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POWER AMPLIFIER

Filed June 25, 1931

FIG. 1

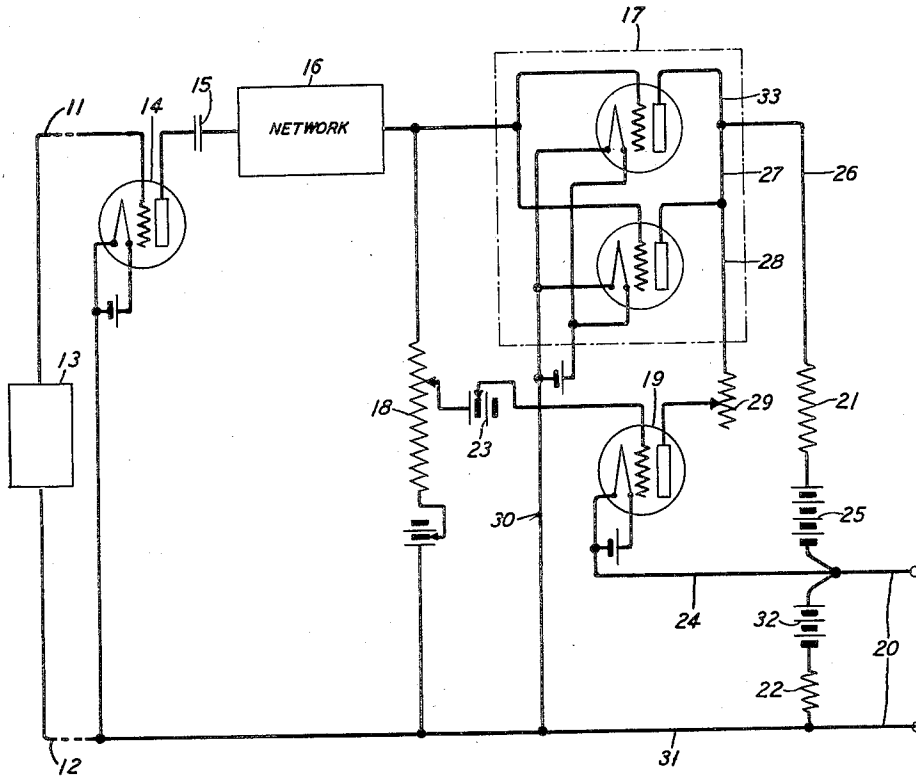
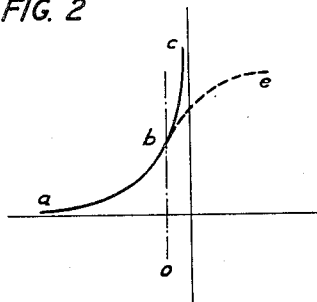


FIG. 2



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POWER AMPLIFIER

Application filed June 25, 1931. Serial No. 546,743.

This invention relates to electric wave repeating apparatus and particularly to the use of electron discharge amplifiers for repeating and amplifying signals for transmission.

5 An object of the invention is to compensate for the distortion introduced in the outgoing signals by operating a vacuum tube amplifier circuit to its full power output whereby the normal ratio of the output impedance of the tube and its connected circuit is departed from during portions of the time.

10 It is well known in the art that if external impedance in the output circuit of a vacuum tube amplifier is greater than the plate resistance, the characteristic of the amplifier becomes nearly linear when the amplifier is operated at low signal amplitudes, thereby rendering the output signal waves practically distortionless. It is also generally known in the art that this reduction in curvature of the characteristic may be enhanced by adding series resistance in the output circuit of the vacuum tube. When it is desired to operate a vacuum tube at high power efficiency, it is necessary that the load impedance be matched to the impedance of the tube and that any added resistance be very small or eliminated entirely. The characteristic of the circuit will become more and more curved up to a definite limit as this resistance is reduced, thereby introducing considerably distortion in the output signal wave. Heretofore, in order to insure markedly increased power output without the accompanying distortion, amplifiers of the push-pull type were employed in conjunction with output transformers having balanced primary windings, but the use of these transformers is not always desirable, especially in circuits where the output currents are of low frequencies and high amplitudes. Even with the use of output transformers the connection of a push-pull amplifier to a line having sides unbalanced with respect to ground is a problem which may involve considerable difficulties.

Several methods have been employed whereby the use of output transformers has been avoided and high power efficiency in the vacuum tube amplifier has been obtained when the plate circuit is worked over practically

the whole characteristic. The distortion thus introduced in the signal wave by the considerable decrease in the vacuum tube output circuit impedance is reduced by impressing a compensating voltage on either the input or the output circuit of the amplifier. Those methods are disclosed in U. S. Patent 1,856,373, granted to E. T. Burton on May 3, 1932. In that patent a compensating vacuum tube is arranged with respect to the amplifier vacuum tube in the following ways: (1) It has its grid circuit connected in parallel and its plate circuit connected in series with the grid circuit of the amplifier. (2) It has both its grid and its plate circuits connected in series with the plate circuit of the amplifier.

According to the present invention, the desired compensation is effected by connecting the respective grid circuits of the compensating and the amplifier vacuum tubes in parallel and their respective plate circuits are connected in parallel. A portion of the latter circuits is connected in a special manner to operate over a common path wherein compensation is effected.

A better understanding of the invention will be had from the following detailed description and appended claims when taken in conjunction with the accompanying drawing in which:

Fig. 1 illustrates schematically an embodiment of the invention for effecting positive current compensation to correct for distortion inherent in the production of even order multiple frequencies;

Fig. 2 represents the input potential-output current characteristic of the power amplifier circuit shown in Fig. 1.

