AUGUST, 1929 25 CENTS

RADIO

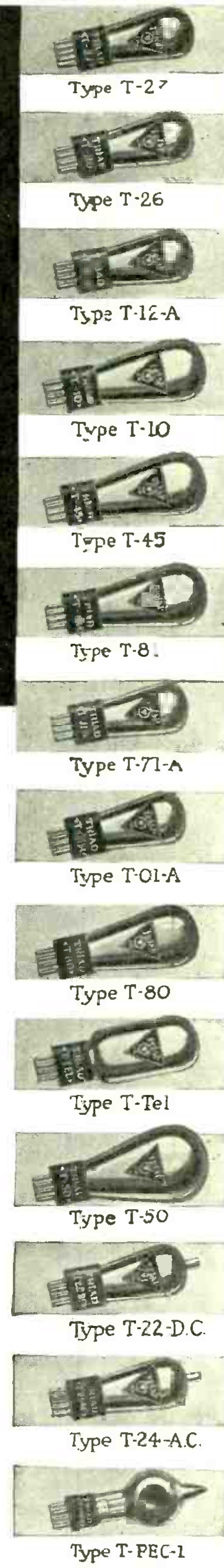
IN THIS ISSUE

ANSWERS TO SERVICE PROBLEMS
EXPERIMENTS WITH A-C DETECTORS
WINNING THE WAR AGAINST THE PEST
OF RADIO INTERFERENCE
ANALYSIS OF ATWATER KENT 55
AND FADA 25 RECEIVERS

Beulah

"RADIO," August, 1929. Vol. XI, No. 8. Published monthly by Pacific Radio Publishing Co., Pacific Bldg., San Francisco, Calif. $2.50 per year. 25 cents per copy. Entered as second class matter at Post Office at San Francisco, Calif., under the Act of March 3, 1879.

TRĪAD



INSTANT... *nation-wide popularity ....won on quality alone!*

THE demand for TRĪAD is sweeping along to tremendous proportions — and TRĪAD quality has done it! Quality that eliminates all guesswork from tube buying and selling; quality backed by an actual bonafide guarantee of six month's perfect service or a satisfactory adjustment. Every dealer *knows* what that means — *reduced service calls*, easier and quicker sales, greater profits and absolute satisfaction for him and his customer. Here is the greatest achievement in radio tube history — accomplished by a group of nationally-known pioneers in the industry. The TRĪAD Line is complete, including even Television and Photo-Electric Cells. Don't delay — send in your stock order *now*. TRĪAD customers won't accept substitutes.

Call your jobber or write us direct for complete Triad dealer information

TRĪAD MANUFACTURING CO., INC.
Pawtucket, R. I.
West Coast Factory Representatives:
W. J. NOEL, 508 Eddy Street, San Francisco, Calif.
J. A. CASH, Pioneer Bldg., Seattle, Wash.

"Ask for the tube in the yellow and black triangular box."

THE BEL CANTO SERIES

This NEW AMRAD *Line* *SELLS!*

THE opinion of Amrad Distributors expressed with emphatic enthusiasm in the May Convention has been corroborated by Amrad dealers in every section of the country.

Here is a radio line, out of the intensely competitive field—yet priced reasonably enough to sell readily.

It wins on appearance — for Amrad Consoles are beautiful examples of master furniture design; it wins on examination — for every detail of the chassis is engineered with painstaking exactness; it wins on demonstration for the tone is a marvel of rich, full, loveliness — the finest tone in radio!

Built-in full floating dynamic speakers; screen grid tubes in three stages; eight tubes including two powerful 245 tubes in push pull; extra heavy construction; four tuned circuits for maximum selectivity; special audio system. The most notable product of 1929.

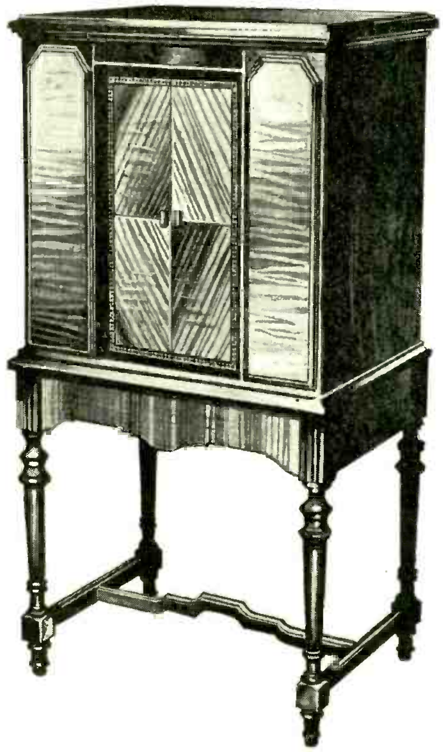
THE AMRAD CORPORATION
MEDFORD HILLSIDE, MASS.

J. E. HAHN
President

POWEL CROSLEY, Jr.
Chairman of the Board

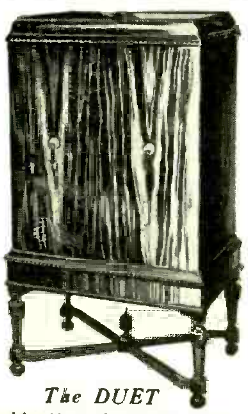
There are still open dealer territories for authorized Amrad dealers. Write today to Dept. UX for full details.

THE BEL CANTO SERIES



The SERENATA

Modern sliding door cabinet of diamond matched Oriental Walnut, and other fine woods. Uses standard Amrad shielded grid chassis with R. C. A. 106 Dynamic Speaker. *List* $245



The DUET

Combination electrical radio and phonograph, inspired by the finest Art Moderne furniture. Of Oriental Laurel, with Macassa Ebony base rail. Includes the R. C. A. 106 Dynamic Speaker built in cabinet. *List* $495

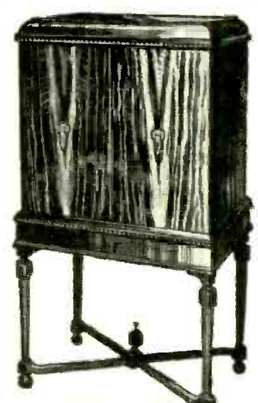
Each Amrad model has phonograph pick-up attachment.

The ARIA

Selected Butt Walnut Veneer, with African Walnut overlay. New ultra-sensitive Amrad chassis using shielded grid tubes; equipped with Dynamic Speaker.

List $198

Prices slightly higher West of the Rockies.



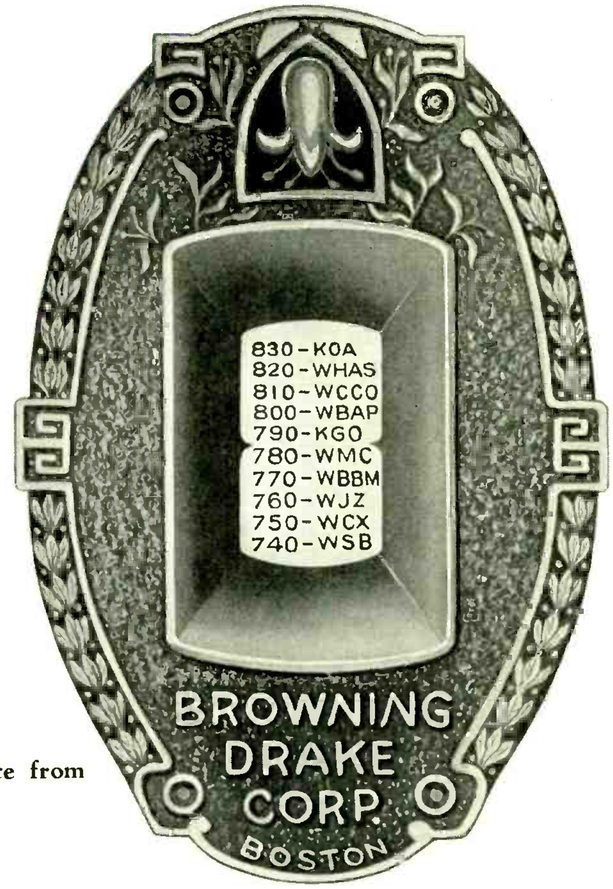
The SYMPHONY

Beautiful cabinet of Art Moderne design. Front and sides veneered in highly figured East Indian Laurel Wood, with base rail of Macassa Ebony, decorated with inlays of ebony and holly. Uses 8 tubes.

List $295

What do you think of this?

"SEMI-AUTOMATIC" TUNING



1930
BROWNING — DRAKE

1. Five tuned circuits—nine tubes
2. Tuned antenna
3. Push-pull audio (245 power tubes)
4. Power Detection (plate rectification)
5. Hum Eliminator
6. Dial in kilocycles and stations
7. Band-pass filter effect (10 k.c. selectivity)
8. A.C. screen-grid and heater type tubes
9. Mershon trouble proof condenser
10. Voltage regulation adjustment
11. Power unit integral part of chassis
12. Hand rubbed satin Duco finish
13. Large size (12 in.) dynamic speaker
14. Phonograph and short-wave connection.

Six models, table and console, ranging in price from $98.00 to $172.50

(Prices slightly higher west of the Rockies.)

Kilocycles and important stations on the dial!

WE ARE proud to announce this as the leading feature of the finest receivers we have ever produced. Nearly a million and a half people all over the world listen in on Browning-Drake receivers, and no other set has ever commanded the enthusiastic popularity of a vast radio amateur following.

Located in a new plant with a production capacity of over 1500 sets per day in a district famous for the skill of its precision labor, we are equipped to make, month in and month out, scheduled shipments of the highest quality merchandise. The Browning-Drake exclusive franchise is fast becoming one of the most profitable in the industry.

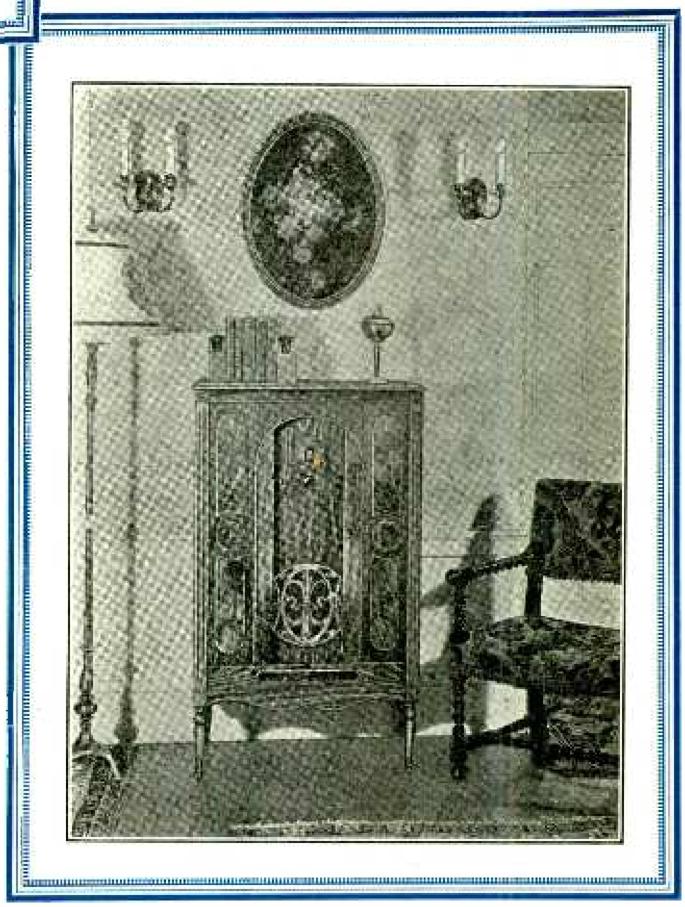
ALL signs point to the outstanding popularity of the small console for 1930, convenient and artistic in size and more economical than table models with associated equipment. This attractive number uses the standard chassis, both heater tube and screen-grid types, with dynamic speaker and "semi-automatic" tuning. The cabinet has a Satin Duco finish on selected walnut and American gumwood. Dynamic speaker. Dimensions, 38 x 26 x 14.

LIST PRICE

Model 64 (heater tubes), $137.50

Model 54 (screen-grid), $142.50

THE modern large console design for 1930 carries the body of the cabinet much lower than former highboy types, is of slender, graceful lines and uses sliding rather than hinged doors. These features are outstanding in the beautiful console model featured as the Browning-Drake leader. Exquisitely figured and matched walnut paneling, in Satin Duco finish, contributes to a beauty of appearance which reflects the performance of the instrument itself. Cabinet work by one of the oldest New England piano manufacturers. Dynamic speaker, "semi-automatic" tuning. Dimensions, 46 x 27 x 15.



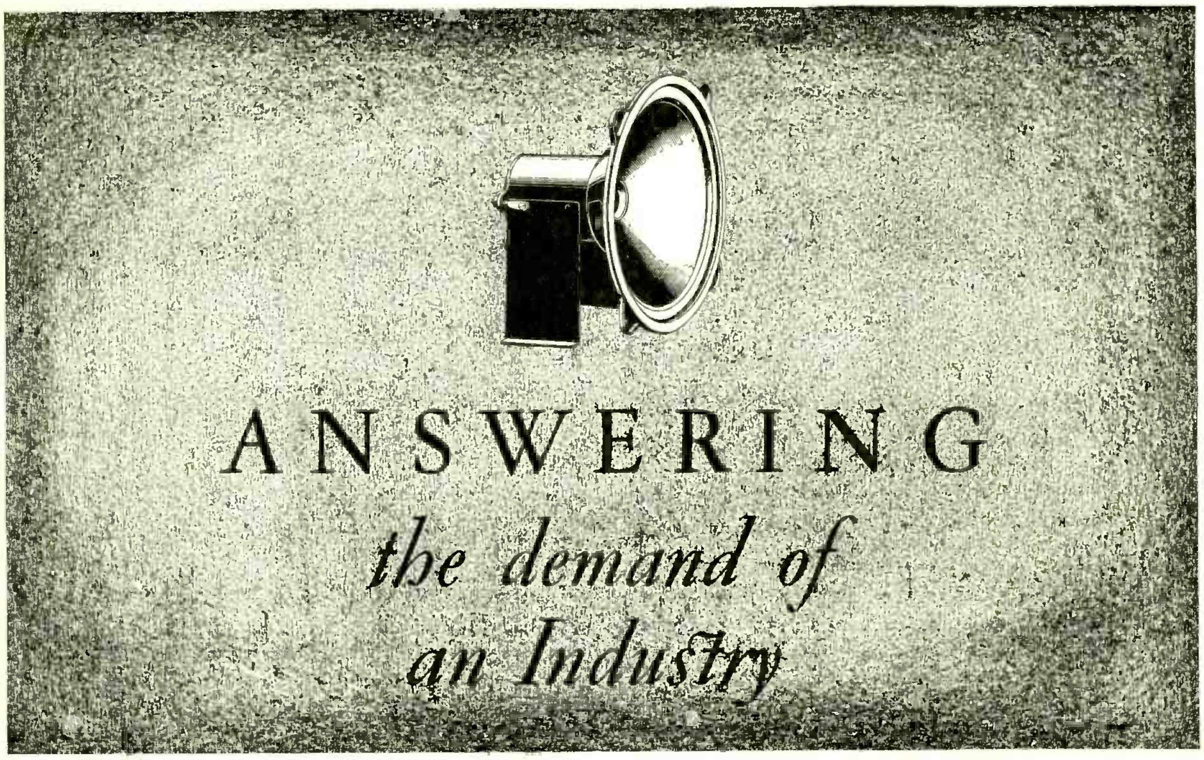
LIST PRICE

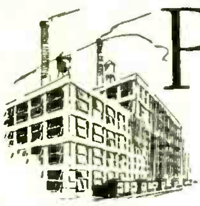
Model 65 (heater tubes), $167.50
Model 55 (screen-grid), $172.50

BROWNING-DRAKE CORPORATION

CALVARY STREET, WALTHAM, MASS.

California Representatives: Factory Sales Agencies Co., 508 Eddy Street, San Francisco and 2700 South Hill Street, Los Angeles





PROVED superior in the most critical scientific tests known to America's leading radio laboratories the New Jensen Concert Dynamic Speaker won their immediate endorsement. Sixteen manufacturers at the R. M. A. Show last month announced their new radio receivers equipped with Jensen Electro-dynamic Speakers.

Individually, they in co-operation with Peter L. Jensen have adapted this speaker to their own specific requirements. Collectively, they have established a new era of *better* reproduction and Jensen has answered the demand of an industry for finer tone quality and greater dependability.

Equally as complimentary are the manufacturers of phonographs, talking moving picture equipment and other sound reproducing apparatus who find their requirements answered with either the Jensen Standard, Concert or Auditorium Speaker.

Jobbers and dealers will find new impetus to the sale of dynamic speakers separately or in radio furniture. And, of course, radio receivers Jensen equipped will sell better.

An attractive schedule of net prices is available to all members of the trade on this most complete line of speakers offered with eight, ten and twelve inch cones. List prices range from $25 to $55 on DC models and from $32.50 to $70 on AC models. Cabinet models range in price from $42.50 to $100.

LICENSE UNDER LEKTOPHONE PATENTS

Jensen

ELECTRO-DYNAMIC SPEAKERS

JENSEN RADIO MANUFACTURING CO. · 6601 S. Laramie Ave., Chicago, Ill. · 212 Ninth St., Oakland, Cal.

You Cannot Match These Prices for Such Superlative Performance

This Is Unquestionably the Greatest Value in Radio

CONSOLE

$72.00

NET

Tubes Not Included

EIGHT TUBES (AC) and rectifier—nine tubes in all. All electrical components are scientifically shielded. Four R.F. tubes and push-pull audio. Maximum selectivity. Enormous volume. Faithful, undistorted tone. Tuning condensers shielded and mounted on cast aluminum block to insure rigidity. Inductance coils shielded in beautifully burnished copper casings.

Console: 24″ wide, 15″ deep, 38″ high. Table model: 25″ wide, 16″ deep, 12″ high. Jensen electro-dynamic speaker used in console models.

CONSOLE by SULMOCK

BEAUTY

A console in walnut. Beautiful in appearance and very sturdy in construction. The finest kind of cabinet work.

8 TUBES and Rectifier

Nine Tubes in All

Push-Pull Amplifier

CONSOLE COMES TO YOU COMPLETE WITH THE . . . .

JENSEN ELECTRO-DYNAMIC SPEAKER

ORDER A SAMPLE RECEIVER NOW! . . .

Buy Direct—Save Money—Get Value! Telegraph your order for one of these receivers now. No delays. We have but a limited number of sets available. When they are sold at these low prices there will be no more.

We ship anywhere by express. Remember—IMMEDIATE SHIPMENTS . . . anywhere.

SALES COMPANY

Oakland, California

Mail Orders Shipped Same Day Received When Possible . . . . .

Prices Are F. O. B. Oakland

PACIFIC RADIO SALES CO.,
357 Twelfth Street, Oakland, California.

Ship me .... Consoles .... *Table Models* AT ONCE. I am enclosing a 50% deposit, the balance to be paid for by me upon receipt of the shipment.

Name ....

Street & No. ....

City ....

State ....

Ship Via: ....

PAM puts wings on muted notes

MODERN musicians in their search for original effects use muted instruments more than ever before—and thus lessen the power of music to penetrate the distant corners of large ballrooms.

This difficulty has been overcome entirely at the Marigold Ballroom, Minneapolis, Minnesota, where the orchestra music is picked up by a microphone which delivers it through a PAM installation to loudspeakers placed in remote corners.

Thousands of ballrooms need PAM equipment today and wide awake dealers will see that they are supplied.

A new 16-page bulletin giving mechanical and electrical characteristics, representative installations, and many new PAM amplifiers will be sent upon receipt of 10 cents in stamps to cover postage. When writing ask for bulletin No. R10.

Samson Electric Co.

Main Office: Canton, Mass.

MEMBER R.M.A.

Factories: Canton and Watertown, Mass.

Manufacturers Since 1882

PACIFIC COAST OFFICES:

327 Tilden Sales Bldg.
SAN FRANCISCO, CALIF.

324 North San Pedro Street
LOS ANGELES, CALIF.

2607-11 Second Avenue
SEATTLE, WASH.

637 East Broadway
PORTLAND, ORE.

MARIGOLD BALLROOM, MINNEAPOLIS, MINN., PAM EQUIPPED

TONE QUALITY

An Outstanding Feature of All General Amplifiers

MODEL GA-15

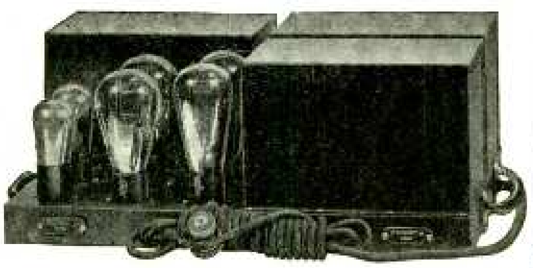
A two-stage power amplifier employing one 227, two 245 power tubes in push-pull and one 280 rectifier. Will deliver approximately 4.5 watts of undistorted energy to the reproducer. Suitable for the home or other moderate sized installations.

Price (less tubes) $85.00

MODEL GA-20

A three-stage power amplifier incorporating dual push-pull. The tubes required are one 227, two 226s, two 250 power tubes and two 281 rectifiers. Will deliver approximately 14 watts of undistorted energy to the reproducers. Suitable for apartment house, theatre or other service requiring extreme volume reserve.

Price (less tubes) $225.00



MODEL GA-30

A three-stage power amplifier employing two 227s, two 250 power tubes in push-pull and two 281 rectifiers. Will deliver approximately 12 watts of undistorted energy to the reproducers. As in all other General Amplifiers, no output device is required.

Price (less tubes) $175.00

THE manufacturer and the purchaser of "Sound Projection" equipment realize the important relationship of the power amplifier to the satisfactory performance of the complete assembly. The rapidly increasing demand of the general public for finer tone quality necessitates improved design in all associated equipment. This demand has been successfully met in General Amplifiers.

Created by an engineering staff whose sole aim has been to give the public the best in power amplification. Built by men thoroughly experienced in their construction and operation. A product of merit is the result.

Sound engineering and inbuilt quality together with the incorporation of many distinctly unusual features have made possible this line of power amplifiers of unrivalled performance and tone quality. From the faintest whisper to tremendous volume absolute faithfulness in reproduction is maintained. Volume, tone fidelity, stability and service are assured with General Amplifiers.

Our engineering staff, specialists in the design and manufacture of power amplifiers to meet specific requirements, are always pleased to cooperate with you in your problems of audio amplification.

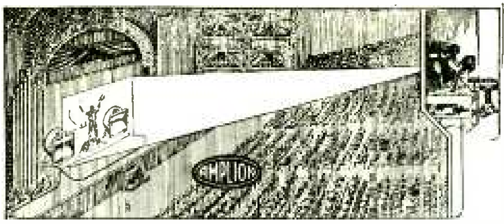
These and other models, not illustrated, are fully described in our Bulletin R3, which will be sent on request.

GENERAL AMPLIFIER COMPANY

27 Commercial Avenue, Cambridge, Mass.

MAKERS OF HIGH-GRADE POWER AMPLIFIERS

AMPLION OFFERS THE LATEST PUBLIC ADDRESS EQUIPMENT

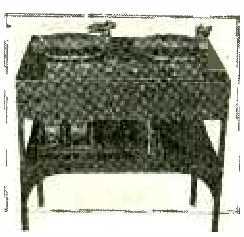


Amplion Giant Dynamic
Largest Ever Made
Air Column Unit

Built especially for public address and band repeating in large halls, theatres and open spaces. Designed to operate on an output of 10 to 30 watts of undistorted power. Field supply 1¼ amps. at 6 volts D. C. This giant Amplion Dynamic Unit (weight 20 pounds) is capable of range and volume heretofore unattainable in any Unit, and is the largest ever built.

Amplion Exponential
10 ft. Air Column Horn

Specially designed to reproduce the human voice and orchestral music in talking picture and group address installations.



(PMS-2 Standard)

Amplion Cabinets for
Moving Pictures

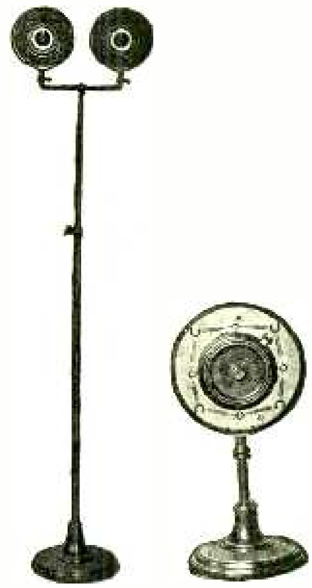
Cabinets contain 2 turntable electric motors. Also contains space for Amplifier. Amplion electric pick-up and control board for fading one piece of music into another, or making instantaneous switches.

Amplion Dynamic Cone Chassis

A. C.-111 is designed for a direct current—field supply of 6 volts—with step-down input transformer, audio input cord and field supply switch. The field draws one amp. from a 6-volt storage battery, or other field magnetizing supply. Full wave trickle charger may replace storage battery.
Diameter of cone—9 inches.
Chassis over all—height 9½ inches.
Overall width—11 inches.
Overall depth (front to back) —7¾ inches.

Microphone Amplifier

Furnishes one stage of Audio Frequency Amplification and the direct current energy for the Amplion Microphone from 110 volt 60 cycle A. C. current. Will operate into any standard power amplifier.



Double Stand   Desk Stand

Amplion Microphone

Finest instrument in Europe or America, is equal to the finest scientific instrument made costing four times as much. It is a sensitive Carbon Microphone free from carbon noises. For broadcasting, theatre or public address use. With the use of Amplion Microphone the signal strength is greatly increased and tone quality is retained. Stands shown furnished only when ordered extra.

Amplion Electric
Phonograph Pick-up

Specially designed for the new electrically recorded phonograph records. Has permanent field magnet of special cobalt steel which makes possible a high magnetic field in a small space. Tone arm is adjustable in length, to accommodate the new 16-inch records, made for talking picture use.

FOLDER AND COMPLETE INFORMATION ON REQUEST

AMPLION CORPORATION 133-145 WEST TWENTY-FIRST ST. **NEW YORK**

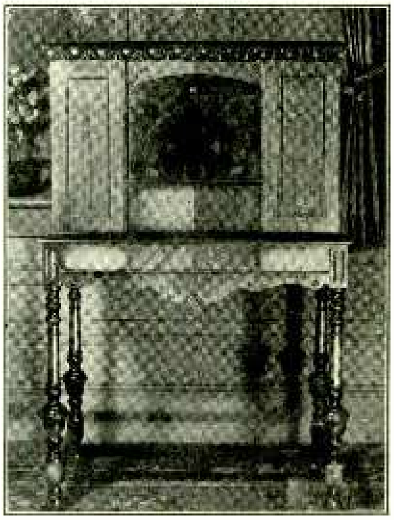
WARE Electric

Years Ahead of Its Time!

Band Selector Tuning

THE first important departure from conventional tuning systems is the band selector, invented by Dr. F. K. Vreeland and developed by Paul Ware, of neutrodyne fame. The band selector admits the *entire* broadcast channel through the radio frequency amplifier, so that the full range of tone frequencies is equally amplified before it reaches the audio-frequency system. Conventional tuned radio frequency amplifiers with sufficient selectivity to meet modern conditions cut off the higher frequencies, producing the familiar "radio effect." With Ware reception you enjoy, for first time, the full magnificence of radio reception, the low tones in their powerful richness and also the high frequencies essential to brilliance in musical reproduction and good articulation in speech, undiminished in volume. The band selector makes the receiver unresponsive to signals on neighboring channels, offering a degree of selectivity unattained heretofore with any commercially built receiver.

A. C. Screen Grid Tubes



Of course the Ware Electric employs alternating current screen-grid tubes. More than this, it employs them in their full effectiveness, attaining an enormous multiplication of the incoming impulse. A small indoor aerial gets down to the noise level under midwinter conditions. The Ware radio frequency system offers greater amplification than four efficient stages using three-element tubes. The noise level, however, is far lower because only two tubes contribute "amplifier hiss." Consequently, the Ware receiver offers distant reception beyond comparison.

245 Power Output Tube

The mere use of a powerful output tube is of itself no assurance of efficient performance, for most audio-systems with several watts of electrical energy in the output circuit can radiate only a fraction of that power acoustically. The Ware audio system, while employing a power detector, has not gone to the extreme of eliminating one audio stage and therefore its output volume is only restricted by the handling ability of the power amplifier tube which is many times greater than the requirements of any home. The total power drawn from the power line, however, is but half that of many well known radio receivers.

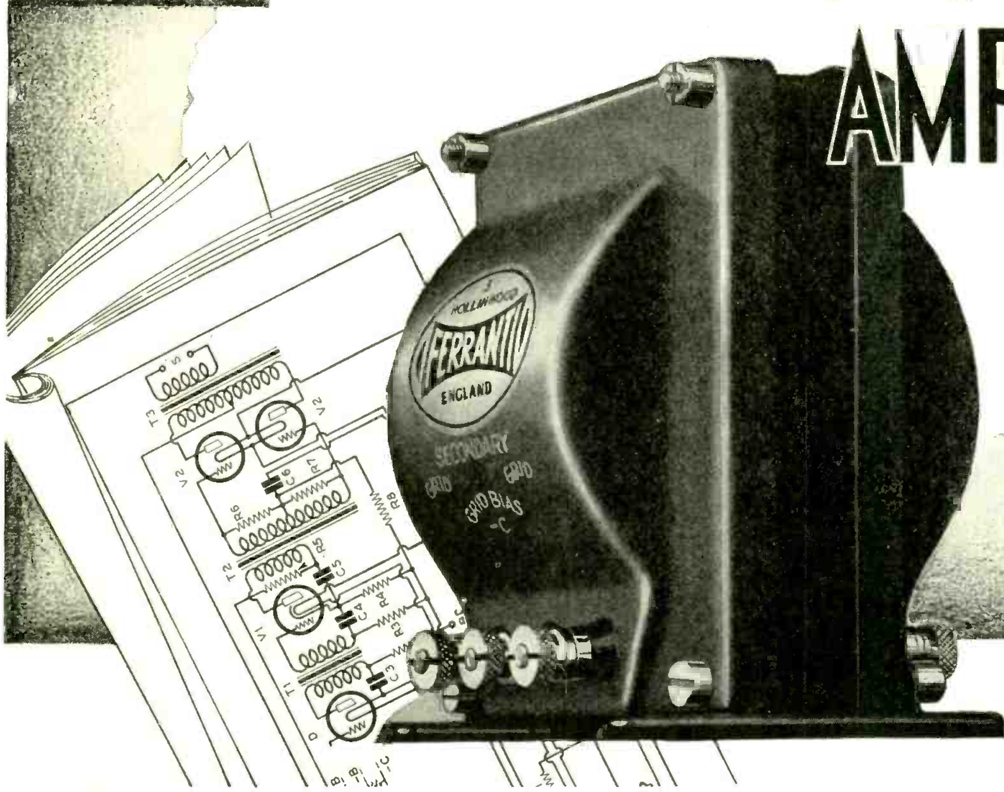
Priced from $195 and up. Console Model No. 10 with RCA 106 Dynamic Reproducer (illustrated) priced at $280.

WARE MANUFACTURING CORP.

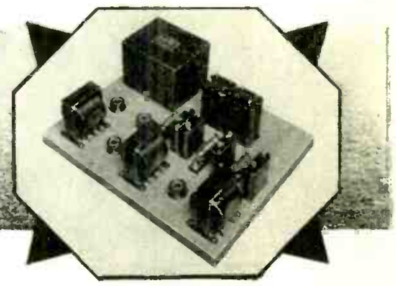
TRENTON, N. J.

NEW YORK OFFICE: 480 LEXINGTON AVENUE
NEW YORK

YOU CAN BUILD *Marvelous* POWER AMPLIFIERS



FOR RADIO RECEIVERS—
FOR PUBLIC ADDRESS
SYSTEMS AND OTHER
AMPLIFYING USES



BUILT FROM A
FERRANTI DIAGRAM

THIS NEW BOOK TELLS YOU HOW!

YOU need Ferranti's New Book to build the latest, most approved heavy-duty Power Amplifiers for every purpose. Crammed with the combined knowledge of the most experienced Power Amplifier Engineers. The last and best word on Power Amplifiers for engineers, constructors, installation men and *everyone* interested in radio's latest development.

10 Amplifier Hookups and Diagrams

Follow the diagrams and instructions *exactly*. You can produce Power Amplifiers for every purpose as fine as it is possible to build . . . Power Amplifiers with the most astonishing natural reproduction . . . with high gain and flat response level, capable of operating several speakers at maximum volume. You can build Power Amplifiers using the UX171, UX250 and even the very new UX245 type tube. That's how late *this* book is!

Build Amplifiers for Profit

Schools, hotels, theatres, stores, hospitals, public auditoriums, churches, ball parks, and factories are calling for Power Amplifiers. You can make money supplying the demand. Or you can build a complete *Public Address System* and rent it out at a high figure.

A demonstration will sell any outfit you build according to the diagrams in Ferranti's New Book.

Exhaustive tests by engineers and experts in reproduction have definitely established the superiority of FERRANTI Engineered Power Amplifiers over the best of the available commercial power amplifiers.

Use FERRANTI Transformers to Improve Any Amplifier

Acknowledged the finest obtainable audio transformers, FERRANTI Transformers are used exclusively by engineers when the highest tone quality and most natural reproduction are demanded.

FERRANTI Transformers have low self and mutual capacity in addition to low magnetic leakage. These are but 2 of many reasons why they are demanded by engineers and others working to high standards.

FERRANTI Transformers are incomparably finer than the best of ordinary commercial transformers. There's a special FERRANTI Transformer for *every* audio and output requirement. Insist on FERRANTI Transformers from your dealer. Send T-O-D-A-Y for FERRANTI'S *New* Power Amplifier Book.

FERRANTI

FERRANTI, Ltd.
Hollinwood, England

FERRANTI, Inc.
130 West 42nd Street, New York

FERRANTI ELEC., Ltd.
Toronto, Ont., Canada

PACIFIC COAST REPRESENTATIVE . . . . . THE SPECTOR CO., RIALTO BLDG. . . . . . SAN FRANCISCO, CAL.

-COUPON-

FERRANTI, Inc.
130 West 42nd St., Suite 161, New York City
Gentlemen:—I enclose....c in coin for which please send me post-paid the book or books checked to the right.

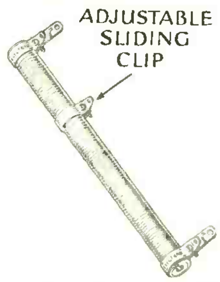
☐ Ferranti's New Book on Power Amplifiers 15c
☐ Ferranti's 1929 Year Book on Audio Amplification, 15c
25c for both

Name..
Address..
City.............................. *State*..........

You Can Spend a Lot More and Get Less
—*But You Can't Spend Less and Get More*

VALUE in radio equipment is like value in everything else. You can get a lot of quality at small cost *if you know how to choose.* The *safe* way is to *follow the leaders*—do what the engineers do; buy what they buy. Electrad invites you to select your voltage and volume controls on that basis—because radio engineers the world over know that the name "Electrad" on a resistance symbolizes perfection at the lowest possible price.

TRUVOLT *All-Wire* RESISTANCES



U. S. Pat. 1676869 and Pats. Pend.

Safest for your eliminator or power pack because patented construction makes for greater durability and satisfaction. Resistance wire is first wound on an asbestos-covered enameled copper core, then this in turn wound on a grooved, fire-clay base. This means a cooler unit that holds its rated value. The sliding clip—an exclusive Electrad feature—permits convenient variation. 22 stock sizes, for all usual needs.

Super-TONATROL High-Power Volume Control

U. S. Pats. 1034103-1034104 and Pats. Pend.

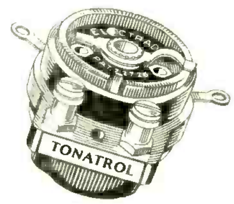
A new Electrad development without a parallel. Perfect control of high voltages, with rapid heat dissipation in excess of five watts, unequalled smoothness and *durability beyond all expectations.* Resistance element fused to an enameled metal base. Pure silver floating contact that improves with use, owing to minute silver deposit on the resistance. Seven types with uniform or tapered curve. $2.40 to $3.50.

U. S. Pat. 1676869 and Pats. Pend.

TRUVOLT Variables

Same superior construction as fixed type, with the addition of a handy control knob and variable contact arm for fine adjustment. Due to unique winding, the contact travels endwise over the resistance wire, giving smoother operation with less wear. One-hole mounting, sturdy frame and perforated ventilating shield. Greatly simplifies eliminator construction. 22 stock sizes. $2.50 each.

U. S. Pats. 1034103-1034104-1593658 and Pats. Pend.



TONATROL Volume Controls

A complete line of volume controls for all types of receivers. Rugged construction means long wear. The finest of insulating materials and a smoothly operating mechanism that regulates volume and tone from a whisper to the full power of your amplifier. Made with or without filament switch attached. $1.50 to $3.00.

ELECTRAD, INC.,
Dept. *PR8*, 175 Varick St.,
New York, N. Y.

Please send data on:

.... TRUVOLT Resistances,
.... Super-TONATROL.
.... TONATROL LINE.

Name ....

Address ....

....

....

175 Varick St., New York, N.Y.

ELECTRAD
INC.

Western Representatives: UNIVERSAL AGENCIES

905 Mission Street, SAN FRANCISCO, CALIF.

RADIO
for the profession

Volume XI | AUGUST, 1929 | No. 8

*A*re You *Stumped* By *Service* Problems?

Read How One Jobber Helps His Dealers

By J. EDWARD JONES
Manager Service Department, Leo. J. Meyberg Co.

To whom should a dealer look for help when his service men run up against a stump, if not to his jobber? This means that the successful radio jobber should maintain a competent technical staff and well-designed testing equipment so as to be able to answer questions and to do jobs that are beyond the capabilities of the dealer's organization.

Furthermore, such a service department should be the clearing-house from which is distributed technical information about radio apparatus and means for overcoming the various disturbances to radio reception. At least, this is the way that the writer regards his job and consequently judges that others will be interested in how the work is done by one successful jobber in California.

Any repairs can usually be made very readily if the cause of the trouble is known. The first thing to be done, before trying to cure a sick radio set, is to diagnose the case. So we consider that the testing apparatus is the most important equipment in a radio service department.

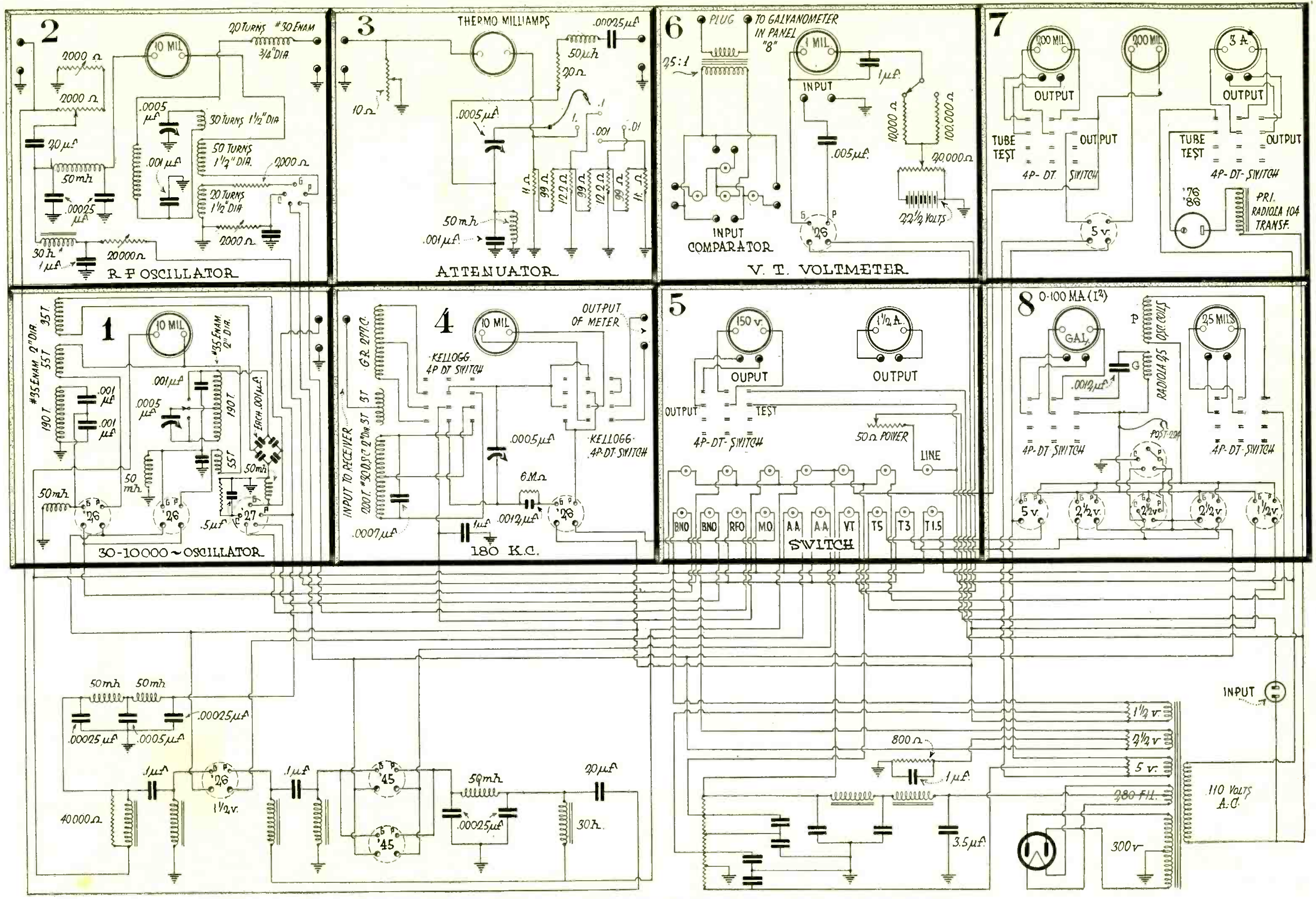
The minimum equipment should include oscillators for both radio and audio frequencies, tube testers, and continuity testers. An attenuator and vacuum tube voltmeter will also be found useful, if for no other reason than to be able to give to the ever-inquiring boss, salesman or customer an opinion based upon known facts.

Much of the effectiveness of this equipment depends upon the manner in which it is arranged so as to expedite performance. We have mounted all of our equipment on one large frame, as shown in the accompanying illustration.

This frame holds eight units or panels. 1—an audio-frequency oscillator, 2—a radio-frequency oscillator, 3—an attenuator, 4—a 180 kc oscillator, 5—a control panel, 6—a vacuum tube voltmeter, 7 and 8—tube testers. The circuit arrangements are shown in detail in the schematic diagram on the next page. Power for operating these various units is supplied from an a.c. source through the usual types of transformers, rectifiers and filters, which are mounted in the rear of the panel. In the rear also is an impedance-coupled audio-frequency amplifier designed to give as uniform a frequency amplification curve as possible.

In the lower left-hand panel, No. 1, is a beat note a-f oscillator which has a continuously variable output of from 30 to 10,000 cycles. This consists of two r-f circuits in which '26 tubes are used to generate the r-f oscillations. The two circuits are identical in all respects except that the grid coil of one is tapped and shunted with a .0005 μf variable condenser for variation of the beat note of a-f output. A pickup coil, shunted by a capacity bridge, is coupled to the untuned oscillator circuit and applies the a-f current to the grid of a '27 mixer tube. The output of the mixer goes to a pair of tip jacks on the panel and may be used for testing the characteristics of a-f components, amplifiers or loudspeakers, or for modulating the r-f current emitted from the r-f oscillator in panel No. 2.

This r-f oscillator employs a '27 tube, getting plate and heater supply from the power pack through switches on the control panel, unit No. 5. The grid circuit is coupled to the plate and pickup coils, the latter being a part of the only tuned circuit. Minimum grid bias is supplied by a 2000 ohm fixed resistor between grid and ground and may be added to by an increase in a 2000 ohm variable resistor between ground and cathode. Carefully designed r-f and a-f filters are placed in the plate lead, and the plate voltage may be varied by means of a 20,000 ohm variable resistor in this lead. The output of the a-f amplifier.



Schematic Drawing of Testing and Measuring Equipment, Power Pack and Audio Amplifier through a 20 μf condenser, is connected to a potentiometer in the plate lead of the r-f oscillator, making it possible to modulate the latter with the amplified output of the a-f oscillator, a radio set, phonograph or any other source. Tip jacks are provided for a modulated input that does not need to be amplified, and another pair of tip jacks provide outlet connections.

Panel No. 3 houses an attenuator which is used to measure the strength of an a-f or r-f signal. It is used in conjunction with the vacuum tube voltmeter in panel No. 6 and contains a four-tap decade resistance block shunted by a .0005 μf variable condenser for filling in between taps. A 0-125 thermo milliammeter is connected in series with the input leads, upon which a reading of 100 ma gives voltages specified by the taps in the resistance block, namely, .001 to 1 volt. A reading of 1 ma with the tap at .001 would indicate 10 microvolts. The variable condenser further reduces this to 1 microvolt.

The 20 ohm resistor, 50 μh choke and .00025 μf condenser connected in series in the output lead constitute a dummy antenna with an effective height of 4 meters. This is used in testing sensitivity of receivers in microvolts per meter.

Just below the attenuator panel is an 180 kc modulated oscillator designed especially to test Radiola i-f transformers and amplifiers. This unit employs a '26 tube as a generator, with a 10 ma plate meter in the circuit to show resonance. A Kellogg 4 p.d.t. switch in the plate meter circuit connects the meter to a pair of tip jacks, making it possible to use it for other purposes. Another 4 p.d.t. switch allows the choice of two separate oscillatory circuits; one for ± 180 kc and the other for a range of from 500 to 1500 kc, both being modulated at about 500 cycles by the grid leak and condenser. This makes it possible to test the r-f circuits of a 180 kc superheterodyne as well as the i-f stages and provides a simpler method of matching coils and gang condensers than that provided by the precision instrument in panel No. 2.

No. 5 is the control panel, having plate and filament switches for the beat note oscillator tubes, r-f oscillator, modulated oscillator, audio amplifier, vacuum tube voltmeter, all tube testers and the 110-volt line. It includes a 0-150 volt a-c meter which is used constantly across the line in order to advertise any change in test conditions. Tip jacks and a switch are provided in case this meter is desired for another purpose, and a 50 ohm power rheostat is used in series with the line for regulation of voltage fluctuation. The 1½ ampere meter in this panel is so located for convenience, being connected to a pair of tip jacks.

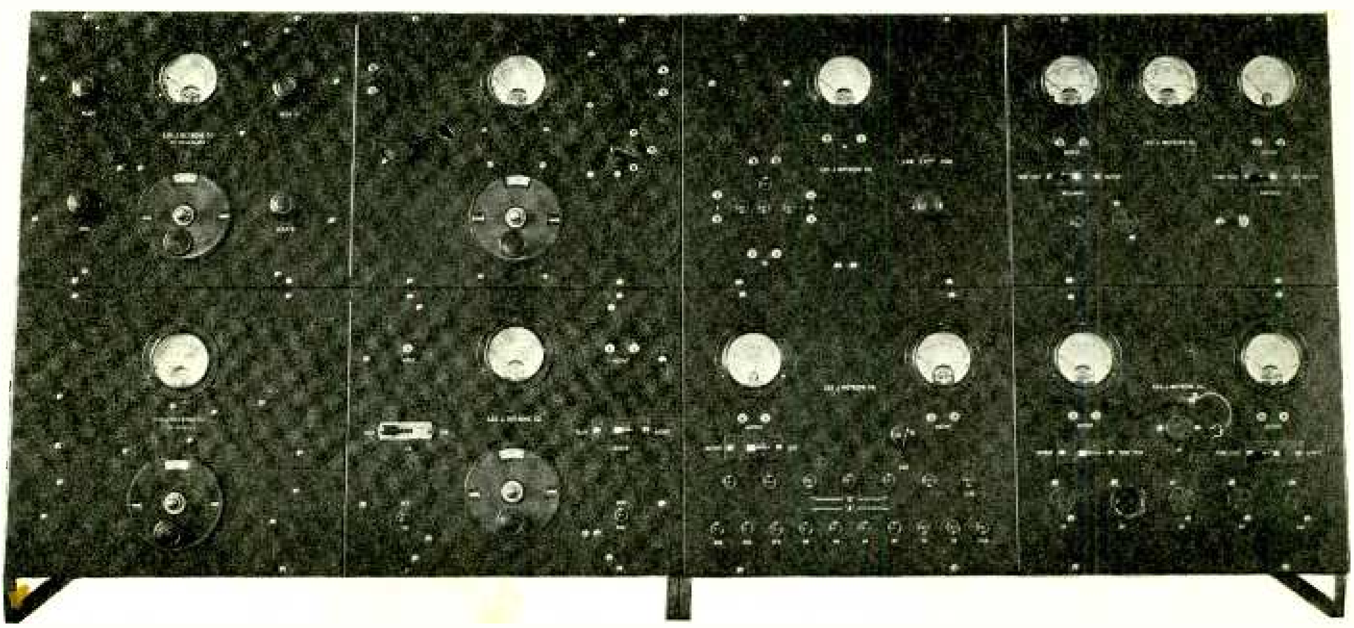
The vacuum tube voltmeter shown in the sixth section has numerous uses, most important of which are the tests of a receiver's sensitivity, selectivity, overall gain and fidelity. To determine the sensitivity of a receiver in microvolts per meter a modulated signal is applied from the oscillator, the vacuum tube voltmeter being connected to the receiver's output. Then the attenuator is connected to the input circuit and adjusted until the voltmeter gives a reading indicating 50 mw. A reading in microvolts is taken direct off the attenuator and divided by the number of meters in the antenna, which in this case is 4. This value, the μv/m necessary to give an output of 50 mw is the nearest to a standard yet devised and gives a satisfactory comparative check on the sensitivity of any receiving set.

Selectivity is judged by measuring the voltage output of a receiver when tuned to resonance with an incoming signal (preferably from the modulated r-f oscillator) and again at certain points off resonance. Several points should be plotted on each side of the resonance peak and a curve drawn to show relative strength of signals ± 5 kc either side of resonance. Measuring overall gain or the gain or loss of any unit is merely a matter of using the attenuator and vacuum tube voltmeter in the input and output circuits respectively and comparing results. To get a fidelity curve on a-f apparatus the beat note oscillator is connected to the input and varied over the calibrated scale, readings being taken at each frequency to be plotted. To judge the overall fidelity of a receiver it is necessary to modulate the r-f oscillator with the beat note oscillator, varying the former only when curves are wanted at more than one radio frequency. A 22½-volt battery is used for plate supply to the vacuum tube voltmeter tube, two resistors allowing a double range for the instrument.

Four switches and four sets of tip jacks are mounted on the left of the voltmeter panel, although they have nothing to do with the latter. These, as may readily be seen, merely constitute a comparator system for several loudspeakers. The center switch connects the receiver output to the primary of a 25 to 1 step-down transformer, the secondary of which may be connected across the galvanometer in the tube-testing unit.

Panel No. 7 is for testing rectifier and ballast tubes. Two 0-200 milliammeters give simultaneous readings on both plates of a type '80 rectifier, while only one is used for the '81, and one 0-3 ammeter indicates the effectiveness of either a '76 or an '86 ballast tube. A screw and a strip of brass form the "socket" for the ballast tubes, making it unnecessary to screw the tube into a base.

(Continued on Page 54)



Front View of Test Panel

ARITHMETIC of a *Humless Power-Pack*

How to figure plate current drain, resistors chokes and transformers

By J. E. SMITH
President, National Radio Institute

THE purpose of a power pack is to supply electric current at the voltages necessary for the various tubes in a radio receiver or a phonograph amplifier. The alternating current ordinarily available at 110 volts, 50 or 60 cycles, must be rectified and filtered for use as plate or grid supply, and must be stepped up for high plate voltages and stepped down for filament voltages by means of a power transformer.

