis, and hookup wire.

Electronic cribbing was reported last month by a school inspector in Turin, Italy, when he caught two students using a walkie-talkie during exams. One had concealed a small transmitter in a plaster cast on his left arm, and the other had a receiver hidden in a bandage around his head.

An Economy-Size Code Set for the Beginner

Variable pitch and loudspeaker operation make this an efficient practice oscillator

By HAROLD GOULD

WITH the amateur radio world going through a stage where more people want to get into the act, many would-be hams are applying themselves to learning the code. To get the most out of code practice, the newcomer needs a source of audio-frequency power that will produce clear signals.

Pictured in the photos is a unit that makes for efficient code practice. This oscillator has stability and puts out a clear note with adjustable pitch. It provides for speaker operation. Using it, the instructor can illustrate his talk with actual demonstrations untrammeled by headphone cords or headbands.

With the easily accessible terminal strip the operator can cut the speaker out of the circuit, hook in headphones, or combine them with a remote line. It is also suitable for use as an extension speaker.

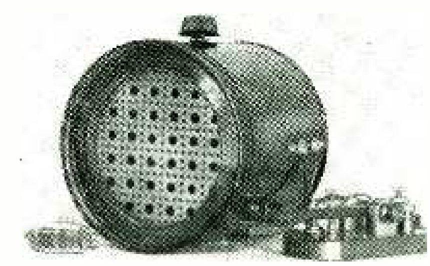
Above all, this little outfit rings the bell for economy.

Simplicity marks the circuit. However, one or two points need comment. Practically any output transformer will work, but greater volume results when the impedance the speaker reflects into the plate circuit is as high as possible—the specified 7,000 ohms to v.c. strikes an optimum and is easily obtained.

The choice of tube deserves explanation. The 6AK6 is used because it gives greater volume than a triode, its current compares favorably with many of the battery-type miniatures (it draws 107 ma in this circuit), it puts little strain on the pocketbook, being available at many surplus stores, and it stands more chance of finding use in later equipment than a battery tube.

Why use a 6-volt heater tube instead of a battery type? If the latter were used, the voltage would fall too low for speaker volume. A low-voltage tube would require a B-battery, which would add to the cost of the set. The heater-type tube also withstands rough treatment better than the more fragile filament type.

Except for the pitch control, the parts group around the speaker magnet. The potentiometer, with its switch, mounts on the wall of the case. Besides varying the signal pitch, this control compensates for differences in component values which might be used.



This code set is built into a jam tin.

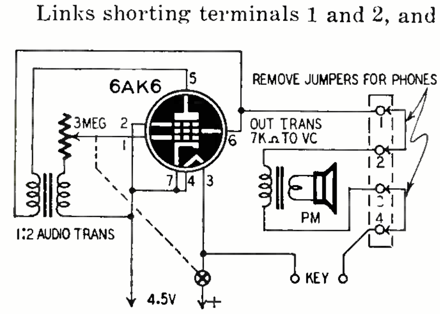
Also, when you put additional impedance—headphones, say—into the plate circuit, the pitch changes. With the potentiometer, it is a simple matter to restore the previous pitch.

As the photos show, a flange joins the speaker to the lid of the container. This makes it slightly directional, but the builder may omit it if desired. To save drilling, the flange solders directly to the lid. Four generous spots of solder hold the 4-inch PM speaker to this flange.

An aluminum U-bracket holds the audio transformer, and bolts fasten this strap to two of the speaker's mounting holes. A 5 x 5-inch economy-size tin serves as a case for the set.

A novel method of mounting the tube socket requires an 8-32 machine screw, a nut, and a metal bracket. Start the screw into the lug side of the wafer socket's center hole. It will only go two or three turns before binding. This will anchor the socket firmly to the end of the screw. All you need to do then is back up the nut, which tightens the assembly to the bracket, and makes everything solid. This method eliminates cutting large holes in metal, or smaller ones for the mounting screws. One hole large enough for the 8-32 screw is all that is needed, once you bolt the other end of the bracket down.

Links shorting terminals 1 and 2, and



The circuit is simple and economical.

3 and 4 ready the set for speaker operation. Adding a pair of phones is simple: just substitute their leads for any two link connections, depending on whether the phones are to be in series or parallel with the speaker, or independent of it.

Most of the parts fit on the speaker.

To hook the unit to a remote station line, remove the appropriate link and connect the line to the vacant terminals. Used with such a remote line—a speaker and key at the other end—you'll need a switch that short-circuits the key when receiving.

The greatest claim to versatility of this unit is its ability to pinch-hit for a signal generator. It supplies a handy source of a.f. voltage for audio testing. Connect a lead to terminal 1 or 2 (with speaker in circuit) through a 0.1-µf paper capacitor. Then ground terminal 3 or 4 (key terminals shorted) to the chassis of the set under test. (Beware of midget a.c.-d.c. receivers with hot chassis!)

If you follow these directions, you will have an audio signal generator with a range of about 100 to 3,000 c.p.s. You can install the blocking capacitor into the container permanently, and use a separate binding post for a.f. output. A switch in series with the voice coil of the speaker will silence the speaker when making audio tests.

While its volume proves adequate for the average room under normal conditions, this oscillator cannot compete with a nearby boiler factory. Adding a battery in the plate line—anything from 3 volts upward—will boost the volume if necessary.

The unit can be placed with the speaker opening at the top, or it can rest on its side, alarm-clock style. To prevent rolling in the latter position, solder a brass nut about 1¼ inches from each side of a center line plumbed down from the pitch control. Equip these nuts with ⅜-inch machine screws for feet.

Install the flashlight cells, turn on the switch, and you're ready for the first mad "dash."

Meter For Fractional-Ohm Measurements

The resistance between contacts on switches, relays, connectors, and similar components is usually only a small fraction of an ohm, yet its absolute value plays a major role in insuring efficient operation of some electrical and electronic circuits. Because very low resistances cannot be read on standard ohmmeters, expensive bridges are often used. A simple electronic circuit for measuring contact resistance was described in *Electronic Engineering* (London).

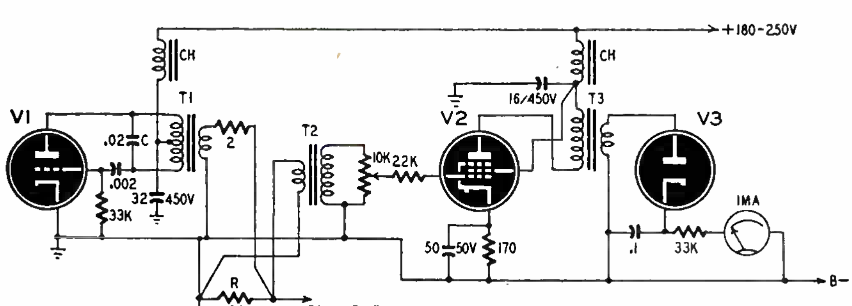
V1 may be a power amplifier triode, tetrode, or pentode connected as a 1,000-cycle oscillator. T1 is a conventional push-pull output transformer. The oscillator may be adjusted to 1,000 cycles by changing the value of C and by varying the grid resistance. The oscillator should deliver approximately 1 ampere into the 2- and .04-ohm resistors in series.

V2 is a pentode voltage amplifier, and V3 is a diode v.t.v.m. using one half of a 6H6 or a similar half-wave rectifier. The gain of V2 should be sufficient to deflect the meter to full scale when .04 volt is applied across R.

Adjust the meter to full scale with the 10,000-ohm control, then connect the relay contacts across R. The instrument is self-calibrating. Because R is fed from a high-impedance source (2 ohms), the meter will drop to half scale when the contact resistance equals R, or to one-fifth scale when contact resistance is .01 ohm.

R should be connected to the instrument through a heavy four-conductor cable to avoid long leads between it and the contact under test. Be sure that connections between test leads and contacts are *good*.

T2 should be a high-quality transformer having a mu-metal or similar core and a turns ratio of 50 to 1. A high-grade transformer designed to match a 5,000-ohm plate to a 2-ohm load should do the job. T3 should have a 1-to-1 turns ratio and a primary inductance of approximately 8 henries.



A Capacitance Relay of High Sensitivity

By ERNEST J. SCHULTZ

THE capacitance-operated relay is an amazingly simple device, considering the variety of its potential applications. It has been successfully used as a burglar alarm, a garage-door opener, and a window-display switch, as well as in practical jokes, magician's acts, and so on.

The practical circuit shown in the diagram consists of an 6SN7-GT oscillator and rectifier and an 884 gas triode. The oscillator section of the 6SN7-GT is designed so that, when carefully adjusted, a slight change in capacitance between its grid and ground results in a large reduction in the energy the tube puts out. The second section of the 6SN7-GT is connected as a diode and rectifies the oscillator voltage, producing a d.c. voltage dependent on the strength of the oscillator output. The d.c. voltage is applied to the grid of the 884 gas triode, biasing it to cutoff. A potentiometer in the grid of the 884 permits critical adjustment of the bias voltage, so that the device can be made extremely sensitive to a small reduction in bias. When any capacitance approaches the sensitive oscillator grid, the oscillator output decreases, resulting in less rectified d.c.; this reduces the grid bias on the 884, causing the tube to conduct and operate the plate relay.

As a.c. is used directly for plate voltage, it is necessary to connect a filter capacitor across the relay coil to prevent chattering. The device is an on-off affair: that is, when a capacitive body is brought near, the relay closes; and when the capacitance is removed, the relay opens.

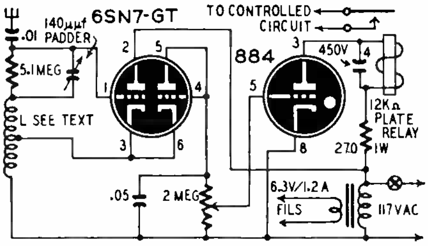
The size of the relay filter capacitor is not critical. It can be made larger than specified in the schematic, resulting in a longer delay in shutoff time. The chassis was made from thin-gage aluminum and measures 6 x 5 x 2 inches.

The oscillator frequency is about 3 mc so that it will not interfere with the broadcast band. No connections are made directly to the chassis for safety's sake. The coil is 100 turns of No. 28 d.c.c. close-wound on a 1-inch diameter, 3-inch long Bakelite form.

When ready to test the instrument, connect a short wire to the antenna terminal, plug in the device, and allow a few minutes warmup. Turn the bias control on full (arm toward plate), and, with an insulated tuning screwdriver, adjust the 140-μμf padder very slowly until the plate relay closes; then carefully back off the capacitor a hair or two until the relay opens again. When the hand is brought near the antenna, the relay should now close.

For added sensitivity, withdraw your hand and slowly reduce the bias voltage by adjusting the potentiometer until the relay again operates; then back off on the setting carefully until the relay opens. Now the sensitivity should be much greater. The sensitivity can be made very high, but too great a sensitivity is undesirable as the instrument will then become subject to line-voltage variations.

Great sensitivity with stability can



The capacitance-operated relay circuit.

be obtained by connecting a large metallic "pickup" to the antenna. However, the "pickup" must not be grounded; a screen door or kitchen table top are good examples of the many common pickups around the home. If a long wire or large pickup is used, it may be necessary to connect a small capacitor in series with the antenna terminal. A 50-μμf trimmer was found to work with a 40-foot wire. Long wires are not recommended, however, as the device is an oscillator and might radiate enough signal to cause interference with radio services.

As pointed out before, the capacitance relay can be used to open doors of a garage or turn on display lights in a store window, but the load switched must not be greater than the relay contacts can handle. It may be necessary to use an auxiliary relay.

The relay can also be used to control another, locking-type relay which, once actuated, remains closed until reset, thus leaving a warning switched on until shut off.

(If the relay is to be used as a protective device such as a door opener or burglar alarm, use an all-wave receiver to check for radiation from the oscillator. Since the coil is tuned by its distributed capacitance and the stray wiring capacitance, its frequency will be approximately 3 mc. FCC regulations require a license for operating radio equipment which radiates a signal in excess of 15 microvolts per meter at 1/6 wavelength from the antenna. This approximates being unable to receive the signal at a distance in feet from the antenna equal to 157,000 divided by the frequency in kc. If the oscillator in the alarm works on 3 mc (3,000 kc), the signal should not be detected at a distance equal to 157,000/3,000, or 52 feet.

(For the same length of antenna and power input to the oscillator, radiation falls off as the frequency is made lower; therefore, it is suggested that the oscillator coil be shunted with a capacitor which will cause the oscillator to operate below the broadcast band in frequency.—*Editor*)

PARTS LIST FOR CAPACITANCE RELAY

Capacitors: 1—4 μf, 150 volts, electrolytic; 1—.05, 1—.01 μf, 200 volts, paper; 1—140 μμf, variable.
Resistors: 1—5.1 megohms 1/2 watt; 1—270 ohms, 1 watt; 1—2 megohms potentiometer.
Miscellaneous: 2—sockets, octal; 1—transformer, filament-type, 6.3 volts, 1.2 amp. secondary; 1—plate relay with 10,000 or 12,000 ohm coil, contacts to suit; 1—884, 1—6SN7 tube; line cord, hook-up wire, assorted nuts and bolts.

SLIDE RULE CALCULATION

Certain problems lead to an equation of the form $C = \sqrt{a^2 + b^2}$.
For example, a circuit with 28 ohms resistance and 18 ohms reactance has an impedance $Z = \sqrt{28^2 + 18^2}$.
An interesting slide-rule solution to this equation appeared recently in *Wireless World* (England). It was contributed by a reader.

The following description assumes familiarity with multiplying, dividing, and working with roots on a slide rule. The steps are listed as follows:

1. Taking the previous example, find 28/18, with the quotient appearing on the D scale. For convenience the larger number is placed in the numerator. Disregard the quotient, but note 2.42 on scale A (without changing the setting).
2. Mentally add 1, obtaining 3.42 and move the cursor to that number on A. Without changing the setting find the corresponding number on D (1.85).
3. Multiply 1.85 by the original denominator (18) by moving slide and cursor along D scale. The answer is 33.3.

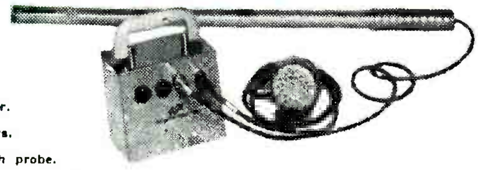
Here is the proof. The first step gives $\frac{28^2}{18^2}$. The next step first produces $1 + \frac{28^2}{18^2}$ or $\frac{18^2 + 28^2}{18^2}$ which is equal to $\frac{Z^2}{18^2}$. This becomes Z/18 in the same step. Therefore the last step results in Z.

This type of calculation occurs frequently in radio work. A little practice with this method on the slide rule will save much time.

SAVE MONEY 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.

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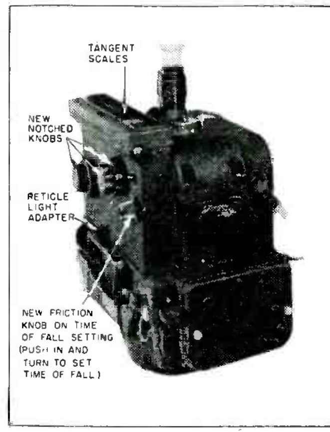

Contains many precision gears, cams—planetary assemblies gyros—switches, motors, slide rule, tangent scale, adjustable coated optic system, outside silvered mirrors. Comes in heavy, metal, safe-like container.

Brand new and complete.

