July 19, 1938. M. ARTZT 2,123,924

DIRECT CURRENT AMPLIFIER

Filed July 31, 1934

Fig. 1.

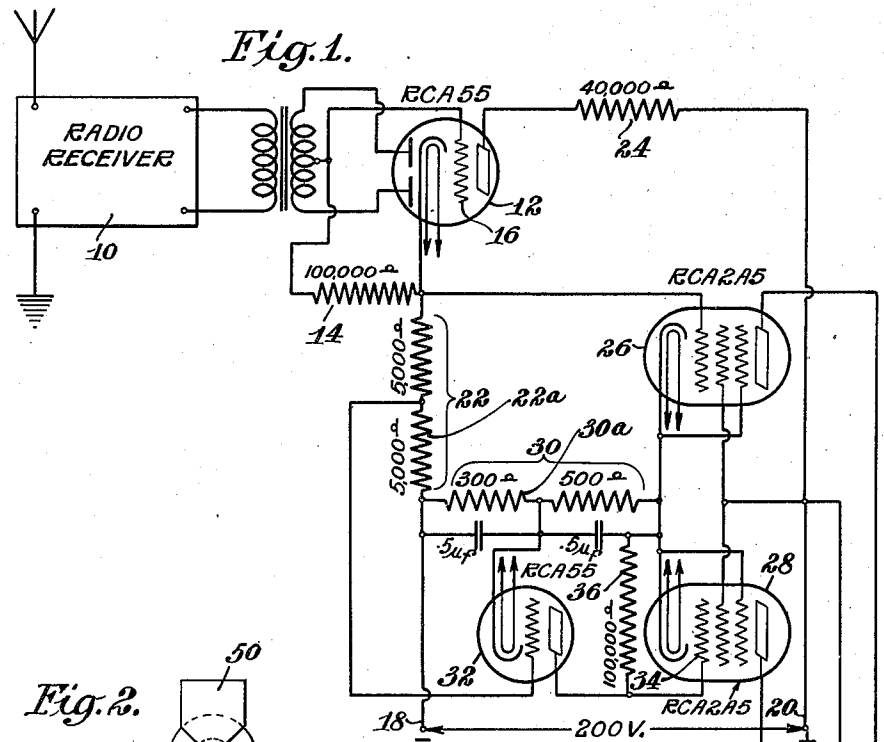


Fig. 2.

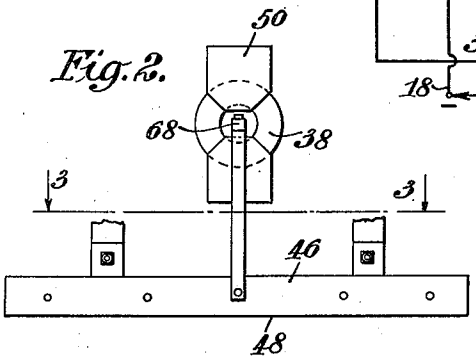


Fig. 3.

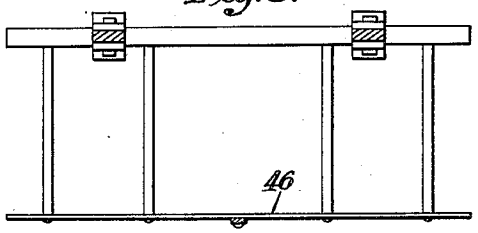
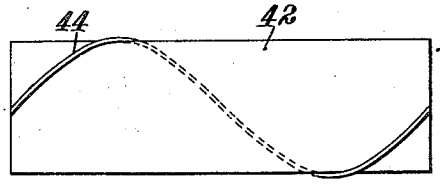
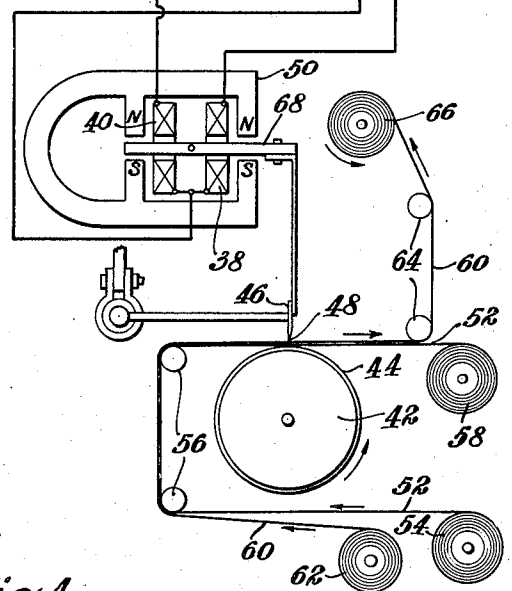