The first problem in the design of a power pack is the determination of the amount of high voltage direct current which it will be called upon to supply. This depends upon the number and types of tubes in the receiving set which is to be used with the power pack.

The amount of plate current which is drawn by any tube depends upon its effective plate voltage, increasing as the plate voltage increases. The effective plate voltage E_p depends upon three factors: the supply voltage E_s, the operating grid voltage E_g, and the amplification factor *mu*. The effective plate voltage, with negative grid voltage, is numerically equal to the supply voltage minus the product of the grid voltage and the amplification factor.

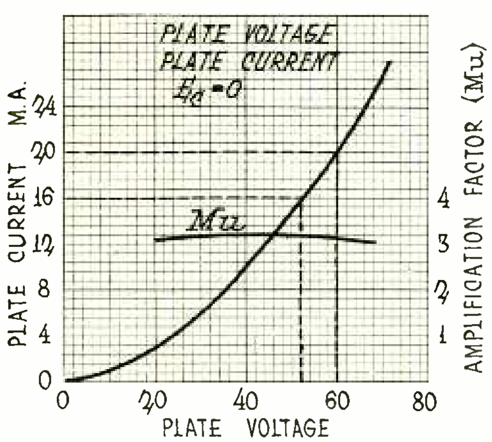


Fig. 1. Characteristics of '71 Tube

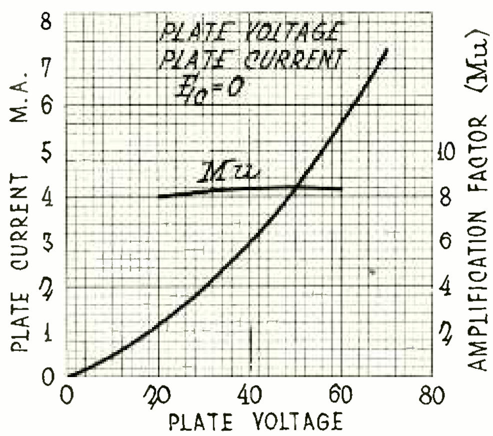


Fig. 2. Characteristics of '26 Tube

In Fig. 1, for example, are shown the plate currents, as well as the amplification factors, corresponding to various effective plate voltages in a '71 power tube. For a plate supply of 180 volts, a grid supply of 40 volts, and an amplification factor of 3.2, the effective plate voltage becomes:

$E_p = (E_s - E_g) = (180 - 3.2 \times 40) = 180 - 128 = 52$ volts. By referring to Fig. 1 it will be seen that the plate current corresponding to 52 volts is 16 milliamperes. In actual practice the *mu* of a '71 tube is often about 3, so that $E_p = (180 - 3 \times 40) = 60$ volts, for which the corresponding plate current is 20 m.a.

Fig. 2 shows the characteristics of a '26 tube, such as often used in the r.f. stages with 90 volts on the plate and 6 volts on the grid, the *mu* being 8.2. For such conditions the effective plate voltage is:

$E_p = (90 - 8.2 \times 6) = (90 - 49.2) = 40.8$ volts. For this voltage the plate current is seen to be 3.1 m.a.

If the '26 tube is used as an audio amplifier, its plate circuit will include the primary of an audio frequency transformer, which may have a d.c. resistance of perhaps 1700 ohms. With 3.1 m.a. this would cause a voltage drop of $IR = (3.1 \times 1700) \div 1000 = 5.3$ volts. Consequently the effective plate voltage would be decreased by this amount and the plate current correspondingly decreased.

Fig. 3 gives similar information for a '27 tube used as an amplifier. If used as a detector in a grid-leak circuit with 45 volts on the plate, its plate current is given as 2 m.a. in the tables of tube characteristics.

Consequently the plate current and voltage demand on a power pack which is to supply a six-tube set using three '26 tubes as r.f. amplifiers, one '27 tube as detector, one '26 tube as audio amplifier, and one '71 tube would be:

No. and Type of Tubes	Plate Volts	Grid Volts	*mu*	Plate Current
3—'26	90	—6	8.2	9.3 m.a.
1—'27	45	Grid-Leak	.....	2.0 m.a.
1—'26	90	—6	8.2	2.6 m.a.
1—'71	180	—40	3	20.0 m.a.
				33.9 m.a.

Thus the rectifier and filter must be designed to supply the set with 33.9 m.a. at 180 volts. In addition it must supply a maximum negative grid bias of

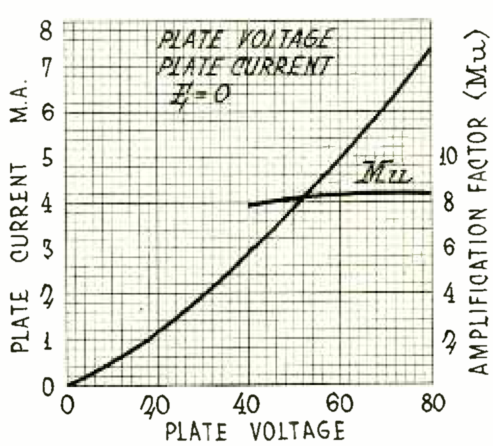


Fig. 3. Characteristics of '27 Tube

40 volts and must also take care of the losses in the resistances which are used to reduce the supply voltage necessary for the various tubes.

A voltage divider which can be used to supply the plate and grids of the six-tube set mentioned is shown in Fig. 4.

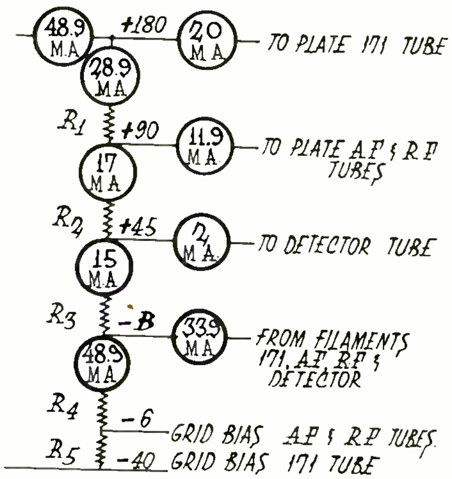


Fig. 4. Typical Voltage Divider

Its resistance losses are readily figured. The plate of the '71 tube requires 20 m.a. drawn directly from the 180-volt terminal and returned to —*B* without loss. All the rest of the plate current for the various tubes must flow through R_1 at whose terminal 9.3+2.6 m.a. (or 11.9 m.a.) are drawn off at 90 volts for the '26 r.f. and a.f. tubes and returned to —*B*. The remainder of the current will flow through R_2, at whose terminal 2 m.a. will be drawn off at 45 volts for the '27 tube and returned to —*B*. Some current must flow through R_3 in order to establish a voltage drop across it and to provide stable operation. This may be arbitrarily taken as 15 m.a., which will give a convenient size for R_3 and be suitable to the circuit design. This gives a total of 33.9 + 15 = 48.9 m.a. to be drawn from the filter.

The resistor values necessary to give the required voltages are figured from Ohm's Law $R = E/I$, when R is the resistance in ohms, E is the voltage drop, and I the number of amperes. A milliampere is .001 ampere. The values required for the voltage divider specified are:

Resistor	Voltage	Current	Resistance
R_1	90	.0289 amp.	3110 ohms
R_2	45	.0170 amp.	2650 ohms
R_3	45	.0150 amp.	3000 ohms
R_4	6	.0489 amp.	123 ohms
R_5	34	.0489 amp.	695 ohms

A conventional two-stage filter with a full-wave rectifier appears in Fig. 5.

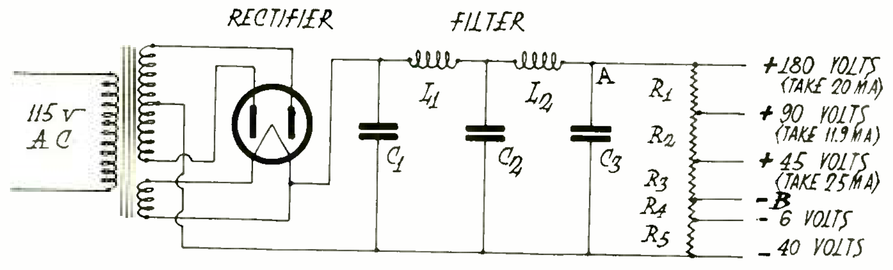


Fig. 5. Conventional Two-Stage Filter

The two choke coils are assumed to have a d.c. resistance of 800 ohms each. They carry a current of 48.9 m.a. (or .0489 amperes). Each causes a voltage drop of 800 x .0489 = 39 volts. Consequently the voltage across the first condenser is the sum of these two, the plate voltage and the grid voltage = 39 + 39 + 180 + 40 = 298 volts.

Instead of using a series arrangement in the voltage divider, several commercial power packs secure greater economy in the use of available voltage and current and reduce a.c. hum by employing a parallel-series arrangement as in Fig. 6. Here the plate current for the '71 power tube is taken from the end of the first choke so that L_3 and the plate-filament circuit of the power tube are in parallel with L_2, R_1, R_2 and R_3. After drawing off 20 m.a. for the power tube, 28.9 m.a. are left to pass through the second choke L_2. At the 90-volt terminal 11.9 m.a. go to the r.f. and a.f. plates and at the 45-volt terminal 2 m.a. to the detector plate. The value of the resistances are now:

Resistor	Voltage Drop	Current	Resistances
R_1	45	.017 amp.	2640 ohms
R_2	45	.015 amp.	3000 ohms
R_3	6	.0289 amp.	208 ohms
R_4	40	.0489 amp.	819 ohms

In the economical design of a filter circuit another consideration is the substitution of a resistor for L_2, as in Fig. 7.

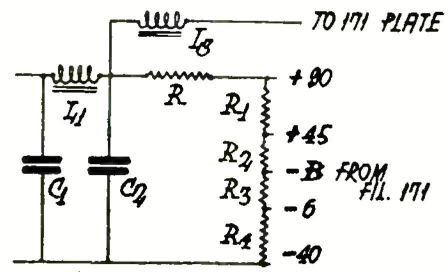


Fig. 7. Second Step in Development of Economical Filter

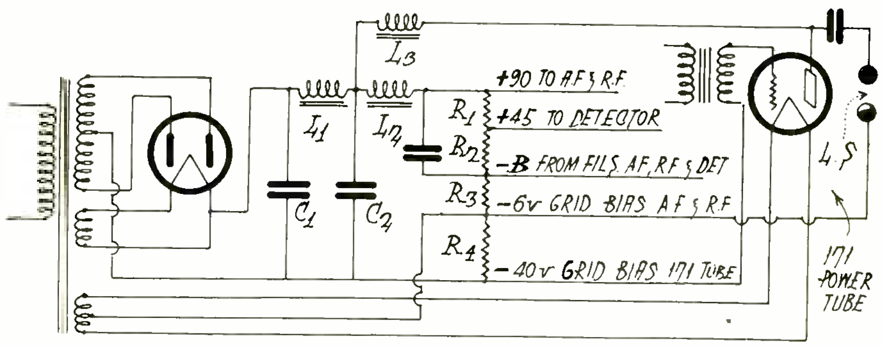


Fig. 6. First Step in Development of Economical Filter

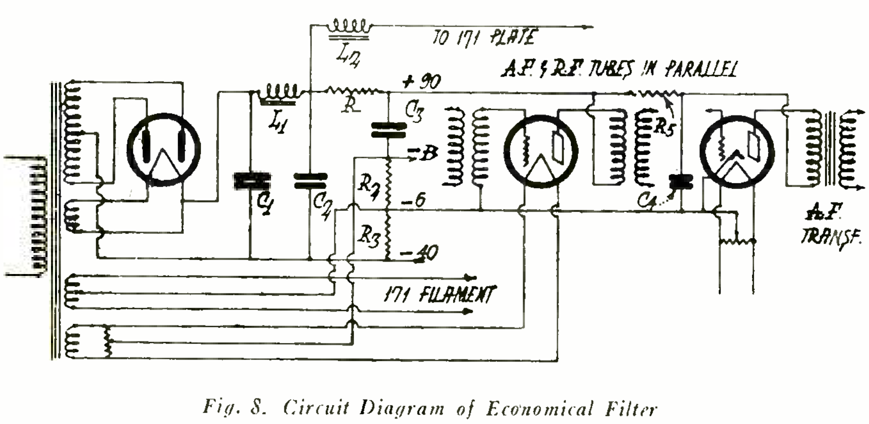


Fig. 8. Circuit Diagram of Economical Filter

This is effective under certain conditions and saves the cost of an expensive choke coil. If L_1 and L_3 are 800-ohm chokes the voltage required across C_2 is equal to the voltage drop in L_3 plus the plate and grid voltages on the '71 tube. These are equal to (800 x .02) + 180 + 40 = 236 volts. The circuit in parallel with C_2 consists of $R + R_1 + R_2 + R_3 + R_4$. The voltage across R then is equal to 236—(45 + 45 + 6 + 40) = 100 volts. As .0289 amp. is to be carried its resistance should be 100 ÷ .0289 = 3460 ohms.

Further decrease in current consumption, and consequently further elimination of hum, can be obtained by eliminating R_1 and obtaining 45 volts for the detector plate through R_5 which is placed in parallel with the 90-volt supply to the r.f. and a.f. plates in Fig. 8, both being connected to the —6 volt terminal of R_2. This should give $(96-45)=51$ volts across R_5, which, since it carries .002 amp., should have a value of $51 \div .002 = 25{,}500$ ohms.

It has already been shown that there are 236 volts across C_2 and 100 volts across R which carries $11.9+2=13.9$ m.a. Consequently R should have a value of $100 \div .0139 = 7200$ ohms. The total load current is 20 m.a. (for the '72 tube) $+11.9$ m.a. (for the r.f. and a.f. tubes) $+2$ m.a. (for the '71 tube), a total of 33.9 m.a., as compared with the 48.9 m.a. in the original circuit. The voltage drop across L_1 is $800 \times .0339 = 27.12$ volts. So the voltage necessary across $C_1 = 27.12 + 236 = 263.12$ volts. As R_2 must produce a drop of 6 volts for a load of 11.9 m.a. its resistance is $6 \div .0119 = 504$ ohms. Likewise R_3 has a resistance of $40 \div .0339 = 1180$ ohms.

Grid bias resistances are ordinarily obtained by letting the plate circuits of one or more tubes develop a voltage drop across a resistance. Thus in Fig. 9 it will be noted that the grid voltage for the r.f. and a.f. '26 tubes are obtained from their combined plate currents, although the circuit design requires a higher plate voltage for the r.f. tubes than for the a.f. tube. The grid voltage for the '71 tube is obtained from its own plate current.

To calculate the values of the voltages and resistances in this circuit will be instructive. Let it be assumed that 800-ohm chokes are used, that the r.f. tubes have 120 volts on their plates and 6 volts on their grids, the a.f. tube 90 and 6, and the '71 tube 180 and 40. Let it further be assumed that the current drain of three r.f. tubes is 21.6 m.a., the a.f. tube 2.5 m.a., the detector 2.5 m.a., and the '71 tube 20 m.a., a total of 46.6 m.a. Then:

Necessary voltage across $C_2 = 16 + 180 + 40 = 236$ volts.

Voltage drop in $L_1 = 800 \times .0466 = 37.2$ volts.

Necessary voltage across $C_1 = 37.2 + 236 = 273.2$ volts.

Necessary voltage across $C_3 = 120 + 6 = 126$.

Necessary voltage across $C_4 = 90 + 6 = 96$.

Resistor	Volts Across R	Current Through R	R
R_1	110	26.6	4140
R_2	30	5	6000
R_3	50	2.5	20400
R_4	6	24.1	249
R_5	40	20	2000

Elimination of hum. When an alternating current is impressed across the plate and filament of a rectifier tube

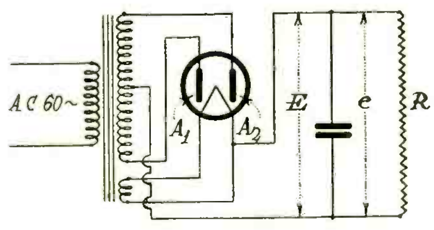


Fig. 10. Full-Wave Rectifier Circuit and Rectifier Voltage

whose plate is kept positive with respect to the filament, current will flow in only one direction. If the rectifier has two plates A_1 and A_2 in Fig. 10, A_1 will be positive with respect to the mid-point of the transformer secondary during one-half cycle and A_2 will be positive during the other half cycle. Consequently such a tube will pass a unidirectional current whose frequency is twice that of the supply voltage. If the rectifier uses but one plate the frequency of the rectified current will be the same as that of the supply voltage.

Thus the voltage E which changes the condenser in the full-wave rectifier circuit of Fig. 10, has a frequency of 120 cycles when the supply is 60 cycles. But the condenser tends to smooth out the pulsations so that the voltage *e* across its terminals contains much less of a ripple than does E. This is illustrated in Fig. 11. The reason for this is that the condenser is being charged while E is increasing and is discharging while E is decreasing. The instantaneous discharge voltage from moment to moment tends to neutralize the decrease in the charging voltage so that the condenser output voltage is steadier than the input voltage.

The mathematical equation which expresses the relation between E and *e* shows that for any given frequency and load resistance R the amount of steady d.c. voltage depends upon the value of

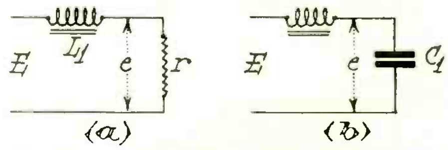


Fig. 12. Choke Coil and Choke Condenser Connection in Filter

the condenser C, *e* becoming smaller as C becomes larger. Experiments show that there is no especial advantage for this purpose in having C larger than 4 mfd. and that 2 mfd. capacity suffices for many cases. But still more filtering is necessary to reduce the ripple voltage before it can be impressed on the tube plates without causing an a.c. hum.

This filtering action could also be accomplished by using the choke coil L_1 in Fig. 12a. Its effect in minimizing the ripple voltage can readily be figured

(Continued on Page 55)

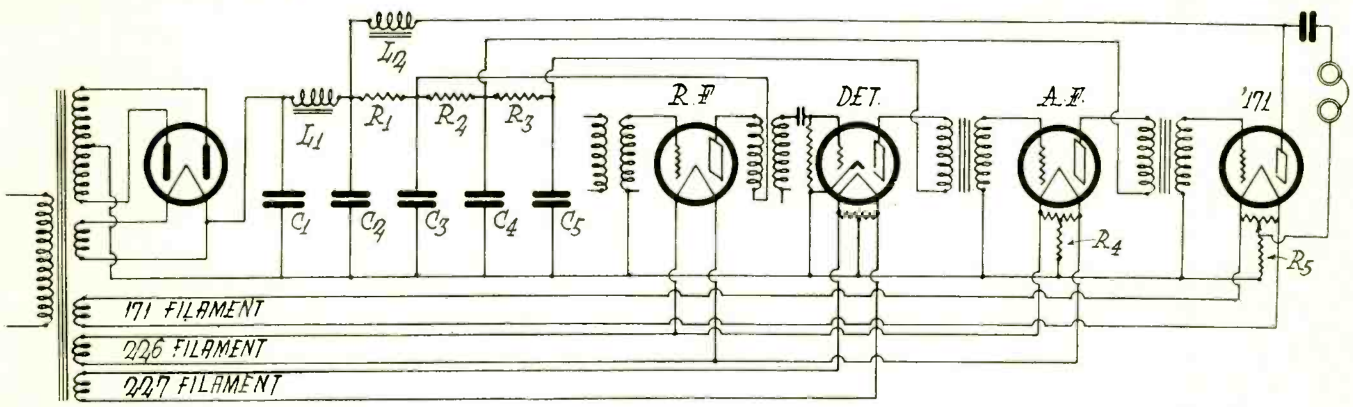


Fig. 9. Current Supply System to A.C. Receiver

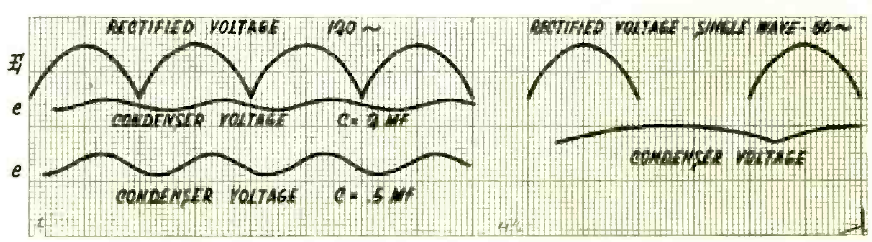
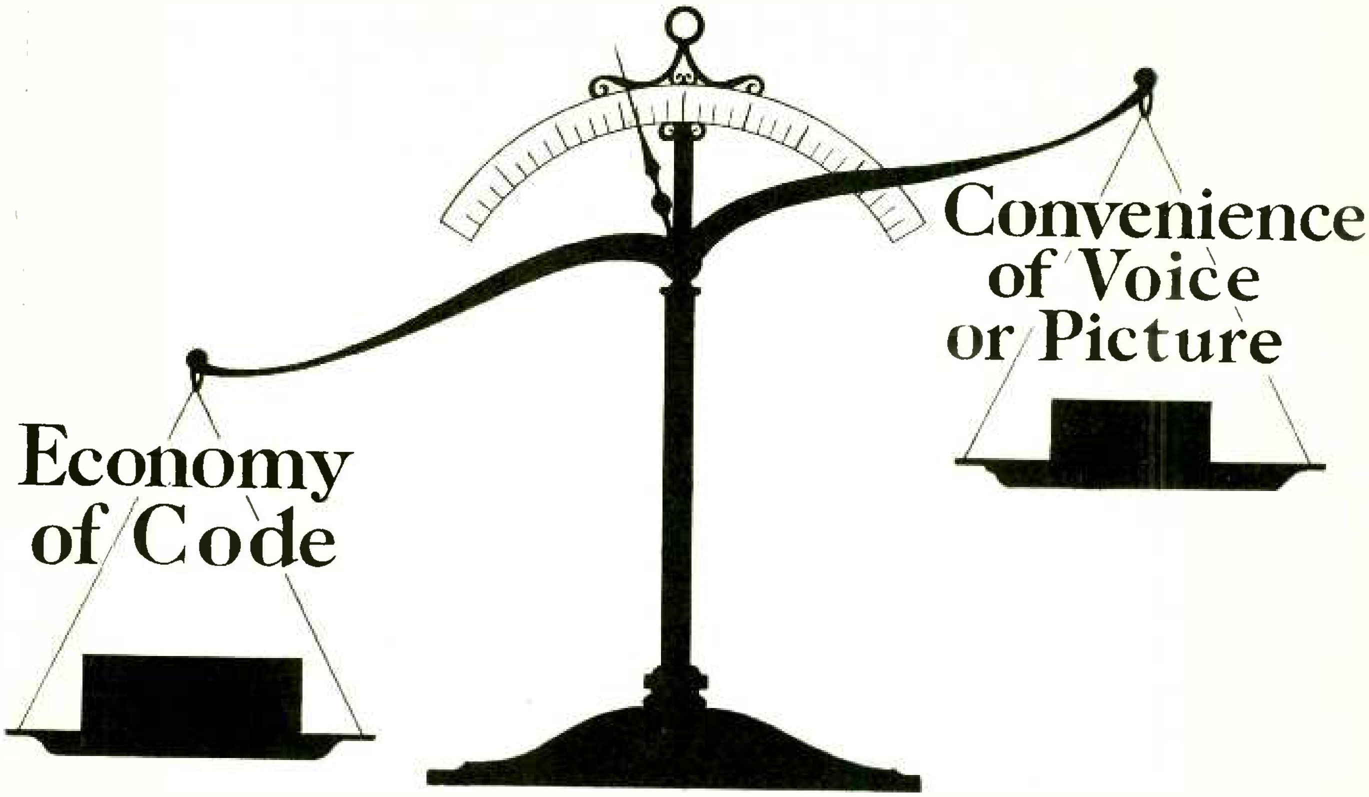


Fig. 11. Effect of First Condenser in Reducing Hum



The Future of Radio Communication

As Forecast by

FREDERICK EMMONS TERMAN
Stanford University

THE advent of commercial facsimile transmission and experimental television has resulted in a host of prophecies, most of which are based more on imagination than on exact analysis of the situation.

An understanding of what the future holds for telegraph, telephone, television and facsimile transmission requires first of all an appreciation of the factors which make our existing communication systems take their present form. Thus the telegraph has survived in competition with the telephone, and today one finds all news, stock reports, etc., transmitted by the apparently cumbersome dots and dashes of the telegraph code rather than by dictation over telephone lines. Again, the transcontinental telephone line came fifty years after the transcontinental telegraph, and at the present time there is a trans-Atlantic cable which can send messages at the rate of 1900 letters per minute, yet there is no expectation of telephoning over such a cable without breaking it up into 600 to 800 mile lengths with the insertion of amplifiers.

The frequent use of the telegraph instead of the telephone as a means of communicating information is not a result of inertia, unprogressiveness or other similar reasons, but is because the *telegraph code is inherently a more economical method of communication than is the human voice.* The telegraph code is a shorthand method of exchanging ideas, and is inherently much simpler than talking. Thus in pronouncing the word "lee" the voice takes about 0.36 seconds, and in this time hundreds of irregular sound vibrations have been set up. To send the same word "lee" by telegraph code requires the transmission of *dot-dash-dot-dot-space-dot-space-dot,* in place of the hundreds of cycles demanded by the voice.

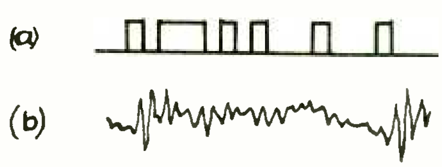


Fig. 1. Code Vibrations and One-Thirty-sixth of the Voice Vibrations Used to Transmit "Lee"

The difference between these two methods of communication is brought out strikingly in Fig. 1, in which *a* shows the dots and dashes required to send the *entire* word "lee," while *b* shows the sound vibrations corresponding to approximately *one thirty-sixth* of the same word.[1] That is, *b* shows the sound vibrations for 0.01 seconds, but vibrations similar to these lasting for 0.36 seconds are required in speaking this one word. It is apparent from Fig. 1 that the dot-dash characters representing the word "lee" could be repeated over a wire thirty-six times while rendering the spoken word only a single time. Thus in this simple case the telegraph code will transmit the same information at least thirty-six times as fast as the telephone, without making any more demands upon the communication system.

The actual ratio of telegraph speed to telephone speed can be readily determined for any particular case. With the telephone it is necessary to transmit a band of frequencies about 2000 cycles wide, i.e., from 400 to 2400 cycles, in order to get only such fair service as given by our usual home phone. Transmission of a quality high enough to avoid the necessity of frequent repeating requires a frequency band of at least 4000 cycles. On the other hand, the side band in cycles required in transmitting ordinary words by means of the Continental Morse code is approximately 0.55 times

[1] This record is taken from "The Sounds of Speech," by Irving B. Crandall, B. S. T. J., Vol. 4, page 586, October, 1925.

(Continued on Page 57)

Freak Reception *Near a Powerful Broadcast Station*

Crystal reception without aerial or ground; stovepipe detector and water-tank speakers; elimination of static; radio house lighting.

By AN ELECTRICAL ENGINEER

DX FANS may recount the thrills of reception from stations 4,000 miles away, but some interesting experiences may also be had with a set located in a home only 4,000 inches (100 meters) from one of the most powerful broadcasting stations in the world. In such a location, when an experimenter wishes to learn whether a tube has burned out or whether the interruption in the radio program was due to the station, the antenna lead may be touched to the ground. If a bright spark occurs he will know that the hiatus in the program was not due to the station. Even though the antenna be of the indoor type, when an ungrounded wire connected to it is picked up with bare fingers, a slight but unmistakable odor of burning flesh and a very minute, needle-like burn on the fingers usually results.

Frequently, when the electric lights are turned off at the switch, some of the lamps in the home, on the porch, and in the garage continue to glow as though they were operated at more than half of normal voltage, until the radio station signs off. Each evening it is the same lamps which show this phenomenon. Turning on certain house lamps may detune the radio-illumination circuit and extinguish the occult light. This was also observed in the home of a neighbor, who called the power company electrician to see if a power circuit defect had developed. While power companies have sued farmers for obtaining power inductively from a fence wire paralleling a transmission line, it would seem improbable that a broadcasting station would sue an experimenter who arranged a tuned circuit to light his house by radio.

Both in the author's home and in a near-by school a stove with no electrical connections has reproduced radio programs distinctly. In one case the gas pipe probably acted as an antenna, a water pipe as a ground, a rusted stove pipe as a crystal and a hot-water tank served as a loudspeaker. This was discovered by a little girl, who announced to her incredulous parents that the rats had a radio! A similar phenomenon was observed in the garage when music was weakly but distinctly emitted from the metal guard of a portable light when it was laid upon an automobile fender.

With a tuned r.f. receiving set of recent design this station can be heard on all points of the dial at full loudspeaker volume, even with a very short antenna and with the controls set to give minimum volume. On at least one occasion, with the set detuned as far as possible, and with the antenna disconnected, some one in another room suggested that the radio be turned down to a more comfortable volume!

On one evening after we had been listening to grand opera sent many miles by telephone to the adjacent station and by radio to our home a few hundred feet away, a new feature of the set was discovered. The lights were being turned out for the night and, on extinguishing the last one, the grand opera suddenly ceased and jazz music of approximately the same volume was received from a station 350 miles away. When the light chain was repeatedly pulled, grand opera from Chicago through the adjacent station, or jazz from Louisville were received alternately. It happened that earlier in the evening we had unintentionally placed the dial on the Louisville position and had left the volume control partly on, and the change in the lighting circuit had changed the effective antenna, as the power lines acted through capacity as a parallel antenna. While this experiment has been repeated on other nights, the second station did not vanish but could be heard with greatly decreased volume until the power circuit was again changed to favor it.

The effect of a lighting circuit as an antenna was demonstrated in a test with a high priced a.c. superheterodyne enclosed for experimental purposes in a heavy copper casing with the antenna and ground leads of the set disconnected and placed inside the shield and with no openings in the shield except one which provided a tortuous path for the a.c. power leads. Under this condition the near-by station could be heard with loud volume at about 40 places on the station-selector, and a low-power station 10 miles away gave normal volume at one very narrow place on the dial. This same set, however, was found to give all the selectivity desired when located a few hundred feet farther from the powerful broadcasting station. With a less selective type of superheterodyne receiver the powerful station can be heard at approximately 20 places on the dial when the set is located several blocks away.

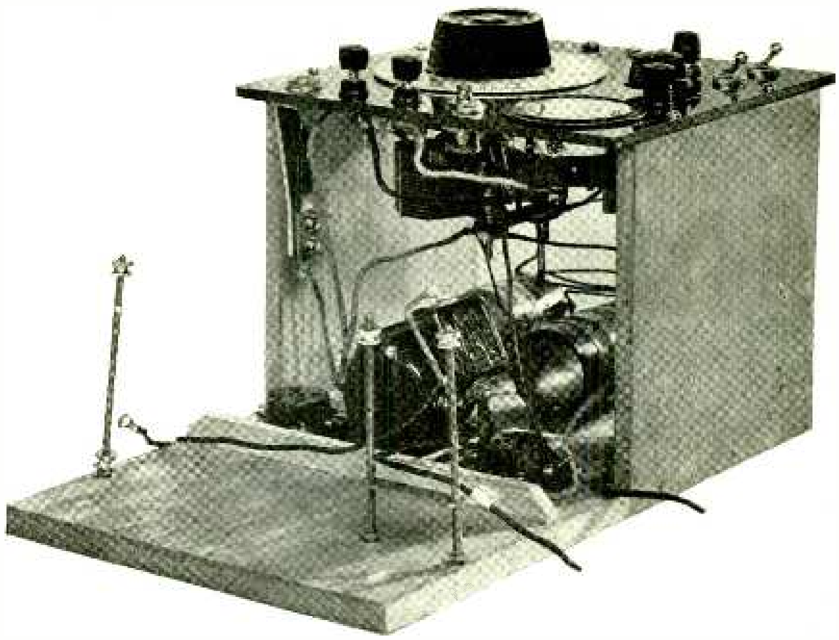
With a radio set composed of a crystal, head phones and a coil of a few turns of wire, good reception has been obtained from the near-by station without antenna or ground connections. With this simple radio set in a coat pocket it is possible to walk about the house and hear a radio program from head phones. Under this condition the shielding effect of the earth is not noticed in the cellar, even at the wall adjacent to the broadcasting station. In fact, the simple, untuned crystal set could be heard when it was placed in a copper wash-boiler with its lid in place and with no wires extending outside, except a short pair of leads to the head phones. Ordinary crystals had a short life in service with so much radio power, but a Rectox copper-oxide disk gave fine results; although in locations more remote from a station, they might not be sensitive, due to their high capacitance.

Operation of a radio set adjacent to a high-power station has disadvantages, such as, for example, telephone interference and the inability to tune out the trill of picture transmission by radio or to prevent the simultaneous reception of programs sent out on the regular frequency and on the short-wave emanating from the experimental station operated in conjunction with the broadcast station; but it has one advantage, namely, that there is plenty of power available so that static is scarcely ever detectable and the a.c. set has been operated satisfactorily on the local station, even without the detector tube!

TROUBLE SHOOTING *A Radio Set*

WITH AN R.F. OSCILLATOR AND DIP METER

By EVERETT E. POWER



View of Assembled Test Kit Without Batteries

NOTWITHSTANDING all the information that has been published regarding the construction of set-testing equipment, there is still a dearth of information regarding the principles which govern its use and how to use it to the best advantage. Even a simple r.f. oscillator and grid-dip meter, whose circuit diagram is shown in Fig. 1, is well adapted for neutralizing and lining up the r.f. tuner of a set and for locating troubles which are not shown by the ordinary current and voltage readings. A more elaborate outfit is necessary for finding troubles in superheterodynes.

The circuit in Fig. 1 consists essentially of a vacuum tube oscillator whose grid circuit contains a 0-1.5 m.a. milliammeter and to which an r.f. feeder wire is attached. The grid circuit is opened and closed by a switch *S*. The oscillator can also be calibrated as a wavemeter for calibrating the dial settings of a new receiver.

This outfit is particularly useful in lining up gang condensers, the idea being that each condenser and its associated coil is accurately tuned to the same frequency by the control knob. This is attained by adjusting the receiver condensers so that each gives maximum dip reading on the milliammeter in the grid circuit when the r.f. feeder wire is converted to the grid side (stator plates) of each condenser in turn.

The switch *S* is kept open until the oscillator tube is oscillating. When the switch is closed, the meter will indicate a current of from .25 to .4 m.a., depending upon the type of tube and the voltage applied in the set. If an absence of grid current indicates that the receiver tube is not oscillating, change tubes and check connections and applied voltages until grid current is shown.

The oscillator and receiver should

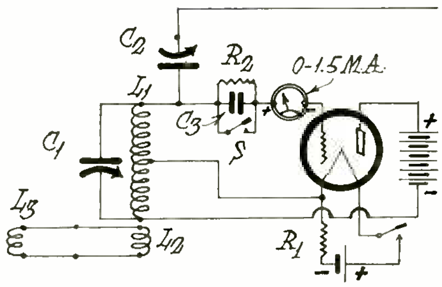


Fig. 1. Simple Oscillator and Grid Dip Meter

C_1—500 mmfd. variable condenser

C_2—15 mmfd. variable condenser

C_3—250 mmfd. fixed condenser

L_1—50 turns of No. 26 silk on 2½-in. tube. 25 turns each side of center

L_2—3 turns on same coil as L_1

L_3—5 turns on 1-in. form. L_1 and L_2 are not critical

R_1—Filament control device. For '99 tubes use 20-ohm resistance or Amperite. For WD-11 use 1.6-ohm resistance. Rheostats are satisfactory.

R_2—Grid-leak of approximately 3 megohms. Try several and select the one that gives the best audio note.

(Switch *S* open during tests.)

The feeder wire is several feet long and has a clip on the end to facilitate connecting to condenser plates. The meter covers 0-1.5 m.a.

Batteries, 2 Eveready No. 768 and 2 Eveready No. 771.

then be tuned to the same frequency by watching the meter as the receiver dial is rotated. At one or more points the meter needle will suddenly "dip" and then return to normal as the dial is rotated. These points of minimum grid current are resonance points at which the receiver circuit is tuned to the same frequency as is the oscillator. More than one resonant point indicates the presence of oscillator harmonics which are multiples of the fundamental frequency. The harmonics show less dip than does the fundamental.

If this dip or decrease in grid current cannot be noticed, increase the capacity of C_2, tune the receiver to another frequency, and try again. Also check the feeder wire connections. After the meter works, adjust C_2 to show maximum dip without instability.

Then adjust the trimmer condenser in the set until maximum dip occurs as the feeder is connected to each of the condensers in the gang in turn. It may be necessary to go over the gang several times. During the whole operation the main condenser control and oscillator should remain unchanged. On sets that have a tendency to oscillate at the higher frequencies, the lining up should be done at a lower frequency, say 550 k.c. This will tend to compensate for the decrease in sensitivity at the lower frequencies. The condensers will usually be staggered at the higher frequencies and thus reduce the sensitivity where it is not so desirable.

On a few sets, such as the later Majestics and Kolsters, the outside rotor plates are slotted. By bending these plates properly, the condensers can be lined up throughout the whole range. Set the variable condenser gang at minimum capacity and adjust the trimmers to a position approximately half way between minimum and maximum capacity. Now rotate the condenser gang until the first segment of the slotted rotor plate has just fully meshed. Now use the dip meter and bend the plates in or out until the condensers are lined up. The grid current meter should now drop to a minimum current as the feeder clip is moved from one stator to another. Now rotate the variable condenser until the second segment has just fully meshed and proceed to bend the second segments until the condensers are lined up. Do not bend the segment that

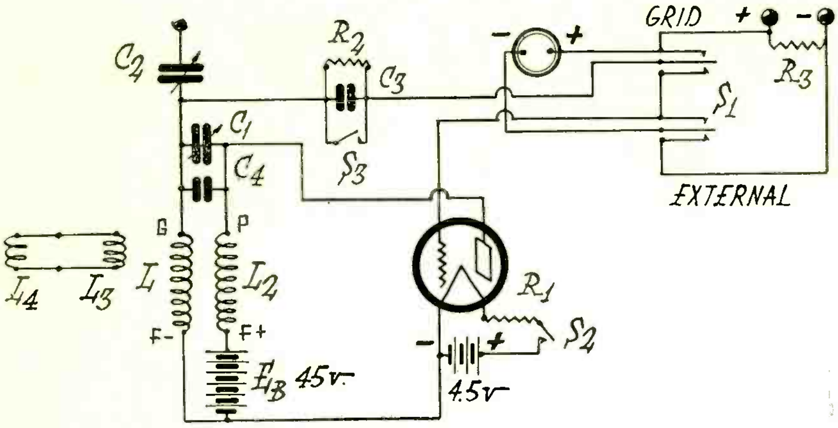


Fig. 2. Circuit Diagram of Outfit for Testing R.F. and 180 K.C. Amplifiers

meshes first because this will mis-align the condensers at the higher frequencies. When the second segments have been properly bent, proceed to bend the third set and so on. After the plates have been properly bent, the trimmers can be used for closer adjusting if found necessary.

In sets where the stator is not easily accessible, the feeder can be connected to the grid terminal at the socket or put into the hole for the grid prong so that it makes contact. If it is necessary to remove one tube, all of them should be removed so as to compensate for the grid-filament capacity.

Complete failure to dip indicates either an open condenser lead, shorted condenser, open coil or grounded grid, probably due to a grid-filament short.

To neutralize a receiver, connect it to a ground and short antenna to which the oscillator is coupled by means of its coupling coil or r.f. feeder wire. Start the oscillator with S open and rotate C_1 until a buzz is heard in the receiver speaker. Tune the receiver and oscillator to about 1300 k.c. (230 meters) and adjust the neutralizing condensers with a wooden screwdriver and a dummy tube until the set is free from oscillation at all points of the dial.

The dummy tube is prepared by cutting one filament prong from a good tube of the same type as is used in the set. It should be placed in the first neutralized r.f. stage and the corresponding neutralizing condenser should be adjusted until minimum volume is heard from the speaker or head phones. This is repeated for each r.f. stage, replacing the original tubes in the stages which are not being tested.

When calibrating the oscillator as a wavemeter, disconnect the feeder wire and short the switch S, using the zero beat method. Be sure that the batteries are in good condition when the calibration is made.

A somewhat more elaborate outfit which may also be used for aligning the 180 k.c. intermediate frequency transformers in the Radiola 60, 62 and 64, and as a volume indicator is shown in Fig. 2. This requires the use of additional 180 k.c. plug-in coils and two more toggle switches.

These coils L_1 and L_2 may be wound on bakelite forms 15/16 in. in diameter and 2¼ in. long, both being wound in the same direction and each requiring 47 turns of No. 28 wire for the broadcast band and 105 layer-wound turns for 180 k.c. The grid and plate terminals are taken off in the center with the B plus and grid returns at the ends. L_3 consists of 6 turns of wire wound just below the coil socket and L_4 of 5 turns on a 1 in. form for external coupling.

C_1, C_2 and C_3 are the same as the corresponding condensers in Fig. 1. C_4 is a .001 mfd. fixed condenser connected between the plate and grid prongs of the 180 k.c. coil only, being conveniently placed inside the coil. R_1 and R_2 are the same as in Fig. 1. R_3 is a 3-ohm shunt resistance, S_1 is a Yaxley 760 and S_2 and S_3 may be any good toggle switches.

For use as a grid dip meter S_1 is thrown so that the meter is in the grid circuit. The feeder wire is connected to C_2, and then to the grid side of the tuned r.f. circuit under test. When the oscillator and receiver are tuned to resonance the grid current will decrease suddenly. By using this method, tuned r.f. circuits may be aligned and troubles in the r.f. amplifier located as previously explained.

For neutralizing the feeder wire is disconnected and the coupling coil L_4 is connected, being placed near the receiver antenna. S_3 is opened and the set neutralized in the customary manner.

To change to the 180 k.c. band it is merely necessary to remove the broadcast range coil and insert the 180 k.c. coil in its place. L_4 can be placed beneath the first detector inductance, but practice has shown that it is better to couple to the oscillator coil. A piece of paper should be inserted between the grid prong and the socket contact of the oscillator tube. This will prevent any change in voltages and at the same time stop the oscillations that are not required. The proper dial setting for 180 k.c. can be determined by taking the average of readings from several sets that are operating properly.

When the meter is changed from the grid circuit to the external circuit by means of S_1 and is connected directly into the B plus lead to a power detector, it gives a much better indication of relative r.f. amplification than does a loudspeaker. If the B plus detector lead cannot be conveniently reached, the lead may be broken by means of an adapter which is inserted in the receiver's detector socket as shown in Fig. 3a.

Such an adapter can be made from an old UY-227 tube base on which is mounted a small UY-227 socket for holding the tube. All prongs and terminals, except the plates, are connected from one to the other. The positive lead to the meter is taken from the plate prong of the tube base and the negative lead is taken from the plate terminal of the adapter socket. This method can be used with the Radiola 60, while the 180 k.c. oscillator is being used to align the i.f. transformers, thus making other instruments unnecessary.

Where grid-leak and condenser detection is used the volume indicator of Fig. 3b is satisfactory for aligning and neutralizing the r.f. amplifiers. This consists of an output transformer, carborundum detector, and the meter in the test set. The primary of the transformer is connected across the loudspeaker terminals.

A more complete outfit whose circuit

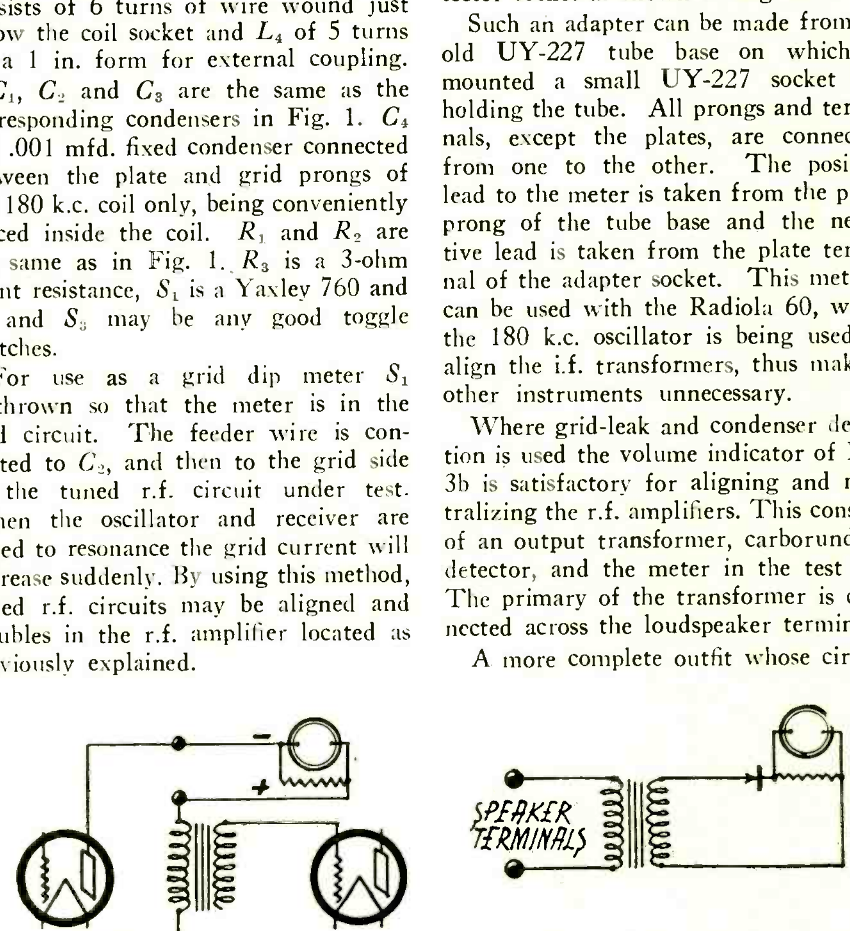


Fig. 3. Circuits for Comparing R.F. Amplifications

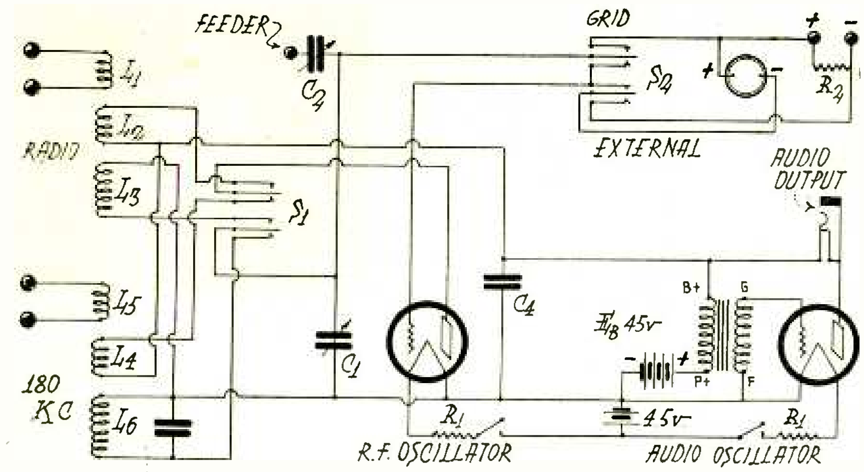


Fig. 4. Circuit With R.F. and A.F. Oscillators

L_1 4 turns	L_4 50 turns	C_1 500 mmfd. variable	C_4 .05 mfd. fixed
L_2 30 turns	L_5 6 turns	C_2 15 mmfd. variable	R_1 20 ohm fixed
L_3 60 turns	L_6 105 turns	C_3 .001 mfd. fixed	R_2 3 ohm
			S_1 and S_2 Yaxley 760

is shown in Fig. 4 uses a separate audio frequency oscillator instead of a grid-leak and condenser to modulate the r.f. oscillator. The switch S_1 is used instead of changing the plug-in coil to change from the broadcast band to 180 k.c. Its use as a grid-dip meter or volume indicator is the same as already described. The accompanying picture shows its general appearance with the batteries removed. All the coils are wound on 2-in. bakelite tubes.

The audio frequency oscillator can be used to supply a.c. for testing a.f. circuits and amplifiers, lines, and bridge measurements of inductance and capacity. Its limited frequency range makes it unfit for use in making frequency-response curves. C_4 is necessary to by-pass the r.f. current in the r.f. oscillator plate circuit. Too small a capacity in this condenser will prevent oscillation at the lower frequency end of the broadcast band and too large a capacity will lower the frequency of the audio oscillator.

The good points of Figs. 2 and 4 are combined in Fig. 5 which also includes a four-pole double-throw switch for changing the milliammeter from the grid circuit to the plate circuit. This allows its use as a vacuum tube voltmeter, a

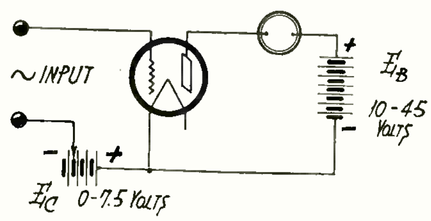


Fig. 6. Details of Simple V. T. Voltmeter Circuit

simple diagram of which is shown in Fig. 6. While this is useful in measuring small, low-frequency a.c. voltages where the current consumption must be small, it is not dependable for high-frequency work because of the numerous capacities which are connected in the circuit. Its general operation is otherwise the same as for Figs. 2 and 4.

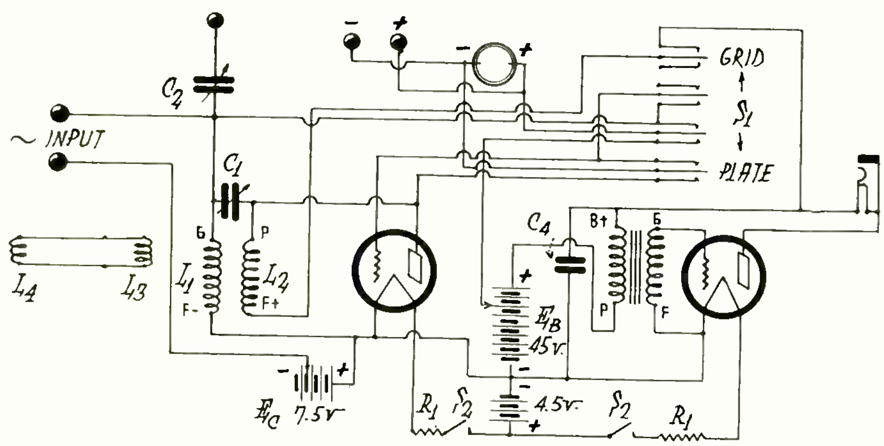


Fig. 5. Circuit Diagram of Test Kit With V. T. Voltmeter

L_1, L_2, L_3, L_4, C_1, C_2, R_1 and S_2 same as for Fig. 2, C_4 same as Fig. 4, S_1 Four-Pole Double-Throw Anti-Capacity Switch

A better volume indicator than those in Fig. 3 is shown in Fig. 7. It is connected directly across the speaker terminals so that a.c. is impressed between the grid and filament of the tube. The grid bias E_c is increased negatively until the plate current with no signal is zero. The negative half of an incoming signal

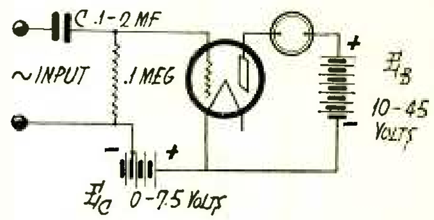


Fig. 7. V. T. Voltmeter as Volume Indicator

has no effect but the positive half will decrease the grid bias and thus increase the plate current. If the meter needle goes off the scale increase the grid bias and put a variable shunt across the milliammeter terminals. By increasing negatively the grid bias, the plate current can be made zero for ordinary signal strength and at the same time a full scale deflection obtained on louder signal strength. The change in meter deflection for a small signal change is very much larger than for other methods of volume indication.

