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PUSH-PULL TUBES IN ONE ENVELOPE

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ONE-TUBE SUPER-REGENERATOR

25Z5 TUBE IN COMPACT UNIVERSAL

CURES FOR SQUEALS IN SUPERHETERODYNES

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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

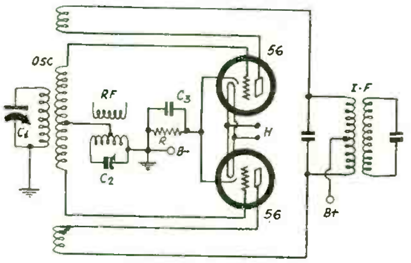


FIG. 1

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.

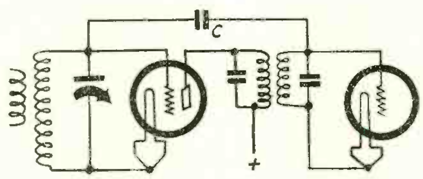
Detuning by a sufficient amount without losing the signal is more favorable the higher the intermediate frequency, because the amount of detuning needed is a matter of a definite number of cycles whereas the loss of signal is a matter of frequency ratio. Thus 5,000 cycles is smaller compared with 400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

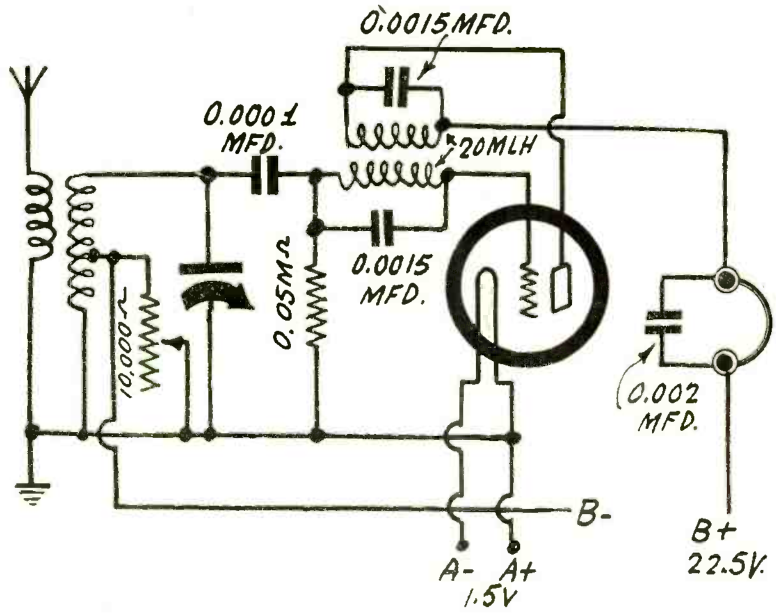
A Simple, One-Tube Short-Wave SUPER-REGENERATOR

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, 1/8 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, 1/8 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 1/8 inch; last coil, three turns of No. 18 enamel wire, center-tapped, with primary of 1.25 turns wound adjacent, separation 1/8 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:

