

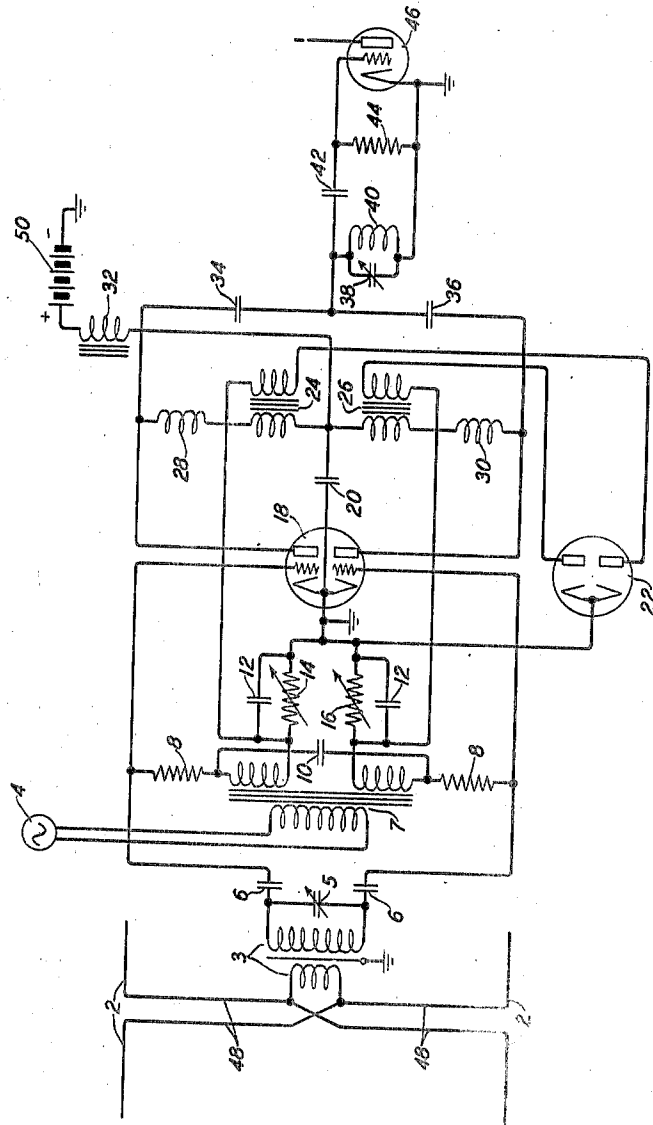
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H. T. BUDENBOM

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BALANCED VACUUM TUBE CIRCUIT

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INVENTOR
H. T. BUDENBOM

BY
H. O. Wright

ATTORNEY

UNITED STATES PATENT OFFICE

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BALANCED VACUUM TUBE CIRCUIT

Horace T. Budenbom, Short Hills, N. J., assignor to
Bell Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

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3 Claims. (Cl. 179-171.5)

This invention relates to balanced, or so-called push-pull, vacuum tube circuits. More particularly, it relates to improved methods and means for maintaining the initial relative adjustment of the two sides of such circuits.

This application is a continuation in part of my copending application Serial No. 231,333, filed September 23, 1938, relating to Radio direction finding systems.

In accordance with the method of the invention, energy from the output of each side of a balanced or push-pull vacuum tube circuit is separately rectified and introduced as a control voltage in the control grid circuit of its side of the circuit, maintaining the gain of that side constant. If the two sides are initially balanced, the desired balanced relation will be maintained, or, conversely, any desired degree of unbalance between the two sides of the circuit will be maintained after initial adjustment to the desired condition.

The energy to be employed for control purposes may be derived directly from the fundamental frequencies of the circuit or it may be derived from harmonics of these fundamental frequencies appearing in the outputs of the circuit under normal operating conditions. Furthermore, an especially appropriate control may be obtained by selecting a harmonic for control purposes which varies in a particular desired manner. By way of illustration, for a balanced modulator used in a radio direction finding system, as described in my above-mentioned copending application, it is especially desirable that a harmonic, which results from the same coefficient of the tube characteristic that determines the modulating characteristics, be selected for control purposes. In this instance, the second harmonic of the low modulating frequency was chosen as complying with the above-stated desideratum.

An object of the invention is, therefore, the provision of means for maintaining the adjustment of balanced, or push-pull, vacuum tube circuits.

A further object is to provide a method and means for maintaining an initial balance between the two sides of a push-pull vacuum tube circuit.

Another object is to provide means for maintaining the balance of a balanced vacuum tube modulator which functions in accordance with the same coefficient of the vacuum tube characteristics as determines the modulating properties of the tubes.

Additional objects will become apparent during the course of the following description and in the appended claims.

The principles of the invention will be more readily understood in connection with the accompanying drawing illustrating a preferred embodiment thereof.

The sole figure of the drawing illustrates the application of the principles of the invention to the maintenance of a balanced relation in a balanced modulator for radio direction finding systems.

