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RADIO WORLD

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The First and Only National Radio Weekly

Twelfth Year *594th Consecutive Issue*

INDUSTRY'S RECOVERY CODE

(See Page 15)

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RESISTANCE PUSH-PULL

Theoretical Considerations and Some Practical Applications

By Herman Bernard

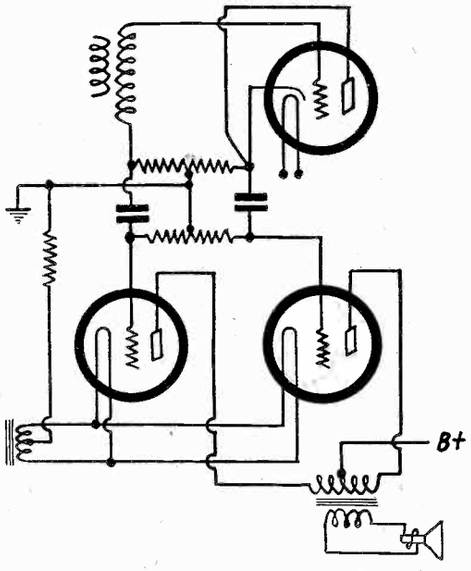


FIG. 1

The 56 is shown, used as a diode. There is no B voltage applied. The secondary of the symbolic transformer connects to cathode through the load resistor. Since this secondary end is not grounded, the system in general may be used for supers rather than for t-r-f sets. The voltage center of the diode load resistor is grounded.

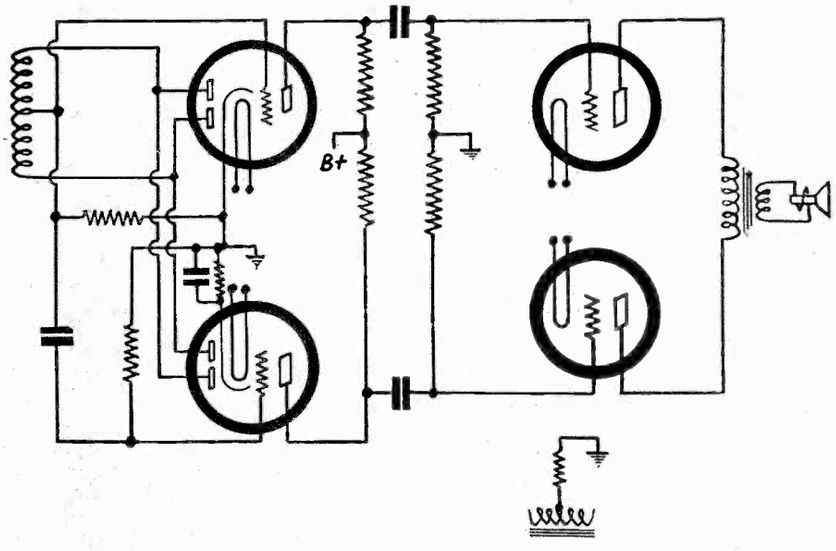


FIG. 2

Here a different method is pursued. Two 55's are shown feeding two triodes. The biasing resistor for the triodes connects from center of the filament secondary, to B minus. The two diodes of the 55's are paralleled in full-wave rectification. In the upper leg the triode unit of the tube is coupled from the diode by the direct method. So increasing signal intensity increases the bias. In the lower leg there are stopping condenser and grid leak, so increasing signal intensity decreases the bias. The voltages in the plate loads are opposite but not equal. But they may be equalized.

THE subject of push-pull resistance-coupled audio-frequency amplification has come to the fore again, due to the recommendation that the 53 tube be used, since there are two tubes in one envelope, and the chassis does not become cluttered up with tubes to support the audio channel.

There is no commercial receiver that uses push-pull resistance coupling, which is a sort of warning, and, moreover, the achievement of good balance is necessary, otherwise the push-pull circuit is not quite so good as the single-sided circuit, because not truly push-pull.

Several attempts to get satisfactory results from push-pull resistance coupling have been made, with incomplete success. Always an easier and steadier result could be attained by including the transformer. More recently better success has been encountered, and while the theoretical considerations have been put forth lately with some gusto, absence of assignment of values of constants always leads to the supposition the circuit has not been built and tested. In any circuit including anything except zero frequency current (d.c.) the experimental results are the things of importance. One can accurately predict d-c results but not a-c results. Nature intervenes with unexpected contributions.

It is highly advisable that those experimentally inclined take up the work of reducing push-pull resistance coupling to practice, and in line with that idea some fundamentals are presented herewith.

In Fig. 1 is a circuit that represents the

(*Continued on next page*)

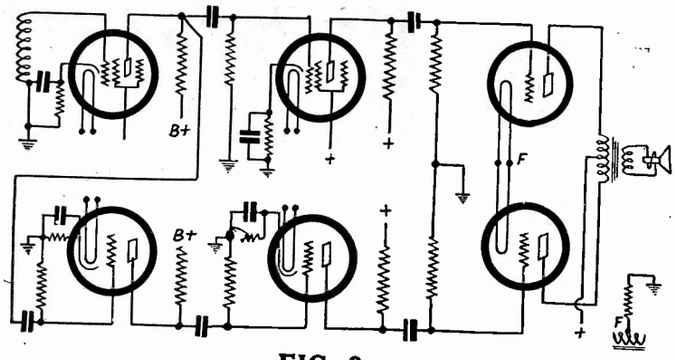


FIG. 3

Phase-shifting is exemplified in this diagram. Assuming that the upper left-hand tube is the detector, there follow on that plane two resistance-coupled stages of audio. However, a companion audio channel of three stages may be used, and then the output will be 180 degrees out of phase as between the two tubes.

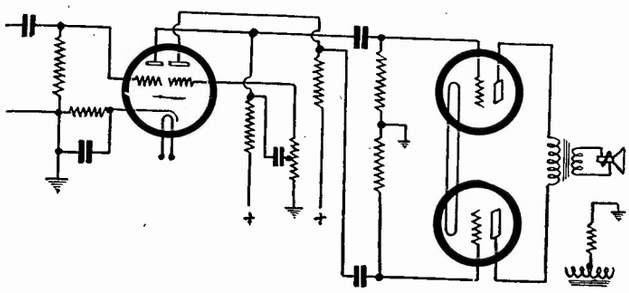


FIG. 4

The 53 tube is used as a phase-inverter. An audio input to the 53 is assumed. The grid and plate to left in the 53 symbol is the first audio amplifier, the output of which is fed to the upper power tube as well as, in part, to the phase-inverting section, or right-hand grid and plate in symbol.

(Continued from preceding page)

attainment of push-pull by utilizing a diode detector feeding a push-pull stage. Obviously the detector output will not load up the power tube stage, but the idea remains unchallenged that the push-pull effect is introduced.

The tube may be a 56, with plate tied to cathode, the combined result used as the rectifier's cathode, while the element ordinarily serving as the grid would be the anode. The heater voltage is applied as usual, and the winding may be center-tapped, if a.c. is used for heating. There is no B voltage.

It is essential to prevent some loss of signal that the load resistance be grounded. Fortunately, it is practical to ground the center of this resistance.

Let us consider the signal input between anode and cathode. The tube will rectify only when the anode is made positive by radio frequency.

A seeming contradiction will arise at once. The anode is positive. From anode (grid) through the secondary coil we come to one extreme of the load resistor, and this point is negative. First it is positive, at one instant, and next, but at the same time, it is negative, so which is it?

The Two Factors

We have to consider two factors. One is the effect of the r-f signal. This drives the anode positive and negative, but rectification takes place only during the positive cycle. The moment that direct current flows, due to rectification, as it can flow in only one direction, away from the cathode, as to audio frequencies or pulsating direct current here concerned, the right-hand side of the load resistor is positive, the left-hand negative, and most of the total voltage drop takes place in the load resistor. This serves two purposes, helping to attain linearity of detection and also increasing the voltage available for transfer, that is, improving the quantity of utilizable output from the detector.

If we simply regard the current through the load resistor as direct current, then, with cathode positive, center tap of the resistor would be one-half of the extreme negative value on the load, and the left-hand end would be the full negative value. If the d.c. is pulsating, then if the center is taken as the datum, the voltage betwen grounded center and either extreme would be the same at any instant, but would be oppositely polarized. It is direct current pulsating at the frequency of the modulation. There is really no true a.c. in the load resistor, except radio frequency. It is not necessary, however, to insert a condenser or filter system to remove this, because the load resistor is so high any filter would seriously attenuate the higher audio frequencies, and the capacity inherently across the resistor, due to the wiring, tube, etc., is usually quite enough.

The grounded center of the resistor may be regarded as an operating point, with half the pulsation above it and half below, to present something like a parallel to the usually graphic representation of a sine wave of alternating current.

The stopping condensers at the extremes of the load resistance therefore are charged simultaneously in alternate polarities of equal magnitudes, the familiar push-pull condition of "equal but opposite voltages." They discharge through the grid leaks. These condensers serve a conversion function, in that their discharge is oscillatory, hence there is a.c. in the grid circuits, whereas there was no true a. c. in the anode-cathode circuit, except r.f.

The bias is applied to the output tubes in the usual way, the resistor at left being the one for self-bias. There is nothing theoretically the matter with this circuit, balance may be struck without much difficulty, as the point so far discussed as the midpoint need not necessarily be the mid-resistance point but rather the mid-voltage point between the extremes. Thus a very sensitive a-c voltmeter could be used, with a steady modulation input, and the adjustment made until the voltage drop across one section was equal to that across the other.

The stopping condensers then should be equal, and the grid leaks likewise, if the output tubes are statically balanced, the condition meant when "matched tubes" are mentioned. The dynamic balance is the one that results in equal signal voltage across either leg of a load or tank. The static balance is the existence of the same operating point for both push-pull tubes at no signal, when the d-c voltages applied are the same, as they will be.

If the tubes are not matched, a good approximation is to increase the plate resistance of the tube that requires such treatment, by extra biasing of that tube to a negative value exceeding that of the other, but most of the d-c plate current still should flow through the common biasing resistor. A condenser would be required across the extra biasing resistor, none across the common one.

Another Method

This circuit, or one like it, the author tried some years ago, but there was not enough output from the detector to get real speaker response from the push-pull tubes (nor was it expected there would be), and when pentode output tubes came along, the attempt was not repeated, because push-pull resistance coupling has the sole advantage of quality, and the pentodes would not be consistent.

Even if a driver stage were interposed, the volume of sound would not be enough in the output, without a pentode.

Only the other day the author tried another push-pull resistance-coupling scheme, as in Fig. 2. Regarding the upper part of the circuit, it may be considered as single-sided audio after a diode detector, with the triode of the diode as first audio amplifier or driver, and the next tube as the output (45). We have shown that the cathode is positive to audio frequencies, therefore with grid of amplifier tied to left-hand extreme of the load resistor the bias on the tube is negative by the amount of the rectified voltage. That is, the bias is approximately equal to the signal voltage. The stronger the signal, the more negative the grid.

