HOW TO MAKE PUSH-PULL CURVES—Page 5

FEB. 18
1933

RADIO WORLD

REG. U.S. PAT. OFF.

15 Cents
Per Copy

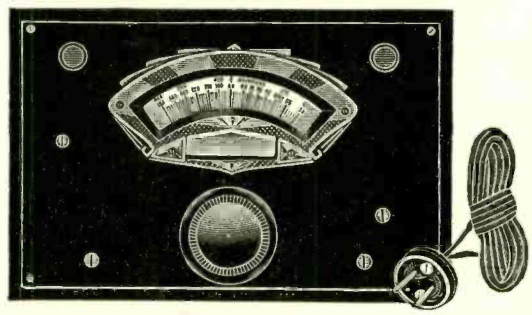
The First and Only National Radio Weekly
Eleventh Year *569th Consecutive Issue*

REVIEW OF LATEST CIRCUIT METHODS

Subscribers! Important!

Note subscription expiration date on wrapper containing your copy of RADIO WORLD. If nearing expiration date, please send in renewal so that you will not miss any copies. Subscription Dept., RADIO WORLD, 145 W. 45th St., New York City.

All-Frequency Service from a Test Oscillator



The test oscillator has a frequency-calibrated dial, registering 50 to 150 kc, while above this tier of frequencies are registered all the popular commercial intermediate frequencies. So just consult the dial scale.

A COMPLETELY self-operated a-c test oscillator, fundamental frequencies from 50 to 150 kc, with the line frequency, 60-cycle hum, used as modulation but not heard except at resonance, affords all-frequency service, from 50 kc up. This is true because the fundamental may be used as registered on the exclusively frequency-calibrated dial, and harmonics may be used for any higher frequencies, almost without limit. All oscillators are tested up to the 28th harmonic, but response of sufficient intensity may be obtained even beyond the 50th harmonic, and there are proven cases of good results up to the 150th harmonic.

Therefore when fundamental frequencies are low, as here, you may set down the lowest, 50 kc, as one extreme, while the harmonic orders give almost unlimited service to line up short-wave receivers, converters and broadcast receivers that respond to police frequencies.

Average Accuracy 1% or Better

The a-c test oscillator, 105-120 v., 50-60 c., uses a 56 tube, a frequency-stabilized grid circuit, Hartley oscillator and a-c on the plate. Special pains have been taken to assure accuracy, and the test oscillator is guaranteed to be accurate to within 2 per cent. However, at some settings the accuracy is almost perfect, while the average accuracy is 1 per cent. or better. The 2 per cent. rating is the extreme deviation, present in only a few instances.

Therefore in possessing one of these oscillators one knows that he has an instrument of a degree of accuracy more than sufficient for the purposes to which the oscillator will be put, i.e., lining up intermediate amplifiers and padding, in superheterodynes, or lining up condenser gangs in t-r-f systems.

The oscillator will yield sharp zero beats with carriers, and the accuracy may thus be checked at any time against broadcast carriers, using the tenth harmonic (500 to 1,500 kc). This harmonic is used for all broadcast frequencies.

If any particular frequency setting that is a multiple of 50 is ascertained for a receiver or other tested device, frequencies separated therefrom in steps of 50 kc may be registered by setting the test oscillator at 50 kc and tuning the tested device. This is particularly handy in frequency calibration, and for finding frequency extremes in receivers that cover some of the police frequencies.

Get One of These Test Oscillators *Free!*

The oscillator is self-powered as an a-c device, but may be obtained also in battery model. The circuits used are simplifications of the Hartley oscillator and the construction of all oscillators is under the supervision of graduates of the Massachusetts Institute of Technology, who test each oscillator to verify its accuracy.

The a-c model is constantly modulated and yields zero beats at all times. The battery model has a switch at left for modulated-unmodulated service, and yields zero beats on unmodulated but not on modulated service.

The a-c test oscillator parts may be obtained free with a one-year subscription for RADIO WORLD, 52 issues, one each week, at $6.00, the regular subscription price, while the cost is $1.50 extra for wiring and calibrating. The $1.50 is turned over by us to an outside laboratory. Order Cat. PRE-ACOW and remit $7.50 with order. The 56 tube is 72c extra.

The battery model requires a 230 tube, a 22.5-volt small B battery, and a 1.5-volt dry cell. Order Cat. PRE-BATOW and remit $7.50 with order. The 230 tube is 78c extra. Batteries not supplied.

The main scale of the frequency-calibrated dial reads from 50 to 150. The bars are 1 kc apart from 50 to 80 kc and 2 kc apart from 80 to 150 kc. Thus for broadcast work, using the 10th harmonic, the separation as registered by the bars is 10 kc from 500 to 800 kc and 20 kc from 800 to 1,500 kc. On an upper tier the intermediate frequencies are printed: 175, 260, 400 and 450 kc, with a bar to the left of 175, representing 177.5, and a bar to the right of 175, representing 177.5. These, with 130 on the fundamental, represent all the popular commercial intermediate frequencies. Any other intermediate frequency may be obtained either directly from the fundamental, or by dividing a higher desired frequency by the nearest whole number to yield a frequency represented on the fundamental.

DIRECTIONS FOR USE

Remove the four corner screws and the cover, insert the 56 tube in its socket, restore the cover and screws, connect the a-c attachment plug to the wall socket, and the a-c test oscillator is ready for service at broadcast frequencies. No other coupling is necessary, as radiation is strong enough. Mentally affix a cipher to the registered frequencies on the lower tier (so 50 is read as 500, and 150 as 1,500), and set the dial for any desired frequency. At resonance the hum will be heard. Off resonance it will not be heard. For testing intermediate frequencies, connect the bared end of a wire to the output post of the test oscillator, other bared end of this wire to plate of the first detector socket. The first detector tube may be removed and bared wire pushed into the plate spring. The intermediates then are tuned for strongest hum response. If an output meter is used, tune for greatest needle deflection.

The battery model is connected to voltage sources as marked on oscillator outleads and is used the same way, except that output lead may have to be wrapped around the aerial near set for a few turns to effectuate coupling at broadcast frequencies. The modulation is a high-pitched note, instead of hum.

RADIO WORLD, 145 West 45th Street, New York, N. Y.

ALL SHIPMENTS MADE EXPRESS COLLECT.

ROLAND BURKE HENNESSY
Editor

HERMAN BERNARD
Managing Editor

RADIO WORLD

The First and Only National Radio Weekly
ELEVENTH YEAR

J. E. ANDERSON
Technical Editor

J. MURRAY BARRON
Advertising Manager

Vol. XXII | FEBRUARY 18th, 1933 | No. 23, Whole No. 569

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

OFFICERS: Roland Burke Hennessy, *President and Tresurer;* M. B. Hennessy, *Vice-President;* Herman Bernard, *Secretary.*

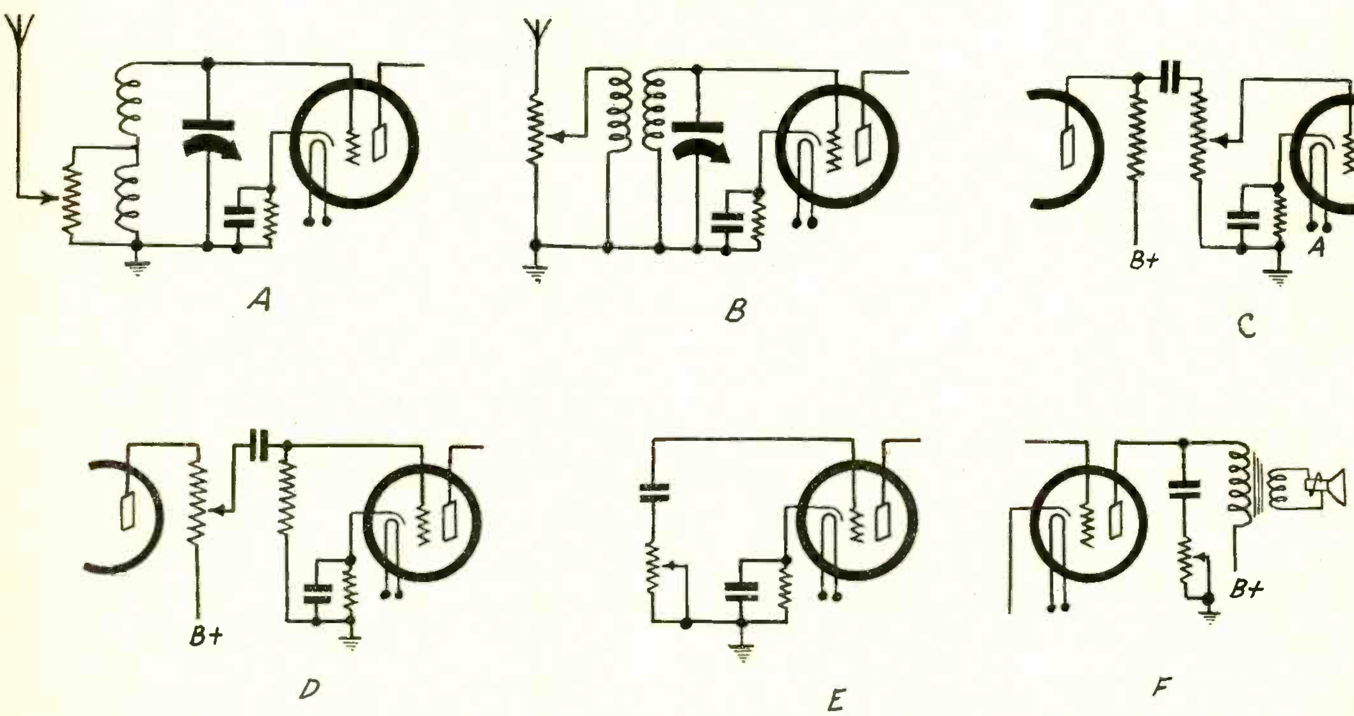
Entered as second-class matter March, 1922, at the Post Office at New York, N. Y., under Act of March 3, 1879. Title registered in U. S. Patent Office. Printed in the United States of America. We do not assume any responsibility for unsolicited manuscripts, photographs, drawings, etc., although we are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

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.

VOLUME CONTROLS

Being Shifted to Audio Channel

By Capt. Peter V. O'Rourke



Various types of volume and tone controls. In A the control is not effective enough for highly sensitive circuits, and while B represents an improvement in this direction, very strong locals may be picked up even with the arm at ground potential. C and D are controls of the volume at the audio level, while E and F are tone controls. The plate circuit positions for the audio controls are preferable as safeguards against hum increase at low resistance values between arm and ground or B plus.

VOLUME control vogues change. There is a reason. Formerly it was standard to recommend that the volume control be ahead of the detector. The principal reason was to protect the detector from being overloaded. However, then came more sensitive receivers, also automatic volume control, and linear detectors that readily stand 25 volts or more, and in full-wave fashion 50 volts or more. This changes the situation as follows:

(1)—The receivers are so sensitive that there is enough pickup without any aerial, rendering volume controls of the type shown in A to be of small effect.

(2)—Automatic volume control tends to protect the detector from overload, and besides the new detectors (diodes) would stand almost anything that the receiver would put into them. Hence volume controls at the audio frequency level became popular. They rule to-day.

Controls Ahead of Detector

Many different types of volume controls ahead of the detector were used in t-r-f sets. One was that shown in A, but even so the set might be too sensitive to make that type of control worth-while, therefore the type shown in B might be used. This is more effective, but some strong locals might come in, due to stray pickup, even when the arm of the adjustable voltage divider was at ground.

When it was important to have the control ahead of the detector two facts had to be given consideration: the gain had to be cut down and the input as well. So combination controls became popular, usually consisting of two adjustable voltage dividers on a single shaft, one to cut down gain, the other to cut down input. It was important to reduce input because that tended to correct for crossmodulation even in the early tubes of the remote cutoff type, which still permitted some crossmodulation.

The combination purpose might be served by a single adjustable voltage divider, whereby there would be a limiting resistor in the cathode leg or legs of controlled tube or tubes, arm to ground, and extremes of the resistor to limiting resistor and to antenna. The return was made through the pri-

(*Continued on next page*)

(*Continued from preceding page*)

mary of the antenna coupler, and moving the arm cut down both gain (by increasing the negative bias) and input (by progressive reduction of the high side of the antenna coil to ground potential). This method was pretty good, the only objection being a scratching sound when the control was turned to maximum sensitivity. This sound was present only during the movement, and not after the control was left at the adjusted point.

Question of Hum

But in circuits that are very sensitive, whether they have a.v.c. or not, provided that diode detection is used, as with the 55, 85 or battery-operated tube worked as diode, the location of the control in the audio channel is generally preferable.

In C the grid load resistor is the total resistance of the voltage divider, whereas the amount of voltage taken off, for delivery to the second tube's grid circuit, is varied until the desired amount is obtained. This system would be all right if the positions for low resistance values between arm and ground did not increase hum. In some circuits they do not, but probably in most of them they do, therefore it is preferable to have the control in the plate circuit, as in D. In all instances it is preferable to have the load on the plate or grid circuit constant, and vary the amount of voltage taken off. That is, do not use the control as a rheostat.

The hum-introduction associated with grid circuit adjustments applies also to tone controls, and indeed these are unwittingly volume controls of a sort, since they reduce the volume by the amount that they reduce the high audio frequency response. So instead of locating the control in the grid circuit, as in E, it may be placed in the plate circuit, as in F, even if the only plate circuit left (due to single-stage audio) is that of the output tube.

How A. V. C. Works

By either of the actual volume control methods for audio frequency circuits, C and D, the volume may be cut down to zero, as well as increased to maximum, so the full sweep is enjoyed. Even if there is stray pickup this will be killed off, if desired for any given moment to make the set silent by volume control adjustment. Those receivers not equipped with silent tuning, and which cause locals to blast when one tunes throughout the dial span, may have the volume control, if of the type C or D, set at no response, during such tuning. If desired, a switch may be put across the total volume control, and thus the load shorted, and this switch used at closed position for silent tuning, being opened of course for the reception of signals. The steady bias on the tube will not be altered by this method.

Automatic volume control, as its name suggests, limits the amount of volume to a predetermined level. This level is decided by the antenna, the receiver's gain and the position of the manual volume control. Then, in theory at least, the volume of no station will be greater than that set for the loudest local.

In this connection it should be pointed out that the advantages of a.v.c. of this type are prevention of blasting by locals, and reduction or elimination of fading. While the word "elimination" is a pretty strong one to use in connection with fading, it is a fact that recently developed receivers with full a.v.c. (governing two stages at least) do not evidence the slightest fading, even when tested on stations that otherwise fade badly. In New York City this is true particularly of WJY, Schenectady, and WBA-WBZA, Boston-Springfield, Mass.

Reaction to Limitation

One might say that the levelling of volume is not obvious theoretically, since with a receiver not possessing a.v.c. no station will come in louder than the loudest local. That is true, but the loudest local is greatly reduced in volume, being checked by the a.v.c., since the higher the rectified voltage in the a.v.c. tube, the higher the negative bias and the lower the amplification. Hence all locals come in with about the same volume, as determined by the adjustment either for the loudest local or indeed any other local. This effect is so real that some persons not fully acquainted with the technique complain that full a.v.c. reduces the volume of the strongest locals too much. On weak signals, however, the volume control is not of such absolute effect, although being relatively effective, as intimated in the previous discussion concerning fading.

It is practical to use a.v.c. in t-r-f sets, of course, but it must be understood that selectivity will be less. The most usual way to introduce a.v.c. is in the intermediate channel of a superheterodyne, controlling the single i-f stage (if there is only one), or both i-f stages (if there are two), while all i-f stages, no matter how numerous, may be thus controlled, and the oscillator, also, if it is a 58 tube.

Where the volume control is in the audio channel it should not vary the bias, and in the diagrams it does not. The total resistance of the adjustable voltage divider should be of the same values as if fixed resistors were to be used in the same circuit positions.

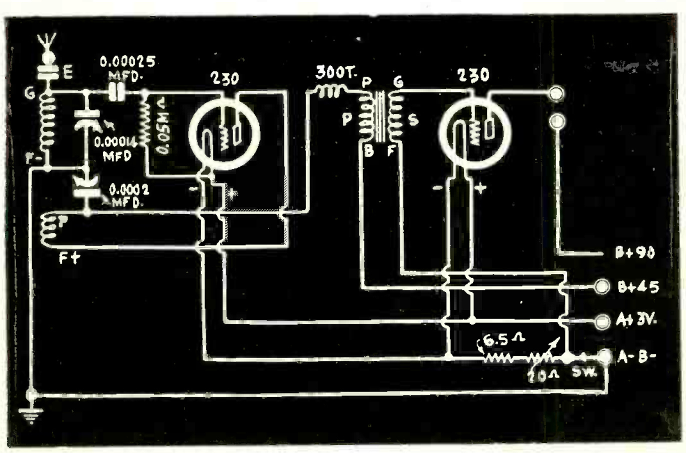
Revamping Set for A. V. C.

The question often arises concerning the introduction of a.v.c. in existing circuits. The best way to accomplish this is to use a duplex diode detector in full-wave fashion. For a t-r-f set a 100-turn center-tapped r-f choke may be inserted inside the form of the existing coil, the 55 or 85 replacing the present detector, the coil center connected to a load resistor of 0.5 meg., the other side of which resistor goes to cathode, while the two extremes of the coil are connected to the two anodes of the 55 or 85. Then the returns of the circuits that are to be controlled are interrupted by high resistances, 0.1 meg., or more, bypassed to ground by 0.1 mfd. or so, and led to the high potential side of the detector load resistor (center tap of choke).

For superheterodynes, either a semi-tuned i-f stage may be added that has center-tapped secondary, or a special tuned transformer of correct frequency, that has center-tapped secondary, replaces the existing transformer that couples to detector.

The only precaution necessary is that the grids be not positive when there is no signal, and this is taken care of by grounding the cathode of the 55 or 85, connecting grid cap of that tube directly to the load resistor (center tap of coil, or arm of adjustable voltage divider), and individually biasing the controlled tubes in the usual way, to a value high enough to prevent any oscillation where none is wanted.

Two-Tube Short-Wave Circuit



A dependable two-tube, battery-operated short-wave circuit, for use with standard UX type two-winding plug-in coils. A set of four coils, using 0.00014 mfd. tuning capacity, will permit tuning from below 1,500 kc to above 20,000 kc.

A dependable earphone short-wave circuit, using conventional two-winding UX base plug-in coils, may be constructed from the diagram herewith. The two windings suffice because instead of an antenna primary there is a small condenser E, of about 50 mmfd. capacity, although up to 100 mmfd. may be used. The capacity depends on the length of the aerial and its elevation. If regeneration fails as the capacity of E is increased, reduce the capacity until regeneration is obtained at the lowest frequency of the largest coil.

The second winding, or tickler, is the smaller one, and is in the plate circuit. Inductive feedback causes oscillation, and the 0.0002 mfd. condenser serves as a throttle to reduce the feedback to the required amount of regeneration. The condenser may be of greater capacity, if desired, up to 0.00035 mfd.

The detector is a 230 tube, and detection arises from the grid leak and condenser combination. The rotor of the feedback condenser is grounded, so that body capacity either is absent or, at the very highest frequencies, is not troublesome.

Also the output tube is a 230, and between it and the detector is a coupling transformer for audio frequencies. This may be any ratio. The 300-turn choke helps smooth out the regeneration, and sometimes results are improved by putting a bypass condenser of 0.00025 mfd. or thereabouts across the primary of the audio transformer, or from its P post (plate connection) to ground, it makes small difference which.

Besides regeneration control there is a volume control rheostat. The values of parts not given in this text will be found imprinted on the diagram.

This is not a new hookup by any means, but it is a standard, dependable one, and thousands of users who work this circuit bring in European and other foreign stations with excellent earphone volume. Since the circuit is battery-operated, it should be economical in upkeep, and the voltage and tubes are so chosen that this will be true. The A supply may consist of two No. 6 dry cells in series, which should last for months, as should the two 45-volt B batteries that are also series-connected, the 45-volt tap to detector, the 90-volt tap to the phones.

PUSH-PULL CURVES

How to Take Them, Using One or Two Meters

By Einar Andrews

TAKING a characteristic curve of a push-pull amplifier can be done just as easily as taking one on a single tube. A circuit must be arranged whereby the bias on one tube can be increased by a certain amount and that on the other decreased by the same amount. The currents in the plate circuits of the two tubes should be measured simultaneously and their difference taken. If a differential milliammeter of suitable range is available that can be used for measuring the difference directly. If no such meter is available two milliammeters connected as M1 and M2 may be used, or a single milliammeter which by means of a switch can be connected in the plate circuit of either tube.

The same operating bias should be given the two tubes. This is supplied by the battery V. If the two tubes are 245s then the voltage of V should normally be 50 volts.

A grid leak of 50,000 ohms is connected in each tube. It is more important that these resistances should be exactly equal than that they should be just 50,000 ohms. Whatever their values they should be accurately known.

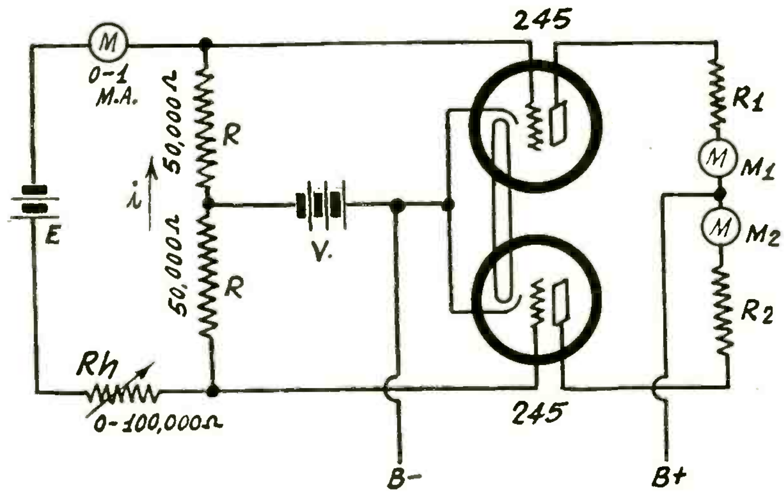


FIG. 1

By means of this circuit the performance of a stage of push-pull or a stage of Class B amplification can be studied with the same ease as the taking of a plate current curve on one tube.

Variation of Grid Voltage

Suppose an auxiliary battery E connected in series with a meter M, the two 50,000-ohm resistors, and a variable resistor of about 100,000 ohms. A current i will flow through the circuit in the direction of the arrow. The voltage drop in each resistor will be Ri, in which R is the resistance in ohms of either leak. The grid voltage on the upper tube will be (V + Ri) and that on the lower tube will be (V — Ri). When i is large enough to make Ri equal to V, the voltage on grid of the upper tube is 2V and that on the lower is 0.

