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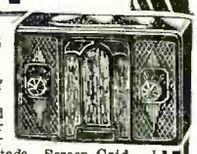

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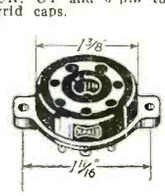

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REMEDIES for SQUEALS

Due to Harmonics in a Super

By J. E. Anderson

IT HAS been observed in superheterodynes that at certain settings of the dial there is a heterodyne squeal that seems to relate the intermediate and the signal frequencies in a definite way. Particularly, it appears that the harmonics of the intermediate frequency beat with the signal to produce audible beats.

It may be that the intermediate amplifier distorts so that harmonics of the intermediate frequency are produced, or it may be that the second detector is responsible. In either case the harmonics must be coupled back in some manner so that they can mix with the signal frequencies of suitable values, or the signal frequencies might get by the intermediate selector and mix with the harmonics of the intermediate in the second detector.

Isolation Remedy

If either situation obtained, the remedy for the heterodyning would be to isolate the different parts of the super more thoroughly. That is, the squealing could be stopped by preventing the harmonics from going back to the first detector or by preventing the signal frequencies from getting to the second detector. Since in either case the transferred frequencies have the same values the same kind of filter would work and it would not make any difference whether the mixing took place in the first or the second detector, or in both. The filtering would work both ways.

Another Explanation

But suppose we have perfect filtering and we still have heterodyning. Further, suppose that there is no distortion of appreciable magnitude in the intermediate amplifier, so that no harmonics are produced, and that heterodyning of the type mentioned still remains. Naturally, under those conditions we must seek another explanation for the production of this interference.

The new explanation can best be carried through by example. Let us suppose that the intermediate frequency is 400 kc. With this intermediate it has been found that heterodyning occurs when the tuner is set to receive 800 and 1,200 kc, apparently

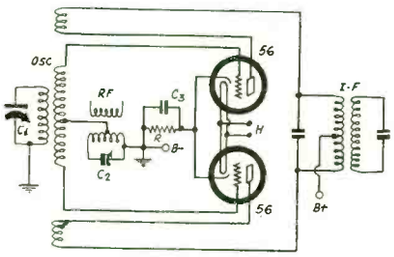


FIG. 1

The circuit of a push-pull oscillator with a possible method of impressing the r-f signal and taking off the i-f signal.

the second and the third harmonics of the intermediate.

When the receiver is set to receive 800 kc, the oscillator in that circuit is set at 1,200 kc. The r-f amplifier and first detector produce harmonics of the 800 kc signal. Therefore there are present in the circuit, in addition to the signal, frequencies of 1,600, 2,400, and so on. The oscillator also produces harmonics of its own fundamental. They are 2,400, 3,600, and so forth. We note that the third harmonic of the signal frequency is equal to the second harmonic of the oscillator frequency, both being 2,400 kc. Hence we can have zero beat between them, and this zero beat can be impressed on the intermediate frequency of 400 kc as a modulation. By zero beat here is meant actual zero as well as approximate zero beat. That is to say, it is zero beat from this point of view if there is heterodyning less than 10,000 cycles.

Other Examples

A similar explanation applies to the 1,200 kc interference. When the circuit is set to receive 1,200 kc the oscillator is set at 1,600 kc. It is noted that the fourth harmonic of the signal frequency is equal to the third harmonic of the oscillator, both being equal to 4,800 kc. Hence we can have heterodyning.

It is to be expected that the heterodyning between the third and the fourth harmonics will be considerably weaker than that between the second and the third, and that is borne out in practice. The heterodyning is much stronger on 800 kc than on 1,200 kc.

Filtering Ineffective

Against this interference, filtering would be quite ineffective, that is, filtering of the type that was previously mentioned. The damage is done in the first detector. Then what can be done to prevent or to minimize the heterodyning? First of all, harmonics of the oscillator must be eliminated to minimized. Several means are available for doing this. In the first place, the oscillator can be constructed so that it generates few harmonics. Ordinarily this means that the coupling between the plate and the grid should be loose. But there is a limit to this. Oscillation will stop if the coupling is made too loose. Some gain, however, may be achieved in this direction, and by very simple expedients. The grid stopping condenser may be made smaller, the grid may be connected to a tap on the grid leak, or it may be connected to a tap on the coil. Reducing the feedback by any means limits the intensity of the oscillation and hence reduces the harmonic content, and it also makes the resonant current larger in proportion to the grid and plate currents.

Selective pick-up is another means of reducing the harmonics from the oscillator. If the pick-up coil is coupled inductively to the frequency-determining circuit very little harmonic will get into the mixer tube. This assumes, of course, that the mixer and the oscillator are separate tubes. Loose coupling of any kind between the oscillator and the mixer will help to keep down the intensity of the harmonics.

Much heterodyning could be eliminated by using a straight line first detector. But attempts to use diode detection have not been very successful. Indeed, they have been entirely unsuccessful.

Selecting Intermediate

The heterodyning will depend on the

intermediate frequency regardless of the particular manner of dependence. Hence we can avoid interference by selecting the proper intermediate frequency, or at least we can minimize the trouble.

Suppose, for example, that the intermediate frequency is 175 kc instead of 400 kc. In this case it has been found that heterodyning occurs at 700, 875, 1,050, 1,225, and at 1,400 kc. Instead of two places we now have five possible places of interference. Yet there will be less annoying interference from these five than from the two in the other case. The reason is not far to seek: it is a matter of order of harmonics and the decreasing intensity of harmonics as the order increases.

Take the lowest possible frequency at which heterodyning may occur, namely, 700 kc. The oscillator will be set at 875 kc. The fourth harmonic of the oscillator will zero-beat with the fifth harmonic of the signal. There is not likely to be much energy in the fourth and the fifth harmonics.

The next place where interference may occur is 875 kc, the oscillator being set at 1,050 kc. The fifth harmonic of the oscillator will beat with the sixth of the signal. The intensity of the interference may be expected to be less than before. At the other possible points of interference still higher harmonics are beating, and the intensities of the heterodynes are correspondingly weaker.

Two Points of View

We demonstrated that the heterodyning could be produced by beating of harmonics of the signal and oscillator frequencies, and therefore that it was not necessary that the harmonics of the intermediate frequency should beat with the signal frequency. But the difference between these two is only one of view point. When the harmonics of the signal and the oscillator frequencies are beating we may express the situation symbolically as follows: $(F + f)n = (n + 1)F$, in which $F + f$ is the oscillator frequency, f the intermediate frequency, F the signal frequency, n the harmonic of the oscillator frequency and $(n + 1)$ the harmonic of the signal frequency. This formula may be simplified into $nf = F$. But this simplified formula is exactly that which we would set down if the heterodyning were due to beating between harmonics of the intermediate frequency and the signal frequency. Mathematically, then, the two phases of the subject are the same, but physically there may be a difference as to the place where the harmonics of the intermediate frequency are mainly produced.

Avoidance of Heterodyning

Because of this identity it appears that in order to avoid the heterodyning it is necessary to select the intermediate frequency suitably rather than to introduce filtering. We have already pointed out that if the intermediate frequency is low the intensity of the heterodyning will be less although there will be more places where the squealing might occur. We are limited in this direction by the fact that as the intermediate frequency is reduced image interference becomes a nuisance.

Perhaps some advantage can also be gained by selecting an intermediate frequency that is an odd multiple of 5,000. This has the advantage that the heterodyning will be half way between two stations at half of the possible points of interference. For example, suppose that the intermediate frequency is 175 kc. The first point of interference is 700 kc. The squeal is directly on the 700 kc station. The next point of interference is 875 kc. The squeal will be half way between 870 and 880 kc. If the 880 kc station is wanted the squealing can be avoided by detuning a little in one direction and if the 870 kc station is wanted the squealing can be avoided by detuning a little in the opposite direction. Even if there is no detuning in either case the heterodyne will be 5,000 kc, which may be quite weak. If detuning becomes necessary it may be done without appreciably weakening the signal for it need not be done more than 5,000 cycles.

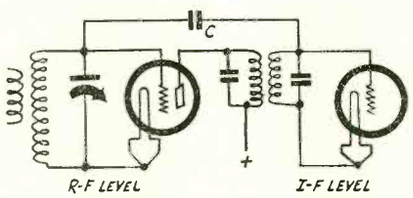
Detuning by a sufficient amount without losing the signal is more favorable the higher the intermediate frequency, because the amount of detuning needed is a matter of a definite number of cycles whereas the loss of signal is a matter of frequency ratio. Thus 5,000 cycles is smaller compared with 400 kc than compared with 50 kc.

Suppressing Harmonics

Designing the oscillator and the amplifiers so that the strength of the harmonics is weak is the best way of eliminating the heterodyning. A push-pull oscillator would be practically free from even order harmonics. Hence if the oscillator were made of this type and at the same time the intermediate frequency were selected so as to be an odd multiple of 5,000 cycles, there would be little troublesome heterodyning. It is admitted that a push-pull oscillator is not very practical in an ordinary superheterodyne receiver since it requires two tubes for the oscillator alone whereas the latest practice is to use a single tube for both the oscillator and the mixer. However, the push-pull oscillator can be used also as mixer so that no more tubes are required than when separate oscillator and mixer tubes are used.

The circuit in Fig. 1 is a push-pull oscillator showing a possible method of mixing. The signal voltage is impressed on the two grids in phase. That is, in so far as the signal is concerned the two grids are in parallel. Any signal voltage that may be impressed may be regarded as a variable bias on the grids of the oscillator tubes. The output will vary according to the difference between the frequencies involved, and this difference will be picked out by the i-f circuit.

Trap to Eliminate Interference



SINCE one of the conditions under which squeal interference may arise in a superheterodyne is when a harmonic of the intermediate frequency amplifier beats with the frequency of the received carrier, the interference may be eradicated by a wave trap for a single i-f harmonic and r-f fundamental, since both are the same frequency.

The Six Interferences

Assuming an intermediate frequency of 175 kc, there are six frequencies represented in the total possible on a broadcast receiver where this type of interference would arise. These are 525, 700, 825, 875, 1,050, 1,175 and 1,125 and 1,400 kc (multiples of 175 kc). Of course, some receivers will not tune as low as 525 kc, which would rule out that frequency as a source of such interference. Also, 875 and 1,125 kc are not multiples of 10 kc, and might not cause any trouble, but a sensitive receiver, such as a superheterodyne is likely to be, could produce the squeal from foreign stations on frequencies that are multiples of 5 located in South American, Central American and Cuban stations.

However, since in practice the trouble is experienced in connection with WLW, which is on 700 kc, and locals on 1,400 kc, as well as on 1,050 kc, it can be seen that the trouble most likely refers to the intermediate frequency of which the squeal tuning points on the receiver's dial are harmonics of those frequencies.

One Trap for Each Frequency

To apply the wave-trap or filter method is entirely practical, therefore, to get rid of trouble arising from the harmonics of the intermediate amplifier, but for each interfering frequency in the broadcast band there would have to be an equivalent tuned filter in the intermediate amplifier. Assuming one desired complete correction, it would be necessary then to have six different tuned circuits, each one representing one of the possibly troublesome harmonics of the intermediate frequency.

Correct Polarity for Stability

Such a solution might be valuable at that, but undoubtedly would be awkward. However, since every superheterodyne has a radio frequency level of tuning, even if the only such stage is the tuned input to the modulator, this is of itself a filter, so if the radio frequency tuning system is coupled loosely to the intermediate amplifier, the r-f tuning itself should act as a wave trap or filter, one that tunes out the six harmonics in the given instance as it reaches them. The same frequency of carrier to which the r-f level responds is of course the interference-filtering frequency too.

The same effect might be produced if the grid-to-plate capacity of the modulator tube were large, but it is small in receivers, and if it were large there would be reduced frequency range for a given coil-condenser combination, and accompanying instability. So, too, instead of the coupling condenser C being between grid and plate to increase the capacity where it is desired low, it is between grid and grid, and it is practical to maintain the correct phase relationship to avoid instability by the direction of the winding of the coils or by the polarity of connections to their terminals.

Small Condenser

The diagram shows the r-f level tuned circuit and the coupling to the intermediate amplifier by the i-f transformer. The condenser C would be extremely small, say of the order of a few micro-microfarads. The squeal interference would be due to a beat, hence the intermediate carrier is modulated by this beat, and the proposed remedy is to remove the beat by removing one of the components causing it (the harmonic of the intermediate frequency).

It is obvious, of course, that if the harmonic of the intermediate frequency were exactly the same as the frequency to which the r-f level is tuned there would be zero beat, and no interference, because only a difference causes a beat. But the difference may arise because the intermediate stages are not tuned to exactly

(*Continued on next page*)

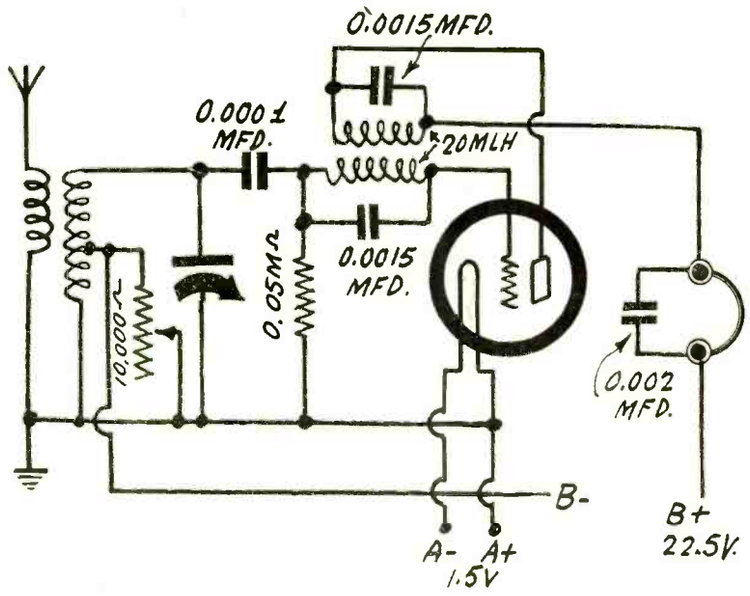
A Simple, One-Tube Short-Wave SUPER-REGENERATOR

By C. F. W. Collinge

HERE is a combination of the Hartley regenerative circuit for short waves, with super-regeneration added. Only one tube is used, a 230, which will oscillate with 1.5 volts on the filament, so a dry cell is used for filament heating, without filament resistor.

The theory of the super-regenerator is that an auxiliary frequency of oscillation is introduced so as to permit the attainment of higher amplitude, or elevate the spillover point. The auxiliary oscillation is a brake on the spillover of the other frequency. Therefore a regeneration control of the signal carrier level is needed, and as this must not be one that affects the steady oscillation of the auxiliary frequency, it is shown as a rheostat, or potentiometer used as rheostat, across the feedback portion of the variably tuned circuit.

The super-regenerator is not much good for broadcast frequencies, but it is suitable for short waves, and the shorter the waves the better. If reception in the region of the ultra frequencies is to be attempted, radio frequency chokes in some instances are advisable, one in each filament leg, between filament and battery, and consisting of two turns of No. 18 wire on a small diameter, the chokes decoupled.



Inaudible Extra Frequency

The auxiliary frequency of oscillation should be as low as practical. If it is 10,000 cycles of course the high-pitched tone would constitute a modulation of the signal, and thus create ever-present interference. All the earlier models of super-regenerators had this objectionable tone, but it certainly seems preferable to sacrifice some sensitivity to obviate this interference, hence the frequency may be around 30 kc. That is well above audibility, and probably as low as can be conveniently obtained. It is not necessary to have the auxiliary frequency just that, and indeed one may not have at hand any ready means of accurately measuring that frequency, but the conditions are satisfied if the grid and plate coils have an inductance of 20 millihenries and the condensers across them are equal, and about 0.0015 mfd. If commercial fixed condensers are used they may be put across the coils as diagramed, and then an equalizer used for making the lesser capacity equal the greater one. The test is that oscillation should obtain, and the equalizer should be tried therefore first across one of the fixed condensers and then across the other.

There is no telling just how far off the commercial fixed condensers may be, though rated 0.0015 mfd. If they are exactly 0.0015 mfd. the frequency will be a little lower than 30 kc, as 0.0015 mfd. is the actual requirement if 30 kc is to prevail. Should the condensers be within 10 per cent., then a variable or equalizing condenser 0.00035 mfd. may be used, since the deviation from commercial rating may be 10 per cent. maximum and in opposite directions. Another way out would be to use the 1,000 to 1,500 mmfd. superheterodyne padding condensers and adjust each one.

Frequency Check-up

To check up on the auxiliary frequency of oscillation the regeneration control of the signal frequency feedback may be set to short out the small part of the winding, between tap and ground, and the output of the auxiliary frequency of oscillation, now the only frequency, loosely coupled to the antenna feeding a broadcast set. See how far apart in frequency, on the basis of a known frequency separation on the broadcast set's dial, the squeals are heard. The beats are those between stations tuned in and harmonics of the auxiliary frequency. Suppose one beat is heard at 700 kc and another the next at 730 kc. Then the auxiliary frequency of oscillation is 30 kc. Or, the dial, if of known frequency span, may be traversed, the squeals counted, and divided into the frequency span. For 96 channels of 10 kc each, 1,500 kc to 540 kc, there would be 32 squeals or beats, if the auxiliary frequency were 30 kc, because 32 goes into the 960 kc frequency span of the broadcast band 30 times.

(*Continued on next page*)

R-F Tuner as Interference Trap

(*Continued from page* 4)

the same frequency, hence there would be different absolute harmonic frequencies in each stage, the difference being small, but enough to enable a harmonic of one stage to beat with the r-f or signal frequency While this is true and possible, the trouble is deeper, because with only one stage of i-f, or indeed with first and second detectors coupled by a transformer having only one winding tuned, with no tube between, the trouble is still present.

Must Track Well

The admonition is given, however, to tune the intermediate frequency carefully, using loose coupling from a test oscillator, and using also an insulating screwdriver. A test for mistuning as a contributant to the trouble is to retune the intermediate amplifier when the interference is present, for then exact resonance of all i-f circuits, if the squeals arise from slight deviation of resonance at the i-f, would enable total elimination of the squeals.

For the r-f tuning to serve also as trap for the i-f amplifier harmonics, it must track the oscillator with great accuracy, since the frequency determinant is the intermediate frequency in conjunction with the oscillator frequency. Thus, the r-f tuning is merely to reduce or eliminate image interference, improve selectivity and increase amplification, but not to determine the frequency of response, as it has no effect on this. True, it does affect the amplitude, but it does not affect the frequency. If the r-f level is to be used also as a trap for intermediate frequency harmonics, it must be most accurately tuned to the signal frequencies corresponding to the difference between the oscillator and the intermediate frequencies.

To sum up, while the trap system is suggested for eliminating squeal interference due to beats between an original carrier frequency and an harmonic of the intermediate frequency approximately equal to that frequency, several traps would be needed, and as the r-f tuner is itself a trap, no extra device is necessary, save a small coupling condenser.

This remedy was devised by me on February 16th at 12.30 p.m. and then disclosed by me to J. E. Anderson while we were discussing the article which he has written on squeal interference in superheterodynes.

(*Continued from preceding page*)

If squeals can't be heard in sufficient numbers, because the receiver is not sensitive enough, the leak value may be raised to 7 to 10 meg., so that grid blocking occurs, and this would constitute a high-pitched modulation note. Then tuning in of stations would not be necessary, for modulation would supplant the beats.

Test for Oscillation

The main purpose, however, is to be sure that the auxiliary oscillator is oscillating, and this may be confirmed by registering even a few beats in conjunction with a broadcast receiver that has aerial connected to it as usual, and output of the one-tube set coupled to the aerial. This output may be obtained by wrapping a few turns of wire around the tube base or around the coupled low frequency coils, and similarly wrapping the other end of this wire around the aerial near where it enters the set.

Another way of telling whether the auxiliary frequency of oscillation exists, although it is more of an estimate than an actual confirmation, is to listen in, with circuit formed as diagramed, and ascertain if the noise level is high. Some experience is necessary, to afford a basis of comparison of noise levels. Or, the circuit from grid to grid condenser may be shorted, a station tuned in, and then the short removed to ascertain if the noise level increases considerably. If it does, then the auxiliary oscillator is oscillating.

It is commonplace to classify the super-regenerator as in the experimental stage, yet of course it does work, and moreover it is sensitive. The statement that the noise level is high is merely another way of revealing the existence of extraordinary sensitivity, a degree considerably beyond that of the more formal regenerator, at least at the higher frequencies, say, around 10 to 30 meters or so.

Coil Data

The system may be worked with plug-in coils, so that a wide range of frequencies could be covered. Of course the tuning condenser would be of small capacity, and the selection of the capacity would depend largely on how high in frequency you intend to go. For a specified band coverage within the frequency ratio yielded by the signal level tuning condenser of course a permanent coil would be used.

As some specified capacity must be the basis of inductive directions, let us select 0.00014 mfd., whereupon the winding data for covering from about 20,000 to a little below 1,500 kc, using 1.25 inch diameter plug-in forms, would be: largest coil, 56 turns of No. 28 enamel wire, tapped at 7 turns from the ground end, with primary of 5 turns wound adjacent, ⅛ inch separation; second coil, 20 turns of No. 28 enamel wire, tapped at 5 turns from the ground end, with primary of 3 turns wound adjacent, ⅛ inch separation; third coil, 7.5 turns of No. 18 enamel wire, tapped at 4 turns from the ground end, with primary of 1.25 turns, wound adjacent, separation ⅛ inch; last coil, three turns of No. 18 enamel wire, center-tapped, with primary of 1.25 turns wound adjacent, separation ⅛ inch.

Interests Best Minds

Such coils will meet the requirements, but commercial coils that have somewhat different numbers of turns and sizes of wire, made by reliable manufacturers, may be substituted. The directions given are for close winding. Some commercial coils are space-wound and as the size wire may be different, also, naturally the numbers of turns will not correspond to those given for the coils, yet the commercial products may be relied on to meet the requirements too.

While the circuit shown is a simple one indeed, and one that requires few and inexpensive parts, it nevertheless represents a development that has interest for the best engineering minds, for the super-regenerator (not this one particularly) is the subject of comparative analysis by the Radio Research Board, consisting of some of the leading radio engineers of England. This board is under the Department of Scientific and Industrial Research, and it works in conjunction with the National Physical Laboratory, which is the approximate equivalent of our own Bureau of Standards.

What Experts Say

The following excerpt is from the board's recently-released report for 1931:

"In connection with the general investigation of the propagation of ultra-short waves being conducted by the Board, information was required on the relative performance of various types of receivers, particularly on the wavelengths under consideration, 7, 9, 11 and 13 meters.

"Five receivers were available and these fell into three classes, one being the simple retroactive (regenerative) detector type, two of the super-regenerative type, and two of the supersonic-heterodyne type (superheterodyne to us).

"The overall performance measurements were made on these receivers with the measuring apparatus already installed at the National Physical Laboratory, using a radio frequency carrier oscillation with a 10 per cent. modulation at 1,000 cycles per second superimposed thereon.

"The results obtained on the various receivers showed the relation between the radio frequency employed and the input voltage to a dummy aerial connected to the receiver, under conditions which gave a constant output of 1 volt across a 10,000-ohm resistance in anode (plate) circuit of the last stage.

"The relationship between the input and output voltages for each receiver was also obtained, and for the two supersonic-heterodyne receivers selectivity curves for the intermediate stages were included. A field test was also carried out in which the output from the receiver was measured when receiving from a local portable transmitter. The test was made at only one frequency in order to check the relative accuracy of the measurements made in the Laboratory test.

Good Word for Super-regenerator

"A detailed discussion of the results of the tests . . . shows that both the super-regenerative and the supersonic-heterodyne types of receiver are much more sensitive than the simple retroactive detector. Where a high sensitivity is required over the range of wavelengths in question, the advantage appears to lie quite definitely with the supersonic-heterodyne type of receiver which, it is contemplated, may be developed to a higher degree than is represented in the two receivers used for these tests.

"The tabulated results of the tests, as obtained from graphs, show that the overall voltage amplification under conditions given above, may rise from about 860 for the simple retroactive detector type to 100,000 for the super-regenerative type, and to nearly 3,000,000 for the supersonic-heterodyne type.

Good Signal Range on Low Waves

"Some idea of the signalling range possible of the various receivers may be gained from the fact that the least sensitive of the five receivers (the simple regenerative type) has been successfully used for reception and direction-finding purposes at distances up to 20 miles from a half-wave transmitting aerial with a maximum current of 0.5 ampere."

While the section of the report had to do principally with transmitters, the extract quoted of course dealt with receivers, and the amplification from the super-regenerative type was almost 1,000 times greater than that obtained from the simple regenerative set, these two being examples of equal number of tubes used (only one tube, to be exact), whereas of course the superheterodyne showed up much better, being thirty times more sensitive than the super-regenerator but of course was a multi-tube outfit.

Two Push-Pull Tubes in a Single Envelope

THE first push-pull tubes in one envelope have been announced. The tubes are known as the 79, and while for Class B amplification in automobile receivers particularly, they indicate a trend toward possible new push-pull tubes of the Class A or cross A and B types in one envelope. The data on the 79 as supplied by RCA Radiotron Co., Inc., and E. T. Cunningham, Inc., follow:

The 79 is a heater-cathode type of tube combining in one bulb two high-mu triodes designed for Class B operation. It is intended for use in the output stage of radio receivers, especially those of the mobile type, employing a 6.3 volt heater supply. In such applications, the 79 is capable of providing a nominal power output of 5.5 watts at a plate voltage of 180 volts.

The triode units of this tube have separate external terminals for all electrodes except the cathode and heater, so that circuit design is similar to that of Class B amplifiers utilizing individual tubes in the output stage.

The 79 is constructed compactly in a small dome-top bulb and employs a small six-pin base and top cap.

TENTATIVE RATING AND CHARACTERISTICS OF THE 79

Heater Voltage (A.C. or D.C.)	6.3 Volts
Heater Current	0.6 Amp.
Overall Length	4 9/32" to 4 17/32"
Maximum Diameter	1 9/16"
Cap	Small Metal
Bulb	ST-12
Base (Refer to Outline Dwg. No. 92S-4237)	Small 6-Pin

CLASS "B" POWER AMPLIFIER

Plate Voltage	180 max.	Volts
Dynamic Peak Plate Current (per plate)	90 max.	Milliamperes
Average Plate Dissipation.	7 max.	Watts
Typical Operation:		
Heater Voltage	6.3	Volts
Plate Voltage	180	Volts
Grid Voltage	0	Volts
Static Plate Current	7.5	Milliamperes
Load Resistance (plate to plate)*	7000	Ohms
Nominal Power Output**	5.5	Watts

**With average power input of 380 milliwatts applied between grids.

*A load resistance of 10,000 ohms (under conditions of a 380 mw. input) will reduce the average d-c plate current but will give somewhat higher distortion than the 7,000 ohm load.

Installation

The base pins of the 79 fit the standard six-contact socket which may be installed to operate the tube either in a vertical or in a horizontal position.

The bulb of this tube will become very hot under certain conditions of operation. Sufficient ventilation, therefore, should be provided to circulate air freely around the tube to prevent overheating.

The heaters are designed so that the normal voltage variation of 6-volt automobile batteries will not affect to any great extent the performance or serviceability of this tube. In such service, the heater terminals of the socket should be connected directly across a 6-volt battery; leads to the battery should have as low resistance as practicable.

In case the heaters are operated on a.c., the transformer winding supplying the heater circuit should be designed to operate the heater at 6.3 volts for full-load operating conditions at average line voltage.

Application

The 79 is suitable for use in a Class B amplifier output stage of automobile receivers and other receivers where the available high-voltage supply is limited to 180 volts.

As a power amplifier (Class B), the 79 is used in circuits similar in design to those utilizing individual tubes in the output stage. It requires no grid bias, since the high-mu feature of the triode units reduces the steady plate current at zero bias to only a few milliamperes. This feature is particularly important because it prevents the variation of bias with applied signal which would otherwise exist if any self-bias arrangement were employed.

During operation of this tube as a Class B amplifier, the grids of the two triode units are alternately swung positive each half cycle. Considerable power is required to do this under ordinary conditions. If, however, the secondary emissivity of the grids were made nearly equal to unity, the required power to swing the grids could be appreciably decreased. Tubes possessing this feature can be constructed, but the secondary emissivity is not independent of signal voltage and frequently causes negative grid current. Furthermore, secondary emission behaves erratically during the life of the tube. Thus, to have a Class B tube which will give uniform results throughout its life, it is preferable from the tube design standpoint, to eliminate secondary emission insofar as possible even at the expense of greater driving power. Unless tubes for use as Class B amplifiers are capable of producing uniform results throughout their life, it is practically impossible to design circuits to use them.

Current Fluctuation

The direct current requirements of Class B circuits are subject to fluctuation under operating conditions. The power supply, therefore, should have as good regulation as possible to maintain proper operating voltages regardless of the current drain. For this purpose, a high-voltage B-battery or a suitably designed B-eliminator may be employed. In the design of a power supply for a Class B amplifier, consideration should be given to the peak current demand of the amplifier.

As previously pointed out, the grids of the 79 are alternately operated sufficiently positive to cause grid current to flow in their input circuits. This feature imposes a further requirement on the preceding amplifier stage. It must supply not only the necessary input voltage, but it must be capable of doing so under conditions where appreciable power is taken by each grid of the Class B amplifier tube. Since the power necessary to swing the grid positive is partially dependent on the plate load of the Class B tube, and since the efficiency of power transfer from the preceding stage is dependent on transformer design, it is apparent that the design of a Class B audio power amplifier requires that more than ordinary attention be given to the effects produced by the component parts of the circuit. These effects may be produced in the first-stage amplifier by the design factors of the power-output stage. For this reason, the design of a Class B audio amplifier with its driver stage is somewhat more involved than for a Class A system, and must be checked for each change in the component parts.

A complete discussion of design features for Class B amplifiers would be rather extensive, but certain outstanding points may be mentioned. The interstage transformer is the link interconnecting the driver and the Class B stage. It is usually of the step-down type, that is, the primary input voltage is higher than the secondary voltage supplied to the grids of the power output tube. Depending upon conditions, the ratio of the primary of the inerstage transformer to one-half its secondary may range between 1.5/1 and 5.5/1.

The transformer step-down ratio is dependent on the following factors:

1. Type of driver tube
2. Type of power tube
3. Load on power tube
4. Permissible distortion
5. Transformer efficiency (peak power).

The primary inductance of the interstage transformer should be essentially the same as if the transformer were to be operated with no load, that is, into an open grid. Since power is transferred, the transformer should have reasonable power efficiency. It should be noted that the power output and distortion are often critically dependent upon the circuit constants which should, therefore, be made as nearly independent of frequency as possible. This applies particularly to the interstage coupling transformer and to the loudspeaker. Since it is difficult to compensate for leakage reactance of the coupling transformer without excessive loss of h-f response, the leakage reactance of this transformer should be as low as possible.

The type of driver tube chosen should be capable of handling sufficient power to operate the Class B amplifier stage. Allowance should be made for transformer efficiency. It is most important, if low distortion is desired, that the driver tube be worked into a load resistance higher than the normal value for optimum power output as a Class A power amplifier, since distortion produced by the driver stage and the power stage will be present in the output.

Data on Class B

The following notes on Class B Amplifier circuits are of value from the design standpoint:

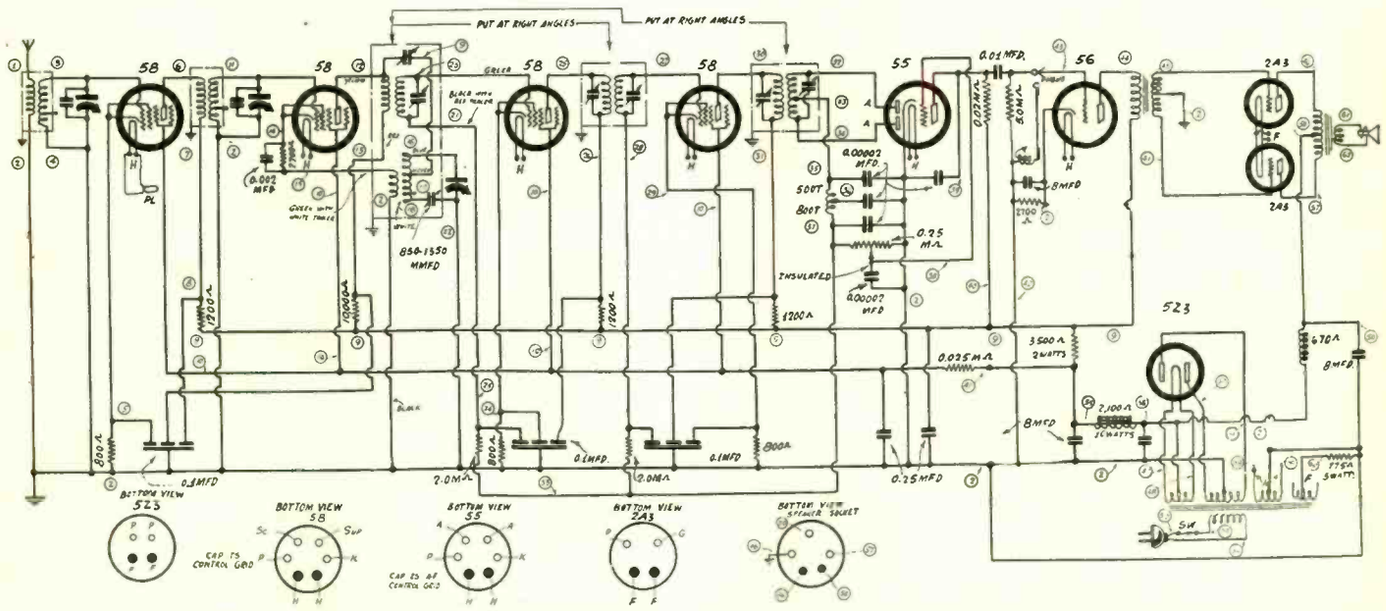
The load on the driver tube or tubes is chosen higher than for undistorted power rating to hold overall distortion to a minimum. For a single triode driver, its minimum plate load should be approximately 2 to 4 ties the plate resistance of the driver tube. For a push-pull triode driver stage, its minimum plate load per tube should be approximately equal to the plate resistance of an individual tube. This ratio for push-pull operation is permissible principally because of elimination of second harmonic distortion. This minimum plate load is the value used for calculating peak power transformer efficiency.

An interstage transformer with high step-down ratio causes low distortion in the Class B input circuit, but limits the available signal. A satisfactory transformer design makes use of grid distortion to cancel a part of the distortion produced in the plate circuit of a Class B stage. For this reason, the transformer step-down ratio must not be too great. Resistance losses of the primary and secondary may be distributed on the basis of the most economical design. It is important to consider that only one-half of the secondary furnishes power at a time.

The load values for the class B amplifier stage given under Rating and Characteristics will change slightly with available input if maximum output and low distortion are desired. It is important to consider that only one-half of the primary of the output transformer furnishes power at one time.

The Nine-Tube A-C, 15-Watt PUSH-PULL DIAMOND

By Herman Bernard



Here is the promised Push-Pull Super Diamond, concerning which preliminary details are given this week, with constructional data to follow. The new 2A3's are used in the output, while the new 5Z3 is the heavy-duty rectifier.

NINE tubes are used in the Push-Pull Super Diamond, because the original seven-tube single-sided output model has had added to it a driver for the push-pull stage and also the extra output tube.

The maximum power output is 15 watts, and unless a driver were provided it would not be practical to load up the output stage except on strongest locals. As it is, the driver takes a negative bias of approximately 10 volts, for it is a 56 tube at about 150 plate volts.

The amplification factor of the output stage is low, compared to that of the pentode class, and simply to add push-pull, without a driver, would cause the volume of sound to be less in an eight-tube set using the 2A3's or '45's than in a seven using the pentode, and there is no need of having a high-powered output unless there is a large voltage input to the power tube stage.

Automatic Cutoff

Since the radio frequency and intermediate frequency stages, as well as both detectors, are virtually unchanged compared to the 7-tube model, under usual conditions of installation and antenna length the second detector's rectified voltage on locals will be around 10 volts. If a longer and higher antenna is used of course this voltage may be greatly exceeded, and will rise so high that it will cut off the amplification in the triode unit of the 55. Therefore the receiver is self-protected against any serious overload by signal voltage on tubes following the triode unit of the 55, and the only limitation on antenna height and length is that the aerial should not be so effective as to reduce seriously the selectivity of the first tube, otherwise squeals might result, due to image interference. The shorter the aerial the greater the image frequency suppression, because the resultant looser coupling increases the selectivity.

