RADIO WORLD

REG. U.S. PAT. OFF.

The First National Radio Weekly

664th Consecutive Issue—Thirteenth Year

DEC. 15 1934

15c Per Copy

MEASUREMENT OF CAPACITY

MAP OF RADIO DISTRICTS

NEW CATHODE-RAY TUBES

WIDE-PURPOSE GENETESTER

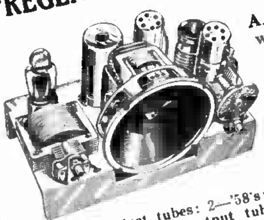
BIG ARTICLE ON MAIN PROBLEMS OF SUPERS

If You Are Buying Any Type Of Receiver .....

ACCEPT ONLY POWERTONE PRODUCTS

"REGENT" Short-Wave Receiver

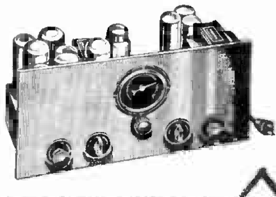
Four-Tube A.C. Operated with built-in Dynamic Speaker



Uses four latest tubes: 2—'58's; 1—'80 and 1—'2A5 power pentode output tubes. Kit includes 4 Bruno coils covering a tuning range from 15 to 200 meters. An extra coil for broadcast band (200-550 meters). Extra 79c.

No. PBS—4 Complete kit of parts, Less tubes $11.50
Wired and tested, extra $2.00
Walnut cabinet 1.50
Set of Matched R.C.A. licensed tubes $2.36

ALL-STAR ALL-WAVE Superheterodyne



Short-Wave A. C. Superheterodyne Receiver

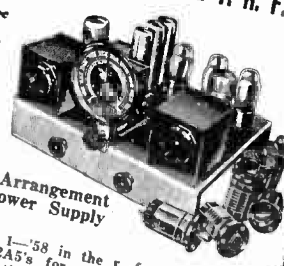
America's EIGHT leading manufacturers of short-wave parts have opened the treasured secrets of their laboratories in the design of this, the most advanced, built-it-yourself short-wave receiver.

Features: continuous band-spread, super-sensitivity (7 tubes), 15 to 550 meters, high fidelity audio system.

Complete kit of parts (List $56.52) $32.14
Kit of parts for beat note oscillator $1.71
Matched R.C.A. licensed tubes 4.21

"OLYMPIC" FIVE-TUBE T. R. F.

Five-Tube A. C. All-Wave Receiver. Equipped with full vision Airplane Dial

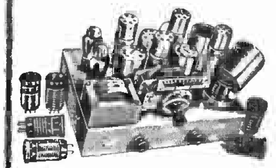


Novel-Coil Arrangement Built-In Power Supply

Latest tubes: 1—'58 in the r. f. stage; 1—58 detector; 2—2A5's for push-pull power stage and 1—'80 rectifier. Kit includes two sets of four coils. Extra broadcast set available for $1.58.

No. OK5—KIT (less tubes) $17.95
Wired and tested $4.00
Special shielded metal cabinet 2.50
Matched R.C.A. licensed tubes $3.01

SC6 ALL-WAVE Superheterodyne



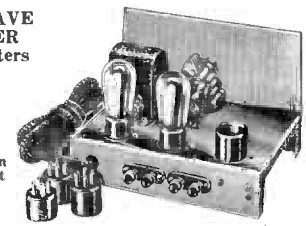
Six Tube Receiver *Tuning From 15 to 550 Meters*

Tubes: 1—2A7; 2—58's; 1—55; 1—80 and 1—2A5.

Kit comes complete with matched dynamic speaker. Broadcast coils at $1.58 pair.
No. SC-6S—KIT—(modernistic dial) $24.50
No. SC-6A—Airplane dial) extra $2.00
Wired and tested, extra 5.00
All metal cabinet (either model) 2.50
Set of matched R.C.A. licensed tubes $3.77

"ROCKET" Two-Tube

SHORT-WAVE RECEIVER 15-200 meters



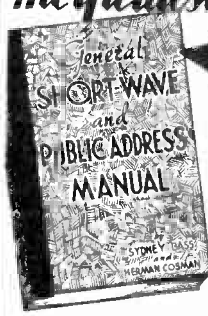
Uses two 230 tubes. Operates on two 45 volt "B" Batteries.

Kit comes complete with 4 coils and instructions.
No. SW5017—KIT (less tubes) $4.50
Wired and tested, extra $1.00
Matched R.C.A. licensed tubes 94c.

Every RADIOMAN Should Have THIS VALUABLE RADIO GUIDE

The Greatest Radio Book Value!

192 PAGES



An authoritative work on general radio touching upon short-waves, public address, transmitting, testing devices and transmitting. Pictorial and schematic diagrams and complete listing of parts. Receivers from a one-tube battery to a nine-tube All-Wave Receiver.

BOUND IN A CARDINAL RED LEATHERETTE COVER

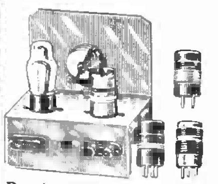
Special! 50c

Authors—Arthur Lynch, Herman Bernard, Frank Grimes, Herman Cosman, W. Bruno, Everette M. Foster, George R. Argabrite and Milton Reiner. Complete tube characteristics, short-wave stations, curves and public address data.

Servicemen will find a horde of ideas to increase their incomes with new methods of servicing, new equipment, new gadgets and new schemes of selling. Experimenters will find scores of modern equipment to build at very low cost.

NOTE: If you are not satisfied with the Manual, return the book immediately and your money will be returned.

"SCOUT" One Tube Short-Wave

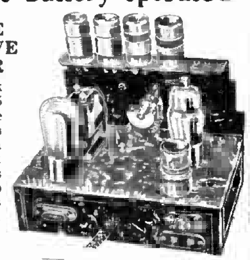


15 to 550 Meter One-Tube Receiver *Using the Low Current Consuming 230 Tube. Ideal for Beginners.*

Requires 1—45 volt and 2 No. 6 dry cells for operation. Broadcast coil at 39c. Kit includes set of 4 coils and complete instructions.
No. SRLK—Complete kit of parts, less tube $3.95
Wired and tested, extra $1.00
R.C.A. licensed tube 47c.

'COSMAN TWO' Battery-Operated

TWO-TUBE SHORT-WAVE RECEIVER

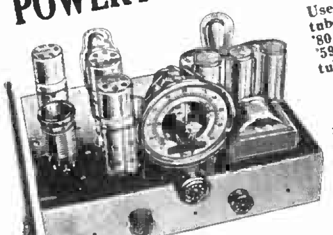


Has a novel rack accommodating 5 coils, four for the short-wave bands and one for a broadcast coil. Kit includes four coils tuning from 15 to 200 meters. Uses two low current tubes—a 232 and a 233.

No. C2K—Complete kit of parts $5.95
Wired and tested, extra $1.50
Matched R.C.A. tubes 1.64

POWERTONE All-Wave Receiver

Uses two '58 triple grid tubes, one '56 triode, one '80 type rectifier and one '59 triple grid amplifier tube.



Available in two models. Kit includes 4 special low loss Bruno coils (15 to 200 meters), and all metal cabinet.
Special Broadcast coil, 79c.

No. 5004K—Kit (modernistic dial) less tubes $17.95
With airplane type dial, extra $2.00
Wired and tested, extra 4.00
R.C.A. licensed tubes $3.09

FREE Catalog

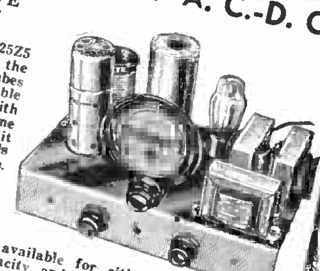
184 Pages full of everything in radio. Short wave receivers, public address equipment, replacement parts, tubes and thousands of other radio items.

Merchandise GUARANTEED perfect quality and the product of reputed manufacturers. All merchandise is shipped within 24 hours after received. LOWEST WHOLESALE PRICES

Send for your Copy Today

Three Tube Universal A. C.-D. C.

SHORT-WAVE RECEIVER



Features the new 25Z5 tube as rectifier for the power supply. Other tubes are '43 and '78. Available in two models, one with a modernistic dial and one with an airplane dial. Kit of parts include 4 coils covering 15 to 200 meters.

All-metal cabinet 1.00

An all-metal cabinet is available for either model. Aid in preventing any hand capacity and thus assuring more accurate reception.

No. SW5114—Complete kit of parts (modernistic dial.) Less tubes $7.95
With airplane type dial, extra $2.00
Wired and tested, extra 2.00
R.C.A. licensed tubes 2.38

TRY-MO RADIO COMPANY INC

85 CORTLANDT ST. NEW YORK, N.Y.

Roland Burke Hennessy
Editor
Herman Bernard
Managing Editor
M. K. Kunins
Technical Editor
OFFICERS
Roland Burke Hennessy
President and *Treasurer*
M. B. Hennessy, *Vice-President*
Herman Bernard, *Secretary*

RADIO WORLD
REG. U.S. PAT. OFF.
The First National Radio Weekly

Price. 15c per Copy; $6.00 per Year by mail. $1.00 extra per year in foreign countries. Subscribers' change of address becomes effective two weeks after receipt of notice.

Entered as second-class matter March, 1922, at the Post Office at New York, N. Y., under Act of March 3, 1879. Title registered in U. S. Patent Office. Printed in United States of America. We do not assume responsibility for unsolicited contributions, although careful with them.

THIRTEENTH YEAR

Vol. XXVI | DECEMBER 15, 1934 | No. 14. Whole No. 664

Published Weekly by Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y.
Editorial and Executive Offices: 145 West 45th Street, New York
Telephone: BR-yant 9-0558

A 5-Watt Transformerless

Universal Public Address Amplifier

By Morris N. Beitman
Supreme Publications

In my book, "Principles of Public Address Systems," appeared a circuit diagram of a 5-watt universal P.A. system. This circuit because of its simplicity of parts and adaptability to use with 110 volts d.c. or a.c. brought much favorable comment and found extensive application.

A number of the later type radio tubes is utilized to do away with the power transformer and to combine the two stage resistance coupled amplifier in one tube. The type 79 tube, originally placed on the market as a class B twin power amplifier, is utilized for this dual purpose.

Two Tubes in One

In reality this tube contains two sets of similar triode elements with a common cathode in a single bulb. The output of the first plate is resistance coupled to the second grid. A 2,000 ohm cathode resistor serves to apply the negative bias to both grids.

The second plate of the 79 is transformer coupled to two 48's in push-pull. The grid bias of —20 volts for these tubes is obtained from batteries. This enables the full plate voltage to be applied to the plates for a five watt output. Of course, the choke must be of the type possessing high inductance with very little d.c. resistance. The 1,500 ohm resistor in the screen grid lead serves to drop the voltage about 20%, a value suggested by the tube manufacturer. By carefully placing the parts and using a load of 1,500 ohms per tube, the distortion may be easily kept within the tolerance limits.

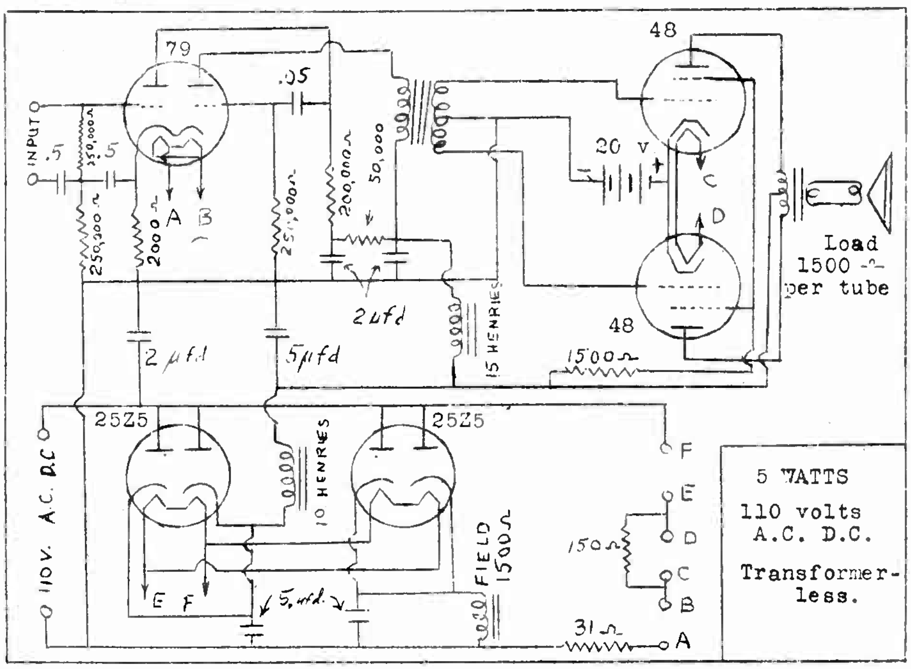
Power Conservation

Two 25Z5 tubes are used in the rectifier circuit. These tubes remain in the circuit with d-c input also, although then not serving any useful purpose. One tube serves the field coil and the other the amplifier.

The tubes are wired in a combination to waste as little power as possible in the voltage limiting resistors. These resistors should be of the power type sufficiently large to handle their respective drops. The values should not be less than 20 watts for the 31 ohm, and 30 watts for the 150 ohm resistor.

The total current drain is about 100 watts which is quite economical for universal P.A. systems.

POPULAR CIRCUIT MADE TRANSFORMERLESS



A popular 5-watt power amplifier.

Action Taken by Board In Cases of Amateurs

The twentieth report of the Telegraph division of the Federal Communications Commission states that 387 amateur station licenses were granted of which 197 were new applications and 190 were modifications or renewals.

It was further stated that the amateur radio operator license of Benson Ernstein, W8KGO, Cleveland Heights, O., was suspended from and including June 9, 1935, because he permitted operation of his licensed station by a person without valid operator's license.

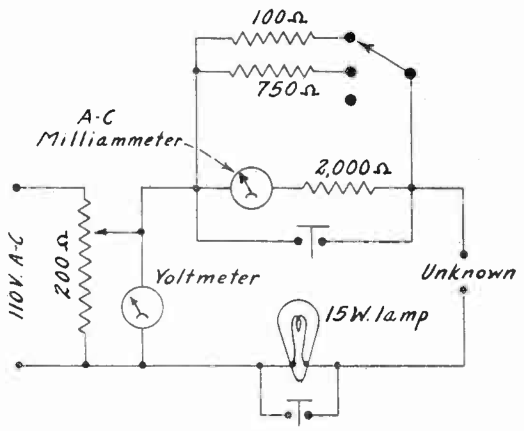
Virgil Childers, Eagle Rock, Calif., and Louis Martucci, Everett, Mass., were barred from examination for radio operator privileges for a period of six months because found operating an unlicensed amateur radio station with valid operator's licenses.

Also Robert Francis Hilburn, W6EWJ, Dallas, Teas, had his radio operator's license suspended to June 26, 1935, because he operated an unlicensed station without valid operator's license and permitted the operation of a subsequently licensed station in violation of rule 400, which pertains to the operation of amateur stations only by licensed operators.

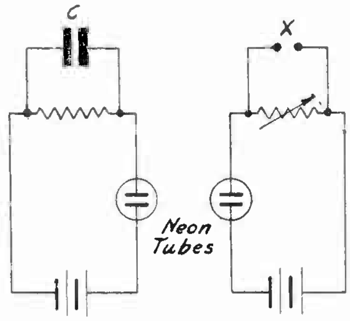
The Measurement of Capacity

Methods Useful for Service Men—Simplified Process Detailed

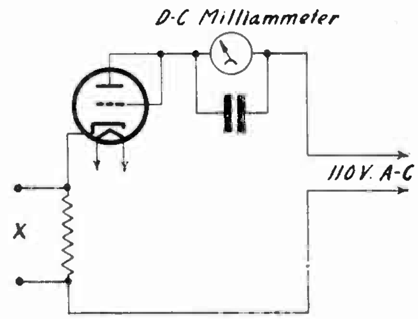
By M. K. Kunins



The measurement of an unknown capacity may be easily made by means of an a-c milliammeter.



An unknown capacity may be visually compared with a known capacity by comparing the alternating flashes from two neon tubes.



An unknown capacity "x" may be roughly measured by connecting it in the resistor-condenser unit usually used for biasing the cathode of an a-c tube.

THE service man and radio experimenter frequently find it necessary to measure the capacity of a fixed condenser. For such work extreme accuracy is not necessary, but what is required is a method that is simple, of fair accuracy and which does not necessitate the use of many meters.

There are many methods of measuring the capacity, leakage and power factor of condensers but many of them involve the use of apparatus not usually available to general experimenters and service men.

One of the commonest methods used to check condenser capacities is to connect the condenser in series with an a-c milliammeter across the 110-volt 60-cycle line. Since the current is equal to the line voltage divided by the reactance of the condenser, it is possible, if we know the line voltage and the current, to calculate the capacity. The formula usually given when this method is used is:

$$C = \frac{1000\ I}{6.28\ f\ E}$$

where I is the milliammeter reading, f is the frequency in cycles and E is the line voltage. Since the ordinary a-c milliammeter has an effective range over which readings can accurately be made of about five to one, it follows that to make it possible to measure all sizes of condensers which are ordinarily encounted a number of meters is required. This is a disadvantage, of course, especially since an a-c milliammeter does not form a common part of the usual equipment of the home laboratory or the service shop.

Use of A-C Voltmeter

Another method used for the measurement of capacities consists of connecting an a-c voltmeter in series with the unknown capacity across the line. The usual procedure in this case is first to measure the line voltage with the voltmeter alone and then to note the voltage reading with the voltmeter connected across the line in series with the unknown capacity. If the resistance of the voltmeter is known, then the capacity may be calculated as follows:

$$C = \frac{1000000}{6.28\ f\ R \sqrt{\left(\frac{E_L}{E_V}\right)^2 - 1}}$$

where C is the capacity in microfarads, f is the frequency in cycles, R is the voltmeter resistance, E_L is the line voltage, and E_V is the voltmeter reading when in series with the condenser. If this method is to be used it will be found that several voltmeters are necessary or at least a low reading voltmeter with several multipliers is required, because accurate indications will be obtained only when the reactance of the condenser is reasonably large in comparison with the resistance of the voltmeter. For this reason, the ordinary 150-volt a-c voltmeter, such as is commonly used to check line voltages, and which has a total resistance of about 15,000 ohms cannot be used to measure large fixed condensers, the reactance of which is so small that a negligible change in voltage is produced when the condenser is connected in series with the voltmeter.

Shunting the Meter

However, by a somewhat different method we may make use of such a voltmeter to measure all sizes of condensers commonly used in radio receivers. A voltmeter of this type may be utilized for these measurements when it is shunted by a condenser to lower its effective resistance. This shunted meter may then be connected in series with the unknown capacity across the line. For different sizes of unknown capacity, this shunt capacity may be made of compatible size, and thus the range of this arrangement is extended. In the utilization of this device, the voltage across the known meter shunt condenser is measured with and without the unknown condenser shorted. Then the capacity of the unknown capacity in microfarads is:

$$C = \frac{E_s\ C_s}{E_L - E_s}$$

where C_s is the capacity of the condenser shunting the voltmeter and E_L is the line voltage when the unknown condenser is shorted and E_s is the voltage when the unknown condenser is not shorted.