We can start our measurements with this adjustment, that is, with the bias on the upper tube equal to twice the operating bias and the bias on the lower tube zero. The corresponding currents in the two plate circuits are observed, their difference obtained and recorded as the first plate current observation. Then the grid voltages are changed by changing the current i. Another plate current observation is made. This is continued until the voltage adjustment of the two tubes is just the reverse of the adjustment at the beginning, that is, until the bias on the upper tube is zero and that on the lower is equal to 2V.

The current i can be varied both by varying the voltage of the battery E and by varying the resistance of Rh. Variation of both is convenient when Ri is to be adjusted to even values of volts.

The plot of the data obtained should be the difference between the two plate currents against the values of Ri, for Ri represents the signal voltage and the difference between the two plate currents represents the signal current as it would flow in the secondary of an output transformer.

It is clear that as the current through the resistors R becomes zero, or nearly zero, it is necessary to reverse the polarity of the battery E in order to continue the experiment. This reversal represents the reversal of the signal voltage.

Different Curves Obtained

If the data obtained by this method are properly plotted the resulting relation between the plate current and the values of Ri will be a straight line. It is instructive to repeat this run for different values of V. If V is very high so that the plate current of both tubes is practically cut off when i is zero or small, the resulting curve represents the performance characteristic of a Class B amplifier. If V has the normal value of the operating bias in a push-pull amplifier, the resulting curve is the performance characteristic of a Class A push-pull amplifier. For intermediate values of V the resulting curves represent the performance characteristics of amplifiers which are compromises between Classes A and B.

Let us investigate the requirements of the "signal supply circuit." If the resistance of Rh is set at zero, the total resistance in the circuit is 2R, which in this case we have assumed to be 100,000 ohms. If the value of V is 50 volts, then 2Ri should equal to 2V, or 100 volts. Hence the battery E should have this voltage, or as near it as practicable. The maximum current in the circuit is determined by the voltage of the battery and the total resistance. Therefore the current is 100/2R, or one milliampere. Meter M, therefore, should be a 0-1 milliammeter.

Since the maximum value of the rheostat is equal to the values of the two grid leak resistors, the current can be cut in two by means of the rheostat. In order to cut it down more it will be necessary to reduce the voltage. Suppose, for example, that we wish to cut down the signal voltage to 10 volts. Rh should be set at zero and the voltage of the battery reduces to 10 volts. There is no battery that will give this voltage, but there is a combination of dry cells that will give 10.5 volts. The rheostat Rh could be used to cut the extra half volt.

Use of Voltmeter

The measurement of the signal voltage 2Ri can be done with a voltmeter as well as with a milliammeter. The meter is connected across the two grid leaks and left connected. The reading on the meter is then the input voltage. This voltage can be varied by varying the applied voltage E and by varying the resistance of the rheostat.

Public Is Interested in Hearing Police Calls

Recently manufacturers of commercial receivers have been making their superheterodynes tune to frequencies higher than 1,500 kc, usually around 1,750 kc, which permits bringing in some police calls, as well as some amateurs. The police calls provide extra interest, and in some cases great additional interest, particularly among the younger folk. And the older ones lose a little of that blase after-dinner manner when a hurry-call is broadcast by a police transmitter to cruiser numbers this and that to rush to the scene of a dramatic event.

Besides the wide frequency spectrum achieved by letting the tracking problem be a little forgotten above 1,500 kc, for the t-r-f coils will not go up as high in frequency as will the oscillator, a tap is provided on some receivers.

Examinations Provided for Broadcast Courses

Rochester, N. Y.

The Board of Education has inaugurated a comprehensive 1933 schedule over WHAM in which the results of radio teaching will be matched against those of classroom instruction.

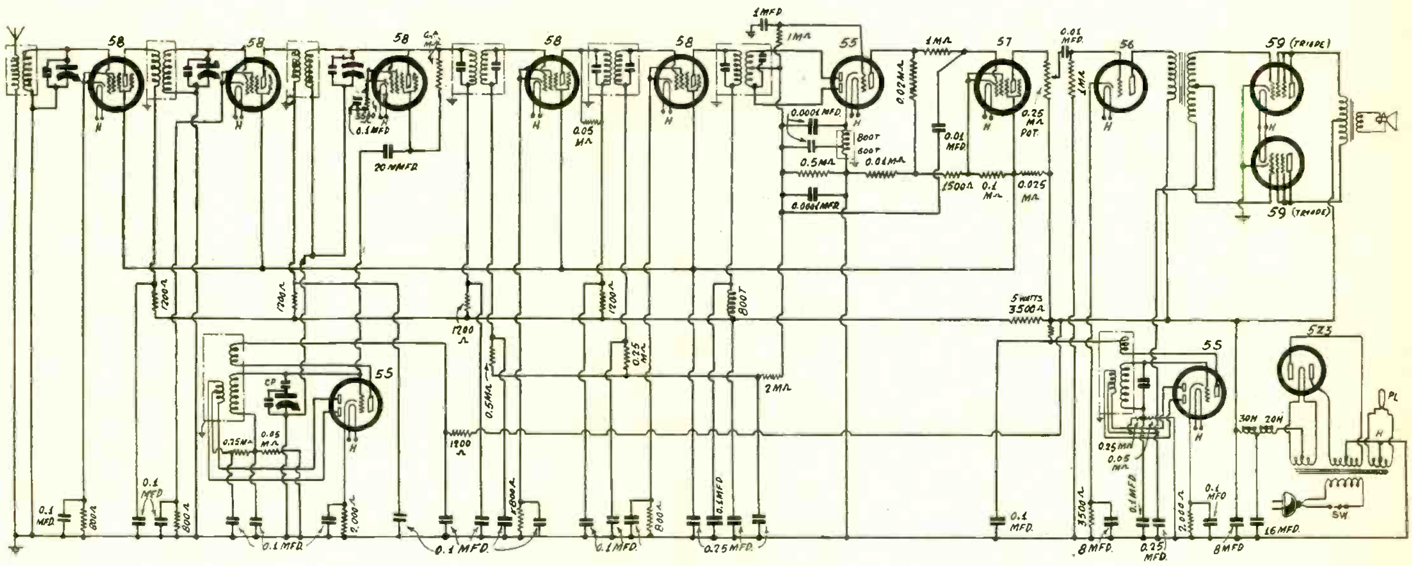
7B science is taught Tuesday and Thursday afternoons from 1:30 to 2:00; 7B social studies on Monday and Wednesday afternoons from 1:45 to 2:00, and geography on Tuesday and Thursday mornings from 11:30 to 11:45. (EST.)

Pupils taking supervised radio instruction will be given the same term examinations as those who receive personal instruction, to afford concrete evidence of the results of what the Board already characterizes as "beginning of what will be usual and widespread procedure in a few years."

RECENT IMPROVEMENTS

And Some Worthy Novelties in a Thirteen-Tube Super

By C. L. Rutgers



In this thirteen-tube superheterodyne automatic volume control, noise suppression control, stabilized oscillation, and optional Class A or B amplification, with separate C supply, are included.

NEW developments have come fast in receiver design in the past year or so, and quite a few of them are incorporated in the thirteen-tube superheterodyne design, including also features that have not as yet been introduced in commercial receivers.

There is not a receiver circuit for kit construction, either, that incorporates a stabilized oscillator. All oscillators used in present-day receivers are subject to frequency shifts. And there is no high bias Class B amplifier in such receivers.

There is another development that has yet to be worked out. It is push-pull resistance coupling. The subject has been treated theoretically for several years, but a practical, dependable circuit is still awaited. With the diode as detector it should not be altogether difficult to attain push-pull resistance coupling, and it is hoped that in months to come the "perfected" circuit of that type will be printed in these columns, although the same hope was expressed months ago, and the fact still awaits achievement.

Better Familiarity

However, taking what we have, and adding the stabilized oscillator, and also a C bias supply that is independent of the B supply as to the biasing voltage value, we can effectuate a thirteen-tube circuit where each tube actually contributes something. Moreover, by analyzing and studying the circuit we can familiarize ourselves with latest improvements, or such facts pertaining to them as may have escaped us in the great wealth of new developments that has been contributed within the last year or so.

When we look at the first tube, a tuned radio frequency amplifier, we may notice that the volume control is not associated with that circuit. There are several reasons. One may be that almost any type of volume control at the r-f level will contribute detuning effects, because it will change the grid bias value, hence plate impedance. Another is that the control will not be so effective at radio or intermediate frequencies as at audio frequencies in a truly sensitive receiver. An incidental reason is that the danger of stray coupling of leads to and from the volume control is virtually nil when the control affects audio frequencies. The audio circuit also is often nearer to the front panel position that the control would occupy than is the r-f level.

So if you will look at the third tube to the left of the push-pull output you will find the volume control is an adjustable voltage divider in the plate circuit of a 57 tube. The control is completely effective.

Freedom From Regeneration

Going back now to the first tube we find that it has a biasing resistor of 800 ohms. This will afford a bias of about 4.5 volts, because the plate voltage has been reduced from maximum by the resistor in a resistor-capacity filter (3,500 ohms, 5 watts), and will be around 150 volts, which is sufficient. The relatively high bias is an adjunct of the stabilization of the circuit against oscillation, and the resistor-capacity filters in all r-f, i-f and oscillator plate circuits are to the same effect. In fact, lest there be a trace of oscillation or regeneration in the i-f channel a resistor of 0.05 meg. (50,000 ohms) is shown across the plate winding of the second intermediate transformer. If there is stability without this resistor, omit the resistor. Otherwise include it. The value is low enough to insure stability even when oscillation otherwise would be rather strong.

The third tube from left, a 58, is the modulator, and the biasing resistor is 3,500 ohms. The 58's do not run quite as uniform as the 57's, therefore some other value of resistor may be used, if desired, to maintain the bias voltage at 10 volts or a little less. It may be less, because the plate voltage is lower than the maximum, but the smaller the bias voltage, the sooner the tube would be overloaded by the oscillator.

However, to take care of that we have a stabilized oscillator, consisting of a 55 tube, the diode units used for full-wave rectification of the oscillation voltage. Not only does this oscillator afford frequency stability (freedom from drifting) but amplitude stability as well. The amplitude should not vary more than 2 per cent., whereas the frequency should not vary more than a small fraction of a per cent., using this system. It has been tried out, with meters in the diode rectifier and triode plate circuits, and with no change in current at any and all settings of the tuning condenser.

Alternative Adjustments

Not only is the oscillator frequency- and amplitude-stabilized, but it is subject to voltage rectification retardation, also called time delay. Since the diodes will not rectify until the anodes are positive, and since the return is to ground, no rectification will take place unless and until the oscillation amplitude exceeds the bias voltage of the tube.

Suppose that the triode of the 55 is adjusted, as it should be, until 10 milliamperes flow in the plate circuit. This adjustment may not be actually necessary, as the 2,000-ohm biasing resistor should take care of the current satisfactorily, but if it does not, the current will be too small, the tube unstable, showing visible signs of irregular cathode emission, whereupon a lower value of resistor would be used, until 10 ma actually did flow, or the adjustment to this value made in another manner, to be explained.

Taking up the three windings of the oscillation coil we find that one is in the grid circuit and is returned to the joint of two resistors. Just what the values of these resistors should be will depend on the amount of oscillation, degree of coupling, etc., but the total of both should not be less than 250,000 ohms, to present a high resistance load to the rectifier, and therefore the one so marked may remain thus, and if a larger bias voltage is needed from the rectifier, to affect the grid, then the 0.05 meg. value may be increased accordingly. So, as this point may be shifted, and will affect the bias, the 2,000 ohms in the cathode leg may be much less, and the adjustment for 10 ma made by changing the division of the rectified voltage. This may be done conveniently with a 250,000-ohm adjustable voltage divider, with grid return to arm, extremes to ground and rectifier coil.

Constant Plate Impedance

The plate winding is the feedback coil, and should consist of at least one-quarter the number of grid turns, and be tightly coupled to the secondary. The number of turns and closeness of this winding to the grid coil determines to a considerable extent the amount of rectified voltage, because governing the input to the rectifier. One extreme of this coil goes to one anode of the duplex diode, the other extreme to the other anode, with center to one side of the load resistor, as explained. Thus as the oscillation builds up the rectified voltage increases, the negative bias increases, the tube settles down to an equilibrium and since the response is linear, the output is linear, and the plate impedance remains constant.

Since this oscillator is stable, the circuit quickly settles to a state of equilibrium wherein the voltages do not change, for any tendency to change is corrected within the time of a single cycle. This action is so fast that meters will not respond to them, or show any needle movement, but an oscillograph would reveal the action.

Separate C Supply

The steady voltage condition therefore is useful, if we desire this advantage, for C bias supply. Cathodes of the output tubes could be returned to the cathode of the oscillator, the 2,000 ohm resistor reduced to 300 ohms and the power tube grid returns made to the left-hand extreme of the mixer oscillator rectifier (center tap of the rectifier pickup coil), and the voltage between cathode and the center tap adjusted to 28 volts for Class A amplification. However, a separate oscillator is used in the circuit for C voltage supply, to illustrate the method, and to avoid beats the frequency of this is made higher than the highest one to which the earlier oscillator will tune. Say, 2,500 kc would be selected.

The coupling between the oscillator for signal service and the modulator is made electrically, by using a small condenser, shown as 20 mmfd. (0.00002 mfd.), but may be an adjustable equalizing type condenser 20-100 mmfd., since the detuning effect on the oscillator would be slight, on account of the relatively high resistance to ground (through the 0.05 meg. resistor to plate, through plate coil to B plus to ground, in the 58 modulator output circuit). This form of modulation of the combined screen-plate circuits is becoming popular, due to the reduction of secondary emission effects, hence the considerable shrinkage of the amplitudes of the even order of harmonics, of which the second harmonic is always the strongest.

When the condenser is 20 mmfd. the selectivity is highest, when it is 100 mmfd. the sensitivity is highest, but as there is sensitivity to spare, lower values than 100 mmfd. will be preferred.

Demodulator Input

The intermediate channel is more or less standard, until we reach the input to the diode full-wave second detector, or demodulator. We see the plate circuit ahead is filtered with an r-f choke coil of 800 turns, which has an inductance of 10 millihenries, and to ground is a condenser of 0.1 mfd., so that there will be virtually no field surrounding this choke coil, and no shielding of the coil required. We put the choke there to help get rid of beats between harmonics of the intermediate frequency and signal frequencies equal to those harmonics. For 175 kc intermediate frequency there could be six such beats. We want none.

Now, the demodulator's cathode circuit is filtered, too, but since we must support the audio frequencies in this circuit we can not use very large condensers. We select a tapped high inductance r-f choke coil, 20 millihenries, total 1,300 turns, and put three 0.0001 mfd. bypass condensers from extremes and tap to negative side of the rectifier. Still, this choke will have a field, and it may result in back coupling, and facilitate those six beats we desire to eliminate, hence this choke coil should be shielded.

Now, the 55 demodulator is, as such, a regular type for fullwave action, but the triode unit is used only as an amplifier of the direct voltage, and the signal is therefore removed. It can not be removed at the grid without a high resistance between grid and the common return of the anodes' circuits, for the signal simply would be obliterated. However, with 1 meg. or more between grid and center tap, the condenser from grid to ground to remove the carrier and modulation, and leave only the d-c, may be 1 mfd. In fact, it may be greater in capacity, but 1 mfd. is high enough. Only the lowest audio frequencies will get through, and when they do they add something to the audio region where the response is naturally the weakest, so the contribution is welcome.

The Direct Voltage

So the 1 meg. resistor prevents the shorting of the 0.5 meg. load resistor of the rectifier, and as we desire to send the signal along we use a stopping condenser of 0.01 mfd. (lower left of the 57 tube), and connect the other side of this condenser to the 57 grid.

By using 0.02 meg. (20,000 ohms) in the plate circuit of the d-c amplifier triode of the 55, 1 meg. between plate of 55 and grid of 57, we have direct coupling of the d-c output of the 55 to the grid of the 57. No signal, mind you, just direct voltage. The signal gets into the 57 by way of the stopping condenser, or, more exactly, by means of the parallel 1,020,000 ohms (1 meg. in series with 0.02 meg.) which are in parallel with the rectifier load resistor, d-c voltage separation being afforded by the stopping condenser.

Now, the voltage on the plate of the 55 is low, around 20 volts, and it may be lower. It may be zero, and still the signal would go through, for you will remember that the signal is taken from the 0.5 meg. rectifier load resistor. The d-c amplifier triode of the 55 serves merely as automatic bias control.

The bias on the two intermediate tubes is governed largely by automatic volume control in the usual manner. The effect is to have increased bias with increased signal, hence reduced amplification the greater the input. Hence at no signal input the amplification would be maximum, and there might be noise between channels. Actually this type of circuit, with diode-biased triode, even when the triode is a d-c amplifier, yields little noise, as the circuit is a special noise-suppressor by itself, as follows: When there is no signal there is no bias on the 55 triode because there is no voltage drop across the 0.5 meg. load resistor. With high plate voltage and zero bias, in a tube circuit with high resistance grid load, there is no amplification. Hence at no signal even inter-channel noise does not get through.

Cast of Grid Current

The only exception is that there might be a little 55 triode grid current, and this too produces noise. The remedy is to have the aerial at least long enough to produce sufficient voltage to prevent positive grid. Even six inches of aerial, or one quarter the distance from antenna binding post to floor, usually will be sufficient for this precautionary purpose.

However, the 57 tube in the circuit is a noise suppressor, and since this tube is a great amplifier, there will be much more volume of sound this way than if the triode of the 55 were used as signal amplifier.

The volume is greatest when the plate voltage on the 55 is zero. As the plate voltage is increased the current through the 0.02 meg. plate load resistor is increased, the potential difference across this resistor increases, and the negative bias on the 57 increases. Thus the resistor marked 0.01 meg. (10,000 ohms) may be smaller, and more volume will obtain, but it should be some compromise value that renders the 57 effective as a noise suppressor.

From screen of the 57 to ground the voltage divider consists of 10,000 ohms, 1,500 ohms and 100,000 ohms in series, 120-volt drop, so about 1 ma will flow, and as the 57 current will be small compared to this, even at minimum bias, the voltages will be about 10, 1.5 and 100. The same screen voltage is used for all screens.

Signal's Effect

Along comes a signal. The voltage in the demodulator load resistor, 0.5 meg., increases, the triode is diode-biased, hence the bias on the 55 triode is increased, the current through the 0.02 meg. plate resistor is less, the bias on the 57 is less, but that bias will not drop below the steady value as obtained through the 1,500-ohm resistor. So a strong signal will make the d-c amplifier virtually ineffective in altering the bias. But a weak signal will decrease the negative bias relatively, the plate current will increase through the 20,000-ohm resistor, the bias on the 57 will increase. At no signal the increase will be greatest, hence the bias will rise to perhaps 10 volts, or at least to more than the bias voltage that will cut off the signal. That is how a noise suppressor works, and it is a control working opposite to a.v.c., in that at no signal input everything is cut off at the audio channel, whereas with a.v.c. at no signal there is no a.v.c. and no tendency to increase the bias, so amplification is at its height.

The question naturally arises, if the set has a.v.c., then the voltage at the second detector is about the same at all times, except when there is no signal, when there is no voltage, hence the n.s.c. circuit will not cut down sensitivity. But it does cut down sensitivity because there is a sharp distinction only between complete cutoff as it exists at no signal and no cutoff as it exists at strongest signal, while in-between values of signal cause intermediate values of "cutoff." That is, there is a gradation in the effectiveness, and that effectiveness appears in diminished form at signal values where it would not be desired at all. In other words, the a-v-c controlled tubes are not linearly active. Therefore a compromise is necessary, and it may be established quite simply by using smaller values of resistance where 0.01 meg. is designated, or this may be a rheostat adjusted somewhere between maximum and less than maximum, but not at zero, for though loudest response then will obtain, no n. s. c. action will be present.

Since the 57 is practically the only type tube suitable for n. s. c., and since we are to use push-pull with transformers, there must be another tube between, and this is the

(Continued on next page)

A STABLE OSCILLATOR

Frequency Constancy Provided by Equal Coil

By J. E. Anderson

HERE is a frequency-stable oscillator that can be used at different frequencies. In most cases stabilization can be effected at only one frequency, but this is an exception made possible by the fact that the grid impedance is infinite. The oscillator combines stabilization by critical adjustment and by amplitude-controlled bias.

The oscillator is of the tuned plate type, the tuned circuit consisting of L1C1C2. However, C2 is supposed to be so large that its effect on the natural frequency of the circuit may be neglected. The stabilizing reactance is a coil L1 in the plate circuit. It is marked L1 because it has exactly the same inductance value as L1 in the resonant circuit. There is to be no mutual inductance between the two coils L1.

If the grid resistance of the circuit had not been infinite it would have been necessary to use a capacity in the plate lead for stabilization, and therefore stabilization could have been effected at only one frequency.

Grid and Pickup Windings

The grid winding L2 is not especially critical but it must have a sufficient number of turns to insure oscillation. If L2 has the same number of turns as L1 and if the coupling is moderately close, oscillation will result. Even if L2 has only one-third as many turns as L1 there will be oscillation provided that the coupling between the coils is close. Tight coupling between L1 and L2 is beneficial in respect to frequency stability, for if there were unity coupling that alone would stabilize the circuit.

The pick-up winding L3 should have an inductance approximately equal to that of L1, but it is not at all critical. It should be center-tapped. The winding may be made of two small r-f choke coils mounted inside the form holding L1 and L2.

The grid is given a bias by means of a resistor R2, which may be of the order of 2,500 ohms. A condenser C4 of not less than 0.1 mfd. should be connected across the resistor. In addition to the bias furnished by the resistor R2 there is amplitude controlled bias from the drop in the load resistance R1. When the oscillator first starts vibrating the bias on the grid is that determined by R2. At first there is no rectification because the amplitude is not high enough to offset the drop in R2. However, the amplitude increases until rectification begins, and at that time the bias on the grid becomes greater than the drop in R2. The increase in the bias is proportional to the increase in the amplitude and therefore there is a check on the amplitude. It is possible to arrange the circuit so that amplitude equilibrium occurs before the grid takes any current, and this condition is necessary if the plate stabilizing inductance L1 is to perform its intended function.

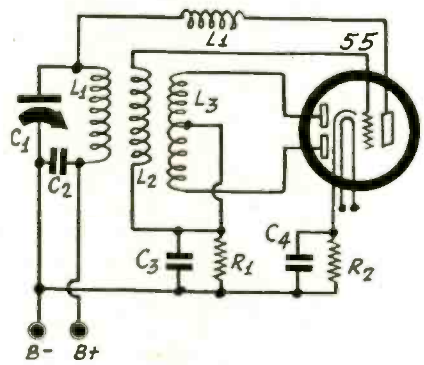


FIG. 1.