Shipping weight 150 lb. **$69.95**

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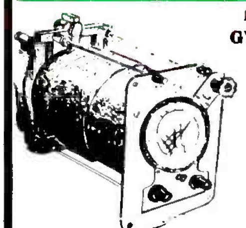
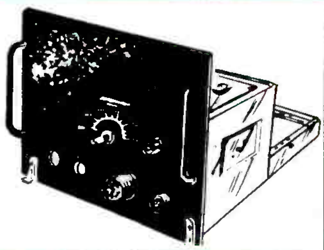


For Mark 4 Automatic Pilot

$4^{95}

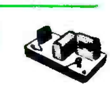
ALL-PURPOSE CHASSIS

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

5 GANG VARIABLE CONDENSER

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

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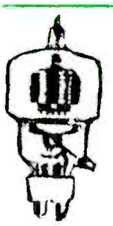
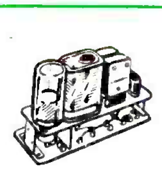


Just the tube for that 1KW final—typical operation 2500 volts at 400 MA. An ideal tube for that induction heater or dielectric heater. Efficient operation at 1500 V. to 3000 V.

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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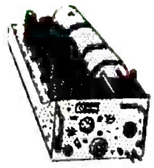
50 W, 30 ohms 1.7 amps. max. F283 95¢

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

BRAND 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.

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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.

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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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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¢

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

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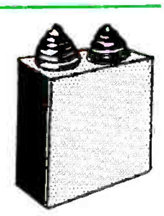

1. MFD 5000 V. **$2.95**
1. MFD 6000 V. **$4.95**
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2 MFD. 1000 V. **95c**

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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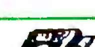

Normally opens at 95° F85-1 H5 **49¢**

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RC 1206 modulation transformer. 815 Class AB2. 56W. audio. RC 1205 driver transformer. 65N7 to 815, Class AB2—Companion to RC 1206.

ONLY **$4.95** FOR BOTH UNITS

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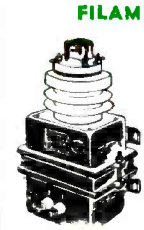

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For High Voltage Rectifiers. PRI. 115V., 50/60 Cycle.
SEC. 5V., C/T @ 10 Amp.
35 KV R.M.S. Test 12 KV D.C. Operating. Uses 872A Tube or other tubes.

NEW **$5.95**

872-A....$1.75

SAVE MONEY BRAND NEW GUARANTEED

GENERAL ELECTRIC SELSYN

Type 2J1G1

Will operate from 110 volts, 60 cycle by using a resistor or a condenser in series. Size is 2¼" in diameter x 4¾" long. Ideal for beam antenna position indicator.

Price $2.75 per pair —

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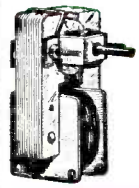

Sturdy shaded pole A.C. induction motor. 15 watts, 3000 rpm.; 4 mounting studs; 110-120 volts, 50-60 cycles. A.C. only. When geared down, this unit can operate an 18" turntable with a 200 lb. dead weight. Use it for fans, displays, timers and many other practical purposes. Ship. wt. 2 lbs.

UNUSUAL BUY $1.49

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Breaks at 3 MA. Beautifully Constructed and delicately pivoted. Approx. 2000 ohms resistance. Housed in dustproof aluminum can. Plugs into 5 prong socket. Only .... 95¢

5000 ohm D.P.S.T. relay normally open $1.95

SELSYN TYPE 32779

115 V. 60 cycle repeater. 2½" diam. x 2½" lg. Use as transmitter or repeater.

#43. Price $3.95 each

SUPER SPECIAL

3 lbs. Asst. Hardware, No. F270D $1.00

AIRCRAFT BATTERY PART NO. 3151 $29.00

24 Volt Air Craft Battery 17 AH at 5 hour rate wt. filled. 52 lbs. made by Electric Storage.

IGNITION COILS FOR G.E., SYLVANIA, ETC. Photo Flash Tubes

$1.29 Primary: 150V. condenser discharge. Secondary: 15,000 V. Can also be used on model airplanes.

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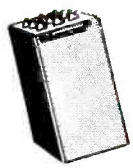

$1.95 NO. OT-134

Primary 110V, 60 Cy. Sec. 700V each side of center at 80 MA, 6.3V at 1.2 Amps. 5V at 3 Amps. Hermetically sealed Size 6" x 3½" x 3".

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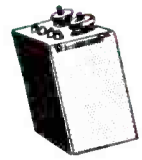
110V, 60 Cy. Sec: 300V ea. side of center at 125 MA, 6.3 V at 2.1 Amps, 5V at 3 Amps., Hermetically sealed, size 6" x 3½" x 4¼".

POWER TRANSFORMER



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DIRECTIONAL GYRO M-1

A-5 Automatic pilot Mfd. by A. C. Spark Plug under license of Sperry Gyroscope Co., Inc.

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LIP MIKE

with head band and cord.

NO. OT-131 95¢

1 MEG PREC. RES.

± 1%

89c

MATCHING TRANSFORMER

69¢ NO. OT-136

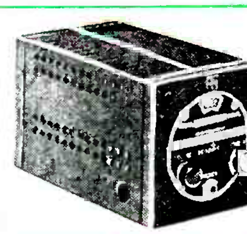
500 Ohms to grid, hermetically sealed

TYPE HE

100W, bleeder consisting of 5 sections 750 Ohms 23 Ohms, 23 Ohms, 7,500 Ohms, 3,000 Ohms. Total 11,296 Ohms.

NO. OT-147 49¢

LAZY Q FIVER



(BC 1206)

Setchell Carlson receiver; 4 x 4 x 6⅝"; 3 lb. 14 oz. Draws .75 amps at 24v. D.C. IF freq. 135 kc; super-het.

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DRAKE F15/U HARMONIC FILTER

Good for T.V. $2.95

Standard Brand Noise Filter

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No. F223 D.P.S.T. 30 amps., black bakelite case. 39¢

DUAL VAR. CONDENSER

No. F303 120 mmfd per sec. 95¢

TRANSFORMER

NO. OT-148

95¢

Audio osc. transformer with output and feed-back winding.

CHASSIS

NO. OT-150

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Containing: 110 AC relay, 3 miniature sockets with tube shields, 5 condensers and 6 res. 3" x 5" x 1".

MINE DETECTOR SCR 625

Detects metallic objects (ferrous or non-ferrous) to a depth of approx. 6 ft. Find outboard motors on the bottom of lakes, locate underground piping, treasure, metallic fragments in lumber, etc. Used $39.95

WELL KNOWN CONDENSER, NO. F219

.1 MFD, 7000 V $1.95

RELAY, No. F305, S.P.D.T. and S.P.S.T., 6500 ohms $1.95

TUBES

815 —	$1.95
3AP1	2.95
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VR150	.69
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3Q4	.44
3S4	.44
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VT127A	2.95

250 MFD AT 10V.

ROUND CAN ⅝ x 2

14¢ NO OT-110

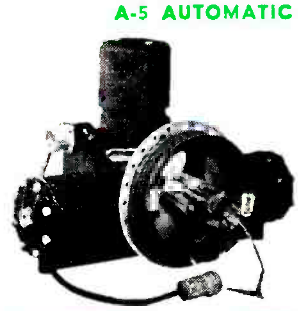
6 MH-500MA

29¢

No. OT-139

Pie wound on ceramic form.

A-5 AUTOMATIC PILOT SERVO M1



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Has ¼ horsepower shunt type DC motor, 27.5 V. 11 amps. input, speed 6000 rpm. Has hydraulic lift — (Intended use — Hydraulic lift actuates Ailerons on airplane). Overall length 16", width 12", height 11". Net weight 28 lbs. Shipping weight 35 lbs. Hardware for cable drum included. Brand new in original packing boxes.

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Ideal as Antenna Direction Indicator for Ham, Television, or Commercial Use. 6 V @ 60 cy. operates it. .... New $2.95

DISCHARGE RESISTOR

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No. OT-128

General Elect. thyrite type 5F, 130 V.A.C. or D.C.

S14 110 Volts 2½ Watt Argon Bulbs 25¢ ea.

HERSHEL RADIO CO

DEPT. RE 6

5249 GRAND RIVER
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Write for Free Catalogue

All orders F.O.B. Detroit—Minimum order $2.00—Michigan customers add 3% sales tax—20% payment must accompany all orders.

Receiver Circuits in Mobile Radio Service

Squelch circuits and double conversion are common in these sets

By I. QUEEN

TRANSMITTERS for FM (or PM) are simpler than AM transmitters because they require so little speech equipment. It is much easier to swing the carrier frequency than to modulate its amplitude. It was shown in the article on mobile transmitters that very simple circuits are needed to phase-modulate a radiotelephone transmitter.

On the other hand, an FM receiver requires more elaborate design and more tubes than an equivalent AM set. High gain is necessary to saturate the limiters. The FM discriminator circuit is more complex and more critical to adjust than a conventional AM detector.

Receivers for the radiotelephone band are superhets, some using the double-conversion method. The use of two converters and two separate i.f. amplifiers gives excellent sensitivity and selectivity. Oscillators are generally crystal-controlled and held to a high stability (.005% or better).

In some cases different harmonics of the same crystal produce the two i.f. beats. In Fig. 1 the 18th harmonic of the crystal combines with the carrier to produce the first (high) i.f. This frequency is mixed with the second harmonic of the *same* crystal to produce the second (low) i.f. which is 1.6 mc. Both the first i.f. and the crystal frequency depend upon the assigned carrier.

Ordinarily, a receiver is left on continuously to await a call and a squelch circuit quiets it until a carrier is picked up. When the signal is powerful enough to saturate the limiter the squelch tube is blocked.

Sensitivity of a receiver is defined in terms of a "quieting signal". In any set the quieting signal is the voltage which reduces background noise by 20 db. It is measured in a shielded room to eliminate external r.f. pickup. A voltage is connected to the antenna terminals and varied until the set noise is reduced to 1/10th of its previous value. This input voltage is the quieting signal.

All receivers require a de-emphasis network to compensate for the pre-emphasized transmitted signal. Generally the receiver response is linear from 300-3000 cycles after de-emphasis.

The set should be turned on for about 30 minutes before alignment or retuning. Most of the circuits may be resonated with an AM signal generator. Overall response is checked with an oscilloscope. An FM signal generator should be used to align the critical discriminator primary. The r.f. section may be tuned with a v.h.f. generator and then trimmed by listening to a signal from the associated transmitter. A precise frequency meter is needed to tune the oscillator circuits.

A microammeter in the limiter grid circuit makes a good output meter. The signal should be kept low to prevent saturation and flattening of the response curve. Each amplifier stage is resonated to produce a maximum meter reading.

Some typical radiotelephone receivers have original and rather interesting circuits.

Philco PRT-150G

This 12-tube double conversion receiver has an i.f. bandwidth of 40 kc.

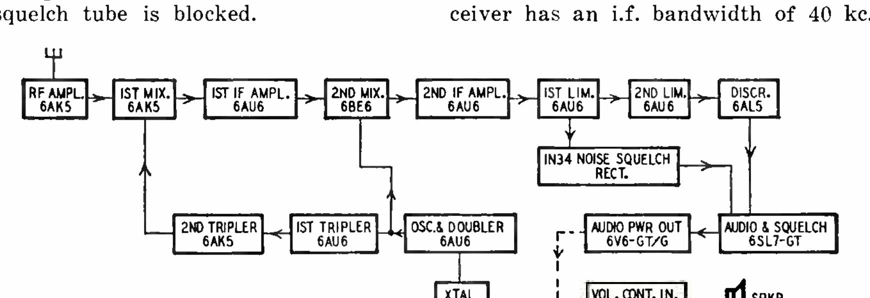


Fig. 1—Block diagram of a receiver typical of the double conversion type.

Its response is 60 db down at 120 kc from the center frequency. Power input is 45 watts at 6.3 volts d.c. Fig. 2 shows the detector, squelch, and audio stages of this receiver.

The incoming signal (152-162 mc) is mixed with the 20th harmonic of a crystal to produce the high (15-mc) i.f. The second harmonic of another crystal mixes with the first i.f. to produce the second i.f. of 1 mc. The detector tube is an FM 1000 whose first and second grids operate as grid and anode of a modified Colpitts oscillator.

The higher frequency noise components of the audio signal are fed to a 6AQ6 noise amplifier which is coupled back to pin 4 of the 6SL7, a second noise amplifier, then to the 6AQ6 noise rectifier. When noise is high, the audio channel is blocked by the rectified noise voltage. The squelch control is set to just quiet the receiver when no signal is received.

General Electric ES 1B

This 15-tube receiver is a double superhet with 2 r.f. stages. The 18th harmonic of a crystal produces the high i.f., and the second harmonic of the same crystal produces the low i.f.

In the absence of a signal, the cascade limiters are not fully saturated and noise is present at the discriminator output. This noise is rectified and the d.c. voltage is used to block the audio amplifier and quiet the set. The noise voltage is negligible when a signal saturates the limiters.

Farnsworth M200-2

This 13-tube double conversion set is designed for railroad communications. Its response is 80 db down at 120 kc from the center frequency. Input power is 70 watts. As in the previous case, one crystal is used to produce both i.f.'s.

A squelch circuit triode gets its signal from the first limiter. With no signal, the limiter grid voltage is negligible so the squelch tube plate current is high. As the squelch plate is directly coupled to the first audio stage, the latter is blocked. A strong r.f. signal blocks the squelch triode and permits audio amplification. A crystal rectifier and network is provided to prevent unblocking of the audio tube by strong noise bursts.

Harvey 541

A single conversion receiver, this set uses 14 tubes and three crystals. There are two r.f. stages and four i.f. stages, the last two of which operate as limiters. Total battery drain is 6 amps.

The discriminator is a conventional Foster-Seeley type using two crystals and the squelch rectifier is also a crystal. When no signal is being received, the noise output of the discriminator is amplified and fed to a crystal rectifier. This rectified voltage (positive) and a negative voltage from the discriminator center tap are both applied to the grid of the squelch tube. In the absence of a signal, the resultant volt-

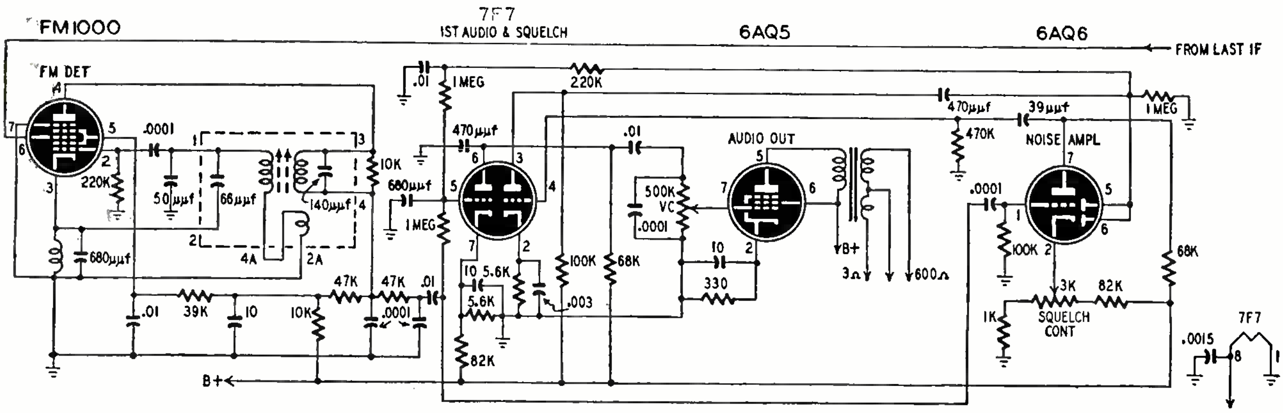


Fig. 2—Detector, squelch and audio circuits of the Philco set. The rectified noise voltage blocks the audio channel.

age is positive and the squelch tube conducts and blocks the audio. When a signal comes in, the net voltage is negative and the squelch tube is blocked.