Some Unbalance

If we put a stopping condenser at this high potential end of the load resistor and feed the signal to a succeeding tube, which may be the triode of the same sort of tube as above, the signal will drive the grid positive. That is due to the operating point. There is a negative bias on the lower triode section of the duo-diode-triode tube, and the signal will drive the grid positive because the positive region, in respect to the operating point, is the large one. Cutoff soon is reached at the negative side, therefore there is much more positive than negative contribution, hence an effective positive result.

In the diode-biased example we drove the grid negative with the signal, now we drive the grid of a companion tube positive with the signal, both at the same instant. Again we have equal but opposite voltages, hence push-pull, although with some unbalance.

It will be noted that in general there seems no great need to worry about dynamic balance in Figs. 1 and 2, because the dynamic and static conditions are the same, and we do not have to equalize equality.

This would seem to be true all right of Fig. 1 when granting equalities of the push-pull tubes, the output transformer sections and the halves intended of the voltage load load resistor of the diode. But in Fig. 2 we can not agree that balance has been struck. In fact, we built the circuit and measured it dynamically and know that balance is absent. The reason is clear enough.

Reason for Unbalance

Consider the duo-diode-triode in the upper half of the diagram, a 55. Taking the standard reference point, the cathode, we find that the plate voltage is the potential difference between cathode and the supply, say, 250 volts. This does not change under any conditions due to the operation of this tube. The bias does vary, going negative as the input is increased, and may run from 0 to 20 or 30 volts. Since the bias does change, this is equivalent to a change in plate voltage supply and there is no limit to the operating point within the specified 30 volts.

Take the companion tube below. This has a self-bias, but the bias also decreases with the signal, because with greater intensities more current flows through the biasing resistor, but the change is not as great, because made from the operating point, instead of (as in the tube above), nor is the plate voltage supply constant, because the decrease in bias simply apportions the supply voltage differently, increasing the plate voltage as much as it increases the grid bias.

The change is not quite the same in quantity, for in the upper leg the total voltage is 250 x X, while below it is 250 volts.

Dissimilar Voltages

The voltages developed by the signal across the outputs of the 55 tubes were dissimilar, the diode-biased method giving 100 per cent. as against the cathode-biased methods 88 per cent. Equalization may be introduced by putting two resistors in series, in the plate circuit of the upper 55, whereby their total resistance is equal to that of the resistor in the lower 55's plate circuit, and the joint is, in voltage or resistance, 12 per cent. down from the plate. If the resistor in the lower leg is 50,000 ohms, then the two in the upper leg may be 6,000 ohms and 44,000 ohms, respectively. The stopping condenser would be connected to the juncture of the two series resistors, and the smaller resistor would be nearer the plate.

Correction for unbalance in one stage may not necessarily result in balance in a subsequent stage. The voltage may be read on an a-c voltmeter, of proper type, and the necessary adjustment made in each stage.

Use as Current Indicator

A high resistance a-c voltmeter is not common, and exists principally in the rectifier type. If the test is made with a 60-cycle modulated radio frequency put into the tuner, the audio frequency after rectification is low enough to serve for both static and dynamic balance. If the meter is to be used as a grid circuit voltmeter, it would have to be at its high-voltage range, so the current will be small, but the voltage will be low, and an accurate determination becomes difficult as a mechanical or visual act.

However, the a-c meter may be used as a current meter, in series with the grid load, provided the approximate voltage is first ascertained in the usual way, and the resistance of the grid leak checked; or the voltmeter may be used as the total grid load, if the resistance in the companion grid leg is made the same as that of the meter's multiplier that is in service.

A vacuum tube voltmeter would do the whole trick.

The circuit under discussion actually works, and the results are good. However, as intimated, there is considerable work, not of an uninteresting character, however, in balancing the stages, though perhaps instruments are required that the general run of experimenters does not possess.

One fact stood out, that the hum was lower than that experienced with the same type of filtering, in any other audio circuit.

53 as Phase Inverter

In neither of the examples discussed is a tube devoted only to phase-inverting. When such exclusive use is included, the sacrifice amounts to the per-stage gain for such a tube. That is, one tube contributes nothing except inversion of the phase. This will be almost exactly 180 degrees, although it seems necessary to that end that the stopping condensers be smaller than usual. The leaks should be larger, as compensation, unless there is motorboating, when the leaks may and should be reduced, for then the low-frequency accentuation is too great.

The 53 tube is recommended as a phase inverter, tnd as there are two tubes in one envelope, the sacrifice is hidden. That is, so much less is taken out of one triode as is equal to the gain of the other triode.

The circuit, Fig. 4, was built with 100,000-ohm plate loads for the 53, and 0.25 meg. grid leaks, 0.006 mfd. stopping condensers, and standard voltages The negative bias is around 3 volts when the biasing resistor is 200 ohms, the plate loads as stated, and the applied B voltage 250 to 300 volts. The current of both triodes flows through the biasing resistor.

There has been a change from the tentative rating of the tube, so that 3 volts is now the recommended negative bias for amplification, whereas it had been higher, and 7.5 volts is the recommended bias for detection. However, the circuit shown is not wholly stable, and a degree of stability is introduced, if necessary, by heightening the bias to around 4 or 5 volts, although other methods may be utilized, such as lowering the leak values and stopping condenser values, or several methods combined.

The voltage across one plate load is measured, then across the other, and the resistors then are apportioned accordingly, on the basis of the method used with the 55's.

Though the circuit has been built and tested, it is not recommended that it be reproduced except for experimental purposes, as it does not function properly yet. It may be well to investigate the use of low d-c resistance filter choke, instead of the high-resistance speaker field, as this field, used as choke, is an impedance common to the audio tube circuits, and thus provocative of instability.

The filtering in all instances consisted of 16 mfd. next to the rectifier and 16 mfd. at the end of the B choke, which keeps the hum well in check.

Flash-over in the 83 Due to Deposit of Film

Members of the radio trade and amateur station operators have been puzzled by the flash-over which sometimes occurs in the type 83 full-wave mercury vapor rectifier tube. W. M. Perkins, chief of radio application department of National Union Radio Corporation, explains this phenomenon as follows:

"In the handling and shipping of the Type 83 radio tube, the excess mercury often deposits itself in a film across the stem of the tube, thus furnishing an electrical path between the electrode connections. It is the burning away of this deposit which causes the flash-over.

"For really ideal operation, only the filament should be allowed to burn for a period of three to four minutes. After this, the plate voltage may safely be applied. This burning of the filament will warm the tube sufficiently to drive off the condensation of the mercury on the stem. Amateurs should follow this precaution as well as to be careful not to overload.

"The Type 83 is designed to stand an applied voltage of 500 volts rms per plate and deliver 250 milliamperes d. c. output. Providing the tube is operated within this rating, excellent life will result, but overloading will cause early failure. The application of higher a-c voltage than 500 volts per plate will give rise to electrolysis in the glass of the stem which results in stem rupture."

WIDE RANGES COVERED

An a-c receiver 15 to 2,400 meters, in 110 or 220 volts, is made by the Fanning Radio Labs., 377 87th Street, Brooklyn. N. Y. There are also two models, a-c and battery, covering from 75 to 555 meters, also a d-c model. In ac-dc midgets there are four models covering 15 to 200 meters, 75 to 555 meters, 175 to 555 meters, and 1,000 to 2,400 meters.

EXPLORERS GET VALUED AID OF THE AMATEURS

There are few remote spots on the face of the globe where civilized man has penetrated in recent years that have not also seen the invasion of amateur radio.

Whenever an exploring party goes forth to probe deeper into the mysterious recesses of the earth, or whenever a scientific expedition sets out to uncover new secrets in the history and pre-history of mankind, amateur radio accompanies and provides communication, often the sole link with the civilization left behind.

In the past ten years more than a hundred such expeditions have accepted the cooperation of amateur radio, through the American Radio Relay League, the national organization. It was Captain Donald B. MacMillan, in 1923, who took the first expedition radio transmitting equipment and an amateur operator to run it with him on his Arctic trip of that year, as a contribution of the League. Don Mix, the operator on that historic trip, provided such reliable communication with the homeland that MacMillan has never since ventured into the North without short wave radio equipment and an amateur to operate it.

Three in Field Now

This example was followed by other explorers who noted its success and made inquiries to the League regarding similar arrangements for their journeys. In 1924 another expedition received amateur cooperation; in 1925, three benefited by amateur assistance, and by 1928 the figure had risen to nine for that year alone. And so it went, until the actual total reached more than one hundred. When the Byrd Expedition went to the Antarctic, three of its four operators were amateurs, and amateur stations in the United States furnished a great part of the communication with this country.

At this moment there are three scientific expeditions in the field depending upon amateur contact for their news and messages to and from the homeland. On June 20th the staunch little schooner Morrissey sailed from Staten Island with the Bartlett Northeastern Greenland Expedition aboard, the seventh time Capt. Bob Bartlett has gone into the North with an amateur aboard to operate the radio equipment.

The problem of NX1XL, the station of the University of Michigan Scientific Expedition in Greenland in obtaining reliable communication with the States is a difficult one. Fred W. Albertson, the operator, claims one of the worst radio locations in the world for two-way communication, and for that reason many of the messages are sent "blind." But, even so, they seldom fail to get through.

Off to Arctic

The third American scientific expedition now in the North rejoices in the title "Expedition of Explorers Associated." It sailed off to the Arctic on the Norwegian boat Norkap II with the radio equipment under the call signal LDTE, being operated by a New England amateur, H. E. Mallinckrodt, formerly owner of amateur station W1DHA. The expedition is depending entirely upon amateur radio for communication, and in this as in all other cases the "hams" are maintaining regular schedules and standing by their posts so that the party may never be cut off from the outer world.