This oscillator is both frequency and amplitude stabilized. The coil in the plate lead stabilizes the frequency if there is no grid current and the rectifier stabilizes the amplitude and prevents grid current.

The value of R1 should be as high as practicable. If grid current can be prevented there is no danger of blocking even if the resistance is very high. If irregular oscillator should occur, it is best to reduce the value of R1. A good starting value is 0.5 megohm, but it may be necessary to use a resistance one tenth as large. The condenser C3 across the load resistance should not be smaller than 0.1 mfd. and it may be many times larger.

As the circuit stands there is no impedence in the plate return. If there is any other tube connected to the same plate supply it might be well to put in a radio frequency choke coil in the B plus lead to L1.

The self bias and the amplitude controlled bias serve as a delayed automatic volume control for the check in the increase of amplitude does not begin until the oscillation has attained a certain value determined by the self bias, but after that the check is relatively rapid.

Check is Sought on Additions to Chains

Commissioner Harold A. Lafount proposed the following orders "to avoid further duplication of programs:"

"No broadcasting station licensed by this Commission and not now presenting identical programs simultaneously with other stations connected by wire, and generally known as chain or network, shall be added to the said chain or network without the consent of this Commission."

"A program shall not be broadcast simultaneously over two or more stations in the same city without the consent of the Federal Radio Commission."

No action was taken by the Commission on the proposals.

A THOUGHT FOR THE WEEK

IT was a somewhat dismal affair. It was supposed to be one of those spasmodic radio affairs in which melodrama, comedy, tragedy and vocal fireworks were shot all over the place, leaving the listener a little bit mixed as to the continuity.

Father expressed doubt as to what it was all about, but Junior fixed the status of it by remarking: "I'll tell you what it is, Dad. It's a picture puzzle with one of the pieces missing."

No-Grid-Current Class B Amplifier

(Continued from preceding page)

56, to which a transformer primary presents a suitable load. It serves as driver for the 59 triodes, and since the input will be large, the 59 bias of 28 volts may be considerably exceeded, and the tubes worked as a cross between Class A and Class B, say, at 35 volts negative bias, or may be worked as Class B entirely, at around 40 or 45 volts negative bias, as no special coupling transformers are needed, there being no grid current.

The Output Adjustment

The C supply is obtained from the 2,500 kc oscillator, which otherwise duplicates the oscillator used in the carrier mixing circuit. The 59 tubes, with say 250 plate volts applied, may be hooked up as shown, and the grid-return made to such point on the C rectifier load resistor as will yield the desired 59 plate current. If the current is measured in one 59 tube only, both tubes working, the resultant biasing voltages would be approximately as follows for the currents stated, at 250 plate volts applied:

Plate Current	*Negative Bias Volts*
26 ma	28
7 ma	40
0 ma	50

The 59, it will be remembered, may be used in Class B fashion with Grid No. 3 tied to plate, while the two other grids, Nos. 1 and 2, are tied together to serve as control grid, cathode to ground, a zero bias and a grid current operating condition on any signal input. However, the circuit illustrating this article uses the high negative bias Class B method if the bias is raised high enough, as explained, and this is a no-grid-current method, and avoids the distortion otherwise present at low signal values due to grid current. Therefore the grid-tying is in Class A fashion, though the biasing may be such (28 volts) as to constitute Class A operation, somewhat higher (35 volts) for a compromise between Class A and Class B, while still higher (45 to 50 volts) for Class B.

The rectifier of the B supply has a choke input, to improve regulation, although this requires a higher voltage of the power transformer secondary than if a condenser were in this position, due to absence of the potential-elevation effect of such condenser.

BANKRUPTCY PROCEEDINGS

Petitions Filed By

Paul Ware, radio engineer, 75 West St., New York City; liabilities, $37,953; assets unknown.

Receivers Appointed

Cavalier Radio Corp., Chicago, Ill., involuntary; creditors include Central Radio Laboratories.

VELOCITY MICROPHONE

Like Ammeter, It Responds to Rate of Flow

By Glenn Washburn

THE velocity microphone has made its appearance. Just what is a velocity microphone and in what manner does it differ from condenser and carbon microphones?

The condenser microphone is a condenser loudspeaker working in reverse, and the velocity microphone is a dynamic speaker working in reverse. It would be just as logical to call the microphone a dynamic microphone. But why is it called a velocity microphone? Because the output is proportional to the velocity of the air in the sound waves, or to the velocity of the armature, which is supposed to be so light that it follows the air vibrations accurately.

The condenser microphone differs in this respect in that it responds to the pressure of the sound wave. The armature of this is not supposed to move at all but it must move a little in order to give an effect. The condenser microphone is similar to a voltmeter. Both measure pressure, one air pressure and the other electrical pressure. The ideal voltmeter is one that does not draw any current, but even the best practical voltmeters draw a little. Likewise, the condenser microphone "draws a little movement." That is to say, the armature moves a little bit.

Velocity Response

The velocity microphone in a sense is equivalent to an ammeter. The ammeter responds to the rate of flow of electricity, that is, to current. The velocity microphone responds to rate of flow of air, or to the air current, which in this case means the velocity of the air.

In Fig. 1 is a simple sketch of the velocity microphone. There is a strong magnet, either permanent or electromagnetic, which is represented by the two poles N and S. Between the two poles is mounted a very light diaphragm R. It is made of duralumin and may be ¼ of an inch or so wide, 3 inches or so long, and about 0.0005 inch thick. It is corrugated like a washboard just to give it strength. If the diaphragm were viewed in the direction of the magnetic field it would look like a resistance symbol, if the observer had good eyes.

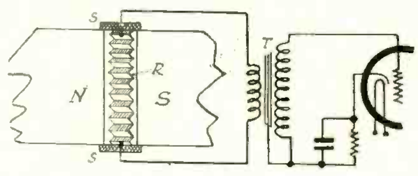


FIG. 1

The principle of the velocity microphone is the same as that of the dynamic speaker except that it operates in reverse.

How does it work? Well, suppose sound waves fall on the flat side of the strip of duralumin. It will start vibrating in unison with the sound vibrations. In vibrating it will cut lines of magnetic force. Therefore we have the elements of an electrical generator—a conductor moving across a magnetic field in such a manner that the lines of force will be cut. The motive force in this case is the sound wave instead of a gasoline engine or a water turbine. But the principle is the same. We have an electrical generator which will generate a voltage of the same form as the sound waves that strike the diaphragm.

However, we have only one conductor. Therefore the voltage generated will be low. For that reason a step-up transformer is needed between the generator and the amplifier. The primary of transformer T should have a turn or two of heavy wire but the secondary should have a larger number of turns. The transformer might be constructed by taking an audio input transformer and putting a single turn of heavy wire around it. This would be used as primary and the regular secondary would be used in the grid circuit.

Reversal of Function

If T were a regular power transformer intended for a loudspeaker having a single turn for voice winding the diaphragm would be driven if the large winding were connected to a source of sound power, such as the output of an amplifier. The diaphragm R would become the cone of the speaker. Of course, there would be very little sound because of the small radiating surface, but the diaphragm would move.

The ends of the diaphragm are mounted in insulating supports S. in such a manner that the strip of metal is held firmly in place between the pole pieces of the magnet.

The sensitivity of the microphone will be greater the stronger the magnetic field, because the voltage induced in the moving strip is proportional to the strength of the field. Hence only a very strong permanent magnet or an electromagnet should be used. Neither should there be any needless air space between the sides of the armature and the pole piece faces. There should be just enough to insure clearance between the armature and pole faces.

Whereas the construction of a condenser microphone, or even a carbon granule microphone, is relatively difficult, the construction of the velocity microphone is quite within the skill of most radio fans who have access to a few machine shop tools. The velocity microphone has the advantage of high fidelity over a very wide band of audio frequencies.

CORPORATION REPORTS

Allis-Chalmers Manufacturing Company. Inc.—Preliminary report for 1932: Net loss after depreciation, taxes, interest and other charges, $2,955,043, contrasted with net profit of $1,255,431, equivalent to 96 cents a share on 1.312,252 no par capital shares, in 1931; bookings, $12,316,555, compared with $22,687,048 in preceding year; unfilled orders on Dec. 31, $5,441,825, against $7,889,332 a year before.

Reducing Short-Wave Tuning Difficulties

Although 0.00014 mfd. condensers are normally used for short-wave work, since the frequency change accounted for by the condenser span with the proper coil will be ten times as great with the smallest coil than with the largest, the tuning difficulty increases greatly, and stations may be passed over, on the small coils, unless the greatest care is taken. In fact, the tuning in this spectrum becomes decidedly tedious, and only a good "catch" will atone for the trouble.

One part-solution to the problem is to use a still smaller capacity condenser, and since the maximum capacity is not to be cut down for respective bands, at least one extra coil would be needed, say, with 90 mmfd. capacity, five coils instead of the usual four. Indeed, to get down low enough, with that capacity, six coils would be required (10 meters).

Another handy way of improving conditions is to use a dial with a large reduction. There are dials now on the market that are much like the broadcast commercial types, but the reduction is 30-to-1. This makes it slow work changing from a frequency at one end, for a given coil, to the opposite end, but then no particular care is needed for such work. When care is essential the dial with its close tuning facility comes in mighty handy.

Some dials have a dual ratio device, so that large changes of capacity can be quickly made, then a lever thrown for close tuning.

The ratios change from 6-to-1 to 30-to-1.

This would be all right if all such dials did not disturb the calibration, but one type at least throws it off several degrees, comparing the slow-motion to the quick-motion position.

A cure would be to use the quick motion only for large changes, but never for actual tuning, since all sets for short waves eventually are calibrated, at least in a sense, as one knows approximately where the frequencies should come in.

The use of a small manual trimmer helps to tune accurately if the trimmer is very small, compared with the total capacity.

New WCAU Building Has Acoustic Novelty

Philadelphia.

The new WCAU Building has seven studios ranging in size from a speaker's room to one that will hold an orchestra of 100 men. The station uses 50,000 watts.

A new acoustic principle of "live" and "dead" ends has been employed. From one-half to two-thirds of each studio, depending entirely upon size, is built of sound-absorbing material to form the "dead" end. Here microphones will be placed to pick up every part of the program originating in the "live" portion of the studio. The walls in the "live" end reflect the sound waves to the microhones in the "dead" end of the room.

A private laboratory and workshop have been provided for Dr. Leopold Stokowski, director of the Philadelphia Symphony Orchestra.

An unusual feature of the studio edifice is a 100-foot glass tower, which, when lit by banks of low-voltage mercury vapor lamps, casts a blue glow into the skyline for twenty-five miles.

The conversion table printed herewith is highly accurate, because worked out by the factor 299,820. Most tables are based on the factor 300,000, which is erroneous to 6 parts in 100,000.

The table is entirely reversible, for instance, 10 meters equal 29,982 kc., or 29,982 meters equal 10 kc. Any quantities not included in the table may **be read by shifting the decimal point.** If moved to the right for frequency the point is moved to the left for wavelength, and vice versa. The shift is therefore in opposite directions.

The factor 299,820 is based on the velocity of a radio wave, which **is equal** to the velocity of light, or 299,820,000 meters per second. **By dropping the** three ciphers (dividing by 1,000), the factor 299,820 is used, and the **answer** reads in kilocycles.

Wavelength in meters is equal to velocity divided by frequency. Frequency in cycles is equal to the velocity divided by the wavelength.

[Prepared by Bureau of Standards, Department of Commerce. Reprinted by permission of Government Printing Office.]

kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc
10	29,982	1,010	296.9	2,010	149.2	3,010	99.61	4,010	74.77	5,010	59.84	6,010	49.89	7,010	42.77	8,010	37.43	9,010	33.28
20	14,991	1,020	293.9	2,020	148.4	3,020	99.28	4,020	74.58	5,020	59.73	6,020	49.80	7,020	42.71	8,020	37.38	9,020	33.24
30	9,994	1,030	291.1	2,030	147.7	3,030	98.95	4,030	74.40	5,030	59.61	6,030	49.72	7,030	42.65	8,030	37.34	9,030	33.20
40	7,496	1,040	288.3	2,040	147.0	3,040	98.62	4,040	74.21	5,040	59.49	6,040	49.64	7,040	42.59	8,040	37.29	9,040	33.17
50	5,996	1,050	285.5	2,050	146.3	3,050	98.30	4,050	74.03	5,050	59.37	6,050	49.56	7,050	42.53	8,050	37.24	9,050	33.13
60	4,997	1,060	282.8	2,060	145.5	3,060	97.98	4,060	73.85	5,060	59.25	6,060	49.48	7,060	42.47	8,060	37.20	9,060	33.09
70	4,283	1,070	280.2	2,070	144.8	3,070	97.66	4,070	73.67	5,070	59.13	6,070	49.39	7,070	42.41	8,070	37.15	9,070	33.06
80	3,748	1,080	277.6	2,080	144.1	3,080	97.34	4,080	73.49	5,080	59.02	6,080	49.31	7,080	42.35	8,080	37.11	9,080	33.02
90	3,331	1,090	275.1	2,090	143.5	3,090	97.03	4,090	73.31	5,090	58.90	6,090	49.23	7,090	42.29	8,090	37.06	9,090	32.98
100	2,998	1,100	272.6	2,100	142.8	3,100	96.72	4,100	73.13	5,100	58.79	6,100	49.15	7,100	42.23	8,100	37.01	9,100	32.95
110	2,726	1,110	270.1	2,110	142.1	3,110	96.41	4,110	72.95	5,110	58.67	6,110	49.07	7,110	42.17	8,110	36.97	9,110	32.91
120	2,499	1,120	267.7	2,120	141.4	3,120	96.10	4,120	72.77	5,120	58.56	6,120	48.99	7,120	42.11	8,120	36.92	9,120	32.88
130	2,306	1,130	265.3	2,130	140.8	3,130	95.79	4,130	72.60	5,130	58.44	6,130	48.91	7,130	42.05	8,130	36.88	9,130	32.84
140	2,142	1,140	263.0	2,140	140.1	3,140	95.48	4,140	72.42	5,140	58.33	6,140	48.83	7,140	41.99	8,140	36.83	9,140	32.80
150	1,999	1,150	260.7	2,150	139.5	3,150	95.18	4,150	72.25	5,150	58.22	6,150	48.75	7,150	41.93	8,150	36.79	9,150	32.77
160	1,874	1,160	258.5	2,160	138.8	3,160	94.88	4,160	72.07	5,160	58.10	6,160	48.67	7,160	41.87	8,160	36.74	9,160	32.73
170	1,764	1,170	256.3	2,170	138.1	3,170	94.58	4,170	71.90	5,170	57.99	6,170	48.59	7,170	41.82	8,170	36.70	9,170	32.70
180	1,666	1,180	254.1	2,180	137.5	3,180	94.28	4,180	71.73	5,180	57.88	6,180	48.51	7,180	41.76	8,180	36.65	9,180	32.66
190	1,578	1,190	252.0	2,190	136.9	3,190	93.99	4,190	71.56	5,190	57.77	6,190	48.44	7,190	41.70	8,190	36.61	9,190	32.62
200	1,499	1,200	249.9	2,200	136.3	3,200	93.69	4,200	71.39	5,200	57.66	6,200	48.36	7,200	41.64	8,200	36.56	9,200	32.59
210	1,428	1,210	247.8	2,210	135.7	3,210	93.40	4,210	71.22	5,210	57.55	6,210	48.28	7,210	41.58	8,210	36.52	9,210	32.55
220	1,363	1,220	245.8	2,220	135.1	3,220	93.11	4,220	71.05	5,220	57.44	6,220	48.20	7,220	41.53	8,220	36.47	9,220	32.52
230	1,304	1,230	243.8	2,230	134.4	3,230	92.82	4,230	70.88	5,230	57.33	6,230	48.13	7,230	41.47	8,230	36.43	9,230	32.48
240	1,249	1,240	241.8	2,240	133.8	3,240	92.54	4,240	70.71	5,240	57.22	6,240	48.05	7,240	41.41	8,240	36.39	9,240	32.45
250	1,199	1,250	239.9	2,250	133.3	3,250	92.25	4,250	70.55	5,250	57.11	6,250	47.97	7,250	41.35	8,250	36.34	9,250	32.41
260	1,153	1,260	238.0	2,260	132.7	3,260	91.97	4,260	70.38	5,260	57.00	6,260	47.89	7,260	41.30	8,260	36.30	9,260	32.38
270	1,110	1,270	236.1	2,270	132.1	3,270	91.69	4,270	70.22	5,270	56.89	6,270	47.82	7,270	41.24	8,270	36.25	9,270	32.34
280	1,071	1,280	234.2	2,280	131.5	3,280	91.41	4,280	70.05	5,280	56.78	6,280	47.74	7,280	41.18	8,280	36.21	9,280	32.31
290	1,034	1,290	232.4	2,290	130.9	3,290	91.13	4,290	69.89	5,290	56.68	6,290	47.67	7,290	41.13	8,290	36.17	9,290	32.27
300	999.4	1,300	230.6	2,300	130.4	3,300	90.86	4,300	69.73	5,300	56.57	6,300	47.59	7,300	41.07	8,300	36.12	9,300	32.24
310	967.2	1,310	228.9	2,310	129.8	3,310	90.58	4,310	69.56	5,310	56.46	6,310	47.52	7,310	41.02	8,310	36.08	9,310	32.20
320	936.9	1,320	227.1	2,320	129.2	3,320	90.31	4,320	69.40	5,320	56.36	6,320	47.44	7,320	40.96	8,320	36.04	9,320	32.17
330	908.6	1,330	225.4	2,330	128.7	3,330	90.04	4,330	69.24	5,330	56.25	6,330	47.36	7,330	40.90	8,330	35.99	9,330	32.14
340	881.8	1,340	223.7	2,340	128.1	3,340	89.77	4,340	69.08	5,340	56.15	6,340	47.29	7,340	40.85	8,340	35.95	9,340	32.10
350	856.6	1,350	222.1	2,350	127.6	3,350	89.50	4,350	68.92	5,350	56.04	6,350	47.22	7,350	40.79	8,350	35.91	9,350	32.07
360	832.8	1,360	220.4	2,360	127.0	3,360	89.23	4,360	68.77	5,360	55.94	6,360	47.14	7,360	40.74	8,360	35.86	9,360	32.03
370	810.3	1,370	218.8	2,370	126.5	3,370	88.97	4,370	68.61	5,370	55.83	6,370	47.07	7,370	40.68	8,370	35.82	9,370	32.00
380	789.0	1,380	217.3	2,380	126.0	3,380	88.70	4,380	68.45	5,380	55.73	6,380	46.99	7,380	40.63	8,380	35.78	9,380	31.96
390	768.8	1,390	215.7	2,390	125.4	3,390	88.44	4,390	68.30	5,390	55.63	6,390	46.92	7,390	40.57	8,390	35.74	9,390	31.93
400	749.6	1,400	214.2	2,400	124.9	3,400	88.18	4,400	68.14	5,400	55.52	6,400	46.85	7,400	40.52	8,400	35.69	9,400	31.90
410	731.3	1,410	212.6	2,410	124.4	3,410	87.92	4,410	67.99	5,410	55.42	6,410	46.77	7,410	40.46	8,410	35.65	9,410	31.86
420	713.9	1,420	211.1	2,420	123.9	3,420	87.67	4,420	67.83	5,420	55.32	6,420	46.70	7,420	40.41	8,420	35.61	9,420	31.83
430	697.3	1,430	209.7	2,430	123.4	3,430	87.41	4,430	67.68	5,430	55.22	6,430	46.63	7,430	40.35	8,430	35.57	9,430	31.79
440	681.4	1,440	208.2	2,440	122.9	3,440	87.16	4,440	67.53	5,440	55.11	6,440	46.56	7,440	40.30	8,440	35.52	9,440	31.76
450	666.3	1,450	206.8	2,450	122.4	3,450	86.90	4,450	67.38	5,450	55.01	6,450	46.48	7,450	40.24	8,450	35.48	9,450	31.73
460	651.8	1,460	205.4	2,460	121.9	3,460	86.65	4,460	67.22	5,460	54.91	6,460	46.41	7,460	40.19	8,460	35.44	9,460	31.69
470	637.9	1,470	204.0	2,470	121.4	3,470	86.40	4,470	67.07	5,470	54.81	6,470	46.34	7,470	40.14	8,470	35.40	9,470	31.66
480	624.6	1,480	202.6	2,480	120.9	3,480	86.16	4,480	66.92	5,480	54.71	6,480	46.27	7,480	40.08	8,480	35.36	9,480	31.63
490	611.9	1,490	201.2	2,490	120.4	3,490	85.91	4,490	66.78	5,490	54.61	6,490	46.20	7,490	40.03	8,490	35.31	9,490	31.59
500	599.6	1,500	199.9	2,500	119.9	3,500	85.66	4,500	66.63	5,500	54.51	6,500	46.13	7,500	39.98	8,500	35.27	9,500	31.56
510	587.9	1,510	198.6	2,510	119.5	3,510	85.42	4,510	66.48	5,510	54.41	6,510	46.06	7,510	39.92	8,510	35.23	9,510	31.53
520	576.6	1,520	197.2	2,520	119.0	3,520	85.18	4,520	66.33	5,520	54.32	6,520	45.98	7,520	39.87	8,520	35.19	9,520	31.49
530	565.7	1,530	196.0	2,530	118.5	3,530	84.94	4,530	66.19	5,530	54.22	6,530	45.91	7,530	39.82	8,530	35.15	9,530	31.46
540	555.2	1,540	194.7	2,540	118.0	3,540	84.70	4,540	66.04	5,540	54.12	6,540	45.84	7,540	39.76	8,540	35.11	9,540	31.43
550	545.1	1,550	193.4	2,550	117.6	3,550	84.46	4,550	65.89	5,550	54.02	6,550	45.77	7,550	39.71	8,550	35.07	9,550	31.39
560	535.4	1,560	192.2	2,560	117.1	3,560	84.22	4,560	65.75	5,560	53.92	6,560	45.70	7,560	39.66	8,560	35.03	9,560	31.36
570	526.0	1,570	191.0	2,570	116.7	3,570	83.98	4,570	65.61	5,570	53.83	6,570	45.63	7,570	39.61	8,570	34.98	9,570	31.33
580	516.9	1,580	189.8	2,580	116.2	3,580	83.75	4,580	65.46	5,580	53.73	6,580	45.57	7,580	39.55	8,580	34.94	9,580	31.30
590	508.2	1,590	188.6	2,590	115.8	3,590	83.52	4,590	65.32	5,590	53.64	6,590	45.50	7,590	39.50	8,590	34.90	9,590	31.26
600	499.7	1,600	187.4	2,600	115.3	3,600	83.28	4,600	65.18	5,600	53.54	6,600	45.43	7,600	39.45	8,600	34.86	9,600	31.23
610	491.5	1,610	186.2	2,610	114.9	3,610	83.05	4,610	65.04	5,610	53.44	6,610	45.36	7,610	39.40	8,610	34.82	9,610	31.20
620	483.6	1,620	185.1	2,620	114.4	3,620	82.82	4,620	64.90	5,620	53.35	6,620	45.29	7,620	39.35	8,620	34.78	9,620	31.17
630	475.9	1,630	183.9	2,630	114.0	3,630	82.60	4,630	64.76	5,630	53.25	6,630	45.22	7,630	39.29	8,630	34.74	9,630	31.13
640	468.5	1,640	182.8	2,640	113.6	3,640	82.37	4,640	64.62	5,640	53.16	6,640	45.15	7,640	39.24	8,640	34.70	9,640	31.10
650	461.3	1,650	181.7	2,650	113.1	3,650	82.14	4,650	64.48	5,650	53.07	6,650	45.09	7,650	39.19	8,650	34.66	9,650	31.07
660	454.3	1,660	180.6	2,660	112.7	3,660	81.92	4,660	64.34	5,660	52.97	6,660	45.02	7,660	39.14	8,660	34.62	9,660	31.04
670	447.5	1,670	179.5	2,670	112.3	3,670	81.70	4,670	64.20	5,670	52.88	6,670	44.95	7,670	39.09	8,670	34.58	9,670	31.01
680	440.9	1,680	178.5	2,680	111.9	3,680	81.47	4,680	64.06	5,680	52.79	6,680	44.88	7,680	39.04	8,680	34.54	9,680	30.97
690	434.5	1,690	177.4	2,690	111.5	3,690	81.25	4,690	63.93	5,690	52.69	6,690	44.82	7,690	38.99	8,690	34.50	9,690	30.94
700	428.3	1,700	176.4	2,700	111.0	3,700	81.03	4,700	63.79	5,700	52.60	6,700	44.75	7,700	38.94	8,700	34.46	9,700	30.91
710	422.3	1,710	175.3	2,710	110.6	3,710	80.81	4,710	63.66	5,710	52.51	6,710	44.68	7,710	38.89	8,710	34.42	9,710	30.88
720	416.4	1,720	174.3	2,720	110.2	3,720	80.60	4,720	63.52	5,720	52.42	6,720	44.62	7,720	38.84	8,720	34.38	9,720	30.85
730	410.7	1,730	173.3	2,730	109.8	3,730	80.38	4,730	63.39	5,730	52.32	6,730	44.55	7,730	38.79	8,730	34.34	9,730	30.81
740	405.2	1,740	172.3	2,740	109.4	3,740	80.17	4,740	63.25	5,740	52.23	6,740	44.48	7,740	38.74	8,740	34.30	9,740	30.78
750	399.8	1,750	171.3	2,750	109.0	3,750	79.95	4,750	63.12	5,750	52.14	6,750	44.42	7,750	38.69	8,750	34.27	9,750	30.75
760	394.5	1,760	170.4	2,760	108.6	3,760	79.74	4,760	62.99	5,760	52.05	6,760	44.35	7,760	38.64	8,760	34.23	9,760	30.72
770	389.4	1,770	169.4	2,770	108.2	3,770	79.53	4,770	62.86	5,770	51.96	6,770	44.29	7,770	38.59	8,770	34.19	9,770	30.69
780	384.4	1,780	168.4	2,780	107.8	3,780	79.32	4,780	62.72	5,780	51.87	6,780	44.22	7,780	38.54	8,780	34.15	9,780	30.66
790	379.5	1,790	167.5	2,790	107.5	3,790	79.11	4,790	62.59	5,790	51.78	6,790	44.16	7,790	38.49	8,790	34.11	9,790	30.63
800	374.8	1,800	166.6	2,800	107.1	3,800	78.90	4,800	62.46	5,800	51.69	6,800	44.09	7,800	38.44	8,800	34.07	9,800	30.59
810	370.2	1,810	165.6	2,810	106.7	3,810	78.69	4,810	62.33	5,810	51.60	6,810	44.03	7,810	38.39	8,810	34.03	9,810	30.56
820	365.6	1,820	164.7	2,820	106.3	3,820	78.49	4,820	62.20	5,820	51.52	6,820	43.96	7,820	38.34	8,820	33.99	9,820	30.53
830	361.2	1,830	163.8	2,830	105.9	3,830	78.28	4,830	62.07	5,830	51.43	6,830	43.90	7,830	38.29	8,830	33.95	9,830	30.50
840	356.9	1,840	162.9	2,840	105.6	3,840	78.08	4,840	61.95	5,840	51.34	6,840	43.83	7,840	38.24	8,840	33.92	9,840	30.47
850	352.7	1,850	162.1	2,850	105.2	3,850	77.88	4,850	61.82	5,850	51.25	6,850	43.77	7,850	38.19	8,850	33.88	9,850	30.44
860	348.6	1,860	161.2	2,860	104.8	3,860	77.67	4,860	61.69	5,860	51.16	6,860	43.71	7,860	38.14	8,860	33.84	9,860	30.41
870	344.6	1,870	160.3	2,870	104.5	3,870	77.47	4,870	61.56	5,870	51.08	6,870	43.64	7,870	38.10	8,870	33.80	9,870	30.38
880	340.7	1,880	159.5	2,880	104.1	3,880	77.27	4,880	61.44	5,880	50.99	6,880	43.58	7,880	38.05	8,880	33.76	9,880	30.35
890	336.9	1,890	158.6	2,890	103.7	3,890	77.07	4,890	61.31	5,890	50.90	6,890	43.52	7,890	38.00	8,890	33.73	9,890	30.32
900	333.1	1,900	157.8	2,900	103.4	3,900	76.88	4,900	61.19	5,900	50.82	6,900	43.45	7,900	37.95	8,900	33.69	9,900	30.28
910	329.5	1,910	157.0	2,910	103.0	3,910	76.68	4,910	61.06	5,910	50.73	6,910	43.39	7,910	37.90	8,910	33.65	9,910	30.25
920	325.9	1,920	156.2	2,920	102.7	3,920	76.48	4,920	60.94	5,920	50.65	6,920	43.33	7,920	37.86	8,920	33.61	9,920	30.22
930	322.4	1,930	155.3	2,930	102.3	3,930	76.29	4,930	60.82	5,930	50.56	6,930	43.26	7,930	37.81	8,930	33.57	9,930	30.19
940	319.0	1,940	154.5	2,940	102.0	3,940	76.10	4,940	60.69	5,940	50.47	6,940	43.20	7,940	37.76	8,940	33.54	9,940	30.16
950	315.6	1,950	153.8	2,950	101.6	3,950	75.90	4,950	60.57	5,950	50.39	6,950	43.14	7,950	37.71	8,950	33.50	9,950	30.13
960	312.3	1,960	153.0	2,960	101.3	3,960	75.71	4,960	60.45	5,960	50.31	6,960	43.08	7,960	37.67	8,960	33.46	9,960	30.10
970	309.1	1,970	152.2	2,970	100.9	3,970	75.52	4,970	60.33	5,970	50.22	6,970	43.02	7,970	37.62	8,970	33.42	9,970	30.07
980	303.9	1,980	151.4	2,980	100.6	3,980	75.33	4,980	60.20	5,980	50.14	6,980	42.95	7,980	37.57	8,980	33.39	9,980	30.04
990	302.8	1,990	150.7	2,990	100.3	3,990	75.14	4,990	60.08	5,990	50.05	6,990	42.89	7,990	37.52	8,990	33.35	9,990	30.01
1,000	299.8	2,000	149.9	3,000	99.94	4,000	74.96	5,000	59.96	6,000	49.97	7,000	42.83	8,000	37.48	9,000	33.31	10,000	29.98

