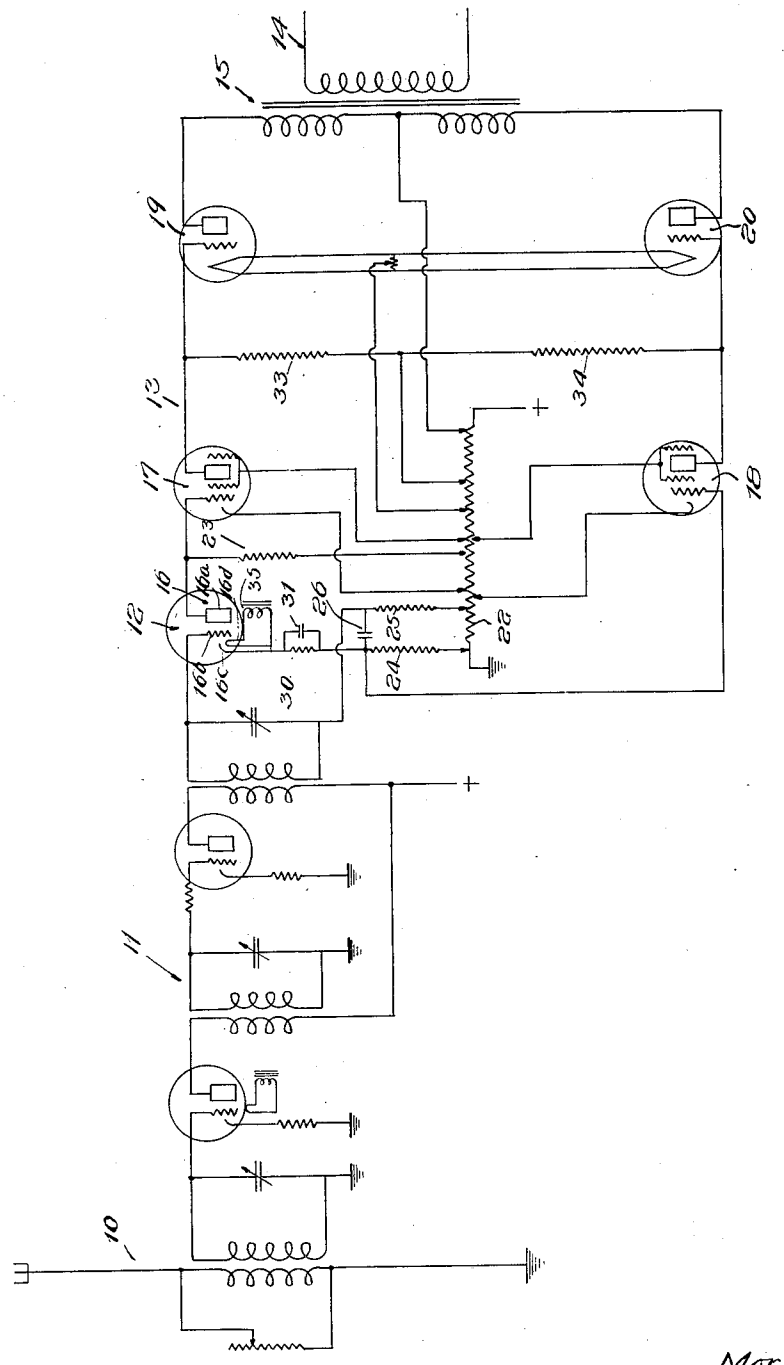
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RADIO APPARATUS

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RADIO APPARATUS

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9 Claims. (Cl. 179—171)

The invention relates to radio apparatus, and more particularly to push-pull amplifier systems of the type shown and described in my co-pending application, Serial No. 420,448, filed January 13, 1930.

A particular object of the invention is to provide means for maintaining predetermined operating conditions, or potentials, in the tubes of push-pull systems having means other than transformers for coupling the output of a tube to push-pull tubes. Thus, the invention is particularly adapted to be embodied in push-pull systems to couple the output of a tube and the push-pull tube directly, or by a combination of resistances and capacities, or by a combination of inductances and capacities.