A NOVEL HOTEL RADIO INSTALLATION

A new system for the transmission of radio programs to rooms in the Hotel Lincoln, New York City, requires no individual wires to the rooms but employs the steel framework of the building. In a room on the top floor are six master receiving sets, each using the same aerial but tuned to a different station. The output from each set is carried by wire to a monitor table at which is seated an operator who controls the volume of reception. From this table are wires which lead to six oscillators completely shielded by copper nettings. The output of each oscillator is modulated by the audio frequency from its associated receiver and then transmitted into the steel frame of the building, each being on a different wavelength.

The re-transmitted programs are picked up in the rooms by receiving sets which respond only to the new wavelengths. These receivers are of the one-piece portable type with built-in loud-speaker.

Kodaking Electricity *in Action*

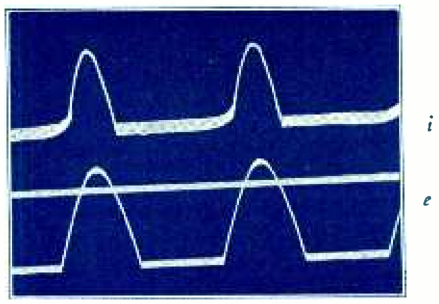


Fig. 1. Charging Current and Output Voltage from Rectifier

HOW PICTURES OF VOLTAGE AND CURRENT ARE TAKEN AND WHAT THEY EXPLAIN

By G. F. LAMPKIN

An apparent anomaly in electrical work is the charging of a battery by a source whose voltage reads lower than that of the battery. For instance, a d.c. voltmeter reads 2.7 volts when connected to the output of a tungar charger; the voltage measured on the battery is 6.0. But when connected to the battery, the same charger is able to shove 2 amperes into it. As a comparison, water's running up hill seems to be in the same class.

It requires only a study of electrical wave forms, with perhaps a few references to the methods of determining them, to explain away the anomaly. An oscillograph picture of battery charging looks like that of Fig. 1. The upper trace is the charging current fed to the battery. The lower curve is that of the output voltage of the rectifier. The horizontal line is the battery voltage.

The tungar rectifier, of course, allows current to flow only one way; so that, even though the battery voltage be higher than that of the charger, current cannot back up through the circuit. Only when the charger voltage is higher than that of the battery does current flow, in the correct direction.

The reading given by a d.c. meter on the half-wave rectified voltage is the average value taken over the period of one cycle, or approximately 32 per cent of the peak value. The d.c. battery voltage is about 78 per cent of the peak charger voltage. Thus, while the d.c. meter shows the charger voltage as less than half that of the battery, still for short periods of time the charger voltage is actually higher than the battery voltage, and during these short periods charging current flows.

A d.c. meter has a permanent magnet, and a moving coil through which flows all or part of the current which is to be measured. The permanent magnet forms a steady magnetic field, with which the current in the coil reacts to twist the coil about its axis. A restraining spring keeps the coil from rotating like a motor. Any given current twists the coil till the turning force is balanced by the spring, when the resulting deflection of the pointer is a measure of the current. If the current in the coil be reversed, the meter deflection will reverse also.

If a pulsating current is measured, the pointer will tend to follow the pulsations; but because the coil and pointer assembly is comparatively heavy it will not follow variations that occur faster than four or five times a second. If the fluctuations have a frequency of 60 or 120 cycles per second, there will be only a slight flutter of the needle about its average position. For any type of wave a d.c. meter reads the average value. On a simple rectified half wave a d.c. meter reads 32 volts if the peak is 100; on a rectified full wave the reading is 64 volts, on a.c. the d.c. meter reads zero.

In order to measure a.c., the permanent magnet can be replaced by a fixed coil. Through both this coil and the moving coil is passed the current to be measured. The current through the moving coil, instead of reacting with a permanent field, reacts with the field produced by itself from the fixed coil. Suppose any given current flowing in the meter be doubled. The field of the fixed coil will be doubled, as will also that from the moving coil, so that the turning force on the pointer becomes four times as great. In other words, the force on the pointer is proportional to the square of the current.

If the connections to the meter are reversed, the current in both the fixed and moving coils reverses, so that the relation of one with respect to the other is unchanged. The pointer moves in the same direction as before the reversal. Thus on a.c. the pointer reads positive for either positive or negative direction of current. As with the d.c. meter, however, the moving coil and pointer cannot follow rapid changes in current, and the force on the meter needle is proportional to the average square of the current.

The electrodynamometer type of meter, as the above is called, gives readings in effective values, for any type of wave. Root-mean-square, abbreviated r.m.s., is a synonym for effective. Other types of meters, including the iron-vane, coil-and-plunger, hot-wire instrument, etc., read r.m.s. values. Such meters can, of course, be used to measure either a.c. or d.c.

To determine the peak value of a wave, the circuit of Fig. 2 can be utilized. The condenser is charged on the positive half-cycles, and after a few cycles reaches the peak value of the wave. The d.c. voltmeter has a very high resistance so that it discharges the condenser only by a negligible amount between cycles. The meter reads the peak value of the wave directly. The ordinary vacuum tube voltmeter, in which the a.c. wave on the grid is bucked out with d.c. bias until the plate current resumes its initial value, is another peak-reading voltmeter.

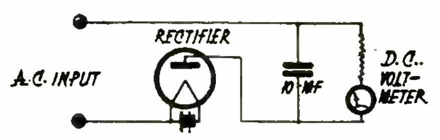


Fig. 2. Circuit for Measuring Peak Value

All these instruments give readings which are averages over comparatively long periods of time. Instantaneous values of electrical quantities can be determined by use of an oscillograph. In its most general form it is nothing more than a d.c. meter which is capable of following four or five thousand fluctuations per second.

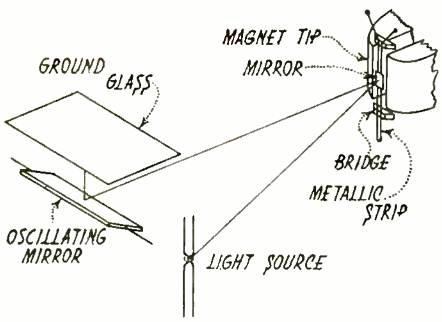


Fig. 3. Essential Elements of Oscillograph

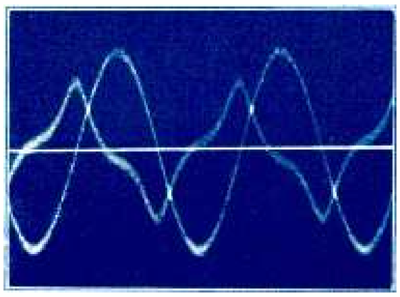
Fig. 3 shows an oscillograph stripped to its simplest details. The meter element has the permanent magnet in whose field a one-turn moving coil is placed. The coil is simply a fine metallic strip stretched over bridge supports so that the current goes down one side and up the other. Centered between the bridges and glued to the two metallic strips is a tiny mirror. Light from a source is reflected from this meter mirror to another mirror, or to a photographic film. The second mirror rotates, or oscillates, so that it causes the spot of light to move at right angles to the deflection caused by the meter mirror.

With both mirrors stationary, a single spot of light shows on a ground glass viewing screen. With a.c. flowing in the meter element the mirror twists slightly back and forth about its zero position and widens the spot into a line across the screen. With rocking of the second mirror, the line becomes a curve which shows the instantaneous values of current flowing in the meter element. Strictly speaking, the instrument in this function of visual observation is an oscilloscope.

As an oscillograph the instrument makes permanent records. In this case, the second mirror is removed from the light path, and the meter mirror throws its line through a narrow slit. Back of the slit and at right angles to it is moved a photographic film; the combination of the two movements causes the spot of light to trace the current curve on the film. An analogous action can be had by retracing a pencil line back and forth across a piece of paper, and then drawing the paper at right angles to the line from beneath the pencil. The light-moving coil system of the oscillograph, using a beam of light for a pointer, permits recording of waves up to approximately 5000 cycles per second. The upper limit, of course, may vary considerably either way, depending on the details of the machine.

There are also other types of oscillographs—the electrostatic, rather than the electromagnetic as above; the string oscillograph; the cathode ray oscillograph; and a refinement of the latter in the Dufour oscillograph, which is about the fastest known. With it pictures of waves of a frequency of ten million can be taken.

Curve "a" of Fig. 4 was traced by a 60-cycle voltage from the power lines.



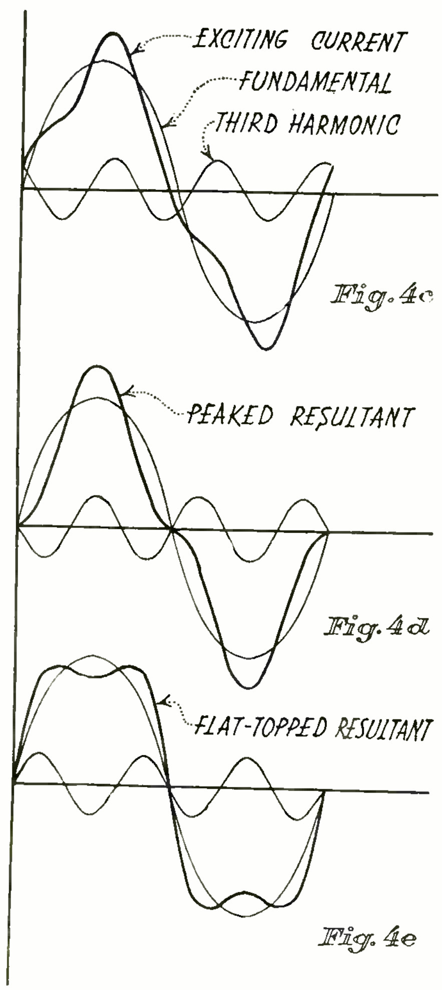


Fig. 4. Analysis of Current Wave with Fundamental and Third Harmonic

It is very nearly a pure sine wave—that is, a wave which has a component of 60 cycles only, and no harmonic components of 120, 180, 240, etc., cycles. A pure sine wave is made the basis of practically all a.c. measurements and calculations.

Any a.c. wave whatsoever that repeats itself periodically can be resolved into a fundamental and harmonic frequency components of definite magnitudes and relative positions. Thus the performance of circuits or apparatus can be predicted for any periodic a.c. wave whatsoever, if the performance for single-frequency waves is known. If a wave departs from the simple sine curve, it contains harmonics to varying degrees.

Sometimes an approximate idea of the harmonic content can be had by inspection. Curve "b" of Fig. 4 is the current flowing into a small 300-watt filament transformer with no secondary load—in other words, the exciting current. The curve "a" is the voltage that was impressed on the transformer. It is at once apparent that the exciting current wave is distorted from the pure shape. By comparing the shape with that synthesized in Fig. 4c from a fundamental and a third harmonic, it may be seen that the exciting current harmonic content is chiefly 180 cycles. Smaller amounts of the fifth and seventh harmonics are also present.

By measuring and tabulating the height of the curve at equidistant points along the zero line, and by subjecting these data to a rather laborious analysis, the exact magnitudes and relative positions of the fundamental and various harmonic components could be determined. The relative positions, or phases, or the components play an important part in the wave shape. Two other synthesized forms are plotted in Fig. 4, d and e, with the same magnitude of fundamental and third harmonic as in 4c. By merely shifting the starting point of the third harmonic the wave shape can be changed from a peak to a flat top.

The third harmonic component in exciting current becomes more pronounced as the magnetic flux density in the transformer core increases; i. e., as saturation is approached. In audio transformers the presence of d.c. plate current tends to prematurely saturate the core. Preventing the d.c. from flowing in the winding aids in overcoming harmonic distortion due to magnetic action in the transformer.

If an a.c. wave is symmetrical about the zero axis—if it repeats in the second half-cycle the negative of the values in the first half—it contains only odd harmonics. All even harmonics, including zero frequency or d.c., are absent. Such waves are the type met with in alternating current power work. Symmetry in the rotating machinery of a power system allows only symmetrical waves to be produced or maintained.

In radio work, however, all types of waves and harmonics are encountered. In general, the more irregular the wave, and the sharper the breaks or changes in the curve, the greater will be the harmonics in both number and magnitude. Not only may there be one fundamental and its harmonics; there may be two or more fundamentals, each with its attendant train of harmonics. Fig. 5 shows the wave shape obtained from a buzzer compared with a 60-cycle wave for timing and shape. Such a ragged, irregular form indicates a myriad of harmonics.

The change in shape from a pure sine wave to a distorted wave, occasioned by passing through a circuit or apparatus, is caused by a non-linear relation between input and output over all or part of the working range. By non-linear relation is meant that a change of current or voltage does not produce an equal, or proportional, change in another current or voltage. A rectifier in a battery eliminator is a non-linear device that causes intentional wave form distortion. An improperly operated amplifier tube causes undesirable wave-form distortion.

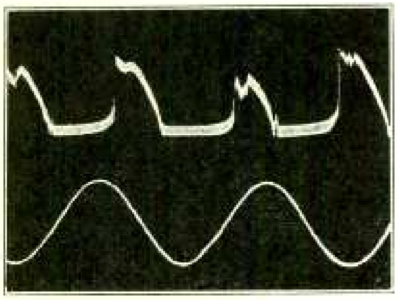


Fig. 5. Current Wave with Many Harmonics (upper) and 60-Cycle Voltage Wave (lower)

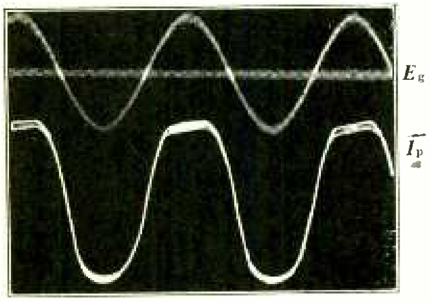


Fig. 6a. Current Wave of Amplifier with Too Low a Grid Bias

Examples of amplitude distortion in an improperly operated amplifier are shown in the oscillograms of Figs. 6a and 6b. In the one case the d.c. grid bias was too low, so that the grid swung positive and took enough grid current on the positive voltage peaks to lower the input voltage. The plate-current curve at these points was sliced off. In the other case the grid bias was too high, with the result that on the negative grid voltage swings the plate current was brought down in the cutoff region. The upper traces on the films are the practically pure input voltages. A synthetic curve in Fig. 7a, compounded from a fundamental and second harmonic, shows by comparison with 6a or 6b that the latter contain a good bit of second harmonic. It may be noted that these waves, containing even harmonics, are not symmetrical.

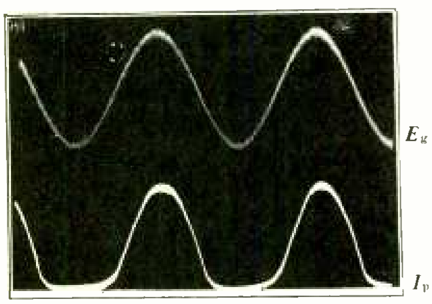


Fig. 6b. Current Wave of Amplifier with Too High a Grid Bias

If two tubes were operated in a push-pull amplifier, the plate current of one tube would swing up as that in the other went down, something as in Figs. 7a and 7b. It is assumed that distortion occurs on the negative swing. The output from a push-pull amplifier is taken so that the difference of these two currents is obtained. Subtracting 7a from 7b in effect adds the fundamental components and cancels the second harmonics. The resultant output wave is the nearly pure form had in 7c. Such cancellation of the even harmonics is one reason for the efficacy of the push-pull amplifier.

The action of a battery-charging rectifier has been shown in Fig. 1. A somewhat similar action is had when a rectifier feeds a condenser as the first element of a filter system. The condenser charges to a voltage somewhat less than the peak of the input. It is only when the output voltage of the rectifier is higher than the condenser voltage that current flows from the rectifier into the filter system.

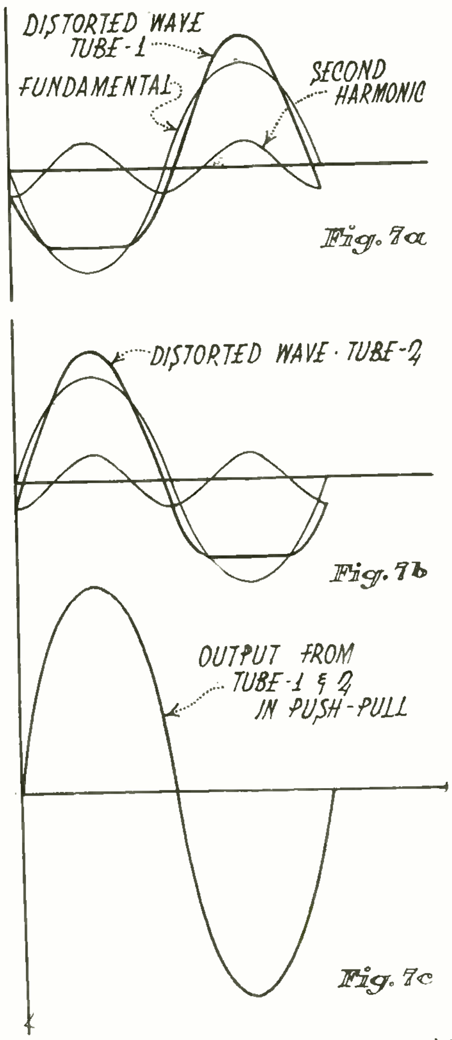


Fig. 7. Analysis of Current Wave with Fundamental and Second Harmonic

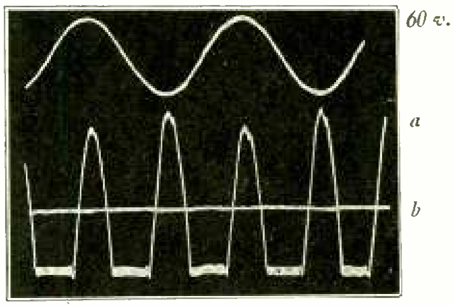


Fig. 8. Oscillogram of Full Wave Rectifier Feeding a Condenser

The oscillogram in Fig. 8 was taken on a *B* eliminator using a full-wave rectifier. If a full-wave rectifier were feeding a resistance load, the half loops of rectified current would touch at the bottom. Instead, when feeding the condenser, the half loops of current occupy only a fraction of the half cycle. However, the d.c. value of these half loops must be the same as the d.c. in the load, shown by curve "b" on the film. To have this average value, the short-period jabs of current must be extremely large. On the film the current through the rectifier rises to more than twice the average d.c. Such a load imposed on the rectifier tube materially shortens its life. Omission of the first condenser in the filter system removes the cause of these heavy current jabs, so that the current through the rectifier becomes much more uniform and the tube life is prolonged. At the same time, however, the d.c. output voltage is lowered and the hum increased somewhat.

As has been said, the average values of the two waves "a" and "b" in Fig. 8 are the same. The average value of any wave may be stated as the total area under a complete cycle of the curve divided by the length of the cycle. For

(Continued on Page 74)

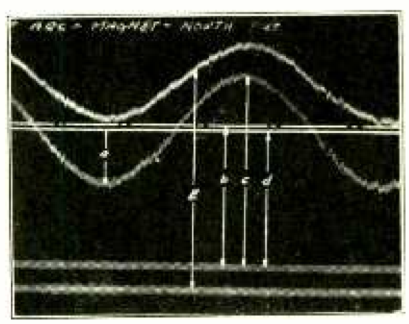


Fig. 9. Oscillogram of Current and Voltage on a Mercury Arc Tube

a.—Peak value of alternating component of current=3.34 amps.
b.—R.M.S. value of total current=8.7 amps.
c.—Peak value of total amount=11.75 amps.
d.—Average or d.c. value of total current=8.4 amps.
e.—Voltage wave=25.5 volts average.

Experiments with AC Detector Tubes

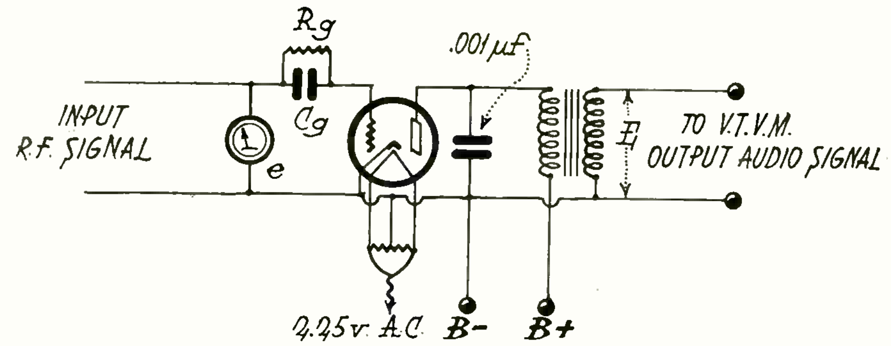


Fig. 1. Oscillator Circuit Used for Measurements

By GLEN H. BROWNING

Since the average radio man is more interested in actual results than in any discussion of the complicated theory of detection, the writer herein confines himself to an account of some experiments with the '27 and '24 types of tubes when used as detectors. These experiments were concerned with the relative merits of these tubes when used in detector circuits with grid leak and grid condenser and with grid bias.

The function of a detector in a radio set is to rectify the incoming signal, which appears in the r.f. amplifier as a radio frequency alternating current modulated by an audio frequency current; so that after the signal has passed through the detector only the audio frequency current is present. That is, the detector only unscrambles the voice frequencies, which have been transmitted from the sending station by means of a carrier, so that these voice frequencies are audible on head phones or in the loud speaker as the case may be.

There are two generally accepted methods of doing this. One is by means of a grid leak and grid condenser placed in the grid circuit of the detector tube and the other is by means of a *C* battery placed in the grid return. This latter method is usually called plate detection. There is an opinion prevalent in radio circles that the quality of signals detected by the use of a *C* battery is better than those obtained by means of the grid leak and condenser. However it is definitely known that the grid leak and condenser method gives considerably more signal strength. In fact the difference is so great that it may be readily observed by ear.

As loud speakers and audio amplifiers, which were formerly the worst offenders from the standpoint of quality, are being rapidly improved, those interested in perfect radio reception are scrutinizing each part of the receiver for possible sources of distortion. As a consequence, plate detection is being employed even at the expense of signal strength. Whether or not this is a step in the right direction cannot be entirely decided from the data at hand, yet the experimental facts tend to show that if the right values of grid leak and grid condenser were used practically the same quality could be obtained by this method as is obtained with plate detection.

There are two possible sources of distortion in the detection of radio signals. One is due to the variation of detection efficiency for different audio frequencies, i.e., a frequency of, say, 90 cycles would appear in the audio amplifier with less intensity than a frequency of 2000 cycles, though both frequencies were of equal strength before they passed through the detector. The other is due to the fact that extraneous audio frequencies are always introduced to some minor extent. If two frequencies are simultaneously put into a detector, not only are those two frequencies present in the output, but also other frequencies which represent the sum and the difference, and harmonics of the original.

The method of measuring detection used by the writer is shown in Fig. 1. The r.f. signal was generated by an oscillator whose frequency was held constant at 1000 k.c. This was modulated by a second oscillator which generated the audio frequencies. Care was taken that the radio signal was completely mod-

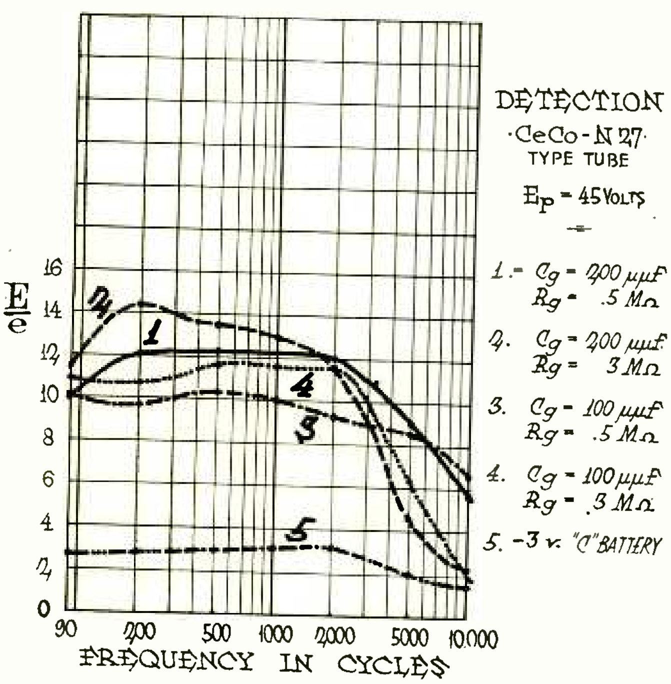


Fig. 2. Results of Measurements of '27 Type Tube

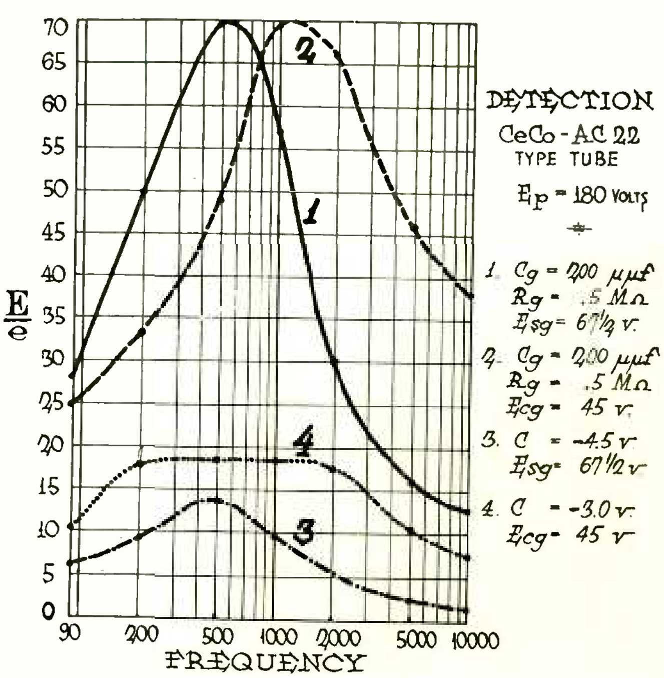


Fig. 4. Results of Measurements of A.C. Screen-Grid Tube as Detector

ulated at all times. This completely modulated r.f. voltage was put into the detector tube, the magnitude of the input voltage being measured by means of a Rawson thermal voltmeter which had a range as low as .3 volt full scale. The output audio voltage developed across the secondary of an audio transformer was measured by means of a vacuum tube voltmeter. Thus the conditions used in the experiment were as near as possible to those encountered in actual practice.

The results of the measurements made on a '27 type tube are shown in Fig. 2, where the audio voltage developed across the secondary of the audio transformer, divided by the radio volts put into the detector, is plotted against the modulating audio frequency. In this case the input radio signal was held constant at .1 of a volt.

Curve 1 shows the detection obtained with the use of a grid condenser of 200 mmf. and a grid leak of .5 meg. Curve 2 was obtained with C_g 200 mmf. and R_g 3 meg. Curve 5 gives an idea of the amount of detection obtained with a *C* bias of 3 volts, which was found to give the greatest amount of detection that could be obtained by this method. Note that the grid leak and condenser method gives roughly four times the efficiency obtained by the *C* battery method.

It is also interesting to observe that the frequency distortion when the grid leak and grid condenser are used is quite apparent, though if the grid leak is only .5 meg and the grid condenser 200 mmf. (Curve 1) probably no noticeable difference to the ear would be observed. Thus it would seem that practically the same quality, as far as the detector was concerned, could be obtained by using a .5 meg grid leak and a 200 mmf. condenser and at the same time the efficiency of the system would be increased four times. It should be also observed that the frequency curve of the first stage audio transformer is included in these curves; but this transformer was a very good one and when used with a '27 type tube had a flat characteristic over the frequency range used.

We now come to the question of overload in the two systems of detection, for this might cause distortion of either of the two types spoken of. Fig. 3 shows the results of the tests, where output audio volts are plotted against input radio signal. Curve *a* was taken with the grid leak and condenser method with C_g 200 mmf. and R_g .5 meg. No sign of overload is indicated by either method, even when 3.5 volts are developed across the secondary of the first stage audio transformer. This signal strength would mean that at least 56 volts could be delivered to the input of the power tube, which would be sufficient to overload most of the tubes used in the last audio stage. In the case of the grid leak and condenser system this voltage would be obtained with an input signal to the detector of .195 volt while in the case of the *C* battery detector the input r.f. signal would have to be .775 volt.

Let us now examine the a.c. screen-grid tube to determine its relative advantages as a detector. As the screen-grid tube has a very high plate resistance a special high impedance audio transformer should be used. But as there were none on the market when these experiments were made the same audio transformer was used and the plate resistance of the screen-grid tube kept as low as possible by using 180 volts on the plate at all times.

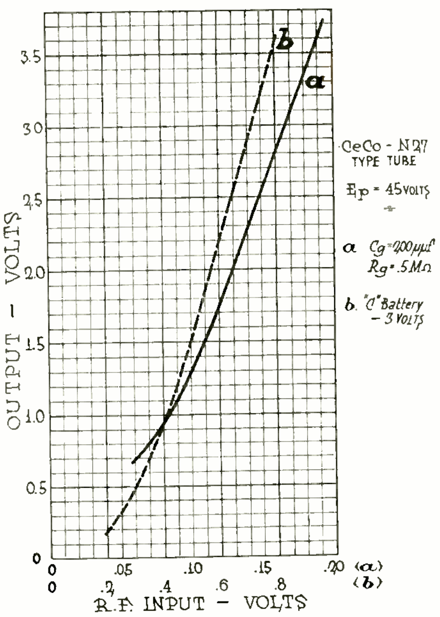


Fig. 3. Comparison of Overload Tests With Grid and Plate Detection

Fig. 4 gives the performance of this tube as a detector. Curve 1 and Curve 2 were taken with the grid leak and condenser. In Curve 1 the signal was impressed on the control grid while in Curve 2 the signal was impressed on the screen-grid. Both curves show that about five times as much signal strength can be obtained with the same input as was obtained with the '27. However, the frequency distortion is very great so that it excludes its use except where good quality is not essential. (This frequency distortion could be materially reduced by designing an audio transformer whose characteristics match the screen-grid tube.)

By means of the voltages and the *C* battery indicated on the chart, Curves 4 and 5 were obtained. Curve 4 was taken with the input signal impressed on the screen-grid and a *C* battery of —3 volts. This shows a very fair frequency curve with slightly more signal strength for a given input than is obtained with the '27 tube.

In summary, these results show that:

(*a*) An a.c. screen grid tube gives five times the output voltage of a '27 tube for the same input, but gives serious audio-frequency distortion.

(*b*) With either type of tube the grid leak and condenser method gives about four times the signal strength obtained with the grid bias method.

(*c*) With the '27 tube there is little difference between the two methods of detection, so far as frequency distortion or overload are concerned, provided that a low value of grid leak is used.

(*d*) With two a.f. stages, power tubes of the '50 type or smaller will overload before a '27 detector will overload.

(*e*) With a '27 detector with grid leak and condenser, a completely modulated r.f. signal of 0.1 volt into the detector will give about 1.2 volts across the secondary of the first audio transformer.

THE STONING OF A MINOR PROPHET

The intuition of poet or artist has on occasion been responsible for significant predictions in the field of science. For obvious reasons, prediction to be orthodox must come from competent, not to say prominent, men of science. The prediction described below appears somewhat difficult to classify as either artistic or orthodox, but seems worthy of record.

During the winter of 1878-9 a rough Pennsylvania mountain school teacher, aged about 50, ventured to express his belief in the coming of wireless telegraphy. For this he was mercilessly rebuked by one of the most distinguished physicists of America, then a man in his late thirties. This incident, described below in the words of an eye-witness, is all the more interesting because the physicist was a man of lively mind and intense natural curiosity. The eye-witness is an early graduate of Mount Holyoke.

It was the winter of 1878-9. The Teachers' Institute of Fayette County, Pennsylvania, was meeting at Uniontown in the courthouse.

Public school teachers from all over the county—big towns, small towns, rich farming sections and mountain districts—were present.

This week's break in the routine teaching—the week between Christmas and New Year's—was an unusual opportunity for these teachers. There were sure to be on the program a few real celebrities—scientific, literary, musical and what-not.

In this particular year, Dr. —— was the great light.

One of his talks was on telegraphy—the Atlantic cable and the marvelous achievements of Morse and Fields. At the close, opportunity was given for questions.

(Continued on Page 80)

As The Trade Thinketh . . .

DR. H. K. NIXON:
Professor of advertising and sales, Columbia University, School of Business.

"The radio industry today faces great possibilities, balanced by some serious economic problems."

DR. DONALD A. LAIRD:
Colgate University, in a paper on "Nervous Reaction to Variations in Sound," presented before the Acoustical Society of America.

"The pitch or tone of a sound, and not its volume, is responsible for shattered nerves." This helps to explain why a shrieking soprano is so annoying to a radio listener. It can be corrected by by-passing some of the higher frequencies.

JAMES G. ALLEN:
Radio Engineer, Duquesne Light Co., Pittsburgh, Pa.

"A favorite expression among salesmen is 'leaking transformer.' This idea has caught like wildfire and extends from coast to coast. There have been transformers that leaked and gave radio interference, but they are rare enough to deserve a place in a museum."

H. H. WALKER:
Los Angeles Electragist, specializing on apartment house radio installations.

"The electragist serves the need for large radio installations. Nobody buys bananas in a plumbing shop, but people have been known to buy radios from drug stores and even by mail. The electragist personally installs and adjusts every instrument."

WALTER KRAHL:
Chief Engineer, Arcturus Tube Co., in discussing tube characteristic curves.

"The only curve of tube performance that really means anything is one with the customer's dollars and cents on the abscissa. With the screen-grid tube it is possible to give the buyer greater sensitivity per dollar. And with the '45 tube we can give him better quality per dollar."

COL. GEO. M. STUDEBAKER:
A director of the Colin B. Kennedy Corp., South Bend, Ind.

"The point of saturation in the radio field is not in sight, radio to my mind being in the same position in this respect as the automobile industry fifteen years ago. Even with the tremendous growth of the radio industry in the past five years only one-third of the homes in the country have radio and less than one-fifth have modern apparatus."

HARRY W. WELLS:
Radio Research Engineer with the All-American Lyric Malaysian Expedition, en route to Dutch Borneo.

"The Japanese are great radio fans, the widespread ownership of sets being eloquently demonstrated by the veritable forests of tall bamboo poles, which are used for aerial masts. Thousands of these bamboo masts sprout from the roofs of the larger cities like Tokio, Kobe, Koyoto, Yokohama, Osaka and Kamakura."

PAUL WARE:
New York City, Consulting Engineer and radio manufacturer.

"The screen-grid tube has a permanent place in receiver design and will contribute significantly to attainable selectivity and sensitivity. Entirely new design precautions, however, must be taken with respect to shielding, placing of parts, etc., to prevent interaction of r.f. circuits."

EDGAR H. FELIX:
Radio Consultant to National Electrical Manufacturers' Association.

"The action of the House in opposing the Dill measure, calling for a census of radio sets, is a flagrant disregard for the industry's most vital need. The history of the radio industry has been largely the history of radio legislation which has imposed senseless restrictions on broadcast allocation and in turn obstructed progress in the development of the art."

DR. STANLEY MARIE:
Tube Engineer, Triad, in explaining why Triad tubes have a dull-surfaced plate.

"The dull-surfaced or carbonized plate in Triad tubes is intended to prevent the reflection of heat or light waves that might interfere with electronic movements in the tube and to minimize the heating of the plate and its consequent emission of gases. 'A single gas molecule would be as great an obstruction to the flight of an electron as an Egyptian pyramid would be to a baseball.' "

Ammunition Against RADIO

What the boys are

The campaign against radio interference is being waged all over the United States. Workers are tracking down the enemy everywhere, but as yet have found no one method of extermination which is effective in every case. While the main reliance is being placed upon individual effort, the various radio trade associations and public utility corporations are lending their aid for the benefit of the radio user.

A record of some of the general methods which have been effective appear on this page. In the future it is hoped to publish accounts of specific cases which readers have met in practice. Such accounts will be welcome and be paid for.

In general, according to James G. Allen in the I. R. E. *Proceedings* for May, 1929, every service man should know the following simple rules for locating radio interference:

1. Remove the antenna and ground wires and notice the change in noise intensity. If the noise continues undiminished, look for set trouble. If the noise is cut down not more than 50 per cent, look for trouble in the complainant's own house wiring and appliances, as this indicates that most of the noise is entering the set by conduction. If nearly all the noise goes when the antenna is removed, look for outside interference.

2. Find out what electrical equipment is being used in the neighborhood. If any appliances are suspected, have them turned on and off several times while listening to the receiver.

3. If all your observations indicate that the public utility's equipment is probably the source of trouble and if you are not able to locate the exact source, then call upon the utility company for assistance.

Equipment for locating interference sources consists of self-contained superheterodynes, low frequency amplifiers, exploring coils, audibility meter, and miscellaneous meters. The most useful is the suitcase super. Set testers are handy when the real trouble lies in the set and the owners are obstinate and troublesome. Care must be taken that this does not lead to free service work. The low-frequency amplifier is useful when near the source of trouble, as it picks up the disturbance only when at a short distance from the source and avoids the false indications met while using a more sensitive receiver.

When a source has been found, the interference is most effectively killed by connecting a filter in the line which supplies current to the electrical device which is causing the trouble. If this is not possible such a filter may be connected in the line at the service switch near the meter or even between the plug socket and the radio set, though in the latter case less noise will be eliminated than if the filter is installed at the source.

Suitable filters are, in general, of the low pass type, i. e., they will readily pass the 60-cycle current and block the higher audio frequencies which constitute the "noise." In some cases it is sufficient to connect two fixed condensers between the two sides of the line and ground, thus simply by-passing the audio frequencies. In other more obstinate cases it is necessary to insert choke coils in the line so as to block the high frequencies and allow them to be by-passed to ground as in Fig. 1.

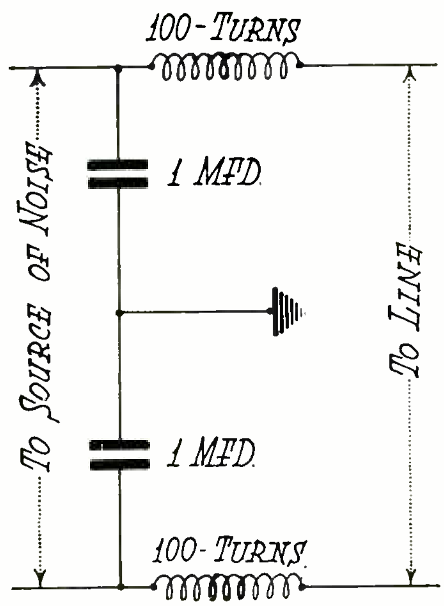


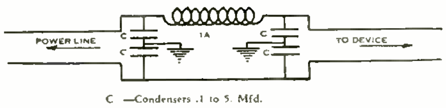
Fig. 1. The Big Bertha, a filter circuit which will kill four-fifths of the cases of line noise

The circuit in Fig. 1 is applicable to four-fifths of the cases.

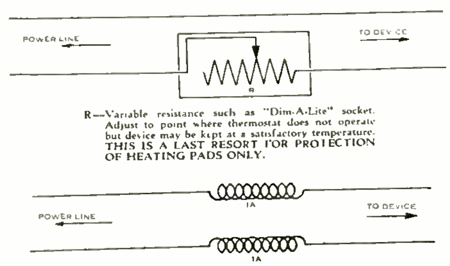
Any service man can make up such a filter from two r.f. chokes shunted by two high-voltage condensers. The chokes may consist of 100 turns of wire each bank-wound on a double wooden bobbin or fiber cylinder. No. 14 wire should be used for a 4-ampere load; No. 12 wire for 6 amperes, and No. 10 wire for 9 amperes, using d.c.c. wire and insulating between layers with Empire cloth. The condenser should be tested for 500 volts and should be installed in metal boxes or have insulated terminals, 1 or 2 mfd. usually being sufficient.

A similar filter can be purchased ready-made in the form of a number of

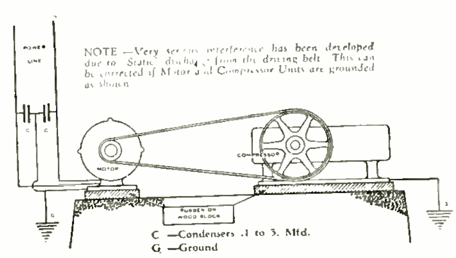
RMA DIAGRAMS OF FILTER SYSTEMS



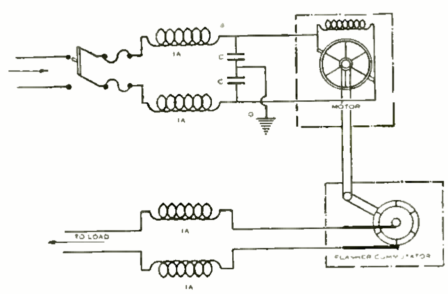
For Doorbells, Buzzers and Annunciator Systems



For Heating Pads and Thermostatically Controlled Devices



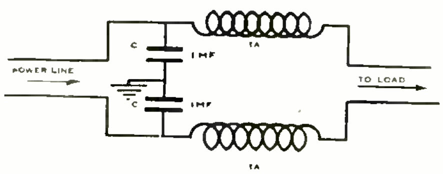
For Refrigerator with Belt-Driven Compressor



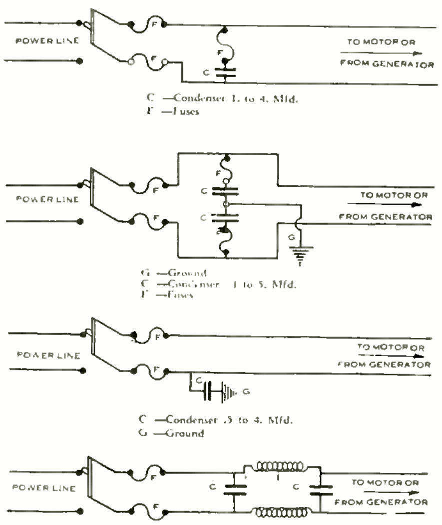
For Motor-Driven Sign Flasher

Choke 1a—For 5 amperes or less, about 150 turns of No. 18 wire wound in a single layer on a fiber, bakelite or porcelain tube 3 in. in diameter and 8 in. long. If double cotton-covered wire is used the layer should be treated with shellac or insulating varnish. When larger wire is used, in accordance with the same specifications as for Choke 1, the dimensions of the tube may be increased. Both chokes are air-core and no iron should be placed in the spool or tube.

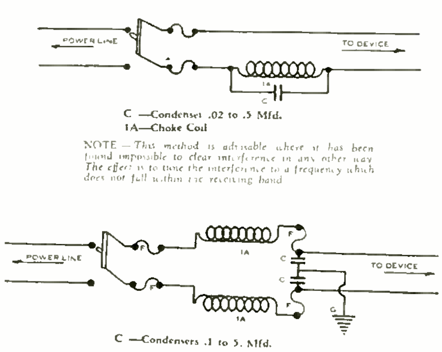
Winning the War *INTERFERENCE* doing on the firing line



For Oil Burners with Constantly Operating Ignition Plugs



For Motors and Generators



For Miscellaneous Devices

Choke 1—For 5 amperes or less; about 560 turns of No. 18 insulated wire wound on a spool having a core diameter of 3/8 in., an outside diameter of 1½ in., and a winding space of 9/16 in. deep and 7/16 in. wide. The spool may be of fiber, bakelite or paraffin-treated wood. If cotton-covered wire is used the spool should be treated with shellac or insulating varnish and then baked. If enameled wire is used the layers should be separated by insulating paper. When it is necessary to carry 10 amperes No. 16 wire should be used; 20 amperes, No. 14; 25 amperes, No. 12; 30 amperes, No. 10; 50 amperes, No. 8, etc. The spool dimensions should be correspondingly increased when wire larger than No. 18 is used.

noise suppressors which are on the market.

This type of filter has been especially successful in eliminating interference caused by any motor-driven device, such as an electrical refrigerator, vacuum cleaner, vibrator, washing-machine, or oil-burner. It has five terminals, two of which are connected to the current supply terminals of the motor, two to the two sides of the supply line, and one to ground.

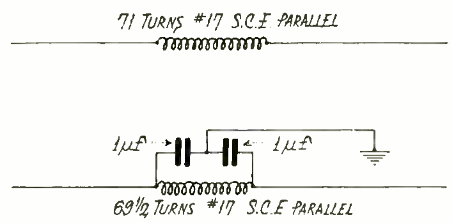


Fig. 2. Circuit of a successful eliminator of line interference

Another commercial filter which has proved successful in many cases employs the circuit shown in Fig. 2. It consists of two r.f. chokes,, each of which is connected in one side of the power line near the load, and one of which is by-passed by two 1 mf. condensers whose midconnection is grounded. The coils consist respectively of 71 and 69½ turns of doubled No. 17 s.c.c. wire wound on a 1½ by 2 in. rectangular cardboard form. Each coil is wound in two layers on the same form, one coil being separated from the other by three layers of .01 fish paper. This particular device does not employ an iron core, although some others do, with provision for moving the core in or out so as to roughly tune the circuit.

A typical device of this character is rated at .76 k.w. or about 7 amperes at 110 volts. If the motor to which it is attached draws more than 7 amperes, an additional device should be added for each additional 7 amperes or fraction thereof, connecting the two or more devices in parallel. Thus a 3-h.p. motor would require three such devices in parallel if they are placed at the motor.

In the case of X-ray apparatus, diathermic equipment, sign flashers, electric warming-pads, or other electrical devices where sparking occurs, the problem becomes more difficult, since the radiation from the spark is transmitted through

(Continued on Page 60)

Practical Interference Elimination

By HECKERT PARKER

After exhausting available sources of information about methods and means to combat "man-made static" or electrical interference to broadcast radio reception, the Leo J. Meyberg Co. has adopted the apparatus listed here as the most *practical* to handle and recommend to dealers. The whole subject is highly complicated and, without a rather extensive technical training involving experience with the gamut of electrical and radio devices, no one can possibly write the specifications and say in every case just what apparatus or system of filters will stop the noise under each particular set of conditions. Therein lies our opportunity. The more experiments we make with it the more expert our whole organization will become.

The disturbances to radio reception are produced by three sources:

First.—Static originating in the ether or atmosphere, referred to as "natural static." With this we are more or less familiar and already know that there is nothing that can be done by way of eliminating or reducing it. So-called static eliminators have appeared from time to time but this house will never sell them. Any reduction of that kind of static can only be secured by a corresponding decrease of the radio signal strength of the same frequencies as the static itself.

Second.—Wave signals set up by radio tubes. Fortunately, these do not bother except in case of regenerative receiving sets.

Third.—Wave signals set up by an electrical spark gap. The wave form is exactly the same in all three cases and generated at any frequency. The old-style spark-gap wireless transmitter, the arc or gap of a common doorbell buzzer, power motor brush, make-and-break contacts such as sign flashers, lamp sockets, auto ignition systems, ignitors for oil burners, all generate a wave of most any old frequency and when these frequencies are within 200 to 550 meters (1,500 to 600 kilocycles) or the radio broadcast band, then they cause trouble, which is interfering with the volume of radio sales.

This third class of disturbance—"man-made static"—can be tackled with hope of some success.

When a radio set is tuned to a radio broadcast signal of say—300 meters, one does not mind additional signal of that frequency coming in over the light wires or in over anything else, but one does object to signals at other frequencies coming into his set from any source whatever. What we can do is to filter out all other frequencies within the broadcast band and allow only the 60-cycle power current to pass into the set over the line connection.

Electrical disturbances set up by arcing contacts, leaks on power lines, violet ray, X-ray and similar devices set up a wave signal which reaches the receiving set through two channels:

First.—It is propagated through the atmosphere just as are signals from a broadcast station. The disturbance caused will be in proportion to the strength or power of the signal and the distance from the set, just as the power and distance of a broadcast station affects ability to pick up signals. The whole mass of metal in a building, including the electrical wiring, the water, gas or heating pipes, metal building framework, etc., also picks up this disturbance and in turn radiates it to the receiving set aerial, aerial lead-in, and the r.f. coils and r.f. wiring of the set.

To determine what part of the disturbance reaches the set in this manner, disconnect the aerial lead-in from the set and note how much of the disturbance stops. If this discloses that much of the disturbance does come in over the aerial and lead-in, much or all of it can be stopped very often by using a shielded lead-in, especially where the lead-in is long or passes through two or more floors of the building from the roof to the set. The material used and method of installation of shielded lead-ins are given below.

Likewise try disconnecting the receiver ground. Much disturbance can reach the set through the ground if connected to a water-pipe system or other metal piping in the building. The remedy for this is a separate independent ground. The material and methods for installaton of independent grounds are given below.

Second.—Radio frequency currents follow Ohm's law and likewise take the path of least resistance. Copper offers a much lower resistance path than air, hence these disturbances will jump to the light or power wires at the point of the disturbing arc and follow these wires to the receiving set. Sometimes these disturbing currents at both radio and audio frequencies will travel for miles over the power company primaries or trolley feeders to reach a receiving set. It can be stated conservatively that well over 50 per cent of the disturbance to radio reception reaches the set over the power wires and, fortunately, can be stopped by the use of suitable filtering devices.

How to Stop Radio Disturbances Carried Over Power Lines

It is a very easy matter. Just eliminate the apparatus causing the interference! However, when the owner of a disturbing motor, sign flasher, diathermy

(Continued on Page 62)

Importance of Ground Connection in Minimizing Interference*

By **N. E. BORCH**

ANY radio receiver, with the exception of a loop-operated set, must have a good ground connection in order to perform at maximum efficiency. From many radio installations recently inspected, it has been determined that the average radio service man does not realize the importance of grounds both on power lines and on the receiver proper. In many cases grounds are left off entirely because a set is found to operate better with no connections to the ground binding post in the receiver. If this were a true condition, the manufacturer of receivers would not provide a ground connection, and, therefore, the reason for the receiver operating better must be an external one.

Cold water pipes, when used as ground, may be anything but perfect, particularly in tall buildings. Wherever a pipe joint is made high resistance is introduced by white or red lead, leadite, or various cement compounds. The resistance of the fresh water flowing in the pipes is also very high compared to that of salt water. The total resistance in some apartment houses has actually measured up to between 200 and 300 ohms and, in such instances, the ground is useless.

Electric power companies usually connect the neutral service wire to the nearest cold water pipe. Some water companies object to this and use an insulated pipe-coupling joint in the pipe line near the ground. This is done to prevent electrolysis. When such insulating coupling joint is used the water pipe system in the building may possibly act as a counterpoise but never as a real connection to the earth.

Ground pick-up of interference often occurs where a water pipe is used as a common ground to the power company's neutral, or where the water pipe is running close and parallel to any wires carrying and fluctuating electrical current. This ground pick-up may also occur in the ground wire itself before it is connected to either the water pipe or the independent ground.

Independent ground is always the best except where no moisture is found in the soil. Water pipe will, at times, run for a considerable distance before it enters moist soil. This will have the effect of decreasing the selectivity of the receiver and will cause considerable extraneous pick-up. Technologic Paper No. 108 of the Bureau of Standards contains data pertaining to suitable grounds for wired telephone and electrical power installations. From experiments it has been determined that the moist stratum of the earth is found between six and eight feet below the surface and if a good contact is made to this moist stratum, the very best ground is always had. Mr. Heckert Parker, in the August, 1928, RADIO gives some valuable information as to soil resistance, the effect of moisture and temperature on the resistivity of soil, the seasonal variation of pipe grounds, the variation of resistance with depth, and the effect of salt water as compared with fresh water.