TUBE CHARACTERISTICS

224A

Type of tube—Cathode tetrode.
Socket—Five-contact.
Purpose—R-F amplifier and detector.
Overall height—5¼ inches.
Overall diameter—1 13/16 inches.
Filament voltage, a-c or d-c—2.5 volts.
Filament current—1.75 amperes.

Bias Detector

Load resistance—250,000 ohms.
Plate voltage, applied—180 volts.
Screen voltage—45 volts, or less.
Grid bias—4 volts.

Amplifier, Resistance Coupled

Load resistance—250,000 ohms.
Plate voltage, applied—250 volts.
Screen voltage—25 volts.
Grid bias—1 volt.
Plate current—0.5 milliampere.
Amplification factor—1,000.
Plate resistance—2,000,000 ohms.
Mutual conductance—500 micromhos.
Voltage gain—11 or more.

Amplifier, R-F

Plate voltage—180 volts.
Screen voltage—90 volts.
Grid bias—3 volts.
Plate current—4 milliamperes.
Grid bias resistance—300 ohms.
Amplification factor—400.
Plate resistance—400,000 ohms.
Mutual conductance—1,000 micromhos.

Amplifier, R-F

Plate voltage—250 volts.
Screen voltage—90 volts.
Grid bias—3 volts.
Plate current—4 milliamperes.
Amplification factor—615.
Plate resistance—600,000 ohms.
Mutual conductance—1,025 micromhos.
Grid-plate capacity—0.010 mmfd., max.
Grid-cathode capacity—5.0 mmfd.
Plate-cathode capacity—10 mmfd.
Socket No. 9, Jan. 21 issue.

227

Type of tube—Cathode triode.
Socket—Five contact.
Purpose—Detector and amplifier.
Overall height—4 11/16 inches.
Overall diameter—1 13/16 inches.
Filament voltage, a-c or d-c—2.5 volts.
Filament current—1.75 amperes.
Grid-plate capacity—3.3 mmfd.
Grid-cathode capacity—3.5 mmfd.
Plate-cathode capacity—3 mmfd.
Amplification factor—9.

Bias Detector

Plate voltage—250 volts.
Grid bias—30 volts.

Amplifier, 135-Volt Plate

Plate voltage—135 volts.
Grid bias—9 volts.
Plate current—4.5 milliamperes.
Bias resistance—2,000 ohms.
Plate resistance—9,000 ohms.
Mutual conductance—1,000 micromhos.
Maximum undistorted output—80 milliwatts.
Optimum load resistance—13,000 ohms.

Amplifier, 180-Volt Plate

Plate voltage—180 volts.
Grid bias—13.5 volts.
Plate current—5 milliamperes.
Bias resistance—2,700 ohms.
Plate resistance—9,000 ohms.
Mutual conductance—1,000 micromhos.
Maximum undistorted output—165 milliwatts.
Optimum load resistance—18,700 ohms.

Amplifier, 250-Volt Plate

Plate voltage—250 volts.
Grid bias—21 volts.
Plate current— 5.2 milliamperes.
Grid bias resistance—4,000 ohms.
Plate resistance—9,250 ohms.
Mutual conductance—975 micromhos.
Maximum undistorted output—300 milliwatts.
Optimum load resistance—34,000 ohms.
Socket No. 8, Jan. 21 issue.

235 and 551

Type of tube—Supercontrol tetrode.
Socket—Five contact.
Purpose—R-F amplifier and detector.
Overall height—5¼ inches.
Overall diameter—1 13/16 inches.
Filament voltage, a-c or d-c—2.5 volts.
Filament current—1.75 amperes.
Grid-plate capacity—0.010 mmfd., max.
Grid-cathode capacity—5 mmfd.
Plate-cathode capacity—10 mmfd.

First Detector

Plate voltage—250 volts.
Screen voltage—90 volts.
Grid bias—8 volts (about).

Amplifier, 180-Volt Plate

Plate voltage—180 volts.
Screen voltage—90 volts.
Grid bias—3 volts.
Plate current—6.3 milliamperes.
Grid bias resistance—350 ohms.
Amplification factor—255.
Plate resistance—250,000 ohms.
Mutual conductance—1,020 micromhos.

Amplifier, 250-Volt Plate

Plate voltage—250 volts.
Screen voltage—90 volts.
Grid bias—3 volts.
Plate current—6.5 milliamperes.
Bias resistance—350 ohms.
Amplification factor—370.
Plate resistance—350,000 ohms.
Mutual conductance—1,050 micromhos.
Socket No. 9, Jan. 21 issue.

226

Type of tube—Filamentary triode.
Socket—Four contact.
Purpose—Amplifier.
Overall height—4 11/16 inches.
Overall diameter—1 13/16 inches.
Filament voltage, a-c—1.5 volts.
Filament current—1.05 amperes.
Grid-plate capacity—8.1 mmfd.
Grid-filament capacity—3.5 mmfd.
Plate-filament capacity—2.2 mmfd.
Amplification factor—8.3.

Amplifier, 90-Volt Plate

Plate voltage—90 volts.
Grid bias—7 volts.
Plate current—2.9 milliamperes.
Bias resistance—2,400 ohms.
Plate resistance—8,900 ohms.
Mutual conductance—935 micromhos.
Maximum undistorted output—30 milliwatts.
Optimum load resistance—9,800 ohms.

Amplifier, 135-Volt Plate

Plate voltage—135 volts.
Grid bias—10 volts.
Plate current—5.5 milliamperes.
Bias resistance—1,800 ohms.
Plate resistance—7,600 ohms.
Mutual conductance—1,100 micromhos.
Maximum undistorted output—80 milliwatts.
Optimum load resistance—8,800 ohms.

Amplifier, 180-Volt Plate

Plate voltage—180 volts.
Grid bias—14.5 volts.
Plate current—6.2 milliamperes.
Bias resistance—2,300 ohms.
Plate resistance—7,300 ohms.
Mutual conductance—1,150 micromhos.
Maximum undistorted output—180 milliwatts.
Optimum load resistance—10,500 ohms.
Socket No. 1, Jan. 21 issue.

245

Type of tube—Filamentary triode.
Socket—Four contact.
Purpose—Power amplifier.
Overall height—5⅝ inches.
Overall diameter—2 3/16 inches.
Filament voltage—2.5 volts.
Filament current—1.5 amperes.
Amplification factor—3.5.

Amplifier, 180-Volt Plate

Plate voltage—180 volts.
Grid bias—34.5 volts.
Plate current—27 milliamperes.
Grid bias resistance—1,300 ohms.
Plate resistance—1,900 ohms.
Mutual conductance—1,850 micromhos.
Maximum undistorted output—780 milliwatts.
Optimum load resistance—3,500 ohms.

Amplifier, 275-Volt Plate

Plate voltage—275 volts.
Grid bias—56 volts.
Plate current—36 milliamperes.
Grid bias resistance—1,550 ohms.
Plate resistance—1,670 ohms.
Mutual conductance—2,100 micromhos.
Maximum undistorted output—2,000 milliwatts.
Optimum load resistance—4,600 ohms.
Socket No. 1, Jan. 21 issue.

46

Type of tube—Filamentary double grid.
Socket—Five contact.
Purpose—Classes A and B power amplifier.
Overall height—5⅝ inches.
Overall diameter—2 3/16 inches.
Filament voltage, a-c—2.5 volts.
Filament current—1.5 amperes.

Class A Amplifier

Plate voltage—250 volts.
Grid bias—33 volts.
Plate current—22 milliamperes.
Bias resistance—1,500 ohms.
Amplification factor—5.6.
Plate resistance—2,400 ohms.
Mutual conductance—2,350 micromhos.
Maximum undistorted output—1,250 milliwatts.
Optimum load resistance—6,400 ohms.

Class B Amplifier

Average Characteristics for Two Tubes.

Plate voltage—300 volts.
Grid bias—Zero.
Plate current—8 to 70 milliamperes.
Maximum undistorted output—16 watts.
Optimum load resistance—5,000 ohms, minimum.
Plate voltage—400 volts.
Grid bias—Zero.
Plate current—12 to 75 milliamperes.
Maximum undistorted output—20 watts.
Optimum load resistance—5,500 ohms.
Socket No. 7, Jan. 21 issue.

247

Type of tube—Filamentary pentode.
Socket—Five contact.
Purpose—Power amplifier.
Overall height—5⅝ inches.
Overall diameter—2 3/16 inches.
Filament voltage, a-c—2.5 volts.
Filament current—1.5 amperes.
Plate supply voltage—250 volts.
Screen voltage—250 volts.
Grid bias voltage—16.5 volts.
Plate current—31 milliamperes.
Screen current—6 milliamperes.
Grid bias resistance—400 to 450 ohms.
Amplification factor—150.
Plate resistance—60,000 ohms.
Mutual conductance—2,500 micromhos.
Maximum undistorted output—2,500 milliwatts.
Optimum load resistance—7,000 ohms.
Socket No. 7, Jan. 21 issue.

210

Type of tube—Filamentary triode.
Socket—Four contact.
Purpose—Power amplifier.
Overall height—5⅝ inches.
Overall diameter—2 3/16 inches.
Filament voltage, a-c—7.5 volts.
Filament current—1.25 amperes.
Amplification factor—8.

Amplifier, 250-Volt Plate

Plate voltage—250 volts.
Grid bias—22 volts.
Plate current—10 milliamperes.
Grid bias resistance—2,200 ohms.
Plate resistance—6,000 ohms.
Mutual conductance—1,330 micromhos.
Maximum undistorted output—400 milliwatts.
Optimum load resistance—13,000 ohms.

Amplifier, 350-Volt Plate

Plate voltage—350 volts.
Grid bias—31 volts.
Plate current—16 milliamperes.
Bias resistance—1,950 ohms.
Plate resistance—5,150 ohms.
Mutual conductance—1,550 micromhos.
Maximum undistorted output—900 milliwatts.
Optimum load resistance—11,000 ohms.

Amplifier, 425-Volt Plate

Plate voltage—425 volts.
Grid bias—39 volts.
Plate current—18 milliamperes.
Grid bias resistance—2,050 ohms.
Plate resistance—5,000 ohms.
Mutual conductance—1,600 micromhos.
Maximum undistorted output—1,600 milliwatts.
Optimum load resistance—10,000 ohms.
Socket No. 1, Jan. 21 issue.

250

Type of tube—Filamentary triode.
Socket—Four contact.
Purpose—Power amplifier.
Overall height—6¼ inches.
Overall diameter—2 11/16 inches.
Filament voltage, a-c—7.5 volts.
Filament current—1.25 amperes.
Amplification constant—3.8.

Amplifier, 250-Volt Plate

Plate voltage—250 volts.
Grid bias—45 volts.
Plate current—28 milliamperes.
Grid bias resistance—1,600 ohms.
Plate resistance—2,100 ohms.
Mutual conductance—1,800 micromhos.
Maximum undistorted output—1,000 milliwatts.
Optimum load resistance—4,300 ohms.

Amplifier, 350-Volt Plate

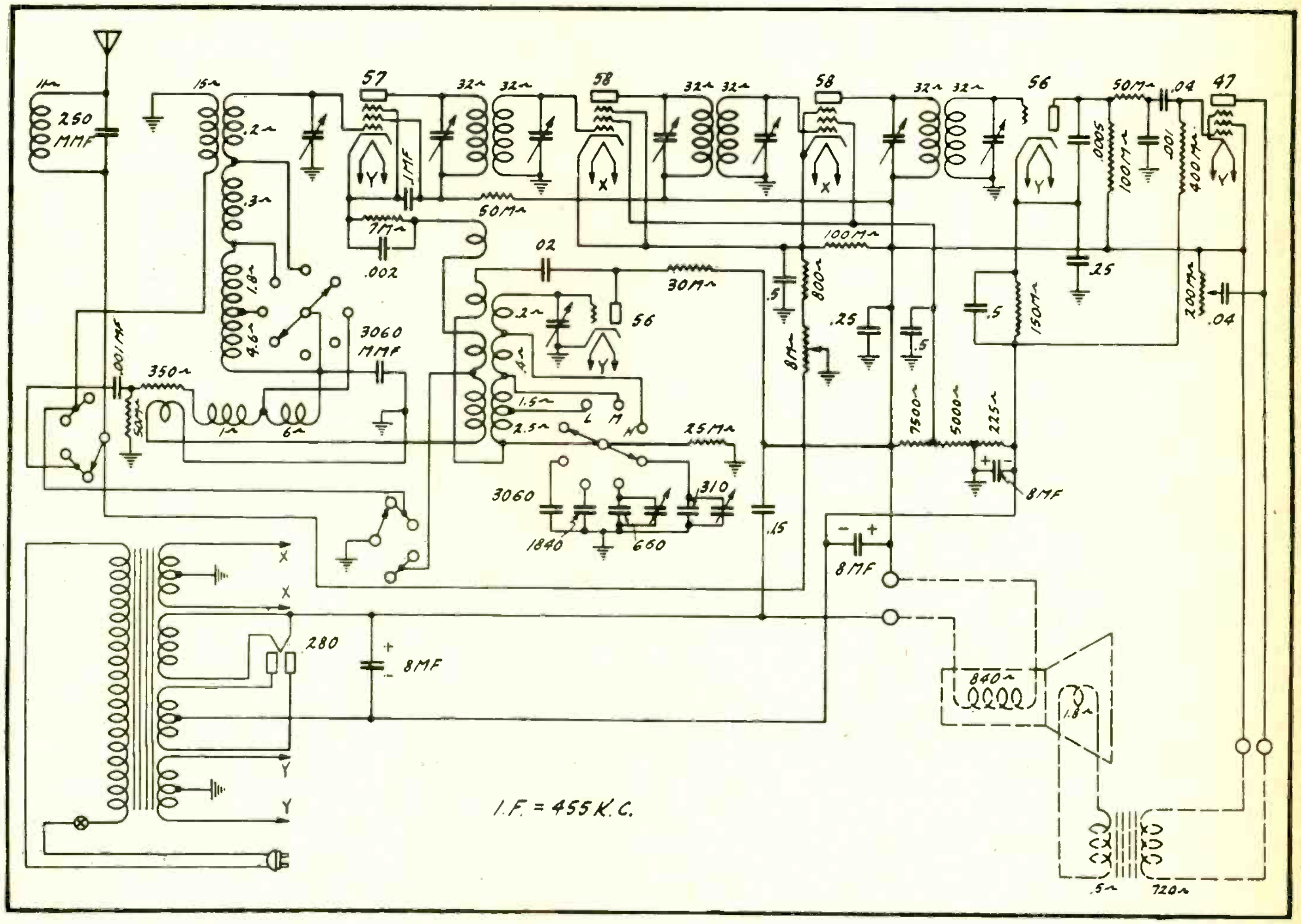
Plate voltage—350 volts.
Grid bias—63 volts.
Plate current—45 milliamperes.
Grid bias resistance—1,400 ohms.
Plate resistance—1,900 ohms.
Mutual conductance—2,000 micromhos.
Maximum undistorted output—2,400 milliwatts.
Optimum load resistance—4,100 ohms.