Fig. 4.





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UNITED STATES PATENT OFFICE

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DIRECT-CURRENT AMPLIFIER

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Application July 31, 1934, Serial No. 737,720

6 Claims. (Cl. 179—171)

My invention relates to improvements in direct-current amplifiers.

One of the objects of my invention is to provide an improved direct-current amplifier adapted particularly for amplifying incoming picture signals in a facsimile system, and supplying the amplified signals to the operating circuit of recording apparatus at the receiving station, the amplifier having advantages over those proposed heretofore in the way of being more sensitive, more stable, comprised of fewer tubes, and comprised of fewer parts generally.

Other objects and advantages will hereinafter appear.

In accordance with my invention, a pair of electron tubes are connected in push-pull relation to comprise a push-pull stage. A third tube functions to reverse the operating action of one tube with respect to the other in the push-pull stage, and a cathode resistor in this stage is connected to conduct the plate currents of both tubes which are balanced so that the sum of their respective currents through this resistor is substantially constant. The reversing tube is supplied with polarizing voltages from the cathode resistor. A fourth tube is controlled by the incoming picture signals, and operates to effect variation of the bias on the reversing tube and one of the tubes of the push-pull stage. The operating action is such that every tube, under no signal, is either at zero plate current or at full plate current. Direct coupling between the various tubes is used throughout the circuit. There is a common "B" supply for all tubes, and no "floating" batteries are used at any point in the circuit.

My invention resides in the improved amplifier and system of the character hereinafter described and claimed.

For the purpose of illustrating my invention, an embodiment thereof is shown in the drawing, wherein

Figure 1 is a diagrammatic view of a facsimile receiving system embodying and operating in accordance with my invention;

Fig. 2 is an elevational view of one of the parts, looking toward the left in Fig. 1;

Fig. 3 is a sectional view, the section being taken on the line 3—3 in Fig. 2; and

Fig. 4 is a plan view of one of the parts in Fig. 1.

Referring to Fig. 1, the incoming signals are intercepted by a suitable receiver 10, rectified by a tube 12, and appear as direct current signals across a resistor 14 connected as shown to supply bias on the grid 16 of this tube. These signals appearing across the resistance 14 are the only source of bias for the grid 16. A substantially constant polarizing potential of 200 volts is applied across the output connections 18 and 20 from the tube 12. A resistance 22 is connected as shown in the output connection 18 from the tube 12, and a resistor 24 is connected in the output connection 20 from the plate of this tube.

A first electron tube 26 and a second electron tube 28 are connected as shown in push-pull relation to comprise a push-pull stage. A cathode resistor 30 is connected in the push-pull stage to conduct the plate currents of both the tubes 26 and 28.

An electron tube 32 is connected as shown to the input circuit of the tube 28 to reverse the operating action of the latter with respect to the operating action of the first tube 26, as will hereinafter more fully appear. The bias on the grid 34 of the tube 28 is determined by the voltage across the resistor 36 connected in the plate circuit of the tube 32.

The polarities are as indicated.

The tubes 26 and 28 are balanced so that the sum of their respective return plate currents through the resistor 30 is constant. Constant polarizing voltages are therefore supplied to the reversing tube 32 from the resistor 30.

