Oct. 27 1934

A NEW AUTO SET

Price 15c Per Copy

RADIO
REG. U.S. PAT. OFF.
WORLD
The First National Radio Weekly
657th Consecutive Issue—Thirteenth Year

Ingenious Mobile, Universal PA System

Superiority of Choke Input

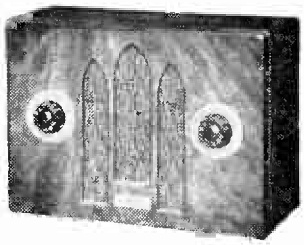
CRAFTSMANSHIP IN AN ALL-WAVE RECEIVER

An enormous amount of engineering work was put into the construction of this custom-built all-wave superheterodyne. See article on pages 12 and 13.

110 kc to 20 mgc Wired Set Complete with RCA Tubes $16.64

HERE is a tuned-radio-frequency model DIAMOND OF THE AIR for covering from 110 kc to 20 mgc, therefore truly all-wave, and costing you only $16.64. And if you don't want such wide wave coverage, say, want only short waves, or only the broadcast band, the cost is even less. The difference is due to the cost of extra coils, that's all. The Series 1040 DIAMOND OF THE AIR is just the thing for those who want real reception at low cost, and who are willing to use plug-in coils, because in that way the cost of constructing the set is kept down. The results are of a high order.

This model uses one 25Z5 rectifier, one 43 tube, one 44 tube and one 77 tube. And the wired receiver is supplied completely equipped, ready for operation, with four RCA tubes and built-in speaker, in cabinet.



The series 1040 DIAMOND OF THE AIR is an all-wave instrument contained in an attractive midget cabinet and has tuning control and volume control. By using adapters operation may be enjoyed on 6-volt d-c supply, on 32-volt farm lighting systems, or on 220 volts a-c or d-c. The standard model is for 90-120 volts a-c operation, any commercial frequency, or on 90-120 volts d-c. Shipping weight, 8 lbs. Net price, complete, in cabinet, wired....$16.64

Extreme pains have been taken to make this inexpensive all-wave DIAMOND OF THE AIR a truly worth-while product, despite the exceptionally low cost. We believe that it is the lowest-priced all-wave receiver in the world. And we know that users are fully satisfied with results. The instrument is really high grade.

Some examples of how pains were taken: The speaker used is a real dynamic. The broadcast-band coverage is from 540 to 1,710 kc, complete coverage, and even into some police frequencies. Antenna is built in. There is provision for phonograph or earphone attachment. The steel shield cabinet is of burl walnut Bakelite finish. The receiver is made to function well on 90-120 volts of any commercial frequency, i.e., 25, 40 or 50-60 cycles. The filtration is so good that operation on even 25 cycles is entirely satisfactory.

This receiver is sold only in cabinet, wired, and complete. No separate chassis is obtainable.

The adapters permit operation on automobiles, boats, farm light plants, steamships, etc.

Model 1040-A. 4-tube universal wired receiver, complete with four RCA tubes, and coil for the broadcast band only; contained in attractive midget cabinet; dynamic speaker; phonograph connecting posts. Shipping weight, 8 lbs. Net price....................**$10.77**

Model 1040-B. Same as above, except that four coils are supplied for the short waves only, 1,500 kc to 20 mgc. Shipping weight, 8 lbs. Net price......**$14.68**

Model 1040-C. Same receiver, with broadcast coils, also low-frequency coils (to 110 kc) and short-wave coils (1,500 kc to 20 mgc). Shipping wgt., 8 lbs. Net price **$16.64**

ADAPTERS

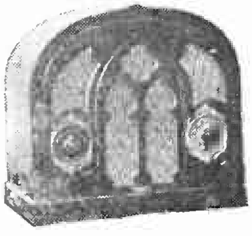
Auto adapter, complete with suppressor. Cat. 1040-ATAD **$7.35**

32-volt Farm Light Plant Adapter, Ct. 1040-FLPA **5.40**

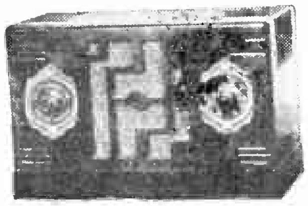
220-volt adapter for ac-dc use, Cat. 1040-220..... **.88**

540-1,900 kc Set for AC Operation $12.91

FOR those who are interested only in the broadcast band we have a splendid ac t-r-f model DIAMOND OF THE AIR that tunes from 540 to 1,900 kc, and therefore gets some police and amateur calls as well; that has frequency-calibrated and illuminated airplane dial; and that can be bought, complete with tubes, all wired and ready for operation of its self-contained dynamic speaker, at only **$12.91** net, for 50-60 cycles a.c., 105-120 volts. Model 1041-DL, at left, and Model 1041 at right, are the same sets except for cabinets. Not only may the receiver be bought already in its cabinet, but separately as a wired chassis, with speaker and tubes (less only cabinet). Besides, there is a model for 25 cycles a.c., 90-120 volts, and another for 220 volts a.c., 50-60 cycles. This is a tuned-radio-frequency receiver, five-tube model, using two 6D6, one 6C6, one 42 and one 80. It will be noticed that the economical and electrically strong 6-volt series tubes are used in the receivers proper. The primary power consumption is 55 watts. Not only is this a fine receiver, but it is made right, and every attention has been paid to detail. The airplane type dial is frequency-calibrated, so that the frequencies are read directly. There is provision for phonograph connection. The cabinet is walnut. And the performance, from the viewpoint of sensitivity and electricity, is adequate even for exacting needs, despite the sensationally low price, only **$12.91** net. This price admittedly seems out of all reason, compared to satisfactory performance, and yet the answer is found in the great popularity of this particular model. And, just as a hint, it makes a dandy and appreciated gift.



Take your choice between the Model 1041-DL five-tube t-r-f broadcast DIAMOND OF THE AIR in a de luxe Gothic cabinet (shown above) at 59c extra, net price $13.50, or exactly the same receiver in the oblong cabinet illustrated at right.



The oblong cabinet in which the 1041 is housed. The complete receiver, with speaker and tubes, costs only $12.91 in the cabinet illustrated above. The price is F.O.B. Sandusky, O., which applies to all prices quoted. See notice at bottom of this advertisement. Study the lines of the two cabinets into which the same chassis is put and select the one that better suits your living room, parlor, bedroom or den.

DUAL-WAVE DIAMOND OF THE AIR

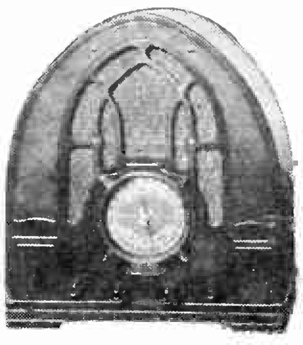
THE most popular receiver today is the dual-wave type that covers the broadcast band and one short-wave band. On that one short-wave band are found the most important foreign stations. The coverage of the Model 1042 receiver is: broadcast band (550 to 1,500 kc) and short-wave band (5,500 to 16,000 kc). Therefore the short waves are tuned in from 18 to 55 meters, and that is the band on which the most important foreign program transmitters are working. Anybody who has not had his taste of short-wave reception will do well to be initiated with either of these two dual-band receivers. Model 1043 is illustrated at left, and is a superheterodyne for foreign and domestic reception. There are also the following valuable features: built-in antenna, frequency-calibrated dial, separate short-wave switch (no plug-in coils), dynamic speaker, figured walnut cabinet with figured Oriental overlays. And the price of Model 1042 (at right) is only **$18.21** net, F.O.B. Sandusky, O. (Shipping weight, 10¾ lbs.)

Model 1043, illustrated at left, has an airplane frequency-calibrated and illuminated dial, and besides can be obtained for battery operation and 32-volt operation. It is a superheterodyne of the switch type, covering the broadcast band and 18 to 55-meter short-wave band. It has automatic volume controle and tone control. It is for 105-120 v. 50-60 cycle operation. Primary power consumption 60 watts; shipping weight, 175 lbs. Net price **$18.80**

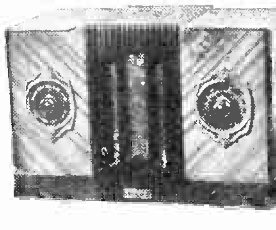
Same as above, except for 25-cycle operation, order Model 1042-25. Net price **20.27**

Mattery model (less batteries). Model 1042-B........................ **18.80**

32-volt model (for farm lighting plants; a.cfl operation). Model 1042-FLO **23.52**



Dual-wave DIAMOND OF THE AIR, Model 1043. Covers broadcast band and also one short-wave band, 55 to 18 meters. Equipped with automatic volume control, manual volume control, airplane illuminated dial calibrated in frequencies, tone control, wired and supplied in Gothic cabinet with five RCA tubes; 50-60 cycle, 105-120-volt operation. Model 1043 net price F.O.B. Sandusky, O. $18.80



Dual-wave DIAMOND OF THE AIR. Model 1042, in a handsome oblong cabinet, 11⅜ inches wide by 7½ inches high by 6¼ inches front to back. This covers the broadcast band and also one short-wave band by switching, 55 to 18 meters. The net price of the illustrated model is $18.21. The chassis, speaker, tubes may be obtained (complete less cabinet), by ordering Model 1042-CH @ $14.97. A 220-volt adapter may be obtained at 88c extra. The receiver is a superheterodyne and provides splendid results both on the broadcast band on short waves.

Ten Years of Experience Behind These Sets

The factory is at Sandusky, O., and all prices quoted are F.O.B. factory. You pay the transportation charges from Sandusky in all instances. You may select what carrier you desire and we will ship according to directions. Otherwise shipments will be made by Railway Express Agency. In asking for shipment by other means, please add transportation cost to the prices quoted. Express shipments are sent collect for the amount of the transportation charges. You will get receivers of the very highest type backed by 10 years' experience in making radio receivers. Remit to New York office full amount of net prices. If C.O.D. shipment is preferred, send 25% of net prices. Shipment will go C.O.D. for balance, at 2% above quoted net prices.

GUARANTY RADIO GOODS CO., 145 West 45th Street, New York, N. Y.

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

RADIO
Reg. U.S. Pat. Off.
WORLD
The First National Radio Weekly
THIRTEENTH YEAR

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

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

Vol. XXVI | OCTOBER 27th, 1934 | No. 7. Whole No. 657

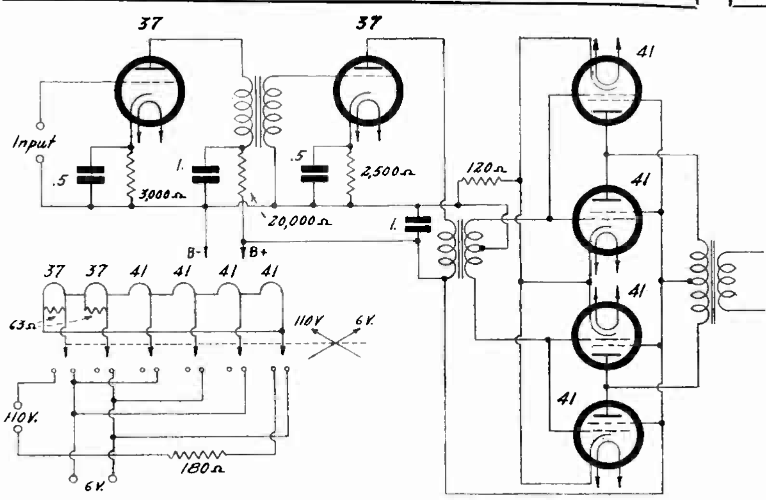
Published Weekly by **Hennessy Radio Publications Corporation,** 145 West 45th Street, New York, N. Y.
Editorial and Executive Offices: 145 West 45th Street, New York
Telephone: *BR-yant* 9-0558

A 14-Watt PA System

Mobile Device Works on 6 or 110 Volts D.C. or on 110 Volts A.C.

By Morris N. Beitman
Engineer, Supreme Sound Systems

INGENIOUS AMPLIFIER



CONVERTER OF D.C. TO A.C.

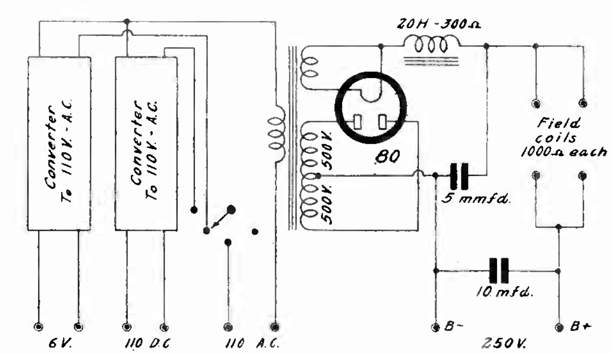


FIG. 1 **FIG. 2**

The 14-watt mobile power amplifier for universal use is shown at left, and a converter unit (6 or 110 volts d.c. to 110 volts a.c.) at right.

THE prime necessity of a portable public address system is its adaptability to different sources of current supply. In temporary mobile work the car's storage battery is utilized as a means of power. While most buildings are wired for 110 volts and may have either a.c. or d.c., in some cities, Chicago for example, alternating and direct current are found in different sections. This imposes the requirement that as a minimum an amplifier for temporary use must be so designed as to be able to use any of these three sources of power.

The problem was solved by using 6.3-volt tubes with a special switching arrangement. See Fig. 1. In one position of the six-pole double-throw switch the tubes are wired in series for 110 volt operation. The 180-ohm resistor reduces the voltage to the proper value. In the other position of the switch the tubes are wired in parallel for 6-volt storage battery operation. The plate supply, which requires 250 volts at 165 milliamperes, is obtained by a special double-vibrator eliminator.

The amplifier uses three stages of transformer-coupled amplification. The last stage is made up of four 41 power pentodes in parallel push-pull to give 14 watts of audio power. If the output transformer is carefully chosen and has the load value of 7,600 ohms, the distortion will be negligible. Type 37 tubes are used in the other stages. Care must be taken in laying out the parts so as to minimize electromagnetic and electostatic feedback. The transformers should have metal covers and be placed at an angle to each other to reduce hum. This angle is best determined by trial on breadboard layout, transformers secured to base.

The plate supply is obtained from a 110-volt a.c. eliminator, using type 80 tube with choke input. In the case of d.c. in order of either 6 or 110 volts, a vibrator converter is used to change that current to 110 volts a.c. The hook-up of this eliminator is shown in Fig. 2. Provisions are made for two dynamic speakers having 1,000-ohm fields.

The large current drain is possible with a type 80 tube only because the greatest variation in current is only 9% of the average; and a filter circuit is used having an input choke of 20 henries.

Assuming the step-up transformer to be 90% efficient, the 110 volt a.c. power requirement varies between 101.5 and 120 watts. This condition requires the vibrator eliminator units to be capable of supplying 120 watts of continuous power.

Choke Input Superior

For B Rectifier—Hum Increase Easily Overcome

IT is generally know that when choke-input filter is used improved regulation with lower peak current will be obtained. This is equivalent to removing C_1 in a condenser-input filter, Fig. 1. The disadvantage of this omission is slightly larger hum distortion and a drop of the output voltage in the order of 20%. However, both these difficulties may be easily overcome.

The voltage loss may be made up by increasing the secondary voltage. With such an arrangement the power loss in the tube itself will be about the same or even less.

The choke-input increases the life of the rectifier tube and permits the use of a tube whose emission has fallen below the point at which the tube would be useful in a capacity-input filter. Since the current drain may vary considerably, the choke-input gives the much needed better regulation (Fig. 2).

Value of Increased Capacity

The filtering action of C_1 may be replaced in the other sections by increasing C_2 and C_3, so that the overall filtering remains the same. It is of interest to know the value of Cx that must be added both to C_2 and C_3 to accomplish this.

The ratio of voltage fluctuation to the total voltage at the terminals of C_1 may be expressed nearly by the equation:

$$\frac{E_f}{E} = \frac{1}{RfC_1}$$

where
R = load resistance
f = frequency of the rectified current
C_1 = capacity in farads

and if the resistance of the choke is small compared to the load resistance, as the case usually is.

For simplicity it may be assumed that all chokes and condensers are equal in value respectively. Then the ratio of voltage fluctuations to the total voltage in either choke condenser (such as C_2 L_1) combination may be expressed by the following formula:

$L = L_1 = L_2$ = inductance in henries
$C = C_2 = C_3$ = capacity in farads

$$\frac{E_f}{E} = \frac{R}{R + 6.28\,fL\,(1 + 6.28\,fRC)}$$

Equation Set Up

In the condenser-input filter the overall filtering action will be equal to the product of the filtering action of C_1, C_2-L_1 and C_3-L_2, or mathematically:

$$\left(\frac{1}{RfC}\right)\left(\frac{R}{R + 6.28\,fL\,(1 + 6.28\,fRC)}\right)^2$$

If in the choke-input filter the overall filtering action is made equal to the above by increasing the capacities by C_x, then its overall filtering action may be expressed as:

$$\left(\frac{R}{R + 6.28\,fL\,(1 + 6.28\,fR\,[C + C_x])}\right)^2$$

Since the last two expressions are equal, they may be set up as an equation. This equation may be solved for C_x, giving this answer:

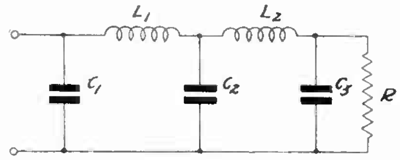
$$C_x = \sqrt{RfC}\left(\frac{1}{39.4\,L} + \frac{1}{6.3\,R} + \frac{C}{L}\right)$$

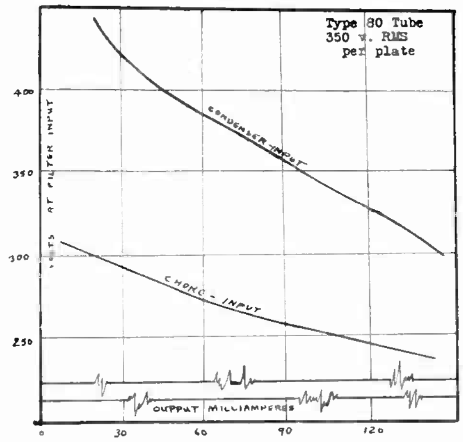
Case of Average Set

In an average receiver we may assume:
R = 3,000 Ω
C = 4 mfd.
L = 15 henries
f = 120 cy. in a full-wave rectifier

This will make C_x somewhat less than 1 mfd. This shows that it is possible to obtain greater filtering action using a total of 10 mfd., divided equally between C_2 and C_3, than is obtainable with 12 mfd. divided equally among C_1, C_2, and C_3, the chokes being the same in both cases.

From the above discussion one realizes that choke-input is superior in almost all respects to the condenser-input.





At top, Fig. 1, a condenser-input filter. At bottom, Fig. 2, a comparison of voltage output for the condenser and the choke input methods. The choke characteristic is about 20% lower in voltage, easily atoned for at the secondary.

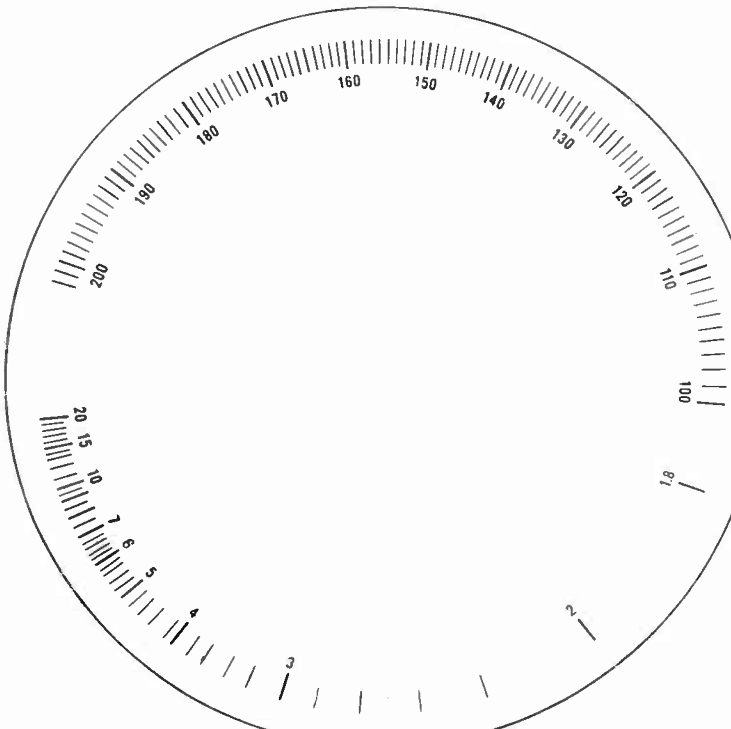
AUDIO OSCILLATOR HINT

If a tube is used as audio oscillator, with transformer coupling, it is always well to use grid leak and condenser if the bias is positive, zero or slightly negative. The stability is improved. Also, by resistor and capacity selection, the frequency of generation can be controlled considerably.

Harmonic Counter Scale Visualized

If a signal generator covers low frequencies it can be used for measuring high frequencies harmonically in several ways, one of them being the introduction of the automatic electric harmonic counter system. By this method one starts at a given point, say, at 100 kc, and thus can measure frequencies that are multiples of 100 kc, or 0.1 mgc.

It can be seen that the fundamental range of 100 to 200 kc can be attained on practically a straight frequency line basis. If the harmonic counter system is applied, the fact that the higher the frequency of the unknown, the nearer to the starting point will be the next response frequency, is utilized. Hence imagine a double pointer, one end indicating 100 kc, the other end in perfect alignment. Then as the pointer is moved the least bit one comes to a mark "20 mgc". Note that from 10 to 20 mgc the jumps are 1 mgc, while at the other extreme, 1.8 mgc up, differences of 0.2 mgc are far apart. Hence this method, good for relatively low frequencies, does not yield sufficiently close results for high frequencies, as jumps of 1 mgc are intolerable.