Amplifier, 450-Volt Plate

Plate voltage—450 volts.
Grid bias—84 volts.
Plate current—55 milliamperes.
Grid bias resistance—1,500 ohms.
Plate resistance—1,800 ohms.
Mutual conductance—2,100 micromhos.
Maximum undistorted output—4,600 milliwatts.
Optimum load resistance—4,350 ohms.
Socket No. 1, Jan. 21 issue.

THE U. S. RA

7-Tube Superheterodyne, 550 kc t



THE No. 700 chassis of the U. S. Radio & Television Corporation is a seven-tube model utilizing the superheterodyne circuit and providing for operation on a frequency range of from 550 kc. to 20 mgc. The tubes consist of a type 56 tube functioning as a local oscillator, a type 57 first detector, two type 58 tubes operating as i-f amplifiers, a type 56 second detector or demodulator, a type 247 pentode audio amplifier and a type 280 full-wave rectifier. The power supply system which supplies the necessary voltages to the various circuits is a component part of the chassis and the field of the electrodynamic speaker acts as the filter choke.

The location and function of each tube in the receiver are shown in Fig. 1.

The frequency range of the No. 700 chassis is divided into four bands, which are indicated by the four frequency scales on a dial chart. These dial scales are printed in different colors corresponding to the four colored dots on the band selector switch knob, and the receiver operates in the frequency range designated by the color of the dot which is directly below the indicator pin. The frequency range covered by the receiver when the band selector switch is in the black position is 550 kc. to 1,350 kc.; in the red position, 1.3 mgc. to 3.2 mgc.; in the green position, 3.0 mgc. to 8.0 mgc.; and in the violet position from 7.5 to 20 mgc. (One megacycle, mgc., is equal to 1,000 kilocycles.)

How Switch Works

The band selector is a four-pole, four-position rotary switch which varies the inductance included in the grid circuits of the first detector and oscillator tubes and which also short-circuits the unused portions of the r-f and oscillator secondary winding. It is necessary to short-circuit the unused portions of the coils to prevent undesirable effects which might be set up by the "dead ends," especially at high frequencies. If left unshorted, these sections might become resonant at some frequency in the range in which the receiver is being operated, due to their inductance and distributed capacity, and would produce energy loss and detuning of the receiver.

The band selector switch also makes provision for short-circuiting the section of the oscillator pickup coil used on the two lower frequency bands, during operation of the receiver on the two upper bands. This same section of the band selector switch also short-circuits the short-wave primary coil when the receiver is used on the low frequencies. Another contact arm of the switch is used to change the antenna input connection when changing from the second to the third frequency band.

The complete circuit is shown in Fig. 2. The input circuit of the first detector is somewhat different from the conventional circuit used in Super-Heterodyne receivers and its operation is best explained by tracing the path of the signal from the antenna to the first detector tube. Signals at all frequencies are picked up by the antenna and cause current at the same frequencies to flow in the antenna circuit. However, a tuned circuit is connected in the antenna lead and is resonant to 455 kc, the intermediate frequency of the receiver preventing signals at this frequency from being impressed on the grid of the first detector. Other signal currents flow through the circuit consisting of the 0.001 mfd. condenser, 350-ohm resistor, image suppression coil (shown in a horizontal position directly below the first detector transformer secondary) and 3,060 mmfd. condenser to ground. A voltage is established across the 3,060 mmfd. condenser due to these signal currents and maximum voltage is induced in the first detector transformer and applied to the grid of the 57 first detector at the frequency to which the circuit is made resonant by the tuning condenser.

Suppression of signals at a frequency of 910 kc or double the intermediate frequency above the frequency to which the receiver is tuned is provided by the image suppression coil. This coil system is designed with

ADIO No. 700

o 20 mgc, Uses Switching Method

constants of such value that the voltage induced in the first detector transformer at the image frequency is compensated for and counteracted by an equal voltage of opposite phase set up in the small coil shown in inductive relation to the image suppression coil. This system of image suppression is used on the two lower frequency bands, the inductance of the image suppression coil being controlled by the band selector switch. The 350-ohm resistor serves to make the image suppression coil rather broadly resonant and more effective over the frequency range in which it operates.

Further Image Control

Further suppression of the image frequency is provided by the natural characteristics of the first detector input circuit. The current flowing in the antenna circuit due to the signal at image frequency will not establish as great a voltage drop across the 3,060 mmfd. condenser as will the current flowing due to the signal at resonant frequency, since capacitive reactance is greater at lower frequencies. The first detector transformer, being resonant to the desired frequency, will also attenuate the image frequency.

The suppression of image response on high frequencies is not a necessity since there is very little possibility that the image signal from one station will interfere with another. Consequently, special care is not taken on the two upper frequency bands to suppress this response and the suppression provided by the selectivity of the first detector tuned circuit is adequate for this purpose.

A type 57 tube is used as the first detector and is of the bias type. Grid bias voltage is obtained from the voltage drop established across the 7,000 ohm resistor in the cathode circuit, by the plate and screen currents flowing in this circuit.

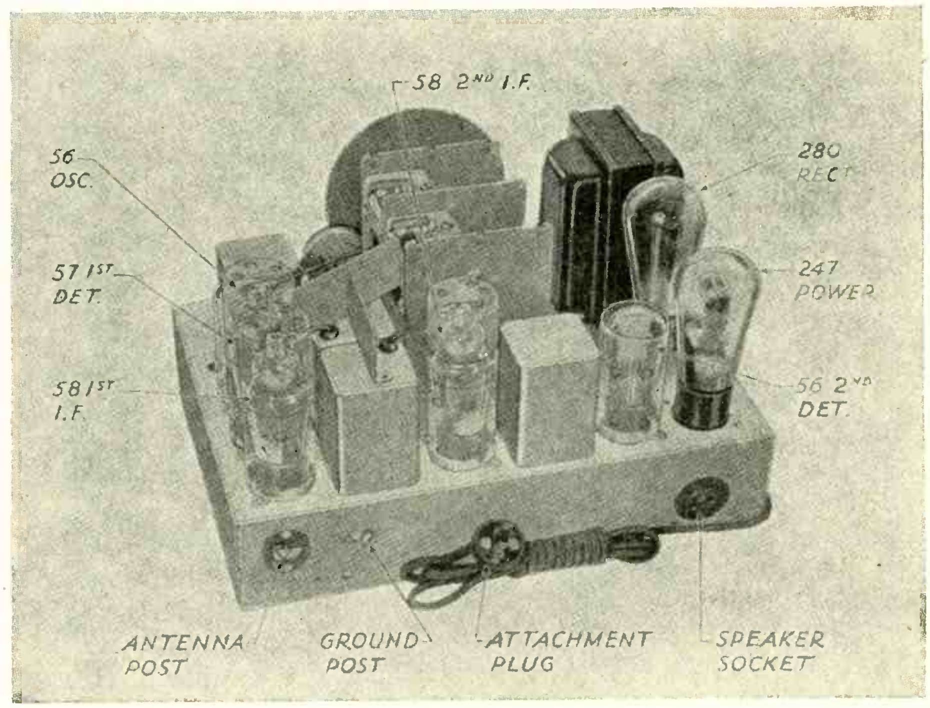
The oscillator is of the tuned grid type and is tuned by the second section of the tuning condenser. The oscillator secondary winding is tapped, these taps being connected to the band selector switch so that the inductance can be varied for the different frequency bands. The frequency of the oscillator signal is always 455 kc above the frequency to which the first detector is tuned when all circuits are in perfect alignment.

Padding Capacities Changed

The band selector switch also changes the padding condenser capacity for each frequency range so that the oscillator circuit will be in perfect alignment at all frequencies. On the two padding condensers of lowest capacity, used when the receiver is operated on the lower frequency ranges, trimmer condensers are provided to take care of variations in the fixed capacity which might affect the alignment of the receiver. On the other two frequency ranges the capacity of the padding condensers is so large that any slight variations would be a small percentage of the total capacity and would not affect alignment.

Grid bias for the oscillator tube is established by the d-c component of the oscillatory current flowing through the 25,000-ohm resistor. The oscillator pickup coil, which is inductively coupled to the oscillator, is connected in the cathode circuit of the first detector.

The first detector is followed by two stages of intermediate frequency amplification, using type 58 tubes. The primary and



secondary windings of the three i-f transformers are tuned, providing six tuned circuits and assuring a high degree of selectivity. High amplification is provided by the use of the high mutual conductance 58 tubes and by virtue of the comparatively low amplified frequency of 455 kc.

56 as Second Detector

Grid bias for the two 58 i-f tubes is variable and is controlled by the 8,000-ohm variable resistor connected in series with the 800-ohm biasing resistor in the cathode circuit of these tubes. The volume control in the No. 700 chassis serves a dual purpose in that it not only varies the grid bias of the i-f tubes but also controls the signals input to the first detector. The resistance in the cathode circuit changes from 800 to 8,800 ohms as the volume is reduced from maximum to minimum thus increasing the i-f bias voltage and decreasing the receiver sensitivity. At the same time the resistance between antenna and ground is reduced from 8,000 ohms to zero resistance, thus cutting the signal input.

A type 56 tube is used as the second detector and is resistance coupled to the 247 pentode power tube. A 100,000-ohm resistor in the plate circuit of the second detector provides the necessary impedance across which the audio voltage is developed.

A special biasing system is used with the second detector to allow it to handle strong signals without overloading. A 150,000-ohm resistor is connected in the cathode circuit and at no signal has a voltage drop of 34 volts established across it due to the second detector plate current flowing in this circuit. This voltage is in opposition to the 17 volt drop across the 225-ohm section of the voltage divider resistor and there is consequently an initial grid bias of 17 volts applied to the grid of the second detector when no signal is applied. When signal is applied to the second detector, the plate current increases in proportion to the strength of the signal and the grid bias is increased accordingly. Much greater resistance to overload is obtained with this method of obtaining grid bias than would be had if a resistance of lower value were connected between cathode and ground without the bucking voltage.

Audio Output

The power audio amplifier utilizes a type 247 Pentode tube and is coupled to the second detector through a .04 mfd. condenser and 50,000-ohm resistor. A 400,000-ohm resistor is connected in the grid circuit to supply the necessary impedance and to apply the grid bias voltage which is developed across the 225-ohm section of the voltage divider resistor.

The output of the audio tube is fed to the electrodynamic speaker by means of the speaker input transformer. Tone control is obtained by connecting a variable 200,000 ohm rheostat and a .04 mfd. condenser in series across the speaker transformer primary.

The power supply system is made up of the usual power transformer and type 280 full wave rectifier tube. The field of the speaker acts as the filter choke and is tuned by means of a .15 mfd. condenser so as to offer maximum opposition to A.C. ripple at 120 cycles. Two 8 mfd. dry electrolytic condensers are used in the filter circuit and the power supply system is completed by the voltage divider resistor which is tapped to supply the necessary screen and grid voltages to the various circuits.

SHORT-WAVE CHARACTERISTICS

A certain percentage of service calls on the No. 700 chassis will undoubtedly be due to customers expecting the same type of reception on short waves as is had from stations operating in the broadcast frequency

(*Continued on next page*)

(Continued from preceding page)

band. Short waves have characteristics different from broadcast waves and the following information will be of assistance in answering certain types of customer complaints.

Fading

Fading is familiar to the broadcast listener as a periodic increase and decrease in the strength of signals, often accompanied by alternate periods of good and poor tone quality.

Fading is much more pronounced on short waves than on the broadcast band. Short-wave fading is more rapid and severe than broadcast fading, sometimes varying from very weak to very loud, several times a minute. Fading on short waves is also governed by the extent of daylight and darkness between the transmitter and receiver as the amount of sunlight has a large influence on the condition of the atmosphere affecting radio transmission. For this reason certain frequencies are received best during daylight and others after dark.

During the day, long distance reception will be best on frequencies from 10 to 20 mgc, while after dark many stations which are received on these frequencies with good volume during the day completely fade out sometime before or after sunset. At night long distance reception is best from 5 to 10 mgc. When trying for distance the listener must therefore take into account the time of day in choosing the listening frequency.

Time Difference

Another factor affecting the time at which certain stations may be heard is the difference in time between the listener and the transmitting station. For instance, most stations in England and other European countries sign off at midnight, their time, although it is then only six o'clock in the evening to listeners on Central Standard Time in the United States. European stations should, accordingly, be listened for during daylight in the United States. On the other hand, Australian time is eight hours earlier than Central Standard Time so it is necessary to listen early in the morning for stations in Australia that are on the air during their night.

Interference

Interference or static on short waves differs in character from that on broadcast waves. Practically no natural static is found on frequencies higher than 10 megacycles. However, on short waves interference from electrical equipment operated in the vicinity of the receiver is more severe than on broadcast frequencies. Certain types of interference are present on some parts of the short wave band and not on others. For example, on 10 to 20 mgc the ignition systems of passing automobiles will cause interference, in some instances so severe as to override a signal of sufficient strength to produce full loudspeaker volume.

Interference from other types of electrically operated equipment, such as street cars, oil burners, etc. is more severe on frequencies in the neighborhood of 3 mgc. So, if static or interference is found on one part of the short-wave band at a certain time, it is often possible to listen on some other part of the band without experiencing interference.

Short-Wave Tuning

Complaints of inability to receive some stations operating on very short waves can often be traced to improper tuning of the receiver. It is essential that the tuning knob be turned very slowly when tuning for distant short-wave stations due to the extreme sharpness of tuning of the receiver when set for operation on short-wave bands. It is possible to pass over a station which will produce full loudspeaker volume without any response from the receiver if the tuning knob is turned too quickly.

Reference should be made to the list of stations given in the instruction book furnished with the Model 7D receiver in order to determine the frequency of the station which it is desired to receive. The band selector switch should then be set for the proper frequency band and the tuning knob turned so that the dial indicator moves very slowly over the dial mark indicating the station frequency.

It should be borne in mind that many of the short-wave stations operate on very irregular schedules and time difference must also be taken into account.

Antenna

An outdoor antenna is essential for satisfactory reception of distant short-wave stations and should be as high as possible. An indoor or light socket antenna does not give very successful results on short-wave reception because the signal picked up from distant short-wave stations is much less than that of broadcasting stations and a good outdoor antenna will pick up more signal energy. A somewhat longer antenna than recommended for the usual broadcast receiver can be used to advantage with the No. 700 chassis. An antenna length of from 75 to 125 feet is recommended for use with this receiver.

SERVICING

In servicing the No. 700 chassis the same general procedure should be followed as in testing a standard broadcast superheterodyne receiver. Check all the accessories first to determine if the cause of the trouble is external to the receiver itself. Tubes should be tested with a tube tester or, if one is not available, should be replaced with tubes which are known to be in good condition. The antenna and ground should be given a thorough inspection and test to make sure that they are in good order and making good contact at the binding posts on the receiver chassis. Test the lightning arrestor for resistance and replace it if it tests abnormally low.

If no trouble is located in the accessories, continue to test the receiver by reading voltages at the sockets to determine any defects of the chassis which may affect these.

Voltages

A reliable set analyzer should be used for making voltage tests on the receiver. If desired, separate high resistance meters may be used for this purpose but are not as handy to use as the set analyzer unless the chassis is removed from the cabinet.

The antenna and ground should be disconnected during voltage readings and the tube shield removed only from the socket in which the analyzer plug is inserted. In reading the i-f voltages at the sockets, oscillation may be caused by the capacity of the analyzer cable. Such oscillation will cause incorrect readings to be obtained but can usually be overcome by touching the control grid connection on the analyzer plug or by grounding this connection through a 0.1 mfd. condenser.

The voltage chart shows the voltages and currents with all tubes in, speaker connected and the set otherwise in operating condition. As indicated by the footnotes, some of the voltages as read at the sockets are not the actual voltages applied to the tubes, but are lower due to voltage drop caused by the meter current flowing through high resistances in the circuit being tested. The higher the resistance of the meter used for taking such readings, the more accurate the readings will be.

Continuity or Resistance Test

Certain defects will not affect voltage readings but may be located readily by means of resistance tests on the receiver circuits. The schematic diagram, shows the resistance of practically every section of the circuit with the exception of coils of very low resistance. For instance, the resistance of the complete oscillator pickup coil system, connected between the first detector biasing resistor and ground is less than 1 ohm and variations in this due to shorted turns could hardly be located with an ohm meter. No resistances are given for the power transformer windings since defects in this part are usually readily apparent either as overheating or as no voltage across the detective winding.

When making continuity tests in circuits containing dry electrolytic condensers it is essential that the positive test prod be on the positive lead. An electrolytic condenser will conduct electricity much more readily when its anode is made negative than when it is positive and an incorrect resistance reading will be had under such conditions.

The schematic circuit diagram should be studied carefully when making resistance tests on the various circuits. Practically all of these circuits can be checked for correctness of resistance without removing the chassis from the cabinet, and in many instances the entire trouble can be located before the chassis is removed for repair. Follow a systematic procedure in making these tests, starting at the antenna circuit and working on through the receiver. An exception to this is, of course, when there is an indication as to where the trouble lies, in which case the resistance tests should be started at that point in the circuit.

Condenser Alignment

The r-f trimmers, which are used to align the receiver at the high frequency end of the broadcast band are located on the variable tuning condenser assembly, one on each section.

There are also six i-f trimmer condensers which are used to align the i-f circuits accurately to 455 kc. The adjusting screws of these trimmers are accessible from beneath the chassis and protrude from the porcelain bases of the i-f transformers. The adjusting screws of the i-f transformer trimmers as well as the r-f trimmers should not be tampered with or changed unless it is apparent that they are out of adjustment. The necessity for readjustment of these circuits is usually indicated by low volume accompanied by broad tuning or a lack of selectivity but all other possible defects which might bring about these effects should be checked before attempting realignment.

A signal generator and an output meter are essential in order to align the r-f and i-f circuits correctly. The signal generator must provide an intermediate frequency signal at 455 kc as well as signals throughout the broadcast band from 550 to 1500 kc.

Aligning Intermediate Condensers

The six i-f trimmers must be aligned accurately before the first detector and oscillator circuits can be correctly aligned. Remove the 56 oscillator tube from the socket and connect the signal generator output to the grid contact of the 57 first detector tube. Adjust the output of the signal generator to as low a value as will give a satisfactory deflection on the output meter with the receiver volume control set at maximum. Too strong a signal will cause overloading of the second detector and make it impossible to peak the i-f transformers properly.

Then adjust the six i-f condenser screws until maximum output is indicated on the output meter. After all six have been adjusted the first time, go over them again and check the setting for maximum output.

Aligning R-F and Oscillator

Turn the tuning condenser rotor until the rotor plates are fully in mesh with the stator plates and check the position of the dial indicator. This should be exactly at the lowest frequency mark on the dial scale. In case this setting is not accurate, loosen the two set screws which hold the drive disc to the tuning condenser rotor shaft and turn the disc until the dial indicator reads correctly. Be careful not to move the tuning condenser rotor while changing this setting. When the drive disc is properly adjusted tighten the two set screws firmly.

Replace the 56 oscillator tube and connect the signal generator output to the antenna post on the back of the chassis. Set the band selector switch so that the receiver is

No. 700 Chassis—Voltages at Sockets
Volume Control at Maximum—Line Voltage 115

Type of Tube	Position of Tube	Function	A Volts	B Volts	Control Grid C Volts	Screen Grid Volts	Screen Grid Current MA	Cathode Volts	Plate Current MA	Grid Test MA
56	1	Osc.	2.4	70	18[1]			0	6.2	6.2
57	2	1st Det.	2.4	170	8.0	170	.3	8.0	1.2	1.6
58	3	1st I.F.	2.4	260	7.0	90[2]	.6	7.0	2.5	4.0
58	4	2nd I.F.	2.4	260	7.0	90[2]	.6	7.0	2.5	4.0
56	5	2nd Det.	2.4	200[3]	17.0[2]			17.0	.2	.3
247	6	Audio	2.4	240	1.6[4]	265	6.8		33.0	38.0
280	7	Rect.	5.0						39 Per Plate	

(1) Varies with frequency. Actual voltage measured across 25,000 ohm bias resistor—39 Volts.
(2) Voltage measured with 120,000 ohm meter.
(3) Voltage measured with 600,000 ohm meter.
(4) Actual voltage measured across 225 ohm section of voltage divider resistor—17 Volts.

operating in the range indicated by the black dial scale and place the signal generator in operation at exactly 1200 kc. Turn the tuning condenser rotor until the dial indicator is at 1200 kc on the dial scale and carefully adjusted the two trimmers on the tuning condenser for maximum output. This adjustment must be made accurately as most efficient operation on all frequency bands will only be had under such conditions.

Then set the signal generator for a signal of 600 kc and turn the tuning condenser rotor until maximum output is indicated. The 600 kc oscillator trimmer condenser should then be adjusted for maximum output. Rock the tuning condenser while making this adjustment; that is, tune slowly back and forth through resonance while varying the capacity of the 600 kc trimmer condenser and adjust this condenser until the output meter shows the greatest deflection when the tuning condenser is tuned to resonance. The 600 kc trimmer condenser adjusting screw protrudes through the top of the chassis near the oscillator tube socket.

Next turn the band selector switch so as to place the receiver in operation in the frequency band indicated by the red dial scale. Set the signal generator for a signal of 1400 kc and tune the receiver to resonance. Then adjust the 1400 kc oscillator trimmer for maximum output while tuning the receiver slowly back and forth through resonance. The adjusting screw for this trimmer is located on the left hand end of the chassis directly below the 600 kc trimmer.

After the foregoing adjustments are carefully and accurately made, the receiver will be in alignment on all frequency bands. No further adjustments on the two high frequency bands are necessary.

R-F and I-F Transformers

The first detector and oscillator transformers are each wound on two separate coil forms and connections brought from them to the band selector switch. The short wave antenna and oscillator transformers are contained in aluminum shielding cans mounted on top of the chassis. These transformers provide the inductance used in the tuned circuits during operation of the receiver on the green and violet frequency bands. The broadcast oscillator and antenna transformers are mounted in aluminum shielding cans beneath the chassis. When the receiver is in operation on the red and black frequency bands these transformers provide the extra inductance necessary for operation on these bands. The broadcast oscillator and antenna transformers are matched at the factory in sets of two in order to provide maximum efficiency and should it be necessary to replace one of these it is advisable from the standpoint of efficient operation of the receiver to replace both of them.

Filter and Bypass Condensers

The i-f transformers are of the same general type used in previous U. S. Radio receivers. They are supplied completely assembled in shielding cans and if any component part of one of these transformers is defective, the entire transformer should be replaced rather than attempting repair or replacement of the defective part.