In operation, under the conditions of no picture signal, the tube 12 is at zero bias, giving full current through the resistors 22 and 24. The potential across the resistor 22 cancels the bias on the tube 26 that is given by the resistor 30. There is therefore full plate current through a printer coil 38 connected as shown in the plate circuit of the tube 26.

The biasing potential for the tube 32, which is supplied by the section 30*a* of the resistor 30, is canceled by the potential across the section 22*a* of the resistor 22. There is therefore full plate current through the resistor 36, so that the tube 28 is biased to cut-off. No current then flows through a printer coil 40 connected as shown in the plate circuit of the tube 28.

When a picture signal is received, the potential across the resistor 14 biases the tube 12 to cut-off, thereby lessening the cancellation effect of the potential across the resistor 22 with respect to the biasing potentials on the tubes 26 and 32. As the plate current of the tube 32 decreases, accordingly, the bias on the tube 28 decreases also to cause a corresponding increase in the plate current of the tube 28 and excita-

tion of the coil 40. Simultaneously with such action, the bias on the tube 26 increases to decrease the plate current of this tube and the degree of excitation of the coil 38.

In operation, either or both of the tubes 26 and 28 are drawing current through the resistor 30. These tubes being balanced and reversed with respect to each other, the voltage across the resistor 30 therefore remains constant.

Under no signal, the tubes 12, 26, and 32 are at full plate current, while the tube 28 is at zero plate current. The system, therefore, cannot drift.

It is to be noted that there is a common "B" supply for all tubes, that the cathodes are relatively high above ground, and that direct coupling is used throughout the circuit. It is also to be noted that no "floating" batteries are used at any point in the circuit.

By using the reversing tube 32 to give the tube 28 the opposite action of the tube 26, the load on the "B" supply remains practically constant instead of varying with signal input. In this way the "B" supply is removed as a factor in determining the stability of the system due to poor regulation of the "B" supply.

The facsimile recording apparatus is represented as being of a conventional construction such as is disclosed in Patent No. 1,848,862 of March 8, 1932, to Charles J. Young, and comprises a rotatable drum 42 provided on its surface with a helical ridge 44. A printer bar 46 is supported as shown with its operating edge 48 parallel to the axis of rotation of the drum 42, and for movement toward and away from the drum by the electromagnetic means 50 of which the coils 38 and 40 form a part. In operation, a strip 52 of record paper is taken from a roll 54 and passes around guide rods 56 and between the drum 42 and the printer bar to a takeup roller 58. The roller 58 is rotated at a constant rate to cause the record paper to be fed through the apparatus at the rate of about six inches a minute, for example.

A strip 60 of carbon paper is taken from a roll 62 and passes around the guide rods 56 and between the drum 42 and the printer bar, and then passes around the guide rods 64 to a takeup roller 66. The roller 66 is rotated in the direction indicated at a constant rate to cause feeding of the carbon strip through the apparatus at a rate slightly less than the rate of feed of the record paper.

The drum 42 is rotated in the counter-clockwise direction at a constant rate of four revolutions a second, for example.

The adjustment and arrangement are such that under conditions of no signal the coil 38 is excited to cause slight counter-clockwise movement of an armature 68 to which the printer bar is connected. There is therefore no pressure of the edge 48 of the printer bar on the paper strips 52 and 60, and the helical ridge 42 sweeps lightly against the adjacent face of the sheet 52 as the drum 42 rotates. Upon the occurrence of a signal, the coil 38 becomes deenergized and the coil 40 becomes energized, as explained, to cause slight clockwise movement of the armature 68 and downward movement of the printer bar to press the two strips 52 and 60 between its operating edge and the helical ridge 44, thereby making a mark on the record strip.

From the foregoing it will be seen that I have provided an improved direct-current amplifier which is particularly adapted for use in connection with facsimile receiving apparatus, and which has advantages over those proposed heretofore in the way of greater sensitivity, greater stability, and the use of fewer tubes and fewer parts generally.

Satisfactory results have been obtained by using the various values of resistance indicated in the drawing, and by using the particular types of tubes identified in the drawing by the respective designations by which they are identified in the trade. The values of resistance, however, are not critical in any sense of the word, and can be varied to suit particular requirements. Also, other types of tubes than those designated can be used.