So, while the aerial pickup is left to the constructor, it can be seen that at all hazards the locals will produce 10 volts, minimum, at which there will be no automatic cutoff, since around 50 volts stops the signal, and also that the effect is gradual. So danger of overloading the 56 is minimized, although of course instantaneous correction may be applied by adjustment of the volume control, for that governs the amount of voltage put into the 55 triode unit. Since there is full automatic volume control of two stages, the second detector's rectified output might be expected to be constant, due to linearity, but it must be realized that the controlled amplifier tubes are not linear operators.

Voltage Considerations

At 13.5 volts negative bias on the 56 the plate current is 5 ma, and the product of 2,700 ohms and 5 ma is 13.5 volts, but that is for 250 volts in the plate circuit, while here the bias will be about 10 volts because the voltage at the common plates head of the power tubes will be around 150 volts. This is plenty, for at even 10 volts negative bias on the 56, with output stage biased at 62 volts negative, the 56 would need a working mu of only 6.2, whereas its rating is 13.8 mu, and the gain per stage may run around half that.

Since the output tubes will draw a total of 80 ma plate current, and the rest of the receiver nearly 40 ma, there will be around 120 ma total, and that would be rather too much to put through a common B choke, so the feed to the power tubes is filtered through an independent choke, around 30 henries commercial rating, the d-c resistance somewhere around 670 ohms. Thus the power transformer must not only handle the current for the whole receiver but must yield the desired voltage, which at maximum, between center of 5-volt winding and B minus, should be somewhere around 365 and 375 volts.

The voltage drop in the choke leading to the power tubes will take care of the safeguard against more than 300 volts applied, while looking toward the forward part of the receiver, the drop through the 3,500-ohm, 2-watt resistor, and 2,100-ohm choke at 40 ma, would leave 150 volts applied, a little of which will be dropped in filter resistors, and in the case of the autodyne tube, as much as 20 volts.

The 5Z3 Rectifier

The 5Z3 rectifier will handle the current, and the voltage, too, for its maximum rating is 250 ma at 500 volts rms maximum. The heating value of 500 volts rms, or d-c equivalent, is 353 volts, so 53 volts may be dropped in the feed to power tubes. At 80 ma the drop across 670 ohms would be 53.6 volts. Thus the power dissipation in the speaker field, which is the 670-ohm choke, would be 4.3 watts, approximately. This has nothing to do with the power output of the receiver, but only with the sensitivity of the speaker, which is greater as the wattage dissipated in the field is greater. For instance, a permanent magnet speaker would have a no-wattage rating in this respect, whereas the power output of the receiver would be unchanged.

The output tubes, the 2A3's, and the rectifier tube, are new, and as some will not be familiar with their rating, characteristics and connections, the data will be found herewith and on page 7.

The 2A3's used in push-pull this way, are a sort of cross between Class A and high-negative-bias, no-grid-current Class B. This is obvious from the fact that the negative bias for a single-sided circuit is recommended at minus 42 volts, whereupon 60 ma will flow, if the plate voltage is 250 volts, whereas for the push-pull circuit the same value of biasing resistor would be used, plate voltage 300 volts, the plate current per plate would be 40 bias from the 775-ohm resistor would be

LIST OF PARTS

Coils

One antenna coupler, primary wound over secondary; enclosed in an aluminum shield, for 0.00041 mfd.; tapped for 70-200 meters.
One interstage r-f coupler, primary wound over secondary; enclosed in an aluminum shield, for 0.00041 mfd.; tapped for 70-200 meters.
One combination oscillator coupler for padded 0.00041 mfd. and one 175 kc first intermediate transformer, both enclosed in one high aluminum shield; oscillator tapped for 70-200 meters.
One 175 kc intermediate transformer enclosed in aluminum shield.
One 175 kc intermediate transformer with center-tapped secondary; enclosed in aluminum shield.
One tapped 20-millihenry r-f choke.
One 12" dynamic speaker, 670-ohm field coil, output transformer (5,000 ohms impedance) matched to the 2A3's in push-pull, 32-inch cable and UY plug attached, connections conforming to diagram.
One power transformer: primary, 110 volts, 50-60 cycles; secondaries: 2.5 volts at 8 amperes center tapped (H); 2.5-volt 5 amperes, c.t., for output tubes (F); 5 volts at 2 amperes, c.t.; high voltage at 375 volts d-c between rectifier filament and ground.
One 15-henry choke, 2,100 ohms d-c, 10 watts at least.
One push-pull input transformer.

Condensers

One three-gang 0.00041 mfd. tuning condenser with compensators built in and with attached screws for mounting purposes; high shield walls between sections.
(*Note: the condensers across primaries and secondardies of intermediate coils are built into these transformers.*)
One 0.002 mfd. fixed condenser.
Five 0.00002 mfd. fixed condensers.
One 0.01 mfd. mica fixed condenser.
Four 8 mfd. electrolytic condensers.
One 850-1,350 mmfd. padding condenser, isolantite base; brass plates.
One shielded block containing nine 0.1 mfd. condensers and two 0.25 mfd. condensers. Equipped with mounting lugs. Shield is to be grounded. Two outleads colored differently than others are the 0.25 mfd. Rest are 0.1 mfd. Block to be fitted under tuning condenser. Black lead goes to ground.

Resistors

Three 800-ohm pigtail resistors.
Four 1,200-ohm pigtail resistors.
Two 2,700-ohm pigtail resistors.
One 3,500-ohm pigtail resistor, 2 watts (twice as thick as others).
One 0.02 meg. pigtail resistor.
One 0.025 meg. pigtail resistor.
Two 2.0 meg. pigtail resistors.
One 5.0 meg. pigtail resistor.
One 0.25 meg. potentiometer, insulated shaft type; tapered; a-c switch attached.

Other Requirements

One chassis, 13.5 x 3 x 8.75 inches overall, drilled for sockets, coils, tuning condenser, for electrolytics and for power transformer.
Six insulated bushings, ends tapped for 6/32 machine screws, so that bushings may be used as if nuts on socket mounting screws, and maintain insulation for parts mounted on top of bushings by means of lugs held by short 6/32 screws.
One dozen lugs.
Two dozen 6/32 machine screws.
One roll of hookup wire.
Five aluminum tube shields for sensitive circuits requiring close shielding of 58 and 55 tubes.
Five grid clips.
One foot of shielded wire to be used between antenna post of set and antenna lug of antenna coupler; overall diameter ½-inch due to thick cotton insulation to prevent loss of signal to ground.
One frequency-calibrated dial, travelling light type, with 2.5-volt pilot lamp and escutcheon.
Five six-prong sockets, two UY sockets and three four-prong sockets (the extra five-prong is for speaker plug).

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just 62 volts. The load resistance on the single-sided stage would be 2,500 ohms, whereas for the push-pull pair, at 300 volts on plates and standard self-bias, plate to plate it would be 5,000 ohms, which doesnt' necessarily mean 2,500 ohms from plate to tap.

Distortion Estimates

At 15 watts the total harmonic distortion is 5 watts, by the self-bias method, for momentary average power output. While no condenser is necessary to bypass the common resistor in biasing the push-pull stage, since the signal current is equal and opposite through this resistor, hence zero signal flow, the B filter capacities should be high, as this increases the time constant, or prolongs the stabilization due to the filter. As the capacities used are somewhat larger than ordinarily prevail in push-pull circuits, the total harmonic distortion may be expected to be less than 5 per cent.

By the fixed bias method there would be only half as much, or 2.5 per cent. total harmonic distortion, but in a receiver like this there is no handy way of obtaining fixed bias, for the power tube plate current is two-thirds of the total, and self-bias predominates no matter which way you turn. Large enough capacity and inductance for filters to stabilize the current changes in the power tube circuit due to the signal are wholly beyond the scope of such a receiver as this, and the only practical remedy would be batteries or a separate C supply.

As compared to the seven-tube model, the bias resistor for the 58 autodyne tube is made 2,700 ohms instead of 3,500 ohms, as 2,700 ohms gave nearer the desired voltage, and besides the 3,500 ohms was recommended first for a 57 used in this position. The plate current ran higher in the 58 than in the 57, which is the reason for the reduction in resistance value. Also, this reduction to keep the bias from running to high was necessary to sustain oscillation all over the dial. With the 57 the oscillation was always present with 3,500 ohms for biasing, but with the 58, which was later selected for this position, oscillation in some instances stopped at around 600 kc unless the bias was kept to within recommended limits, i.e., using 2,700 ohms.

Short-Wave Experiments

The original seven-tube set showed the padding condenser at elevated position, between stator of the oscillator tuning condenser and coil, and another model showed the padding condenser grounded, as builders expressed a preference for the grounded method because of that rendering adjustments relatively free from body capacity effects. The grounded method is made standard now. It requires an eight-lead coil, the code for connections being imprinted on the diagram. If a coil has nine leads, other one unaccounted for, cut it off, unless you want to experiment with 70-200-meter signals, which would be the purpose of the other tap, to which the full capacity of the oscillator tuning condenser would be switched, while r-f coils would be likewise switched. That is, padding condenser must be cut out for short-wave experiments, stators switched from illustrated positions to taps.

With a pentode output tube the high audio frequencies may be accentuated, and therefore high capacities were used in the second detector rectifier filter and from plate to ground in the triode unit of the 55, but with the low mu output tubes this accentuation of the higher audio frequencies is absent, and no compensation of that nature should be included. So the capacities that were formerly 0.00025 mfd. are now 0.00002 mfd., or 20 mmfd.

I-F Oscillation

It may happen that the intermediate amplifier will oscillate on account of this capacity reduction, although this is a rarity. The oscillation is intermittent, when present, and sounds as if it were audio frequency oscillation, so-called motorboating. However, since the cause is known to be i-f oscillation, the remedy would be to rearrange the second intermediate amplifier circuit, putting the 1,200-ohm resistor now in the plate circuit, instead in the screen circuit, moving the 0.1 mfd. along with the resistor, to screen, with positive side to the screen voltage feed. Then the plate of the second intermediate tube would be returned directly to the screen voltage feed, and not to the higher B voltage as shown. This

(*Continued on next page*)

CHECKING UP PADDING

Formula for Oscillator Inductance— True Capacity Curve

By Einar Andrews

THE curve in the accompanying graph shows how the capacity of the oscillator condenser should vary in relation to the capacity in the r-f circuit when the intermediate frequency of the superheterodyne is 175 kc. At 1,500 kc the ratio C/Co, that is, the ratio of the oscillator capacity to the r-f capacity, is unity. This is true because the inductances in the two circuits have been chosen so as to bring it about. As indicated on the drawing the ratio of L/Lo is equal to the square of the ratio of the signal frequency to the oscillator frequency. The oscillator inductance, therefore, is considerably smaller.

If this ratio is chosen for the inductances the capacities in the two circuits will be equal at 1,500 kc. For lower frequencies the capacity in the oscillator will be less and at 500 kc it is only about 0.69 of the capacity in the r-f circuit.

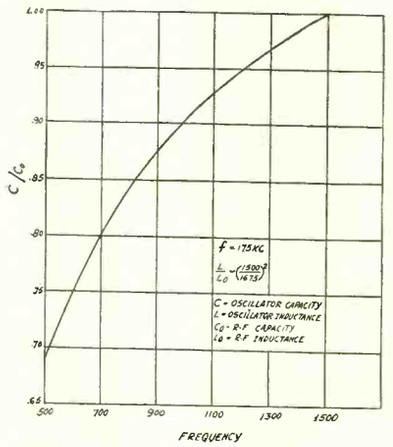
If condenser plates are to be cut so that the oscillator will follow properly the signal, that is, so that the oscillator frequency is always 175 kc higher than the signal frequency the ratio of capacities must be as the curve indicates. This does not mean the relative shape of the condenser plates but the ratio between the capacities.

Actual Values

If the r-f inductance is 246 microhenries the capacity in the r-f circuit at 1,500 kc is 45.7 mmfd. According to the curve the oscillator capacity should have the same value. At 700 kc the required capacity in the r-f circuit is 210 mmfd. The curve shows that the capacity in the oscillator circuit should be 0.8 of this, or 168 mmfd.

If the circuit is padded by means of a condenser in series with the oscillator tuning condenser the same ratio of capacities should exist if the padding is close. The inductance may be chosen on the basis given in the formula. That is, the oscillator inductance, may be smaller than the r-f inductance in the ratio $(1{,}500/1{,}675)^2$. If the inductances are given this ratio the capacities in the two circuits when the receiver is set on 1,500 kc should be exactly equal. It is always possible to make them so by means of the trimmer condensers across the main tuning condensers.

Moreover, the series condenser should be chosen so that the capacity ratio has the correct value at about 600 kc. Let us see how this works out, using the values



plotted on the graph. At 600 kc the capacity ratio is given as 0.75. Now if there is a condenser Cs in series with the oscillator condenser, which has a value equal to Co, the capacity in the rf circuit, the actual capacity in the osillator circuit is CsCo/(Cs+Co). Therefore, the capacity ratio becomes Cs/(Cs+Co), and this should equal 0.75. Now we can find Cs in terms of Co. It is Cs=3Co. Now if the inductance in the r-f circuit is 246 microhenries the value of Co is 286 mmfd. Hence Cs should be 858 mmfd. This is very close to the value obtained by more accurate methods.

Checking Other Points

Now let us check back to see how close the tracking is at some intermediate point. At 1,200 kc the capacity ratio should be 0.95. At 1,200 kc the r-f capacity is 71.4 mmfd. The capacity ratio is, we found, Cs/(Cs+Co), which gives us 858/(858+71.4), or 0.923. That is a little less than what it should be, so the tracking is not so good at that point. However, it is about there where the deviation is the greatest.

The deviation is also high in the neighborhood of 750 kc. Let us check it from the curve. At 750 kc the value of the capacity ratio is 0.825, as near as can be read from the curve. At 750 kc the value of Co is 183 mmfd. The computed value of the ratio is 0.824, which is closer than the accuracy of the curve warrants.

Many have attempted to use a tracking condenser in place of padding without success. The trouble has been usually that they used the oscillator coil designed for a padded circuit, which is quite different from the coil specified for the tracking condenser. When trouble of this kind arises the fault is not with the designer of the circuit, nor with the designer of the tracking condenser, nor with the maker of the coil, but with the quite original user of the coil, the condenser, and the circuit. The remedy is to adjust the coil to fit the condenser and the intermediate frequency. The tracking condenser can be used for only one intermediate frequency, and that is usually 175 kc.

At 1,000 kc the capacity ratio should be 0.9025 and the computation from the padding condenser gives 0.893. That is a considerable deviation and indicates poor tracking around 1,000 kc. Had the accurate method of padding been used the deviation at 1,000 kc would have been zero, for that would have been one of the conditions imposed.

Detection of Faulty Tracking

While adjusting the tracking it is convenient to have a means of telling whether the oscillator frequency is above or below the desired frequency. Suppose we tune in a station with the set as a t-r-f receiver. There will be a certain dial reading where the station is loudest. Next convert the set to a superheterodyne and again note where the same station comes in. If there has been a shift, the padding or tracking is wrong. If the dial setting the second time indicates that more capacity is needed to tune in the station, the padding condenser should be increased in value, or if the coil is being adjusted, turns should be added to the coil. The coil is adjusted if a tracking condenser is used and the condenser is adjusted if the padding method is employed. Of course, if the second setting of the tuning condenser indicates that the capacity must be increased to bring the station in loudest, then the series condenser or the coil should be reduced. By a few careful observations it should be evident what to do, and by carefully doing it the padding or the tracking should be accomplished in a very short time.

Certain tracking condensers require that the minimum capacity in the oscillator be larger than the minimum capacity in the r-f coil, and consequently that the oscillator inductance should be smaller than that given above.

The Push-Pull Diamond

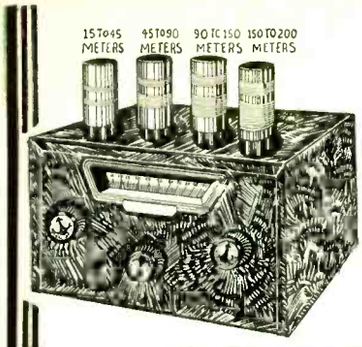
(*Continued from preceding page*)

cure worked in all the instances, some dozen or so, where oscillation was experienced. It helps to prevent this condition if the intermediate coils are put at right angles, the first in respect to the second and the third in respect second. This peculiar arrangement is due to the special position of the coils on the chassis. To do this new mounting holes, four of them, would have to be drilled in the standard chassis.

As for the layout of parts, the picture diagram which is in preparation will show that, in some respect, while photographs will reveal the other details. Two of the electrolytic 8 mfd. condensers are behind the tuning condenser, and two electrolytic 8 mfd. (these must be dry) one anchored to the rear wall of the chassis. The size of the chassis is 13.5 x 3 x 8.75 inches. The front will have the frequency-calibrated tuning dial at center with the combination volume control and a-c switch beneath it. Extra slotted openings at the front will permit segregation of the a-c switch and volume control, to accommodate existing front panels, the slots permitting moving the units as the panel requires, or the openings may be used for the combination switch-volume control and a short-wave tap switch.

The rear and next to rear shield walls of some tuning condensers will have to be cut at the lower left corner so as to clear screws that hold the padding condenser, but standard supply sources probably will have these condensers with the corners already cut off. It is a very simple matter to file them down.

[Further details about the Push-Pull Super Diamond will be published next week, issue of March 11th. A blueprint is in preparation.—EDITOR.]



The New ECONOMICAL A-C Short-Wave Set

Earphone Model, Covers 15 to 200 Meters

THRILLING DISTANCE! ALL ON THREE TUBES!

NO matter if you are a fan interested in the whole wide sweep of the short-wave band from 15 to 200 meters, or an amateur interested only in the "ham" bands, you will enjoy the results from the new ECONOMICAL A-C Short-Wave Set. This receiver has a sensitized 57 detector and a stage of 56 audio, while the rectifier is an '80. The filtration is fine, so that the pleasure of listening to far-distant stations, including foreign ones, is not marred by hum.

The highest efficiency was the aim in designing the set, therefore plug-in coils were used, and these are specially wound to insure adequate overlap of wavelengths between coils for succeeding bands, and to provide highest sensitivity. One coil is used for each of the four bands.

The receiver is housed in a crackle-finish shield cabinet, with back open so that the desired plug-in coil may be handily inserted in the receptacle provided for it on the chassis proper.

The circuit consists of a sensitized detector tuned by a Hammarlund junior midline short-wave condenser with stage of audio and B supply. The same high quality of parts and workmanship prevail throughout. The coupling between detector and audio tube is through a transformer, the plate current being at a low value to hold up the primary inductance, which is of itself high, and therefore make practical the use of a gainful transformer working out of a 57.

The ECONOMICAL Short-Wave A-C Receiver is a brand-new, specially-made product, now offered to the public for the first time, and bringing within the reach of all a dependable short-wave outfit that has an easy-tuning full-vision dial, with knob below; a sensitivity control and a switch. The receiver is sold complete with tubes (one 57, one 56 and one '80). Order CAT. TMACSW-T (price includes tubes)..... **$18.95**

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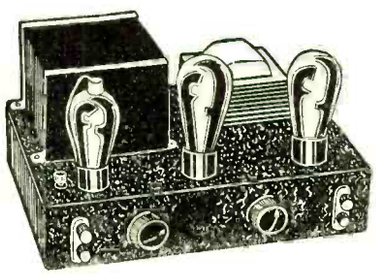
Kellogg Switchboard Company is well known for the quality of its products, and the microphone from its precision factory is one of excellent performance, representing one of the best bargains in microphones. The response curve renders this microphone fully suitable for use by amateurs and for home recording or reproduction. It is not to be confused with toy microphones, as this is a real product from a manufacturer of real standing. Order CAT. TM-TMP at **$1.95**

POWER AMPLIFIERS



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Not only in professional work is this microphone floor stand an advantage, but owing to the extremely low price many who have microphones in their homes, for use with the audio amplifier of their radio set, will want this stand. Order CAT. TM-MFS at **$4.50**

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Each one consists of a first stage of '24 audio transformer coupled to a single-sided output, and includes a husky B supply fully filtered.

CAT. TM-PA-45, consisting of a power amplifier and B supply, using one '24, one '45 and one '80. Power consumption, 40 watts. Maximum undistorted power output, 2 watts. Suitable for gatherings of up to 500 persons. Price (less tubes).....**$10.95**

CAT. TM-PA-47, consisting of a power amplifier and B supply, using one '24, one '47 and one '80. Power consumption, 40 watts. Maximum undistorted power output, 3 watts. Suitable for gatherings of up to 700 persons. Price (less tubes).....**$12.95**

CAT. TM-PA-50, consisting of a power amplifier and B supply, using one '24, one '50 and one '81. Power consumption, 50 watts. Maximum undistorted power output, 5 watts. Suitable for gatherings of up to 1,000 persons. Price (less tubes).....**$15.95**

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	Color Code				Color Code		
	Body	End	Dot		Body	End	Dot
175 ohms—	Brown	Violet	Brown	50,000 ohms—	Green	Black	Orange
350 ohms—	Orange	Green	Brown	60,000 ohms—	Blue	Black	Orange
800 ohms—	Gray	Black	Brown	100,000 ohms—	Brown	Black	Yellow
1,200 ohms—	Brown	Red	Red	250,000 ohms—	Red	Green	Yellow
3,500 ohms—	Orange	Green	Red	500,000 ohms—	Green	Black	Yellow
10,000 ohms—	Brown	Black	Orange	2,000,000 ohms—	Red	Black	Green
20,000 ohms—	Red	Black	Orange	5,000,000 ohms—	Green	Black	Green

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THE 25Z5 IN A 4-TU

Economy Practiced in Filament Circ

Be Worked f

By N. M

Chief Engineer, P

THE 25Z5 rectifier tube has made possible many noteworthy improvements in universal sets. First, it has made possible the use of a regular dynamic speaker and hence greater sensitivity and better quality. Second, it has provided an adequate B supply, which in turn is a contribution to better quality. Third, it has made the receiver more efficient in the sense that it takes less power from the line for a given maximum sound output.

The possibility of using a dynamic speaker arises from the fact that there are two independent parts to the 25Z5 rectifier. That is, there are two independent rectifier elements in the same container. If the two anodes are connected together and then joined to one side of the supply line, there remain the two cathodes which may be used for different purposes.

The Circuit

In the circuit diagram, Fig. 1, which is that of the Postal Universal Model UPD-1, one of the cathodes is connected to the filter and the other is connected to the loudspeaker field, F1. The two rectifiers are really in parallel and each functions apart from the other.

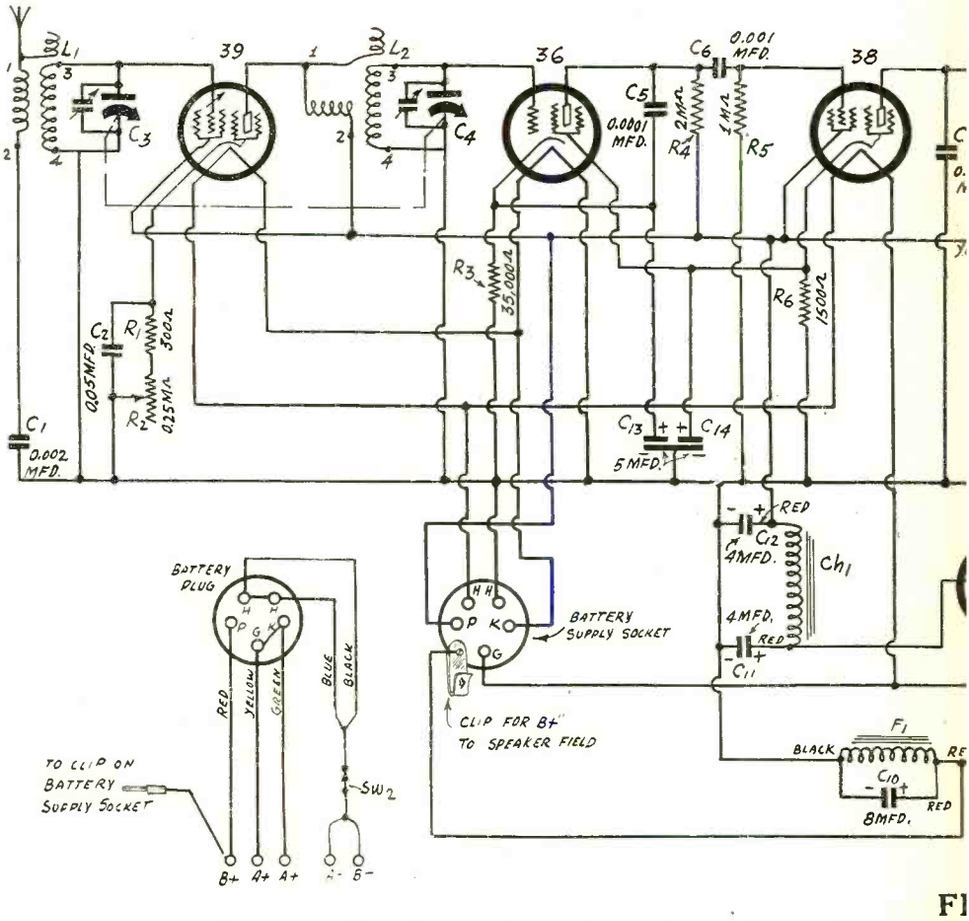
Across the speaker field is an 8 mfd. condenser C10. This condenser helps to smooth out the field current. Associated with the filter choke Ch1 are two 4 mfd. electrolytic condensers, one on the cathode side and the other on the plate side. Note that in each place where an electrolytic condenser is used the anode of the condenser, that is, the red terminal, is connected toward the cathode of the rectifier or some other tube. These condensers are C10, C11, C12, C13, and C14. One of them is not connected directly to a cathode but only the choke Ch1 intervenes.

Two noteworthy features are the bypass condensers used across the bias resistors for the detector and the power tubes. Each condenser has a value of 5 mfd. These large condensers eliminate reverse feedback even on the lowest audio notes and therefore the gain is not reduced.

Provision for Batteries

The receiver is truly universal for it may be used on a-c and d-c lines as well as on batteries. To switch from a-c to d-c or vice versa no changes in the circuit are required. It is only necessary to make certain that the line plug is inserted in the output with the right polarity. Since the circuit will not work with the plug in one direction and no damage will occur, all that is needed is to reverse the plug in case the set does not work the first time.

When batteries are to be used for powering the set a change is necessary, but only a change that can be effected with a plug. At the rear of the universal set is a socket containing five contacts. When the power supply is either d-c or a-c this socket is vacant but when the power is supplied from batteries a special battery plug is inserted in it. This plug is so wired that when it is inserted in the socket the heaters of the three tubes in the circuit become connected in parallel. A 6-volt battery connected to appropriately marked leads on the cable attached to the plug will operate the heaters in parallel. Provision is also made for the terminals of the plate battery.



F

The circuit diagram of a four-tube universal receiver utilizing th current for the

The Heater Circuit

When the set is operated on a-c or d-c all the filaments, including that of the rectifier, are connected in series, and a ballast, R7, is used to take up the excess voltage. The series connection is possible with any shunt because all the tubes require 0.3 ampere. The ballast is put on the positive side of the line and then follows the filament of 25Z5 rectifier tube. After that come the filaments of the 38 power tube, the r-f amplifier, and the detector. Each of the receiver tubes takes 6.3 volts and 0.3 ampere. The rectifier takes 25 volts and 0.3 ampere. Hence all the filaments take 43.9 volts. If the line voltage is 110 volts, the ballast should be 220 ohms. For each additional volt the ballast resistance should be increased by 3.33 ohms. However, if the circuit is adjusted to the mean voltage existing at the place where the set is to be used it is not necessary to change it if the fluctuation does not exceed 10 per cent.

The wattage rating of the ballast should be at least ten watts for the normal dissipation in it will be close to 7 watts. The resistor should be wire-wound and well ventilated.

The Loudspeaker

The dynamic speaker has been designed specially for the 238 power tube, that is, it has been designed so that when connected to this tube the load on it is that which gives greatest undistorted output. Of course, it is the transformer built into the speaker that effectuates the matching.

The speaker field has an especially high resistance, to enable its use on a battery without excessive drain.

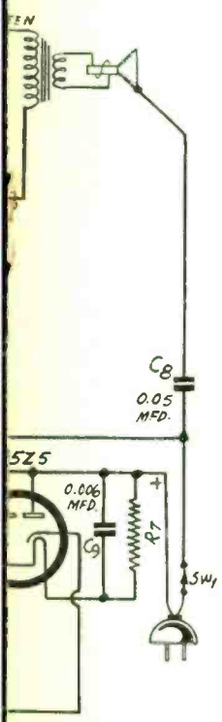
The battery provision of the set is a noteworthy feature. It permits the use of the set in many cases where an ordinary universal set or any a-c or d-c set could not be employed. Thus it may be taken

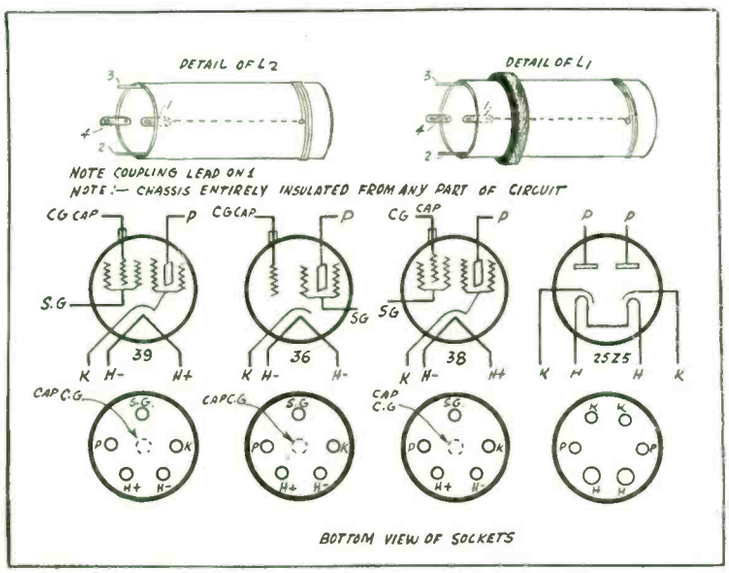
BE UNIVERSAL SET

it—Dynamic Speaker Used—Set Can rom Batteries

Haynes

tal Radio Corp.





. 1

new 25Z5 dual rectifier for supplying the plate voltage and the field ynamic speaker.

aboard a boat to be operated where batteries only are available. It may be used in an automobile where similar restrictions prevail. It may be taken on camping trips to remote places, provided only that the batteries can be carried with the set. Therefore it is not necessary to get a new set just for a trip, nor is it necessary to get a new set when moving from a d-c neighborhood to an a-c neighborhood, or vice versa. It is especially a handy set for commercial travelers who go into places of many different kinds of electric supply or no supply at all.

Controlling Volume

The volume is controlled by means of a 250,000-ohm variable resistor in the cathode lead of the first tube, which is of the variable mu type. In series with the high variable resistance is a 300-ohm fixed bias resistor to prevent zero bias on the tube.

Although there are only three tubes in he circuit proper, there is plenty of amplification to control. There are several reasons for this. First, there is a high gain coil in the antenna circuit. The type of coil used here is illustrated in the insert "detail of L1." There is a small open winding near the top of the coil for coupling at the high frequencies and there is a large coil near the bottom which couples at the lower frequencies.

Between the first tube and the detector is a similar coil, but in this case the large coil is not inductively coupled to the tuned winding. As in the preceding coil the coupling at the high frequencies is by means of an open winding near the top of the tuned winding. The construction and terminal arrangement of this coil are shown in "detail of L2."

These high gain coils and the efficient operation of the r-f amplifier and the detector insure a high sensitivity.

Good tone is a feature of the receiver. How is it secured in such a small set? For one thing it has a high value grid leak resistance and a moderately large stopping condenser between the detector and the power tube. The time constant of the grid leak and the stopping condenser is 0.001 second, which is high enough to assure a good gain on the lower audio notes.

The use of a well-matched dynamic loudspeaker, of course, adds to the quality as well as to the volume that may be obtained from the receiver. A condenser of 0.006 mfd. is connected across the primary of the output transformer, or rather from the plate to the B minus side of the circuit. This condenser improves tone appreciably in that it removes most of the extraneous circuit noises which often are present in sets operated by d-c lines. The by-pass condenser in the plate circuit of the detector is also chosen so that tone shall not be impaired. The value is only 0.0001 mfd., but this should be interpreted in view of the presence of a 2 megohm plate coupling resistor. A small condenser is effective across a high resistance.

The method of securing screen voltage for the detector does two things at once. The screen is connected to the cathode of the power tube, where the bias is some 13 volts above the grid returns. The cathode of the detector is lifted a little above this voltage level, but not nearly as much as the bias on the power tube. Hence there is a low positive voltage on the detector screen. Such a voltage is essential, that is, a positive and a low voltage, if the detector is to function properly with such a high plate resistance in the circuit. The high capacity by-pass condenser, 5 mfd., that is connected between the cathode of the power tube and ground also serves to by-pass the screen of the detector. It is large enough to be effective at the lower audio frequencies that are involved. The bias resistance for the detector is equally well bypassed for at this place also there is a 5 mfd. condenser. These large values of by-pass condensers have a great deal to do with the performance of the set at the low audio frequencies. They are large enough to prevent reverse feedback.

LIST OF PARTS

Coils

L1—One antenna high-gain tuning coil
L2—One interstage high-gain tuning coil
Ch1—One filter choke

Condensers

C1—One 0.002 mfd. condenser
C2, C8—Two 0.05 mfd. by-pass condensers
C3, C4—One gang of two 350 mmfd. tuning condensers
C5—One 0.0001 mfd. condenser
C6—One 0.001 mfd. condenser
C7, C9—Two 0.006 mfd. condensers
C10—One 8 mfd. electrolytic condenser, 200 volt test
C11, C12—Dual 4 mfd. electrolytic condenser, 200 volt test
C13, C14—Dual 5 mfd. electrolytic condenser, 30 volt test

Resistors

R1—One 300-ohm resistor
R2—One 250,000-ohm variable resistor
R3—One 35,000-ohm resistor
R4—One two-megohm resistor
R5—One one-megohm resistor
R6—One 1,500-ohm resistor
R7—One wire-wound ballast resistor

Other Requirements

One 239 super control pentode
One 236 power detector
One 238 power pentode
One 25Z5 dual rectifier
Four five-contact (UY) sockets
One six-contact socket One chassis
One cabinet One carrying case
Three screen clips
One line cord and plug
Hardware assortment
One dynamic speaker
One power switch One battery switch

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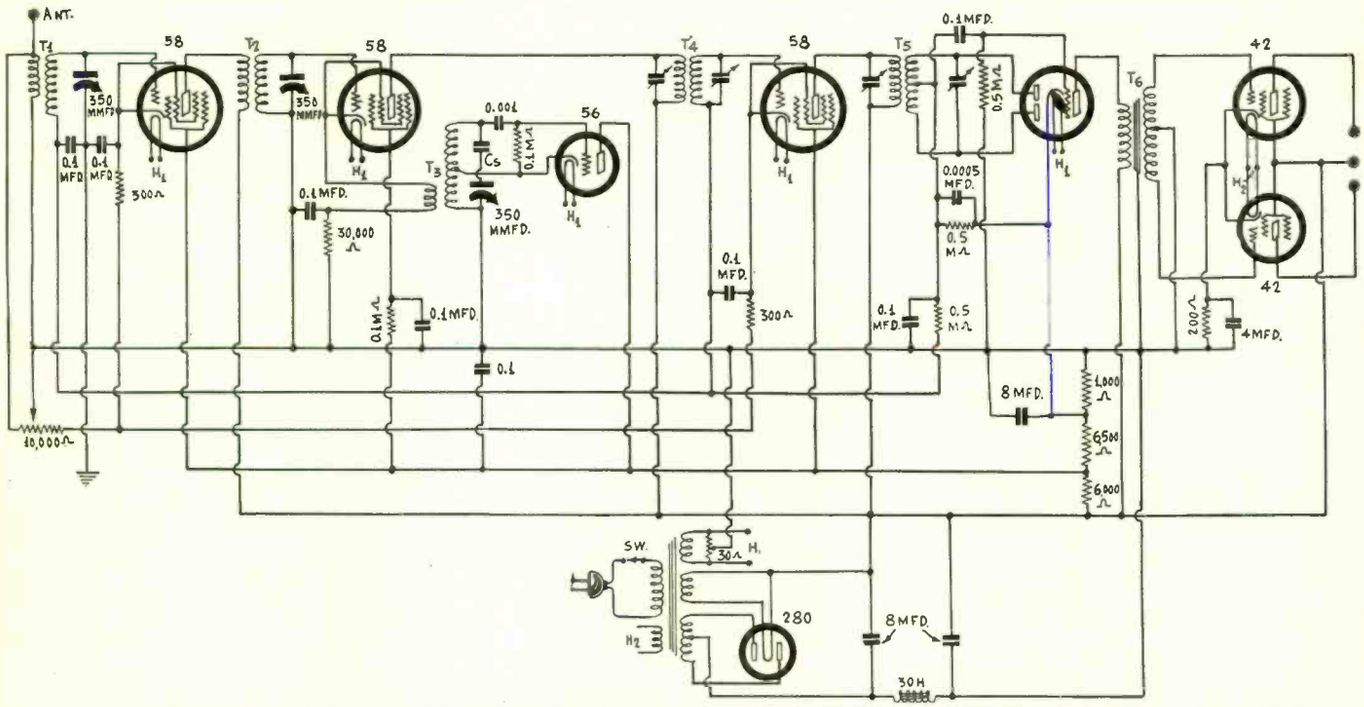
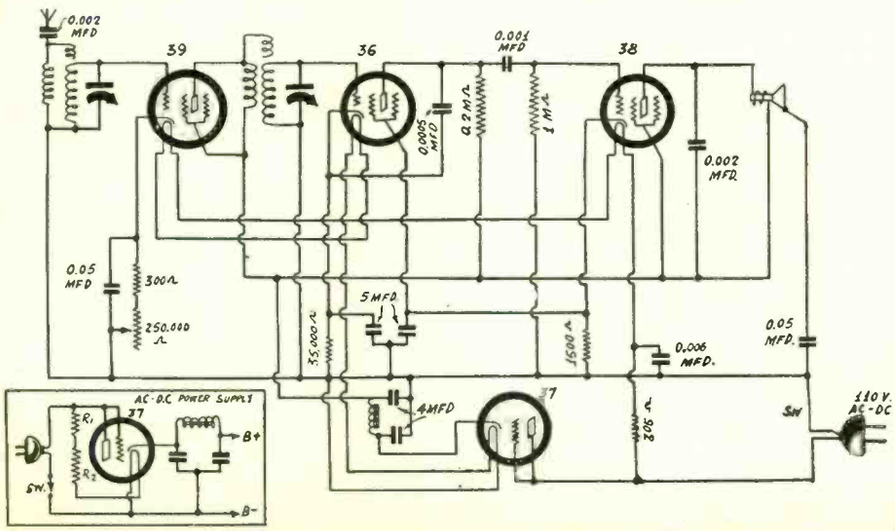


Automatic volume control is applied to the radio frequency and intermediate frequency amplifier tubes, while two 42's in push-pull are used in the output.