The No. 700 chassis uses three 8 mfd. dry electrolytic condensers, two of these being in a single container and comprising the dual filter condenser unit, Part No. 4116. The remaining 8 mfd. electrolytic condenser, Part No. 4119, is used as a bypass across the 225-ohm section of the voltage divider resistor which supplies grid bias to the 247 audio tube and serves to complete the return circuit of this tube for audio frequencies. Methods of testing these condensers have been completely described in previous manuals and it has not been thought necessary to repeat the information herein.

The necessary paper dielectric bypass condensers to prevent the flow of i-f and r-f current through biasing and voltage dividing resistors are provided in this chassis. These may be easily tested for a short or leaky condition by means of a direct reading ohm meter such as is used in making circuit resistance tests. The simplest method of checking these small capacity condensers for open circuit is to shunt them with condensers of similar capacity which are known to be in good order noting if the abnormal condition for which a search is being made, is cleared up.

Band Selector Switch

This assembly serves to vary the inductance included in the grid circuits of the first detector and oscillator tubes and also makes other necessary circuit changes in adapting the receiver for operation on the different frequency ranges. In the event of trouble where the receiver is operating all right on some frequency bands but is inoperative on others, the contacts should be carefully inspected to determine that there is a good electrical contact to the switch blades. The switch contacts are lubricated with light oil at the time of manufacture to insure freedom from noise and under normal conditions no trouble should arise from this assembly.

The band selector switch assembly is furnished complete with all wiring, the 3060 mmfd. and 1840 mmfd. oscillator padding condensers and the 25,000-ohm oscillator bias resistor. It is of extreme importance that all soldered connections connecting the switch to the various circuits be carefully made as poorly soldered joints will seriously interfere with the performance and these switches are subjected to rigid tests at the factory after the soldered joints are made. Should it be necessary to replace any part connected to the switch extreme care must be exercised that no soldering flux flows onto the switch contacts as noisy operation or complete inoperation of the receiver would be brought about by this.

Electrodynamic Speaker

The No. 700 chassis is supplied with a d-c baffle mounting electrodynamic speaker. Part No. 4493. The field of this speaker has a d-c resistance of 840-ohms and is used as the filter choke of the receiver. Under normal conditions the voltage drop across the speaker field is 70 volts.

No. 700X Chassis

Chassis No. 700X as used in Receiver No. 7DX is almost identical in construction to chassis No. 700 except that it is designed for 25-cycle, 115-volt operation. All parts used in the No. 700 chassis are also used in the No. 700X chassis with the exception of the power transformer. The correct power transformer for the No. 700X chassis is shown in the parts price list.

The No. 700X 25-cycle chassis can be operated satisfactorily from a 60-cycle power supply. The reverse is not true, however, and under no circumstances should it be attempted to operate the No. 700 chassis on a 25-cycle power supply.

Possible Troubles

Low Volume—The most common cause of low volume in any receiver is tubes which are not up to standard. Low volume may also be caused by a defective speaker and this should be given a thorough test. Low line voltage will decrease the sensitivity of the receiver or some defect in the chassis causing low voltage to be supplied to one or more of the tubes will bring about the same effect. Misalignment of the receiver circuits will cause low volume but all other possibilities should be checked before realignment is resorted to as a method of cure for this trouble.

Oscillation—The design of the No. 700 chassis is such that the circuit is very stable and under normal conditions no trouble will be experienced from this cause. Oscillation may be brought about by 57 or 58 tubes whose characteristics vary considerably from standard and new tubes should accordingly be tried before making any other tests. Open bypass condensers are a common cause of oscillation and these should be carefully checked. Simple trial replacement is usually the simplest procedure in locating an open bypass condenser. Coupling between plate and grid leads in the chassis will also cause this trouble, and such leads should be separated and pushed close to the chassis. All tube shields must be in their proper position. Grid leads to the tops of the tubes should also be in place and as little exposed as possible.

Excessive Hum—Hum may be caused by heater-cathode shorts in 56, 57 or 58 tubes. A low emission 280 tube or one with unbalanced filament emission will also cause excessive hum. Open filter condensers will cause a loud hum and hum will also be excessive should the .15 Mfd. speaker field tuning condenser be open. Shorted turns in the speaker field will also cause hum.

Hum is present on the carrier waves of some broadcasting stations, and may also be caused by local interference. Disconnect the antenna to determine that the hum is not originating outside the receiver.

Distorted Reproduction—Incorrect tuning of the receiver, especially on the high frequency bands is a very common cause of distorted reproduction. The tuning knob should be very slowly turned back and forth until the signal is the clearest and strongest. Distortion can often be traced to defective tubes, especially the 247. Other causes are open or shorted 8 Mfd. electrolytic bypass condenser or the speaker being out of adjustment.

Radio University

A QUESTION and Answer Department. Only questions from Radio University members are answered. Such membership is obtained by sending subscription order direct to RADIO WORLD for one year (52 issues) at $6, without any other premium.

RADIO WORLD, 145 WEST 45th STREET, NEW YORK, N. Y.

Computation of Power Output

PLEASE outline briefly the method of computing the power output of a tube from the plate current, plate voltage curves.—W. E. H., Detroit, Mich.

A family of plate current, plate voltage curves is needed, that is, a set of these curves taken at different grid bias voltages. Across this set of curves draw a load line corresponding to the load resistance for which the output is to be computed. The load line is drawn through the point of applied plate voltage and the voltage axis with a slope equal to the reciprocal of the resistance. This load line will cut the curves for zero bias and the curve corresponding to a bias twice the operating bias. Read off the current and the plate voltage where the line cuts the two curves. Suppose at zero bias the current is 100 milliamperes and the effective plate voltage is 100 volts. Suppose also that at twice the operating bias the current is 10 milliamperes and the effective plate voltage is 380 volts. The change in effective plate voltage then is 280 volts and the amplitude of the voltage change is 140 volts. The change in the plate current is 90 milliamperes, and the amplitude is 45 milliamperes. Hence the peak power is 140x45 milliwatts. The average power during a cycle is one-half of this, or 70x45. That is, the output of the device is 3,150 milliwatts.

* * *

Standard Frequency Oscillator

WILL you kindly give the design of a standard frequency oscillator that will generate a 5,000 kc wave? It should be stabilized against battery voltage changes. What type of oscillator would be the most suitable?—G. W. R., Chicago, Ill.

For a fixed frequency oscillator the Colpitts would probably be the best. This can easily be stabilized. Use two equal tuning condensers and connect them in series, with the common shaft connected to ground. Use three coils of inductance L/2, L and L/2, L being the inductance required in the tuned circuit. Use a grid leak approximately equal to the plate resistance of the tube. Connect one of the L/2 coils in the plate lead and the other in the grid lead. The largest coil, of course, goes from one condenser station to the other. If each of the condensers is 140 mmfd. the total effective tuning capacity is 70 mmfd. Hence the value of the inductance, L, should be 14.48 microhenries, and each of the smaller coils should be 7.24 microhenries. Winding the wire 32 turns to the inch on a one inch form the large coil requires 27.5 turns and each of the smaller coils 16.8 turns.

* * *

Transformer Iron

WHAT is the difference between the iron or steel used in transformers and the steel used in voltmeters and other instruments? What makes one material good for a transformer and another for an instrument?—T. H. W., Omaha, Neb.

The steel used in a transformer core is easily magnetized to a high intensity. That is, it has a high permeability. But it will not retain much of the magnetism after the magnetomotive force (ampere-turns) has been removed. Steel used in instruments, on the other hand, is very difficult to magnetize, but once it has been magnetized it retains its magnetization after the magnetomotive force has been removed.

Biasing Class B Amplifiers

COULD a radio frequency oscillator in conjunction with a rectifier be used for supplying the necessary grid bias for a Class B amplifier? How high voltages can be obtained in this way?—R. E. M., Atlanta, Ga.

Yes, there is no reason at all why a C supply of this type should not be used. It will not only work on a Class B amplifier but anywhere where a steady voltage is needed. What voltage is obtained depends on very many things but it is not exceedingly difficult to get up to 1,000 volts. And it is just as easy to get one volt.

* * *

Limitation of Oscillation

IF THE grid resistance of an oscillator is infinite so that no grid current can flow, what limits the amplitude of the oscillation? Does the resistance in the oscillating coil have anything to do with it? How does the plate resistance enter?—J. S. S., St. Louis, Mo.

In a tuned-grid oscillator with an infinite grid resistance, the condition for oscillation involved M, the mutual inductance between the tickler and the tuned winding, the capacity C of the tuning condenser across the secondary, the amplification constant of the tube, the inductance of the secondary, the plate resistance of the tube, and the resistance of the oscillation coil. These were connected in such a manner that the resistance of the coil was a factor. Hence it had a major influence on the conditions for oscillation, and in turn on the amplitude of the oscillation.

* * *

Birdies in Super

BIRDIES are twittering in my superheterodyne receiver. The intermediate frequency is 175 kc and there are two radio frequency tuners in front of the mixer. It should be plenty selective enough to cut out image interference but apparently it is not. Is there any other cause of birdies?—W. G. H., Lincoln, Neb.

Yes, there are the harmonics of the intermediate frequency, which might cause birdies on certain frequencies. Since you have an intermediate frequency of 175 kc the first harmonic in the broadcast band is 4rth at 700 kc. It is quite possible that you get annoying whistles on this frequency as well as on the adjacent channel frequencies. The next possibility is at 875 kc, where birdies may occur with 870 and 880 kc. Again there is a possibility at each of frequencies 1,050, 1,225, and 1,400 kc. Of course, if the intermediate frequency is not exactly 175 all of these are shifted a little, depending on how much the i-f is off 175 kc.

* * *

Required Stability of Oscillators

IN RECEIVING short wave signals with the superheterodyne how close is it necessary to hold the oscillator frequency constant? Even if the stability were perfect would that help if the transmitter oscillator varied in frequency?—W. C. H., Camden, N. J.

Just how stable the oscillator must be depends on the intermediate frequency, the selectivity of the receiver, and on the frequency that is being received. Let us take a rather extreme case. Let the intermediate frequency be 100 kc and let the i-f tuner be so sharp that the signal will go out if the circuit is detuned 5,000 cycles. We cannot allow a disappearance of the signal so let us assume that it is necessary to hold the frequency constant to 1,000 cycles. Now let a signal of 30,000 kc be tuned in. Then the oscillator must remain constant to one part 30,000. That is a rather severe requirement. It would not do any good if the transmitter oscillator varied. The only practical way of avoiding trouble from a varying oscillator at the transmitter is to make the receiving tuner so broad that changes would make little difference. And such a broad tuner is not practical. Hence for reliable reception on the short waves it is necessary that both the transmitter and the receiver oscillators remain constant in frequency to a high degree.

* * *

Standing Waves

IS IT possible for the direct wave and the wave reflected by the Heaviside layer to form a standing wave pattern such that in certain regions there would be no reception at all while in other regions, not far from the first, the signals would be very intense? Is it possible that the frequencies in the two rays could be different, or must they always be the same?—R. M. C., Cincinnati, Ohio.

It is possible for standing waves to form for the conditions are right. It is similar to the well-known Lloyds mirror in optics, where the Heaviside layer becomes the mirror. Effectively there are two equal sources of rays very close together, one the direct and the other the image. In the radio case, however, the wave patterns is not constant because the mirror will not stay put. It will warp, rise and fall, and undergo other changes. That is the reason why fading occurs rather than the standing pattern you suggested. If the wave pattern is fixed there can be no difference between the frequencies in the two waves. However, while one is actually changing in respect to the other, the effect is a difference in frequency. This difference in frequency cannot be great because the difference in distance between the two paths is not many wavelengths long.

* * *

Values of By-Pass Condensers

WHAT are the best by-pass capacities across radio frequency plate and screen leads? Many different values are specified in circuits and there seems to be no consistency.—W. H. C., New York, N. Y.

When there is a general inconsistency about anything it is so because the thing is not critical. If there were a best value everybody would be using it. You might say that the larger the condensers the better. However, that does not mean that a 100 mmfd. condenser is preferable to one of 0.1 mfd. if the smaller condenser does the required work 99.99 per cent. as well as the larger. A by-pass condenser is to have such a value that its reactance is negligibly small in comparison with the impedance across which it is connected. Just what is negligibly small is a matter of judgment.

* * *

Oscillator Limitation

THE oscillator in my superheterodyne does not go higher in frequency than 1,500 kc whereas it must go to 1,675 kc in order to reach the 1,500 kc channel. Can you suggest a reason for its failure to reach the high frequency and a remedy?—T. R. D., Memphis Tenn.

No doubt, the trouble is excessive distributed capacity in the oscillator circuit. This may arise in part in the "hot" leads between the condenser and the coil and between the tuned circuit and the grid of the tube. Perhaps most of the distributed capacity arises between the tickler and the tuned windings. It may be necessary to remove the tickler, place a thicker insulator on, and then replace the winding. In your case, however, only a small decrease in the capacity is necessary and it may not be necessary to change the winding.

* * *

Hiss in Receiver

THERE is a very strong hiss in my receiver, an eight tube superheterodyne. Could you suggest anything that might help remove this?—W. H. C., Springfield, Ill.

It may be that you have too close coupling between some coils, possibly in the intermediate amplifier. If you have doubly tuned transformers it is essential that the two coils be far apart in order to get selectivity. This is also true if only one is tuned, although not to the same degree. But if the coils are far enough apart to give good selectivity they are far enough apart not to transmit the noise. If you have an untuned intermediate transformer it may pay to separate the coils a little just to eliminate the noise, even if this entails a slight loss in the sensitivity of the receiver. Or, you might put a copper disc between the two coils.

* * *

Voltages in Resonant Circuit

IF THE alternating current in a tuned circuit is known is it possible to determine the voltage across the condenser or across the coil at resonance? Just how high voltages can be expected?—L. W. A., Des Moines, Iowa.

If an a-c milliammeter of negligible resistance is connected in series with the tuning condenser and the resonant current measured, the voltage across the condenser is equal to the current measured divided by Cw, where C is the capacity in farads and w is the two pi frequency. Since resonance exists the frequency is also equal to the square root of LC, and the voltage across the condenser, or across the tuning coil, is the current times the square root of the inductance divided by the capacity. In symbols, $V = I\,(L/C)^{1/2}$, V being the voltage, I the current in amperes, L the inductance in henries, and C the capacity in farads. As an example, suppose the current is 0.115 ampere, the inductance 245 microhenries, and the capacity is 350 mmfd. Then $V = 96.2$ volts. This might possibly be encountered in the resonant circuit of an oscillator, but not in a radio frequency tuning coil because no tube will take a signal voltage as high as 96 volts.

* * *

Why Padding

WHY IS the adjustment of an oscillator circuit for tracking called padding? The expression does not seem to have any connection with anything else in radio or electricity.—W. J. S., Denver, Colo.

The term "padding" has undoubtedly been lifted from tailoring. A pad is a filler used to produce the desired contour or the desired fulness. In connection with a superheterodyne oscillator a "pad" is used to give the desired shape to the oscillator calibration curve in reference to the curve of the radio frequency tuner. "Pads" are also used to give desired shapes to transmission characteristics. These "pads" are usually wave filters of some form, and they are frequently called pads without apology.

* * *

Purpose of Trimmer Condensers

PLEASE settle an argument for us. Group A says that the purpose of the trimmer condensers on ganged tuning condensers is to compensate for differences in the capacities of the sections of the gang. Group B says that their purpose is to equalize stray capacities in the circuit. Which group is right?—R. C., Milwaukee, Wis.

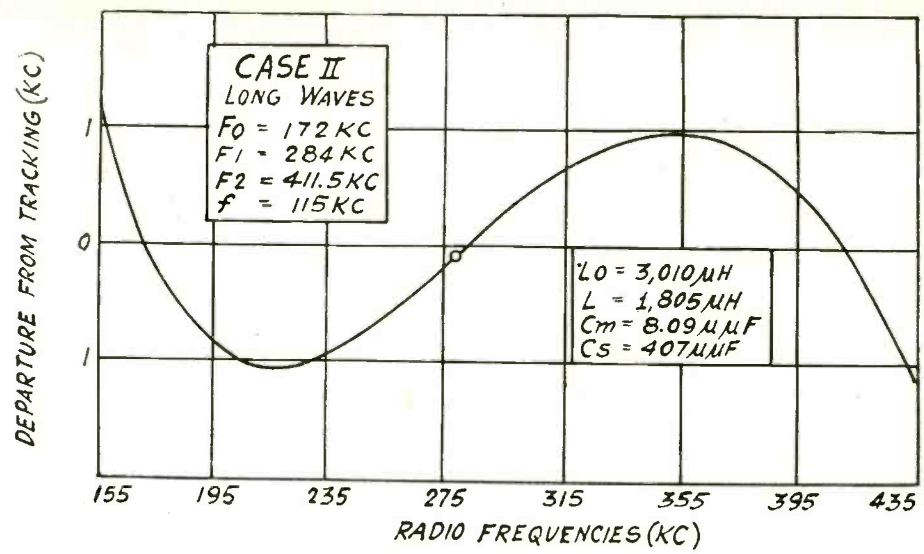
Group B is right. If the rate of change of capacity is not the same for all the condensers in the first place nothing can be done about it except changing the size and shape of the plates. But if there is a difference in stray capacities, which may include the minimum capacity of the condenser sections, then the trimmers can be used to make the minimum setting capacities equal.

* * *

Straight Line Frequency

IF A tuning condenser is straight line frequency for one range of frequencies is it also straight line for other ranges?—B. N. A., Miami, Fla.

A straight line frequency condenser follows this law of change over a given band of frequencies, say from 550 to 1,500 kc. If the same condenser is used for some other frequency band it will be straight line frequency only if the frequency ratio is the same as in the first case.



A tracking curve showing how closely a superheterodyne can be padded in the long-wave band when the intermediate frequency is 115 kc.

* * *

Aerial for Super Diamonds

PLEASE LET ME KNOW how long an aerial to use on the six-tube or seven-tube Super Diamond, and also tell the difference between the two sets. I refer to the a-c receivers.—P. O. E., Dubuque, Ia.

No definite value of aerial length or height can be stated, but the following rule should be observed: do not use an aerial so high or so long as to produce any squeals due to image interference. Thus the height and length may differ in different locations. In New York City, for instance, an aerial wire 10 or 12 feet long, indoors, meets the requirements. In locations more remote from broadcasting stations, particularly from stations operating on frequencies that are harmonics of the 175 kc intermediate frequency, a longer and higher aerial may be used. The seven-tube receiver is no more sensitive than the other, due to complete automatic volume control, but it is somewhat more selective, and there is no fading experienced with it. The six-tube set has the single intermediate tube governed by a-v-c., while the seven-tube set has the two intermediate tubes so controlled.

* * *

Echo Reception

HAVE YOU EVER had the experience with a superheterodyne of bringing in a station on the basis of echo reception, so that you hear the beginning of a word again, as the speaker reaches the end of it, in other words, a result like that of two identical phonograph records being played slightly out of step?—U. W. S., Bangor, Me.

Yes, we have come across that phenomenon, but do not fully understand it. The situation arises with improperly padded oscillator circuits, particularly if padding capacity has been shorted out, or left out of circuit with grid of oscillator possibly open. One theory suggested is that the oscillator and t-r-f tuning pull each other, one taking a turn, then the other taking a turn, and that a phase displacement results.

* * *

58 As Oscillator

IF THE 57 tube is recommended as oscillator in a superheterodyne, may the 58 be used instead?—U. T. W., Miami, Fla.

Yes, the 58 may be used, but may not oscillate unless a smaller value biasing resistor is used than the one specified for the 57. This reduction in value of biasing resistor also may be necessary with either tube if the bias resistor is put between a pickup coil and ground instead of between cathode and pickup coil. Use the highest value of resistor consistent with complete oscillation. By incomplete oscillation is meant stoppage of oscillation at the low radio frequencies. This requires a smaller value of biasing resistor for correction.

* * *

Padding Long-Wave Oscillator

IS IT PRACTICAL to pad a superheterodyne designed to cover the long wave band from about 150 to 450 kc? What intermediate frequency would you recommend for a superheterodyne of this kind?—T. H. J., Toledo, Ohio.

Yes, it is quite practical provided that the intermediate frequency is not made too high. A frequency of 115 kc has been used successfully. In the figure is shown a tracking curve for the range 155 to 435 kc, the intermediate frequency being 115 kc. It will be noticed that the deviation is less than one per cent. even where it is greatest. No better can be done in the regular broadcast band, that is, no better than one per cent. of the intermediate frequency.

Universal Kits Stimulating Business

To those who may be wondering how to develop ways to increase business without going into any great expense it is suggested that they look very carefully into the possibilities of the universal ac-dc receiver. Here is an item that is certainly going over in a big way. Unlike the midget, it has many avenues for sales. Naturally the price is a factor, but the appeal is from a much more plausible angle. Its adaptability is so wide that the reasons for purchasing it are numerous. Men slipping away over the week-end drop the little set into the grip as one would a box of cigars. The camp, the auto, the den, the office, the hospital, are likelihoods. There are a number of manufacturers now in production of such sets. The serviceman or experimenter who wants to make or sell them in his own community finds only one organization that caters to this class of trade and while it also sells the complete receiver ready to operate equipped with tubes, it also markets a kit of factory standard assembled parts, with only simplified wiring to be done. A diagram is furnished with each kit. This company is Postal Radio, 135-137 Liberty Street, New York City.

—J. Murray Barron.

JENSEN NAMED WITH SYKES TO RADIO BOARD

Washington.

After having left unfilled for several months the vacancy caused by the resignation of Chairman Charles McK. Saltzman from the Federal Radio Commission, President Hoover nominated John Christian Jensen as a member of the Commission. The nomination was transmitted to the Senate. which will take action thereon.

The nominations and appointments are to membership on the Commission, and the Commissioners themselves choose a chairman. Eugene O. Sykes has been nominated by President Hoover for reappointment, and this nomination was sent to the Senate at the same time.

Jensen An Instructor

Mr. Sykes has been acting as Chairman, and it is expected that the membership will choose him as Chairman after the Commission as newly constituted is organized.

The terms of both Messrs. Jensen and Sykes are for six years.

Mr. Jensen has had a long career in radio as instructor. During the war he was chief radio instructor in the War Training Unit of the University of Nebraska, and at present is instructor in radio and physics in Nebraska Wesleyan College, a position he has held since 1909, except for the war-time interruption. He was born in Utica, Neb., 53 years ago.

He received the B. Sc. degree from Nebraska Wesleyan University in 1909, and thereafter at intervals attended the University of Nebraska, where in 1916 he received the A. M. degree, the University of Iowa, and the University of Chicago.

Known Also as Author

He is a Fellow A. A. A. S., a member of numerous associations including the Physics Society, American Meterological Society, Nebraska Academy of Science, American Association of University Professors. He is author of papers on the subject of atmospheric electricity in relation to radio reception, and in 1906 was demonstrator of spark transmitter at the Nebraska State Fair.