Raytheon

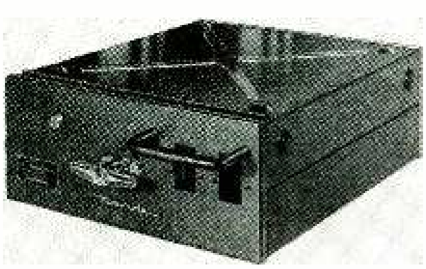
The same receiver-transmitter unit is used for both mobile and fixed service. The receiver is a 12-tube single-conversion superhet with two r.f. and two i.f. stages. Sensitivity is better than 1 μv for 50-mw output. Selectivity is 60 db down at 120 kc off center frequency.

Communications Co. Comco 275

This is another single conversion 14-tube set with two r.f. and three i.f. stages. Selectivity is 6 db down at 28 kc off resonance. Sensitivity is .75 μv for 20 db quieting.

Motorola Research Line

This line of mobile equipment has a number of innovations (secured by



A typical radiotelephone set. This set, one of Motorola's "Research Line", has transmitter and receiver in one unit.

Control head of the Motorola receiver.

patents). For example, model 8433 receiver has a tuned cavity resonator, a sharply-tuned filter and a tunable local oscillator for extreme selectivity. Response is 100 db down at 30 kc off center frequency and sensitivity is .8 μv for 20 db quieting.

The power supply is on a separate chassis so the receiver may be operated from a battery or from the line. Model 8433 is a double superhet using 17 tubes.

Link 2210

The 2210 receiver is a double superhet with 12 tubes. Response is 85 db down at 150 kc off center. Sensitivity is .5 μv for 20 db quieting.

In the absence of a carrier, AM noise is taken from the second limiter and is amplified and rectified. This positive rectified voltage unblocks the squelch tube which in turn blocks the audio stage. When a carrier is tuned in, the AM noise voltage is lost due to limiter action and the squelch tube is cut off.

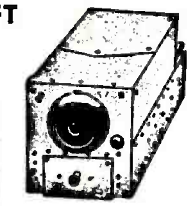
Bendix MRT-1

This receiver uses 17 tubes, four ot which are common to both receiver and transmitter. These are four audio and compressor tubes. The receiver has double conversion and the second limiter saturates at 50 μv. A Foster-Seeley discriminator feeds the audio amplifier.

(*Continued on page* 76)▶

TERRIFIC BUYS FOR SMART, SKEPTICAL BUYERS

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**

SMASH VALUES IN RADIO RECEIVERS

	Used	New
BC-453 RCVR.	...	$21.95
BC-454 RCVR.	$4.95	7.95
BC-455 RCVR.	6.95	9.95
BC-456 MOD.	1.95	3.45
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

The electronic equipment that saved many lives in the war. Set can be modified to use for 2-way communication, voice or code, on following bands: ham band 420-450 mc, citizens radio 460-470 mc, fixed and mobile 450-460 mc, television experimental 470-500 mc. 15 tubes (tubes alone worth more than sale price!): 4—7F7, 4—7H7, 2—7E6, 2—6F6, 2—955 and 1—WE316A. Now covers 460 to 490 mc. Brand new BC-645 with tubes, less power supply in factory carton. Shipping weight 25 lbs.

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

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SETCHEL-CARLSON Beacon Radio Receiver BC-1206-C

Receives A-N beam signals, operates on 24-28 V DC. 5 Tubes: 3—14H7, 14R7, 28D7. Tunes 195 to 420 Kc. Size 4"x4"x6¾" wide. 4 lbs. In original carton. Good Used **$6.75**

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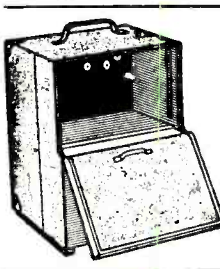


For BC-221 Series freq. meters. BRAND NEW! 3 compartments. Massively built. 14½x10½x10". Value $20.00. Complete with canvas cover for both ends. Yours for only **$4.95**

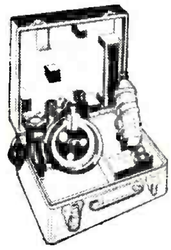
DC AMMETER 0-15 Amps

A terrific buy! 3½" easy reading scale. 75 divisions. Black plastic case 4½"x 5¼"x2¼". Rubber covered test clip leads plus black metal carrying case with hinged cover. Brand New. Wonderful for automotive, battery charging, general test work. Value $25. All yours for only **$4.59**

STROMBERG TELEPHONE

It's a real desk type carbon microphone, with press-to-talk switch. Very massive construction, cord and plug included. Excellent condition. Specially priced **$3.95**

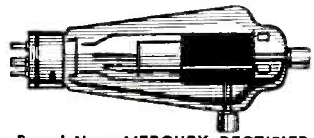
BUBBLE SEXTANT



12.95 COMPLETE

Terrific value for boat owners! Actually worth $100 or more! Has illuminated averaging disc for nighttime use. Complete with carrying case, recording discs, flash light with rheostat for using sextant at night, 2X telescope for faint stars, and Allen wrench. Hurry! Only a few left!

GE THYRATRON FG-105



Brand New MERCURY RECTIFIER

Individually boxed in factory sealed cartons. List Price $40 your cost.................. **$11.95** each

While They Last!

For continuous rectifier and welder control service. Tetrode type, indirectly heated cathode; 10000 V peak, 10000 V peak inverse. Av. Max. current 6.4 amps continuous, 2.4 to 4 amps welder control service.

MONEY SAVING VALUES!

CHECK EACH ONE

Headsets and Mikes

HS23 High Imp. Headset New	$2.85
HS33 Low Imp. Headset New	2.85
HS30 High Imp. Headset New	1.39
HS30 High Imp. Headset Used	.79
T17B. Mikes. New	2.45
T17B. Mikes. Used	.88
T24 High Imp. Mike, New	1.19
T30 Breast Mike. New	.88
T45 (or Navy) Lip Mike New	.98
CD307 Cord for headsets. New	.55
WE Carbon Breast Mike. New	.88
PL55 Plug New	.25
PL68 Plug New	.19
TS13 Handsets New	3.95
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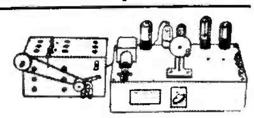
Sensational Value! 80-Meter Receiver

RCA Model AVR-20-A LIMITED QUANTITY! Originally designed for Aircraft and boats. Tunes 2300 to 6500 Kc. Perfect for 80 meter Ham work. Crystal controlled. Phone and CW. Provision for low and high impedance phones. Tubes used: 6B8, 6F7, 6S7, 6K8. 3-gang tuning cond. vernier tuning. Designed for 6 volt operation. Easily converted to 110 volts AC. Less power supply. SENSATIONAL GIVE-AWAY. PRICE WITH TUBES............ **$14.95**

McElroy Automatic KEYER



For Xmtr keying or code practice. Has photocell and sensitive relay. Variable speed motor, 110V AC or DC. Complete with 2-117Z6 and 1-117L6 tubes. your cost.................. **$17.95**

QUANTITY PRICES

Inquiries welcomed from institutions, wholesalers, dealers, large users . . Phone, write, wire for quantity prices.

Please include 25% Deposit with order—Balance C.O.D. MINIMUM ORDER $3.00. All Shipments F.O.B. Our Warehouse N.Y.C.

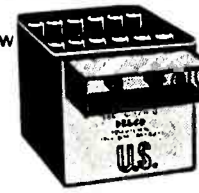
G & G GENUINE MAJESTIC **RADIO PARTS SERVICE**

53 VESEY STREET • NEW YORK 7, N.Y.

ARMY FIELD TELEPHONES

Type EE8—Talk as far as 17 miles. Dependable 2-way communication at low cost. Ideal for home, farm, field. Up to six phones can be used on one line. Each phone complete with ringer. Originally cost govt. $39.90 each. Used, good as new! **$12.95** each

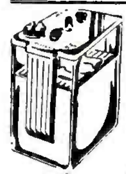
TERRIFIC VALUE 24-VOLT STORAGE BATTERY, BRAND NEW 17 AMP. HRS.



Made by Delco. 12 cells, heavy duty, very rugged. Shipped dry, uses standard sulphuric acid electrolyte.

VERY SPECIAL **$17.95**

WILLARD 2-VOLT STORAGE BATTERY 20 Ampere-Hours



Exact replacement for GE Model LB-530 portables—brand new. 5" high, 3¾" wide, 3" deep. Each **$1.95**

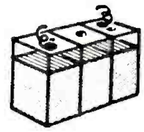
7-PRONG 2-VOLT VIBRATOR

for portable and farm sets. Replacement for GE LB530— **$1.65**

GOULD 6-VOLT STORAGE BATTERY

Navy Standard. Black Rubber Case. BRAND NEW. 15 Amp. Hour Rating **$6.95**

WILLARD MIDGET 6-V STORAGE BATTERY



3 amp hour rating. Transparent plastic case. Brand new. 3¾"x1 13/16"x2⅜" high. Uses standard electrolyte. Each **$2.65**

1-QUART BOTTLE BATTERY ELECTROLYTE

Made by Willard, for above storage batteries. 1 qt. sufficient for 2 two-volt cells. Hermetically sealed. SPECIAL. per qt. bottle................ **$1.25**

SCR-522

Very High Frequency Transmitter-Receiver COMPLETE WITH ALL COMPONENTS

100-156MC. 4 channels. XTAL-controlled, Amplitude Modulated Voice. Electrically tested. Complete as illustrated..... **$77.50**

UHF ANTENNA AN80-A

Suitable for 400 Mc citizens' band, fine for UHF experimenters. 5¼" flat antenna rod, mounted on porcelain base, with mounting plate and right angle feed through. Brand new. Special at.......... **49c**

BC 605 INTERPHONE AMPLIFIER

Can be easily converted to an intercom. set—ideal for office, home or factory.

New	$4.95
Like New	$3.95

T-85/APT5 UHF TRANSMITTER

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**

The squelch circuit (Fig. 3) uses two relays. When a carrier is tuned in, plate current of one squelch tube is sufficient to operate a relay in its circuit. This relay completes B-plus to a d.c. amplifier and another squelch tube. The plate current of the latter tube operates a second relay. This relay normally leaves the audio output cathodes floating, and sound can be heard at the speaker only when a carrier sufficiently strong to operate the squelch is present.

The audio level of this set is substantially constant because of compressor action.

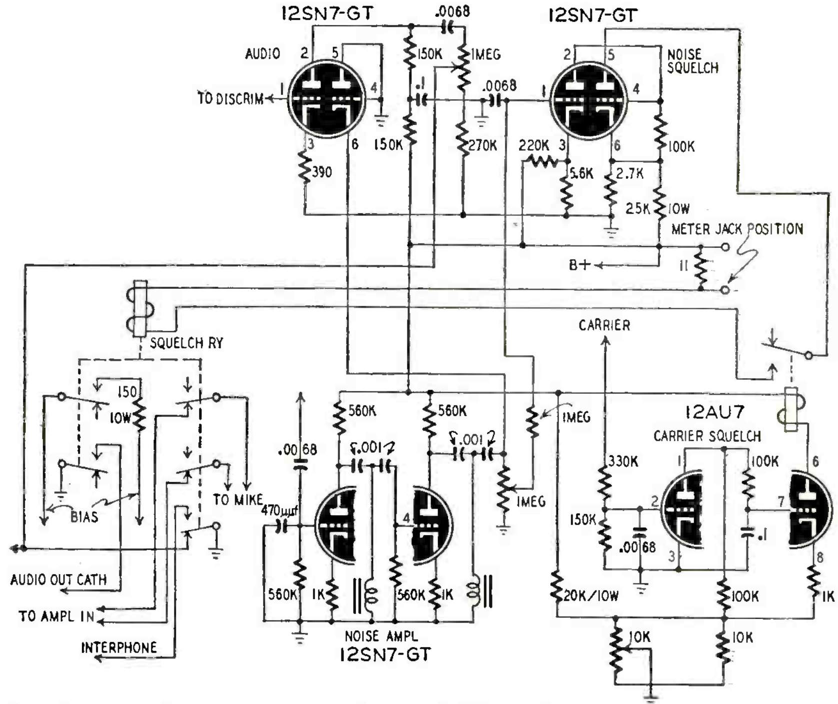


Fig. 3—Squelch circuit of the Bendix MRT-1. The carrier closes the plate relay of the 12AU7 which operates the squelch relay and unblocks the audio.

TELEVISION DX

This month we have four more letters to add to our growing list of DX reports.

Bob Butts of Beeville, Texas has sent us a long list of stations which he has received in the past year, most of them during last summer. On the list are: KNBH, channel 4, Los Angeles; WNBW, channel 4, Washington, D.C.; WTVJ, channel 4, Miami; WAGA-TV, channel 5, Atlanta; WBKB, channel 4, Chicago, WNBQ, channel 5, Chicago; WAVE-TV, channel 5, Louisville; WDSU-TV, channel 6, New Orleans; WMAR-TV, channel 2, Baltimore; WJBK-TV, channel 2, Detroit; WWJ-TV, channel 4, Detroit; WLW-T, channel 4, Cincinnati; WLW-C, channel 3, Columbus; WDTV, channel 3, Pittsburg; WMCT, channel 4, Memphis. Mr. Butts' receiver is a Motorola VT-107 and he uses a stacked Lyte all-channel antenna which is about 40 feet above the ground.

Little Jack Little, the orchestra leader, reported seeing WOAI-TV, Channel 4, San Antonio, one night last April while in Mexico City. He saw the program on a special receiver installation in his car.

Jerry Hines of Spooner, Wisconsin, also pulled in WOAI-TV recently. He has an Admiral receiver and a Vee-D-X model RLY Yagi antenna. Mr. Hines asks if we have any dx reports on WTCN-TV or KSTP-TV. So far the answer is no, but perhaps some of our readers will oblige.

L. E. Benson of Leaksville, N.C., has received WKY-TV, channel 4, Oklahoma City; WNBW, channel 4, Washington, D.C.; and WTVR, channel 6, Richmond. The receiver is a Hallicrafters model 509 and the antenna a Ward two-bay antenna.

CANADIAN FM STATIONS

There were 36 FM broadcast stations operating in Canada—as of April 1, 1950. Operating between 88.3 and 106.9 mc, these stations have effective radiated powers ranging from 250 to 10,940 watts.

A complete list of these stations, their locations, frequencies, and effective radiated powers is printed for the benefit of FM listeners. FM dx'ers will probably want to listen for some of these stations when distant stations are coming through.

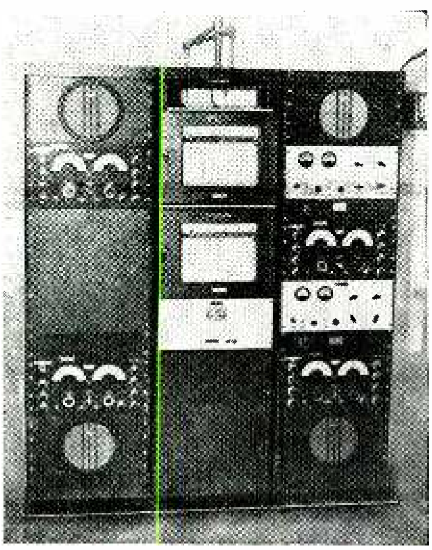
STATION	LOCATION	Frequency (MC/S)	Effective Radiated Power (Watts)
CBF-FM	Montreal, Que.	95.1	10940
CBL-FM	Toronto, Ont.	99.1	5580
CBM-FM	Montreal, Que.	100.7	4510
CBO-FM	Ottawa, Ont.	103.3	380
CBR-FM	Vancouver, B.C.	105.7	1400
CFCA-FM	Kitchener, Ont.	106.1	10000

CFCF-FM	Montreal, Que.	106.5	7700
CFCH-FM	North Bay, Ont.	106.3	250
CFPL-FM	London, Ont.	95.9	4440
CFRA-FM	Ottawa, Ont.	93.9	383
CFRB-FM	Toronto, Ont.	99.9	600
CHEX-FM	Peterborough, Ont.	101.5	250
CHML-FM	Hamilton, Ont.	94.1	400
CHNS-FM	Halifax, N.S.	96.1	250
CHOK-FM	Sarnia, Ont.	97.5	250
CHRC-FM	Quebec, Que.	98.1	595
CHSJ-FM	Saint John, N.B.	100.5	325
CJBR-FM	Rimouski, Que.	101.5	570
CJCA-FM	Edmonton, Alta.	99.5	414
CJCB-FM	Sydney, N.S.	94.9	630
CJIC-FM	Sault Ste. Marie, Ont.	100.5	250
CJKL-FM	Kirkland Lake, Ont.	93.7	250
CJCB-FM	Winnipeg, Man.	103.1	250
CJRT-FM	Toronto, Ont.	88.3	9900
CJSH-FM	Hamilton, Ont.	102.9	9200
CKCR-FM	Kitchener, Ont.	96.7	350
CKGB-FM	Timmins, Ont.	94.5	425
CKLW-FM	Windsor, Ont.	93.9	250*
CKOX-FM	Woodstock, Ont.	106.9	262
CKPC-FM	Brantford, Ont.	94.7	250
CKPR-FM	Fort William, Ont.	94.3	250
CKSF-FM	Cornwall, Ont.	104.5	522
CKTB-FM	St. Catharines, Ont.	97.7	250
CKUA-FM	Edmonton, Alta.	98.1	352
CKVL-FM	Verdun, Que.	96.9	10200
CKWS-FM	Kingston, Ont.	96.3	350

*Temporary authorization.

