Jan. 18, 1944. H. C. DUFT 2,339,466

PUSH-PULL AMPLIFIER

Filed May 13, 1942

FIG. 1

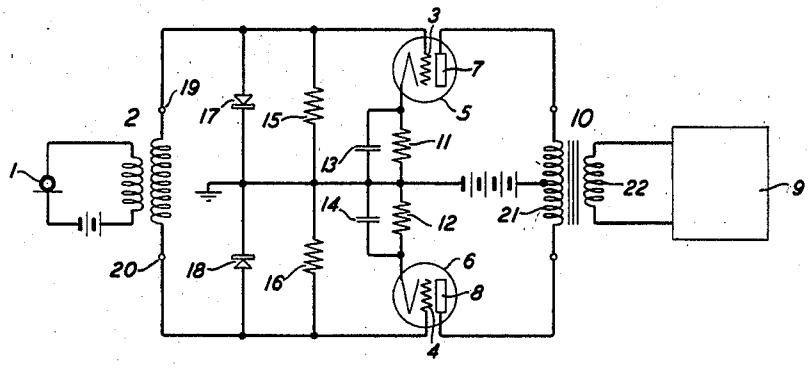
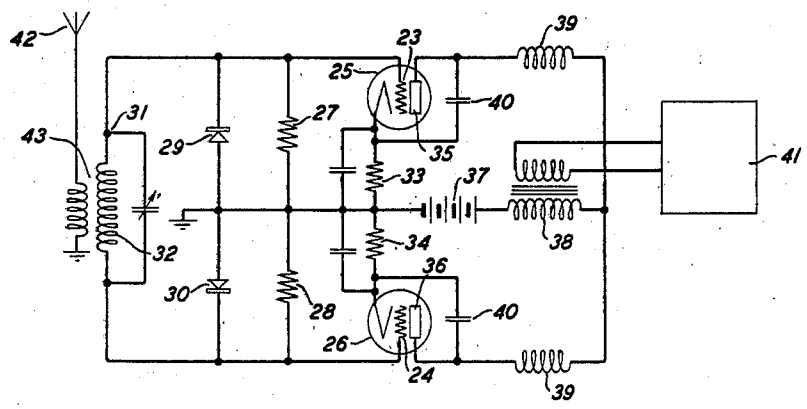


FIG. 2



INVENTOR
H. C. DUFT

BY G. H. Heydt

ATTORNEY

Patented Jan. 18, 1944 2,339,466

UNITED STATES PATENT OFFICE

2,339,466

PUSH-PULL AMPLIFIER

Harry C. Duft, Hinsdale, Ill., assignor to Western Electric Company, Incorporated, New York, N. Y., a corporation of New York

Application May 13, 1942, Serial No. 442,868

3 Claims. (Cl. 250—27)

This invention relates to push-pull vacuum tube circuits and the object of the invention is to increase the gain ratio of such circuits.

In the usual push-pull amplifier the signal waves are impressed on the vacuum tubes by means of a balanced circuit such, for example, as an input transformer with the mid-point of its secondary winding connected to the grounded cathodes of the tubes and its end terminals connected to the grids of the tubes. In such circuits, as is well known, the signal potentials are applied simultaneously to both tubes, one half of the total potential across the terminals of the winding being applied to each tube.

According to this invention the usual mid-point connection from the signal source to the cathodes of the tubes is omitted, large impedances, preferably resistors, are connected across the input circuits of the tubes and these impedances are shunted by oppositely-poled, unilaterally conducting devices, such as ordinary low impedance rectifier elements. In the direction in which each such device is conducting, its impedance is very small as compared with that of the large resistor so that as the polarity of the signal pulse alternates, substantially the full transformer voltage is impressed alternately on the input circuit of each of the tubes.

The application of this type of coupling network to circuits of various kinds will be more clearly understood from the following detailed description and the accompanying drawing in which:

Fig. 1 is an amplifier circuit according to the invention and Fig. 2 illustrates the application of the invention to a full-wave, grid-bias detector.