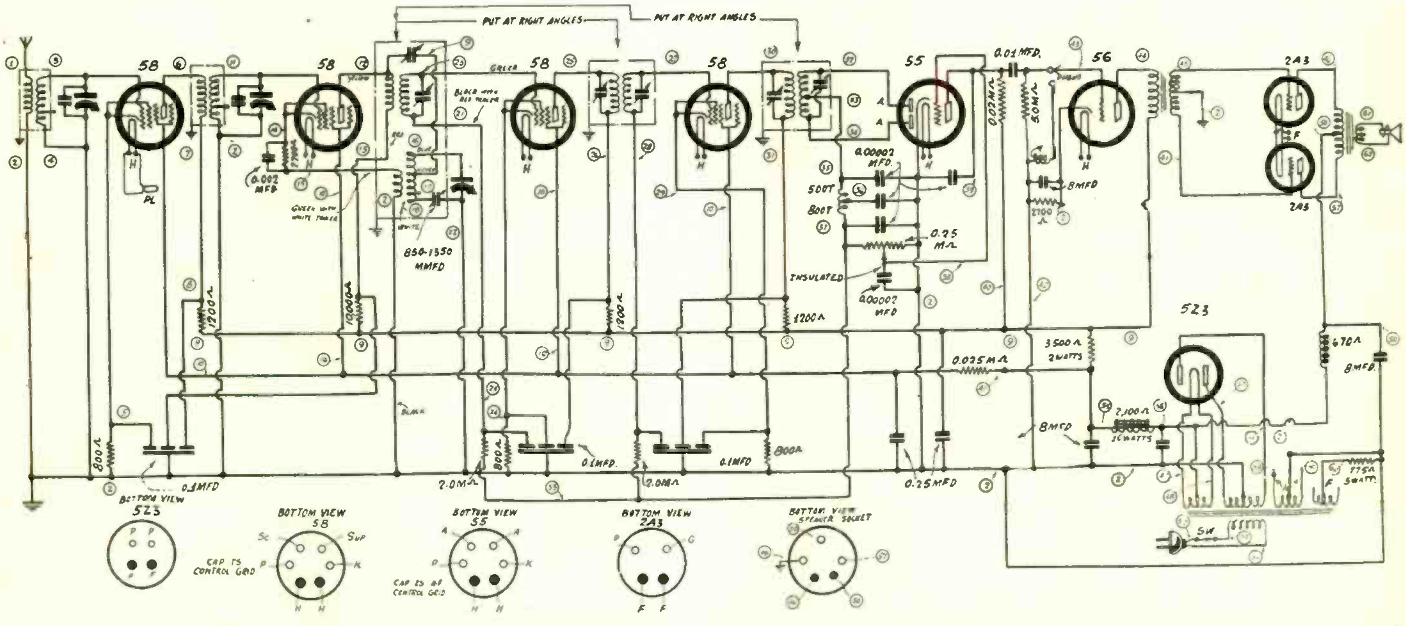
The load on the driver tube or tubes is chosen higher than for undistorted power rating to hold overall distortion to a minimum. For a single triode driver, its minimum plate load should be approximately 2 to 4 ties the plate resistance of the driver tube. For a push-pull triode driver stage, its minimum 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).

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

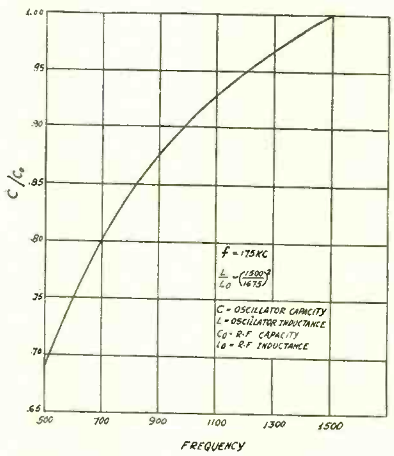
Formula for Oscillator Inductance—True Capacity Curve

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 oscillator 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

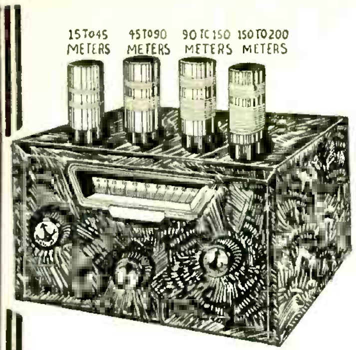
(Continued from preceding page)

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.

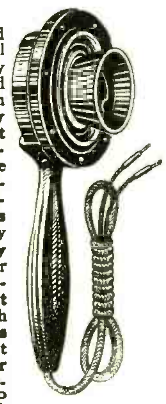
The highest efficiency was the aim in designing the set, therefore plug-in coils were used, and these are specially wound to insure adequate overlap of wavelengths between coils for succeeding bands, and to provide highest sensitivity. One coil is used for each of the four bands.

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.

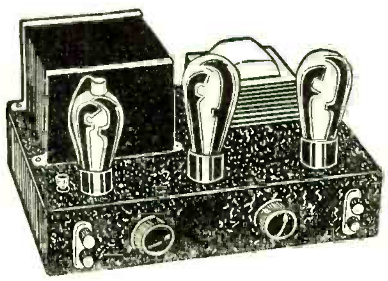
The ECONOMICAL Short-Wave A-C Receiver is a brand-new, specially-made product, now offered to the public for the first time, and bringing within the reach of all a dependable short-wave outfit that has an easy-tuning full-vision dial, with knob below; a sensitivity control and a switch. The receiver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

KELLOGG MICROPHONE



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



MICROPHONE FLOOR STAND

Here is a chrome-plated microphone floor stand, of rigid construction, that will neither sway nor vibrate. The top ring is 6½ inches in diameter. The height can be adjusted from 40 to 70 inches. The clamp lock is engaged by a simple but tightly-gripping thumb screw. 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**

THERE is money to be made in renting or selling power amplifiers, as churches, academies, auditoriums, clubs, societies, stores, rinks and the like are constantly using and buying such equipment. Moreover, as the user's business grows, larger-sized power amplifiers are required, and you grow with your customers. Therefore it is profitable to get organizations and businesses started in the use of power amplifiers, and they will be surprised at the very low cost at which you can sell and install them.