WWV STORM WARNINGS

Disturbance warnings for radio are broadcast regularly by WWV, the radio station of the National Bureau of Standards. The warnings give advanced notice of disturbances affecting high frequency transmissions and apply particularly to transmission paths across the North Atlantic such as New York-London and Washington-Berlin.



Given in code, the warnings follow the time announcements at 19 and 49 minutes past each hour. A series of N's signifies that propagation conditions are normal, a series of U's that they are unstable, and a series of W's that they are disturbed or are expected to become so within twelve hours.

The warnings are based on comprehensive observations of radio, ionospheric, solar, and geomagnetic phenomena at stations throughout the world.

Given a forewarning of a disturbance, a radio operator can minimize its effect by rushing through high priority traffic before the circuit deteriorates, by postponing operations requiring assured radio contact, or by rerouting traffic until the storm has subsided.

REVIEW OF NEW TUBES

AMONG the new tubes announced recently, RCA has four, including the type 5879 sharp cutoff pentode designed especially for input stages of audio systems where low microphonics and hum are required. The tube has a 6.3-volt heater, a transconductance of 1,000 μmhos, and a plate resistance of 2 megohms.

The RCA type 7MP7 is a long-persistence oscillograph tube having magnetic focus and magnetic deflection. Its two-layer screen has a bluish trace for short persistence and a greenish-yellow trace for persistence of several minutes. Heater voltage of the tube is 6.3 volts and maximum anode voltage is 8,000 volts.

The RCA type 5890 is a remote cutoff beam pentode designed for voltage regulation of d.c. supplies of up to 30,000 volts. The type 5826 is a small-size image orthicon having very high sensitivity and good spectral response.

Eitel-McCullough has announced a new u.h.f. triode, the Eimac type 4X-150G for frequencies up to 1,000 mc. The new tube features coaxial construction and lower lead inductance. In typical performance at 750 mc, power output is 100 watts with a power gain of 11. At 1,000 mc, the power output is reduced to 50 watts.

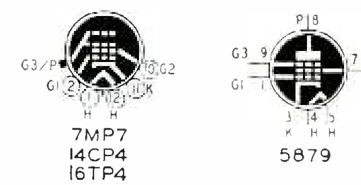
A giant-size 24-inch diameter picture tube has been made by G-E. The tube has a dark face plate and an aluminum-backed fluorescent screen to increase picture brightness. Limited production of this tube is expected.

G-E also announces a new 14-inch glass rectangular television picture tube. The 14CP4 has a useful picture area of 99 square inches. Maximum ratings of the tube are: anode voltage, 14,000 volts; grid No. 2, 410 volts; grid No. 1, 125 volts negative bias.

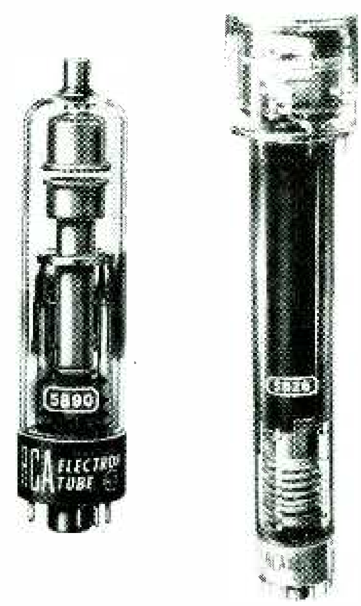
Another new G-E picture tube is the type 19AP4A, a black-face version of the 19AP4.

Du Mont also has a new glass rectangular Kinescope, the type 16TP4, which has a bent-gun design and a gray filter face-plate. As a conversion tube, the 16TP4 provides a larger picture in existing cabinets than the original round tube. Maximum ratings are: anode voltage, 16,000 volts; grid No. 2 voltage, 410 volts; grid No. 1 voltage, 125 volts for negative bias.

A general-purpose subminiature triode is Sylvania's type 6BF7. This duotriode has characteristics similar to the type 6J6 but has separate cathode leads. In typical class-A operation it has a mutual conductance of 4,800 μmhos, plate resistance of 7,000 ohms, and an amplification factor of 34.



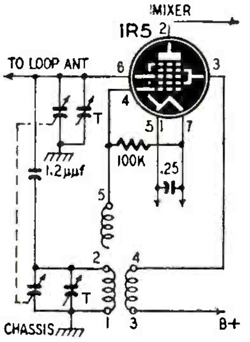
Base diagrams of some of the new tubes.



G-E's giant-size 24-inch picture tube.

TRACKING PHILCO RECEIVERS

If the 48-200, 48-300, and similar models cannot be made to track at both ends of the dial, check the .05-μf a.v.c. bypass, the oscillator grid capacitor, and the resonant capacitor between B-minus and chassis.



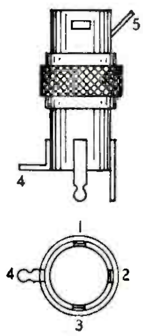
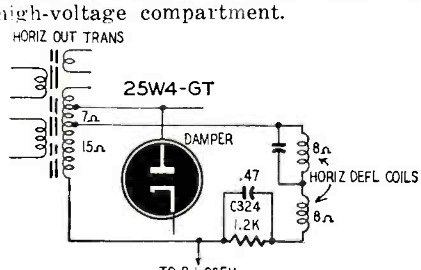


Fig. 1 Fig. 2

The 48-300 has a three-winding oscillator coil connected as shown in Fig. 1. The oscillator may operate, but tracking will be off if the windings are not connected as shown. Drawings in Fig. 2 show the terminals on the T400 oscillator coil used in this model.—*Herman F. Moe*

G-E MODELS 817 AND 821

Several sets have come in with the following complaints: (1) Picture is dim and reduced to one-half its normal width; (2) horizontal black bars across screen; (3) a high-pitched whine can be heard coming directly from the high-voltage compartment.



These troubles have been traced to a breakdown of the 0.47-μf capacitor which bypasses the 1,200-ohm resistor in series with the horizontal deflection coils. This capacitor is C324 in the diagram. Corresponding capacitors can cause the same troubles in models 800, 805, 806, and 807.—*William Ford, Jr.*

TRANSVISION TV KITS

Filter capacitors fail rapidly in some TV kits because of insufficient under-chassis ventilation. I have cured this by drilling several large holes in the bottom of the cabinet and by making sure that there is a space between the bottom of the cabinet and the top of the table.

BUZZ IN ADMIRAL P5

If a buzz is present when this set—made by Continental Radio Corp.—is operated on a.c., try placing a grounded shield between the 117Z6-GT and 1H5-GT tubes.—*James R. Limbeck*

PHILCO 46-1201 AND 48-1201

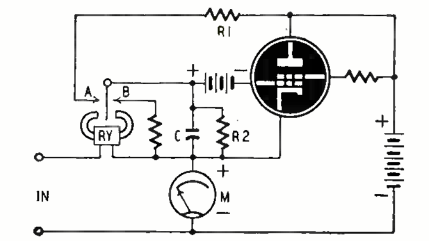
If these models hum on RADIO and not on PHONOGRAPH, check the 15-μf capacitors in the voltage-doubler circuit before looking elsewhere.—*C. R. Lutz*

RELAY-OPERATED VTVM

Patent No. 2,501,704
Robert G. Wilson, Washington, D.C.
(May be used by the U.S. Government without payment of royalties)

Operating on an entirely new principle, voltage on this v.t.v.m. is read directly on a conventional type d'Arsonval instrument and the tube is used only to control current through the meter M. The tube tends to keep the voltage across the meter equal to the voltage to be measured.

When the winding of the polarized relay RY is not energized, its armature is in a neutral position between A and B and the tube is blocked because of the grid battery. Plate current is zero so no indication appears on the meter. When a voltage is applied across the terminals (with the upper terminal positive), current flows through RY and the armature is attracted to A. In this position R1 and R2 form a voltage divider between plate and cathode of the tube. C begins to charge with its upper plate going positive.



The grid voltage is now the resultant of the grid battery voltage and the voltage across C. When the voltage on C equals or exceeds the battery voltage, plate current begins to flow and the meter deflects. The plate current increases until the voltage across M is greater than the input. These voltages oppose, so the current through the relay RY reverses and the armature is drawn to B. This permits C to discharge and the grid bias goes more negative until the voltage across M decreases to less than the input. Again the current through RY reverses, and the armature swings back to A.

In normal operation the armature vibrates between A and B about three or four times per second. The voltage across M pulsates within a narrow range above and below the input voltage. When the meter is properly damped, it indicates an average value substantially equal to the input.

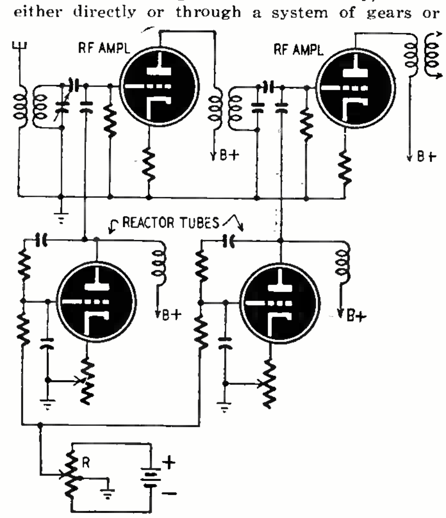
With this type of circuit, range linearity is a function of the d'Arsonval instrument alone, and no zeroing is needed from time to time. However, a small amount of power must be supplied by the source.

The relay may be a Weston type 813J which operates at 3 microamperes. The plate battery must be greater than the voltage to be measured. A grid battery of 300 volts is sufficient for measurements up to 150 volts.

ELECTRONIC TUNING

Patent No. 2,498,932
Marcel Wallace, New York City
(assigned half to Panoramic Radio Corp.)

Most radio tuning is done mechanically, that is either directly or through a system of gears or pulleys. Gang tuning requires that several variable capacitors or slug-tuned coils be positioned for mechanical coupling. It is not easy to adapt these systems for remote tuning.



This invention relies on reactor tubes to tune the r.f. and oscillator stages. The figure shows how the idea can be used in a t.r.f. set, for example. The reactor tubes shunt the tank coils and tune the circuits when R is varied. Each reactor tube is shown with a gain control (in the cathode circuit). If the reactor circuits are identical and if the r.f. stages are also similar, the single potentiometer R can tune all the stages of the receiver at once.

For remote tuning, R and its battery may be located at a distance.

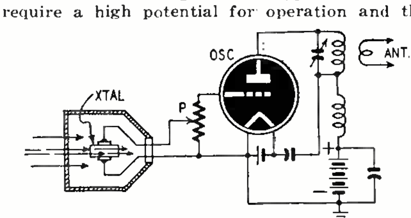
H.F. RADIATION COUNTER

Patent No. 2,500,473
Charles Spaeth, Mamaroneck, N. Y.

This is a new type of radiation counter. The detector is a quartz crystal in a tube filled with a gas mixture. The mixture is of two gases: one an easily-ionized gas such as argon, neon or helium; the other a gas which quenches ionization, such as chlorine or iodine. One end of the tube is made of glass or copper to admit cosmic rays, gamma rays, neutrons or other radiation.

The crystal is part of an oscillatory circuit. P is adjusted so that high resistance shunts the crystal. The total grid leak is so high that oscillations cannot occur. When radiation falls on the tube and crystal, the gas ionizes and lowers the resistance across the crystal. The result is a burst of oscillation which is immediately quenched by the high grid leak resistance.

It is claimed that this detector is much more sensitive than a Geiger-Muller type. It does not require a high potential for operation and the

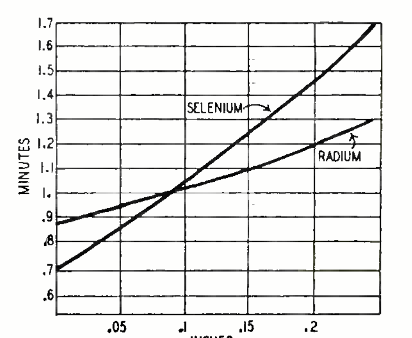


entire counter may be carried aloft in a balloon or located at a remote location such as a mountain top. The count is transmitted to a distant receiver as a radio signal.

RADIATION MEASUREMENT

Patent No. 2,501,174
Gerhard Herzog, Houston, Texas
(assigned to Texas Co., New York City)

The thickness of metals and the density of liquids may be measured by passing gamma rays



through them and measuring the energy which remains. Radium is often used as the source of the rays.

More precise measurements are possible when the rays are relatively weak. Then the absorption rate is greater and this makes it possible to determine thickness or density more accurately. The inventor has determined that artificial radioactive metals such as selenium possess weaker radiation than radium and therefore can give more accurate results.

The graphs shown here compare radium and selenium. They show exposure time versus thickness of iron or steel for a given radiation count. Selenium shows a much higher sensitivity because a small increase in thickness requires a greater exposure change.

The short half-life of selenium must be taken into account. The intensity of radiation decreases each day by an equivalent of .002 inches of steel.

CODE OF ETHICS

A 10-point code of ethics has been adopted by the Dallas Radio Sales & Service association to help improve customer relationship with its members. The provisions of the ten points are:

1—Members displaying the Association emblem guarantee fair treatment to the public.

2—Accurate statements of work done and charges therefor shall be rendered the customer.

3—No misleading statements, advertising, or promises shall be made by a member.

4—All property of customers shall be treated with due care and diligence.

5—All work shall be done in a neat and competent manner.

6—All replacement parts shall be of equal or better quality than those used originally, and all parts replaced shall be tendered the customer when his set is returned.

7—All workmanship by Association members shall be guaranteed for a reasonable length of time, and all disputes as to guarantees may be referred to the Association if all efforts to adjust them have failed.

8—A permanent, comprehensive record of all work done shall be kept as a permanent record, and all complaints shall be handled courteously.

9—Technical assistance shall be rendered to all members at their request.

10—All members, their shops and personnel shall at all times present a neat and businesslike appearance both in person and in their premises.

MORE TEST PATTERN

Three Texas TV stations have increased their test pattern time at the request of the Dallas Radio Sales & Service Association. The stations showing this fine spirit of co-operation are WBAP-TV of Fort Worth and KBTV and KRLD-TV, both of Dallas. Each of these stations is increasing its test pattern time 6 hours per week to give service technicians in the area more time for proper set adjustments.

DINNER MEETING

The annual dinner meeting and election of officers was held April 19 by the Vancouver chapter of the Associated Radio Technicians of British Columbia. Guest speaker was Bill Rea of station CKNW who discussed the TV situation in Canada.