In more detail, in the accompanying drawing, radio signals received on the balanced doublet antenna system, comprising radiating elements 2 and the transposed leads 43 connecting them, to transformer 3 are introduced through transformer 3, tuning condenser 5 and condensers 6, to the control grid circuits of balanced modulator tube 18. Into the latter circuits a low frequency generated by oscillator 4 is also introduced through transformer 7. Condensers 6 prevent any substantial energy of the low frequency from reaching transformer 3. Resistances 8 are added to raise the impedances of the secondary circuits of transformer 7 to approximately the impedance of the radio input circuit above described.

In the anode circuits of balanced modulator tube 18 an appropriate battery 50 provides a suitable anode potential for both circuits, through choke coil 32 which isolates battery 50 from alternating currents established in the aforementioned anode circuits.

Retardation coils 28 and 30 prevent radio frequency energy from passing through their respective circuits but freely pass the second harmonic of the low frequency derived from oscillator 4.

Transformers 24 and 26 are designed to transfer energy of the frequency of the second harmonic of oscillator 4. Numerous methods of tuning inductively coupled circuits to transfer a particular desired frequency and suppress other frequencies are known in the art, as exemplified in the well-known text entitled "Principles of Radio Communication," second edition, by J. H. Morecroft, published by John Wiley & Sons, Inc., New York, in 1927, particularly Figs. 105 and 106 at pages 110 and 111, respectively. At frequencies sufficiently high, tuning may be readily effected by constructing the windings of the coupling transformer to have distributed capacity of appropriate magnitude. At lower frequencies it is usually more convenient to add discrete capac-

ity elements in series or in shunt with one or both of the windings of the transformer, respectively. In the circuit of the attached drawing condenser 20 may be proportioned to tune the primary circuits of transformers 24 and 26 to the frequency it is desired to select, without interference with its further duty, to be mentioned hereinafter. The outputs of these transformers are separately rectified in balanced rectifier tube 22 and passed as unidirectional currents through resistors 14 and 16, respectively, which contribute to the biases of the upper and lower grid circuits of tube 18, respectively. Condensers 12 stabilize the potentials established across resistors 14 and 16, respectively, and condenser 10 by-passes high frequencies around the secondary windings of transformer 7. Resistors 14 and 16 are adjusted until the modulator tube 18 is balanced. The currents from transformers 24 and 26, when separately rectified and fed back to their respective control resistors 14 and 16, are arranged to maintain the gain of their respective sides or halves of the modulator circuit appreciably constant and, therefore, maintain the balanced condition of the circuit, when it has been established.

Since the tube functions as a modulator by virtue of the same coefficient of its characteristic as that which produces the second harmonics employed for gain control, the arrangement above described is peculiarly well adapted to maintain the modulator in balance.

If the modulator is balanced, then the output will include only the side-band frequencies formed by the modulation of the radio wave by the low frequency of oscillator 4 and the problems involved in tuning an output circuit, such as that represented by vacuum tube 46 and coupling circuit comprising coil 40, tuning condenser 38, coupling condensers 42 and coupling resistor 44 to select the desired frequencies, will be simplified.

The identical principles may be applied to maintain the balance between the sides of any push-pull form of vacuum tube circuit or to maintain a desired degree of unbalance where certain order harmonics, as well as the carrier frequencies, are desired to appear in the output of the push-pull circuit, in accordance with the numerous well-known uses of push-pull vacuum tube circuits in the art. Condenser 20 drains off noise currents which may have developed across potential source 50, condensers 34 and 36 freely pass the side-band frequencies, as does

also the coupling circuit between these condensers and tube 46. It is anticipated that numerous applications of the principles of the invention will occur to those skilled in the art. No attempt to exhaustively illustrate all such applications will here be made. The scope of the invention is defined in the following claims.

What is claimed is:

1. In a balanced modulator for producing side-band frequencies consisting of the sum and difference of two input frequencies and which eliminates the input frequencies by balancing them out in the two halves of the modulator output, means for maintaining the balance between the halves of said modulator comprising a shunt circuit across each half of the output circuit of said modulator, said shunt circuit passing the second harmonic of one of the input frequencies and excluding all other frequencies, a second means associated with each of said shunt circuits for extracting therefrom energy of said harmonic frequency, rectifying said energy and passing it through a resistor in the grid circuit controlling the amplification through that half of the modulator with which the particular shunt circuit is associated, whereby the amplification of each half of said balanced modulator is separately maintained constant and the balance between the halves of said modulator is thereby maintained.

2. In a push-pull vacuum tube circuit, means for maintaining a balanced relation between the two sides of said circuit comprising a shunt circuit across the output of each side of said circuit, said shunt circuit in each instance selecting a harmonic of an input frequency of said push-pull circuit and excluding other frequencies present in said output circuit, means associated with each of said shunt circuits for extracting therefrom energy of said harmonic, rectifying said energy and passing it through a resistor in the grid circuit controlling the amplification through that side of the circuit with which the shunt circuit is associated, whereby the amplification through each side of the circuit is maintained constant and the balance between the two sides of said push-pull vacuum tube circuit is maintained.

3. The arrangement of claim 2, the harmonics selected by the said shunt circuits across each side of the output circuit being produced by virtue of the same coefficient of the vacuum tube characteristic as that which produces the desired output frequencies of said push-pull circuit.

HORACE T. BUDENBOM.