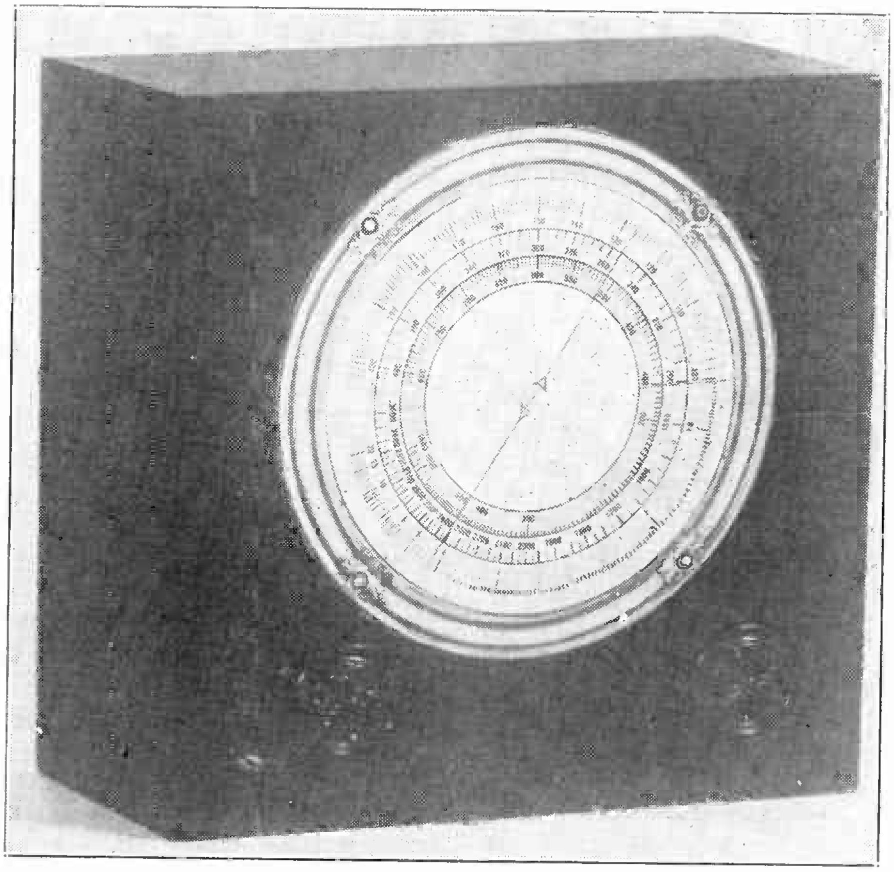
An All-Wave Generator

Switch-Type Instrument Uses Fundamentals 50 kc. to 20 mgc., Works on A.C. or D.C.

By Herman Bernard

THE rule applying to short-wave and all-wave sets, that they should be as simple as possible, also applies to an all-wave signal generator. The model 337-A diagramed herewith has the minimum number of parts consistent with the performance required.

The first requirement is all-wave coverage on fundamentals. Here we have the lowest frequency as 50 kc. It would seem that so low a frequency is not absolutely required. Perhaps that is true at the moment. But to reduce noise in all-wave and short-wave sets, the expediency is being tried of having a stage of high intermediate-frequency amplification, using an extra local oscillator to lower the frequency, and then amplify more quietly at that low frequency. At present around 100 kc or so is the frequency used, but there is no telling whether the vogue will catch on, and the second i.f. be reduced still more. It is extremely unlikely that it will be made less than 50 kc, and so the lowest limit of the present model is a safeguard against obsolescence.



The all-wave signal generator, Model 337-A, has a frequency-calibrated airplane dial, direct-frequency reading from 50 kc to 20 mgc. One knob is for turning the dial, the other is for the combination on-off switch and attenuator.

Inductance Values

The first band, 50 to 160 kc, has about the same tuning ratio as the two next succeedings bands, where Band 2 covers 150 to 500 kc and Band 3 covers the broadcast spectrum, 500 to 1,700 kc. For coverage to the broadcast band, honeycomb coils are used, while for the broadcast and three short-wave bands the inductances are solenoids. All six coils are tapped, the tap position not being critical, although for the low-frequency coils less comparative inductance is required between tap and ground than for the high-frequency coils. The inductance values are:

Band 1 (50-150 kc), 25 millihenries, tapped at 10 millihenries.

Band 2 (150-500 kc), 2.8 millihenries, tapped at 1 millihenry.

Band 3 (500-1,600 kc), 250 microhenries, tapped at 30 microhenries.

Band 4 (1.5-5 mgc), 30 microhenries, tapped at 10 microhenries.

Band 5 (5-10 mgc), 2.5 microhenries, tapped at 1 microhenry.

Band 6 (10-20 mgc), 0.62 microhenry, tapped at 0.3 microhenry.

The honeycombs necessarily are commercial coils. The four solenoids may be wound on 1-inch outside diameter tubing, according to the following directions:

Band 3: 137 turns No. 32 enamel wire, tapped at 35 turns from ground end.

Band 4: 29 turns No. 32 enamel wire, tapped at 15 turns from ground end.

Band 5: 8¾ turns No. 20 enamel wire, tapped at 4 turns from ground end.

Band 6: 4 turns No. 18 enamel wire, tapped at 2 turns from ground end.

The directions are for close winding.

Frequency Ranges

The tuning condenser used has a maximum capacity of 404 mmfd., and has no trimmer. The circuit capacity is 13 mmfd. The condenser minimum is 20 mmfd. So the effective capacity range is from 33 mmfd. to 417 mmfd., since the condenser's minimum disappears for increased capacity settings.

It will be noticed that approximately the full frequency range is utilized for the bands up to and including the broadcast band, a ratio of more than 3 to 1. In fact, the actual frequency ratio obtained for the broadcast band was 3.6, though not all of it is included in the calibration. To provide adequate overlap the maximum capacity theoretically taken was 400 mmfd., and the inductances selected accordingly, although checked also at the high-frequency end of each band for frequency generation with a capacity of 33 mmfd.

There is, therefore, no missout, and a higher ratio of frequency is utilized for the first four bands, while the ratio for the two high-frequency bands is reduced to 2 to 1. This is done without any compensation save selection of the inductance on the basis of tuning beginning at 400 mmfd. total capacity, so only that part of the condenser between 400 and 100 mfd. is used. This is done because the spreadout is much better at the higher capacity settings, and the practice of omitting special compensating methods is consistent with simplicity. The 2-to-1 ratio utilizes 110 degrees out of 180, or 61 per cent. of the dial.

Switch Considerations

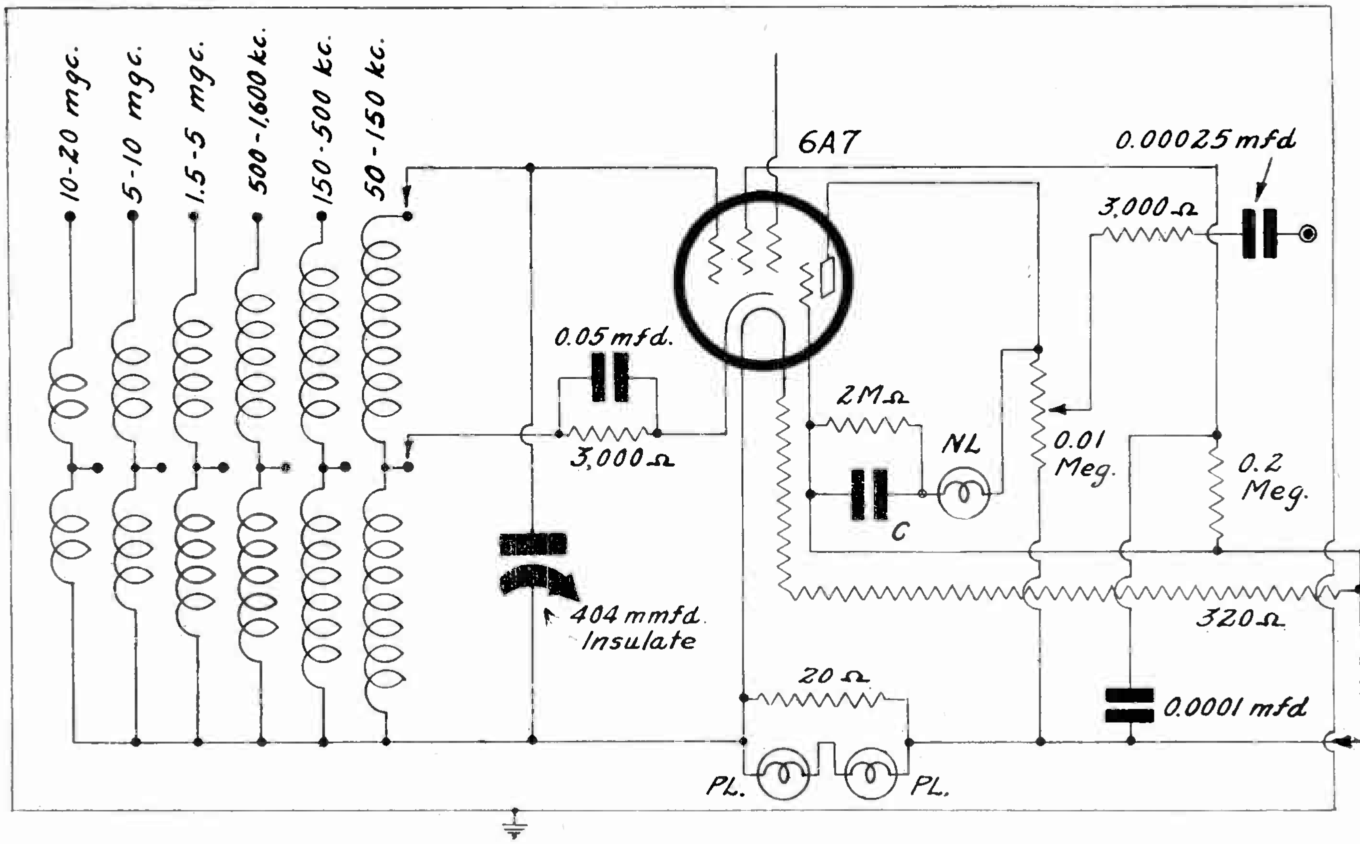
The bands are changed by front-panel switching. A two-deck, six-position switch is required. Switches made by Central Radio Corporation, Yaxley, Soreng-Mangold and Oak Manufacturing Company are entirely satisfactory, and besides all have low contact capacity, of the order of 1 mmfd., and low contact resistance, a few thousandths of an ohm. The capacity must be low, otherwise a frequency-calibrated scale would not apply with 1% accuracy.

It would seem that there is no adjustment of the circuit, that one simply has to put in the parts, and take what frequencies result. This is not true. The common practice of using a compression type trimmer across the tuning condenser leads some to believe that therefore no compensation is provided. However, the 0.2 meg. (200,000-ohm) resistor in the plate leg (Grid No. 2) may be changed, also the condenser across it, shown as 0.0001 mfd., to coincide the circuit for any particular band, using a high frequency of that band, and then the circuit is adjusted for the purposes of the other bands, because only the inductance has to be accurate then to assure tracking a frequency-calibrated dial. It must be remembered that only a particular tuning condenser can be used even with the accurate inductances for the generated frequencies to coincide with the scale.

The circuit proved an interesting one to engineer. The triode section of the 6A7 tube is used as the generator. The circuit

(Continued on next page)

New All-Wave Signal Generator



Precision results were obtained by circuiting an all-wave signal generator as diagramed. The grid shown as free may be grounded as an extra capacity adjustment (increase of capacity).

(*Continued from preceding page*)
is a Hartley, with cathode to coil tap, so that between cathode and ground is the feedback winding, while in the grid circuit is the entire winding, hence an auto-transformation effect is present.

To take off the oscillation the conventional plate circuit of the pentode of the 6A7 is used, but return of load resistor grounded. Thus does one have electron coupling. It is important to have such coupling, or other method for holding the frequency of generation immune from the effects of the circuit being measured.

Right Coupling

Some users of generators must have noticed that as the attenuator is turned, the frequency of generation shifts. This is due to the close relationship of the impedances, one acting upon the other. That is, the primary of the antenna coupler of a set, for instance, becomes a part of the generator. That strictly is not wanted. Hence electron coupling. And yet one may have too much coupling of whatever kind, and something of the same vice of detuning by the measured circuit will prevail. It will be noticed that the conventional control grid of the pentode is left free. Were this tied to the oscillator control grid the capacity effect would be relatively large and the screening destroyed. As a capacity adjustment one has the option of grounding the element. Were Grid No. 4 tied to the conventional plate as part of the output circuit the relationship between generator and output would be too close, and there would be the detuning effect mentioned. Were it tied to the plate of the oscillator (Grid No. 2) or to the screen (Grids Nos. 3 and 5) there would be large grid current in a circuit not intended to carry it, tube life would be shortened, and power wasted. So the method outlined proved the best, and there was no detuning no matter what the position of the attenuator.

Considering the output, there is another possible trouble. While the frequency may be safeguarded in the generator against change due to external causes affected by the attenuator, nevertheless the generator attenuator may act as a volume control on the receiver itself. This is not wanted, either. The vice lies in the fact that the receiver loses sensitivity when the generator control is set to a value intended for low output, while most accurate tests are made with receiver at maximum sensitivity and generator near minimum output. The 3,000-ohm series output resistor took care of that, for no matter if the attenuator has arm grounded, the input to the measured circuit is not shorted, as there are 3,000 ohms across the measured circuit, as a minimum. As a maximum there are 13,000 ohms across the measured circuit, when full generator output is utilized.

High Stability

The circuit, moreover, is remarkably stable. It is not true that the type of tube helps a great deal. In fact, used as a grid-leak-condenser type generator, without limiting plate resistor, the plate current changed considerable over the tuning range of any band. Putting in the 0.2 meg. limiting resistor helped stability a lot. Even with self-bias operation by cathode-resistor voltage drop, the stability was poor. When the 0.2-meg. plate limiting resistor was included the stability was of a high order, better than one part in 10,000.

The test for frequency stability, in qualitative terms, may be made by putting a by-passed milliammeter in the plate circuit (Grid No. 2) and tuning over the entire span of any one band, or all bands, and noting whether the needle moves. When the circuit is completely stable there is practically no movement.

A listening method is to tune in a station, on a set, start the generator, tune the generator to the frequency of the station, then detune the generator a bit, so that a high-pitched note is heard, easily distinguished from the program which for the present purpose constitutes interference, and then listen for fifteen minutes. The pitch should not change in any manner discernible by the ear. If the frequency of the station is 1,500 kc, that is, 1,500,000 cycles, and no change of pitch can be heard, then the change, if any, is 100 cycles or less, and the stability is better than one part in 15,000. Better stability than this is not required of generators, and there are few, if any, generators used as commercial instruments that have anything even approximating such stability.

What Stability Means

By stability we mean that when the generator is set to generate a certain frequency it continues to generate only that frequency and does not drift to some other frequency.

Since a heater type tube is used, all tests and measurements should be made only after the emission has risen to its full value. Also, as an extra precaution, it is well to wait until the generator has been going for two minutes.

The generator works on a.c. or d.c., 90-125 volts. On a.c. the hum of the line is the modulation, heard only at reasonance. On d.c. a neon tube is used as audio oscillator. The resistor that aids this oscillation is marked on the diagram as 2 meg., but may be almost any value equal to or larger than that, without limit, the condenser C being selected so that the tone of modulation is whatever one desires. When 2 meg. was used with C equal to 0.001 mfd. the note was around 3,000 cycles. Circuit conditions other than the time constant of C and 2 meg. affect this frequency.

Instead of putting the heater limiting resistor inside the generator cabinet it is feasible to use an a-c cord that has heater element inside the covering. The cord then gets warm but not hot. The resistance value should be around 320 ohms, and as the dissipation is nearly 33 watts, a resistor of 50

LIST OF PARTS

Coils

Six tapped oscillation coils as follows: two honeycomb coils of total inductances of 25 and 2.8 millihenries; four solenoids of total inductances of 250, 30, 2.5 and 0.62 microhenries.

Condensers

One 0.000404 mfd. (404 mmfd.) tuning condenser without trimmer.
One 0.05 mfd. fix tubular fixed condenser.
One 0.001 mfd. fixed condenser (C).
One 0.0001 mfd. mica fixed condenser.
One 0.00025 mfd. mica fixed condenser.

Resistors

Two 3,000-ohm pigtail resistors.
One 0.2-meg. (200,000-ohm) pigtail resistor.
One 2.0-meg. (2,000,000-ohm) pigtail resistor.
One 0.01-meg. (10,000-ohm) potentiometer with a-c switch attached.
One 320-ohm 50-watt resistor (or built into a a-c cable unit).
One 20-ohm wire-wound resistor.

Other Requirements

One seven-hole medium-sized socket.
One frequency-calibrated airplane dial with two pilot brackets.
Two 6-volt pilot lamps.
One a-c cable and plug (or with 320-ohm, 50-watt resistor built in).
One two-deck, six-position switch.
Two knobs.
One switch-position index plate.
One attenuator index plate.
One shield cabinet and one chassis.
One 6A7 tube.
One output post.
One small neon lamp without limiting resistor built in.

---

watts rating is used, whether inside the cabinet or as part of the cord outfit.

Two Pilot Lamps

If the resistor is built into the cord covering, then there are three wires at the free end, one connected to pilot lamp, one to other heater side, and remaining one to intended B plus connections. It so happened the cord used has an unusual code: black was for positive, common with one end of the limiting resistor; red for negative; white for the side of the heater to which resistor is connected.

If any trouble arises due to oscillation failure on either or both of the high-frequency bands, then a mica-dielectric condenser of 0.001 mfd. or thereabouts may be connected across the heater at the tube.

The reason for the two pilot lamps is that brackets for them are built into the airplane dial, to illuminate both semi-circles.

Harmonics

Because the shield cabinet has to be insulated from conductive connection to the line, to avoid possibility of shorting the line if a grounded wire is accidentally connected to cabinet when the cabinet would be the hot side, the frame of the tuning condenser is insulated from the cabinet by putting a block under it. The condenser is attached to this block with three No. 8/32 machine screws ½ inch long, and the block is attached to the chassis by wood screws. Since the airplane dial is a conductive mechanism, and the cabinet would be connected to line through condenser shaft and dial frame, despite the previous precaution, an insulating extension shaft is used on the condenser. This device receives the ¼-inch shaft of the condenser and extends in the opposite direction a ⅜-inch shaft for the dial hub. A notation for the insulation of the condenser from the cabinet appears on the schematic diagram, but no notation of the insulation of the airplane dial from the condenser, as the dial is not a part of the wiring proper.

Since the generator covers all frequencies, 50 kc to 20 mgc, on fundamentals, there is no intention that harmonics be used. Therefore the harmonic generation has been suppressed to a considerable extent. It will be found, for instance, that the low-frequency band yields small, if any, response between 50 and 80 kc when tenth harmonics are used for 500 to 800 kc measurements. However, as stated, there is no intention of introducing such use. For the fundametal range between 50 and 80 kc, for instance, the response is adequate.

The harmonics, in general, are useful up to the fifth, and therefore the 10 to 20 mgc range may be used for measurements of 20 to 40, 30 to 60, 40 to 80, and 50 to 100 mgc. The harmonic-confusion-elimination methods described in the October 13th issue may be followed for that purpose, especially the harmonic-order method.

However, harmonics may be used as a check, principally as the lower frequencies are more readily handled on an accuracy basis. For instance, using a foundamental, register a particular frequency, say 5,000 kc. The accuracy will be better if when one turns the switch for broadcast-band coverage and uses 1,000 kc generation, the fifth harmonic serving as a check. The registered frequency as attained on a fundamental may be checked by dividing by 2, 3, 4, or 5 and using next a low frequency equal to that quotient.

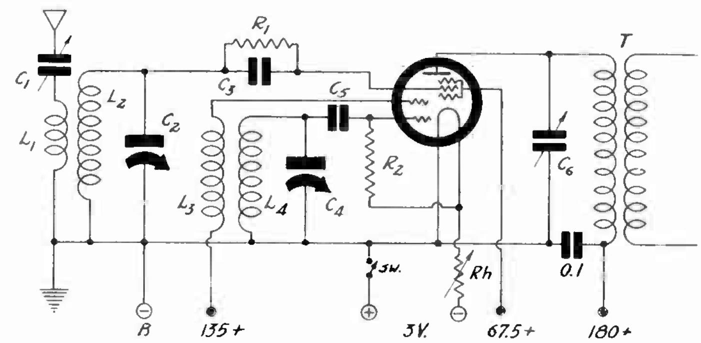
Mixers for Battery Sets; R-F Stage Advisable

Two mixers are shown, both for battery operation. One has antenna connected to the primary of the coil which constitutes the transformer feeding the first detector control grid. This is not good practice, as there should be some tuning ahead of the modulator input. The other diagram does not show whether the antenna stage or an r-f stage feeds the 1C6, but it is better practice to have an r-f stage do that feeding.

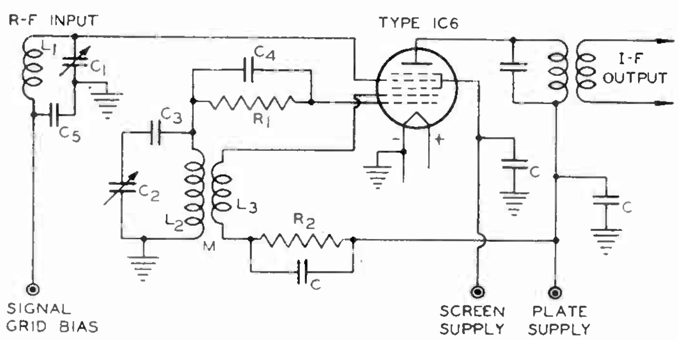
The grid leak and condenser, R1 and C3, in the one diagram, connected to control grid of the pentode, are for constituting the pentode the detector. The other diagram shows negative bias detector arising from "signal grid bias," meaning a battery of some 4.5 to 6 volts. The grid leak method is more sensitive, but the battery method will stand a greater input and therefore cause less likelihood of overloading.