Officers elected for this year are: W. Filtness, president; J. A. Clarke, vice president; Fred Lewis, secretary; Ed Mullins, treasurer; and H. Amos, recording secretary.

SET OWNERS COMPLAIN

Television set owners are increasing their complaints of being given the run-around by set manufacturers, service companies, and retailers, according to Frank J. Moch, president of the Television Installation and Service Association (Chicago) in a forum on television service recently sponsored by the association.

Service technicians attending the forum said that the number of service calls per set is showing a tendency to decline, but that cheaper components in recent sets may cause the number of calls per set to go up again.

The point was made that retailers, especially those who do not do their own servicing, should avoid making exaggerated performance claims. This was aimed particularly at indoor antennas, which generally do not work well in the Chicago area.

TELE CLASS GRADUATES

The second class of television students organized through the cooperation of the Associated Radio-Television Servicemen and the Board of Education of New York City graduated the third week of June. More than 30 technicians took the course.

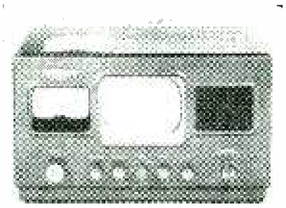
The Board of Education and the ARTSNY plan to continue the program in the fall, with both classes in radio servicing and in television servicing, the latter for the more advanced students who are already capable radio service technicians, or television servicemen who wish to profit by more theoretical training.

ESFETA OFFICIALS AT BINGHAMTON MEETING

Three executives of the Empire State Federation of Electronic Technicians' Associations photographed during the annual meeting at Binghamton May 23. Reading from left to right are treasurer Ben de Young of Ithaca, president Max Liebowitz of New York City, and the secretary, Wayne Shaw of Binghamton.

TV INSTRUMENT

National Co.
Malden, Mass.

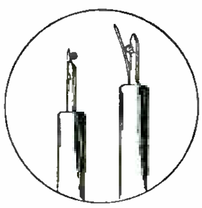


The Videometer is a complete TV receiver with a meter for checking both field strength and line voltage. With it, the technician can avoid measuring ghosts and noise instead of the desired signal when making installations.

TEST PRODS

United Technical Laboratories
Morristown, N. J.

The Klipzon test prod has a point with an opposed steel needle which, when pressed against a wire, lug, or terminal, slides on and grips until

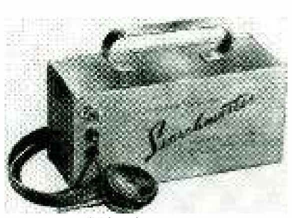


pulled off. The points are made of non-magnetic steel alloy and are needle sharp for piercing insulation. The prods are supplied with red and black Synthane handles and 4-foot red and black test leads.

GEIGER KIT

Science Kits, Limited
Hollywood, Cal.

The Searchmaster kit contains everything needed to assemble a Geiger counter that detects both beta and gamma radiation. The counter is completely portable.



Each set includes tubes, batteries, resistors, capacitors, sockets, type SK-1 Geiger tube, headset and a metal case as well as complete step-by-step instructions for assembling the instrument.

To demonstrate the kit, the manufacturer includes a radioactive specimen with each order.

PLASTIC CAPACITOR

P. R. Mallory & Co., Inc.
Indianapolis, Ind.

The Plascap capacitor is made with a plastic material which adheres securely to the wire leads. This technique, previously considered impossible because any plastic which would stick to the leads would stick to the molds, was achieved by centering the capacitor in a tough plastic shell and then filling with the special adhesive plastic compound. It results in a moisture-proof capacitor.

MICROPHONE

Radio Corporation of America
Camden, New Jersey

The RCA Type KB-3A is a high-fidelity microphone with anti-noise and anti-feedback properties.

It is a velocity ribbon-type microphone with bi-directional characteristics to which necessary acoustic resistances have been added. The response-frequency characteristic of the microphone for a source 3/4-inch distant is essentially flat over the audio range of 50 to 10,000 cycles.

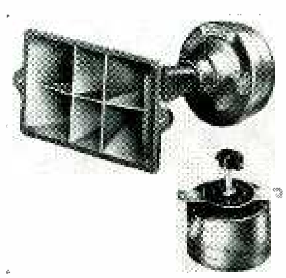
The anti-noise microphone discriminates against a distant source in favor of a close source by values ranging from 6 db at 1,000 cycles to 30 db at 100 cycles for equal sound pressures at

the microphone element. In addition, because of the directional pattern, the discrimination against random noise is better than the above values by an additional 5 db.

MULTI-CELL TWEETER

Atlas Sound Corp.
Brooklyn, N. Y.

Model HR-2 multi-cellular tweeter and high-pass filter is designed for use with any suitable type of cone speaker woofer.

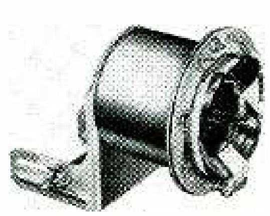


The horn has six cells which offer a wide-angle distribution pattern. The frequency response is efficient up to 15,000 cycles. The unit will handle 25 watts of program material above 1,000 cycles. The die-cast horn is 6 3/4 inches wide, 3 1/2 inches high, and 8 inches deep. The front of the horn is designed for flush mounting.

TV SWEEP YOKE

General Electric
Syracuse, N. Y.

This new sweep yoke will sweep up to 70-degree picture tubes with high efficiency. When used with associated G-E sweep components, the horizontal



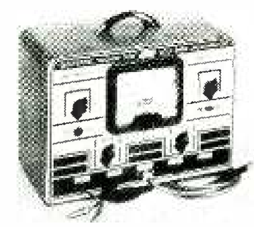
sweep system requires only 20 watts of horizontal input from a 250-volt line.

Horizontal inductance of the new yoke is 18 mh, while vertical inductance is 30 mh. It is available with either a laminated, or for higher efficiency, a ferrite core. These high efficiency units are designed especially for large-diameter tubes.

NEW V.T.V.M.

Feiler Engineering Co.
Chicago, Ill.

The model TS-9 is a new all-purpose v.t.v.m. Its ranges are: for both a.c. and d.c. voltages, 0-5-10-100-500-1,000 volts; decibels from -20 to -16 db; resistance from .2 ohms to 1,000 meg-



ohms in 5 steps; and 0-1 ma d.c. Input impedance is 26 megohms on d.c. and 3 megohms on a.c.

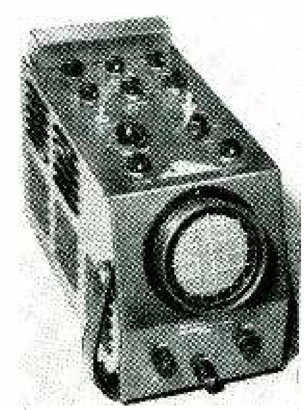
The meter uses two separate tubes in a balanced bridge type circuit with inverse feedback.

The two separate tubes are used because replacement costs in the event of tube failure are less than if a dual triode is used.

POCKETSCOPE

Waterman Products Co.
Philadelphia, Pa.

The model S-14-B Wide Band Pocketscope is designed for compactness and

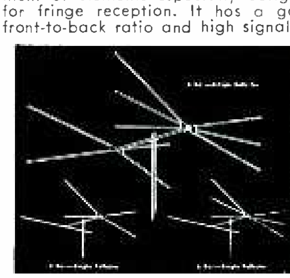


portability. It has amplifier fidelity constant within 2 db from d.c. to above 700 kc without peaking. Its linearized triggered or repetitive time base is continuously variable from 1/2 cycle to 50 kc with either ± polarity of sync or trigger. Amplifier sensitivity is of the order of 50 mv r.m.s./inch and internal calibration of trace amplitude is provided. Observation of limited wave form areas are facilitated by a trace expansion better than four times screen face. Input attenuators and gain controls are non-frequency discriminating.

TV ANTENNA

Brach Mfg. Corp.
Newark, N. J.

The 6-Bar is a factory preassembled TV antenna having a fan-type arrangement of elements especially designed for fringe reception. It has a good front-to-back ratio and high signal-to-



noise ratio and it can be coupled directly to 72-, 150-, and 300-ohm transmission lines. Horizontal or "X" type reflectors may be used.

The antenna is shipped with its elements folded against the boom. They fold out somewhat like an umbrella for installation.

NOISE LOCATOR

Sprague Products, Co.
North Adams, Mass.

The model 302 radio interference locator for the 550 kc to 30 mc frequency range is designed specifically for use by public utility troubleshooters and others interested in man-made radio noise location and reduction, and in power line preventive maintenance work.

The instrument uses a sensitive 8-tube superheterodyne circuit and operates either from self-contained batteries or 115-volt mains. An auxiliary inverter power supply is available for automobile battery operation.

Other features include a built-in loudspeaker, built-in dual range output meter and battery test meter, calibrated r.f. and audio gain controls, and a beat-frequency oscillator for detecting unmodulated signal sources.

Each locator is supplied with both a loop and a collapsible rod antenna for normal use. An r.f. search probe, insulated for 35,000 volts, is also available for cable fault location.

MICRO CAPACITOR

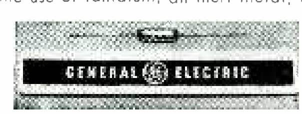
Aerovox Corp.
New Bedford, Mass.

Type P83Z Aerolite capacitors, called "micro-miniatures", are only 3/16 inch in diameter and 7/16 inch long. They are available in 400-volt ratings with capacitances from .0005 to .003 μf and in 200-volt ratings with capacitances from .005 to .01 μf. Their small size is made possible by the use of a metallized dielectric which provides both dielectric and electrodes. These capacitors have a very low self inductance, which makes them useful for high frequency applications.

TANTALYTIC CAPACITOR

General Electric
Schenectady, N. Y.

The new 1-μf, 150-volt Tantalytic capacitor has a size reduction of 90% in comparison to that required by paper capacitors and promises longer life than aluminum electrolytics. These characteristics are made possible by the use of tantalum, an inert metal, in



foil form together with a new non-corrosive electrolytic. The capacitor has lower leakage currents and better low temperature characteristics than conventional electrolytics and is particularly useful in applications where small size is a major factor.

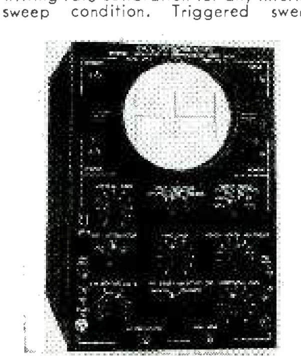
OSCILLOSYNCHROSCOPE

Browning Laboratories, Inc.
Winchester, Mass.

The model ON-5 oscillosynchroscope is designed for study of pulse and transient phenomena as well as for conventional oscilloscope uses.

Vertical amplifier response is flat within 3 db from 5 cycles to 5 mc. Horizontal amplifier is direct-coupled with high-frequency response extending to 500 kc.

The sweep generator may be triggered or recurrent with direct-reading writing-rate calibration for any internal sweep condition. Triggered sweep



speeds from 1.0 msec per inch to 25,000 msec per inch and recurrent sweeps of 10 to 100 kc are available.

An adjustable calibration voltage may be used for determination of vertical deflection voltage amplitudes. Either d.c. or a.c. connection may be made to all deflection electrodes. Also provided is a panel connection to the cathode-ray tube cathode for external beam modulation. The ON-5 is housed in a steel cabinet.

ANTENNA TOWER

Thompson & Ruby, Inc.
Brownstown, Ind.

This new all-aluminum home antenna tower is shipped in riveted sections ready for the installer to join together.

The tower is light in weight, and has a swivel base which makes it adaptable to any type mounting.

CHEST MICROPHONE

Altec Lansing Corp.
Hollywood, Cal.

The 155A Chestplate suspends from the user's neck and carries a 21B capacitor microphone just at the correct distance from the user's mouth. The combination is particularly useful for

announcers and lecturers who must move about while speaking. An impedance matching tube is contained in the chestplate, and the microphone may be used as far as 400 feet from associated equipment.

HV COUPLER

Clarostat Mfg. Co., Inc.
Dover, N. H.

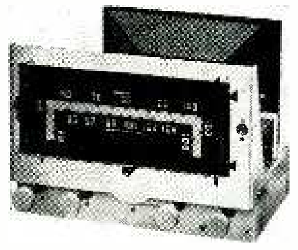
The high-voltage coupler and spacer assembly, 59-186, with nylon insulator shaft, RN-3", for use in high-voltage circuits, is now made available in all Clarostat Pick-A-Shaft type controls, Types AM and AT.

The high-voltage insulator sleeve screws on to the control bushing while its threaded metal-stud end takes the mounting nut. The nylon shaft slips into the control's slot and is gently tapped to snap it permanently in place for the integral control and shaft combination. The high-voltage coupler is rated at 10,000 volts breakdown test.

FM-AM TUNER

Meissner Mfg. Div.
Mt. Carmel, Ill.

A new addition to the Meissner line of tuners, the 9A is complete with



audio and is designed for the low price field.

The tuner has provisions for phono input, full tone control, temperature compensation on FM, and high selectivity and sensitivity. All controls are on the front panel and also operate on phono.

LINE TRANSFORMER

Lynmar Engineers
Philadelphia, Penna.

This transformer is made to match a 70–95-ohm coaxial line to the 300-ohm input of any television receiver. (It may also be used to match a 300-ohm antenna lead to a receiver made for 70–95-ohm coaxial line.)

Some television receivers have connections for both coaxial line and 300-ohm ribbon line. Even with these receivers an improvement is sometimes noted when the coaxial antenna lead is connected to the 300-ohm receiver input through one of these impedance matching transformers.

VOLTMETER

Induustrial Devices, Inc.
Edgewater, N. J.

This new adaptation of the Mini-Volt Voltmeter is the model 410A. It features an expanded scale centered on the common 110- and 220-line voltages, and is accurate to within 2 volts at 110 volts a.c. All features that made the model 400B Mini-Volt famous are retained in this new model. Practically burn-out-proof operation is assured by the glow-lamp indicator which is guaranteed for a minimum of 25,000 hours of operation. 12-inch flexible test leads are tipped with heavily insulated test prods. To assure maximum user safety, the plastic case withstands rough treatment in everyday use. The 410A Mini-Volt as well as the model 400, is not subject to the false indication common to neon test lights.

LIGHTNING ARRESTOR

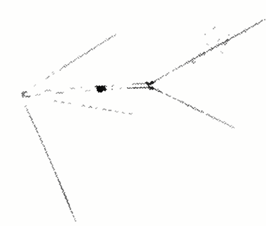
LaPointe-Plascomold Corp.
Unionville, Conn.

The new Model RW 204 is produced for use with the 4-wire cable employed with antenna rotators. It is also designed to serve with standard 300-ohm ribbon transmission line. Pin-point contacts eliminate the need for wire stripping—the arrestor is installed by simply tightening down the cover with two wing nuts.

END-FIRE ANTENNA

Workshop Associates, Inc.
Needham Heights, Mass.

The DUBL-VEE, an all-channel television antenna, uses the end-fire principle with two V's mounted in the same



plane and driven in phase to achieve maximum gain.

Gains up to 7.5 db are possible with single bays, and a double stack has gains up to 10 db with an average standing wave ratio, when matched to 300-ohm line, of less than 2 to 1 over the entire band. Half power angle is 82 degrees on channel 2 and sharpens to 26 degrees on channel 13. The antenna is especially designed for reception in low signal strength areas.

PLUG-IN CHASSIS

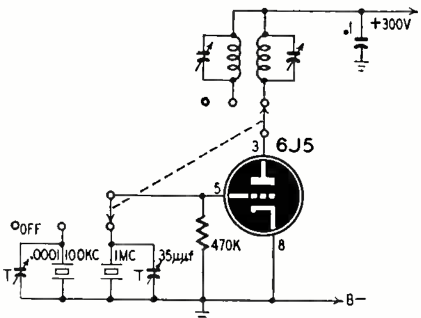
Cinema Engineering Co.
Burbank, Cal.