48's in Push-Pull

AS I HAVE two 42 tubes I would like a diagram of a receiver that uses them in push-pull output. I prefer a superheterodyne, and it should be a-c operated throughout. The oscillator and first detector tubes should be separate.—T. H. H., New York, N. Y.

The circuit is shown herewith, and the resistance values, as well as the constants of significant condensers, are imprinted on the diagram. Although you did not request it, automatic volume control is included, because it is assumed you want it. The radio frequency amplifier and the intermediate amplifier are controlled. The second detector is a 55, and to avoid high plate current at no signal, due to transformer in the plate circuit, the triode unit of the 55 is independently biased. The biasing resistor for the first detector is shown as 30,000 ohms, because the screen voltage is low. In general, the lower screen voltage makes for a better wave form in the modulation. If oscillation does not obtain at the low radio frequencies of the broadcast band, the resistor may be put between cathode and pickup, instead of between end of pickup coil and ground, and of course the bypass condenser would remain across the resistor only, that is, would not be directly grounded otherwise the pickup coil would be shorted. The fourth parallel line from left should have a dot (soldered connection) where it joins the horizontal line from the potentiometer arm.



A universal receiver, with the 37 used as rectifier. When the set is used on d.c. the rectifier is floated on the line. See detail, lower left, in diagram.

* * *

Rectifier Floated

WHAT HAPPENS to the a-c rectifier tube when an a-c and d-c universal set is used on d-c only?—U. T., Waco, Tex.

The rectifier tube is floated on the line, as detailed in lower left of the c diagram revealing a four-tube universal receiver. In the instance cited a magnetic speaker is used, but if a circuit employing the a dynamic speaker and the 25Z5 rectifier is desired, it will be found on pages 12 and 13 of this week's issue. Despite the few tubes, these miniature a-c and d-c universal sets perform well.

* * *

Five-Tube Set

CAN YOU RECOMMEND a good five-tube a-c circuit, using 58, 57 and 59 tubes in the receiver, with 280 as rectifier? I desire a circuit that has been thoroughly tried and tested.—T. F. E., Casco Bay, Me.

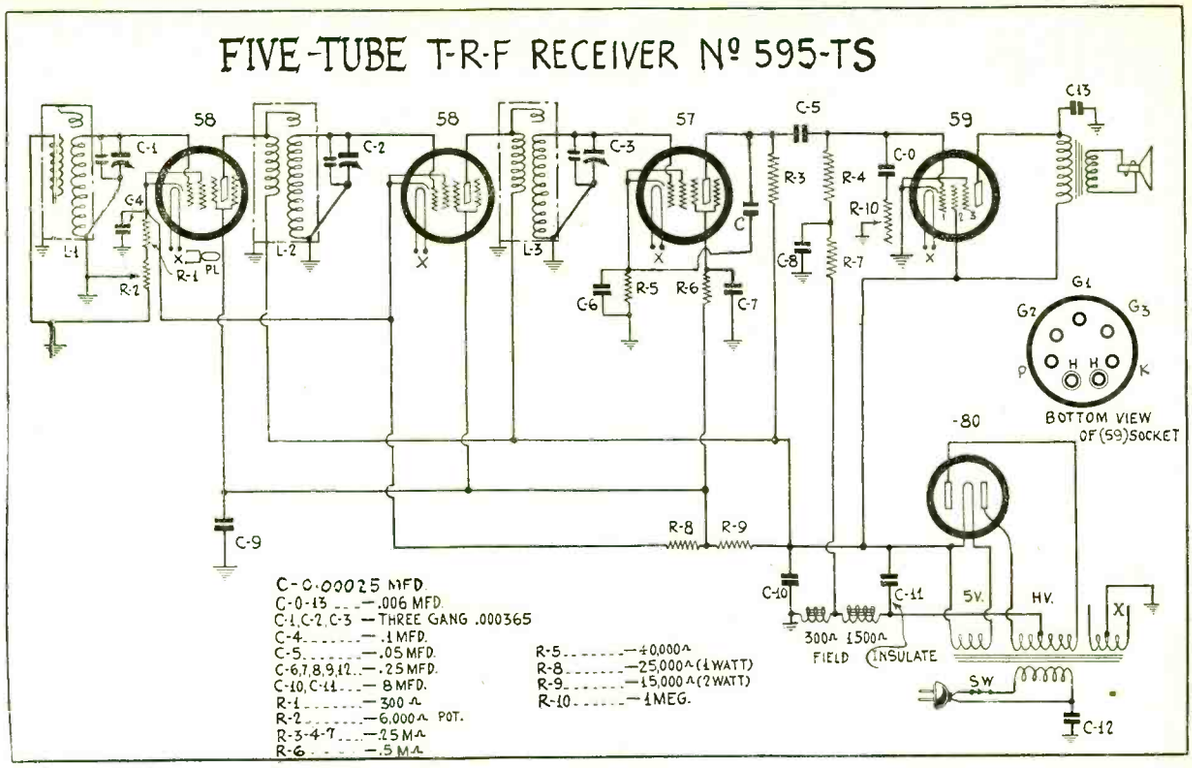
Such a circuit is shown as No. 595-TS, and it is one used in commercial manufacture to excelent advantage, as well as being sold as a kit. The special r-f coils depicted consist of choke primaries in antenna and plate circuits, and with a few turns of wire around the secondary, feeding choke voltage to those secondaries by the capacity coupling between the few turns and the secondary. However, if you have standard coils you may use them. The antenna primary should be read as a choke as explained, and not as one with a metal core. Aerial is connected to the free end. The other end should have the small pickup winding connected to it. A dynamic speaker is used, having 1,800 ohms of field coil, tapped at 300 ohms, and the bias is obtained for the power tube through the drop in the 300 ohms, now a standard practice. Essential values are imprinted on the diagram.

* * *

Tube Voltages

IT IS VASTLY important that the voltage on power tubes should not be ex-

This circuit fulfills the requirement of a correspondent who wants a five tube design "that has been thoroughly tried and tested." Thousands of receivers have been made by a manufacturer who successfully uses this circuit, and besides kits are obtainable for it.



ceeded, using standard specifications, or may the voltage be higher without injury to the tube?—U. T. H. W., Pasadena, Calif.

The voltage limit as stated in standard characteristics charts and as recommended by the tube manufacturers may be exceeded, provided however that the bias is increased accordingly, whereby not more than the maximum recommended current for the lower voltage condition obtains at the higher voltage condition. It is not the high voltage but the high current that affects the tube life, except of course that the voltage must not be even nearly so high as to present a danger of arcing. For instance, if a 50-volt negative bias is standard for a tube (like the 245) at 250 volts applied to the plate, whereupon 32 ma may flow, if the plate voltage is increased to 300 volts the bias should be increased to keep the current with 32 ma. In fact, with the new 2A3 tubes used for push-pull, this very practice is followed, or even exceeded, so that a single-sided circuit requires 42 volts negative bias, drawing 60 ma current, whereas for push-pull the bias is 62 volts negative when 300 volts are applied in the plate circuit, when the current is 40 ma per tube. This is a sort of combination of Class A and Class B, or operation to the left of the normal point on the curve of the tube. Thus the power output capability is increased, being 15 watts in this instance.

* * *

Photo-Cell Use

IS IT PRACTICAL to use a photo-cell as follows: Have a receiver in one place, rectify the r-f, give it some audio amplification if necessary, then modulate a light beam with the audio and have a photo-cell at a continuing audio amplifier somewhere else, as in the same room, to be actuated by the light modulation, hence carry the audio by light?—J. A. E., Salt Lake City, Utah.

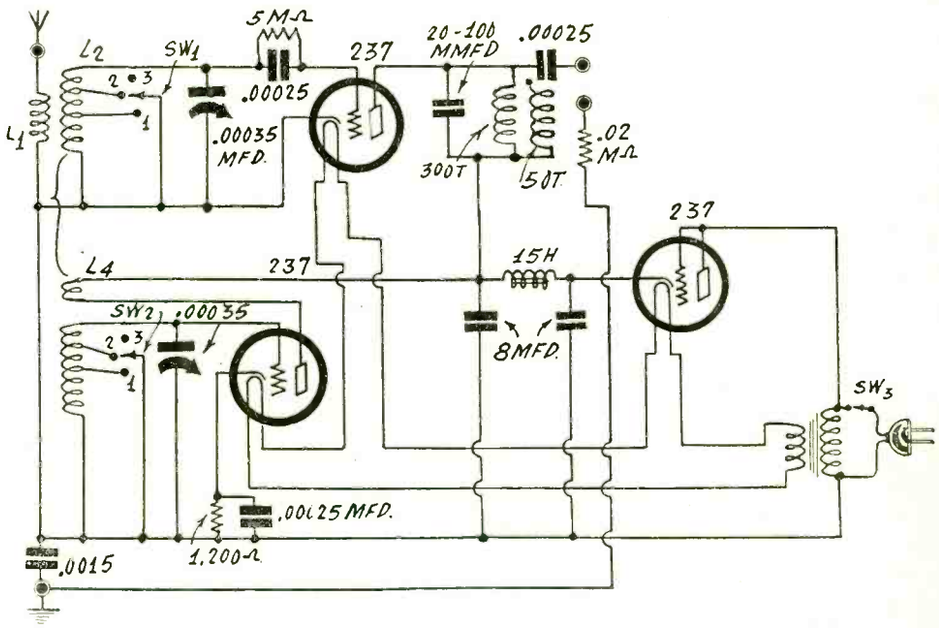
Yes, that is a practical objective and you should have considerable enjoyment experimenting with it.

* * *

Converter Circuit

DO YOU HAVE a circuit for a short-wave a-c converter? I have tried some converters with only fair success, but if you know of a circuit that is a good, consistent performer, and that does not cost much to build, please let me know.—A. P. D., Fort Wayne, Ind.

The circuit diagramed herewith, using three 237 tubes, one of them as modulator, another as oscillator and the third as a rectifier, will give good results. Even though tapped coils are used, and the tuning condensers are of higher capacity than normally, the sensitivity developed is satisfactory, perhaps due to the isolation of the tuning condensers. Ganging for short waves, without manual compensation, always will reduce sensitivity. Here with separate tuning you may feel confident of results. L1 is wound on a 1.75 inch diameter, consisting of 8 turns, and separated by ⅛ inch from the secondary, which has 45 turns, tapped at the tenth and thirtieth turns, counting from grid end. The oscillator has a 20-turn tickler separated ⅛ inch from the secondary, which consists of 38 turns tapped at the tenth and thirtieth turns from the grid end. The wire may be No. 28 enamel, except that for the secondaries between lowest tap and ground the wire may be No. 18 enamel to some advantage, due to the higher frequencies. If you do not desire to short out unused turns, as shown, you may switch the stators of the two tuning condensers instead, which would leave the full secondary in each grid circuit all the time, but either all or smaller parts of it tuned, and would reverse the directions for tap locations, and require a tap on switch for the extreme (grid) connection.



A short-wave converter that performs better than otherwise because its two tuned circuits are independently controlled. Either the shorting method of switching may be used, as illustrated, or the stators switched to taps, full coil always in the grid circuit.

SERIES AND PARALLEL
Resonance Circuits Analyzed

By Einar Andrews

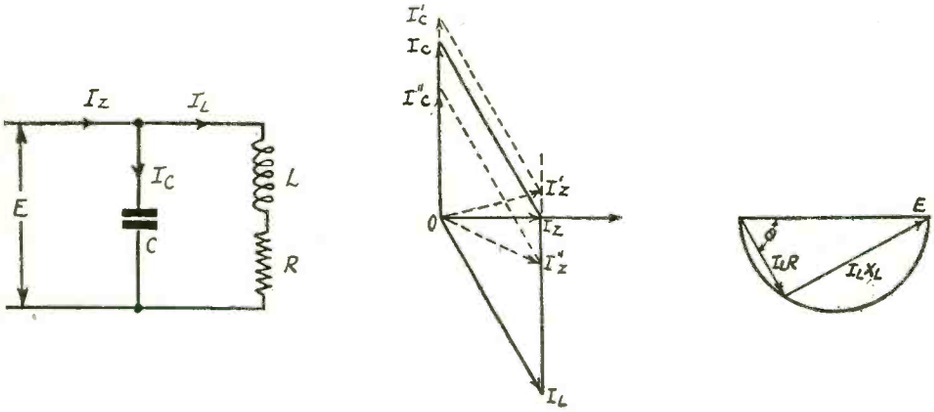


FIG. 1

In a parallel resonant circuit the voltage is connected in shunt with both the coil and the condenser. The current at resonance is in phase with the voltage and is extremely small.

A PARALLEL resonant circuit behaves quite differently from a series resonant circuit. But in what do the circuits themselves differ? Either is made up of a coil having a little resistance and a condenser having a negligible resistance. The two differ only in respect to the location of the driving voltage. In Fig. 1, at left, is a parallel resonant circuit because the driving voltage E is applied across the condenser and the coil in parallel. If the voltage in the same circuit were introduced in the coil L by means of mutual inductance, or if it were introduced in series with either L or C, then it would be a series tuned circuit.

In the figure Iz represents the current flowing in the line, Ic represents the current in the condenser branch and IL the current flowing in the coil branch. It is clear that the sum of the branch currents is always equal to the line current. Yet Iz may be extremely small whereas the coil and condenser currents may be very large. Therefore we have a case where the sum is smaller than its parts. What is meant is the vector sum because all the currents are vectors and their instantaneous directions must be considered as well as their magnitudes.

The Vector Sum

In the middle of Fig. 1 is a vector construction showing the relationship of the three currents. The condenser current Ic is drawn from zero to Ic. It is drawn at right angles to the horizontal line because the condenser current leads the voltage by 90 degrees. The coil current is drawn from zero to IL. This line is drawn at an angle less than 90 degrees because there is resistance in the coil and the angle of lag is not quite 90 degrees. The fact that it is a lag is indicated by the fact that the angle is drawn in the negative direction, or the vector is drawn in the fourth quandrant. The vector sum of these two vectors is the diagonal of the parallelogram constructed with the two vectors as sides, the diagonal that lies between the two vectors, not the one that joins their vertices. Therefore OIz is the vector sum of the coil and condenser currents, and OIz is the line current. This is the same as Iz in the algebraic notation.

The meaning of resonance seems quite clear, but in this case we have to define it. Is resonance that condition when the line current is in phase with the voltage, or is it the condition when the current circulating in the coil and the condenser is maximum? Perhaps it is the condition when the line current is minimum. Ordinarily, the assumption is that there is no difference, and there is none if we can neglect the resistance in the coil.

If we define resonance as that condition when the line current is in phase with the voltage the frequency of resonance is determined by $w^2 = (1 - R^2S/L)/LC$, in which w is 6.28 times the frequency, R is the resistance of the coil, C the capacity of the tuning condenser, and L the inductance of the coil. With this definition of resonance then the impedance of the circuit, at resonance, is equal to L/RC ohms. This is a pure resistance, as it would have to be since we stipulated that the current should be in phase with the voltage. Incidentally, this impedance is assumed to hold even when the resonance condition is defined as $w^2 = 1/LC$. This assumption is correct only if the resistance is so small that $(1/Cw)^2$ is negligibly small in comparison with $(L/RC)^2$. That is usually the case in most practical instances, but there are cases when the assumption is not justified.

Line Current Magnitude

The magnitude of the line current depends on the ratio L/RC. Suppose R is 10 ohms, L, 250 microhenries, and C, 100 mmfd. Then L/RC is 250,000 ohms, and the line current per volt input is only 4 microamperes. The current in the condenser is 628 microamperes, or 157 times greater than the line current. The coil current is about the same as the condenser current.

Now suppose we impress one volt in series with the coil or the condenser. At series resonance the impedance of the circuit is only equal to the resistance, which we have assumed to be 10 ohms. Then one volt will drive a current of 0.1 ampere around the circuit. A comparison of the effect of one volt in series with the circuit and that of one volt across the circuit is interesting. One volt across the circuit produced a line current of 4 microamperes whereas one volt in series produced 0.1 ampere. There is a ratio of 25,000. Again, one volt across the circuit produced a condenser current of 628 microamperes and one volt in series produced a current in the resonant circuit of 0.1 ampere. There is a ratio of 159.

Use of Circuits

A parallel resonant circuit is used when the plate circuit of an amplifier is tuned. In this case the parallel circuit presents a very high impedance to the plate resistance of the tube. A large proportion of the signal voltage in the plate circuit will appear across the resonant circuit and therefore a large current will flow in that circuit. If there is a coil coupled to the resonant coil and if the second coil is in the grid circuit of a second tube, a large voltage will be transferred to that tube.

If the coil and condenser are connected in series in the plate circuit there will be practically no load on the tube at resonance for it will only be the resistance of the coil. That is, the load resistance might be 10 ohms whereas the internal resistance of the tube might be 10,000 ohms. Nearly all the signal voltage drop will occur in the tube and very little in the load. Effective coupling to the next tube cannot be expected.

The Selectivity

The resistance of the coil has a great deal to do with the gain of an amplifier in which the tuned plate arrangement is used. It depends on the ratio of L/RC, and this in turn is related to the selectivity, that is, to Lw/R. If Q is the selectivity the parallel resonance impedance is RQ^2. Hence the amplification depends on the square of the selectivity. If μ is the mu of the tube then the amplification is $\mu kRQ^2/(r_p + RQ^2)$, in which r_p is the internal resistance of the tube and k is the coefficient of coupling between the tuned coil and the grid coil. This shows the importance of using a coil with a high selectivity factor.

Common shielded coils of the midget type have a selectivity of 65. At one million cycles that means a coil resistance of about 24 ohms. A 58 tube has a plate resistance of about 800,000 ohms and a mu of 1,280. Putting these values into the formula there results an amplification of 144k. While this is a high gain for one stage it is not nearly as high as if a selectivity factor of only 100 had been used. This gives a gain of 296k, which is more than twice as great as the gain obtained when the selectivity factor was 65. It is not at all difficult to get a coil with a selectivity factor of 100, or much higher.

In intermediate frequency amplifiers such high selectivity factors are not practical because the sidebands would be cut noticeably. A better overall selectivity is obtained with several moderately selective circuits than with a single circuit of equivalent selectivity at the carrier. Several moderately tuned circuits in tandem will give a response approximately like that of a band pass filter.

Adjusting Trimmers and Pad in Clarion Model 300 Receiver

While the same general principles are followed in lining up a superheterodyne, different manufacturers differ as to details. The following is the manufacturer's recommendation in regard to the Clarion Model 300, diagrams and oher data having been published last week (February 25th):

Adjusting Trimmers: The model 300 receiver has nine trimmer condensers. The setting must be accurate, although with tolerance enough to permit exchange of tubes without ruining sensitivity. Rough handling in shipment will not ordinarily jar these condensers and cause the set to lose sensitivity.

To adjust the trimmers connect your 175 kc oscillator to the first detector type 58 grid cap, and in the following order, readjust trimmers numbers five, six, seven, eight and nine for maximum output; next, disconnect your 175 kc oscillator and connect to the antenna binding post of the receiver the output lead from your broadcast test oscillator or tune in a broadcast signal from a known frequency, crystal controlled, station at 1,400 kc, then reset trimmers two and one respectively for maximum output. This adjustment will track the first detector and r-f stage.

To check the calibration of the receiver, whether it be high or low, trimmer, number three (oscillator) should be reset until a station of known high frequency is brought in at the correct dial marking with peak volume. If your broadcast test oscillator is accurately calibrated, it might be used in place of the broadcast station signal. In this adjustment a signal at about 1,400 kc should be chosen. The setting of the trimmers at 1,400 kc is more critical than it would be at 600 kc, therefore more accurate.

The next adjustment is important and not easily explained in writing, so pay close attention to the following instructions. We will now balance the oscillator to the r-f and first detector stages. Tune the external broadcast test oscillator and the receiver both to 600 kc, then slowly increase or decrease the capacity of No. 4 (oscillator padding trimmer) at the same time and continuously tuning back and forth across the signal with the receiver tuning condenser gang. The output meter needle will now be swinging up and down in step with the variation in tuning. Watch the peak of this swinging closely and readjust No. 4 trimmer until the swinging needle reaches its highest peak. Your output meter mentioned in this test is not to be confused with the tuning meter incorporated in the set.

Standard Resistor Code

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

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

Tube Characteristics

120

Type of tube—Filamentary triode.
Socket—Four contact.
Purpose—Power amplifier.
Overall height—4⅛ inches.
Overall diameter—1 3/16 inches.
Filament voltage, d-c—3.3 volts.
Filament current—0.132 ampere.
Ballast for 6-volt supply—20 ohms.
Amplification factor—3.3.

Amplifier, 90-Volt Plate

Plate voltage—90 volts.
Grid bias—16.5 volts.
Plate current—3 milliamperes.
Plate resistance—8,000 ohms.
Mutual conductance—415 micromhos.
Maximum undistorted output—45 milliwatts.
Optimum load resistance—9,600 ohms.

Amplifier, 135-Volt Plate

Plate voltage—135 volts.
Grid bias—22.5 volts.
Plate current—6.5 milliamperes.
Plate resistance—6,300 ohms.
Mutual conductance—525 micromhos.
Maximum undistorted output—110 milliwatts.
Optimum load resistance—6,500 ohms.

222

Type of tube—Filamentary tetrode.
Socket—Four contact.
Purpose—R-F amplifier.
Overall height—5¾ inches.
Overall diameter—1 13/16 inches.
Grid-plate capacity—0.025 mmfd., max.
Grid-filament capacity—3.2 mmfd.
Plate-filament capacity—12 mmfd.
Filament voltage, d-c—3.3 volts.
Filament current—0.132 ampere.
Ballast for 6-volt supply—20 ohms.

R-F Amplifier

Plate voltage—135 volts.
Screen voltage—67.5 volts.
Grid bias—1.5 volts.
Plate current—3.3 milliamperes.
Amplification factor—290.
Plate resistance—600,000 ohms.
Mutual conductance—480 micromhos.

Audio Amplifier

Plate voltage, applied—180 volts.
Plate load resistance—250,000 ohms.
Screen voltage—22.5 volts, max.
Grid bias—0.75 volt.
Plate current—0.3 milliampere.
Amplification factor—350.
Plate resistance—2 megohms.
Mutual conductance—175 micromhos.

Grid Bias Detector

Operate as audio amplifier but with 3 to 4.5 volts grid bias.

Socket No. 4, Jan. 21 issue.

V-199, X-199

Type of tube—Filamentary triode.
Sockets (UV and UX)—Four contact.
Purpose—Detector and amplifier.
Overall height—V-199, 3½ inches, X-199, 4⅛ inches.
Overall diameter—V-199, 1 1/16 inches, X-199 1 3/16 inches.
Filament voltage, d-c—3.3 volts.
Filament current—0.063 ampere.
Ballast for 6-volt supply—40 ohms.
Grid-plate capacity—3.3 mfd.
Grid-filament capacity—2.5 mmfd.
Plate-filament capacity—2.5 mmfd.
Amplification factor—6.6.

Detector

Plate voltage—45 volts.
Grid bias—A plus.
Plate current—1.5 milliamperes.
Plate resistance—17,000 ohms.
Mutual conductance—Micromhos.

Amplifier

Plate voltage—90 volts.
Grid bias—4.5 volts.
Plate current—2.5 milliamperes.
Plate resistance—15,500 ohms.
Mutual conductance—425 micromhos.
Maximum undistorted output—7 milliwatts.
Optimum load resistance—15,500 ohms.

Socket No. 1, Jan. 21 issue, for X-199 UV socket for V-199.

Characteristics of Two New Tubes in Push-Pull Diamona

2A3's IN CLASS A

PUSH-PULL AMPLIFIER

Filament Voltage (A.C. or D. C.)	2.5		Volts
Filament Current	2.5		Amperes
Direct Interelectrode Capacitances (approx.):			
Grid to Plate	13		uuf.
Grid to Filament	9		uuf.
Plate to Filament	4		uuf.
Maximum Overall Length	5⅜"		
Maximum Diameter	2 1/16"		
Bulb	ST-16		
Base	Medium 4-Pin		
Operating Conditions:	Fixed Bias	Self-Bias†	
Filament Voltage (A.C.)	2.5	2.5	Volts
Plate Voltage	300 max.	300 max.	Volts
Grid Voltage	—62*	—62*	Volts
Plate Current (per tube)	40	40	Milliamperes
Load Resistance (plate to plate)	3000	5000	Ohms
Total Harmonic Distortion	2.5	5	%
Power Output	15	15	Watts

†For this condition, the values given are on the basis of momentary average power output as distinguished from the continuous average power output of the fixed-bias condition. The power output and percentage distortion are functions of the duration and magnitude of the signal which through variation in plate current causes fluctuating grid bias. Obviously, a filter associated with the biasing resistor will tend to stabilize the grid bias. The duration of stabilization increases with the time constant of the filter; the longer the period, the longer the power peaks can be maintained.

*Grid volts measured from mid-point of a-c operated filament.

5Z3 RECTIFIER

Filament Voltage (A.C.)	5.0 Volts
Filament Current	3.0 Amperes
A-C Voltage per Plate (RMS)	500 max. Volts
D-C Output Current	250 max. Milliamperes
Maximum Overall Length	5⅜"
Maximum Diameter	2 1/16"
Bulb	ST-16
Base	Medium 4-Pin

SOCKET VOLTAGES for Zenith Models 430 and 440

Tube Type	*Position*	*Fil. Volt.*	*Plate Volt.*	*Cath. Volt.*	*Screen Volt.*	*Supp. Volt.*	*Plate Current*
Z-58	1st R.F.	2.5	175	2.2	75	2.2	5.7
Z-58	1st Det.	2.5	190	4.5	75	4.5	2.3
Z-56	Osc.	2.5	100	0	..	..	3.5
Z-58	1st I.F.	2.5	200	2.2	75	2.2	5.5
Z-56	2nd Det.	2.5	110	10	..	..	.3
Z-56	1st Audio	2.5	170	80	..	..	.8
Z-57	A.V.C.	2.5	..	—85	..	—85	..
Z-57	Q.A.V.C.	2.5	30	13	75	13	..
Z-59	Driver	2.5	190	20	190	190	13
Z-59	Power	2.5	195	—70	195	195	22
Z-59	Power	2.5	195	—70	195	195	22
Z-80	Rect.	5.0	360	..	..	..	65

Line 115 Volts — All Controls Maximum

(*All readings, with exception of heaters, taken from socket connections to ground. Use 1,000 ohm per volt d-c meter.*)

Balance the i-f at 175 kc, condenser gang at 1,500 kc and oscillator padder at 600 kc.

[*The circuit and other details were published last week, February 25th issue.*]

SENATE VOTES LOTTERY BAN; OTHER CHANGES

Washington.

The House radio bill was passed by the Senate with numerous amendments, including a revision of the House provision to prohibit broadcast of lotteries or similar schemes, to conform with the law which forbids publication in newspapers. The Senate, eliminated a provision that would have limited the number of aliens as officers or directors of a corporation to which a license for station operations is granted.

The bill, which now goes to conference between the House and Senate, amends the basic radio law of 1927, which has been regarded as the first comprehensive legislation relating to control of broadcasting and commercial wireless enterprises.

Court Procedure Laid Down

In addition to changes respecting lotteries and licensees, the Senate amendments establish a new procedure in appeals from the Radio Commission, and lay down new rules respecting hearings under the direction of the Commission.

The section restricting alien membership in licensee boards of directors was stricken out upon a motion by Senator White (Rep.), of Maine, who told the Senate that it was laying a precedent that was unwarranted and was directed solely at one corporation, the International Telephone & Telegraph Co. Senator White told the Senate also that, from the viewpoint of war emergency the section was valueless, since the President had authority to seize all stations under such conditions.

Supervision of Programs

An amendment, designed to give the Radio Commission supervision to some extent over programs originating within the United States but broadcast from stations in neighboring countries, was added by the Senate. The amendment was proposed by Senator Vandenberg (Rep.), of Michigan, and is intended, he said, to require that, when programs originate within the United States and are handled through such remote control for broadcasting back into this country, the operations shall be subject to such rules and regulations as the Commission may prescribe.

Analysis of Amendments

An analysis of some of the major amendments to the bill, prepared by Senator Dill (Dem.), of Washington, follows in part, according to "The United States Daily":

"Your Committee has amended the House text by striking out those words that authorize all hearings to be held by examiners or other employes of the Commission and restricted the use of examiners for holding hearings.

"Your Committee believes it more desirable that the Commission should hold all important hearings and secure more personal knowledge of contests by this method, and for that reason has provided that all hearings on major radio questions shall be held by the Commission, or by a Commissioner, or by a number of Commissioners as the Commission may designate.

"Section 6 of the bill amends section 9 by eliminating the territories and possessions from the zone system, and also by subjecting renewals of licenses to the same restrictions governing the original granting thereof.

Court Procedure on Appeals

"Section 10 substitutes for section 16 of the radio law a simpler and more efficacious procedure in appeals. Your Committee has added provisions giving the licensee, whose license is revoked, or the owner who had been fined, the right to appeal in the lower district court instead of being required to come to Washington, D. C., to prosecute his appeal in the district courts of the District of Columbia.

"This is of particular advantage to the owners of small stations located a long distance from the District of Columbia. It will result also in questions of radio law being submitted to judges of the district courts and circuit courts of appeals, instead of all radio law questions being passed upon by the District Court of Appeals of the District of Columbia.

"This is especially important from the standpoint of building up a series of legal interpretations of radio law by different inferior courts of the United States.

"Section 12 amends section 32 of the Act by providing the same penalty for offenses as is usual in similar cases in other governmentally regulated activities.

Lottery Broadcasting

"Section 13 is a new provision in the radio law and provides that no person shall broadcast by means of any radio station, for which a license is required by any law of the United States, any information concerning any lottery, gift enterprise, or similar scheme, offering prizes dependent in whole or in part upon a lot or chance, and provides penalties for conviction thereof."

35,000-Mile Chase Discloses Bootleggers' Transmitter in Car

After a year of unsuccessful attempts to locate an unlicensed radio station used for directing the landing of liquor, agents of the Department of Justice, assisted by two radio experts, caught up with the elusive station. One day the station would send messages from Asbury Park, N. J., the next from Cape May or Atlantic City, N. J., and the next, perhaps, from Southampton, or Montauk Point, L. I. Always it would send in cipher which changed as often as the location of the station. During the hunt the Department of Justice automobile and direction finding receiver had traveled 35,000 miles.

The elusive station was finally found in a Brooklyn, N. Y., garage on a tip. It had been concealed in a standard Chevrolet sedan in a most ingenious way. On casual inspection there was no evidence of the presence of unusual equipment but on careful examination a transmitting station capable of range of 1,000 miles was revealed. It was hidden under the cushions and under the floor board. When the station was found the car in which it was installed had traveled more than 22,000 miles and it had both New York and New Jersey license plates.

The Department of Justice agents who conducted the search were Horace J. Simmons and Carlos M. Berstein and the radio inspectors were Forest F. Redfern and John L. Hein. The car driver escaped but the names of all involved are known.

The radio inspectors have assisted Department of Justice agents in many cases where the radio plants and operators of bootleggers have been seized.

NEW TEST FOR SYNCHRONIZED WAVE EXPOSED

Washington.

Ellis A. Yost, Chief Examiner of the Federal Radio Commission, has recommended that the applications of WBBM Broadcasting Corporation, Chicago Ill. and KFAB Broadcasting Company, Lincoln, Nebr., to modify their licenses in order that the stations may synchronize with each other at specified night hours and to install automatic frequency control be granted.

In a recent report to the Commission Mr. Yost stated that "should the experiments prove to be a success they would account for one of the most important and advanced steps in radio engineering which has taken place in recent years."

He added:

"Based on prior experiments and accepted engineering knowledge, it is believed that the proposed system of synchronization, together with the capable manner in which it will be operated, has more than an equal chance of proving successful."

Practicability Test

The synchronous experiments would be conducted by the executives and engineers of the applicants, of the Columbia Broadcasting System and of the Bell Telephone Laboratories, Inc. From them it is believed that considerable knowledge will be added on the subject of common frequency broadcasting. The practicability or impracticability is expected to be proved.

The frequency of the stations is 770 kc, simultaneous use by day, alternating by night.

Continuing, Mr. Yost said, according to "The United States Daily":

"The programs which stations WBBM and KFAB would broadcast while synchronized would be of a high order and would provide Columbia programs for a large number of listeners who do not now receive these programs in a satisfactory manner from any other broadcasting station.

Possible Boon to Chicago

"The Chicago area is the second most important in the country to the Columbia Broadcasting System, and these synchronization experiments would provide an outlet for its programs during the hours between 10 p.m. and midnight, thus providing continuous Columbia service to millions of people in the Chicago area who do not now receive such a service.

"The synchronization experiments proposed by the applicants are materially different from any synchronization experiments heretofore undertaken under practical operating conditions. It is the first complete synchronization experiment proposed to the Commission in which the stations to be synchronized are so separated that the good service area of the stations in question do not overlap."

Loops are used in conjunction with receivers, to serve as direction finders for pleasure boat operators. The set is tuned to the desired frequency, the station heard, and the loop turned for minimum response, as that gives sharpest reading.

A compass is associated with the minimum response so that the direction may be read. The 180-degree possible difference presents no handicap whatever.

AIR-SLEUTHING 'HAMS' LOCATE KIN FOR SISTER

Hartford, Conn.

Estranged from his sister for twenty years, Henry C. Caldwell, brother of widowed Mrs. Charles Fredericks, of Los Angeles, Calif., was located by amateur radio in less than one week.