He is interested in the subject of educational broadcasting stations and recently justified such stations selling time on the air.

Short-Wave Converters Used on Direct Current

There are many now living in d-c districts who would like to take advantage of exceptional sales on short-wave converters who heretofore had not been able to have their needs filled. Converters placed on the market, of national repute, have been mostly for a-c operation. The Brunswick now being offered by Nussbaum's, 61 Cortlandt Street, N. Y. City, while for a-c current, can very easily be changed for d-c operation and at practically no expense. New York City having considerable direct current, naturally a large number of persons in this locality are interested, and throughout the country there are many thousands more. Also ships make a worthwhile market and constitute a following that is entitled to know about these matters. It is with the object of serving this large following that Nussbaum's has featured d-c s-w converters. Those out of town can write directly to the Nussbaum Company.

Bar Offers Legal Feature on Chain

The general idea supposed to be held by the public that law is clumsy and difficult is attacked in a series of constructive talks on the lawyers' part in legal reform and public relations over the Columbia Broadcasting System, 6 p. m. Sunday, a weekly feature. The series is entitled "The Lawyer and the Public" and is presented under the auspices of the American Bar Association, whose president, Clarence Eugene Martin, was the first speaker in the series.

One of the novelties will be a question-and-answer sidelight of the series, the purpose being to impart information, not to offer legal advice. However, the experience of others has been that the requests for advice come in much faster than the requests for mere elucidation on legal matters, and the Association is expected to have its hands full trying to appease advice-seekers with the information-only reply.

There have been several chain features pertaining to legal matters, principally the outline of the protection afforded to citizens by the law, the experiences of judges of inferior criminal courts, and a digest of interesting cases and the findings of courts as embodied in their decisions in such cases. None of these features has endured, however, and the American Bar Association will try to put its presentation on a basis making for greater permanence.

608 STATIONS ARE CLASSIFIED

Washington.

The Federal Radio Commission has just issued a revised list of radio broadcast stations. There are 283 stations assigned unlimited time, 20 limited time, and 166 sharing time with others. A summary of the revised list follows:

On January 1st there was a total of 610 stations of which 608 are classified as follows:

	Clear	*Regional*	*Local*	*Total*
Unlimited time	30	128	125	283
Limited time	20	...	...	20
Daytime	17	18	7	42
Sharing time	20	98	48	166
Part time	..	1	1	2
Specified hours	6	34	55	95
Total stations	93	279	236	608
Total frequencies	40	44	6	90

Two stations are not classified above for the reason that the quota units formerly assigned these stations have now been assigned to other stations, but the call letters have not been officially deleted because of pending litigation.

The total number of stations shown above represents the number of outstanding licenses or construction permits, according to "The United States Daily," but because of the great number of stations authorized to share time or with specified hours of operation on the same frequency in the same geographical area, there are in use the equivalent of 382 full-time assignments.

On January 1st there were in use 599 transmitters, exclusive of auxiliary transmitters.

SEVEN-PIN-BASE ANALYZERS

Analyzer plugs such as used by experimenters and service men have been of the six-pin type, with adapters to render service where other types of tubes are to be tested in circuits, but the new analyzer plugs have seven-pin bases, and provide eight connections, thus allowing for virtually any additional changes in tube bases, including a seven-pin base tube with grid cap which doesn't yet exist.

WHITE, SYKES U. S. DELEGATES TO CONFERENCE

Washington.

Senator White, of Maine, who has been prominent in obtaining radio legislation in Congress, and Acting Chairman Sykes, of the Federal Radio Commission, will represent the United States at the North American Radio Telegraph Conference to be held in Mexico City in April or May to settle problems of wavelength, power, etc. Canada, Mexico and Cuba will send delegations.

The International Radio Telegraph Conference, held recently at Madrid, Spain, was unable to agree on certain controversial topics, including the extension of the broadcast band to lower frequencies.

Would Go Below 540 kc

At present the practical band terminates at 540 kc, but a reallocation has been suggested, whereby lower frequencies would be open to broadcasting stations, including the general range of frequencies now used as intermediate frequencies in superheterodynes.

As against the proposal manufacturers have pointed out that the public would be inconvenienced, because present receivers would not bring in the lower frequencies without a considerable change in the circuit, by adding switch and extra coils, or at least by using a long-wave converter.

Preliminary and informal meetings are being held in the respective countries, and it is expected that the delegations will attend the Mexican conference with their minds partly made up, although still open to argument. As there is disparity of opinion, concessions all around are looked for, so as to avoid duplication of the stalemate at Madrid.

Preliminary Conferences

Conferences have been held here with William R. Castle, Jr., Under Secretary of State, by representatives of broadcasting stations, commercial message companies, educators and others. Questions that will come up at the Mexican conference were discussed. There will be other such preliminary conferences.

Super Diamond Soon With Push-Pull Output

Builders who are partial to push-pull have asked about a Super Diamond with such an output. The circuit is in process of development and is expected to be ready within a month, when publication of full details will be begun in these columns.

One of the reasons for not presenting the circuit sooner is that the intended output tubes are not yet on the general market, the 2A3, which, in push-pull, at rated voltages, will deliver 15 watts of undistorted output power. With such tubes it is preferable to use a heavy-duty rectifier, and such will be included.

One of the features of the circuit will be a frequency-stabilized local oscillator, the first one to be presented in a broadcast receiver, and having an accuracy of approximately 1 part in a million, as to frequency shift, as well as an amplitude stability of 2 per cent. or better. High-bias class B amplification is being experimented with, on the basis of a separate C supply, and may be included, which would increase the power output to something like 30 watts. No definite decision has been made on this point.

ACTION IN 116 CASES PERILED, BOARD APPEALS

Washington.

The Federal Radio Commission, in a petition filed with the Supreme Court of the United States, contests a decision by the Court of Appeals of the District of Columbia which nullified an order of the Commission assigning the Johnson-Kennedy Radio Corporation a license to operate in Gary, Ind., with unlimited hours on a frequency shared by two Chicago stations. Termination of the licenses of the two Chicago stations, WIBO and WPCC, was ordered by the Commission.

The Johnson-Kennedy company (WJKS) also submitted a petition, as intervenor, asking review of the case.

Commission's Contentions

The Commission's petition presented the question in the case to the court as follows:

Whether under this Radio Act, the Commission, in exercising the licensing power, is authorized to decline to renew a license to use a frequency previously used by two stations rendering satisfactory service in a grossly overquota State, and, upon a finding that the public interest would be served thereby, to license the use of this frequency to a meritorious station in an underquota State, for the purpose of extending and improving the service of the latter station and bringing about a greater degree of equality in the broadcasting facilities licensed in the two States.

The Court of Appeals found, according to "The United States Daily," that the only apparent reason for granting the application of WJKS "and destroying the other two stations is that Indiana is underquota, which in the circumstances furnishes no substantial justification for the decision of the Commission."

Decision Termed Arbitrary

"As already observed," the opinion stated, "the evidence discloses that WIBO and WPCC have been and are serving public interest, convenience, and necessity certainly to as great an extent as the applicant station. In our view, the conclusively established and admitted facts furnish no legal basis for the decision of the Commission. In other words, the decision is in a legal sense arbitrary and capricious."

In support of its general conclusion, the Commission's petition states, the lower court referred to facts not made the basis of findings by the Commission, and also referred with approval to certain findings of the Commission's examiner whose recommendation that the application should be denied was not adopted by the Commission.

Board Says Court Erred

The court erred, the petition contends, in holding that the Commission does not have authority "to lessen the gross disparity existing between the broadcasting facilities of the two States," in relying upon findings of the examiner which were inconsistent with findings of the Commission, and in holding that the Commission erroneously determined that the public interest, convenience, or necessity would be served by the transfer to the applicant of the frequency assigned to the respondents.

The Commission points out that this is the first case in the courts involving the affirmative application of the act by the Commission.

"It is essential to the proper discharge of the Commission's duties that the court should determine whether the Commission may refuse to renew licenses and thereby curtail the facilities of existing stations, in order to bring about a fair distribution of broadcasting facilities among the States, as provided in the Davis amendment," the petition states.

Other Proceedings Cited

It revealed that substantially the same question is involved in 116 separate proceedings pending before the Commission, in which applications have been filed requesting, in each case, the reassignment to an underserved State or zone of all or a substantial part of the facilities now licensed to a station in an overquota State or zone.

The Davis amendment directs the licensing authority to establish and maintain "as nearly as possible" equality of broadcasting service to each of the several zones, and to "make a fair and equitable allocation of licenses," etc., to each of the States within those zones.

"It seems clear that if the Davis amendment is to have any application it must apply in a case such as this," the Commission's petition declares, "where the State of Illinois is 55 per cent overquota in station assignments, while Indiana is 22 per cent underquota."

Programs' Link With Life is Told

Some 200,000 fewer letters were received by the National Broadcasting Company during last year, compared to 1931, President Aylesworth, of the company, reported to the advisory council. But the telephone wire link used 1,250 miles more wire than during the previous year, or 20,500 miles.

The letters totalled 4,800,000. Gross income dropped $500,000 to $29,000,000, but was enough to cover expenses, including considerable outlay for experimental and laboratory work. More than 500,000 microphone appearances were made, counting each person as numerous persons for every time he or she appeared.

Owen D. Young reported that radio service is increasing, but that co-operative efforts are needed to make the service still more effective. Walter Damrosch recommended that, since inferior music is so much in demand for sponsored programs, that sustaining time be devoted largely to the better types of music. Robert M. Hutchins, educator, said that chain broadcasting lends itself to educational programs, and suggested that the public contribute to the cost of such work. William Green, president of the American Federation of Labor, pointed out that radio disseminated much information about unemployment and alleviation and thus aided materially in coping with the depression problems. Morgan J. O'Brien pointed out the increased interest in religious broadcasts. Mary Sherman recommended that women listen not only to programs primarily intended for them but to all thoughtful programs.

Worcester Stations Denied Extra Service

Washington.

The application by WORC-WEPS, Worcester, Mass., for the facilities of three New York City stations and one New Jersey station has been denied by the Federal Radio Commission on the ground that Worcester now has excellent radio service, and that the four stations cited should be continued.

These four stations are WCDA, Italian Educational Broadcasting Company; WMSG, operated by Madison Square Garden at the time of the application; WBNX, Standard Cahill Company, and WAWZ, Pillar of Fire, a religious station situated at Zarepath, N. J. They share 1,350 kc and their licenses have been renewed.

DIALS READING IN FREQUENCIES ARE IN DEMAND

When one orders a dial from a mail order house, if he uses the words "clockwise" and "counter-clockwise" he may get the wrong type of dial for the condenser he has, and it is better to say that the plates close to the right, or to the left, as the fact is. The direction of closing gives the desired information, as with straight numerically scaled dials the numbers increase with capacity, for condensers that close to the right, 100-0, since the scale moves, and 0-100 for condensers that close to the left. But that is true only when the scale moves. If the scale stands still, and a pilot light bracket moves, then the numbers should run in the opposite direction to the one stated.

However, if you inform the company that your condenser closes to left or to right, and declare whether a stationary scale type with travelling light is desired, or moving scale type with fixed light, you will get the proper kind of dial for your condenser.

When a dial is frequency-calibrated exclusively, the numbers increase as the capacity decreases, and indeed that is true even if the scale has both straight numerical and incidental frequency calibration, for the respective numbers progress in opposite directions.

Exclusively frequency-calibrated dials are coming into vogue now, as better means are being provided for excellent calibration.

Of course a dial can be calibrated for one set, but the problem arises of making the calibration hold true for duplicate sets, or, rather, duplicating the first set.

To achieve excellent results the receiver should not require slightly different dial settings for the same frequencies one night after another, as it may do, if a superheterodyne, and the oscillator not frequency stabilized.

Few if any circuits for broadcast or short-wave use have frequency-stabilized oscillators.

Push-Pull Tube Hinted in Circular

Radio tube manufacturers lately have begun distributing circulars listing the tubes they manufacture, giving a brief description of the purposes of the tubes, as well as stating the list prices, which in many instances have been reduced.

One of the tubes so listed is the 79, described as a Class B twin amplifier, heater type, a-c or d-c, 6.3 volts. The technical information about this tube has not been released yet, but from the description the tube seems to serve the purpose of both push-pull sections in one envelope, a development many have been waiting for.

It is noted that the prices of new tubes are kept low in anticipation of considerable sales of such tubes, but that the difficulty of construction of the multi-filamentary power output tube, the 2A3 triode, results in a list price of $4.00. However, the companion heavy-duty rectifier, which presents no such constructional difficulties, lists at only $1.50. Meanwhile formerly favorite 280 has its list down to 90 cents.

PERMITS FOR AN INCREASE OF POWER ISSUED

Washington.

Recent authorizations by the Federal Radio Commission include eighteen license transfers, four instances of permission to move, three new stations and eleven of power increases.

Where permission alone is granted, this is denoted by "construction permit," but where the actual change is about to be made, or has been made, the word "license" designates this condition. Absence of distinction between the two should be read as if "license." The tabulation follows:

License Transfers

WRNY, N. Y. C., to Marcus Loew Booking Agency.

WTBO, Cumberland, Md., to Associated Broadcasting Corp.

WJW, Akron, Ohio, to WJW, Inc.

KREG, Santa Ana, Calif., to The Voice of the Orange Empire, Inc., Ltd.

WJEQ, Williamsport, Pa., to WRAK, Inc.

WFBC, Greenville, S. C., construction permit assigned to Greenville News, Piedmont Co.

KICA, Clovis, N. M., to Southwest Broadcasting Co.

WTSL, Laurel, Miss., to The Southland Radio Corp.

KTSA, San Antonio, Tex., to Southwest Broadcasting Co.

WMAS, Springfield, Mass., to WMAS, Inc.

KRKD, Los Angeles, Calif., to Fireside Broadcasting Co. (change of name only).

WIS, Columbia, S. C., to Station WIS, Inc.

WFAN, Philadelphia, Pa., to Penna. Broadcasting Co.

WFBE, Cincinnati, O., to Radio Station WFBE, Inc.

WSBC, Chicago, Ill., to WSBC, Inc. (change of name only).

Permission to Move

WPRO, WPAW, Providence, R. I., transmitter and studio from Cranston, R. I., to Providence.

WHDH, Boston, Mass., transmitter to Saugus, Mass.; (license granted).

WGFL, Santa Fe, N. M., to Roswell, N. M.; construction permit.

WICC, Sport Hill Road, Easton, Conn., to Pleasure Beach, Bridgeport (400 feet away); construction permit.

New Stations

WGST, Georgia School of Technology, Atlanta, Ga. 890 kc., 250 w night, 500 w day; unlimited; license granted.

WAZL, Hazleton, Pa., 1,420 kc., 100 w.

KMJ, Fresno, Calif., 580 kc, 500 watts.

Power Increase

WTAG, Worcester, Mass., day power, 250 w, increased to 500 w.

WGAR, Cleveland, O. 1 kw. day, 500 w. night, on 1,450 kc.

KGBU, Ketchikan, Alaska, 500 w day, 900 kc.

WJZ, New York City, from 30 kw. to 50 kw.

KNY, Los Angeles, from 25 kw. to 50 kw, construction permit.

WHA, Madison, Wisc., from 750 w. to 1 kw. day, 940 kc.

WFBC, Greenville, S. C., 100 w to 250 w day; construction permit.

KSO, Des Moines, Ia., 100 w night, 250 w. local sunset; unlimited time.

KPQ, Wenatchee, Wash., 50 to 100 w.

WEAO, Columbus, O., 750 w to 1 kw.

KOY, Phoenix, Ariz., 500 w to 1 kw day. (license).

Maine Looker-in Picks up California

Washington.

G. H. Hanson, of Houlton, Me., received the W6XS test television signals sent from the Don Lee studios here, according to a letter from Mr. Hanson to the station.

W6XS uses 1,000 watts. Mr. Hanson furnished a complete report of the program.

PRICES REDUCED ON 30 TUBES, 10c UP TO $2.25

Of fifty-two tubes to which list prices have been assigned (excluding only newest ones not so listed), thirty have been subjected to price reductions, ranging from $2.25 to 10c per tube. The roster includes all receiver tubes of standard types, as well as tubes used for amateur and similar purposes.

This is the most sweeping, as well as the largest, price reduction ever announced concerning tubes. Even a brand-new type, the 25Z5 voltage-doubler, the list price of which had been announced only a week previously, and put then at $2.75, has been reduced to $2.00. The tube reduced $2.25 is the '10, formerly $7.25, now $5.00. The 56 has been reduced 10 cents, from $1.30 to $1.20.

Tabulation of Reductions

The following tabulation gives the type of tube, the former price, the new price, the amount of reduction, and the percentage of reduction:

Type	Former Price	New Price	Reduction Amount	Reduction Pct.
'10	$7.25	$5.00	$2.25	31
'112	1.55	1.30	.25	16
'22	3.15	2.00	1.15	36.5
'24A	1.65	1.40	.25	15
'30	1.65	1.30	.35	21
'31	1.65	1.30	.35	21
'32	2.35	1.90	.45	19
'33	2.80	2.10	.70	25
'34	2.80	2.15	.65	23
'35	1.65	1.50	.15	9
'36	2.80	1.80	1.00	36
'37	1.80	1.40	.40	22
'38	2.80	1.60	1.20	43
'39	2.80	1.80	1.00	36
'40	3.00	2.00	1.00	33
'41	2.85	1.60	1.25	44
'42	2.00	1.60	.40	20
'43	2.80	2.50	.30	11
'47	1.60	1.50	.10	6
'48	3.75	3.00	.75	20
'50	6.20	4.00	2.20	35.5
'56	1.30	1.20	.10	8
'59	2.50	2.00	.50	20
'79	2.80	2.60	.20	7
'80	1.05	.90	.15	14
'81	5.20	3.50	1.70	33
'82	1.30	1.20	.10	8
V-'99	2.75	2.25	.50	18
X-'99	2.55	1.50	1.05	41
25Z5	2.75	2.00	.75	27

Standard Resistor Code

For First or Second Significant Figure		Number of Ciphers After the Significant Figures
Black	0	None
Brown	1	0
Red	2	00
Orange	3	000
Yellow	4	0000
Green	5	00000
Blue	6	000000
Violet	7	——
Gray	8	——
White	9	——

The color for the first or second significant figure follows this code: body color denotes first significant figure; end color denotes second significant figure; dot denotes number of ciphers after the first two significant figures.

STATION SPARKS

By Alice Remsen

A Melodic Picture

FOR TOM NEELEY'S "SPARKLETS"

(WJZ, Sundays, 9:30 a.m.)

Moving clouds across the sky;
Soft caressing summer breeze;
Whirr of wings as swallows fly
To their nests among the trees.
On the hill above the lea,
Shepherds driving home their flocks;
Tiny wavelets from the sea,
Casting spray upon the rocks.

From a magic silver boat,
Sailing through enchanted air,
Mystic music seems to float,
Stealing on us unaware;
Sparks of melody that flit
Just like fireflies of gold
From a half-forgotten bit
Of a fairy tale of old.

—A. R.

* * *

And if you listen to Tom Neeley's "Sparklets," as played by him and his woodwind ensemble, you, too, will conjure up an enchanting picture. This program may be heard over the following stations: WJZ, New York; WJAR, Providence, R. I.; WFBR, Baltimore, Md.; WGY, Schenectady, N. Y.; WTAM, Cleveland, Ohio; WWJ, Detroit, Mich.; WIS, Columbia, S. C.; WDAF, Kansas City; WWNC, Asheville, N. C.; WIOD, Miami, Fla.; WFLA, Clearwater, Fla.; KTBS, Shreveport, La.; WJAX, Jacksonville, Fla.; WBEN, Buffalo, N. Y.; KDYL, Salt Lake City; WMC, Memphis; KPRC, Houston, Texas.

* * *

The Radio Rialto

Recently I have neglected my old stamping ground, Station WOR, New York; shall make up for it now though, for I have a batch of news from that dear old place. You may or may not know or care that I spent two years there working with George Shackley, Maria Cardinale and Jack Arthur on "Footlight Echoes"; oh, yes; I was the soubrette of that delightful program; enjoyed it, too; sorry to say Maria is no longer with WOR—which I think is a shame, for she is one of the few sopranos able to carry a tune without flatting, reads like a streak of lightning, never grumbles at odd hours for rehearsals, even though she has to come into town from the country; sings almost any type of number and is not temperamental—I judge by this time you understand that I think Maria is okay. . . .

Jack Arthur, whom you've heard on almost every chain and station, is now one of the leading money-makers of radio; he has no less than thirteen commercial programs; he has other names, his right one being Arthur Campbell—and he's also known as Johnny Hart. . . . Several years ago George Shackley, music director of WOR developed a girl offering, to which the public very quickly gave its favor—The Moonbeam Trio; George is now seeking to do the same for three members of the opposite sex—the Rhythm Triplets, who are heard in the station's newest program, "Stepping Along," heard Sunday nights at 9:15 p.m.; the trio includes Thomas Dalton, John Ryan and Joseph Garso. . . . George is also making a great name for himself at impromptu announcing, which is the particular charm of his Sunday morning organ program; he is an excellent organist; take a listen some Sunday at 11:30 a.m. . . .

Another new WOR program is "Fifteen Minutes with Andy Sanella"; associated with Andy on this program are Macy and Smalle, the inimitable comedy team, and Marjorie Logan, personality singer. . . . Don Carney, who has long been known to the radio audience as Uncle Don, over WOR, has now gone network with a series of dog chats; Mondays, 8:30 p.m. over WJZ-NBC network; these dog chats are sponsored by Spratt's Patent, Ltd., and were formerly heard via electrical transcriptions. . . . Ramona, the singing-pianist with Paul Whiteman's orchestra, was seen roller skating in Central Park, New York City, recently; she has challenged Peggy Healy, Irene Taylor and Jack Fulton to a skating contest; Paul Whiteman absolutely refuses to roll along with them, on skates or otherwise. . . .

Would you be interested in knowing that Donald Novis always wrings his hands before going on the air; that Gladys Rice's favorite color combination is black and red; that Frank Black was educated as a chemist; that Paul Whiteman won't ride in a crowded elevator; that Carson Robison's father was Bert Robison, famous cowboy fiddler—or does it matter?

* * *

From WABC comes the reports that Gracie Allen has just returned from a trip to Lake Placid. She had great fun romping in the snow, at the same time keeping a sharp lookout for her missing brother; he's always been such a drifter, you know—there you go again, Gracie! . . . If you want to know what Nat Shilkret is doing these days, listen: he's directing the orchestra, making all the arrangements, and composing much of the music for ten movie shorts, which are being filmed within a period of fifteen days; at the same time he's preparing music and rehearsing his thirty-five piece orchestra for his new C. B. S. program, "The Inside Story," featuring Edwin C. Hill; and finally, he says he's passing his "spare time" writing an opera. . . .

