

Aug. 28, 1945.

A. ALFORD ET AL

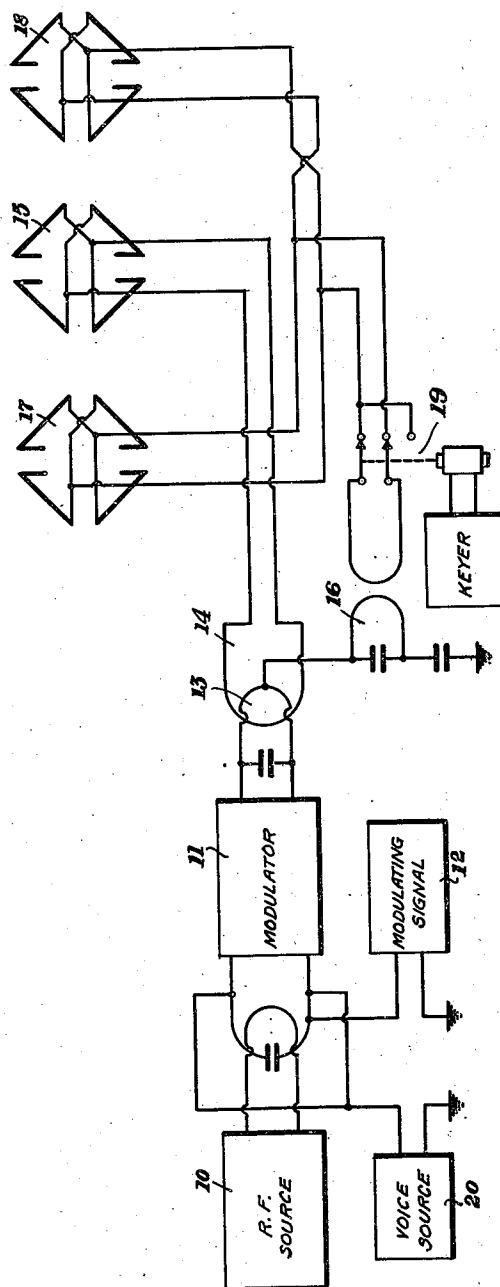
2,383,456

MODULATION CIRCUIT

Filed Nov. 15, 1943

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Fig. 1.



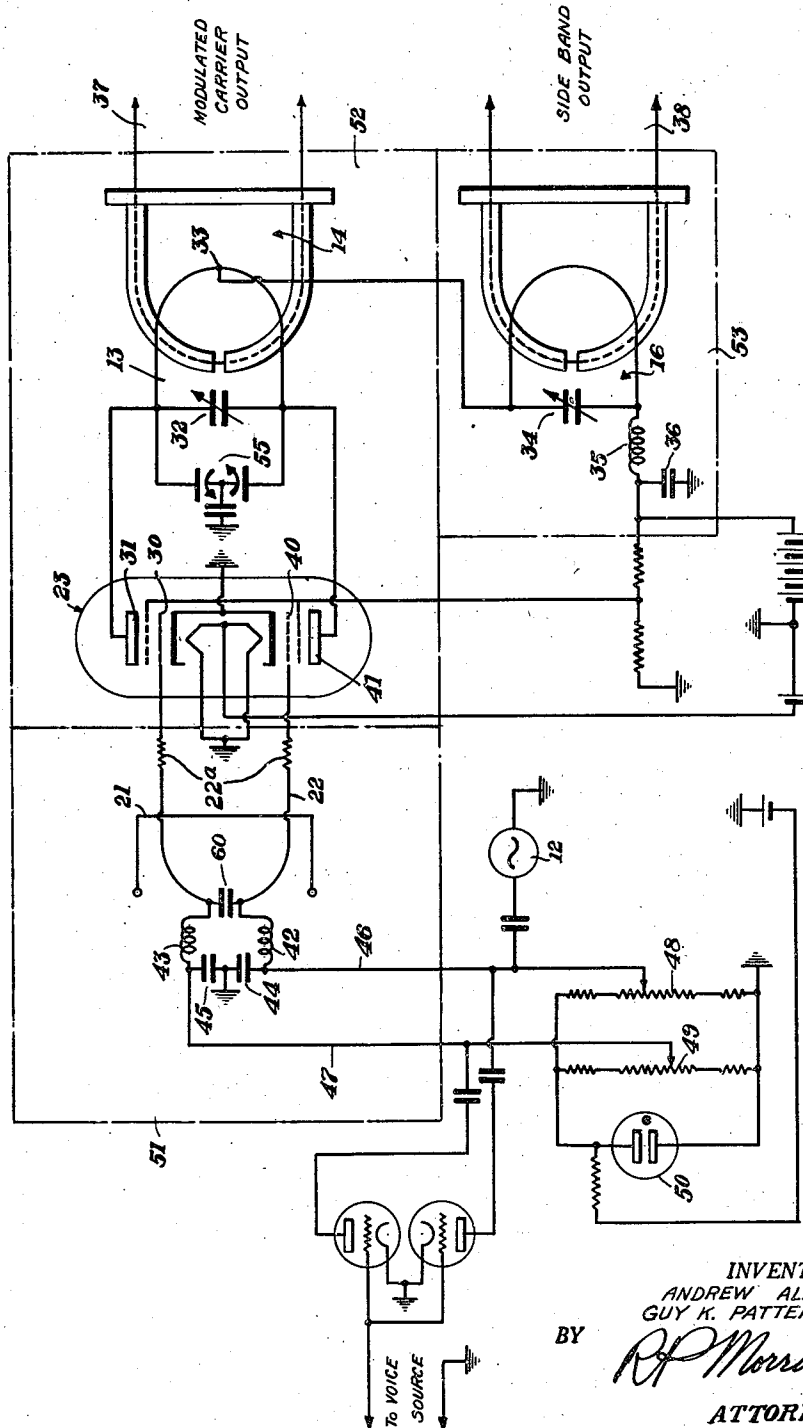
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Fig. 2.