Mrs. Charles Fredericks, 6566 West Boulevard, Los Angeles, filed radiogram No. 20 at W6DTX, the amateur radio station of Maurice M. Koll, 6537 Brynhurst Ave., Los Angeles. It was a plea from a distracted wife and mother, left alone and friendless after suffering the sudden loss of her husband by death. It begged amateur radio to aid her in finding the only person to whom she could turn for help—her brother, Henry C. Caldwell, from whom she had not heard in twenty years. The only hint she could give as to his whereabouts was that he might be in the Government Signal Corps service somewhere in the United States or its possessions.

The same message was filed simultaneously at W6CLN, the amateur radio-telephone station of Ralph O. Gordon, 5708 Kenniston Ave., Los Angeles, and W6ECC, the 3500 kc station of E. F. Shelton, 7014 Madden Ave., Los Angeles.

Over the airways networks of the American Radio Relay League the message flashed, a cry for help, with a plea for amateurs everywhere to contact every Signal Corps post for information concerning Caldwell's whereabouts. Each station receiving the frantic call relayed it to other stations. Soon it clamored in the ether waves in every part of the country and over every faraway Signal Corps post.

Six days later No. 20 caught up with the estranged man! An air mail letter was received by Mrs. Fredericks from her brother, stationed at Governor's Island, New York harbor. A New York amateur had received the plea, contacted the various New York Signal Corps posts, and eventually located the missing man.

Amateurs to Handle Governors' Messages Felicitating Roosevelt

Hartford, Conn.

The nation-wide relay chain of amateur stations being organized by the American Radio Relay League for the conveying of messages of congratulation from the Governors of the 48 states and the U. S. territorial possessions to President-elect Roosevelt, to be delivered at the time of his inauguration, rapidly approached completion.

Stations have been selected in the State capitols for the originating of the message of felicitation from their respective chief executives.

Twenty-one crack stations of the Washington (D. C.) Radio Club have been designated to handle the incoming messages and continuing until the group presentation of the messages to the President-elect late in the afternoon of the 4th.

NEW TUBE CHART SOON

A new tube chart is in preparation, giving the characteristics of all receiving tubes in tabulated form. It is expected to be ready for publication in a few weeks. All the new tubes will be included.

New Device is Piano, Organ, Guitar, Flute, Saxophone, Tuba, Etc.

A foretaste of the new electronic music which Dr. Leopold Stokowski predicts will revolutionize musical instruments of the future was heard over WJZ and other NBC stations of the Blue Network.

In the New York studio was a single instrument, resembling in outward appearance a grand piano. Yet as the performer pressed various buttons the tones of the piano quickly changed into those of the organ, guitar, saxophone and flute.

But this was only the beginning of the musical stunts which this sombre black electronic piano can perform. For other control dials make it simulate the harp, bassoon, French horn, tuba, oboe and clarinet.

How this new family of electronic musical instruments, now achieving wide popularity in Europe, was the outgrowth of the principles which underlay the ordinary radio set, was explained by Orestes H. Caldwell, former Federal Radio Commissioner, now editor of "Radio Retailing," during the "Better Radio Reception" period conducted under the auspices of the Electrical Association of New York.

The electronic piano is the development of Benjamin F. Miessner, of Short Hills, N. J., radio inventor.

NAVY OPPOSES WJSV PERMIT

Washington.

Representatives of the Navy Department testified before the Federal Radio Commission in executive hearing protesting against the issuance of a permanent construction license to WJSV, Old Dominion Broadcasting Company, Alexandria, Va., now under control of the Columbia Broadcasting System, on the ground that the broadcasts cause an interference with naval radio experiments "highly confidential" in respect to "natural defense."

Alexander Holzoff, attorney of the Department of Justice, on behalf of the Navy Department, cross-examined the only witness of WJSV and the Columbia Broadcasting System, A. B. Chamberlain.

On cross-examination, Mr. Chamberlain stated that at a previous hearing when the modification of the previous license was sought for the construction of the transmitter on the Mount Vernon Highway between Alexandria and Washington, he did not mention the naval radio laboratory at Bellevue because he thought the question about the proximity of other stations involved only "commercial" stations. Mr. Holzoff read the former question and it included also "Government" stations.

Paul D. Spearman, counsel for WJSV, then referred to a map which was submitted with the application for the modification of the license showing Bellevue and the topographic situation of the location sought. The Commission granted him five days in which to secure a photostatic copy to be filed with its application and testimony.

The hearing was called as a result of protests filed by the Navy Department because of alleged interference of WJSV during its test period after the modification of the former license had been granted pending the application and issuance of license to cover construction permit. The Navy Department stated that the transmission resulted in "serious interference" with the naval radio laboratory at Bellevue.

WHAM JUMPS TO 25KW FROM SMALL PLANT

An evening-long series of programs featuring the Rochester Philharmonic Orchestra and NBC stars from New York to San Francisco will occupy the NBC-WJZ network March 4th in observance of WHAM's increase in power from 5,000 to 25,000 watts.

From 8:00 to 9:00 o'clock Guy Fraser Harrison will conduct the Rochester Philharmonic with a group of distinguished guest soloists. At 9:45 NBC stars, guests of WHAM in its dedication, will be heard in a half-hour broadcast from Rochester through the same network.

At 9:45 there will be a series of congratulatory broadcasts from San Francisco, New York, Chicago and Washington. WHAM is in Rochester, N. Y., and operates on 1,150 kilocycles.

Technical Aspects

The new 50-kilowatt transmitter of WHAM, recently was completed at a cost of more than $200,000. It gives 100 percent, modulation and an increase in signal strength. The 5,000-watt transmitter used by WHAM since 1927 stands intact, ready for emergency service. The new equipment will be used at an output of 25,000 watts to conform to the station license issued by the Federal Radio Commission.

Installation work was begun in October and was finished about three weeks ago. Tests made while eastern listeners slept have indicated improved transmission in all directions, including Buffalo, Syracuse, southern New York and northern Pennsylvania. A new wing of the WHAM operating building at Victor, N. Y., houses the new equipment.

Shock Protection

Designers protected the operators from dangerous 17,000-volt circuits by including an intricate interlocking system for the doors by which every operator is prevented from entering that part of the building which forms the interior of the transmitter while the currents are on. A master switch must be thrown before the generators and rectifiers can be started, and in order to throw that switch every key to the dangerous enclosure must be in position—not in its door, but in the master switch. There is an outdoor cooling tank—not unlike a swimming pool—used to cool the water which carries heat away from the power tubes. Eight of such tubes are used, each of which must be artificially cooled to prevent fusing from the tremendous heat. Six of the tubes are valued at $450 apiece. Electric power is supplied the station from two cities—Canandaigua and Rochester.

Trouble-Shooting Pilots

Every precaution has been taken to make the transmitter proof against loss of time on the air. A refinement in trouble-hunting is a panel containing a small numbered light for each tube in the transmitter. When a tube develops a defect the corresponding bulb flashes to show the operator exactly where to find the trouble. Improvement in reception from WHAM will mean a new channel for the reception of "blue network" programs and the Rochester offerings developed in the fields of music, world events, education, news and drama.

HIGHER POWER GIVEN 7; POLICE RADIO GROWING

Washington.

Following is a list of recent changes involving power, with new stations noted. Where "construction permit" is cited the license has not yet been granted, but where "license" is cited it has been granted. A "construction permit" is tantamount to approval given, license to follow after certain requirements are filled.

Power Increase

WNAX, House of Gurney, Yankton, S. Dak., construction permit, 1 to 2.5 kw.

WJBK, James F. Hopkins, Inc., Detroit, Mich., licesed 100 w, formerly 50 w.

WJAR, Outlet Co., Providence, R. I., licesed, 250 to 500 w, night power.

WEAN, Shepard Bdcg. Service, Inc., Providece, R. I., licensed, 250 to 500 w night power.

Change of Ownership

WCAU, Philadelphia, Pa., from Universal Broadcasting Co. to WCAU Broadcasting Co., involving change of name only.

WQAO-WPAP, New York, N. Y., from Calvary Bapist Church to Marcus Loew Booking Agency.

KSTP, National Battery Broadcasting Co., St. Paul, Minn., licensed 10 kw to 25 kw until local sunset.

New Stations

Charles W. Phelan doing business as Casco Bay Broadcasting Co., Portland, Me., construction permit, 1,340 kc, 250 w night, 500 w day.

Police

New Bedford, Mass., construction permit, 1,712 kc.

KGZB, Houston, Tex., license, 1,712 kc, 100 w.

Gary, Ind., construction permit, 2,470 kc, 100 w.

WPFF, Toms River, N. J., license, 2,430 kc, 50 w.

WPEG, Jacksonville, Fla., license, 2,442 kc, 100 w.

Television

Dr. George W. Young, Minneapolis, Minn., construction permit, 2,000-2,100 kc, 500 w.

Newsmongers Increase; New Technique Appears

Newsmongers are gaining a more important place in the radio spectrum. Already there are several newspaper men who have won a national reputation for their broadcasts. The main method used is a snappy summary of important news, with occasional sprinklings of freak news items, but some of the newsmongers are developing a style and technique of their own. Recently Philco went on the air with a chain program featuring a news broadcast.

The question of the status of the air purveyors of news is now before the American Newspaper Publishers Association and several news-gathering associations, as not all publishers are agreed that such broadcasts help the sales of newspapers any.

Marconi Inaugurates Ultra-Wave 'Phone, Vatican to Gandolfo

Rome, Italy.

An ultra-short wave telephone system has been installed between the Vatican and Castel Gandolfo, the Papal summer residence located about 15 miles south of Rome, and was inaugurated recently by Marchese Guglielmo Marconi and Pope Pius XI. Signor Marconi established the connection between the two specially-built stations and was the first to speak. Pope Pius also took part in the ceremonies by making an address over the new system.

The new system is expected to come into full use next summer when the Pope will spend the hottest months at Castel Gandolfo, renewing a custom followed by Popes for centuries preceding the break with Italy in 1870.

During his talk Signor Marconi said that it had been believed that ultra-short waves had a maximum range of about 185 miles. He had never believed that this theoretical limit could not be exceeded, and a short time ago he had succeeded in transmitting the waves about 200 miles.

MONOPOLY LAID TO BIG CHAINS

Washington.

The application by WMAL, Washington, D. C., for permission to assign its license to the National Broadcasting Company was opposed before the Federal Radio Commission by Tracy F. Tyler, secretary and research director of the National Committee on Education by Radio. This committee is the largest organized air-education entity in the United States and has utilized NBC chain stations for broadcasts by noted educators in the scientific, psychological, economic and cultural fields.

The license is now held by M. A. Leese, who states that the assignment would permit an outlet for the Blue Network and result in better programs on an economically practical basis, whereas as constituted at present WMAL could not carry on. He described Washington as second to none in the character of its listening public as to education, culture and cosmopolitanism, and added that the committee had never asked for time on the air nor have any educational applications been denied.

However, Mr. Tyler pointed out that there is a great and growing danger of a dual monopoly, due to stations like WMAL being gobbled up by the National Broadcasting Company or the Columbia Broadcasting System. The station, by the way, formerly was associated with CBS, then went on its own entirely, and now wants to sell out to NBC.

"The assignment would be contrary to public convenience and necessity, in that opportunity for local expression would be diminished," said Mr. Tyler, suggesting that the station be permitted merely to affiliate itself with the NBC chain, rather than to have NBC acquire ownership. Otherwise, he argued, there is a danger of all local stations of this type falling under the control of either of the two large broadcasting chains and subject to their complete censorship.

F. M. Russell, an NBC vice-president, said that granting the application would result in improved programs, as "the city lacks sufficient local talent to interest listeners."

DUBIOUS COSMIC RAY BROADCAST

By CY N. TYFIC

Scientists, deeming radio listeners not content with the usual form of static, are introducing static-like sounds as part of scientific demonstrations to the lay listening public. The most recent example was the broadcasting over a Columbia System chain of the sounds made by cosmic rays in a Geiger counter. A speaker before the counter picked up the sounds and delivered them punctually to a microphone, and any chance tuners-in might wonder what the interference was all about.

Indeed, the wonder may be extended to scientifically trained minds in the field of cosmology, for there are two sharply divided classes of thought on the subject of cosmic rays. The optimistic side is taken by Dr. Robert A. Millikan, Nobel prize winner, and head of the Norman Bridge Laboratory, California Institute of Technology, who says that the cosmic ray represents regeneration of atoms, and the sounds heard are therefore equivalent to "birth cries." However, trans-Atlantic scientists, such as Sir James Jeans and Sir Arthur Eddington, of England, pessimistically ascribe the sounds to the destruction rather than creation of atoms, and thus the sounds may be likened to a death rattle. Whatever the true state of facts may be, the tuner-in could not decide the question on the basis of the interference that was brought to his listening post by the broadcast, nor could he tell, unless he had other means of knowing, that the sounds were other than those attendant on the approach, presence or passage of a storm.

Dr. W. F. G. Swann, director of the Bartol Research Foundation, Franklin Institute, Swarthmore, Pa., demonstrated the cosmic ray noise before the science forum of the New York Electrical Society and repeated his performance in a vault of the Ruppert Building, 535 Fifth Avenue, New York City. In a 400-square-foot vault, nearly 500 feet below the roof and nearly 40 feet below the sidewalk level, surrounded by 30-inch steel, including doors of that thickness, Dr. Swann set up his counter. If the cosmic rays could not penetrate that "shield" he would have no rays to count, but it is more difficult to shield out a cosmic ray than a line of force from a radio set coil, and the popping of newly-born (or newly-dead) rays came through with enough force to make the broadcasting demonstration worthwhile from the doctor's viewpoint. Not all the rays got through, as the immense vaults did act as a part shield, but enough came through to satisfy a scientist and make a radio listener blink.

The cosmic ray is believed to contain a vast amount of energy, and the release of that energy, if practical without destroying the experimenter and some empires along with him, is regarded as something to fall back on when wood, coal and oil give out.

It was for his measurement of the cosmic ray that Dr. Millikan got his Nobel prize, and one of his pupils of that period, Dr. Arthur H. Compton, an American, has taken a view of his own about the rays, and is thus a now anti-Millikan, although in the scientific manner.

If the cosmic ray demonstrations could be used for their static-equivalent-producing effects in a negative manner, so as to cancel out existing statis, they would be a great boon to radio, no matter what becomes of the Kennelly-Heaviside layer under the new administration.

STATION SPARKS

By Alice Remsen

The Patrol of the Seas

FOR THE U. S. NAVY BAND, WABC

Tuesday, 11:00 a. m.; Thursday, 11:15 a. m.

With roll of drum
And crash of brass,
The sailors come;
Just watch them pass.
They're on their way
To ship today—
The patrol of the seas!

They roam the world,
Make every port,
Where flags are furled
On ship or fort;
Alert and keen,
Upright and clean—
The patrol of the seas!

In calm or squall
They guard our shores;
At every call
The navy pours
A living chain
Of men again—
The patrol of the seas!

We drink a toast
To men of might,
Our country's boast
In any fight.
All power fall
Upon them all—
The patrol of the seas!

—A. R.

* * *

As I listened to the Navy band I could just visualize those sturdy men in blue, as I have seen them in many different places. You, too, will get a big thrill when this fine band crashes into one of Sousa's stirring marches, or one of the colorful overtures they play so well. Tune in; you'll like them.

* * *

The Radio Rialto

Lots of changes coming in radio! Such is the rumor down the Radio Rialto. Headliners will no longer be used, with the exception of two or three outstanding stars. The little fellow will get a chance to be heard, which is a good thing, for there are many clever artists buried beneath a bushel or so of high-priced folk who are no longer a drawing card as far as the stay-at-home dial hound is concerned. New voices are needed on the networks, and these, under existing circumstances, must not be too high priced. Listeners are becoming much more discriminating and demand better entertainment; and so—if we're lucky we're liable to get it! . . .

Do any of you radio fans remember when E. F. Grossman announced sports for WEAF—thirteen or fourteen years ago? And when the Grebe four-tube receiver was the latest drawing room furniture, with the funny horn for a speaker? And what is more, this four tube set, which stood on the table, cost $175.00—accessories extra!!! . . . And those headphones; oh, boy! four-seventy-five for a Stromberg-Carlson head-phone set! Gee, that seems a long time ago, doesn't it—1924—and what strides radio has made since then? . . .

A word of encouragement comes from a sailor reader of this column, with high praise for my versifying efforts; he wants to know if they are between covers; yes, they are—three booklets are out now and another one is on the press. . . . Just after the completion of his broadcast with Burns and Allen the other night, Guy Lombardo was handed a box which was obviously designed for flowers; fearing a practical joke, he hesitated before opening the box in front of the assembled studio audience; however, it proved to contain an orchid—not from Walter Winchell, but from the Toronto Star, presented regularly to its choice of the best radio feature of the week. A nice gesture, don't you think? . . . Do you know that Sam Coslow, the smooth-voiced tenor who is heard regularly on the CBS California Melodies program as "The Voice of Romance," is the composer of "Moon Song" and "Twenty Million People," song hits that are featured in Kate Smith's picture success, "Hello Everybody"? Coslow is also responsible for the tune "Just One More Chance," which swept the country a year or so ago, and other fine song hits. . . . Those versatile Mills Brothers took the place of instruments so successfully with Victor Young's Orchestra in an unusual experiment over CBS the other evening that veteran engineers in the control room had to peer through the glass to see whether Victor's instruments were playing or the Mills Brothers were at it again; in his own "Sweet Sue," Conductor Young wrote into his orchestration Brother Harry Mills' voice as a trumpet part, Brother Donald as a saxophone, Brother Herbert as a trombone, and Brother John of course, as that deep-toned tuba. . . .

The visitors to studios are increasing; Columbia reports seven thousand, four hundred curious people visited their studios in New York during the evening hours last month. . . .

Arturo Toscanini, conductor of the New York Philharmonic-Symphony Orchestra, is now on his way back to America; he will be on the conductor's podium for the Philharmonic broadcast over the Columbia network on March 5th; Maestro Toscanini has been in Germany recently making plans for his appearance at the 1933 Bayreuth Festival. . . . Opera from the Metropolitan, New York, is now being heard over both NBC networks. . . . Aileen Stanley, famous blues singer of vaudeville fame, is heard over an NBC-WJZ network each Sunday and Monday at 11:00 p. m. . . . No matter how long the Oldsmobile program continues with Gus Van and George Olsen over a nation-wide hook-up on Saturday nights, there is little danger of Van running out of the novelty and dialect songs which he makes his specialty; this veteran vaudeville star has a repertoire of over five hundred of them, to say nothing of the new ones he writes and gathers from week to week. . . .

Some sidelights on NBC artists: Jane Froman is married to Dan Ross, her manager; Frank Black, NBC musical chief, is very fond of succotash; William Merrigan Daly, orchestra leader, was once editor of Everybody's Magazine, and at that time two promising young men on his staff were Sinclair Lewis and Walter Lippman; Gene Arnold, of the Chicago NBC studios, was an insurance adjuster before he became a broadcaster; Dr. S. Parkes Cadman was born in Shropshire, England. . . . Have just found out that Myrtle Vail, author and lead of "Myrt and Marge" is, like myself, a collector of lead pencils; we never throw a pencil away; Myrtle is luckier than I am, for she has a pencil sharpener; I almost drive the desk clerks crazy at the hotel by bringing dozens of pencils, in all phases of bluntness, down to them for sharpening. . . .

Here in Cincinnati things are pretty much the same; a few changes at WLW. . . . The Artists Bureau is no more; the Randall Sisters, The Yodeling Twins, the Wilges Brothers, Fats Waller and the Southern Singers have left the station; there is a new trio of girl harmonizers, recently organized; they sound very good, somewhat on the order of my old friends, the Pickens Sisters and the Humming Birds. . . . Another trio fast becoming air favorites are the Threesome, Grace Brandt, Herb Nelson, and Eddie Albert; these folk sing classics, popular and comedy songs with equal facility. Grace and Eddie both do very fine solo work. . . . Joe Emerson now has a morning program straight across the board; in addition to this, he has a commercial, the Ferris seed program; also sings on the Tales of Terror intermission program with your girl friend; Joe does splendid work. . . . Newcomers to the station are a mountaineer ensemble featuring the yodeling voices of Texas Ruby; the Merrell program has changed its set-up and now features a miniature musical comedy on Tuesday nights; heard them do "Katinka" last night; very fine indeed! . . . Margaret Maloney, Editor of Cincinnati's Radio Dial, has changed the make-up of her program sheets; I like it much better than the old way, for now, all you have to do is look straight across the page to find any program at any given time on all local stations. Easy to find your favorites. . . . Frank Henderson, English actor, well known on Broadway, is making a name for himself here as a fine continuity writer; he wields a facile pen and has an extraordinary gift for paraphrasing historical events in a subtly humorous manner; he writes the anachronisms used on the Crosley Follies; Paul Stewart is responsible for the regular continuity; Paul does a jolly good job on that, too! . . . Old Man Sunshine (Ford Rush) is still holding his own as the premier kiddie's entertainer in these parts. . . . Jan Garber is now at the Netherland-Plaza Hotel in Cincinnati, succeeding Seymour Simons, who is taking a well-earned vacation; Jan is very popular here; glad to see him!

* * *

Biographical Brevities

ABOUT LLOYD SHAFFER

(WLW, Cincinnati)

Your correspondent has received a great many requests for information concerning Lloyd Shaffer, the rising young maestro, but he is very bashful, and it was only just recently that I managed to discover the following facts: Born in Ridgeway, Pennsylvania; educated at Allegheny College, Meadville, same state. Thought he wanted to be a chemical engineer, but after three years of hard study in that direction, music lured him away, and he abandoned his scientific studies for New York and the saxophone. Joined the Keystone Serenaders; after three years of trouping around the country with them, Lloyd joined Henry Thies and his orchestra in Detroit as arranger and saxophonist; Thies came to Cincinnati several years ago; Lloyd came right along with him and made his radio debut over station WLW; when Thies left the Nation's Station some time ago, Lloyd decided to remain in the dual capacity of conductor and arranger.

Lloyd Shaffer is a true musician. He is still pursuing his studies, determined to become a master of serious music. This spring he will reecive academic degrees from two educational institutions: a Bachelor of Music degree from the College of Music of Cincinnati, and a Bachelor of Science degree from the University of Cincinnati. He plans to still continue his

(Continued on next page)

SETS INCREASE BY 5,000,000 IN TWO YEARS

A survey, showing for the first time the proportion of radio sets sold to homes not previously owning sets and the percentage sold as replacements for discarded receivers, has been completed by the Columbia Broadcasting System with the cooperation of five leading manufacturers, 738 radio dealers and distributors and the McGraw-Hill Publishing Company. In addition to this novel division of statistics the survey also presents the first complete data on radio set ownership since the United States Census of 1930.

The statistics, gathered from the confidential sales records of the manufacturers and distributors by States and territories for the years 1930, 1931 and 1932, show that set ownership has increased as much as 140 per cent in sections of the country which revealed a low volume of sets in proportion to population in the 1930 census. The results of the survey have been published by Columbia in a booklet entitled, "The Flood Hits the Valleys."

Homes Newly Equipped

The final compilation in the Columbia survey reveals that of 8,920,000 receiving sets sold from April, 1930, to January 1, 1933, there were 4,760,800 sold to homes which did not previously possess a set. The 1930 census showed that some 12,000,000 homes were equipped with radio. The new survey adds approximately 5,000,000 homes to this figure for a total of 17,000,000 homes possessing sets.

Dealing with the sales by States, the booklet shows that, while total radio ownership in the country at large has increased 40 per cent. since the census, it has increased in such States as Michigan and Iowa, where it was already high in proportion to population, by as little as 20 per cent., and in such states as Florida and Louisiana, where it was low, by as much as 140 per cent. Nine States in the southeast showed an increase in the number of radio homes from 484,404 to 992,304 between April, 1930, and January, 1933. Four States in the southwest increased set ownership from 409,021 to 656,021 in the same period. In the northeast, where the percentage has been high, ownership mounted from 8,340,539 to 11,392,139.

Cross-Section of Sales

The five manufacturers who placed their confidential records at the statisticians' disposal represent 60 per cent. of total radio sales in the period covered. Their records provided a cross-section of nationwide sales. The books of the 738 dealers and distributors, surveyed by the McGraw-Hill Publishing Company, served to show what part of each million set sales represented sales to homes never before owning receiving sets.

John Karol, chief statistician of the Columbia Broadcasting System, directed the work for that organization, and A. P. Hirose was in charge for McGraw-Hill.

CORPORATION REPORTS

Receiver Appointed

The appointment of Irving Trust Co. as receiver for Radio-Keith-Orpheum Corporation, an affiliate of the R. C. A., which had been temporary, became permanent on motion of Irving Trust Co. The appointment was made by Federal Judge Bondy. The following is a preliminary report issued by the Irving Trust Co. covering 1932: Assets, $76,124,794; losses from production and distribution of films, $4,075,834, and from operation of theatres, $3,669,504.

TRADIOGRAMS

By J. Murray Barron

A Canadian Government report states that in 1932 the number of radio sets manufactured by firms classified as musical instrument makers was 58,922. This comes from the office of Canadian National Railways, 673 Fifth Avenue, N. Y. City.

* * *

The Atlas Resistor Co., 423 Broome St., N. Y. City, announces a complete line of wire-wound resistors of special construction with a wide range. The company also makes special sizes.

* * *

Experimenters and servicemen and others quite often find some difficulty in locating firms manufacturing for the trade and not the consumers, even though they may be in the market for a good supply of the particular item. If such information is required, a letter addressed to the Trade Editor will result in putting you in touch with the source of supply.

* * *

About the livest item now in radio is the universal ac-dc receiver. Daily new models are making their appearance, until practically every manufacturer of standard radio receivers is turning out the universal type, and manufacturers who make no other model are coming into the market. There has been a limited attempt to sell kits, in fact only one has been offered nationally to the set builder. With the event of the new 25Z5 tube the build-your-own market has been stimulated. There will probably be some interesting developments in the small compact receiver during this year. Just now there is a large interest and the sales are good.

* * *

A new soldering iron stand, manufactured by G. M. Laboratories, Inc., 1735 Belmont Avenue, Chicago, Ill., is meeting with considerable favor from the trade. It enables saving in power consumption and also convenience in keeping the iron at right soldering temperature when not in immediate use, thus avoiding overheating.

* * *

At a very early date announcement is expected from a New York laboratory of an all-wave radio receiver of the ac-dc universal type covering from about 15 to 550 meters. Production is expected within two weeks.

* * *

During the past Fall and this Winter numerous gadgets and essentials for radio sets and as an aid to better reception have appeared. The items run into a goodly number, nearly all of which have met with approval from the consumer. Some of these items have sold in a limited territory, practically around the metropolitan district, and therefore are quite unknown to readers throughout the country. Arrangements are being made to list them in an early issue.

* * *

Harry Goldman announces from Hotel Edison, N. Y. City, a pre-view of advanced 1933 radio models will be held the first part of April. The manufacturers are lined up for showing.

* * *

Paul S. Weil has been appointed national sales manager, Samuel J. Spector, president of the Insuline Corp. of America, announced. An intensive sales campaign will be inaugurated.

* * *

Test oscillators are proving attractive sales products in the present market. The variable frequency type alone exists, but fixed intermediate frequency oscillators are to be produced soon. A model for each of the popular intermediate frequencies will be available.

TRADE SHOW IN HOTEL SET FOR APRIL IN N. Y. C.

A pre-view showing of advanced 1933 radio models will be held at the Hotel Edison under the auspices of the management from April 10th to 13th, according to announcement made by Harry Goldman, who will have charge of the event. He is well known in the radio field.

A number of large manufacturers has already signified intention to exhibit latest products, indicating that the trade realizes the value of a showing at that time of the year, because of the vast changes and improvements in the industry since the Fall exhibition at the Edison last September.

Many firms are making combination a-c and d-c types in various shapes and sizes. Several manufacturers of electrical refrigerators have also expressed their desire to participate in the show.

Short waves are included, especially broadcast receivers with police tap.

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.*

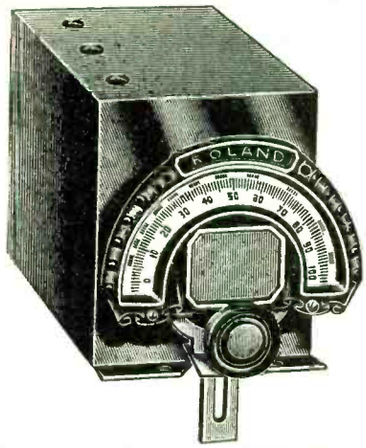
Keith Kinney, 113 So. Missouri Ave., Roswell, New Mex.
Acme Radio Service, 114 Virginia Ave., Indianapolis, Ind.
Howard Electric Shop, Luther Howard, Bloomingdale, Mich.
M. Martin, Box 14, Panhandle, Texas
Philip De Marko, 121 Erickson St., Syracuse, N. Y.
Eugene Gossi, 2148 Marshall Blvd., Chicago, Ill.
Paul J. Bearer, 410 Fairmount Ave., Trafford, Pa.
W. C. Russell, 1616 Brighton Rd., Pittsburgh, Pa.
Elmer Harrold, R. D. No. 1, New Stanton, Pa.
H. E. Green, Radio Servicing & Repairing, 420 Edwards St., Hannibal, Mo.
Broaddus & Lucas, A. G. Broaddus, General Auto Repairing, 2511 N. Lombardy St., Boulevard 4797 J, Richmond, Va.
Wm. Borne Prop., Modern Auto Repair, 96 Charles St., Waterloo, Ont., Can.
C. N. Abbott, 260 E. 40th St., Portland, Ore.
John Schonrock, 324 So. 28th St., Council Bluffs, Iowa
Harold Duncan, 64 Community St., Rock Hill, S. C.
John Marken, 917 Net St., Oshkosh, Wisc.
E. J. Holzgraefe, 1531 State St., Quincy, Ill.
A. C. McIntyre, Good Pine, La.
F. P. Sweet, 921 Market St., Chattanooga, Tenn.
Elmer C. McChesney, P. O. Box 810, South Bend, Ind.
J. McEvey, C-o Inwood Country Club, Inwood, L. I., N. Y.
H. W. Cook, 4103 Helena Ave., Youngstown, O.
Robert E. Van Houte, 2232 Ward St., Berkeley, Calif.

Station Sparks

By Alice Remsen

(*Continued from preceding page*)

studies in musical theory and composition. He has a highly individualistic style of rhythm. His dance band and clever musical arrangements are already well known to network audiences through his numerous NBC broadcasts of "Lloyd Shaffer and his Frigidarians" and "Tangee Musical Dreams." At present he and his orchestra may be heard over WLW, Wednesday nights at 8:30, in "Sunsweet Melodies."



0.0005 mfd. Scovill tuning condenser, brass plates, shaft at both ends so condenser takes 0-100 or 100-0 dials and two can be used with drum dial; sectional shields built in, trimmers affixed; total enclosed in additional shield as illustrated. Access to trimmers with screwdriver. Side holes for bringing out leads to caps of screen grid tubes. Cat. SCSHC @....$1.95

Same as above, with ghost type dial (travelling light). Cat. SCSHC-DL @.....$2.85

DIRECT RADIO CO., 143 W. 45 St., New York City

115 DIAGRAMS FREE

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

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

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

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

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

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

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ADDITIONAL PARTS

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

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

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Wired model, Cat. D5CW (less cabinet) @.... 17.19

Kit of five Eveready-Raytheon tubes for this circuit. Cat. D5T 4.97

FOUNDATION UNIT, consisting of drilled metal subpanel, 13¾ x 8⅝ x 2¼"; three-gang Scovill 0.00035 mfd., brass plates, trimmers, full shield, shields for the 58 and 57 tubes; six sockets (one for speaker plug); two 8 mfd. electrolytic condensers; set of three coils. Cat. D5FU..... 6.19

Super Diamond parts in stock.

FOUR-TUBE MODEL

The four-tube model is similar, except that there is one stage of t-r-f, and a two-gang condenser is used. Tubes required, one 58, one 57, one 47 and one '80. Complete kit, including 8" Rola dynamic speaker (less tubes, less cabinet). Cat D4CK $13.58

Kit of four Eveready-Raytheon tubes for this circuit. Cat 4D.TK 3.89

FOUNDATION UNIT, consisting of drilled metal plated subpanel 13¾ x 2½ x 7"; two-gang 0.00035 mfd. SFL condenser; full shield; two shields for 58-57; center-tapped 200-turn honeycomb coil; five sockets (one for speaker plug); two 8 mfd. electrolytics; set of two shielded coils; 20-100 mmfd Hammarlund equalizer for antenna series condenser. Cat. D4FU $5.49

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0-100 for 5-tube Diamond, Cat. CRD-0, @ $0.91.
100-0 for 4-tube Diamond, Cat. CRD-100 @ $0.91.
[If dial is desired for other circuits state whether condenser closes to the left or to the right.]

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Three 0.1 mfd. in one shield case, 250 volt d-c rating. Cat. S-31 @..... .29
Rola 8" dynamic for 47, with 1800 ohm field coil tapped @ 300 ohms. Cat. FP @..... 3.83
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3 coils for 5-tube. Cat. DT @..... 1.33

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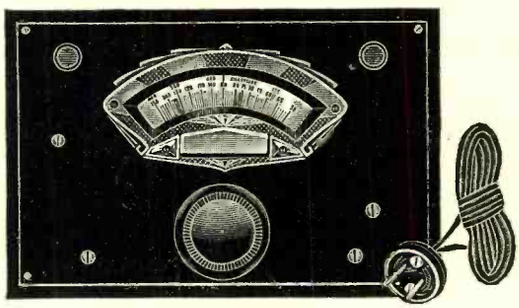

The test oscillator has a frequency-calibrated dial, registering 50 to 150 kc, while above this tier of frequencies are registered all the popular commercial intermediate frequencies. So just consult the dial scale.

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

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

Average Accuracy 1% or Better

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

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

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

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

Get One of These Test Oscillators *Free!*

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

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

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

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

The main scale of the frequency-calibrated dial reads from 50 to 150. The bars are 1 kc apart from 50 to 80 kc and 2 kc apart from 80 to 150 kc. Thus for broadcast work, using the 10th harmonic, the separation as registered by the bars is 10 kc from 500 to 800 kc and 20 kc from 800 to 1,500 kc. On an upper tier the intermediate frequencies are printed: 175, 260, 400 and 450 kc, with a bar to the left of 175, representing 177.5, and a bar to the right of 175, representing 172.5. These, with 130 on the fundamental, represent all the popular commercial intermediate frequencies. Any other intermediate frequency may be obtained either directly from the fundamental, or by dividing a higher desired frequency by the nearest whole number to yield a frequency represented on the fundamental.

DIRECTIONS FOR USE

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

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

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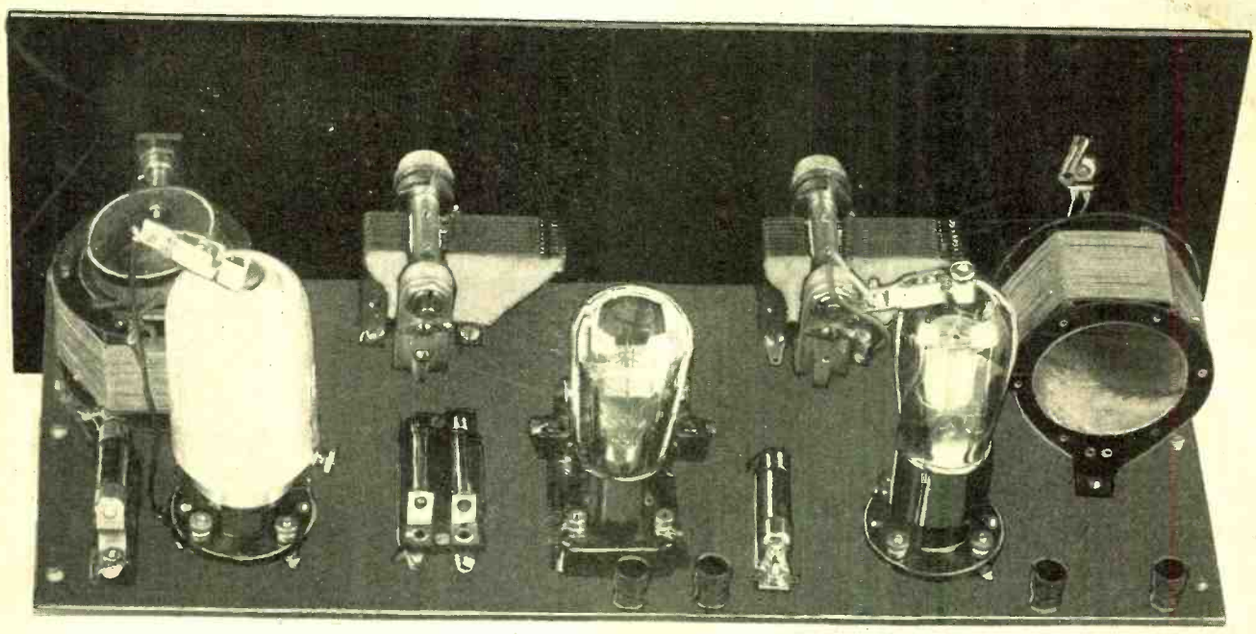

Just a little change in applied voltage and the volume of this 3-tube screen grid set went 'way up. See page 5 for reasons why.