Announcer Harry Von Zell is master of ceremonies in a new movie short, which features Morton Downey, the Funnyboners and Harold Stern's CBS orchestra . . . and those "Smith Brothers," Billy Hillpot and Scrappy Lambert, are breaking into the movies with a two-reeler based on the "nudist" sketch from the Broadway production, "Ballyhoo" . . . Singin' Sam is home safe and sound after an exciting week in Baltimore, where he appeared in vaudeville; when Sam offered to autograph one hundred of his pictures in a downtown drug store, he didn't realize what would happen; a mob of excited fans jammed the store, tied up traffic, and forced the management to lock the doors and call out the police reserves: I always said he was a good looking man but didn't know he'd draw that much of a crowd. . . . One of Columbia's most brilliant musicians is Arnold Brillhart, saxophone player in Andre Kostelanetz's orchestra on "Threads of Happiness' program; Brillhart plays five other instruments in addition to the saxophone; he is a radio expert and has a short wave station in Yonkers, N. Y., where his very early morning amusement is tuning in on musical programs from South Africa and Southern Russia; he is a licensed air pilot and usually flies a plane when he has to travel any distance—and, he's just been granted a vacation from "Threads of Happiness" program so he can fly to Florida and enter two golf tournaments: clever people, these saxophone players. . . .

Meanwhile, here at WLW things are progressing very favorably. Woodbury goes on with a Sunday half-hour program early in March; the Ferris Flower program started last week; Dayton Tire and Rubber is threatening an invasion of the ether via WLW very shortly; Merrill Company is going strong and the Beau Brummel Tailoring Company is also flourishing. . . . Of course, Sohio is still on the air twice daily with Gene and Glenn, at 6:45 over WTAM, Cleveland, and at 7:15 over WLW. . . . Joe Ries, debonair announcer, is the proud father of a second edition of himself. . . . Joe Emerson is receiving lots of fan mail through his Bachelor of Song program; Joe has a rich baritone voice which sounds very appealing over the air. . . . Grace Clauve Raine has a right to be proud of her efforts as vocal coach at WLW; she has, under her direction, a male quartet, male octette, mixed sextette and a chorus; all fine singers, doing justice to anything—sacred music, Gilbert & Sullivan, musical comedy and popular selections. . . . Word just comes in that Danny Engel is now representing Harms in this section of the country; Danny's a good music man, and Harms is a good firm to be with.

* * *

Last week I told you something about the "Notes in Business' program, on WLW, which has created such a stir throughout the business world; I have here a list of the business men on the Advisory Committee; the chairman is J. Ralph Corbett, President of J. Ralph Corbett, Inc., Market Consultants; on the committee are: Norman G. Shidle, Directing Editor of the Chilton Glass Journal Co.; Edward P. Warner, Editor of Aviation; Thomas S. Holden, Vice-President, of F. W. Dodge Corp.; Godfrey M. Lenhar, Editor of Chain Store Age; Sidney D. Kirkpatrick, Editor of Chemical and Metallurgical Engineering; Sydney A. Hale, Editor of Coal Age; Quincy Adams, Editor of Dun's Review; Ernest C. Hastings, President of Dry Goods Economist; Agler Cook, President of Drug Topics; Marco Morrow, Assistant Publisher of Capper Farm Press; Lawrence V. Burton, Editor of Food Industries; Marc Rose, Editor of Business Week; Raymond Bill, President of Federated Business Publications; H. J. Payne, Secretary of Associated Business Papers, Inc.; Charles J. Heale, Editor of Hardware Age; James S. Warren, Editor of Hotel Management; Kenneth H. Condit, Editor of The American Machinist; P. I. Aldrich, Editor of The National Provisioner; Fred Shepperd, Managing Editor of the Case Shepperd Mann Pub. Co.; Virgil B. Guthrie, Managing Editor of the National Petroleum News; J. L. Frazier, Editor of Inland Printer; L. W. W. Morrow, Editor of Electrical World; Powel Crosley, Jr., President, The Crosley Radio Corp.; Samuel C. Dunn, Editor of Railway Age; A. D. Anderson, Editor of Boot and Shoe Recorder; E. I. Shaner, Editor of Steel; D. Paul Smelzer, Manager of Market Research Division, Proctor & Gamble Co.; Douglas G. Woolf, Editor-in-Chief of Textile World, and J. A. Bloch, President of Mail Pouch Tobacco Co. . . . Quite an astonishing array of well-known business names which should help to eliminate any possibility of mis-information on business subjects; if you should like to know more about the aim of this program, drop a card to J. Ralph Corbett, Inc., Carew Tower, Cincinnati, Ohio.

* * *

Biographical Brevities

ABOUT DAVE RUBINOFF

David Rubinoff was born in 1898, in Russia. His first job was selling newspapers. His favorite food is broiled chicken: also likes to nibble at dried pumpkin seeds—an old Russian custom. He does not play golf, bridge or handball. He usually goes to bed between one and two a.m.; rises between seven and eight the same morning. His hobbies are read-

(Continued on next page)

HIGHER STATION POWER ADVISED BY ENGINEERS

High power radio broadcasting is urged, as effective for satisfactory operation of radio receiving sets and reduction of interference, in a report on radio interference just issued by the three national electrical industries—the National Electric Light Association, the National Electrical Manufacturers Association, and the Radio Manufacturers Association. Another report, technical, and for guidance of engineers in measuring radio interference, also was issued.

Higher power broadcasting stations will insure better coverage of the country and should be encouraged by all interested in radio, to improve radio conception, according to the report. Other measures to minimize radio interference which were recommended include construction design of radio sets having a minimum susceptibility to external noises; proper installation of radio sets by dealers with a minimum coupling between antenna circuit and house wiring for other circuits, and installation of radio frequency filters on some types of electrical devices.

Municipal ordinances relating to radio interference, the three associations declared in their report, are generally ineffective and frequently set up standards which in time become a serious hindrance to the proper solution of the interference problem.

Electric light and other power companies are directly interested in the problem of reducing radio interference, and the public utilities were urged, in the report, to reduce radio interference of their consuming public in their own interests.

The report adds that it appears impossible completely to eliminate all possible sources of radio interference and that municipal legislation attempted has been unwise and ineffective.

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 45th Street, New York, N. Y.*

James Strayer, Felton, York Co., Pa.
Lee M. Wright, 490 Sawyer St., Rochester, N. Y.
R. B. Helget, Box 317, Weeping Water, Neb.
J. A. Ivelow, 616 E. 7th St., Peru, Ill.
Kenneth Leef, Section D, Chanute Field, Rantoul, Ill.
Claude Vogel, 4202 Castleman, St. Louis, Missouri.
G. H. Washington, P. O. Box 36, Hillsboro, N. D.
Edward Murrah, 129 Gerrard St., Rantoul, Ill.
Joseph V. Finney, 2155 Webster Ave., Pittsburgh, Pa.
Ernest Clouse, 1317 Sacramento St., Vallejo, Calif.
Frank Massey, R. F. D. No. 7, Winston-Salem, N. C.
Frank Sochats, Box 247, Conway, Pa.
Angelo M. Granopoulos, 6 Fifth St., Ipswich, Mass.
H. Ellsworth Bostwick, 91 Fenwick Avenue, Springfield, Mass.
Alonzo Scull, 120 N. Almont Dr., Beverley Hills, Calif.
Willis G. Tetrick, 225 Belmar Ave., Morgantown, W. Va.
G. F. Gray, 11 Hammersley Ave., Poughkeepsie, N. Y.
Brooks Radio Service, 136 E. 9th St., Cincinnati, Ohio.
Joe Wexler, 165 West King St., St. Augustine, Fla.
John P. Hickey, 149-6th Ave., San Francisco, Calif.
C. L. Piper, 2122 Bucter Rd., Ft. Wayne, Ind.
Radio Service Club, 11 W. Plaza, Reno, Nev.
Jean MacKenzie, P. O. Box 157, Grand Junction, Colo.
R. Friedrich, 5026 N. Keeler Ave., Chicago, Ill.
Clinton N. Child, P. O. Box 7, Goodyear, Conn.
Radio & Electric Service, 2238 Broadway, Ft. Myers, Fla.

TRADIOGRAMS

By J. Murray Barron

While there are a great many very cheap midget radio receivers on the market, especially around New York City, some are also cheap in the sense they are of inferior construction. As low as some have dropped in price, they are still relatively higher in price than those being sold in the West and the Pacific States, but do work after a fashion. The price feature has developed to such a point in the Far West that it has become a race to see how many parts can be done away with and still have the receiver work, at least long enough to close the sale. This sort of business can not last long, either for the retailer or manufacturer. There is something more than just making a sale in business. This every business man knows, but unfortunately many of the offenders are not business men.

Arthur L. Sullivan, 570 Lexington Avenue, N. Y. City, is now handling the Howard line of radio receivers. Here (in the RCA Building) is a radio salon especially arranged to give demonstrations of the various radio receivers, with a comparison test. There is a very wide choice, from the smallest personal receiver to the 20-tube receiver.

* * *

Those who may be interested in short-wave converters to operate on the d-c line and have experienced difficulty may obtain valuable information from Harry Lefkowitz at Nussbaum's, 61 Cortlandt Street, New York City.

* * *

Since advent of the Universal ac-dc receiver considerable interest has been shown from various angles. The latest inquiry is as to whether they can be made to receive police signals and other low waves. Some interesting information on this subject may be had by addressing Trade Editor.

* * *

Louis G. Pacent announces the organization of a private consulting engineering firm, with offices at No. 79 Madison Avenue, New York City, and engineering laboratories at Little Neck, Long Island, N. Y. Mr. Pacent and his staff will specialize in electrical, radio, sound, electronic and motion picture fields. The staff will include H. C. Likel, research engineer formerly associated with Mr. Pacent. Mr. Likel is Professor of Radio Engineering of Pratt Institute School of Science and Technology. Mr. Pacent will continue as President and Director of Pacent Electric Company, but will devote most of his time to his new company, the Pacent Engineering Corporation, on patent development and research, industrial reports, special investigations, market analysis, sales surveys, etc.

Station Sparks

By Alice Remsen

(Continued from preceding page)

ing in bed, listening to the radio and taking photographs. Has a German police dog for a pet.

Always carries a fountain pen in his pocket; seldom has ink in it. His favorite author, Tolstoy; favorite actor, Eddie Cantor; favorite actress, Jeanette McDonald. He selects his own clothes; has twenty-seven suits and nineteen pairs of shoes; is five feet seven inches tall; weighs one hundred and fifty-five pounds; has dark hair and dark brown eyes.

And there's Rubinoff!

TAX PAYMENTS INDICATE SALES MADE MONTHLY

Radio Manufacturers' Association, Inc., issued the following:

The five per cent radio tax law has proven to be much more of a burden to radio manufacturers than a source of revenue to the government. The law became effective June 20, 1932, and the Treasury reports that the collections from the radio tax ending December 31 last aggregated $1,184,510.06. When the excise tax law was passed by Congress the Treasury estimated that the annual receipts from radio and phonograph record taxes would be $11,000,000. The actual returns, therefore, are running about eighty per cent under the estimates of the Treasury and Congress. Business conditions have compelled many radio manufacturers largely to absorb the radio tax and industry leaders believe that the cost of collection to the government has further greatly reduced the meager return to the Treasury. The 1932 radio excise tax collections, a barometer of sales, in detail follow:

June-July	$ 32,848.57
August	76,445.47
September	165,710.65
October	218,722.70
November	298,577.86
December	392,204.81

Revised Phonograph Ruling

RMA has been advised by the U. S. Internal Revenue Bureau of a revision in its rulings regulating the sale of phonograph mechanism under tax exemption certificates. Sales of phonograph record-changing devices, the Treasury rules, are taxable against the original manufacturer and must be paid by him if the mechanism is capable of being used or if it is generally used in radio sets or apparatus. Such phonograh mechanism may not be sold under tax exemption certificates, as such phonograph mechanism is specifically mentioned in the excise tax law as one of the taxable items on which taxes must be paid by the original manufacturer. This advise is for the information of manufacturers of phonograph mechanism and also for receiving set manufacturers in purchasing phonograph mechanism for use in combination receiving sets.

5% Tax Deductable

RMA members who have paid federal excise taxes under the new five per cent law which became effective last June are advised that such excise tax payments to the government are deductible from the gross income of manufacturers in their 1933 income tax returns, except where the tax is included as part of business expense.

The regulation of the Commissioner of Internal Revenue, Treasury Department, relating to deductions of excise taxes, provides:

"Taxes on all of the articles or items listed (including radio receiving sets, phonograph mechanisms and records, mechanical refrigerators, electrical energy and others) are deductible from the gross income of the manufacturer, producer or importer for the taxable year during which the manufacturer, producer or importer pays or accrues such taxes. A jobber, dealer or consumer who reimburses the maufacturer, producer or importer for such taxes, even though billed to him as a specific item is not entitled to deduct from gross income the amounts so reimbursed."

Copies of the regulations relating to deductibility of excise taxes for federal income purposes may be secured from local deputy collectors of Internal Revenue.

Quick-Action Classified Advertisements

**7c a Word—$1.00 Minimum
Cash With Order**

FILAMENT TRANSFORMERS FOR TUBE TESTER. Tapped at 1.5 - 2 - 2.5 - 3 1/10 - 5 - 6-3/10 and 7.5 Volts. Price $2.00. Sparty Radio Service, 93 Broadway, Newark, N. J.

"FORD MODEL—'A' Car and 'AA' Truck," by Page. $2.50. Radio World, 145 W. 45th St., N. Y. C.
"HOW TO WRITE FOR RADIO," by Seymour and Martin. $3.00. Radio World, 145 W. 45th St., N. Y. C.

NEW RADIO AMATEUR'S HANDBOOK, 180,000 words, 207 illustrations, 218 pages (10th edition, issued 1933). Price, $1.00 per copy. Radio World, 145 West 45th Street, New York, N. Y.

1-WATT PIGTAIL RESISTORS @ 9c EACH in following ohmages: 350; 800; 1,200; 20,000; 50,000; 100,000; 250,000; 2,000,000; 5,000,0000. Direct Radio Co., 145 W. 45 St., N. Y. City.

"THE CHEVROLET SIX CAR AND TRUCK" (Construction—Operation—Repair) by Victor W. Pagé, author of "Modern Gasoline Automobile," "Ford Model A Car and AA Truck," etc., etc 450 pages, price $2.00. Radio World, 145 W. 45th St., N. Y. City.

BARGAINS IN FINEST PARTS! — Highest grade, new parts, few of each on hand. National dial, flat type, modernistic escutcheon, type G, clockwise, $2.19; Pilot drum dial No. 1285 @ $1.89; a-c toggle switch, 19c; triple pole, four-throw Best switch, insulated shaft, $1.62; double pole, four throw, $1.08. Direct Radio Co., 145 West 45th St., N. Y. City.

---

115 DIAGRAMS FREE

115 Circuit Diagrams of Commercial Receivers and Power Supplies supplementing the diagrams in John F. Rider's "Trouble Shooter's Manual." These schematic diagrams of factory-made receivers, giving the manufacturer's name and model number on each diagram, include the MOST IMPORTANT SCREEN GRID RECEIVERS.

The 115 diagrams, each in black and white, on sheets 8½ x 11 inches, punched with three standard holes for loose-leaf binding, constitute a supplement that must be obtained by all possessors of "Trouble Shooter's Manual," to make the manual complete.

Circuits include Bosch 54 D. C. screen grid; Balkite Model F, Crosley 20, 21, 22 screen grid; Eveready series 50 screen grid; Erla 224 A.C. screen grid; Peerless Electrostatic series; Philco 76 screen grid.

Subscribe for Radio World for 3 months at the regular subscription rate of $1.50, and have these diagrams delivered to you FREE!

Present subscribers may take advantage of this offer. Please put a cross here ☐ to expedite extending your expiration date.

Radio World, 145 West 45th St., New York, N. Y.

TROUBLE SHOOTER'S MANUAL, Nos. I and II

Having assembled 2,000 diagrams of commercial receivers, power amplifiers, converters, etc., in 1,200 pages of Volume No. 1 of his Perpetual Trouble Shooter's Manual, John F. Rider, noted radio engineer, has prepared Volume No. 2 on an even more detailed scale, covering all the latest receivers. Volume No. 2 does not duplicate diagrams in Volume No. 1, but contains only new, additional diagrams, and a new all-inclusive information on the circuits covered.

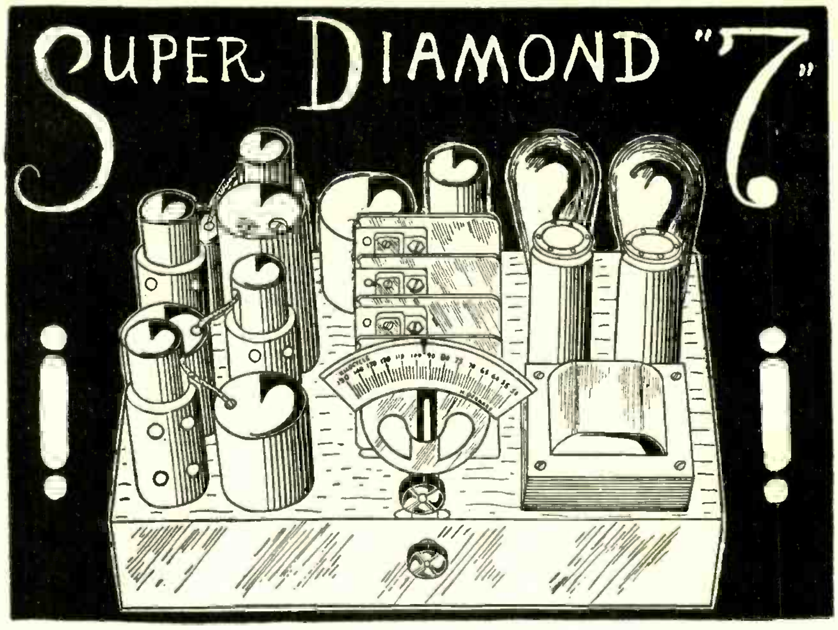
Volume No. 2—Perpetual Trouble Shooter's Manual, by John F. Rider, Shipping weight 6 lbs. Order Cat. RM-VT @ $5.00
Volume No. 1 (8 lbs.). Order Cat. RM-VO @ $5.00

We pay postage in United States on receipt of purchase price with order. Canadian, Mexican and other foreign remittances must be in funds payable in New York.

RADIO WORLD
145 West 45th Street New York City

SOLDERING IRON F R E E !

Works on 110-120 volts AC or DC, power, 50 watts. A serviceable iron, with copper tip, 5 ft. cable and male plug. Send $1.50 for 13 weeks' subscription for Radio World and get these free! Please state if you are renewing existing subscription.
RADIO WORLD
145 West 45th St. N. Y. City



The Set That Brought In 96 Channels Out of 96!

A SEVEN-TUBE receiver, designed by Herman Bernard, with highly accurate padding, and using a frequency-calibrated dial, the Super Diamond 7 is just the thing for DX enthusiasts. The circuit has full automatic volume control, full-wave diode detection, diode-biased 55 triode, and, except for the second detector, triple-grid tubes throughout. Stations 10 kc apart sharply separated though antenna power input of one is 100 times that of other. A circuit with beautiful tone. Complete kit of parts for this receiver, including everything, even speaker, except cabinet, front panel and tubes. (Cat. CKSD7) **$19.62**

FOUNDATION UNIT

The Foundation Unit for the Super Diamond 7 consists of a shielded antenna coil, a shielded interstage r-f coil, a combination oscillator and 175 kc assembly in one high shield, a shielded regular 175 kc transformer, and a shielded 175 kc transformer with center-tapped secondary; also a 0.00041 mfd. tuning condenser, three-gang, with compensators; an 850 to 1,350 mmfd. padding condenser, a frequency-calibrated dial and a drilled chassis. Cat. FU-SD7 @ **$6.55**

[The coils for r-f and oscillator are wound exactly according to specifications of Herman Bernard and are of a higher order of accuracy than in commercial practice, and moreover provide for matching the tuning to the scale of the frequency-calibrated dial that bears Mr. Bernard's name.]

ADDITIONAL PARTS

The nine 0.1 mfd. and two 0.25 mfd. bypass condensers for the Super Diamond 7 are specially made up in one shield, with mounting brackets, and is the same as used in the designer's model. Cat. CU-SD7 @ **$1.20**

Three-gang 0.00041 mfd. tuning condenser, compensators. Cat. TC-SD7 @ **$1.80**

Drilled chassis for the Super Diamond 7. Cat. CH-SD7 @ .... **$ .80**

The tubes used in this receiver are four 58's, one 55, one 59 and one '80. Total, 7 tubes. Tube kit is Cat. TK-SD7 @.. **$5.35**

850 to 1,350 mmfd. padding condenser, 50c; knobs for ¼ inch shafts, 7c each, four for 25c; Bernard's frequency-calibrated dial, 90c; electrolytic condensers, 8 mfd., 49c each; power transformer, $1.95.

SUPER DIAMOND 6

This is a 6-tube a-c receiver, like the "7," only there is one intermediate stage instead of two. Good sensitivity and selectivity, with finest tone yet developed in a super. Uses the same accurate padding system as the "7," same frequency dial. Gets plenty of distance, too.

Complete parts, including speaker (less tubes, less front panel, less cabinet). Cat. SD-CMP @ **$16.22**

Set of shielded coils, consisting of antenna coil, modulator input coil and combination oscillator and first 175 kc intermediate coil (latter two in one shield), and separate intermediate coil with center-tapped secondary. Cat. SDCK................ **$3.95**

Combination oscillator and 175 kc only, in one shield. Cat. OSN @.... **$1.80**

Three-gang 0.00041 mfd. condenser with trimmers built in; ⅜ inch shaft, 1⅛ inches long. Cat. DJ-41-T.......... **$1.98**

250,000-ohm potentiometer with switch. Cat. R25S @............... **$ .72**

Pigtail resistors, 9c each; Rola speaker, $3.83; tube shields, 11c each; UX, UY sockets, 10c; six-pin, 11c; 7-pin, 15c.

The tubes required for the "6" are two 58, one 57, one 55, one 59 and one '80. Cat. TK-5D6 @ **$4.53**

AUTHENTIC CIRCUITS

The Super Diamond series—the six-tube and seven-tube models—are most excellent circuits, carefully engineered and tested. "Everything fits." You will be amazed at what results these circuits yield. They are real "hot" and we unqualifiedly recommend them.

DIRECT RADIO COMPANY

143 WEST 45TH STREET NEW YORK CITY