THE 19 IN CLASS B

Drivers Cited, Also Distortion and Power Outputs

TABLE 1

CLASS B COMBINATIONS USING ONE TYPE 19

DRIVER-CLASS A-ONE TYPE 30: PLATE VOLTS = 135, GRID VOLTS = -9, PLATE MA. = 3

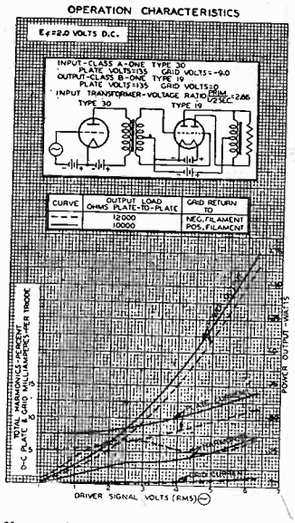
Arrangement	Input Transformer	Output Stage								
	Voltage Ratio Pri. to 1/2 Sec.	Plate Volts	Grid Volts	Total Av. Plate Ma. No Signal	Total Av. Plate Ma. Full Output	Plate-to-Plate Load (Ohms)	Output Watts	Total Distortion % Low Peak	Total Distortion % Full Output	Grid Return Connected To
1	2.66	135	0	10.0	23.5	12000	1.68	6.7	7.1	- Filament
2	2.66	135	0	15.0	28.0	10000	1.74	3.5	7.5	+ Filament
3	1.63	135	-3	2.6	22.5	12000	1.68	6.3	7.5	- Filament
4	1.61	135	-6	0.4	20.0	12000	1.39	16.0	7.5	- Filament

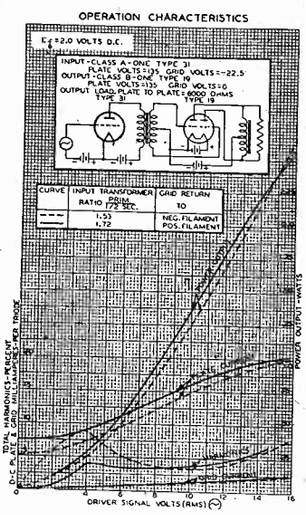
TABLE 2

CLASS B COMBINATIONS USING ONE TYPE 19

DRIVER-CLASS A-ONE TYPE 31: PLATE VOLTS = 135, GRID VOLTS = -22.5, PLATE MA. = 8

Arrangement	Input Transformer	Output Stage								
	Voltage Ratio Pri. to 1/2 Sec.	Plate Volts	Grid Volts	Total Av. Plate Ma. No Signal	Total Av. Plate Ma. Full Output	Plate-to-Plate Load (Ohms)	Output Watts	Total Distortion % Low Peak	Total Distortion % Full Output	Grid Return Connected To
1	1.53	135	0	10.0	40.0	6000	2.59	8.7	7.5	- Filament
2	1.72	135	0	15.0	40.0	6000	2.52	3.9	7.5	+ Filament





The two tables are above. Fig. 1 is next and Fig. 2 is at extreme right. Fig. 1 shows the operation characteristics of the 19 with a 30 driver, Fig. 2 with a 31 driver.

THE type 19 tube is a Class B twin-amplifier designed primarily for use in battery-operated receivers. With 135 volts on the plate the 19 as capable of approximately 2.5 watts output. Combining two high-mu triodes in one bulb, the 19 offers advantages in battery-operated receiver design such as economy in chassis space, high efficiency, good power output at relatively low plate voltages, and good quality. Used in connection with a permanent-magnet type of dynamic speaker, the 19 makes possible the design of battery receivers having performance capabilities approaching those of a-c sets.

In battery receivers, the plate-voltage and plate-current requirements of the output tube are of prime importance. Tubes which require high plate voltages necessitate the use of more battery units, while tubes with high plate-current drains mean frequent battery renewals. The efficiency of the output tube is therefore of first importance when the cost of operation of the set is considered. Class B output systems have inherently high efficiency. Careful design of a Class B output system will insure good quality. The type 19 tube, giving adequate power output with only 135 volts on the plates, merits the attention of set engineers, because of its high efficiency and relatively low plate-current drain.

Operating Conditions Tabulated

In Table 1 and Table 2 are tabulated typical operating conditions for the 19. The combinations of Table 1 employ a type 30 tube as the driver. The combination of Table 2 employ a 31 as a driver.

In arrangement 1 of Table 1, the 19 is operated with zero volts grid bias. The grids are returned to the negative side of the filament. Under these conditions, the power output is 1.68 watts with a total harmonic distortion of 7.1 per cent, at full output. Like many Class B types, the distortion curve of the 19 has a hump at some point below full output. The maximum distortion at this hump is shown in the column headed "Low Peak." In this case it is 6.7 per cent.

Arrangement 2 is practically identical with arrangement 1 except that the grids of the 19 are returned to the positive side of the filament. Under these conditions the power output is increased to 1.74 watts, and the low-peak distortion is reduced to 3.5 per cent. The zero-signal plate current is raised slightly over that in arrangement 1; the plate current at full output is also slightly increased. Listening tests reveal that the higher-order harmonics are reduced when the grids of the 19 are returned to the posiive side of the filaments.

Arrangement 3 shows the effect of a negative-bias voltage on the grids of the 19. The power output is the same as that with arrangement 1. The relative amount of higher-order harmonics is also nearly the same as that for arrangement 1. However, the zero-signal plate current is reduced considerably. This reduction in initial plate current may be of considerable advantage in some designs.

Arrangement 4 shows the effect of an increased negative-bias voltage on the grids of the 19. The power output for the same amount of distortion is reduced from that obtained with arrangement 3. The relative amount of higher-order harmonics, as indicated by listening tests, is increased noticeably. The zero-signal plate current is reduced to a neglible amount.

The 30 and 31 as Drivers

Arrangements 1 and 2 of Table 2 show operating conditions for the 19 with a 31 driver. In the first arrangement, the grids of the 19 are returned to the negative side of the filament, while with arrangement 2, they are returned to the positive side of the filament. Although the power output is approximately the same for both arrangements, the relative amount of higher-order harmonics is appreciably less when the grids are returned to the positive side of the filament.

Fig. 1 shows the operation characteristics of the 19 with a type 30 driver. The solid curves show the operation of the output system with the grids returned to the positive side of the filament, while the dotted curves show the operation with the grids returned to the negative side of the filament. The curves of power output, plate current, and grid current are approximately the same for both arrangements, but it will be seen that a much smoother rise of per cent. total harmonic distortion is obtained when the grids are returned to the positive side of the filament.

Fig. 2 shows the operation characteristics of the 19 with a type 31 driver. The curves of Fig. 2 are presented in the same form as those of Fig. 1 so that a comparison of operation characteristics can be readily made.

The power output obtainable from the 19 is considerably higher when the 31 is used as a driver. However, the 31 driver requires a much larger signal input for full output than does the 30 driver. The plate current of the 31 driver is also higher.

Fig. 3 shows the average plate characteristics of a single-triode unit of the 19.

On an attached sheet will be found specifications for a suitable input transformer for the 19. This transformer used with a 30 driver will give operation characteristics essentially the same as those shown in Fig. 1.

R-F Oscillation in Output

As a word of caution regarding Class B output systems, listening tests sometimes show the quality of the output to be very poor, although the circuit apparently has been designed properly. In such cases, the trouble may be due to radio-frequency oscillation in the output tubes. This oscillations occurs only when an audio-frequency signal is applied to the grids. The result of these radio-frequency oscillations is an audible rasp in the output which easily can be mistaken for higher harmonics of the input signal.

To determine if this rasping is due to oscillations, an a-c signal should be applied to the grids of the Class B output tubes, and the grid leads touched with a finger. If the rasping stops when the leads are touched, it is undoubtedly due to radio-frequency oscillations. A remedy for oscillation is effected by connecting small fixed condensers between each grid and cathode of the Class B stage. Tests have shown that 0.0005 mfd. condensers are usually satisfactory. These condensers may not be required if a speaker-correction network of resistance and capacitance is employed between the plates and cathodes.

It may be desirable to employ a speaker-correction network between the plates of the output tube, in order to maintain a uniform load at all frequencies. For a 10,000-ohm plate-to-plate load on the Class B stage, a resistance of 11,500 ohms and a capacitance

(*Continued on next page*)

Form-Fitting Shields For Tubes Introduced

National Union Radio Corporation of New York announces a new tube shield consisting of form-fitting metal jackets and grounding clip, easily applied to any type tube. Two styles are available so that all requirements for both straight-side and dome-type bulbs are provided for.

The tube shields can be used to replace spray-shield tubes. They are further suggested for trial in noisy receivers and where non-vibrating shielding is desired.

While the tube shields are a National Union development, they are being manufactured by Goat Radio Tube Parts Company, of Brooklyn, N. Y. They have been made available to the trade through National Union distributors.

Meter Sensitivity Raised in New Way

Developments in supersensitive meters giving scale deflection of 0-20 microamperes and 0-3 millivolts have been announced by the Westinghouse Electric and Manufacturing Company. These refinements are the result of three major improvements: reduction in weight of moving parts, a 3-to-1 increase in magnet strength and a 6-to-1 increase in the possible number of turns on the moving coil. This great sensitivity was achieved by making relatively slight improvements in many of the fundamental parts of the instrument.

Material reductions have been made in the weight of pointer, balance weights and parts used for attaching pivots to the ends of the moving coil, permitting the use of lower spring torques, and also decreasing impact load on the pivots and jewels.

Cobalt Steel Magnets, Too

In the past instruments have been made with magnets of chrome or tungsten steels. More magnetic effect is obtained by the use of cobalt steel. Castings having suitable magnetic properties are finished with simple surface-grinding operations and spot-welded to the pole pieces. All mounting holes are then drilled in the soft pole piece metal. This process permits the use of magnets of any material and of varying size with the same pole pieces, thus permitting flexibility in the choice of magnets.

For ordinary work, a small chrome steel magnet is welded to the pole pieces, while for super-sensitive requirements cobalt steel magnet of three times the strength is substituted. It is thus possible to make super-sensitive instruments having three times the current sensitivity and therefore nine times the watt sensitivity due to use of special magnet steel alone.

The third major improvement applies chiefly to microammeters. The current required for a given angular deflection varies inversely as the number of turns in the moving coil. The moving coil swings in a fixed air gap, and its dimensions are definitely limited by core on the inside and pole pieces on the outside. With these limitations, the only way to increase the number of turns of wire is to use a finer size. Instrument makers had for some time been using No. 44 enameled copper wire which is 0.002 in. in diameter.

Wire Finer Than Hair

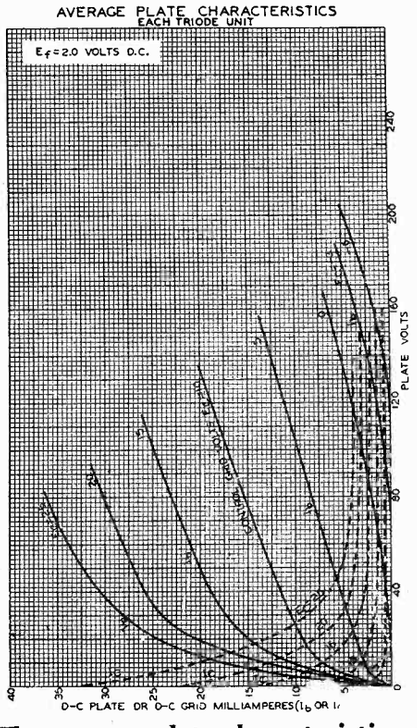
Now the coils are made from wire having a diameter of 0.001 in. and 0.0008 in., gauge numbers 50 and 52, less than half the diameter of the finest human hair. Use of these fine wire sizes allows 4 to 6 times the number of turns for a given coil weight.