FIRST SCREEN GRID TUBE CURVES!

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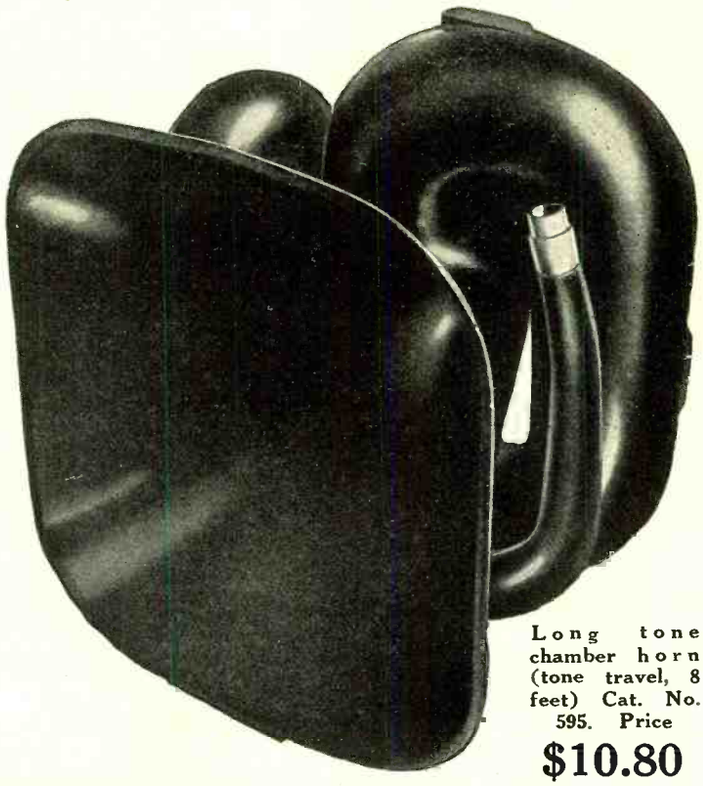
Horn Motor, Cat. No. 112. Price $4.20.

Use a long tone chamber horn, like the No. 595 illustrated at right, with a specially sensitive and faithful motor, (Cat. No. 112), shown at left and enjoy the best. Cat. No. 595, horn loudspeaker, tone travel 8 feet; over-all dimensions, 21¾" high, 18" wide, 13" or 15" deep. Nozzle takes standard size unit. Price $10.80.

Felt-padded Baffle Board FREE with each order for a No. 595. The baffle is used as the inside shipping box. No need to remove the horn from the box. Use the outfit as you receive it, inside a cabinet, or in any other place you desire.



Long tone chamber horn (tone travel, 8 feet) Cat. No. 595. Price

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WHERE space requirements limit you to a smaller size horn, use Cat. No. 570, illustrated below. The tone quality of this medium-sized model far surpasses that of the usual cones, but does not quite come up to that of the No. 595 on the extremely low register (40 cycles and less). However, it is a very satisfactory horn, as good as can be made for the smaller space.

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Felt padded baffle board FREE with each order for a No. 570.

Baffle Board FREE with each horn order!

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THE long tone chamber moulded wood horns are sold with an offer of a FREE baffle board that is felt-padded so that the horn is felt-suspended and doubly protected against possibility of rattles. This is the final point of protection and perfection.

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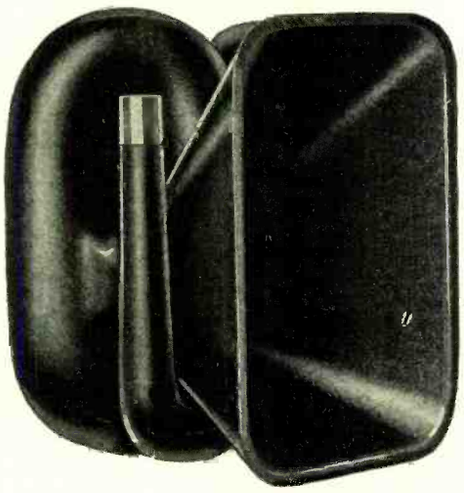
"I do not consider any of the cones now on the market come anywhere near the perfect loudspeaker. Cones invariably favor some frequencies at the expense of others and most of the cones, while over-emphasizing the bass, put a mask of paper rustle over the higher frequencies. There are certain types of non-metallic horns now on the market which, with proper loudspeaker units, give far better reproduction than any 18-inch cone. I strongly advocate a radio set built into a large console cabinet with sufficient room to take in one of the larger exponential horns."

—Dr. Lee DeForest in "Radio News" for April, 1928.

Why saddle a good set to a poor speaker? Travel 8 feet and get somewhere! Travel 6 feet and outstrip the others, anyway!



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A Weekly Paper published by Hennessy Radio Publications Corporation, from Publication Office, 145 West 45th Street, New York, N. Y.
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Curves Reveal Secrets of Screen Grid Tube

Remarkable detection efficiency obtained with 5 volts negative bias and 127 applied plate volts, with resistive load—Grid bias critical indeed for amplification—First presentation of plate voltage, grid voltage curve of this wonder tube.

By J. E. Anderson

Technical Editor

CURVES of the screen grid tube were taken with a circuit identical to that shown in Fig. 1. Eg is a battery which supplied the grid voltage. P is a 400-ohm potentiometer connected across two cells of the battery. By means of this potentiometer the voltage applied to the grid could be varied continuously and set at any desired value. The voltage applied was measured by voltmeter V. Note that the voltage was measured with respect to the negative terminal of the filament of the tube and not with respect to the negative of the filament battery.

R1 is a 622 amperite which dropped the voltage of the filament battery A to the required 3.3 volts. R2 is the load resistance, the voltage drop in which is to be measured. It was a commercial resistor rated at one megohm. It measured close to its rated values for the small plate currents involved.

Ec is a battery which maintained the screen grid at a positive potential. Various values were used for this. Eb is a battery which supplied the plate voltage to the tube under measurement. It was kept at 127 volts throughout.

The Vacuum Tube Voltmeter

The vacuum tube voltmeter was of the —71A type. Its filament was heated with alternating current from a 5-volt transformer. The plate current in this tube was cut down by a high variable resistor R3 and it was measured with a 0-1 milliammeter M. A grid battery Eg2 of 45 volts was put in the grid lead, with positive terminal toward the grid, to prevent the reduction of the plate current to zero for large voltage drops in R2. The vacuum tube voltmeter was calibrated immediately before and after a run by noting the plate current in M for various settings of the lead S on the battery Eb.

Fig. 2 shows four of the curves obtained. The lower curve marked O was taken for Ec zero. Another curve was taken with Ec equal to 22 volts, another with Ec 44 and still another with Ec equal to 66.

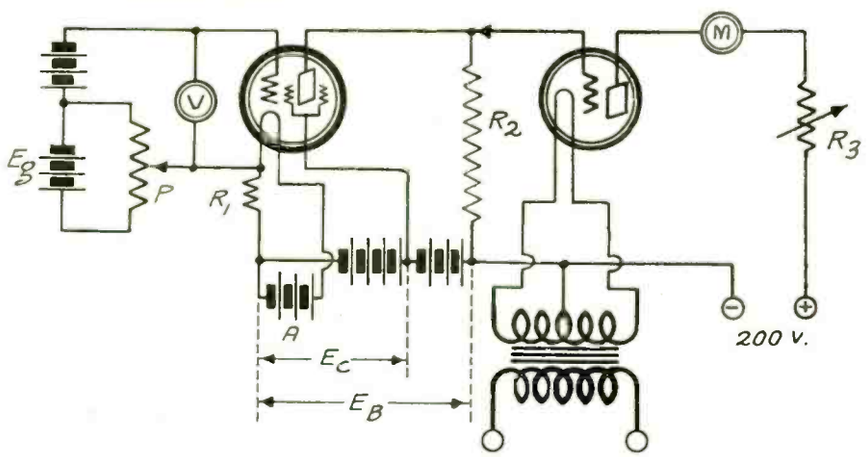


FIG. 1
CIRCUIT ILLUSTRATING HOW CHARACTERISTIC CURVES OF A SCREEN GRID TUBE ARE TAKEN WITH A VACUUM TUBE VOLTMETER.

The upper and lower limits of the curves are interesting. The curve for Ec equal zero has only one limit within the range shown. Each of the other three has two limits. Each of these curves rises rapidly to a value slightly over 125 volts, and beyond that there is appreciable rise. The highest voltage attained is 127 volts, toward which all the curves approach.

Reason for Limitation

The reason they approach 127 volts as a limit is that the total voltage in the plate circuit is 127 volts and the voltage drop in the resistance R2 cannot exceed that value.

The sudden rise of the curves to this value produces very sharp bends in the curves. This indicates that the tube can be used as a grid bias detector very effectively by adjusting the bias to the points of greatest curvature. This was verified for the Ec equal 44 curve. Greatest detecting efficiency was found at 5 volts bias.

Similar upper bends are obtained with other tubes also when they are working into a high resistance. But the sharp upper bend occurs on the positive side, that is, with positive grid bias, and this makes the sharp curvature useless for detecting purposes, for in that case a very high grid current flows and the tuned circuit is practically short-circuited.

With the screen grid tube the bends occur on the negative side where no grid current flows. Hence the selectivity of the tuned circuit is not cut down and a high voltage can be impressed on the grid.

Bias Becomes Zero

The lower limit of the curves is not due to the screen grid tube but to the

Strong Effects of Bias

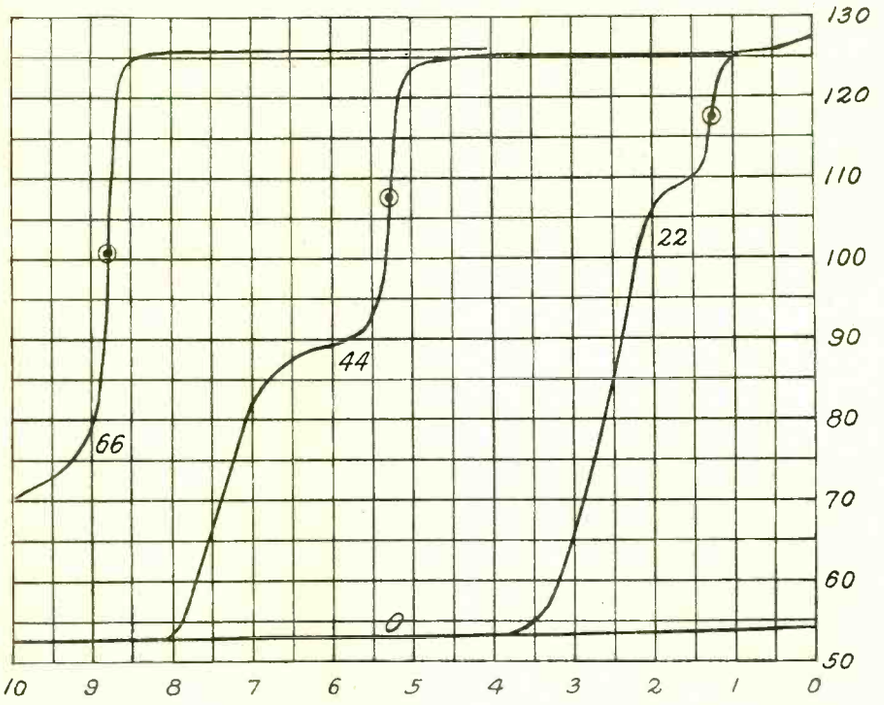


FIG. 2

GRID VOLTAGE, PLATE VOLTAGE CURVES TAKEN ON A SCREEN GRID TUBE WITH A VACUUM TUBE VOLTMETER. ABSCISSAS ARE GRID VOLTS AND ORDINATES ARE OUTPUT VOLTAGE DROP IN LOAD RESISTOR.

(*Continued from preceding page*)

vacuum tube voltmeter. When the voltage drop in the plate resistor R2 became 46.5 volts it was equal to the voltage of the battery Eg2 and thus the bias on the vacuum tube voltmeter became zero. As the drop in R2 becomes less than 46.5 volts the bias on the vacuum tube voltmeter grid is positive, and grid current begins to flow. Due to the high grid resistance, R2, the actual voltage on the vacuum tube voltmeter grid cannot be made positive, and hence the plate current will not change as the applied bias changes. The highest value obtained in this run was 1.07 milliamperes.

This limitation could have been avoided by removing the battery Eg2 and by allowing for the changes in the grid voltage and the plate current. Also it could have been avoided by using a —50 type tube for voltmeter, with high voltage on the plate. In that case it would not have been necessary to use Eg2 at all.

Other Detecting Bends in Curve

There are several other bends in the curves in Fig. 2. In fact each curve contains four bends, two with rising slope and two with falling. The tube detects well at all these bends. The detecting efficiency was tested on the middle curve and it was found that between 5.5 and 6 volts bias the detection was very good. Between 6 and 7 it was fair. Between 7 and 8 it was practically nil, and beyond that point it was also fair but not so good as it was between 6 and 7 volts. It was best of all at 5 volts, that is at the upper sharp bend, for the given plate voltage.

The upper bend on the Ec equals 66 curve is very abrupt, indicating that the tube would be an excellent detector at that point, that is at a bias of 8.5 volts. This was not verified.

Each of the three curves has a relatively straight portion at which the slope is very steep. If the bias is adjusted to these values the tube is an excellent amplifier. The point on each curve where the slope is steepest has been indicated by a dot surrounded by a circle. On the first curve to the right this occurs at 1.25 volts bias. At this point the amplification, or the slope of the curve, is about 50.

On the middle curve the steepest point occurs at 5.26 volts bias. At this point the amplification is between 60 and 70. On the third curve the steepest point occurs at 8.8 volts, at which the amplification is approximately 110.

It is clear that the grid bias adjustment is very critical in each case if the amplification is to be the greatest.

The amplification obtained from these curves is valid only for low frequencies at which the by-pass and stray capacities are negligible. Strictly it holds only for direct current.

In view of the steepness of the characteristic curves of the screen grid tube when working into a high resistance, and the sharpness of the bends, it is advisable to install a device in the circuit by means of which the grid bias can be varied continuously. In no other way can the exact grid bias required for maximum detection or amplification efficiency be obtained.

A 400 or a 2,000-ohm potentiometer connected across two dry cells will provide this continuous variable. This will vary the voltage from zero to 3 volts. Additional bias can be obtained by the use of other cells connected in series with the potentiometer circuit.

In some instances the bias is obtained from a voltage drop in a resistance. Then the voltage may be varied continuously by making the resistor variable continuously. There are many types of such resistors on the market. In fact, most variable resistors are suitable, although the resistance is not quite continuously variable. The variation is in very small steps in wire wound resistors. Resistors of the clarostat type are continuous.

Other Methods

If a potentiometer is connected across a dry cell battery, provision must be included for breaking the circuit when the set is not in use. If this is not done the C battery will deliver current all the time and it will not last long.

One way of obtaining a variable bias is to connect the potentiometer across the A battery, or across one of the filaments in the circuit. This will provide a continuously variable grid bias source of a 5 or 6 volt range. When this is done more cells must be used in the grid battery because the A battery reduces the bias.

Still another way of obtaining a variable grid bias is to connect a 400-ohm potentiometer across the ballast resistor in the negative end of the screen grid tube filament. This will increase the filament current by a small amount but not enough to endanger the tube. In fact the current will increase only 5 per cent.

Ranges Compared

The voltage drop in the filament ballast resistor is normally 2.7 ohms. Thus if the potentiometer is connected across it almost the same voltage range is obtained as if it were connected across a 3 volt battery. This is probably the best arrangement.

When this is used the grid return is to the slider on the potentiometer and additional grid bias cells are connected in series with the lead to the slider, with the positive terminal toward it and the negative toward the grid.

New Books

Storage Batteries Simplified, new enlarged edition, 1928, by Victor W. Page, M. S. A. E., published by The Norman W. Henley Publishing Company, 2 West 45th Street, New York. Price $2.00.

This book discusses the principles, construction, use and care of all types of storage batteries from a thoroughly practical point of view. The principles are explained in an elementary manner in terms easily understandable. Numerous historical references to the pioneers in storage cell development make this phase of the book especially interesting.

The construction of various types of storage batteries is discussed in great detail and is profusely illustrated with drawings and photographs. Many uses to which storage batteries have been put are enumerated and explained in detail. These include submarine operation, automobile ignition, propulsion, lighting, starting, radio A and B batteries, farm lighting equipment, locomotive and street car propulsion, and power house stand-by and emergency service.

The discussion on troubles in and care of batteries is exhaustive and a study of it will enable the student not only to extricate himself from any battery trouble he may encounter but to so care for the battery that a minimum of trouble will be met.

The section on radio batteries and chargers, which is of particular interest to radio fans, contains 50 pages and is one of the most instructive sections in the entire book.

A complete glossary of all technical terms used is appended and the book is fully indexed so that any subject contained in the book can be located instantly.

Up Goes the Volume!

An Account of Some Interesting Experiments with the Economy Three

By Herman Bernard

THE screen grid tube used as a grid bias detector in screen grid fashion, that is, with G post of socket connected to B plus, is shown in the accompanying schematic diagram of the Economy Three.

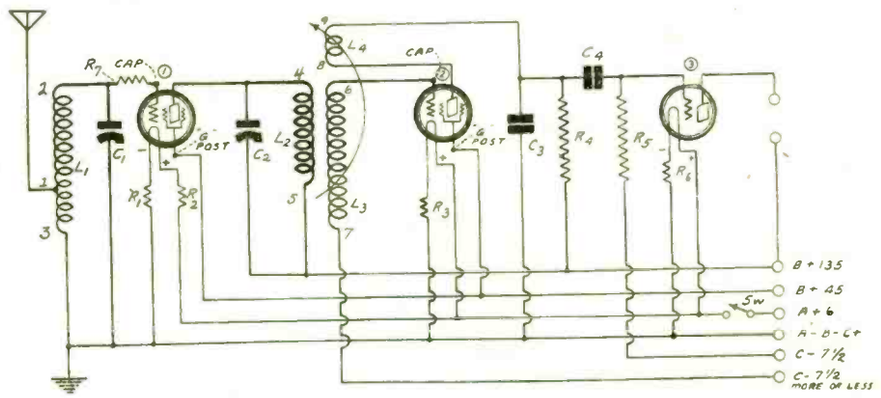
The circuit, with space charge detector, was published in the July 28th issue, and is otherwise the same, except also that now a grid suppressor is shown. This suppressor should be used only if self-oscillation is encountered in the radio frequency amplifier. No specific value of resistance can be recommended, but for the voltages shown in the diagram, no more than 2,500 ohms, probably less, should be used.

The screen grid hookup for grid bias detection affords greater selectivity, while the space charge detector affords greater volume. Both methods should be tried, to determine which one suits you better. It is easy to make the change by switching two leads, so that the G post is used as screen grid and the cap as the control grid.

Voltages Critical

It is necessary to get the voltages correct, and no hesitancy should mark the experiments, for the voltages should be changed until you get the results you are after. These voltages may be regarded as critical, in the light of most recent experiments, for you will notice that the grid bias must be just right, and the correspondingly greater plate voltage likewise.

You will reach a certain point where the amplification goes away up, whereas above and below that point it is just average. The immense difference in volume will startle you, and you will simply experiment until you establish yourself firmly at the highest amplification point. This refers particularly to the radio frequency amplifier, since the tube detects well over a greater margin than it amplifies well.



THE ECONOMY THREE, A NEW RECEIVER WITH ONE STAGE OF SCREEN GRID RADIO FREQUENCY AMPLIFICATION, A GRID BIASED SCREEN GRID DETECTOR AND A SINGLE STAGE OF AUDIO, THAT OPERATES A SPEAKER WITH GOOD VOLUME AND REMARKABLE QUALITY. THE SAME DIAGRAM WAS PUBLISHED IN THE JULY 28TH ISSUE, EXCEPT THAT NOW A SCREEN GRID HOOK-UP IS USED FOR DETECTOR, FOR GREATER SELECTIVITY, RATHER THAN THE SPACE CHARGE DETECTOR THAT GIVES GREATER VOLUME; ALSO A SUPPRESSOR IS SHOWN IN THE GRID CIRCUIT OF THE RF AMPLIFIER, TO KILL OFF ANY SELF-OSCILLATION.

One way of proving the fact that voltages are critical is to use a rheostat experimentally on the radio frequency amplifier. Put this rheostat in the negative leg. You may reduce the filament current to this tube very gradually, and come upon one point where the volume increases enormously. This would seem contrary to expectations. Filament rheostats frequently are used as volume controls. The more resistance cut in, the less volume. But here is a tube that at some point where subnormal resistance is used gives greatly increased volume.

Pointers on Volume

It is not because the filament works better at any point of underheating, but because as the used resistance of the rheostat is increased the voltage drop across it increases, hence increases the negative grid bias, and it is the criticalness of the bias that accounts for the sudden volume spurt.

Obviously you should duplicate that bias with batteries, or with a potentiometer across C batteries, with midpoint connected to grid return, for the potentiometer gives you a gradual range, instead of the set minimum jumps of 1½ volts obtainable from batteries. Another plan is to vary the plate and screen grid voltages gradually, but these voltages preferably should not be far from the values given.

The three-tube set, the result of long experiments with screen grid tubes, is very satisfactory in operation, especially as the step-up ratio of the coils increases the voltage. It will be remembered that an antenna coil of familiar pattern was suggested, but that the three-circuit coil was a special one, with tuned primary, a secondary with about twice the inductance of the primary, and a usual tickler coil of the rotating type. Thus the plate load on the screen grid tube is of high impedance, while the coupling to detector is accomplished with a 100 per cent. gain. This is due to the use of the new Screen Grid Three Circuit Coil. Its equivalent can be made by converting an existing three-circuit tuner, using the secondary of that coil as the primary, ignoring the small primary on that coil, and winding a large secondary on a separate tubing to be placed inside or outside of the other large form. The tickler remains as is.

Distributed Capacity

One point well worth considering is that the large secondary will have some distributed capacity, and this is effectively in parallel with the distributed capacity of the tuned primary and the tuning capacity. For that reason it is well to favor a primary inductance for .0005 mfd. tuning, as the coil will be smaller, also the distributed capacity will be at a minimum, and you can not then escape covering the entire broadcast band, which otherwise might be the result with a home-made coil, where no special precautions are taken to keep the distributed capacity low. This capacity is tantamount to a small condenser across the terminals of the coil. It adds to the minimum or so-called zero capacity of the tuning condenser just when the smallest capacity is desired.

When the voltages are right the set works without any possibility of motor-

(*Continued on next page*)

LIST OF PARTS

L1—One antenna coil for .0005 mfd. tuning.
L2, L3, L4—One three-circuit tuner for .0005 mfd. tuning, with special secondary winding (six connections, Nos. 4, 5, 6, 7, 8 and 9.)
C1, C2——Two .0005 mfd. tuning condensers.
C3—One .0005 mfd. fixed condenser, mica dielectric (optional).
C4—One .5 mfd. by-pass condenser.
R1, R2—Two 10-ohm resistors.
R3—One 20-ohm resistor.
R4—One .5 meg. or higher.
R5—One 5 to 10 meg.
SW—One switch.
One grid suppressor, 2,500 ohms or less.
Three standard sockets.
Two dials.
Two one-inch knobs.
Four binding posts (Ant., gnd., speaker +, speaker —).
One 7x21-inch front panel.
One 8x20-inch subpanel.
One six-lead battery cable.
Two No. 45 Universal Peewee clips.
135 volts of B supply.
One 7½-volt C battery.
Two screen grid tubes and one 112A tube.
One pair brackets, 1" high.

A Double

By Harrison

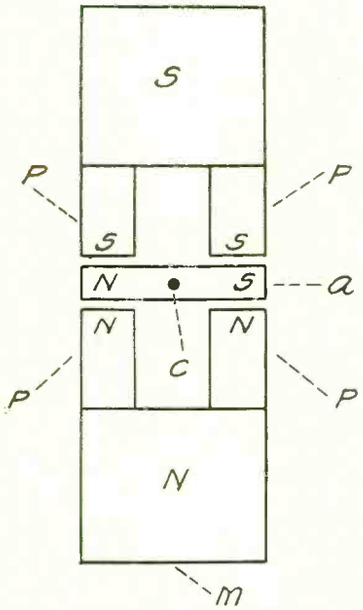


FIG. 1
DIAGRAM SHOWING THE PRINCIPLE OF THE BALANCED, PUSH-PULL LOUDSPEAKER UNIT. THE MAGNETIC FLUX DISTRIBUTION IS MORE EVENLY MADE UNDER THIS SYSTEM OF OPERATION.

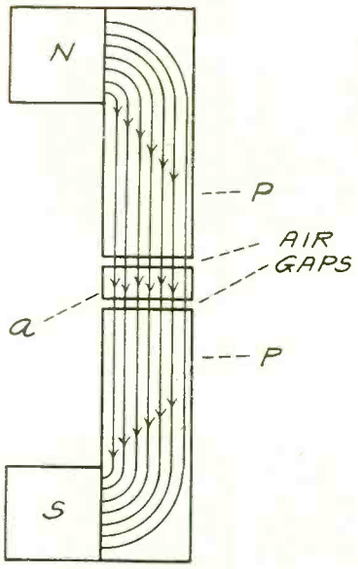


FIG. 2
THIS DIAGRAM SHOWS THE UNSYMMETRICAL DISTRIBUTION OF THE MAGNETIC FLUX IN THE POLE PIECES AND ACROSS THE AIR GAPS WHEN A SINGLE POLARIZING TYPE OF MAGNET IS USED.

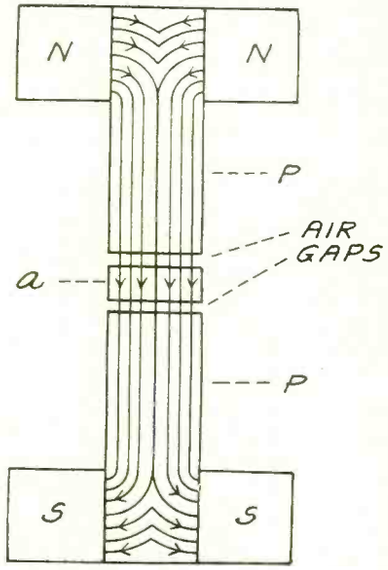


FIG. 3
THIS SHOWS THE SYMMETRICAL DISTRIBUTION OF THE MAGNETIC FLUX IN THE POLE PIECES AND ACROSS THE AIR GAPS WHEN TWO MAGNETS ARE USED, SUCH AS IN A DUO-MAGNETIC UNIT.

Economy Three-Tuber Has Remarkable Tone

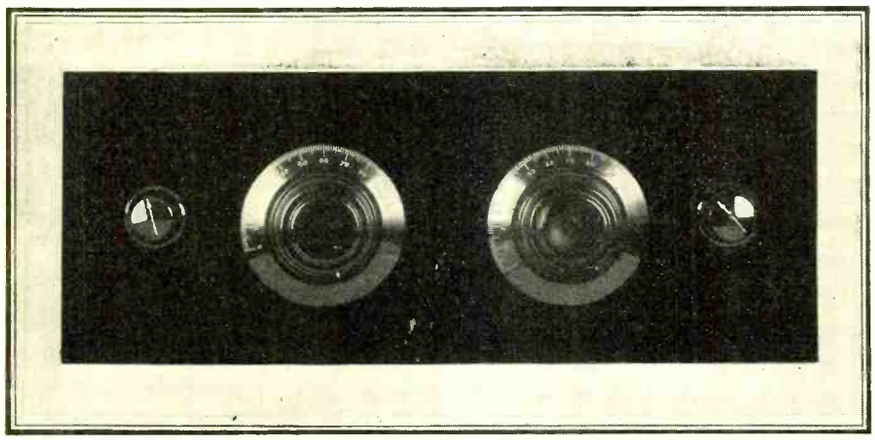
(*Continued from preceding page*)

boating. Some self-oscillation may be present in the radio amplifier, and the resulting sound may be like the put-put of a motorboat engine, but despite the similarity this is not motorboating, but radio frequency oscillation. Proof is found in the fact that a grid suppressor in the input to the RF tube will kill off this oscillation. Motorboating is audio-frequency oscillation, and a suppressor at this point would have no effect upon it.

Results Are Delightful

The experiments with the receiver were interesting indeed, especially as only one audio tube was used, and that the last one. Moreover, the single audio stage was resistance-coupled, which isn't usually counted on to produce enough volume to operate a speaker from two stages, much less from one. But here is the circuit and you are at liberty to try it yourself. You will be delighted not only with the volume, which is ample, but with the quality, which is perhaps a superior feature, for distortion due to audio coupling is avoided, and enough volume is developed to work a 112-A output tube to the limit of its undistorted power output. It is not recommended that the —71A be used as the output tube in this circuit.

Since the 112A is favored, and since a high mu tube may be operated as a grid bias detector at 3½ volts negative, with 1 meg. plate resistor and 135 to 180 volts feeding the resistor, many wonder why such a tube is not recommended. Well, it is. One has been used very successfully, but the screen grid tube as a detector permits somewhat more volume.



FRONT PANEL OF AN EXPERIMENTAL MODEL OF THE ECONOMY THREE. THE PANEL IS 7 x 21 INCHES. THE CONDENSER AND OTHER SHAFTS SHOULD BE 3 INCHES UP, INSTEAD OF THE USUAL 3½ INCHES, IF THE SUBPANEL IS TO HELP SUPPORT THE CONDENSERS AND THREE-CIRCUIT COIL, OTHERWISE THE CABINET LID WILL HIT THE SCREEN GRID TUBE CAPS. IF YOU USE BRACKETS ONLY 1 INCH HIGH YOU MAY CENTER ALIGN THE SHAFTS.

Choice Limited to Two Tubes

Any who have a type —40 tube, however, or who prefer to use one because of the price difference, well may do so without hesitancy. But either a screen grid tube or a mu 30 tube, as described, should be used, for no other tube will give nearly so satisfactory results. Do not use —01A or a special detector tube, but only a high mu tube. Of course it is understood the screen grid tube is a very high mu tube and the type —40 tube a much lower mu tube.

The circuit is being developed into blueprint form, and in a few weeks an announcement is expected. Meanwhile any one interested in the circuit may build it from instructions in this article and in the one published in the July 28th issue, where coil data and other details were given in full.

Magnet Unit

Brown Phelps

IT is generally admitted that the push-pull, balanced type of polarized loudspeaker unit is the most sensitive. Because of its acknowledged sensitivity it is used in most loudspeakers.

What makes this unit more sensitive than other types of polarized units? The complete answer to this question is somewhat involved but one reason is that the construction permits more effective use of the magnetic forces. Another is that the reluctance of the magnetic circuit to alternating magnetomotive forces is low, so that for a given value of signal input a high magnetic flux is set up. Still another reason is that very strong polarizing magnets may be used. The importance of this will be taken up in detail.

Fig. 1 shows the principle of the push-pull type of unit. N and S are the ends of a strong permanent magnet which establishes a strong, steady magnetic field. P are pole pieces, or extensions of the permanent magnet used for the purpose of directing the magnetic flux so as to be most effective in transforming electric and magnetic energy into mechanical energy. An armature is mounted on a spring support indicated by C is mounted between the four pole piece P.

The stiffness of the spring is such that the armature is held exactly in the midway position between the pole piece extensions. If the spring is too weak the armature will be pulled over to one diagonally placed pair of pole pieces. If the spring is too stiff the armature will be held too rigidly in the center and it will not respond readily to the signal. The proper adjustment of the rigidity of the spring relative to the intensity of the magnetic field is such that the armature will just pull away from a pair of pole pieces after it has been forcibly pulled over. Then the unit is most sensitive and least subject to resonance effects. It will respond particularly well to low notes.

Action of Unit

The signal current is passed through a coil surrounding the armature *a*, which becomes magnetized according to the signal, that is *a* becomes a magnet variable polarity.

At some instant the polarity of the armature is as indicated by n and s, that is the left end is a north pole and the right end is a south pole. The pole piece extensions at the ends of the armature always have the polarities indicated by ss and nn on these members.

Now there is a general rule that two unlike poles attract and two like poles repel. Therefore at nn the armature is pushed upward and at ss it is pushed downward. At sn on the left it is pulled upward and at sn on the right it is pulled downward. Therefore the interaction of the permanent magnet and the armature at four different places is such as to cause the armature to turn about C in a clockwise direction.

At some other instant the armature is polarized in the opposite direction, that is so that its north pole is at the right and its south pole at the left. All the four forces acting on the armature are then reversed and the rotation is counter clockwise.

Elementary View

This is a rather elementary view of looking at the action of the unit. As a matter of fact there is no pushing, only relatively so. There is attraction at all the four active points. The magnetized armature is attracted both toward the south pair of pole pieces and toward the north pair. But the attraction is greater than normal at the gaps where unlike polarities occur and smaller than normal where like polarities occur.

A mathematical analysis of the action of the unit will show that the torque, or the force tending to produce rotation of the armature about C, is proportional to the flux produced by the permanent magnet as well as to that produced by the signal current. If the permanent flux is B and the varying flux is b and k is a suitable constant then the torque T equals kBb. This holds for small displacements of the armature only but as the maximum displacement of the armature during normal reception is small it may be regarded as true for all displacements which may occur.

The fact that the force is proportional to the flux produced by the signal current shows that there is no harmonic distortion. This is one of the advantages of balanced construction.

The formula for the force producing rotation of the armature is also proportional to the permanent flux B. Thus the greater the permanent flux the greater the force, and hence the greater is the sensitivity of the the unit. For this reason the design of a permanent magnet loudspeaker unit should be designed with as large permanent flux as possible within practical limitations.

There is still another advantage in making the permanent flux large as compared with the flux produced in the armature by the signal current. For large displacements of the armature some harmonic distortion will be introduced. The larger the permanent flux, the smaller is this distortion for a given displacement of the armature. Hence for good quality on loud signals it is important that the permanent flux be very large. This means that the magnets used should be large.

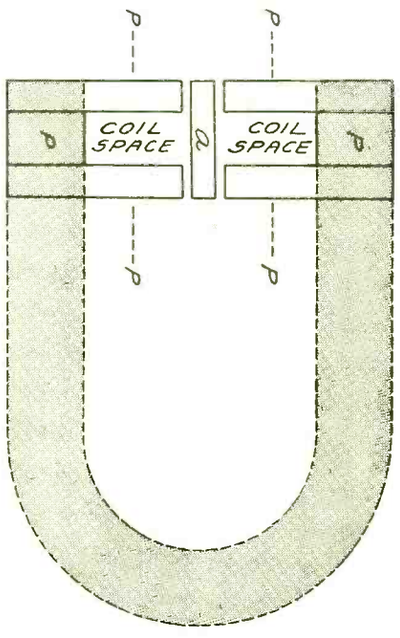
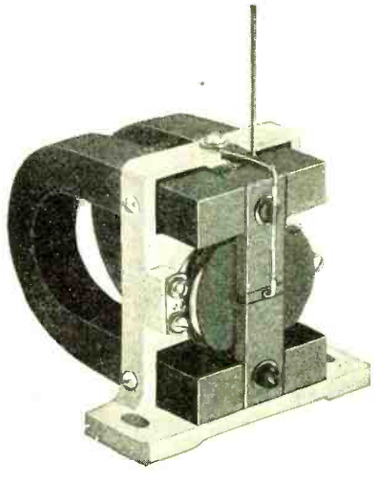


FIG. 4

THIS SHOWS A SIDE VIEW IN SECTION OF THE DUO-MAGNETIC LOUDSPEAKER UNIT. THE POSITIONS OF THE TWO MAGNETS ARE SHOWN IN SHADED OUTLINES.



