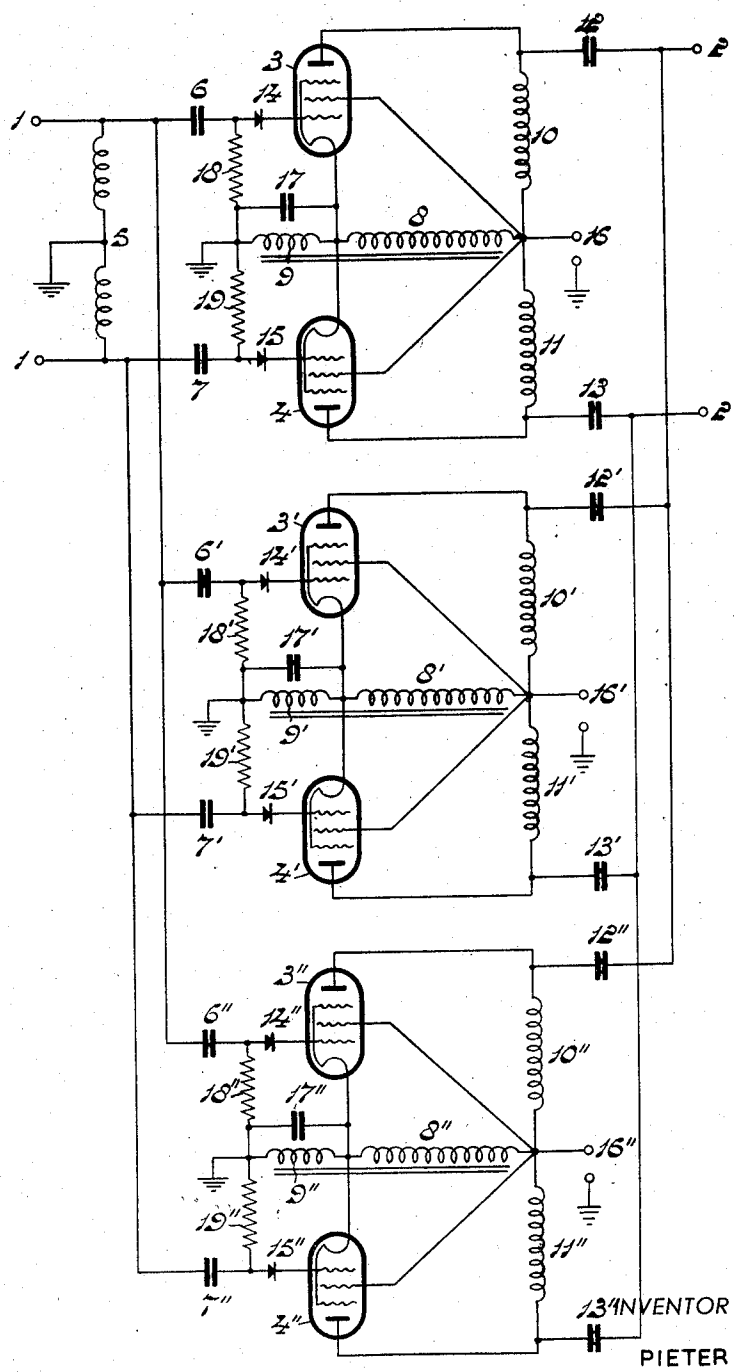
Sept. 30, 1958 P. F. VAN ELDIK 2,854,530

A. C.-BIASED AMPLIFIER CIRCUIT ARRANGEMENT

Filed Feb. 5, 1954



INVENTOR

PIETER FREDERIK VAN ELDIK

BY

AGENT

United States Patent Office

2,854,530

Patented Sept. 30, 1958

2,854,530

A. C.-BIASED AMPLIFIER CIRCUIT ARRANGEMENT

Pieter Frederik Van Eldik, Eindhoven, Netherlands, assignor, by mesne assignments, to North American Philips Company, Inc., New York, N. Y., a corporation of Delaware

Application February 5, 1954, Serial No. 408,537

Claims priority, application Netherlands February 23, 1953

3 Claims. (Cl. 179—171)

The present invention relates to amplifier circuit arrangements. More particularly, the invention relates to amplifiers comprising one or more electric discharge tubes directly supplied with alternating current and each comprising a control grid. The term "direct supply" is here to be understood to indicate the absence of means for converting alternating current into direct current. The present invention has for its object to provide a circuit-arrangement such that the component having the frequency of the supply voltage in the output voltage is very small.

In accordance with the present invention, screen-grid tubes are utilized and alternating voltages from the supply are operative both in the circuit between the grid and the cathode and between the anode and the cathode such that, in the absence of signal voltage on the control grid, the anode current of each tube is practically zero at any instant. Only when a signal voltage occurs will anode current be allowed to flow during the half cycle of the alternating supply voltage when the anode is positive, the tubes operating in so-called class B-setting.

