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W. S. BARDEN

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PUSH-PULL AMPLIFIER CONTROL

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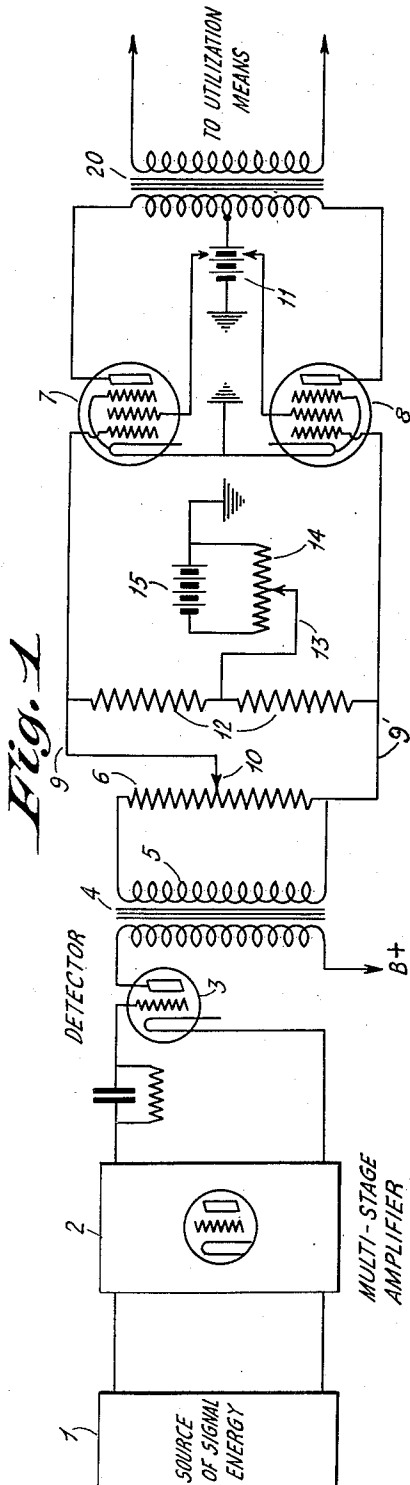
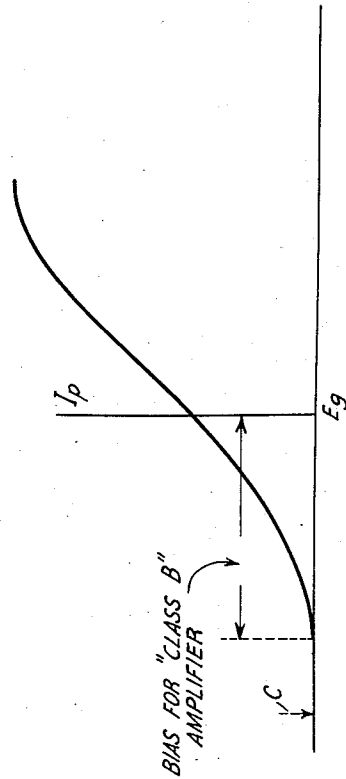


Fig. 2



INVENTOR
WILLIAM S. BARDEN

BY *H. S. Grover*
ATTORNEY

UNITED STATES PATENT OFFICE

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PUSH-PULL AMPLIFIER CONTROL

William Stoddard Barden, Stapleton, N. Y., assignor to Radio Corporation of America, a corporation of Delaware

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12 Claims. (Cl. 179—171)

My present invention relates to push-pull amplifier circuits, and more particularly to push-pull circuit arrangement for gain control.

As is well known the ideal push-pull amplifier should be so constructed that the grid circuits of both tubes are balanced at all times with respect to ground. This ideal design is not easily secured when it is desired to incorporate in the push-pull circuit a simple gain control arrangement. Hence, it may be stated that it is one of the main objects of my present invention to provide a push-pull amplifier circuit, wherein the tubes employed are preferably of the pentode type, which amplifier includes in its input circuit an extremely simple type of gain control arrangement comprising but a single adjustable element, the grid circuits of the amplifier tubes being so designed that they are balanced at all times with respect to ground.

Those skilled in the prior art are, additionally, well acquainted with the fact that an amplifier circuit may be adjusted to function as a class A amplifier, the grid having a direct current potential such that it is biased to a linear portion of the I_p vs. E_g characteristic; a class B amplifier, the grid having a direct current potential such that it is biased at the "cut-off" portion of the aforementioned characteristic; or, as a class C amplifier wherein the grid is biased at a more negative point than the aforementioned "cut-off" point.