The neutral wire on the electrical power company's service to buildings is grounded. But this ground may have a comparatively high resistance. This resistance will be found to fluctuate considerably and may cause instability of reception and excessive external pick-up. This is due to the fact that an improperly grounded metallic object will act as a radiating surface which will pick up energy from passing radio waves. The amount of pick-up will vary with its resistance. After such a condition is found, stability of reception may be increased by regrounding the neutral to a cold water pipe near the earth. This must be done by a licensed electrician because the neutral ground is to be treated in the same manner as a hot wire. In a three-wire service the neutral is always the center wire to the main service switch. In a two-wire service the neutral may be spotted by the use of a test lamp. The lamp will glow when connected from the hot side of the line to the water pipe but will not glow when connected from the neutral to the water pipe. Sometimes the phenomenon of the station riding in on the carrier wave of another may also be greatly reduced by thoroughly grounding the neutral wire.

An independent ground should be made with ½ or ¾-in. galvanized iron rod, or pipe, 6 or 8 ft. long. An increase in diameter of the rod or pipe will not further decrease the ground resistance nor will a length longer than 8 ft. be of any material assistance. Galvanized iron is used to prolong the life of the pipe, not to reduce the resistance, as rust (iron oxide) has no higher resistance than the soil and is just as permeable to moisture. The occasional application of salt water to the soil near the ground state will further decrease the effective resistance. Two or more ground stakes may be used in parallel provided each stake is separated by at least 6 ft.

(Continued on Page 63)

*Radio Interference Bulletin No. 1, Pacific Radio Trade Association.

TECHNICAL BRIEFS

GANGED condensers may be matched by using the circuit shown in Fig. 1. Two r.f. oscillators are used, one being tuned with any good receiving condenser and vernier, the other by the condenser under test. Setting the receiver dial at zero, or minimum capacity, attach the clips to the first of the gang condensers,

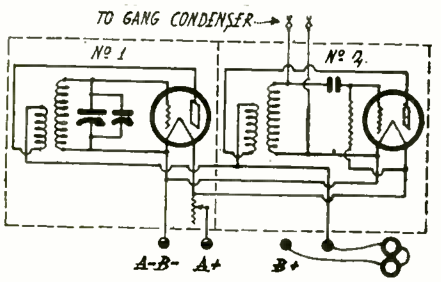


Fig. 1. Circuit of Beat Frequency Oscillator for Use in Matching Ganged Condensers

which will be used as a standard, then tune the first oscillator until zero beat is indicated in the phones. Leave Oscillator No. 1 as it is, change the clips to the second condenser in the gang and vary the trimmer for zero beat as before. Continue thus until all the condensers are matched to the first. Now check up on the maximum capacity of the condensers by tuning Oscillator No. 1 for zero beat with the gang when the latter is turned completely in.

The oscillators must be as nearly alike as possible and shielded from each other. They may be tuned to any convenient band of frequencies, although a finer adjustment may be had if they are designed for the lower frequencies, such as 60 or 100 k.c. R.f. resistance should be avoided if a true zero beat is to be obtained.

PAPER condensers cause a much more serious loss of energy than do mica condensers when used in r.f. and i.f. amplifiers, oscillators, and filter circuits. Dubilier engineers find that mica condensers permit 31 per cent more current in a high-frequency tuned circuit than do paper dielectric capacities, the latter also increasing any tendency toward broadness of tuning.

A SIMPLE method for making one meter serve a double purpose is shown in Fig. 2. It is applicable to either an amateur transmitter or to the power pack for an amplifier. When the 3-p.d.t. switch is closed in one direction it puts the 0-10 milliammeter and a 100,000 ohm series resistor, R_1, across

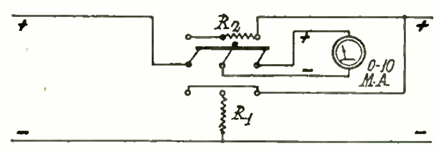


Fig. 2. Circuit for Dual Meter Connection

the plate supply, giving a reading of 0-1000 volts d.c. When thrown to the opposite side the milliammeter is shunted with a resistance, R_2 equal to 1/10 or 1/20 of its internal resistance and is placed in series with the positive lead. A shunt of 1/10 the internal resistance of the meter will allow a reading of 0-100 m.a. That of 1/20 will give a 0-200 m.a. reading.

WHY the impedance of an audio transformer's primary winding should match that of its associated vacuum tube's plate circuit for the lowest audio frequency to be reproduced, rather than at some higher frequency, is not generally understood. That maximum energy transfer occurs when the impedances of the two coupling units are equal is a well-known rule of thumb. The impedance of the tube is about the same for all audio frequencies. The impedance of the primary increases as the frequency increases, and so the curve of energy transfer from tube to primary *drops* for increasing frequencies. On the other hand, the curve of energy transfer from primary to secondary *rises* as the frequency increases. These opposite tendencies neutralize each other so that their resultant curve approximates to a straight line. Which is to say that the energy transfer from tube to secondary is nearly uniform for all frequencies received from a broadcast station if the tube impedance matches that of the transformer primary at the lowest audio frequency.

THE relative amount of hum produced because of unbalance in the filament circuits of '26 and '27 types of tubes is strikingly illustrated in Fig. 3. It will be noted that a 10 per cent displacement increases the hum voltage by about 60 millivolts for the '27 type and

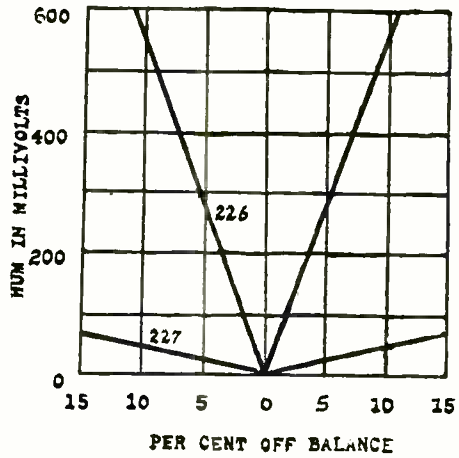


Fig. 3. Relative amount of hum due to unbalanced filament circuits with '26 and '27 types of tubes

by about 550 millivolts for the '26 type. As a satisfactory means for bringing the grid return to the electrical center of the filament circuit, and thereby minimizing the hum from either type of tube, the Clarostat Manufacturing Co. suggests an adjustable center-tap resistance.

WHILE no difficulty may be experienced in figuring the number of ohms required in a resistor to cause a required drop in voltage, $R = E \div I$, an experimenter may be at a loss to know what current-carrying capacity is necessary to insure safety against heat damage to condensers or other near-by units. Modern resistors are usually rated on the basis of the maximum number of watts which they will carry without burn-out. But this rating is entirely too high for safe operation in a poorly ventilated installation. Good engineering practice requires the temperature of operation not to exceed that of boiling water, 212 degrees Fahrenheit. The Aerovox *Research Worker* recommends that a re-

(Continued on Page 74)

Radiotorial Comment

By the Editor

PROFITABLE disposal of trade-ins, admittedly the dealer's most serious problem today, is more dependent upon the ability of the service man than is generally realized. His expert judgment should determine the true worth of an old set which is to be turned in as part payment for a new set. His skill is needed to put the old set into condition for re-sale. And his knowledge of its peculiarities will forestall complaints as to its subsequent performance.

To Trade-In or Not to Trade-In

Too many dealers have blindly bought "a pig in a poke," failing to realize that it is not the original list price of an old set which determines its present value, but its possible re-sale price, based largely upon its selectivity, sensitivity and tone quality, as well as upon its mechanical condition. Too many dealers are carrying a dead stock of trade-ins which they are unable to put into salable condition at any price. Too many dealers have their re-sold old sets turned back. And all because of a lack of a service man who knows his business.

Every purchaser of an old set is a prospective purchaser of a new one. The confidence in a dealer, engendered by satisfactory experience with a trade-in, is the basis for future dealings in the purchase of a new set. But unless a dealer is an expert himself, or has in his employ an expert upon whose judgment he can rely, he will be a wiser and richer man by refusing to handle trade-ins.

RADIO history has shown periodical shortages in the supply of vacuum tubes and a consequent retardation in the sale of radio sets. Some experienced set manufacturers predict that history will repeat itself this year and are planning to deliver all their sets complete with tubes. The tube factories, on the other hand, have announced a production schedule that will create an oversupply of millions of tubes even in the big market that is anticipated. So there you are!

Will Tube History Repeat Itself?

As a matter of fact there will probably be enough good tubes to meet all normal requirements and enough inferior tubes to create plenty of competition. The important point is for the dealer to be sure of the good quality of the tubes in the new sets which he sells. Defective tubes have been responsible for nine out of ten of the service calls on new sets. These calls not only cut the dealer's legitimate profit but also cause consumer ill-will.

PUBLICITY and advertising made this a screen-grid year. The novelty-seeking public, ever interested in possessing the latest development in radio, demands sets with screen-grid tubes. The manufacturers have created and supplied a demand which every dealer can fulfill. But from every section of the country come grumblings and rumblings of dealer dissatisfaction with the performance of screen-grid sets which have been made to sell rather than to perform. One dealer reports that his screen-grid sample gives no better selectivity, sensitivity or tone quality than does another sample which uses three-element tubes. Another dealer reports good selectivity for low volume but poor apparent selectivity for high. Still another tells a tale about getting just as good reception when one screen-grid tube was entirely removed from the set.

Has the Screen-Grid Set Really Arrived Yet?

These tales may be exaggerated, and then again they may not. Certainly there can be no smoke without some fire. There has not been given enough time to determine whether or not all screen-grid sets have yet been sufficiently perfected to justify their widespread use this year.

A certain few sets have been so perfected. They have been intelligently engineered to take full advantage of the remarkable possibilities of the screen-grid tube. But certain other sets are no better than those using the older type of heater tube. So it behooves the dealer to exercise the greatest discrimination in the choice of the line which he intends to sell.

Undoubtedly there will be less initial selling resistance for the screen-grid set. But, from the dealer's standpoint, that is only half the story, since he is as much interested in keeping the set sold as in the initial sale. A lot of screen-grid sets will probably be returned by dissatisfied customers who were oversold. So the wise dealer will satisfy himself that a set will perform before he assumes the responsibility of pushing it.

THE stage is set for the greatest season in the history of radio broadcasting. The manufacturers are geared to top production, the salesmen are pepped up to beat last year's bogie, and the stations promise the finest programs ever. But there is one bad actor who must be hissed off the stage if all the preparations are not to be for naught. This discordant note in the symphony of radio is the direct advertiser. For a long time he caused only a relatively few stations to lose their audiences. But now he monopolizes nearly all of them at least part of the time. And as a consequence those who own radios turn them off when the selling talk starts and those who don't own sets refuse to buy until after the selling talk stops.

Banish the Direct Advertiser

Direct advertising over the radio benefits nobody except the agent who gets a commission for selling the time. It harms the advertiser by breeding ill-will for his product. It hurts the station by causing it to lose listeners. It sickens the industry by decreasing sales. And, if not stopped soon, will kill radio broadcasting.

Nobody objects to a little publicity during a program. We can all be broad-minded enough to laugh with good grace at the patronizing manner in which we are told that we are enjoying some good music because of the good-heartedness of Whosis & Co. in sponsoring a program. We will even suffer them to tell us that they manufacture false teeth for false-faced falsettos, and we will buy them when we become so afflicted.

But when they tell us that their false teeth are better even than the molars which nature gave us and that everyone should have his present dental appendages yanked out by the roots so as to enjoy food chewed with Whosis' teeth, we rise up in our wrath and shut off the set for the night. And then when they tell us tomorrow night that Whosis' teeth are guaranteed to chew 10,000 miles of macaroni without wearing out and that they are insoluble in the denatured alcohol that masquerades as fine old Scotch, we get real mad and shut off the set for the rest of the week.

Nor is there undue exaggeration in this picture of human reaction against the bally-hoo with which the air is filled. Mr. Whosis may like it because he likes to hear his own name—the first thing he ever heard, wrote or learned to spell, his most precious gift to his wife and children, and the great heritage which he bequeaths to posterity. But no one else would pay a burned-out tube for all the Whosis hooey that was ever perpetrated on a long-suffering public.

Radio advertising is, like all forms of advertising, an intrusion. It is not invited. Yet even an uninvited guest may be made welcome, or at least received on sufferance, if he is not obnoxious and does not stay too long. If program sponsors can get this point of view they can help the broadcasters to hold a worthwhile audience.

The listeners can roar, the radio men can rail, and the public-respecting advertisers can object, but the only one who can put a stop to this evil is the manager of the offending station from which such halitosis emanates. Nobody has to tell him that he is in bad odor. He knows it but lacks the backbone to say no to an advertiser who should know better. Why should radio's obituary be "died from halitosis"?

THE decreasing importance of technical problems and the increasing importance of marketing problems have been cited by Prof. H. K. Nixon of Columbia University as the most significant trend in the marketing of radio. But if there is any truth in the old adage that goods which are well made are half sold, this professor of advertising and sales seems to permit the importance of his own specialty to overshadow the importance of the technique whereby radio equipment is manufactured and serviced. It will be many years, if ever, before radio equipment becomes so perfected that the technical man can be given a subordinate role.

Technical Knowledge Needed in Radio

When a factory discharges its engineering staff it will be a signal for the advertising and sales force to look for new jobs. Many problems are yet unsolved in the conversion of the infinitesimal energy from the aerial into sound from the loudspeaker. Unless the engineer is encouraged to overcome these difficulties, the salesman will have no ammunition for his campaign against the selling resistance of the prospective buyer.

The salesman himself should also understand something about the technical side of radio. At any time he is likely to meet the statement that a competitive set has a sensitivity of 5 microvolts per meter or some other technical specification as to selectivity or gain. What can he say about the merits of his set if he cannot quote its corresponding specifications or if he doesn't even know the meaning of these expressions? The first rule in salesmanship is to know your product. Such knowledge, in radio, is a technical problem.

Furthermore, the most important element in the sale of a radio is that it stay sold, as many dealers know from sad experience. The service man generally has the job of keeping it sold. He must have a practical working knowledge of a set's circuit and why it may not function satisfactorily. He must be technically informed. Even as it is, many a purchaser complains that the service man doesn't make his set operate satisfactorily. A good service man is a dealer's best asset.

These comments are not intended to nullify the real purpose of the professor in stressing the necessity for a study of merchandising methods, such as advertising and sales, as well as credits and collections. But they are intended to correct any inference that the solution of technical problems is not equally important.

The DANCING Green Light

By EARLE ENNIS

"Always, that terrible light bored into his face"

BRINSLEY, police reporter for the *News,* tapped on the table with the end of his pencil. "Your trouble," he said, "is that you laugh at psychology, and then use it daily in your business, not knowing that you do so. In the newspaper game, we use it because we understand it, and have learned not to laugh at it."

Captain of Detectives Lew Brady snorted, and reached for a fresh cigar.

"Such as what?" he demanded. Brinsley considered.

"Well, such as the Brillig case, for instance. You took Brillig down to look at his victim, laid out on a slab in the morgue, didn't you? Well—why?"

The captain scowled.

"To get a confession, of course," he snapped. "We figured his nerve would break once he got a look at the old money lender laid out as he had left him in the shop. We stood him so he had to look at the dead man's face. When he looked away he found us staring at him—waiting. Well, it got him, didn't it? It broke him, didn't it? He came clean and told us the works, didn't he?"

Brinsley laughed.

"Sure he did. That's psychology. When everything else failed, you let his conscience break him by accenting its effect. That's just what I'm trying to tell you. The police use psychology and don't know it. Take the case of 'The Tiger.' You've worked on him for two days now, haven't you?"

The captain bit down into his cigar with a vicious snap.

"I'll say we have," he growled. "You don't know the half of it. That boy is made of iron."

Brinsley nodded.

"I can guess some of it," he said. "I've seen plenty in the time I've been down here. Physically—he's made of iron. You may kill him trying to get a confession. But you'll never break him. I got just one slant at him when he came in, and he's prognathus."

The captain removed his cigar.

"He's what?"

"Got a projecting jaw," Brinsley explained. "He's pain-proof, if you get what I mean. You could wind him up by the arms and still he wouldn't talk."

"Yeah," said the captain. "We found that out."

"Right. But that boy's mentality is another matter."

"You said it." The head of the detective bureau laughed heavily. "He hasn't got a scrap. He never went to school a day in his life. He's as dumb as a doorknob."

"Just what I thought," said the reporter. "And still that doesn't mean anything to you birds."

Captain Brady flushed.

"Say! what are you getting at anyhow?" he demanded belligerently.

"Just this," said Brinsley. "You've been trying to smash 'The Tiger' on his strongest side. If you knew anything about psychology, you'd try his weakest side, instead. You'd work on his mind. That's his weak point. His type reasons simply and directly—cause and effect. Down underneath are certain latent fears and inhibitions that come to the surface with the slightest urging. The rest is—concrete. I'll bet a hat he's afraid of black cats and the figure thirteen, and that sort of stuff."

Captain Brady twisted around in his chair.

"Well, granted all that. Where does that get us?"

Brinsley's eyes narrowed.

"It gets a confession, if you know how to use it."

The detective chief leaned back and regarded the reporter in silence.

"Go on," he said briefly. "I'm listening."

"If 'The Tiger' killed three women, as we both believe he did," said Brinsley, "then there's only one thing he's afraid of, and that is the three women he murdered. Do you get me?"

Captain Brady shook his head.

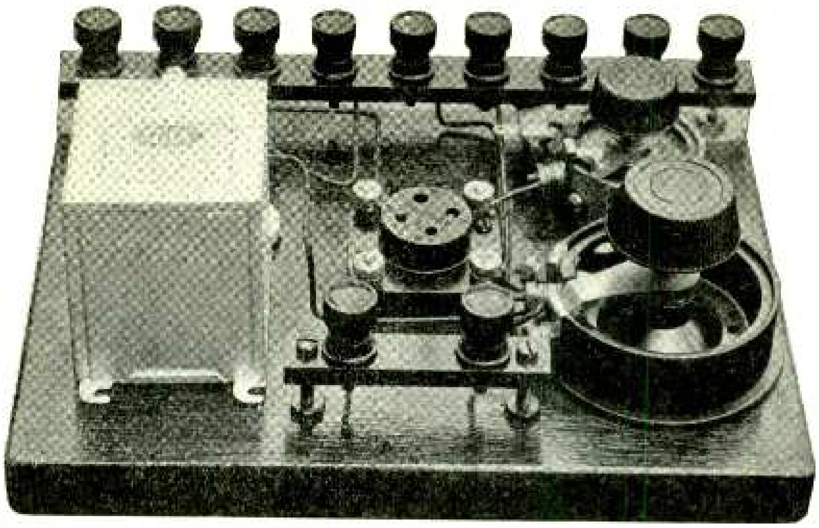
"I do not," he said succinctly. "If he killed 'em he's not afraid of 'em. At least he wasn't when they were alive. Now they are dead, they're dead, ain't they? It's a cinch he's not afraid of 'em now."

Brinsley leaned back and lighted a cigarette.

"I'm not so sure," he said softly. "That is just the point I am coming to."

Something in the reporter's answer caused the head of the detective bureau to regard him closely. He was always a bit nervous with Brinsley at work on a murder case. The *News* man had a habit of digging up weird angles on mysteries that worked out logically and unexpectedly. Brady had once made the mistake of underrating Brinsley, and he had sorely regretted it. He found himself wondering if this was another such occasion.

(Continued on Page 64)



Instrument Whose Construction Was Described in March, 1929, RADIO

What's the Use of a Vacuum-Tube Voltmeter?

It determines the correct grid bias, measures amplifier gain, and tells fidelity of reproduction

By HARRY R. LUBCKE

ALTHOUGH simple and inexpensive to construct, the vacuum tube voltmeter is one of the handiest of instruments wherever radio measurements are made. From an emergency measurement of a step-down transformer voltage to a determination of the gain of a radio-frequency amplifier it serves with equal facility, and with equal accuracy, if properly designed. In a radio receiver its application is valuable and interesting not only to the designer and engineer, but also to the less vitally concerned custom set builder, experimenter, and technically inclined broadcast listener.

The fact that the vacuum tube voltmeter requires only an infinitesimally small current for its operation makes it especially suitable for measuring the feeble electro-motive forces found in the radio receiver. The only current drain is that due to leakage across the socket and tube insulation, and an out-of-phase component due to tube capacity; a matter of one-millionth of an ampere (one microampere) at audio frequencies, and perhaps fifty millionths of an ampere at radio frequencies where capacitance becomes effective.

The meter can be applied to any point in a receiver, regardless of the frequency, with the assurance that the indication will be the true voltage, the instrument described by the writer in March, 1929, RADIO having no frequency error. Consequently the vacuum-tube voltmeter can be credited with the performance of measuring almost any voltage, of any frequency, and of diminutive strength. Besides voltage measurements, currents can be determined by measuring the voltage drop across a known resistor.

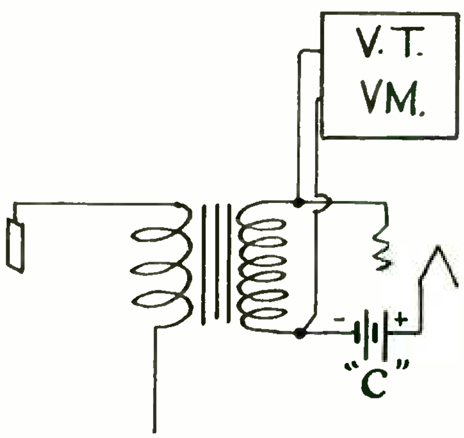


Fig. 1. Connections for determining grid swing of an audio amplifier tube

One of the simplest and yet most valuable receiver measurements is the determination of audio-frequency voltages. In both the design and the operation of an audio-frequency amplifier the magnitude of the signal voltage must be limited to prevent its peak value from exceeding the grid bias of any tube. Should this condition obtain, too much grid current flows and distortion results. Proper design requires that certainly no bias be exceeded, and that the bias on successive tubes increase at least roughly proportional to the increase in signal voltage through the amplifier.

To ascertain the condition in this respect it is merely necessary to connect the input terminals of the voltmeter across the grid and *C*− connection of the coupling device as shown in Fig. 1 and to note the maximum reading for the loudest signal. If the voltmeter is calibrated to read root-mean-square volts, as is the case if an a.c. voltmeter has been used to calibrate it, the observed reading multiplied by a factor of 1½ gives the peak voltage reached, assuming a wave shape not much more sharply peaked than the sine wave.

If this quantity exceeds the grid bias, either the signal input must be reduced or the grid bias increased. Thus, suppose the grid bias on a 112-type tube is 9 volts and that a strong signal consistently gives maximum deflections of 8 volts as read on the meter. The peak value is: $1.5 \times 8 = 12$ volts. This exceeds the bias considerably and if the signal voltage is not to be decreased the bias must be increased to 12 volts. Had the signal peak been 17 volts, say, rather than 12 volts, a tube of larger *input* capacity would be required, such as the

'71 type, which permits a maximum bias of 45 volts.

After the grid biases have been adjusted to correct values the input terminals of the voltmeter can be connected across the loudspeaker terminals, as shown in Fig. 2, and the voltage input to the loudspeaker obtained. Considering the antenna input from a given transmitter a constant, the magnitude of this voltage may serve as an index to the over-all efficiency of the receiver. The effects of various adjustments can be noted and set for a maximum response. By maintaining the voltage reading constant the relative performance of several loudspeakers can be determined. The more or less constant level of dance music or of a certain announcer from a given local station gives a fairly dependable datum for these measurements. A near-by code station is even better.

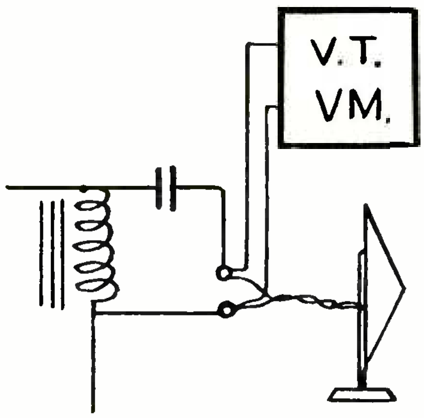


Fig. 2. Measuring the voltage input to the speaker

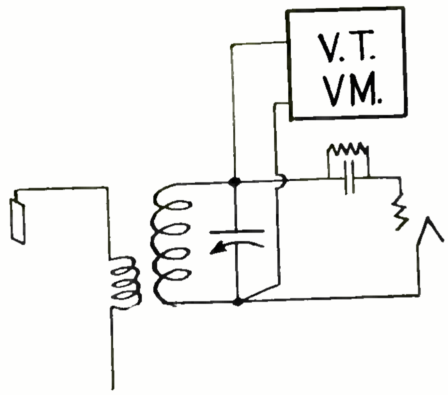


Fig. 3. Measuring the gain of an R.F. Amplifier

In a similar manner the performance of the radio-frequency amplifier can be checked. The input terminals of a low reading, 0-2 or 3-volt full scale range, tube voltmeter are connected across the terminals of the detector resonant circuit as shown in Fig. 3. A positive indication as to whether a new coil, a larger antenna, or a new tube really makes any difference is immediately secured by taking comparative readings.

The foregoing applications have required only the receiver under test and the vacuum-tube voltmeter for their accomplishment. While the tests involving the use of a broadcast station as a standard of signal strength allow certain inconstancies to enter, laboratory tests indicate that these might easily be as small as variations in the day-to-day performance of the receiver itself. The measurements are much more accurate than the simple "hearing" tests often employed. Using a given antenna and supply system with the voltmeter across a given loudspeaker makes possible comparison tests of various receivers that leave no doubt as to the results.

If laboratory apparatus is available, the measurements described are readily refinable to laboratory precision. The use of a standard signal generator to produce a known signal for a radio frequency amplifier or a complete receiver housed in a shielded booth gives definite and accurate results.

A simple and yet accurate method of securing audio-frequency amplifier characteristics, as shown in Fig. 4, employs one vacuum-tube voltmeter for measuring both input and output of the amplifier. Any frequency of calibration errors in the voltmeter are almost completely eliminated. The output of the audio-frequency oscillator is measured by the meter when switch *1* is thrown to *input* and the output voltage of the amplifier is secured when it is thrown to *output*. The input to the amplifier is made some definite fraction of the oscillator output by taking it across a portion of the decade resistance boxes R_1, R_2. The deflections for input and output are made approximately equal by varying the magnitude of R_1 and R_2 to suit the gain of the amplifier under test. For example, if the readings of input and output were 8 v. and 9 v., respectively, with a ratio of R_2 to R of 10 to 1000, the actual input voltage to the amplifier would be: $8 \times 10/1000 = .08$ volt, and with the output voltage of 9, the gain would be: $9/.08 = 112$ times. Readings are taken at representative points in the frequency spectrum and plotted as usual.

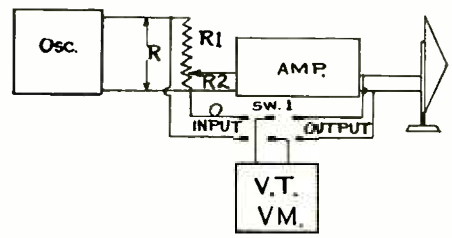


Fig. 4. Taking a Fidelity Curve on an A.F. Amplifier

Tube manufacturers report that at least half of all filament burn-outs can be traced to placing the tube in the wrong socket, such as placing a 1½ volt tube in a 2½ volt socket. The filament current should always be turned off when changing tubes. Otherwise there is possibility that a power tube will be overloaded if the plate prong makes contact before the grid prong. It is also found that careless handling of tubes often displaces the relative position of the elements so that the characteristics may be changed to such an extent that the tube will not function properly.

LIST OF VISUAL BROADCASTING STATIONS

Call Signal	Owner	Frequency (K.C.)	Watts
W1XAE	Westinghse. E. & M. Co., E. Springfield, Mass.	2000-2100	20,000
W1XAY	J. S. Dodge, Lexington, Mass.	4800-4900	500
W1XB	General Industries, Somerville, Mass.	2100-2200	
		2750-2850	500
W2XBA	WAAM, Inc., Newark, N. J.	2750-2850	50
W2XBS	R.C.A. (portable), New York, N. Y.	2000-2100	5000
W2XBU	Harold E. Smith, Beacon, N. Y.	4800-4900	100
W2XBV	R.C.A. (portable), New York, N. Y.	2000-2100	5000
W2XBW	R.C.A. (portable), Bound Brook, N. J.	2000-2100	5000
W2XCL	Pilot Elec. Mfg. Co., Brooklyn, N. Y.	2000-2100	
		2750-2850	250
W2XCO	R.C.A. near New York City	2100-2200	5000
W2XCR	Jenkins Telev. Corp., Jersey City, N. J.	2100-2200	5000
W2XCW	General Electric Co., Schenectady, N. Y.	2100-2200	20,000
W2XR	J. V. L. Hogan, New York, N. Y.	2000-2200	500
W2XX	Robt. F. Gowen, Ossining, N. Y.	2000-2100	100
W3XK	Jenkins' Laboratories, Washington, D. C.	2000-2100	
		2850-2950	5000
W3XL	R.C.A., Bound Brook, N. J.	2850-2950	30,000
W4XE	Wm. J. Lee, Winter Park, Fla.	2000-2100	2000
W6XAM	B. S. McGlashan, Wash. & Oak Sts., Los An.	2000-2100	500
W6XC	R. B. Parrish, 5155 S. Grammercy Pl., L. A.	4500-4600	15,000
W7XAO	Wilbur Jerman, Portland, Ore.	2750-2850	100
W8XAV	Westinghouse E. & M. Co., E. Pittsburgh, Pa.	2000-2200	
		2750-2850	20,000
W9XAA	Chicago Fed. of Labor, Chicago, Ill.	2000-2100	1000
W9XAG	Aero Products, Chicago, Ill.	2000-2100	1000
W9XAO	Nelson Bros. B. & M. Co., Chicago, Ill.	2000-2100	500
W9XAZ	Univ. of Iowa, Iowa City, Iowa	2000-2100	500
WRNY	Aviation Radio Station, Coytesville, N. J.	1010	250

Inside FACTS ABOUT FACTORY BUILT RECEIVERS · ·

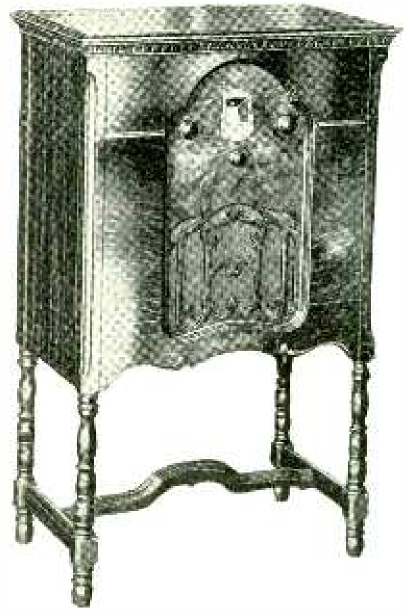
Analysis of the Fada Model 25

By L. M. COCKADAY

SELECTIVITY, sensitivity and freedom from oscillation is secured in the Fada Model 25 by combining two '27 tubes in a neutrodyne circuit with a '24 tube in a tuned r.f. circuit. Heater type tubes are also used in the detector and first a.f. stage and two '45s in push-pull in the last a.f. stage. In laboratory tests the neutrodyne stages showed a voltage amplification of 10 and the screen-grid stage of 40. In selectivity it is capable of tuning in stations separated by 10 k.c. without overlap and yet broad enough to prevent slicing of side-bands.

It is assembled as a console receiver with built-in dynamic speaker, especially designed to eliminate acoustic hangovers and cabinet resonance. The set is housed in a walnut cabinet, with maple panels, carved legs and moulded ornamental stretcher. Although designed primarily to operate on 110-volt 60-cycle alternating current, models for 25 and 40-cycle power are available.

The chassis assembly is 20 by 10¾ in. and is divided into two detachable sections, one for the receiver itself, and one for the power unit. The entire chassis assembly may be removed from the cabinet by detaching four strong bolts. The power unit, which is adjacent to the receiver frame, is attached by two bolts.



Fada Model 25

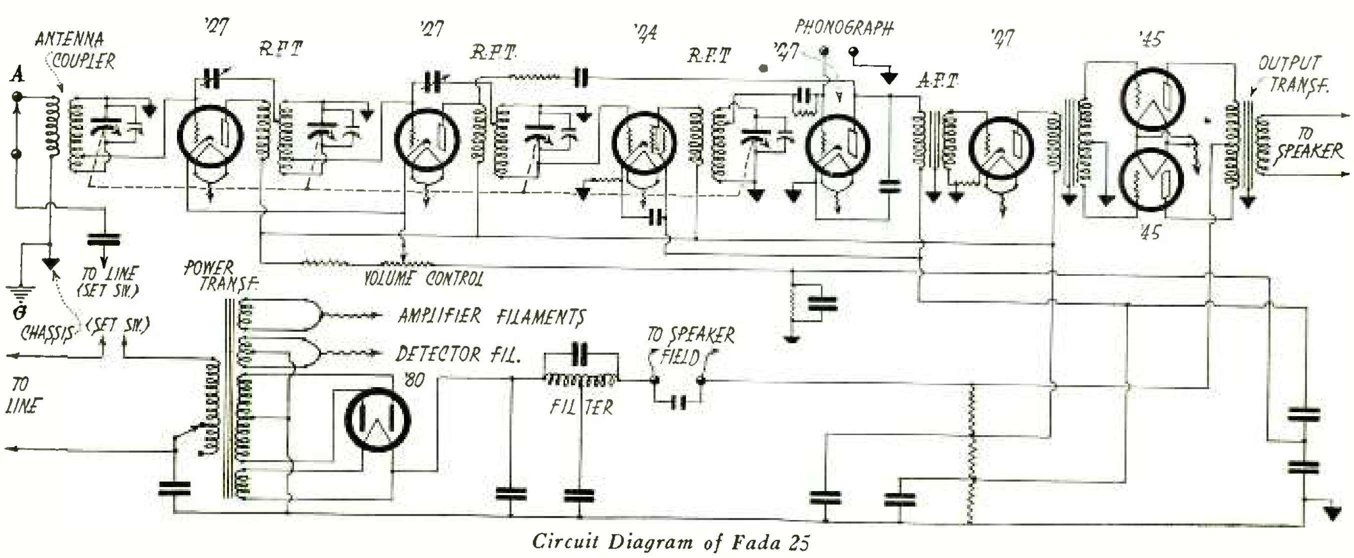
A terminal block, somewhat like a standard telephone switchboard connector, is fastened under the power unit. Power wires to the set attach to this block, and may be removed, should it be necessary to change the unit.

On the receiver chassis (which is to the left of the power unit) are mounted, across the front, four 420 micromicrofarad variable condensers, linked together by a half-inch solid shaft. The condensers are mounted in slotted holes in the frame, and held tight by small springs. This is done to prevent throwing the "gang" condensers out of line, due to the base becoming warped. Compensating condensers are provided, attached to each, and with the exception of the one across the antenna circuit condenser, all are locked at the factory. The antenna compensator is left adjustable, in order to compensate for the length and capacity of the aerial employed. This facilitates accurate one-dial control, without the use of a "dummy" tube in the antenna circuit.

Between the third and fourth condensers, or at the middle of the whole assembly, is a 5-in. illuminated drum dial, which is calibrated in both frequency and wave-length. The "gang" condensers are turned by a friction wheel, which rotates a 5-in. drive wheel attached to the antenna end of the shaft controlling the condensers.

Behind each of the tuning condensers, mounted in a hole in the metal chassis, are the r.f. transformers. Each is supported within the hole in the frame, and covered with an inverted bell-shaped shield. These transformers are wound on a 1-in. diameter form. Coupling in all but the screen-grid stage is loose to insure maximum selectivity. Behind these are the four vacuum tube sockets, and at the extreme rear are the three audio-frequency transformers, namely, the first stage, the input and the output transformers.

Three knobs on the front panel control the operation. At the left is the



Circuit Diagram of Fada 25

conventional "on" and "off" switch; in the middle, directly under the drum dial, is the volume control, and on the right is the tuning control. Knobs are attached to the shafts in a rather unique fashion. The knob itself is slotted, while a phosphor bronze spring fits in a small groove cut cross-wise on the shaft, which fits in the slot. To attach or detach, the knob is pushed or pulled on or off.

Although provision is made for antenna and ground connections, the set may be operated without them. However, it is always desirable to employ a ground with an alternating current set, as it will have a tendency to reduce hum. In the Fada 25, a small switch adjacent to the antenna post is provided for connecting the antenna input to the line side of the power circuit, in series with a small condenser. This makes use of the electric light wires as a substitute for the aerial.

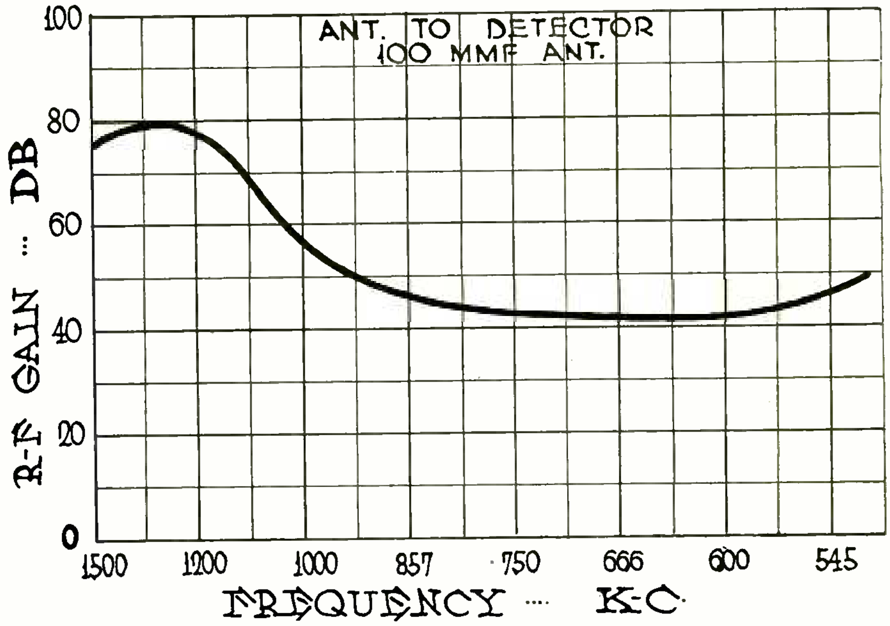
Two phone-tip jacks are provided on the binding post strip at the rear of the set for attaching the receiver of a phonograph through a "pickup."

The r.f. stages progress from right to left, with the detector at the extreme left. The first two stages are neutralized by means of low-capacity condensers connected between the grid and filament circuits. In the screen-grid circuit, tight coupling is employed between the primary and secondary of the transformer in order to take full advantage of the high gain obtainable.

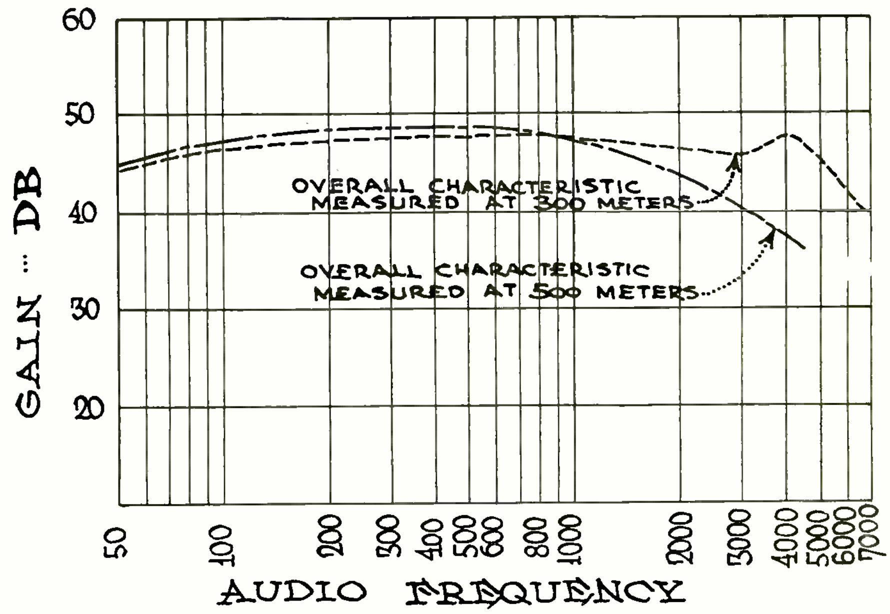
Volume is controlled by means of a potentiometer in the grid circuits of the first two r.f. stages. Variation of the bias alters the impedance of the tube circuit, and regulates the volume to the desired degree.

All wiring is under the chassis. The component parts have been so designed that terminals protrude below the frame, placing all wires within vision. Wires for the power, r.f. and filament circuits are code colored, facilitating easy identification. All grid leads to transformers are shielded in order to prevent coupling.

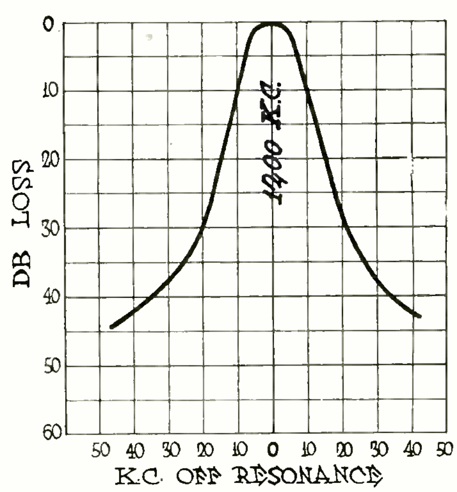
The power unit supplies both plate and filament heater-current for all tubes of the set. In order to avoid coupling between filament circuits, four separate 2.5-volt secondaries are provided on the power transformer. The high voltage secondary feeds the plates of an '80 full-wave rectifier. This circuit supplies all the plate and grid bias voltages in the set, including the 250 plate-volt energy for the '45 tubes, and the 50-volt *C* bias.



Measured R-F Gain of Fada 25 Receiver



Overall Characteristics of Fada 25



Selectivity Curve of Fada 25

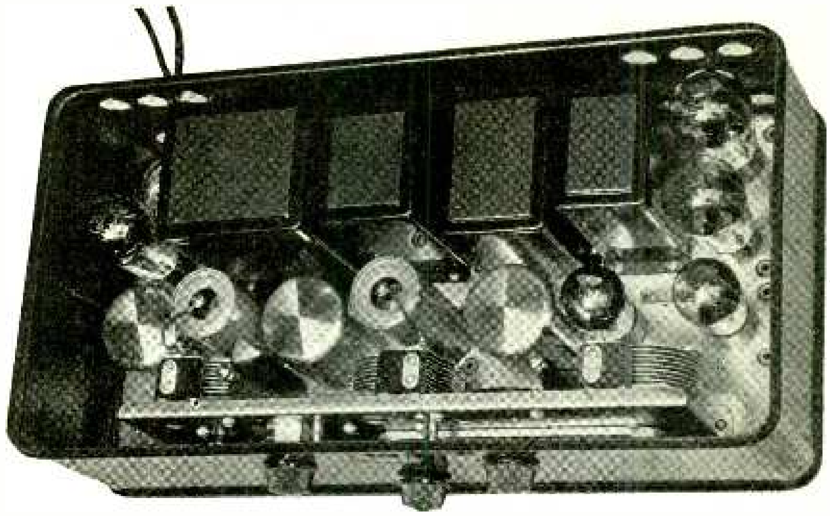
Various intermediate voltages are obtained by means of a voltage divider, connected across the output of the rectifier.

The filter circuit consists of a 5-μf condenser block, and two audio chokes, one of which is the field coil of the dynamic speaker. The primary of the power transformer is tapped in order to allow for the necessary compensation for variations in line voltages.

ERRATUM: In Figs. 3 and 4 of Frank C. Jones' article, "Notes on Audio Amplification," June, 1929, "RADIO," it is necessary to use plate rectification instead of grid rectification. The grid condensers and leaks must be replaced by a *C* battery located in the grid return.

Analysis of the Atwater Kent Model 55

By L. M. COCKADAY



Chassis of Atwater Kent 55

THIS is the first of the screen-grid sets made by Atwater Kent. It employs two '24 tubes in the r.f. stages, with '27 tubes in the detector and first audio and two '45 tubes in push-pull in the second audio. Under test, it showed a total r.f. gain of over 500, and the output of the audio circuit showed approximately straight line amplification from 80 to 6000 cycles.

To keep the detector output below the point where a strong local station will tend to overload the first a.f. stage, a "local" knob is provided on the front panel to adjust the second r.f. transformer so that only one-fourth of its primary is in circuit. For "distance" the entire primary is cut in. Resistance coupling is also used in the first audio stage to prevent overload and to give fidelity of reproduction.

The set has binding-posts for long and for short aerials, the former being for antennas more than 30 ft. in length. It utilizes only three turns in the primary of the first r.f. transformer, thus serving to increase the selectivity. The latter connects the entire primary into the circuit and increases the sensitivity for "distance" reception.

Volume is controlled by direct variation of the shield-grid voltage in the r.f. tubes through a series resistance. This unit varies the potential from zero to about 75 volts, and gives quiet and smooth control of the input to the detector and amplifier. A "bleeder" resistor is connected ahead of the variable unit, reducing the bias voltage from the power unit output to the desired maximum.

In series with the plate of the detector tube is a choke coil to prevent r.f. currents from entering the audio circuits. This is by-passed in the usual manner.

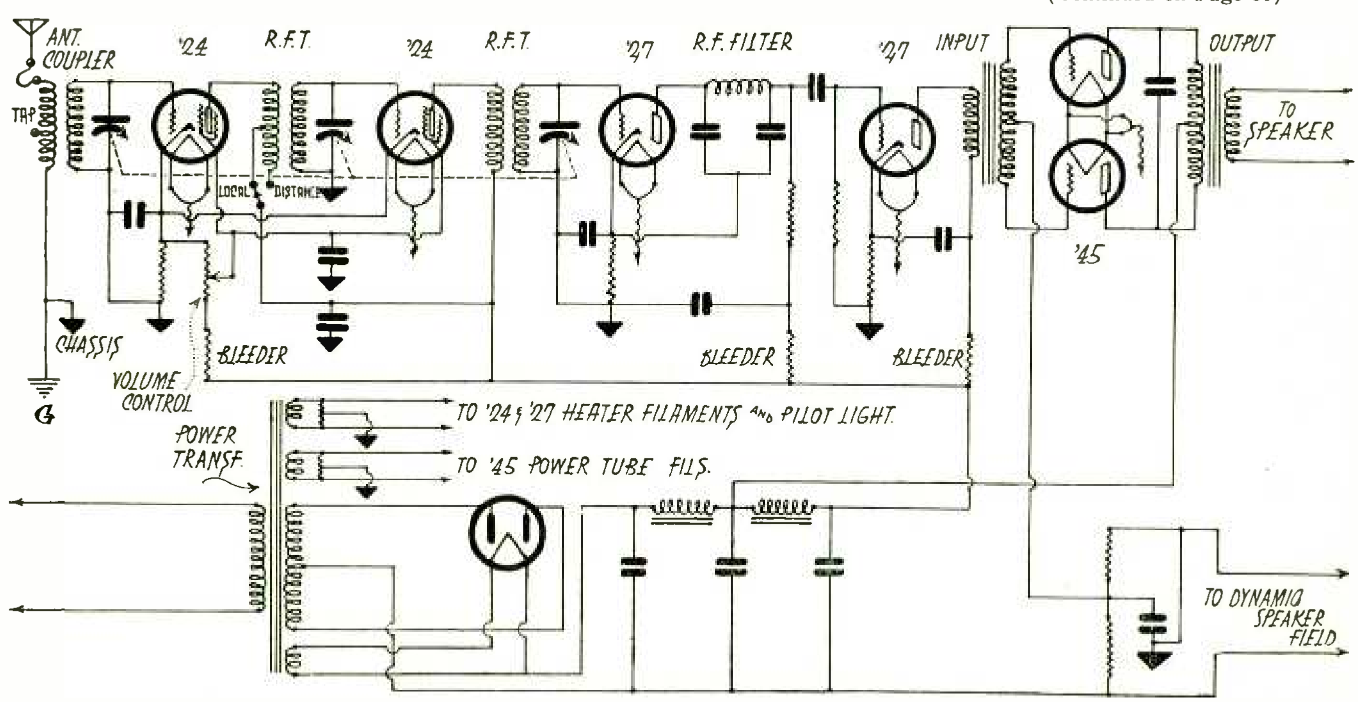
The output of the first a.f. stage feeds to the primary of the push-pull input transformer, and thence, through induction, to the center-tapped secondary, and to the grids of each of the two power tubes. The output transformer feeds to the floating coil of the dynamic speaker. This output unit is especially designed to operate in conjunction with the Atwater-Kent reproducer.

The power unit is virtually the same as employed in all conventional receivers, utilizing a full-wave rectifier tube, fed from a center-tapped line transformer. The rectifier output feeds to a "brute force" filter, consisting of three filter condenser units, and two high inductance audio choke coils. The output from this circuit supplies plate and grid voltages for all of the six receiver tubes, and in addition, excites the field coil of the dynamic speaker. Audio circuit grid bias is obtained through resistances connected in series with the grid returns.

Two 2½ volt filament windings, wound as secondaries on the single power transformer, furnish the necessary cathode heater current for the '24 and the '27 type tubes, and the '45 power amplifier filaments and the pilot light.

Mechanically the Atwater-Kent 55 has an all-metal chassis and is attached in a metal cabinet with eight bolts. Because of the high radio frequencies which are apt to result from the use of screen-grid tubes, each unit in the set, including each of the screen grid tubes, is shielded with the greatest care. All of the r.f. transformers are housed in metal cans, and except for the small holes for the wires, are completely

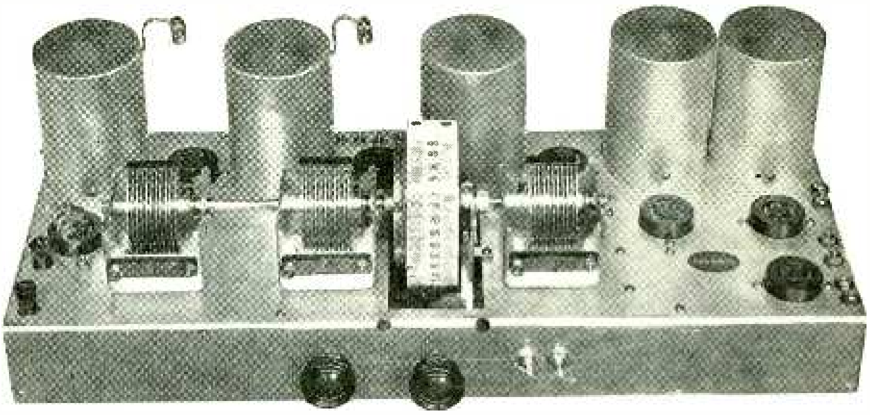
(Continued on Page 80)



Circuit Diagram of Atwater Kent 55

Kit Reviews

The Harkness 1930 Screen-Grid Seven



Front View of Chassis, Without Shielding

This kit is designed to use three '24 screen-grid r.f. tubes, '27 detector and first audio stage, and a power stage of two '45 tubes in push-pull. The chassis and shields are made of aluminum and are punched and tapped for easy assembly. The panel is equipped with an escutcheon plate for the single drum dial, a volume control knob, and two switches, one for the a.c. line and the other for phonograph operation.