An extension of the first method may be devised as shown at left in a diagram. This unit to be described is useful for testing condensers over a range of 0.002 mfd. to 2.5 mfd. and can be used to test all types of electrostatic condensers within the limits of capacity mentioned. In other words, the meter will test for capacity practically every paper condenser used in the present-day radio receiver and also will test some of the mica condensers to be found in such sets. This test unit, as shown in the first diagram, cannot be used for the testing of electrolytic condensers because the voltage is too great. Adaptation for electrolytic purposes may be accomplished by a step-down transformer before the voltage potentiometer.

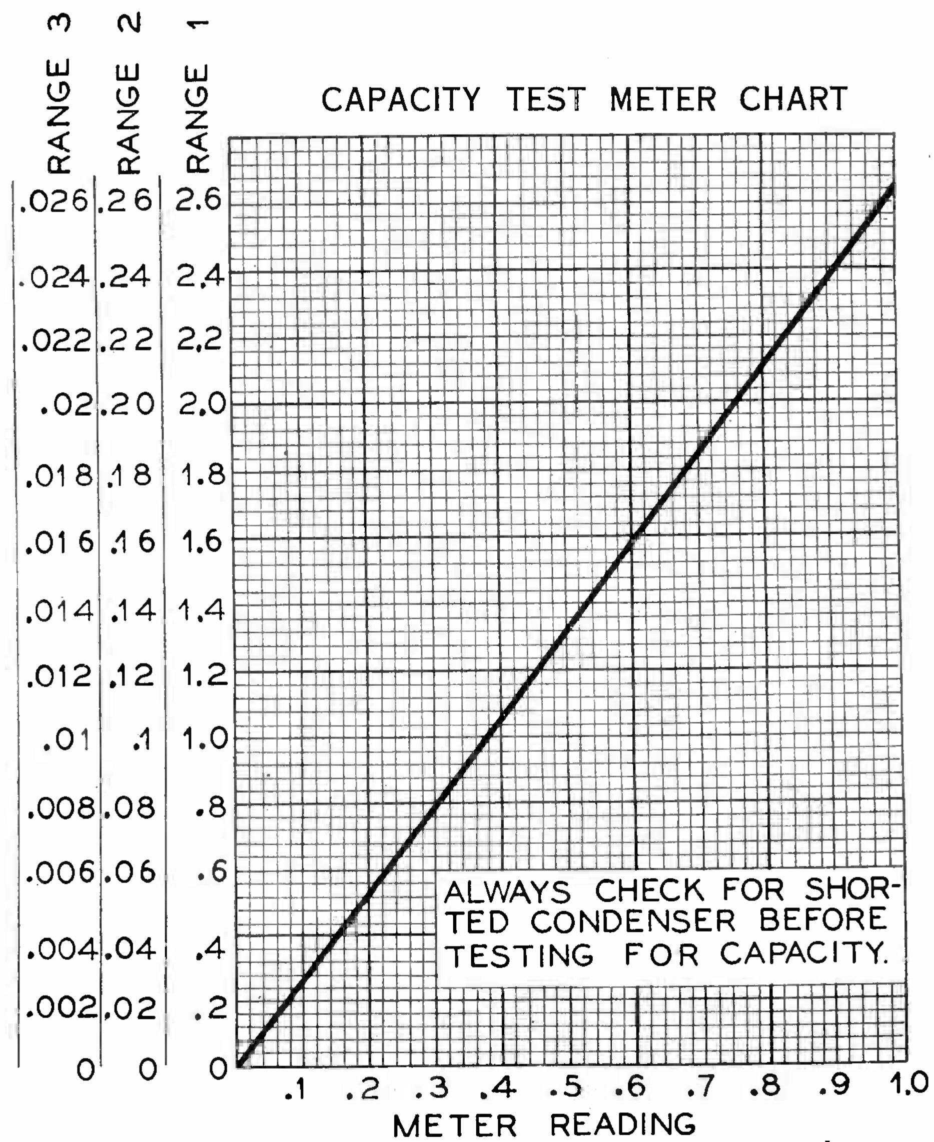
The theory of this capacity test unit is the simple one of applying a known voltage to a condenser and measuring the amount of current that flows through the condenser. From the readings of current and voltage, the capacity may be calculated, but to simplify the matter there is given a graph which makes it possible to read the capacity after the necessary voltage adjustment has been made and the current read from the meter.

Work Is Fast Enough

By resorting to somewhat more complicated calibration methods than are given herein, more rapid testing is possible, but the additional calibration difficulties involved are hardly worth the trouble because the number of condensers which must be checked for capacity by the average service shop or experimenter is not sufficiently great to necessitate very rapid testing. It is believed that the graph will perform its function most satisfactorily and readily and will allow sufficient speed in testing.

The fundamental circuit of the meter is shown in the first diagram to the left. The source of voltage is the 110-volt 60-cycle alternating-current line. Across the line is connected a potentiometer which

(*Continued on next page*)



This chart correlates the meter deflection with the shunt across the meter to obtain the value of the unknown capacity.

Courtesy Aerovox Research Worker

(Continued from preceding page)
serves to permit adjustment of the voltage to the proper value. Theoretically, this potentiometer should be of the continuously variable type, but from the viewpoint of simplicity, it may be an adjustable unit. The calibration graph has been based on the use of such a resistor. The milliammeter is a 1 milliampere full-scale rectifier type a-c instrument. The resistors in this meter's circuit are of the adjustable type and are used as shunts for this meter, to allow for various ranges. The parts required are:

Potentiometer: Adjustable resistor, 200 ohms maximum.

Milliammeter: Rectifier type, 0-1.0 milliampere range.

Shunts: Adjustable resistors, 100 ohms maximum; 750 ohms maximum.

Series meter resistor: Fixed resistor, 2,000 ohms.

An ordinary low wattage incandescent lamp.

Two single-pole, single-throw, push-button switches.

Voltmeter: a-c type, 100 volts range.

Short Indicator

The various parts can be laid out in any convenient manner. If a panel is used the only parts that need be on the panel are the meters and the three switches, and possibly a ruby glass for lamp indications, if this refinement is desired. The incandescent lamp is a short indicator and while it can be mounted in the rear, some arrangement should be made so that the light from it is visible to the operator. The ruby glass should be of fairly large size to accomplish this purpose most efficiently.

After the units are mounted in place, the calibration of the various ranges must be accomplished. All that this really involves is the proper fixed adjustment of the two shunt resistors in the meter circuit to the proper values. This can be done as follows: Temporarily connect the meter to a small filament transformer of six to ten volts, across the secondary of which is placed a low resistance potentiometer. The milliammeter switch should be open and the lamp switch should be closed. The range switch, by means of which the various milliammeter ranges are chosen, should be placed on the contact corresponding to Range 2, which is the position where the 750 ohm resistor is connected across the meter. In series with the lamp side of the line, between the lamp and the unknown test posts, a 10 milliampere a-c milliammeter should be connected, for calibration purposes only. The unknown test posts should be shorted. Now move the arm of the temporary potentiometer across the low voltage filament transformer to minimum position. In this position, no voltage will be supplied to the capacity test meter, when the transformer is connected across the power line. This is a very important point and should be carefully followed, since carelessness will result in a burned-out milliammeter.

Now connect the transformer across the 110-volt line and very gradually move the arm of the potentiometer just mentioned while you are watching both meters at the same time. The thing to do now is to adjust the 750-ohm resistor shunt to such a position that the 0-1 milliammeter will read full scale, when the 0-10 milliammeter reads 10 milliamperes. This is most economically done step by step. If the 10-mil meter reads 10 milliamperes before the 1-mil meter reads full scale, then the 750-ohm resistor shunt resistance should be increased; if the ten-mil meter reads less than 10 milliamperes when the 1-mil meter reads full-scale, then the resistance of the shunt resistor must be decreased.

The best method is to read the two meters, decide what adjustment must be made, then bring the slider of the potentiometer across the transformer to zero voltage position before the actual adjustment of the shunt resistor is made. When the resistance of the 750-ohm resistor shunt is adjusted so that the 1-milliampere meter reads full scale when the 10-mil meter reads ten milliamperes, the calibration of Range two is completed. It is now necessary to calibrate Range 1. This is done in a manner similar to that used in the calibration of Range 2 except that the 10-milliampere milliammeter is substituted with a 100-milliampere milliammeter of the alternating current type. The job to do here is to adjust the 100-ohm resistor shunt to that value which will cause the one mil meter to read full scale when the 100-mil meter reads 100-milliamperes. When this has been accomplished, the calibration of the unit is completed and the meter is ready for use.

It should be realized that the accuracy available from this instrument will depend greatly upon the care with which the foregoing adjustments of the resistor shunts were carried out. Furthermore, when the proper adjustments have been found, means should be taken to prevent any future changes in the adjustments. If slider type of resistors are used, the clamping nuts should be well tightened.

The unit may now be restored to its original condition without the filament transformer and the potentiometer across it. The 100-milliampere meter is also removed. It will not appear as shown in the diagram at the left, and is now ready for use. After the unit has been connected across the line, the slider on the voltage adjusting potentiometer should be set to the point where the voltmeter reads 100 volts. This reading should be 100 volts at all times. If the voltmeter does not read 100 volts, the capacity reading will inaccurate to the degree that this reading is off. Ordinarily, this reading may be a few volts more or less than 100 volts, without seriously impairing the instrument's accuracy because condensers themselves generally have capacity tolerances of plus or minus 10 per cent or even more. Since the condensers may be ten per cent higher or lower than their rated value, a few per cent inaccuracy in the meter adjustment is not of too great importance. If the line voltage fluctuations are considerable, it may be necessary to constantly readjust the line potentiometer, however.

Now to test the capacity of an unknown condenser. This may be a condenser that has been lying around without a calibration on it and it is desired to ascertain whether it will fill a certain purpose. Or, the bypass condensers of a balky receiver may be suspected of foul play. Whatever the purpose is, the condenser may be measured by connecting it across the unknown test terminals. Range switch 1 (with the 100 ohm resistor shunt) then should be connected into the circuit.

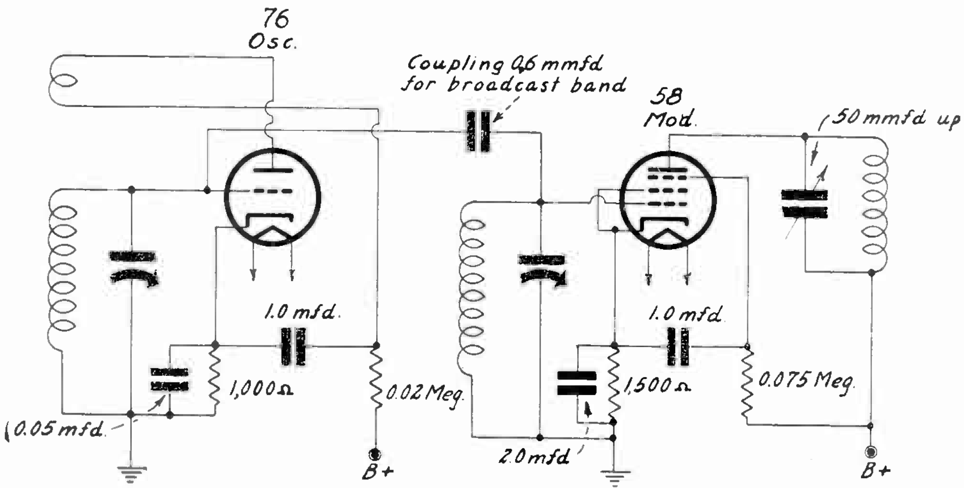
Then, while keeping the milliammeter push button switch depressed, the capacity meter is connected across the 110-volt power line and the line potentiometer adjusted for a reading of 100 volts on the voltmeter.

(Continued next week)

Superheterodyne Design Problems

Chief Trouble is in the Mixer—Some Remedies

By Herman Bernard



The oscillator at left is coupled to modulator at right through a small fixed capacity. By this method certain troubles are averted. For much higher frequencies the coupling may have to be increased a little. It would be satisfactory to switch from one capacity, 0.6 mmfd. (a commercial product), to 1.5 or 2 mmfd.

THE problems associated with the design and engineering of a superheterodyne, especially for multi-range coverage, are numerous and in some respects baffling. In fact, like so many other problems in radio, there is no present complete solution for some of them, and compromises must be adopted. It is this selection of compromises that differentiates the performance of one receiver from that of another.

A grouping adopted for the present discussion follows:

1—Selection of tubes.
2—B supply
3—C supply
4—Radio-frequency circuit
5—Mixer
6—Intermediate frequency amplifier
7—Audio-frequency amplifier
8—Selectivity and fidelity
9—Sensitivity

Trend to 6.3-Volt Tubes

Naturally, some of these classifications overlap. Since the circuit is a unit, any one itemization may be shown to be related to any other. The purpose of the tabulation is largely to provide a sequence of discussion.

The selection of tubes is concerned with most of the itemization. It concerns both the power consumption and durability of the tubes, also the performance of the receiver in some aspects. In the main, it will be found that even for a-c operation, the automotive series tubes is being used growingly. The day may come when their use will be almost exclusive for a-c sets, save for power tubes and rectifier. The designation "automotive" may have to be dropped.

The two considerations that impel the selection of the 6.3-volt series tubes are the lower power requirements and the ruggedness of the elements. The performance is the same as that of the equivalent 2.5-volt series tubes.

Take two typical tubes, the 58 and the 6D6. The 58 requires 2.5 volts at 1 ampere for the heater, or 2.5 watts. The 6D6 requires 6.3 volts at 0.3 watt, or 1.89 watts, or only about three-quarters the amount of power required for the other. The saving is not very important, unless the number of tubes runs high. But then the consideration of ruggedness must not be ignored. This applies to the handling of the tubes as well as their use in the set. The tube has to be considered from the moment it leaves the factory until the tube's serviceability has been exhausted by use.

Battery Type Tubes

Therefore durability and economy have something to do with the choice of tubes for an a-c set. For other uses these factors do not enter so much. For automotive sets, the 6.3-volt series is compulsory. For battery sets the A and B current drain are controlling, and the choice narrow for any given use of performance.

Tube selections become somewhat habitual, especially as circuits become practically standardized. An example is the use of the pentagrid converter tube. There is one such tube for each general series, except that for the battery group there are two, the 1A6, which is all right for broadcast or lower frequencies, and the 1C6, necessary if there is to be anything like satisfactory performance at frequencies above 10 mgc. When high conductance is needed to make amends for circuit losses at high frequencies, the 1C6 must be used. Its conductance is practically double that of the other tube.

Also, the selection of tubes has something to do with each other itemization in the list, directly or indirectly. The regulation of the B supply, for instance, refers in a way to the type of rectifier tube used.

If a rectifier type C supply is used, the choice is limited to a filament type tube, for the negative bias must be applied the moment the set is turned on, lest the power tubes be damaged by operation at high voltage without bias, and possibly filter condensers ruined. Freedom from cross-modulation and inter-modulation depends somewhat on the tubes used. The mixer may be a good or a poor performer, depending on the same consideration. The intermediate amplifier's gain also is based on the tube selection, while the audio channel must have tubes to fill the specific purposes: otherwise fidelity will be adversely affected. Of all the considerations perhaps selectivity depends least of all on the type of tube used.

Well-Regulated B Supply

The B supply of course is a problem associated with any type of a-c receiver. Highest standards would dictate the selection of a B supply consisting of a mercury-vapor rectifier, a choke input, a low-resistance main B choke, and a low-resistance high-voltage secondary winding. In this way the regulation is excellent, the best obtainable at present. The voltage drop in the rectifier is practically constant at 15 volts, regardless of current, due to the negative resistance characteristic of this tube. The voltage change due to current variations through the coils is small because the d-c resistance of these coils is small.

But the high-voltage secondary has to be of higher voltage than ordinarily, about 25% more, as there is no condenser next to the rectifier to hold up the voltage. Also the ripple voltage is large when the first condenser is encountered, and the first filter capacity in particular must be considerably larger than the 8 mfd. found in other systems.

Having the hum level low, practically unnoticeable, is a primary requirement. Other factors affect hum. Coupling between power transformer and audio transformer should be avoided, and these devices placed at the critical angle of no electromagnetic coupling. In circuits where the B current may be small, as in resistance-coupled amplifiers, two plate resistors are used in series, and from the joint to cathode a large capacity is put.

Impedance Values

The impedance of the condenser should be one-tenth that of the resistor (the d-c resistance and impedance of the resistor being the same). The frequency to consider is 60 cycles for half-wave rectification and 120 cycles for full-wave rectification. The impedance of 1 mfd. at 60 cycles is 2,650 ohms and at 120 cycles is half that, so the resistors would be respectively 25,000 and 12,000 ohms, respectively. It is better to use even larger capacity, the same proportion of ten to 1, the condenser's impedance proportionality being inverse, that is, the higher the capacity the lower the impedance. The lower resistor is necessary anyway in circuit where the resistor must not be so large as to reduce the plate current appreciably, because of a power-handling purpose of the circuit. This would apply to driver and output power tubes, the only instances (save for the rectifier) when power considerations enter. All other purposes of tubes in sets are for voltage handling.

The C supply, to be consistent with best regulation, should be of the rectifier type. Hardly any sets have this, but probably the situation will change in the future. The greatest power output for equal other conditions arises when the rectifier type or battery C supply is used. Also, there is no common impedance in the bias circuit, which is a circuit free of signal current. The rectifier type C supply is on exactly the same footing as the use of batteries for biasing, and is suggested because of the reluctance of set owners to having batteries where the service can be derived from the power line.

Other Biasing Methods

Both batteries and the C rectifier represent fixed bias. The next best choice is semi-fixed bias. A heavy bleeder current is used, by putting a relatively low resistance across the output of the filter, and connecting cathode to a positive point and grid return to B minus. Through this resistance also flows plate current of the biased tubes, and the smaller the proportion of this tube current to the bleeder current the better the regulation or performance. In all instances a large bypass condenser is required across this biasing section. Another adaptation of semi-fixed bias is to use a tapped negative-leg B choke. But due to the high resistance of the winding, usually speaker field, the regulation is poor.

Self-bias, due to the drop in a cathode resistor, is the one most used, because most economical, but it is also the one that has minimum performance advantages. By poor regulation is meant that the voltage changes considerably due to changes in B current necessitated by the effect of the carrier or modulation upon the receiver tubes.

The first consideration usually arising concerning the r-f circuit is that there must be a stage of t.r.f. Practically everybody is agreed to this. The principal reason is that interference is lessened. Selectivity is increased, of course, but this is advantageous principally in relation to image suppression. Other purposes for which selectivity is required are served by the intermediate amplifier. And, besides, at the intermediate level the selectivity is practically constant, regardless of the station-selector frequency. This condition is described as "arithmetic selectivity."