VIEW OF THE ASSEMBLED DUO-MAGNETIC LOUDSPEAKER UNIT, SHOWING THE LARGE POLE PIECES AND ARMATURE. THE ALUMINUM FRAME HOLDS THE UNIT TOGETHER WITHOUT ANY HOLES IN THE MAGNETS.

Large Flux Produced

The amount of flux produced by a permanent magnet depends on the length of the magnet, on its cross section, and on the strength of the magnetic material. Properly tempered chrome steel is a suitable material for permanent magnets. It will produce a large flux and will retain its magnetization provided that the magnet is much longer than its cross sectional dimensions.

The cross section of the magnet should also be large in order that the reluctance be low, for the lower the reluctance the greater is the flux. This is one reason why a two magnet unit is better than one which has a single magnet, assuming that each of the magnets has the same cross-section as the single.

But it is not enough to have strong magnets to have large useful flux. It is the flux across the armature air gaps which counts. Hence the pole pieces used should have a large cross section also. The same applies to the armature across which the flux passes. A short and chubby armature gives better results than a long narrow one.

The use of two magnets symmetrically placed with respect to the pole pieces permits the more uniform distribution of the flux in the pole pieces and thus decreases the reluctance since no part of the pole pieces will be saturated before others.

Flux Distribution

Fig. 2 shows the distribution of the flux when a single magnet is used. In the corners of the pole pieces away from the magnet there is very little flux. Even across the air gaps on the side away from the magnet there is not as much flux as on the side next the magnet. Fig. 3 shows the distribution of the flux when two magnets are used. While there is little flux at the ends of the pole pieces away from the air gaps, the distribution is uniform at the gaps.

Fig. 3 shows partially the end construction of the duo-magnetic unit. The two magnets are indicated by squares marked NN and SS. The coils and the armature support spring have been omitted.

Fig. 4 shows a side view, or rather section, of the unit. The position of one of the magnets is shown in shaded outlines. Again the coils and the armature spring have been omitted but the coil space is indicated.

The advantages of using two magnets are:

Stronger polarizing flux and hence greater sensitivity.

Symmetrical construction and uniform distribution of the flux.

Less harmonic distortion than for single magnet unit for same volume.

Greater ease of mounting the unit.

DC "A" Eliminator

By Walter J. McCord

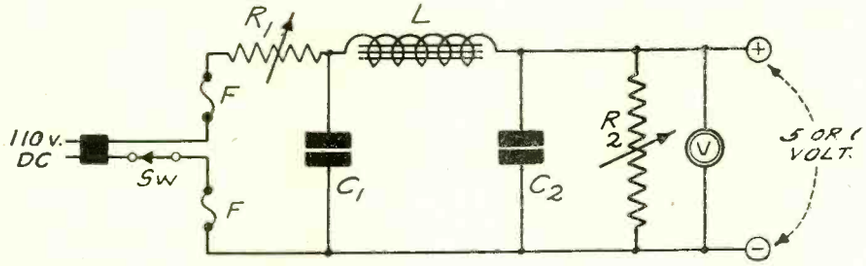


FIG. 1
THE CIRCUIT DIAGRAM OF AN A BATTERY ELIMINATOR WHICH WORKS DIRECTLY FROM A 110 VOLT DC POWER LINE.

RADIO listeners living in districts served with direct current are desirous of eliminating the storage A battery and substitute some device which takes the filament current directly from the line. What kind of device will do this?

The simplest form of such device is a rheostat put in the line for the purpose of dropping the voltage down to the required 6 or 5 volts. But this will admit the ripples to the filaments, and the set served with this unfiltered current will hum badly. Hence a filter is necessary.

There is no definite way of constructing this filter and no definite number of parts. A single large condenser connected across the line will do a great deal to cut down the hum. If a suitable inductance coil be placed in series with the line the hum will be reduced still further. And then if a second large condenser is connected across the line almost every trace of ripple is eliminated. Fig. 1 shows a complete A battery eliminator for use on a 110 volt DC line.

In this circuit FF are two line fuses placed in the supply leads of the device to protect the installation as well as the house against the possible consequences of a short circuit. These fuses should be as small as the current drawn by the set permits. For example, if the set contains six tubes and each tube draws ¼ ampere, the total current will be 1½ amperes. Hence the fuse should be rated at about 3 amperes.

Line Rheostat Used

The line rheostat R1 is used for cutting down the voltage to fit the tubes. Its value depends on the current taken from the line and on the voltage at the source. The value can be calculated easily by an application of Ohm's law.

Assume that the voltage across the filament terminals of the set is 6 volts. Also assume that there is a 15 volt drop in L when a current of 1½ amperes is flowing. The total drop in the filaments and the choke coil L is 21 volts. Now if the line voltage is 110 volts the drop in R1 must be 110-21, or 89 volts. The value of R1 then should be 89/1.5, or 59 ohms.

R1 should have a current carrying capacity of at least 2 amperes. Of course if the device is to be used for a receiver which draws more than 1½ amperes, R1 must be able to carry more and at the same time its resistance value should be smaller.

For a 1½ ampere receiver R1 may be a 60 ohm rheostat which will carry the required current. But if a rheostat of this type is not obtainable then R1 may be built up of other resistance devices. For example, two electric lamps, one 100 watts and one 50 watts, placed in parallel, have a resistance of 80 ohms. One 200 watt lamp has a resistance of 60.5 ohms, and it has adequate current carrying capacity. By the use of electric lamps and other electric appliances the proper resistance can be built up.

It is not always possible to find the proper resistance by using a simple combination of lamps or resistors. For that reason R2 is connected across the 6 volt line. The purpose of this is to increase or decrease the current that flows through the choke coil L and the resistance R1 and hence to change the voltage drop in them. R2 serves as a vernier voltage adjustor. A 10 ohm rheostat may be used here.

Voltmeter for Adjustment

The voltmeter V is connected across the filaments in order to facilitate voltage adjustments.

The choke coil L must be able to carry the heavy filament current without saturation of the core, as well as without overheating. This means that the core must be made of large section and that the wire be of a heavy gauge. The inductance of the coil need not be over .25 henry under full load, and it may be as low as .05 henry. Coils of this type may now be obtained.

The most effective portions of the filter are the two by-pass condensers C1 and C2. They should be of the electrolytic type in order that very large capacities may be obtained. It will be observed that the resistance R1 is on the line side of the first condenser. So is also the line switch Sw.

The object of placing these on the line side is to prevent any high voltage from reaching the condensers. If these condensers are formed at 25 volts they will be safe provided that the filament switch in the set is not opened while the power is on.

Electrolytic condensers formed at such a low voltage have enormously high capacities for a given size. They are available in units of 1,000, 2,000, 4,000 and 6,000 microfarads. A couple of 4,000 microfarad units should be sufficient to eliminate all trace of hum.

Precautions During Adjustment

When this A battery eliminator is first adjusted it is well to connect a resistor across the output terminals which is equal to the resistance of the filaments to be connected across them. Otherwise the filaments may be subjected to a dangerously high voltage. The correct resistance for any combination of tubes can be determined from the characteristics of the tubes to be used.

Let us assume that the voltage across the terminals is to be six ohms and also that there are six tubes in the circuit each drawing ¼ ampere. The total current is then 1½ amperes. Six volts divided by 1½ amperes gives 4 ohms. This is the resistance that should be connected across the filament terminals while the A battery eliminator is adjusted.

If there are no rheostats or ballast resistors in the filament circuit the voltage across the output terminals of the eliminator should be 5 volts. Five volts divided by 1½ amperes gives a resistance of 3.33 ohms, which in this case should be the value of the resistor connected across the terminals while adjusting.

If another combination of tubes is used the total filament current should be added up and this should be divided into the terminal voltage to obtain the resistance to be used for adjustment of the voltage.

If the receiver has a filament switch built in, which nearly all sets have, this must be kept closed at all times. In fact, to make sure of this it is well to short circuit it with a piece of wire and to solder the connections. If it is opened at any time the voltage across the by-pass condensers will rise to a value which may break them down. The voltage across R2 and across the voltmeter will rise also, and these two also may be damaged.

Cost of Operation

The cost of operating the A battery eliminator will be considerable. But it will be less than if a storage A battery were used if this were charged from the 110 volt line. Hence this circuit will not only save all battery troubles but it will actually save operating charges. It will be about 20 percent more efficient than a charger and A battery, and it will never run down. For a set drawing 1½ amperes the hourly cost will be 1.4 cents when power costs 8.5 cents per kilowatt hour.

LIST OF PARTS

FF—Two three ampere fuses and one fuse block.
Sw—One 110 volt switch.
R1—One heavy duty resistance, about 60 ohms and 200 watts.
R2—One 10 ohm rheostat.
C1, C2—Two 4,000 mfd. electrolytic condensers.
L—One heavy duty choke coil, from .05 to .25 henry.
V—One 0-10 voltmeter.
Two binding posts.
One plug and cord.

Aerovox Enlarges Again

Samuel I. Cole, head of the Aerovox Wireless Corporation, 70 to 72 Washington Street, Brooklyn, N. Y., announces that this concern has been forced to expand again. The increased demand from fans and manufacturers alike for the popular Aerovox brand of condensers and resistors has made necessary the addition of 10,000 square feet of floor space to the plant in the same building.

This is the third factory enlargement of Aerovox in a short time.

The line has been considerably augmented and those wishing to know the complete numbers manufactured may receive the information by addressing Mr. Cole. Mention RADIO WORLD.

—J. H. C.

The Way of the Wire

Personal Preferences Conflict, But Rule Decisions —Author Likes Flexible, Stranded, Insulated Kind, and Tells Why

By H. B. Herman

APPEARANCE, safety and convenience are the main considerations regarding the wire you use in building a set. You may want a particularly good-looking job, and therefore may prefer insulated bus, with its shiny black coat almost brilliant, the symmetry of right-angel bends in the wire heightening the architectural effect you cherish.

A little less good-looking perhaps, but easier to work with, is the flexible stranded wire, with the same glossy coat, black preferred, but colors being available. Then there is the solid, single-strand wire with insulation you can push back with your anger, after having cut the wire at the desired point.

The remaining type of stranded insulated wire used for connections in sets is annunciator or bell wire, with its cotton-wrapped insulation and wax finish.

Among the non-insulated types the round and square bus are popular, or have been popular, for the set-building public is taking to insulated wire more and more.

Not Cock-Sure

I have had some experiences with all these types of wire, and I would like to set forth what I think of them and their uses, just to express my own views, and not necessarily to insist that I must be right about them in all instances. I realize some must dissent from my findings. I grant them the same right to their opinions as I hope all will extend to me in regard to my own!

Must Stand Up

Stiff wire, round or square or octagonal, insulated or bare, I have no use for, because (1) it has no "give"; (2) it intensifies any tendency toward microphonism, especially in the grid lead; (3) it is harder to work.

Every set should be built so that it will stand handling. It should be strong enough to resist the wear and tear of shipment. It may be true indeed that the receiver you are engaged on is intended only for use in the very room where it is being transformed from a kit of parts into a working marvel of sensitivity and sound. But you may move. The set would have to stand the kindly treatment of the gentle hands of husky moving men. Or you may decide to make a gift to some friend or relative in another State, and honor him or her with the very circuit of your own design and construction. Under any of these circumstances the stiff wire may work loose, for all the points regarding wiring security revolve about soldering. Stiff wire, when a strain is placed upon it, ducks the responsibility nine times out of ten, and obligingly confers it upon the solder.

Grid Modulation of "Gong"

Vibration of a long solid, stiff grid wire will modulate the grid circuit and accentuate any tendency toward microphonic effects. While microphonism usually is a form of mechanical coupling, this grid-modulation of a gong-like sound, due to any motion striking the wire, makes matters so much worse that I long ago forewent the use of stiff wire.

Compared with stiff bare bus, round, square or otherwise, the insulated stiff wire is harder to work, because the insulation has to be peeled off at the connecting point, and when worked does not lend itself to so much neatness, as the corners have a tendency to be rounded. This is a mere matter of personal taste and I am merely expressing my own, you will remember. Personally I care not about your finely rounded or neatly squared corners, for I am a staunch disciple of the school of flexible wire and use point-to-point connections, not long, architectural effects. Factory-made receivers, many fine custom-made sets, innumerable home-constructed receivers, are made with flexible wire, preferably insulated. I could no more consider absence of insulation a virtue than I could denounce anybody's personal taste in wiring as a vice!

Too Much Confidence

Bare wire implies in every instance a blind confidence in the continued existence of things as they are. All experience should lead one to the inevitable conclusion that things may change—usually do. A quarter of an inch separating two right-angle bus leads, one carrying the B current the other the filament current, are a constant menace to all the tubes in your receiver. One wire may drop on or be pushed against another. The short may be disastrous to tubes—and more.

Besides, when you're working over a set wired with bare bus you may cause a short with an accidental connection completed through a screwdriver, or somebody may drop a conductor into the set and cause the short that way. Some conductors I've met ought to be dropped into a set!

Against this argument is a strong one: popular taste in some quarters runs specifically to bare, squared-off bus wiring.

What One Dealer Said

I was talking to a radio dealer on Greenwich Street, New York City, the other day. He buys many second-hand, factory-made and home-made sets, from time to time, as the market makes possible, and services them for resale, rewiring nearly all of them, and certainly all that have flexible wire connections.

"Why don't you let well enough alone?" I inquired idly, for I know him very well.

"I do whatever is necessary to sell the set," he replied. "My customers don't want sets that are wired with flexible, insulated wire. They want shiny bus-bar wiring, square bus preferred, not insulated, and I simply give them what they want. It costs me $6 labor charges to rewire a set, and about $5 average in parts replacements. The set loses its dusty appearance and I can sell it. I'd rather sell the set as is, if I could, but I can't, so I don't try any more. I've been in this business seven years."

Cheap Insurance

There was no doubting him, for he has always been truthful, and I ascertained from subsequent personal observation that he was quite right—in his particular location and with his own clientele, at least.

There is no reason to suppose his statement does not cover the general situation, yet it can not be said that any public preference is necessarily correct. The sets, I am convinced, would give less trouble if flexible wire were used, for the flexible wire will take up any unexpected or intentional strain, while insulation is cheap insurance, and everybody should have it.

I prefer the stranded flexible insulated wire, and use black exclusively, since with leads properly brought to binding posts or a terminal strip or connecting jack and cable plug, there is no particular need for an informed radioist needing protective coloration like an insect!

A kind of flexible wire I do not like is bell wire, because the wax with which the insulation is impregnated makes the wire too "greasy" for me to work with conveniently. Sometimes it is hard to make solder stick, the wire itself, when the insulation is pared off for connecting purposes, preventing the solder from adhering, unless the bared protrusion is filed or otherwise treated. Benzine will clear it nicely, if rubbed on with a rag, but one does not like to use benzine or its companion solution, naphtha, since these are inflammable. Carbona will do the trick nicely, without any possibility of ignition.

Price Question

Bell wire also is popular in some quarters, particularly with the Bell Telephone Company, but I suppose the price question enters considerably in that instance, because so many, many miles of wire are used. In a radio receiver, however, the type of wire used makes so little price difference that one well may indulge his tastes. A fact not to be ignored, however, is that bell wire is insulated, and none but the very brave seem to want bare wire. The big companies will have none of it, nor will the set constructors who have an eye to safety and long life of anything they produce.

Custom set builders greatly prefer insulated wire, although they, too, have to bow to public demand, against their better discretion. As a custom set builder usually is a service man, to boot, and as he will most likely be the one to service the sets he makes, his choice is for insulation.

His Preference

Yet he has to make a living, he has to work as fast as is consistently possible, and he will not naturally prefer the stranded wire from which the insulation is not so easy to remove.

He wants to snip a piece of wire at a desired point and push back the insulation with his fingers. That saves him forty minutes on every set he wires, and his time means money.

Those of us who are not professional set builders, but simply build a few sets a year for ourselves and our friends, don't mind the extra time it takes to pare off bits of insulation, for the wire we use looks ever so much better than the more convenient push-back type.

DURHAM APPOINTS KILLAM

Killam, Inc., of Portland and Seattle, has been named Oregon and Washington representative for Durham products. Francis R. Ehle, president of the International Resistance Co., made the announcement.

Literature Wanted

THE names and addresses of readers of RADIO WORLD who desire literature on parts and sets from radio manufacturers, jobbers, dealers and mail order houses are published in RADIO WORLD on request of the reader. The blank below may be used, or a post card or letter will do instead.

RADIO WORLD,
145 West 45th St., N. Y. City.

I desire to receive radio literature.

Name .....

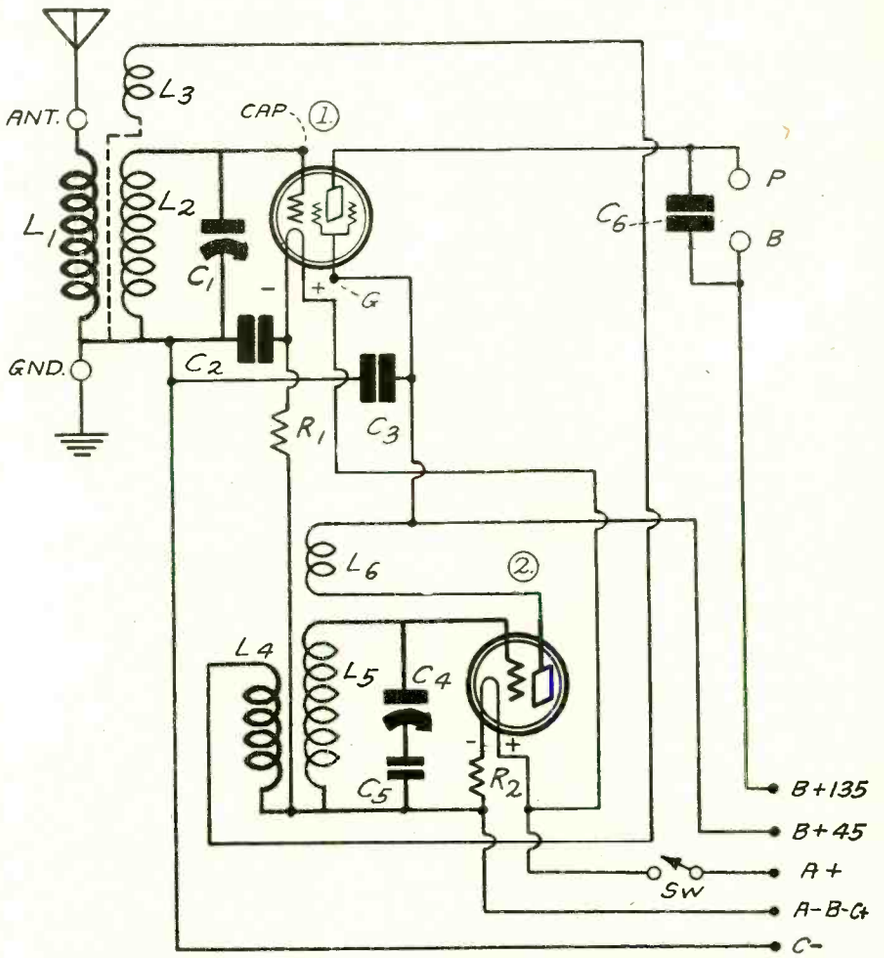
Address .....

City or town .....

State .....

A. J. Bost, 405 W. Main St., Burlington, N. Carolina.
H. E. Blackman, Glenview, Illinois.
R. O. Lindblad, Box No. 2, Newport, Minnesota.
Star Radio Mfg., 4130 Ruckle St., Indianapolis, Ind.
Dwight M. Lag, 521 Roosevelt Ave., Kewanee, Illinois.
Carlisle Horning, 20 Park Avenue, Casitle, N. Y.
Wm. Vallese, 181 Julian St., Providence, R. I.
Frank Reynolds, Box 1496, Pittsburfh, Penna.
Frank Murray, 511 W. 44th St., New York City.
I. S. Evans, 1215 Sixth Ave., (Rear), Altoona, Pa.
L. W. Baab. 2510 California St., Berkeley, Calif.
H. H. Collins, Campbellsville, Kentucky.
Frank Castek, 15 So. Grant St., Hinsdale, Illinois.
Harry A. Ely, 540 Third St., Brockenridge, Pa.
A & K Service Sta., T. C. Bobil, Denver, N. Carolina.
B. B. Gray, Fruithurst, Alabama.
Carl J. Haussman, 67-47 Cooper Ave., Glendale, L. I., N. Y.
Edw. Barrown, 76 St. Nicholas pl., New York City.
E. F. Carrington, 3509 Hartford Ave., Baltimore, Md.
W. Wm. Hunt, Box 213, Point Richmond, California.
Frank van Gilluwe Jr., 1517 Poppy Peak Drive, Pasadena, Calif.
E. Grassman, 754 E. 152nd St., New York City.
H. E. Reighard Oil Co., 847 24th St., Altoona, Pa.
S. Grundy, 8 Vivian Ave., St. Vital, Winnipeg, Manitoba, Canada.
Dominican Trading Co., Dept. of Radio, Apartado 726, Santo Domingo. RD
Dr. C. B. Moffett, Dixon, Missouri
Russell E. Haggith, 15 Furlong St., Rochester, N. Y.
Wallace Abern Athie, Box 65, Cobden, Illinois.
Jack H. Smith, 108 East 15th Street, Oklahoma City, Okla.
G. Ryan, Ryan's Radio Shop, 315 E. Grand, Hastings, Mich.
Ernest Lord, 2303 Collinwood Sta., Cleveland, Ohio.
F. J. Menzel, 8815 Birch St., Oakland, Calif.
William J. Riley, 21 Cohasset St., Roslindale, Mass.
S. R. Criswell, 2415 1-2 Cheremoya Ave., Hollywood, Calif.
L. W. Baab, 2510 California St., Berkeley, California.
J. Champagne, Box 740, Moosup, Connecticut.
Oran Cantwell, Floydada, Texas.
H. A. Heffelfinger, 44 Parker Street, Carlisle,
H. L. Hinderer, 367 S. Schuyler Ave., Kankakee, Illinois.
Milton H. Murray, 6427 Mount Ave., St. Louis, Missouri.
Edward A. Mitchell, Essex Theatre, Broadway & 103rd St., N. Y. C.
L. P. Graner, 421 Canal Street, New York City.
C. H. Ostermeier, 1506 Chelton Ave., Pittsburgh, Penna.
R. Arthur Heiser, 1517 Olivewood Ave., Cleveland, Ohio.
Thomas F. McGrath, 420 East 138th St., New York City.
E. D. Acton, Bell Merc. Bldg. Oak Creek, Colorado.
C. D. Lowenstein, Savannah Sugar Refining Corp., Port Wentworth, Savannah, Georgia.
A. J. Conroy, 625 Market Street, Youngstown, Ohio.
Kay Radio Service, 680 Bedford Ave., Brooklyn, N. Y.
E. H. Paston, 2043 East 4th Street, Cleveland, Ohio.
A. N. Moore, 67 Granite Street, Brooklyn, N. Y.
George B. Perrive, 549 Avenue E., Bayonne, N. J.

The Solution of in an All-



A MIXER FOR SHORT AND LONG WAVES, WHICH RENDERS POSSIBLE A RANGE FROM 15 TO 500 METERS WITH A PARTICULAR MAKE OF SHORT WAVE COILS. THE NOVELTIES OF THE CIRCUIT, BESIDES THE ALL-RANGE FEATURE AND SCREEN GRID USE, ARE A NEW FORM OF LOOSE COUPLING BETWEEN OSCILLATOR AND MODULATOR, SYNCHRONIZED TUNING OF OSCILLATOR AND MODULATOR REGARDLESS OF THE FREQUENCY OF THE INTERMEDIATE CHANNEL, AND DETECTION BY GRID BIAS, WHICH MAY BE AROUND 22½ VOLTS.

WHEN commercial short wave coils are used in a mixer for a Super-Heterodyne, particularly for a receiver that will bring in broadcast as well as higher frequency programs, if the coupling is made through the usual primary of the oscillator inductance, as is common practice in broadcast receivers, it will be too strong. It results in self-oscillation of the modulator tube, tricky tuning of the oscillator, compensating tuning between the two circuits, and diminished selectivity. It therefore becomes necessary to utilize some different form of coupling.

As the result of months of experimenting a coupling form is presented here for the first time anywhere that solves the problem nicely.

To understand the diagram readily, assume that the coils have the low potential ends of primary and secondary terminating at a common lug. This happened to be true of the coils used, and it is true of some other short wave inductances. The line joining the bottoms of the primaries and secondaries in the diagram denotes this interconnection.

The Coupling Solution

Except for grid bias detection, using a screen grid tube, and for the coil L3, which is ordinarily the plate coil in short wave tuners, the modulator has a standard input at the received frequency. The oscillator is standard as to plate coil L6 and secondary L5, the oscillation being produced by a fixed tickler coil, without condenser aid.

The coupling novelty consists of taking the free end of the primary of the oscillator coil, which is the high radio frequency potential point of that inductance, and connecting it to the corresponding terminal of the tertiary of the modulator coil, which would be the plate post in other hookups. The other end of the third coil L3 in the modulator circuit is connected to minus A, as shown by the dotted line, or left unconnected.

Which course to resort to will depend on the intensity of your aerial pickup, because the stronger the pickup the greater the ten-

Five Problems Wave Mixer

dency to produce unwanted oscillation in the modulator circuit. This is contrary to the general rule, whereby the tighter the antenna coupling or stronger the input, the less the tendency toward self-oscillation.

Improved Results

Much better results were obtained in the experiments by leaving the low end of L3 unconnected. This was particularly true on short waves, although also true in the broadcast band. Besides, the antenna input could be used at full strength without self-oscillation. The short wave stations came in smoothly, with scarcely even a rushing sound in the speaker. Almost perfect quiet—denoting freedom from extraneous noises of any sort—and then in came the station, full and clear.

Of course an intermediate channel was used. Next came a single stage of audio, made possible by a grid biased screen grid second detector. The diagram of the intermediate channel and the audio stage was published in the July 21st issue of RADIO WORLD.

Experimenters too deeply doctrinated have come to regard an unconnected coil end as anathema. The phrase "dead end loss" comes to mind prohibitively. But nothing is a loss that produces a gain. A damper on free oscillation is a virtue and not a vice. The coupling is reduced about 60 per cent. by the open-end method, and loose coupling between oscillator and modulator is a requisite even on the broadcast band, while on short waves it is an imperative, inflexible, essential, supreme necessity—and more. Half the troubles in Super-Heterodynes are due to excessive coupling between these circuits. The tighter the coupling, the more these supposedly independent circuits are united, and their separate functions and identities should be preserved with fervid zeal.

Automatic Provision

The thought will occur to many that the coupling will be too tight for the short waves, since the inductive field is larger, and a system to suit all needs must necessarily have looser coupling as the frequency is increased. However, the coils themselves provide the remedy. The primary of a coil intended for broadcast use is larger by far than the primary of any coil intended for short waves. Also the tickler coils are smaller for short waves, that is, likewise have fewer turns.

Within the working range of any particular coil the primary or tickler coil is all right as it is.

Therefore when you change coils to change bands of reception, you automatically reduce the coupling, or rather the inductance used for coupling. Since the pickup is through what would be the primary of the oscillator and the standard tickler coil of the modulator, coil changing for different bands changes the coupling in the right direction, and in the right degree.

Only three other novel points arise. One is the grounding of C minus detector. This is made necessary by the fact that the antenna coil is grounded. Since the end of that coil is connected to the end of the secondary in the coils used, the secondary, at the point of grid return, is grounded. As the grid return is to C minus, this is grounded. There is no good reason why C minus should not be grounded, instead of A minus.

To make the average potential of negative filament, C minus and screen grid (G post) about the same, the bypass condensers C2 and C3 are used. These may be .006 mfd. mica fixed condensers, although if you have two condensers of different capacities, use the higher for C3.

High Strays Eliminated

The second remaining novelty is the fixed condenser C6, which may be used across the primary of the first intermediate transformer, as shown, or may be connected from plate of the modulator to C minus. It is the usual radio frequency shorting condenser, which aids detection. But as it bypasses strongly above 10,000 cycles, it clears out virtually all high-pitched interference. High audio frequently strays are killed.

In some instances your intermediate frequency coils in days to come may have high impedance primaries, with a condenser put across the primary to provide the desired intermediate frequency, and in such instances you will not need C6, because the built-in condenser will have high enough capacity.

When such coils do arrive, and it is confidently expected that some enterprising manufacturers will produce them, you will have a primary tuned to the intermediate frequency, and a secondary with, say, twice as many turns, but without condenser across it, representing a much higher frequency, and one sufficiently apart from the intermediate frequency to prevent any possibility of having two intermediate frequencies in one coil which would respond to the oscillator tuning at one predetermined point and at one unexpected point. The secondary, having twice as many turns as the primary, would double the voltage, so that from an economical intermediate channel using screen grid tubes you would get, free, the gain ordinarily obtained from a -01A tube stage simply by the step-up ratio of the transformers, or even greater gain than that, while of course the high impedance load on the screen grid tubes would give you a sensitivity beyond your greatest expectations, and with few tubes, at that. The diagram published July 21st points the way.

Equalized Tuning

The small fixed condenser C5, in series with the oscillator tuning condenser, is a physically small variable, adjusted to one point and left thus, so that the oscillator tunes in at the same dial numbers as does the modulator. It constitutes the third remaining new development. This keeping in step holds good even on the short waves. The higher frequency dial setting of the oscillator, where two points are possible due to the intermediate frequency permitting repeat tuning, is to be preferred, because more stable and dependable. Simply tune in a broadcast station with the small condenser shorted out, then remove the shorting bus and turn the setscrew of the little adjustable condenser until the station can be brought back by having the oscillator dial read exactly the same as does the undisturbed modulator dial.

This little solution of an old difficulty has never been presented before, and may be adopted for almost any Super-Heterodyne.

—HERMAN BERNARD.

[The author's discussion of mixers for Super-Heterodynes, affording short wave as well as broadcast band reception, began in the July 7th issue, was continued in the July 21st and 28th issues, and will cover still more fascinating phases in issues soon to be published. All Super-Heterodyne enthusiasts will find the subject immensely attractive, especially as a circuit is gradually developed to blueprint form. At present only advanced Super Heterodyne students are asked to follow the author's laboratory experiments, and on the basis of their findings and his own the concensus circuit will be founded.]

Four Different Voltages Perplex Swiss Buyers

Washington.

Switzerland has been relatively slow in radio development compared with surrounding European countries, Assistant Trade Commissioner Kenneth M. Hill, Berne, advises the Department of Commerce. The full text of the report follows:

"There are only five broadcasting stations in Switzerland and 62,000 licensed radio receiving sets, of which more than one-half are crystal sets, according to statistics issued in January, 1928.

"In Switzerland different voltage is used in different parts of the country. In the Canton of Berne, for example, 110 volt, 125 volt, 140 volt and 220 volt current is used although 125 volt current is most common.

"There is a movement on foot, however, to standardize at 220 volts, and for this reason the Swiss are reported loath to invest in an expensive set when there is a possibility of a change in voltage within a year or two.

"A few German manufacturers are now marketing transformers in Switzerland which permit the adaptation to different voltage in case a purchaser is obliged to adjust his set to another voltage. One large Swedish manufacturer has a similar system built into cabinet."

New Japanese Station Is Answer to Mountain

Washington.

A new station at Kumanoto, Japan, call letters JOGK, commenced operating this month, Consul Henry D. Hitchcock, Nagasaki, says in a report to the Department of Commerce. The full text of the report follows:

"The new station, of ten kilowatt power, broadcasts on a wavelength of 380 meters. It is expected that inauguration of the new station will increase the Japanese demand for radio sets. Up to the present but few sets had been sold, owing, it is said, to the poor reception from stations over the mountains in central and eastern Japan."

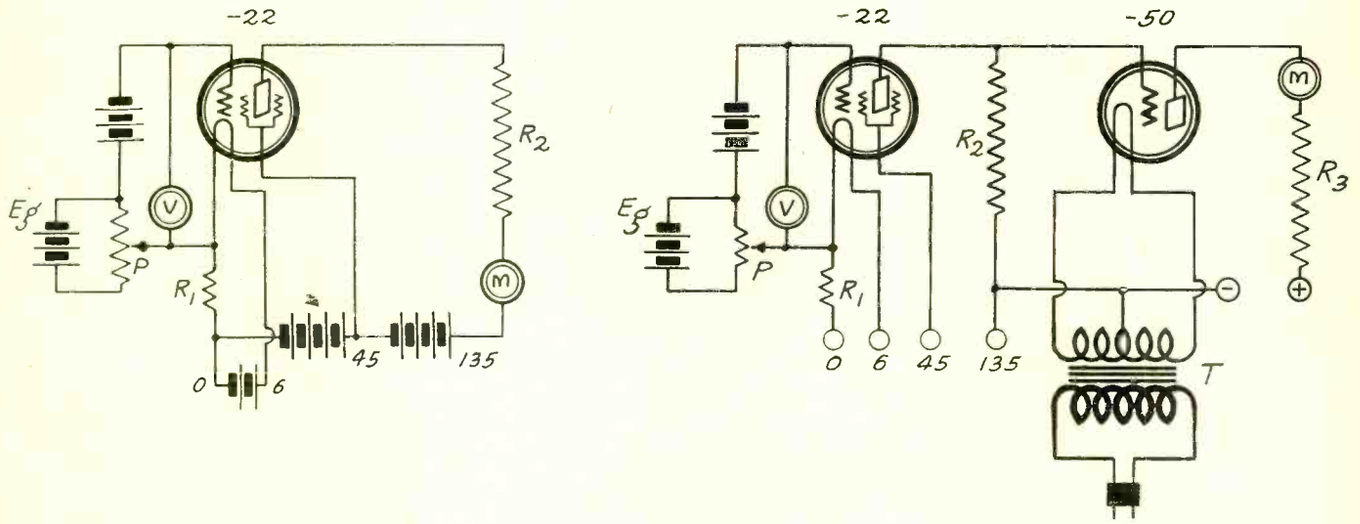
LIST OF PARTS

L1L2L3, L4L5L6—Two sets of short wave coils, with a home-made coil, if necessary, to bring in the broadcast waves, although some coil kits do both in commercial form.
C1, C4—Two .00014 mfd. tuning condensers.
C5—One .0001 to .00005 mfd. adjustable condenser of the set-screw type.
C2—One .006 mfd. fixed mica condenser.
C3—One .006 mfd. or larger capacity fixed condenser.
R1—One 20-ohm resistor.
R2—One 4-ohm resistor.
C6—One. 001 mfd. fixed mica condenser.
One switch.
Four binding posts (Ant., Gnd., P and B).
Two sockets (1) and (2).
Two dials.
One 7x12 inch front panel.
One 7x10 inch subpanel.
One set of 2 inch high brackets.
One 5-lead battery cable.
One screen grid tube (1) and one 112A tube (2).

How to Run Curves on

By J. E.

Technical



CURVES showing the relationship between the grid voltage and the plate current in screen grid tubes working into high resistances are not generally available. Yet such curves are very important if intelligent design of screen grid tube circuits is to be done.

One reason for the lack of these curves is that they cannot be taken with instruments ordinarily available in amateur laboratories. If the curves are to be taken by the same method as is used for taking the curves of general purpose tubes it is necessary to use a sensitive microammeter for measuring the plate current, and it is also necessary to have a low range voltmeter for measuring the known grid potentials applied to the control grid.

But microammeters of adequate sensitivity are not to be found in many radio laboratories, for they are expensive and are not adapted to many routine measurements of receivers. Hence if amateurs as well as many professional radio experimenters wish to take such curves on screen grid tubes another method is necessary, one utilizing the apparatus already at hand.

The simple circuit shown in Fig. 1 is that ordinarily employed in taking grid voltage plate current curves. In this Eg is a battery which supplies the grid voltage required to take the curves. P is a high resistance potentiometer by means of which fine adjustment of the voltage is obtained. R1 is the usual filament ballast by means of which the filament current is adjusted. This may also be a rheostat.

The usual filament, screen grid and plate voltages of 3.3, 45 and 135 volts are indicated. R2 is the load on the tube, which may have any value from zero up, and it may be resistance, inductance, capacity, or a combination of two or more of these. M is a meter which is capable of accurately measuring the plate current for any grid voltage that may be applied, which is measured by the voltmeter V.

Voltage Measurement Possible

Now if R2 is a resistance of about 1 megohm the current in the plate circuit will probably never exceed 100 microamperes. Most of the readings will be much less than this. Hence a microammeter having a range of 0-100 microamperes would have to be used. A 0-1 milliameter would not be nearly enough sensitive, and not many radio experimenters have even a meter of this sensitivity.