This new line of plug-in amplifier chassis follow telephone equipment practices. They can be mounted in three positions: on the front or the back of a relay rack, or horizontally through the front of the rack panel, whichever is most convenient.

When mounted on the front or back of a relay rack, chassis is vertical, similar to conventional telephone selector switch mounting. Mounting frames are available to accommodate either vertical or horizontal mounting. Chassis are available in a number of different widths.

CRYSTAL FREQUENCY STANDARD

Section 12.135 of the FCC rules and regulations governing amateur radio services states that the licensee of an amateur station shall provide equipment or a means for measuring the carrier frequency of the transmitter. The equipment shall be independent of the transmitter control system and sufficiently accurate to assure operation within the band being used. Some amateurs use receivers to check the band edges although few receivers are sufficiently stable or accurate for this purpose. An inexpensive crystal calibrator which provides 100-kc and 1-mc markers to 30 mc or higher was shown in *Short Wave Magazine* (London).



The circuit is a triode oscillator having 100-kc and 1-mc crystals and tuned circuits in the grid and plate circuits, respectively. The 100-kc coil may be a winding from a 132-kc i.f. transformer or a 30-mh choke. The 1-mc coil may be the secondary of a broadcast antenna or r.f. coil, or a 0.75- to 2-mh r.f. choke. Each plate coil is tuned to resonance by connecting a 10- or 15-ma meter in the cathode circuit and adjusting its tuning capacitor for minimum current.

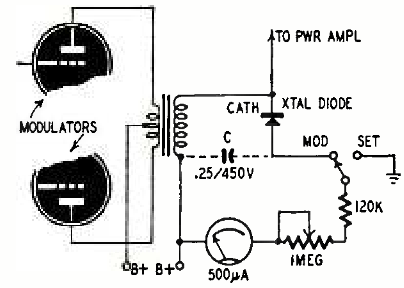
The crystals should be adjusted to exactly 100 kc and 1 mc by beating their harmonics of fundamentals against broadcast stations having frequencies harmonically related to the crystal frequencies. The 100-kc crystal can be checked against broadcast stations operating on 600, 700, 800, 900, and 1000 kc. The 1-mc crystal can be checked against the 1000-kc broadcast station or WWV on 5 or 10 mc.

SIMPLE MODULATION METER

A somewhat unusual modulation indicator for AM transmitters was built by G2AIQ and described in *Short Wave Magazine* (London). The circuit is shown.

The unit consists of a surplus 500-μa d.c. meter, crystal diode, two resistors, and a s.p.d.t. switch. When the switch is in the SET position, the meter measures the d.c. plate voltage applied to the modulated amplifier. Because the d.c. and a.c. voltage across the secondary of the modulation transformer are equal during 100% modulation, the a.c. voltage can be measured and the meter calibrated in modulation percentage.

Throw the switch to SET and adjust the 1-meg control until the meter reads 400 μa. Throw the switch to MOD and modulate the transmitter. The meter will then read the a.c. voltage across the secondary of the transformer. Since the meter is adjusted to 400 μa



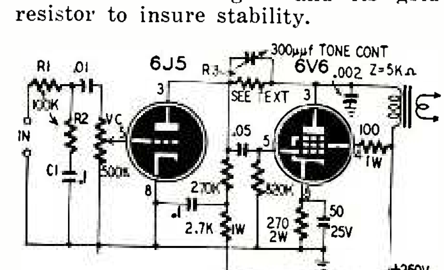
for the d.c. plate voltage, 400μa will indicate 100% modulation and 200 μa will indicate 50%.

Because this meter has a sensitivity of 2,000 ohms per volt, the resistors will have to be changed when the plate voltage is higher than 350 or when a different meter is used. Capacitor C damps the meter so it rises rapidly and falls slowly. The voltage rating of C should be sufficient to withstand voltage peaks across the secondary.

SIMPLE A.F. AMPLIFIER

A novel two-stage, general-purpose audio amplifier was described in *Short Wave Magazine* (London). Its circuit is shown in the diagram.

Because this unit may be used with crystal pickups, a bass-boost circuit consisting of R1, R2, and C1 were added. The author claims that the amplifier works well without bias on the 6J5. However, we would suggest that a 1,200-ohm resistor be inserted in the cathode circuit as an experiment. This resistor may or may not be bypassed. A 47,000-ohm resistor can be placed between the 6V6 grid and its grid resistor to insure stability.

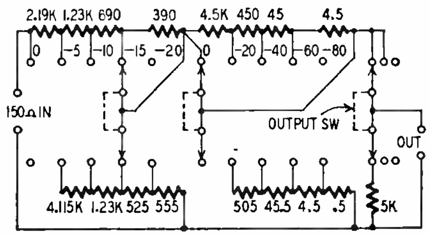


Negative feedback between the 6J5 and 6V6 plates is through resistor R3. Try a 4.7-megohm unit and experiment with other values to find one which gives noticeable improvement in quality without reducing the gain below useful levels. A 300-μμf trimmer capacitor is connected across this resistor as a tone control.

CALIBRATED ATTENUATOR

Calibrated attenuators are useful additions to audio oscillators and some types of special-purpose a.f. amplifiers. A switched attenuator having input and output impedances of 150 and 5,000 ohms, respectively, is described in *Wireless World* of London. The circuit is shown.

One switch is calibrated from zero to 20 in steps of five decibels, and another from zero to 80 in steps of 20 decibels. The resistors can be made by connecting in series and parallel known values or by winding them with resistance wire.

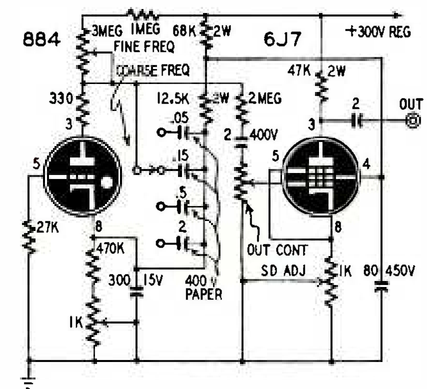


The output switch connects a 5,000-ohm resistor across the output of the network when correct termination is required. Additional positions are provided for feeding an external 5,000-ohm load and for turning off the signal. The attenuator calibration will not be correct if the load across the output is more or less than 5,000 ohms.

LOW-SPEED SWEEP GENERATOR

Designed to have an unusually low range of frequencies, this sawtooth generator was used to modulate a Klystron in a microwave spectrograph described in *The Review of Scientific Instruments.*

Covering from 2 to 160 cycles, this circuit will make a useful addition to oscilloscopes having sweep generators



which cannot be adjusted lower than 20 or 25 cycles. In this case, the sweep may not be sufficiently stable or accurate at the end of its lowest range.

The 884 is a conventional relaxation oscillator and the 6J7 is a sawtooth amplifier delivering a sawtooth having its amplitude variable between 0 and 100 volts.

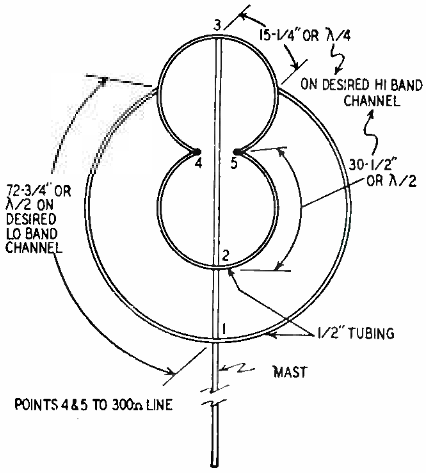
NOVEL TV ANTENNA

After reading "Antennas for Television" in the June, 1949, issue, I constructed a circular antenna for channel 5, the weakest in my location. Because the harmonics of channel 5 do not fall in the TV band, I was unable to receive channel 9. Not wanting to erect separate high- and low-band antennas, I experimented and developed what I call a tricircular antenna which performs well on both bands.

The antenna consists of three circular antennas connected as shown. The smaller ones, for channel 9, are 61 inches in circumference; and the larger, for channel 5, is 145½ inches in circumference.

Points 1, 2, and 3 connect to the mast. Points 4 and 5 are 3 inches apart for connecting a 300-ohm transmission line. The ends of the larger loop connect to a smaller one at points a quarter wavelength from its open ends.

Reception can be peaked on any band by making the circles a full wavelength in circumference at the weakest channel. The circles are made from ½-inch aluminum or copper tubing.



Dimensions for other channels are given in the article named in the June, 1949, issue. These dimensions need not be corrected for end effects.—*C. F. Alberti*

REPLACING BANDPASS COILS

Many of the older superhet receivers have three-gang tuning capacitors and a bandpass antenna circuit (Fig. 1) instead of a tuned r.f. amplifier. If it is necessary to replace either of these coils—they are usually on the same form—they are hardly ever available unless the manufacturer has them in stock.

Fig. 2 shows how the original circuit can be altered to permit the use of standard slug-tuned antenna coils. Remove and discard the old coils and replace them with two universal antenna coils mounted side by side so

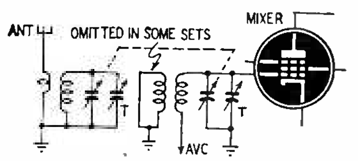


Fig. 1—Antenna circuit before changes.

there is common coupling between them. The coils may be mounted above or below the chassis.

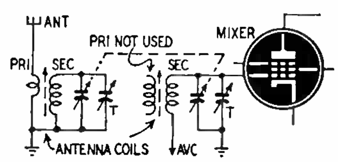


Fig. 2—The circuit after alterations.

After aligning the slugs at 600 and the trimmers at 1600 kc, some sets perform better than they did with the original coils.—*Wilbur J. Hantz*

REDUCING BATTERY DRAIN

Some amplifiers and receivers designed for 6-volt operation have 300-ma tubes which place a heavy drain on the battery. Heater current can be reduced to half its original value by replacing the 300-ma tubes with corresponding 150-ma types. Some direct substitutions are: 6S7 for 6K7, 6SS7 for 6SK7, 6W7 for 6J7, 6T7 for 6Q7, 6D8 for 6A8, 6ST7 for 6SR7, and 6SZ7 for 6SQ7. The minor differences in transconductance, amplification factor, or plate and screen currents will not affect the performance of the average receiver or amplifier.

It is possible to substitute a 6ZY5 for a 6X5 or 6W5-G and save 300 or 600 ma, respectively, if the B-drain is less than 40 ma, a 6X5 for 6W5-G if the drain is less than 70 ma. An OZ4 will replace any of these rectifiers if the B-drain is between 30 and 75 ma.—*Charles Erwin Cohn*

TV ANTENNA INSTALLATIONS

TV antenna installations in fringe-areas can be simplified by using a detailed road map of your vicinity, a compass, and a radiation pattern of the antenna you plan to use. Mark the locations of all nearby TV stations on the map. Center the radiation pattern over the spot where the antenna is to be installed. You will be able to see exactly where the major lobes lie in respect to the different stations.

This system has been used to locate the source of reflections and has proved helpful in bringing in a weak channel. If the antenna you select does not have lobes which point toward all stations, try the pattern of another type of antenna.

Radiation patterns for various types of TV antennas can be obtained from manufacturers or from their catalogs and sales literature.—*John J. Pagano*

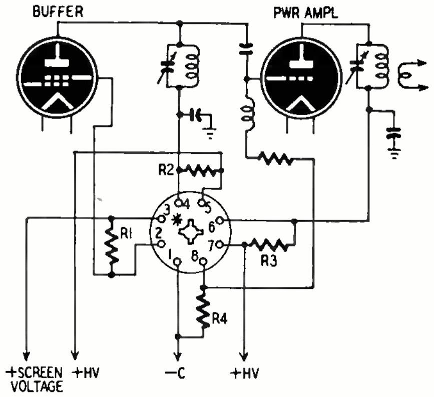
TRANSMITTER METER PLUG

Metering a multistage transmitter is usually done with a rotary tap switch or by plugging the meter into panel jacks connected in the various circuits. The first method is convenient; but since the meter leads are usually soldered to the switch, the meter can not be used for other purposes. The plug-and-jack scheme is more flexible because it permits the meter to be used elsewhere; but it can be dangerous to the user, particularly where higher voltages are encountered and the jacks are above ground.

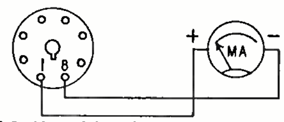
However, with equipment no more elaborate than an octal plug or an old tube base and a slightly modified Bakelite octal socket, it is possible to make a milliammeter switching plug-in arrangement that is foolproof, electrically safe, convenient, and universally usable.

Carefully file three additional locating grooves in the Bakelite octal socket, as shown. Since there are now four of these grooves in the socket, the octal plug may be plugged in in four different ways; to provide a maximum of four circuits into which the meter can be switched. If more circuits are desired, a second socket can be used to supplement the first.

Then solder the meter leads, which can be of any convenient length, to the octal plug. One good way is to connect the meter positive lead to pin 1 and the negative lead to pin 8. That completes the meter plug.



*FILE IN 3 ADDITIONAL KEY LOCATING GROOVES
BOTTOM VIEW OF SOCKET SHOWN



METER CONNECTIONS TO OCTAL PLUG-BOTTOM VIEW

The modified socket may be wired into a typical circuit as shown in the diagram. Resistors R1, R2, R3, and R4 are shunting resistors which have a negligible effect on the operation of the meter or the circuit. They may be from 20 to 100 ohms in value. The higher resistances are used in low current circuits, and the lower resistances in high current circuits. The actual resistance value is not critical and 47- or 68-ohm, 2-watt carbon resistors will do very well. An alternative method is to use a 1-ma meter and make R1, R2, R3, and R4 appropriate shunting resistances to extend the range of the meter to the best value for the particular circuit in which it is to be used. When the meter is across R1, R2, R3, and R4, it reads buffer screen, buffer plate, power amplifier plate, and power amplifier grid currents, respectively when the plug is rotated.

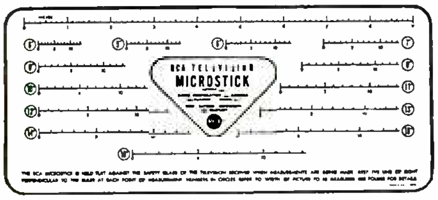
Using the meter switching plug is quite simple. Just rotate the plug to the desired locating groove and plug it in. The meter will then measure the current in that circuit.—*Edwin W. Hill*

WORKBENCH KINK

I have a small but powerful permanent magnet fastened to the wall behind my work-bench. Whenever I am working from a diagram or from sheets of notes, I place the papers against the magnet and then lay a small piece of magnetic metal on top of them. Thus I have a magnetic clip board which does not damage the papers while keeping them out of the way where they will not become soiled, burned or torn.
—*Forrest Rand*

TV RULER

A television ruler that checks a number of the important factors in television reception has been developed by the RCA tube department as an aid to service technicians. The "Microstick" is a flat plastic ruler that is held against the picture tube face while making checks.



The Microstick may be used to measure the bandwidth of a receiver, calibrate vertical wedges in test patterns, determine the beat frequency of interference, and measure the air path distance of ghosts or other reflected signals.

The design of the ruler is based on the 53.3-microsecond duration of one horizontal line. The length of the ruler is equal to the picture width and it is divided into 53 equal divisions. Each division represents 1 microsecond so that the duration of any signal in the picture can be measured. Knowing the duration of the signal, its frequency can be calculated easily. The ruler is scaled for use with all picture tube sizes.

CK703 AUDIO OSCILLATOR

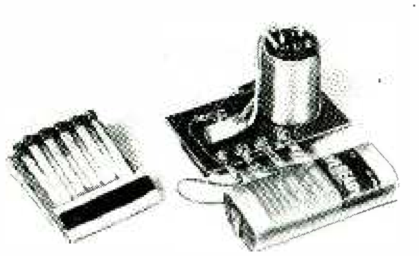


Photo of the CK703 crystal triode audio oscillator described in the June issue ("Experimental Circuits for Crystal Triodes", page 66). The fixed capacitor across the Ouncer winding is removed to get the highest frequency (in this case 5,000 cycles) from the transformer.