A 300-ohm potentiometer is shunted across the antenna and ground connections, allowing control of the input signal strength to the grid of the untuned antenna coupling stage. This resistor controls the volume without discrimination of frequencies. Grid bias is supplied to the first tube from the drop through a fixed resistor between cathode and ground plus that from the lower portion of the volume control. Inductively coupled transformers couple the next two stages, grid bias being supplied from individual resistors. The primary of each, as well as the cathodes and screen-grids, are carefully bypassed, and the plates and screen-grids are provided with a positive potential from taps in the voltage divider.

A third transformer, similar to the two preceding ones, couples the third r.f. stage to the detector, for which a '27 tube is used in a plate rectification circuit with high plate voltage and a corresponding bias. An r.f. filter in the output circuit of the detector halts the flow of any remaining r.f. current.

The detector is coupled to the first a.f. stage by means of resistances, one of the s.p.d.t. switches breaking the circuit for the phonograph input. Transformers are employed between the first and second audio stages and in the output circuit of the power stage. Grid bias for the power tubes is supplied from the drop through a resistor in the power unit connected between the filament center tap and ground.

The power pack is conventional; one '80 tube being employed as a rectifier, two chokes with a condenser from each terminal to ground comprising the filter. Either a magnetic or an a.c. dynamic speaker may be used, a plug being provided for the field of the latter.

The kit is accompanied by complete directions and pictorial diagrams so that the complete set can be assembled in a few hours. All the wiring is under the base and is quite simple. The power unit is completely wired ready for use. Both the receiver chassis and power pack can be enclosed in any standard cabinet having minimum inside dimensions of 20½ in. width, 8 in. height and 12 in. depth.

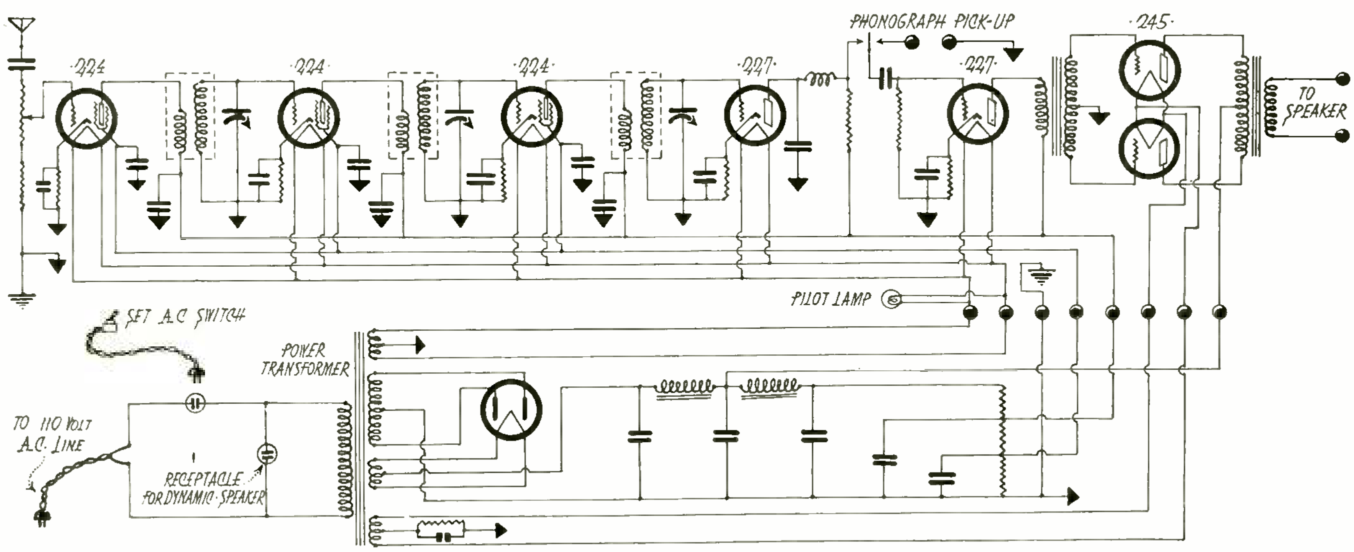
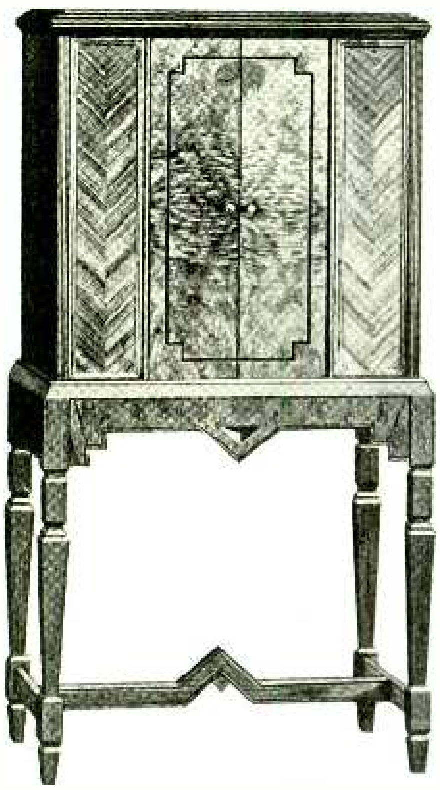


Fig. 1. Circuit Diagram of Harkness Kit

New Equipment From the Radio Manufacturers

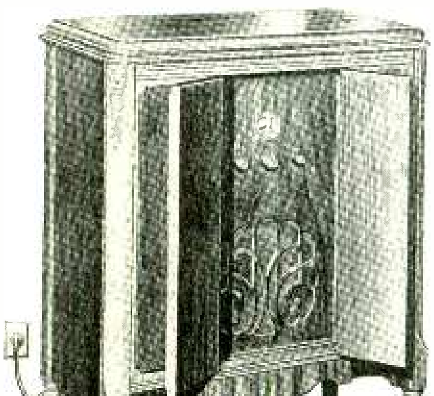
Contributions to This Department Are Invited

Crosley Radio Corporation announces a number of new models equipped respectively for either screen-grid, heater type, a.c. filament or d.c. filament tubes. Any one of these four types of chasses may be obtained in a walnut console, with or without built-in speaker, or in a metal cabinet, with or without legs.

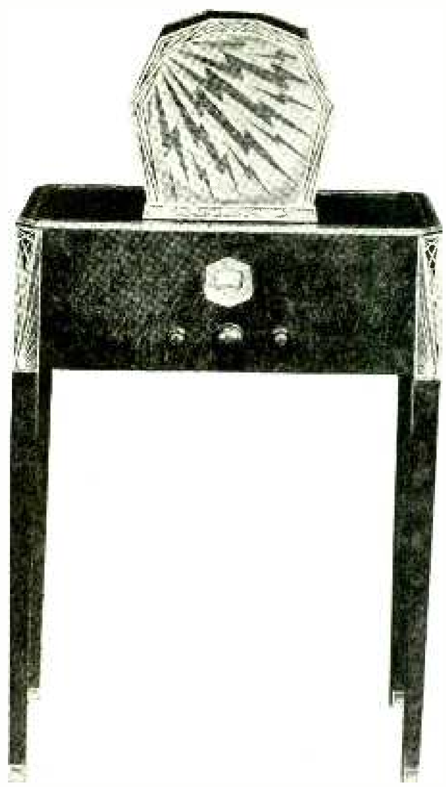


Crosley 82 Type of Cabinet

The S-chassis, which is used in the 82-S, 41-S and 42-S models, has three '24 tubes in the r.f. stages, a '27 detector, a '27 first audio, and two '45 tubes in push-pull in the last stage, with '80 rectifier. The 82-S is a con-



Crosley 42 Type of Cabinet



Crosley 41 Type of Cabinet

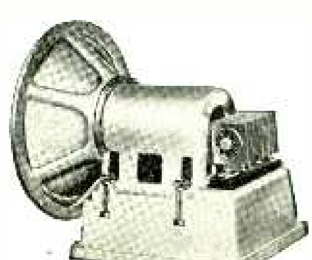
sole without speaker, the 41-S a metal cabinet, and the 42-S a console with speaker.

Corresponding cabinets with '27 tubes in the r.f., detector and first audio stages and two '45 tubes in the last audio are the 82-H, 41-H and 42-H. The 82, 41 and 42 have three r.f. stages with '26 tubes, detector with '27, first audio with '26, and last audio with two power tubes in push-pull. An '80 rectifier is used in each case.

The 83 is a console, the 61 a metal cabinet and the 62 a console with speaker, all using d.c. tubes, five '01A and three '71A. The 21 and 22 likewise use three '22, two '01A and one '71A. The 31 and 32 are metal cabinet and console respectively, with four '26, one '27 and one (and two) '71A, with '80 rectifier.

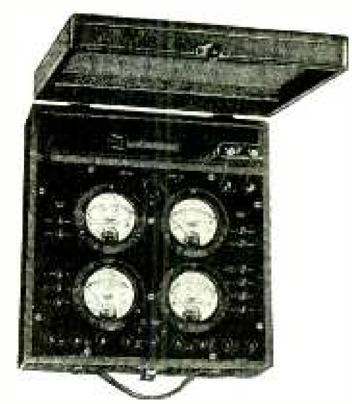
The Crosley speakers include the Dynacone and the Dynacoil, an electro-dynamic type. The Musicone is no longer in production. These speakers are furnished in various forms and may be used as table models or may be installed in consoles with complete receivers.

Amervox Electrodynamic Speaker Units are made in several types for operation either with 110 or 220-volt a.c., 25 or 60 cycles, 90-110 volt d.c., or 6-volt d.c. The



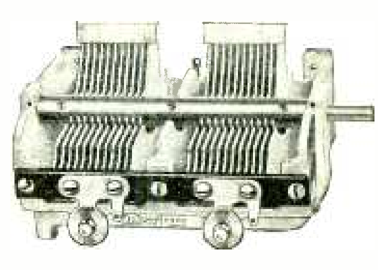
first-named type, as illustrated herewith, contains a step-down transformer in its base and uses current rectified by an Elkon M16 unit together with a ripple filter. The second type requires 45 ma. at 90 volts from a power pack for field excitation. The third type uses a battery. The field coil is designed to carry 6½ watts without overheating and has a flux density of 14,000 lines per sq. in. The cone, voice coil and spring are extremely light and strong and are designed to give distortionless reproduction from 30 to 7000 cycles for inputs as high as 14 watts.

The Jewell 409 Set Analyzer gives simultaneous readings of plate current and plate, grid and filament voltages by means of four instruments mounted in its panel. These in-



clude a 0-12-60-300 milliammeter, a 0-120-300-600 d.c. voltmeter, a 0-10-100 d.c. voltmeter, and a 0-4-8-16-160-800 a.c. voltmeter. Tests are made by inserting the analyzer plug in the socket from which the tube has been removed and by pressing two buttons in the analyzer. Scales are selected by push-buttons.

De Jur-Amsco Variable Condensers are made in single, double and quadruple units with the usual .0003, .00035 and .0005 mf. maximum capacities in each section. Each section of the double and quadruple units is provided with a grounded compensator capable of adjustment up to 35 mmf. With



compensators at minimum capacity the minimum of each section of the large frame condensers is 17.5 mmf. and of the short frame 19.5 mmf. The individual sections of the ganged types are matched by the micrometric displacement of the stator plates to any specified tolerance. They are made with either single or double space, and are as small and light as is consistent with strength and rigidity. They have a three-bearing shaft and three-hole mounting.

ANALYSIS OF MAJESTIC 180

THIS new Majestic model is a seven-tube set employing five '27 type tubes and two '50s. It has connections for operation from either a long or short antenna wherein a 25,000-ohm fixed resistor, shunted by a .001 mfd. fixed condenser, is connected across the ground. The antenna is conductively coupled to the input coil which is shunted by the first section of the condenser gang. The inductance of this coil is variable to a small extent so that the antenna system may be resonated with the three other tuned circuits of the receiver. The knob for this trimmer is located on the panel so as to control the selectivity.

Inductive transformer coupling is used between each r.f. stage, Rice neutralization being employed. The heaters of the three r.f. tubes, detector and the first a.f. tube are supplied with 2.5 volts from the power unit.

The plate voltage is delivered to the three r.f. and first a.f. tubes from the main power line via a 1915-ohm resistor and the 2730-ohm speaker field. Another resistor of 30,000 ohms reduces this voltage still further for the detector plate.

The minimum grid bias for the three r.f. tubes is obtained from the voltage drop through the 600-ohm fixed resistor which, in series with the 75,000-ohm volume control, connects the three r.f. cathodes to ground, or *B*—. To increase the resistance in the 75,000-ohm variable resistor is to increase the grid voltage on these three tubes and hence increase the volume. Grid bias for the first a.f. tube is obtained from the drop through a 1650-ohm resistor which connects the cathode of this tube to ground.

Two .5 mfd. condensers connected to two different sections of the r.f. cathode lead bypass this lead. Two more are used to bypass the r.f. plate leads to ground, while another .5 mfd. and a 1 mfd. condenser are used on the detector plate lead. The first a.f. cathode is also equipped with a .5 mfd. bypass condenser, which completes what should be an effective r.f. filter system.

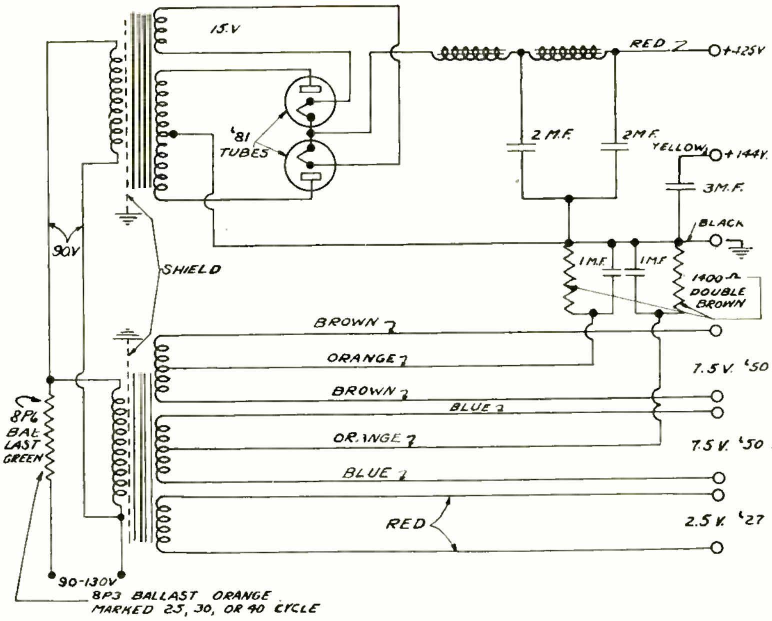


Fig. 2. Circuit Diagram of Majestic Power Unit

Grid detection is used, the grid condenser and leak being of the normal values of .00025 mfd. and 2 megohms respectively. A .002 mfd. feedback condenser takes care of any stray r.f. that may have found its way through the detector tube.

The secondary of the first a.f. transformer is tapped for the phonograph unit input which is permanently connected into the circuit and operated by a drum switch that opens the detector plate circuit when the phonograph is used. The first transformer secondary then becomes an autoformer, the voltage output of the phonograph unit being stepped up according to the turns ratio of the autoformer. The 30,000-ohm variable resistor that is connected across the ground and the other phonograph unit terminal acts as the volume control for this system, and is connected on the same shaft as that for the radio set.

The second a.f. stage is in push-pull, employing two type '50 tubes. Transformer coupling is used on both input and output circuits. A 3920-ohm resistor is connected in series with the speaker field, the 1915-ohm resistor mentioned above and the 425-volt line in order to complete the voltage dividing system across the output of the power unit.

Two transformers are used in the power unit, their primaries being connected in parallel, and a ballast resistor is in series with both. This gives practically uniform primary voltage for any variation in line voltage from 90 to 130 volts. One transformer has three low-voltage secondaries supplying heater and

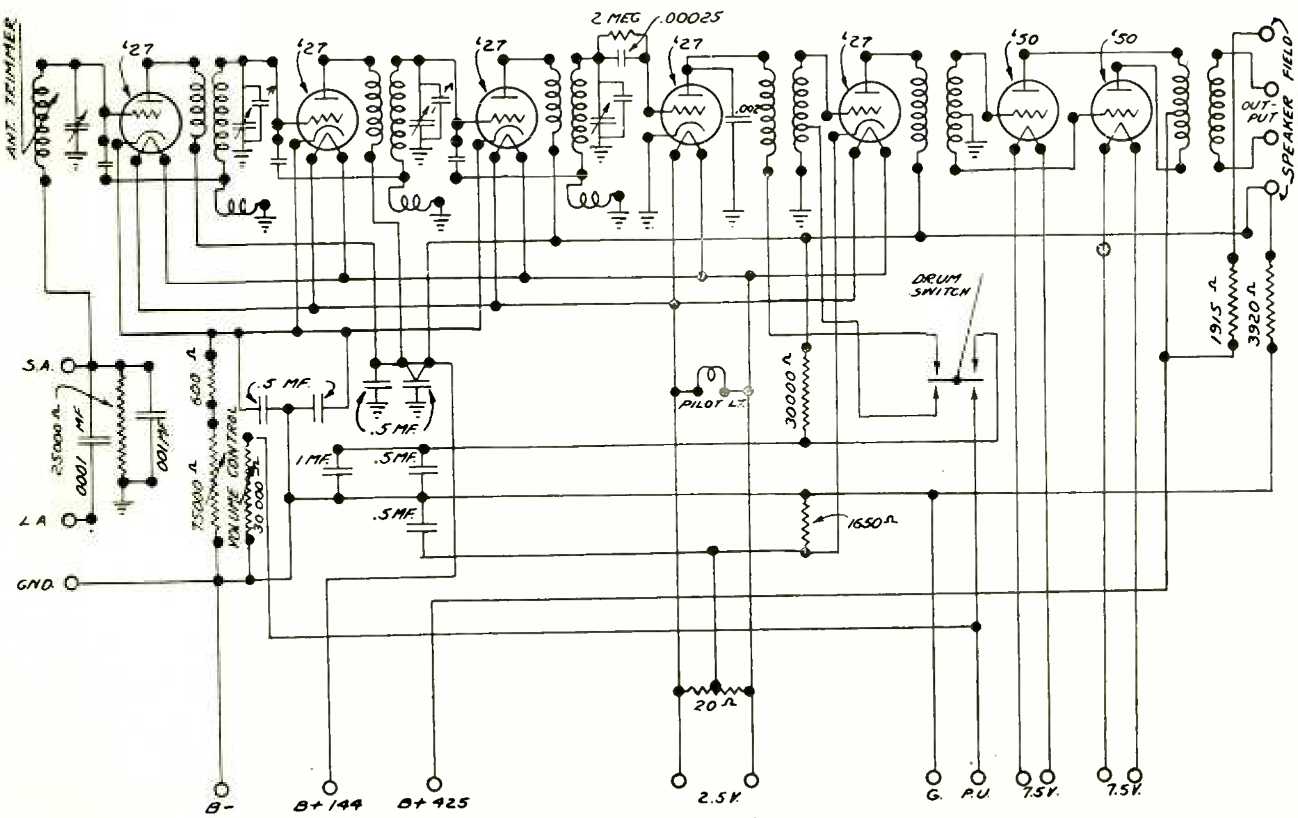
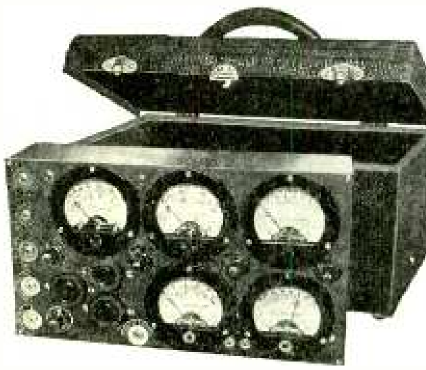


Fig. 1. Circuit Diagram of the Majestic Model 180 Receiver

filament voltages to all '27 type tubes and separately to each '50 type tube. Two 1400-ohm resistors, each shunted by a 1 mfd. condenser, connect the center taps of the two 7.5-volt secondaries to ground, thereby supplying the grid of each '50 tube with its required bias.

The second transformer supplies the high voltage to the plates of the two '81 rectifying tubes and 15 volts to the series filaments of the same tubes. The output of the rectifier is filtered through two a.f. chokes and two 2 mfd. condensers. The r.f. plate voltage is further filtered by the field coil of the speaker and a 3 mfd. shunt condenser.

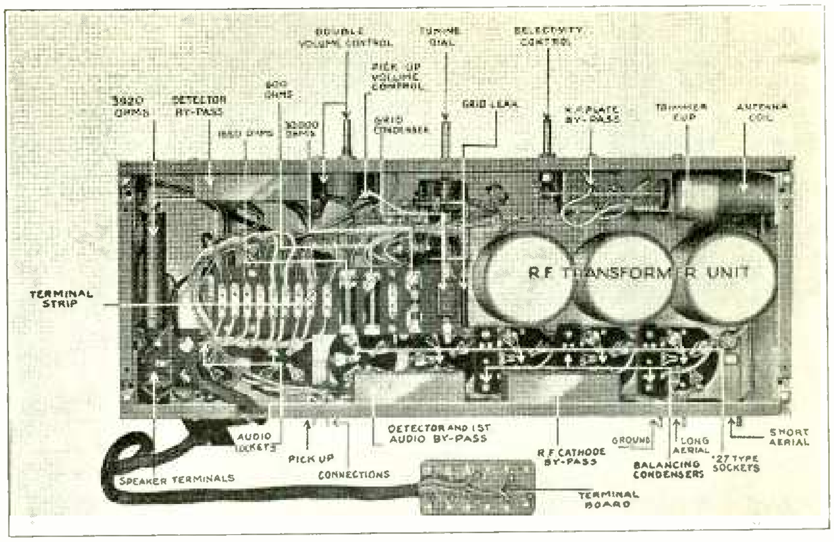
The Hickok set and tube tester has five meters whereby it is possible to make simultaneous readings when testing all types of a.c. and d.c. sets and tubes, including the screen-grid type. These instruments include four voltmeters and a plate milliammeter with a range of from 20 to 200 m.a. The



former include a plate voltmeter with range 300 and 600 volts, a grid voltmeter with range 100-0-80 volts, a.c. filament and line voltmeter, 3.3-15 and 150 volts, and a d.c. filament voltmeter, range 7.5 volts. The voltmeters have a resistance of 1333 ohms per volt. All meters are heavily bus-barred to a five-lead cable so that the possibility of burn-out is minimized. A complete set of instructions and tube specifications accompany the set which is housed in a bakelite case and equipped with a plush-lined leather carrying-case.

Powerizers are socket-power amplifier units made by the Radio Receptor Co. They are available in four standard sizes for undistorted outputs ranging for 1.5 to 15 watts. This company also builds amplifier racks and

control panels for audio distribution systems, as well as special amplifier units. Their engineers recommend that ¾-watt output be allowed for each magnetic cone, 2-4 watts for each dynamic cone, and 5-8 watts for a dynamic unit with air column.



Majestic Model 180 Chassis

RMA STANDARD DEFINITIONS FOR RECEIVING SETS

1. Receiving Set (Receiver).

A device for converting radio waves into perceptible signals.

2. Tuning.

Primarily, the adjustment of a circuit or circuits to resonance. Used also to mean the adjustment of a circuit or system to secure maximum transmission of a desired signal.

3. Sensitivity.

The degree to which a radio receiving set responds to signals of the frequency to which it is tuned.

4. Detector.

That portion of the receiving apparatus which, connected to a circuit carrying currents of radio frequency, and in conjunction with a self-contained or separate indicator, translates the radio-frequency power into a form suitable for operation of the indicator. This translation may be effected either by the conversion of the radio-frequency power or by means of the control of local power. The indicator may be a telephone receiver, relaying device, tape recorder, and so on.

The most common type of detector is a vacuum tube, operated on a non-linear portion of its characteristic curve, thereby converting a modulated radio frequency current into a modulated direct current.

A tube which operates similarly to a detector tube but the output of which does not operate on an indicator, may properly be called a frequency-converting tube.

5. Fading.

The variation of the signal intensity received at a given location from a radio transmitting station as a result of changes in the transmission path.

6. Selector (Station Selector).

The manual adjustment means by which the user of a broadcast receiver is enabled to bring one or more of its circuits into resonance with any desired signal within the range of the receiver. There are three general methods of manual station selection. In these the mechanical means used in any of the three methods may consist of direct connected drives, with or without auxiliary close-adjustment means, or may consist of close-adjustment means only.

7. Multiple Selector.

That method of manual tuning adjustment in which mechanical means are provided for setting independently each of two or more tuned circuits or groups of tuned circuits to resonance at any frequency within the range of the device.

8. Master Selector.

That method of manual tuning adjustment in which one mechanical means is used to bring all the tuned circuits simultaneously into approximate resonance with any desired frequency within the range of the device, and additional auxiliary means are provided to bring one or more of the tuned circuits into exact resonance.

9. Uni-Selector.

That method of manual tuning adjustment in which one and only one mechanical means is provided to the user for bringing all tuned circuits into practical resonance at any desired frequency within the range of the receiver, there being no additional separate means for resonance adjustment and no other controls which appreciably affect the calibration of the uni-selector.

10. Direct Selectors.

Direct selectors are those in which the motion ratio between the knob, dial, or other actuating means and the driven device is unity.

11. On-Off Switch.

The manual means for connecting and disconnecting a source or sources of power which are supplied to the receiver.

12. Selectivity Control.

The manual adjusting means by which the user of a broadcast receiver may produce changes in circuit to produce two or more degrees of selectivity or by which he may produce a gradual change in this respect between limits.

13. Interference.

Confusion of reception due to strays, undesired signals or other causes; also that which produces the confusion.

14. Swinging.

The variation in intensity of a received radio signal resulting from changes in the frequency of the transmitted waves.

15. Stability.

The characteristic of a radio receiving set to perform uniformly without generating objectionable audio-frequency or radio-frequency oscillations for all possible adjustments of the controls. A radio receiving set is stable when such oscillations are absent.

16. Shielding.

The metallic enclosure of a receiving set or its parts to prevent undesirable reaction, through electrostatic or electromagnetic fields, between circuit elements of fields inside of the enclosure, and elements or fields external to the enclosure.

17. Partial Shielding.

The application of shielding to a portion of the circuit elements of a radio receiving set. In literature describing partial shielding, the elements so shielded shall be specified.

18. Interstage Shielding.

The application of shielding to the circuit elements or stages of a radio receiving set to prevent undesirable intercircuit or interstage reaction.

19. External Shielding.

The application of shielding to a complete radio receiving set to prevent interaction, through electrostatic or electromagnetic fields, between the elements of the receiving set and external circuits except through intended coupling means.

20. Terminal Markings.

The markings for binding posts or terminals on radio receivers shall be as follows:

a. The binding post for connecting the antenna wire shall be marked with the word *Antenna* or the abbreviation *ANT,* and the binding post for connecting the ground wire shall be marked with the word *Ground* or the abbreviation *GND.*

b. Binding posts for connecting the conductors extending to a loop shall be marked *Loop 1, Loop 2,* etc., to correspond to similar markings on the loop.

c. The binding posts for making connections to "output" apparatus or circuits shall be marked *Output.*

21. Protection of Output Terminals.

In a receiver, where provisions are made for separate B and C voltages on the last tube, the output terminals shall be protected and the insulation of the B+PWR lead shall be adequate for 500 volts d.c.

22. Wiring Diagrams.

Each receiving set shall be supplied with a picture-type wiring diagram showing in perspective the terminals, batteries, etc., with the external electrical connections.

23. Power-Cable Connection to Receiver.

On sets requiring external batteries a power-supply cable shall be permanently attached to the radio receiver and this point of attachment shall not be readily accessible. Separate wires shall be provided for each filament, plate, and grid battery connection.

24. Service-Manual Sheet Size.

The standard size of service-manual sheets shall be 8½ by 11 inches with three-hole punching, the two outer holes each being 4¼ inches from the center hole.

25. Selectivity.

The degree to which a radio receiving set is capable of differentiating between signals of different frequencies.

26. Volume Control.

The manual adjusting means by which the user of a broadcast receiver is enabled to adjust the sound volume delivered by the sound-reproducing device on any signal input, within limits depending on the strength of the signal and the sensitivity of the receiver and the sound-reproducing device.

27. Underwriters Laboratories Requirements.

On sets operating from electric light sockets, all construction shall be in accordance with the latest rules of the Underwriters' Laboratories.

28. Insulation Resistance.

All components of the audio circuit shall have an insulation resistance of not less than 15 megohms measured between adjacent insulated conductors or between an insulated part and the metal framework. Insulation resistance tests shall be made after a 25-hour exposure at an average humidity of 90 per cent and a temperature of 100 degrees F.

29. Battery-Operated Set.

A radio receiver designed to operate from primary and/or storage batteries shall be known as a "battery-operated set."

30. Socket-Powered Set.

A radio receiver of the "battery-operated" type, when connected to a power unit operating from the electric light line, supplying both filament and plate potentials to the tubes of the receiver, shall be known as a "socket-powered set."

31. Electric Set.

A radio receiver operating from the electric light line, without using batteries, shall be known as an "electric set."

32. A. C. Tube Electric Set.

A radio receiver employing tubes which obtain their filament or heater currents from an alternating current electric light line without the use of rectifying devices, and with a built-in rectifier for the plate and grid-biasing potentials, shall be known as an "A. C. tube electric set."

33 D. C. Tube Electric Set

A radio receiver employing tubes which obtain their filament or heater currents from a direct current electric light line without the use of rectifying devices, and with a built-in power plant for the plate and grid-biasing potentials, shall be known as a "D. C. tube electric set."

RMA BETTER RADIO RECEPTION MANUAL

One of the major problems facing the radio trade is the elimination of the "man-made static" which causes so much unnecessary interference with radio reception.

These extraneous noises in the radio receiver are controllable and can be eliminated. How to do it is explained fully in the latest edition of the "R. M. A. Better Radio Reception Manual," which has just been published by the Engineering Division of the Radio Manufacturers' Association.

The first edition of this important booklet was published by the Radio Manufacturers' Association in 1927 and created a nation-wide sensation through its disclosure of many methods of making radio reception more enjoyable for the public through the control of noises filtering into the receiver from outside sources. The latest edition of the Interference Manual is not a revised edition; it is a complete new work which tells in detail just how to locate and eradicate "man-made static."

Radio retailers will find the Manual of incalculable value in impressing their customers with the fact that the radio industry is leaving no stone unturned to make radio reception as clear and enjoyable as is humanly possible.

The new Manual gives detailed information as to the various types of electrical appliances which are liable to cause interference, how the cause of the noise can be located, and, finally, how the noises can be eliminated through the installation of various types of filters.

The booklet contains over a dozen wiring diagrams, covering every major type of static producer and is the only information of its kind ever available in one book.

The price of the Manual is 25 cents and copies can be obtained from the Radio Manufacturers' Association, 32 West Randolph Street, Chicago, Ill.

NEWS OF THE RADIO TRADE

Los Angeles will hold its seventh annual radio show in the Ambassador Auditorium, September 1-7.

Arco Electrical Corp. of Chicago announce production of a new screen-grid receiver as well as *A* and *B* power units, controllers, chargers and batteries.

The Radio Corporation of America has licensed under its tube patents Eveready Raytheon, Ce Co, Sylvania, La Salle, Champion, Hygrade, and Tung-Sol.

The Trav-Ler Manufacturing Corporation of Chicago has been purchased by Harold Wrape and associates of St. Louis. They are concentrating on the manufacture of a portable set for loop operation with screen-grid tubes.

The name of the Pilot Electric Manufacturing Company has been changed to the Pilot Radio and Tube Corporation. The organization will continue to function as before, no changes in either management or policy being contemplated.

The sixth annual radio show conducted by the Pacific Radio Trade Association in the Civic Auditorium at San Francisco will open on August 17 and close on August 24. All exhibit space has been sold and a large attendance is anticipated.

The Vision Tone Sales Company of Dallas, Texas, is marketing a combined radio, phonograph and motion picture machine in which records and films are synchronized to create talking pictures in the home. The outfit lists for less than $400.

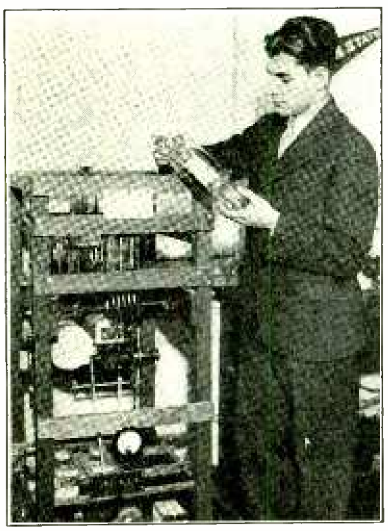
The Sterling Manufacturing Company, Cleveland, Ohio, manufacturers of radio accessories, are now making the Stuart, Noon and Oxford uni-central receivers. These sets employ screen grid tubes as r.f. amplifiers and '45 tubes as power amplifiers with dynamic speakers built in.

Station W2XCL, located at 323 Berry Street, Brooklyn, N. Y., which has been operating since March 27 under a construction permit issued by the Federal Radio Commission, has been licensed by the commission as an experimental visual broadcasting station to transmit in the 2000-2100-kilocycle channel (142.9-150 meters). A new system of disc scanning and simple method of maintaining synchronization has been developed by the Pilot Radio and Tube Corporation, which operates the station and sells the parts for a complete television receiver in knock-down form.

With the Amateur Operators

ACCOMPLISHMENTS AT W2ALU

W2ALU is a 1000-watt station operated by John B. Knight and Fred M. Link in their apartment at 583 Riverside Drive, New York City. This station has established two-way communication with every continent, some sixty countries, and has maintained unbroken contact with the Byrd polar expedition through WFBT and WFAT ever since it left the United States. Besides acting as a medium for sending and receiving personal messages between members of the crew and their friends this station acts as an emergency stand-by for the New York Times station WHD. The station has also maintained communication with the MacMillan Arctic expedition, the University of Michigan Greenland expedition, and the Ford rubber plantation in Brazil.



Transmitter at W2ALU

The transmitter, as illustrated herewith, is of the push-pull type of tuned grid-tuned plate, equipped with two De Forest 500-watt tubes with 3000 volts normally on the plates. A modulator is to be added for phone work. It normally operates on 41.3 meters. Rectification is accomplished with a 10,000-volt mercury arc.

The aerial is of the current-feed, fundamental type, with a phased radio-frequency half-wave feeder. The aerial proper comprises two 32-foot single wires. The feeders are two 64-foot wires, accurately spaced ten inches apart. This spacing causes the two lead-ins to neutralize each other very efficiently.

The receiver is a four-tube job, comprising one stage of tuned, screen-grid amplification, followed by a regenerative detector and a conventional two-stage audio amplifier.

The work of Knight and Link has not been confined to the cheery communication of the amateur, but has reached into many unusual events of human interest. During the tragic tornado in Porto Rico some months ago, they rendered a splendid service to victims and to relatives in the United States by relaying messages to and from the short-wave station in the Virgin Islands. When the yacht Vaterland of Count Felix Von Luckner steamed through the Panama Canal to pick him up in Havana, Link and Knight offered their station's services in keeping the Count in touch with his crew. They got one of their greatest thrills when they established communication with the whaler *Neilson Alonzo,* ice-bound in the Bay of Whales, Antarctica. Daily communication was maintained for a period of well over two weeks, and, as far as is known, W2ALU was the only station to maintain this schedule. This feat was largely responsible for calling attention to the practicability of radio communication with the Byrd Expedition. The splendid work of these two young men has proved to the world once more the sterling value of amateur radio as a great public servant and not merely an experimental plaything.

OSCILLATOR ASSEMBLY FOR 10 METERS

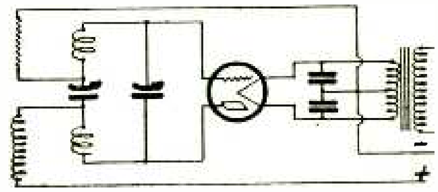
By A. Binneweg, Jr.

The 10-meter band is of considerable interest to experimenters, for reflector systems can easily be used, thus giving maximum results for a given power output. This band is comparatively wide and apparatus for these frequencies can easily be assembled. The cost of a 10-meter set is often less than sets of the same type for lower frequencies. Special design and construction is necessary, as will be described.

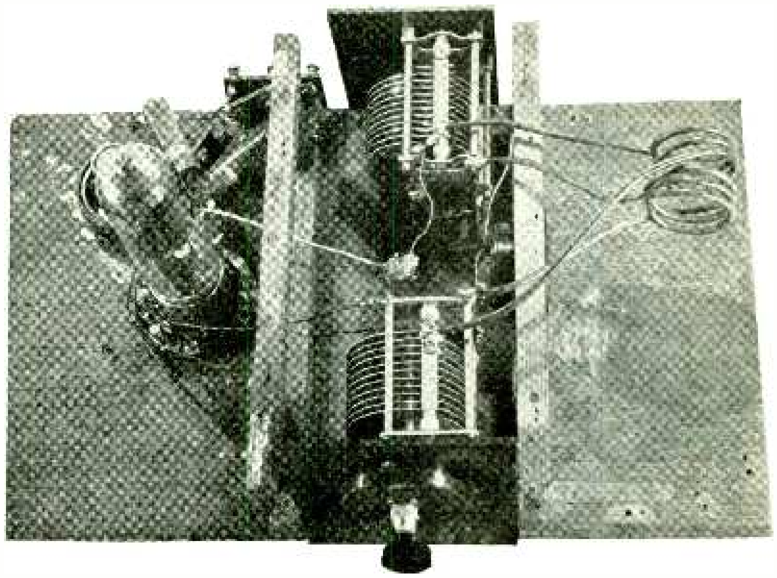
The circuit and assembly is shown in accompanying illustrations. This circuit operates readily at the highest frequencies, and it is simple to adjust. A 5000-ohm gridleak is used.

Ordinary circuits usually operate quite differently at 5 and 10 meters. Often the Hartley circuit will give more output if no filament clip is used, or a condenser or choke is connected in this lead. The tuned plate and grid circuit works well, but there are two tuned circuits, and small constructional differences may throw off the range of one. A circuit employing only one tuned circuit is usually easier to adjust. Results often depend upon the tube used; one tube may give poor results, while another of the same type may function quite well. In general, tubes having well-separated leads in the stem give best results.

The filament transformer used was not provided with a center-tap, so a center-tapped gridleak shunted across the filament provided this. The by-pass condensers are two of any of the usual sizes. A small 30-turn basket coil is used as a choke. Both condensers are mounted on 4x6-inch pieces of bakelite and are double-spaced. The tuning coil leads are soldered to the condensers. The inductances are in the clear, and the antenna coil can be coupled to them in any convenient manner.



Circuit for 10-Meter Transmitter



Assembly of 10-Meter Transmitter

In the usual shack a vertical Zeppelin antenna can be used. The feeders extend vertically about one-quarter wavelength and one of the wires extends beyond that one-half wavelength, this being the radiating part. The tuned reflecting wires are arranged vertically around a horizontal parabola, the "radiator" being at the focus.

The parabolic reflector will be used to quite an extent, below 20 meters. Its operation is quite simple. At the instant the main antenna is excited, electrons accelerate in the wire. "Kinks" travel out in the electrostatic lines, these causing electrons in near-by wires to move also, but somewhat later. A rough analogy is the operation of the pistons of an ordinary automobile engine—first one piston starts its motion, then the next moves, etc. Finally all the wires in the reflector are "radiating." Obviously a maximum effect results in the various wires if these are resonant at the transmitted frequency, and this usually means that each wire must be made approximately the same length as the radiating part of the main aerial. Design curves have already appeared in Radio.

The properties of the parabola are such that toward the rear of the reflector there is interference between radiation from the various wires, while in the direction of transmission there is reinforcement. Practically there is always some loss to the rear of the reflector, but in a theoretical arrangement no power would be used to the rear. Two equal voltages in opposition in an electrical circuit expend no power. Equal forces in opposition do no work. The space to the rear of a reflector is acted upon by "waves" out of phase, and thus there is more or less complete cancellation, little power being lost. Power only "proceeds" in the direction of transmission, which makes a reflector quite efficient for transmission in a given direction. Interference with stations not in the direction of transmission is minimized.

The receiver for 10 meters should have short leads and a small "midget" will serve as the secondary condenser. The narrow bands require only a small tuning condenser, so that if the receiver is designed for 10 meters, it may also be used in the other bands by plugging in the proper coil. It is convenient to use two midgets in parallel, so that one may listen outside the amateur bands, or compensate for small differences in coil construction, since it is more convenient to use a whole number of turns. The tube-base plug-in arrangement is so simple and economical that it has become popular.

A coil wound on a piece of 1-inch bakelite tubing and shunted by a midget of four plates or so serves as a wavemeter. A small extension handle and case ought to be used, and the cost is so small that a separate meter can be used for 10 meters. To avoid errors it is perhaps best to spot a few points with lecher wires, then harmonics from 20 and 40 meters can be used to complete the calibration.

ANTENNA INSULATION

By Jack Bront

Some puzzling things happen to ship transmitters. Among them, and particularly annoying, is the mysterious drop in antenna current, which any amount of retuning, readjustment or increase in power will not reclaim. The indicator on the aerial ammeter develops a self-consciousness complex and coyly cavorts in the penury of the lower scale readings. This is especially true in old installations which, although obsolete, are nevertheless like the poor, always "present or accounted for." One certain fundamental cause for loss in aerial amperes is so obvious that it is almost entirely overlooked.

Along this line we remember that since the earliest days of radio—in the hoary and be-whiskered nineties—the electric power transmission line has been a handy and suitable point of reference when delving into the necessarily extreme pressures built up in radio dissipating devices. Probably nowhere else is insulation subjected to a more acid test than in piloting high electric pressures across fog belts, desert dust areas, regions of chemical fumes—through sleet, snow and rainstorms. Here only the ultra-efficient in dielectric materials will stand the gaff of the enemies of isolated high voltages. And the premier insulation in general use is highly glazed porcelain of good quality.

But the most devastating conditions in power line insulation are mild indeed compared with those ravages incurred when salt water (in solution or crystallized in the presence of moisture) affects ship installations; especially in an all-enveloping atmosphere of funnel gases from the furnaces. The point is that, since power lines are equipped with the most practical and dependable insulation known, how much more care, thought and common sense should be applied to marine insulation, where slight losses may be almost disastrous. Any ship antenna, with a transmitter firmly attached to its "nether limbs," is deserving of, at least, half decent insulation. Heaven forbid that we recount the vices of the terrible "Electrose" so abundantly "wished on a gullible radio public," as one New York executive deemed it.

Even the best of insulating material for antennas is affected by various elements. Dielectric effectiveness at sea is impaired by moisture, soot and especially the salt from spindrift—or actual immersion in salt water, as on deck. Every insulation leak modulates the radio current. There is a subsequent ill-afforded loss in power, in tone and in distance. For example, an otherwise piping-toned arc transmitter may render an inimitable sound like that produced when a self-assertive and determined canine attaches himself firmly to the southern expanse of a well-filled pair of trousers.

As an example of the effect of moisture on high voltage insulation the writer has untangled snarls in power lines carrying above 7000 volts barehanded, and with only dry cedar underfoot. The same line, on foggy days, would have presented a most effective and certain opportunity for suicide.

One particular radio transmitter develops approximately 25,000 volts on an ordinary ship antenna. Minus the presence of efficient insulation and on an accompanying drop in resistance at the free end of the aerial from practically infinity to Heaven knows what, the effective utility of the transmitter falls to a minimum. A resonance variation is, of course, obvious, along with the depletion of pressure. The crux of the whole matter is that ship insulation is too often handled in a careless, indifferent manner. A common result is that antenna current is reduced and power wasted.

Happily, rain or moisture of any sort cleanses good and suitable insulation, but has a vicious tendency to further impair poor insulation, especially when foreign and conductive substances are present. On some vessels, at night in bad weather, the deck insulator may present a pyrotechnic display comparable to a first-class lighthouse. A sine curve of the emissions may present an appearance resembling a cross section of the captain's dinner after the cabin boy has taken a header down the engine room hatch.

There is no reason for any operator having to lower an aerial to apply grease, tooth and nail, every half-hour. Yet, as opportunity presents itself, insulators should be overhauled, examined for streaks and cracks holding moisture, and the grime removed with a cleaning agent. Power companies continually scrub and polish line insulators, when necessary, just to keep its sluggish 25 and 50-cycle stuff in its proper place.

All the pretty photographs of the newest, shiniest and fanciest transmitters, fresh from the cycle factory, do not by any means eliminate the "boiler factory" and the double-jointed, side-ejecting, one-lung rock crushers still afloat on the merchant ships; and which obsolete instruments deluded steamship companies still believe to be the last word in radio. These antiques, to a great extent build up antenna voltages which would shame the G. E. into starting into the spud and onion business. Careless and indifferent insulation of these relics produce some horrible noises in distant phones, especially in inclement weather.

When the aerial ammeter demonstrates an unexplained modesty, break out the field glasses and gaze passionately at the overhead insulators. If any suspicion is aroused, do your stuff. Like the old prospector mentioned to his fellow traveler on the adjacent cloud (just after the powder cache blew up): "Well, old timer, this is new territory. We may find something yit."

A price list and catalog from American Radio Hardware Co., 135 Grand St., New York City, lists angles and brackets, cable markers, terminal lugs, tube contacts, screws and nuts, binding-posts, battery and fuse clips, tip jacks, sockets, etc.

BOOK REVIEWS

"Radio Telegraphy and Telephony," by R. L. Duncan and C. E. Drew, 950 pp., 6x9 in., published by John Wiley & Sons, Inc., New York City. Price $7.50.

This new text embodies the experience of two veteran teachers as how to best impart a working knowledge of the causes, effects and uses of radio phenomena. They first lay a firm foundation of facts about the fundamentals of electricity and magnetism, placing special emphasis upon the construction and operation of motors, generators and storage batteries as well as upon electric meters. They then explain the theory of alternating currents and of condensers. The remaining four-fifths of the book is concerned more specifically with radio.

The one-hundred page section devoted to vacuum tubes is perhaps unrivalled in simplicity, conciseness and completeness of treatment. All of its varied uses as an amplifier, detector, oscillator and rectifier are thoroughly explained in a manner which is within the mental grasp of the average student. The treatment includes a.c. and screen-grid tubes.

Full details are given regarding broadcast and commercial receivers for both high and low frequencies. Two chapters are devoted to rectifier and filter circuits and their associated condensers.

The theory of radio transmission is introduced by a discussion on antennas and resonance and is continued with descriptions of various types of modern broadcast, commercial and amateur transmitters. The arc and the spark each has a chapter, as have also direction-finders and other radio equipment such as crystals and microphones.

The entire treatment is comprehensive and thorough, with a minimum of mathematics. It is written especially for the instruction of the commercial or amateur operator. Theory is so expertly woven into practice that this book's wealth of information becomes really readable and interesting.

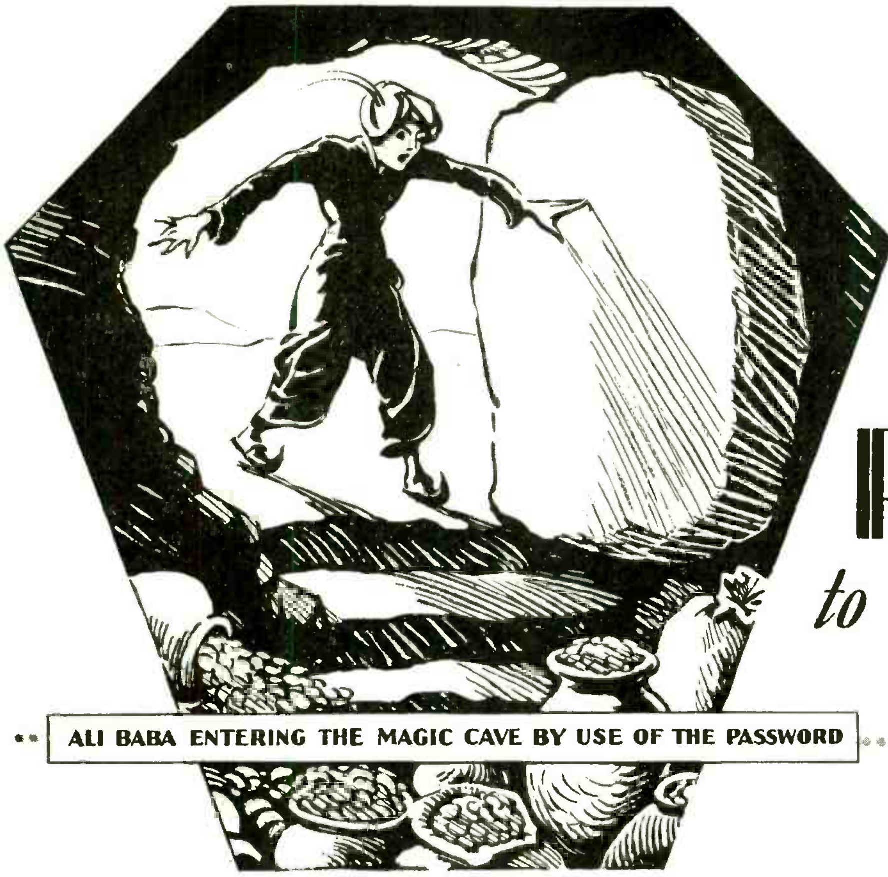
NEW PUBLICATIONS FROM THE MANUFACTURERS

"Tomorrow in the Tube Industry" is the subject of an interesting booklet wherein the Ce Co Manufacturing Co., Providence, R. I., stresses the importance of vacuum tube sales as a profit builder.

"Sound Advice" is the title of an attractive booklet from the Stevens Manufacturing Corporation, Newark, N. J. It illustrates and describes the Stevens line of magnetic, dynetic and dynamic speakers, the Sibley electric phonograph motor, turntable and pick-up.

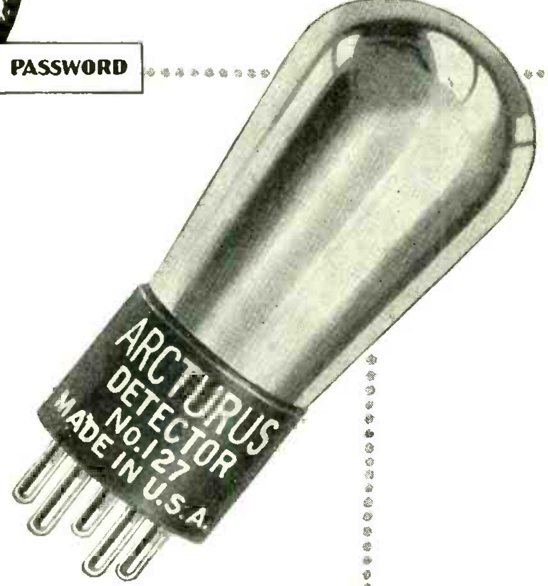
Bulletin No. 136 from the National Company, Inc., Malden, Mass., is a descriptive price list of new items. These include the M.B.-29 tuner, which is a compete chassis with 4 screen-grid a.c. tubes in the r.f. stages and '27 detector, the type H drum dial with scale projected on ground-glass screen, Velvetone power amplifier, the 4-tube "thrill-box" for short wave reception, and various radio parts.

Radioart Laboratories, Inc., of Cleveland, Ohio, have issued a circular on their eight step-down transformers for obtaining 110 volts from a power supply of 130 to 250 volts, 25, 50 or 60 cycles, for operating a.c. radio sets and electrical appliances not requiring more than 70 watts, 160 watts or 300 watts.



ALI BABA ENTERING THE MAGIC CAVE BY USE OF THE PASSWORD

The PASSWORD *to magic reception*



THE moment you put an ARCTURUS A-C Long Life Tube in every socket of your radio receiver, you give the Password to the air and to radio reception.