The present invention including the simple and highly effective type of gain control is not only well adapted for the class A and C push-pull amplifier arrangements, but is particularly suited for the class B push-pull amplifier circuit.

Accordingly, it is pointed out that an important object of the present invention is to provide a push-pull amplifier circuit, embodying a gain control arrangement which includes but one adjustable element and grid circuits balanced at all times with respect to ground, and which additionally includes a means for converting at will the operating characteristic of the amplifier whereby the latter may function as a class A, class B or class C push-pull amplifier circuit.

Other objects of the present invention are to improve generally the simplicity and efficiency of gain control devices for an audio frequency amplifier, and to particularly provide a volume control adjustment in a push-pull amplifier circuit which is not only durable and reliable in operation, but economically manufactured and installed in the circuit.

The novel features which I believe to be char-

acteristic of my invention are set forth in particularity in the appended claims, the invention itself, however, as to both its organization and method of operation will best be understood by reference to the following description taken in connection with the drawing in which I have indicated diagrammatically one circuit organization whereby my invention may be carried into effect.

In the drawing,

Fig. 1 diagrammatically shows a radio receiving circuit embodying the present invention,

Fig. 2 graphically illustrates the operation of the audio frequency amplifier of Fig. 1 as a class B amplifier.

Considering, now, Fig. 1 it will be noted that the reference numeral 1 designates a source of signal energy which is adapted to supply radio frequency energy to a multi-stage amplifier conventionally represented by the numeral 2. The amplified energy from the amplifier 2 is then detected in a detector circuit embodying an electron discharge tube 3 having its grid circuit arranged in the well known manner for detection by means of grid rectification.

It will be recognized that the foregoing elements comprise the conventional elements of a modern radio receiver, and therefore need not be described in any further detail.

The detected output from the detector circuit is impressed upon the common input circuit of the push-pull audio frequency amplifier by means of an audio frequency coupling transformer 4, the primary 5 of which transformer has connected across it a resistor 6 having a magnitude of about one or two megohms. The control electrode, or grid, of the electron discharge tube 7 is connected by means of a lead 9 to any desired point on the resistor 6 by making the end of the lead 9 in contact with the resistor 6 adjustable, as at 10.

The grid of the tube 8 is connected by a lead 9' to the low potential side of the resistor 6. It will be noted that both tubes 7 and 8 are of the so-called pentode type. That is to say, these tubes are of the type employing a "suppressor" grid, the latter being disposed between the positive screen grid and the anode and being connected within the tube to the cathode of the tube whereby the suppressor grid is maintained substantially at cathode potential. This type of tube is well known to those skilled in the art and need not be described in any further detail. The anodes of tubes 7 and 8 are connected to a common transformer primary 10, the midpoint of

the latter being connected to the positive terminal of a source of direct current energy 11, the negative terminal of the latter being grounded. The common cathode lead of both tubes 7 and 8 is grounded.

A pair of grid leak resistors 12, 12 are connected in series with each other and both in shunt across the input electrodes of each of tubes 7 and 8. The resistors are so chosen that their magnitudes are identical, and it is to be clearly understood that a single resistor could be used in place of two resistors and its midpoint connected as in the case of the two resistors shown in Fig. 1. In any event, the midpoint of the resistors 12, 12 is connected by an adjustable lead 13 to any desired point on the resistor 14 which is connected in shunt across the source of direct current biasing potential 15, the latter having its positive terminal grounded.

By adjusting the lead 13 to an appropriate point on the resistor 14 it is possible to bias the grids of tubes 7 and 8 in such a manner that it can operate either as a class A, class B or class C amplifier.

In Fig. 2 there is shown the I_p vs. E_g characteristic of an amplifier tube. There is designated on this characteristic the bias required for class B amplifier operation. It will be noted that to secure such operation it is necessary to adjust the lead 13 on the resistor 14 to that point which will result in biasing of the grids of tubes 7 and 8 so that with no signal applied they will be biased substantially at "cut-off" of the characteristic.

It will thus be seen that with this type of adjustment, plate current will only flow when signals are impressed upon the common input circuit of the push-pull amplifier. This type of operation is highly desirable in cases where it is desired to economize plate current, as for example in radio receivers installed in automobiles and the like. That is to say, in cases where sources of current must be economized class B amplifier operation is desirable. Similarly, by proper adjustment of the lead 13 it is possible to bias the grids of tubes 7 and 8 at a point such as C in Fig. 2 thereby resulting in class C amplifier operation. In some cases this type of operation is desirable.

Lastly, by suitable adjustment of the lead 13 the grids of tubes 7 and 8 can be so biased that class A amplifier operation will result, it being well understood that such operation takes place along the linear portion of the characteristic shown in Fig. 2.