Referring to Fig. 1 the signal input voltage is received over conductors 11 and 12 from a generating or reproducing source 13 such as a transmitter, a repeater, or an amplifier, and impressed on the grid circuit of a thermionic tube 14 say the third stage of a signal shaping amplifier circuit. Desired shaping of the signals in the output circuit of tube 14 is obtained by condenser 15 and a suitable network shown diagrammatically by block 16. The output of tube 14 is in turn impressed on

the grid circuit of a thermionic tube or a bank of thermionic tubes shown within block 17 which represents the fourth and last stage of the amplifier circuit. Across the signal input circuit of the last stage is connected a potentiometer 18 to which is adjustably connected the grid circuit of a compensator thermionic tube 19 so that both the input circuit of the last stage and that of the compensator tube, are adapted to receive the signal input voltage.

The plate circuit of the compensator tube 19 is connected in common with a part of the plate circuit of the amplifier tubes 17 in such a way that when the compensating voltage is impressed on the amplifier voltage in the impedance common to both circuits, the output plate current, in response to an incoming positive impulse, causes a decrease in the amplitude of the amplifier output current as described in the following description of the operation.

The operation of the circuit arrangement shown in Fig. 1 will now be described by referring to Fig. 2 which represents the input potential-output current characteristic of the amplifier circuit before and after compensation of the positive current impulses is effected to correct for dissimilarity of reproduction of positive and negative impulses. The normal or uncompensated characteristic of the amplifier circuit is represented by curve *a b c* of Fig. 2 which is indicative of high distortion in the positive current side of the output signal wave of the amplifier circuit. Therefore, in order to reduce this distortion and cause the degree of amplification to be approximately the same for both sides of the signal wave, the plate circuit of the compensator tube 19 is arranged to include resistance 21 which constitutes a part of the plate circuit of the amplifier tubes 17. The plate circuit of amplifier tubes 17 includes the balancing resistance 22 in addition to the series or common resistance 21, the resistance 22 not being a part of the plate circuit of the compensator tube 19. The resistances 21 and 22 have preferred values of approximately 2,000 and 500 ohms respectively with certain types of commercial vacuum tubes.

The "C" potential furnished by battery 23 in the compensator grid circuit is so adjusted that when no signal input voltage is applied across potentiometer 18 the compensating plate current is reduced to a low or zero value. In the case where a negative signal is applied, the compensator tube grid is carried still further negative with no compensating effect on the amplifier output circuit thereby causing the plate current of the latter to follow the portion *ba* of the characteristic. When an increasing positive voltage is applied to the input, the compensator plate will draw current which will increase with the input voltage.

The plate current of the compensator tube, due to an incoming positive sweep of the incoming signal wave, flows through a circuit extending from the plate and filament of tube 19, conductor 24, battery 25, resistance 21, conductors 26, 27 and 28, resistance 29, back to the plate of tube 19. The plate current of the amplifier tubes 17, due to the same incoming positive sweep of the incoming signal wave, flows through parallel paths between the plates and filaments of the amplifier tubes, conductors 30 and 31, resistance 22, batteries 32 and 25, resistance 21, conductor 26, conductors 27 and 33 in parallel, back to the respective plates of the tubes 17. Thus the plate current of the compensator flows through resistance 21 which is common to the plate circuit of the amplifier tubes, but does not flow through resistance 22. This causes the output of the compensator tube to act on the output of the amplifier tubes to produce a decrease in the current in the output circuit 20. By properly adjusting the constants of the compensator stage, the curve *be* is made the inverse image of the curve *ba*, thereby producing an input potential-output current characteristic, which shows the positive output current of the amplifier circuit reduced to amplitudes symmetrical with those of the negative output current. This type of compensator is known as a "positive" compensator since it effects the positive sweeps only of the incoming signal wave. Its effect is similar to the type of compensator circuit shown in Fig. 1 of the applicant's U. S. Patent 1,856,373, supra.

What is claimed is:

1. An amplifier circuit, a space discharge device, a second space discharge device, said devices having curved amplification characteristics and being so arranged with respect to each other that the input voltage is impressed on the first device and the total input voltage or any part thereof is simultaneously impressed on said second device, an output circuit for each of said devices, the output circuits being so arranged with respect to each other that the currents in a common portion of the output circuits are superimposed on each other in such a manner as to effect in a portion of the output circuit of the first device only, a characteristic having on opposite sides of its operating point, curves which are symmetrical but inversely disposed to each other.

2. An amplifier circuit according to claim 1 wherein the output circuits are connected in parallel with a portion of each, connected in common.

3. An amplifier circuit according to claim 1 wherein an impedance element is common to both of said output circuits and a second impedance element is individual to the output circuit of the first mentioned discharge device whereby the current in said output

circuits are superimposed on each other so that the output current of one device effects a control on the output current of the other device.

5 4. An amplifier circuit according to claim 1 wherein a resistance element is common to both of said output circuits and a second resistance element is individual to the output circuit of said first mentioned first discharge
10 device whereby the currents in said output circuits are superimposed on each other for the purpose of effecting a change in the curva-

ture of the output current characteristic of the amplifier circuit.

5. In an amplifier circuit according to claim 1, means for adjusting the characteristics of said second discharge device so as to obtain desired changes in curvature of the amplification characteristic of the amplifier circuit.

In witness whereof, I hereunto subscribe my name this 20th day of June, 1931.

EVERETT T. BURTON.

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