Magic - - the results you get - -

Programs in only 7 seconds *against 30 to 60 seconds with other tubes*

No hum - clearer reception

Realistic, true tone

Efficiency not impaired by current changes.

And l-o-n-g life

ARCTURUS Tubes have established a world's record for long life

You'll marvel at the vast difference a complete set of these *better* ARCTURUS Tubes makes in reception.

Distant stations . . . more volume . . . clearer reception . . . *the radio world is yours!*

Command it with ARCTURUS A-C Long Life Tubes - - in every socket. See your dealer.

WEST COAST REPRESENTATIVES

UNIVERSAL AGENCIES
905 Mission Street, San Francisco, Cal.
201 Calo Bldg., Los Angeles, Cal.

WESTERN SALES & SERVICE CO.
W. 1817 Augusta Avenue, Spokane, Wash.

The NEW SCREEN-GRID *№ 124*

Better screen grid receivers are being offered the American public because they specify the *new* ARCTURUS A-C Screen Grid Tube—built with a full year's experience and having the same advantage as all other ARCTURUS Tubes.

ARCTURUS RADIO TUBE CO. NEWARK, N.J.

ARCTURUS

BLUE A-C LONG LIFE TUBES

SERVICE PROBLEMS

(Continued from Page 19)

The eighth panel contains the usual tube-testing equipment for emission and oscillation readings. For the latter method a 0-100 current squared, thermocoupled milliammeter in the grid lead of an oscillatory circuit shows the grid current drawn during the oscillation of the tube. This reading, while merely comparative, will much more readily show up a defective tube than will the emission test. As these tests are comparative, just as effective results may be had on d.c. tubes as if direct current were used. The 3-volt filament tubes are placed in the 2½-volt socket.

This equipment has proved to be sufficient for making any tests that have been required in servicing factory-built receivers. This service is maintained exclusively for dealers and not for the ultimate consumer. Scrupulous care is exercised to avoid any type of job which might be profitably done by a dealer. For instance, if it is known that a dealer is equipped to rejuvenate tubes, a set of "duds" is sent back to him with a notation as to their trouble so that he can do the job for his customer. In such ways the dealer is encouraged to take advantage of his jobber's service without fear of losing the opportunity to make a legitimate profit on work which he can do himself.

Our policy regards the service man as a super-salesman. It is the excellence of his work that sells his firm to the dealer. For, when all is said and done, the primary purpose of a jobber's service department is to win the good will of the trade.

NEW RADIO CATALOGS

American Reproducers Corp., 1200 Summit Ave., Jersey City, N. J., describe and illustrate a.c. and d.c. types of Amervox electrodynamic speaker units.

Catalog No. 429 from Hardwick, Hindle, Inc., Newark, N. J., is devoted to H. H. vitreous enamel-coated resistance units. It contains valuable charts and tables for determining the size of unit needed for a specified purpose.

"Variable Condensers for the Manufacturer" is the subject of a bulletin from De Jur-Amsco Corp., Fairbanks Bldg., New York City. It contains curves and structural details of single, double and quad "bathtub" condensers.

Cable Radio Tube Corp., Brooklyn, N. Y., are distributing a handsome brochure on the "Y's and where 4's of Speed radio tubes."

The *Radiobuilder* for June 15, 1929, from Silver-Marshall, Inc., of Chicago, has an interesting and timely discussion of the use of the a.c. screen-grid tube as an r.f. amplifier and detector.

ARITHMETIC OF A POWER PACK

(Continued from Page 22)

from a simple formula. Assuming that the resistance R of the coil is so much smaller than the reactance X that R may be neglected, the current I through the coil is equal to $E \div (X+r) = E \div (6.28\ f\ L + r)$. But I is also equal to $e \div r$. Therefore $E \div (6.28\ f\ L + r) = e \div r$ and $e = E\ r \div (6.28\ f\ L + r)$. Consequently a high value of L causes a low value of e. Substituting a value of 50 volts for E, 2000 ohms for r, 120 cycles for f, and 25 henries for L would give a value of 4.8 volts for e.

By combining the condenser and the choke coil as in Fig. 12b still more effective filtering can be accomplished. Theoretical calculations showing that e is then approximately equal to $E \div 39.5\ f^2\ L\ C$. Assuming an E of 50 volts at 120 cycles, a 25-henry choke and 2 mfd. condenser, e will be found to be about 1.8 volts as compared to 4.8 volts with the choke alone. Similar calculations on the other elements of the filter in Figs. 5 or 8 would enable the determination of a value of e so low that there will be a minimum of hum.

The design of the choke coils also offers an interesting study. The preceding study has shown the wisdom of using a choke with a high inductance for a given resistance, since the ripple voltage is inversely proportional to the inductance. The inductance L of a coil depends primarily upon the number of turns N, the magnetic state of the iron μ, area of the coil A, and the length of the iron path l. This may be expressed by the formula $L = .4\ N^2\ \mu\ A \times 10^{-8}/l$. The inductance is also dependent upon the

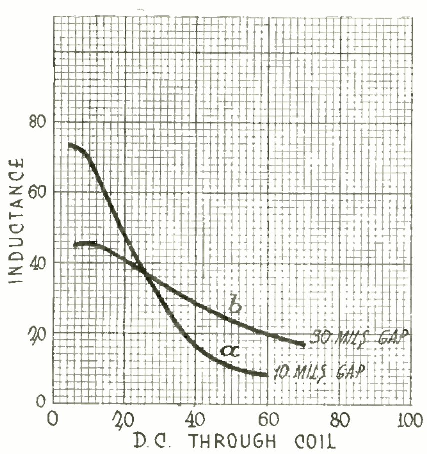


Fig. 13a. Choke Coil Characteristics

amount of direct current flowing through the coil and the size of the air-gap in the magnetic circuit.

Some of these points are illustrated in the curves of Fig. 13, one of which shows the effect of air-gap size and amount of d.c. on the measured inductance of a coil and the other of which shows the flux of density for a specified number of ampere turns. It is evident that an a.c. swing about the point y will not produce as great a change in flux as though it were working at x. Consequently the inductance, which is a function of the change of flux, decreases rapidly as y is approached. For larger air-gaps the ampere-turns flux-density curve takes a form such that for a larger number of ampere turns the inductance may actually be greater than with a smaller air-gap.

The power transformer should be designed to supply the several secondary voltages without excessive heating. The amount of heat developed is dependent upon the amount of current which is drawn from the windings. The amount of current which a wire will carry without undue heating depends upon the size of the wire and whether the wire is freely exposed to the air or is closely contained in a poorly ventilated housing.

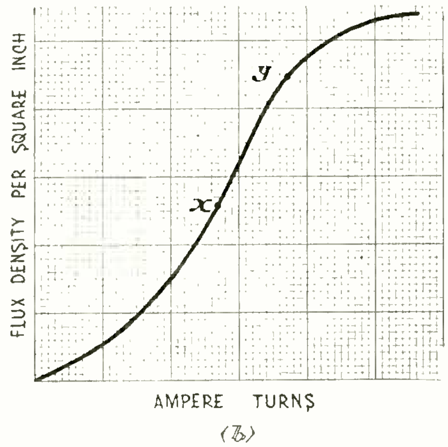


Fig. 13b. Choke Coil Characteristics

Good practice allows the use of 1000 circular mils for each ampere to be carried, although many conservative designs are figured on the basis of 1500 c.m. per ampere. Specifications for some of the standard wire sizes are:

Size B & S Gauge	Diameter Enamel Wire Inches	Area Circular Mils	Ohms per 1000 feet
16	.0526	2583	4.0009
18	.0419	1624	6.374
20	.0335	1022	10.14
22	.0267	642.4	16.12
30	.0108	100.5	103
32	.0087	63.21	163.8
34	.0069	39.75	260.5

The filament current requirements for any specified number of tubes are known. The plate current requirements include not only the d.c. load current but also the a.c. ripple current which flows through the first condenser.

The voltage E which will be furnished by a transformer coil depends upon the frequency f, the cross-section A of the iron core in centimeters, the number of turns N, and the flux density B of the iron. These are related by the equation

$$E = 4.44\ f\ A\ N\ B\ 10^{-8}.$$

For instance if the iron be worked at a B of 8000 lines per sq. cm., which is a safe design for 60 cycles, and the iron has a cross-section 1⅛ by 1⅛ in. (8.17 sq. cm.), the number of turns necessary for a 115-volt primary is had from the equation.

$$115 = 4.44 \times 60 \times 8.17 \times 8000 \times 10^{-8} \times N = .174\ N, \text{ whence } N = 660 \text{ turns}.$$

The secondary turns are in proportion to the ratio of the voltages. A 600-volt secondary would be figured from $E_2/E_1 = N_2/N_1$ or $N_2 = 660 \times 600 \div 115 = 3450$ turns. Likewise a 5-volt secondary calls for $660 \times 5 \div 115 = 2.87$ turns (use 3 turns).

The general routine for the design of a power pack to be used with any receiver or power amplifier is similar to that here outlined as a more or less specific problem. This covers all the requirements ordinarily met excepting the provision of condensers for by-passing audio frequency currents. Such condensers not only minimize the ripple voltages which otherwise might be impressed upon the tubes but also provide low impedance paths for audio frequency currents.

In following the path of the a.f. currents in Fig. 14, for example, which shows a power tube with an output transformer, it will be noted that the circuit is completed from the plate, through the primary of the output transformer, through the condenser C_2, through R_3, through the mid-point of the filament transformer secondary, and thence to the filament.

If the circuit of Fig. 6 is employed, where the voltage for the plate of the a.f. tube is taken across an output resistance, it will be necessary to have a condenser across this resistance. Similarly, in Fig. 8, where there is no output resistance, a condenser is used and is necessary. The capacity of this condenser is found to be about 2 mfd., although in many cases 4 mfd. has been used. The value of this condenser is more or less determined by the value of the resistance which is across it. The reactance of a condenser is expressed by the formula $X = \frac{1}{2}\ \pi\ f\ C$ and if this value of impedance is found low compared to the resistance, it is sufficient. Likewise, the detector circuit demands a condenser for both the ripple and low reactance considerations.

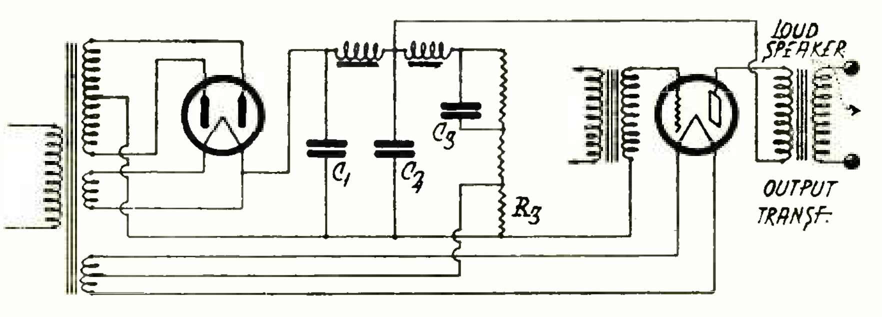


Fig. 14. Circuit for Power Tube With Output Transformer

FUTURE OF RADIO

(Continued from Page 23)

the number of words transmitted per minute.[2] Thus a high quality telephone circuit which transmits a 4000-cycle side band of frequencies, and over which a rapid talker might say 150 words per minute, is capable of transmitting telegraph code signals at the rate of about 7300 words per minute. It would, of course, be impractical to operate a single telegraph system at this tremendous speed, but an equivalent result could be obtained by using a number of slower speed channels over this same circuit by means of carrier currents.

The reason for the survival of the telegraph after the advent of the telephone is clear. The telegraph method of communication is a more economical means of transmitting information than is the telephone, and is accordingly always used where its type of service is satisfactory for the task at hand. The economics of the situation are such that the telephone is used *only when the telgraph will not do the job.* This statement may sound radical at first, but it will be verified when one thinks over the circumstances when the telegraph is used. Practically every telegraph use could be replaced by the telephone, but at greater expense, while most telephone conversations could not be satisfactorily replaced by a telegraph message.

Morse's greatest contribution to the world was really the Morse Code. There had been workable telegraphs before his invention, but they lacked a *code,* and accordingly failed to have commercial value.

The code that Morse gave to the world was not merely a great idea, it was also substantially the best code of its type that could be devised. It is still used for reception by ear. For printer telegraph and tape recording systems improved codes have been developed, in which the principal change has been in using a negative dot to represent a dash. Such a system is over 50 per cent faster than the Continental Morse code because it replaces dashes by dots, and also obviates the necessity of spacings between dots and dashes of the same letter.

The inherent superiority of the telegraph is strikingly brought out by one of the recently laid Atlantic cables, which, while using a band of frequencies from zero to only 60 cycles, transmits information at the rate of approximately 185 words per minute. This cable uses a printing system, in which the received impulses actuate typewriters that print the message directly without human intervention. The transmitter is worked by perforated tape that has the proper dot and dash perforations made in it by a mechanism operated like a typewriter. Incidentally this particular cable can be operated nearly two and a half times as fast as at present whenever the traffic will make this necessary.

Having considered the telephone and telegraph it may be wondered what can be expected from picture transmission. Some enthusiasts predict that the day is coming when news will be typed, and then transmitted by sending a picture of the typewritten page. This can be done, of course, but exact analysis shows it to be a most uneconomical process because the Morse code is an infinitely simpler method of conveying intelligence than picture transmission. It is obvious, for example, that sending the letter *e* by transmitting one dot of the Morse code is nothing at all compared with sending a picture of the same letter.

At the present time the RCA conducts a regular commercial picture transmission business. These pictures are of such quality as to satisfactorily reproduce a typewritten page. To do this requires sixty lines to the inch, representing 3600 dots per square inch. Captain Ranger has stated that it is necessary to preserve up to the third harmonic to get the necessary quality of pictures. *This means that a frequency band of 10,800 cycles is used by the RCA to transmit one square inch of typewritten page per second.* As one square inch of single space typing represents approximately 12 average length words, such a circuit transmitting 4000 cycle side band of frequencies will carry pictures of typewritten material at the rate of about 265 words per minute. This is about twice as fast as one could talk over the same circuit, but it is nowhere near the speed of 7300 words per minute obtainable by the telegraph.

While picture transmission methods are undoubtedly less refined now than they will be in the future, it is apparent that picture transmission will not supplant the telegraph, but will act as a supplement, providing a service that the telegraph cannot render. The field of facsimile transmission without question is in the sending of signatures, photographs, drawings, tables of data, etc., rather than in direct competition with the telegraph.

Television is merely picture transmission speeded up until something like fifteen pictures per second are transmitted. The frequency band required to send moving pictures by electricity depends upon the size and quality of pictures desired. If the quality is such as to reproduce a readable "still" of a typewritten page, then the transmission of each square inch of moving picture by the RCA system of facsimile transmission requires a frequency band of 162,000

[2] This figure is derived from the data given in "Notes on the Effective Heating of Code Transmitters," by F. E. Terman, I. R. E. Vol. 16, page 802, June, 1928, assuming in addition that a good signal requires frequencies up to 1.6 times the dot frequency. This gives received signals suitable for the operation of printing telegraph systems.

cycles! It is of course possible to "get by" with a poorer quality picture that is moving than is possible when the picture is still, yet the side band required for even small moving pictures having esthetic value is distressingly large. Pictures with twenty-four lines to the inch, and in which the sharpness obtained by preserving up to the third harmonic is sacrificed, can be transmitted by a side band a little under 4000 cycles wide, but such television has little value other than demonstrating the marvelous fact that television, however poor, actually does exist, and that an experimenter can really receive moving pictures with apparatus of his own construction. Improvements in television methods which will reduce the frequency band required in television can be expected, but the nature of a moving picture is one that apparently inherently requires an unusually wide band of frequencies.

The future development of radio can be intelligently forecast if one keeps in mind the fundamental requirements of telephone, telegraph, and picture transmission. The number of radio frequencies is strictly limited, and there is little doubt that in the near future every cycle is going to be worked to the limit. Whether the cycles available are going to be used for telegraph, telephone, facsimile or television transmission in the end depends upon the economic service which each cycle can render when working in these different ways.

Each 50,000 cycle band of frequencies with single band transmission can be used to give a fair television image two inches square, or to broadcast ten programs, or to carry something over ten trans-oceanic telephone conversations, or to transmit 300 square inches of good quality picture per minute, or finally to transmit about 90,000 words per minute by telegraph. Looking at the problem from this point of view makes it appear economically unfeasible to allow many television stations to take up valuable radio frequencies when each television station giving only a rather poor type of service requires the same band of frequencies as 600 telegraph stations, each sending at the rate of 150 words per minute.

In attempting to look ahead, it is reasonably safe to predict that while television stations will certainly exist, the number of such stations broadcasting pictures of sufficient quality and size to have entertainment value will be very limited. It is more probable that home television will be received over power or telephone lines from a local transmitter centrally located and operating by "wired wireless." It would be relatively easy for such circuits to carry the frequency band required in producing television transmission that would have real entertainment and educational value.

Another way of looking at the television situation is to consider the size of good quality (50 lines per inch) picture that could be transmitted by the use of all the radio frequencies from 10,000 cycles (30,000 meters) to 30,000,000 cycles (10 meters) for the sending of this one picture. This entire band of frequencies 29,990,000 cycles wide would be sufficient to transmit a picture only about four feet square, and would use up every radio frequency now being used by code and broadcasting stations. The problem of radio television is not: "Can it be done?" for it has already been accomplished, but rather: "Will it be worth the price?"

Most of the radio frequencies suitable for transmission will be divided between broadcasting, toll telephone across oceans, and telegraph over great distances, with probably a generous assignment of frequencies to each of these uses. Broadcasting will hold its own even in competition with the telegraph, which by virtue of its code utilizes the frequencies so efficiently. Each broadcasting station, while needing a wide band of frequencies, provides a service that is simultaneously of value to perhaps thousands of listeners, while each telegraph message, or conversation over the radio long distance phone channel is of value to only the sender and the receiver of the information.

Electrical methods of communication have a unique place in our civilization. They have no competitor, and any potential rival that may appear in the future will have to be a rapid traveler. In this day and age we expect to know the new world's champion ten seconds after the knock-out blow was delivered, to know the result of the election before morning, to hear the bat crack against the ball before the home run hit has cleared the fence, and to hear of Lindbergh's success within seconds after its consummation. Contrast this with the battle of New Orleans, fought many days after the treaty of peace had been signed.

Anything less than the speed of light is too slow. Imagine trying to communicate from San Francisco to London by means of a mechanical or sound vibration in the air. Such a wave travels five miles per second, and would take about five hours to reach its destination. Ten hours would elapse before the sender got an answer to his *Hello!*

WINNING THE WAR AGAINST RADIO INTERFERENCE

(Continued from Page 35)

space in addition to the interference conducted over the wires. The installation of a line filter will help to reduce the noise, but the space radiation cannot be thus by-passed. The radiating equipment can sometimes be shielded in a completely enclosed copper-lined box so that the effective radiation does not extend over 100 ft. Many cities have ordinances designed to prevent the operation of such equipment when it interferes with radio reception. In which case the dealer's best bet is to invoke the aid of the law.

One of the most difficult kinds of interference to combat is that from an oil-burner which uses a grounded spark coil and vibrator for ignition purposes, the grounding usually being to the furnace frame. The most effective method is to substitute a transformer ignition system whose secondary, high voltage leads and spark plug are insulated from ground and whose high voltage leads are enclosed in a grounded metal shield. Then by connecting choke coils and condensers in the primary leads of the transformer it is usually possible to prevent radiation.

Special precautions are also necessary with oil-burner motors which have a commutator and brushes. It is usually necessary to clean the commutator and adjust the brushes until no sparking occurs. Even then it is wise to connect a 1 or 2 mfd. condenser across the brushes.

A flashing electric sign is radio's worst enemy. Its interference is radiated through space and conducted through wires. It is generally necessary to experiment with all the different methods herein suggested, starting with the simplest and proceeding with the more complex until the interference is stopped. Under any circumstances it is advisable to install a 1 mfd. condenser in each lamp circuit and in their common return.

All such corrective installations must meet the approval of the local electrical inspector in order not to invalidate any fire insurance policy. Consequently they should be made by a competent electragist, who is familiar with the code requirements. The larger installations should be properly fused.

Fig. 3 shows antenna conditions which James G. Allen cites as typical of those found in half the homes today, causing not only poor signal pick-up but lack of selectivity, high interference pick-up, and the production of noises at points of contact with metal and masonry and at loose joints and clamps. The reference letters in the sketch refer to the following faults:

(A) Total length of antenna and ground lead is double the correct value.

(B) Many antennas are found passing over or under lines carrying current at high voltages. This is extremely dangerous to life and property. A broken wire or accidental contact during a storm or at the time of installation may mean death to all touching the wire or the radio.

(C) Antenna lead-ins laid over various pipes and brackets.

(D) Unsoldered and corroded joints.

(E) Ground wire loosely wrapped around corroded pipe or loose ground clamp.

(F) Lead-in and ground wire wrapped together.

(G) Lead-in tangled with loose wires or scraping against metal scraps or spouting.

(H) No insulators.

(I) Down lead along drain pipe.

(J) Turn taken around pipe to hold wire in place.

(K) Against damp masonry.

(L) Parallel to 110-volt wires and to telephone lines.

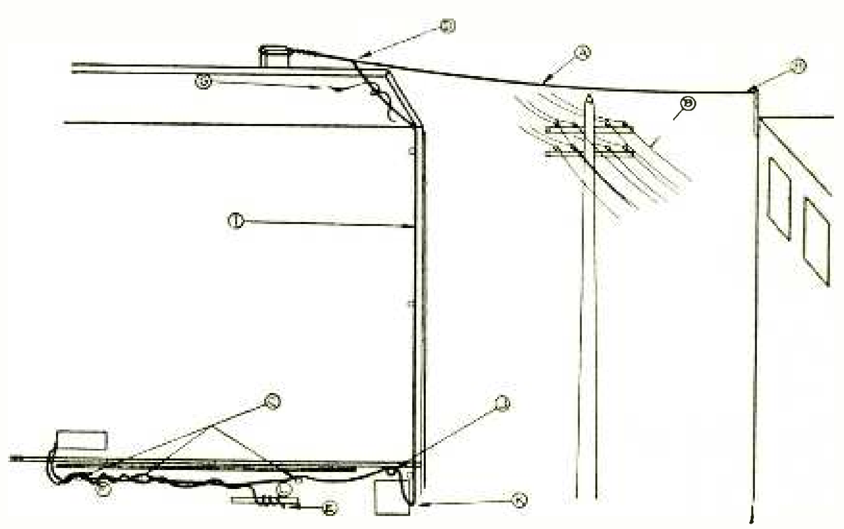
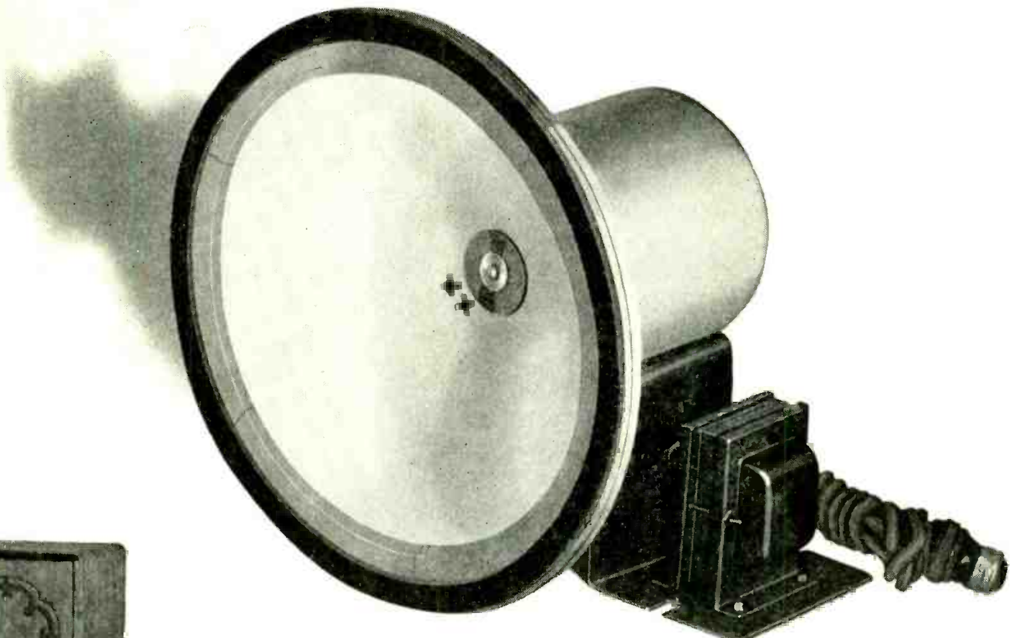


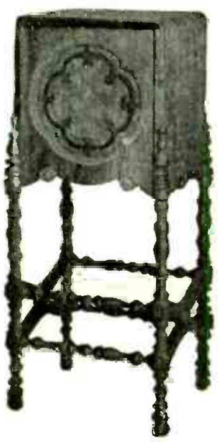
Fig. 3. Typical Faults in Aerial Installations

Announcing the NEW

WRIGHT-DE COSTER REPRODUCER

Even More Wonderful





"E" Cabinet
Small Console Model

The Speaker of the year

NO HUM

DID you hear this speaker at the "R. M. A." show? Clear, distinct enunciation—no hum—Soft Mellow Music. Write Department R for descriptive matter and address of nearest district sales office. If you are in a hurry for a sample speaker order one at the same time.

"D" Cabinet
Table Model

WRIGHT DeCOSTER, INC.

MAIN OFFICE AND FACTORIES

ST. PAUL, MINN.

Practical Interference Elimination

(Continued from Page 36)

or X-ray machine refuses to go out of business because he is causing disturbance to his neighbor's radio entertainment, then methods described herein, which will cost somebody some money, must be used. Inasmuch as the greater part of these disturbances reach the set through the connection of the set to the power lines or house current, filtering methods are considered first.

(a) Filtering directly at the device causing the disturbance can eliminate from 90 per cent to 100 per cent of the disturbance.

(b) Filtering at the power service entrance (meter) of the building housing the disturbing apparatus may eliminate from 80 per cent to 100 per cent of the disturbance.

(c) Filtering at both points (a) and (b) may be necessary.

(d) Filtering at the power service entrance (meter) of the building where receiving set is located can eliminate from 50 per cent to 100 per cent of the disturbance.

(e) Filtering directly at the receiving set can eliminate from 25 per cent to 90 per cent of the disturbance.

Types of Filtering Devices for Stopping Electrical Disturbances

A. *Single Condensers*—from ¼ mf to 1 mf or more capacity having a d-c test of 400 volts or over. Potter types A-320, 303, 402 and Nos. 105, etc. Simply connect the condenser across the spark or arc direct or connect a non-inductive resistance of 1,000 to 3,000 ohms in series with the condenser and bridge this combination across the arc. Resistances recommended for this purpose are such as Potter or Tobe. If this interferes with the functioning of the spark, see method under B—double condenser filters.

Many power companies ground one side of their lines at the service entrance to every building. Often one leg of a small condenser, say ½ mf capacity, can be connected to ground or the water pipes and the other leg of the condenser touched to both sides of the power lines at the receiver. When connected to the "live" side of the power lines, sometimes much noise can be shunted to ground. Of course, the user must always put the attachment plug back into the convenience outlet so that these connections are not reversed. If the plug is reversed, then the single condenser will be short circuited and will not function. To make certain this will not occur, two condensers connected in series and the center tap grounded can be used, such as Potter "Interference Eliminators," Nos. 103-03, etc., or Tobe Jr. "Filterette."

These condenser filters can be used at the disturbing device or at the set and should be tried in both places.

B. *Double Condenser Filters*—The Tobe Filterette Jr. and the Potter No. 103-03 are about equal in effectiveness for small motors such as drink mixers, sewing machines, etc. Potter No. 104-04 for motors up to about 1/6 h.p. and Potter No. 105-05 for motors up to ½ h.p. or electrical apparatus of same wattage. The No. 105-05 should be used for warming pads and similar electrical thermostats.

Where one condenser bridged across a spark gap in series with a resistance interferes with the function of the spark, then use two condensers in series (or Potter 105-05) with a resistor of 1,000 or 2,000 ohms between the center tap of the condensers and the ground connection.

C. *Choke Filters*—When inductive filters or chokes alone are used, care must be exercised that the wire-size used in the choke is large enough for the current to be carried, i.e., the amperage capacity of the chokes must equal that of the wiring and device to be filtered. In case of very large motors, of say 5 h.p. and over, the chokes may have to be made of wire as large as No. 6 B.&S. copper, and are very expensive. There is not on the market today a manufactured line of chokes. They must be specially designed and made for each case by a mechanic with a knowledge of the radio principles involved, and installed by an electrician familiar with the Underwriters' requirements for such wiring.

D. *Combined Choke and Condenser Filters*—There are many such devices offered and many extravagant claims made by their sponsors. We have selected for this type of device the "Quietus," made by the Day-Fan Company, because of its good design, rugged construction, reliable concern back of it, and its low price as compared with other similar less effective devices costing more. It has a capacity of 1,000 watts at 110 volts and by connecting two or more in multiple, motors up to 4 h.p. can be filtered. (See the Day-Fan folder for details of installation.)

Where "code" wiring must be done, condensers or other filters may be required to be installed in steel boxes and all wiring done in rigid steel conduit or flexible metallic conduit.

Eliminating Interference Picked Up Through Aerial or Ground

Aerial or Lead-in Pick-up.—As explained above, considerable disturbance can be picked up by the aerial and lead-in. An effective remedy is to use a shielded lead-in and for this purpose No. 14 R.C. lead-sheathed wire is used. About twice the usual length of horizontal aerial is used to overcome the choking effect of the sheath on the lead-in and capacity to ground between the conductor and sheath, but with more modern and more sensitive sets the usual 50 to 75 ft. horizontal aerial will be sufficient length. The object of sheath on the lead-in is to shunt disturbances radiated by power wiring in a building where the lead-in is long or parallels power wiring for a considerable distance.

Because of the extra weight of this shielded wire, care must be exercised to secure the sheath at the top end so that the weight of the whole wire will not pull on the soldered joint between the copper conductor of the lead-in and the aerial wire. The lead sheath is grounded to the water pipes or other suitable ground. Use care in making a soldered connection to the lead sheath as the thin lead wall may be melted in soldering. Make certain that the copper conductor of the shielded lead-in is thoroughly insulated from all contact with ground.

Ground Connection Pick-up.—Because one side of the power lines is grounded to water pipes, disturbances find a ready path into the set when the latter is grounded to the same pipes. Likewise any other metal in the building may carry disturbances into the set. The remedy is a separate and independent earth contact for the set.

The best earth contact is one of lowest resistance. The lowest resistance earth contact can be made by driving a ½-in. galvanized iron pipe *not less than six feet* (more than six or seven feet does not help) into the earth. Moist earth provides a lower resistance than dry earth. The resistance is made still lower by saturating the earth around the pipe with salt water. An economical method for installing such a ground is to set a six or eight-inch diameter concrete or tile drain or sewer pipe into the earth about 18 to 20 inches, allowing the top of the tile to extend above the surface two or three inches. Pack the earth around the outside of the tile but keep all earth out of the inside of the tile. Drive the iron pipe into the earth in the center of the tile. (Make certain the pipe reaches a point six feet below the surface.) Then fill the space between the iron pipe and the tile with common rock salt and pour in all the water possible. When the salt is dissolved, fill it again. Try to get fifteen or twenty pounds of salt dissolved into the earth around the iron pipe, and then keep it moist.

Copper cans with "secret" chemicals are more or less bunk and not any more effective than the type of ground described above. Make a tight connection at the top of the pipe with No. 14 R.C. wire and insulate this wire carefully from any contact with the walls or metal part of the building as it extends to the set. Keep the ground lead-in wire as short as possible.

Remember that any filter may fail to some degree at some particular place or under some conditions, but the same filter may prove effective in another case a few feet distant. Do not condemn a filter unless you are certain that it has been properly installed.

GROUND CONNECTIONS

(Continued from Page 36)

A shielded ground wire is very effective in reducing the ground pick-up. A No. 14 wire with a lead shield is available and should be used in all cases of bad interference. The ground wire itself must be connected to the ground rod and the lead shield to the nearest water pipe.

Electrolysis may be set up if a steam, gas, conduit or hot water pipe is used for a ground and in nearly all cases it will be found that such a type of ground is worse than none at all. Cases where such pipe were used as ground have been found where the pipe system was badly affected by electrolysis, thus both endangering the building and making replacement difficult and expensive.

Summary: Wherever possible use an independent ground.

1. Make the ground wire as short and direct as possible.

2. If a water pipe must be used, make the connection to the pipe as near the earth as possible (remember that copper wire will always have a lower resistance than an iron pipe).

3. Use only approved ground clamps for connection to water pipe or ground rod.

4. Never connect ground wire to steam, gas, conduit, hot water pipe or telephone grounds.

5. The ground wire must be insulated and treated in the same manner as the aerial.

6. To prevent ground pick-up, keep the wire as far away from power wires and grounded metallic objects as possible.

7. Do not run the ground wire close and parallel to the aerial.

8. Before attaching ground clamp to pipe or rod clean surface with sandpaper.

9. Wherever ground pick-up is had, shield the ground wire as specified above.

10. Where an unusually low resistance earth contact is desired, or where the soil is dry, sand or gravel, two or more pipes may be driven not less than 6 ft. apart, nor more than 10 ft. apart, and the two or more pipes connected in multiple or parallel to form the ground for the receiver.

The Dancing Green Light

(Continued from Page 40)

"Look here," he said. "If you've got something on your mind, let's have it. Frankly, I'm stumped. We've tried everything. We know as well as we know anything that 'The Tiger' killed those women, but we haven't a case that will stand in court. It's too circumstantial, if you get what I mean. A clever attorney would knock it down like a row of ten pins, in ten minutes, especially with a couple of women on the jury. I've got to have a bomb-proof case, or the sob-sisters will get the womens' clubs all hopped up about this baby, and public sympathy will spring him out before we can nail him down."

Brinsley grinned. Women on juries were a tender subject with the captain. Brinsley appreciated the fact that there was a well-founded reason for it. The verdicts of women-jurors were nearly always oblique ones, and at variance with the concrete evidence of the cases submitted to them. Every judge in the city felt the same way, yet dared not voice it because of the votes the women swung. He had heard officials hold forth before on the subject, and always profanely.

"Listen," he said. "You admit you're stumped. Well, I'm not. I am willing to bet anything within reason that I can get a confession out of 'The Tiger.' I believe, like you do, that he is guilty. But it seems to me that he can be broken, so a four-year-old child could handle him. You've tried your police stuff on him and he's come back like a rubber man. Well—let me crack him with psychology. What do you say?"

Captain Brady stared at the *News* reporter, decided he was in deadly earnest, in spite of the bantering tone, and laid down his cigar.

"Joe," he said, "if you can do that, you can have anything that this department has to offer, from the bootleg concession to the commissioner's purple necktie. I think you're crazy, myself, but I'm willing to be shown."

Brinsley chuckled.

"You've gone a long ways then," he replied. "We'll make it a dinner—the loser to pay. There is one condition I want to attach, and that is that I'll attempt to obtain a confession on the assumption that 'The Tiger' is guilty. Psychology and police work differ in one particular. The police can make an innocent man confess to something he did not do. Psychology gets only the truth. If 'The Tiger' is innocent, then I'm stumped. If he is guilty — God help him!"

The captain threw back his head and laughed.

"That's a hot one. If you fail, you say he is innocent, and we are just where we started."

Brinsley shook his head.

"If he's innocent, I'll leave it to you to say so. And if that happens, we'll not be back where we started, because I'll line up the *News* and every other newspaper in town to save him. It'll be a fight that will make your hair stand up."

He leaned across the table, his jaw set belligerently, and his eyes agleam with a fighting light. It was plain, even to Brady, that Brinsley believed in the issues for which he fought.

"All right, all right," said the detective head, mollified. "When I'm ready to say he's innocent you can tear down the works on my head. Until then I'm not going to worry."

"I don't want you to worry," Brinsley shot back. "I want you to cooperate. It's a great sight easier to smack a headline on the street that the police are railroading an innocent man, than to say they are trying to get a confession of a crime. Right now, I'm out for the confession, and I take it you're willing to play ball to get at the facts."

It was the iron hand in the velvet glove, weaving a pattern that Brady could read. It was an ultimatum in his own language.

"Sure, sure," he said heavily. "I get you. Sure, we'll cooperate. Don't we always?"

"Sure you do," Brinsley replied, and the most carping critic could not have detected anything but the utmost friendliness in his tone. The captain sighed and picked up his dead cigar.

"Now we got that off our chests," he said, "what's the plan. If I'm gonna help, I got to have the facts."

And Brinsley proceeded to tell him.

THE triple murder for which 'The Tiger' had been taken into custody, was one of those particularly atrocious crimes which, at irregular intervals, shock whole communities, and produce tremendous revulsions in the popular mind. Three somewhat elderly women who lived in a little cottage at the edge of the city, where the rural fringe of homes were replacing the vine-covered and rose-grown houses of a bygone generation. "Rosemond," as the cottage was known, was as old fashioned as its owners—three spinster sisters, known respectively as Miss Ella, Miss Mary and Miss Margaret Rixon.

The house itself sat somewhat back from the road, with a box hedge in front, and gardens of the type prevalent in the early eighties. The sisters had an income of sorts from some estate, which

(Continued on Page 66)

HOTEL MONTCLAIR

Room and Bath Tub and Shower $3 to $5 per day For 2 persons $4 to $6 per day Suites $8 to $12 per day Special Monthly and Yearly Rates	49th to 50th Sts. Lexington Ave. NEW YORK CITY 800 Rooms Each with Tub and Shower *Radio in Every Room*

3 minutes' walk from Grand Central. Times Square, Fifth Avenue Shops important commercial centers, leading shops and theatres nearby. 10 minutes to Penn. Station.

Grand Central Palace only 2 short blocks away

S. Gregory Taylor, *President*

Oscar W. Richards, *Manager*

Get the Next Six Issues of "RADIO" for $1.00

CONTINENTAL & MACK PRODUCTS

4 NEW PRODUCTS FOR 1930

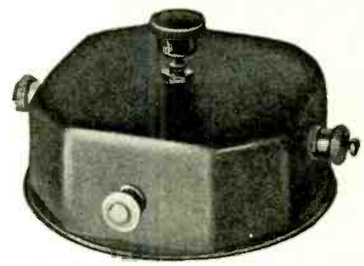
No. 150 Mack Spring Aerial

The best Indoor Aerial money can buy. Price 25c

No. 100 Mack Spring Aerial

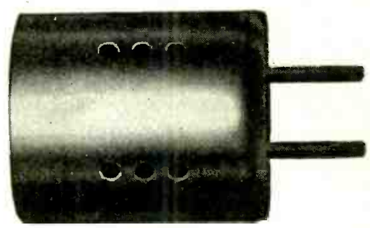
The most efficient and practical Aerial known to science. Fits any set, any roof. Can be erected in five minutes. Lasts a lifetime. Price $1.75

Continental Modulator No. 3



A combination Wave Trap, Local Interference and Static Eliminator. Price $2.00

Continental Voltage Control No. 2



A real ballast Voltage Control, to protect A.C. tubes. Will not burn out. Price $1.50

Jobbers and Dealers Write for Prices and Literature on Our Entire Line

Gardiner & Hepburn, Inc., 2100 Washington Avenue, Philadelphia, Pa.

Be Warned

YOU can use second rate condensers in your SHORT WAVE RECEIVER—BUT, remember the fellow blowing the trombone who complained, "I blow it in so nize und it comes out so rotten."

HIGH FREQUENCY WAVES will go into your circuit readily enough, but the results may not be so good.

CARDWELL TAPER PLATE Condensers have heavy, die cast plates, hold their calibration, don't vibrate, and will give the stability so necessary in the SHORT WAVE RECEIVING CIRCUIT.

YOU'RE NOT GAMBLING WHEN YOU CHOOSE A CARDWELL

CARDWELL CONDENSERS VARIABLE—FIXED—TRANSMITTING—RECEIVING

"The Standard of Comparison"

Literature upon request

The Allen D. Cardwell Mfg. Corp.
81 Prospect Street, Brooklyn, N. Y.

There's a CeCo Tube for every Radio

CeCo PRONOUNCED SEE-CO RADIO TUBES

All Types in Stock. Immediate Shipments.

The Largest Exclusive Radio Tube Manufacturers in the World

The Offenbach Electric Co. guarantees to replace, without cost, any defective CeCo Tube, if replacement is asked for within a reasonable time after purchase of the tube.

FILTERVOLT

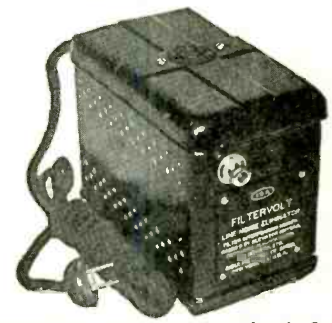
LINE NOISE ELIMINATOR

For A.C. Tube or Sets using any type eliminator

A.C. or D.C. 25 to 60 cycles

110, 220, and 32 Volt Farm Systems

List Price $15.00



Banishes line noises caused by electric flasher signs, elevators, refrigerators, electric light switches, washing machines, vacuum cleaners and all electric appliances operated in or near your home. Efficiency Guaranteed.

Sold By All Dealers. Manufactured By

INSULINE CORPORATION OF AMERICA
78-80 Cortlandt Street, New York City

MAIL ORDER SERVICE

ANYWHERE

Our Service Is Prompt and Reliable

Get the Products shown at top of this advertisement from *Northern California's Largest Wholesalers*

OFFENBACH ELECTRIC COMPANY

"The House of a Million Radio Parts"

1452 Market Street, San Francisco, Calif.

We Sell at Dealer Prices to Set Builders, Dealers and Experimenters

150 OTHER

Nationally known lines in stock. Let us send you our latest circulars. Ask us to place your name on our mailing list.

THE DANCING GREEN LIGHT

(Continued from Page 64)

kept them comfortably in modest circumstances, so that they kept to themselves, and grew old together, letting the days pass like the leaves of a slowly turned book, which yellowed with the passage of time. They were greatly respected, although at no time reported either wealthy or miserly.

The only man about the place was Old Ben, a gardener, who worked for many of the families in the neighborhood—an old sailor, whiling away the latter years of his life with the flowers and shrubs which he loved. The only other persons who ever visited the three women was the minister of a little Lutheran church, which they attended with meticulous care every Sunday, rain or shine, and various tradespeople.

Thither on the night of October third had come a fiend in human form, warped in brain, distorted in perception, who remained but a few tragic moments, and who left behind him a trail of ghastly horror that stunned the peaceful community in which the thing had happened. . . . .

It was an early-morning milkman, with the meager portion of cream which constituted the one extravagance in which the three sister indulged, who discovered the gruesome tragedy. Surprised to see a light burning in the orderly kitchen so early in the morning, as he placed the bottle atop the outside cooler, he peered through the glass door. The soles of a woman's feet, lying with the peculiar helplessness of the dead, met his gaze. For a moment he could not draw his eyes away, and then mechanically, fearfully, he reached out a hand and knocked.

"I knocked kind of easy at first," he told the police. "I don't know why—something in the way she was lying made me do it, I guess. When nobody came out, I knocked again. The knocks echoed in the house like everybody was dead. Nothing happened and my nerve gave out and I ran for the wagon."

It was to Policeman Thomas Maloney that the milkman told his story. Maloney was ringing headquarters, a block from the spot, when the milkman galloped up, pulling his horse to a sliding stop.

"There's something wrong down to the Rixon house," he panted, from sheer excitement. "There's one of 'em lying on the floor and the lights are on and nobody answers when I knock."

Maloney reported, and went to the house with the milkman. The homicide squad went out immediately. What they discovered was spread across the front page of every newspaper in the state for two days—the most terrible murder in the city's whole criminal history. Two of the elderly women—Miss Ella and Miss Margaret—had been strangled, one with a silk muffler, the other with her apron. The third had been killed by a blow on the head—apparently a poker, found near the body. It was Miss Mary whose feet the milkman had seen, as he peered through the kitchen door.

Twenty-four hours of intensive investigation by Detective Sergeant Tom Mahon and the homicide squad, left the motive a mystery. The house had not been ransacked, despite the fact that robbery would seem to be the only intelligent motive. The police finally came to the conclusion that some prowler had attempt to enter the place for the purpose of looting it, the sisters had come upon him, and he had killed them to prevent future identification.

The authorities have certain well-established lines along which they work. Given a crime, they determine roughly why it was committed, and then look about to see who had both opportunity and incentive to commit it. Once this person is located, he or she is "arrested on suspicion" and a confession is sought. Often the evidence is bent into an accusatory chain to fit the situation. In a surprisingly great number of cases, they are correct in their judgments—sufficiently so to innoculate them with the theory of infallibility. Also, now and then, they are astonishingly wrong.

It was this system which landed "The Tiger" in jail within twenty-four hours after the case had found its way into the press. For one thing, "The Tiger" had a record. He had been released from state's prison only a few days before, after serving a sentence for assault with intent to commit murder during a drunken brawl. Prior to that he had been in a reform school. From the first his record was against him.

On the night of the triple murder, he had applied to the Lutheran minister for a meal. But for the hideous crime, it is possible this visit might never have been recalled. As it was, when the shocked clergyman heard of the fearful crime, the following morning, he recalled the rat-like face of "The Tiger" with its undershot jaw, and reported the incident to the detective bureau.

Captain Brady picked "The Tiger" instantly from the description. He showed the minister a picture from the rogue's gallery.

"The same man," said the latter.

The call went out. Half an hour later, a stool pigeon whispered in the ear of a detective. The latter used the telephone. The shotgun squad stamped into a cheap lodging house, knocked down a locked door with a gun butt, and dragged "The Tiger" forth into the light. He had twenty dollars in nickels and dimes in his pockets. They asked him about that when they gave him the third degree.

"Mooched it," he replied, the sweat of agony trickling down his face.

"Naw yuh didn't," sneered a detective. "Yuh glommed it outa the old dames' clock, didn't yuh? Or out of a cookie jar in the kitchen, huh? Come clean now. We don't want to hurt yuh, but we got the goods on yuh and yuh know it. Where'd yuh get it, huh?"

But "The Tiger" stuck to his story, insisting he had gathered the money by panhandling the amount in the streets. The police waved that explanation aside. He was "The Tiger," wasn't he? He'd done time before, hadn't he? He was just "out of stir," wasn't he? And broke? Besides—look at him! Didn't he look guilty of anything from arson to murder? He did. He had been given that kind of a face to start with. Who would believe him?

Bit by bit the police built up the case against him. A woman came forward, when "The Tiger's" picture was printed in the newspapers. She had seen him on the street that led to the Rixon cottage about six o'clock that night. It must have been after he had eaten at the minister's home. What was he doing there? "The Tiger," yanked from his cell at two o'clock in the morning, drugged with sleep, grilled under a battery of lights, denied the woman had seen him.

"That looks like the man," the woman faltered, confronted with "The Tiger" in the unfamiliar surroundings of police headquarters.

"Sure it's him," said the detectives. "He was there okay."

"Aw, you're batty," growled "The Tiger." "I never seen the dame before."

A street car conductor was brought in. He picked "The Tiger" out of a line-up of prisoners.

"He got on my car about nine o'clock," he said. "He had a handful of nickels and dimes. They was old coins—like they'd been layin' away somewhere."

"Aw, yuh never seen me before," snarled "The Tiger."

They shut him up with a slap across the mouth. They would have used a fist, except that a slap never shows in the police court dock.

"He's the guy," insisted the conductor, and went out satisfied that he had done his duty as a citizen and a public employee.

"The Tiger" went back to his cell, but not to sleep. The police saw to that. When he nodded in his bunk, a trusty woke him up. When he sagged from weariness, he was taken "upstairs" and grilled again. When he snarled and protested, he was smashed with an elbow or a knee. Forty-eight hours of it—and no confession. In his sunken face, "The Tiger's" amber eyes gleamed with a murderous light, like baleful coals of hate, reflecting the heat of his unbreakable spirit. An iron man? A man of lava, within whose heart there burned a terrible fire. His jailor watched him warily.

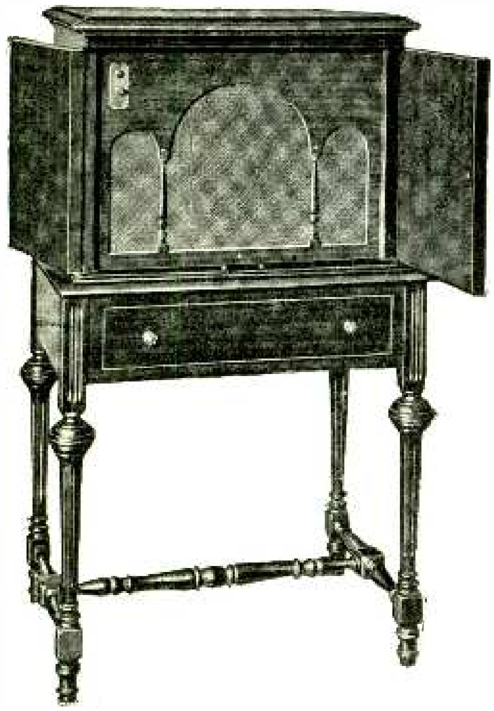
(Continued on Page 68)

Never Before at this Price!

KOLSTER

ELECTRO-DYNAMIC REPRODUCER

Combined with 210 Power Amplifier and "B" Supply Unit



MODEL K-5

Height	42 "
Width	25½ "
Depth	19 "

FEATURES

1. Electro-Dynamic Reproducer (10¼ - in. dia.)
2. 210 Power Amplifier. Fine tone quality.
3. Supplies "B" voltage, if desired.
4. Can be used with any electric or battery set.
5. Complete A.C. Electric operation.
6. Beautiful pencil-striped walnut cabinet.

List Price $175.00
(without tubes)

This radio equipment is KOLSTER built, packed in the original Kolster cases and cartons, shipped direct to us from the Kolster factory.

Every Set and every Electro-Dynamic Reproducer is BRAND NEW; each bears the Kolster guarantee tag and original serial number.

Our ability to buy these world-famous KOLSTER RECEIVERS and REPRODUCERS for cash, enables us to offer them at remarkably low prices.

THIS finely matched, rugged unit comprises a complete heavy duty Electro-Dynamic Reproducer, including a 210 Power Amplifier with "B" supply unit, all self-contained on a steel frame. It weighs 45 pounds without the cabinet. The cabinet itself is of pencil-striped walnut, beautifully designed with Cathedral grille. It is equipped with switch for control of house current to reproducer, power unit and amplifier. A pilot light indicates when the reproducer is in operation.

If desired, the 210 Power Amplifier will also supply 22, 67 and 90 volts "B" current, sufficient for any set using up to 8 tubes. An automatic voltage regulator tube, UX-874, maintains the "B" voltage silent and steady.

This Electro-Dynamic Reproducer can be used with any battery or A.C. set, replacing the last audio stage or can be used with all tubes of the set. Wherever used, it will bring out every shading and range of tone; every note is reproduced with utmost faithfulness, pure and undistorted. It will modernize any radio receiver.

The following tubes are required for its operation: 2-UX-281 (for full-wave rectification); 1-UX-210 (for super power amplification); 1-UX-874 (for voltage regulation). For use with phonograph pick-up, 1 additional audio stage is recommended between the pick-up and this Reproducer.

A 20-ft. cable is included with each instrument. Operates direct from 50-60 cycle, 110-120 volt A.C. current.

Such opportunity as herein presented is seldom available. And they won't last long at this low price. We suggest quick action—there's quality here—at a price heretofore unknown.

Now $49.50

AMERICAN SALES CO.

19-21 Warren Street — New York City

THE DANCING GREEN LIGHT

Continued from Page 66)

"A bad egg," he told his assistant. "The quicker the better," he added, making a significant gesture across his throat and pointing upward.