In the design and construction of these public address systems a liberal safety factor has been allowed. They may be used with single or twin speakers.

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**

BOSCH CABINET

An elegantly-finished cabinet to house either a dynamic or a magnetic speaker of 8-inch diameter cone. This is an excellent cabinet into which to put a spare speaker. Order CAT. TM-BCAB at **$2.25**

RESISTORS

WE have a wide assortment of the finest types of commercial pigtail resistors made. These are manufactured for us in quantity and are sold at prices far below those prevailing elsewhere. Each resistor is guaranteed to be in excellent condition, and is of the type that does not change in resistance value appreciably with temperature. The rating is 1 watt except where otherwise specified.

	Color Code		
	Body	End	Dot
175 ohms	Brown	Violet	Brown
350 ohms	Orange	Green	Brown
800 ohms	Gray	Black	Brown
1,200 ohms	Brown	Red	Red
3,500 ohms	Orange	Green	Red
10,000 ohms	Brown	Black	Orange
20,000 ohms	Red	Black	Orange

	Color Code		
	Body	End	Dot
50,000 ohms	Green	Black	Orange
60,000 ohms	Blue	Black	Orange
100,000 ohms	Brown	Black	Yellow
250,000 ohms	Red	Green	Yellow
500,000 ohms	Green	Black	Yellow
2,000,000 ohms	Red	Black	Green
5,000,000 ohms	Green	Black	Green

ANY FOUR OF ABOVE RESISTORS, 30c

3,500 ohms, 2 watts, for reducing the maximum B voltage to about 180 volts for r-f tubes. Price, 11c.

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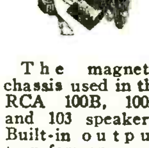
NEW YORK, N. Y.

SPECIALS



The magnetic chassis used in the RCA 100B, 100A and 103 speakers. Built-in output transformer permits use of up to 400 volts. Corrugated cone, 9 inches diameter. Large permanent magnets. CAT. TM-RCA **$3.75**

For the construction of short-wave plug-in coils, Isolantite forms permit of high efficiency, due to minimized losses. These forms have UX (four-pin) bases and strongly - embedded prongs. CAT. TM-ICF (each)........**39c**

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.

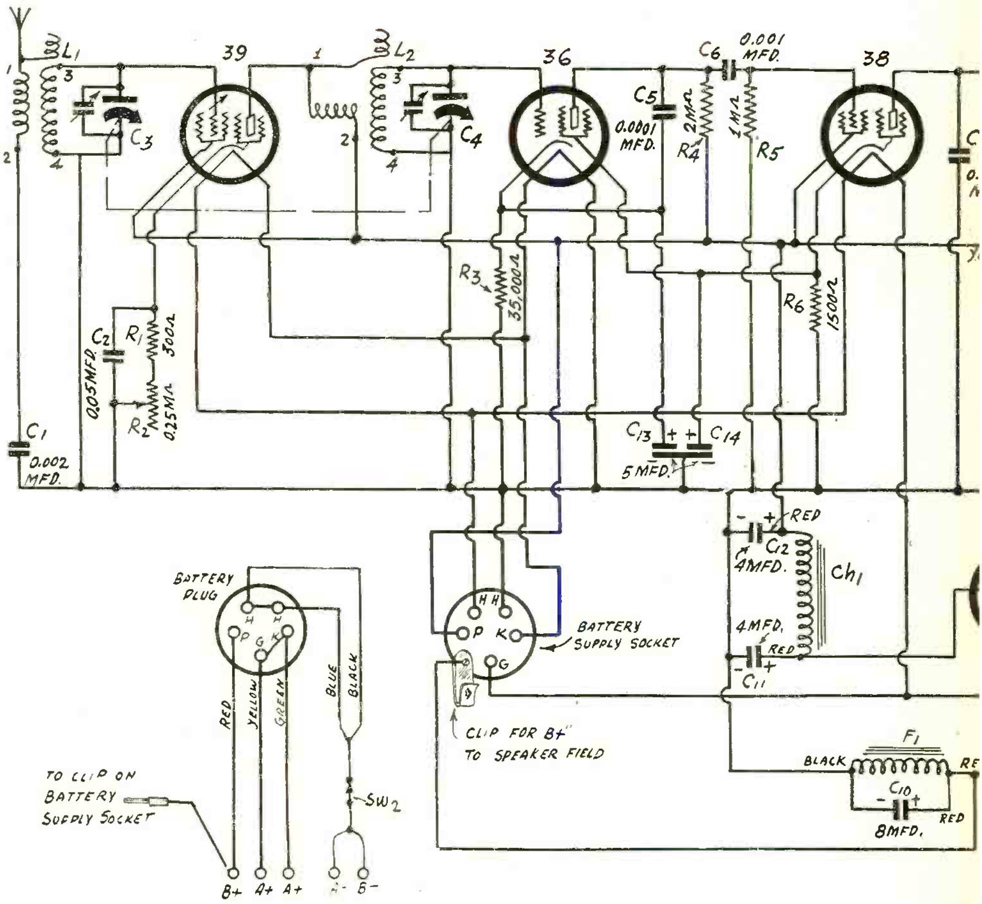
Across the speaker field is an 8 mfd. condenser C10. This condenser helps to smooth out the field current. Associated with the filter choke Ch1 are two 4 mfd. electrolytic condensers, one on the cathode side and the other on the plate side. Note that in each place where an electrolytic condenser is used 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.



