Aug. 8, 1939 O. W. GREENBERG 2,169,096

ELECTRICAL AMPLIFIER SYSTEM

Filed Jan. 2, 1935

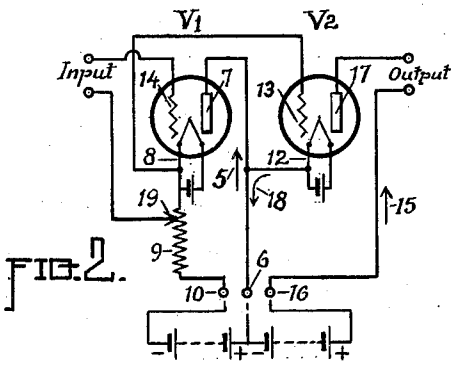


FIG. 2.

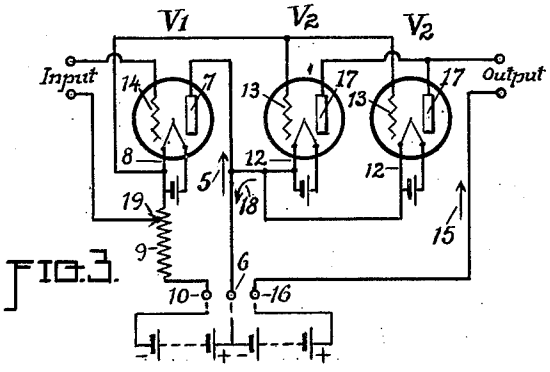


FIG. 3.

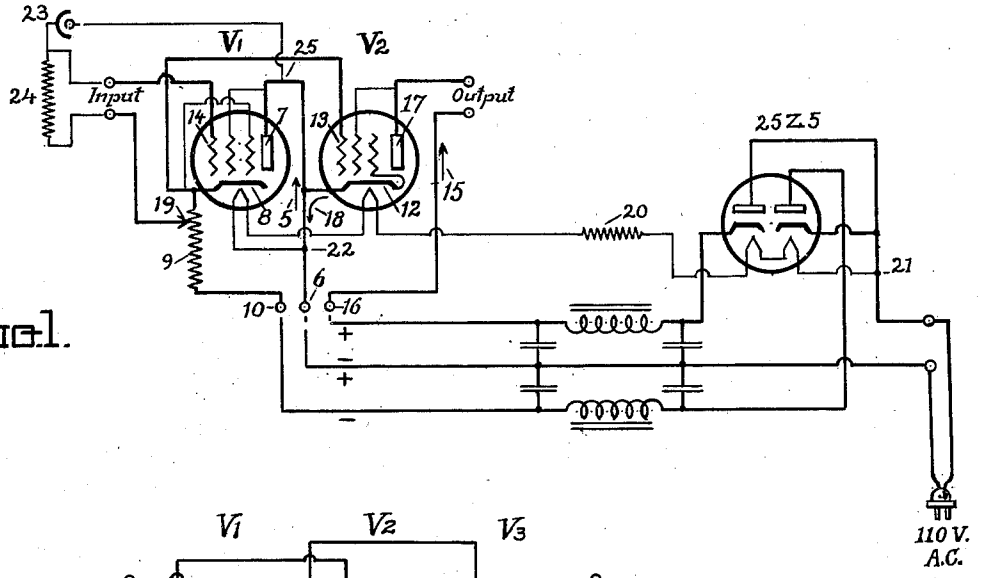


FIG. 1.

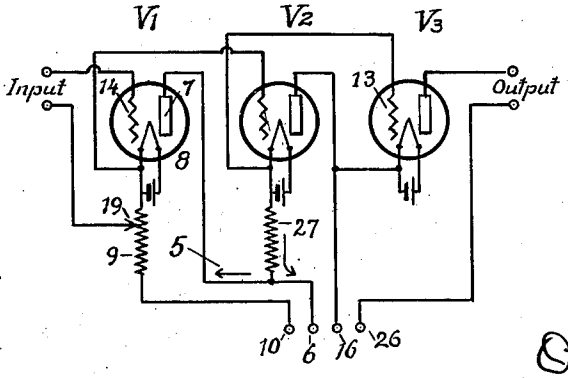


FIG. 4.