High Gain Desired

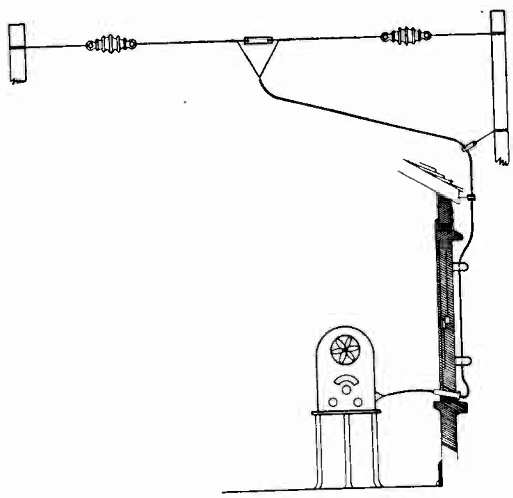
If there is a good reason for having one stage of t.r.f. perhaps there is just as good a reason for having two stages of t.r.f. However, as switching from the front panel for coil changing is imperative, due to popular reaction, and the number of switched circuits has to be kept at a minimum, and besides placement of another assortment of coils raises another problem, except in special engineering endeavors more than one r-f stage are to be expected.

The r-f stage itself needs little special consideration beyond the statement that it should be included, and that the primary in the plate circuit of the tube should be of high enough impedance to develop a sizeable voltage for effective transfer to the modulator input. In this circuit noises are most serious, hence the gain should be as large as practical, as the higher the ratio of the gain to the circuit noise, the higher the ratio of signal to noise.

But we must not forget that an antenna has to be used, and must be coupled to the first tube. Noise brought in by the aerial therefore has to be considered.

Noise Is a Problem

Learned societies are co-operating in a study of causes of and remedies for noises in sets. It is not the intention to anticipate any of their findings. In general it is known that noise brought in by way of the aerial largely originates nearer the ground. Hence if no pickup takes place between antenna and ground one source of noise is reduced. Moreover, it should be noted carefully, when the pickup by the leadin is killed this way, there is less aerial. In many installations the leadin is by far the more effective part of the antenna. The horizontal portion might be disconnected with slight difference noted.



Doublet aerial.

The method for killing the pickup by the leadin is to use a transmission line. The best type, not in lay use yet, is the concentric tubing. That consists of two hollow copper tubings, one inside the other, either one grounded, the other live. It is usual in station practice to ground the outer tubing. Twisted pair, and more widely separated transposed leadins, both for the purpose of neutralizing signal voltage developed in the line, are used increasingly.

A point worth noting is that when the leadin ceases to be a part of the antenna the aerial is electrically shorter, and so the coupling between stations and receiver is looser. And a system of loosened coupling results in the reduction of the type of noise created by motors of various types.

A series antenna condenser will sharply reduce the input of this noise, and reduce the signal pickup less.

A Simple Noise Remedy

Undeniably the input will be much less generally, but receiver amplification may be increased. While the tube noises become greater the greater the gain, still the riddance of the main trouble is the reward, and the net result is far more satisfactory.

The reason evidently has to do with the smaller antenna capacity, looking into the set, presenting a low impedance to the interfering frequency, which usually is somewhere around 50 kc. The fact that the motor noises repeat themselves along the broadcast band on the set dial discloses the frequency. The spacing of repetitions in frequencies is the same. The original trouble therefore is on a frequency equal to the difference between consecutive frequencies of noise tuned in, and the repetition is due to harmonic generation in the receiver of this troublesome frequency. Service men can make quite an impression on afflicted clients by resorting to this remedy, demonstrating the wiping out of the noise, and necessarily explaining that the signal now is without interference, though the total result is weaker. An extra stage of audio would easily compensate for the diminution without endangering the remedy.

Cross-modulation, or one carrier riding in on another, is reduced or eliminated by use of remote cutoff type tubes, which also are aids in preventing inter-modulation, which consists of distortion of a program from regeneration or overload. Regeneration is avoided by r-f filtering, especially the use of bypass condensers of much greater than usual capacity across series-cathode resistors, for r.f., 1 mfd. and for i.f. 2 mfd. Proper shielding is assumed.

Mixer Troubles

The mixer is decidedly troublesome. This is also called the converter tube, because in that tube the incoming carrier frequency is changed to the intermediate frequency. This change at present is to a lower frequency.

Some of the mixer troubles follow:

1—Oscillator does not sufficiently modulate the modulator.

2—Oscillator overmodulates the modulator.

3—Oscillator conductance becomes too low at high frequencies.

4—Oscillator and modulator lock at high frequencies

5—Charging current at oscillator frequency flows in the modulator tuned circuit

6—Coupling changes with frequency.

7—Oscillator is unstable.

8—Unintentional grid current flow in modulator or oscillator or both.

9—Oscillator harmonics too strong

10—LC ratio is low

11—Oscillator couples strayly to r-f tubes.

12—Mispadding.

If the oscillator output does not sufficiently modulate the modulator there will be a strongly hissing response, noise due to the receiver will be heightened, and mixer tube performance in general will be poor.

Modulation Adjustment

Assuming the modulator negatively biased in the usual way, measure the plate current. Remove or short the biasing resistor and insert a 1.5-volt dry cell for negative bias, between grounded (B minus) cathode and grid return. Restore the circuit to its original form. Produce enough generation from the local oscillator, or make the coupling to modulator tight enough, so that the plate current will be exactly what it was with the 1.5-volt dry cell used for biasing.

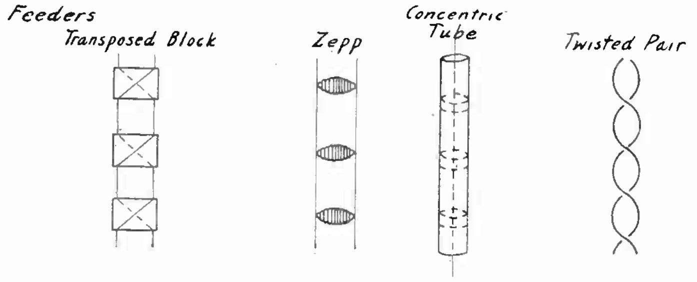
If the local oscillator delivers different voltages at different dial settings of the same band, use the test setting that produces the largest voltage. For negative-biased tubes using the series-cathode method, or equivalent, the plate current increases without carrier increase. For grid-leak condenser type circuits the opposite is true.

Repeat Points

Increasing the plate voltage on the oscillator may be resorted to as a method of increasing the amplitude.

The local oscillator may overmodulate

(*Continued on next page*)



Transmission lines identified.

(*Continued from preceding page*)
the modulator. The previous test would show that, as then the plate current would be larger than that obtaining when the sole biasing basis is the 1.5-volt cell.

Where grid-leak-condenser detection is used the test need not be made, as the method of biasing is sufficiently automatic and complete to afford its own safeguard.

Fewer tickler turns, looser coupling between modulator and oscillator, and lower oscillator plate voltage will reduce amplitude as a corrective for overmodulation.

One sign of overmodulation is that a station may be tuned in at two points, one close to the other, with silence between. This same condition may prevail at high frequencies, due to repeat responses because the oscillator and modulator frequencies differ by only a small percentage, so test for repeats due to overmodulation by using the broadcast band.

Oscillator conductance is a function of the tube. Such conductance loosely refers to the amount of current that will flow through the tube at some stated voltages at the terminals. For triodes this is called usually the mutual conductance. For tetrodes, pentodes, etc., the transconductance is referred to, on the basis of plate current, as a special case of mutual conductance, on account of the other influencing elements. Especially is this a significant distinction in the case of screen grid tubes, where the plate current, hence transconductance, depends practically on the screen voltage, and not on the plate voltage.

Conductance of Tubes

Put in an everyday term, the mutual conductance or transconductance may be described as the "hop" of the oscillator. More conductance, more hop. Since the trouble is that the oscillator has too little conductance, let us look at the ratings of a few tubes as to conductance in micromos, based on measuring plate current change due to grid voltage change:

6C6=1225
6D6=1600
6F7=1100
24A=1050
30= 900
34= 620
35= 420
37=1100
55=1100
58=1600
78=1650
112A=1800

The table does not give the conductance of the oscillator of the pentagrid type tubes, nor of the 56 and 76, both of which are excellent oscillators, and of relatively high conductance. And the values in the table are taken for the optimum conditions, besides not having to do with the actual conductance when oscillating, which may be greater or less, depending on the type of oscillator. For the types other than grid-leak-condenser bias the conductance is higher during oscillation, because the oscillation voltage works against the steady negative bias. Leak condenser hookup causes increase in negative bias as the oscillation amplitude increases, on the basis of the curvature of the tube characteristic.

In general, the higher conductance type of tubes is to be preferred, so that if a separate oscillator is to be used it may be the 56 or the 6.3-volt equivalent, the 76.

The Electrons

The triodes used as the oscillators in pentagrid converter tubes have a good mutual conductance, as proved by the fact that oscillation is maintained to 25 mgc, but there is little control of coupling. The type of coupling intentionally present is called electron coupling because it depends on the mixing of electrons, or coupled emission. Some electrons have the frequency of the oscillator and other electrons the frequency of the modulator. Still others have the frequency of the intermediate channel.

Only the intermediate-frequency electrons have any interest after the conversion, hence a tuned-plate circuit is used to detour the higher frequencies (oscillator and modulator) from the i-f circuit. A capacity of no less than 50 mmfd. should be used. In practice around 200 mmfd. is found.

The pentagrid tube has certain advantages. There is only one envelope. Radiation is minimized that way, also stray coupling, both due to shorter and fewer wires connecting tubes externally. The coupling is substantially independent of frequency. In some aspects this may be injurious, since there is no selectivity in the coupling, and circumstances might require lesser coupling at higher frequencies to safeguard against locking, although other reasons in other cases impel tighter coupling at higher frequencies.

Displacement and Space Charge

Besides there may be displacement coupling. If there is a voltage across two separate circuits and a small condenser unites these circuits, the current flowing through the condenser is known as the charginig current or displacement current. So we may have displacement current at the oscillator frequency in the control grid circuit of the modulator, especially when the two frequencies differ by only a small percentage, as when the station carrier frequency is high. This displacement current reduces the conversion conductance, or the obtainable i-f output voltage compared to the two voltages put into the tube. If the coupling could be loosened this displacement current might be avoided, but in the pentagrid converter tube the electron coupling is fixed, and the displacement current might become serious. Use of a separate oscillator tube permits selection of a coupling value more consistent with requirements, and even introduces the possibility of changing the coupling for high frequencies.

Space-charge coupling is due to the electrons accumulating. There is a sort of vibrating cloud of electrons in the space stream. The tendency of the elec trons is to flow from the cathode and strike the plate. The "elastic" property of the electrons tends to make some of them bounce off the plate back toward the cathode. But an extra grid often is interposed to prevent this secondary emission. In all tubes, even where the electrons are prevented from returning toward the cathode beyond the suppressor grid, the accumulation may take place, the accumulation or cloud being in a state of agitation. All frequencies concerned in the operation of the tube influence the space charge, hence the space charge is an unintentional form of coupling. As yet it can not be quite eliminated.

Coupling and Overcoupling

Also, this extra coupling helps make the two circuits lock when the signal-carrier frequency is high. That is, instead of two frequencies there is one frequency. Thus the benefit of r-f tuning is lost and tube performance is lowered by overload. The other unintentional coupling, due to displacement current, has the same effect. And it is therefore well to try to control the coupling even where intentional coupling is used.

A small condenser connected from grid of separate local oscillator to grid of modulator makes a good coupling device. Space-charge coupling may be counteracted by this method, although for the higher frequency bands the capacity may have to be around 1.5 to 2 mmfd., somewhat less for lower frequencies. But for a pentagrid converter tube space charge coupling has to remain, as it is the inherent basis of operation that the space charge be varied by the oscillator frequency about the control grid.

Coupling changes with frequency, when not intentional and corrective, tend to make the performance uneven, modulation changeably too great or too little or just right, not only from band to band, and sometimes even in the tuning of a single band. Inductive and capacitive methods are referred to particularly.

Frequency Stability

Instability of the oscillator is practically always present. There is no acknowledged stabilizing method that does not require at least an extra tuning condenser or an extra coil or tube. Some methods require an extra condenser and extra coils. However, a series resistor helps, and must be bypassed. It is located in the plate circuit, and lest the B voltage be reduced too much the series resistance should not be more than twice the plate resistance. For triodes around 10,000 to 20,000 ohms would be used, for other tubes 100,000 ohms or so. A way will no doubt be found for stabilization of the oscillator in a more complete way without much amplitude loss and without requiring extra parts that are bulky or costly.

A ready aid is to operate the oscillator at a much higher plate voltage and negative grid bias than usually. Then the change in oscillator amplitude becomes much less as the tuning condenser is rotated from one extreme to the other.

Amplitude stability and frequency stability run hand in hand. The previously-cited case of the oscillator that developed different voltages of oscillation at different frequency or capacity settings in a given band was simply an example of an unstable oscillator. When a plate current meter needle is relatively steady over a tuning range the frequency stability and amplitude stability (they are the same) are good.

Grid current is obnoxious when unintentional. Even the leak-condenser type of circuit is a device for drawing power from the utilized source, hence selectivity is lower. Sensitivity is greater only because of the rectification in the grid circuit, that is, use of the amplifying properties of the tube, just as in the case of any other diode-biased triode, which the grid-leak-condenser circuit really is. The fixed-bias, semi-fixed bias and self-biased types of circuits are better from the viewpoint of selectivity, because no power is taken from the source, that is, the tube is not a current-drawing device, considering it for the moment as if a meter. But grid current may flow nevertheless, and is to be avoided. It will flow even when the bias is 0.8 volts negative on heater type tubes, and even when the bias is more negative than that, due to ionization about the grid.

If the modulation is introduced into or output taken from an extra element, as modulation of suppressor, or output from plate returned to ground, where the positive element is the screen, current from these grids will flow. This is largely a space charge effect. Electrons in motion produce a voltage and this voltage influences the grid so that current flows. All such current is at the expense of the cathode and sometimes grid current may be as large as plate current, thus seriously affecting the performance. What current the grids take is denied the plate.

Harmonics

Strength of oscillator harmonics is a serious drawback when there is no t.r.f. ahead of the modulator. Then a station may be tuned in at the low-frequency end of the dial though it belongs at the opposite end. WMCA ought to come in only at 85 on the dial, let us say, and so it does, but also it comes in at 20. The second harmonic of the oscillator produces the result, and the trapping by the r-f section is insufficient to keep out the lower-frequency carrier. The harmonics may be reduced by shifting the operating point of the oscillator, as by increasing the plate voltage. If the series-plate resistor method is used for stabilization aid it will be found that the odd order harmonics are very greatly attenuated, almost absent. If the oscillator were made push-pull there would be practically no harmonic output, as push-pull eliminates the even order harmonics from the output. But push-pull oscillator circuits require more switching and more coils and condensers, or special coils, and are not used commercially.

The LC ratio means the ratio of inductance to capacity. For high conversion transconductance this ratio should be high. When the usual capacity condenser, say, 350 to 400 mmfd., is used for tuning the broadcast band, and no change made, except usual padding, for higher frequencies, some capacity like 430 mmfd. actually will be present at one end of the tuning, whereas capacities in excess of 100 mmfd. should not be used for such high frequencies, because the inductance is low.

Improved Ratio

As the capacity is made less at maximum, the inductance of course is increased, to strike the same desired low frequency of a band. Either separate condensers may be used, larger capacities for broadcast band, or only part of the span of the same condensers used for high frequencies, or small condensers used for all frequencies, the public educated to getting the broadcast band in two jumps, or the large condensers padded to the same effect to constitute them electrically small ones for the megacycle regions.

Stray coupling between oscillator and other tubes causes havoc. The way to avoid this is to shield the coils carefully, ground the shields, use thickly shielded wire on overhead grid leads, wire with a thick serving of cotton, so the sheath is not close to the conductor, and ground the sheath. Short leads throughout the oscillator and r-f sections are important, and the higher the frequency the greater the importance.

Mispadding is the source of more trouble in the mixer than is anything else. First, those who try to wind their own coils get into trouble, as they can not get the right proportion of turns between the oscillator and the modulator. Then when capacity padding has to be done they haven't the means at hand for making capacity measurements, and must grope with condensers of commercial rating which may be 25 per cent. off.

Calculations

At least for trimming the oscillator the air-dielectric condenser should be used. The frequency generated by the oscillator, in conjunction with the intermediate frequency, exclusively determines the frequency to which the receiver will respond, and the r-f tuning has nothing to do with it.

The method of calculating for the padding was given October 27th and the attainment of the inductance values may be enjoyed without calculation by recourse to a book, "The Inductance Authority," that gives the number of turns for various sizes and insulation types of wire, for various popular diameters, to attain desired inductance. The information is contained in charts.

The Intermediate Channel

The intermediate amplifier's principal purpose is to provide selective gain at a single frequency. It may be used as an adjunct of fidelity, by introducing some method of controlling the selectivity. So, when distant stations are to be received, and high selectivity is necessary, a control can be made to provide such selectivity. For high fidelity, or good fidelity, such selectivity is too much. A method is then introduced that permits passing 7.5 kc sidebands, or something of that order.

Important indeed is the stability of the intermediate channel. If the amplifier is made just on the verge of oscillation, increase in line voltage, or other conditions, may cause the i-f level to oscillate, which produces much squealing. Even incipient oscillation is ruinous. Therefore the intermediate channel, though presenting no special problems, should be well shielded and filtered, and if there is any trace or danger of oscillation, the series-cathode biasing resistors should be by-passed by large enough condensers to stop the trouble, 2 mfd. or more, whereupon separate filtration of plate and screen may not be necessary. It is well to use shielded wire for the overhead grid leads, and ground the shields, it not being important that the wire with thick serving of cotton or other insulation be included, as the capacity is related to the condenser across the grid winding, and this condenser in itself is large.

Limitation of Selectivity

The voltage of the second i-f tube may become rather more than one expects, so if automatic volume control is not included, the negative bias may be made a volt or so greater than on similar tubes at i-f and r-f uses.

That the channel should permit audio quality, the selectivity has to be limited. It is easy to make this channel too selective. And it is not acceptable to detune it to broaden the curve, since the reduction of sensitivity due to detuning is very marked. A test may be made by introducing into a signal generator an audio tone of 7,500 cycles, and one of 1,000 cycles feeding the r-f or i-f circuit, and comparing the audio output, as read on an output meter in the power tube plate circuit. The higher frequency should not be much less in amplitude at output than the lower, when the difference is due to the selectivity. Detuning the intermediate amplifier a little is satisfactory for this test, as that is the readiest means of alering the selectivity, but as a permanent proposition will not do, except in special instances where this detuning is allowed for, is very slight and intended for establishment of a band-pass filter.

The audio amplifier should be able to withstand the largest voltage likely to be put into it. For a particular location, the loudest local is tuned in, all controls full on, and the plate current in this tube watched, so see that it does not rise beyond that found when the biasing is momentarily shorted from this tube. In fact, the loudest passage should not cause the plate current to be more than 90 per cent of the zero-bias current, just to cite a safe figure.

Sensitivity

If the first audio tube is properly taken care of, the rest can be depended on, more or less, because manufacturers and set-builders generally take good care of the output stage but do not always make such careful selection for a driver.

Selectivity and fidelity have been covered in connection with some other itemizations, and there remains only a word about the sensitivity. This may be made almost as high as it can be, provided no bad effects arise as from regeneration and the like, save only that as the sensitivity is increased the input has to be decreased. It is well enough to argue that a strong input has its advantages, and one of these is stated as being favoring of the signal against noise, but the conclusion is reckless because too inclusive. What type of noise? Some forms of noise, those incident to the signal itself, are unchanged in comparison to the signal, no matter how much or how little is picked off the antenna as utilized energy.