Both diagrams represent the use of the 1C6 pentagrid converter tube. This is an improvement over the 1AC, in fact, the emission is just about doubled. Hence there is better performance at the higher frequencies, should short waves be a goal. The 1A6 did not amount to much above 10 mgc. The 1C6 was brought out particularly to give decent response for frequencies from, say, 10 to 25 mgc.

For the battery-bias diagram C4 may be 0.00025 mfd. to 0.0001 mfd., while R1 may be 50,000 ohms. One reason for keeping the leak value relatively low, in battery sets, is to avoid excessive voltage drop in the leak, as from one point of view there is a drain on the tube by high leak values, caused by the fact it does take power to run the leak. While theoretically the larger the leak the greater the drop and the greater the sensitivity, where does the sensitivity come in if the tube stops oscillating?



It is not good practice to omit pre-selection. An r-f stage is advisable.



The 1C6 as mixer has a limiting resistor, R2, of 20,000 ohms, and a condenser C of 0.0001 mfd. to aid stability.

Heat Method As Used For Measuring Sound

Sound is measured usually on the pressure basis. Now engineers of the Round Hill station of Massachusetts Institute of Technology have a way of measuring sound by the heat that it produces. Metal strips one-millionth of an inch thick are stacked up, and the electrolytic action causes current to heat the dissimilar electrodes, and the heat varies a resistance introduced into a very sensitive amplifier. The response of the system is said to be keen enough to yield a reading of one one-hundred-millionth of a volt.

At present measurements are confined to frequencies up to 10,000 cycles a second, which is near the upper limit of hearing. Soon it is expected to make heat measurements of radio frequencies up to 300 kc, and after that even of higher frequencies.

Making the Oscillator Track

In All-Wave Superheterodynes; Simplified Formulas Stated

SUPERHETERODYNE receivers of today must be tuned with a single adjustment. The accomplishment of this with a receiver covering a certain frequency range requires that one or more tuned r-f circuits must be adjusted over that range while, at the same time, the oscillator circuit must be caused to "track" at a constant frequency difference from the r-f circuits. It is universal practice to use a "gang" of variable capacitors operated by a common shaft to tune both the signal and the oscillator circuit.

The most popular design of the present-day superheterodyne circuit includes for each of the signal circuits, a fixed inductor, an initially adjustable minimum capacitor, and a variable tuning capacitor. To obtain approximately the necessary frequency difference, the oscillator will include values of inductance and minimum capacitance different from those of the signal circuits, a fixed capacitor in series with the inductor, and a variable capacitor the same as those used with the signal circuits.

Less of the Cut and Try

The present popularity of multi-range receivers has increased the need for a simple method of designing these circuit elements. A simple method of design requiring no charts or other tools, except possibly a slide rule, is presented. This method is based on a mathematical analysis flexible enough to cover any frequency range and any intermediate frequency. It is sufficiently accurate to provide the required circuit values and to reduce greatly the necessity for experimental cuts and tries.

The circuits most frequently used to obtain alignment of oscillator and radio-frequency circuits are illustrated by Figs. 1 and 2. Fig. 1 represents the radio-frequency circuit consisting of inductance L and capacitance C. C is variable over a sufficient range to cover the desired range of frequencies. The minimum capacitance of the circuit, including that of the tubes and other elements, is considered as included in C. For the solution of the problem to be considered, it is necessary to know either the value of L or the value of C at some particular frequency. If the value of C at a frequency F_0 is expressed as C_0, the corresponding value of L is given by the expression:

$$L = 25330/C_0 F_0^2 \qquad (1)$$

in which L is expressed in microhenries, C_0 in micro-microfarads, and F_0 in megacycles. These are generally the most convenient units to use in the solution of the problem under consideration.

Shunt Capacity

Fig. 2 represents the oscillator circuit. In this circuit, the capacitance C is to be varied simultaneously with C of Fig. 1 and is to have the same value as C of Fig. 1 at all adjustments. The rate of variation of C with condenser setting is not important as long as the r-f tuning condenser and oscillator tuning condenser change at the same rate.

The capacitance C_3 represents the difference in minimum capacitance between the oscillator tuning capacitor and the radio-frequency tuning capacitor. Under certain conditions, the oscillator minimum may be the smaller (particularly, if C_4 is large); in this case, C_3 must be assigned a negative value. In most cases, C_3 will be positive. The capacitor C_2 is the series tracking capacitor, sometimes called the padding condenser. The capacitance C_4 is always present in a real circuit, since the distributed capacitance of the coil appears in this position. However, if C_4 is small compared to C_2, C_4 may be considered as a part of C_3. *This may be done in practically all cases in which the intermediate frequency is lower than the signal frequency.*

When the required shunt capacitance C_4 is large and the series capacitance C_2 is small, C_4 must be taken into account. Also, in some cases, the adjustable shunt capacitor may be placed in the position of C_4. When C_4 must be considered, either C_3 or C_4 must be known approximately. This is not a serious restriction, since usually only one of these capacitances is adjustable. The other represents distributed capacitance of a coil, capacitance of wiring, input capacitance of a tube, or other similar factors and combinations; all of these may be estimated with sufficient accuracy. A small error in this estimate is compensated in practice by adjustment of the other shunt capacitor.

Three Tie-down Points

The desired relation between the resonant frequencies of the circuits of Fig. 1 and Fig. 2 is given by the relation:

$$f_1 = f + f_0 \qquad (2)$$

where f_1 is the resonant frequency of the oscillator circuit,
f is the resonant frequency of the radio-frequency circuit, and
f_0 is the intermediate frequency.

When the circuit of Fig. 2 is used this relation cannot be satisfied at all frequencies. Instead, there are, in general, three frequencies at which equation (2) is exactly satisfied. The departure from this equation is in the regions between and just beyond these frequencies. The three values of the signal frequency (the "tracking frequencies") are designated as F_1, F_2, and F_3. These frequencies should be chosen in advance for each band under consideration. F_2 should be chosen near the center of this band; F_1 and F_3, for best results, should be placed near but not at the ends of the band.

On the following page is a summary of the formulas for calculating superheterodyne-oscillator constants. The Appendix contains the mathematical derivation of these formulas. For practical use in design problems, the summary sheet gives all necessary information to determine L_1, C_2, and C_3 or C_4 for the circuit shown in Fig. 2. It is assumed that the following design information is available.

I. The intermediate frequency, f_0.
II. The tracking frequencies, F_1, F_2, F_3.
III. The inductance, L, or the capacitance, C_0, at frequency, F_0.
IV. The capacitance, C_4, or the capacitance, C_3.

Equations (24), (25), (26), and (27) may be used to check the results obtained. Also, these equations may be used to determine the oscillator frequency when circuit constants are known.

Examples Cited

Two examples illustrating the use of these formulas follow:

Example I

Design a circuit covering the receiving frequency range from 150 kc to 420 kc and using an intermediate frequency of 465 kc.

Given: For frequency of 150 kc, C = 400 mmfd.

Arbitrarily chosen: Tracking frequencies of 175 kc, 260 k, and 380 kc.

Each of the cases will be worked out with given data as follows:

Case 1: Where $C_4 = 0$.

Case 2: Assume tube is connected across coil to give maximum voltage at grid of tube. C_4 will include tube input capacitance and distributed capacity of coil. Assume $C_4 = 12$ mmfd.

Case 3: Assume that trimmer of capacitor has been adjusted to match minimum capacitance of r-f section. Consequently, $C_3 = 0$. The adjustment of minimum capacity is made by varying C_4.

Case 4: Same as Case 3, except that oscillator minimum trimmer has been removed from tuning capacitor. Minimum capacity of oscillator section is assumed to be 20 mmfd. less than the minimum of the r-f circuit. Consequently, $C_3 = -20$ mmfd.

Frequencies are expressed in megacycles in order to give small numerical quantities.

Given: $f_0 = 0.465 \quad 2f_0 = 0.930 \quad f_0^2 = 0.2162$
$F_1 = 0.175 \quad F_2 = 0.260 \quad F_3 = 0.380$
$F_0 = 0.150 \quad C_0 = 400 \quad C_0F_0^2 = 9.00$

Then: $a = 0.175 + 0.260 + 0.380 = 0.815$

$b^2 = (0.175 \times 0.260) + (0.175 \times 0.380) + (0.260 \times 0.380)$
$= 0.0455 + 0.0665 + 0.0988 = 0.2108$

$c^3 = 0.175 \times 0.260 \times 0.380 = 0.01728$

$d = 0.815 + 0.930 = 1.745$

$l^2 = (0.2108 \times 1.745 - 0.0173)/0.930$
$= (0.3680 - 0.0175)/0.930$
$= 0.3507/0.930 = 0.377$

$m^2 = 0.815 \times 1.745 + 0.216 + 0.377 - 0.211$
$= 1.423 + 0.005 + 0.377 = 1.805$

$n^2 = (0.01728 \times 1.745 + 0.2162 \times 0.377)/1.805$
$= (0.0302 + 0.0815)/1.805 = 0.1117/1.805$
$= 0.0618$

Case 1

$C_2 = 9.00(1/0.0618 - 1/0.377)$
$= 9.00(16.18 - 2.65) = 9.00 \times 13.53$
$= 121.8$ mmfd.

$C_3 = 9.00/0.377 = 23.9$ mmfd.

$L_1 = L(0.377/1.805)(145.7/121.8) = 0.2496L$

Case 2

$C_4 = 12$ mmfd.

$A = 9.0(1/0.0618 - 1/0.377) = 121.8$

$C_2 = 121.8$ (½ + square root of quantity ¼ + 0.0985)
$= 121.8$ (0.500 + square root of 0.3485)
$= 121.8 (0.500 + 0.590)$
$= 132.8$ mmfd.

$C_3 = 9.00/0.377 - 12 \times 132.8/144.8 = 23.9 - 11.0$
$= 12.9$ mmfd.

$L_1 = L\,(0.377/1.805)\,(145.7/144.8)$
$= 0.210L$

Case 3

$C_3 = 0$

$C_2 = 9.0/0.0618$
$= 145.7$ mmfd.

$C_4 = 9.0/(0.377 - 0.062) = 9.0/0.315$
$= 28.5$ mmfd.

$L_1 = L\,(0.377/1.805)\,(145.7/174.2)$
$= 0.2088L$

Case 4

$C_3 = -20$

$B = 9/0.377 + 20 = 23.88 + 20$
$= 43.88$

$C_2 = 9/0.0618 + 20 = 145.7 + 20$
$= 165.7$ mmfd.

$C_4 = (165.7 + 43.88)/121.8$
$= 59.7$ mmfd.

$L_1 = L\,(0.377/1.805)\,(1 + 5.7/225.4)$
$= 0.1348L$

The example chosen was selected to show

wide divergency between values of C_2 and L_1/L for the various cases. When C_2 is larger, the differences between cases are much less pronounced.

The check formulas give for Case 4:

$l^2 = 9/(-20 + 43.8)$
$= 0.377$
$m^2 = 9/0.1348(59.7 - 22.7) + 9/0.1348 \times 37.0$
$= 1.803$
$n^2 = 9/145.7$
$= 0.0618$
$f_1^2 = 1.805\ (f^2 + 0.0618)/(f^2 + 0.377)$

Calculations of Values

Check calculations tabulated for end frequencies, tracking frequencies, and two others will be found in the tabulation at bottom of columns 2 and 3. In this tabulation the value $f_1 - f$ shows that tracking is very good except at the extreme high-frequency end.

Example II

Design a circuit covering the receiving range of 10 to 23 megacycles and using an intermediate frequency of 465 kc.

Since the signal frequency is considerably greater than the intermediate frequency, the equations of Case 1 ($C_4 = 0$) will be used.

Given: For frequency of 10 megacycles, C = 400 mmfd.

Arbitrarily chosen: Tracking frequencies of 12, 16 and 20 megacycles.

Given:

$f_0 = 465$	$2f_0 = 0.93$	$f_0^2 = 0.216$
$F_1 = 0.12$	$F_2 = 18$	$F_3 = 20$
$F_0 = 10$	$C_0 = 400$	$C_0F_0^2 = 40000$

Then:

$a = 48$
$b^2 = 192 + 240 + 320 = 752$
$c^3 = 3840$
$d = 48.93$
$l^2 = 752 \times 48.93 - 3840 = 32960$
$m^2 = 234.8 + 0.2 + 32960 - 752 = 35560$
$n^2 = (184000 + 712)/35560$
$= 5.19$
$C_2 = 40000\ (0.1927 - 0.00003)$
$= 7708$ mmfd.
$C_3 = 40000/32960$
$= 1.21$ mmfd.
$L_1 = L\ (32960/35560)\ (7709/7708)$
$= 0.927L$

In this case, C_2 is so large compared with the tuning capacitor that C_2 could be omitted; a small correction of the inductance value would then be required. The resultant capacity of 400 mmfd. and 7700 mmfd. in series is 380 mmfd.; if the series capacity is omitted, inductance L_1 must be reduced to correspond to the increase in C. L_1/L is then equal to $0.927 \times 380/400 = 0.88$. An increase in the value of minimum capacity will complete the correction.

With the series capacity C_2 omitted, exact tracking occurs at only two points; however, tracking will be so close to the conditions of Example II that the difference is of little consequence.

R-F CIRCUIT

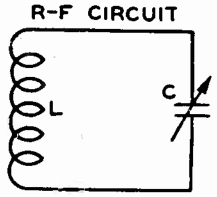


FIG. I

OSCILLATOR CIRCUIT

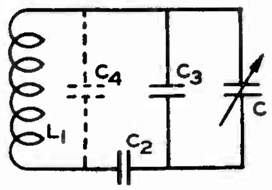


FIG. 2

Frequencies expressed in megacycles
Inductances " " microhenries
Capacitances " " micromicrofarads

Basic Considerations and Relations

f_0 = Intermediate frequency

F_1, F_2, F_3 = Frequencies at which exact tracking is to be obtained.

$a = F_1 + F_2 + F_3$ (3)

$b^2 = F_1F_2 + F_1F_3 + F_2F_3$ (4)

$c^3 = F_1F_2F_3$ (5)

$d = a + 2f_0$ (6)

$l^2 = (b^2d - c^3)/2f_0$ (7)

$m^2 = l^2 + f_0^2 + ad - b^2$ (8)

$n^2 = (c^3d + f_0^2l^2)/m^2$ (9)

C_0 = Tuning capacitance at frequency F_0

$L = 25330/C_0F_0^2$, or if L is known, then $C_0F_0^2 = 25330/L$ (1)

$A = C_0F_0^2(1/n^2 - 1/l^2)$ Required only for Case 3 (16)

$B = (C_0F_0^2/l^2) - C_3$ Required only for Case 4 (20)

Case 1: When $C_4 = 0$, or $C_4 \ll C_2$ (the usual case).

$C_2 = C_0F_0^2(1/n^2 - 1/l^2)$ (10)

$C_3 = C_0F_0^2/l^2$ (11)

$L_1 = L(l^2/m^2)(C_2 + C_3)/C_2$ (12)

Case 2: When $C_3 = 0$.

$C_2 = C_0F_0^2/n^2$ (13)

$C_4 = C_0F_0^2/(l^2 - n^2)$ (14)

$L_1 = L(l^2/m^2)C_2/(C_2 + C_4)$ (15)

Case 3: When C_4 is known.

$C_2 = A\ (1/2 + \sqrt{1/4 + C_4/A}\ )$ (17)

$C_3 = (C_0F_0^2/l^2) - C_2C_4/(C_2 + C_4)$ (18)

$L_1 = L(l^2/m^2)(C_2 + C_3)/(C_2 + C_4)$ (19)

Case 4: When C_3 is known.

$C_2 = (C_0F_0^2/n^2) - C_3$ (21)

$C_4 = C_2B/(C_2 - B)$ (22)

$L_1 = L(l^2/m^2)(C_2 + C_3)/(C_2 + C_4)$ (23)

* * * * * * * * * * * * * * * * * * *

Check Formulas

Equation for oscillator frequency:

$f_1 = m\sqrt{(f^2 + n^2)/(f^2 + l^2)}$ (24)

Equations for l^2, m^2, and n^2, in terms of oscillator constants:

$$l^2 = C_0F_0^2/(C_3 + \frac{C_2C_4}{C_2 + C_4}) \quad (25)$$

$$m^2 = C_0F_0^2/(L_1/L)(C_4 + \frac{C_2C_3}{C_2 + C_3}) \quad (26)$$

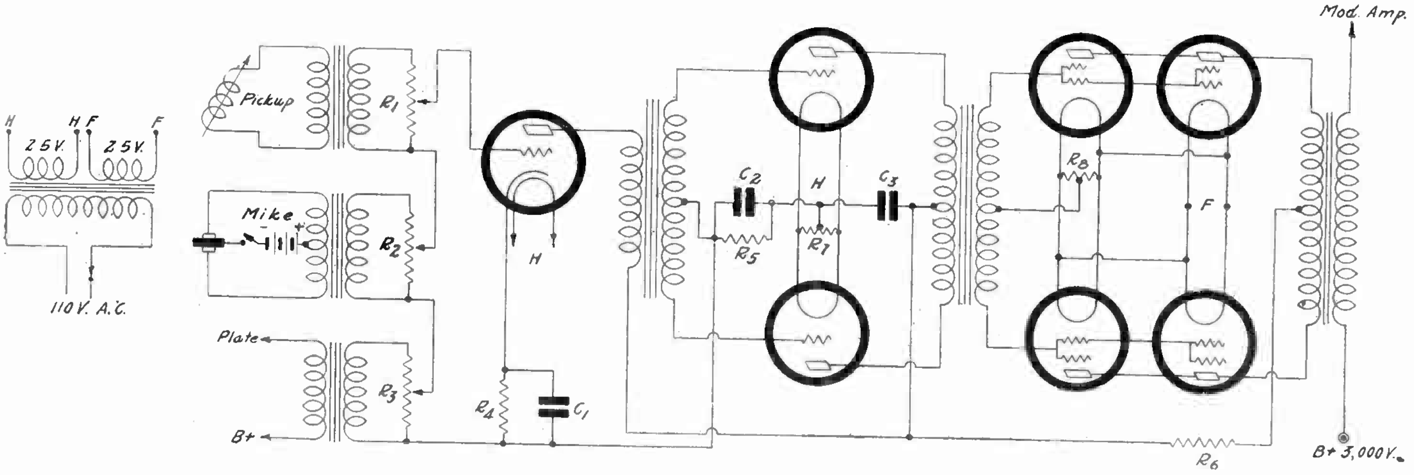
$$n^2 = C_0F_0^2/(C_2 + C_3) \quad (27)$$

f	0.150	0.175	0.220	0.260	0.320	0.380	0.420
f^2	0.0225	0.0306	0.0484	0.0576	0.1024	0.1444	0.1764
$f^2 + 0.0618$	0.0843	0.0924	0.1102	0.1294	0.1642	0.2062	0.2382
$f^2 + 0.377$	0.400	0.408	0.425	0.445	0.479	0.521	0.553
f_1^2	0.380	0.409	0.468	0.526	0.619	0.714	0.778
f_1	0.616	0.640	0.684	0.725	0.787	0.845	0.882
$f_1 - f$	0.466	0.465	0.464	0.465	0.467	0.465	0.462

A Ham Speech Amplifier

56 First AF, 56 Push-Pull Driver and 46 Parallel-Push-Pull Output

By Russell De Jonge
W8DIB, Zeeland, Mich.



Speech amplifier for a high-class amateur transmitting installation.

THE radio-frequency generator and associated amplifier, as well as power supply for an entire amateur transmitter, were described last week, issue of October 20th. This article describes the speech amplifier and modulator unit which converts the continuous-wave (code) transmitter into a modern amateur radiophone station.

The first principal part of this unit is the microphone. It changes audible voice frequencies or music into minute electrical pulsations. Another converter of sound vibrations into electrical pulsations is the magnetic pickup, the needle of which is vibrated at sound frequencies by the irregularities in the groove of a record, the coil changing the sound into electrical pulsations. The third input is the land line from remote places which might be a telephone line but in this case is the output of a radio receiver. The microphone is the only input requiring a battery, which in this circuit is a 6-volt storage battery. When the microphone is not being used the battery should be disconnected by opening the switch.

Class A 2A3 Output

Each of these B "interpreters" has its individual volume control connected across the secondary of the step-up audio transformers. The primaries are connected as is shown in the accompanying diagram.

The output of the faders are connected directly to the grid of a type 56 tube whose automatic bias is 13.5 volts. The output of this tube is transformer coupled to a pair of 2A3 triode amplifiers. The 2A3 tubes are run Class A. The coupling transformer is a step-up transformer whose primary is matched to the plate circuit of the 56, the step-up ratio is 5 to 1.

The grid bias for these tubes is obtained by the automatic bias method. This stage is the driver stage, being so called because it "drives" the final or modulator stage.

46 Parallel Push-Pull

The driver is transformer-coupled to the modulator stage by a transformer whose turns ratio is 1 to 1. Two pairs of 46 tubes connected in parallel push-pull combination are used as modulators. The purpose of the modulator is to superimpose an audio frequency upon the continuous-wave signal. The audio frequency may be either voice or music, according to the selection of the volume controls preceding the first speech amplifier.

A heavy-duty modulation transformer is connected as shown in the diagram. In order that the high voltage will not cause puncture or short circuit the transformer should be insulated for at least 3,000 volts. The secondary winding is inserted into the plate lead of the type 60. This lead also supplies the screen voltage of the 60. This lead must be cut and permanently connected to the secondary winding. The voltage developed across the secondary winding should be equal to that developed in the final radio-frequency stage. The percentage of modulation is one hundred per cent. when these voltages are equal.