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ELECTRICAL AMPLIFIER SYSTEM

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Application January 2, 1935, Serial No. 90

3 Claims. (Cl. 179—171)

This invention relates to systems employing two or more vacuum tubes to amplify or otherwise modify variations of input potential, and has particular reference to the coupling means for establishing operative connection between one tube and another.

The object of this invention is to provide a multi-stage amplifier, simple, stable and of few parts, possessing the advantages inherent in the direct resistance-coupled type, without the drawbacks encountered in one variety or another of this type.

Among the inherent advantages of direct coupled amplifiers is in that they are non-periodic and do not discriminate between one frequency and another and in the ability to amplify the values of both continuous and varying electrical currents.

The drawbacks encountered in one variety or another of the direct coupled amplifiers, above referred to, and eliminated in the subject matter of this invention are the abnormally high voltages for the plate current supply; the difficulty of controlling same and the increased cost of the parts resulting therefrom; the balancing of one voltage with another, resulting in instability; the multiplicity of resistors carrying appreciable currents and subject to deterioration thereby; and the abnormally high voltage power transformer for transmorming the A. C. line voltage when same is used as a source of current supply.

In the accompanying drawing: Figure 1 illustrates a two stage amplifier system operated directly from a 110 volt A. C. power line thru a double rectifier of the —25Z5 type, with a photoelectric cell unit connected to the input. Figure 2 is a two stage amplifier, which, for greater clarity, is shown battery operated. Figure 3 is a two stage battery operated amplifier, with two power output tubes connected in parallel. Figure 4 is a three stage amplifier with binding posts for three sources of plate supply, not shown.

Referring to the drawing in general the plate current of the first tube VI flows (in the conventional sense) in the direction indicated by the arrow 5, from the binding post 6, connected to the positive terminal of any suitable source of current supply, to the plate 7, across the plate-cathode resistance, within the tube, to the cathode 8, thru the resistor 9, to the binding post 10, and back to the negative side of the source of current supply. The voltage drop across the terminals, is divided proportionately between the fixed resistor 9 and the variable plate-cathode resistance of the tube V1. The plate current of the second tube V2, flows (in the conventional sense) in the direction indicated by the arrow 15, from the binding post 16, connected to the positive terminal of a suitable source of current supply, thru the output load, not shown, to the plate 17, cathode 12, and, as indicated by the arrow 18, to the common binding post 6, back to the negative terminal of the same source of current supply. The plate 7, of the first tube V1, is directly or conductively coupled to the cathode 12, of the second tube V2, and the cathode 8, of the said first tube V1, is directly or conductively coupled to the grid 13, of the said second tube V2. Thus there is established a novel coupling between the first and second tubes, and a novel grid-cathode circuit, which includes the plate-cathode path of the first tube, in series therewith. This coupling provides against grid choking, should an excessively strong signal impress a positive potential on the grid 13.

Potential difference existing at any time between the cathode 8, and plate 7, of the first tube V1, due to voltage drop across the plate-cathode resistance, will be impressed on the grid 13, and cathode 12, of the second tube V2.

When a signal is impressed on the grid 14, of the first tube V1, to cause it to go somewhat positive—or, in other words, less negative—the plate-cathode resistance is decreased, the voltage drop across same is decreased, causing the cathode 8 to go more positive—or less negative—in respect to its plate 7, and this makes the grid 13, of the second tube V2, more positive—or less negative in respect to its cathode 12. This, of course, results in an increase in the plate current flow of the second or output tube V2. When the potential on the grid 14, is made more negative, the reverse results of those described above takes place and the plate current in the second tube V2, is decreased.

Attention is here called to the fact that, unlike the direct resistance and resistance-capacity coupling, the coupling in this system does not reverse the phase of the input signal, an increase in input signal strength results in increased output current. This is a very important characteristic where amplified variations of a direct current are to be obtained, as in work connected with photoelectric cells and laboratory apparatus.

The bias on the grid 14, is shown obtained from a tap as at 19, on the cathode resistor 9.

The bias on the grid 13, is obtained from the voltage drop across the plate-cathode resistance of the first tube V1.