2,383,456

Filed Nov. 15, 1943

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MODULATION CIRCUIT

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Application November 15, 1943, Serial No. 510,268

12 Claims. (Cl. 250—11)

This invention relates to modulation circuits and more particularly to modulation systems particularly suitable for energization of radio beacons.

In certain types of radio beacons, it is often desirable to energize one of the antenna units with carrier and side band energy and to energize other cooperating antenna units with side band energy only. This has commonly been done by systems feeding modulated energy to opposed diagonal points of a high frequency bridge circuit of such a nature that at one terminal the carrier wave will balance out and permit only side band energy to be fed out, while at the diagonally opposite terminal the carrier energies will add in phase so that both carrier and side band output is obtained.

It is a principal object of our invention to provide a modulating circuit which will produce separate modulated carrier waves and side band wave outputs without the use of special bridge circuits.

It is a further object of our invention to provide a modulating system in which voice frequency may be applied to a modulator simultaneously with the application thereto of other modulating signals and carrier frequency waves, and in which there is provided one output carrying the voice frequency signals and the other modulating signals together with carrier frequency, and a second output circuit carrying only the side bands of said other modulating signal.

It is a further object of our invention to provide a small and light-weight modulating unit for energizing a radio beacon.

According to a feature of our invention, we provide a vacuum tube arrangement operating substantially as a push-pull amplifier modulator to which unit is applied a radio frequency energy in push-pull relation. Accordingly, in the output of the vacuum tube arrangement, there is provided an amplified radio frequency excitation. The midpoint of the push-pull output circuit is coupled with a further output loop tuned substantially to the carrier frequency. However, because of the push-pull input and output characteristics, none of the carrier frequency will appear in this circuit. A modulating signal is then applied to one grid only of the push-pull vacuum tube circuit, thus producing an unbalanced modulated wave in the output circuit of the vacuum tube arrangement. This unbalanced voltage will feed to the second output circuit, and in that circuit will consist only of the side band energy of the modulated wave. However, in the principal circuit, there will be present the carrier frequency as

well as the side band modulating frequencies. In order to prevent intercoupling of the two output circuits, a shielding is generally provided between the two output circuits. Furthermore, in order precisely to balance the push-pull modulation, independent bias control is provided for the push-pull vacuum tube circuit, and in the output circuit, a differential phase balancing condenser is provided.

A better understanding of our invention and the objects and features thereof may be had from the particular description thereof made with reference to the accompanying drawings, in which:

Fig. 1 is a block schematic diagram of a radio beacon arrangement incorporating a modulating system in accordance with our invention; and

Fig. 2 is a schematic wiring diagram of the modulating circuit in accordance with our invention.

Turning first to Fig. 1, 10 represents a radio frequency source coupled to the input loop of modulator 11. In the output of modulator 11 is provided a balanced output loop 13 coupled over a loop 14 to a centrally positioned antenna unit 15. A modulating signal is supplied from source 12 to one side of modulator 11, producing in loop 13 a modulated carrier wave which consists of the carrier frequency and the side band energy. This energy is supplied to unit 15. Coupled to the midpoint of loop 13 is a second output loop 16. This loop, because of its symmetrical connection with respect to loop 13, will not receive any of the balanced radio frequency energy from source 10. However, the modulating signal is unbalanced in character and therefore there will be developed in loop 16 side band energy. This energy is fed over a coupling line and a keyer 19 to the outer antenna units 17 and 18 arranged on opposite sides of central antenna unit 15. The respective lengths of the lines are so chosen that energy in unit 15 is 90° in phase from energy in units 17 and 18 while the energy in units 17 and 18 is in phase opposition with respect to one another. Keyer 19 serves alternately to reverse the potential fed to antenna units 17 and 18, thus producing a keyed beacon signal.