Assuming, however, that the lead 13 has been adjusted to render the push-pull amplifier operative as a class B push-pull amplifier, it will be seen that effective and simple gain control is secured by adjustment of the single tap 10, and that simultaneously the grid circuits of tubes 7 and 8 are maintained balanced at all times with respect to ground. Furthermore, it should be noted that parasitic oscillations are substantially eliminated by the resistors 12, 12, thus comprising another important advantage of the present invention.

It is believed that the operation of the gain control arrangement 6, 10 will be obvious from the aforementioned description and the drawing. Whenever it is desired to reduce the volume of the reproducer, coupled by transformer 20 to the output of the push-pull amplifier, it is merely necessary to move the tap 10 towards the low potential terminal of the resistor 6. It is, of

course, to be understood that any type of utilization means may be employed, a reproducer not being the only device adapted to be coupled to the output of the push-pull amplifier. To increase the gain of the amplifier it is merely necessary to move the tap 10 towards the high potential side of the resistor 6. In any case, the grid circuits of tubes 7 and 8 are maintained exactly balanced with respect to ground thus resulting in optimum push-pull operation. Simultaneously, the production of parasitics is constantly reduced, and even eliminated, by the resistors 12, 12. In virtue of the power derived from the pentode tubes connected in push-pull, it is quite feasible to employ only the single push-pull stage for audio frequency amplification between the detector and a reproducer.

The present invention lends itself, in addition, to use in a receiving circuit employing automatic gain control of the radio frequency amplifier stages. It is not believed necessary to describe any such automatic gain control arrangement since those skilled in the prior art are well acquainted with the type of circuit wherein a special automatic volume control tube is utilized in connection with the detector output for controlling the gain of the radio frequency amplifier in such a manner that a substantially constant radio frequency amplification level is maintained at all times. Such an arrangement is shown, for example, in British Patent 283,120 of May 10th, 1928. In such a case variation of the gain control employed in the push-pull circuit would result in a highly satisfactory type of volume control adjustment, particularly since the radio frequency amplification level would be maintained substantially constant by the aforementioned automatic gain control.

Furthermore, while I have indicated and described one arrangement for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular organization shown and described, but that many modifications may be made without departing from the scope of my invention as set forth in the appended claims.

What I claim is:

1. In a radio receiver including a detector, a push-pull amplifier having its common input circuit coupled to the detector output, the common output circuit of the push-pull amplifier including coupling means, said push-pull amplifier comprising a pair of tubes, a resistor in said common input circuit having one of its terminals fixedly connected to the grid of one of the push-pull tubes, and a manual volume control means for the receiver comprising means for adjustably connecting the grid of the other push-pull tube to said resistor, and a resistive path, having its midpoint grounded, in shunt with said resistor between said control means and said fixed terminal.

2. In a radio receiver including a detector, a push-pull amplifier having its common input circuit coupled to the detector output, the common output circuit of the push-pull amplifier including coupling means, said push-pull amplifier comprising a pair of tubes, a resistor in said common input circuit having one of its terminals fixedly connected to the grid of one of the push-pull tubes, and manual volume control means adjustably connecting the grid of the other push-pull tube to said resistor, a resistive path having its midpoint grounded, said resistive path com-

prising a pair of grid leak resistors connected between said grids.

3. A push-pull amplifier circuit comprising a pair of tubes having a common input circuit adapted to be coupled to a source of energy to be amplified and a common output circuit including means for coupling the amplifier to a device for utilizing the amplified energy, a pair of grid leak resistors connected in series between the grids of the push-pull tubes, said resistors being of the same magnitude, means for grounding the common terminals of said resistors, said means including an adjustable source of direct current potential, and a variable resistor connected in shunt with said resistors, the grid of one of said push-pull tubes being permanently connected to one of the terminals of said variable resistor, and the grid of the remaining push-pull tube being connected to the adjusting element of the variable resistor.

4. A push-pull amplifier circuit comprising a pair of tubes having a common input circuit adapted to be coupled to a source of energy to be amplified and a common output circuit including means for coupling the amplifier to a device for utilizing the amplified energy, a pair of grid leak resistors connected in series between the grids of the push-pull tubes, said resistors being of the same magnitude, means for grounding the common terminals of said resistors, said means including an adjustable source of direct current potential, and a variable resistor connected in shunt with said resistors, the grid of one of said push-pull tubes being permanently connected to one of the terminals of said variable resistor, and the grid of the remaining push-pull tube being connected to the adjustable element of the variable resistor, said adjustable potential source being adapted to vary at will the operating characteristic of the push-pull amplifier in such a manner that it can be operated as a class A, class B or class C amplifier.