The cathode resistance employed at 9, is relatively very high and of the order of .5 to 1 megohm or more, depending on the characteristics of the tube and the voltage employed in connection therewith. The object of this is to provide a voltage drop or potential difference between the anode 7 and cathode 8 that will be negligible when the grid 14 is neutral. This negligible difference of potential is impressed between the grid 13 and cathode 12 of the second tube V2. Thus, when the grid 14 of the first tube is neutral grid 13 of the second tube is also substantially neutral, so that the biasing of the former will result in the biasing of the latter, thereby dispensing with an otherwise necessary and separate biasing device for the grid of the second tube. Thus, the biasing of the system is simplified, a feature of particular value in connection with a laboratory, photo-electric and other special uses.

Referring now to Figure 1 exclusively, the system is shown operated from a 110 volt A. C. power line. When so operated and in conjunction with the well known —25Z5 type of double rectifier tube in combination with the well known filter system hook up, illustrated, the whole provides a simple, practical and inexpensive system for amplifying both periodic and non-periodic signals.

The rectifier and filter system, above mentioned, supplies two separate plate voltages, one of which is applied across the terminals 16, and 6, for tube V2, and the other across 6, and 10, for the tube V1. These tubes and the rectifier are of the heater type. The heater elements are all connected in series with a resistor 20, across the line voltage as at 21 and 22.

Tubes V1 and V2, here shown, are of the —77 and —43 types respectively in both of which the screen grids are shown connected to their respective plates, and the space charge grids to the cathodes. However, a potential difference may be impressed on the screen grids for modulating or to obtain other effects.

It will be noticed that in this amplifying system there is but one operating device besides the two tubes, namely the resistor 9, and that there is little to get out of order, especially since the resistor carries very little current, so that the heat characteristics are in no wise severe.

A photo-electric unit is shown, coupled to the input, consisting of a cell 23 and a resistor 24.

Positive voltage on the anode of the cell is derived from one of the plate circuits, as at 25. The voltage drop across the resistor 24 is impressed on the grid of the first tube. When the light on the cell 23, is increased, the current flow in the resistor 24, increases, resulting in a greater potential drop across the input terminals. This makes the grid 14, more positive in respect to the cathode 8, and results in an increase of the output current.

In Figure 3 the tubes employed are of the three element type and are shown battery operated.

In Figure 3 there are shown two output tubes V2, V2, connected in parallel, both driving plate voltage from the same source.

In Figure 4 there is shown a three stage amplifier. The tubes V1, V2 and V3, are supplied with plate voltage from separate sources thru the binding posts 26, 16, 6 and 10.

A cathode resistor 27, similar to the cathode resistor 9, of the first tube V1, is shown in the cathode return of the second amplifier tube V2. The voltage drop across the terminals 16 and 6 is divided proportionately between this fixed resistor 27 and the variable plate-cathode resistance of the tube V2. Potential difference existing at any time between the cathode and plate of the tube V2 is impressed between the grid 13, and cathode of the next tube V3. The grid bias for this second amplifier tube V2, is obtained from the voltage drop across the plate-cathode path of the first amplifier tube V1.

I claim:

1. In an electrical system employing tubes having an anode, cathode and control grid, a tube included in the following circuits; one circuit including therein the grid, the cathode and means adapted to impress a signal across the said grid and cathode; a second circuit including therein exclusively and in the order enumerated the anode, said cathode, a resistance and a plate supply unit the total voltage across the terminals of which is divided between the impedance of the tube and the said resistance and the third circuit including therein exclusively the said anode, said cathode, the grid of another tube and the cathode of said other tube.

2. In an electrical system employing tubes having an anode, cathode and control grid, a first tube and a second tube, a direct connection between the cathode of the first tube and the grid of the second tube whereby in relation to each other the same potential is maintained on these two elements and direct connections between the anode of the first tube, the cathode of the second tube and the positive terminal of a plate supply unit whereby in relation to each other the same potential is maintained on the said anode, said cathode and said terminal.

3. In an aperiodic electrical system employing tubes having an anode, cathode and control grid, a first tube and a second tube, the first tube included in the following circuits: one circuit including therein the grid, cathode and means adapted to impress a signal across the said grid and cathode; a second circuit including therein exclusively the anode, cathode, a resistance and a plate supply unit the total voltage across the terminals of which is divided between the impedance of the tube and the said resistance and a third circuit including therein exclusively the said anode, said cathode, the grid of the second tube, the cathode of the second tube and return to the anode; the second tube in addition to the above said third circuit, included in the following circuit: a plate supply unit, a load, anode, cathode and return to the said plate supply unit.

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