These instruments are only 2 in. or 2 7-8 ins. in body diameter, giving full-scale deflection on one or two microwatts. The lowest standard microammeter has a scale 0-20 microamperes, and a coil resistance of about 2,100 ohms.

Small millivoltmeters of hitherto unattainable sensitivity are available with scale of 0-3 millivolts with a resistance of about 9.1 ohms.

A high resistance microammeter has been designed to measure the voltage produced by dissimilar metallic electrodes in extremely weak solutions, such as drinking water. For special requirements, a very highly damped instrument can be obtained by use of the cobalt steel magnet.

The 19 in Class B



The average plate characteristics of a single-triode unit of the 19.

(Continued from preceding page)

of 0.021 mfd. should be connected in series between the two plates. For a 12,000-ohm load, the resistance should be 13,800 ohms and the capacitance 0.017 mfd.; for a 6,000-ohm load, the resistance should be 7,000 ohms and capacitance 0.035 mfd.

Balance to Center Tap

A more effective, but also more expensive, way of apply the correction network is obtained by balancing the network to the center tap of the interstage transformer. The value of resistance between each plate and center tap is one-half that given above, while the value of each capacitance is twice that given above, say RCA Radiotron Co., Inc., and B. T. Cunningham, Inc.

The primary inductance of the output transformer should be high enough to give good low-frequency response; yet, at the same time, it should be kept sufficiently low to obtain good high-frequency response. Close coupling and low leakage reactance are necessary for low distortion levels and good power output at high frequencies.

Major Bowes is Head of New United Station

Four stations in the New York area on 1,010 kc will combine and be operated by a new company under the direction of Maj. Edward Bowes, of the Capitol Theatre. The stations are WHN, WPAP, WQAO and WRNY. Recently WHN applied to the Federal Radio Commission for permission to remove its transmitter from Forty-fifth Street and Broadway to Long Island City.

There will be a new studio for the combination and also a new transmitting plant. The latest type of plant has been ordered, and while the exact location has not been selected, it is said the transmitter will "be somewhere in the suburbs."

The new outfit will be devoted largely to commercial broadcasting. Major Bowes will continue his work at the Capitol, in which he shares a financial interest with Metro-Goldwyn-Mayer, the movie producers and distributors. The combined station probably will have the call letters WMGM.

Major Bowes said that the Federal Radio Commission had issued the construction permit.

No New Tubes, Says Muldowny with Relief

S. W. Muldowny, chairman of the tube committee of the Radio Manufacturers Association and chairman of the board of National Union Radio Corporation, stated that development of new types of tubes, which set such a furious pace during the past year, has definitely slowed down.

"I am sure this slackening in the production of new tube types will be good news to the entire radio trade," said Muldowny. "It is an indisputable fact that the development of new types of tubes, particularly those designed for special adaptations and dual purposes, has had a great deal to do with the remarkable progress made in radio during the past year. This fact is self-evident in the expansion of new markets such as ac-dc compacts and automotive radio. Nevertheless, the introduction of so many types in such a short period of time not only put a severe strain on the tube manufacturer but worked great hardship on the trade.

"As chairman of the tube committee of the R. M. A. I am happy to announce that no new types are contemplated at present, and general opinion among leaders of the industry indicates that no need will appear in the immediate future for a type of tube which is not already in production.

"From the dealer viewpoint, this should give him an opportunity to familiarize himself with all types of tubes now being made and in addition, it presents an opportunity to take stock of his service and test equipment needs for the immediate future."

Eight-prong and nine-prong tubes are said to be in the laboratories, but remote as to introduction into the market.

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.*

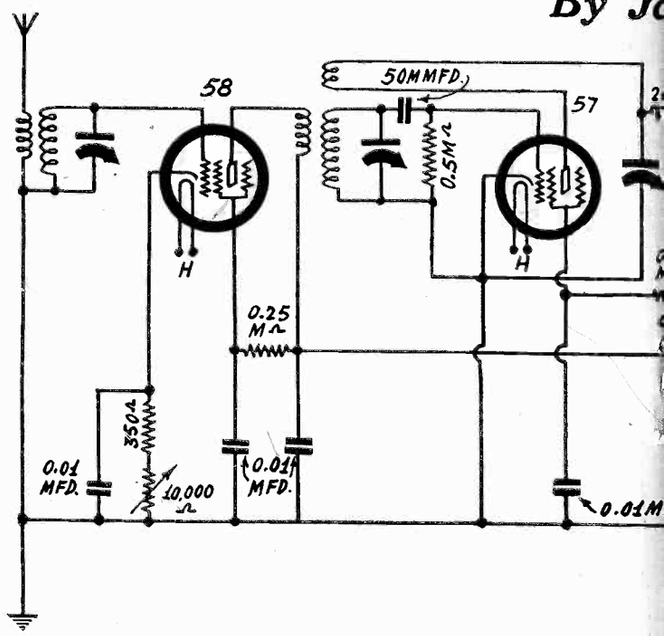
Edward Smart, 111 Oswego St., Victoria, British Columbia.
John McNulty, 54 O'Connor St., Wellsville, N. Y.
Lewis Radio Service, 4105 N. Damen Ave., Chicago, Ill.
C. H. Krueger, 2931 N. 4th St., Milwaukee, Wisc.
John González, P. O. Box 22, San German, Porto Rico.
Elbert H. Carroll, West Boylston, Mass.
A. C. Bayly, c/o Nash Nichols Co., 1110 American Ave., Long Beach, Calif.
Chas. K. Hood, 404 Granet Ave., Hazel Park Sta., Royal Oak, Mich.
Jno. D. Young, 2750 5th Ave., So., St. Petersburg, Fla.
Mark J. Swartz, Hershey, Penna.
R. Friedrich, 5026 N. Keeler, Ave., Chicago, Ill.
Geo. B. Gish, Fox Lake, Ill.
Robert Burk, 2110 Vega Ave., Cleveland, Ohio.
Bill S. Wedel, 305 6th St., Huntington Beach, Cal.
C. F. Bell, Jr., P. O. Box 252, Altadena, Calif.
Clifford Talbot, 219 Mellon Place, Elizabeth, N. J.
Kenneth E. Gould, 110 East Third St., Prophetstown, Ill.
Jack H. Nixon, Box 1526, Alexandria, Louisiana.

CONSTANTS FOR 5-TU

Standard T-R-F Stage and Represen

By Jo

Excellent reception of short waves is provided by this circuit, which has the standard t-r-f stage and regenerative detector. In this portion of the circuit the constants are selected partly on the basis of commercial short-wave coils, the winding data for which also are given in the text. The regeneration control is quite smooth and the detuning effect of the feedback condenser is slight.



HOW many times the circuit consisting of a tuned radio frequency stage and regenerative detector with shunt feedback control has been described I don't know, any more than I know how many more times it will be described again, but we all know that it works very well. That is the reason it gets such a play.

Whenever new tubes come along that are to be used in such a circuit, new experiments have to be made, so that the constants will be properly selected. This has been done long since for the 58 and 57, but when a total receiver is to be built there may have to be some slight changes, and the set diagramed is one in which the changes have been experimentally determined.

One of the important considerations is the voltage of the B supply after the field, and for a set with a 2A5 or 47 output tube this voltage should be around 365 volts d.c. This means that the voltage at the filament end of the speaker field is around 450 volts to ground, and therefore any condensers used for filtering this voltage should be of the 500-volt rating.

Thus the full B voltage as obtained after filtration is fed to the output tube in two places, to the first audio tube and to the radio-frequency amplifier tube. In the case of the detector, large series resistance cuts down the applied plate voltage to around 50 volts, while the screen voltage is effectively around 30 volts. The two 0.25 meg. resistors in the bleeder and series network account for this, and the plate load resistor is only 0.05 meg. (50,000 ohms), because that is the value that works best.

The radio-frequency part of the circuit is simple and familiar, and while the volume control is a rheostat that alters the bias, which introduces some detuning, it is advantageous because it is a gain control and will correct for any tendency of the r-f tube to oscillate, as it may at some of the higher frequencies. Thus the tube may be worked up to its maximum gain, for the increased sensitivity and selectivity, and in those circumstances when there would be a spillover, the control is retarded a bit.

The operation of the two controls, however, one for volume and the other for regeneration, should be almost completely independent. There is some slight interdependence, but it is too small to be noticeable in mere operation, and shows up only on measurements with highly-sensitive instruments. You can not have one tube coupled to another without the tuning of one tube having some effect on the tuning of the other. But when the effect is of such a low order that we can not measure it handily, as the effect a receiving circuit has on a broadcasting antenna due to the ether coupling, we can forget about it.

The coils used are of the plug-in type, and the data are given for coils as wound on Alden's forms by Sickles, and which are widely distributed. The antenna coil has two windings, primary and secondary, beside each other. The interstage coil has three windings, with the primary wound within part of the winding space occupied by the secondary, while the tickler is below the secondary.

With the circuit built as shown there was activity even on the 10-to-20 meter coils, although in this region some short-wave sets give virtually no response, and possibly even do not regenerate. I know that the going is toughest on the smallest coil, and also that this is a daylight reception coil.

Well, anyway, the present circuit does give considerable response in this region, and it can be said it does regenerate at all dial positions even on this smallest coil, so what reception is brought in depends considerably on the operator.

The 57 is a high-gain tube, so is the 58, while the 2A7 has the highest mu of any receiving tube so far, and yet the volume is not too much. Short-wave signals, at least those most desired, do not deliver anything like the voltage in the antenna as do one's favorite broadcast-band stations. The amplification after the detector ought to be considerable. Here it is about as much as can be obtained from any two tubes (assuming only a single tube in an envelope). Although the 58 is shown as the first audio tube, a 57 may be used at slightly greater gain.

The grid leaks in the audio channel are shown as 0.5 meg., as such a value is safe, but it is always good practice to try higher values of grid leaks, provided that the plate current in the two tubes concerned (the audio amplifiers) does not increase materially. Of course the 58 or 57 first audio plate current will be low, less than 0.5 ma, but even so, an increase to 1 or 2 ma would become dangerous to the life of the 1-watt plate resistor and besides would indicate flow of grid current, which is inimical to quality.

Higher leak values produce more volume and also give the low notes an extra kick, but the low-note accentuation may be so great that motorboating sets in, and then the leaks have to be reduced to such value as is consistent with the absence of this trouble.

The biasing reistor of the power tube, 410 ohms, also furnishes the screen voltage for the first audio amplifier, and particularly due to the common purpose a large condenser should be across this resistance. A value of 50 mfd. is specified, and this is easily obtainable in a 30-volt-rating electrolytic condenser about one-third the physical size of an 8 mfd. 500-volt electrolytic. Use of small condensers to bypass the biasing resistor in the power tube stage always cuts volume, and particularly hurts the low notes.