In Fig. 1 a source 1 of signal current is connected by means of a transformer 2 to the grids 3 and 4 of the tubes 5 and 6 which have anodes 7 and 8 connected in conventional push-pull relation to a load 9 through an output transformer 10. The grids may be negatively biased in any known manner, such as by cathode resistors 11 and 12 shunted by suitable condensers 13 and 14. The input circuits are shunted by high resistors 15 and 16 and by rectifier units 17 and 18 which are oppositely poled to conduct toward their grounded common connection as shown.

During the half cycle of the signal current in which the terminal 19 of the transformer is positive with respect to the terminal 20, current flows from terminal 19 through rectifier 17 and resistor 16 to terminal 20, but the impedance of the rectifier is very small as compared with that of the resistors 15 and 16 so that substantially the full signal potential is applied between the grid and cathode of the tube 6. During the next half cycle the relative polarities of the terminals 19 and 20 are reversed and current flows from terminal 20 through rectifier 18 and resistor 15 to terminal 19 thereby applying practically the full signal potential to the tube 5.

In this particular circuit the grids are alternately driven more negative with respect to the corresponding cathode so that the initial grid bias, if any, will ordinarily be small. As each tube becomes active its plate current is greatly decreased in accordance with the signal and this large change of current in one half of the primary winding 21 of the output transformer induces a corresponding current in the secondary winding 22 in the well-known manner.

It will therefore be apparent that this circuit gives substantially twice the change in grid potential obtained with a conventional push-pull input circuit and that by proper choice of rectifier units and values of the shunting and bias resistors, it is possible to approximate closely to the theoretical six decibel increase in gain. In many cases this additional gain will make it possible to use a single stage amplifier where a two-stage circuit would otherwise be required.

The circuit of Fig. 2 shows how the principle of the invention may be applied to a detector-amplifier for modulated carrier waves. In this circuit the signals received by the antenna 42 are applied through the transformer 43 to the grids 23, 24 of the tubes 25, 26 and the input circuits of the tubes are shunted by high resistors 27, 28 as before. In this case, however, the opposed rectifiers 29 and 30 are poled in the opposite direction to conduct toward the grids of the tubes. During the half cycle when the carrier frequency pulses are positive at the upper terminal 31 of the coil 32, rectifier 30 will substantially short circuit resistor 28 and practically the full signal potential will be applied to the input of tube 25 to decrease the bias due to the resistor 33. In the succeeding half cycle of the carrier frequency rectifier 29 will short circuit resistor 27 and the potential is applied to the tube 26 to decrease the bias due to the resistor 34.

The plates 35 and 36 are connected to the power supply 37 through the primary winding of an output transformer 38 and as in the case of a conventional grid-bias detector the carrier frequency components are eliminated by choke coils 39, 39 and condensers 40, 40 so that the modulations of the carrier frequency are detected and conducted

to the load circuit 41. The tubes 25 and 26 therefore operate as a full-wave detector but due to the application of the full signal potential to each tube the output level will be much higher than that of a conventional circuit.

While the invention has been described for purposes of illustration with reference to particular circuits it will be understood that the general principle involved is applicable to circuits of various other types within the scope of the following claims.

What is claimed is:

1. The combination with an unbalanced source of alternating signal potentials, two vacuum tubes having input electrodes and two high impedances forming with the electrodes a balanced input circuit, of means for alternately applying substantially the full potential of the source to the input electrodes of each of the tubes comprising opposed rectifier units connected in series across the source of signal potentials and connections between the rectifier units and the balanced input circuit.

2. In a vacuum tube system the combination with an unbalanced source of signal potentials, a load circuit and a pair of vacuum tubes having cathodes connected to ground, grids connected to the signal source and anodes connected in balanced relation to the load circuit, of means for applying substantially the full potential of the source between the grid and cathode of each tube alternately comprising a high impedance connecting the grid of each tube to its cathode and series opposed rectifier units shunting the impedances.

3. In combination, two vacuum tubes having grid, cathode and plate electrodes, high impedances connecting the grid and cathode electrodes in balanced push-pull relation, means for negatively biasing the grids, means for interconnecting the anodes and cathodes as a full-wave, grid-bias detector, an unbalanced source of modulated carrier signals connected to the grids and rectifier elements connected in shunt to the high impedances and poled to conduct from the grid to the cathode of the tube.

HARRY C. DUFT.