How Much Pickup?

The argument in favor of a husky pickup from the antenna is that then the signal gets a preference as against noises arising in the set, but with the sensitivity of present-day receivers to consider, the noise in the set, due to thermal agitation of electrons, shot effect, hiss, etc., does not begin to compare with the noises from man's and nature's composite contribution to radio ills in the form of unnatural and natural static. These, principally the noises from machines, which noises are the result of self-excited carriers rather close to ground and affecting any unshielded leadin, argue for the reduction of the pickup and the use of the shielded transmission line, and if the receiver noise is to be reduced, that should be done at the expense of sensitivity. One can not have highest sensitivity and fullest freedom from noise. The set can amplify only what is there, no more, no less. There is always some noise, but proportionately less when the pickup is small. And the more sensitive the set, by an impish relative law of nature, the more the noise is amplified compared to the signal.

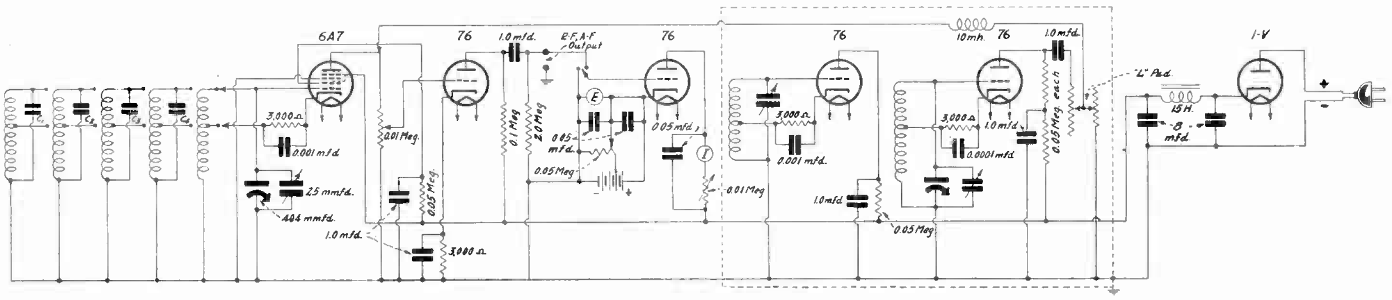
Parting Word

Finally one gets to that dangerous irritating threshold known as the noise level, whereupon it is well to turn the sensitivity control somewhat to the left (reducing sensitivity), or, failing to find that method acceptable, turn the control to the extreme left, so that a clicking sound is heard, denoting that a switch has been opened and the power shut off from the set. The only proviso is that this particular sensitivity control has to have on it the a-c switch.

Six Tubes for the Genetester

Signal Generator, Audio Beat Oscillator, VTVM Included—Special Precedure for Calibrating Audible Values

By Herman Bernard



A general purpose testing device for alternating-current frequencies and voltages, known as the Genetester.

A MAN had a three-tube universal receiver to service. The instrument he used for making frequency and voltage measurements had six tubes. Was this ridiculous?

It does not make any difference how many or how few tubes are in the receiver or amplifier to be checked, the measuring device still has to yield a certain minimum of service, and if six tubes are required for this service, then six tubes are not too many.

The following is the composition of the six-tube device:

(1) A signal generator, working on fundamentals, 54 to 17,000 kc, direct reading in frequencies, with equivalent wavelength values obtainable.

(2) A beat-note audio-frequency oscillator, 50 to 10,000 cycles, direct reading in frequencies.

(3) Radio-frequency output subject to control, from practical minimum to absolute maximum. Attenuation direct reading in decibels.

(4) Audio frequencies subject to amplitude control, direct reading in percentage modulation.

(5) Audio output independently obtainable.

(6) Vacuum tube voltmeter for reading r-f output voltage, a-f voltage, combination of a-f and r-f voltages (modulated output).

(7) Amplifier stage for r-f and a.f.

(8) Rectifier.

Decimal Repeating Dial

The radio-frequency generator is no doubt familiar. It is the same as found in the 339 signal generator, using an airplane dial of the decimal-repeating type. That is, the calibrations in frequencies are 54 to 170 kc for one tier and 170 to 540 kc for the corresponding arc on the lower semi-circle. Wavelength equivalents are on the inside arcs. For the third band, multiply the first by 10 for frequencies, or divide the wavelength equivalents by 10: for the fourth band multiply the second arc by 10, or for wavelengths divide by 10: for the fifth band multiply the first frequency range by 100, or for wavelengths divide the corresponding metrical scale by 100. This method provides maximum spreadout. An article about this was printed in the November 10th issue.

The audio oscillator consists of a beat-frequency device, comprising two tubes. One tube is operated at a fixed radio frequency. The other is varied in frequency slightly in respect to the first one. The differences are from 50 to 10,000 cycles, hence audio values. To stop the radio frequencies from coming through, this unit is separately shielded and also there is r-f choke to constitute a low-pass filter.

Unusual Type Coupling

The coupling between the two tubes must be slight. Therefore only such coupling as is due to the adjacency of the tubes is used. This is probably partly capacitative and partly inductive. Also there may be some aspects of thermal coupling as well as electrostatic coupling. Anyway, it is one form of coupling that is practically independent of frequency, though not independent of amplitude.

The radio frequencies at which these two oscillators work are not of great importance, so long as the coupling is confined to audio frequencies. Otherwise, for fundamentals lower than those of the intended r-f oscillator at the front end there would be harmonic responses.

The radio-frequency output is electron coupled to an amplifier tube. The main purposes of the amplifier is to put a high impedance between the generator and the utilized r-f output, further to remove the work circuit from affecting the frequency or amplitude of the original generation. The method shown is completely free from such effects.

The r-f generator is stabilized by using a circuit that works toward stability, and by putting a bypassed high resistance in the positive-grid circuit. The tube is a 6A7 used peculiarly. It was found that by using the triode as the oscillator, with augmented electron attraction due to the pentode screen being positive, and grounding the normal pentode control grid, stability was enhanced. Also the grounded control grid, No. 4 of the element series for this tube, increased the trans-conductance.

Decibel Notation

With stability in the generator circuit a milliammeter needle in the positive-grid circuit would stand practically still over the tuning range of any band. Also, with frequency stability there is amplitude stability, a statement practically repeating what has just been written. With amplitude stability the current through the output load resistor, here a potentiometer, is constant. When the current is constant the voltage drop is constant over the complete resistance, though by attenuation less than the full voltage may be taken off. With voltage constant the calibration of the r-f output may be on the basis of decibels down.

The decibels notation is in general rather dangerous because misleading. First, the object has to be firmly fixed in mind. Since the device is to be used on an amplifier that has power output, the power basis is used, and at maximum output, that is, no attenuation, the rating is 0 decibels down. For lesser amounts the values may be set from 0 to 24 db down, using the formula

$$-\text{db} = 10 \log_{10} \frac{R1}{R2}$$

where R1 is the total resistance of the potentiometer and R2 is the resistance between arm and ground.

The audio frequencies can be controlled as to pitch, as explained, simply by tuning, but also can be controlled as to amplitude. Since the amplitudes of any of the notes at maximum are about the same, the percentage modulation notation may be applied. There is only a single tone, so the formula used may be

$$\% M = \frac{100\, Ed}{Ec}$$

where Ed is the difference between the modulated and unmodulated carrier voltages and Ec is the voltage of the carrier alone. These voltages may be read on the vacuum tube voltmeter as the basis of establishing the calibration, or, without any direct-reading percentage modulation control, the percentage could be calculated each time.

Slideback VTVM

The vacuum tube voltmeter is of the slideback type. This is the simplest one to work, as it does not require any calibration except that on a d-c voltmeter. The vacuum tube is negatively biased practically to cutoff, or, until the sensitive current meter reads zero. This is done with zero input. Then when an unknown alternating voltage of any frequency, radio or audio, is put in, the arm of the potentiometer is slid to a still more negative position until the plate current is restored to what it was originally, say, zero. Then the voltage read on the d-c voltmeter connected from arm to negative of the line is read, and this is the peak value of the unknown a-c voltage. To obtain the root-mean-square value, if desired, multiply the peak or crest value as thus obtained by 0.707.

The radio-frequency generator more or less takes care of itself, due to the use of precision commercial apparatus, consisting of tuning condenser, five tapped coils and calibrated airplane dial. There is one adjustment to make for the low-frequency band, at or near 150 kc or so, by using an air-dielectric trimmer of 25 mmfd. For the rest of the bands small condensers comprised of twisted wire take care of the other capacity adjustments near the high-frequency end of each band. The low-frequency ends take care of themselves, due to precision inductance and checked tuning condensers.

How to use broadcasting stations as standards for low radio-frequency checkup has been described recently, particularly in the September 29th issue. Use of these standards for short waves was described in the November 24th issue.

Audio Calibration

If one wants to calibrate his audio oscillator there are several ways of doing this, without resorting to expensive equipment. Two ways will be interchanged, one for broadcasting stations with modulation removed, and the other on the 60-cycle line frequency.

The r-f generator in the present device may be used in the broadcasting-station method. Take the local stations, or as many stations of known frequency as can be tuned in well on a broadcast receiver, and beat harmonics of the r-f generator with these frequencies to obtain audio tones.

Modulation (program) is most easily removed by reduced aerial coupling after the station has been tuned in so that the program can not be heard. Then beat the r-f low-frequency generator with this station frequency. Leaving the generator set as it is, tune the receiver until another beat is heard. This beat should be different in frequency than the first, which was zero beat, so that a finite value is obtained, and this is compared aurally with the note from the audio beat oscillator.

The formula, in words, is as follows: Use a low fundamental frequency of a generator, zero beat with a broadcasting station, divide the generator frequency into the station frequency to obtain the harmonic order. Add the generator fundamental to or subtract the generator fundamental from the station frequency, and then turn the receiver to other station frequencies. When a note is heard read it as the difference between station frequency and the generator harmonic multiples.

In symbols the formula is:

$$F_x = F1_n \pm F_2/k$$

where F_x is the unknown audio frequency in kilocycles n is the harmonic order of F1 for zero beat with a station frequency, F_2 is another station and k is a whole number near n reducing F_2 to not more than 10 kc difference from $F1_n$.

Examples Cited

Since the calibration will depend a great deal on the receiving capabilities of the set perhaps the simplest practical method is to tune to zero beat with one station, using a known frequency of the generator, and, leaving the generator set, tune through the receiver range and pick up audible notes, determining what are the frequencies of these notes, by dividing the succeeding station frequencies until the result does not differ from the frequency of the first station by more than 10 kc.

So, starting at the lowest-frequency station, in New York City it might be WMCA, 570 kc. Use 142.5 kc fundamental of the generator. The fourth harmonic of 142.5 kc equals the station frequency. Then as the frequencies in the receiver are increased, the next for zero beat would be five times 142.5 or 712.5 kc. No station is there, but the fourth harmonic of 142 kc is 710 kc, and there is a station, WOR, on 710 kc, so the beat frequency heard from WOR and the generator is 712.5 minus 710 kc or 2.5 kc or 2,500 cycles. The sixth harmonic of 142.5 kc is 855 kc. There is a station on 860 kc, WABC. so here we get a note equal to 5,000 cycles. The seventh harmonic of 142.5 is 997.5. No station near enough. The eighth harmonic is 1140 kc. There is a station on 1130 kc. The note is 10,000 cycles, one terminal frequency.

Further Cases

Moving to a higher generator frequency, use 190 kc, the third harmonic of which is 570 kc, and zero beat the harmonic with WMCA on that station fundamental, 570. Now multiply 190 by 4, 5, etc., getting 760, a zero beat with WJZ; 950 kc, a 10,000 note with WAAT, 940 kc; 1,140 kc, a 10,000 cycle note with WOV, 1130 kc; 1330 kc, no beat; 1,520 kc, a 20 kc beat with WCNW or WMBQ, if calibration is desired to 20,000 cycles, although this note few can hear, and other measurement methods would be required.

Again, use the fifth harmonic of generator's 114 kc for zero beating with 570 kc. The sixth, seventh and eighth, etc., yield 684, 798, 912, 1026, 1140, 1254, 1482. The stations yielding notes are KYW, Philadelphia, 1020 kc, a 4,000 cycle note; WNEW, 1250 kc, a 6,000 cycle note; and WCNW or WMBQ, 1500 kc, an 8,000 cycle note.

Using the tenth harmonic of 57 kc to beat with WMCA, the frequencies now becoming more numerous, we have for the eleventh, twelfth, etc., 627, 741, 798, 855, 912, 969, 1026, 1083, 1140, 1197, 1254, 1311, 1368, 1428, 1485. From 860 kc we get 5,000 cycles; from 1020 kc we get 6,000 cycles; from 1140 we get 10,000 cycles again; from 1254 we get 4,000 cycles.

Using 66 kc fundamental, zero beating with 660 kc for the tenth harmonic, trying lower orders, we get 594 and 528, both barren; higher frequencies are 726, 792, 858, 924, 990, 1056, 1122, 1188, 1254, 1320, 1386, 1452. These yield 2,000 cycles; 4,000 cycles and again 2,000 cycles.

Lower Register

It is clear that by this method we may take care of the upper register, but scarcely of the lower one, for how are we to get result 50, 60, 70 cycles apart? We could not expect finally to get results below 1000 cycles. As yet we got only as low as 2000 cycles.

At this point the line frequency comes to our aid. We may put a small part of the line voltage into a vacuum tube, even into the vacuum tube voltmeter, and put phones in the plate circuit. We would hear the 60-cycle note. As we couple the beat oscillator to this same tube, as by putting the lead to the plate of the VTVM, we can register 60 cycles as the lowest frequency that yields a beat, which should be resolved to its lowest resultant pitch by tuning, then as we tune the beat oscillator slowly we come to another response point, which is 120 cycles, then another, 180 cycles, etc., until we reach 1,800 cycles.

Thus we have the lower and upper parts of the intended curve accounted for, and need only check one against the other, that is, there should be coincidence, or the curve should be smooth, and, of course, the two segments meet. If they don't meet, shift the low-frequency points by one harmonic, as you may have made that mistake, and if everything is all right you're through with the calibration.

If there is a contradiction, apply the shape of the low-frequency curve to the incomplete curve based on the high-frequency curve, and check back on the 60-cycle harmonics for coincidence this time. This result should be close enough to enable you to prepare the calibration, which is simply using plotting or cross-section paper, with frequencies on one dimension and dial settings on the other. If the dial settings are written down as if for 0-180, the result may be communicated to a blank dial by protraction, for direct reading.

What the Map on Pages 12 and 13 Represents

In its efforts to enforce the provisions of the various radio laws the Federal Communications Commission has been obliged, quite naturally, to divide the territorial expanse of the United States into zones, the affairs of which are administered by individual field offices representing the Federal Communications Commission, sitting at Washington, D. C.

It has been found most convenient to apportion this territory among twenty district offices, situated in the most prominent cities of the country. Varying population concentrations and natural and political boundary considerations has caused these districts to be of varying and inconsistent dimensions. To appreciate therefore how such a division actually works out, the map appearing on the center pages of this issue was prepared.

On this map has been designated the manner in which the twenty district offices have been assigned their respective areas of jurisdiction. These districts are designated on the map, in the center of their respective domains, with the Arabic numerals, 1, 2, 3, etc. The main field offices of the Commission, associated with each individual district, has been designated by a four pointed star. Other cities where examinations are held more or less regularly are indicated by round dots.

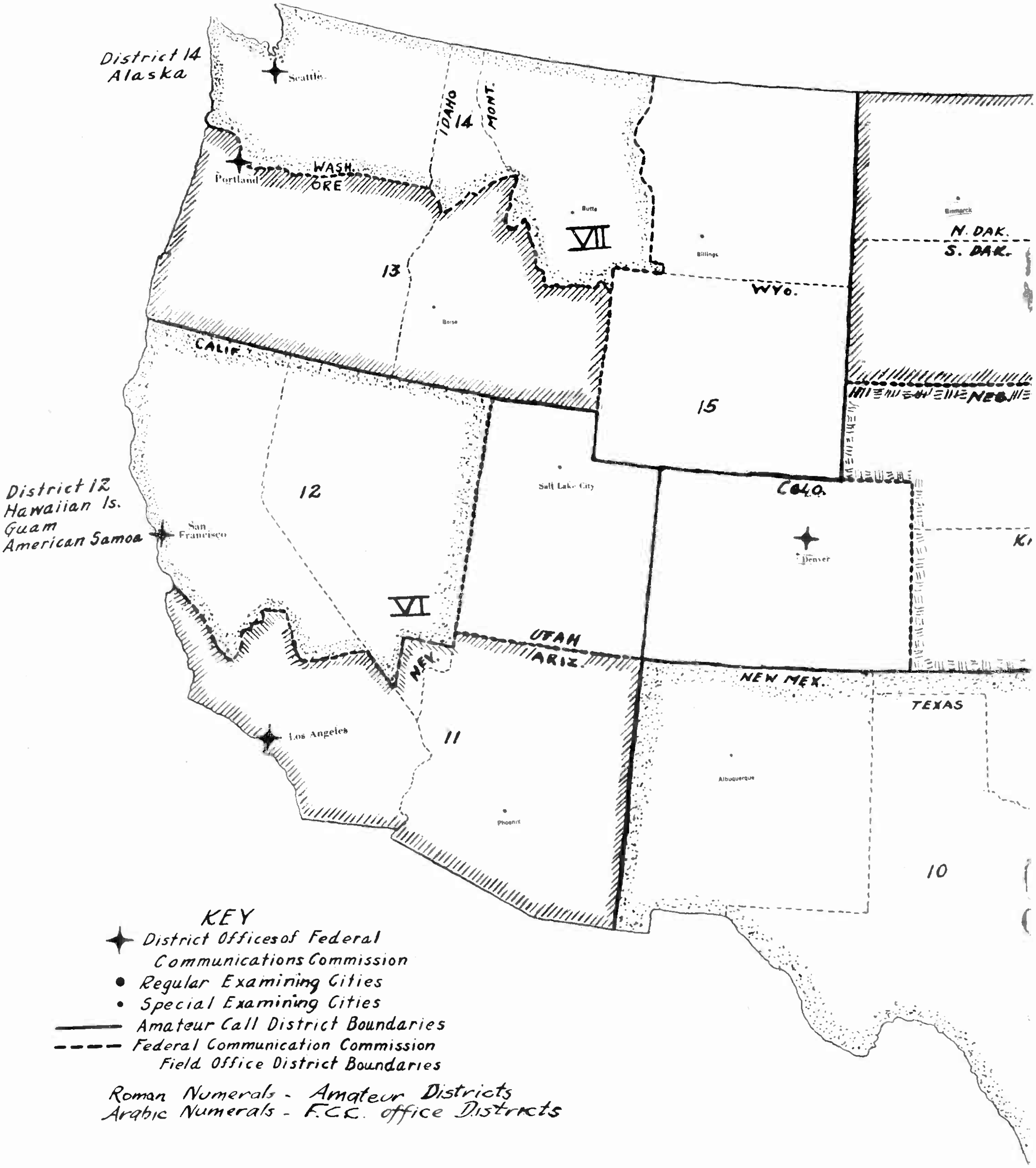
In each case, the examinations held at these latter cities are arranged by the main oce of that district and information concerning these matters is obtainable from those points. Reference to the map readily shows where the main office of each district is located. The boundaries of these Federal Communications Commission field office districts are indicated by the heavy dotted lines.