The circuit lends itself to ready duplication with parts one may have about the home or shop. The plug-in coils are familiar, besides the data to wind your own are given, but if you have other plug-in coils you might try them, as very likely the

Coil

Antenna St

Coil No. 1.—Secondary, 51¾ turns No. 22 turns per inch.
Primary at bottom, ⅛" distant from lo silk covered or enamel wire, close-wou

Coil No. 2.—Secondary, 22¾ turns No. 2 16 turns per inch.
Primary, at bottom, 3/32" distant from silk covered or enamel wire, close-wou

Coil No. 3.—10¾ turns of No. 22 double inch.
Primary, at bottom, 3/16" distant from silk covered or enamel wire, close-wou

Coil No. 4—4¾ turns of No. 22 double s inch.
Primary, 3/32" distant from lower end silk covered or enamel wire, close-wou

Interstag

Coil No. 1.—Secondary, 50 turns No. 30 sin Primary, wound in between secondary silk covered wire.
Tickler, distant 5/32" from lower end covered wire, close-wound.

Coil No. 2.—Secondary, 23 turns of No. 2 Primary, wound in between secondary silk covered wire.
Tickler, distant 3/32" from lower end wire.

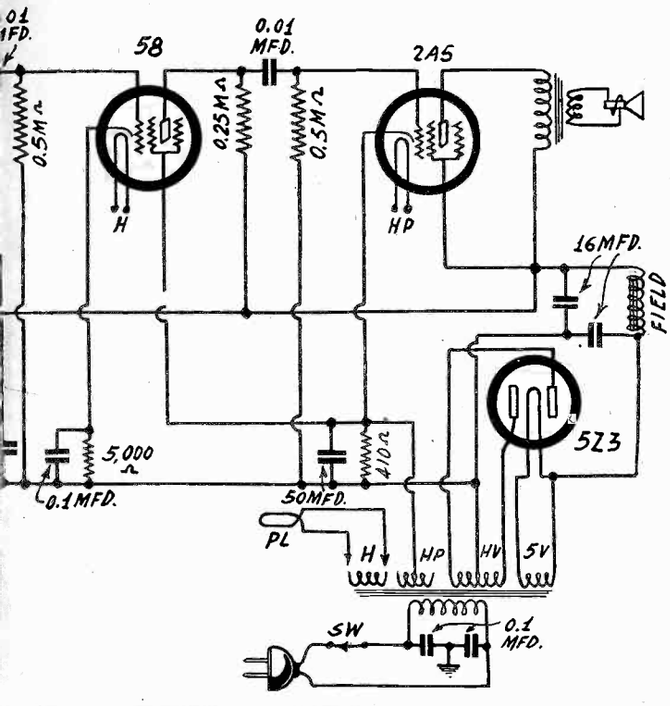
Coil No. 3.—Secondary, 11 turns of No. 2 Primary, wound in between secondary covered wire.
Tickler, distant 3/32" from lower end wire.

Coil No. 4.—Secondary, 5 turns of No. 26 Primary, wound in between secondary wire.
Tickler, distant 3/½" from lower end o wire.

BE SHORT-WAVE SET

ve Detector, with Two Audio Steps

Tully



The r-f tube is a 58, the detector a 57, while the first audio amplifier is a 58 and the output a 2A7. However, a 57 may be used as first audio amplifier without any circuit changes whatever. The screen voltage on the first audio tube is the same as the bias of the output tube, polarities reversed, of course. There is no hum trouble in this set, as 32 mfd. filter capacity and a speaker field-choke are used.

LIST OF PARTS

Coils

One set of four UX-base plug-in coils, as described
One set of four six-pin-base plug-in coils, as described
One power transformer

Condensers

One two-gang 0.00014 mfd. tuning condenser
One 50 mmfd. feedback condenser
Six 0.01 mfd. mica fixed condensers
Three 0.1 mfd. bypass condensers
Four 8 mfd. 500-volt electrolytic condensers, which may be in four separate cans, or two cans, double eights, in each can
One 50 mfd. 30-volt electrolytic condenser
One 50 mmfd. grid condenser

Resistors

One 350-ohm pigtail resistor
One 10,000-ohm rheostat, or potentiometer used as rheostat
Four 0.25 meg. pigtail resistors
One 0.05 meg. pigtail resistor
One 0.5 meg. pigtail resistor
(Do not use wire-wound resistors for the above items).
Two 0.5 meg. pigtail resistors
One 5,000-ohm pigtail resistor
One 410-ohm wire-wound resistor

Other Requirements

Five six-hole sockets, two four-hole sockets and and one five-hole socket (the last-named is for the speaker cable's plug).
One a-c switch and cable
One chassis
One dial
Two knobs
Antenna-ground binding post assembly
Three grid clips
One dynamic speaker with output transformer built in, for pentode tube (around 6,000 ohms impedance); field coil built in.

)ata

(UX Form)

silk covered or enamel wire, wound 40

d of secondary, 15 turns of No. 31 double Color ring code, green.

ble silk covered or enamel wire, wound

end of secondary, 7 turns of No. 31 double Color ring code, yellow.

vered or enamel wire, wound 16 turns per

end of secondary, 6 turns of No. 31 double Color ring code, red.

ered or enamel wire, wound 6 turns per

condary, 4 turns of No. 31 enamel double Color ring code, blue.

Six-Pin)

k covered wire, turns 1/32" apart.
at the lower end, 31 turns of No. 32 single

e secondary, 16 turns of No. 30 single silk Color ring code, green.

le silk covered wire, turns 5/64" apart.
the lower end, 15 turns of No. 32 single

ndary, 8 turns of No. 30 single silk covered Color ring code, yellow.

le silk covered wire, turns 3/32" apart.
at lower end, 8 turns of No. 32 single silk

ndary, 7 turns of No. 32 single silk covered Color ring code, red.

silk covered wire, turns spaced 3/32" apart.
er end, 4 turns of No. 32 single silk covered

dary, 5 turns of No. 32 single silk covered Color ring code, blue.

results will be quite as excellent that way. The biasing resistor for the r-f tube is shown as 350-ohms, but if you have anything from 150 to 350 ohms you may use that, and if you have no 10,000-ohm rheostat use one of a maximum from 2,000 ohms up to 25,000 ohms. Ot course there's a difference, and I found 10,000 ohms satisfactory, but as to a mere matter of fineness of this control, as against buying a new part, certainly you can use what you have.

The 0.25 meg. resistors must not be altered, but the 0.05 meg. resistor in the 57 plate circuit may be from 0.025 meg. to 0.05 meg. (25,000 to 50,000 ohms), and the grid leak in the detector, instead of being 0.5 meg., may be somewhat higher or lower, higher values to be preferred if any change is to be made. The grid condenser will work well if 0.0001 mfd., instead of half that value, but if there is any difficulty about regeneration all over the dial, put two 0.0001 mfd. in series to constitute 0.00005 mfd. (50 mmfd.) and increase the leak resistor to the specified 0.5 meg.

The radio-frequency choke, 25 mlh, may be any choke you have, of the honeycomb or similar type, so long as it has at least a few hundred turns. The 25 mlh choke has 1300 turns. The inductance of an 800-turn choke of the same type of construction is around 10 mlh, which is sufficient also, and even 3.2 mlh (400 turns) proved satisfactory, but there was a little more smoothness of regeneration control when the choke was large, i.e., 25 mlh. So if you have 25, 60, 80, 100 etc. mlh chokes, use the one with the highest inductance. The distributed capacity should be very low, however.

Various values of resistors were tried for biasing the first audio tube, but more than 5,000 ohms should not be used, although less than 5,000 ohms would be all right, say, down to 2,000 ohms or so.

The 410-ohm resistor, under the circumstances narrated, afforded a bias voltage of 17 volts, which is close to correct, and yet 500 ohms gave 20 volts, which is all right, too, so if you have a 500-ohm 1-watt resistor you may use that. Though this is a power tube stage, the wattage of the resistance may be that low, because the total current does not exceed 40 ma, and the biasing voltage is only 20 volts at most, so around 0.8 watt is the dissipation.

The speaker field resistance is not so material. Actually 1,800 ohms was used. Fields of 1,200 to 2,500 ohms may be used without any circuit changes whatever, although the output transformer should be one for the pentode class of tubes. The output impedances of the 2A5 and 47, and even the 59, are not so far different that one need to worry as to the speaker. If a speaker is meant for one it will serve for the other, but this hardly holds true of substitution of triodes for pentodes.

There is one possible disadvantage of the 2A5 tube, and that is, since it is of the heater type of construction, it does not draw enough current immediately to cause the regulation of the system to lower the voltage, hence the maximum starting strain is upon the filter condensers, and particularly on the one next to the rectifier, therefore, again, be sure that 500-volt condensers are used, which may be four separate eights in separate cans, or two cans with two eights in each can.

The power transformer may have only one 2.5-volt winding, and if so use that for all four tubes. If the 5-volt winding is center-tapped use the center for take-off of the B supply. Otherwise follow diagram and take off the B from either side of the 5-volt winding.

Radio University

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

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

Set Won't Start Promptly

A MOST PECULIAR thing has happened to my set. Formerly it started playing as soon as I turned it on. Now it does not start that way, but I have to turn the set on (hearing nothing), wait a few moments, turn if off, and then turn it on again.—J. H. W.

Put a 10-watt or higher rating resistor of 15,000 ohms from maximum B plus to ground, or between the feed of the B line to the r-f and similar tubes and ground, if the second-mentioned voltage is lower than the maximum.

* * *

More Kick Desired

IN MY SUPERHETERODYNE I do not get enough kick. The r-f and i-f tubes are 58's and the plate voltage is 100 volts, the screen voltage around 50 volts. The screen voltage is obtained through a 50,000-ohm resistor. I have tried increasing the voltage, but then i-f oscillation sets in.—O. H.

You will get much more volume by increasing the B voltage on these tubes to around 200 to 250 volts. While it is true that oscillation might result, the usual precautions against such oscillation then should be taken. The complete precaution consists of interrupting the B plus return of the plate windings of the i-f transformers with radio-frequency choke coils of 25 millihenry or higher inductance, and bypassing these chokes with 0.1 mfd. or higher capacity. Then each screen lead should have a resistor in it, similarly bypassed, although the effect of increasing the plate voltage is likewise to increase the screen voltage, due to the series resistor. The remedies are suggested for the i-f level, but if needed may be applied to the r-f level as well, in the same way. The individual screen resistors should be around 25,000 ohms, perhaps a little less, so as not to dampen the circuit too much. Experiment will dictate the values.