Since both the 2A3 and 46 tubes are the filament type tubes, separate filament windings are necessary so that the correct bias can be supplied to the tubes. Both of these secondary windings supply 2.5 volts. Secondary No. 1 is connected to the 56 and 2A3 tubes and secondary No. 2 is connected to the four type 46 tubes.

High-Class Equipment

The negative as well as the positive of 400 volts is common to both of the units, the radio-frequency amplifier and the modulator and speech amplifier. Two hundred and fifty volts positive is supplied to the type 56 tube and 2A3 tubes from the 400-volt terminal through a series resistor R6.

With a complete outfit, such as has been described, the radio amateur today can rest assured that he has the equipment equalling any other rig as to stability and quality. It is not, however, the most powerful on the air, because its output is limited to 200 watts. The Government will license it for 1,000 watts. If, however, one is desirous of increasing the output to 1,000 watts he may do it with the addition of a 1-kilowatt tube operated in a linear manner. With this addition the transmitter will be as powerful and as reliable as any amateur installation.

With the rig as I have described the amateur will be able to contact stations otherwise out of his reach, provided that he has a reliable receiver.

License Necessary

Before this unit is operated an amateur must obtain from the United States Government a license to operate the equipment. The Government has set aside several bands of frequencies in which the amateurs are allowed to operate. The laws concerning the operation of such stations can be had by requesting them from the Federal Communications Commission, Washington, D. C.

An amateur, according to the regulations, must have equipment to check his frequency. He must check the frequency before every transmission. To do this he must have modern equipment. The most important is a frequency meter.

The values of the resistors and condensers in the diagram are tabulated below:

R1	25,000 ohms	low wattage
R2	25,000 ohms	low wattage
R3	25,000 ohms	low wattage
R4	2,700 ohms	low wattage
R5	1,500 ohms	high wattage
R6	2,200 ohms	high wattage
R7	20 ohms	high wattage
R8	20 ohms	high wattage

C1	0.1 Mfd.
C2	0.1 Mfd.
C3	1.0 Mfd.

FAREWELL TO STATIC!

Static is as unsteady and indeed as unreliable as its name does not suggest. Anything static is something that stands still, but the static we know in radio is restless. Very pronounced at long waves, it becomes negligible in the broadcast band, then becomes severe to about 17 meters, after which it disappears. If it would disappear at zero frequency or infinite wavelength and never come back nobody would complain.

A THOUGHT FOR THE WEEK

YOU KNOW JULE DELMAR, of course; or, if you don't, you acknowledge that you don't know show business. Jule has just become associated with the WOR Artists Bureau, located in that station's studio at 1440 Broadway, New York City.

A history of the American stage and the world of native entertainment would not be complete without something concerning the experience and ability of Jule Delmar. Starting a good many years ago in the smaller towns and on less important circuits of the country, he at last reached that point of importance and usefulness where he was needed by the Keith-Albee Circuit and later by the R.K.O. He was practically the czar—though a most reasonable and human one—of the Southern part of the big R.K.O. Circuit, and the managers of those houses below the Mason & Dixon Line and the players who appeared in them will tell you that Jule Delmar knew his business from A to Z and that they trusted him to do the right thing at the right time and in the right way.

Broadway and Radioland are glad that Jule Delmar's light is shining again—although permit us to remark right here that his light really never has gone out.

Radio certainly is bringing the big men of the theatre into its fold—and one of the best of all these is our old friend and townsman, Jule Delmar.—R.B.H.

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.***

Gregory H. Diez, 950 N. Clinton Ave., Rochester, N. Y.
Edward Arnold, 42 West Fordham Road, The Bronx, New York City.
Harry Latta, Jr., 116 St. Mary's St., Raleigh, N. C.
R. C. Ashcraft, 226 North Signal St., Ojai, Calif.
Alexander Pacelt, 1552 Buena Vista West, Detroit, Mich.
Chas. J. Adams, 3435 Finlaw Ave., Pensauken, N. J.
Ole Anderson, 819 Weller St., Seattle, Wash.
C. H. Annis, 1702 So. 52nd St., Tacoma, Wash.
Charles W. Anderson, Grantsville, Utah.
Julius Jacobson, Vashon, Wash.
Chas. E. Barns, 11741 Mansfield, Detroit, Mich.
H. H. Bouson, 623 Insurance Bldg., Seattle, Wash.
Oscar Bradford, 1814 N. Fayette St., Saginaw, Mich.
Lawrence Solie, Nome, No. Dak.
G. Arthur Black, Clinton, S. C.
E. F. Boran, 820 Doyle Ave., West Homestead, Penna.
Earl G. Bartels, Sidlo, Simons, Day & Co., First National Bank Bldg., Denver, Colo.
Arthur D. Calvert, Chicora, Penna.
R. E. Cotton, 12905 Imperial Ave., Cleveland, Ohio.
Edward G. Craft, 2055 "S" St., Lincoln, Nebr.
Geo. G. Caldwell, 4000 - 5th St., N.W., Washington, D. C.
Carl Cadwallader, Radio Service Dept., Thos. J. Wadson & Son, Hamilton, Bermuda.
W. T. Dice, Fowler Radio Shop, 816 Merced St., Fowler, Calif.
Warren J. Daugherty, Kincaid, Kans.
D. Dootson, P. O. Box 280, Port Alberni, B. C., Canada.
H. F. Dickten, 2550 N. Webster St., River-Grove, Ill.
Richard B. O'Connor, 30 Ninety-first Street, Brooklyn, N. Y.
Raymond Brennan, 6136 Lebanon Ave., Overbrook, Philadelphia, Pa.
Bertram Reinitz, 18 Twenty-first Street, Brooklyn, N. Y.

CORPORATE REPORTS

ZENITH RADIO CORPORATION—Net loss for the quarter ended July 31, 1934, $36,573, after depreciation expenses, taxes, and other charges; compared with a net profit of $8,336 last year, before federal taxes. In August Hugh Robertson, vice-president and treasurer, reported to stockholders a profit.

Large PA System on Rack and Panel

For large halls, auditoriums, theatres and the like, the public address system may assume considerable physical proportions. The service to be rendered is a large one, and therefore more apparatus is needed, for furnishing greater power, and the rack-and-panel type of construction becomes attractive.

The assembly illustrated herewith is suitable for any type of microphone, except a carbon type, as there is no energizing force for driving such a transducer. However, even a carbon microphone could be used, as all that would be needed would be a small battery to potentialize the buttons.

Some of the microphone types that have the best acoustical qualities are not the most sensitive devices, and therefore a pre-amplifier is used. This consists of stages of amplification preceding the main amplifier. Thus the voltage amplification is divided into two parts. On the top shelf only voltage amplification is used. On the middle shelf, where the main amplifier is housed, all the amplification is of the voltage type up to the output stage, which is a power amplifier. Double push-pull 56 Cascaded stages are used for loading up the push-pull 2A3 output tubes.

To keep hum well below the 5 per cent. allowable limit, special pains are taken as to filtration. Hence the B supply for the pre-amplifier is situated below, and this same nether component takes care of the excitation of the fields of the two dynamic speakers used. The speakers are baffled in a separate compartment and are not shown.

On the front panel are three adjustment controls and a switch and an earphone jack. Thus the operation may be monitored from the rack; that is, the volume adjusted on the basis of the operator listening to what the amplifier is reproducing.

Such a piece of apparatus as this is to be used in connection with a microphone, as when somebody is to speak and it is the serious intention of the management that the speaker be heard all over the house. Some who address the public do not realize this necessity. The public-address system makes up for the deficiency.

Also, music is to be played in the hall or theatre. By placing speakers in suitable locations, such as sound engineers can spot with trained ears, the distribution of sound is made more uniform and the reproduction louder and more realistic.

The installation illustrated herewith is the design work and product of Harvey Sampson, sound specialist and operator of Harvey's Radio Shop, New York City. His amplifiers are used by the most noted singers and orchestras.

THEATRE INSTALLATION

Rear view of a rack-and-panel public-address system developed by Harvey Sampson, of Harvey's Radio Shop, New York City. The top shelf holds the pre-amplifier, for building up the microphone level, and thus permitting use of a crystal microphone. The mid-section houses the power amplifier proper. Below is the power supply for the pre-amplifier, and a field exciter. This type of installation is used in theatres.

Pro or Con—Which Shall It Be?

SHALL WE HAVE GOVERNMENT RADIO CENSORSHIP? You can't make up your mind on the subject by reading the speeches made during the annual assembly of the National Advisory Council on Radio in Education held recently in Chicago. A number of men whose convictions are interesting even if not conclusive and still more prominent educators and microphone declaimers disagree quite thoroughly over the pros and cons of the case. Many of them missed a most important angle of the subject—for no matter why or when or by what administration radio censorship is established there always remains the positive danger that a big percentage of our population will claim that a synonym for censorship is propaganda.

Again, and for the seventh time, let us proclaim to the whole world that radio can save the expense, resentment and unpleasant features of censorship only by keeping its skirts clean and sending out nothing over the air-waves that calls for censorship. Who shall decide? Why, the same duo that decides most things at home and in national life—good, old Dr. Decency and his partner, Dr. Commonsense.

They make a strong team.

Engineers Press for High

Shields Under Tube Sockets, Large R-F

I. F. and Even New L

By Roger

POPULAR demand for all-wave sets has energized the radio engineers, so that various paths are being pursued experimentally, all aiming at maximum results. What are desired principally are maximum sensitivity with minimum noise. Sufficient selectivity is not difficult to attain, as it is largely a tracking problem, and the methods have been reduced to a mathematical certainty, that is, a theoretical certainty. The adjustments have to stay put or the mathematics helps little.

The circuit shown herewith is one in which some of the accepted practices are pursued, including a tuned-radio-frequency stage to improve the rejection of images, more than one coil in a shield compartment, switching for band shifting, automatic volume control and tone control.

What does not appear from the diagram is the fact that the designer has been much interested in still increasing the sensitivity, although the receiver has performed remarkably well, and is contained in a workmanlike housing, as illustrated on the front cover. More gain, more gain, is the cry. And so the designer hit upon the idea of putting shields under the sockets, to prevent pickup between and among wires in that location, and in that way he was able to press to higher gain without oscillation at the radio-frequency level.

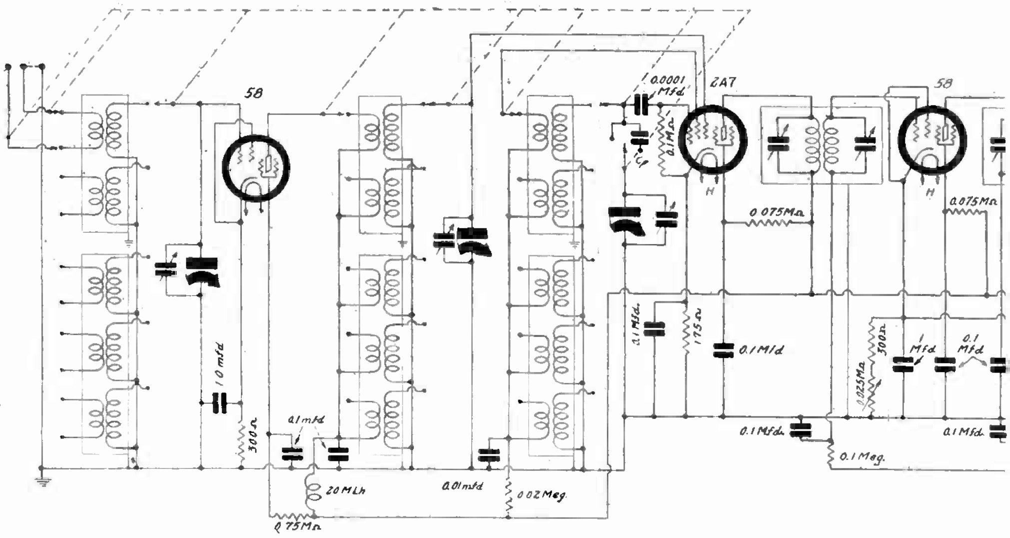
Splendid Design

By using larger than usual bypass condensers across the cathode resistors that serve biasing purposes, still more gain could be produced. And so from one point and circuit to another test after test was made, to improve the gain, and after each long effort there was a ratable increase. Of course the point will be reached beyond which further gain becomes impractical, because one strikes the noise level, and interference (noise) is amplified almost as much as the signal. The ratio or signal to noise should be high.

The design herewith is a splendid one, and may be followed by those who want to build an all-wave set. The padding is carried out through all the bands, although Cp, representing the padding condenser, is included in the diagram only for the broadcast band. There is a separate Cp for each band.

A three-gang 0.00035 mfd. condenser is used, as in that way the broadcast band is covered completely at one switch stop. There are five positions, and the set tunes from 540 kc to above 30,000 kc, or to nearly 9 meters. This is quite some coverage.

One of the problems is to stop the oscillator from drifting. This correction is introduced to a considerable extent by the inclusion of the 20,000-ohm limiting resistor, which is bypassed. Also, the leak is made somewhat larger than usual. By this balance the drift was not serious, and the slight amount experienced showed up only above 15 mgc. Attention to drift is becoming more and more pronounced, especially as a frequency-calibrated dial



This all-wave receiver has coils for two bands — broadcast and inte coils for the three remaining bands in another shield compartment nearly to 9 meters. Every effort was m

is used, and the coincidence of the response and the scale depends on freedom from drift at the very high frequencies, as well as on other niceties.

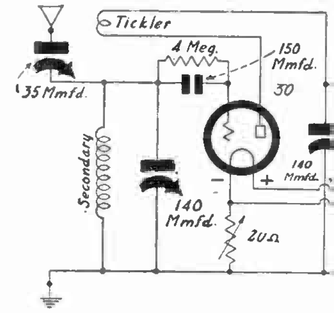
More Gain, Less Noise

The circuit does not contain the expediency of using a stage of high intermediate-frequency amplification, introducing another oscillation voltage, and thus lowering the synthetic frequency to something around 100 kc or less. This should produce more gain at less noise. Some engineers have stated that they did accomplish this desired end by using that method. Whether the scheme will become more or less standard time alone will tell. At least it is obvious that close attention is being given to the higher requirements of performance. The engineering of a set such as this takes several months, and

Small Set Responds t

The regenerative detector is one of the most sensitive devices known to science. Particularly is this sensitivity applicable to short-wave reception. Therefore a simple set like this, consisting of such a detector and a stage of transformer-coupled audio-frequency amplification, can yield a response to any signal, hence is comparable on this basis to the large receiver diagrammed at the top of this page.

It has been said that the small set can produce a response. Yes, it can pick up practically any short-wave station on earth that any other set can pick up, but with this difference: you may not be able to hear the program. The response referred to may consist merely of a whistle. It is the larger, more powerful set that develops the better ratio of signal to noise, although the regenerative set is not bad in that respect, either. The trick is to get the regenerator operating at its most sensitive point, and this may prove trying. One of the main considerations is to have the antenna series condenser set just right, so that the effective resistance in the antenna circuit is not too high for proper regeneration, and also so that there is not too

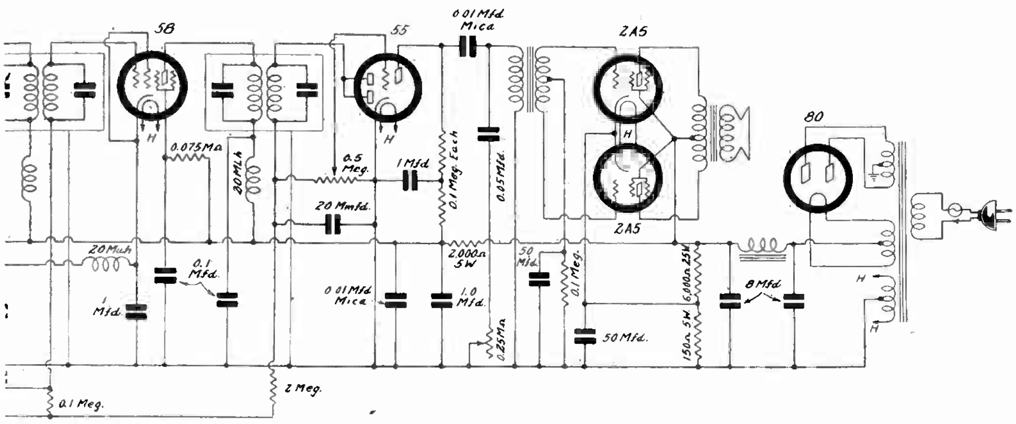


This simple receiver can tically any short-wave tran does not necessarily mean

er Gain in All-Wave Sets

Bybass Capacities, Reduced Secondary
ow-Noise Tube Tried

C. Emory



·mediate short waves — in one shield compartment per stage, and per stage. The coverage is from 540 kc to higher than 30 mgc, or ıade to develop sensitivity to the utmost.

the results of such devotion of time are expressed in the diagram herewith, but the problem never seems to remain solved, as it is a healthy fact that engineers no longer remain contented with what they have done but always strive to outdo themselves and their competitors.

So all-wave circuits may be regarded as in a fluid state, with no likelihood that anything approaching the standardization of broadcast sets in the last few years will be accomplished in the near future. Already the padding and trimming of the circuits are giving concern. Accurate condensers must be used. And by accurate one means not only that the capacities must be what they should be when the set is produced, but that the capacities must stay put during the life of the set.

What About Trimmers?

So the compression type of trimmer may be abandoned finally, because of the spring action that changes with temperature and moisture, hence changes the capacity. Also jars and vibrations affect the setting, and a set lined up before shipment may arrive at its destination considerably out of alignment, due to the knocks and bangs conferred on it during transit.

Some sets have around twenty such trimming and padding devices, and it is inconceivable that air-dielectric condensers would be used throughout, though theoretically acceptable. Where would one put them all? Possibly twisted wire, leads cemented in place after correct capacity is set, will be used for trimming, and air-dielectric condensers for series padding, provided the padding capacity does not have to be inordinately high. If it has to be very high, a mica fixed condenser may be used across the adjustable padder.

The intermediate frequency used in this receiver is 465 kc. An eight-deck, five position switch is required for the tuner. That is due to the use of a primary open at both ends, for transmission line connection from a doublet antenna.

From Antenna to Set

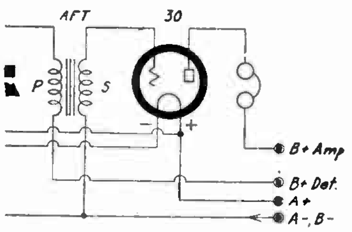
For use of the Marconi type (grounded) antenna the second binding post from upper left may be joined to the right-hand binding post. The object of the transmission line and noise-reducing antenna system generally is to improve the ratio of signal to noise. Therefore it is obvious that, having devoted much time to antenna treatment, engineers now are returning to the receiver for further improvement. The science of constructing an all-wave set is therefore in a state of flux, and even a new tube is expected that is specially built to produce a high ratio of signal to noise. Data on this tube, and on the expected date of its announcement, are being kept a strict secret.

The pentagrid converter tubes, 2A7 and 6A7, are still very popular, but it is not unlikely that in due course tubes with looser electron coupling will be introduced, as there is a tendency in some sets for the modulator and oscillator to lock, where the frequency difference between them is comparatively small, as it is bound to be at high signal frequencies of station carriers.

Just a Suggestion

Of course a way out may be found in connection with the tubes already mentioned, as by using a load from pentode plate to ground, where the coupling still is of the electron type, but weaker, and of course the tube ceasing to be a pentode in reality. Just as the variable-mu tube, or so-called super-control tube, was invented to cure cross-talk troubles, so may tubes producing high gain at low noise, and tubes providing coupling that is just right for very high frequencies and lower frequencies, or vario-coupling tubes, come along in due course.

Practically Anything



gain a response from prac- ısmission on the air, but that discernment of the program.

much pickup. The variation of impedance due to tuning this condenser is very large, hence suitable settings may be attained for all short-wave bands, usually one setting sufficing for each band. Then the throttle condenser, 140 mmfd. to right of the detector tube, is slowly and carefully adjusted, and when the tube is just below the point of spillover the greatest sensitivity is attained. For ease of tuning, the superheterodyne has it all over the regenerator, but in results per dollar spent it is hard to beat the regenerator. There is wide room for both types of receivers.

One drawback of the regenerative set is that it is hard to make it follow a calibration of frequencies, as the tickler control detunes the grid circuit, and at high frequencies this shows up seriously. Also, from day to day or night to night the settings may have to be different, because the losses in the circuit are different. Hence the tickler control, though successful, does not repeat itself on any calibratable basis, and since this is true, the calibration of the tuning condenser in the grid circuit, in terms of frequency, does not become practical.