5. A push-pull amplifier circuit comprising a pair of tubes having a common input circuit adapted to be coupled to a source of energy to be amplified and a common output circuit including means for coupling the amplifier to a device for utilizing the amplified energy, a pair of grid leak resistors connected in series between the grids of the push-pull tubes, means for grounding the common terminals of said resistors, said means including an adjustable source of direct current potential, and a variable resistor connected in shunt with said resistors, the grid of one of said push-pull tubes being permanently connected to one of the terminals of said variable resistor, and the grid of the remaining push-pull tube being connected to the adjustable element of the variable resistor, said grid leak resistors having such magnitudes that parasitic oscillations are substantially eliminated and the grid circuits of said push-pull tubes are maintained balanced at all times with respect to ground.

6. In a radio receiver, an audio frequency amplifier, an audio frequency transformer, said amplifier including a pair of tubes connected in push-pull, a manual volume control device for said receiver comprising a fixed resistor connected across the secondary of said transformer, an adjustable connection from the grid of one of the amplifier tubes to said resistor, a connection from the grid of the other amplifier tube to one terminal of the resistor, an impedance in parallel with said resistor, and a connection from

said impedance to the cathodes of said pair of tubes.

7. In a radio receiver, an audio frequency amplifier, an audio frequency transformer, said amplifier including a pair of pentode power output tubes connected in push-pull, a manual volume control device for said receiver comprising a fixed resistor connected across the secondary of said transformer, an impedance in parallel with at least a part of said resistor, connections from said impedance to the cathodes of said output tubes, an adjustable connection from the grid of one of the amplifier tubes to said resistor, and a fixed connection from the grid of the other amplifier tube to one terminal of the resistor.

8. In a radio receiver, a detector stage, an audio frequency amplifier, an audio frequency transformer having its primary connected across the output electrodes of the detector tube, said amplifier including a pair of tubes connected in push-pull, a manual volume control device for said receiver comprising a fixed resistor connected across the secondary of said transformer and an adjustable connection from the grid of one of the amplifier tubes to said resistor, the grid of the other amplifier tube being fixedly connected to one terminal of the resistor and means for maintaining the grids of the amplifier tubes balanced at all times with respect to ground.

9. In a radio receiver, a detector stage, an audio frequency amplifier, an audio frequency transformer having its primary connected across the output electrodes of the detector tube, said amplifier including a pair of tubes connected in push-pull, a manual volume control device for said receiver comprising a fixed resistor connected across the secondary of said transformer and an adjustable connection from the grid of one of the amplifier tubes to said resistor, the grid of the other amplifier tube being fixedly connected to one terminal of the resistor, a resistance path connected between the amplifier grids, and a connection to ground from a point on said path dividing the latter into resistors of equal magnitude.

10. In a radio receiver, a detector stage, an audio frequency amplifier, an audio frequency transformer having its primary connected across the output electrodes of the detector tube, said amplifier including a pair of pentode power output tubes connected in push-pull, a manual volume control device for said receiver comprising a fixed resistor connected across the secondary of said transformer and an adjustable connection from the grid of one of the amplifier tubes to said resistor, the grid of the other amplifier tube being fixedly connected to one terminal of the resistor, a resistance path connected between the amplifier grids, and a connection to ground from a point on said path dividing the latter into resistors of equal magnitude, the cathodes of said amplifier tubes being grounded.

11. In a radio receiver, a detector stage, an audio frequency amplifier, an audio frequency transformer having its primary connected across the output electrodes of the detector tube, said amplifier including a pair of tubes connected in push-pull, a manual volume control device for said receiver comprising a fixed resistor connected across the secondary of said transformer and an adjustable connection from the grid of one of the amplifier tubes to said resistor, the grid of the other amplifier tube being fixedly con-

connected to one terminal of the resistor, a resistance path connected between the amplifier grids, and a connection to ground, including a variable grid bias source, from a point on said path dividing the latter into resistors of equal magnitude.

12. In a radio receiver, an audio frequency amplifier, an audio frequency transformer, said amplifier including a pair of tubes connected in push-pull, a manual volume control device for said receiver comprising an impedance connected across the secondary of said transformer, an im-

pedance connected in parallel with at least a part of the first mentioned impedance, an adjustable connection from the rigid of one of the amplifier tubes to one of said impedances, a connection from the grid of the other amplifier tube to one terminal of one of the impedances, a connection from one of said impedances to the cathodes of said tubes, and means biasing the grids of said tubes included in the last mentioned connection.

WILLIAM STODDARD BARDEN.