It should not be overlooked that District 7 also includes Porto Rico and the Virgin Islands, that District 12 also includes the Hawaiian Islands and Guam and that District 14 also includes Alaska. Also, the city of Texarkana, Texas, paradoxically enough, is under the jurisdiction of the office in New Orleans, La., rather than to the Texas offices.

It has also been deemed useful to include in this map the nine divisions of the country from which the amateur call signals are derived, shown by the Roman numerals, I, II, III, etc. This will tend to clarify the haze that has developed in some sections of the country where confusion between the field oce districts and the amateur call districts may be incurred.

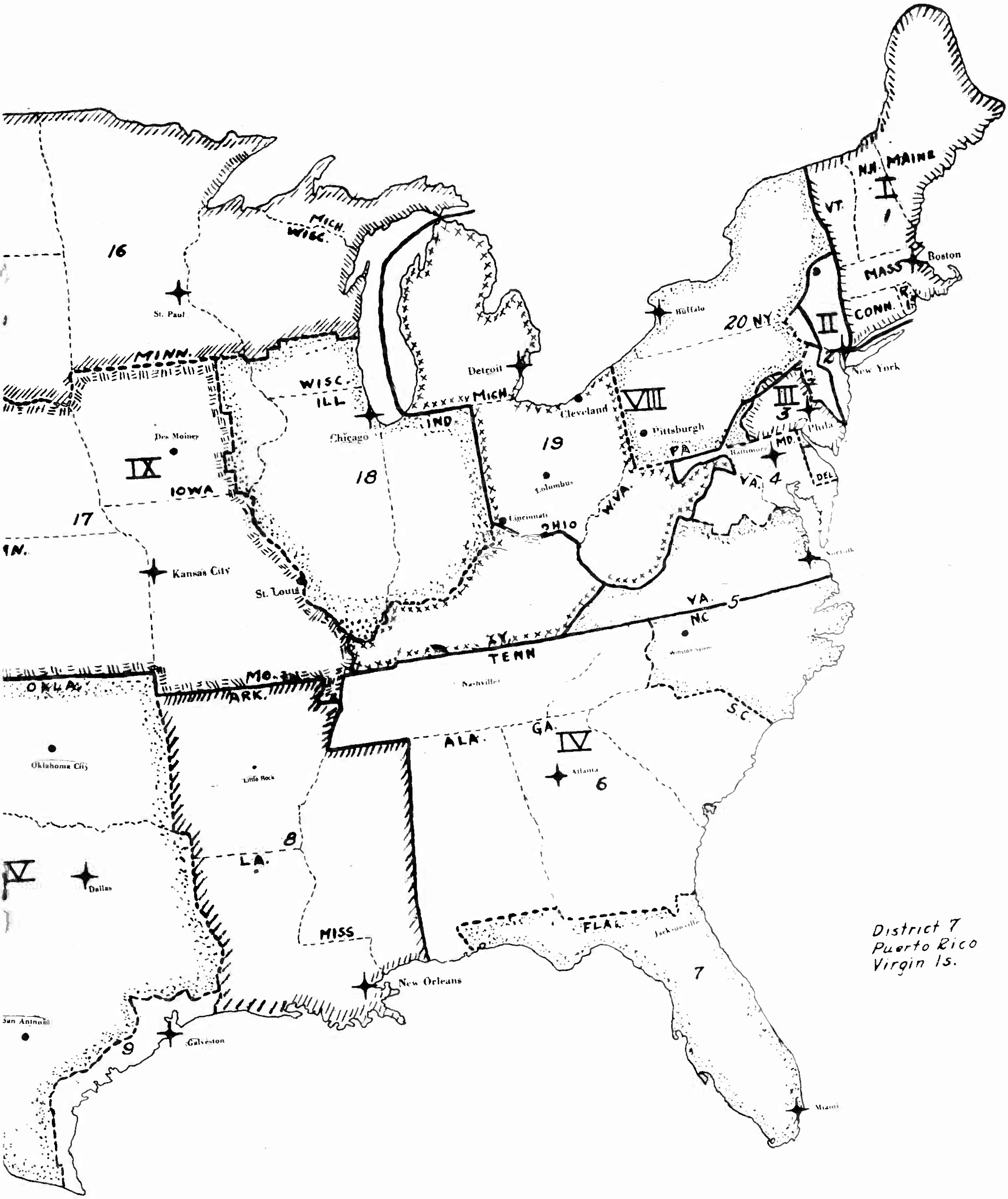
It is believed that a map such as this is not obtainable elsewhere and accordingly should be of some utility.

AMATEUR DISTRICTS AND



The United States has been divided into twenty districts, each of which is assigned to one of the twenty offices of t amateur call districts are divided between more than one office of the Commission. This map shows the various di may be taken. See detail

) FIELD OFFICE DISTRICTS



he Federal Communications Commissi on. Since the nine amateur call districts have been retained, some of these visions in their correct placement together with all the cities at which examinations for Federal operator licenses d explanation on page 11.

Two New Oscilloscope Tubes

The 907 and 908 Excellent for Photography

By M. K. Kunins

THE essence of success in the field of cathode ray oscilliography requires that the cathode ray beam produce a spot of light on the screen of intense brilliance. It is also essential that this spot be as small as possible so the images traced on the screen are sharp. These limitations are a matter of concern to those engineers responsible for the design of cathode ray tubes, since the tubes themselves will determine these abilities. Recent activity in the field of cathode ray tube design has been spirited. There are now commercially available several types of fine tubes, 903, 904, 905, 906, 907 and 908.

Tubes 903, 904, 905 and 906 have been available for several months and their detailed characteristics have appeared in former issues of the RADIO WORLD. Tubes 907 and 908 have just been announced.

The 903, 904, 905 and 906

The detailed characteristics of the 907 and 908 are indicated later on, but meanwhile we intersperse brief characteristics of the immediately preceding types for comparison:

903 Heater ratings—2.5 volts, 2.1 amperes
Anode No. 2 voltage—1000 volts
Anode No. 1 voltage—174 volts
Accelerating voltage—250 volts
Size of tube—9 in. screen x 20½ in. long
Electomagnetic coil deflection

904 Heater ratings—2.5 volts, 2.1 amperes
Anode No. 2 voltage—1000 volts
Anode No. 1 voltage—210 volts
Accelerating voltage—100 volts
Size of tube—5 in. screen x 16½ in. long
Electrostatic and magnetic deflection
Electrostatic sensitivity—0.33 mm./-volt DC.

905 Heater ratings—2.5 volts, 2.1 amperes
Anode No. 2 voltage—1000 volts
Anode No. 1 voltage—200 volts
Size of tube—5 in. screen x 16¾ in. long
Electrostatic deflection only.
Sensitivity—0.38 mm./volt DC
0.46 mm./volt DC

906 Heater ratings—2.5 volts, 2.1 amperes
Anode No. 2 voltage—600 volts
Anode No. 1 voltage—120 volts
Size of tube—3 in. screen x 11¾ in. long
Electrostatic deflection only.
Sensitivity—0.55 mm./volt DC
0.58 mm./volt DC

Their Own Improvements Marked

The group of tubes shows remarkable improvements over tubes previously used, and produce vividly bright spots on their screens for viewing purposes. A spectral energy curve of their luminosity will show that the most intense spot occurs at a wavelength of about 5250 Angstrom units, in the region of maximum color sensitivity for the eye, among the greens. This produces an image on the screen that is most readily seen by the eye.

However, oscillographs are not used only for viewing purposes. Many times it is desirable to photograph the image. Unfortunately, the ordinary photographic films are not very sensitive to the green color of the image obtainable from these tubes. Therefore it has been necessary to develop two new tubes, known as the 907 and 908, which are very sensitive for photograpahic purposes, since the image is bluish in color, the color to which most photographic emulsions are most sensitive. The spectral energy curve for these new tubes would show that the sensitivity is maximum in the blue-violet region, at 4250 Angstrom units. Another marked advantage of the 907 and 908 tubes for photographic purposes over tubes formerly available is the very short time of phosphorescence of the screen—on the order of less than 25 microseconds as compared to the 0.1 second or so connected with the older types. These features are very valuable for the photography of the cathode ray tube's images. the inertialess characteristic of the electron beam and a highly actinic image of extremely short persistence are of prime importance.

Data on the 907

Tentative ratings and characteristics of the 907 as given in an RCA Radiotron Co. copyright release follow:

907

GENERAL

Heater Voltage (A.C. or D.C.)		2.5	Volts
Heater Current		2.1	Amperes
Direct Interelectrode Capacitances			
Grid to All Other Electrodes		10.0 max.	$\mu\mu$f
Deflecting Plate D_1 to Deflecting Plate D_2 (Top Set)		3.0 max.	$\mu\mu$f
Deflecting Plate D_3 to Deflecting Plate D_4 (Bottom Set)		1.5 max.	$\mu\mu$f
Overall Length		16-17/32" ± ⅜"	
Maximum Diameter		5-5/16"	
Bulb		J-42	
Caps (Four)		Small Metal	
Base (Refer to Drawing No. 92S-4344)		Medium 5-Pin Ceramic	

CHARACTERISTICS

High-Voltage Electrode (Anode No. 2) Voltage		2000 max.	Volts
Focusing Electrode (Anode No. 1) Voltage		600 max.	Volts
Grid Voltage		Never positive	
Grid Voltage for Current Cut-off** (Approx.)		—40	Volts
Fluorescent-Screen Input Power per sq. cm. (Av.)		10 max.	Milliwatts
Typical Operation:			
Heater Voltage		2.5	Volts
Anode No. 2 Voltage	1000	2000	Volts
Anode No. 1 Voltage (Approx.)	200	400	Volts
Grid Voltage	*	*	Volts
Deflect. Sensit'y (Plates D_1 and D_2)	0.38	0.19	Mm/Volt D.C.
Deflect. Sensit'y (Plates D_3 and D_4)	0.46	0.23	Mm/Volt D.C.

*Adjusted to Give suitable luminous spot.
**With approximately 400 volts (to focus) on Anode No. 1

The 907

The 907 is a high vacuum, cathode ray tube with a fluorescent viewing screen five inches in diameter. It is designed with two sets of deflecting plates for purposes of deflection control. Further, it produces a highly actinic spot of short persistence suitable for moving film recording of recurrent and transient electrical phenomena.

The electron source is a substantial cathode, indirectly heated, which, in conjunction with a control grid electrode, and a focusing and accelerating electrode, constitutes an electron gun which projects a beam of electrons upon the viewing screen. The resultant luminous spot can be regulated as to size and intensity by suitable choice of electrode voltages.

Deflection of the beam may be accomplished electrostatically by the use of the two sets of deflection plates, the electrostatic fields of which are at right angles to each other. In operation one field serves to reproduce the voltage under observation; the other is used to provide suitable timing control.

The 907 is recommended for recording use in oscillographic applications where

Installation

The BASE pins of the 907 fit the standard five-contact socket which may be installed to operate the tube in any position. The socket should be made of good insulating material and be designed to provide adequate spacing between contact springs to prevent voltage breakdown. A socket constructed with insulating barriers between contacts is recommended.

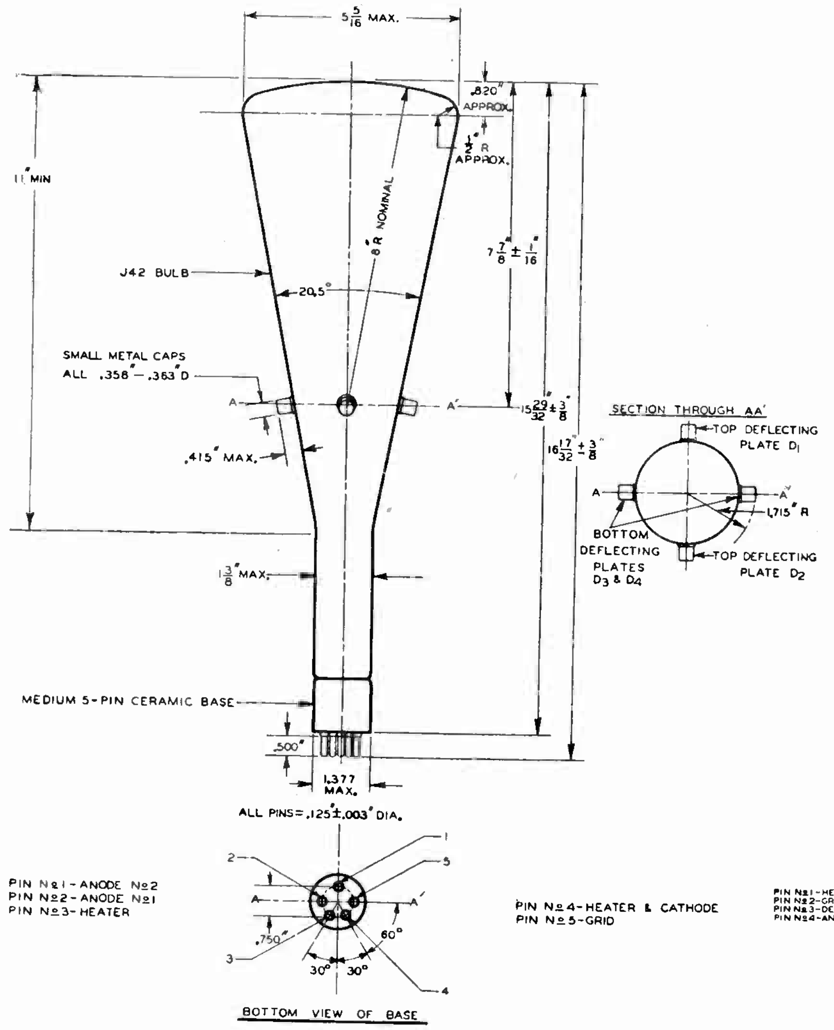
The BULB of this tube, except for the screen surface, should be enclosed in a grounded case. If an iron or steel case is employed to minimize the effect of extraneous fields on tube operation, care should be taken in its construction to insure that the case is completely demagnetized.

The HEATER is designed to operate at 2.5 volts. The transformer winding supplying the heater circuit should be designed to operate the heater at this recommended value under average line-voltage conditions. IF THE CIRCUIT DESIGN IS SUCH AS TO CAUSE A HIGH-VOLTAGE BETWEEN THE HEATER WINDING AND GROUND, THE HEATER TRANSFORMER SHOULD BE ADEQUATELY INSULATED TO WITHSTAND THE HIGH VOLTAGE.

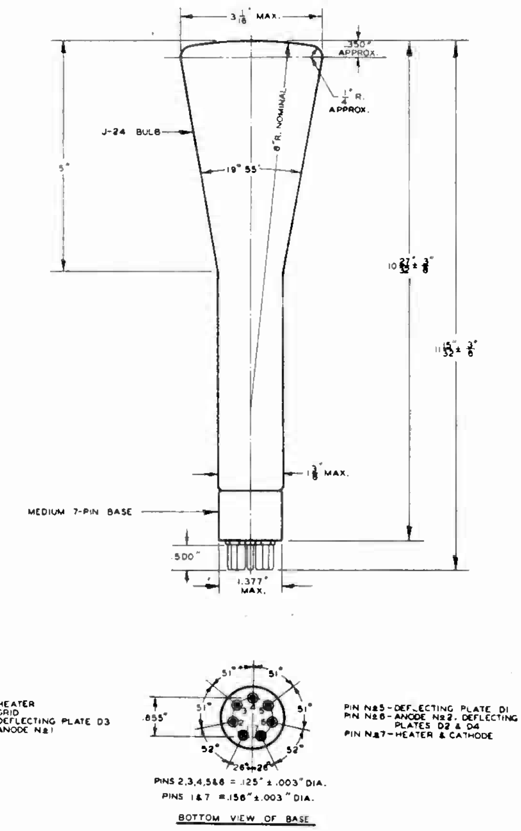
The CATHODE is connected within tube to one side of the heater. Grid and anode returns should be made to the No. 5 base terminal.

The D-C SUPPLY VOLTAGES may be conveniently obtained from a rectifier system employing a high-voltage recti-

Cathode Ray Tubes



907



908

The physical details of the two new cathode ray tubes.

fier tube or tubes. Since the current demand of a cathode-ray tube is very small, the rectifier system may be of the half-wave or voltage-doubler type. For the same reason, little filtering is necessary. Ordinarily, the use of a 0.5 to 2.0 μf shunt condenser is all that is required.

Two sets of ELECTROSTATIC PLATES at right angles to each other are located within the apex of the bulb cone to provide for deflection of the electron beam. One set is used for the voltage under observation; the other for timing control. To maintain each set of plates at essentially the d-c potential of anode No. 2, the two plates of each set should be connected together through a 20 meg. resistor, the mid-point of which is tied to Anode No. 2 (ordinarily grounded). This arrangement insures that the electron beam is not distorted by d-c potentials built up on the deflecting plates.

The 908 Discussed

The 908 is similar to the 907, except that it is smaller in size and can be used with coils for electromagnetic deflection of the beam. It is designed with two sets of deflecting plates for purposes of deflection control to which connection is made through the terminals in the base of the tube. Deflection of the beam may be accomplished either electrostatically or electromagnetically.

The electrostatic deflection is obtained by the use of the two interconnected sets of plates, the electrostatic fields of which are at right angles to each other. Electromagnetic deflection of the beam along one axis may be accomplished by substituting an electromagnetic field for the electrostatic field set up by the bottom set of deflecting plates. The electromagnetic field is positioned so that its effect is at right angles to that of the top set of deflecting plates. Due to its small size and its ability to produce a highly actinic image of short persistence, the 908 is especially suited for recording use in oscillographic applications where compactness is a requirement. The tentative ratings and characteristics of the 908 follow:

Installation

The BASE pins of the 908 require the use of a standard, 0.855-inch pin-circle diameter, seven-contact socket which may be installed to operate the tube in any position. The socket should be made of good insulating material and be designed to provide adequate spacing between contact springs to prevent voltage breakdown. A socket constructed with insulating barriers between contacts is recommended.

The BULB of this tube, except for the screen surface should be enclosed in a grounded case. If an iron or steel case is employed to minimize the effect of extraneous fields on tube operation, care should be taken in its construction to insure that the case is completely demagnetized.

The HEATER is designed to operate at 2.5 volts. The transformer winding supplying the heater circuit should be designed to operate the heater at this recommended value under average line-voltage conditions. IF THE CIRCUIT DESIGN IS SUCH AS TO CAUSE A HIGH VOLTAGE BETWEEN THE HEATER WINDING AND GROUND, THE HEATER TRANSFORMER SHOULD BE ADEQUATELY INSULATED TO WITHSTAND THE HIGH VOLTAGE.

May Use Half-Wave Rectifier

The cathode is connected within the tube to one side of the heater. Grid and anode returns should be made to the No. 7 base terminal.

The d-c supply voltages may be conveniently obtained from a rectifier system employing a high voltage rectifier tube or tubes. Since the current demand of a cathode ray tube is very small, the rectifier system may be of the half-wave or voltage doubler type. For the same reason, little filtering is necessary. Ordinarily, the use of a 0.5 to 2.0 mfd. shunt condenser is all that is required.