The invention utilizes the property of such tubes that at a constant value of the grid voltage the anode current, above a given value of the anode voltage, is substantially independent of the latter. In this zone, the anode current practically depends only on the grid voltage. When operating in this zone, an amplifier according to the invention permits the achieving of the result that for a considerable part of the half cycle, during which a positive supply voltage is applied to the anode, the signal voltage on the anode is substantially determined only by the signal voltage on the control grid and practically does not depend upon the supply voltage on the anode, it being assumed that the voltage on the screen grid is also an alternating voltage which changes substantially in the same manner as the alternating supply voltage on the anode.

Use may be made of all kinds of tubes comprising a screen grid between the control grid and the anode. Preferably pentodes are employed.

If two tubes are in push-pull arrangement, an amplified voltage is set up across the output circuit, so that the negative half cycle of the signal voltage is also allowed to pass, for the whole duration of the half cycle of the supply voltage during which the anodes are positive. Output voltage does not occur during the negative half cycle of the supply voltage, but this is met by connecting in parallel a number of tubes or a number of pairs of push-pull connected tubes supplied with different phases. The simplest way will, in general, be to use three tubes or three pairs of tubes supplied with alternating voltages displaced in phase by 120° relatively to one another.

In order to suppress the grid current, otherwise produced during the half cycle in which the grid is positive relatively to the cathode, rectifiers may be used in the grid-supply conductors.

In order that the invention may be readily carried into effect it will now be described in greater detail with reference to the accompanying drawing in which the single figure is a schematic diagram of an embodiment of the circuit arrangement of the present invention.

With reference to the figure, input terminals of the amplifier are denoted by **1** and its output terminals by **2**. The amplifier is intended to be supplied from a three phase network of, for example, 50 cycles per second and 220 volts per phase. It comprises three pairs of push-pull connected tubes **3** and **4**, **3'** and **4'**, **3''** and **4''**. The circuit-arrangement of the several pairs of tubes is uniform, hence the circuit-arrangement of only one pair will be explained. Connected between the input terminals is a centrally grounded inductor **5**. The input voltage is supplied to the control grids of the pairs of tubes through capacitors **6**, **7** in push-pull arrangement.

The anodes are supplied with alternating voltage from a source, for example the mains, which may be connected between point **16** and ground. The several pairs are supplied with alternating voltages displaced in phase by 120° relatively to one another.

The tubes are represented as pentodes, the anodes being connected through output inductors **10**, **11** to the mains terminal **16** and by way of capacitors **12**, **13** to the output terminals **2**. Resistors **18** and **19** are disposed between the control grids and ground.

According to the invention, a two winding iron-cored inductor or autotransformer **8**, **9** is connected between the mains terminal **16** and ground, its tapping point being connected to the cathodes. This tapping point is so chosen as to obtain the aforesaid effect, that is, in the absence of signal voltage, and during the positive excursion of the mains voltage supplied at the point **16**, the voltage at the junction of windings **8** and **9**, which is applied to the cathode produces a negative bias at the control grids of the tubes **3** and **4** of sufficient magnitude to maintain the tubes in substantially the cut-off condition during the half cycle in which the anode is positive. This is the so-called class B-setting. During the major part of the positive half cycle of the A. C. supply connected to the point **16**, the anode current will be substantially independent of the value of the anode voltage. In this manner, it is ensured that the component of mains frequency in the output voltage is very small. More particularly, during the positive half cycle of the A. C. supply connected between point **16** and ground, the anode, screen and cathode electrodes of tubes **3** and **4** will attain positive potentials with respect to ground potential. By an appropriate selection of the tapping of the transformer **8**, **9**, the cathode voltage is made sufficiently positive relative to the control grids of the tubes that the tubes are maintained substantially cut off. When a signal voltage is applied to the terminals **1—1** the cut-off condition is altered so that when the grid of tube **3** is made more positive by a positive excursion of the input signal tube **3** is rendered conductive during the positive going half cycle of the input signal. Similarly, when the input signal to terminals **1—1** reverses in phase, tube **4** becomes conductive during the positive going excursion of its control grid.

Since the anodes and screens of tubes **3** and **4** are positive during only one-half cycle of the A. C. supply applied to terminal **16**, these tubes process the input signal for only this half cycle period. In order to continuously process the input signal, tube pairs **3'–4'** and **3''–4''** are additionally provided, these tube pairs being energized at their terminals **16'** and **16''** with A. C. supplies phased 120° relatively to the supply applied to terminal **16**. Under these conditions there will always be at least one tube pair in condition for processing the input signal to terminals **1—1**.

