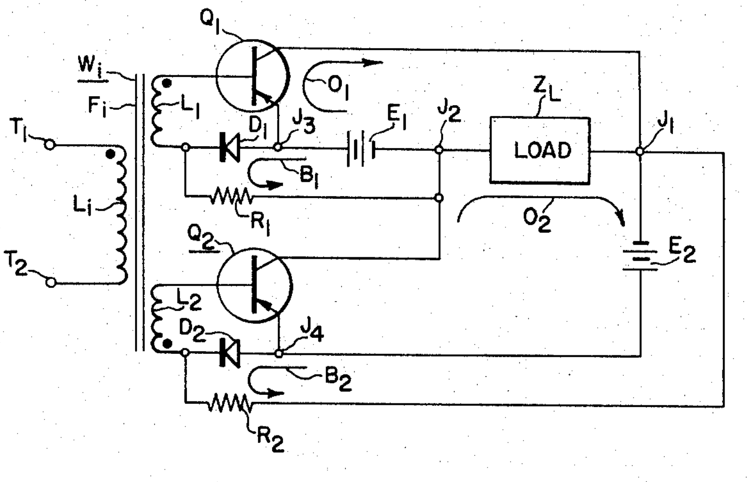
Nov. 7, 1967 A. S. GOLDSMITH 3,351,866

AMPLIFIER CIRCUIT HAVING SEPARATE AND INDEPENDENT OUTPUT AND BIASING PATHS

Filed Sept. 18, 1964



INVENTOR

Alan S. Goldsmith

BY [signature]

United States Patent Office

3,351,866

Patented Nov. 7, 1967

3,351,866

AMPLIFIER CIRCUIT HAVING SEPARATE AND INDEPENDENT OUTPUT AND BIASING PATHS

Alan S. Goldsmith, Plainfield, N.J., assignor to Westinghouse Electric Corporation, Pittsburgh, Pa., a corporation of Pennsylvania

Filed Sept. 18, 1964, Ser. No. 397,510
2 Claims. (Cl. 330—15)

The present invention relates to amplifier circuits, and more particularly to diode biased transistor amplifier circuits.

Various transistor audio amplifier circuits have been devised requiring no output transformer between the transistors, usually connected in a push-pull fashion, and the load. A basic disadvantage of many of these circuits is the inability to obtain a stabilized temperature and voltage operating point because of the use of biasing resistors. To overcome this, diodes were substituted for the biasing resistors. Ideally, the voltage-current characteristics of the diode should be substantially similar to those of the emitter-base diode of the transistor. In particular, the matching of the voltage-current characteristics with shifts in temperature is highly desirable for temperature stabilization. Nevertheless, another disadvantage exists in the presently known resistor and diode amplifier circuits in that the output signals of the amplifier and the biasing path are in series. As a consequence of this there is degenerate feedback of the output signals to the input with a resulting loss of power gain. When diode biasing is used, it is essential that the diodes pass a substantial amount of current in order to forward bias the diode into the low impedance portion of its voltage-current characteristic. The impedance of the diode must be small at the input frequency as compared to the input impedance of the transistor or else distortion will result. Since the output signal of the transistor subtracts from the biasing potential, the output and biasing paths being in series, the available biasing current for the diode is limited. It therefore becomes difficult to maintain the diode in its low impedance region without drawing excessive diode current which greatly limits battery life and also limits the life of the diodes. To avert the latter problem electrolytic capacitors could be used to bypass the biasing diodes. However, such capacitors are large expensive and short lived.

It is therefore an object of the present invention to provide a new and improved diode biased transistor amplifier circuit.

It is a further object of the present invention to provide a new and improved amplifier circuit having separate and independent output and biasing paths.

It is a further object of the present invention to provide a new and improved diode biased transistor amplifier circuit having non-interfering output and biasing paths.