* * *

Police Band Coverage Poor

IN A SET I built that is supposed to switch to the police band, as well as to the broadcast band, police signals come in only over the higher capacity part of the dial, and the circuit is dead from then on.—K. G.

It is assumed your set is a superheterodyne. The failure on part of the dial for police waves is due to poor tracking or absence of tracking. You will have to determine at what frequency the oscillator coil oscillates when the condenser is at minimum capacity, for police waves, and then you will know if the inductance is too high or too low. Probably it is too high, and the response over part of the dial is due to tuning to the low-frequency setting, which of course causes the set to be dead after the possibility of low-frequency setting is exhausted. After the oscillator inductance is properly selected for the high frequency end, a padding capacity, the value of which also must be determined experimentally, should be included, and this would be selected for some position around 70 on a numerical dial, assuming numbers increase with capacity. A test oscillator is required for this work. One that covers the broadcast band will do, as its second harmonics and in some instances third harmonics may be used.

Push-Pull's Value

IN A PUSH-PULL amplifier, is it a fact that the amplifier will work with one of the push-pull output tubes removed from socket? What is the advantage of push-pull?—J. W. S.

The circuit will "work," after a fashion, with one tube out, but that doesn't prove anything. In a resistance-coupled push-pull amplifier, single-aided operation is obtained with one of the banks of tubes out, with better results than with transformer-coupling, with one bank out. The advantage of push-pull is that it permits greater power output at less distortion. That does not mean more volume of sound, as the sound quantity refers to the sensitivity. The power refers to the ability to stand the gaff.

* * *

Mars Communication

HAS ANY PROGRESS been made lately in communicating with Mars? Did some professor ever try to make an ether ascent in a rocket in connection with this aim?—G. D. C.

No progress has been made lately or otherwise in communicating with Mars. No professor, or anybody else, we hope, ever attempted the rocket ascent for any purpose. Temperature and oxygen would be two deterring considerations, but the crash to earth would probably come before any other troubles would materialize. Communication with Mars requires a common medium of intelligence and presupposes the existence of articulate life on that planet. We have seen grotesque pictures of what Martians are assumed to look like, if such animals exist, of whatever appearance, but closer than that we never got in arriving at verification. It has been found recently from cosmic ray research, that from Mars the carrying power is particularly good on a certain frequency in the short-wave spectrum. This should be the frequency to use, perhaps, but what to say and whom to address, and how long to await the answer are problems that baffle us, too. Nothing herein stated denies the remote possibility that some day (or night) communication with Mars may be established —two-way, we hope.

* * *

Where the 53 Won't Do

REGARDING the 53 tube, which I take it consists of two high-mu (35-mu) tubes in one envelope, may not a suitable short-wave set be made, using one tube for r-f amplifier and regenerative detector, another for first and second audio, a third tube as output, and the usual rectifier?—T. W. D.

No, this method does not work out well. To answer your question we set up the circuit. The tube does not lend itself to this combination of uses on short-waves. The feedback, possibly through the tube capacities, was entirely too much. Control of r-f stage oscillation became a very serious problem even on the second highest band of short-wave frequencies. The audio combination works all right, but not the r-f. The tube's special uses, outside of triode driver for Class B and Class B output, should be verified carefully before the conclusion of satisfactory service is drawn.

* * *

Class B for Battery Sets

DO YOU THINK that Class B audio is satisfactory for battery-operated sets, and if so, would the new 19 tube be satisfactory?—K. D.

Yes, it is a method of getting a respectable amount of power out of battery type tubes at relatively low B voltage, 135 volts. The 19 tube is satisfactory, and special data on its use in Class B output, with either a 30 or 31 tube as driver, will be found in this issue.

* * *

Oscillator Won't Work

THE OSCILLATOR in my superheterodyne does not function now, hence reception has stopped. I get an audio

howl that changes in pitch slightly as I turn the tuning dial from one extreme to the other. I had been doing some experimenting with the set and perhaps something I did caused it to go haywire. —J. D. C.

The condition you describe, if you have the grid leak type of oscillator, may be due to open grid return, or other open in the oscillator coil. Remove the oscillator coil from the receiver, examine it closely and test for continuity each winding on the coil. Restore any break encountered. If in your experimenting you made the not uncommon mistake of putting the grid condenser between the grid and the cathode, with secondary grounded to B minus, check up to be sure that the connection makes the parallel leak go from grid to cathode and the grid condenser from grid to coil. Otherwise there would be an open grid, as in the broken coil example, and besides the leak might get hot.

* * *

Pentode Speaker, Triode Tube

I HAVE A SPEAKER that was intended for a pentode type tube, and naturally it has a high impedance, around 6,000 ohms, whereas the output tube I desire to use has an impedance of around 2,500 ohms. I would like to use this speaker for a while, as I can not well get another now, and was wondering if you can suggest a method.—H. C.

You may use self-bias on the output tube, and incorporate a resistor of twice the usually-recommended value. That will establish a compromise. It will reduce the sensitivity a bit, but will increase the plate resistance considerably, and you will get pretty good quality. Doubling the biasing resistance does not by any means double the voltage. For instance, if instead of 775 ohms used for biasing the 2A3 tube, the resistor is 1,550 ohm, the bias voltages will be 60 and 72 volts, respectively.

* * *

56 Drives Two 2A's

A 56 DRIVER is suggested to feed 2A3's in push-pull. Is this sufficient to swing the output stage?—J. E.

Yes. The 56 should have maximum B voltage, as stated on characteristic charts, and the negative bias that goes along with that B voltage. If the current is rather large for the primary of the transformer to be used, put a resistor of 50,000 to 100,000 ohms in the plate circuit, put a condenser of 0.01 mfd. to plate, other side of condenser to P of primary of transformer, and return primary of transformer to 56 cathode. This is known as filtering, or parallel feed. As you realize, it keeps the direct current out of the primary, hence the primary inductance is held up. maintained. Otherwise that inductance would be reduced by the d.c., and there might be a falling off of response at the low audio frequencies.

* * *

Beat Note Oscillator

CAN A SATISFACTORY beat note oscillator be built, using as one oscillator a rather high frequency coil, with fixed condenser, and as other oscillator, a similar coil, and a variable condenser?—R. D.

Yes. The tuning condenser, however, on the variably-tuned oscillator would have to be extremely small. In this sense 50 mmfd. would be very large.

* * *

Transformer Ratios

TWO AUDIO TRANSFORMERS that I have are different as to ratios, but I cannot tell just what the ratios are, hence the difference. Is it all right to measure the d-c desistance of one winding, then that of the other, and divide the smaller into the larger, to get the ratio, and also to determine which is primary and which is secondary?—K. D.

That method would be all right if you could be sure that the same size wire was used on both windings of each transformer, although each transformer might have different size wire, so long as on its primary and secondary the wire size was the same. However, if yours are audio transformers of the interstage type (not output transformer), a better way would be to connect the assumed secondary to the 110-volt a-c line, the voltage of which is measured, and then measure the voltage of the other winding. Then the division you suggest would apply. This method, you see, is independent of the wire size. Or, if you'd rather, you may use the lower voltage of a power transformer for the test.

* * *

Vacuum Tube Voltmeter

WHEN A VACUUM tube voltmeter is built, does it measure the root mean square value of the voltage, or the peak voltage?—G. D. C.

The usual type of vacuum tube voltmeter measures the peak voltage. However, the device may be calibrated for rms values, and then, while it would measure peak values, it would "read" rms values.

* * *

Pilot Lamp as Resistor

IS IT ALL RIGHT to use a pilot lamp as a series resistor in an a-c and d-c set? Is the resistance constant?—H. X.

No, the pilot lamp should be used principally for illumination, and a parallel resistor of lower value than the operating resistance of the lamp put in the circuit. In commercial practice a 10-ohm resistor is used generally. Relying on a pilot lamp alone is decidedly bad practice.

* * *

Relay Protects Meter

IS THERE a fuse for protecting a 0-1 milliammeter?—C. L. F.

No. The fuses are not reliable on such small current. But there is a vacuum relay which guards against overloads. Suppose that, in testing with the scale connected from 0 to 30 volts, you accidentally touch the test lead across the 150 volt section. Instead of a costly burn-out as in ordinary meters, the vacuum relay will throw open and remain open as long as there is an overload. When the extra voltage is removed, the relay automatically closes and the meter is again ready for use.

Audio Twice in New System

WILL YOU please explain in terms of modulation the system of no-image superheterodyne you have been featuring?—E. L. S.

The carrier is modulated when transmitted from the station. The receiver's functions are: (1) remove the carrier, leaving only the modulation, or audio frequencies; (2) provide a local oscillation at the intended intermediate level and impress the aforesaid audio frequencies thereon; (3) amplify the new carrier; (4) remove the new carrier, resolving into modulation fundamental again; (5) amplify the audio frequencies as such.

* * *

Worth of the Ultra Frequencies

WILL YOU PLEASE tell me what is the reason for all the experimenting being done on the ultra frequencies, and why Guglielmo Marconi is spending so much time on this, as the results of sound broadcasting in the present band are good, the medium short waves have enough troubles to keep most persons off, except amateurs, and there does not seem to be a single commercial utilization of the ultra frequencies, and yet we hear so much about them and so many scientists seem to be spending most of their lives with them. Besides, they travel only a short distance and real value is obtained only from large distance.—H. C.

The object of the experiments is to endow the higher frequencies of transmission with greater commercial applications. It is known that static is virtually absent from these frequencies, and as static is one of the impediments to regular service on nearly all other frequencies, if the range of the ultras can be extended, and by directed effort can be made to give service over distances of hundreds of miles, the usefulness will become really important.

One of the incidental uses would be the enlarged sending areas of television transmitters, when these transmitters are generally in the ultra frequency spectrum, as it is expected they will be.

Nearly all the important television experimenters the world over are given to the idea that the ultra frequencies of radiation will have to be used.

ONE APPROACH TO TELEVISION FOUND IN SKY

Boston.

Ten years ago, while radio engineers were delving into the mysteries of radio receiver research, a young astonomer, Dr. Francois Henroteau, now head of the Astrophysical Department of the Dominion of Canada, scanning the heavens at night, was originating an idea that was eventually to prove the evident solution of television.

Dr. Henroteau's ambition was to eliminate the use of cumbersome telescopic lenses and apply in their stead light-sensitive devices, such as photo-electric cells, to bring the stars close to the human eye. Photocells are sensitive to a wider band of colors than the eye, hence their value in astronomy.

Finally an idea came to him which would provide an ultra-flexible means of star-gazing, in fact, a real "eye", as facile as the human eye, but as sensitive to the colors of the spectrum as a photocell—a Super Eye.

Needed Cathode Ray Pickup

With the development of a Super Eye, which would be electrical in nature, its application to the coming art of television was an obvious step, and the device suited the idea perfectly.