TYPE	NAME	BASE	SOCKET CONNECTIONS	DIMENSIONS MAXIMUM OVERALL LENGTH x DIAMETER	CATHODE TYPE ■	RATING: FILAMENT OR HEATER VOLTS	RATING: FILAMENT OR HEATER AMPERES	RATING: PLATE MAX. VOLTS	RATING: SCREEN MAX. VOLTS	USE Values to right give operating conditions and characteristics for indicated typical use	PLATE SUPPLY VOLTS	GRID VOLTS ■	SCREEN VOLTS	SCREEN MILLI-AMP.	PLATE MILLI-AMP.	A-C PLATE RESISTANCE OHMS	MUTUAL CONDUCTANCE MICRO-MHOS	VOLTAGE AMPLIFICATION FACTOR	LOAD FOR STATED POWER OUTPUT OHMS	POWER OUTPUT WATTS	TYPE
1A6	PENTAGRID CONVERTER ⊙	SMALL 6-PIN	FIG. 20	4 11/16" x 1 9/16"	D-C FILAMENT	2.0	0.06	180	67.5	CONVERTER	180	−3.0 min.	67.5	2.4	1.3	500000	Anode-Grid (#2) 135 max. volts, 2.3 ma. Oscillator Grid (#1) Resistor, 50000 ohms. Conversion conductance, 300 micromhos.				1A6
1C6	PENTAGRID CONVERTER ⊙	SMALL 6-PIN	FIG. 20	4 11/16" x 1 9/16"	D-C FILAMENT	2.0	0.12	180	67.5	CONVERTER	180	−3.0 min.	67.5	2.0	1.5	750000	Anode Grid (#2) 135 max. volts, 3.3 ma. Oscillator Grid (#1) Resistor, 50000 ohms. Conversion conductance, 325 micromhos.				1C6
2A3	POWER AMPLIFIER TRIODE	MEDIUM 4-PIN	FIG. 1	5 5/8" x 2 1/16"	FILAMENT	2.5	2.5	250	—	CLASS A AMPLIFIER	250	−45	—	—	60.0	800	5250	4.2	2500	3.5	2A3
								300	—	PUSH-PULL AMPLIFIER	300 300	−62 −62	Self-bias Fixed-bias		40.0 40.0	Power Output is for 2 tubes at stated load, plate-to-plate			5000 3000	10.0 15.0	
2A5	POWER AMPLIFIER PENTODE	MEDIUM 6-PIN	FIG. 15A	4 11/16" x 1 13/16"	HEATER	2.5	1.75	250	250	CLASS A AMPLIFIER	250	−16.5	250	6.5	34.0	100000	2200	220	7000	3.0	2A5
2A6	DUPLEX-DIODE HIGH-MU TRIODE	SMALL 6-PIN	FIG. 13	4 17/32" x 1 9/16"	HEATER	2.5	0.8	250	—	TRIODE UNIT AS CLASS A AMPLIFIER	250 ⌘	−1.35	—	—	0.4	—	—	Gain per stage = 50-60			2A6
2A7	PENTAGRID CONVERTER ⊙	SMALL 7-PIN	FIG. 20	4 11/16" x 1 9/16"	HEATER	2.5	0.8	250	100	CONVERTER	250 ♥	−3.0 min.	100	2.2	3.5	360000	Anode Grid (#2) 200 max. volts, 4.0 ma. Oscillator Grid (#1) Resistor, 50000 ohms. Conversion conductance, 520 micromhos.				2A7
2B7	DUPLEX-DIODE PENTODE	SMALL 7-PIN	FIG. 21	4 17/32" x 1 9/16"	HEATER	2.5	0.8	250	125	PENTODE UNIT AS R-F AMPLIFIER	100 250	−3.0 −3.0	100 125	1.7 2.3	5.8 9.0	300000 650000	950 1125	285 730	—	—	2B7
										PENTODE UNIT AS A-F AMPLIFIER	250 ╪	−4.5	50	—	0.65	—	—	—	—	—	
6A4 also LA	POWER AMPLIFIER PENTODE	MEDIUM 5-PIN	FIG. 6	4 11/16" x 1 13/16"	FILAMENT	6.3	0.3	180	180	CLASS A AMPLIFIER	100 180	−6.5 −12.0	100 180	1.6 3.9	9.0 22.0	83250 45500	1200 2200	100 100	11000 8000	0.31 1.40	6A4 also LA
6A7	PENTAGRID CONVERTER ⊙	SMALL 7-PIN	FIG. 20	4 11/16" x 1 9/16"	HEATER	6.3	0.3	250	100	CONVERTER	250	−3.0 min.	100	2.2	3.5	360000	Anode Grid (#2) 200 max. volts, 4.0 ma. Oscillator Grid (#1) Resistor, 50000 ohms. Conversion conductance, 520 micromhos.				6A7
6B7	DUPLEX-DIODE PENTODE	SMALL 7-PIN	FIG. 21	4 17/32" x 1 9/16"	HEATER	6.3	0.3	250	125	PENTODE UNIT AS R-F AMPLIFIER	100 250	−3.0 −3.0	100 125	1.7 2.3	5.8 9.0	300000 650000	950 1125	285 730	—	—	6B7
										PENTODE UNIT AS A-F AMPLIFIER	250 ╪	−4.5	50	—	0.65	—	—	—	—	—	
6C6	TRIPLE-GRID DETECTOR AMPLIFIER	SMALL 6-PIN	FIG. 11	4 11/16" x 1 9/16"	HEATER	6.3	0.3	250	100	SCREEN GRID R-F AMPLIFIER	250	−3.0	100	0.5	2.0	exceeds 1.5 meg	1225	exceeds 1500	—	—	6C6
										BIAS DETECTOR	250	−1.95	50	Cathode current 0.65 ma.		—	Plate coupling resistor 250000 ohms. Grid coupling resistor 250000 ohms.**				
6D6	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	SMALL 6-PIN	FIG. 11	4 11/16" x 1 9/16"	HEATER	6.3	0.3	250	100	SCREEN GRID R-F AMPLIFIER	250	−3.0 min.	100	2.0	8.2	800000	1600	1280	—	—	6D6
										MIXER IN SUPERHETERODYNE	250	−10.0	100	—	—		Oscillator peak volts = 7.0.				

⊙ Grids #3 and #5 are screen. Grid #4 is signal-input control-grid.
╪ Applied through plate coupling resistor of 200000 ohms. **For grid of following tube.
⌘ Applied through plate coupling resistor of 250000 ohms.

TYPE	NAME	BASE	SOCKET CONNECTIONS	DIMENSIONS MAXIMUM OVERALL LENGTH x DIAMETER	CATHODE TYPE ■	RATING: FILAMENT OR HEATER VOLTS	RATING: FILAMENT OR HEATER AMPERES	RATING: PLATE MAX. VOLTS	RATING: SCREEN MAX. VOLTS	USE	PLATE SUPPLY VOLTS	GRID VOLTS ■	SCREEN VOLTS	SCREEN MILLI-AMP.	PLATE MILLI-AMP.	A-C PLATE RESISTANCE OHMS	MUTUAL CONDUCTANCE MICRO-MHOS	VOLTAGE AMPLIFICATION FACTOR	LOAD FOR STATED POWER OUTPUT OHMS	POWER OUTPUT WATTS	TYPE
6F7	TRIODE-PENTODE	SMALL 7-PIN	FIG. 27	4 17/32" x 1 9/16"	HEATER	6.3	0.3	100	—	TRIODE UNIT AS AMPLIFIER	100	−3.0	—	—	3.5	17800	450	8	—	—	6F7
								250	100	PENTODE UNIT AS AMPLIFIER	250	−3.0 min.	100	1.5	6.5	850000	1100	900	—	—	
								250	100	PENTODE UNIT AS MIXER	250	−10.0	100	0.6	2.8	Oscillator peak volts = 7.0. Conversion conductance = 300 micromhos.					
'00-A	DETECTOR TRIODE	MEDIUM 4-PIN	FIG. 1	4 11/16" x 1 13/16"	D-C FILAMENT	5.0	0.25	45	—	GRID LEAK DETECTOR	45	Grid Return to (−) Filament			1.5	30000	666	20	—	—	'00-A
01-A	DETECTOR★ AMPLIFIER	MEDIUM 4-PIN	FIG. 1	4 11/16" x 1 13/16"	D-C FILAMENT	5.0	0.25	135	—	CLASS A AMPLIFIER	90 135	−4.5 −9.0	—	—	2.5 3.0	11000 10000	725 800	8.0 8.0	—	—	01-A
10	POWER AMPLIFIER TRIODE	MEDIUM 4-PIN	FIG. 1	5 5/8" x 2 3/16"	FILAMENT	7.5	1.25	425	—	CLASS A AMPLIFIER	350 425	−31.0 −39.0	—	—	16.0 18.0	5150 5000	1550 1600	8.0 8.0	11000 10200	0.9 1.6	10
11 12	DETECTOR★ AMPLIFIER TRIODE	WD 4-PIN MEDIUM 4-PIN	FIG. 12 FIG. 1	4 1/8" x 1 3/16" 4 11/16" x 1 7/16"	D-C FILAMENT	1.1	0.25	135	—	CLASS A AMPLIFIER	90 135	−4.5 −10.5	—	—	2.5 3.0	15500 15000	425 440	6.6 6.6	—	—	11 12
19	TWIN-TRIODE AMPLIFIER	SMALL 6-PIN	FIG. 25	4 1/4" x 1 9/16"	D-C FILAMENT	2.0	0.26	135	—	CLASS B AMPLIFIER	135 135	0 −3.0	—	—	Power output value is for one tube at stated load, plate-to-plate.				10000 10000	2.1 1.9	19
'20	POWER AMPLIFIER TRIODE	SMALL 4-PIN	FIG. 1	4 1/8" x 1 3/16"	D-C FILAMENT	3.3	0.132	135	—	CLASS A AMPLIFIER	90 135	−16.5 −22.5	—	—	3.0 6.5	8000 6300	415 525	3.3 3.3	9600 6500	0.045 0.110	'20
22	R-F AMPLIFIER TETRODE	MEDIUM 4-PIN	FIG. 4	5 3/32" x 1 13/16"	D-C FILAMENT	3.3	0.132	135	67.5	SCREEN GRID R-F AMPLIFIER	135 135	−1.5 −1.5	45 67.5	0.6* 1.3*	1.7 3.7	725000 325000	375 500	270 160	—	—	22
24-A	R-F AMPLIFIER TETRODE	MEDIUM 5-PIN	FIG. 9	5 3/32" x 1 13/16"	HEATER	2.5	1.75	275	90	SCREEN GRID R-F AMPLIFIER	180 250	−3.0 −3.0	90 90	1.7* 1.7*	4.0 4.0	400000 600000	1000 1050	400 630	—	—	24-A
										BIAS DETECTOR	250●	−5.0 approx.	20 to 45	—	Plate current to be adjusted to 0.1 milliampere with no signal.						
26	AMPLIFIER TRIODE	MEDIUM 4-PIN	FIG. 1	4 11/16" x 1 13/16"	FILAMENT	1.5	1.05	180	—	CLASS A AMPLIFIER	90 180	−7.0 −14.5	—	—	2.9 6.2	8900 7300	935 1150	8.3 8.3	—	—	26
27	DETECTOR★ AMPLIFIER TRIODE	MEDIUM 5-PIN	FIG. 8	4 1/4" x 1 9/16"	HEATER	2.5	1.75	275	—	CLASS A AMPLIFIER	135 250	−9.0 −21.0	—	—	4.5 5.2	9000 9250	1000 975	9.0 9.0	—	—	27
										BIAS DETECTOR	250	−30.0 approx.	—	—	Plate current to be adjusted to 0.2 milliampere with no signal.						
30	DETECTOR★ AMPLIFIER TRIODE	SMALL 4-PIN	FIG. 1	4 1/4" x 1 9/16"	D-C FILAMENT	2.0	0.06	180	—	CLASS A AMPLIFIER	90 135 180	−4.5 −9.0 −13.5	—	—	2.5 3.0 3.1	11000 10300 10300	850 900 900	9.3 9.3 9.3	—	—	30

★For Grid-leak Detection—plate volts 45, grid return to + filament or to cathode. ● Applied through plate coupling resistor of 250000 ohms or 500-henry choke shunted by 0.25 megohm resistor. *Maximum.

TYPE	NAME	BASE	SOCKET CONNECTIONS	DIMENSIONS MAXIMUM OVERALL LENGTH x DIAMETER	CATHODE TYPE ■	RATING: FILAMENT OR HEATER VOLTS	RATING: FILAMENT OR HEATER AMPERES	RATING: PLATE MAX. VOLTS	RATING: SCREEN MAX. VOLTS	USE	PLATE SUPPLY VOLTS	GRID VOLTS ■	SCREEN VOLTS	SCREEN MILLI-AMP.	PLATE MILLI-AMP.	A-C PLATE RESISTANCE OHMS	MUTUAL CONDUCTANCE MICRO-MHOS	VOLTAGE AMPLIFICATION FACTOR	LOAD FOR STATED POWER OUTPUT OHMS	POWER OUTPUT WATTS	TYPE
31	POWER AMPLIFIER TRIODE	SMALL 4-PIN	FIG. 1	4 1/4" x 1 9/16"	D-C FILAMENT	2.0	0.13	180	—	CLASS A AMPLIFIER	135 180	−22.5 −30.0	—	—	8.0 12.3	4100 3600	925 1050	3.8 3.8	7000 5700	0.185 0.375	31
32	R-F AMPLIFIER TETRODE	MEDIUM 4-PIN	FIG. 4	5 3/32" x 1 13/16"	D-C FILAMENT	2.0	0.06	180	67.5	SCREEN GRID R-F AMPLIFIER	135 180	−3.0 −3.0	67.5 67.5	0.4* 0.4*	1.7 1.7	950000 1200000	640 650	610 780	—	—	32
										BIAS DETECTOR	180♥	−6.0 approx.	67.5	—	Plate current to be adjusted to 0.2 milliampere with no signal.						
33	POWER AMPLIFIER PENTODE	MEDIUM 5-PIN	FIG. 6	4 11/16" x 1 13/16"	D-C FILAMENT	2.0	0.26	180	180	CLASS A AMPLIFIER	180	−18.0	180	5.0	22.0	55000	1700	90	6000	1.4	33
34	SUPER-CONTROL R-F AMPLIFIER PENTODE	MEDIUM 4-PIN	FIG. 4A	5 3/32" x 1 13/16"	D-C FILAMENT	2.0	0.06	180	67.5	SCREEN GRID R-F AMPLIFIER	135 180	−3.0 min.	67.5 67.5	1.0 1.0	2.8 2.8	600000 1000000	600 620	360 620	—	—	34
35	SUPER-CONTROL R-F AMPLIFIER TETRODE	MEDIUM 5-PIN	FIG. 9	5 3/32" x 1 13/16"	HEATER	2.5	1.75	275	90	SCREEN GRID R-F AMPLIFIER	180 250	−3.0 min.	90 90	2.5* 2.5*	6.3 6.5	300000 400000	1020 1050	305 420	—	—	35
36	R-F AMPLIFIER TETRODE	SMALL 5-PIN	FIG. 9	4 17/32" x 1 9/16"	HEATER	6.3	0.3	250	90	SCREEN GRID R-F AMPLIFIER	100 180 250	−1.5 −3.0 −3.0	55 90 90	— 1.7*	1.8 3.1 3.2	550000 500000 550000	850 1050 1080	470 525 595	—	—	36
										BIAS DETECTOR	100● 250●	−5.0 −8.0	55 90		Plate current to be adjusted to 0.1 milliampere with no signal.						
37	DETECTOR★ AMPLIFIER TRIODE	SMALL 5-PIN	FIG. 8	4 1/4" x 1 9/16"	HEATER	6.3	0.3	250	—	CLASS A AMPLIFIER	90 180 250	−6.0 −13.5 −18.0	—	—	2.5 4.3 7.5	11500 10200 8400	800 900 1100	9.2 9.2 9.2	—	—	37
										BIAS DETECTOR	90 250	−10.0 −28.0	—	—	Plate current to be adjusted to 0.2 milliampere with no signal.						
38	POWER AMPLIFIER PENTODE	SMALL 5-PIN	FIG. 9A	4 17/32" x 1 9/16"	HEATER	6.3	0.3	250	250	CLASS A AMPLIFIER	100 180 250	−9.0 −18.0 −25.0	100 180 250	1.2 2.4 3.8	7.0 14.0 22.0	140000 115000 100000	875 1050 1200	120 120 120	15000 11600 10000	0.27 1.00 2.50	38
39-44	SUPER-CONTROL R-F AMPLIFIER PENTODE	SMALL 5-PIN	FIG. 9A	4 17/32" x 1 9/16"	HEATER	6.3	0.3	250	90	SCREEN GRID R-F AMPLIFIER	90 180 250	−3.0 min.	90 90 90	1.6 1.4 1.4	5.6 5.8 5.8	375000 750000 1000000	960 1000 1050	360 750 1050	—	—	39-44

★For Grid-leak Detection—plate volts 45, grid return to + filament or to cathode.
■Either A. C. or D. C. may be used on filament or heater, except as specifically noted. For use of D. C. on A-C filament types, decrease stated grid volts by ½ (approx.) of filament voltage.
● Applied through plate coupling resistor of 250000 ohms or 500-henry choke shunted by 0.25 megohm resistor.
♥Applied through plate coupling resistor of 100000 ohms.
*Maximum.

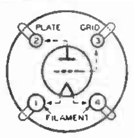


FIG. 1

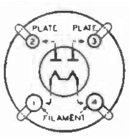


FIG. 2

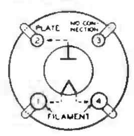
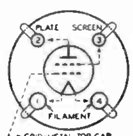
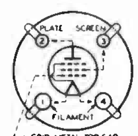


FIG. 3


GRID-METAL TOP CAP
FIG. 4


GRID-METAL TOP CAP
FIG. 4A

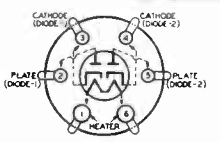


FIG. 5

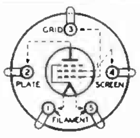
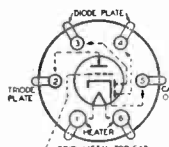
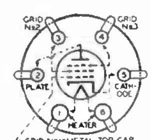


FIG. 6


GRID-METAL TOP CAP
FIG. 13


GRID No.1-METAL TOP CAP
FIG. 14

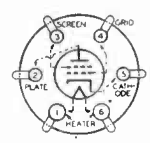


FIG. 15

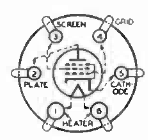


FIG. 15A

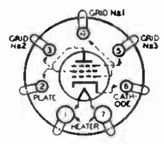
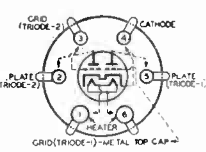
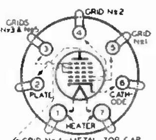


FIG. 18


GRID (TRIODE-1)-METAL TOP CAP
FIG. 19


GRID No.4-METAL TOP CAP
FIG. 20

INDEX OF TYPES BY USE AND BY CATHODE VOLTAGE

CATHODE VOLTS	POWER AMPLIFIERS	VOLTAGE AMPLIFIERS Including Duplex-Diode Types	CONVERTERS IN SUPERHETERODYNES	DETECTORS	MIXER TUBES IN SUPERHETERODYNES	RECTIFIERS	CATHODE VOLTS
1.1	—	11, 12	—	11, 12	—	—	1.1
1.5	—	26	—	—	—	—	1.5
2.0	19, 31, 33, 49	30, 32, 34	1A6, 1C6	30, 32	1A6, 1C6, 34	—	2.0
2.5	2A3, 2A5, 45, 46, 47, 53, 59	2A6, 2B7, 24-A, 27, 35, 55, 56, 57, 58	2A7	2A6, 2B7, 24-A, 27, 55, 56, 57	2A7, 24-A, 35, 57, 58	82	2.5
3.3	'20	22, '99	—	'99	—	—	3.3

Tube symbols and bottom views of socket connections have pin numbers according to the new system recently standardized by Radio Manufacturers Association, Inc. Courtesy RCA Radiotron Co., Inc. Copyright, 1934.