FI

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

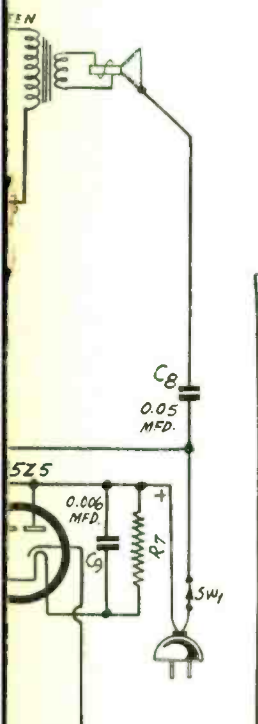
BE UNIVERSAL SET

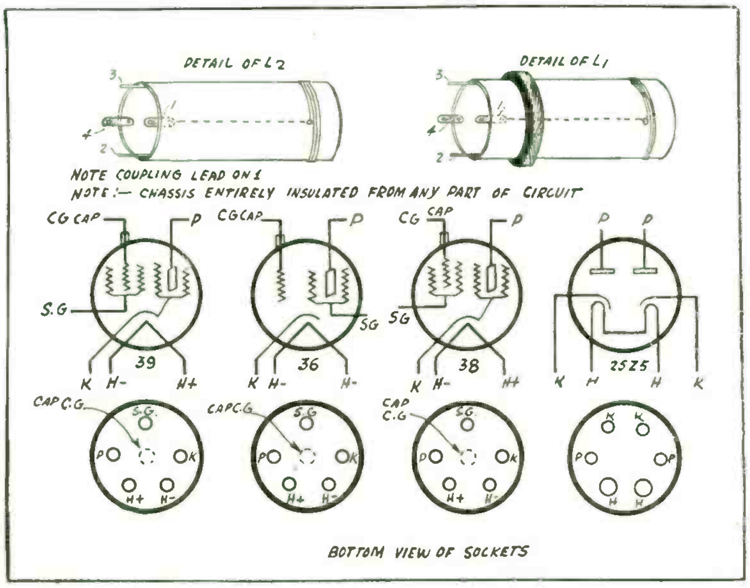
it—Dynamic Speaker Used—Set Can

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 by-passed 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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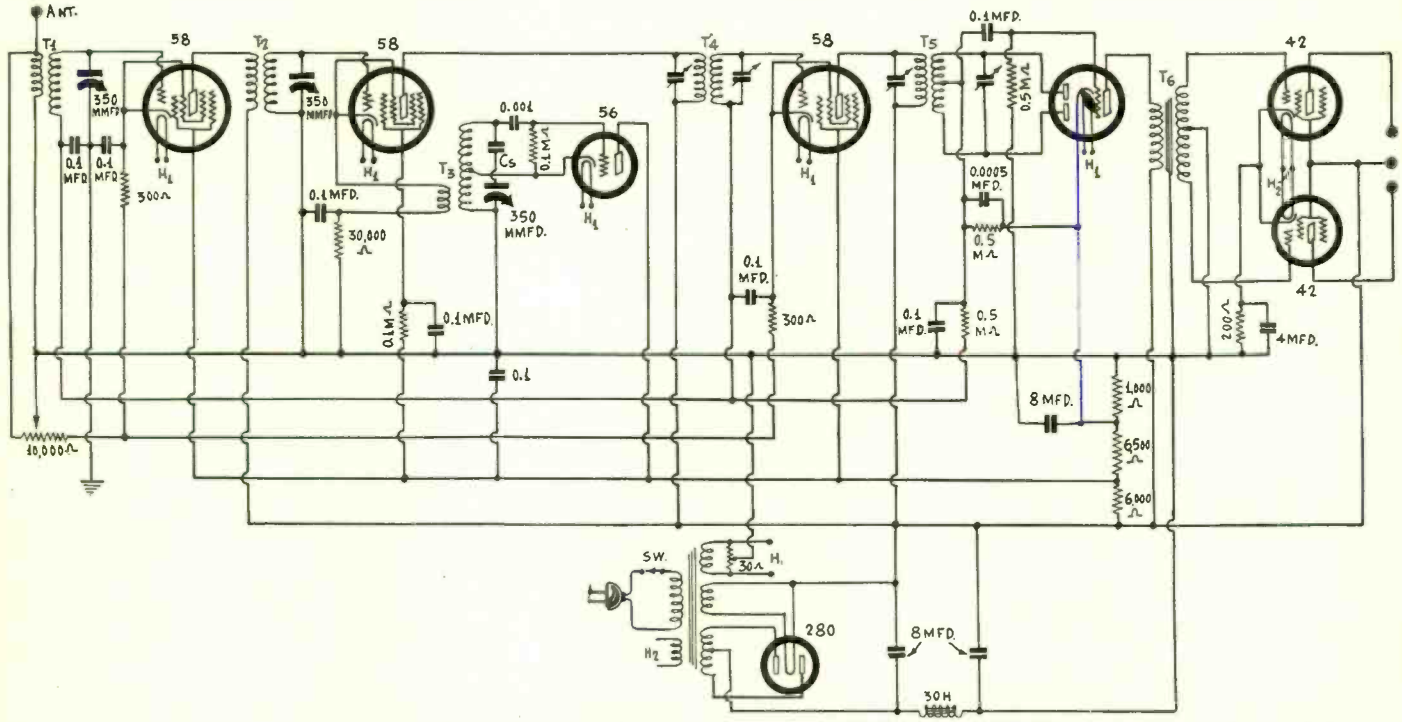
ground, and of course the bypass condenser would remain across the resistor only, that is, would not be directly grounded otherwise the