Patents were taken out in many countries and have been in existence for more than three years. The natural question that arises is why hasn't the Henroteau Super Eye been used in television long before this? The answer is that this eye needs the cathode ray type of receiver or reproducer to be fully effective and since the receiver itself had not been perfected, little thought was given to a television "camera."

Like all good inventions, the Henroteau Super Eye is simple, as simple as the cathode ray tube itself. The image to be televised is picked up by a high grade photographic lense and focused on a plate inside a glass tube, much like a television cathode ray tube. This plate is made up of millions of tiny globules which are miniature photocells. A sweeping beam of light or electrons rapidly scans this plate in the familiar cathde ray manner.

Fine Detail Set Forth

With the image playing constantly on the plate each cell has the opportunity to fully register the amount of light or shade the lense directs upon it. As the scanning beam sweeps each minute cell it releases the electricity charged up in that cell, the amount varying according to the amount of light or shade playing upon it from the lense. The discharge places the voltage upon the grid of an amplifying tube.

The outstanding advantages of this method of television pickup, besides the simplicity, is the fact that pictures of tremendously fine detail, up to 500 lines a frame, are possible; pictures with such good light pickup that the long dreamed of out-of-door scenes of baseball and football games become near realities.

It is this powerful light pickup and consequent impulse which makes this Super Eye the connecting link in bringing cathode ray television to a point of practical utility.

The cathode ray receiver had been foreseen by early workers, but a method of picking up the picture which could work up to the 500 line possibilities of the cathode ray picture reproducer seemed remote. Mechanical methods completely failed.

Even though the speed could be obtained by high speed and unwieldy apparatus, the breaking up of the picture into so many fine dots made each one so small and in turn its impression upon the photocell so small that amplification to any useful point was impossible to all intents and purposes.

With the Henroteau device, the scanning beam sweeps with the speed required for the 500 line television, but instead of being limited to the microscopic amount of light impulse which would result in the ordinary method of pickup, the beam arrives at each dot to find it holding a relatively large electrical charge which the beam releases instantly. On a basis of 24 pictures a second, it means that each minute particle will give an electrical impulse based on an exposure of 1/24 of a second, instead of 1/1,000,000 of a second under ordinary scanning conditions.

It is seldom that the literary figure of speech, "star-gazing," has such a literal parallel as in this case of the Canadian astronomer, who, scanning the remote stars, found the answer to television.

TRADIOGRAMS

By J. Murray Barron

Morris Lager, of the Try-Mo Radio Corp., New York City, which corporation operates a chain of radio stores catering to the amateur, experimenter and the general public, has returned from a trip through the mid-west. "Indications point to a favorable uptrend and the general business opinion is good," he reports.

* * *

Postal Radio Corp., 135 Liberty Street, New York City, is now offering a televisor. It is quite simplified, requires only two connections and comes in either kit form or wired. To the many experimenters in television there is lots of leeway in the development of television to the point that broadcast reception has reached. There are thousands of radio experimenters who have not as yet attempted to receive television broadcasts and yet others have found the study very interesting.

* * *

That radio experimenters are consistent mail-order buyers is well known to these houses, while organizations outside of the field are beginning to learn this. A nationally known typewriter firm has found it a good business proposition to sell its products through retail radio stores of the proper type, as so very often the families buying radio receivers have children who attend school or college and are in the market for a machine and as the retailer can offer the company guarantee and is backed up by them the customer is fully protected. This system of selling typewriters through radio outlets should be of a great advantage to the mail order customer in the small community who may be miles from the nearest agency.

ARCTURUS OPERATING UNDER BLANKET CODE

Newark, N. J.

The Arcturus Radio Tube Company has signed President Roosevelt's NRA code and has begun operation under this code.

In accordance with the provisions of the code, the earnings of Arcturus employees were increased approximately 5 per cent irrespective of the shorter working hours. The working force was increased 17 per cent. In taking on new help, Arcturs officials announced that preference was given to former employees.

WYNN'S CHAIN COMPLETES ITS SEVEN STUDIOS

The studios of the Amalgamated Broadcasting System, 501 Madison Avenue, New York City, have been completed.

Each of the seven studios is of a distinct color scheme, using the most modern of lighting equipment. In order that the truest sounds reach the ears of the radio listener, the studios have the newest acoustical equipment, which has been especially designed by Amalgamated engineers.

An unusual technical achievement in all of these studios is the complete isolation by a chamber of surrounding air. This affords sound-proofing to such a degree that the volume of a large symphony orchestra could not be heard even if the listener's ears were propped up against the walls.

Wynn Heads System

All the studios are located on the fourteenth floor of the building. The largest studio has been built to accommodate especially large ensembles, while two others can house orchestras up to 40 pieces. The remaining four are "intimate" studios. A special air-cooling system, noiseless in operation, is also one of the features of Amalgamated's new studios.

Ed Wynn is president of the system.

A massive organ built especially for broadcasting has been installed in one of the studios.

This organ, designed by R. P. Mathews, of the Marr and Colton Organ Co., is a three-manual instrument, equipped with every type of sound effect used in modern broadcasting.

"Only One with Organ"

According to James Rich, chief organist and director of Amalgamated's Musical Bureau, "the use of the organ together with unique combinations of the string sections of orchestras and other musical devices, is in a very embryonic state, compared to the amazing growth of other types of radio features.

"We are the only network having an organ in our main studios. This one instrument, combined with a twenty-five piece orchestra, gives the radio audience the same rich tonal quality as that of a fifty piece orchestral unit."

Enormous Business Ahead, Says Peters

H. R. Peters, president of National Union Radio Corporation, returned to New York after an extended tour of inspection of the World's Fair in Chicago.

"It is a glorious spectacle," said Mr. Peters, "well worth the expenditure of energy necessary to see it in its entirety.

"The Fair gives one a keen appreciation of the miracles which have been wrought through man's ability to harness the power of electricity. It gives me a keen sense of pride to realize that I am connected with an industry so vitally important to the progress of mankind. While the panorama of development during the last century seems to have moved at a terrific pace, I am confident that in so far as radio is concerned, we are merely on the threshold of an era in the radio business, which will dwarf the past."

RECOVERY CODE SEEKS TO INSTIL ETHICS IN RADIO

Washington.

After many weeks of work by the Radio Manufacturers Association Board of Directors and Code Committee, a national code for the radio manufacturing industry was filed with the National Recovery Administration.

Immediate application of the code's labor provisions, which it is estimated would give work to 10,000 more radio factory employees and increase industry's annual payroll by $3,000,000 was asked.

Members and the industry were urged by the RMA Board to make the wage increases and reduced working hours of the industry code operative at once.

The RMA also applied to the Government for immediate acceptance and operation of the industry code labor provisions. These are substantially those in President Roosevelt's voluntary code and of that submitted recently by the electrical industry.

The RMA code for the industry was approved by the Association's Board of Directors at a special emergency meeting at the Mayflower Hotel. The code was filed with the Government within forty-eight hours because of serious new problems facing employers and labor following the National Recovery Administration's voluntary code plan. The RMA had planned originally to submit the code to members and the industry before filing, but there will be ample future opportunity for its consideration.

36-Hour Maximum in Factory

The labor features of the RMA code, which would apply to all radio manufacturers including non-members of the Association and will be administered and enforced by the RMA, provide a 36-hour maximum week for factory workers. For all other employees except executive, administrative, research and engineering and supervisory employees and traveling and commission salespeople, a maximum working week of 40 hours is provided.

On the wages the RMA code provides a minimum wage for factory employees of 40c per hour unless this rate per hour for the same class of labor on July 15th, 1929, was less than 40c in which case the rate per hour shall be not less than the rate per hour paid on July 15th, 1929, and provided also that in no event shall the rate per hour be less than 30c. For all other employees, except commission salespeople, the RMA code provides minimum wages at the rate of $15 per week except that office boys and girls, learners and casual employees up to 5 per cent of the payroll may be paid 80 per cent. of these minimum wages.

Provision is made for adjustment of wages of employees above the minimum scale and also for extra-hour employment during seasonal peak periods.

Radical Changes

The minimum wage and maximum working hour provisions of the RMA code appear, to the RMA Board of Directors and the Code Committee, of which W. Roy McCanne of Rochester, New York, is chairman, to be the best probably obtainable in order to obtain prompt acceptance by the Government. The labor provisions were adopted by the Code Committee and approved by the RMA Board of Directors after weeks of labor and consideration of literally bales of statistical and other data.

W. L. Allen, prominent among the deputies on the staff of General Hugh S. Johnson, Administrator for the Government, has been designated to handle the RMA code. He recently had charge of the electrical industry code. The RMA Code Committee and officers will welcome suggestions from Association members or non-members, the latter having been advised of the industry code provisions.

The RMA code is replete with many provisions widely changing merchandising practices in the interests of jobbers and dealers as well as manufacturers and designed to stabilize the industry and its employment. Among major features of the code are two outstanding provisions. One is for a special trade agreement under Section 4 of the National Industrial Recovery Act providing uniform contracts between manufacturers, distributors and dealers, definitely establishing standard discounts, relations and trade practices in the marketing of receiving sets. The provision does not yet extend to but may be applied to other radio products.

Another most important plan in the industry code, also initially applying to receiving sets, would establish a scale of minimum but not maximum prices for various classes of receiver chassis based on a weighted average of production costs.

No set manufacturer would be permitted to sell below this weighted average "cost of production," that is, there would be price-fixing.

The code is described as being eminently fair both to small and large legitimate manufacturers of receiving sets. The code also provides against sales below "cost of production" by makers of other radio products.

The RMA code consists of general provisions affecting all radio manufacturers and also anticipates commercial use and, therefore, includes application to television. Various industry groups have additional chapters in the code containing provisions relating to their special interests. There are separate chapters for manufacturers of receiving sets; tubes; parts, cabinets and accessories; loud speakers, sound distribution equipment and fixed condensers. These group codes may be expanded later.

The code creates a Radio Emergency National Committee, composed of chairmen of the RMA Divisions, with broad powers to administer the national code, both for Association members and non-members—any one engaged in radio or television manufacture. It specifically provides that the code shall, with the approval of the President, be administered by the Radio Manufacturers Association through its Radio Emergency National Committee and be applicable to all manufacturers of radio and television products.

The Committee is given extensive powers to enforce all provisions of the code, including sales below cost of production, and all receiving sets below the proposed weighted average price. Provision is made for improving merchandising.

Summary of Code

Following is a summary of the provisions of the proposed code for the radio industry:

Title: Code of Fair Competition for the Radio Manufacturing Industry as Submitted for Revision.

Whom Affected: Radio manufacturing industry, its employees and contractees. The industry includes manufacturers of receiving and television sets, tubes, parts, cabinets, speakers, condensers and sound equipment.

Effective Date: Tenth day after approval by President Roosevelt.