TYPE	NAME	BASE	SOCKET CONNECTIONS	DIMENSIONS MAXIMUM OVERALL LENGTH x DIAMETER	CATHODE TYPE ■	RATING FILAMENT OR HEATER VOLTS	RATING FILAMENT OR HEATER AMPERES	RATING PLATE MAX. VOLTS	RATING SCREEN MAX. VOLTS	USE Values to right give operating conditions and characteristics for indicated typical use	PLATE SUPPLY VOLTS	GRID VOLTS ■	SCREEN VOLTS	SCREEN MILLI-AMP.	PLATE MILLI-AMP.	A-C PLATE RESISTANCE OHMS	MUTUAL CONDUCTANCE MICRO-MHOS	VOLTAGE AMPLIFICATION FACTOR	LOAD FOR STATED POWER OUTPUT OHMS	POWER OUTPUT WATTS	TYPE
40	VOLTAGE AMPLIFIER TRIODE	MEDIUM 4-PIN	FIG. 1	4 11/16" x 1 13/16"	D-C FILAMENT	5.0	0.25	180	—	CLASS A AMPLIFIER	135 ¤ 180 ¤	− 1.5 − 3.0	—	—	0.2 0.2	150000 150000	200 200	30 30	—	—	40
41	POWER AMPLIFIER PENTODE	SMALL 6-PIN	FIG. 15A	4 1/4" x 1 9/16"	HEATER	6.3	0.4	250	250	CLASS A AMPLIFIER	100 180 250	− 7.0 −13.5 −18.0	100 180 250	1.6 3.0 5.5	9.0 18.5 32.0	103500 81000 68000	1450 1850 2200	150 150 150	12000 9000 7600	0.33 1.50 3.40	41
42	POWER AMPLIFIER PENTODE	MEDIUM 6-PIN	FIG. 15A	4 11/16" x 1 13/16"	HEATER	6.3	0.7	250	250	CLASS A AMPLIFIER	250	−16.5	250	6.5	34.0	100000	2200	220	7000	3.00	42
43	POWER AMPLIFIER PENTODE	MEDIUM 6-PIN	FIG. 15A	4 11/16" x 1 13/16"	HEATER	25.0	0.3	135	135	CLASS A AMPLIFIER	95 135	−15.0 −20.0	95 135	4.0 7.0	20.0 34.0	45000 35000	2000 2300	90 80	4500 4000	0.90 2.00	43
45	POWER AMPLIFIER TRIODE	MEDIUM 4-PIN	FIG. 1	4 11/16" x 1 13/16"	FILAMENT	2.5	1.5	275	—	CLASS A AMPLIFIER	180 250 275	−31.5 −50.0 −56.0	180 250 275	—	31.0 34.0 36.0	1650 1610 1700	2125 2175 2050	3.5 3.5 3.5	2700 3900 4600	0.82 1.60 2.00	45
46	DUAL-GRID POWER AMPLIFIER	MEDIUM 5-PIN	FIG. 7	5 5/8" x 2 3/16"	FILAMENT	2.5	1.75	250	—	CLASS A AMPLIFIER □	250	−33.0	—	—	22.0	2380	2350	5.6	6400	1.25	46
								400	—	CLASS B AMPLIFIER ♦	300 400	0 0	—	—	Power output values are for 2 tubes at indicated plate-to-plate load.				5200 5800	16.0 20.0	
47	POWER AMPLIFIER PENTODE	MEDIUM 5-PIN	FIG. 8	5 3/8" x 2 1/16"	FILAMENT	2.5	1.75	250	250	CLASS A AMPLIFIER	250	−16.5	250	6.0	31.0	60000	2500	150	7000	2.7	47
48	POWER AMPLIFIER TETRODE	MEDIUM 6-PIN	FIG. 16	5 3/8" x 2 1/16"	D-C HEATER	30.0	0.4	125	100	CLASS A AMPLIFIER	96 125	−19.0 −20.0	96 100	9.0 9.5	52.0 56.0	— —	3800 3900	— —	1500 1500	2.0 2.5	48
49	DUAL-GRID POWER AMPLIFIER	MEDIUM 5-PIN	FIG. 7	4 11/16" x 1 13/16"	D-C FILAMENT	2.0	0.12	135	—	CLASS A AMPLIFIER □	135	−20.0	—	—	6.0	4175	1125	4.7	11000	0.17	49
								180	—	CLASS B AMPLIFIER ♦	180	0	—	—	Power output values are for 2 tubes at indicated plate-to-plate load.				12000	3.5	
50	POWER AMPLIFIER TRIODE	MEDIUM 4-PIN	FIG. 1	6 1/4" x 2 11/16"	FILAMENT	7.5	1.25	450	—	CLASS A AMPLIFIER	300 400 450	−54.0 −70.0 −84.0	—	—	35.0 55.0 55.0	2000 1800 1800	1900 2100 2100	3.8 3.8 3.8	4600 3670 4350	1.6 3.4 4.6	50
53	TWIN-TRIODE AMPLIFIER	MEDIUM 7-PIN #	FIG. 24	4 11/16" x 1 13/16"	HEATER	2.5	2.0	300	—	CLASS B AMPLIFIER	250 300	0 0	—	—	Power output value is for one tube at stated load, plate-to-plate.				8000 10000	8.0 10.0	53
55	DUPLEX-DIODE TRIODE	SMALL 6-PIN	FIG. 13	4 17/32" x 1 9/16"	HEATER	2.5	1.0	250	—	TRIODE UNIT AS CLASS A AMPLIFIER	135 180 250	−10.5 −13.5 −20.0	—	—	3.7 6.0 8.0	11000 8500 7500	750 975 1100	8.3 8.3 8.3	25000 20000 20000	0.075 0.160 0.350	55
56	SUPER-TRIODE AMPLIFIER DETECTOR★	SMALL 5-PIN	FIG. 8	4 1/4" x 1 9/16"	HEATER	2.5	1.0	250	—	CLASS A AMPLIFIER	250	−13.5	—	—	5.0	9500	1450	13.8	—	—	56
										BIAS DETECTOR	250	−20.0 (approx.)	—	—	Plate current to be adjusted to 0.2 milliampere with no signal.						
57	TRIPLE-GRID DETECTOR AMPLIFIER	SMALL 6-PIN	FIG. 11	4 11/16" x 1 9/16"	HEATER	2.5	1.0	250	100	SCREEN GRID R-F AMPLIFIER	250	− 3.0	100	0.5	2.0	exceeds 1.5 meg.	1225	exceeds 1500	—	—	57
										BIAS DETECTOR	250	− 1.95	50	Cathode current 0.65 ma.		—	Plate coupling resistor 250000 ohms. Grid coupling resistor 250000 ohms**				

★For Grid-leak Detection—plate volts 45, grid return to + filament or to cathode
Requires different socket from small 7-pin.
□Grid next to plate tied to plate. ♦Two grids tied together. **For grid of following tube.
¤ Applied through plate coupling resistor of 250000 ohms.

TYPE	NAME	BASE	SOCKET CONNECTIONS	DIMENSIONS	CATHODE TYPE	FIL. VOLTS	FIL. AMPERES	PLATE MAX. VOLTS	SCREEN MAX. VOLTS	USE	PLATE SUPPLY VOLTS	GRID VOLTS	SCREEN VOLTS	SCREEN MILLI-AMP.	PLATE MILLI-AMP.	A-C PLATE RESISTANCE OHMS	MUTUAL CONDUCTANCE MICRO-MHOS	AMPLIFICATION FACTOR	LOAD OHMS	POWER OUTPUT WATTS	TYPE
58	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	SMALL 6-PIN	FIG. 11	4 11/16" x 1 9/16"	HEATER	2.5	1.0	250	100	SCREEN GRID R-F AMPLIFIER	250	(− 3.0 min.)	100	2.0	8.2	800000	1600	1280	—	—	58
										MIXER IN SUPERHETERODYNE	250	−10.0	100	—	—	Oscillator peak volts = 7.0.					
59	TRIPLE-GRID POWER AMPLIFIER	MEDIUM 7-PIN #	FIG. 18	5 3/8" x 2 1/16"	HEATER	2.5	2.0	250	—	AS TRIODE ¶ CLASS A AMPLIFIER	250	−28.0	—	—	26.0	2300	2600	6.0	5000	1.25	59
								250	250	AS PENTODE ** CLASS A AMPLIFIER	250	−18.0	250	9.0	35.0	40000	2500	100	6000	3.00	
								400	—	AS TRIODE ♦ CLASS B AMPLIFIER	300 400	0 0	—	—	Power output values are for 2 tubes at indicated plate-to-plate load.				4600 6000	15.0 20.0	
71-A	POWER AMPLIFIER TRIODE	MEDIUM 4-PIN	FIG. 1	4 11/16" x 1 13/16"	FILAMENT	5.0	0.25	180	—	CLASS A AMPLIFIER	90 180	−19.0 −43.0	—	—	10.0 20.0	2170 1750	1400 1700	3.0 3.0	3000 4800	0.125 0.790	71-A
75	DUPLEX-DIODE HIGH-MU TRIODE	SMALL 6-PIN	FIG. 13	4 17/32" x 1 9/16"	HEATER	6.3	0.3	250	—	TRIODE UNIT AS CLASS A AMPLIFIER	250 ¤	−1.35	—	—	0.4	—	—	Gain per stage = 50-60			75
76	SUPER-TRIODE AMPLIFIER DETECTOR★	SMALL 5-PIN	FIG. 8	4 1/4" x 1 9/16"	HEATER	6.3	0.3	250	—	CLASS A AMPLIFIER	250	−13.5	—	—	5.0	9500	1450	13.8	—	—	76
										BIAS DETECTOR	250	−20.0	—	—	Plate current to be adjusted to 0.2 milliampere with no signal.						
77	TRIPLE-GRID DETECTOR AMPLIFIER	SMALL 6-PIN	FIG. 11	4 17/32" x 1 9/16"	HEATER	6.3	0.3	250	100	SCREEN GRID R-F AMPLIFIER	100 250	− 1.5 − 3.0	60 100	0.4 0.5	1.7 2.3	650000 1500000	1100 1250	715 1500	—	—	77
										BIAS DETECTOR	250	− 1.95	50	Cathode current 0.65 ma.		—	Plate coupling resistor 250000 ohms. Grid coupling resistor 250000 ohms**				
78	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	SMALL 6-PIN	FIG. 11	4 17/32" x 1 9/16"	HEATER	6.3	0.3	250	125	SCREEN GRID R-F AMPLIFIER	90 180 250 250	(− 3.0 min.)	90 75 100 125	1.3 1.0 1.7 2.6	5.4 4.0 7.0 10.5	315000 1000000 800000 600000	1275 1100 1450 1650	400 1100 1160 990	—	—	78
79	TWIN-TRIODE AMPLIFIER	SMALL 6-PIN	FIG. 19	4 17/32" x 1 9/16"	HEATER	6.3	0.6	250	—	CLASS B AMPLIFIER	160 250	0 0	—	—	Power output value is for one tube at stated load, plate-to-plate.				7000 14000	5.5 8.0	79
85	DUPLEX-DIODE TRIODE	SMALL 6-PIN	FIG. 13	4 17/32" x 1 9/16"	HEATER	6.3	0.3	250	—	TRIODE UNIT AS CLASS A AMPLIFIER	135 180 250	−10.5 −13.5 −20.0	—	—	3.7 6.0 8.0	11000 8500 7500	750 975 1100	8.3 8.3 8.3	25000 20000 20000	0.075 0.160 0.350	85
89	TRIPLE-GRID POWER AMPLIFIER	SMALL 6-PIN	FIG. 14	4 17/32" x 1 9/16"	HEATER	6.3	0.4	250	250	AS TRIODE ¶ CLASS A AMPLIFIER	160 180 250	−20.0 −22.5 −31.0	—	—	17.0 20.0 32.0	3300 3000 2600	1425 1550 1800	4.7 4.7 4.7	7000 6500 5500	0.300 0.400 0.900	89
										AS PENTODE ** CLASS A AMPLIFIER	100 180 250	−10.0 −18.0 −25.0	100 180 250	1.6 3.0 5.5	9.5 20.0 32.0	104000 80000 70000	1200 1550 1800	125 125 125	10700 8000 6750	0.33 1.50 3.40	
										AS TRIODE ♦ CLASS B AMPLIFIER	180	0			Power output values are for 2 tubes at indicated plate-to-plate load.				13600 9400	2.50 3.50	
V-'99 X-'99	DETECTOR★ AMPLIFIER TRIODE	SMALL 4-NUB SMALL 4-PIN	FIG. 10 FIG. 1	3 1/2" x 1 3/16" 4 1/8" x 1 3/16"	D-C FILAMENT	3.3	0.063	90	—	CLASS A AMPLIFIER	90	− 4.5	—	—	2.5	15500	425	6.6	—	—	V-'99 X-'99
112-A	DETECTOR★ AMPLIFIER TRIODE	MEDIUM 4-PIN	FIG. 1	4 11/16" x 1 13/16"	D-C FILAMENT	5.0	0.25	180	—	CLASS A AMPLIFIER	90 180	− 4.5 −13.5	—	—	5.0 7.7	5400 4700	1575 1800	8.5 8.5	—	—	112-A

★For Grid-leak Detection—plate volts 45, grid return to + filament or to cathode.
■Either A. C. or D. C. may be used on filament or heater, except as specifically noted. For use of D. C. on A-C filament types, decrease stated grid volts by ½ (approx.) of filament voltage.
Requires different socket from small 7-pin.
**Grid #1 is control grid. Grid #2 is screen. Grid #3 tied to cathode.
¶Grid #1 is control grid. Grids #2 and #3 tied to plate.
♦Grids #1 and #2 connected together. Grid #3 tied to plate.
¤ Applied through plate coupling resistor of 250000 ohms.
**For grid of following tube.

RECTIFIERS

TYPE	NAME	BASE	SOCKET CONNECTIONS	DIMENSIONS	CATHODE TYPE	FIL. VOLTS	FIL. AMPERES	PLATE	SCREEN	RATINGS	TYPE
5Z3	FULL-WAVE RECTIFIER	MEDIUM 4-PIN	FIG. 2	5 3/8" x 2 1/16"	FILAMENT	5.0	3.0	—	—	Maximum A-C Voltage per Plate....500 Volts, RMS Maximum D-C Output Current....250 Milliamperes	5Z3
12Z3	HALF-WAVE RECTIFIER	SMALL 4-PIN	FIG. 22	4 1/4" x 1 9/16"	HEATER	12.6	0.3	—	—	Maximum A-C Plate Voltage....250 Volts, RMS Maximum D-C Output Current.... 60 Milliamperes	12Z3
25Z5	RECTIFIER-DOUBLER	SMALL 6-PIN	FIG. 5	4 1/4" x 1 9/16"	HEATER	25.0	0.3	—	—	Maximum A-C Voltage per Plate....125 Volts, RMS Maximum D-C Output Current....100 Milliamperes	25Z5
1-v°	HALF-WAVE RECTIFIER	SMALL 4-PIN	FIG. 22	4 1/4" x 1 9/16"	HEATER	6.3	0.3	—	—	Maximum A-C Plate Voltage....350 Volts, RMS Maximum D-C Output Current.... 50 Milliamperes	1-v°
80	FULL-WAVE RECTIFIER	MEDIUM 4-PIN	FIG. 2	4 11/16" x 1 13/16"	FILAMENT	5.0	2.0	—	—	A-C Voltage per Plate (Volts RMS). 350 400 550 D-C Output Current (Maximum MA.) 125 110 135 The 550 volt rating applies to filter circuits having an input choke of at least 20 henries.	80
'81	HALF-WAVE RECTIFIER	MEDIUM 4-PIN	FIG. 3	6 1/4" x 2 7/16"	FILAMENT	7.5	1.25	—	—	Maximum A-C Plate Voltage....700 Volts, RMS Maximum D-C Output Current.... 85 Milliamperes	'81
82	FULL-WAVE ▶ RECTIFIER	MEDIUM 4-PIN	FIG. 2	4 11/16" x 1 13/16"	FILAMENT	2.5	3.0	—	—	Maximum A-C Voltage per Plate....500 Volts, RMS Maximum D-C Output Current....125 Milliamperes Maximum Peak Inverse Voltage....1400 Volts Maximum Peak Plate Current.... 400 Milliamperes	82
83	FULL-WAVE ▶ RECTIFIER	MEDIUM 4-PIN	FIG. 2	5 3/8" x 2 1/16"	FILAMENT	5.0	3.0	—	—	Maximum A-C Voltage per Plate....500 Volts, RMS Maximum D-C Output Current....250 Milliamperes Maximum Peak Inverse Voltage....1400 Volts. Maximum Peak Plate Current.... 800 Milliamperes	83
84 also 6Z4	FULL-WAVE RECTIFIER	SMALL 5-PIN	FIG. 23	4 1/4" x 1 9/16"	HEATER	6.3	0.5	—	—	Maximum A-C Voltage per Plate....350 Volts, RMS Maximum D-C Output Current.... 50 Milliamperes	84 also 6Z4

▶ Mercury Vapor Type. ° Interchangeable with Type 1.

,NS

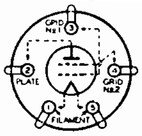


FIG.7

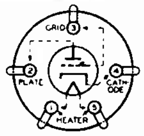


FIG.8

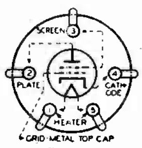


FIG.9

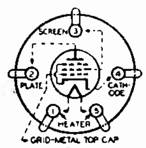


FIG.9A

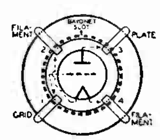


FIG.10

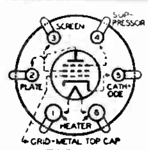


FIG.11

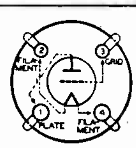


FIG.12

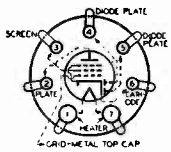


FIG.21

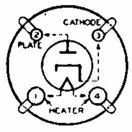


FIG.22

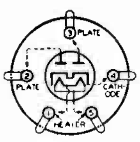


FIG.23

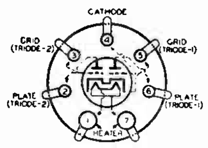


FIG.24

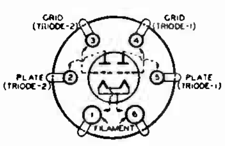


FIG.25

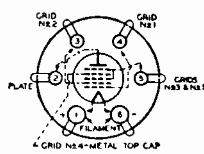


FIG.26

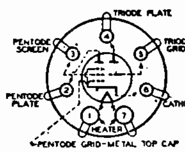
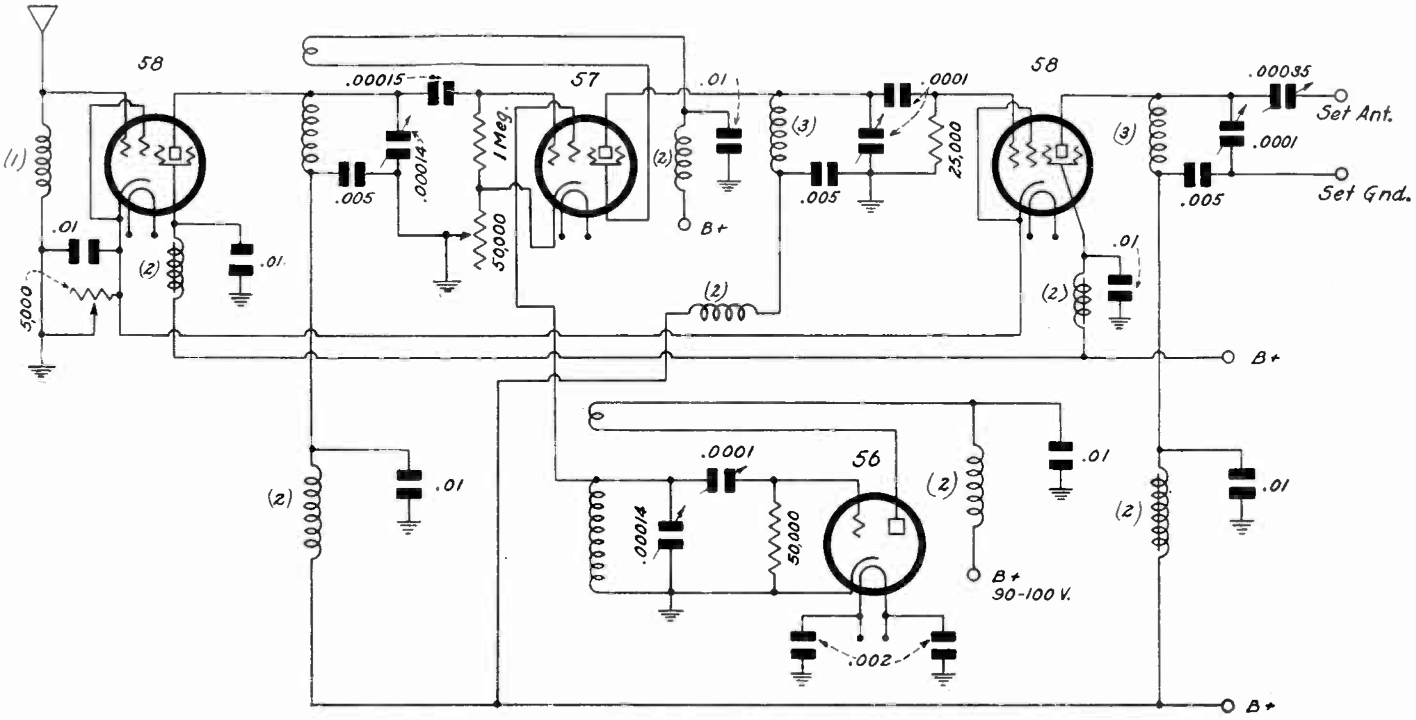


FIG.27

INDEX OF TYPES BY USE AND BY CATHODE VOLTAGE

CATHODE VOLTS	POWER AMPLIFIERS	VOLTAGE AMPLIFIERS *Including Duplex-Diode Types*	CONVERTERS IN SUPERHETERODYNES	DETECTORS	MIXER TUBES IN SUPERHETERODYNES	RECTIFIERS	CATHODE VOLTS
5.0	112-A, 71-A	01-A, 40, 112-A	—	00-A, 01-A, 40, 112-A	—	5Z3, 80, 83	5.0
6.3	6A4, 38, 41, 42, 79, 89	6B7, 6C6, 6D6, 6F7, 36, 37, 39-44, 75, 76, 77, 78, 85	6A7, 6F7	6B7, 6C6, 6F7, 36, 37, 75, 76, 77, 85	6A7, 6C6, 6D6, 6F7, 36, 39-44, 77, 78	1-v, 84	6.3
7.5	10, 50	—	—	—	—	'81	7.5
12.6	—	—	—	—	—	12Z3	12.6
25.0	43	—	—	—	—	25Z5	25.0
30.0	48	—	—	—	—	—	30.0

Tube symbols and bottom views of socket connections have pin numbers according to the new system recently standardized by Radio Manufacturers Association, Inc. Courtesy RCA Radiotron Co., Inc. Copyright, 1934.



A four-tube short-wave converter.

Radio University

ANSWERS to Questions of General Interest to Readers. Only Selected Questions Are Answered and Only by Publication in These Columns. No Correspondence Can Be Undertaken.

Neon Tube Coupling

HAVING CONSTRUCTED a neon audio oscillator, I am desirous of using this for modulation purposes. It seems very difficult to get proper coupling. So far I have not been able to get the audio or modulation into the r-f circuit. Can you suggest a method?—K. L.

Lead the intended ground or negative end of the neon-tube oscillator to its termination through the tuned winding of the radio-frequency stage, if the audio intensity is not great. Otherwise a pickup coil in the neon circuit may be put in series with one of the elements of the vacuum tube, for instance, between screen and screen load, if a screen-grid tube is used.

* * *

Growl But No Signals

A SMALL short-wave set that I bought consists of a regenerative detector and two stages of resistance coupling. When I connected up the batteries all I heard was a steady growl. Also it seems there is no regeneration in the tuner, assuming I could detect the presence of regeneration through the noise. Please indicate remedies.—I. L.