MISTAKE CORRECTOR

A new faculty for modern computers—the ability to correct mistakes as well as to detect them—has been developed at the Bell Telephone Laboratories by Dr. R. W. Hamming.

Most computers can recognize if they have made a mistake, but the new development makes it possible for the machine to correct its own mistake and proceed to the correct answer. The new method can be applied to any type of digital computer either of the electronic type or the relay type.

A laboratory model of the corrector has been made that will catch and correct one mistake and catch—but not correct—two simultaneous mistakes. The chances of two simultaneous mistakes occurring are about one in a million.

FREDDIE'S FUND

We have received the following letter a short time ago from Herschel Thomason, the radio technician whose little son's plight was described in the June issue of RADIO-ELECTRONICS.

"Dear Editor:

Received another bunch of checks from you yesterday and sure was glad to get them. I believe this brings the total to $774.

"I am enclosing a picture of Freddie that was taken about two weeks after

he received his legs. You will notice that he is really interested in something on the sidewalk.

"We really appreciate your help and thank you again.

Herschel Thomason"

We are still accepting contributions for Freddie. Remember, no contribution is too small! A list of further contributors follows:

Balance from April 26	$769.00
Anonymous—Philadelphia, Pa.	$1.00
Anonymous—Pittsburgh, Pa.	1.00
Anonymous—San Antonio, Texas	5.00
Belmont Radio—St. Petersburg, Fla.	5.00
C. L. Bolton—Norfolk, Va.	1.00
Louis T. Buelter—Jamaica, N. Y.	1.00
Francis J. Chamberlain—Dover, N. H.	5.00
Dan and Butch—Philadelphia, Pa.	1.00
Walter De Clue—Herculaneum, Mo.	1.00
Van H. Ferguson—Tallahassee, Fla.	2.00
John T. Frye—Logansport, Indiana	2.50
Robert M. Harvey—North Wilkesboro, N. C.	10.00
A. A. Horton—Norfolk, Va.	1.00
Lillian L. Horton—Norfolk, Va.	1.00
Hytron Radio & Electronics Corporation —Salem, Mass.	100.00
Inman's Radio Service—Frankfort, Ky.	5.00
Insuline Corporation of America —Long Island City, N. Y.	10.00
A. J. Kaluza—Conneaut, Ohio	5.00
LaPointe Plascomold Corp.— Unionville, Conn.	5.00
E. Ludwig—Port Clinton, Ohio	1.00
Dean Post—Arlington, Va.	5.00
Radio Center—Norfolk, Va.	1.00
Lewis Scriven—Brooklyn, N. Y.	10.00
Bobby and Linda Suter—Maple Heights, Ohio	1.00
Sylvania Electric Products, Inc.— New York, N. Y.	100.00
E. Williams—Port Clinton, Ohio	5.00
R. V. Williams—Norfolk, Va.	1.00
Wise—Chicago, Ill.	2.00
Total as of May 29	$1057.50

TV SERVICE DATA

To meet the service technician's need for service data on new sets which have just appeared on the market, Howard W. Sams Co. has initiated a new special service. A supplement containing manufacturers' schematics and other data on just-released televisers is being enclosed with each regular folder. The service technician can use the schematic to solve most of his problems until the complete folder on the receiver has been prepared.

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.

JULY, 1916, ELECTRICAL EXPERIMENTER

Modern Radio Transmitting Apparatus
Receiving Two Radio Messages on One Aerial
A Listening-in Switch for Radio Receptors
High Spark Frequency in Radio-Telegraphy, by Peter G. M. Clute
A Precision Variable Condenser
Utilizing Fuse Parts in a Detector, by Frank Talone
New Hook-up for Undamped Oscillations, by Francis R. Pray
Tubular Audion Hook-Up
Wave Length Computation

TWO CORRECTIONS

Captions are reversed on the resistance and capacitance zero adjustment controls in the "Signal Tracer and V.T.V.M. Combined," on page 44 of the May issue. Our thanks to Mr. Louis A. Josephson, of Bloomington, Ill., for this correction.

Mr. Hatfield, the designer of the instrument informs us that by using a d.c. v.t.v.m. probe having a 1.1-megohm isolating resistor, it is possible to measure voltages in circuits having extremely high impedance. This probe will multiply the meter reading by 1.1. A peak-reading a.c. probe can be used for measuring r.f. voltages. The multiplication factor of the probe will depend on the type which you use.

The capacitor across the converter output transformer T1 in the schematic of the Low-Noise FM Front End on page 62 of the June issue is shown as 25 μf. The correct value is 26 μμf. Its actual value may vary slightly with the transformer you use.

TITLE CHANGE

John F. Rider Publisher, Inc., announces the title of its forthcoming book, *New Cathode-Ray Tube at Work*, has been changed to *Encyclopedia on Cathode-Ray Oscilloscopes and their Uses*. The book deals with oscilloscopes and syncroscopes manufactured during the past ten years.

800-WATT AMPLIFIER

? *Please prepare a diagram of an 800-watt final amplifier and multiplier for use with my 25-watt, 80-meter v.f.o. I would like to use 813's in the final and one or two 3C24's in the multiplier stage. The Q of the final tank circuit should be about 12 on all bands between 3.5 and 30 mc. This unit is to be link-coupled to the v.f.o.—E.M., Philadelphia, Penna.*

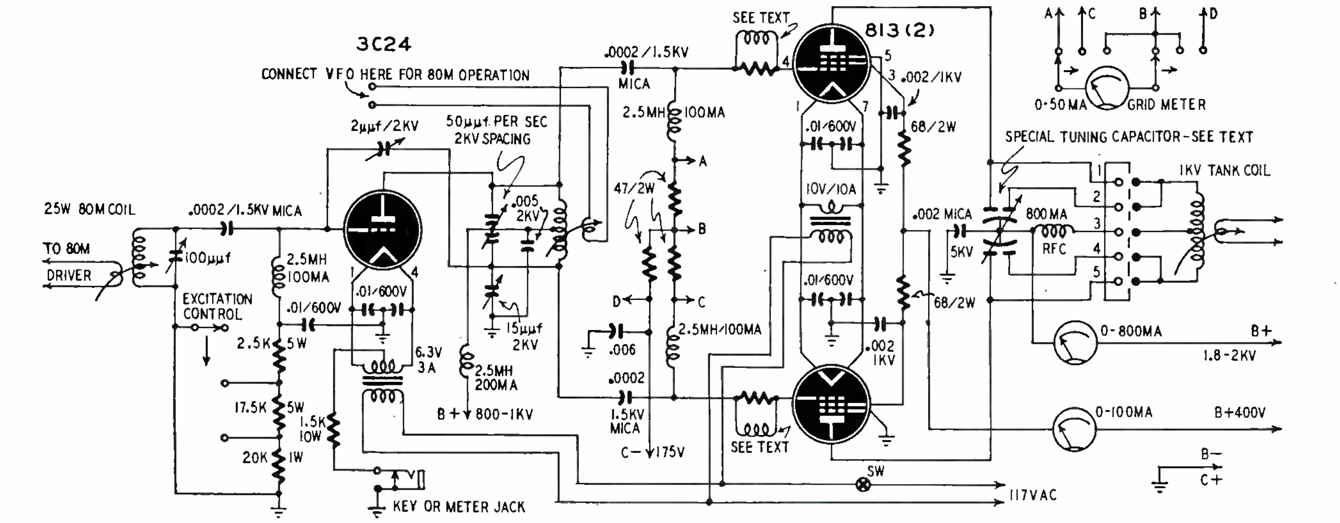
A. It is highly possible that the 3C24 will supply sufficient drive when its plate circuit is working at 2, 4, and 8 times the input frequency. When working straight through on 80 meters, the 3C24 should be turned off and the link from the v.f.o. connected to the 50-watt coil in 813 grid circuit. Swinging links and a variable grid leak in the multiplier stage permit the loading to be adjusted to meet operating conditions. 3C24 grid current is 15 ma for second-harmonic operation, about 8 ma for the fourth harmonic, and 5 ma on the eighth. It may be necessary to experiment with the grid current and grid-leak resistance when multiplying to 10 meters. Be sure that the plate dissipation does not exceed 25 watts.

Parasitic suppressors consisting of approximately 15 turns of No. 20 enamel wire around a 1-watt, 100,000-ohm resistor are placed in the grid circuits of the 813's. The r.f. choke in the 813 plate circuit should be of the all-band type. A National type R-175 or equivalent will work nicely.

The final tank capacitor is a special job made by isolating approximately one-fourth of the stator plates in each section of a 100-μμf-per-section variable with 0.2-inch spacing. The isolated sections are connected across terminals 1 and 5 on the jack bar. The remaining capacitor sections are connected to terminals 2 and 4. The 10- and 20-meter coils are modified to connect between terminals 1 and 5. The 80- and 40-meter coils have jumpers between plugs 1 and 2, and 4 and 5, therefore, the full capacitance of each section is available on these bands.

A switch on the grid meter permits the operator to read at will the grid current of each 813 separately or the total grid current. The 15-μμf variable between the multiplier plate coil and ground balances the grid currents.

This rig will do a nice job on the phone bands if it is plate modulated. Approximately 400 watts of audio is required for 100% modulation. If the modulation transformer does not have separate plate and screen windings, the 813 screen voltage should be obtained from the plate supply through a dropping resistor. The v.f.o. should have a buffer stage to prevent frequency shift during modulation peaks or keying.



INSTANT-HEATING INTERCOM

? *Have you printed a circuit of an instant-heating intercommunicator in the past two or three years? If so, in which issue? If you do not have a circuit, please prepare one for me.—R. C. B., Durham, N.C.*

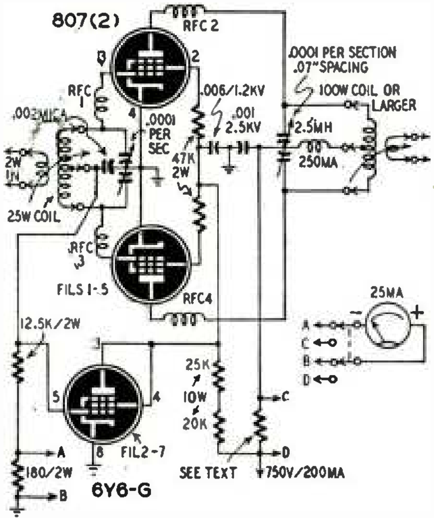
A. A circuit of an instant-heating intercom was described in an article on page 41 of the September, 1948, issue of RADIO-CRAFT. This issue is available from this office for 40¢.

A selenium rectifier and battery tubes eliminate the warm up time.

PUSH-PULL FINAL

? *I have a Signal Shifter and would like a diagram of a pair of push-pull 807's to be driven by this unit. Please provide a means of protecting these tubes in the event of excitation failure. I would like to use commercial coils in the input and output stages. Please design the stage for 150 watts input.—W. C. K., Cumberland, Md.*

A. This amplifier has been so designed that neutralization is not required. Mount the grid coil and its tuning capacitor under the chassis and the plate components above it. The 47-ohm resistors in the screen leads and the r.f. chokes in plate and grid leads eliminate parasitics. The chokes consist of 18 turns of No. 20 enameled



wire close-wound on a ¼-inch form or a 1-watt resistor of several thousand ohms. The shunt between meter terminals C and D should be selected so the full-scale reading of the meter is 250 ma.

SURPLUS DIAGRAMS

? *Can you tell me where I can obtain diagrams and conversion data on most of the surplus radio and electronic equipment on the market?—D. H. R., Canton, Ohio*

A. Technical manuals on some types of equipment are available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. A catalog of available manuals will be sent upon request to the GPO.

Three multigraphed booklets titled *Schematic Manual for Surplus Electronic Equipment—Volumes I and II, and III*, available for $1 each from Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. A free bibliography of sources of information on surplus equipment is also available from the same source.

Other publications on surplus radio and electronic equipment are: *Conversion Diagrams*, published by R & M Radio Co., 1426 N. Quincy St., Arlington, Va. Price $2.00.

Surplus Circuit Diagrams and *SCR-274-N Circuit Diagrams with Conversion Data*, published by Troup Engineering Co., 2221 Grand Ave., Long Beach 4, Calif. The price is $2.00 for the former and $1.00 for the latter.

Surplus Radio Conversion Manual, published by Techno-Graphic Publications, P. O. Box 877, Los Angeles 35, Calif. Price $2.50.

R. E. Goodhart, 345½ N. Palm Drive, Beverly Hills, Calif. has a variety of diagrams for sale. A comprehensive list of the available diagrams, cross-indexed for BC and SCR nomenclatures, is available from him for 25¢.

TRANSFORMER QUERY

? *I have a 350-watt a.f. output transformer designed to be used with class-B 811's operated with zero bias and 1,250 volts on the plates. It has two secondaries. The turns ratio of half the primary to either secondary is 11.6 to 1 How can I use this transformer?—B. G.—New York, N. Y.*

A. Because the turns ratio is 11.6 to 1 for *half* the primary to either secondary, the turns ratio of the full primary to either secondary will be twice this value or 23.2 to 1.

The square of the turns ratio N equals the primary impedance divided by the secondary impedance, or $N^2= Z_p\ Z_s$.

Because the turns ratio is fixed when the transformer is manufactured, we have a choice of matching the load to the tubes or matching the tubes to the load. When the plate-to-plate impedance of a set of tubes is known, the required load impedance is $Z_s=Z_p\ N^2$. If the tubes must match the load, the primary impedance is $Z_p=Z_s N^2$. In this instance, select tubes which will present a plate-to-plate load that approximates the desired primary impedance while delivering the desired power output.

Push-pull-parallel 811's operating under the conditions you have given have a plate-to-plate impedance of approximately 8,000 ohms. Connect the secondaries in parallel-aiding for 15-ohm loads and in series-aiding for 60-ohm loads.

If you use tubes having a plate impedance higher than 8,000 ohms, the load impedance will be higher than 15 and 60 ohms. If the plate impedance is lower than 8,000 ohms, the load impedance will be lower than 15 or 60 ohms if the generator and load circuits are to be matched.

SUCCESSFUL VARIOTENNA

Dear Editor:

Having finally had time to build a slightly altered version of your Transpole Variotenna, here are some comments.

I'm located where gas storage tanks block direct pickup from most stations and where reflections travel crazily into a small enclosed court. I've used an indoor V, a folded dipole and reflector, and a Di-Loop, the latter two on a rotator outside the window. None of these gave satisfactory reception on all channels, and some channels required a booster. The Variotenna provides fair to excellent reception on all seven channels with no booster.

I'm more than satisfied with the results. I have a 4-mc band-pass receiver and want the nearest thing to monitor reception I can get. I consider the Variotenna the best answer I've seen.

LESTER DEL REY
New York, N. Y.

NOTHING NEW IN RADIO

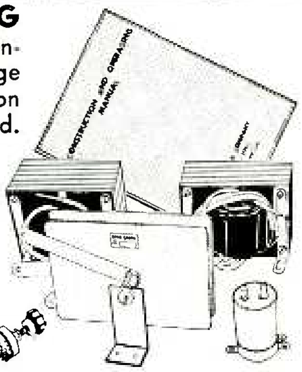
Dear Editor:

In each issue of your magazine we read letters from disgruntled readers who find too much emphasis being placed on TV and non-radio applications of electronics.

Perhaps you should make a point of the fact that there has been nothing really new in AM radio in ten years, and little new information in fifteen. What advances have been made have been in the manufacture of better (in some cases cheaper) components.

Any reasonable comparison with a good 1938 radio and a good 1950 radio is apt to leave one with the feeling that maybe we're going downhill—and don't attempt to compare prices!