Monopolies and Oppression: The provisions are not to be used for sanctioning or promoting monopolies or to oppress small enterprises.

Collective Bargaining: Safeguarded to employees, as is right to organize.

Company Union: No employee obliged to join one.

Child labor: No employee under 16 years of age to be hired.

Minimum Pay: For factory employees, 40c per hour, unless the rate on July 15th, 1929, was less, but in no event less than 30c per hour. Casual and incidental labor excepted, minimum 80% of the foregoing two, but limited to 5% of a month's total payroll to "process labor." Other employees (office help, etc.) on weekly salary, minimum $15, with same exception of 80% ($12) for casuals.

Hours of Labor: For process labor, not to exceed 36 hours per week. For others, not to exceed 40 hours per week. Exceptions for seasonal peaks or emergencies.

Sale Prohibited: No sale or offer to sell any product made contrary to the age, time and pay provisions is permitted.

Prices: One list price for entire country made mandatory. No secret rebates, gifts, bonuses to customers, etc., permitted, except extra discounts for quantity sales, and usual sales promotional aids, manufacturers to dealers, the promotion cost is limited to 3% of net selling price, quantity discounts 5% per $25,000, 10% per $100,000 up. Ways existing in the industry for hiding price concessions are listed and condemned, such as billing without enforcing collection, discriminating allowance for "repairs," etc. Manufacturer to fix own prices, but discounts, which must not be exceeded, are enumerated. Provision made for a standard cost accounting system later, and reports thereunder by manufacturers, so minimum prices for particular classes of sets, etc., by number of tubes and uses, may be fixed, on basis of these as yet unascertained data. Meanwhile nothing may be sold for less than the cost of the production, except close-outs, and such would be legal only if approved in advance by the National Recovery Administration.

Warranty: A standard warranty is enacted, guaranteeing freedom from defective material and workmanship for 90 days after consumer sale.

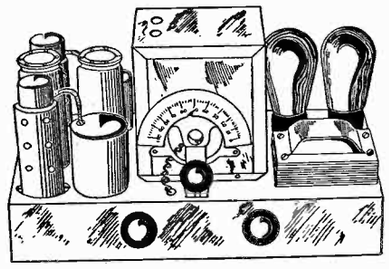
Penalties: Violations of the code constitute unfair competition and punishable under the Industrial Recovery Act by $500 fine, jail and loss of license to do business.

Contracts: Manufacturer agreements with distributors and retailers, and agreements by manufacturers with retailers, are standardized and prior agreements voided. "Distributors" are defined as those who "maintain adequate warehouse stocks and a proper selling organization for selling direct to dealers and who actually sell broadly to dealers." Contrary agreements, even if prior, are abrogated.

Discounts: Not to exceed following: from manufacturer to distributor, sets listing at $30 or less, 40 and 15%; $31 to $50, inclusive, 50 and 5%; $51 to $100, 50 and 10%; $101 up, $50, 10 and 5%; parts, 50 and 5%. Distributor to dealer, 36%, 40%, 40 and 5%, 40 and 10%, and 40%, for same price groupings as above. Provisions for advertising and sales promotion allowances to be inserted in agreement. Manufacturer-dealer agreements same as distributor-dealer agreements, discounts and all.

Payment: All payments 2% 10 days, 30 days net; or 2% on bills dated from 1st to 15th of month if paid on or before the 25th; or 2% if dated 16th to 26th and paid by the 10th of following month. Invoice date is date of shipment.

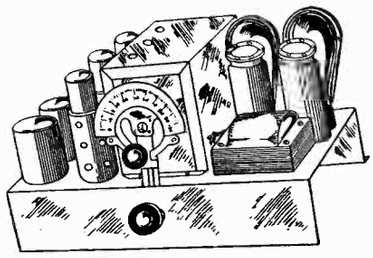
Administration: The executive committee of R. M. A. to constitute Radio Emergency National Committee and be responsible for the administration of the code. Six divisions are to be set up: sets; tubes; parts, cabinets, accessories; speakers; sound distribution equipment; fixed condensers.



BLUEPRINTS, COILS and CHASSIS

FOR THE TUNED R-F

DIAMOND OF THE AIR



FOUR-TUBE DIAMOND

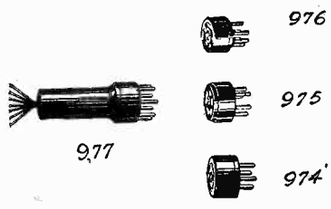
Extremely fine performance, including fetching tone quality, marks the Four-Tube A-C 1933 Diamond of the Air, blueprint of which is now available (half-scale). Many have been surprised that so much can be accomplished on a t-r-f set that costs so little to build. The circuit uses a two-gang 0.00035 mfd. condenser. Special coils are required. The chassis is metal, 13.75 x 6.75 x 2.5 inches.

Send $3.00 for six months subscription (26 issues) and get the blueprint, two official shielded coils and the drilled metal chassis free. Order PRE-D-4-COMB.

FIVE-TUBE DIAMOND

The Five-Tube A-C 1933 Diamond of the Air provides greater sensitivity than the four-tube model, also somewhat more selectivity, as a three-gang condenser is used. An infallible method of permanently suppressing oscillation is introduced, so that besides having a sensitive and selective set one will have a stable receiver. The tone is most excellent. Send $4.00 for 34 weeks subscription (34 issues) and get the blueprint, three shielded coils and drilled metal chassis free. Chassis is 13.75 x 9 x 3 inches. Order Cat. PRE-D-5-COMB.

Analyzer Plug and Adapters



For constructing a set analyzer, an analyzer plug, to go into a receiver socket, is necessary. We offer the exclusive seven-pin analyzer plug, plain long handle as illustrated, and three adapters that enable putting the plug connections into UX, UY and six-pin receiver sockets. The plug has 5-foot 7-lead cable. All four parts sent free on receipt of $6.00 for one-year's subscription (52 issues). Order Cat. PRE-ANPLAD.

0-10,000-Ohm Resistance Meter

A 0-10,000-ohm ohmmeter and continuity tester. A rheostat is built in for correct zero resistance adjustment. The unit contains a three-cell flashlight battery. Supplied with two 5-foot-long wire leads with tip plugs. Case is 4-inch diameter baked enamel. Sent you for an order for one year's subscription for RADIO WORLD (52 weeks) at the regular rate of $6. Order Cat. PRE-500.

We do not pay postage on resistance meter. Average postage 17c.

RADIO WORLD and RADIO NEWS } $7.00

Get both of these mazagines for one year for $7.00, although the regular subscription price of RADIO WORLD alone is $6.00 a year and that of "Radio News" alone is $2.50 a year. Instead of paying $8.50 you pay $7 and you get 52 issues of RADIO WORLD (one a week) and 12 issues of "Radio News" (one a month). "Radio News" recently bought "Citizens Radio Call Book," and "Technical Review" and consolidated them with "Radio News." This offer at this combination price applies only to United States and possessions. Send $7.00 and order Cat. PRE-RWRN.

To Canadian and other Foreign subscribers the combination price offer is at $8.50 for these two magazines. Order Cat. PRE-FOR-RWRN.

RIDER'S MANUAL

The standby of the service man is John F. Rider's "Perpetual Trouble Shooter's Manual," of which Vols. 1 and 2 have been published.

Vol. 1 consists of 2,000 diagrams of commercial receivers, power amplifiers, converters, etc. Total pages, 1200.

Vol. 2 contains additional diagrams on the same basis as above, but in Vol. 2 there is no duplication of any of the diagrams printed in Vol. 1.

To get Vol. 1 free, send $9.00 for 1½-year subscription (78 weeks) and order Cat. PRE-RM-1.

To get Vol. 2 free, send $9.00 for 1½-year subscription (78 weeks) and order Cat. PRE-RM-2.

PHONOGRAPH MOTOR

Allen-Hough synchronous phonograph motor, 78 revolutions per minute; takes up to 12-inch records. Works from a-c line, 50-60 cycles, 105-120 volts. Equipped with felt-covered turntable. To start the motor give it a slight impetus. Fits into 3-inch depth, hence handy for compact installations. Given free with 34-weeks subscription at $4.00. Order Cat. PRE-PHOMO.

A-C, D-C SOLDERING IRON

A serviceable iron that works on a-c (any frequency) and d-c, 105-120 volts. Sent free on receipt of $1.50 for three-months subscription (13 issues). Order Cat. PRE-SOLIN.

DOLLAR SPECIALS

R-F CHOKE COILS

These coils have 50, 100, 200, 400 and 800 turns, diameter 1 inch, and are suitable for detector plate filtering, screen filtering, grid and plate loads, etc. The 50 is for short waves, 100 for television band, 200 for broadcast band, 400 for high intermediate frequencies (450 to 300) and 800 for lower intermediate frequencies. Any four, or four of a kind, or combinations not exceeding total of four, sent free on receipt of $1.00 for 8 weeks trial subscription. Order Cat. PRE-4-CH and state chokes desired, by quantity and number of turns.

TWO BOOKS BY ANDERSON AND BERNARD

"The Superheterodyne," by J. E. Anderson and Herman Bernard. A treatise on the theory and practice of the outstanding circuit of the day. Special problems of superheterodynes treated authoritatively.

"Foothold on Radio." A simple and elementary exposition of how broadcasting is conducted, with some receiver circuits and an explanation of their functioning. Both books sent free on receipt of $1.00 for 8 weeks trial subscription. Order Cats. PRE-SH-FH.

CHOICE OF PANEL TYPE METERS

One meter sent free with each $1.00 trial subscription (8 weeks). Order Cat. PRE-MTR and add the number of the meter to the catalogue number. Any number of meters may be ordered on the equivalent extended subscription basis.

0-6 Voltmeter D.C.	No. 326
0-50 Voltmeter D.C.	No. 337
6-Volt Charge Tester D.C.	No. 23
0-10 Amperes D.C.	No. 338
0-25 Milliamperes D.C.	No. 325
0-50 Milliamperes D.C.	No. 350
0-100 Milliamperes D.C.	No. 390
0-300 Milliamperes D.C.	No. 399
0-400 Milliamperes D.C.	No. 394

HANDY PACKAGE OF PARTS

One grid condenser of 0.00025 mfd., with clips; one 5-to-7 meg. fixed grid leak; one knob with ¼-inch shaft; one a-c cable and plug. All sent on receipt of $1.00 for 8-weeks trial subscription. Order Cat. PRE-HANPKG.

SHIELDS FOR 57, 58 TUBES

Aluminium shields of the type specified by the tube manufacturers for sensitive circuits, so that the shield top fits snugly about the tube dome, are obtainable, six free on receipt of $1.00 for 8 weeks trial subscription. Order Cat. PRE-TUBSH.

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

(WE PAY POSTAGE ON ALL PRODUCTS LISTED ON THIS PAGE, EXCEPT OHMMETER).