

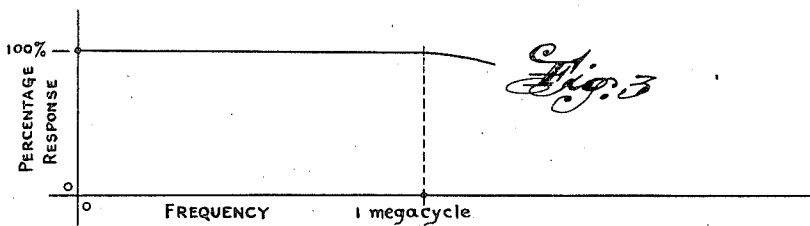
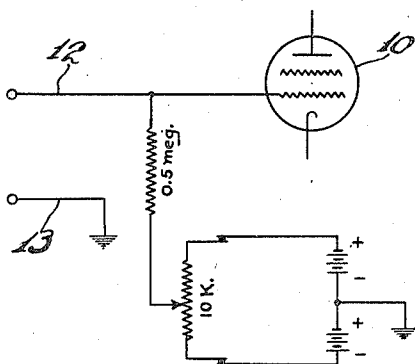
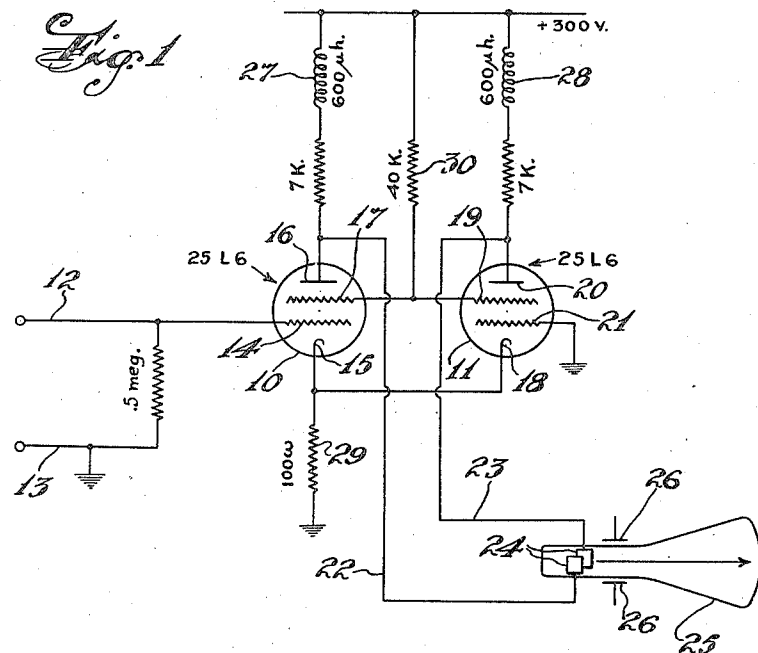
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AMPLIFIER

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AMPLIFIER

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2 Claims. (Cl. 179-171)

My invention relates to improvements in amplifiers.

In general, it is desirable, for the final deflection amplifier of a cathode-ray oscillograph or television receiver, to employ a push-pull amplifier to keep the average potential of each pair of deflection plates approximately constant and thus minimize defocusing of the spot with deflection. Common practice at present is to use a resistance-capacity coupled AC amplifier in which the signal is fed directly or through preamplifiers to the grid of one tube, and a portion of the plate output of the first tube is fed to the grid of the second tube so that the outputs of the two tubes are approximately equal but in opposite phase. Particularly in oscillograph amplifiers, however, it is desirable to include both very low and very high frequencies in the range over which the amplifier response is flat. With the usual arrangement as outlined, the provisions in the circuit for good low-frequency response are detrimental to good high-frequency response, and vice versa.

An arrangement sometimes employed, where very low frequency response is desired, is to use a direct-coupled or DC amplifier in which a high resistance voltage divider between the plate of the first tube and ground is used to feed a portion of the plate output of the first tube to the grid of the second tube. While this arrangement gives flat response at the low frequencies down to and including DC or zero frequency, the high frequency response is often poor. Furthermore, in these amplifiers a relatively large number of parts is required, there are a number of critical adjustments, and relatively small fluctuations in plate-supply voltage result in an unbalance of the amplifier circuit.

With the foregoing in mind, it is an object of my invention to provide an improved DC amplifier for symmetrical deflection of the beam in a cathode-ray tube or for other uses where a push-pull output is desired, which has advantages over the various amplifiers used heretofore in the way of greatly improved response in the high-frequency range, and a reduction in the number of parts required.

Another object of my invention resides in the provision of an improved direct-coupled symmetrical amplifier combining high gain with good high-frequency response, in which no critical adjustments are required, which has high stability in the presence of wide variations of plate-supply voltage, and which permits the use of

pentode tubes without the distortion usually associated with such tubes.

Other objects and advantages will hereinafter appear.

In accordance with my invention, two pentode or tetrode tubes are used for the amplifier. The input signal is applied to the control grid of the first tube, and the control grid of the second tube is held at a fixed potential. The signal is transferred in opposite phase to the second tube by a combination of cathode and screen-grid coupling. A signal, applied to the control grid of the first tube tends to produce changes in the same phase on the cathodes of the two tubes and in opposite phase on the respective screen-grids of the tubes, and an amplified change in opposite phase on the plate of the first tube. Since the control-grid of the second tube is held at fixed potential, the cathode and screen-grid changes on the second tube tend to produce an amplified change on the plate of the second tube in the same phase as the input signal on the grid of the first tube.

My invention resides in the construction and arrangement hereinafter described and claimed.