EDWARD A. BERNHOLZ
Syracuse, N. Y.



TRANSFORMER WINDING

Dear Editor:

I have found in the article on winding output transformers by James Langham (December 1948) that some important things have been left out which might prevent corrosion.

It is essential to exclude all moisture from the winding. Before touching the wire at all, dip your hands in high-grade transformer oil. Impregnate the interleaving paper with transformer oil. Make sure that the wires are clean. Use fine sandpaper to clean the wire, not a knife or razor. Clean all solder joints with benzine or carbon tet.

I hope these hints may be helpful.

D. E. O'N. WADDINGTON
Natal, South Africa

(Mr. Waddington obviously lives in a very humid climate. These precautions usually are not necessary in most of the United States, but may be useful to readers in other climates.—*Editor*)

"I've seen that voice someplace before."
Suggested by Art Howland, Los Angeles, Calif.

$3.00 FOR CARTOON IDEAS

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

Address
RADIO CARTOONS, RADIO-ELECTRONICS
25 West Broadway, New York 7, N. Y.

LOOK AT PAGE 24!

Dear Editor:

The last two issues of your magazine were especially good. I particularly like the way articles are headed under different classifications such as FM, TV, Test Equipment, etc. Let us have more articles on transmission lines, wire recorders, and FM.

Television has not yet come to this city, but I am trying to keep up with it through your magazine.

RICHARD COOVERT
Portland, Oregon

CAPACITANCE PICKUP

Dear Editor:

I would like to express my appreciation of Arthur Trauffer's courtesy, so often neglected by writers who discuss inventions, in his February story on "FM Phonograph Pickup".

There is one important point in the design of such pickups that will bear more emphasis. The mass, and therefore the motional reactance of the needle, should be reduced to the lowest possible minimum consistent with stiffness and a very high natural vibration frequency. Obviously a tubular form, without such appendages as a needle chuck, a vibratory axis, or extra electrode section will accomplish this object and at the same time provide ample surface area for the capacitance pickup function. Duraluminum or magnesium is the best material. The jewel tip may be cemented into one end of this tubular needle with shellac or other thermo-plastic material.

As Mr. Trauffer suggests, this is a fascinating and fertile field for experimentation with rich rewards in very closely approaching, if not actually realizing, the dream of perfect fidelity of reproduction.

I may add that, dynamically, the response of such a pickup is absolutely linear through much wider ranges of vibration amplitude than are encountered in phonograph recordings. The frequency response curve cannot be other than linear down to zero c.p.s. because this is an amplitude and not a velocity type of device when used with an FM or AM capacitive translator.

B. F. MIESSNER
Miessner Inventions, Inc.
Morristown, N. J.

LIKES MEATY ARTICLES

Dear Editor:

Your magazine is far ahead of anything in this country for the average intelligent radio enthusiast. It puts emphasis on the service technician's trials and tribulations and is a veritable mine of useful information.

The articles are of real meaty interest. I've gathered a larger stack of red hot circuits from one year's copies of RADIO-ELECTRONICS than I have in ten years from the "high-falutin" magazines which, if they do have a circuit diagram, often don't show circuit values.

LESLIE FIELD
Yorks, England

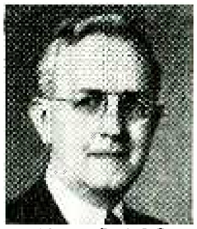
WANTS MORE ON TV

Dear Editor:

I also live out here in Oregon where we have no TV yet, but I am in favor of your TV articles and hope to see many more. I can't agree with Mr. H. D. Thompson's letter in your March issue.

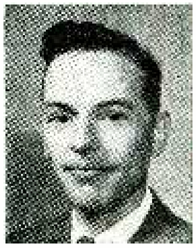
I also like the other articles in your magazine. I would like to see something on a portable vibrator tester that can be plugged in the a.c. line and doesn't take much space.

WM. R. THOMPSON
Salem, Oreg.


MAX F. BALCOM

Max F. Balcom was elected chairman of the Board of Directors of SYLVANIA ELECTRIC PRODUCTS, INC. Mr. Balcom has been associated with Sylvania since 1918, and has long been active in industry activities. President of the RMA in 1948-49, he is presently chairman of the association's television committee.

The board also announced the election of three new directors: EDWARD J. POOR, who resigned as chairman in 1943; RICHARD L. BOWDITCH, president of C. H. SPRAGUE & SON CO.; and H. WARD ZIMMER, vice-president in charge of operations.


J. E. TEMPLETON

J. E. (Earl) Templeton, former manager of the Los Angeles branch of P. R. MALLORY & CO. succeeds WALTER HARVEY as manager of the Wholesale Division. CHARLES GUTHEIL succeeds Mr. Templeton as Los Angeles manager.


THOMAS A. WHITE

Thomas A. White, president of the JENSEN MANUFACTURING Co., and LAURENCE A. KING, president of the ROLA Co., were elected to the Board of Directors of the MUTER Co., television component manufacturer. Both the Rola and the Jensen companies are subsidiaries of the Muter Co.


G. A. BRADFORD

G. A. Bradford has been appointed advertising manager for the tube divisions of the GENERAL ELECTRIC COMPANY, Schenectady, N. Y.

Mr. Bradford, a graduate of Colgate University, has been with General Electric since 1936 in various accounting, sales promotion and advertising positions. Prior to this new appointment, he was responsible for advertising and promoting General Electric motors and controls in the Apparatus Department. He was named credit and collection manager of the G-E Credit Corporation in 1942 before entering war service.

Harry P. Bridge, head of the HARRY P. BRIDGE CO., Philadelphia advertising agency which handles many accounts in the industry, received a life membership in the University of Florida Marketing Society.

Lawrence O. Paul, former business manager at ARMOUR RESEARCH FOUNDATION OF ILLINOIS INSTITUTE OF TECHNOLOGY, a nonendowed and nonprofit organization, was named assistant director. Mr. Paul joined the Foundation in 1946. In his new position he will plan and organize promotional and developmental activities.

J. Benton Minnick was named national merchandising manager for television by MOTOROLA, INC. HOWARD C. HANDWERG was appointed to a similar position in the auto radio division.

Barney Balaban, president of PARAMOUNT PICTURES, and EDWIN L. WEISL were elected to the Board of Directors of ALLEN B. DU MONT LABORATORIES, INC. They replace BERNARD GOODWIN and ARTHUR ISREAL, JR., who resigned.

Percy L. Spencer was named vice-president in charge of RAYTHEON MANUFACTURING CO.'s power tube division. At the same time, NORMAN B. KRIM was promoted to vice-president in charge of the receiving tube division and ERNEST F. LEATHEM was appointed assistant to the president.

Alfred Zuckerman was elected a Vice-president of DAVID BOGEN CO., INC. He will continue as chief engineer in charge of design and development.

Clarence S. Tay, formerly general manager of the ADMIRAL CORP.'s four distributing divisions, has been elected president and board chairman of these divisions.

Personnel Notes

John S. Meck, Plymouth, Ind., television set manufacturer, has acquired a substantial stock interest in the SCOTT RADIO LABORATORIES, INC., and has assumed the presidency of that firm. . . . **Leonard Ashbach** acquired a controlling interest in WILCOX-GAY CORP. Mr. Ashbach has assumed chairmanship of the board of directors. . . . **Jack Pettersen** appointed assistant advertising manager and **N. H. (Terry) Terwilliger** sales promotion manager of MOTOROLA, INC. . . . STARRETT TELEVISION CORP. named **Stuart D. Clayton** regional sales manager of the Midwest area. . . . AIR KING PRODUCTS CO., INC., announced the following appointments:—**S. M. Decker,** assistant chief engineer; **I. J. Melman,** head of the advanced development division; **James White,** manager of contract sales. . . . **Dr. Donald B. Sinclair** appointed chief engineer at GENERAL RADIO CO.

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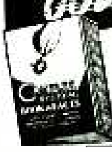

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TELEVISION SERVICING, by Solomon Heller and Irving Shulman. Published by McGraw-Hill Book Company, Inc., N.Y. 6½ x 9½ inches, 434 pages. Price $5.50.

This practical book is written for the service technician who wishes to do television work. The first five chapters present enough information to enable the reader to make a good receiver installation, chapter 6 gives a summary of TV troubles, ten more chapters deal with individual receiver stages and trouble localization, and the last chapter discusses remedies for interference trouble. The book is written in a very clear, easy-to-read style.—*MW*

A DICTIONARY OF ELECTRONIC TERMS, edited by Harry L. van Velzer. Published by Allied Radio Corporation, Chicago, Ill. 6 x 9 inches, 64 pages. Price 25 cents.

Edited by an associate professor of electrical engineering of the University of Illinois, this dictionary contains over 2,500 television, radio and industrial electronic terms. The definitions cover modern techniques principally, though many words no longer in general use are included for historical reasons.

FUNDAMENTALS OF RADIO-VALVE TECHNIQUES, Book I of Philips' Technical Library, by J. Deketh. Published by N. V. Philips' Gloeilampenfabriken, Eindhoven, Netherlands. Distributed in U.S.A. and Canada by Elsevier Pub. Co., New York. 6 x 9 inches, 557 pages. Price $5.00.

Devoted to properties, principles, and construction of radio and electronic tubes, this is an up-to-date work which will appeal to persons engaged in designing, maintaining, or studying radio receivers, amplifiers, or allied electronic circuits.

The 33 chapters have such titles as Basic Principles of the Action of a Radio Valve, Electron Emission, The Construction of Radio Valves, Consequences of Curvature of the Characteristics, Noise of Amplifying Valves, Negative Feedback, and Microphonic Effect. All chapters are illustrated with drawings, charts and photographs.

A 52-page appendix contains numerous charts, tables, equations, formulas, and other useful information.

Book II of the Philips' Technical Library Series is DATA AND CIRCUITS OF RECEIVER AND AMPLIFIER VALVES. Retailing for $2.75, it has 409 pages which are devoted to technical specifications, operating data, and practical circuits for Philips tubes manufactured between 1933 and 1939.

Book III is the first supplement to Book II and contains similar material on tubes introduced in 1940 and 1941. Containing 213 pages, it sells for $1.90.

Although the tubes described in these books are not employed in this country except in imported sets, the circuit information is thorough and much of it can be applied to similar tubes regardless of make. Complete receiver circuits are given including construction data on all-wave coils and i.f. transformers.—*RFS*

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RADIO TUBE VADE MECUM 1950, eighth edition. Published by P. H. Brans, Ltd., Antwerp, Belgium. (Distributed in the United States by Editors and Engineers, Ltd., Santa Barbara, California.) 8 x 11½ inches, 508 pages. Price $3.20.

This new 1950 edition comes out in one large volume of more than 500 pages. A number of languages have been added, and this polyglot edition can be used in any of 15 European and 3 Asiatic languages.

New items, including nonodes, transducers, accelerometers, phasitrons, projection tubes, crystal diodes and transistors have been added for the sake of completeness. Tubes of all types to the number of 15,000, with their characteristics and a certain amount of data on equivalent types, comprise the rest of the book. The editors state that some of the material includes advance information on a large number of 1950 types which were not yet in production at the time the book was printed.

ACOUSTIC MEASUREMENT, by Leo L. Beranek. Published by John Wiley & Sons, Inc., N. Y. 6 x 8½ inches, 914 pages. Price $7.

Intended as a reference for graduate students and workers in acoustics, this book covers the fundamentals of nearly every type of acoustical measurement, the details of many kinds of measuring apparatus, and the theory of many acoustic phenomena. Charts and diagrams and a careful mathematical treatment make the text a thorough one. A knowledge of advanced calculus is assumed.

COMMUNICATION CIRCUIT FUNDAMENTALS, by Carl E. Smith. Published by McGraw-Hill Book Co., N. Y. 6½ x 9 inches, 401 pages. Price $5.

This volume, the second of four designed for a complete course in radio and communication engineering, covers the fundamentals of d.c. and a.c. circuit theory in the first 15 chapters. Five additional chapters serve as an introduction to vacuum-tube theory. The book is intended for use as a text in a planned study course, but should be useful for reference and home study. Knowledge of calculus (available in the first volume, *Applied Mathematics*) is assumed.

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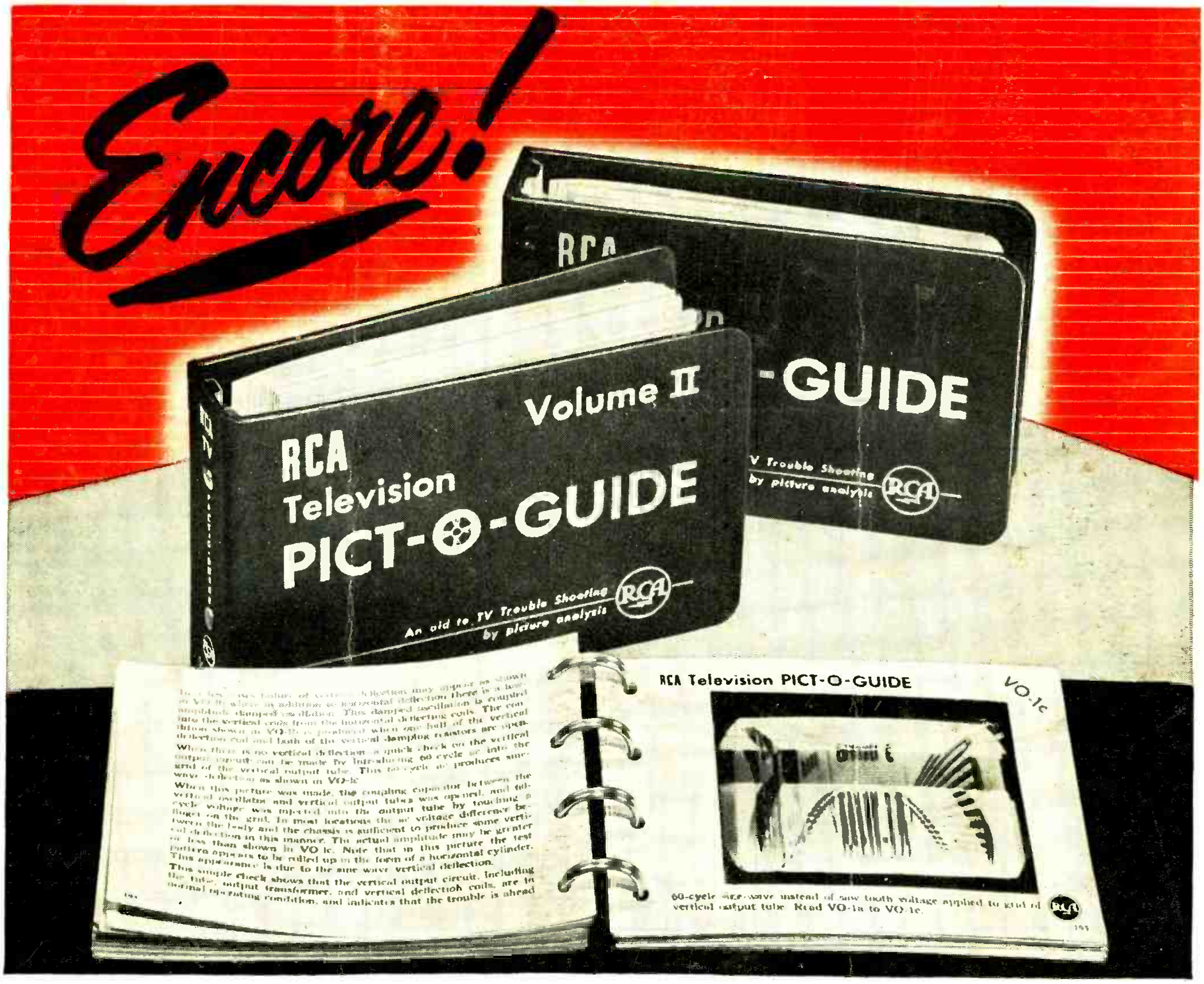

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