Broadly, the present invention provides an amplifier circuit in which a pair of transistors operative in a push-pull manner have diode biasing circuits in which the diodes are maintained in their low impedance state independently of the output circuit, which drives a load without permitting output signals to appear at the input of the transistors to cause degenerate feedback.

These and other objects and advantages of the present invention will become more apparent when considered in view of the following specification and drawing, in which:

The single figure is a schematic diagram showing the amplifier circuit of the present invention.

Referring to the figure, a pair of transistors Q_1 and Q_2 are connected to operate in a push-pull fashion. An input transformer W_1, having a core F_1, a primary winding L_1, secondary windings L_1 and L_2, is utilized to drive the transistors Q_1 and Q_2. Input signals, which, for example, may be at an audio frequency, are applied to a pair of input terminals T_1 and T_2 of the primary winding L_1 of the input transformer W_1. By transformer action input signals appear at both of the secondary windings L_1 and L_2. The phase of the signals appearing at the secondary windings L_1 and L_2 is determined by the dot convention as shown. The dotted end of the secondary winding L_1 is connected to the base electrode of the transistor Q_1, while the undotted end of the secondary winding L_2 is connected to the base of the transistor Q_2. The dotted end of the primary winding L_1 is shown at the terminal T_1 so it may be assumed that the signals appearing at the secondary winding L_1 will be in phase with the input signals at the primary winding L_1, while the signals at the winding L_2 will be 180° out of phase therewith.

Separate output circuits O_1 and O_2, as shown by the arrows, are provided to drive the load Z_L in a push-pull fashion. The output circuit O_1 includes a series connection of a battery E_1, the emitter-collector circuit of the transistor Q_1, with the positive terminal of the battery being connected to the emitter electrode, and the load Z_L, with the collector electrode of the transistor Q_1 being connected to a junction J_1, at one end of the load Z_L, and the negative electrode of the battery being connected to a junction J_2, at the other end of the load Z_L. The load Z_L, for example, may comprise a resistor or other impedance elements. The other output circuit O_2 of the transistor Q_2 includes the emitter-collector circuit of the transistor Q_2, which has its emitter electrode connected to the positive terminal of a battery E_2 and its collector electrode connected to the junction J_2 of the load Z_L. The series output circuit O_2 is completed through the load Z_L which has the junction J_1 connected to negative terminal of the battery E_2. The batteries E_1 and E_2 are shown to be separated physically. However, of course, they may form one battery having voltage taps thereon.

Separate and distinct from the output circuits O_1 and O_2 are biasing circuits B_1 and B_2, as shown by the arrows in the figure, associated respectively with the transistors Q_1 and Q_2. Biasing circuit B_1 includes the battery E_1, a diode D_1, which has its anode connected at a junction J_3 to the emitter electrode of the transistor Q_1 and to the positive terminal of the battery E_1, and its cathode connected to the undotted end of the secondary winding L_1 and to one end of a resistor R_1, whose other end is connected to the negative terminal of the battery E_1 at the junction J_2. The biasing circuit B_2 includes the battery E_2, a diode D_2 and a resistor R_2. The diode D_2 has its anode connected at a junction J_4 to the emitter electrode of the transistor Q_2 and to the positive terminal of the battery E_2 and its cathode electrode connected to the dotted end of the secondary winding L_2 and to a resistor R_2. The other end of the resistor R_2 is connected to the negative terminal of the battery E_2 at the junction J_1.

By such circuit connections, it can be seen that the output circuit O_1 and the biasing circuit B_1 and the output circuit O_2 and the biasing circuit B_2 operate independently of each other without output signals in the output circuits interfering with the biasing levels of the respective transistors Q_1 and Q_2. Thus, incoming audio signals applied to the input terminals T_1 and T_2 are transformed and appear at the secondary winding L_1 and L_2 of the transformer W_1. The transistors Q_1 and Q_2 operate in a push-pull fashion so that the transistor Q_1 will supply output signals to the load Z_L from the junction J_1 to the junction J_2 when the input signals applied to the base of the transistor Q_1 are of a negative polarity. Conversely, the transistor Q_2 will supply output signals to the load Z_L from the junction J_2 to the junction J_1 when a signal supplied to its base is of a negative polarity or, in other words, when the input signals are of a positive polarity because of the dot convention as described previously. The output signals appearing in the output circuits O_1 and O_2 do not appear at the input of the respective transistors Q_1 and Q_2 because the batteries E_1 and E_2 connected between the load Z_L and the respective emitter electrodes isolate the output circuit from the input of the transistors.