A preferred form of the invention is embodied in radio apparatus which comprises a tube that has its output coupled directly to push-pull tubes through electrical resistances. The load in the output or plate circuit of the tube which is coupled to the push-pull tubes is divided into two sections, the voltage across one of the sections being applied to the input circuit of one push-pull tube and the voltage across the other section being applied to the input circuit of the other push-pull tube. Means is provided for maintaining predetermined potentials in the elements of the tubes.

Many other objects and advantages will become apparent as the following description progresses, reference being had to the accompanying drawing which is a diagram of radio apparatus embodying the invention.

In the accompanying drawing, the invention is disclosed in connection with a radio-receiver comprising a radio frequency amplifier, a detector and an audio frequency amplifier, but it is to be understood that my invention is limited to such use only to the extent indicated in the appended claims.

In the drawing, 10 indicates generally an antenna circuit coupled to a radio frequency amplifier 11 which is coupled to a detector stage 12, the output of the detector stage 12 being coupled to an audio frequency amplifier 13. The output circuit of audio frequency amplifier 13 is coupled to the secondary winding 14 of an audio frequency transformer 15. Obviously, the secondary winding 14 may be connected in the usual manner to a loud speaker, or the equivalent.

The detector stage 12 preferably comprises a tube 16 comprising a plate 16*a*, a grid 16*b*, a cathode 16*c* and a filament 16*d*. The audio frequency amplifier 13 comprises, in this instance, screen-grid tubes 17 and 18 and power or output tubes 19 and 20, the primary windings of the audio frequency transformer 15 being included in the plate circuits of the tubes 19 and 20. Operating potentials are impressed upon the grid, plate and cathode elements of the several tubes by means comprising a voltage divider 22.

The output circuit of the detector tube 16 includes resistances 23 and 24 which are preferably substantially equal to each other, the resistance 24 being arranged in parallel with a resistance 25 and a condenser 26, arranged in series.

The plate 16*a* is connected directly to the control grid of the tube 17 and to one terminal of the resistance 23, the other terminal of the resistance 23 being connected to the voltage divider 22. One terminal of the resistance 25 is connected to the voltage divider 22 and the other terminal thereof is connected to one plate of the condenser 26 and to the grid 16*b* to provide a predetermined bias upon this grid. It will be noted that the grid 16*b* is included in a tuned circuit and that this circuit is coupled to the output circuit of the radio frequency amplifier 11.

One terminal of the resistance 24 is connected to the voltage divider 22 and the other terminal thereof is connected to the other plate of the condenser 26 and to one terminal of a resistance 30 which has its other terminal connected to the cathode 16*c*, the resistance 30 being shunted by a relatively large condenser 31. That terminal of the resistance 24 which is connected to the condenser 26 is also connected to the control grid of the tube 18.

As described in more detail in my co-pending application, Serial No. 420,448, the variations in the voltage drop across the resistance 23 are impressed upon the control grid of the tube 17 and the variations in the drop across the resistance 24 are impressed upon the control grid of the tube 18, the variations in voltage drops being substantially equal and opposite in phase.

The normal operating conditions with regard to the bias voltages and plate currents are determined in the usual manner by the constants of the circuit, and the primary object of the invention is to provide means whereby any change in these conditions, which the incoming signal tends to produce, is automatically prevented. Thus, assuming that prior to the time a signal is impressed upon the antenna circuit, a predetermined bias obtains on the grid 16*b*, it is readily understood that if a signal is impressed upon the grid the rectified carrier current which will then flow in the plate circuit of the tube 16, in addition to

the normal plate current, will cause a larger voltage drop across the resistance 23 and will tend to increase the bias on the control grid of the tube 17 to change it from the predetermined correct bias for that grid. However, there will be a larger voltage drop across the resistances 24 and 30 so that the cathode 16c will become more positive and, therefore, the bias on the grid 16b will be increased. This increase of bias on the grid 16b decreases the plate current so that it returns to substantially its original value, and the bias on the control grid of the tube 17 is returned to its proper value. Of course, the bias of the grid 18 will tend to change in the same manner as the bias on the grid 17 when a signal is impressed upon the antenna circuit 10, but the bias of the grid 18 will tend to become more positive when the bias of the grid 17 tends to increase, and vice versa. As a change of this character in the bias of the tube 18 is effected by an increase of the normal plate current, and such increase of the normal plate current causes an increase in the bias of the grid 16b so that the plate current is decreased to its original value, the bias of the tube 18 will be returned to its original value.