pickup coil would be shorted. The fourth parallel line from left should have a dot (soldered connection) where it joins the horizontal line from the potentiometer arm.

* * *

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

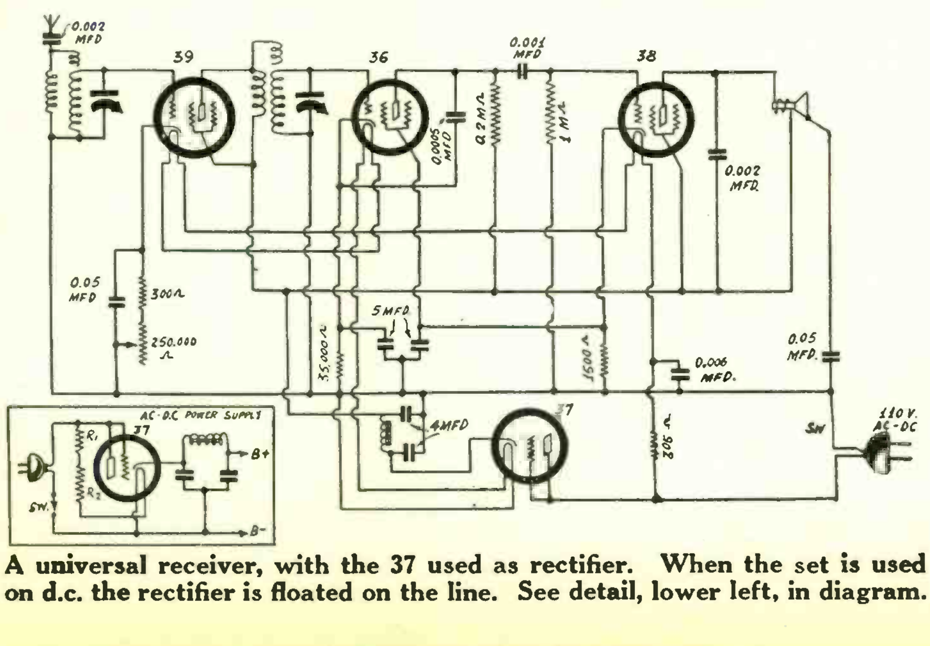


Automatic volume control is applied to the radio frequency and intermediate frequency amplifier tubes, while two 42's in push-pull are used in the output.

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



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.