The steady tone is due to feedback in the audio amplifier. When the feedback is at a low frequency, about that of the repetition of explosions of a motorboat engine, it is called motorboating, but whatever the frequency, if motorboating means oscillation, it is motorboating. Therefore it is suggested that you put a large capacity condenser across the B batteries, or reduce either of grid resistor in the audio channel until the trouble disappears. Old B batteries augment this trouble a great deal and fresh ones should be tried. When you get rid of this trouble you will better be able to judge whether there is any trouble in the tuner. A visual test for regeneration is to put a bypassed current meter in series with the plate circuit, and when the regeneration control is varied over its extreme there should be sharp differences of plate current. If the needle stays still there is no feedback. Try reversing the connections to either the secondary or the tickler, also increasing the B voltage on the detector, decreasing the series antenna condenser, or, if no such condenser is in circuit insert one, and have it small enough to do the trick. Decreasing the value of the plate load resistor also helps regeneration. Finally try more tickler turns.

* * *

Balanced Colpitts

WHAT IS the balanced Colpitts receiver? Is it advisable to use this receiver in a converter? I desire to build a four-tube short-wave converter. Please show a diagram.—P. M. L.

The balanced Colpitts is an oscillator, not used for reception, but for transmission, or, in test oscillator practice, for generation, as the word goes. The balanced Colpitts diagram is shown at bottom of this page. Across the tuning coil L are the two sections of a gang condenser. Frame is grounded to B minus, and leak R1 returned to that point. The two series inductances L/2 are one-half L. They create the balance. If unable to obtain three inductances, two of which equal half the inductance of the third, use five coils. Across one put the tuned circuit. Connect two coils in parallel and use each of two parallel pair as L/2. The need for the balanced Colpitts, or other stabilized circuit, is ever-present in short-wave converters, but the science has not advanced so far that the application is being made. A diagram such as the one at top of this page may be followed for conformity to present practice.

* * *

Separate C Supply

WHY ARE NOT C eliminators included in the better grade of receivers? I do not know of any commercial set that has a C eliminator built in. I mean a separate rectifier for C bias.—E. D. C.

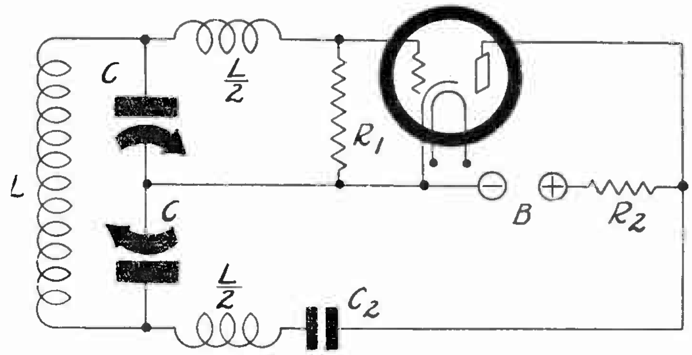
Probably the cost prevents a wider use of this device. On the whole it is extremely advantageous to have a separate C supply, and the rectifier tube for this purpose may be any small receiver tube, although precautions must be taken to avoid wrong polarities. For instance, a filament type tube would require a seperate filament winding. A heater type tube ought not be used if filament type tubes obtain the bias, as then during warming up of the C rectifier the power tubes would be zero biased.

* * *

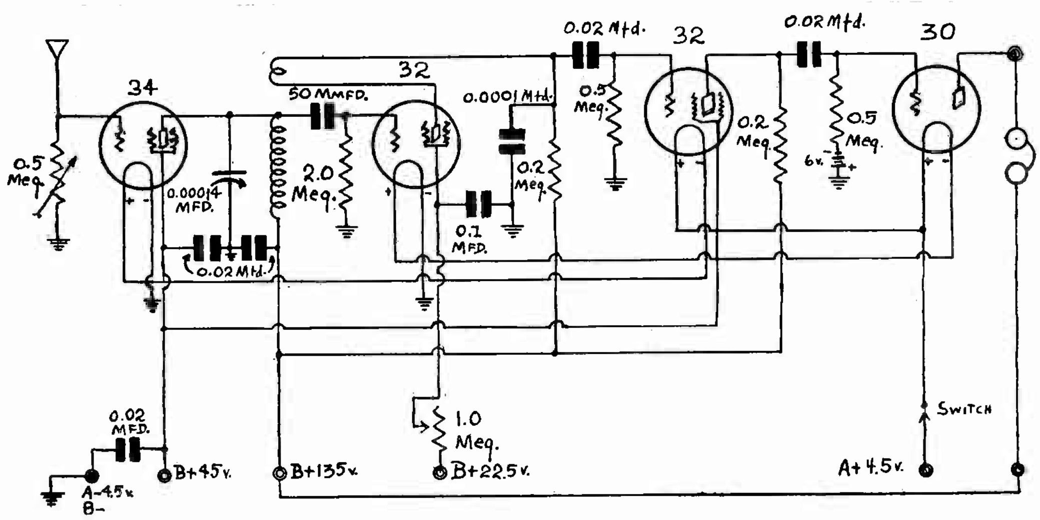
Voice-Coil-Connected Lamp

CAN NOT a neon tube with limiting resistor be used as output indicator, by connection across the voice coil of a dynamic speaker?—O. C.

Yes, that is practical, although since the voice coil is the secondary of a large ratio step-down transformer, unless the signal put into the primary is very large there would be no indication in the lamp. However, the lamp could be connected across the primary, though access to the primary is not so handy.



A Colpitts oscillator. This circuit is known as the balanced type and is stable because of the series conductances L/2.



Four-tube battery short-wave set.

Closeness of Dial Reading

TO ABOUT WHAT percentage would you say that an ordinary dial could be read? I ask this because a dispute has arisen between a friend and me. One of us says that 1 per cent. is about all that can be expected while the other insists that one-quarter of one per cent. can be read easily.—J. B.

The answer depends somewhat on the type of dial. Ruling out the button size dials used on midget sets, and assuming a diameter of something around 2.5 inches or more, with a sharp index, there should be no trouble in reading to one-quarter of one per cent. Readings to 1 per cent., of course, are easy, since they represent simply the difference betwen adjoining bars of a scale calibrated from 0 to 100. Perhaps that's what gave the 1 per cent. contender his idea. If the diameter is 3 inches, a reading to one-quarter of one per cent. would be equal to discrimination of a difference of 0.012 inch.

* * *

Power Economy

WHEN A SERIES resistor is connected between a transformer winding and filament served, since the voltage at the tube is cut down, is there not a power economy, compared with working a tube requiring a higher voltage?—C. D. A.

The question of power economy depends on the current flowing and the voltage that drives the current. Your question does not give the details. The tube requires less voltage. But suppose it requires more current? Instead of 6 volts at .25 ampere it may require 2.5 volts at 1.75 amperes. In the first case, the dissipation in the tube filament was 1.5 watts. In the second case it was 4.375 watts. Yet the voltage was lower in the second instance. Ignoring the limiting resistor, refer to the voltage at the transformer, and read the total current. The power is the product of the two, and the resistor need not be considered independently. It represents a power loss, but the power expended has been determined including the loss.

* * *

Knife-Edge Pointers

IT SEEMS TO ME that the pointers on airplane dials are too thick by far, in most instances, somewhat better in other instances, but that knife-edge pointers should be used.—I. K.

Closer pointers no doubt will come in due course, although there is no need of the pointer outpacing the circuit. For instance, there is still trouble with oscillator drift at the higher frequencies of short waves, and not until this is corrected in most receivers, and the calibration therefore takes on more significance, is there need for closer pointing. In fact, the broadness of the pointer, that you refer to, is in a measure a mask for the drift and in general the lack of coincidence between receiver calibration and actual response frequency. In a known instance the pointer thickness, measured in kilocycles, so to speak, was 35 kc in the highest frequency band. This proves that you are right that closer pointers, and even knife-edged ones, will be an advantage, but that advantage only will apply when the receivers themselves are closer than they now are to following a production calibration curve.

* * *

More Trouble Abroad

RECENTLY I SENT an American receiver to a friend of mine in a foreign country. This set had a disc dial which was driven through contact that a small wedge wheel made with the edge of the disc. My friend reports that this wheel rides in bumpy fashion over the disc periphery, but this was not true when I sent him the set, for I tried it out painstakingly. What shall I tell him?—K. L.

Tell him that the bumps are caused by the electrolytic action between the dissimilar metals—the copper of the wedge wheel and the aluminum, brass, etc., of the disc proper. This wheel can be removed by unscrewing a nut. When the deposits are cleaned away with ammonia the trouble will disappear. The repaired part should be rubbed thoroughly dry before replacement.

* * *

Speaker and Microphone

CAN A SPEAKER be considered as an inverse microphone?—P. W.

Yes, because the microphone receives sound and changes it into electrical form, while the speaker receives electrical energy and changes it to sound. Both devices are therefore transducers, because they accomplish a change from sound values to electrical values, no matter in which direction.

* * *

Time Map

I WOULD LIKE to obtain a mercator map of the world for classification of the countries, etc., as to their respective times, so I can use better sense in tuning for a foreign station when it is on the air.—W. D.

Trade questions, such as this one, should be addressed to Trade Editor, RADIO WORLD, 145 West 45th Street, New York, N. Y. Such a map is obtainable.

* * *

Inertialess Electron Stream

IS IT CORRECT to say that the electron stream is inertialess?—I. N.

Yes, it is. The stream responds practically instantly to outside influences and this is the equivalent to absence of inertia. Had the stream inertia it would tend to keep on doing what it had been doing, in the manner it had been doing it though presented with an influence or inducement to do otherwise. In fact, the cathode-ray oscillograph tube is commonly referred to as one using the "inertialess" cathode ray, which is an electron stream.

* * *

The 32 as Detector

CAN THE 32 be used as a detector in a short-wave set? I have heard it is not recommended as detector. I would like to build a set using plug-in coils, with a blocking stage ahead of the regenerative detector. Two stages of audio for good earphone reproduction are desired.—W. C.

The 32 can be used as detector. It is the 22 that is not recommended for detection. The circuit shown at the top of this page has 34 as the blocking tube, two 32's as detector and first audio tubes, and a 30 output tube.

* * *

Harmonic Values

CAN YOU SUGGEST a simple way for me to measure the relative values of harmonics of a signal generator?—I. K.

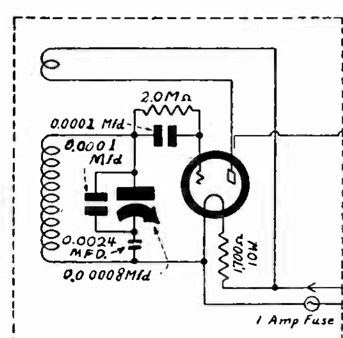
A method which suggests itself is to attach an antenna to the generator, meaning any wire long enough to radiate, so a response is heard in the receiver without any other connection, and then put a meter bypassed d-c current meter in series with the detector plate (or in a superheterodyne, the second detector plate). Balance out the d.c., if you can, with a battery voltage reversed in polarity (positive toward plate, negative toward B plus). This will enable closer readings, as you start with zero. Now set the generator going and note the current readings of the meter for known harmonics, for various frequencies of the generator, harmonics of which respond in the receiver. This method is limited by the generator's amplitude stability, or equality of output at all fundamental settings.

* * *

Simplest Generator

KINDLY SHOW the simplest universal signal generator for coverage from about 110 kc up, with modified bandspread, so that it will be possible easily to determine frequency differences of 1 kc on the fundamental. A word about the use of harmonics for higher frequencies would be appreciated. —L. E. C.

The simplest generator is diagramed below. This works on a.c. or d.c., but on d.c. there is no modulation. If a coil having secondary inductance of 3.5 millihenries is used, and across this secondary is put the usual tuning condenser, say, 350 to 400 mmfd. or so, and a 0.0001 mfd. condenser put in parallel, the coverage will be from about 110 kc to 200 kc safely. Differences of 1 kc then would be easily read. As for harmonics, they can be used without confusion. See the articles on the use of harmonics in the September 29th issue. In general, if two consecutive response-creating frequencies of the generator are used for harmonics, the difference between the frequencies read, divided into one of the frequencies read, gives the harmonic order of the OTHER frequency read. Methods applying the harmonic order, that is, multiplying a read frequency by a whole number, are most accurate.



Simple signal generator with modified bandspread.

Station Sparks *By Alice Remsen*

CROONERS AND THE TOOTHACHE

MY SISTER IVY, who lives in London, England, sends me an English weekly, "The Radio Times." Some of their comments on American programs are very amusing. This week there is a cartoon entitled "Baying At the Moon," and this comment follows: "It is a very good drawing of a negro sitting in a swamp apparently baying at the moon, and it looks to us very much like a visual conception of the people who croon with the dance bands. At least, we have often imagined that only a very melancholy negro sitting in a swamp with a bad toothache could produce some of the sounds we hear." . . . And speaking of amusing things, the housewives of the nation will no doubt be pleased to hear that Allan Prescott, the Wife Saver, is to continue his activities, via the NBC-WJZ network each Monday and Wednesday at 11:00 a. m., under the sponsorship of Fels and Co. This youngster manages to pack a lot of humor into the broadcasting of such prosaic things as "How to Turn Your Husband's Socks"—and "What to Do When the Milk Turns Sour." Associated with Prescott will be, of course, Ray Heatherton, the romantic baritone, and Oscar, the pianist, who is really Irving Miller; and do they have a good time together! Well, rather!! . . . There is a new morning commercial on three times weekly that you should enjoy; it is called "The Land of Beginning Again," featuring the poems and philosophic comment of Rod Arkell, the singing of Ruth Everest and Harrison Knox, the music of Lew White at his organ, and an instrumental ensemble. Each Monday, Wednesday and Friday morning at 10:30 a. m. over an NBC-WEAF network. Also, on Sunday the program will be on the air for a half-hour, with Louis Katzman's Orchestra furnishing the musical background instead of White and the ensemble, and with Arkell and the same soloists, at 4:30 p. m., over an NBC-WJZ network. . . .

TIGERS AND BIRDIES

Frank Buck, Ali, Tim and the other jungle adventurers heard in Frank Buck's Pepsodent program, have moved from Chicago to New York, and will hereafter broadcast from Radio City. Charlie Range and Hal Woods, the sound effect men who are responsible for the trumpeting of elephants, the roar of tigers, chirping of tropical birds, and other jungle sounds, and Ferrin Fraser, the novelist, who writes the adventures for radio presentation, accompanied Buck to New York. . . . Josephine Gibson, celebrated cooking expert and head of the home economics department of the Heinz Company, is back on the air over an NBC-WJZ network with her Hostess Counsel talks each Monday, Wednesday and Friday at 10:00 a. m. Miss G. speaks from the Heinz Auditorium, Pittsburgh, and is accompanied by Milton Lomask, violinist and concertmaster of the Pittsburgh Symphony, and Louis Miller at the organ. . . . Sunday afternoon at 2:00 p. m. brings us Anthony Frome, tenor, and Alwyn Bach, narrator, in a new series of fifteen-minute broadcasts under the sponsorship of the M. J. Breitenbach Company, over an NBC-WJZ network. Frome, who is known as the Poet Prince, brings a romantic cycle of songs from all over the world, with Bach setting the scene for each melody; we wander in fancy with the Poet Prince through many countries, while he sings folk songs in the native language of each country visited. . . .

UNCLE EZRA ON DECK

City slickers of the East now have a chance to listen to a brand of rustic humor and philosophy that has captivated westerners, for old Uncle Ezra, long-time favorite of National Barn Dance audiences, has a series of thrice-weekly programs of his own. Under the sponsorship of the Dr. Miles Laboratories, Uncle Ezra now operates his own mythical small town, five-watt radio station over an NBC-WEAF network each Wednesday and Friday at 7:30 p. m., and each Sunday at 7:15 p. m. He is supported by a large cast of actors including his wife, Nora Gunneen. . . . Angelo Ferdinando and his orchestra have taken to the air for another winter from the Hotel Great Northern. Four times weekly over an NBC-WJZ network. . . . Isn't it grand?!!! Sherlock Holmes is coming back! The first broadcast will be on Sunday afternoon, November 11th, at 4:00 p. m. over an NBC-WJZ network. Richard Gordon will again impersonate Holmes, and Leight Lovell, veteran British stake artist, the vere beloved Watson. Joseph Bell, of course, will be heard in his old role, and it will be sponsored again by the George Washington Coffee concern, and I offer thanks here and now for the treat which I know is in store for me!! . . . Winter is upon us, at least it seems that way when cough drops start going on the air. This time it's Luden's. They have a jolly good show for you, too—Dick Liebert's Musical Revue, featuring Dick, of course, at the organ; Robert Armbruster and Milton Kraus, at two pianos, a novelty quartet and Mary Courtland, contralto. November 2d is the opening date, 8:15 p. m. the time, and WJZ the station—oh, yes, and the blue network. . . . Armbruster, by the way, is in charge of the dovetailing of musical fragments, original and otherwise, to be used in the sequences of the Lux Radio Theatre presentations, each Sunday at 2:30 p. m. over an NBC-WJZ network. . . .

HERE COMES TITO GUIZAR

Over at CBS Tito Guizar has started his new series for Brillo, each Sunday at 12:30 p. m. . . . and those famous "Og, Son of Fire" stories are being dramatized for the kids three times a week, Mondays, Wednesdays and Fridays at 5:00 p. m. These stories, as you probably know, were originally written by Irving Crump for the "Boys Life" magazine; now they are being used to advertise the Libby, McNeill & Libby products. . . . Another popular series has returned to CBS—"Marie, the Little French Princess," five times weekly, at 2:00 p. m. . . . The Curtis Institute of Music, Philadelphia, will present its sixth annual series of vocal and orchestral concerts over the Columbia network beginning Wednesday, October 24th, at 4:15 p. m. . . . The garage of America's Little House, at Park Avenue and 39th Street, is being used as a broadcasting studio by CBS; one of the programs heard regularly from there is the Triangle Club, sponsored by Benjamin Moore and Co.; each Wednesday at 11:30 a. m. starting on October 24th. . . . Leon Belasco and his orchestra are back on the air from the Casino de Paree; twice weekly, Sundays at 11:30 p. m. and Wednesdays at 11:00 p. m. CBS. . . . It is Alexander Gray who is pinch-hitting for Everett Marshall on the Broadway Varieties show these Wednesdays at 8:30 p. m. Everett is having his tonsils out. . . . The American School of the Air opens again on WABC and network for its sixth consecutive season, on Monday, October, 22d, and each day thereafter except Saturday and Sundays, at 2:30 p. m. . . . Gordon, Dave and Bunny, the Oxol Trio, have had their contract renewed, and may still be heard each Monday and Wednesday at 5:45 p. m. . . . Another popular program to return to the air is Columbia's Dramatic Guild, Sundays at 10:30 p. m. . . . Waring's Pennsylvanians are all set for a five-week vaudeville tour beginning November 2d. They will play Cleveland, Pittsburgh, Washington, Baltimore, and Philadelphia. So look for them in your home town. . . .

ABS SPREADS OUT

The American Broadcasting System now boasts of eighteen stations in its tie-up. Burt McMurtrie, director of program operations for ABS, is planning an extensive schedule of well-known names in the radio and theatrical field which he will present this winter over the newly formed network. Well, the more networks the merrier, so far as the artist is concerned; it means that much more work. . . . An old WLW artist, Tony Cabooch, and his daughter, Jimmy Dew, have been signed by ABS for a five-time weekly schedule. . . . Brad Browne, an old friend of CBS fame, will also be heard in the "Wild Goose Chase," which is nothing more nor less than the old "NitWit" hour—our pals, Lord Ashcart, Professor R. U. Musclebound, Aphrodite Godiva, Madame Mocha de Polka, etc., will be heard with Brad; Mondays at 10:00 p. m. . . . Trixie Friganza has also been coralled by ABS as the Mistress of Ceremonies on their "Americana" program, which may be heard for a full hour each Saturday night at 9:00 p. m. . . . Another old time variety actress, Marie Hartman, has been signed by ABS to appear in a series entitled "Furnished Rooms," written especially for her by Ned Joyce Heaney. These sketches will be heard each Monday, Wednesday and Friday at 8:45 p. m. over the ABS-WMCA network. . . .

STUDIO NOTES

Johnny Green and Betty Barthell are the latest vaudeville combination to be recruited from radio. . . . David Ross was the first person around the CBS studios to show up wearing his winter spats. . . . Elsie Thompson, formerly organist at the Brooklyn Paramount Theatre, has joined the CBS staff as pianist and organist. . . . Peter Van Steeden, NBC orchestra leader, is a handball enthusiast. . . . John Seagle, NBC baritone, was born in Paris. . . . You should taste Jimmy Melton's lemon chiffon pie. Yes; he makes it himself. . . . Frank Black's parents were Dutch Quakers. . . . Ralph Kirbery is receiving instructions in flying from Jack Ericson, "the flying bandsman." . . . Irene Beasly never sings before breakfast. . . . Jack Benny smokes on an average of twenty cigars a day. . . . Frank Parker skips rope every morning for fifteen minutes. . . . A short featuring the Pickens girls is now being shown in theatres. Little Patti plays the ingenue lead. . . .

STATIONS SEEK NEW TALENT

Stations are seeking new artists, new songs and new dramatic pieces. Some hold auditions in the form of competition.

Quick-Action Classified Advertisements

5 cents a word. 50 cents minimum.

WORK AT HOME: Men, women make good money. Particulars for stamp. Chas. Link, 3286 East 116th St., Cleveland, Ohio.

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

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

POEMS SET TO MUSIC—Send poems to McNeil, Bach. of Music. 1582 West 27th St., Los Anegles, Calif.

"GATEWAY TO RADIO" by Maj. Ivan Firth and Gladys Shaw Erskine. An intimate exposition by experienced authors, directors and players, of the radio broadcasting industry, with helpful hints on gaining success as a radio author or actor. Contains much of interest to sponsors, program-builders, studio directors, advertising agencies and listeners. Contains reprints of manuscripts of successful air plays. Price $2.50. Book Dept., Radio World, 145 W. 45th St., N. Y. City.