It may be mentioned at this point in the description that the resistance 30 and condenser 31 may be omitted if it is so desired as the values of the resistances 23 and 24 may be increased. However, the resistance 30 and the condenser 31 are preferably employed so that the constants of the detector circuit are more easily determined.

The apparatus is arranged so that the A. C. component of the signal may vary the bias of each of the tubes 17 and 18 in the usual manner without having its amplitude checked or reduced as is the case with the D. C. component. This is accomplished by preventing the A. C. component from affecting the grid bias of the detector tube. To this end, and as set forth above, the resistance 30 is by-passed by the condenser 31 and the resistance 24 is shunted by the resistance 25 and the condenser 26 in series. The resistance 25 is of a much higher value than the resistance 24 and the condenser 26 is sufficiently large so that it comprises a very small part of the total impedance of the shunt circuit. Since the grid bias of the detector is in effect the voltage between the cathode 16c and that plate, of the condenser 26, which is connected to the resistance 25, it will be seen that the A. C. plate current will have a very small impedance path from the last mentioned plate of the condenser 26 to the cathode, which path comprises the condensers 26 and 31. The condenser 31 is, of course, relatively large to pass audio frequencies.

The A. C. component will flow in parallel paths through the resistances 24 and 25, but as the resistance 25 is of a much higher value than the resistance 24, most of it will flow through the resistance 24 and there will be a large voltage variation, or voltage drop in the resistance 24. There will also be a relatively large voltage variation, or voltage drop across the shunt circuit which includes the resistance 25 and the condenser 26, but most of it will be across the resistance so that there will be a comparatively small or negligible variation in voltage across the condenser 26. The small voltage variation across the condenser 26 added to the correspondingly small voltage variation across the condenser 31 constitute the total variation in grid bias of the detector occasioned by the A. C. component in the plate circuit of the detector.

The tubes 17 and 18 of the first push-pull stage are coupled directly to the tubes 19 and 20, respectively, resistances 33 and 34, respectively, being provided for this purpose.

Generally I prefer to provide a separate winding 35 on the power pack (not shown) to supply the heater current for the detector tube 16 in order to conform to the manufacturer's specifications (as to the maximum voltage between the cathode and heater) as the cathode of the detector tube has a potential with respect to ground different from that of the other tubes.

It is not necessary that the detector tube be coupled to the first push-pull stage, as an amplifying tube may be coupled to the first push-pull stage in the same manner as the tube 16 is coupled to the tubes 17 and 18 to obtain like results. In this case, the effect of the signal need not be considered, the circuit being particularly adapted to maintain correct operating voltages when new tubes are inserted therein. Of course, the circuit shown in the drawing also compensates for variations in tubes.

When the grid leak detection is employed and the detector is coupled to the first push-pull stage, the normal plate current will be decreased by the incoming signal, but the system will function in a manner similar to that in which it functions when grid bias detection is employed. When grid leak detection is employed the resistance 25 is connected to the voltage divider 22 in such manner that the grid of the detector is positive with respect to its cathode.

The foregoing detailed description has been given for clearness of understanding only and no unnecessary limitations should be understood therefrom, but the appended claims should be construed as broadly as permissible in view of the prior art.

What I claim as new, and desire to secure by Letters Patent, is:

1. In amplifying apparatus, a power supply, a push-pull stage comprising two tubes having input circuits; an output circuit coupled to said input circuits, the load of said output circuit being divided into sections separated by the power supply, the control grid of each of said tubes being subjected to variations in the voltage drop across one of said sections, means for maintaining the average direct current in said output circuit substantially constant when the conditions, under which the radio apparatus is operating, vary, and means providing an audio-frequency path in parallel with one of said sections.

2. In amplifying apparatus a power supply, a push-pull stage comprising two tubes having input circuits, an output circuit coupled to said input circuits, the load of said output circuit being divided into sections separated by the power supply, the control grid of each of said tubes being subjected to variations in the voltage drop across one of said sections, means subjected to the direct current component in said output circuit for preventing sustained fluctuations in the control grid potentials of said tubes, and means providing an audio-frequency path in parallel with one of said sections.