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

Figure 1 is a simplified, diagrammatic showing of an amplifier constructed and operating in accordance with my invention;

Fig. 2 is a view similar to Fig. 1, showing a modification; and

Fig. 3 is a graphical illustration of the operating characteristic of my improved amplifier.

The amplifier embodies the two tetrode tubes 10 and 11. The signal or wave-form to be investigated or otherwise utilized is connected to the input circuit 12 and 13 of the first tube 10, whereby the signal is applied to the control grid 14.

When a positive signal is applied to the control grid 14 of the first tube 10, its plate and screen-grid current tend to increase, making its cathode 15 more positive and its plate 16 and screen-grid 17 less positive. Any increase in the positive potential of the cathode 15 of the first tube 10 applies also to the cathode 18 of the second tube 11 since these two cathodes are connected together. Any such increase in positive potential on the cathode 18 will tend to reduce the plate and screen-grid currents of tube 11 and make both its screen-grid 19 and its plate 20 more positive. Since the respective cathodes 15 and 18 of the tubes 10 and 11 are connected to-

gether, and since also the respective screen-grids 17 and 19 of the tubes are connected together, the changes induced on these elements in the second tube 11 tend to nullify the original effect induced on the corresponding elements of the first tube 10 by the input signal impressed on its control grid 14. That is, as the potential on the screen-grid 17 of tube 10 tends to be driven less positive by the action of the input signal through tube 10, the potential on the screen-grid 19 of the tube 11 tends to be driven more positive by the action of tube 11. Likewise, when the potential of the cathode 15 of tube 10 tends to be driven more positive by the action of tube 10, the potential of the cathode 18 of tube 11 tends to be driven less positive by the action of tube 11. Therefore, if the circuit constants be properly chosen, the potential changes on the respective plates 16 and 20 of the tubes 10 and 11 will be approximately equal in amount and opposite in direction, which is the desired effect.

The control grid 21 of the second tube 11 is grounded as shown, and is therefore held at a fixed potential. For other combinations of circuit components and constants, it may be desirable to hold the control grid 21 of tube 11 at a fixed potential above or below ground.

The plate output from the respective tubes 10 and 11 is applied, by the connections 22 and 23, across the deflection plates 24 of a cathode-ray oscillograph 25, for example. The input terminals 12 and 13 may be connected to a pre-amplifier, or to a saw-tooth oscillator for sweep.

A similar amplifier may be used to supply the deflection plates 26.

By means of my improved push-pull amplifiers, the average potential of each pair of deflection plates can be kept approximately constant, thereby minimizing defocusing of the spot with deflection.

As illustrated in Fig. 3, my improved amplifier gives flat or constant response, and one-hundred-percent response from DC or zero frequency to one megacycle.

Positioning can be effected by regulating the bias on a preceding, direct-coupled amplifier. If my improved amplifier is used alone, however, positioning can be controlled by an arrangement such as is shown in Fig. 2.

The inductances 27 and 28 are not essential to the operation of the circuit, but when properly chosen values are employed, extend the high-frequency range to which the response is flat by effectively increasing the value of plate-load reactance at the proper rate to compensate for the increased effect of stray and output circuit-capacitance.

Pentodes may be used for the tubes 10 and 11, in lieu of tetrodes, in which case the suppressors would be connected directly to their respective cathodes.

Distinctive features of my improved push-pull amplifier reside in the facts that the input signal or wave-form, taken from the external source to be investigated or otherwise utilized, is applied directly to the control grid of one tube, that the respective output voltages of the two tubes 10 and 11 are equal in amplitude and opposite in phase, that the control grid 21 of the

second tube 11 is held at fixed potential, that the signal developed on the second tube 11 is produced by the combined effects of tying the two screen-grids 17 and 19 together and of tying the two cathodes 15 and 18 together, that the two cathodes 15 and 18 are returned to ground or to the negative side of the high-voltage supply through a common resistor 29, and that the screen-grids 17 and 19 are supplied from the positive side of the high-voltage supply through a common resistor 30. In other words, in my improved push-pull amplifier, coupling through a common screen-grid resistor 30 and through a common cathode resistor 29 is used to transfer a portion of the signal from the first tube 10 to the second tube 11, and to produce changes of equal amplitudes and opposite phase on the two plates 16 and 20. The respective values of resistance, capacity and inductance designated in the drawing are given by way of example, and have been found to give satisfactory results.

A practical application of my improved amplifier is disclosed in my copending application Serial No. 312,358, filed January 4, 1940, and relating to a cathode-ray tube oscillograph.

In the claims, the term "tube" is used in the broad sense, and refers to a group or unit of elements such as a cathode, control grid, screen-grid and plate, and is intended to embrace a construction wherein two of such units or groups are contained in the same envelope.

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. An amplifier comprising a first tube, a second tube, each of said tubes having a cathode and a control grid and a screen-grid and a plate, the respective screen-grids of said tubes being tied together, the respective cathodes of said tubes being tied together, a single resistor common with respect to said tubes and connected to said cathodes and through which said cathodes may be returned to ground or to the negative side of the high-voltage supply for said amplifier, and a second and single resistor common with respect to said tubes and connected to said screen-grids and through which said screen-grids may be supplied from the positive side of said high-voltage supply and providing a coupling through itself and through said common cathode resistor to transfer a portion of the signal, applied to the control grid of said first tube, from said first tube to said second tube to produce thereby changes of substantially equal amplitudes and opposite phase on said plates when the control grid of said second tube is held at a substantially fixed potential.

2. In an amplifier of the character described, a first tube having a control grid to which the input signal is applied, a second tube having a control grid to be held at a substantially fixed potential, and a combination cathode and screen-grid coupling for transferring the signal in opposite phase from said first tube to said second tube.

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