TECHNICAL SCHOOL GRADUATE wants position in radio factory or laboratory. Factory experience. Write B. Mac-Holmes, Box 132, Corona, N. Y.

SPECIAL—500 business cards, $1.25. QSL cards, lowest prices. Cumberland Printing Co., Box 2145, Knoxville, Tenn.

CAST ALUMINUM RADIO CHASSIS. Send 10-cent stamp for blueprint. Valentine, Stewartsville, New Jersey.

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

U. S. GOVERNMENT SHORT-WAVE STATION LIST

2,400 short-wave stations listed by frequency, wavelength, with call, location, and power. Some time-tables included. All the short-wave phone transmitters on earth (except amateurs)!

Distance map for world application printed right in the book!

THE CONTENTS:

Station Identification: List of the most popular short-wave program stations of the world that use characteristic "air signatures."

Foreign Alphabetic Pronunciation: How the letters of the alphabet and numbers 1 to 50 are pronounced in English, French, Spanish, German and Portuguese.

Short-Wave Broadcasting and Police Radio Stations by Countries: The calls, location and frequencies are given for the whole world. It repeats data found in the main grouping of the 2,400 stations by frequencies.

Distances to Foreign Cities: A textual and map-illustrated explanation of how to determine how far any one city on earth is from some other city.

Short-Wave Radiophone Stations by Frequencies: This is the comprehensive, never-before-available list of the 2,400 or more stations, including all the program stations on earth that send on short waves, using phone (speech and music) but not including amateurs. A treat unparalleled in radio history—the most accurate list of its kind man has ever produced!

Time Zone Chart: This insert (stitched right in the book) is a black and white reproduction of a colored chart issued by the Hydrographic Office, Navy Department.

Send $1.00 for 8-weeks subscription for RADIO WORLD *and ask for "World Short-Wave Radiophone Transmitters" sent post-paid as premium.*

RADIO WORLD
145 WEST 45th STREET,
NEW YORK CITY

Presenting the New...

POWERTONE

Signal Generators

Model 77 DeLuxe Type SIGNAL GENERATOR

- **Calibrated Frequency Range 115-3000 KC. with a 1000 cycle Modulated Signal.**
- **Operates efficiently on A.C. or D.C. Current.**
- **The Model 77 signal generator is the ideal for simplicity and accuracy in service oscillators.**

THE tubes employed are a 6A7 and a '37. The 6A7 operates in a unique circuit which generates audio and radio frequencies from this same tube. The radio frequency circuit uses an electron coupled type oscillator which is inherently extremely staple. This circuit generates powerful harmonics which are available down to 10 meters. The .F. modulated signal can be employed for checking intermediate frequencies and for testing the general overall gang of All-Wave frequency circuits.

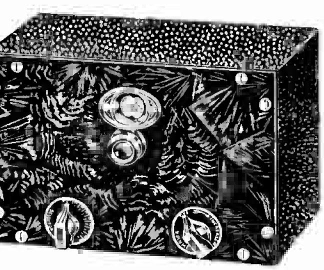
The audio frequency note generated by the 6A7 is fixed at 1,000 cycles and is brought out to tip jacks on the front panel. This signal may be employed to check speech amplifiers, condensers, coils and etc., as well as being capable of supplying an audio signal which is always of use about the service laboratory. By this arrangement it is possible to use the audio frequency note separately. In this way the instrument allows the user to obtain either pure R.F., pure radio or modulated R.F.

Another startling feature in the Signal Generator is the new Egert dial employed. This new dial allows the serviceman to absolutely read accuracies as close as 500 cycles at any point of the broadcast band. This dial in conjunction with the electron coupled oscillator gives a standard as close as 1/10 of 1% of frequency. The appearance of the unit is beautiful in every respect The entire unit is completely enclosed in a handsome black metal etched portable carrying case. A calibrated curve with a complete set of operating instructions are supplied with each oscillator. Also instructions are given how to add an attenuator.

Battery Model: Size 6x5x9". Weight 4½ pounds.

List Price $25.00. Cat. No. PO-77. NET $10.95

BERNARD SIGNAL GENERATOR



High Stability; Accuracy 1%

HERE IS THE FIRST NEWS of our exclusive battery-operated Signal Generator, designed by Herman Bernard, and using his frequency-calibrated scale for fundamentals of 135 to 380 kc. with all popular intermediate frequencies inscribed right on the dial, and with calibration, also directly on the dial, for the broadcast band. Thus coverage from 135 to 1,520 kc is read. Higher frequencies, almost without limit, also can be measured without confusion. And the price is the world's lowest for such an instrument.

No Charts! Scale is Directly Read in Frequencies

This laboratory-tested Bernard precision instrument, Model 336-SG, uses a 34 r-f oscillator in a stabilized circuit, has attenuator that contributes NO DETUNING, and has optional modulated-unmodulated service by switching. The audio oscillator is a 30. Electron coupling is used between a.f. and r.f. and also between output and measured circuit. Accuracy is 1 per cent.

Model 336-SG is in a crinkle-finish black shield cabinet, 9" wide, 6" high, 5" front to back, weighs 7½ lbs. complete. It has bar-handle control of volume and modulation. It is useful for lining up superheterodyne i-f channels, also the r-f channels of any receivers, and can be used satisfactorily for peaking on short waves as well. Instruction sheet supplied. Order Cat 336-SG, wired, complete with 22.5v. B battery, 4.5v. A battery, and tubes, ready to operate, (shipping weight, 8 lbs.) Cat. No. 336-SG. NET **$7.95**

TEST OSCILLATOR With Output Indicator

ACCURATELY calibrated with direct reading of major frequencies on full vision tuning dial. Rigid design and special oscillator circuit guarantee a clean steady output signal, which will not drift or shift under any conditions. Supplied in three models: A.C., A.C.-D.C. universal and Battery.

Extreme care has been taken in its construction and accuracy is guaranteed to be better than 2%. This rating is extremely conservative. In many instances accuracy better than 1% is obtained. The primary scale is calibrated from 50 to 150 k.c. The bars are 1 k.c. apart from 50 to 80 k.c. and 2 k.c. apart from 80 to 150 k.c. Therefore when used with TRF receivers (using the 10th harmonic) the separation as registered by the calibration points is 10 k.c. from 500 to 800 k.c. to 1500 k.c.

On the upper on secondary scale the popular intermediate frequencies are clearly marked: 175, 260, 400 and 450 k.c. with 177.5—175—172.5 spotted. Frequencies not marked can be obtained by means of harmonics, by simply dividing the desired frequency by small whole numbers to obtain the nearest scale frequency.

Strong harmonics are present due to the character of the oscillator circuit employed. In actual practice sufficient signal is available for checking purposes up to the 50th harmonic and beyond. In many cases strong steady signals have been obtained up to the 150th harmonic.

Output indicator consists of a built in glow tube, which is extremely sensitive and follows every variation in frequency and intensity of the signal impressed on the indicator.
All Models **$10.95**

New 192 Page Short-Wave and P. A. Manual 50c

TRY-MO RADIO CO., Inc.
85-RW CORTLANDT STREET
179 GREENWICH STREET
NEW YORK CITY

VISIT OUR BARGAIN BASEMENTS

Instructions for Servicing Automobile Receivers

The Diamond of the Air auto set, described on opposite page, is a six-tube superheterodyne using the latest type of high-efficiency tubes and newest super circuit, giving exceptional sensitivity and tone quality, in a compact design, easy to install and service.

Installation Procedure

1. After the set has been unpacked, remove the four screws from bottom of cabinet, remove the front cover by carefully inserting screw driver at either side and exerting slight twisting pressure, slide chassis forward out of cabinet and inspect tubes to make sure if they are completely down in their sockets, after which replace chassis, front of cabinet and four screws as they were originally.

2. Determine most satisfactory mounting position on bulkhead which should be at the left-hand side or directly in front of steering column. Spot the mounting bolt location and drill ½ inch diameter hole. Insert bolt through hole and assemble washer and nut on engine side. Hang receiver over bolt head and tighten nut.

3. Attach flexible shafts to control unit by first inserting shaft as far in as possible and then tighten set screws of shaft housing, being careful they are not so tight as to cause shaft to bind in housing.

4. Mount control unit on steering post in approximately correct position. Set pointer to "530" on the dial. Turn upper control on set to extreme clockwise position. Carefully place right hand shaft in position on upper control of set and tighten screws. Next turn lower control of set to left until switch snaps, remove left-hand knob from control head by turning to correct position, place left-hand shaft in position on lower control of set and tighten set screws securely.

5. Adjust control unit position so that shafts leave set with least amount of bend possible and fasten securely in this position. Trial of controls will show best location for smooth operation.

6. Attach heavy rubber-covered lead to ammeter terminal.

7. Connect pilot light wire from control head to short black wire on set, making connection close to set, and tape up joint. Ground shield by loosening screw under nearest corner of set and connecting wire therefrom to end of shield and tighten up screw.

8. Disconnect ignition leads from spark plugs, attach one suppressor to top of each plug and reattach the ignition lead to free end of suppressor. Disconnect center wire from distributor head, and substitute distributor suppressor, then plug center wire into free end of suppressor.

9. Attach generator bypass condenser to generator frame by means of screw holding cut-out. Connect wire from condenser to generator side of cut-out switch.

10. A roof antenna is usually best, although antenna beneath the car will usually be found satisfactory. Connect shielded lead from set to antenna lead-in. Lead-in should be shielded its complete length and this shield grounded to car as near the antenna as possible and the other end connected to shielded loom coming from the set. Thick covering between sheath and conductor is necessary to avoid loss due to capacity to ground.

11. Turn left-hand knob on control head to right. If connection directions have been correctly followed, dial should become illuminated immediately and the tubes reach correct operating temperature in approximately 30 seconds.

12. Operation: The right-hand knob is the tuning control. The left-hand knob is a combination switch, volume control and key which locks the set when turned completely to left and pulled out.

Service Notes

If the radio fails to operate when unpacked, or stops working after a few days, proceed as follows: (1) Have tubes checked. (2) Remove chassis and check for loose connections. (3) Give the set a check-over entirely.

The circuit diagram on opposite page gives all necessary resistance and capacity values for serving the set.

Balancing intermediate frequency coils. These are peaked to 175 kc, and are trimmed through the top of the tall cans by means of a small screwdriver and a 5/16-inch socket wrench. Chassis must first be removed from cabinet and signal from test oscillator fed into grid cap of the 6A7 tube.

Balancing R-F Coils. The tuning control must first be attached to tuning condenser shaft with pointer set to 530 when tuning condenser is turned to maximum. Tune in a weak signal at its proper dial marking near 1,400 and adjust first the second trimmers on variable from front of chassis for loudest signal. If signal does not come at proper dial setting carefully adjust rear trimmer on variable to shift signal to its proper location and then readjust first and second trimmers. After reinstalling set in card slightly readjust first trimmer through hole in top of cabinet.

Ignition Noise. Fouled plugs or plugs with improperly adjusted gaps will affect the operation of the set. Burned or improperly adjusted breaker points will also impair the performance. In some cases a .5 mfd. or 1 mfd. condenser connected from ammeter to car frame will be required. Also, in some installations using a roof antenna, a .5 mfd. condenser connected from car frame to dome lamp lead at point where it leaves bulkhead will be required. It is usually necessary to connect a .5 mfd. condenser from primary of ignition coil to ground and from relay switch on generator to ground. Ground all of the control rods going to the instrument board of the car by soldering to each rod a length of copper braid and connecting same to the motor head. Isolate the battery lead to the ignition coil by running same through a grounded shield. In some cases it may be necessary to solder a short piece of copper braid from the shaft of the tuning condenser of set to the common ground point on the chassis just below the shaft.

Tubes should be tested at regular periods and replaced if necessary in order to maintain best performance. Each tube may be checked by comparison with a new one of the same type in its place.

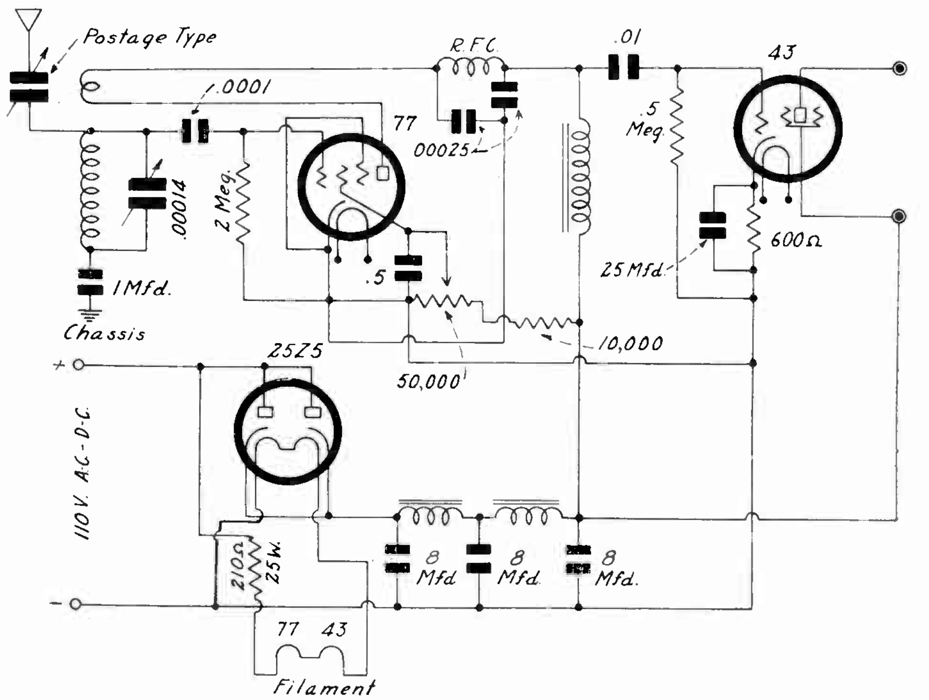
"B" power supply should require little or no attention. A full wave vibrator in connection with the primary of a transformer and the 6-volt storage battery furnishes the means of obtaining the proper "B" voltage. With the power turned on a slight buzz should be heard which indicates proper operation of vibrator. Failure to observe this buzz will denote a faulty condition, in which case the complete set should be subjected to a close test and inspection.

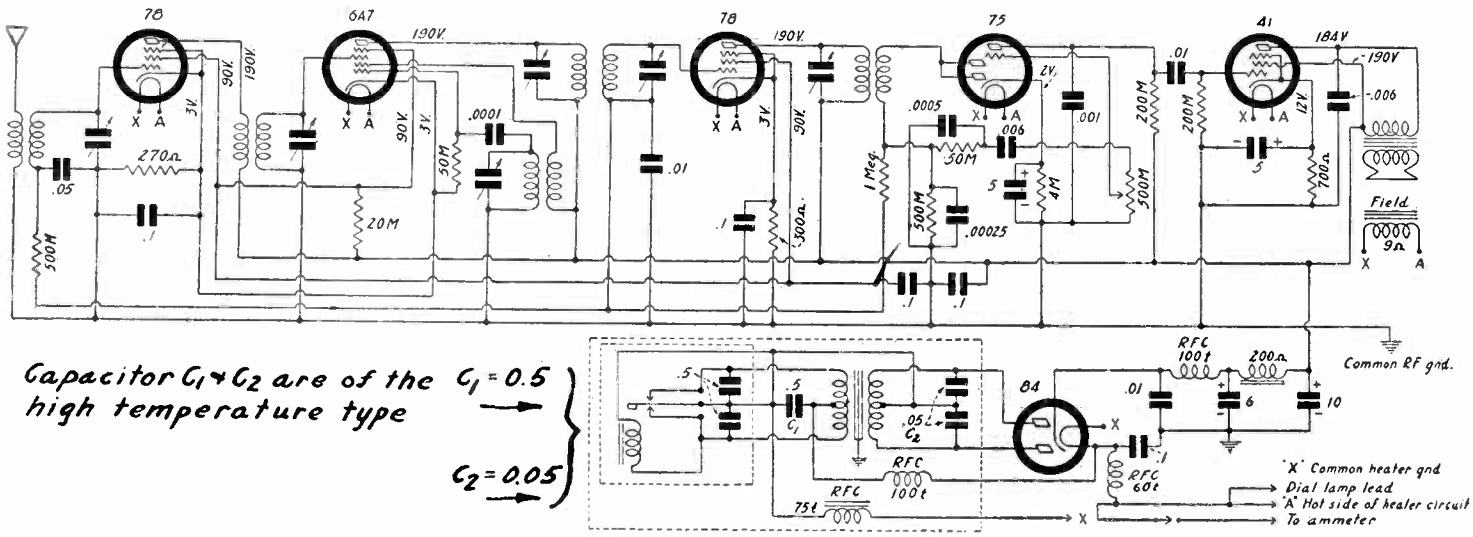
How to Obliterate Receiver Hum

Since the question of hum arises so often in regard to simple short-wave sets, the question is whether the universal type of receiver can be free from hum. Indeed it can. It will work just as quietly as any other a-c receiver. One way to be sure of this result is to use two separate chokes, and plenty of filter capacity. In the diagram the two chokes are 30 henries each, and are not on the same core. This is a mistake some make. They read such a diagram as implying that the two windings may be on the same core. If they are on the same core, there may be more hum if both windings are used than if only one is used, and also more hum if the mid-section 8 mfd. condenser is included than if it is omitted.

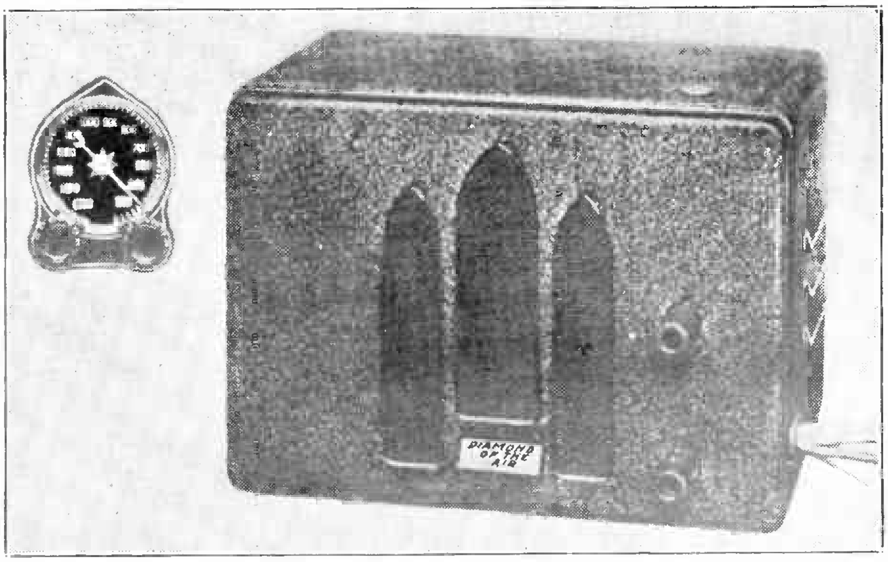
An audio choke load for the detector is also advisable. This may be the secondary of an old audio transformer. Some additional filtration is obtained in this way.

In connecting to the line care should be exercised that positive of the receiver goes to positive of the line and negative of the receiver to negative of the line, as a wrong connection might damage the first electrclyti condenser.





The circuit diagram of the Diamond of the Air automobile receiver. At left are shown the small cabinet housing the set, and the remote tuning-volume control.



Six-Tube Auto Receiver Uses a Vibrator Unit

THE gradual increased demand for convenience and reduction of expense has made the selection of the B-batteryless type automobile receiver almost unanimous.

There are two general types of auto B eliminators: the vibrator and the converter. The vibrator makes and breaks a circuit, and due to the associated coil system, varying electro-magnetic fields are set up. The variation in the magnetic field, or spurt and collapse, constitutes a.c. Therefore the output of the vibrator's primary can be communicated to a secondary and fed to a rectifier tube, like the 84, and we can obtain a high-voltage rectified value. The d.c. output in the circuit diagramed, which is the 6-tube Diamond of the Air car set, is 190 volts.

R-F Waves Squelched

Not only must the audio-frequency ripple be filtered out, but also the radio-frequency strays arising from the action of the vibrator. As is well known, the vibrator is a very effective type of B eliminator for car sets, but the filtration must be good, otherwise there would be more interference than from a motor generator, filtration values equal in both instances. Also, the strays referred to are familiar aspects of shock-excitation voltages, for the strays are of practically all frequencies. Therefore a radio-frequency choke coil is used with condensers to get rid of this type of interference, and the result is that there is quiet and pure-tone operation, and the nuisance of the B batteries is swept aside.

Mastering the problems associated with motor generator or vibrator-unit types of B eliminators is part of the job of the car set designer, and to a considerable extent the success of the set depends on the success of this particular solution.

So, after the filtration was made all that was necessary, the shielding was made even more than was absolutely necessary, and we have the actual case of shield within shield, so that there will be no interference from the opposite direction, that is, due to interaction arising from disturbances coming into the set.

High-Temperature Condensers

Moreover, it must be known that quite some heat develops in part of the circuit where condensers are placed, and instead of putting just the run of condensers there, high-temperature type condensers were used. These are identified as such on the diagram, two to the left of the plates of the 84, and one to the left of the primary of the transformer feeding the 84.

The circuit is a standard one. It has been found that most "highly original" circuits do not give much satisfaction, except mental satisfaction in the accomplishment of a scientific feat. The sets to build are those that are orthodox, and to which much pains has been given to make the engineering of the highest practical type. So we have here a stage of tuned-radio-frequency amplification ahead of a pentagrid converter tube, with a stage of high-gain intermediate-frequency amplification, a diode second detector, a triode driver and a 41 output tube. This is a very satisfactory pentode for car use.