Two sets of Electrostatic Plates at

(*Continued on next page*)

908

GENERAL

Heater Voltage (A.C. or D.C.)	2.5	Volts
Heater Current	2.1	Amperes
Direct Interelectrode Capacitances:		
Grid to all Other Electrodes	10 max.	$\mu\mu$f
Deflecting Plate D_1 to Deflecting Plate D_2 (Top Set)	4 max.	$\mu\mu$f
Deflecting Plate D_3 to Deflecting Plate D_4 (Bottom Set)	3 max.	$\mu\mu$f
Screen Persistence. Brightness negligible in less than 25 μ seconds.		
Overall Length	11-15/32" ± 3/8"	
Maximum Diameter	3-1/16"	
Bulb	J-24	
Base (Refer to Drawing No. 92S-4342)	Medium 7-Pin	

CHARACTERISTICS

High-Voltage Electrode (Anode No. 2) Voltage			1000 max.	Volts
Focusing Elecrode (Anode No. 1) Voltage			300 max.	Volts
Grid Voltage			Never positive	
Grid Voltage for Current Cut-off** (Approx.)			—40	Volts
Fluorescent Screen Input Power per sq. cm. (Av.)			10 max.	Milliwatts
Typical Operation:				
Heater Voltage			2.5	Volts
Anode No. 2 Voltage	600	800	1000	Volts
Anode No. 1 Voltage (Approx.)	120	160	200	Volts
Grid Voltage	*	*	*	Volts
Deflect. Sensit'y (Plates D_1 and D_2)	0.55	0.41	0.33	Mm/Volt D.C.
Deflect.Sensit'y (Plate D_3 and D_4)	0.58	0.44	0.35	Mm/Volt D.C.

*Adjusted to give suitable luminous spot.
**With approximately 200 volts (to focus) on Anode No. 1.

(Continued from preceding page)
right angles to each other are located within the bulb neck to provide for deflection of the electron beam. One set is used for the voltage under observation, the other for timing control. One plate of one set is tied to one plate of the other set; the tie is connected to Anode No. 2 within the tube. In order to maintain the free plate of each set at essentially the DC potential of Anode No. 2, each of these plates should be connected through a resistor of one to 10 meg. to the Anode No. 2 socket terminal (ordinarily grounded).

Coils for Deflection

This arrangement insures that the electron beam is not distorted by d-c potentials built up on the deflecting plates. If during operation, the zero axis should be permanently deflected, it is because the beam current is too high for the resistor used. Ordinarily, low beam currents should be used. When photographs are taken at such times, when it is necessary to use a high beam current, the values of the deflecting plate resistors should be reduced so that the zero axis shift will not carry the spot off the screen.

When two electromagnetic coils are utilized for deflecting purposes along one axis, they should be placed opposite each other, each as close to the bulb neck as possible, and should be concentric with the diameter of the bulb neck passing through the centers of the top set of deflecting plates. The free plate of the bottom set should then be connected to the Anode No. 2 socket terminal. Positioning of the coils as directed locates the axis of the electromagnetic field so that it intersects the axis of the electron beam and is perpendicular to it. Furthermore, the deflection caused by the electromagnetic field is at right angles to that produced by the electrostatic field.

The 908

When the electromagnets employ an iron core to concentrate the magnetic flux, the iron core should be close to the external magnetic path. The design of the magnetic coils will depend on the application involved. Data on 908 application follow:

Applications

The study of electrical wave shapes and transients, measurement of modulation, adjustment of radio receivers, determination of peak voltages, tracing of vacuum-tube characteristics and many similar operations can be conveniently performed by means of a cathode-ray tube oscillograph.

The diagram illustrates the circuit for an oscillograph. The electrode voltages are obtained from a bleeder circuit connected across the high-voltage supply of a rectifier system. By means of potentiometers in the bleeder circuit, the voltages for Anode No. 1 and for the Control Electrode (Grid) can be adjusted to meet operating requirements.

Deflection

Deflection of the electron beam may be accomplished by two electrostatic fields at right angles to each other. In operation, one field is controlled by the phenomena under observation; the other is used for timing control. The latter field serves to spread the tracing across the fluorescent screen.

In the 908, deflection of the electron beam along one axis may be accomplished, if desired, by substituting an electromagnetic field for the electrostatic field produced by the "bottom set" of deflecting plates.

Focusing of the light spot produced by the beam is obtained by adjustment of the ratio between the voltages on Anodes No. 2 and No. 1. In general, this voltage ratio should be approximately 5 to 1.

Size of Spot

Regulation of spot size and intensity may be accomplished by varying Anode No. 2 current and/or voltage. The current, or number of electrons, to Anode No. 2 may be increased by decreasing bias voltage applied to the Control Electrode (Grid). Raising the current of Anode No. 2 increases spot size and intensity. Raising the voltage applied to Anode No. 2 accelerates electron speed, decreases spot size and increases intensity.

For example, a small-sized spot may be obtained by making the Control Electrode more negative and/or by increasing the Anode No. 2 voltage. A large-sized spot with higher intensity may be obtained by making the Control Electrode less negative and by increasing the Anode No. 2 voltage. In making these adjustments, consideration should be given to the limiting voltage and current conditions shown in the tube ratings.

In applications involving extremely accurate measurements, the current to Anode No. 2 should be reduced to the minimum value consistent with the desired brilliance of pattern. Where brightness is an important consideration, it may be obtained by increasing the voltage applied to Anode No. 2 up to the maximum value. This practice, however, is not always desirable since the greater acceleration of the electrons in the beam causes reduced deflection sensitivity.

It should be noted that a beam producing a spot of high intensity will burn the fluorescent screen if it is allowed to remain stationary even for a short interval. Such operation may cause excessive heating of the glass with resultant puncture. To prevent this possibility, it is recommended that the beam be kept in motion. It is well to apply controlling voltage to the deflecting system before permitting the electron stream to flow. Stopping of the electron beam may be accomplished by removing the voltage on Anode No. 2 or by increasing the bias voltage on the Control Electrode to cut-off.

Photograph of Images

Photographs may be taken by focusing a camera on the screen and exposing for a suitable length of time. The time of exposure depends on the speed of the camera lens, the kind of film, and the brightness of the pattern. Where transients are to be photographed, maximum brightness and a rapid exposure are required; where recurrent wave forms are to be photographed, low brightness can easily be compensated for by longer exposure. Although good results have been obtained with verichrome film, panchromatic film is more sensitive to the green color of the screen pattern. The use of the latter reduces the time of exposure.

For high-speed photographic work involving non-recurring phenomena, it is permissible to exceed the maximum Fluorescent-Screen input power per sq. cm. for the short interval required to make the exposure. The extent to which the anode current may be increased without harming the screen is a direct function of the rate of beam travel and pattern size, and an inverse function of duration.

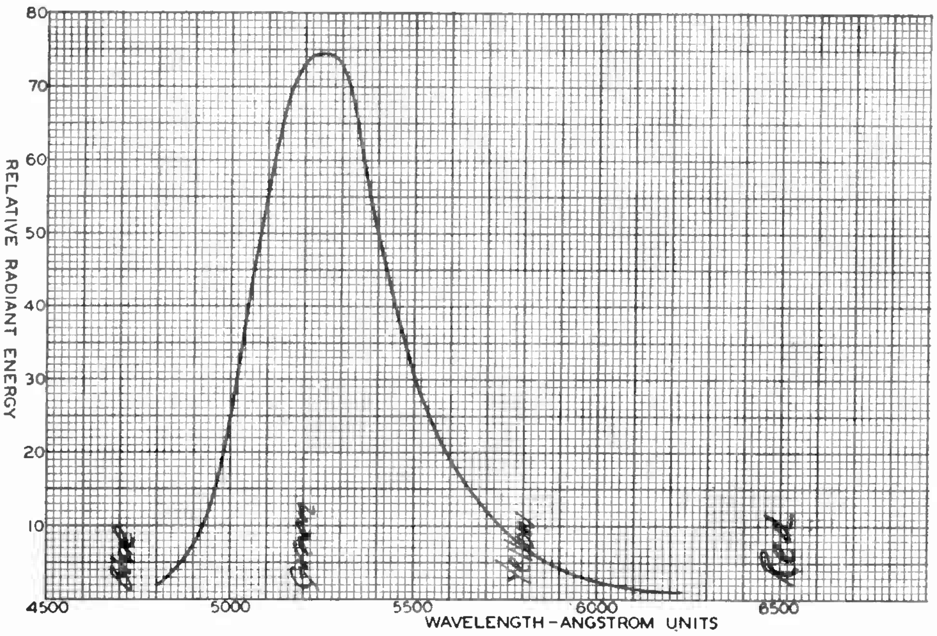
A means of obtaining such short-interval operation is through the starting and stopping of the electron beam by means of the Anode No. 2 voltage or by means of the Control Electrode voltage as explained above. Controlling the electron beam by instantaneously decreasing the Control Electrode voltage from cut-off is the preferable method in that the operation may be made coincident automatically with the exposure and does not involve high-voltage switchinig operations.

Word of Caution

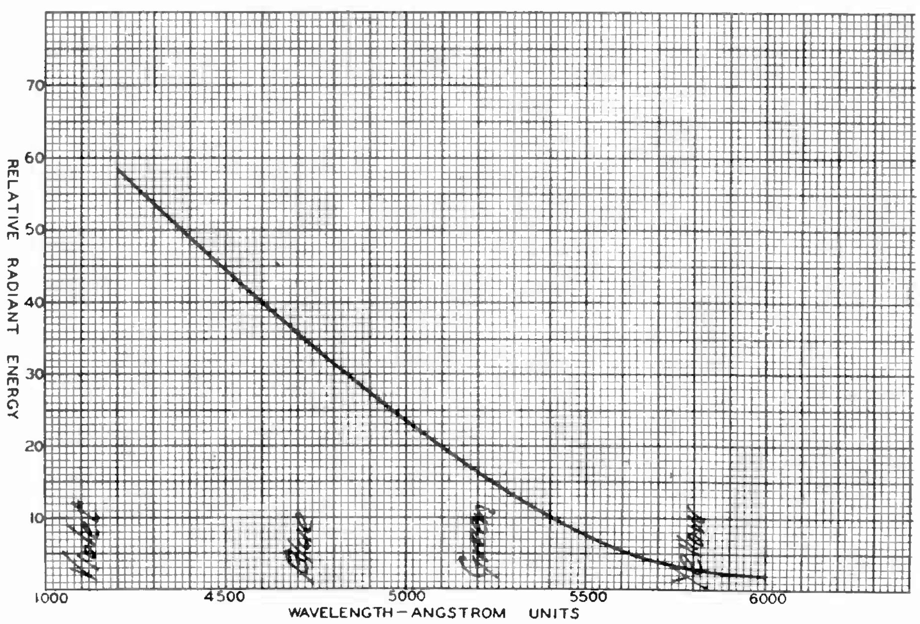
THE HIGH VOLTAGES AT WHICH CATHODE-RAY TUBES ARE USED ARE DANGEROUS. THE GREATEST CARE SHOULD BE TAKEN TO GUARD THE OPERATOR FROM COMING IN CONTACT WITH THESE VOLTAGES. Precautions include the enclosing of high-potential terminals and the using of a "disconnect" switch to break the high-voltage circuit when access to the enclosure is required. In most installations, it is recommended that the positive high-voltage terminal rather than the cathode terminal be grounded. With this method which places the cathode and heater at a negative potential with respect to ground, the dangerous potentials can easily be made inaccessible.

In the use of cathode-ray tubes, al-

Cathode-Ray Tubes Compared



Spectral Intensity Curve for 903, 904, 905 & 906 Cathode Ray Tubes



Spectral Intensity Curve for 907 & 908 Cathode Ray Tubes

The greater effectiveness of the older types 903, 904, 905 and 906 cathode ray tubes for viewing purposes, the eye being more sensitive to green, is vividly indicated in the greater sensitivity of the phosphorescent screen material in the green region of the spectrum. The greater effectiveness of the new 907 and 908 cathode ray tubes for photographic purposes, the emulsion being more sensitive to blues, is vividly indicated in the greater sensitivity of the phosphorescent screen material in the blue violet end of the spectrum.

ways remember that the high voltages may appear at normally low-potential points in the circuits, due to condenser breakdown or incorrect circuit connection. Recommended procedure is: Before touching any part of the cathode-ray tube circuit or its associated circuits, be sure to turn off the power-supply switch and to ground both terminals of any charged condensers in the circuit.

Literature Wanted

Readers desiring radio literature from manufacturers and jobbers should send a request for publication of their name and address. Address Literature Editor, RADIO WORLD, 145 *West* 45*th Street, New York, N. Y.*

Looker Brothers, Norfolk, Nebraska.
J. MacKenzie, 12961 Hamilton, Highland Park, Michigan.
F. H. Pugh, 1311 Michigan Avenue, Buffalo, New York.
Samenwerkende Maatschappij. MEGA, Nationalestraat. 32-34, Antwerpen. Belgium.
M. C. Burrell, R. D. No. 4, Box No. 54, Olympia, Washington.
Karl Amatneek. 792 East 175th Street, Bronx, New York City.
John L. Angelino, 14 Niewindt St., Curacao, N. W. I.
E. M. Allen, c/o N. Y., N. H. & H. R. R. Co., Waterbury, Conn.
Dr. T. S. Bronson, 169 Wright St., New Haven, Conn.
M. D. Banta, Box 146, Keyes. Calif.
Randall L. Baron, 461 Myrtle St., Glendale, Calif.
W. R. Crain, 510 Greenleaf St., Elizabeth City, N. C.
John C. Dallas, Garfield Hospital, 11th & Fla. Ave. N.W., Washington, D. C.
Chas. Eggers, 823 So. 7th St., La Crosse, Wis.
J. L. Hill, 1127 Charles St., Rockford, Ill.
J. B. Marion, 731 Dobbins St., West Palm Beach, Fla.
T. B. Perkins. 9803 75th Ave., South Edmonton, Alberta, Canada.
W. W. Swanson, First National Bank, Highmore, S. D.
Thos. C. Stewart, 100 Claremont Ave
Schubeck Radio Service, 3860 Norwalk St., Hamtramck. Mich.

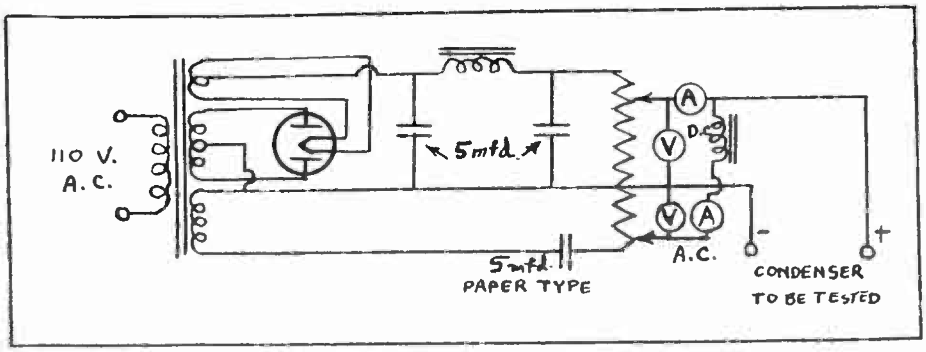
INTERMEDIATE FREQUENCIES

The intermediate frequency of a superheterodyne for wide-frequency coverage should be high as practical, to support image selectivity at megacycles. At present no higher than 480 kc is used. Twenty kc high is the distress call. Sixty higher is the low end of the broadcast band. It is possible, though mechanically difficult, to change the r.f. For the same oscillator padding, for each higher band the r.f. must be increased by the r.f. capacity ratio.

Electrolytic Condenser Analyzed

Leakage Has Its Advantages—Heat Increases Capacity

By Morris N. Beitman
Supreme Publications



A simple circuit for testing electrolytics.

ALMOST everyone of us has at one time used in building or replaced an electrolytic condenser. Very few of us, however, had the opportunity to read the limited existing literature on this subject. In view of this some facts relating to the theory of operation and practical testing methods are here presented.

The electrolytic condenser is a fixed condenser of high capacity and compact size suitable for use with voltages not exceeding about 500 volts. These condensers must further be used only with a-c or pulsating d-c. Because of these characteristics electrolytic condensers are especially well suited for use in radio rectifier filter circuits, where these advantages over paper type condensers are fully realized, and their limitations are of no consequence.

What the Electrolytic Is

The electrolytic condenser consists of an anode to which the positive connection is made, the cathode used in conjunction with the negative connection, and the electrolyte. Aluminum is usually used as the anode in condensers for radio application. Other metals such as tantalum and magnesium find some use: the chief advantage of tantalum being its ability to withstand acid corrosion. For the cathode either aluminum or copper is used in connection with aluminum anode.

Many different electrolytes are used with aluminum and their choice depends greatly upon the voltages to be applied to the condenser. A few electrolytes appear below with their respective critical voltages:

$NaSO_4$	40 volts
$KMnO_4$	112 "
$(NH_4)_2CrO_4$	122 "
KCN	295 "
NH_4HCO_3	425 "
NH_4HPO_4	460 "
$Na_2B_4O_7$	480 "

(From "Electrochemical & Metallurgical Industry," p. 216, 1909.)

How Film Forms

Sometimes mixtures of two or more compounds are used. The density of the electrolyte varies from a liquid which contains a fairly large percentage of water to a paste which is commercially called "dry."

The dielectric film forms electrochemically on the surface of the anode. The properties of the electrolytic condenser are due to this film formation. The exact nature of this film is not known, but it is extremely thin making possible high capacity per unit area. The capacitance of a film formed at 300 volts on aluminum is 0.12 mfd. per square inch, about eight hundred times that of a paper condenser for this voltage.

The film is formed by applying a potential of proper value. The capacity is almost inversely proportional to the potential at which the film is formed. When the potential is first applied, the current is only limited by the resistance of the electrolyte and the external resistance present. Naturally under this condition high currents flow. The film forms quite rapidly, however, and the leakage current drops to a safe value of about 0.2 milliamperes per microfarad. In radio rectifier circuit the leakage current is of little importance.

Leakage Advantage?

The rectifier tube does not heat-up instantaneously, and because of this the voltage at first is of a small value. This voltage partly forms the film which reduces the leakage current when the rectifier tube heats-up to the full value and supplies the full voltage. Further some of the tubes used in the radio are probably of the cathode heater type requiring considerable time to heat-up and thereby not only fail to draw current themselves, but surpress any signal that would have excited the grids and caused current of greater magnitude to flow in the filament type power tubes. In other words, it is almost an advantage to have large leakage currents at the period when the set itself requires very little current. This equalization of current keeps the voltage at a safe value at all times.

Temperature also has an effect that is of a distinct advantage in radio application of electrolytic condensers. The capacity increases with the temperature up to certain limits. By mounting the electrolytic condensers near the power and rectifier tubes their temperature may be raised. Very little change occurs past 120° Fahrenheit, and because of other factors it is best not to surpass this value. A condenser having a capacity of 8 mfd. at 70° F., will have over 11 mfd. capacity at 120° F.

Simple Test Circuit

The circuit illustrated is well adapted for testing electrolytic condensers in production or for general testing. The d-c serves as the polarizing voltage. The two potentiometers can be used to adjust the voltages and thereby approach the actual circuit conditions. The difference of the current reading on the d-c milliammeter between open test terminals and condenser to be tested in circuit is the leakage current. The a-c milliammeter can be directly calibrated to read in microfarads of capacity. For more exact testing demands a bridge circuit is used.