While but one embodiment of my invention has been disclosed, it will be understood that various modifications within the conception of those skilled in the art are possible without departing from the spirit of my invention or the scope of the claims.

I claim as my invention:

1. In a direct-current amplifier, a first electron tube and a second electron tube connected in push-pull relation to comprise a push-pull stage, a cathode resistor connected in said stage to conduct the plate currents of both of said tubes, a third electron tube connected to the input circuit of the second tube to reverse the operating action of the latter with respect to the operating action of the first tube, said first and second tubes being balanced whereby the current through said resistor remains substantially constant over substantially the normal operating range of said amplifier, said third tube being supplied from said resistor with polarizing voltage, a fourth electron tube having its output circuit connected to the input circuit of said first tube, a second resistor connected in the grid circuit of said fourth tube and to which the incoming signals are applied, and connecting means for supplying an operating potential to said amplifier.

2. In a direct-current amplifier, a first electron tube and a second electron tube connected in push-pull relation to comprise a push-pull stage, a cathode resistor connected in said stage to conduct the plate currents of both of said tubes, a third electron tube connected to the input circuit of the second tube to reverse the operating action of the latter with respect to the operating action of the first tube, a fourth electron tube, a second resistor connected in the output circuit of said fourth tube and in opposition with respect to said cathode resistor, said first and second tubes being balanced so that the sum of their respective plate currents through said cathode resistor is substantially constant, said third tube being supplied with polarizing voltage from said cathode resistor, and connecting means for applying signals to a control circuit of said fourth tube.

3. In a direct-current amplifier, a first electron tube and a second electron tube connected in push-pull relation to comprise a push-pull stage, a third electron tube connected to the input circuit of the second tube to reverse the operating action of the latter with respect to the operating action of the first tube, a cathode resistor connected in the push-pull stage to conduct the plate currents of both the first and second tubes, the resulting potential drop in said resistor serving to bias the third electron tube, a fourth electron tube connected to the input circuit of the first tube and operating to control the bias

thereon in accordance with signals applied to said amplifier, the respective potentials of the cathodes of said tubes being relatively high with respect to ground, and a source of potential supply common to said tubes.

4. In a direct-current amplifier, a first electron tube and a second electron tube connected in push-pull relation to comprise a push-pull stage, a cathode resistor connected in said stage to conduct the plate currents of both of said tubes, a third electron tube for reversing the operating action of the second tube with respect to the operating action of the first tube, said first and second tubes being balanced so that throughout the normal operating range of said amplifier the sum of their respective plate currents through said resistor remains at a substantially constant value, said third tube being supplied with polarizing voltage from said resistor, and a fourth electron tube common with respect to said first and third tubes for controlling the bias thereon, the conditions of polarity in said amplifier being such that with no signal applied thereto only the second tube is biased to at least the cut-off point and the first and third and fourth tubes are caused to operate at substantially pull plate current.

5. In a direct-current amplifier, a first electron tube and a second electron tube connected in push-pull relation to comprise a push-pull stage, a cathode resistor connected in said stage to conduct the plate currents of both of said tubes, a third electron tube connected to the input circuit of the second tube to reverse the operating action of the latter with respect to the operating action of the first tube, said third tube being supplied from said resistor with polarizing voltage, a fourth electron tube connected to the control circuits of said first and third tubes for controlling the respective biasing potentials thereon, and means for varying the biasing potential on said fourth tube in accordance with signals applied to said amplifier.

6. In a direct-current amplifier, a first electron tube and a second electron tube connected in push-pull relation to comprise a push-pull stage, a third electron tube connected directly to the second tube and operating to reverse the operating action of the latter with respect to the operating action of the first tube, a fourth tube directly connected to the first tube and resistively connected to the third tube and operating to control the respective biasing potentials on the first and third tubes, and means for varying the biasing potential on the fourth tube in accordance with signals applied to said amplifier.

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