It is doubtful whether the experimenter could borrow a microammeter, for these meters are extremely delicate as well as expensive and any one having such a meter would be extremely reluctant about trusting it to some one else.

It is not the current in the plate circuit of a screen grid tube which is of prime interest when the load is resistive, but it is the voltage drop across the resistance in the plate circuit. If the voltage is

The Four Horsemen of Fidelity Apocalypse

By Roger M. Wise

Engineering Department, E. T. Cunningham, Inc.

The paramount qualities that contribute most to quality performance in a radio receiver may be listed as follows:

1. The fidelity of reproduction and the efficiency of the loud speaker.
2. The circuit design of the receiver, which requires proper tone frequency characteristics of the audio frequency circuits and proper circuit constants for the particular tubes for which the receiver was designed.
3. Correct battery voltages.
4. The correct tubes of satisfactory quality.

Needs Good Speaker

Failure to meet properly and fully the requirements of each one of the above factors will result in impaired performance.

If, for instance, the speaker is of inferior quality it may be deficient in response to the bass range, and if so, no amount of care in the selection of the tube supplying energy to the speaker can adequately compensate for this fault. As well try to get good music by having a master pianist play on a decrepit and untuned piano.

The "input" is all that could be expected but the "output" would be far from satisfying.

One respect in which receivers of early design have been lacking is in the audio amplifier circuit design, inadequate transformers being used, which overamplified some portions of the audio band and at the same time entirely failed to amplify the bass notes.

Voltages Vital

With such a handicap the use of a power tube in the last stage is of comparatively little value from the point of quality reproduction, although it will permit much greater volume to be obtained.

In such a case we have the parallel of a fine instrument capable of exquisite tone and melody being played by a rank novice, who plays merely a melody without the finer shadings of bass notes which give character to a musical composition.

The use of correct voltages is a matter of vital importance which may be likened to that of proper adjustment of the keys, pedals and other vital parts of the piano or other instrument.

Tube Choice

The fourth major factor, that of the selection of correct tubes of satisfactory quality, is the final link in the chain which make for satisfactory radio performance.

Without high quality tubes, properly used, deterioration soons set in, and all advantage of careful selection of the remaining equipment is set at naught.

Screen Grid Tubes

Anderson

Editor

known the performance of the tube under specific operating conditions is known, and if the value of the resistance is also known then the current is known. Hence one way out of the difficulty is to measure the voltage developed across R2. But how?

Here another difficulty present itself. No ordinary voltmeter capable of measuring the voltage developed across a resistance of the order of one megohm exists. A much more delicate and sensitive voltmeter than a microammeter would be required, for the current required to operate the voltmeter would be greater than the current through the load resistance.

The only voltmeter suitable for the purpose is a vacuum tube voltmeter, and this must be adjusted so that it never takes any current at all. Fig. 2 shows the circuit diagram in which such a meter has been connected across the load resistance R2. This voltmeter may employ any vacuum tube which will handle all the voltages which are likely to develop across R2 as Eg is varied from zero to about 3 volts. A -50 type tube is suggested, though a -71A may serve the purpose.

A -50 Recommended

If the -50 tube is selected T should be a filament transformer having a secondary voltage of 7½ volts. The plate voltage may be 450 volts as suggested in the drawing, or it may be lower, depending on what is available. The plate voltage supplied to the tube under test and that applied to the voltmeter tube should be entirely independent. Preferably batteries should be used for the screen grid tube while under test, while a B battery eliminator may be used for the voltmeter. Precautions should be taken to insure the filament voltage and the plate voltage on the voltmeter tube remain constant both during the test run and during calibration, and that they remain the same in both instances.

The milliameter M in the plate circuit of the voltmeter tube may be any instrument which is available. R3 is a resistance connected in the plate circuit in series with the meter to limit the plate current and to adapt the plate current to the range of the milliammeter used. It should be a variable resistor having a range of 500 to 100,000 ohms, such a power clarostat. Once adjusted, the value of R3 must not be changed.

When Eg is set at zero, that is, so that the reading on V is zero, the current through R2 will be the greatest, for it is assumed that no readings on the screen grid tube will be taken for positive values of Eg. It will never be used with positive bias. When the current in R2 is greatest the voltage drop in it will also be greatest.

The drop in R2 constitutes a negative bias on the voltmeter tube. Hence when the current in R2 is greatest the current in M will be least.

Calibrating the Voltmeter

The first observation is taken with the reading on V adjusted to zero. The corresponding reading on M is taken and recorded in a table opposite the value of Eg, or the reading on V. Then the Eg is adjusted until the reading on V is a quarter volt. The corresponding reading on M is taken and recorded. The grid battery is then adjusted until V reads ½ volt and so on until the entire battery Eg has been used.

For large readings of V the current in R2 is very small. Indeed it may be zero. When no current flows in R2 there is no bias on the grid of the voltmeter tube and hence the current in the milliammeter is very large.

It is now necessary to calibrate the voltmeter tube. This is done by taking the grid lead to that tube and connecting it to various positions on the plate battery for the screen grid tube. It is not necessary to change the circuit in any other way. When the grid lead is moved to the negative end of the plate battery or to the filament battery the bias on the voltmeter tube is 135 volts. This is likely to reduce the current in the plate circuit of that tube to zero, or at least to a very low value.

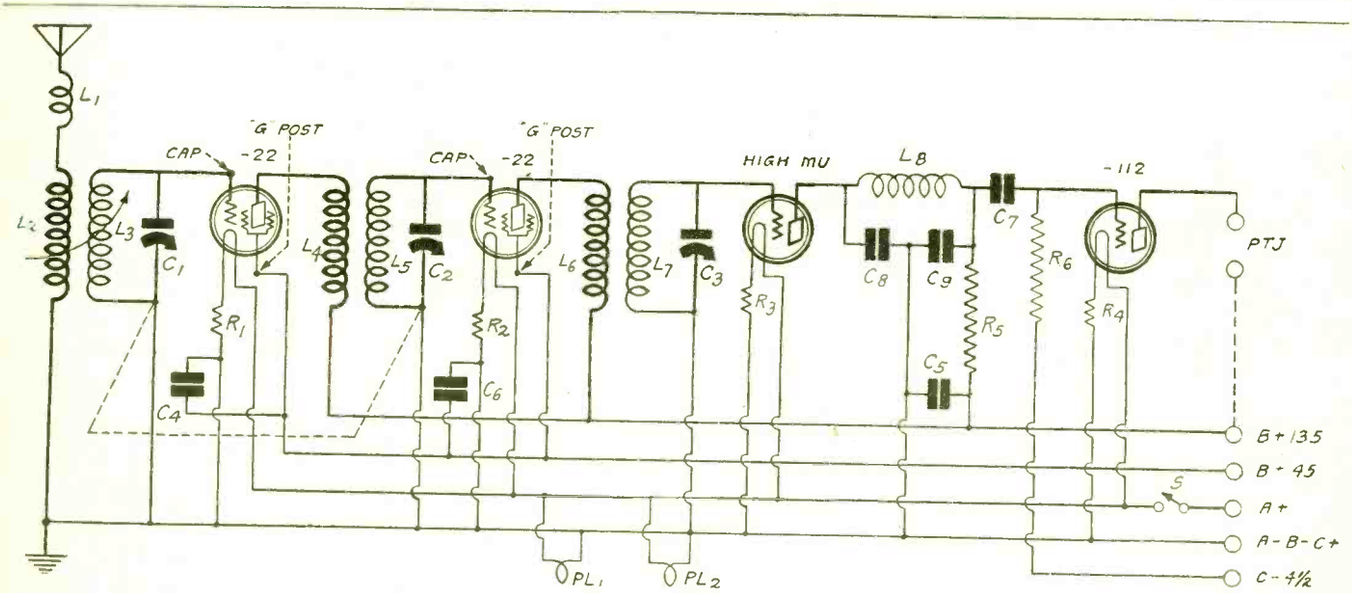
This reading is taken whatever it may be. Then the grid lead is moved to 22½ volts, that is to the middle tap on the 45 volt section. The current in M is observed and recorded opposite the 22½ volts. Then the grid lead is moved up to 45 volts and so on up to 135 volts.

When readings on M have been taken every 22½ volts from zero to 135 volts a curve of grid bias against plate current is plotted. This curve is the calibration curve of the vacuum tube voltmeter and from it the voltage drops in R2 for given currents in M may be obtained. Hence a known relation between Eg and the voltage drop in R2 has been obtained and the grid voltage, output voltage curve for the screen grid tube may be obtained. The grid voltage plate current curve also may be obtained by dividing the voltage drop in R2 by the resistance.

The Useful Range of Curve

It should be observed that the voltage drop in R2 is more useful for it gives the voltage input to the next tube while the current does not. The value of the resistance R2 varies as the current through it varies and this variation is automatically taken care of when the voltage drop is obtained.

It is only the straight portion of the curve between the grid voltage on the screen grid tube and the voltage drop in R2 which is useful. The grid bias on the screen grid tube should be adjusted to that value which gives a voltage drop in R2 which lies in the middle part of the straight portion of the curve. Then a maximum signal voltage swing may be impressed on the screen grid tube with a minimum of second harmonic distortion.



SURPRISING RESULTS CAN BE ACHIEVED WITH A CIRCUIT EMPLOYING GANG CONTROL IF THE COUPLING BETWEEN THE ANTENNA AND THE FIRST TUNED CIRCUIT AND BY INSERTING A VARIOMETER L1 IN THE ANTENNA CIRCUIT. NOT ONLY WILL THIS ARRANGEMENT SERVE AS A TRIMMER OF THE TUNED CIRCUITS BUT IT WILL TUNE THE ANTENNA CIRCUIT, THEREBY BOOSTING THE VOLUME SEVERAL TIMES. THIS CIRCUIT IS INTENDED FOR USE IN CONNECTION WITH A POWER AMPLIFIER AND BOOSTER. IT EMPLOYS TWO SCREEN GRID TUBES WITH A HIGH MU DETECTOR. THUS IT IS CAPABLE OF HIGH SENSITIVITY AS WELL AS HIGH SELECTIVITY

The Custom Set Builder

Why and How He Prospers in His Work

By James H. Carroll

Contributing Editor

A COMPOSITE photograph of the greatest presidents of the United States shows a countenance typically American, shaded with the lines of character and etched with the lights and shadows of genius. A composite photograph of the custom set-builders of the nation would show a physiognomy just as American, with character, ability, skill and mechanical genius limned thereon.

One of the most startling growths in the history of radio, apart from the development of radio itself as an art and an industry, is the healthy growth of the custom set builder, both individually and as a class. Starting by the roadside in a small way, in the early phase of the industry, with humble beginning in most every instance, the custom set builder has grown from a Colossus of "Roads" to the Colossus of Radio. A gigantic, outstanding figure, much of the future trend, growth and swing of radio depends upon his guidance.

Few people, in or out of the industry, realize the importance, standing and influence wielded by this self-same custom set builder.

Knows His Business

The custom set builder has much to offer his clients beyond his mere set building facility. He cheerfully gives them advice on the best circuits to suit their needs and location. He knows how to select the best of these circuits to give them the most satisfaction. He is unhampered by restrictions and gives them advancement in design, refinements and improvements that are about a year ahead of the market. He does not charge them for waste, because he has no waste. He does not charge them interest on large stocks of parts because he does not carry them but he buys mostly as he needs. In many cases, if the circuit selected is on the market in kit form, he merely has to order the kit and buy the minor parts to complete the job.

He eliminates guesswork and the element of worry for his customers as in the instance of the screen-grid tube. He knows the best uses of this tube and advises the circuit accordingly. If a National Screen Grid Five is the best thing for his customer rather than a seven tuber with three straight RF stages, he will so advise him although his profit may be less. Also with AC tubes, he instructs in their use and care and his installation avoids all destructive losses so that the upkeep is kept at a minimum.

His job is skillfully constructed by his master hand throughout. It is not the product of many hands, practiced to varying degrees of skill and when it is completed it stays put until scrapped or otherwise disposed of.

Good Reason for Good Work

It is to his interest to turn out a job that will stay sold, with the least service that will eat into his modest profits and he therefore builds accordingly.

It pays him to turn out work that will satisfy his customers, merit their sincere recommendations and thus bring him new orders. He is, therefore, an asset to his community in general and to the radio industry as a whole. After he has completed the installation he thereafter maintains a friendly interest in his clients and is always ready with advice and service.

Every good job put out by the custom set builder is another advertisement in a long series of ads, beginning at the inception of his business. However, our custom set builder is keenly perceptive and fully realizes the value of advertising, using it to good advantage in his business. He runs copy in whatever mediums will best help him and uses literature and follow-ups logically and intensively. He does not rely alone on goodwill to keep his business going, and he has, perhaps, a better idea of the value of advertising and a clearer sense of the best mediums to place it in than many of the large manufacturers. He knows, too, the value of consistent advertising and that more loss than gain is entailed by "splash" campaigns where copy is placed spasmodically, the product boomed meantime dying a natural death from lack of follow-up to keep interest alive.

Will Not Be the Goat

While he is willing to do all he can to back manufacturer campaigns he is unwilling to finance the fame of new parts or circuits entirely at his own expense, his own campaign being based upon the amount of money he can afford to spend during the year.

To tube manufacturers, the custom set-builders are invaluable customers being insatiable consumers of all kinds of tubes, for their own uses and for their installations. To the parts and kit manufacturers they open a vast field of sales, the combined custom set business amounting to yearly volume far beyond the demand for parts of set manufacturers from parts manufacturers.

The Colossus is gradually awakening and beginning to figure his field and look to his own interests as is evidenced by the movement toward a National Association. If this were once started with decisive aims and benefits in view for its members, radio would be well on the way toward stability and the influence for good wielded by the Colossus would be decisively felt and participated in by all of us.

Some Examples

In New York City the customer set builder is strong. There are many of them in New York and vicinity and they are all shining examples of skill, ability and character. They are all doing well, notwithstanding that their field is more limited by competition than their country brothers. To cite a few examples, Paul R. Fernald, of H. & F. Radio Laboratories, 168 Washington Street, is one of the pioneers. Established since the inception of radio, he has a fine and growing clientele of high-class fans who always seek the newest and best and who keep up-to-date every year by having their receivers and installations modernized. Many of them order the newest circuit built as soon as it is announced.

Another pioneer is Walter J. McCord, of the Jaynxon Laboratories, 57 Dey Street, established for many years and doing a fine business. He builds and repairs sets, eliminators and speakers. He also has a good following built up by giving honest service and good work. He is held in high respect by all his customers and new business comes to him daily from their recommendations.

Radio Construction Laboratories, 142 Liberty Street, specialize in high power power packs, developing the best in modern quality reproduction with dynamic speakers to match. They also do expert testing and give advice on radio problems.

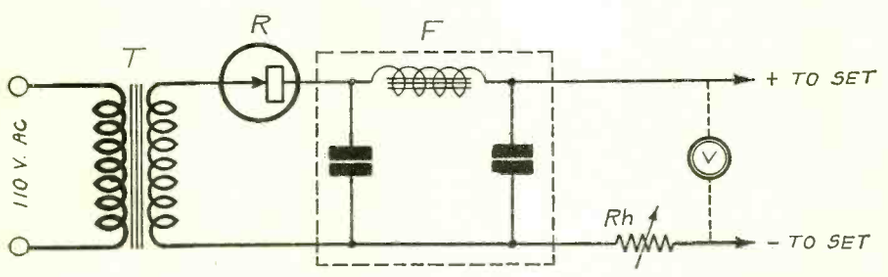
Satisfy Customers

R. D. Montgomery, 63 Cortlandt Street, is also an old-timer in the ranks of custom set-builders. He knows radio thoroughly through study and practice and always satisfies his customers.

Rossiter, Tyler & McDonnell, 136 Liberty Street, is another house that is built upon satisfaction and the reputation of prescribing the best for their clientele.

Rudy Siemens, one of the trail-blazers in the radio field, runs the Central Radio Service Bureau at 72 Cortlandt Street, and is one of the successful custom set-builders in Manhattan. He also has a fine testing equipment at the service of his following.

S. Hammer, on Liberty Street, is another live wire.



A BATTERY ELIMINATORS WILL UNDOUBTEDLY FIND GREATER APPLICATION THE COMING RADIO SEASON THAN EVER BEFORE. SUITABLE ELECTROLYTIC CONDENSERS AND HEAVY DUTY FILTER COILS HAVE BEEN DEVELOPED FOR THIS SERVICE. RECTIFICATION IS OBTAINED BY THE USE OF ORDINARY STORAGE BATTERY CHARGERS, EITHER OF THE TWO AMPERE RATING OR TRICKLE CHARGERS, DEPENDING ON THE DRAIN THAT IS EXPECTED.

Poor Hearing's Problem

How to Make Ringing of Phone and Door Bells Audible in Headset While Program is Being Received

By C. G. M. Brabant

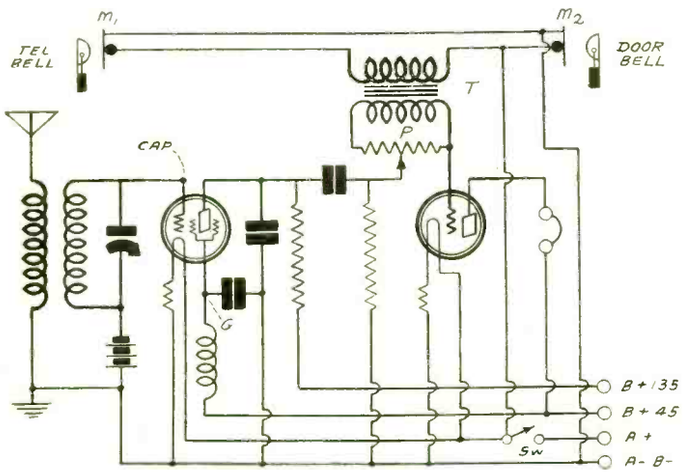


FIG. 1

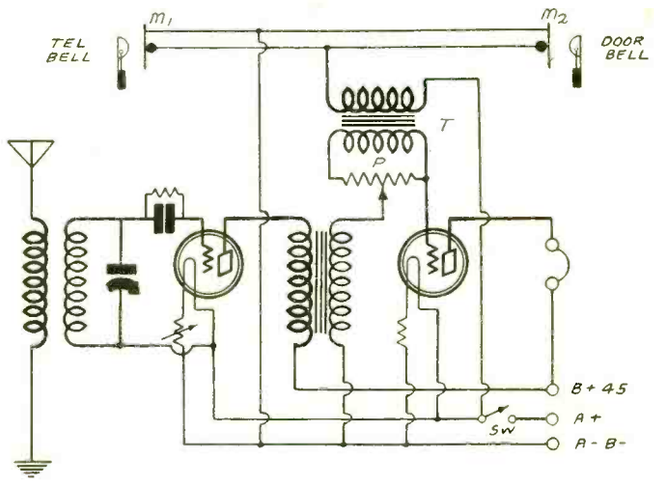


FIG. 2

A DIAGRAM SHOWING HOW TO CONNECT TWO MICROPHONES TO A RADIO SET SO THAT THE SOUNDS OF THE TELEPHONE AND DOOR BELLS WILL BE HEARD IN THE HEADSET (FIG. 1). THE TUNER SHOWN IS SIMPLY ILLUSTRATIVE OF THAT OF ANY RECEIVER, WHILE THE AUDIO STAGE IS THE LAST ONE OF ANY SET. RESISTANCE COUPLED AUDIO IS ILLUSTRATED FIG. 2 IS A CIRCUIT SHOWING HOW TO CONNECT THE MICROPHONE CIRCUIT INTO THE RADIO SET WHEN TRANSFORMER COUPLING IS USED.

A MAN of defective hearing liked to listen to radio, but he could not use a loudspeaker, for when the volume was loud enough for him to hear it was unbearably loud for those around him whose hearing was normal. He preferred to use a headset so that he could listen in whenever he wanted without disturbing anyone else.

But listening with the headset raised a problem when he was alone. He could not hear either the door bell or the telephone bell, and it was important that he should hear both.

Some kind of indicator which would show him when either bell was ringing was needed, and this indicator could either be optical or acoustic. For example, the ringing of the door bell might turn on a red pilot light placed on the panel of the radio set, and the ringing of the telephone bell might turn on a green pilot light. The problem also might be solved acoustically by coupling the bells to the radio receiver in such a manner that the sound of the bells could be heard in the headset.

Simple Arrangement Desired

To make the ringing of the bells turn on lights, relays would be necessary. The current in one of the bell circuits could be made to close a switch in a circuit containing the pilot light Or the sound of a bell could be made to actuate a microphone which in turn would actuate a relay switch for closing the pilot light circuit. But either of these schemes is rather complex, and the simplest possible arrangement was desired. Furthermore a visual indicator is not the best kind of alarm, for it requires constant watching. And a person who is enjoying radio reception is not as a rule very watchful, or he would not be enjoying the reception.

An acoustic indicator is by far the better, and it is easier to combine this with the radio set so that the sound from the bell will crash in on the music. This interference is not very pleasant but it is no more unpleasant when it crashes in on the headset than when it crashes in on the loudspeaker through the air. The more unpleasant the crashing the more effective is the alarm.

Various simple arrangements could be devised for coupling the bells to the radio receiver. In some instances no special arrangement at all is necessary, for the radio receiver picks up the disturbance in the bell circuit. But this pick-up is not dependable.

Microphones Installed

A more definite arrangement is to place a microphone near the bell and then couple the microphone circuit to the audio amplifier in the receiver. The input from the bell to the radio receiver may be adjusted either by adjusting the distance between the microphone and the bell or by adjusting the voltage input by means of a potentiometer.

If the telephone and the door bells are close together a single microphone will be enough. It is mounted half way between the two bells so that the sound from either will actuate the microphone with equal intensity.

If the two bells are far apart two microphones will be necessary, for if a single pick-up were used it would have to be so far from either bell that the sound received from either would not actuate it. Whether one or two microphones are used, the sound of both bells will be heard in the headset. But this should not cause any confusion, for the sounds of the two bells are different and it will be just as easy to recognize the characteristics of the two bells when heard through the headset as when heard through the air.

Suggested Circuit

Fig. 1 shows a suggested circuit for hooking up two microphones, M1 and M2, so that the sound of both will be heard in the headset. One microphone is placed near each bell and then the two are connected in parallel across the primary of the microphone transformer T. Across the secondary of this transformer is connected a 500,000-ohm potentiometer P by means of which the intensity of the signal from the bells is adjusted to suit the amplifier and the listener.

One side of the secondary and the potentiometer is connected to the grid of the amplifier tube. The slider on the potentiometer is connected to the top of the grid leak resistor. This case is for a resistance coupled amplifier.

In case the detector and the audio amplifier are connected by means of a transformer the secondary of the microphone transformer is connected between the grid of the amplifier and the grid terminal on the coupling transformer in the manner shown in Fig. 2.

Many types of microphones are available on the market which are suitable for this purpose, some of which are inexpensive. For example, a microphone button such as is used in dictaphones will serve the purpose nicely.

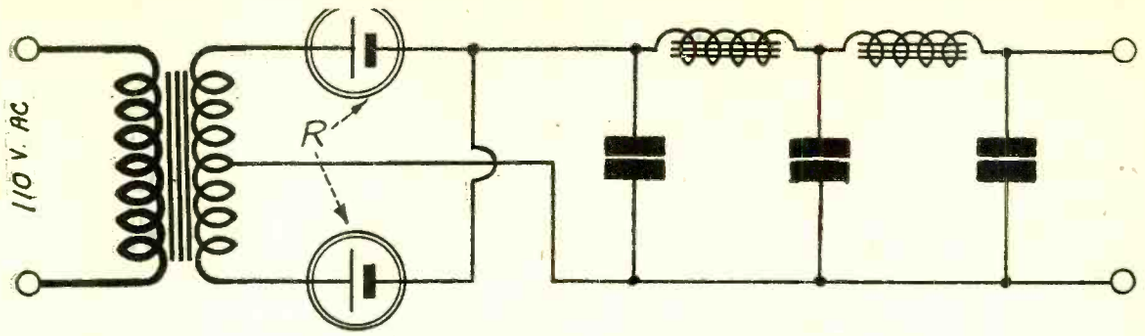


FIG. 703
The circuit diagram of a full wave rectifier and filter in which the rectifier elements are of the electrolytic type. Circuit requested by Rudolph Zimmerman

Radio University

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When writing for information give your Radio University subscription number.

PLEASE PUBLISH a circuit diagram of a full wave rectifier and filter in which the rectifier elements are of the electrolytic type.

(2) Also please publish a diagram of a half-wave rectifier and filter suitable for filament current supply.

RUDOLPH ZIMMERMAN,
St. Louis, Mo.

(1) Fig. 703 shows the circuit of a full-wave rectifier using two electrolytic rectifiers R.

(2) See Fig. 704 for a single wave rectifier. T and R may be an ordinary battery charger capable of supplying the necessary current. F is a filter which will handle the filament current which is to be drawn. The two inductance coils must have a large current carrying capacity and the condenser should be of the electrolytic type. Its capacity should be about 4,000 mfd.

* * *

HOW CAN a vacuum tube with negative bias on the grid rectify current when no grid current flows? What does it rectify?

(2) Please explain the action of a vacuum tube when used with grid bias for detection.

(3) How is it possible for the grid voltage to be negative half of the cycle and positive the other half when the grid is made so much negative that it never goes positive?

EDWIN E. BURTON,
Fall River, Mass.

(1) It can't rectify and it does not rectify anything. It detects.

(2) The fluctuating signal voltage on the grid changes the plate current in the tube. During half of the signal wave the signal voltage decreases the actual voltage on the grid and thus decreases the plate current. During the other half the signal voltage increases the actual voltage on the grid and thus increases the plate current. The decrease is always less than the increase when the grid is sufficiently negative and therefore an effect similar to rectification appears in the plate circuit.

(3) It is not possible. The grid is always negative if the grid bias is greater than the amplitude of the greatest radio signal. What is meant by negative half of the wave is that part of the wave which increases the normal bias on the grid. By positive half is meant that part of the wave which decreases the normal bias on the grid. The signal voltage is measured from the normal bias, not from the point from which the bias itself is measured, that is, the negative end of the filament.

* * *

DOES THE SHIELD around a tuning coil change the constants of that coil, that is, its inductance and resistance?

(2) Will more tuning capacity be required when the coil is shielded than when it is not?

(3) If the condenser also is enclosed in the shield will more or less capacity be needed to tune the coil to a given frequency?

(4) What effects will the shielding have on the constants of the condenser, that is, its capacity and resistance?

GUSTAVE HILMAN,
Tallahassee, Florida.

(1) The shielding increases the resistance of the coil and decreases its inductance.

(2) Since the inductance is decreased by the shielding one would expect that more capacity would be needed to tune the coil to a given frequency, but this increase in capacity is not always apparent on the tuning condenser. In fact, less capacity may be necessary. The shielding increases the distributed capacity of the coil and this may be more than enough to offset the decrease in the inductance.

(3) When the condenser also is included in the shield the distributed capacity is still greater, and in this case it is usually necessary to decrease the setting of the condenser to tune the circuit to the given frequency.

(4) There is a slight increase in the resistance of the condenser but this increase is negligible for the total resistance in the condenser is a very small portion of the total resistance in the tuned circuit. There is a considerable increase in the minimum setting capacity of the condenser.

* * *

SOMETIMES when listening to a strong local station the signal suddenly fades out. It always seems to happen when the programs are most interesting. What may be the cause?

JACOB BERNSTEIN,
Bronx, New York

One of your nearest neighbors has a higher and better antenna than yours and it is very close. When he tunes in on the signal you have, he takes it away from you. Install a better antenna.

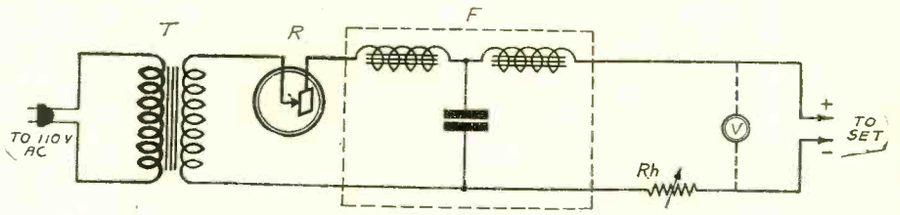

FIG. 704

THE CIRCUIT DIAGRAM OF A SINGLE WAVE RECTIFIER AND FILTER SUITABLE FOR FILAMENT CURRENT SUPPLY. THE CONDENSER IS OF THE ELECTROLYTIC TYPE AND THE TRANSFORMER AND RECTIFIER ARE THOSE OF A STORAGE BATTERY CHARGER. CIRCUIT REQUESTED BY RUDOLPH ZIMMERMAN

122 Excluded Stations Win License to Sept. 1

Washington.

Licenses of 122 broadcasting stations included among the 164 cited for failure to serve the public interest, were extended until September 1 by the Federal Radio Commission under a General Order. The old licences of these stations expired August 1.

The Commission announced that the action was taken because it had been impressed by the arguments presented by some of the stations regarding their public service, and that the extension of time was made to permit the Commission to "determine definitely that no injustice will be done any broadcaster, and that no community will be unjustly denied the radio service it prefers."

Two additional stations, KFVG, Independence, Kans., and WLBY, Iron Mountain, Mich., have been denied their application for renewal of licenses, making a total of 42 of the 164 stations to be eliminated thus far. These stations, it was found had defaulted their rights for relicensing by failure to offer testimony to show their public service.

Situation Recounted

The Commission had previously announced that 36 stations had defaulted, and four others had voluntarily retired from the broadcast spectrum. The text of the statement follows:

"The Federal Radio Commission extended to September 1, 1927, the licenses of 122 radio broadcasting stations whose cases were heard subject to General Order No. 32, issued May 25, 1928, which order provided that unless those stations made a showing at hearings set originally for July 9, 1928, that public interest, convenience or necessity would be served by granting their applications for renewal they would be denied renewal as of August 1, 1928.

"The Commission has been impressed at the public hearings with the cases made by quite a number of these stations regarding the local and community service they are rendering, and in order to determine definitely that no injustice will be done any broadcaster, and that no community will be unjustly denied the radio service it prefers, the Commission desires ample time to study the voluminous documentary evidence before it, affecting these cases."

Extension Order

The General Order of the Commission regarding the extension follows:

"General Order No. 36.—At a session of the Federal Radio Commission held at its office in Washington, D. C., on July 26, 1928:

"This order is issued with reference to all broadcasting stations listed in, or later made subject to, General Order No. 32 of this Commission, issued on May 25, 1928, excepting the following:

"1. Those stations with respect to which pending applications for renewal of license have been denied by the Commission, such stations having in each case been so notified by order dated July 25, 1928.

"2. Those stations that have heretofore surrendered their licenses.

"3. Those stations with respect to which there have not been heretofore duly filed with this Commission applications for renewal of their existing licenses.

Thirty-one Days Extension

"It is ordered that all existing licenses to broadcast of all broadcasting stations listed in, or later made subject to General Order No. 32 (other than those above excepted) be, and the same are hereby, further extended for a period of thirty-one days to terminate at 3 o'clock a.m., Eastern Standard Time, September 1, 1928, subject, however:

"1. To such modifications as may heretofore have been appended thereto, and

"2. To the condition that this order shall not be deemed or construed as a finding or decision by the Commission, or as any evidence whatsoever, that the continued use or operation of any of said broadcasting stations serves, or will serve, public interest, convenience or necessity, or that public interest, convenience or necessity would be served by the granting of any pending application for renewal of license to broadcast with respect to such station, and any licensee subject to this order who shall continue to use or operate a broadcasting station during the period covered by this order shall be deemed to have assented to said condition."

Manufacturers Sales Opens Boston Office

The Manufacturers Sales Co., 377 Fourth Avenue, New York City, representing several lines, has opened offices at 552 Massachusetts Avenue, Cambridge, Mass. This branch will be under the supervision of Herbert H. Buck, formerly of "Popular Radio," a trained radio man widely known in the field.

Among the lines carried here are the full line of Corbett cabinets and console, including the new console de luxe with built-in phonograph pickup; Lignole panels, the new, complete 1929 inlays in beautiful tones; Kenneth Harkness Screen Grid and AC kits and the new H. F. L. Isotone.

The chassis of this new H. F. L. will be ready in a few days and will be on display there and at the New York office. Full information on all these lines will be sent to those interested upon application to either of above addresses. Mention RADIO WORLD. —J. H. C.

New B Rectifier Uses Chemical that is Dry

An interesting device is the Pow-R-Driver just placed on the market. This unit is the result of three years of exhaustive research work and experimentation on the part of F. A. Rojas, head of the Rojas Chemical Works, and he regards it as his greatest product in this line. The Pow-R-Driver is a high-powered rectifier for use in all types of B eliminators, power packs and amplifying units, introducing also a condenser capacity into the circuit of hundreds of microfarads, greatly improving the filtering, giving greater energy and reserve power. It is claimed that low notes are perfected by this huge capacity and general tone production greatly improved. No extra filament winding is needed on the transformer and a center tap is not required. Full-wave rectification is delivered up to 750 volts at a current flow of 100 milliamperes.

Another claim for it is that there is no exhaustion process from the moment that it is placed in use, but that the elements and composition improve with use.

It is a small, compact unit, made in two sizes, the eight-cell for —12 type power tubes, the 16-cell for —71, —10 and —50 types. It is simply plugged into the rectifying tube socket of the B eliminator or socket-power amplifier and left to run without further attention.

It was designed to work efficiently with all the modern electric sets, power phonographs and all types of eliminators. The electrolyte is solid, non-acid and non-creeping and the device can be turned upside down safely, as there is nothing to spill.

The large anode surface affords ample heat dissipation, reduces hum to a minimum, working the power tubes at capacity potential and with a minimum of plate current drain consequently increasing life of the tubes and giving greater volume without distortion together with improved tone quality. Tests are now being made and further technical data will be given later on. In the meantime, those desirous of complete data will obtain them upon addressing Universal Electro Chemical Corp., 30 West 15th Street, New York City. Mention RADIO WORLD.—J. H. C.

Dellinger Selected to Allocate Waves

Washington, D. C.

The Federal Radio Commission has appointed Dr. J. H. Dellinger of the Bureau of Standards as Chief Engineer to assist the Commission in working out the new allocation plan necessitated by the amended radio act which makes mandatory the distribution of stations and powers equally among the five radio zones.

The appointment is for three months and Dr. Dellinger will accept provided he gets the approval of the Secretary of Commerce for a leave of absence for that period.

Dr. Dellinger is now chief of the radio laboratory of the Bureau of Standards. He is an outstanding authority on radio, a fellow and past president of the Institute of Radio Engineers and holder of degrees in physics from Western Reserve, George Washington and Princeton Universities. He has been with the Bureau of Standards since 1907 and he now holds the rank of physicist. He is the author of many articles on radio and other electrical subjects and he collaborated in the preparation of "Principles Underlying Radio Communication," a Government publication.

Dr. Dellinger's salary while with the Radio Commission will be at the rate of $7,000 per annum.

The position was first offered to John V. L. Hogan, a consulting engineer of New York and a leading member of the Institute of Radio Engineers. But Mr. Hogan declined the position because of pressure of private business. He will assist the Commission in an advisory capacity, nevertheless.

A THOUGHT FOR THE WEEK

THE interest in a broadcast program used to be directly proportional to the square of the distance between the sender and receiver but now it is directly proportional to the square root of what-have-you.

RADIO WORLD

Trade Mark U. S. Pat. Off.

The First and Only National Radio Weekly

Radio World's Slogan: "A radio set for every home."

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⅛	Page, 4⅛" S. C.	57 lines	37.50
1	Column, 2¼"x11"	145 lines	100.00
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Tex Rickard's Lament

POOR Tex Rickard! He'll have to take a part of those millions he has made out of exploiting the flat-nosed gentry and apply it to his losses on the dolorous "World's Championship" fight recently put on at the New York Stadium. And the distraught Tex blames it mostly on radio!

Let us all burst into tears at the sight of this poor inexperienced boy trying to put it up to anything except the one thing that possibly turned the dirty card for him—the fact that a lot of folk just naturally rebelled at the idea of paying forty dollars or so for the doubtful pleasure of seeing a first rate fighter iron out the proboscis of a second-rater.

Poor Tex, indeed! It's tough when the well-trained fight fans finally wake up and refuse to jump through the ring any more. No wonder the doughty Gene wants to retire from the ring!