3. In amplifying apparatus, a power supply, a tube having a control grid and a plate and input and output circuits, respectively, connected to said grid and plate, said output circuit being divided into sections separated by the power supply, a push-pull stage having two tubes provided with input circuits, one of the last mentioned input circuits being subjected to voltage variations across one of said sections and the other being

subjected to voltage variations across another of said sections, and means including means forming an audio-frequency path in parallel with one of said sections for maintaining the average direct plate current substantially constant under varying operating conditions.

4. In amplifying apparatus, a power supply, a tube having a control grid and a plate, and input and output circuits, respectively, connected to said grid and plate, said output circuit being divided into sections separated by the power supply, a push-pull stage having two tubes provided with input circuits, one of the last mentioned input circuits being subjected to voltage variations across one of said sections and the other being subjected to voltage variations across another of said sections, and means including a condenser and a resistance connected in series and forming an audio-frequency path in parallel with one of said sections for maintaining the direct plate current in said output circuit substantially constant under varying operating conditions.

5. In amplifying apparatus, a power supply, a tube having a control grid and a plate, and input and output circuits, respectively, connected to said grid and plate, said output circuit being divided into sections separated by the power supply, a push-pull stage having two tubes provided with input circuits, one of the last mentioned input circuits being subjected to voltage variations across one of said sections and the other being subjected to voltage variations across another of said sections, and means including a condenser and a resistance connected in series and forming an audio-frequency path in parallel with one of said sections for maintaining the direct plate current in said output circuit substantially constant under varying operating conditions, one terminal of said condenser being connected to said grid.

6. In amplifying apparatus, a power supply, a tube having plate, grid and cathode elements, and input and output circuits operatively connected thereto, the impedance of the output circuit being divided into sections separated by the power supply, a resistance in parallel with one of said sections and having one of its terminals connected to one end of said load section through a condenser by-passing audio-frequencies, said terminal of said resistance being connected to said input circuit, and a push-pull stage comprising two tubes having input and output circuits, one of the last mentioned input circuits being subjected to voltage variations in one of said load sections and the other being subjected to voltage variations in another of said load sections.

7. In amplifying apparatus, a power supply, a push-pull stage comprising two tubes having input circuits, a third vacuum tube having an output circuit coupled to said input circuits, said output circuit being adapted to transmit audio frequency signals to said input circuits, the output circuit being divided into sections separated by the power supply, the control grids of said push-pull tubes being subjected to variation in the voltage drops across said sections to secure the proper phase relationship for push-pull operation, and a shunt circuit around one of said sections, the control grid of said third tube being connected to an intermediate point on said shunt circuit dividing the impedance of said shunt circuit into two portions, whereby for the audio frequency signals being transmitted, the impedance between the cathode end of the last mentioned section and said point is low compared to the impedance between said point and the other end of the last mentioned section.

8. In an electrical circuit for transmitting signals, a repeating tube having input and output circuits with a load and a shunt circuit for said load common to said input and output circuits, said shunt circuit consisting of a plurality of sections having impedances differing widely in value as far as audio frequencies are concerned, the section having the smaller impedance providing an audio frequency path of low impedance in said input circuit, which path shunts said load and the other section so that said input circuit is not subjected appreciably to the degenerative action of the signal voltage across said load, and a second tube having input and output circuits, the input circuit of said second tube including said load and being subjected to the signal voltage across said load, and the output circuit of said second tube being adapted to operate means responsive to said signals.

9. In an electrical circuit for transmitting signals, a repeating tube having input and output circuits with a load and a shunt circuit for said load common to said input and output circuits, said shunt circuit consisting of a plurality of sections having impedances differing widely in value as far as audio frequencies are concerned, the section having the smaller impedance being adapted to block direct current and providing an audio frequency path of low impedance in said input circuit, which path shunts said load and the other section so that said input circuit is not subjected appreciably to the degenerative action of the signal voltage across said load, and a second tube having input and output circuits, the input circuit of said second tube including said load and being subjected to the signal voltage across said load, and the output circuit of said second tube being adapted to operate means responsive to said signals.

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