What Do You Think?

Because of the phenomenon, known as skin effect, radio-frequency currents tend to travel on the outermost section of a conductor. To minimize the resistance offered to a radio-frequency current, therefore, this surface must be as large as possible and as conductive as possible. That is why Litz wire is used--so that the outside surface becomes the outer surface of many small wires connected in parallel.

Now, let us consider the wire with a coating of enamel for insulating purposes. It is generally understood that there is no perfect insulator and that those substances that are called insulators are in reality very high resistances or low conductors. It is therefore not at all far-fetched to state that the enamel coating of a copper wire is really a high resistance surface that is coated on the wire surface.

It has been said that radio frequency currents tend to travel in the outermost section of a conductor. Therefore, if the conductor happens to be enamel-covered, this r-f current will try to traverse a highly resistant conductor and suffer a great loss. Similarly, it may be reasoned that the same thing occurs when a coating of oxide forms on an electric conductor.

Isn't it logical to infer therefore that radio-frequency wiring should not be enamel-covered but rather should be bare? Also that this bare wire should be maintained at a constant luster? Have we been fools to believe that Litz wire minimizes radio frequency effective resistance induced by skin effect?

What do you think?

Radio University

ANSWERS to Questions of General Interest to Readers. Only Selected Questions Are Answered and Only by Publication in These Columns.

The 6D6 Tube

IS THE 6D6 the detector of the series, the letter "D" standing for detector? What is the equivalent tube in the 2.5-volt series?—I. L.

The super-control detector of the 6.3-volt series is the 6C6, which also may be used as an amplifier. The super-control amplifier of the series is the 6D6. Therefore the D does not stand for detection. The equivalent 2.5-volt series tubes are 58 for the 6D6 and 57 for the 6C6.

* * *

Mutual Conductance Test

WHEN A TUBE is to be tested, is the mutual conductance test a good one, and is it preferable? Are there various types of mutual conductance tests? State the best one. Is the term mutual conductance quite correct, in that there is mutuality?—K. W. C.

The mutual conductance test is the best single one for a vacuum tube. The two methods used for such a test are for static and for dynamic mutual conductance. Static testing means d-c voltages, dynamic testing means a-c voltages. Naturally, as the tubes are used under dynamic conditions, the dynamic test is preferable. The test consists of using a-c plate voltage and varying a-c input to control grid, noting the change in plate current. For static purposes a d-c meter is used. For dynamic purposes an a-c current meter is used. If a one-volt a-c change is made on the grid side, with a.c. on the plate, and an a-c current meter in the plate circuit, the mutual conductance is the milliampere current change multiplied by a thousand. The term mutual conductance has become rather a fixture, although the "mutual" part of it does not seem to have any basis for inclusion. The control circuit is no part of the conductance being measured.

* * *

Stability and Voltages

IN THE SELECTION of tubes for a signal generator that I intend to build, will you kindly let me know whether an a-c model preferably should have screen-grid tubes?—L. C.

In general, the screen grid tubes lend themselves more readily to stability, provided that for the a-c or dual models, such as the 58, 57, 6C6, 6D6 etc., the plate and screen voltages are high enough. Operation between 200 and 250 volts for the plate and 100 volts or so for the screen, conventional use, would be satisfactory. For low plate voltages the instability is noticeable. Also, the higher the negative bias the better the stability, although reduction of amplification and also strong harmonics must be taken into consideration. Triodes are entirely satisfactory on smaller voltages. You should note carefully how any tube is used, because numerous applications cause the screen-grid tubes not to perform as such, due to unusual external connection of the elements. For instance the 57 may be operated as a triode by tying suppressor, screen and plate together. Also for electron coupling purposes the plate is sometimes used as a pickup grid, and the true plate or positive grid is the screen.

* * *

A-C Resistance

AS I HAVE no means of determining the a-c resistance and desire to provide some suitable match as a tube load, please give a simple rule.—I. L. W.

Measure the voltage between cathode and plate. Measure the current in the plate circuit. The d-c resistance is the voltage in voltas divided by the current in amperes. The a-c resistance may be taken as half the d-c resistance. Greatest energy transfer takes place when the load impedance is equal to the impedance of the source.

New Licenses Sought On 1200 to 1500 Kilocycles

The repeal of the Radio Act of 1927 and the subsequent adoption of the Communications Act of 1934 has resulted in a scramble for licenses to operate broadcast stations throughout the country on low powers. The latest applicants for these privileges are:

T. H. Barton, Eldorado, Arkansas	1370 kc. 100 watts, Unlimited time
Calcasieu Broadcasting Co., Lake Charles, La.	1500 kc. 100 watts, Unlimited time
Wm. J. Reynolds, Selma, Alabama	1500 kc. 100 watts, Daytime only
W. Wright Esch, Daytona Beach, Fla.	1420 kc. 100 watts, Unlimited time
Community Broadcasting Co., Toledo, Ohio	1200 kc. 100 watts, Daytime only
Lake Region Broadcasting Co., Lakeland, Florida	1310 kc. 100 watts, Unlimited time

Special Set Will Transmit Roar and Hiss of Vesuvius

The secrets of famous Mount Vesuvius will be broadcast to the world when Italian radio engineers, equipped with an NBC pack transmitter, accompany a party of scientists into the heart of the volcano's fiery crater.

The expedition probably will make the descent within the next two months, during which period special radio equipment will be constructed, and the researches conducted by the side of the lava lake will be short-waved to America and rebroadcast here over National Broadcasting Company networks.

This unusual event will mark the first time that American-made portable transmitting equipment has been used in Europe. NBC engineers at Radio City are now designing a special short-wave pack set which will accomplish the extremely difficult task of transmitting the sounds of the volcano from a depth of several hundred feet within the mountain. The equipment will be ready within a few weeks and then will be sent to Italy for thorough tests before the party of scientists descends into the crater to discover its subterranean secrets.

Dr. Max Jordan, NBC representative in Central Europe, will head the radio contingent of the expedition. He will describe for NBC listeners the awesome wonders of the volcano's interior and will place the microphone so that the rumble and hiss of the boiling lava will be heard by the audience thousands of miles away. The date and other details of the unusual broadcast will be announced soon.

WOR GETS PICTURE PERMIT

The Bamberger Broadcasting Service, Inc., owners and operators of WOR, Newark, N. J., have been granted permission to construct an experimental transmitter of 1000 watts power for special facsimile communications. This equipment is being constructed for the frequencies of 31600, 35600, 38600 and 41000 kilocycles.

THE AMATEUR ORACLE

Address Questions Concerning Amateur Regulations and Technique to M. K. Kunins (W2DPS), Technical Editor, Radio World, 145 West 45th Street, New York, N. Y.

Anything Above 110 Mgc.

IS IT TRUE that amateurs are allowed to operate on any wavelength below five meters?—N. B. K.

The Federal Communications Commission has ruled that amateurs may use any frequency above 110 mgc (which is equivalent to 2½ meters and below), providing the regular rules of operation are followed. The regulation regarding the keeping of a log record is especially important.

* * *

Distance in Treasure Hunting

I HAVE JUST READ your interesting article on Treasure Hunting in the December 1st issue of the RADIO WORLD. About what distance apart could the receiver and transmitter be operated and to what depth could a metal object, say about one cubic foot in size, be located?—C. L. F.

The distance between the receiver and transmitter and the depth of the metal being probed are related since the distance between the transmitter and receiver is not the actual distance between them measured on the ground but rather is the distance from the transmitter to the buried metal to the receiver, or vice versa. Hence, these distances may be considered as one item. If the apparatus is built as shown with the acorn tubes and the parabolic reflector, sufficient energy should be available for depths of perhaps several hundred feet according to the composition of the soil. The horizontal distance between the apparatus may even be on the order of several miles, but of course, this will necessitate that measurements be made infinitely more accurately since the errors will be aggravated by the distance.

* * *

Centimeter Waves

I WOULD LIKE to experiment with centimeter transmission, especially with the new acorn tubes, and would appreciate any information on transmitter and receiver design and parabolic reflector antennae. Also, please explain the government regulations as to station and operator's license on such wavelengths.—R. M. Jr.

During the last five weeks, RADIO WORLD has published several articles pertaining to ultra high frequency work and you are referred thereto. Since these acorn tubes are a new development, not much work has been done in their adaptation. It is therefore necessary for each individual experimenter to find out for himself the various technicalities of the field. However, we might indicate that with such a tube to operate on wavelength of one meter or so, the oscillatory circuit of these tubes would require coils of about one quarter to one half inch in diameter and of from two to eight or so turns. No condensers for tuning are used, the distributed capacity of the circuit furnishing this item. It is imperative that all insulating materials be of the highest quality since at these frequencies the dielectric losses are tremendous. It is also important that all parts be substantially constructed to minimize frequency drift. If you will refer to the article on Treasure Hunting appearing in the December 1st issue of RADIO WORLD, you will note some facts on the construction of a parabolic reflector antenna. The points to remember in this device is that the antenna wire is placed at the focal point of a parabolic surface which is equal to one quarter wavelength of the current in the antenna. In other words, if the transmitter is working on one meter, the antenna is placed one quarter of a meter or about ten inches away from the rear of the parabolic surface. The length of the antenna should be one half wavelength or twenty inches. The width of the parabolic reflector surface should theoretically also be one half wavelength, but due to its mass, is practically slightly less. The length of this parabolic surface, or the distance to which it extends beyond the antenna is optional. The thing to remember here is that the longer it is, the sharper does the beam become. It is recommended that you construct this reflector without further ado since much more may be learned by practice. Regarding the regulations pertaining to ultra high frequency transmissions, it may most cogently be said that appropriate amateur licenses are necessary. When you are equipped with such licenses, you may operate on any frequency above 110,000 kc. or 2½ meters. For further details, refer to the article entitled "This way to amateur tickets," appearing in the RADIO WORLD for November 24, 1934.

* * *

25Z5 on 220 Volts

WILL YOU PLEASE advise me whether the 25Z5 will function on 220 volts without stepping it down to 110 volts? Also, will a 60 watt step down transformer be alright to use for a 40 wat soldering iron?—D. N.

The 25Z5 is a rectifying tube with a 25 volt filament. For proper operation, therefore, this tube must not be subjected to a voltage on its filament that is greater than 25 volts. Consequently, it is not sufficient that you step the 220 volts down to 110 volts but it must be stepped down to 25 volts. If you mean to ask whether the 220 volts must be stepped down to 110 volts for a set that utilizes this tube from such a line voltage, the answer would be that it is necessary to step the voltage down to 110 volts.

So long as your step down transformer is of larger capacity that the lead requirements, and so long as the voltage output is satisfactory, you may use it for the purpose you indicate. In other words, a 40 watt soldering iron may be used with a 60 watt step down transformer.

* * *

Prefixes Explained

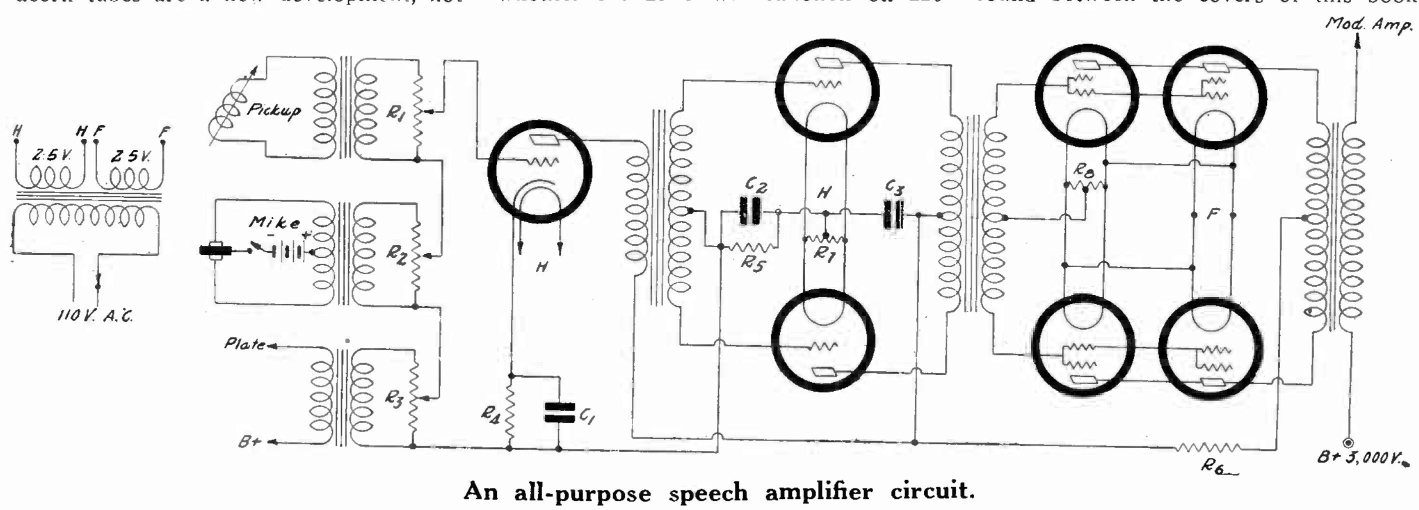
CONFUSION EXISTS in my mind concerning the difference between radio units that have different prefixes. Please clarify these prefixes.—K. B.

Whether the unit is the volt, ampere, ohm or what not, the prefixes affixed to any of these units has the same meaning. Thus, the prefix milli affixed before the word volt means one one-thousandth of a volt and when affixed before the word ampere, means one one-thousandth of an ampere. Similarly with the ohm or other unit. A list of various prefixes and their effects follow:

Meg or mega—multiply by one million
Myria—multiply by ten thousand
Kilo—multiply by one thousand
Hecto—multiply by one hundred
Deka—multiply by ten
Deci—divide by ten
Centi—divide by one hundred
Milli—divide by one thousand
Micro—divide by one million
Milli-micro—divide by one trillion
Micro-micro—divide by one quadrillion
(Also called pico)

NEW BOOKS

All interested in public-address systems will find in "Principles of Public Address Systems," by M. N. Beitman, Supreme Publications, Chicago, much practical information. Beginning with two-button and condenser microphones the author in a simple and concise manner covers the really important topics. Placing of microphones, radio and phono inputs, acoustic feed back, mixing and volume controls, vacuum tubes and coupling, power amplifiers, output coupling, loud speakers and placement, the decibel, P. A. measurements, power level are only some of the topics taken up in detail. Some very useful circuits are given. Much applicable data will be found between the covers of this book.



An all-purpose speech amplifier circuit.

Station Sparks *By Alice Remsen*

BIG CHANGES ON NETWORKS

RUMOR HAS IT THAT MANY CHANGES ARE SCHEDULED on the networks after January 1st. Bigger and better programs have been promised. In my humble opinion programs have been changing for the better since last year. At the present time "amateurs" are the rage. There's too much of this, however. Ernest Cutting, who started it all over NBC networks with his "Airbreaks," is still serious in his intention to give the little known artist a break. Major Bowes has an amusing way of presenting his amateurs. Lanny Ross is doing it, too, and so are WOR and WMCA. The WOR presentation is commercial. Another style of program which is being slightly overdone is the "Gay Nineties" type. In so far as my recollection serves me, Kathryn Parsons was the first to realize the pull of old-fashioned songs. Since then many have followed her, and now young Hammerstein is glorifying his grandfather's music-hall on WABC. . . . John Tasker Howard, an authority on old American music and author of several books on the subject, is doing a good job of his "America in Music" series over WJZ on Monday nights. . . . The Gibson Family started something when they brought original music and lyrics to the air—new stuff each week; a tall order, but Deitz and Schwartz are keeping it up; repeating once in a while, but making the same mistake as Warner and Paramount films—working choruses to death. It remains for us to see now what other new features will be presented after January 1st. Go to it! . . .

BIG HOLIDAY EVENTS

Christmas Day will bring a varied assortment of programs via the NBC networks. King George of England will send greetings to America during a special holiday program short-waved to NBC by the BBC from 9:00 to 10:10 a.m. The famous Catacombs in Rome, Italy, refuge of the early Christian martyrs, will be the scene of an international program heard over NBC networks at 1:00 p.m., EST. A liturgical service of ancient songs of the church will be sung by the Benedictine Choir of San Anselmo's Church. In the afternoon, "Hansel und Gretel," Humperdinck's famous Christmas opera, will be broadcast from the stage of the Metropolitan Opera House over the combined NBC-WEAF-WJZ networks. A Christmas morning carol service in German will come from the Zion Lutheran Church in Baltimore, one of the oldest churches in this country; there will be a chorus of three-hundred-and-fifty voices and a choir of trumpets will be heard. This broadcast will be sent also by short wave to Germany. . . . Arrangements are now being made to broadcast the Christmas Eve services from the ancient Einselden Monastery in Switzerland. This program will be followed by a special concert of Christmas music by the Cleveland Symphony Orchestra and another short-wave program of Yuletide folk songs from a little village in Czechoslovakia. Other NBC programs during the afternoon and evening include the lighting of the Community Christmas Tree near the White House; the presentation by a large chorus and soloists of Maunder's lovely Christmas cantata, "Bethlehem"; a radio adaptation of Jerome K. Jerome's famous allegory, "The Passing of the Third Floor Back," by the NBC Radio Guild; a message to wounded World War veterans by the American Legion National Commander, Frank Belgrano, and the annual Christmas Eve Party at the National Press Club in Washington. . . .

CANTWELL WRITES 'EM

An old friend of mine, Johnny Cantwell, well-known vaudeville author, is writing that new series on WJZ, Gigantic Pictures, Inc. It is a musical comedy program, with Johnny Blue taking care of the musical portion. Sam Hearn, vaudeville comedian, is being starred and is supported by Alice Frost and other veteran microphone performers. The vocalists include Betty Jane, contralto; George Beuchler, baritone; and Larry Grant. Each Sunday, at twelve noon. Sponsored by Tastyeast. . . . An all-star radio show marked the opening of Station KYW, the NBC outlet in Philadelphia on December 3rd. It was a five-hour program. Many NBC headliners were heard. . . . The first issue of the Rooster Gazette went to press over an NBC network on December 4th, and inaugurated a new series of novel dramatizations which are being heard twice weekly. The Rooster Gazette, a comedy-drama, brings to the listeners the fast talking and witty Roddy Roderick, publisher and editor of the world's "durndest" gazette. Two persons, Agnes Moorehead and Clarance Straight, well-known NBC actors, play all the characters whose activities are centered around the country newspaper of Coopertown in Bradford County. Published in a barn on a broken-down press, and with an editor noted for his harum-scarum actions, the Rooster Gazette makes its appearance over NBC-WEAF networks at 5:30 p.m. on Tuesdays and Thursdays. . . .

GOOD LUCK, MAY AND PETER

"Radio's Happiest Couple," May Singhi Breen and Peter de Rose, celebrated their fifth wedding anniversary on December 8th. The Breen and De Rose partnership is unique in many ways, but especially from the standpoint that it grew out of an association in radio. May Singhi Breen, known as the "Ukulele Lady," and Peter de Rose, famed as the composer of many popular song hits, met, courted and announced their engagement on the air. They really are a very happy couple, ideally suited to each other. . . . Henry F. Seibert, distinguished American organist of the Town Hall and Holy Trinity Lutheran Church, has inaugurated a series of monthly concerts over the nation-wide WABC-Columbia network. He will be heard on the last Friday of each month at 4:30 p.m. . . .