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

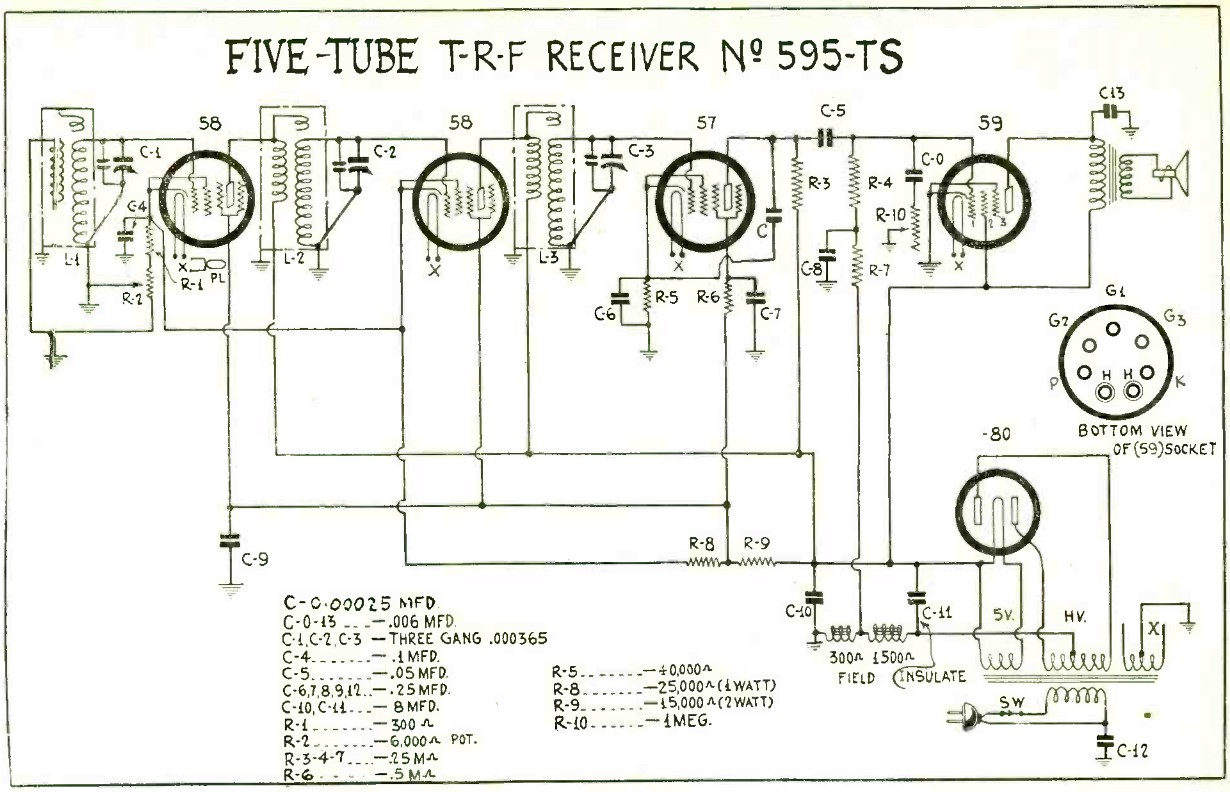
CAN YOU RECOMMEND a good five-tube a-c circuit, using 58, 57 and 59 tubes in the receiver, with 280 as rectifier? I desire a circuit that has been thoroughly tried and tested.—T. F. E., Casco Bay, Me.

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.

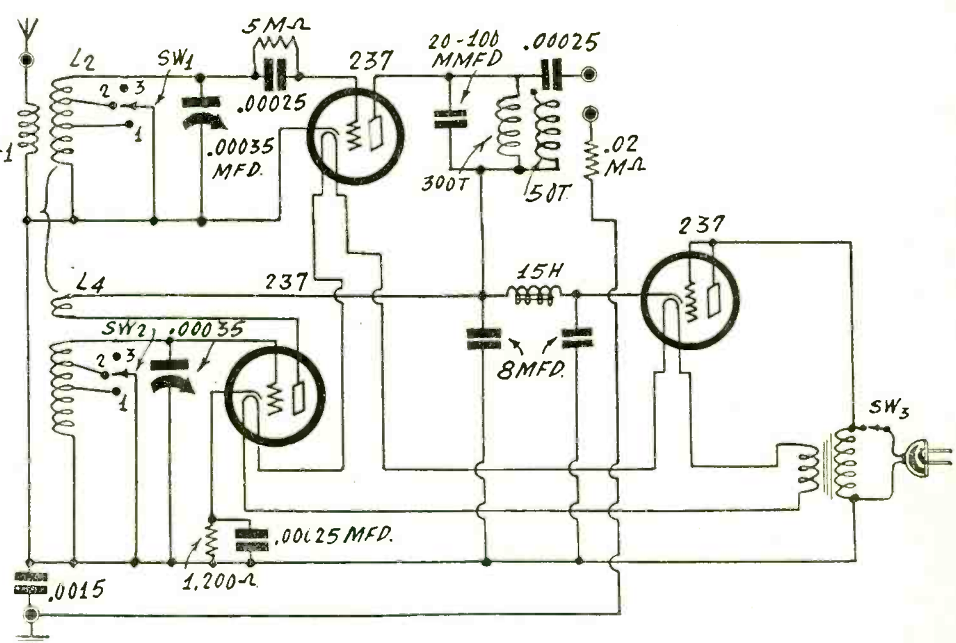
Yes, that is a practical objective and you should have considerable enjoyment experimenting with it.