This was the man whom Brinsley, the police reporter for the *News*, argued had a weak spot. This was the man from whom he expected to wring a confession by the mysterious force of psychology. Upstairs in his office, Captain of Detectives Brady snorted derisively at Brinsley's empty chair.

"Psychology—hell!" he said explosively. "A short piece of hose beats that a mile." With this recapitulation, he went to dinner.

Brinsley was too busy for dinner. He hurried to his office and went into conference with his city editor. The conversation was short and pithy. Other executives of the paper were summoned. Before the little group, the night reporter laid down his plan. When he had finished, Dartman, the managing editor, leaned back with a low whistle. They were in Dartman's office.

"Can it be done — mechanically, I mean?" he asked.

"Well," said Brinsley. "I pried Cap Brady loose from his inhibitions sufficiently to get the 'sweat box' at headquarters. It's the old third degree room that the Welfare Committee had discontinued. They still use it—on the quiet, of course; though most of the cases are handled in the dicks' bureau, where the Committee can't get to them. Brady thinks the whole thing is the bunk, but I sandbagged him and he loosed up."

"Fine," said Dartman. "There still remain the mechanical features. . . . "

"That," said Brinsley, "is where I've got to have help. I can get the people I need. But to tie up a broadcast station—that will take the paper's influence. I know what I want, but how to get it is another matter. If we could get Marks of the Standard Electric Company in on this . . . . He's a live wire and always out for anything new. This is new, at least."

"That's fortunate," said Dartman. "I'm having dinner with him in an hour. I'll put it up to him. What else?"

"I'll go ahead with the other details," said Brinsley quickly. "If Marks comes in, and we can use his equipment . . . I got the Hooper Agency on the phone, and they'll slip me the people I need. All the rest is about two hour's work."

Dartman rose.

"I'll see Marks," he said briefly. He held out his hand to Brinsley. "It's a great stunt, boy. I want to be in on the finish. Where can I get you?"

"I'll be at police headquarters part of the time. The night operator there will know where to find me if I'm not."

"It will be quite the cleverest thing I've ever seen, if you can swing it," said Dartman.

Brinsley flushed, for Dartman was not given to extravagant praise.

"Thanks," he said briefly. "I'm not sure it will succeed, of course, but it's worth a trial. It will be a big scoop for the *News* if we win."

Dartman smiled.

"Go to it," he said. "I wish you luck."

Brinsley took a long breath and sallied forth into the night. The fast work was yet to be done. . . .

Simon Grosman was a booking agent, of a type of which there are scores in New York, who operated under the name of the "Hooper Agency." A dingy office, up a dingier stairway, an unwashed glass door, a room thick with tobacco smoke, and Simon, humped over a littered desk. That was the picture! It was Simon's proud boast that he could supply anything in the theatrical profession from a trick elephant to an opera company in an hour. He was one of the few who could make good the boast, for he knew everybody in the business, and everybody knew him. Simon made a barrel of money, but he always insisted he was on the verge of starvation.

Brinsley, filled with his idea, stamped up the foot-worn stairs. Grosman greeted him by kicking a fat cat off of a dusty chair, and waving a hand.

"I didn't get so much from the telephone message," he said, "but whatever you want, I got it."

"I'm not so sure, Simon," said Brinsley, making elbow room amid the desk litter. "This is one for the book." Grosman grunted.

"Like always you come with bait for a sucker. I bet I lose money again."

Brinsley laughed.

"Go on," he said. "This will make you—if you can help me put it over."

Grosman hunted over his desk, found a wet cigar butt, lighted it and waved a smoking match.

"Sure—they always do. For twenty-five years, now, people bring me propositions that are going to make me. Well—all I got I make myself. See? Anyhow, it don't cost nothing to listen. Shoot!"

Brinsley shot. As he talked, Grosman's eyes began to sparkle. He had an instinctive fondness for the dramatic and the original, and this was both. In fact, it represented something he had never before contacted in even his eventful existence. Besides, Brinsley represented the thing that had always intrigued Grosman—the press. To get one's name on the front page of a metropolitan newspaper was better than money. He edged forward in his chair, his cigar gone out.

"By golly—that's an idea," he said, after a bit. "I think I got just the man for you. Wait—I should see! I think I got his telephone somewhere." He began to paw over his papers, finally holding up a card triumphantly. "See? A system I got. Like a card indexes, only better. Every one on desk I keep it, and when I want it, all I got to do is look for it."

He used the telephone on his desk and contacted the man he wanted. After a brief conversation he hung up.

"Just the man," he said. "Such a face—phooey! I should meet it on a dark night—not me!"

"Fine," said Brinsley. "Now for the others."

Grosman went to work. Inside of his guaranteed hour, he had the people that Brinsley wanted—down to the last individual. The police reporter left before Grosman had finished his task, leaving word that Simon was to call him at police headquarters when it was done. As he left the building, a taxi driver signalled him.

"Police headquarters," said Brinsley, and the driver stepped on the gas.

There was a call awaiting him from Dartman at the latter's home. . . . It was short and to the point.

"Marks will play ball," said Dartman. "He will be at the studio all evening. . . "

On his way out of the central station, Brinsley bumped into Captain Brady. Brady favored him with a grin.

"How's the psychology plan coming?" he asked, derisively.

"If you were a psychologist you could tell that by looking at me," Brinsley replied. Brady snorted.

"Well, don't forget I'm giving you a fair chance," he said. "If you fall down, I get the right to rub it in, you know."

"A good dinner at the best hotel in town?" Brinsley hurled the challenge and waited.

"You're on," growled Brady, and climbed into his car.

Dartman had apparently paved a broad highway for Brinsley's reception by Marks of the Standard Electric Company, for the latter greeted the police reporter with the utmost consideration.

"Dartman gave me a rough idea of the plan," he said, when they were comfortably seated in his office off the main wing of the giant plant, which housed the vast laboratory and broadcast equipment of that immense institution. "I'd like to get it more in detail, if you don't mind. I have issued orders to hold the technical staff until we have gone into it."

"That is better than I hoped," said Brinsley. "I may be running up against technical difficulties. If I am, you will have to set me right."

He closed the door of the office against possible interruption. Then, drawing up a chair, he began to outline the idea in crisp, colorful sentences.

(Continued on Page 70)

ATTENTION: MANUFACTURERS

NEW!

A Sensational CONDENSER That Will Have Great Bearing in the Radio Industry

Here Are the Specifications:

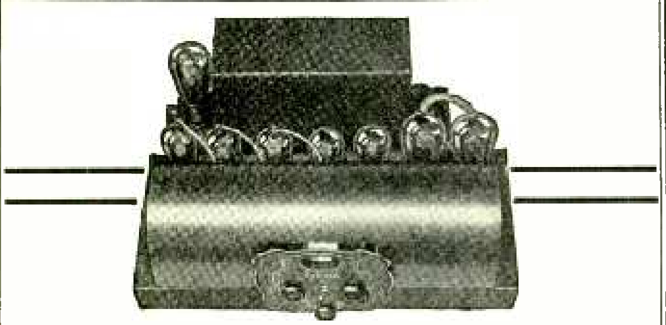
SAFE CONTINUOUS WORKING VOLTAGE—1000 V. D. C. (750 r.m.s. R. A. C.)
FLASH TEST (Multitudinous)—1500 V. D. C. (1000 V. A. C.)
BREAKDOWN VOLTAGE—2700 V. D. C.
POWER FACTOR—Less than 1%
CAPACITY—Non-inductive, within 5% of rating
INSULATION RESISTANCE—Over 600 Megohms per MFD.
DIELECTRIC LOSSES—Negligible
BREAKDOWN VOLTAGE, FOIL TO CASE—Over 5000 V.A.C.
PHYSICAL DIMENSIONS—About ¼ present standards.
FATIGUE TESTS PROVE UNEXCELLED LONGEVITY

Actual Size

Write at once stating your requirements. Samples and Prices on Application.

A. M. FLECHTHEIM & CO., Inc.

136 Liberty Street — New York City, N. Y.



NOW! Screen-Grid Radio Under Your Own Brand!

Premier's new private brand merchandising plan is truly the answer to profitable radio sales. Now you can set your own price on quality merchandise to meet every market change and condition—and get every possible price concession by buying direct from factory. It's the sure-cure for top heavy inventories, burdensome contracts and restricted territories. Most of all, *it preserves your greatest asset—your trade identity and good will.*

As Modern as Radio Can Be

Up to the minute with every desirable sales feature is the 7-tube (8 with rectifier) screen-grid Premier chassis model 724, illustrated. Eye value, tone, volume and distance. Push-pull amplification, all metal 100% shielded, phonograph pickup, and latest tube combination employing three 224, two 227, two 245 and one 280 type tube.

Write for full details

PREMIER ELECTRIC COMPANY

1801 Grace Street, Chicago — *Established 1905*

X-L VARIO-DENSER

INCREASES EFFICIENCY AND POWER OF RECEIVER

Radio Science proves neutralization the only satisfactory method of controlling oscillation in tuned radio frequency circuits, thus increasing actual power per stage of amplification from 25% to 300%.


Model "N" Vario-denser

X-L Products give accurate values and dependable service. Endorsed by radio engineers, designers and set builders and standard in all best known circuits.

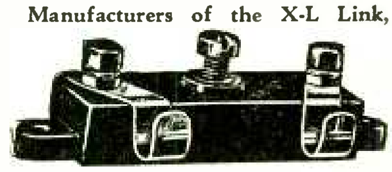
Model "N" has variable capacity, adjustable from 1.8 to 20 micro-micro farads. Price each $1.00

The Bakelite X-L Push Post excels in looks, action, service and convenience. No screwing—no shearing of wires—no jarring loose. Price each 15 cents.


X-L Push Post

Model "G" with grid clips made in three variable capacity ranges. Price each $1.50.

Manufacturers of the X-L Link, the 100% Voltage Control and many-purpose Light Socket Adapter.


Model "G" Vario-denser

Write for descriptive literature and free book of circuit diagrams.

X-L RADIO LABORATORIES

Dept. J-1224 — 1224 Belmont Avenue — Chicago, Ill.

THE DANCING GREEN LIGHT

(Continued from Page 68)

Marks sat motionless, watching the reporter through half-closed eyes. As Brinsley talked, Marks' eyes narrowed to slits, as his interest grew. Half an hour of it . . . Marks reached out and touched a button. A call boy responded.

"Send Mr. Bates to me and find Strombol, and tell him I want him."

The boy gone, Marks leaned over the table.

"Mr. Brinsley," he said. "Let me congratulate you. I believe it can be done just as you have outlined. What the ultimate effects will be, of course, I can't predict. But there is little or no technical difficulty in the way. I think we can help you put this over."

Brinsley leaned, his hand shaking.

"Well," he said, a bit unsteadily, "it was a pretty big order, but I had a lot of personal faith in it."

Marks laughed.

"It is going to be a tremendously interesting experiment," he said, "viewed purely as a psychologic matter. . . Ah—Mr. Bates . . . ."

There was "something doing" at police headquarters. There was no doubt of that. The night police reporters from the various papers each "flashed" their respective offices to this effect. They had sensed a flurry of activity in the case of "The Tiger" among the upper office men, without being able to put their fingers on it. Captain Brady was in his office, his door locked—an unusual move at night.

"The *News* has something," one man flashed his paper. "Brinsley's busier than a cat on a tin roof, and he won't talk. Brady's behind a locked door, and there's a gang of workmen in the 'sweat box' doing something, and they won't talk."

"Well, you get it," he ordered. "That's what you're paid for. Blast it out of Brady, or I'll get me a new police reporter."

This was purely a form of speech, common to editors, but it failed to cheer the man on the other end of the wire. Half an hour of work convinced him that the affair was "deadlocked."

"Damn!" said the reporter, glancing at his watch, and figuring his "deadline," the last hour he could get it into print, "we're stung!"

They were. How badly, only Brinsley knew. It had been one of the conditions of the experiment, that only the *News* was to have a hand in it. There is a well understood code of honor in the gathering of news from official sources, observed by those in public life as well as by those of the newspaper profession itself. It pivots on the idea that where a reporter uncovers some individual angle of an affair, it shall be kept inviolate between him and any official whom he takes into his confidence, until such time as he himself releases it for general circulation.

Of such confidential minutæ is the warp and woof of a newspaper scoop woven, sometimes swinging on the gossamer filament of a mere tacit understanding. Such was the case with Brinsley's plan in regard to "The Tiger." Captain Brady would have liked to have taken the other reporters into his confidence in the affair, but he dared not. Unless Brinsley released it, he would do nothing, could do nothing. And Brinsley had no intention of releasing it. Let the others swing their heels and find out if they could what it was all about, as he had been forced to do on numerous occasions. In a few short hours they would read it all in the *News,* and his caution would be justified to his everlasting credit.

It was a daring thing which the police reporter of the *News* had undertaken. Long before midnight, Captain Brady had begun to realize this fact. A grudging admiration of Brinsley's undertaking began to assert itself and he called one of his men.

"Give the *News* man any help he wants," he said shortly. "He's got an idea. See? I'm going to let him run it to earth. Tell the boys to give him a hand with whatever he wants. I'm kinda interested myself."

Things ran smoother for Brinsley after that. With the jail electrical staff, he did some scouting in the "sweat box." There were two ventilators in the room, which opened off the corridor that led to Brady's office. One of these was removed, under direction of Strombol, the engineer for the Standard Electric Company, and a frame with a ground glass was substituted in its place. Directly across the narrow lightwell, was a window which opened into an adjoining room. On the sill of this window, certain apparatus was set up, resembling a movie projector to which a radio set had been coupled.

Brady was amazed when, shortly after midnight, Brinsley informed him the stage was all set. He stared at the complicated machinery.

"Takes a lot of junk," he remarked. "I thought this psychology stuff was all mental."

Brinsley chuckled.

"It takes machinery to get some people started," he replied maliciously. Brady snorted.

"I'll be in my office when you get ready," he said, and went out.

With the work at the jail practically completed, Brinsley grabbed a taxi and, with Detective Sergeant Tom Mahon, who had been assigned to the Rixon case by Captain Brady, he sped off into the night, on the trail of other details that must be done with equal speed.

The results of this trip were seen in various ways.

At one a. m., a moving van backed up to the Rixon home, and certain articles of furniture, a picture or two, and some clothing was loaded into it. Neighbors who ventured to question the procedure, were disconcerted by the flash of a police star. Not theirs to question official procedure, whatever unsatisfied speculations kept them gossiping wakefully until the van rolled off.

Two o'clock! Brinsley faced a group of people, summond by Simon Grosman, in the studio of the Standard Electric Company, giving a few last instructions.

"There's one little change," he said, consulting a notebook in his hand. He glanced at Detective Sergeant Tom Mahon.

"I'll show 'em," said the detective, and proceeded to rearrange the group . . .

Across the city, Dartman, the publisher of the *News*, and Blank, the city editor, sat in Dartman's den, their eyes on a little table clock, watching the second hand trot steadily around the tiny circle.

"Wonder what's gone wrong?" said Dartman suddenly. Blank shook his head. He always backed his men.

"Nothing," he said succinctly. "Those things take time, that's all." He appeared much calmer than he was. The strain was beginning to tell on his nerves also.

Dartman lighted a fresh cigar, chewing restlessly.

Two-thirty . . . The telephone bell rang sharply. Dartman scooped the instrument from the table. Blank leaned forward tensely. Brinsley on the wire . .

"Come ahead! We're all set!"

"Gad!" exclaimed Dartman. "Right away!"

They ran down the front steps together. Dartman's car shot up from the driveway, and a moment later they were racing along the smooth highway, toward the city.

The others were already there when they reached police headquarters—Captain Brady, Tom Mahon, two other detectives, Marks of the Standard Electric, Brinsley and a shorthand man. The police reporter was haggard from strain, but his eyes gleamed. He came forward at once.

"I'm going to let Captain Brady explain the layout, so you will understand just what is being attempted," he said. "You have all met, I take it?"

There was a general greeting, all present either being acquainted, or knowing each other by reputation. Brady led the way into a room at the end of the hall, adjoining his own office.

"We call this the listening post," he said, throwing back the door.

There was a table against the far side of the room, in front of which were a number of chairs. Dictaphone headsets were scattered along the table. Before each chair was a small hooded device, somewhat resembling an old fashioned stereoscope, mounted on a stand. At the end of the table, a row of buttons and small switchboard lights.

"This is where confessions are sometimes obtained," explained the head of the detective bureau. "The dictaphones give you the sounds from the 'sweat box' where the prisoner is held, and the periscopes give you an unobstructed view of his movements. It is surprising what a man will do and say when he thinks no one is looking at him or listening to his words . . ."

The bureau head arranged the group at the long table, Brinsley at his elbow, Dartman next, and the others without any definite order. Dartman leaned down and peered into the hood. He was looking at a miniature view of the inside of a jail cell. There was a chair, a table, and a bunk against the wall. He could also see the door with its tiny barred window opening into the corridor.

"Great Scott!" he muttered.

"See that ventilator up to the left?" asked Brinsley.

Dartman studied the view for a minute.

"Oh, yes . . . up there!" he said.

"Yes. Well, keep one eye on that and the other on 'The Tiger'," said Brinsley. "That's the stunt!" The captain was speaking, explaining about a powerful white light, so arranged in the cell that it bored continually into the prisoner's face at all times, no matter where he sat or stood.

"At first the prisoner doesn't mind it," said the captain. "But as it goes on, hour after hour, he tries to get away from it. We have men in here listening and watching, taking down what he says in shorthand. Sometimes we have to keep 'em in here for days. It's a tough form of solitary. Since the water cure was abolished, we've got to do the next best thing. This is it. When a bird is guilty, he gets to be a babbling fool with this light after him all the time."

"An innocent man would go mad just as easily, I'm thinking," said Marks.

"None have," said Brady. "We get used to telling. When a man sits down and buries his face in his hands to get away from the light, we let him out. We know it's no use. But I've never seen a guilty maverick that could stand it."

"How about 'The Tiger'?" jibed Brinsley.

The captain growled.

"He went to sleep on his, damn him," he said.

He touched a button on his table and a uniformed policeman stepped into the room.

"See that we are not disturbed until I give the word, Morrisey," the captain ordered. "Let any of the electricians in, but no one else—no other reporters." The man nodded and withdrew.

Brady turned to Brinsley.

"I guess we're ready," he said. He touched another button and the lights in the room went out, save for a small globe over the stenographer's pad at the end of the table. Brady picked up a telephone, of the intercommunicating type.

"That you, Joe? This is Brady. All right—put 'The Tiger' back in the 'sweat box' again. Keep the corridor doors locked while you're moving him. He's a bad bird. See? And tell him nothing. Just chuck him in and leave him. That's all!"

The receiver clicked. The group waited in the dark. The stenographer picked up his fountain pen. In the hoods, the light in the cell went out, leaving only a dim, opague glass in front of the watchers. The room was silent, save for the breathing of those in it, and the restless movement of someone settling his head-receivers into a more comfortable position.

Presently there came to their ears, a faint, hollow, thumping sound—a shuffling, unrythmic beating. . . .

"They're coming down the corridor," Captain Brady explained in a low tone. "Those are the feet you hear. . . ."

There was a sudden rumble as the steel door of the "sweat box," controlled by an electric switch in a shielded niche far down the corridor, rolled back in response to a signal from one of the guards. In the hoods of the periscopes, a faint square of light showed on the ground glasses, with shadowy figures outlined against it, in movement.

"What the hell's the idea?"

The hoarse voice spoke suddenly in every ear, as the dictaphones picked up "The Tiger's" rough inquiry. There was no reply from his warders. Just a movement, a sound of shuffling, and the blurring of shadows in the dim-lighted squares of the hoods. The rumble of the closing door was distinctly audible, as the steel barrier rolled into place, shutting the prisoner in a keyless prison. The departing footsteps down the corridor . . . .

Listening intently, the watchers heard "The Tiger" stumble into the table. He gave an exclamation. At Captain Brady's a tiny red light glowed for an instant, as the jailor signalled the prisoner's presence in the "sweat box." The captain reached for a switch, and the terrible light in the cell came on . . .

In the brilliant glare, as pitiless as a noonday sun, the little group saw, for the first time, "The Tiger." He was a squat, swart man, with quick vicious eyes, slightly bowed arms, and a stoop—a sort of leaping crouch, characteristic of the man who preys, whatever strata of life may claim him for its own. At the moment, startled and on guard, he was backed against the table, staring at the light above him, his jaw sagging, looking every inch, just what the police claimed him to be—a killer!

For the first time, Dartman and the others understood fully what the authorities had been up against in their efforts to wring a confession from this man. "The Tiger" was plainly not the type to bend under physical stress . . . .

Into the receivers came a sudden moaning sound, that rose to a wail and died away. Marks pulled the receivers from his head and looked about the room. No, it was in the headset . . . he put the caps back again. "The Tiger" had whirled, so that his hook-nosed profile stood out sharply, huddled over the table like a trapped spider. His hands gripped the back of the chair defensively, waiting, listening . . . The third degree had begun in earnest.

There was an hour of it . . . a hell of mechanics unleashed on human nerves, already taut from inner stresses. Sirens that wailed up and down like a soul in torture. One shrill, hardly audible note, that continued ceaselessly, plucking at the prisoner's endurance. Voices that whispered from here and there—hidden speakers set into the walls and ceiling . . .

"You did it, you did it . . . you did it. . ."

"God, what a system," said Dartman to himself, the sweat standing out on his own head.

Again and again came one devilish note—a rippling sound, a thud, and a scream, worked in some ingenious manner. Gradually, as he listened, it struck Dartman that this was a suggestion of the gallows, thrown at the crouching man over and over again—a suggestion that his brain must sooner or later translate into terms of sheer terror . . . .

"The Tiger" was going frantically around the polished walls of his cell now, feeling for the contrivances, set beyond his fingers, his face working, his nerves yammering for release. And always the terrible light, like an incarnate finger of justice, bored into his face wherever he turned. . . . It was beginning to get him!

Finally, Captain Brady nudged Brinsley with his elbow, and nodded. The police reporter picked up another telephone and called a number in a low voice. A moment later, the light in the cell went out, and in the altered ventilator in the corner of the cell, a faint greenish glow appeared. Dartman and the others stared at it in fascination. Brady opened a key, and spoke into a microphone.

"Up there," he whispered, "right over your head . . . up above you!"

There was a faint glow in the cell now—just enough to distinguish "The Tiger" as he whirled and gazed up at the flickering green light high above him. . . . As he looked the wavering light began to take shape, to clarify. As he caught what was gradually forming there, he sagged back, cursing, mumbling . . .

He was looking into the interior of the living room of the Rixon home—at Sarah Rixon and her sister, sitting beside a table with a light aglow. It was the scene the killer of the aged women had seen, as he first peered through the windows of their little cottage on the night of the murder. It had been staged with a fidelity of detail that was amazing—staged from the notebook of Detective Sergeant Tom Mahon, in the studio of the Standard Electric Company.

A half-strangled cry broke from "The Tiger's" lips. Coached in their parts, garbed in the clothing of the dead women, a little group of theatrical folk were reenacting in front of a television screen, the murder itself. The furniture, the pictures on the walls . . . all had been transferred to the broadcast studio, that the thing might be done right. Captain Brady himself, peering into his hood, sat like one stunned. Dartman was speechless. . . . .

It has been said that a murderer, after a crime, has no very coherent idea of details, the main thing standing in his memory being the actual killing. This applies to crimes of calculation and deliberation, such as the Rixon case. "The Tiger," viewing his triple murder on the ground glass of the television projection screen, was not conscious of any mistakes due to the faulty estimates of the police reporter of the *News*, or the detective in charge of the case. Before his horror-stricken eyes, he saw only the hideous details of the terrible crime, which he thought buried in his own consciousness, pictured in detail by a wavering green light, apparently on thin air.

A more intelligent murderer might have suspected a trap. But "The Tiger" was not of a high order of intelligence. He was potentially fearful of things which he did not understand. The flickering, tell-tale light, which seemed to paint on the wall of his cell, the story of his crime, was to him a thing supernatural. He could fight physical torture, but this was different. This was conscience . . . God!

The picture went on. The knock on the door . . . Sarah Rixon laid down her sewing and opened the door. "The Tiger" saw himself step into the room . . . saw what followed, the weak, futile struggles, the blows, the three killings much as they had occurred . . . dancing, wavering, weaving, high above his head . . . the workbasket struck the floor, and spilled its contents!

There was a sudden scream, as "The Tiger" in the cell of horror, flung himself at the steel wall, shrieking, cursing, beating his fingers against the ungiving surface, babbling, confessing . . .

The door to the cell burst open as the terrible white light came on again. Two detectives ran in, grabbed the terrified, drooling, broken prisoner, and flung him into the chair. While "The Tiger" clung to them, trying to shut out the awful, dancing green light on the wall, they began to hurl questions at him. Upstairs, in the listening post, the stenographer's pen began to whip hieroglyphics upon the pages of his notebook, beneath the shaded light of the table. Brinsley had won!

It was seven o'clock in the morning. Brinsley and Captain Brady faced each other across the breakfast table, in the most expensive hotel in the city. A copy of the *News* was between them, its flare headlines telling of "The Tiger's" confession—a newspaper scoop that was to make journalistic history. Brinsley had eaten largely—at the Captain's expense, and for a loser, Brady appeared quite cheerful.

He lighted a cigar with great deliberation, sank bank with a contented sigh, when it was going nicely, and regarded the police reporter of the *News* with unfeigned respect.

"Say, tell me," he said. "Where can a guy get a book on this here psychology stuff, anyhow?"

TECHNICAL BRIEFS

(Continued from Page 37)

sistor be used at 25 per cent of its maximum watt rating or 50 per cent of its maximum rated current-carrying capacity if it is to be used in a confined space such as a receiver, amplifier or power supply unit. If a high enough resistance of the required current-carrying capacity cannot be secured in one unit, two or more units of the necessary capacity may be connected in series to give the required resistance.

Permeability is a measure of a material's ability to carry magnetic lines of force. An iron core which has a permeability of 400 is able to carry 400 times the number of lines as would be carried by air for the same number of ampere-turns in a coil. The inductance of a primary coil is directly proportional to the permeability of its core.

Permalloy is the trade name of a highly permeable alloy whose composition varies from about 30 per cent nickel and 70 per cent iron to 85 per cent nickel and 15 per cent iron. The percentage of nickel is indicated by a number which precedes the word: Thus 45 permalloy contains 45 per cent of nickel and 55 per cent of iron. For pure iron or pure nickel the permeability is about 400; for 45 permalloy, about 2,000; for 80 permalloy, about 12,000; but for 90 permalloy, about 2,300.

According to Arthur E. Thiessen in the General Radio *Experimenter,* 45 permalloy is sometimes used for the cores of interstage audio transformers because of the high primary inductance which is thus made possible with a small number of turns. But unless special precautions have been taken in the design they cannot be used in plate circuits which draw comparatively large currents, as permalloy cores become saturated at much lower current values than do silicon steel cores. Furthermore any mechanical shock may cause a permalloy core to lose its high permeability.

KODAKING ELECTRICITY IN ACTION

(Continued from Page 30)

a pure a.c. wave the total area over one cycle is zero, because the positive area is equal to, and cancels, the negative area. For any wave shape whatsoever the use of a d.c. meter will determine the average value directly. In a.c. waves the average value of the wave on one-half cycle only is often used. In such a case a pure a.c. wave has an average of 63.7 per cent of the peak value. The effective value is 1.11 times the average, or 70.7 per cent of the peak. The factor, 1.11, given by the ratio of the effective value of a wave to the average, is called the form factor. For a rectangular wave, the effective and average values are equal, so that the factor is 1. The more peaked the wave, the higher becomes this factor.

When an a.c. is superposed on a direct current, the value of direct current remains unchanged as long as the a.c. is not larger than the d.c. The effective value of the wave does change, however. The r.m.s. value of the resultant wave is given by $\sqrt{(I_{dc})^2+(I_{ac})^2}$, where I_{dc} and I_{ac} are the average and r.m.s. values, respectively, of the individual d.c. and a.c. components. Suppose an a.c. whose peak is 100 m.a. is combined with 100 m.a. of d.c. The r.m.s value of the a.c. component is 70.7 m.a. Performing the calculation indicated gives $\sqrt{(100)^2+(70.7)^2}=\sqrt{10{,}000+5{,}000}=122.5$ m.a. as the r.m.s. of the resultant wave.

Fig. 9 shows curves of current and voltage on a mercury arc tube. These traces are of the type of d.c. with a.c. superposed. The various quantities are indicated on the curve. The tiny ripples on the curves were caused by the fluctuations in the mercury arc.

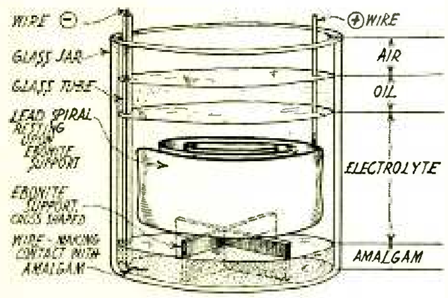
A note from W. L. Jepson describes the method of obtaining I. C. W. on the Coast Guard T-4 transmitter more thoroughly than was brought out in his article in the March, 1929, issue. The 500-cycle a.c. from the alternator is impressed upon the d.c. plate supply through a transformer across a plate reactance. The result is a variation in the plate voltage to the extent of the voltage of the 500-cycle supply. In other words, the a.c. voltage adds to the 1000 volts d.c. on the positive alternation and subtracts from it on the negative alternation, the completeness of the modulation depending upon the maximum potential of the 500-cycle a.c.

THE LEAD-MERCURY-ZINC BATTERY

By R. RAVEN-HART

A remarkably interesting type of storage battery has recently been developed in Russia (by Professor Goubaref, of Kieff). As far as I can trace, the first description that appeared in print was in the Moscow *"Radioljubitjel"* (*"Radio Amateur"*), in Nr. 5 of 1928. The idea (which I have tested) is well worth passing on.

The positive element is a strip of lead, say ⅛-in. thick, about 3 in. wide and



Lead-Mercury-Zinc Storage Battery

12 in. long, rolled into a rough spiral. The turns of the spiral must not touch each other, as the lead expands somewhat during the charge; for the same reason, about ¼ in. should be left between the outside of the spiral and the wall of the container (a jam-jar is suitable). To this lead spiral a lead wire is connected to give the positive terminal. It is desirable to jag the lower edge of the spiral with a pair of scissors, to increase the surface exposed to the electrolyte.

The spiral rests on an ebonite (or waxed wood) support of such a size that the lead is held about ¾ in. above the surface of the negative element, which consists of an amalgam of mercury and zinc, lying at the bottom of the jar. This amalgam is produced during the formation of the cell; at first, it is merely pure mercury, enough to cover the bottom of the jar to a depth of say ½ in. Connection to it is made by a nickel or soft iron wire (no other metals are suitable) which dips into the amalgam, and which is protected from the electrolyte by a glass tube, plugged at the ends with sealing wax.

The electrolyte is composed of sulphuric acid of a density of about 1.175, in which zinc has been dissolved; the quantity of zinc to be used is from 3½ to 4 per cent by weight of the weight of the mercury. After formation, the zinc disappears from the electrolyte and forms a semi-liquid amalgam with the mercury; hence, to replace splashed or spilt electrolyte, sulphuric acid (without zinc) is to be used, and (as usual) distilled water to replace evaporation. The electrolyte should cover the lead spiral by about ½ in. It is desirable to add another half inch or so of mineral oil above this.

All the above dimensions are for an *A* battery cell; by reducing the dimensions and using test tubes as containers very satisfactory *B* batteries can be made up, especially for small transmitters.

The only trouble for the amateur is the formation of the cell. This involves about ten charges and discharges, but they can be rapid. During charge, the lead goes black; after complete blackening another 15 minutes of charge should be allowed. The cell should then be discharged (it will stand even a complete short-circuit), and the charging recommenced. After about ten cycles of charge and discharge the cell can be put into use, although its capacity will not fully be normal till after about fifty charges and discharges, so that this capacity will rise slowly during the use of the cell. The final capacity is about 20 ampere-hours for every 8 sq. in. of active surface of the negative element (the amalgam), so that practically speaking a jar of 3¼-in. diameter will give a capacity of 20 ampere-hours.

One advantage over the ordinary battery is that the voltage is higher; 2.5 to 2.8 volts per cell; but the outstanding feature is that the cell will stand rapid charging and very rapid discharge, and can be left discharged for weeks without any ill effects. Another important point is that the only part which needs eventual replacement is the lead spiral, the cheapest part of the cell, and even this is stated not to lose more than 1/16 in. in thickness after 300 charges.

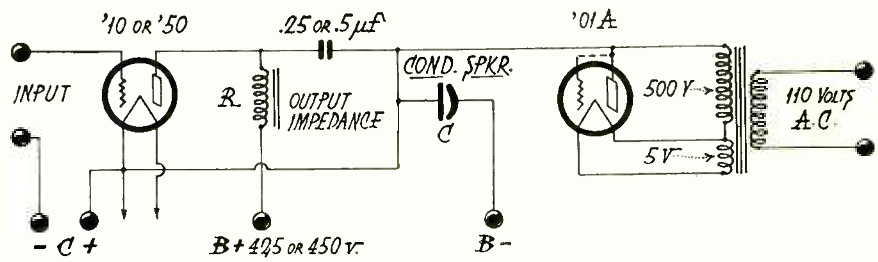
CIRCUIT FOR CONDENSER SPEAKER

Since many experimenters are interested in trying out the condenser type of loudspeaker which is beginning to appear on the market, a circuit recommended for the Kylectron is shown herewith. It includes the power stage of audio amplification, the condenser speaker and the rectifier for supplying the polarizing voltage to the speaker.

The speaker consists essentially of a perforated metal plate across which is stretched a flexible diaphragm consisting of a rubber compound which is coated with a thin metal foil. A single 8x12-in. section has a capacity *C* of about .004 m.f. in series with the output impedance *R* of the power amplifier. A constant polarizing bias of 500 to 600 volts is applied across the speaker.

The frequency response of the speaker depends upon the product *R C*, so that the relative degree of response of the higher to the lower frequencies can be adjusted without loss of total energy response by changing either *R* or *C*. *R* may be increased by using a tube of higher output impedance or by means of a transformer between tube and speaker; or, at the cost of efficiency, by inserting an auxiliary resistance in series with the speaker. *C* may be changed by using more or less speaker sections or by changing their series-parallel connection.

For four 8x12-in. units, *R C* should be about 65, *R* being in ohms and *C* in microfarads. For a six-section speaker *R C* should be about 100. For the larger speaker the high frequencies emerge in a narrower beam which is more effectively concentrated on the listener, even though the higher value of *R C* gives less response in the high frequencies. A higher value of *R C* may be used if the amplifier has a rising characteristic.



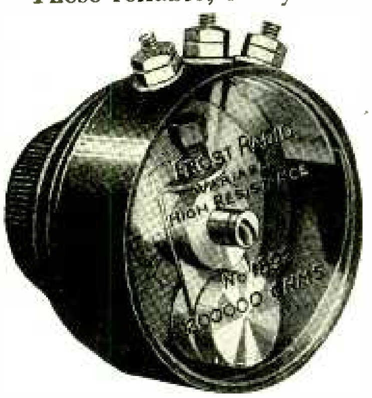
Circuit Connection for Kylectron Speaker

The biasing unit is operative only when connected to an output device giving a closed d.c. path for the passage of the biasing charge. If the output circuit contains a condenser a ½ megohm gridleak may be connected across the output terminals to complete the d.c. path. The .25 or .5 m.f. condenser shown in the circuit diagram allows the completion of the a.c. path through the speaker without including the 110-volt transformer. An '01A tube may be used as a rectifier. No filtering circuit is necessary because the biasing currrent is negligible after the polarizing voltage builds up to peak.

The speaker is mounted in a baffle, behind which there must be at least 6 in. of free air space. The speaker sections should all be in approximately the same plane, the plane facing the normal position of the distance. Experience has shown that this type of speaker is better adapted to the reproduction of voice frequencies than to the very low notes.

FROST-RADIO VOLUME CONTROLS supplied in any curve to meet your exact requirements

YOU can secure Frost-Radio Volume Controls in any of the curves shown herewith, as well as in many other curves to suit your most exacting needs.

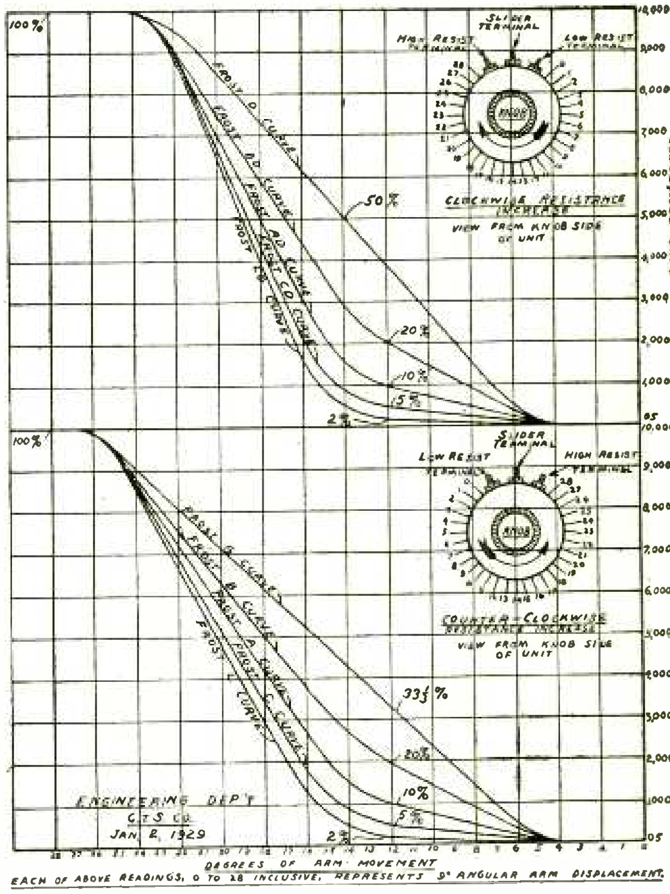


FROST-RADIO

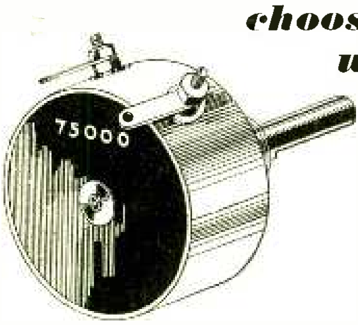
These reliable, finely-built volume controls are made with any desired resistance gradient, in metal shell or Bakelite shell type, and with either wire wound or carbon element construction, single or tandem mounted. Resistance is designed to increase with either clockwise or counter clockwise knob rotation. Smooth running, non-inductive and not affected by temperature or humidity changes.

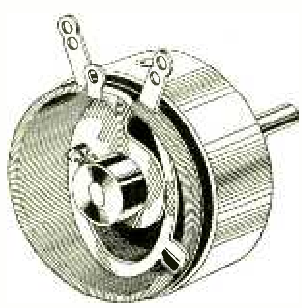
No matter what your volume control requirements may be, Frost-Radio can meet them. Our long experience and tremendous volume of production have placed us in a unique position to be of service to you in supplying exactly what you want when you want it.

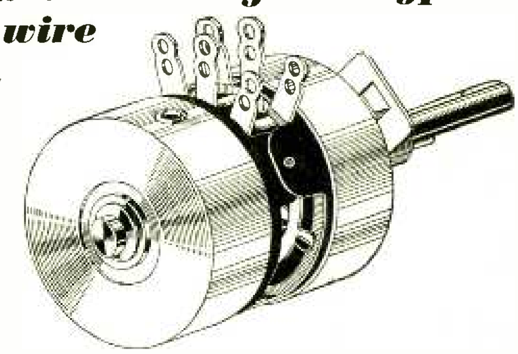
All good dealers supply Frost-Radio Volume Controls or can get them for you in a hurry. For special sizes, styles and resistance curves, write us direct.



A complete line that gives you a wide range of types to choose from, in either wire wound or carbon element design







Frost-Radio Wire Wound Resistors are made in four different sizes, all metal shell, with resistances ranging from fractional to 10,000 ohms, with or without D.C. battery switches . . . Frost-Radio Carbon Element Resistors are made in several types, Bakelite or metal shell cases; distinguished by low hop-off, in fractional ohms if desired; also may be combined with A. C. switch.

HERBERT H. FROST, Inc.

***Main Offices and Factory:* ELKHART, INDIANA**
160 North La Salle Street, CHICAGO

The Largest Manufacturers in the World of High Grade Variable Resistors

Mail coupon for complete data on all Frost-Radio Volume Controls

We have some interesting new literature on these items that you should have. The coupon brings it without charge. Write for this today; fill out and mail this coupon now.

Herbert H. Frost, Inc.
160 North La Salle Street, Chicago
Send me by return mail the new literature you have telling all about Frost-Radio Volume Controls.

Name ....

Address ....

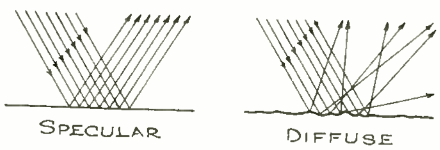
City .... *State* ....

Visual Transmission

By JOHN P. ARNOLD

Successful transmission of visual images depends largely on the efficiency of the optical parts of the system, that is, in making the best use of the available illumination. When light falls upon a surface, it is either transmitted, reflected or absorbed, depending on the nature of the surface. Some of this light can be made to illuminate the cathode of a photoelectric cell and generate the image signals, but the rest of it is lost.

Phototelegraphic systems usually make use of the light transmitted through a translucent substance. For example, at the sending station, a photographic transparency (positive or negative) of the original picture is made. This is wrapped around a clear glass cylinder, inside of which is placed the photoelectric cell. An intense beam of light is concentrated by means of lenses upon the film, the light passing through it and the glass cylinder and falling upon the cathode of the photoelectric cell.



Reflection of Light

When light passes through such translucent mediums as glass and the photographic film, it is for the greater part transmitted, but some is reflected and the rest absorbed. The amount of light absorbed by clear glass is only about 5 to 12 per cent of the total light. The amount absorbed by the film depends upon the density of the various points upon which the concentrated beam of light falls. Thus, the transmitted light varies with the densities of the film.

As it is possible to use very intense light sources, the problem of generating electrical current of sufficient magnitude after amplification for the purpose of transmission presents no particular difficulties, and small losses in the optical system are of no great importance. But in the case of television, no inefficiency can be tolerated.

In television the subject is no longer a translucent film, but an opaque solid, often human beings, who cannot bear the light and heat produced by very intense sources of light. Also only the reflected light from the subject can be collected by the photoelectric cell.

We find that the light reflected from a surface depends upon three conditions: (1) the molecular condition or color of the surface, (2) the angle at which the light rays strike the surface, and (3) the wavelength or color of the incident light rays. Moreover, the reflection may be either specular or diffuse. If the surface is smooth, the reflection is specular; if it is rough, the reflection is diffuse. This is illustrated in Fig. 1.

The following table gives the reflection coefficients for various surfaces:

Material	Coefficient of Reflection
Highly polished silver	.92
White blotting paper	.82
Chrome yellow paper	.62
Yellow wallpaper	.40
Brown cardboard	.20
Blue-green paper	.12
Dead black paint	.01
Black velvet	.004

Thus the portion of the total light reflected from many surfaces is very small indeed, even if all of it could be collected by the photoelectric cell or cells. This is one of the great problems of television: to collect sufficient light to produce electric signals which can be readily amplified. A satisfactory answer has not yet been found, but the foregoing considerations certainly indicate that the greatest possible efficiency must be obtained.

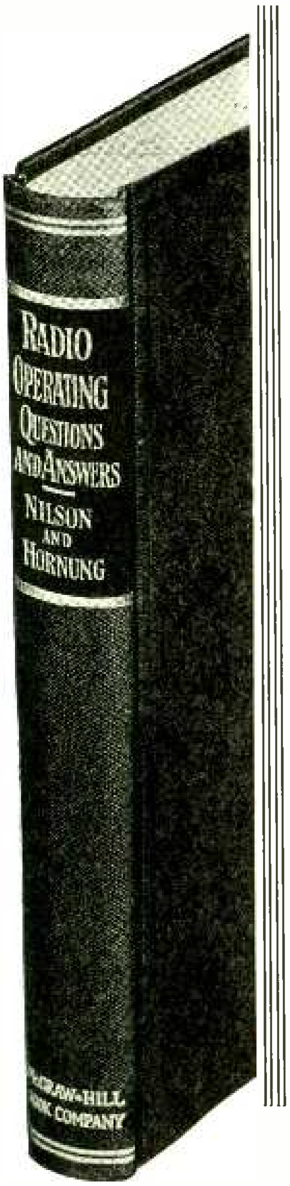
(In order not to appear more learned than we are, it should be mentioned that the foregoing facts were drawn from the first chapter of W. E. Barrows "Light, Photometry and Illumination.")

TELEVISION PROSPECTS

The number of "lookers-in" on television broadcasts was estimated at twenty thousand by C. Francis Jenkins, the Washington inventor, in a recent microphone interview over the Columbia broadcasting system conducted by Dr. Lee DeForest. This estimate we believe to be unduly optimistic. We find more consolation in Mr. Jenkins' statement that the manufacture of kit receivers is increasing, that transmitting facilities are to be offered to the regular broadcasters, and that daily schedules of visual image transmissions are more frequent. It was also mentioned during the course of this interview that the art has progressed to a stage comparable with sound broadcasting, in 1920, that is, in those days "when it was difficult to distinguish the efforts of an ambitious soprano from the shrillness of the pipe organ." Furthermore there is every reason to believe that the technique of visual message transmissions will advance more rapidly than in the case of sound broadcasting since many of the problems solved in the case of the latter are applicable to the former.

(Continued on Page 80)

Now You Can Get Your Radio Operator's License—with Ease!



AT LAST, a book covering practically every conceivable radio problem and question has been published! This book, just off the press, is crammed full of highly important *new* radio information. It will be invaluable to those who wish to take examinations for their Commercial, Broadcast, Radiotelephone or Amateur License. For this book is intended especially for students and operators who are about to take the government examination for a radio operator's license. It gives over four hundred actual examination questions and shows how they should be answered.

RADIO OPERATING
Questions and Answers

By ARTHUR R. NILSON
Lieutenant (Technicist) (Communications) U.S.N.R., Member Institute of Radio Engineers; Fellow Radio Club of America

and J. L. HORNUNG
Fellow Radio Club of America; Associate Member Institute of Radio Engineers; Radio Instructor

267 pages, 5½ x 8, 91 illustrations, $2.00

THIS book will give those who are looking for a description of high frequency circuits some mighty valuable information. Complete description and information on ship stations, vacuum tubes, arc and spark transmitters, commercial receivers and radio compass, storage batteries, motors and generators are included in this book. The new Western Electric broadcasting transmitter type 6A is thoroughly explained and illustrated.
General and theoretical questions on radio and electricity as well as the 1929 radio laws and a complete explanation of amateur transmitting and receiving stations for government license examination all appear in this book.

Can You Answer These Questions?

(They are just a few of the 400 questions contained in this great book)

398—What adjustments are necessary on an amateur transmitter in order to comply with the law as to wave length, etc.?

22—What are the characteristics of the various types of waves emitted from various transmitters?

51—What is an arc?

106—Describe the nature of oscillatory discharge of a condenser through a spark gap and an inductance.

111—Draw a diagram and explain the construction and electrical functioning of a closed-core transformer.

299—What is the penalty for violating any United States or international radio law?

296—What is the law on secrecy of messages?

376—State Ohm's law in full. How would you find the resistance in a circuit if the voltage and current are known?

45—Draw a diagram of a filter capable of being used with a high-power vacuum-tube transmitter and explain the operation of the filter.

23—Draw a diagram of a complete commercial installation including a receiver employing a regenerative detector with one step of audio amplification. A tube transmitter provided with a radio-phone attachment. The transmitter is to be operated by storage batteries. Showing charging equipment to be used with both emergency batteries and receiver batteries. State in watts or kilowatts the power used. Ampere-hour capacity. Include the motor generator and an automatic starter.

1929 Radio Laws

It is very important to know the correct answers to radio law questions for you are sure to be asked many questions on this subject. Furthermore, you should not depend upon printed statements concerning radio laws that you may have received some time ago. These statements are without doubt obsolete today. Radio Operating Questions and Answers gives you in the form of questions and answers (the easy method of learning) every important radio law as of 1929. Procedure for obtaining radio compass bearings—complete explanation of the cable-count system and an explanation of laws pertaining exactly to the amateur are included in this chapter. Over sixty radio-law questions *alone* are listed.

Read This List of Chapter Headings

I.—Diagrams and Explanation of Complete Commercial Transmitter, Receiver, and Auxiliary Equipment. II.—Tube Transmitters. III.—Arc Transmitters. IV.—Spark Transmitters and Transmitters in General. V.—Receiving Apparatus and Radiocompass. VI.—Storage Batteries. VII.—Motors and Generators. VIII.—Radio Laws and Traffic Regulations. IX.—General and Theoretical Questions. X.—Broadcasting Transmitters. XI.—Amateur-Station Operation.

General and Theoretical Questions

In addition to direct and specific radio questions there is a whole chapter devoted to general and theoretical questions. Questions that give the operator a well rounded knowledge of radio and electricity. Questions that require the knowledge of mathematical formulae are given and, of course, completely answered with the formulae worked out. Questions calling for definitions are also asked and the answers given in this chapter.

ORDER FROM **"RADIO"**

428 Pacific Building — San Francisco, Calif.
415 Lexington Avenue — New York City

ATWATER KENT 55

(Continued from Page 45)

sealed. The chassis is grounded, and serves as the cathode, negative plate supply return connection.

Tuning is accomplished by means of one dial located in the center of the receiver, and controls the three tuning condensers by means of a metal belt lashed around a wheel attached to the shaft of each of the condensers. The dial itself is turned by a pinion-gear attached, through the panel, to the control knob. A window on the front panel clearly shows the dial scale, through illumination provided by the pilot light.

The "local distance" switch, previously mentioned, is located directly to the left of the tuning control. Above this unit is the power switch, which turns the line voltage "on" and "off." To the right of the tuning control is the volume regulator.

Across the rear of the chassis is the power unit, including transformer, chokes and condensers, and the push-pull transformers. These units are individually shielded in order to prevent feedback of line "hum" into the radio circuits. At the left is located the rectifier tube and the dynamic speaker plug. This speaker outlet supplies both set output and direct-current power for operation of the reproducer. The r.f. stages progress from left to right, leading to the detector, first stage audio amplifier, and finally at the extreme right, to the push-pull amplifier tubes.

Measured Voltages for Model 55 Atwater-Kent Receiver

Filament—$F-$ to $F+$ contacts on all tubes except rectifier	2.4
F_1 to F_2 on rectifier tube socket	4.9
Plate—Cathode to plate of first and second r.f. tubes (vol. control at max.)	175.
Cathode to plate of detector tube	105.
Cathode to plate of first audio tube	70.
Filament terminal to plate of second audio tubes	235.
Grid—Cathode to grid of r.f. tubes (vol. control at max.)	3.
Cathode to grid of detector tube	12.
Cathode to grid of first audio tube	2.
Filament to grids of second audio tubes	42.
Screen—Cathode to screen of r.f. tubes (vol. control at max.)	85.

A concession to operate wireless telephone, telegraph and television between San Juan del Sur and Managua, Nicaragua, with the right to extend the service internationally, has been granted All America Cables, Inc. Equipment has been ordered and two stations are expected to be in operation in about ninety days. One of the All America Company's cables terminates at San Juan del Sur, Nicaragua. The wireless concession is to continue twenty years, at the expiration of which the government of Nicaragua has the option to purchase the stations or to permit the company to continue operation under general laws and regulations.