The voltage to be amplified will, in general, be an alter-

nating voltage whose frequency may greatly exceed the mains frequency. Direct voltage, also, can be amplified by conditioning the input circuit and the output circuit, hence by omitting the capacitors. The inductor part **9** connected in the grid circuit may be shunted by a capacitor **17** having such a value as to practically constitute a short-circuit with regard to the frequency of the voltage to be amplified. As is customary, the suppressor grids are connected to the cathodes. The screen grids may be connected to the mains terminal **16** or to a tapping point of the inductor **8**.

The mains voltage may alternatively be connected between the point **16** and the cathodes or between a tapping point of coil **8** and the cathodes. The rectifiers **14** and **15** serve to prevent the occurrence of an exceedingly high grid current during the half cycle in which the control grid is driven positive relatively to the cathode.

The diodes **14** and **15** act as current limiters and thus serve to prevent the occurrence of an exceedingly high grid current during the half cycle in which the control grid is driven positive relatively to the cathode.

While the invention has been described by means of a specific example and in a specific embodiment, I do not wish to be limited thereto, for obvious modifications will occur to those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. An amplifier circuit arrangement comprising an electron discharge device having a cathode, a control grid, a screen grid and an anode, means for applying a first alternating voltage having a given frequency value to said anode thereby to energize said anode, inductive means coupled between said cathode and a point at ground potential comprising a secondary winding of transformer means coupled between said first-mentioned means and said cathode for producing a second alternating voltage having said given frequency value and an amplitude and polarity relative to said first alternating voltage sufficient to produce substantial anode current cut-off in said device during positive going excursions of said first alternating voltage, means for applying a signal voltage to said control grid, and output signal circuit means coupled to said anode.

2. An amplifier circuit arrangement comprising a pair of electron discharge devices each having a cathode, a control grid, a screen grid and an anode, means for applying a first alternating voltage having a given frequency value and in the same phase sense to the screen grids and anodes of said devices thereby to energize the said screen grids and the said anodes, inductive means coupled between the cathodes of said devices and a point at ground potential comprising a secondary winding of transformer means coupled between said first-mentioned means and said cathodes for producing a second alternating voltage having said given frequency value and an amplitude and polarity relative to said first alternating voltage sufficient to produce substantial anode current cut-off in said devices during positive going excursions of said first alternating voltage, said second alternating voltage being applied to said cathodes in the same phase sense, means for applying signal voltages in push-pull arrangement to the control grids of said devices, and output signal circuit means coupled to the anodes of said devices.

3. An amplifier circuit arrangement comprising a plurality of signal paths, each of said paths comprising first and second electron discharge devices each having a cathode, a control grid, a screen grid and an anode, means for applying a first alternating voltage having a given frequency value and in the same phase sense to the screen grids and anodes of the devices of a first of said paths thereby to energize said screen grids and anodes, inductive means coupled between the cathodes of the devices of said first path and a point at ground potential comprising a secondary winding of transformer means coupled between said first-mentioned means and said cathodes for producing a second alternating voltage having said given frequency value and an amplitude and polarity relative to said first alternating voltage sufficient to produce substantial anode current cut-off in said devices during positive going excursions of said first alternating voltage, said second alternating voltage being applied to said cathodes of the devices of said first path in the same phase sense, means for applying a third alternating voltage having said given frequency value and a phase different from said given phase sense to the screen grids and anodes of the devices of a second of said paths thereby to energize said screen grids and anodes, inductive means coupled between the cathodes of the devices of said second path and a point at ground potential comprising a secondary winding of transformer means coupled between said third voltage applying means and said last-mentioned cathodes for producing a fourth alternating voltage having said given frequency value and an amplitude and polarity relative to said third alternating voltage sufficient to produce substantial anode current cut-off in said devices of said second path during positive going excursions of said third alternating voltage, means for applying signal voltages in push-pull arrangement to the control grids of said first and second devices of each of said paths, means connecting the anodes of said first devices of said paths in parallel, means connecting the anodes of said second devices of said paths in parallel, output signal circuit means coupled to the anodes of said devices and means coupled to the control grids of said devices for limiting current flow to said control grids during positive going excursions of said second and fourth alternating voltages.

References Cited in the file of this patent

UNITED STATES PATENTS

1,620,506	Alexanderson	Mar. 8, 1927
2,338,410	Cousins	Jan. 4, 1944
2,339,466	Duft	Jan. 18, 1944
2,616,988	Rodenhuis	Nov. 4, 1952
2,646,469	Long	July 21, 1953
2,762,011	Kogge	Sept. 4, 1956

FOREIGN PATENTS

645,256	Great Britain	Oct. 25, 1950