* * *

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 1/8 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 1/8 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

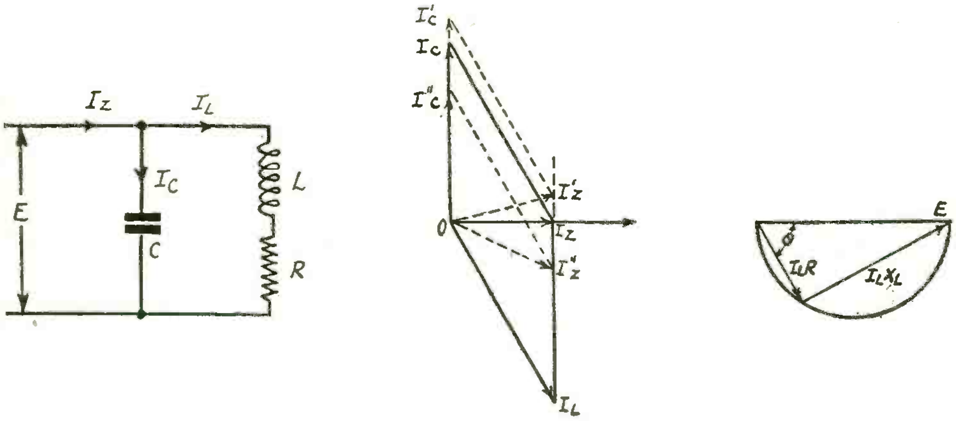


FIG. 1

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 significant 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—5¼ 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	Ist 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.*

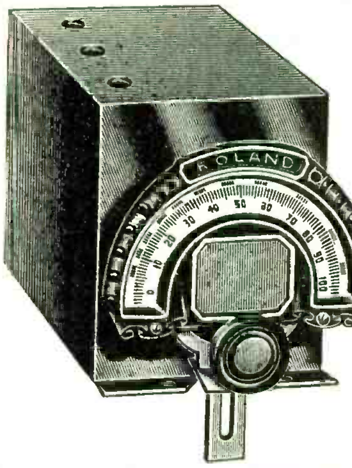
Keith Kinney, 113 So. Missouri Ave., Roswell, New Mex.
Acme Radio Service, 114 Virginia Ave., Indianapolis, Ind.
Howard Electric Shop, Luther Howard, Bloomingdale, Mich.
M. Martin, Box 14, Panhandle, Texas
Philip De Marko, 121 Erickson St., Syracuse, N. Y.
Eugene Gossi, 2148 Marshall Blvd., Chicago, 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.

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

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

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

BLUEPRINTS

627. Five-tube tuned radio frequency, A-C operated; covers 200 to 550 meters (broadcast band), with optional additional coverage from 80 to 204 meters, for police calls, television, airplane, amateurs, etc. Variable mu and pentode tubes. Order BP-627 @ ....25¢

RADIO WORLD
145 WEST 45TH ST., NEW YORK, N. Y.

Quick-Action Classified Advertisements

7c a Word—$1.00 Minimum
Cash With Order

SHORT WAVE D.C. radio, 12 to 550 meters; cost $50; for sale, $25, or exchanged for standard keyboard portable typewriter. Phone RHinelander 4-0624.

FULL-SCALE PICTURE DIAGRAM OF TWO-TUBE 15-200-METER BATTERY RECEIVER— Printed in Radio World dated April 2, 1932. This is the diagram asked for by so many readers who were interested in the short-wave receiver described in issue of Feb. 27, 1932. Both copies mailed for 30c. RADIO WORLD, 145 W. 45th St., New York City.

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

"TALKING MOVIES," by James R. Cameron. A History of the Talking Movie since 1899, with an elementary explanation as to how the pictures are produced and reproduced. Paper cover, $1.50. Radio World, 145 W. 45th St., New York, N. Y.

The Set That Brought In 96 Channels Out of 96!