Divider Takes Guess Out of B Voltages

In nearly all B battery eliminators taps are brought out on the voltage divider and the corresponding binding posts are marked by definite voltages, such as 45, 90, 135 and 180 volts, yet no provision is made for adjusting the voltages at these binding posts. Some users suppose that the actual voltages are those that are marked, regardless of what circuit is used with the B battery eliminator or what the input voltage may be.

It is well known that the voltages at these points depend not only on the input voltage on the rectifier but also on the current that is drawn from the device as a whole as well as from the various voltage taps. For example, the voltage at the so-called 45-volt tap has one value when one tube is connected to it, another value when two tubes are connected to the point, and still another when three tubes are connected, and so on. This applies also to all the other voltage taps. Not even the taps provided for grid bias remain fixed in voltage when the current changes. In fact the entire voltage distributor is one uncertainty.

Affect Quality

This state of affairs is not conducive to the best results, for there is no assurance that any tube in the circuit will be operated at the proper plate and grid voltages, and therefore the output from a set served with such an eliminator is quite uncertain both as to quality and as to volume.

A few resistor manufacturers have realized the need for adjustable voltage taps so that the voltage at any one of the taps could be adjusted to the proper value for any circuit and for any combination of tubes and have provided resistors with such taps.

But in order to make use of the adjustable taps and to obtain correct voltages it is necessary to have a high grade voltmeter with which to measure the voltages obtained for various settings of the taps. Such meters are not available in the home or in the amateur laboratory. They are not even available in many radio stores or in the tool kits of many service men. Hence in most cases the voltage can only be adjusted by guess, the result of which may be even worse than no adjustment at all.

A Step in Advance

One of the resistor manufacturers (Electrad, Inc.) has provided an output voltage divider not only with adjustable but with calibrated taps. With this device it is only necessary to connect the terminals according to directions and to set the knobs according to the number and type of tubes used in the receiver to be served. The proper voltage is assured at every tap.

A 28-page booklet accompanies the device, in which the calibrations for eight different combinations of tubes are given with the proper settings of the various taps for each combination. This practically covers all the sets which are operated by B battery eliminators. The calibration presumes a total voltage across the voltage divider of 220 volts, which is the most common output voltage of B battery eliminators.

Other Useful Data

Besides the knob settings for the eight conventional sets there is a great deal of other data in the book which help in obtaining the proper voltages. For example, in the event the output voltage of the rectifier and filter is higher than 220 volts a table of series multiplier resistance is given by means of which the voltage across the divider can be brought down to the 220 volts. These resistances are given for five different voltages higher than 220 volts and for five different totals plate currents. For example, if the voltage available is 450 volts and the current through the series resistor will be 30 milliamperes, the value of that resistor should be 7,500 ohms. This is just one of the 25 different combinations listed.

Another table gives the plate current characteristics of all the standard tubes used in receivers from the —99 to the —50.

Numerous circuit diagrams showing the connections of the voltage divider and the series multiplier are also given as well as many calibration curves for both plate voltage and grid bias.

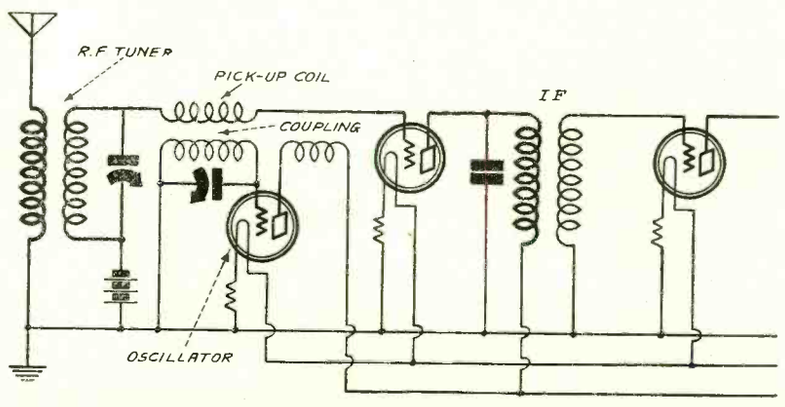
Shows Much Research

The booklet contains the results of a great amount of research work and measurements on all types of receiver as related to the voltage divider.

The voltage divider is enclosed in an attractive molded bakelite case and is provided with soldering lugs as well as binding posts. The bottom of the unit is of solid sheet metal and the sides are of perforated sheet metal, thus giving adequate ventilation to the resistors.

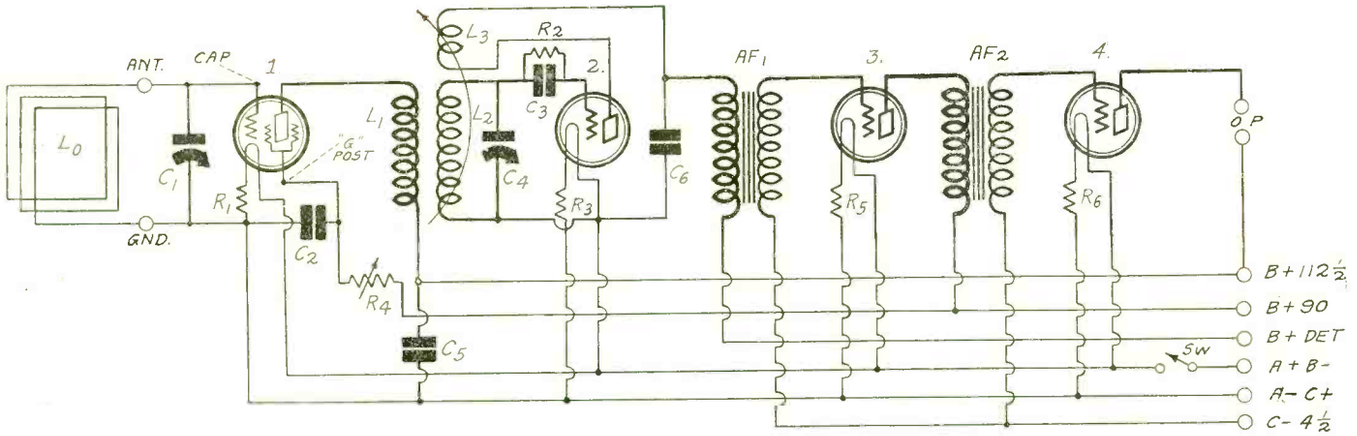
Any one interested in the divider or booklet should write to Arthur Moss, c/o Electrad, Inc., 175 Varick Street, New York City, and mention RADIO WORLD.

COUPLING AFFECTS BEAT FREQUENCY

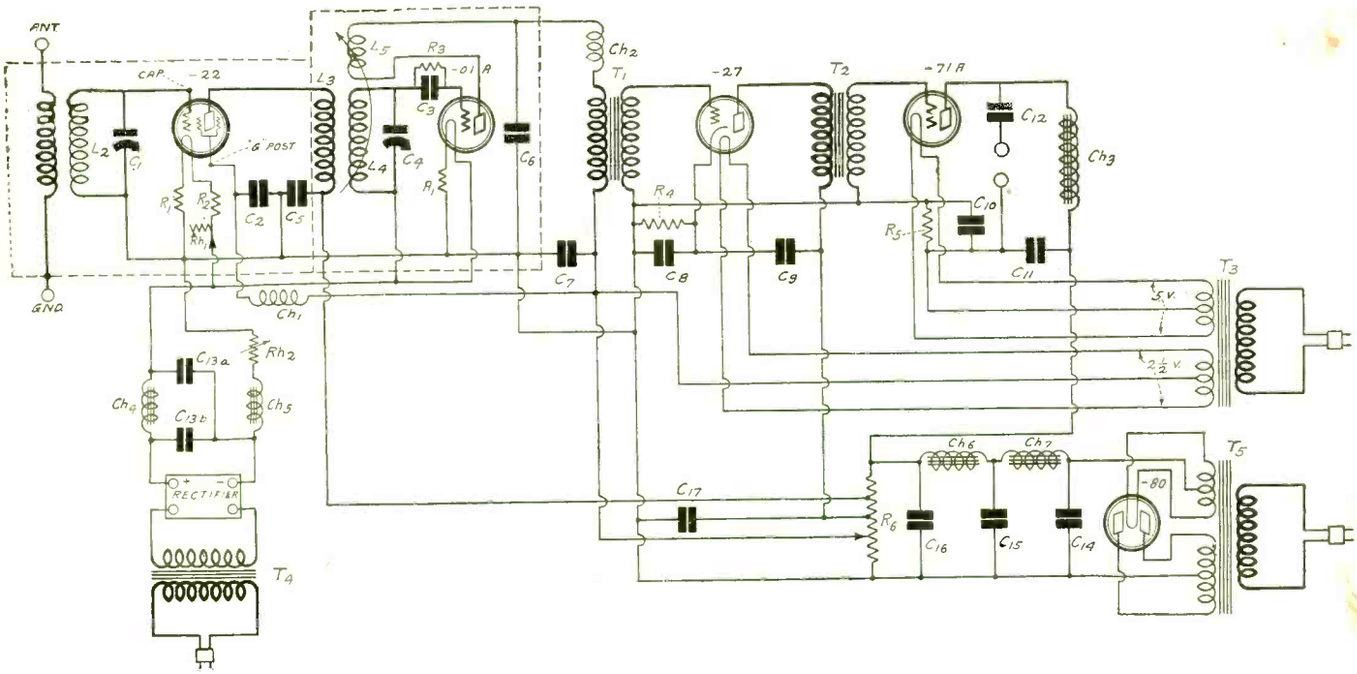


THE CIRCUIT OF A SUPER-HETERODYNE MIXER IN WHICH THE BEAT OR INTERMEDIATE FREQUENCY IS AFFECTED BY THE DEGREE OF COUPLING BETWEEN THE PICK-UP COIL AND THE OSCILLATOR.

Screen Grid Circuits



THERE IS A CONSTANT DEMAND FOR CIRCUIT DIAGRAMS OF RECEIVERS SUITABLE FOR PORTABLE SETS. HERE IS SUCH A CIRCUIT COMPRISING ONE SCREEN RF AMPLIFIER WITH LOOP INPUT, A REGENERATIVE DETECTOR, AND TWO STAGES OF TRANSFORMER COUPLED AUDIO FREQUENCY AMPLIFICATION. SINCE THE CIRCUIT IS INTENDED FOR PORTABILITY THE DETECTOR AND THE FIRST AUDIO SHOULD BE OF THE —99 TYPE AND THE LAST TUBE MAY BE EITHER A —99 OR A 120, DEPENDING ON THE AMBITION OF THE BUILDER. A RECEIVER SUCH AS THIS CAN BE USED FOR HOME RECEPTION AS WELL. AN OUTDOOR ANTENNA MAY BE SUBSTITUTED FOR THE LOOP BY USING A TUNED RF COUPLER IN PLACE OF THE COIL ANTENNA.



THIS IS THE CIRCUIT DIAGRAM OF A COMPLETE RADIO INSTALLATION IN WHICH THE FILAMENTS OF THE RADIO FREQUENCY TUBES ARE HEATED BY AN A BATTERY ELIMINATOR MADE OF A LOW CURRENT CHARGER AND HEAVY HIGH CURRENT FILTER CHOKES AND ELECTROLYTIC CONDENSERS. THE AUDIO TUBES ARE HEATED WITH ALTERNATING CURRENT. THE PLATE VOLTAGES ARE SUPPLIED BY A FULL WAVE RECTIFIER AND FILTER WHILE THE GRID POTENTIALS ARE OBTAINED THROUGH VOLTAGE DROPS IN INDIVIDUAL RESISTORS. SUCH A COMBINATION CAN BE USED INDEFINITELY WITHOUT FEAR OF RUNNING DOWN ANY BATTERIES, FOR THERE IS NONE. THE POWER SUPPLY WILL HAVE ABOUT THE SAME LIFE AS THE AMPLIFIER TUBES.

Intimate Facts Given On Television Tube

Raytheon Technical Bulletin, Vol. 1, No. 3, published by the Raytheon Manufacturing Company, Cambridge, Mass., contains a very interesting article entiled "Useful Facts About the Raytheon Kino Lamp," by D. E. Replogle.

Numerous curves are given showing the characteristics of the Raytheon Kino Lamp. Some of these curves are: Relation of Light Output and Brightness to Direct Current through Raytheon Kino Lamp, Visual Contrast Curve, Brightness Variation with Alternating Current Change, and Relation of Current Output to Power Input. In fact it contains all the characteristics of the tube which are useful in designing television receiving equipment.

WHEN THE RUSH STARTS

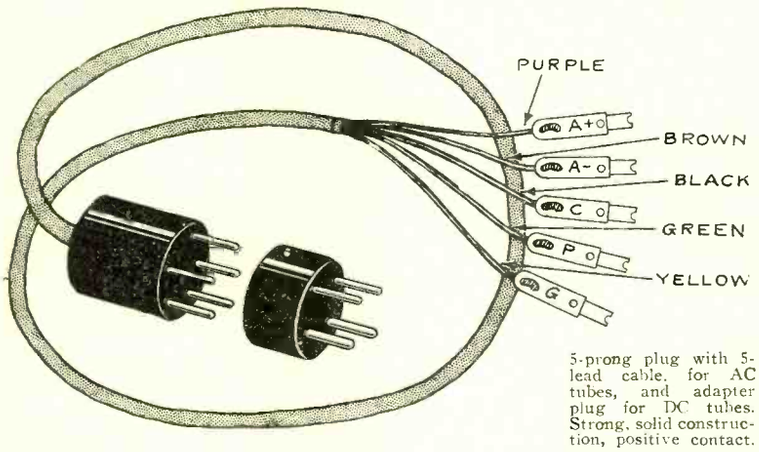
If two or more tubes in your set become inefficient all of a sudden, your voltages may be too high.

WABC Becomes a Key Station for Columbia

WABC of the Atlantic Broadcasting Company, Richmond Hill, New York, has joined the Columbia Broadcasting system, J. Andrew White, president of the Columbia System, and Alfred H. Grebe, president of the Atlantic Broadcasting Company, announced.

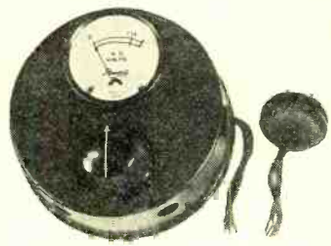
WABC will act as alternate 'key" station with WOR. The new arrangement is to become effective Sept. 2.

Universal AC and DC Short-Wave Adapter Plugs! Voltage Regulator!



5-prong plug with 5-lead cable, for AC tubes, and adapter plug for DC tubes. Strong, solid construction, positive contact.

Handiest thing in the world for any short-wave adapter. Put detector tube of your present set in socket of any short-wave adapter you build, put plug in detector socket of your broadcast receiver. Cable, 34". Leads identified both by color scheme and tags. May be used as 5-lead battery cable plug with UY socket. 5-prong plug with 5-lead cable (Cat. No. 21AC) **$1.50**
4-prong extra plug only, for DC short-wave adapter (Cat. No. 21DC) **$0.50**
Cat. No. 21AC and 21DC ordered together **$1.75**
Cat. No. 21AC and 21DC with 99 adapter **$2.25**



Line voltage regulator for AC sets has an AC meter showing line voltage, and a power adjustable resistance so that the line voltage may be reduced until it reads 110 volts. Wall plug and socket for connection to AC cord from the set also built-in (Cat. No. 218) **$5.00**

Accurate Meters for Exacting Radio Uses! Speaker Switch!

Cat. No. 390, reading 0-100 milliamperes. Price ..**$1.65**

Cat. No. 326, reading 0-6 volts DC, price **$1.65**

Two of the most popular meters are Cat. No. 390, reading 0-100 milliamperes, and Cat. No. 326, reading 0-6 volts DC. Both are panel mount types (2 5/64" hole). See illustrations above. No. 390 is recommended for sets having six tubes or more, particularly if a —71, —10 or —50 tube is used as the output. May be kept permanently in circuit. For DC measurements 0-100 milliamperes. Cat. No. 390 .....**$1.65**
The 0-6 panel voltmeter may be kept permanently in circuit (Cat. No. 326) **$1.65**

PANEL AC VOLTMETER

Cat. No. 351 For reading 0-15 volts AC **$2.25**

PANEL MILLIAMMETERS

Cat. No. 311 For reading 0-10 milliamperes DC **$1.95**
Cat. No. 325 For reading 0-25 milliamperes DC **$1.85**
Cat. No. 350 For reading 0-50 milliamperes DC **$1.65**
Cat. No. 399 For reading 0-300 milliamperes DC **$1.65**

PANEL AMMETER

Cat. No. 338 For reading amperage, 0-10 amperes DC **$1.65**

6-VOLT A BATTERY CHARGE TESTER

Cat. No. 23 For showing when 6-volt A battery needs charging and when to stop charging; shows condition of battery at all times **$1.85**

VOLTAMMETER

Cat. No. 35 For testing amperage of dry cell A batteries and voltage of B batteries (not B eliminators); double reading, 0-50 volts, 0-40 amperes DC **$2.00**

HIGH RESISTANCE VOLTMETERS

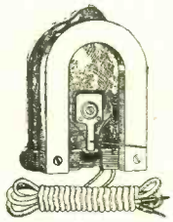
A 0-300 DC voltmeter with a very high resistance. Specially made that way so it will test the output voltages, from maximum to any intermediate voltage, of any B eliminator or grid biasing resistor. Cat. No. 346 ..... **$4.50**

[Note: 0-500 volts, instead of 0-300 volts, is No. 347. Tests ALL power packs—Price $5.50.]

PANEL VOLTMETERS

Cat. No. 335 For reading DC voltages, 0-8 volts **$1.65**
Cat. No. 310 For reading DC voltages, 0-10 volts **$1.65**
Cat. No. 337 For reading DC voltages, 0-50 volts **1.65**
Cat. No. 339 For reading DC voltages, 0-100 volts **$1.75**
Cat. No. 40 For testing A and B batteries, dry or storage, but not for B eliminators: double reading, 0-8 volts and 0-100 volts DC scale.....**$2.25**
Cat. No. 42 For testing B batteries, dry or storage, but not for B eliminators; 0-150 volts DC scale.....**$2.00**
Cat. No. 348 For testing AC current supply line, portable, 0-150 volts.....**$4.50**

In home or store you often want to operate two speakers together, or each separately, and this speaker switch, the Speakerelay, does the trick! Connect the cord to the set and the speakers to the jacks in the switch. Turn knob at No. 1 at left to operate one speaker alone, to No. 2 to operate both speakers together, and to No. 1 at right to operate the other speaker alone. Enclosed in moulded Bakelite case. (Cat. No. 121)..... **$2.00**



Powerful unit, excellent for any cone or similar type of speaker. Stands up to 150 volts unfiltered. Very loud. Adjustable armature. Well packed. Won't get damaged in shipment. Supplied with apex, chuck and nut. Unit easily mounted. **$3.75**

Build yourself a very fine large cone speaker and get the fullest enjoyment of the quality your receiver offers. Nothing but praise has been heaped on these 36" and 24" speakers. Also, their appearance is so entrancing that they fit nicely into the surroundings of the finest living rooms and parlors. Expert radio and acoustical engineers indorse them. Nobody need be without a really fine speaker of 36" or 24" diameter, now that all have a choice of these two sizes at the same price. Remember, a five-day money-back guaranty attaches to each of these speaker kits!
Take your choice of a 24" or 36" diameter cone speaker kit, with Unit No. 1098 (see description at left). Either size at same price. Tri-foot pedestal FREE with each kit order. Front sheet of designed Phonotex, rear sheet of plain Phonotex. Radio cement furnished with each kit. Also mounting bracket, apex, chuck and nut, with instruction sheet. Fine tone quality reproduced at large volume. Ornamental and efficient cone easily built by anybody. Novices find not the slightest difficulty. As the unit is adjustable you can adjust the impedance until best results are obtained. These speakers are used as demonstrators in stores in New York City at full volume without rattling. Low notes are reproduced particularly well, because of the large radiating surface. Apex is at center for highest efficiency. (Cat. No. 36 for 36" or Cat. No. 24 for 24") **$6.00**
Kit is complete, including unit, apex, bracket, chuck, nut, paper, pedestal, cement and instruction sheet.

If bothered by interference between stations or living near a station that comes in all over the dials and prevents you from getting other stations, use a wave trap and trap out the offender at will. Turn of the knob covers entire broadcast band. Trap is encased in moulded Bakelite (Cat. No. 22WT).... **$1.50**

Guaranty Radio Goods Co.
141 W. 45th Street, N. Y. City

Please mail at once C.O.D. on a five-day money-back absolute guaranty, your catalogue numbers as follows, for which I will pay the advertised prices, plus a few cents extra for postage:

Cat. No. ..... Cat. No. ..... Cat. No. .....

Name .....

Address .....

City..... State.....

SEND NO MONEY!

Acceptance Speeches to be Sent by Chains

The acceptance speeches of the Presidential candidates of both the Republican and Democratic parties will be broadcast over nation-wide hook-ups.

Herbert C. Hoover's address will be broadcast from his home in Palo Alto, California, Saturday, Aug. 11, at 4 p. m., Pacific Standard Time. This is 5 o'clock Mountain Standard Time, 6 o'clock Central Standard Time and 7 p. m. Eastern Standard Time. Daylight Saving Time is an hour later in each instance.

Alfred E. Smith will deliver his acceptance speech from the Capitol steps in Albany, N. Y., on Wednesday, Aug. 22, at 7:30 p. m., Eastern Daylight Saving Time.

Thus Mr. Smith will speak eleven days after the Hoover acceptance speech, but half an hour earlier in the day.

According to word from the offices of the National Broadcasting Company the same hook-up will be used for the acceptance speeches of both candidates.

The Columbia Broadcasting chain also is to broadcast both events.

Let Radio World Follow You on Your Vacation

If you are a subscriber and are going away this summer, send us your name and change of address and we will see that the paper reaches you every week.

If you are not already a subscriber, send us one dollar and your name will be placed on our subscription list from now until Labor Day and your address will be changed as often as you desire. Such change should reach subscription office two weeks in advance of date of publication.

Subscription Dept., RADIO WORLD, 145 West 45th Street, New York City

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Please look at the subscription date stamped on your last wrapper, and if that date indicates that your subscription is about to expire, please send remittance to cover your renewal.

In this way you will get your copies without interruption and keep your file complete.

Subscription Dept., RADIO WORLD, 145 West 45th Street, New York City.

Quick Action Classified Ads

Radio World's Speedy Medium for Enterprise and Sales

10 cents a word — 10 words minimum — Cash with Order

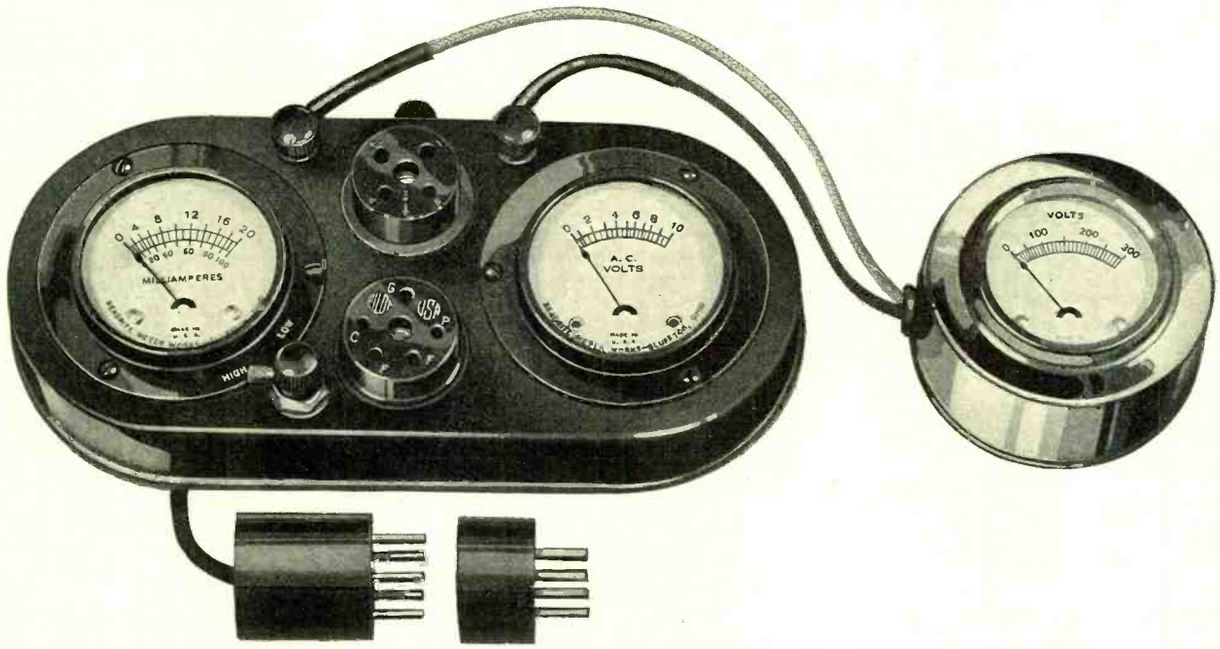
BLUEPRINTS of National Screen Grid Five, 4-tube Screen Grid Diamond and Karas 3-tube Short Wave Set—three blueprints—one dollar. Guaranty Radio Goods Co., 145 W. 45th St., N. Y. C.

KARAS SHORT WAVE SET, three tubes, 13 to 750 meters, described in the March 31, April 7, 14, 21 and 28 issues. Send 60 cents for these five issues and get blueprint free. **RADIO WORLD, 145 W. 45th St., N. Y. City.**

USED MOTORCYCLES. Low terms. Also Parts. Accessories. Catalog Free. Western Motorcycle Co. 947 East 15th St., Kansas City, Mo.
12-5-28

SCREEN GRID TUBES, famous standard manufacturers, no bootleg, $4.50 each. Special three circuit tuner, high primary impedance for screen grid tuned plate, $2.50. Antenna coil for screen grid circuits, adjustable primary, $2.00. Aluminum shield caps fit over entire screen grid tube, $1 each, C.O.D. only.—Philip Cohen, 236 Varet Street, Brooklyn, N. Y.

12 VITAL TESTS
In Only 4½ Minutes!



The Handsome Outfit, Shown One-Half Scale

With this Scientific Trouble Shooting Combination AC and DC Tester (at left) and the high resistance voltmeter (at right) twelve vital tests were made of tubes and receivers, in 4½ minutes, because the combination can be used quickly for the following purposes:

(1) to measure the filament voltage, up to 10 volts, of AC and DC tubes.

(2) to measure the plate current of any one tube, including any power tube, from less than 1 milliampere up to 100 milliamperes;

(3) to measure the total plate current of a receiver or amplifier, up to 100 milliamperes. (Hardly any set draws more). Open common A and B of set and connect to P of tester socket and to P prong under adapter plug;

(4) to measure the B voltage applied to the plate of tube; the voltage across B batteries or B eliminators, up to 300 volts.

(5) To determine the condition of a tube, by use of the grid bias switch.

(6) To measure any tube's electronic emission (tester cuts in at no load, hence plate current equals filament emission).

(7) To regulate AC line, with the aid of a power rheostat, using a 27 tube as guide, turning rheostat until filament voltage is 2.5 or 2.25 volts.

(8) To test continuity of resistors, windings of chokes, transformers and circuits generally.

(9) To find shorts in bypass and other condensers, as well as in inductances, resistors and circuits generally.

(10) To read grid bias voltages, including those obtained through drops in resistors (bias read by noting plate current and voltage and consulting chart).

(11) to determine the presence of distortion and overloading, by noting if milliammeter needle fluctuates.

(12) to determine starting and stopping of oscillation, as milliammeter needle reads higher current for oscillation and lower for no oscillation.

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

Please send me at once, on a five-day money-back guaranty, one complete Two-in-One (AC and DC) scientific trouble-shooting test set, consisting of one No. 215 and one No 346, for which I will pay the postman $13.50, plus a few cents extra for postage.

☐ If 0-500 v. high resistance voltmeter No. 347 is preferred, put cross in square and pay $14.50, plus postage, instead of $13.50, plus postage.

☐ One No. 215 alone, $10.00.
☐ One No. 346 alone, $4.50.
☐ One No. 347 alone, $5.50.
☐ Two adapters for UV-199 tubes, $1.00.

NAME .....

ADDRESS .....

CITY..... STATE.....

Service Men, Custom Set Builders, Home Constructors, Experimenters, Teachers, Students, Laboratories

Order one of these combination 215 AC-DC testers and 346 meter 0-300 volts. Send no money. Just fill out coupon. If after five-day test you're not delighted, return and purchase price will be promptly refunded! Here's what you get for only $13.50.

(1) One newly-designed Two-in-One 0 to 10 voltmeter for AC and DC. Same meter reads both. Scale especially legible at 1½ to 7½ volts. This meter reads the AC and DC filament voltages.

(2) One DOUBLE reading DC milliammeter, 0 to 20 and 0 to 100 milliamperes, with changeover switch. This reads plate current, which is always DC in all sets.

(3) One 0-300 volts high resistance voltmeter, No. 346, with tipped 30" cord to measure B voltages.

(4) One 5-prong plug with 30-inch cord for AC detector tubes, etc., and one 4-prong adapter for other tubes.
(5) One grid switch to change bias.
(6) One 5-prong socket.
(7) One 4-prong socket.
(8) Two binding posts.
(9) One handsome noire metal case.
(10) One instruction sheet.

$13.50
SEND NO MONEY

[If 0-500 voltmeter No. 347 is desired instead of No. 346, price of combination is $14.50.]

No. 215 Universal AC-DC Tester Alone.....$10.00
No. 346 high resistance 0-300 voltmeter alone..... $4.50
No. 347 high resistance 0-500 voltmeter alone..... $5.50

Flechtheim Power Block

The latest addition to the line of by-pass, high-voltage and filter condensers of the A. M. Flechtheim Company of 136 Liberty Street, New York City, is a new condenser block designed for use with the new —50 type power tube. This condenser pack is designated in the line as the type DX-250.

EVERY FRIDAY at 5.40 P. M. (Eastern Daylight Time) Herman Bernard, managing editor of **Radio World**, broadcasts from WGBS, the Gimbel Bros. station in New York, discussing radio topics, mostly television.

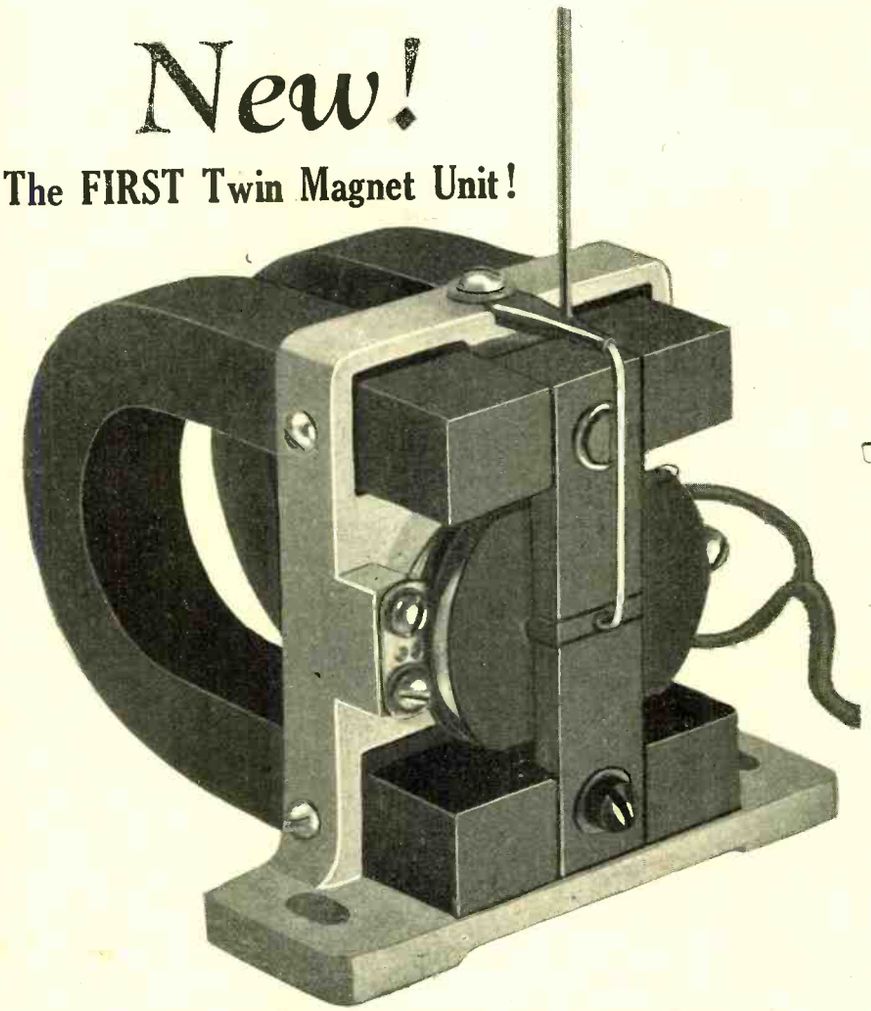
POLO

DUO-MAGNETIC UNIT

TWIN MAGNETS
DOUBLE SENSITIVITY

New!

The FIRST Twin Magnet Unit!



Polo Duo-Magnetic Unit, shown actual size. Weight three full pounds. Supplied complete with five-foot cord, apex, chuck, nut and moulded metal mounting bracket (Senior model) **$10.00**

No Filtering at 180 Volts!

THE magnet coil of the unit consists of two separate windings, connected in parallel, so that the current divides between them. This enables you to put TWICE AS MUCH current through the coil without danger of harming it!

Use 180 volts on a —71A or —10 tube, with proper negative grid bias, and you do not need an output filter, the usual list price of which is around $10.00. The coil of the unit safely carries 25 milliamperes!

Enormous Volume, No Rattling!

THE volume obtainable from a set depends to a large extent on the efficiency of the unit. The Polo Duo-Magnetic Unit is incredibly loud—enormously loud—yet without rattling! The SENSITIVITY IS DOUBLED by the use of two magnets —the first time two have been used in a commercial unit. The magnets are genuine, efficient, costly chrome steel, and there are no holes in them. Holes weaken a magnet and shorten its life.

POLO ENGINEERING LABORATORIES

57 Dey Street (Suite 6), Corner Greenwich Street Tel. CORtland 5112 **New York, N. Y.**

ASTOUNDING

Performance—And Why!

THE new and startling Polo Duo-Magnetic Unit is of the balanced armature type, needing no adjustment and no servicing. It is exceptionally efficient, long-lived and mechanically rugged. Here is a summary of its superiority:

(1) Twin magnets double sensitivity.

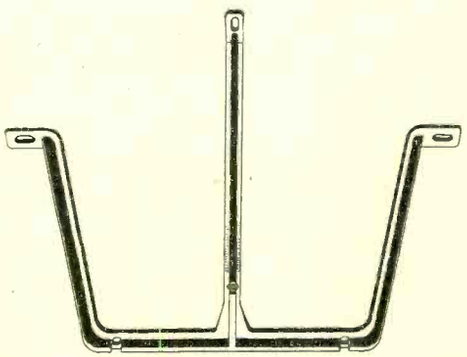
(2) Magnets are of chrome steel.

(3) Magnet coil consists of two windings in parallel, doubling the flux and the current handling capacity.

(4) Volume is extraordinary, and without rattling, due to twin-magnets, great flux density, short air gaps, balanced silicon steel armature and single-piece coupling rod and pin. The pin WON'T BREAK OFF!

(5) Die cast aluminum frame fits assembly to 1/1000 of an inch, enhancing rigidity.

(6) Large, solid machined pole pieces.



Moulded bracket FREE with each unit order; also cord, apex, chuck and nut.

Every unit undergoes seventeen careful tests and is guaranteed against all mechanical or electrical imperfections. This unit needs no after-servicing, but will last indefinitely. It works superbly any cone, cloth, Balsa or skin speaker and is one of the most remarkable units ever produced. Make Polo your choice and you'll rejoice!

POLO ENGINEERING LABORATORIES,
57 Dey St. (Suite 6), corner Greenwich St., New York, N. Y.

Enclosed please find ten dollars for which send me one Polo Duo-Magnetic Unit, with five-foot cord, moulded metal bracket, apex, chuck and nut. YOU ARE TO PAY SHIPPING CHARGES. If after a 10-day trial I return the unit YOU WILL QUICKLY REFUND THE TEN DOLLARS.

NAME .....

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[Note: Shipments Begin on August 25. Orders Filled in Sequence of Their Receipt]