Bias potential is applied to the emitter electrodes of the transistors Q_1 and Q_2 at the junctions J_3 and J_4, respectively, from the positive terminal of the batteries E_1 and E_2. A return path, however, for the biasing current passing through the diodes D_1 and D_2 is provided by the resistors R_1 and R_2, respectively, which are connected across the diode and battery series connection. Thus, the biasing circuits B_1 and B_2 may operate at a predetermined current level so that the diodes D_1 and D_2 will be in their low impedance regions irrespective of the output signals then appearing in the output circuits O_1 and O_2. The diodes D_1 and D_2 are selected to have similar voltage-current characteristics as the corresponding emitter-base diode characteristics of the transistors Q_1 and Q_2. By such a selection of diodes, the temperature and voltage operating points may be stabilized and thereby improve the overall operation of the amplifier circuit. Moreover, the biasing circuit operating independently of the input circuit limits distortion of incoming signals since the diodes remain throughout both the positive and negative excursion of the incoming signals in their low impedance state.

Although the present invention has been described with a certain degree of particularity, it should be understood that the present disclosure has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the scope and the spirit of the present invention.

I claim as my invention:

1. An amplifier circuit operative with a common load comprising, a pair of transistors connected to function in a push-pull manner and each including base, collector and emitter electrodes, said pair of transistors being of the same conductivity type, input circuit means for applying input signals to the base electrodes of each of said transistors so that said transistors function in a push-pull manner, a biasing circuit connected respectively to each of said transistors, each biasing circuit including a source of direct potential, a diode and an impedance device operatively connected to forward bias said diode, said source being operatively connected to the emitter electrode of the respective transistor to supply bias potential thereto, and an output circuit respectively connected to each of said transistors to drive said common load, said collector electrodes of said pair of transistors directly connected respectively to opposite ends of said load, each output circuit including one of said separate sources of direct potential, the emitter-collector circuit of the respective transistor and said load and operative to function independently of said biasing circuits, with current being supplied through said load in opposite directions from each of said output circuits respectively.

2. An amplifier circuit operative with a common load comprising, a pair of transistors connected to function in a push-pull manner and each including base, collector and emitter electrodes, said pair of transistors being of the same conductivity type, input circuit means for applying input signals to the base electrodes of each of said transistors so that said transistors function in a push-pull manner, a biasing circuit connected respectively to each of said transistors, each biasing circuit including a separate source of direct potential, a diode and an impedance device operatively connected in series to forward bias said diode, the voltage-current characteristics of said diode substantially matching these characteristics of the emitter-base diode of the respective transistor, said separate sources being operatively connected to the emitter electrode of the respective transistor to supply bias potential thereto, and an output circuit connected respectively to each of said transistors to drive said common load, said collector electrodes of said pair of transistors directly connected respectively to opposite ends of said load, each output circuit including one of said separate sources of direct potential, the emitter-collector circuit of the respective transistor and said load and being operatively connected in series to function independently of said biasing circuits with output signals appearing in said output circuits not affecting the biasing levels of either of said transistors, with current being supplied through said load in opposite directions from each of said output circuits respectively.

References Cited

UNITED STATES PATENTS

2,860,193 11/1958 Lindsay ---------- 330—15 XR

FOREIGN PATENTS

626,699 4/1963 Belgium.

ROY LAKE, *Primary Examiner.*

NATHAN KAUFMAN, *Examiner.*

E. C. FOLSOM, F. D. PARIS, *Assistant Examiners.*