EDDIE CANTOR GOES COLUMBIA

Eddie Cantor will go Columbia in 1935. That is to say, upon his return from Europe, Eddie will move over to WABC and the Columbia network on behalf of Pebeco Tooth-Paste, on February 3rd, at 8:00 p.m. and each Sunday thereafter at that same time. Rubinoff will again be with Eddie—for who could think of one on the air without the other? Cantor is now touring Europe with his wife and three of his daughters. . . . The Columbia Broadcasting System, in behalf of the American School of the Air, has just published the 1934-1935 edition of its Teachers Manual and Classroom Guide as an aid in augmenting broadcast instruction. The manual, issued for the sixth consecutive year, directs reference work and active participation in the subjects treated during the School of the Air programs on the nationwide CBS network. It is compiled by Helen Johnson, broadcasting director of the American School of the Air. The contents include synopses of each day's radio projection, footnoted with music references and visual aids, such as lantern slides, paintings and illustrated books; helpful publications, news bulletins, motion pictures, and vocational guidance bibliography. It is distributed free to all educators requesting it. . . . The most famous babies in the world—the Dionne quintuplets of Ontario—will make their radio debut over the Coast-to-Coast networks of the Columbia Broadcasting System and the Canadian Radio Commission on Thursday, December 20th, from 8:15 to 8:30 p.m. EST. Watch your local newspapers for this event. It will be more than interesting. . . . Several of the youthful aspirants to stage and radio heard on the Harlem Amateur Night program over the WMCA-ABS network, have already netted appearances on local colored theatre stages. Two girls, Gertrude Green, vocalist, and Alma Greasy, violinist, were particularly successful. . . . There is a new boy and girl team on the air from the studios of WIP in Philadelphia through the facilities of the WMCA-ABS network. Their names are Pat and Patty, they may be heard each Tuesday, Thursday and Friday at 9:45 a.m. . . .

STUDIO NOTES

Lawrence Tibbett's first audition at the Metropolitan Opera was recorded as a complete flop. All he got for his effort was a chilly "Thank you." A friend succeeded in arranging another hearing for the youthful Californian which resulted in a contract paying $60 a week. . . .

Gene Carroll, of Gene and Glenn, was in no mood to hear what the well-dressed young men are wearing today when he appeared for a broadcast at the NBC studios in New York the other night. The reason: his hotel room had been robbed of his entire wardrobe including nine suits, two topcoats, sweaters, a couple of watches and two bundles of laundry. . . .

Tony Wons, star of the House by the Side of the Road program on NBC, has a habit which other members of the cast know and appreciate. He carries several different brands of cough drops in his pocket during rehearsals and broadcasts.

A THOUGHT FOR THE WEEK

NO WONDER MEN ARE MAKING THE BIG MONEY as entertainers on the air. The Harvard Psychological Laboratory, in working out a carefully studied survey of the broadcasting field, has been forced to the conclusion that ninety-five per cent of listeners prefer men entertainers.

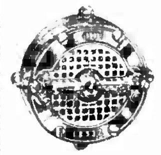
That's a rather cruel way of declaring that women represent only five per cent of the interest, affection and admiration of the millions of listeners throughout the North American continent. And yet it would seem that a lot of sponsors do not at all agree with this declaration, judging by the percentage of women entertainers on practically all kinds of programs, as compared with the Eddie Cantors, Joe Penners and Ed Wynns, who are drawing their thousands of dollars per week. We wonder what the women of the microphone think of Harvard's declaration.

BOTH ENDS AGAINST MIDDLE

Children like thrilling stories. Sponsors often make their radio presentations morbid. So parent associations have appealed to the Federal Radio Commission. It is a case of seeking good will and producing ill will, and paying twice, i.e., once for sponsoring and once for getting nothing but deserved condemnation.

RUBY DOING WELL

The remote community of Ruby, Alaska, insists on adequate radio service and as a result has two stations, KIKP and KIKS, in process of completion under the supervision of the Ruby Community Radio Committee.



UNIVERSAL

Stretched Diaphragm Type 1935 MODEL "BB"

Now with stretched diaphragm fully protected against damage. Superlative quality of reproduction makes Model "BB" the general all-purpose microphone for both voice and music. No increase in price. Sold by Jobbers everywhere.

Universal Microphone Co., Ltd
424 Warren Lane
Inglewood, Calif. U. S. A.

CHASSIS

We render prompt and accurate service on special chassis to your specification. Single or quantity orders filled. Rigid metal chassis, durable finishes of great variety. Send specifications for quotation.

KORROL

MFG. CO., Inc., 232-RW Greenwich St., N.Y.C.

ACCURATE Fixed Mica Condensers

Capacities measured on a bridge.

1,000-VOLT RATING

0.0025 mfd... 12c	0.0008 mfd... 13c	0.0004 mfd... 15c
0.002 mfd... 12c	0.0007 mfd... 13c	0.0003 mfd... 15c
0.0015 mfd... 12c	0.0006 mfd... 13c	0.0002 mfd... 15c
0.0009 mfd... 13c	0.0005 mfd... 15c	0.0001 mfd... 15c

Any six of above, 60c; any 12 of above, $1.10. Any assortment permitted.

ACCURATE PIGTAIL RESISTORS

¼-WATT RATING

Bridge Measured

100 ohms..... 9c	4,000 ohms.. 10c	40,000 ohms.. 11c
200 ohms..... 9c	5,000 ohms.. 10c	50,000 ohms.. 11c
300 ohms..... 9c	6,000 ohms.. 10c	60,000 ohms.. 11c
400 ohms..... 9c	7,000 ohms.. 10c	80,000 ohms.. 11c
500 ohms..... 9c	8,000 ohms.. 10c	.1 meg....... 12c
600 ohms..... 9c	9,000 ohms.. 10c	.15 meg...... 12c
700 ohms..... 9c	10,000 ohms.. 10c	.2 meg....... 12c
800 ohms..... 9c	12,000 ohms.. 11c	.5 meg....... 12c
1,000 ohms.. 10c	15,000 ohms.. 11c	.6 meg....... 12c
1,500 ohms.. 10c	17,000 ohms.. 11c	.7 meg....... 12c
2,000 ohms.. 10c	20,000 ohms.. 11c	.8 meg....... 12c
2,500 ohms.. 10c	25,000 ohms.. 11c	.9 meg....... 12c
3,000 ohms.. 10c	30,000 ohms.. 11c	1.0 meg...... 13c
3,500 ohms.. 10c	35,000 ohms.. 11c	1.5 meg...... 13c
		2.0 meg...... 13c

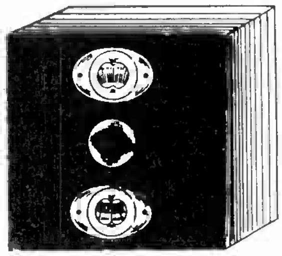
Any six of above resistors, 50c; any 12 resistors, 90c.

Each condenser and each resistor is specially tested and calibrated, and a personally written notation of the resistance or capacity value is furnished. We pay postage sending out these condensers or resistors if you remit purchase price with order.

DIRECT RADIO CO.
145 W. 45th Street, New York, N. Y.

New Signal Generator Free
with $6 (One Year) Subscription

NOW for the first time you can get a wired and tested Signal Generator free as a premium with a $6 subscription for Radio World (52 issues, one each week). Imagine getting Radio World for a year, and also a splendid Signal Generator! Never before have we made so generous an offer as this. Moreover, the offer is revocable without notice. So you'd better act now.



The Signal Generator, PRE-6, has practically straight-frequency-line tuning. It works on 90-125 volts, a.c. or d.c., and is modulated on a.c.

The Signal Generator offered as a premium with a one-year subscription is a serviceable instrument, of durable and accurate construction, and enables the peaking of intermediate frequencies, as well as broadcast frequencies. Moreover, short-wave frequencies can be determined. Determinations in frequencies in kilocycles and wavelengths in meters are made by use of this splendid instrument.

SCALE READS DIRECTLY IN FREQUENCIES AND WAVELENGTHS

MANY experimenters and service men want a really good Signal Generator that serves their purposes abundantly and that costs little. Here it is. Model PRE-6 Signal Generator is given free with a one-year subscription for RADIO WORLD, a most amazing offer, nothing like it ever having been made before in the radio field. And this generator is obtainable in no other way.

The scale reads directly in frequencies of the fundamental (109 to 200 kc, with bars 1 kc apart), and wavelengths of the fundamental (2,700 to 1,500 meters, with bars 10 meters apart). Besides the intermediate frequencies on the fundamental scale, others are on the scale on the next tier from top, including the following imprinted twice: 400, 450, 465 and 480 kc. The reason for these imprints appearing twice is that an automatic check-up on whether the channel measured is tuned exactly to the right i.f. is obtained, when using harmonics, for there is a response in the receiver channel when the generator is turned to one and then another of these two points. Hence no harmonic confusion is possible. Also, 250 and 260 kc are imprinted once on the second tier, for no confusion can result, as second harmonics are used.

GUARANTEED ACCURACY IS 1%

THE upper tier, at the edge, is 109-200 kc, the lower corresponding tier at the edge is for wavelengths. One inside tier has the registrations for the popular intermediate frequencies not on the fundamental. The other inside scale reads 0-180, so that any odd frequency one is interested in may be recorded elsewhere in respect to a calibration in degrees of a semi-circle.

The 335 dial scale is used.

The guaranteed accuracy is 1 per cent. This is checked twice in a precision laboratory. The accuracy is not changed when a tube is inserted. The wired, calibrated, tested Signal Generator is supplied less tube. All you have to do is to insert a 30 tube and start making precision measurements.

Send $6.00 for one-year subscription, and ask for PRE-6. Present subscribers may renew on this basis. Shipping weight, 3 lbs. Enclose postage if prepaid shipment is desired. It's cheaper.

Foundation Unit for this Signal Generator can be obtained by sending $3 for six-months subscription (26 issues, one each week). The Foundation Unit consists of frequency-calibrated scale, two escutcheons, knob, coil, tuning condenser, and wiring diagram. Order PRE-3. Shipping weight, 1 lb.

RADIO WORLD, 145 West 45th Street, New York, N. Y.
OUT WEEKLY — 15c a copy at News-stands.

Quick-Action Classified Advertisements

5 cents a word. 50 cents minimum.

UP TO $300 PAID FOR DIMES dated before 1895; Liberty Head Nickels $200; Colonial Coins $300. Send 15c complete Catalog. Nationalcoin, (LL) Springfield, Massachusetts.

INVENTIONS WANTED, Patented or unpatented, any size, any material, for any legitimate purpose. Now is the time to act. Send us your ideas. A square deal assured. Bosley Mfg. Co., 79 High Street, Torrington, Conn.

COMPLETE TRAINING FOR AMATEUR LICENSE, $1.50 weekly. N. Y. Wireless School, 4 West 105th Street, New York City; phone: CLarkson 2-7456.

P. A. PRINCIPLES of PUBLIC ADDRESS SYSTEMS

- A practical handbook, full of useful information, fully illustrated, written by M. N. Beitman, an engineer and noted authority on amplifiers.
- Considers in detail two-button and condenser microphones, radio and phono input, acoustic feed back, mixing and volume controls, use of vacuum tubes, interstage coupling, power amplifiers, output coupling, loud speaker placement, the decibel, P. A. measurements, power level, and other points of importance including actual circuit diagrams of P. A. systems.
- Everything about public address practice. Price: 50 cents, postpaid.

SUPREME PUBLICATIONS 3727 West 13th St. Chicago, Illinois

"WILLCOX AUTO ELECTRICIAN'S WIRING MANUAL"—Complete wiring diagrams for all U. S. cars made in 1928-1929-1930-1931-1932. Complete data on ignition systems, generators, starting motors, batteries and lighting. Printed on tough, wear-resisting paper that can be washed with gasoline without injury to print or paper. Loose-leaf style in sturdy covers. Size 11 x 12". 300 wiring diagrams. Price $10.00. RADIO WORLD, 145 W. 45th St., New York City.

"RADIO TROUBLE SHOOTING," E. R. Haan. 361 pages. 300 illustrations. $3. RADIO WORLD, 145 W. 45th., N. Y. City.

SHORT-WAVE AND PUBLIC ADDRESS MANUAL
FREE

192 pages, 400 illustrations, costing $4,000 to produce. And yet a copy of this manual will be sent to you free if you send $1.00 for an 8-weeks subscription for RADIO WORLD. Existing subscribers may extend their subscriptions under this offer.

Bound in cardinal red leatherette, this manual includes articles on the construction of short-wave receivers from one to nine tubes, inclusive, and all values between, supers and t-r-f, with the clearest imaginable illustrations, both photographic and draughting. Besides the usual plain circuit diagram there is a pictorial diagram for each circuit. And all the photographs are brilliantly alluring and informative. Portable short-wave sets, design and winding of coils for short waves and broadcasts (intimately illustrated), list of short-wave stations with meters and kilocycles and hours on the air; trouble-shooting, and forty other topics, all done well.

The public address section contains data on different systems, how to use them, and offers opportunities to turn public address work to profit. Besides, there are articles on testing and servicing not encompassed by the title of the manual—signal generators, broadcast home and portable sets, analyzers, formulas, capacity data. Everything plainly told, simple language, from microphones to speakers.

Send $1.00 now and get RADIO WORLD for 8 weeks and the manual free. Ask for Cat. PR-SPAM.

RADIO WORLD, 145 W. 45th St., New York, N. Y.

RADIO WORLD AND RADIO NEWS. Both for one year $7.00. Foreign $8.50. Radio World, 145 W. 45th St., N. Y. City.

"SAFETY-FIRST" SHORT-WAVE KITS

These Leonard kits contain complete parts; nothing else to buy, for building a 1 or 2 tube regenerative detector short wave and broadcast radio set tuning from 15 to 550 meters.

Many enthusiastic builders have registered reception from as far as India on these small sets. Simple instructions are furnished so that any one, young or old, can build it with no trouble at all.

Features of the Kit:

All broadcast type vernier dial, complete set of 5 coils from 15 to 550 meters, chassis of heavy steel with black crackle finish as well as panel; silver contact regeneration control for smooth action; complete blueprints and instructions, all necessary wire, nuts, screws, etc.; all controls on front panel; special vernier to bring in those weak signals.

1-TUBE BATTERY KIT

A battery operated short wave receiver which covers from 15 to 550 meters. Police signals, amateurs, foreigners, transatlantic phone stations. Uses 1-230 tube, 2-2½ volt dry cells and 1-45 volt "B" battery. Tubes not supplied.

Cat. No. C4000.
Our Price **$4.75**

2-TUBE BATTERY KIT

Similar to the one tube, only here we can actually operate a loud speaker on some stations because of the addition of another 230 tube which makes the signal much louder. Uses 1-230 detector and 1-230 as first audio, 2-2½ volt dry cells, 2-45 volt "B" batteries. Not supplied.

Cat. No. C4001.
Our Price **$5.45**

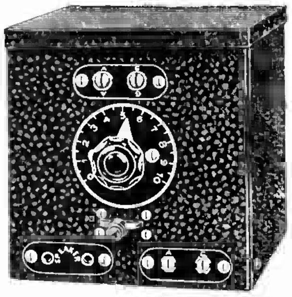
2-TUBE A.C.-D.C. KIT

The latest in efficient small sets—Same layout as the battery sets but with no necessity for either A or B batteries. Simply plugs into the A.C. or D.C. line. Uses the latest type dual 6F7 tube as detector and one stage of audio and 1-37 as rectifier. Not supplied. Foreign reception is most consistent with this set.

Cat. No. C4002.
Our Price **$6.50**
Either Kit Wired at Factory $1.00 Extra

Federal 5 and 10 Meter Transceiver

FEATURES: A highly efficient wired transceiver which is gaining in popularity every where.
Designed for portable work as well as for stationary use.
A correctly engineered unit designed to give the service required of it.
Operation on five or ten meters by simply changing coils.
Five and ten meter coils provided with the unit.
Uses only parts made by the foremost manufacturers.
Performance limited solely by topographical location.
Is now in use by leading amateurs.
Weight only 6 pounds.
Adaptable for six volt, 2.5 volt and 2 volt operation.
Size 5½ x 5¾ inches.



The transceiver is mounted in a strong steel case which is finished in black crystal. All component parts are mounted on a steel cadmium finished chassis. Transmission and reception are done by the simple throwing of a switch.

Models: The 6 volt model uses a 76 and 41. This is ideal for use in motor boats, airplanes, automobiles, etc. A six volt battery lights the filaments, and either "B" batteries or 6 volt "B" eliminators supply plate voltage. As low as 90 volts will operate this unit. The 2.5 or A.C. model is suggested for stationary usage. Here we use a 56 and a 2A5. For this unit we supply an especially designed power pack which not only supplies the plate and filament voltages, but supplies microphone current. No batteries are needed. It may be well to mention that this unit and the 6 volt may be used interchangeably by inserting the proper tubes.

The two volt model is ideal for both portable and FIELD WORK. Where there is no voltage source available, this model is brought into play. Through the use of a 30 and 33, only 2 volts of A battery are necessary, and as little as 90 volts of "B" will operate the transceiver efficiently.

Model 601. For 6 volt operation (using 76 and 41 tubes, not supplied)
Your Price **$13.50**

Model 602. 2.5 volt or A.C. operation (using 56 and 2A5 tubes, not supplied)
Your Price **$13.50**

Model 603. For 2 volt (using 30 and 33 tubes, not supplied)
Your Price **$12.50**

A.C. Power Pack for all electric operation of Model 602 Transceiver
Cat. No. 602P. Our price, less 80 tube **$5.50**

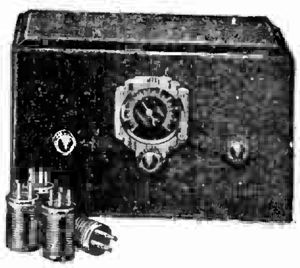
Above four products are sold only in wired form.

Federal All-Electric 3 Tube A.C. — D.C. Short Wave Receiver

A new, wired deluxe complete short-wave set with the highest of efficiency.

Consistent world-wide reception is now within the reach of everyone's pocket. Through the use of the latest tubes a three tube set, self-powered from either A.C. or D.C. is made possible.

Thousands of these sets are now rendering excellent service. Amateurs, experimenters and short-wave authorities have proclaimed its merits. Points 12,000 miles distant have been heard consistently, some stations on loud speakers. Some favorites are London, Germany, Rome, France, Russia, etc. Though primarily designed for short wave, it very efficiently receives signals simply by the insertion of broadcast coils.



Latest type full vision Airplane Dial, 270° scale; latest type tubes (1-77, 1-43, 1-25Z5); 1-high efficiency plug in coil (set of 4), 15 to 200 meters; silver contact regeneration control finished chassis; crackled finished heavy steel cabinet; four section filter system, hum-less built-in power supply. Size 11¼ x 7¼ x 7¼ (overall).

Cat. No. C4003. Our Price (with 4 coils, less tubes) **$13.95**
Two broadcast coils, extra 89c (both)

GUARANTY RADIO GOODS CO., 145 W. 45th St., New York, N.Y.