STONING A MINOR PROPHET

(Continued from Page 32)

In the far corner of the courtroom there arose a red-headed, rather unkempt individual whom we recognized as a teacher of one of the mountain districts—a man of at least 40.

This was his question: "Professor, don't you think that the time is coming when messages will be sent without connecting horizontal wires? Perhaps with only upright wires at each station?"

The learned professor turned upon the mountaineer all the force of his polished sarcasm. It seemed to us who were breathless listeners that the mountaineer must be properly punished for even thinking such a preposterous and unscientific possibility.

When Dr. —— had finished, the man who had remained standing throughout his tirade quietly remarked, "That's all right, Professor, but there are some folks in this room who will live to see just the thing that you say can't happen.

P. B. S. in "Science."

TELEVISION PROSPECTS

(Continued from Page 78)

Laurens E. Whittemore, engineering staff, American Telephone & Telegraph Co., and secretary of the American delegation to the International Radiotelegraph Conference of 1927: "What the future will bring forth as to television, no one can, at this time, predict with certainty. It is fundamentally true, however, that in addition to some apparatus complications, a much wider frequency band is necessary to secure results which are pleasing to the eye than is required for satisfactory sound transmission."

Arthur E. Kennelly, professor of electrical engineering at Harvard University: "Although television has been repeatedly and strikingly demonstrated, it is still in an experimental stage. It remains to be seen how far it can be introduced commercially."

O. H. Caldwell, Federal Radio Commissioner: "Television, when it comes, will probably be quartered here" (i. e., in the short wave spectrum).

Gen. J. G. Harbord, President of the Radio Corporation of America: "And, to crown all, television, that branch of the radio art which will bring to our homes the visual as well as the aural record of stirring scenes and events, is already giving promise for the future so far as the laboratory is concerned."

The Magnavox Co. has registered the trademark "Dynamic" with the U. S. Patent Office.

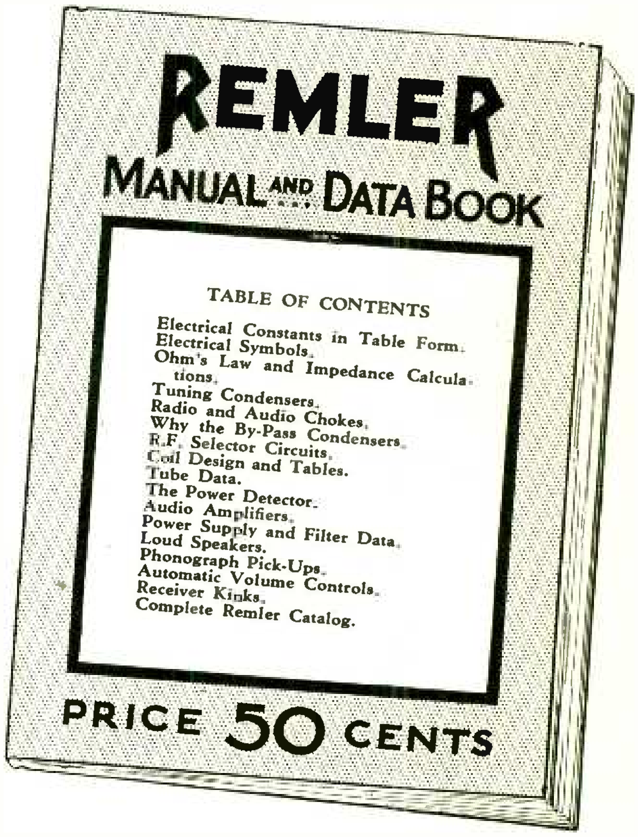
Think—

what these new REMLER products mean to you! . . .

THEY Provide You—the Radio Experimenter or Professional Set-Builder—with New Fields of Endeavor for the 1929-30 Season—Establish New Standards of Perfection for Experimental and Custom-Built Receivers.

YOU WILL WANT A COPY OF THIS NEW MANUAL AND DATA BOOK

CHOCK FULL OF INDISPENSABLE INFORMATION— YOU WILL USE IT EVERY DAY . . . READY AUGUST 20th



NEW REMLER

PARTS FOR 1929-30 SEASON

Note that this advertisement carries both list prices and the established net prices at which you can buy from your Remler Distributor. They are for your protection. You can buy from any Remler Distributor with the assurance that you are purchasing at the minimum figure.

		LIST	NET
No. 36	Choke, 50 mh.	$ 1.50	$ 1.05
No. 37	Choke, 150 mh.	2.00	1.40
No. 38	Power Detector Filter Choke	2.00	1.40
No. 51	Five-Prong Socket	.75	.53
No. 565	Screen-Grid Tube Constant-Gain R. F. Transformer	3.00	2.10
No. 659A	.0001 mfd. Heavy-Plate SLW Condenser	5.00	3.50
No. 915	Push-Pull Input Transformer. 1½ to 1 ratio. Resonant Primary	6.00	4.20
No. 916	Push-Pull Input Transformer. 3 to 1 ratio. For use in conjunction with No. 920 First-Stage Transformer	12.00	8.40
No. 917	Push-Pull Intermediate Transformer, 3 to 1 ratio	12.00	8.40
No. 924	Push-Pull Output Choke for use following '45 or '50 tubes push-pull	8.00	5.60
No. 925	Heavy-Duty Push-Pull Output Transformer with flat frequency characteristic over full frequency band. Secondary windings for both magnetic and dynamic speakers	20.00	14.00
No. 926	Microphone Coupling Transformer for standard carbon-button microphone	6.00	4.20
No. 927	Push-Pull Microphone Coupling Transformer	12.00	8.40
No. 955	Power Transformer. For '50-type tubes	20.00	14.00
No. 960	Filter Choke. 80 henries under no-load conditions. Mounted	8.00	5.60
No. 1632	Bath-Tub Type Two-in-Line. .00035 mfd. Condenser. Heavy-plate. Completely shielded. Composite Frequency Characteristic	12.00	8.40
No. 1633	Bath-Tub Type Three-in-Line .00035 mfd. Condenser. Heavy-Plate. Completely shielded. Composite Frequency Characteristic	15.00	10.50
No. 1634	Bath-Tub Type Four-Gang .00035 mfd. Condenser. Heavy-Plate. Completely shielded. Composite Frequency Characteristic	18.00	12.60
No. 1635	Bath-Tub Type Five-Gang .00035 mfd. Condenser. Heavy-Plate. Completely shielded. Composite Frequency Characteristic	21.00	14.70
No. 111	Kit	80.00	....

If you can't conveniently obtain the Remler Parts you need from our distributors you may forward your order to us for prompt handling. *We can accept orders for Remler Parts only.*

THESE REMLER DISTRIBUTORS

will serve you promptly and courteously. They are parts specialists and carry a full line of Remler Parts as well as those of other manufacturers. You can place your entire order with any one of them with the assurance that it will be filled completely, *with the parts you specify.*

OFFENBACH ELECTRIC CO.
1452 Market Street — San Francisco, Calif.

RADIO SUPPLY COMPANY
912 South Broadway — Los Angeles, Calif.

NEWARK ELECTRIC CO.
226 West Madison Street — Chicago, Ill.

RADIO JOBBERS, INC.
142 Liberty Street — New York City, N. Y.

GRAY & DANIELSON MFG. CO.
260 First Street — San Francisco

A Landslide

THE dealer and jobber circulation of "RADIO" will be increased to more than twenty-eight thousand copies... effective with the September issue ... out on September first

▼ ▼ ▼ ▼ ▼ ▼ ▼ ▼ ▼

and 1432 importers and exporters will also receive "RADIO"

▼ ▼ ▼ ▼ ▼ ▼ ▼ ▼ ▼

giving "RADIO"... we believe... the largest trade buying circulation of any radio magazine in the world.

▼ ▼ ▼ ▼ ▼ ▼ ▼ ▼ ▼

Not to mention the many thousands of custom builders... engineers... service men... and manufacturers who also read "RADIO"

▼ ▼ ▼ ▼ ▼ ▼ ▼ ▼ ▼

It is well for us to state that the circulation is guaranteed under BOND and by U.S. Government Post Office Receipt... showing the actual number of copies MAILED.

THE TELEPIX SYSTEM

The Telepix system of still picture communication which has been developed by Marvin Ferree and Joseph Wissmar should be of interest to amateur phototelegraphic experimenters since the system can be simplified by a little ingenuity so that the cost of the apparatus for transmitting and receiving is reduced to a minimum.

In the first place, one can dispense with photoelectric cells, elaborate amplifying systems, delicate galvanometers and other expensive apparatus. Furthermore, the transmitting equipment, which is usually the most expensive part of other systems, should cost but little more than the receiver. Since it is almost necessary for experimenters to do both their own transmitting and receiving (there are very few people transmitting still pictures with practically everybody interested in television work), this system is quite worth while, and communication can be arranged for either wire or radio circuits. Again the same apparatus can be used both for sending and receiving whereby two-way communication is easily effected.

As a commercial system the inventors had for one of their objects that the method would be especially adapted for use with telegraph lines arranged on the duplex system so that the sending impulse and the correction impulse (reverse current) could be sent simultaneously in opposite directions along the same line.

Only the main features of the system are described in this article, and it has not been thought necessary to go into the details of the particular scanning and synchronizing methods, as these are not unusual or unknown to the average experimenter.

The picture to be reproduced is first placed in front of an ordinary photographic camera in order that a negative of it can be made on a transparent glass plate. Before the negative impression is made, however, a transparent grating having a series of parallel lines thereon is placed in the camera in front of the negative so that the negative image will consist of a series of parallel opaque lines of varying width. The continuous tone of the picture to be reproduced is thus duplicated in what may be called broken line.

The inventors state that they prefer a grating or screen of 65 lines to the inch for reproducing ordinary photographs, although they do not limit themselves to any particular form of grating. For instance, they mention screens ruled with horizontal and vertical lines (as is usually employed in photoengraving processes for newspaper and magazine reproductions), but find this less satisfactory than the line screen, as the improved transmitting plate made by their process avoids the coarse pattern produced when the negative is taken through a grating having crossed lines.

This negative is now used for making an enlarged positive transparency which is preferably twice as large as the negative of the original picture.

The enlarged positive is then printed on a thin plate of copper or other suitable metal by means of an ordinary printing frame. This metal plate, which may be called the transmitting plate, is covered with a sensitive coating comprising fish glue, ammonium bichromate and white of eggs. The formula for this mixture is given as 16 oz. of fish glue, 1 oz. of ammonium bichromate, 6 egg whites and 34 oz. of water. The ingredients are thoroughly mixed and spread upon the highly polished surface of the copper plate. This coating is then dried, in which condition it is not very sensitive to daylight but is sufficiently sensitive to the powerful arc light used for printing thereon from the enlarged positive.

After the copper plate has been exposed, it is washed in cold water until the portions of the coating which have not been acted upon by the light are washed away and the plate is then dipped in an aniline dye which is absorbed by the remaining gelatine. The plate is now washed to remove any surplus dye and is then baked over a flame until the adhering coating has been transformed into a hard enamel-like material.

After the enamel has been formed, the plate is cleaned by rubbing it with a mixture of salt and dilute acetic acid. This eats away any of the gelatine which does not correspond to the image so as to produce clean bright copper lines between parallel lines of enamel of varying width, but without etching the plate.

This plate is now bent so that it can be placed upon the transmitting drum with the lines of the copper parallel to the axis of the drum. A hard steel stylus or needle traces a course over this plate and closes the electrical circuit whenever it makes contact with the bare copper (thus generating the picture signals which are to be transmitted to the receiving station) and opening the circuit when the needle rides over the enamel-like material which is a non-conductor of electricity. The needle, passing over these alternate lines of conducting and non-conducting material, is made to generate electrical impulses (by being connected in a circuit with a local battery) which vary in duration in proportion to the tones of the original picture.

At the receiving station there is a receiving drum over which travels a stylus (preferably made of an alloy of platinum and irridium so that it is unaffected by chemical action). The apparatus is synchronized so that both the sending and receiving needles are always over the same relative position of both the copper transmitting plate and the receiving paper on which the likeness of the original is recorded.

For recording the picture the inventors employ an electro-chemical method. First an absorbent pad is placed on the receiving dum. This pad is saturated with a solution which, by electrical decomposition, produces a color effect. This solution is preferably a starch or dextrine solution in water which contains dissolved potassium iodide and potassium bromide. The effect of the addition of potassium bromide is to secure markings of a brownish tone upon the recording paper with which the receiving needle makes contact. This receiving paper, which is placed on top of the absorbent pad, is also saturated with the solution just mentioned, but the pad, which is made of pure unsized paper consisting practically of pure cellulose, is highly important because the receiving paper dries so quickly that long pictures cannot be efficiently received.

The action of the picture signals from the sending station is to color the receiving paper due to the action of the current upon chemically treated paper, and thus form a positive duplicate of the original picture. Due to the making and breaking of the electrical connections as the needle rides over the transmitting plate, the received picture is in broken tone, but this is not visible to the naked eye because the picture formed on the receiving drum is only one-half the size of the picture on the transmitting plate, and because the markings on the receiving paper spread out slightly due to the moisture it contains.

This system is similar to those of Bakewell, Caselli, Thorne Baker, Meyer, Fulton and others. Its chief advantages lie in the simplicity of the apparatus required for setting up communication; but the quality of the reproductions are not nearly so satisfactory as in the case of the photographic method as exemplified by Dr. Korn and the Bell commercial systems. Experimenters who are interested in the further mechanical and electrical details of the system can refer to U. S. Pat. No. 1,529,473 of March 10, 1925, assigned to Pacific and Atlantic Photos, Inc., from which the foregoing account was taken.

ERRATUM: In Figs. 3 and 4 of Frank C. Jones' article, "Notes on Audio Amplification," June, 1929, "RADIO," it is necessary to use plate rectification instead of grid rectification. The grid condensers and leaks must be replaced by a *C* battery located in the grid return.

THE NEW

Seven Seas Console

First With A-C Shield Grid Tubes

ONCE again Leutz leads, introducing the first A/C Console to use the superior A/C Shield Grid Tubes. The result—a superior Console which will meet all competition, 100% shielding, wide spacing between radio frequency transformers and metal and unit construction contribute to make up the finest in radio for the coming season—the new Seven Seas Console by Leutz.

Unit Construction

THE electrical equipment is divided into four separate units: 1, chassis; 2, power amplifier; 3, power pack; 4, dynamic loud speaker. Two 210 tubes in the push-pull amplifier. Three A/C Screen Grid Tubes in the radio frequency amplifier. All heater tubes including one in the detector circuit and one in the first audio stage and a full wave rectifier using two 281 tubes. Here is a radio into which are incorporated the new features of 1930 radio with an unusually perfect audio amplifier. Highest quality dynamic speaker used.

A RADIO that defies competition. A sales leader for the dealer who wants something better than the ordinary to sell. Investigate the Seven Seas Console by Leutz.

Features:

- A/C Operation
- Single Dial
- Dynamic Speaker
- Push-Pull Audio
- 2/210 Power Tubes
- 100% Shielding
- Adjustable Selectivity
- Shield Grid Tubes
- Heater Type Tubes
- Unit Construction
- 9 Tubes
- Maximum Range
- Tremendous Volume
- Perfect Reproduction
- Walnut Console

FRANCHISE APPLICATIONS ARE INVITED
from established dealers

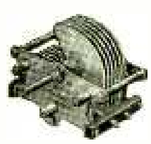
LITERATURE ON REQUEST

C. R. LEUTZ, Inc.

Long Island City, New York, U. S. A.

CABLES: "Experinfo"—New York

West Coast Representative: B. J. HOWDERSHELL, Detwiler Bldg., 412 W. Sixth Street, Los Angeles



DESIGN OF POWER SUPPLY UNIT

THE first factors to be considered in the design of an economical and efficient power supply unit are the current drain and the maximum voltage required by the load. The load current is equal to the sum of the plate currents of the various tubes in the receiver and amplifier, plus the current drawn by the voltage divider and regulator tube, if one is used. If reliance for a steady voltage output is placed upon the bleeder current in the divider it should be designed to absorb about 20 m.a. If a regulator tube is used it will require about 30 m.a. at the 90-volt output, 5 m.a. then being enough for the divider.

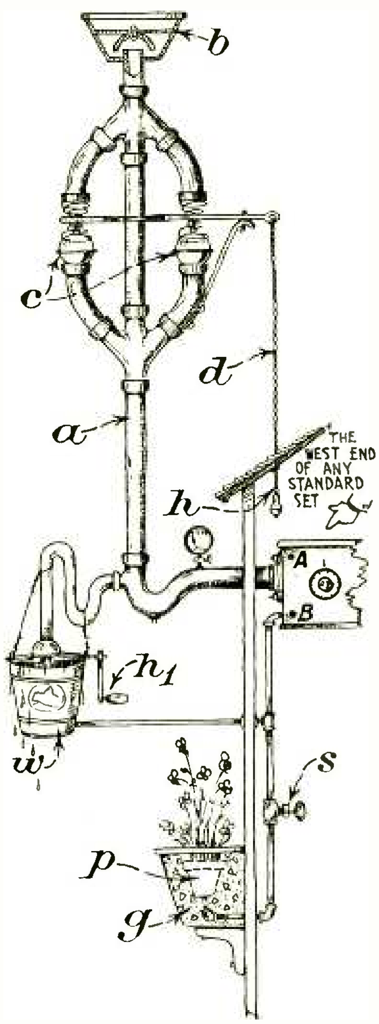
The d.c. voltage from the rectifier should be equal to the sum of the maximum *B* and *C* voltages plus the voltage drop in the choke coils. In analyzing the design of a unit to supply 400 volts *B* and 35 volts *C*, the Aerovox *Research Worker*, from which these facts are briefed, figures a drop of 60 volts in two 400-ohm 30-henry chokes, or a total of 495 volts for a receiver and push-pull amplifier using two '10 tubes.

In considering the selection of a rectifier it is shown that not more than 375 volts at 75 m.a. can be had from an '80 tube. So it is necessary to use an '81 in a half wave or two '81's in a full-wave rectifier, the latter method being preferred because of its quieter operation.

For the best design the transformer should supply 475 volts a.c. per plate in order to give an output of 495 volts. If it is necessary to use a "standard" 600-volt transformer the two '81 tubes

(Continued on Page 94)

The Soup-or-Nuts Antenna-Ground



PRICE ONLY $49.49 F. O. B.

Easiest to Install and Operate
Greatest Capacity and Distance

b Extra heavy copper lined high wave catch basin which no wave can escape.

c Brilliantly polished high frequency, low-wave collector. Thousands of kilocycles surging about this spherical surface keep it brightly polished and unsurpassed in beauty.

d Unusual heavy wave inputs that clog the receiver may be relieved by a sudden downward pull upon the grasping unit *h*. This is an exclusive feature of this super-excellent antenna.

a Cast iron cylindrical lead-in, closely filled and compacted under three tons hydraulic pressure with magnetic iron filings and gold dental fillings. The molecular action of the filings combined with the capillary attraction of the fillings has been completely utilized in this extraordinary invention.

w Wave trap. Readily adjusted by the regulator h_1. This par excellent appliance (which even a child can attach in a few hours) will freeze out those unwanted, unappreciated local stations.

s Static amplifier and distance eliminator, a necessary adjunct to every antenna.

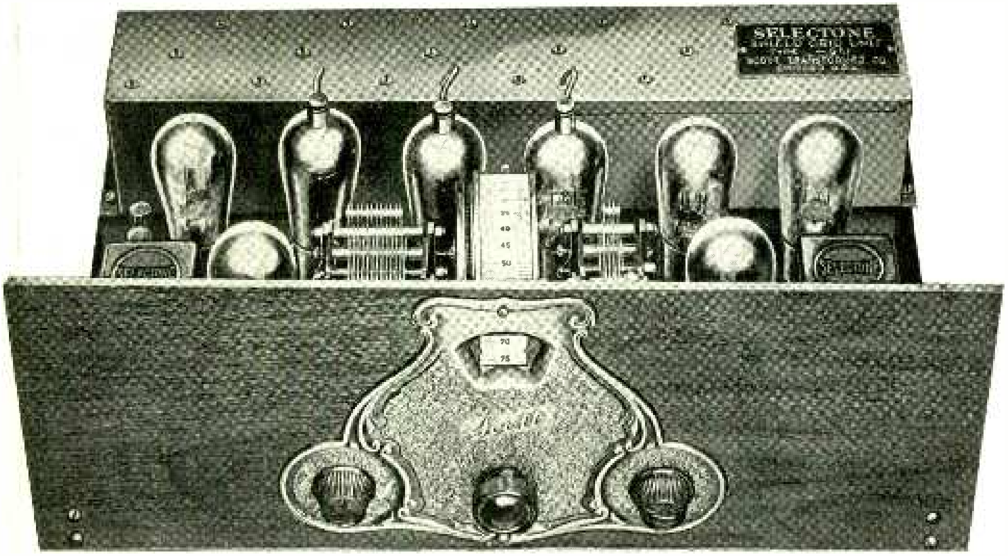
g Supersaturated radio-active soil composed of guanous loam, table salt, cold tea leaves and coffee grounds—a perfect and cool contact for the buried energy diffuser, *p*.

p Interred ground connection. A far-famed method of hiding the unsightly ground return. A joy to the eye.

This marvelous energy collector is unconditionally guaranteed by every plumbing shop, mail order house and gyp by whom it is sold. All that is necessary to make it work is to stretch a 50 ft. length of wire from binding-post *A* and a short length of wire from *B* to the nearest water-pipe.

117 PROGRAMS 6000

Brought in Clearly by World's



Read this record of DX performance

We repeat our challenge to ANY Radio Manufacturer to show a better *verified* DX record than that listed below.

1—A better record for a number of broadcasting stations heard from 6000-8000 miles distant.
- 6 stations heard—*distance* 6000 miles.
- 7 stations heard—*distance* 7000 miles.
- 6 stations heard—*distance* 8000 miles.

2—A better record for number of programs heard from stations distant 6000 or more miles over a period of from one to three months.
- 19 programs from stations 8000 *miles away.*
- 19 programs from stations 7000 *miles away.*
- 79 programs from stations 6000 *miles away.*

The New Scott A. C. Shield Grid 10

This receiver with its extremely high-gain Shield-Grid three-stage intermediate amplifier calibrated to absolute precision, is, we believe, the most sensitive, most powerful A.C. receiver ever made available. It combines, for the first time in the history of radio, direct A.C. operation, tremendous power, perfect tonal realism, single dial tuning, and actual 10 kilocycle selectivity under any and all conditions. The A.C. Shield-Grid 10 is a precision instrument in the fullest sense of the word and it is this precision which makes possible the amazing performance records which the receiver is establishing wherever installed. Precision is carried to such extremes that an adjustment is provided for *instantly* and *accurately* altering the inductance of each intermediate transformer in order to obtain maximum amplification from each tube.

Single Dial - One Spot Tuning

You'll appreciate Scott *precision* when you turn the Scott single dial, for you'll see that stations come in at maximum volume on a very sharp resonance point and that they go out completely at the slightest movement of the tuning dial. And you'll further appreciate Scott precision and Scott engineering when you discover that no station comes in at more than one point on the dial! No "spill-overs," no "harmonics," no thinking you have a distant station only to find it a badly distorted harmonic of a local! Never before has radio offered you so much in convenience, simplicity, power, range, tone and perfect performance as in the Scott World's Record A.C. 10.

Type 245 Push-Pull Audio

As illustrated above, the Scott World's Record A.C. 10 is a two-unit instrument. The first detector, Shield-Grid amplifier, oscillator and second detector are combined in a compact unit with the controls. The A, B, and C power supply for the tubes and for the dynamic speaker is contained in a separate unit which also embodies the wonderful Scott Push-Pull 245 audio system, with its tremendous capacity for undistorted, hum-free output. Mail coupon today for full particulars.

Color coded cable connects pack to receiver.

The Scott Power Pack and Push-Pull Amplifier is designed to give unlimited years of satisfactory, trouble-free service. It is built to the same quality and precision standards as Scott Receivers.

SCOTT TRANSFORMER COMPANY

4450 RAVENSWOOD AVENUE, ASSOCIATED SILVER BLDG., CHICAGO, ILL.

TO 8000 MILES AWAY

Greatest DX Receiver!

This Is the Kind of Performance Your Radio Dollars Should Buy for You!

Most any old set will bring in "out-of-town," has a dynamic speaker and a more or less successful simplified tuning control. But why spend money for average performance, when those same dollars will bring you the thrills of hearing stations that "any old set" can't get? Why buy an ordinary, factory-built receiver, when a laboratory built, laboratory tested set costs no more? Get a Scott—the receiver that holds practically *all* the World's Records—117 Programs 6000 to 8000 miles away! Get the new Scott A.C. Shield-Grid 10. Experience such thrills as we did on May 29th, 1929, when we picked up Sidney, Australia, 12,000 miles away. Think of it! 12,000 miles, and the reception *was not code*, but voice—rich, loud, golden voice and was listened to for over an hour. That's the kind of performance *you* want, and the new custom-built Scott World's Record A.C. Shield-Grid 10 stands ready to bring you distant reception such as you never dreamed possible from a present day receiver. Read all about this sensational radio development on the opposite page.

12,000 MILE VERIFICATION

Just Received!

On May 29th, a standard Scott World's Record Receiver with our new S. W. Adapter, tuned in Sydney, Australia—12,000 miles away.

This reception was accomplished right in the heart of Chicago from a location not at all favorable. The receiver was located in a steel constructed building within *fifty feet* of an *electric elevated railroad* with its high voltage lines. *Fifty feet* to the front of the building is a *steel bridge* and in the neighborhood surrounding it are *steel constructed buildings*.

Yet even in *this* location the SCOTT WORLD RECORD SUPER RECEIVER brings in stations from all parts of the civilized world.

POSTAL TELEGRAPH — COMMERCIAL CABLES

CABLEGRAM

1020 LAWRENCE AVE
PHONE SUNNYSIDE 1199

69CHFW 19 VIA RCA
SYDNEY AUSTRALIA -- MAY 14th 1929 FILE 1200

DLT E H SCOTT

FORTY FOUR FIFTY RAVENSWOOD AVE CHICAGO

LOG YOUR RECEPTION 2 ME MAY TWELFTH AS PER YOUR CABLE HEREBY VERIFIED

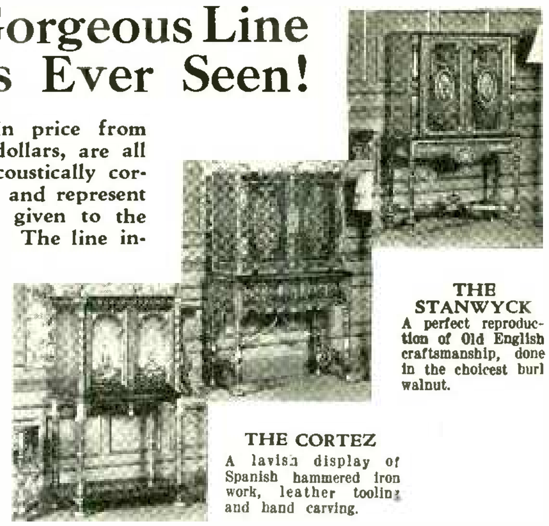
TWO M E

FV - RQ

525P

The Most Gorgeous Line of Cabinets Ever Seen!

Scott consoles, ranging in price from twenty to four hundred dollars, are all especially designed and acoustically corrected for Scott Receivers, and represent the greatest thought ever given to the design of radio furniture. The line includes authentic reproductions of every period motif including Colonial, Renaissance, Gothic, Louis XIV, and Early Spanish. Every design requirement is perfectly met and the quality standard followed in their construction makes Scott consoles the most gorgeous creations ever shown. *And you get these fine cabinets from us for just about half what they would cost you in the open market!*



THE STANWYCK A perfect reproduction of Old English craftsmanship, done in the choicest burl walnut.

THE CORTEZ A lavish display of Spanish hammered iron work, leather tooling and hand carving.

THE CHATHAM A rare and true classic in Gothic period art. The door panels are genuine oil paintings.

Mail COUPON *for* ILLUSTRATED BOOK

Clip, fill-in and mail the coupon at once. It will bring you a beautifully illustrated book showing all the new models of Scott World's Record Radio. Fully describes the A.C. Shield Grid 10, the D.C. Shield Grid 9, and both the A.C. and D.C. 4 tube Symphony models. Also shows the Scott line of specially designed, custom-built consoles. Send the coupon today.

SCOTT TRANSFORMER CO.,
Asso. Silver Bldg., 4450 Ravenswood Ave.,
Chicago, Ill.
Send me your illustrated free book.

Name ....

Street ....

Town .... *State* ....

SCOTT
WORLD'S RECORD
RADIO

RADIOADS

A CLASSIFIED ADVERTISING SECTION READ BY BETTER BUYERS . . . .

Discontinued Merchandise and Job Lot Advertising Must Be Plainly Indicated as Such . . . .

REMITTANCE MUST ACCOMPANY ALL ADS — **RATES: 8 CENTS PER WORD — $6.00 PER DISPLAY INCH**

RADIOADS FOR THE SEPTEMBER ISSUE SHOULD REACH US BY AUGUST FIFTH

"RADIO THEORY AND OPERATING"—4th edition revised, by Mary Texanna Loomis, President of Loomis Radio College, member Institute of Radio Engineers. The leading radio text and reference book of the day. Used by more than 300 radio schools, universities, high schools and technical colleges, and by all the Government radio schools. The book contains 992 pages, 800 illustrations, is right up to date, and is really a whole library on radio. Among the many subjects covered are marine radio operating, radio compass work, land radio operating, television, broadcasting, radio construction, repairing and servicing, airways communications, radio accounting, message forms, junior engineering, and the 1929 radio laws. For sale by bookdealers throughout United States and many foreign countries. Price $3.50, postage paid. Buy of your bookdealer, or send check or money order to Loomis Publishing Company, Dept. 12, Washington, D. C.

AMATEURS-EXPERIMENTERS-BUILDERS—We serve over 4000 IRE, ARRL, etc., experimenters and "nuts." Full discounts. $50,000.00 stock approved parts—no sets. Over four pounds, catalog, circuits, data, prepaid, 50c. Weekly bulletins (new items, results of experiments, etc.) 20 weeks, $1.00. Sample experimenters "Over the Soldering Iron" magazine, 25c. Transmitting data, price list, etc., 25c. Kladag Radio Laboratories, established 1920, Kent, Ohio.

7¼" PYREX strain insulator, 250-watt size. Made by Corning Glass Company. The publishers of "RADIO" are fortunate to announce that we can offer our readers one of these insulators FREE with a subscription to "RADIO." Send $2.50 now in full payment for a 7¼" PYREX insulator for your antenna and get "RADIO" for a year. Or you can have FOUR of the small PYREX 3" aerial insulators FREE with one subscription. "RADIO," Pacific Building, San Francisco, Calif.

GENERAL RADIO WAVEMETERS GIVEN FREE. The type 247-W wavemeter is yours, free of all cost, with only one subscription to "RADIO" for two years. Full price for the wavemeter and the subscription to "RADIO" is only five dollars. No further payments of any kind to make. Only a few of these wavemeters left. Get one now—act quickly. Send $5.00 and your order to "RADIO," 428 Pacific Building, San Francisco, Calif.

SARGENT-RAYMENT OWNERS—Your set converted to A.C. Screen-grid and 345 output tubes for $25.00, including necessary parts. Matched standard screen-grid tubes, $4.00 each. Special S-M power pack, $30.00. More volume, more distance, better tone. Satisfaction guaranteed. Sargents built to order. Radio Inspection Service Co., authorized Silver-Marshall Service Station and Jobber, 193 Trumbull St., Hartford, Conn.

LAST CHANCE! This is the last time that we can offer you a copy of Professor Hermann Schnitzel's humorous book of radio lectures—"Und Comes It Now." Only a handful of copies left. Get a copy free with a subscription to "RADIO" for 4 months. Full price for the book and the subscription to "RADIO," only one dollar. "RADIO," Pacific Bldg., San Francisco, Calif.

RADIO MEN WANTED—Positions wanted—Agencies wanted—Merchandise wanted and for sale—All of these matters can be brought to the attention of readers of "RADIO" with an advertisement in this RADIOAD Section. The rate is eight cents per word. One ad will convince you. More and more advertisers are using these columns. They pay! Mail your ad now for the next issue. "RADIO," San Francisco.

FOR SALE CHEAP—1 three-stage POWERIZER amplifier for heavy volume. Rebuilt with General Radio Transformer in last stage. Uses one '50, two '81, two '27 tubes. Gives good tone. Has no output transformer and can be hooked direct to dynamic speaker. Will sell for $50.00 without tubes. Address Box 101, care of "RADIO," San Francisco.

450 REVIEW QUESTIONS—Supplement to the textbook "Radio Theory and Operating." Just off press. Designed for the home study work of persons preparing for Government examination. Valuable assistance to instructors and students. Price 25 cents in coin or postage. Loomis Publishing Company, Dept. 25, Washington, D. C.

SPECIAL SERVICE—Speaker Rewinding, Magnetizing, $1.50 to $2.50. B Eliminator and A.C. Power Unit Service. Transformer Rewinding, Filter Block Repair. Fast service. Specially equipped shop. Guaranteed work. Clark Brothers Radio Co., Albia, Iowa.

SALESMEN WANTED—Screw-holding screw driver. Amazing brand new patented invention! Retails $1.50. Factories, garages, electricians, auto, radio owners buy on sight! Exclusive state territory. Genuine opportunity, earn big money. Free trial offer. Jiffy 1027, Winthrop Bldg., Boston.

JEWELL RADIO SERVICE SET PATTERN 117, Weston A.C. Voltmeter Model 528, Sterling R408 Tube and Set Tester, Jewell Radio Set Analyzer Pattern 199. Mello Heald eleven receiver in cabinet. G. R. Ewalt, Herington, Kansas.

SELL Pilot "Super-Wasp" receivers, 14 to 500 meters, built and tested, $40.00 or "Super-Wasp" kit, $29.00. We pay postage. Gussie Groth, Hartley, Iowa.

SALESMEN ATTENTION!—Chance to make extra money selling our complete radio index log to dealers. Write for sample and information. Shield Press, P. O. Box 1634, Indianapolis, Ind.

COMPLETE AMATEUR TRANSMITTING and receiving station. Parts, apparatus for sale. Bargain. Martyn Cooney, 475 30th Street, San Francisco, Calif.

WANTED—Men to work with National Radio Service organization. No selling scheme. Radio Doctors, Inc., Dept. R., Essex St., Salem, Mass.

NAVY SURPLUS 800 radio generators and battery dynamotors D.C. and 500 cycles. List. Harry Kienzle, 501 East 84th St., New York.

U. S. CUSTOM SET BUILDERS names, addresses, 50 for 50c, 100 for $1.00. Radio Lab., Box 84, Salt Lake City, Utah.

15 EKKO RADIO STATION STAMPS—No two alike, $1.00. Chas. A. Phildius, 510 East 120th St., New York City.

NAVY SURPLUS—800 radio generators and battery dynamotors, D.C. and 500 cycles. List. Harry Kienzle, 501 East 84th Street, New York.

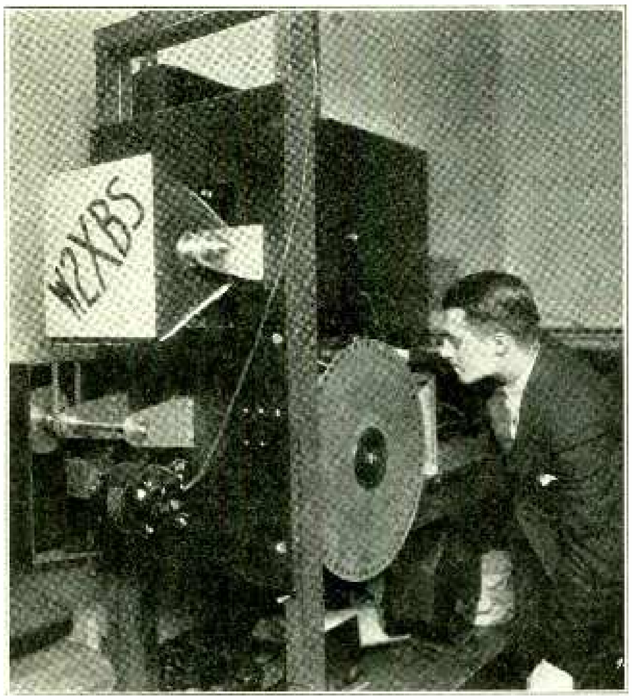
TELEVISION AT W2XBS

THE experimental broadcasting station of the Radio Corporation of America, call letters W2XBS, at 411 Fifth Avenue, New York City, is frequently used for conducting basic experiments in television transmission and reception. Its experimental activities have followed several years of television research and development by engineers of the General Electric Company, under the direction of Dr. E. F. W. Alexanderson, and by television specialists of the Westinghouse Electric and Manufacturing Company, under the supervision of Dr. Frank Conrad.

Recently the television broadcasting has been regularly carried on daily from 7 to 9 p. m. The radio channel assigned to W2XBS is from 2000 to 2100 kilocycles, which is equivalent to a band of from 142.8 to 149.9 meters. The power employed at present is 250 watts, although it is expected that this will be considerably increased shortly. Pictures are 60 scanning lines high, vertically, and 72 elements wide, horizontally. Twenty complete pictures are transmitted each second. Scanning is in such a direction that looking at the received picture, the scanning light spot moves from left to right and from top to bottom.

Transmissions consist of pictures, signs, and views of persons and objects. Announcements are made frequently by transmitting a picture of the call letters of the station. The equipment is contained in a room adjacent to one of the recording studios of R.C.A. Photophone, Inc., and occasionally actors from the sound movie studios will appear before the photo-cells of the transmitter.

Experimental work on such subjects as fading, radio transmission over various parts of New York City and vicinity, picture quality, and other phases of television problems is being carried on by W2XBS.



Picture Target and Monitor Scanning Disc at W2XBS

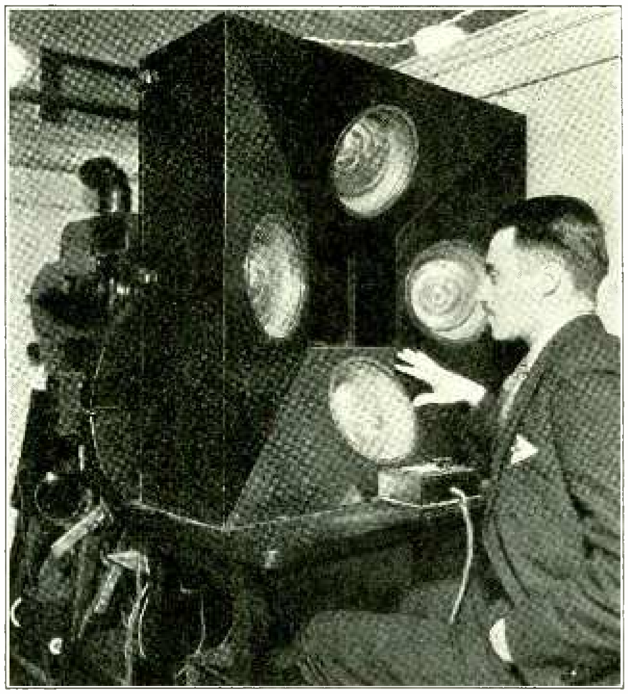


Photo-Cells of Television Scanner at W2XBS

SCHEDULES FOR THE AUSTRALIAN RUN

Gathered by A. B. NOLAN, KDRD and I. MARGOLIS, ex-KDRD

GMT	Stn.	Frqncy. K.C.	Char. of Brdcst.	Location
0027	PKX	19.23	Time	Malabar, Java
0030	VIA	500.	Time	Adelaide
0040	VIS	500.	Weather	Sydney
0057	KUO	435.	Weather	San Francisco
0100	VIP	500.	Weather	Perth
0157	VIM	500.	Time	Melbourne
0200	VIS	500.	Weather	Sydney
0200	VIO	500.	Weather	Broome
0200	VIM	500.	Weather	Melbourne
0215	NPG	4180. 8360.	Weather	Observations U.S. & Can.
0230	KUO	435.	Weather	S. F. Bay
0255	NPO	57.5	Time	Manila
0255	NSS	17.05	Time	Annapolis
0255	VIS	500.	Time	Sydney
0255	NAA	8330.	Time	Arlington
0300	VIS	500.	Weather	Sydney
0330	NPG	42.83 8360.	Weather	Ship and Shore Obsrv. & Frcst.
0410	KPH	445.	Press	S. F. Bulletin
0420	KPH	136.4	Press	"
0420	W6XI	6425.	Prs.& Lst.	"
0430	WNU	90.1	Press	New Orleans
0500	VIS	500.	Weather	Sydney
0550	VMG	133.3	Press	Apia, Samoa
0555	NPG	62.	Time	San Francisco
0600	WHD	9375.	Press	N. Y. Times
0605	KFS	97.6	Press	San Francisco
0700	VIS	500.	Weather	Sydney
0755	NAA	8110.	T. & Prs.	Arlington
0815	KPH	136.4	Press	U. S. & West. Some Foreign
0830	VMG	133.3	Weather	Apia, Samoa
0830	WII	21.82	Press	N. Br'nsw'k, N.J.
0900	KUP	6250.	Press	S. F. Examiner
0930	KHK	136.4	Press	Honolulu
1000	NPL	30.59	Press	San Diego
1030	VIS	500.	Weather	Sydney
1030	VLD	500.	Weather	Awanui, N. Z.
1055	VIS	500.	Time	Sydney
1100	VIM	500.	Weather	Melbourne
1100	VIT	500.	Weather	Townsville
1130	VIA	500.	Weather	Adelaide
1227	VIA	500.	Time	Adelaide
1230	VIS	375.	Press	Sydney
1257	VIP	500.	Time	Perth
1355	NPO	57.47	Time	Manila
1415	NPG	4180. 8360.	Weather	Obsrv. from U.S. Can. & Alaska
1530	NPG	42.83 8360.	Weather	Ship & Shore Obsrv. & Frcst.
1645	KUO	435.	Weather	S. F. Bay
1655	NSS	17.05	Time	Annapolis
1655	NAA	8330.	Time	Arlington
1700	KPH	445.	Weather	San Francisco
1720	KPH	136.4	Weather	San Francisco
1720	W6XI	6425.	Weather	San Francisco
1955	NPG	62.18	Time	San Francisco
2030	KHK	136.4	Press	Honolulu
2100	VLW	500.	Time	Wellington (Tues. & Fri.)
2130	VLW	500.	Weather	Wellington
2230	NPM	54.	Weather	Except Sunday
2230	VLA	500.	Weather	Auckland
2259	VLW	500.	Time	Except Sunday
2300	VIS	500.	Weather	Sydney
2330	VIA	500.	Weather	Adelaide
2355	NPM	26.11	Time	Honolulu
2400	VIB	500.	Weather	Brisbane.
2400	VJZ	125.	Weather	New Britain
2400	VPD	133.3	Press	Suva, Fiji Isl.

DESIGN OF POWER SUPPLY UNIT

(Continued from Page 88)

will give an output of 660 volts at 75 m.a. To reduce this to 495 volts a 2200-ohm resistor should be introduced in the positive lead just before it enters the filter circuit. Thus the voltage across the first filter condenser will be 165 volts less than if the resistor were introduced elsewhere in the filter circuit.

In general, the lower the a.c. voltage which will give the desired d.c. voltage from the rectifier, the longer will be the life of the rectifier tubes and the lower the cost of the transformer and the filter condensers. The same general principles and conclusions are applicable in the design of power units to be used with '45, '71-A, or '50 tubes. In all cases the condensers should have a voltage rating of 1½ times greater than the d.c. potential across their leads so as to take care of various peak conditions.

ARTHUR H. HALLORAN - - Editor
P. S. LUCAS - - - Associate Editor
H. W. DICKOW - Business Manager
A. I. RIVETT - - - - Draughtsman
FRANK C. JONES - Technical Adviser

Entered as second-class matter at Post Office at San Francisco, Calif.

RADIO

Established 1917 Published Monthly

Address all communications to

"RADIO"

Pacific Building, San Francisco, California

NEW YORK - 415 Lexington Avenue
Phone: Murray Hill 5992
CHICAGO - 307 North Michigan Avenue
Phone: State 6079
SAN FRANCISCO - Pacific Building
Phone: DOuglas 0136
BOSTON, MASS. - 86 St. Botolph Street

Subscription Price, $2.50 per year in U. S. and Canada
$3.00 in Foreign Countries

VOL. XI AUGUST, 1929 No. 8

CONTENTS

FORECAST FOR SEPTEMBER ISSUE

J. Garrick Eisenberg specifies the shop equipment needed by a dealer and tells how it is used to service receivers. D. L. Bedingfield discusses the design of r.f. transformers. Frank C. Jones describes how the actual performance of any receiver may be accurately determined, illustrating his points with analyses and performance curves of the Sparton 301 and Radiola 44. For the benefit of the experimenter he also describes the construction of a remarkably efficient three-tube set with '24 r.f. stage, power detector, and '45 a.f. stage R. William Tanner discusses the design and construction of i.f. transformers. G. F. Lampkin demonstrates the advantages of push-pull a.f. amplification. B. S. Naimark presents practical data on extending the usefulness of meters. R. Raven-Hart explains the functions of the plate bypass condenser. C. B Horsley discusses the tuned circuit. Several writers tell of overcoming troubles which are encountered by service men. And for the amateur operator there is a wealth of practical information.

INDEX TO ADVERTISEMENTS

IN THIS ISSUE

An Eye-Opener!!

No further proof required!
Every Service Man and Dealer MUST be equipped with SUPREME DIAGNOMETER Model 400-B if he is to profitably solve every radio service problem. No other testing device or equipment on the market approaches the great range and flexibility of this *complete, portable, simplified radio-laboratory* . . . . . in a carrying case providing compartments for all necessary tools, adapters, tubes and accessories.

The greatest medium available for producing service profits—creating good will—and increasing sales of receiving sets!

Order Now to Assure Fall Delivery

Following the enthusiastic reception given SUPREME DIAGNOMETER Model 400-B, at its initial showing at the Chicago RMA show, dealers everywhere are placing orders in such volume as to prohibit promises of immediate deliveries.

PLACE YOUR ORDER NOW! Orders will be accepted for future delivery on specified dates against which reservations will be made that will insure delivery on desired date. Make use of this plan to avoid later disappointments.

Most good distributors carry the SUPREME DIAGNOMETER in stock. If your distributor cannot supply you, send your order direct on order form below.

SUPREME INSTRUMENT CORP.,
333 Supreme Bldg., Greenwood, Miss.

Please ship .... SUPREME DIAGNOMETER Model 400-B, on the basis checked below:
Net Cash—$139.50 F. O. B. Greenwood, Miss.
Time-Payment Plan—$33.50 Cash and 8 monthly payments of $15.00 each F. O. B. Greenwood, Miss. (No dealers' discounts.)

Date of shipment ....
Signed ....
Firm name ....
Street address ....
City .... State ....

REFERENCES:
Name ....
Address ....
Name ....
Address ....
Name ....
Address ....

DISTRIBUTOR:
Name ....
Address ....

The "SUPREME DIAGNOMETER" Compared with "Set Testers"

Following is comparison of the Supreme Diagnometer with the three leading set testers, which are designated "A," "B" and "C," and the most popular test board on the market, which sells for more than double the price of the Supreme Diagnometer. "X" indicates YES. Blank space indicates NO.

Tests, Functions and Facilities	Set Tester "A"	Set Tester "B"	Supreme Diag-nometer	Set Tester "C"	Test Board
D. C. Filament Voltage Reading	X	X	X	X	X
A. C. Filament Voltage Reading	X	X	X	X	X
Plate Voltage Reading	X	X	X	X	X
Plate Current Reading	X	X	X	X	X
Simultaneous Plate Current and Voltage Readings	X		X	X	X
Grid Voltage Reading	X	X	X	X	X
Cathode Bias Reading	X	X	X	X	X
Screen Grid Voltage	X	X	X	X	X
Control Grid Voltage	X	X	X	X	X
Analysis Without Use of Adapter	X	X	X	X	X
Line Voltage Reading	X	X	X		X
Locate Unbalanced Secondaries	X		X		
Reads Both Positive and Negative Cathode Biasing			X		
Oscillation Test of Tubes			X		
A. C. Line Tube Testing			X		
Bias Emission Tube Tester			X		
Tests 15 Volt Filament Tubes Independent of Radio			X		
Tests Screen Grid Tubes Independent of Radio			X		
Tests Overhead Filament Type Tubes Independent of Radio			X		
Tests Both Plates '80 Type Tubes			X		
Rejuvenates Thoriated Filament Tubes Out of Set			X		
Without Removing from Set			X		
D. C. Continuity Tester Without Batteries			X		
Furnishes Modulated Signal for Testing			X		
Synchronizing—					
By Thermal—Meter Method			X		
By A. C. Meter Method			X		
By Audible Method			X		
Neutralizing Signals Provided			X		
Thermo—Couple Movement Meter			X		
Tests Gain of Audio Amplifiers			X		
Measures Up to 250 Mils. A. C. Current			X		
External Use of Meters	X	X	X	X	X
Of 750 D. C. Meter	X		X		X
Of 750 A. C. Meter	X		X		X
Of 2.5 Amps. Milliammeter			X		
Measures Capacity of Condensers .01 to 9. Mfd.	X		X		X
Tests Charger Output by Meter			X		
Bridges Open of Audio Stages for Tests			X		
Positive Milliammeter Protection for Tube Testing			X		
500,000 Ohm Variable Resistor for Testing			X		
30 Ohm Rheostat for Testing			X		
Self-Contained Power Plant for All Required Tests			X		
Percentage of EFFICIENCY	38%	26%	100%	26%	36%

In addition to the foregoing, the "SUPREME DIAGNOMETER," through its multiplicity of circuits, provides innumerable combinations of value in servicing and analysis work. More than a set tester or test board—a complete laboratory in portable, convenient form at a surprisingly low price. The greatest aid to the radio industry yet developed.

SUPREME
Radio Diagnometer

Makes every conceivable test on any Radio Set-

Registered May 28, 1929.

Trade-Mark 256,950

UNITED STATES PATENT OFFICE.

THE MAGNAVOX COMPANY, OF OAKLAND, CALIFORNIA.

ACT OF FEBRUARY 20, 1905.

Application filed February 25, 1928. Serial No. 262,234.

DYNAMIC

STATEMENT.

To the Commissioner of Patents:

The Magnavox Company, a corporation duly organized under the laws of the State of Arizona, and located at Oakland, California, and doing business at 4250 Horton Street, city of Oakland, county of Alameda, and State of California, has adopted and used the trade-mark shown in the accompanying drawing, for RADIO LOUD-SPEAKERS, TELEPHONE RECEIVERS, AND PARTS THEREOF, in Class 21, Electrical apparatus, machines, and supplies, and presents herewith five specimens showing the trade-mark as actually used by applicant upon the goods, and requests that the same be registered in the United States Patent Office in accordance with the act of February 20, 1905, as amended.

This trademark has been continuously used and applied to said goods in applicant's business since on or about January 1, 1915.

The trademark is applied or affixed to the goods, by placing thereon a printed label on which the trademark is shown, or in any other suitable manner.

The undersigned hereby appoints Townsend, Loftus and Abbett, a firm composed of Chas. E. Townsend, Wm. A. Loftus, James M. Abbett and Thos. Castberg, whose address is 909-917 Crocker Building, San Francisco, California, its attorneys, with full power of substitution and revocation to prosecute this application, to make alterations and amendments therein, to receive the certificate of registration, and to transact all business in the Patent Office connected therewith.

[L. S.]

THE MAGNAVOX COMPANY,
By F. B. TRAVERS,
Vice Pres.

Press of
THE JAMES H. BARRY COMPANY
SAN FRANCISCO, U. S. A.