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

FOUNDATION UNIT

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

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

Complete parts, Push-Pull 9-tube Diamond, speaker; less tubes, front panel and cabinet $23.41

ADDITIONAL PARTS

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

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

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

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

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

SUPER DIAMOND 6

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

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

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

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

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

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

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

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

AUTHENTIC CIRCUITS

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

DIRECT RADIO COMPANY
143 WEST 45TH STREET NEW YORK CITY

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Get, EXTRA, one-year subscription for any One of these magazines:

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8 MFD. CONDENSER

Four for Only $1.47

We are able to offer brand-new 8 mfd. wet electrolytic condensers, with insulating washers, mounting nut and lugs at four for $1.47. These condensers are freshly made for us in quantity by Polymet Manufacturing Co. and are highly recommended by us for assurance of full capacity and for their ruggedness. They are of the inverted mounting type. Single condenser, lugs, washers, nuts. Cat. Poly-8 @......49c **Four for the price of three, i.e., $1.47**

DIRECT RADIO CO.

143 West 45th St. New York City

DIAMOND PARTS

Tuned Radio Frequency Sets

FIVE-TUBE MODEL

A-C operated circuit, 50-60 cycles, 105-120 volts using two 58 t-r-f stages, 57 power detector and 47 output, with '80 rectifier. Three gang shielded condenser and shielded coils in a sensitive, selective and pure-tone circuit. Dynamic speaker field coil used as B supply choke. Complete kit of parts, including 8" Rola speaker and all else (except tubes and cabinet). Cat. D5CK @............$15.09

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.

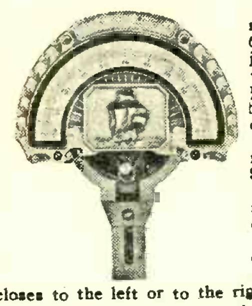
FOUR-TUBE MODEL

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 13¼ 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 $5.48

INDIVIDUAL PARTS



Travelling light vernier dial, full-vision 6-to-1 vernier, projected indication prevents parallax; takes ¼" or ⅜" shaft; dial bracket, lamp, escutcheon.

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.]

8 mfd. Polymet electrolytic, insulating washers, extra lug. Cat. POLY-8 @..................$0.49

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

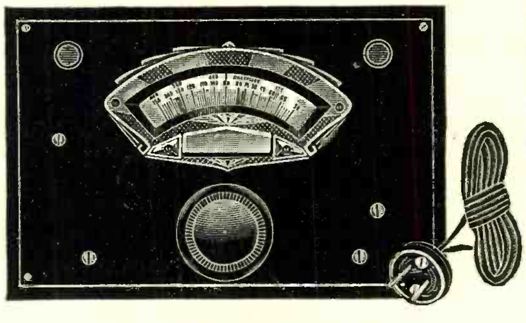
2 coils for 4-tube. Cat. DP @.................... .90

3 coils for 5-tube. Cat. DT @.................... 1.35

DIRECT RADIO CO.

143 WEST 45th STREET
NEW YORK, N. Y.

All-Frequency Service from a Test Oscillator



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

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

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

Average Accuracy 1% or Better

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

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

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

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

Get One of These Test Oscillators *Free!*

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

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

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

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

The main scale of the frequency-calibrated dial reads from 50 to 150. The bars are 1 kc apart from 50 to 80 kc and 2 kc apart from 80 to 150 kc. Thus for broadcast work, using the 10th harmonic, the separation as registered by the bars is 10 kc from 500 to 800 kc and 20 kc from 800 to 1,500 kc. On an upper tier the intermediate frequencies are printed: 175, 260, 400 and 450 kc, with a bar to the left of 175, representing 177.5, and a bar to the right of 175, representing 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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PADDING CONDENSERS

Either capacity, 50c

A HIGH-CLASS padding condenser is required for a superheterodyne's oscillator, one that will hold its capacity setting and will not introduce losses in the circuit, for losses create frequency instability. The Hammarlund padding condensers are of single-condenser construction on Isolantite base, with set-screw easily accessible, and non-stripping thread. For 175 kc. intermediate frequency use the 750-1250 mmfd. model. For i.-f. from 460 to 365 kc., use the 350-450 mmfd.

0.0005 HAMMARLUND S. F. L. at 98c.

A sturdy, precision straight frequency line condenser, no end stops. The removable shaft protrudes front and rear and permits ganging with coupling device, also use of clockwise or anti-clockwise dials, or two either side of drum dial. Front panel and chassis-top mounting facilities. True straight line. This rugged condenser has Hammarlund's high quality workmanship and is suitable for precision work. It is a most excellent condenser for calibrated radio frequency test oscillators, any frequency region, 100 to 60,000 kc., short-wave converters and adapters and TRF or Superheterodyne broadcast receivers. Lowest loss construction, rigidity; Hammarlund's perfection throughout.

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