Should it be desired to also apply voice signal to the beacon, this may be done by connecting a voice source 20 across the input loop of modulator 11 so that this voice energy is in parallel. Thus, the radio frequency energy will be modulated so that this voice frequency energy will be applied to central antenna unit 15 and to antennas 17 and 18.

A preferred circuit for the modulator 11 of Fig.

1 together with the input and output loops is illustrated in Fig. 2. In this arrangement, energy from the radio frequency source is supplied over a loop 21 to input loop 22. This input loop applies the carrier wave in push-pull to the control grids 30, 40 of a double tetrode tube 23. If desired, parasitic suppressing resistors 22a may be included in loop 22. A condenser 60 is provided in loop 22 so that the bias on the separate grids 30 and 40 may be independently controlled and further so that signals may be independently applied to these grids. The balanced loop output circuit 13 tuned to resonance at the carrier frequency by a variable condenser 32 is coupled to anodes 31, 41 of tube 23. At the midpoint 33 of loop 13 is provided a connection to loop 16 which is tuned by variable condenser 34 and which may be connected to ground through radio frequency choke 35 and by-pass condenser 36. A loop 14 is coupled with loop 13 to furnish the output leads for this circuit. Energy from a modulating signal source 12 is applied over lead 46 and radio frequency choke 42 to grid 40 of tube 23. This serves to apply an unbalanced modulating signal producing unbalanced sideband energy in output loop 13, thus providing in 13 sideband energy as well as carrier frequency energy. The unbalanced sideband component in loop 13 is also fed over midpoint 33 to loop circuit 16 and from this circuit is supplied over output leads 38 to a desired load which may be antennas such as 17 and 18 of Fig. 1.

In order that the circuit may be properly balanced, we provide a differential bias control comprising potentiometers 48 and 49 connected by leads 46, 47 and chokes 42, 43, respectively, to grids 40 and 30 of tube 23. A voltage regulating tube 50 is provided to assure that constant voltage is applied across potentiometers 48 and 49. By adjusting this differential bias control, an amplitude balance in the output of tube 23 may be readily achieved. In addition, a differential phase balancing condenser 55 is provided across tuned loop 13. This condenser is adjusted until the phase balance is achieved in loop 13 so that in the absence of modulating signal from source 12 there is no output in loop 16. By-pass condensers 44 and 45 may be provided to by-pass any radio frequency energy which may pass chokes 42 and 43 to ground.

To prevent any coupling between the input and output circuits 22, 13 and 16, separate shield arrangements 51, 52 and 53 are provided about each of these separate components. This shielding is essential if all the carrier frequency is to be excluded from loop 16 when the parts are assembled, for example, in a compact modulating unit where close spacing is required.

In an actual full-scale operating model of the modulator in accordance with this invention, it was found possible to make the entire unit in such size to be readily portable. The unit, including the modulator, the necessary radio frequency oscillators and the tone generating source, may be housed in a casing about the size of a suitcase and light enough to be readily carried by one man.

While we have described a particular embodiment of our invention related to a particular type of beacon, it is clear that this description is made merely by way of example and that many modifications may present themselves to those skilled in the art. For example, if it is desired to have the voice frequency sidebands transmitted from loop 16 to the exclusion of loop

13, it is merely necessary to make the connections to grids 30, 40 in parallel instead of push-pull relationship.

Also, instead of keying the output line, the keying device may be arranged to alternately connect source 12 to lines 46 and 47, if desired. What we consider as our invention is embodied in the objects set out above and in the accompanying claims.

What is claimed is:

1. A modulating system for producing two output waves, one of carrier frequency plus side bands, and the other of side band frequencies only, comprising vacuum tube means having two control grids and two anodes, an input circuit coupled to said grids, a center-tapped loop output circuit coupled to said anodes, a source of carrier frequency energy, means for coupling said source of carrier frequency energy to said control grids in push-pull relation, a source of signal energy, and means for coupling said source of signal energy to one only of said control grids to modulate said carrier frequency energy to produce side bands, whereby carrier frequency and side band energy is developed in said loop output circuit, and side band energy only at said center tap.

2. A system according to claim 1, further comprising separate bias adjusting means coupled to said control grids to independently adjust the bias on said grids.

3. A system according to claim 1, further comprising differential condenser means connected across said loop output circuit to adjust the balance in said loop.

4. A modulating system according to claim 1, further comprising bias control means for independently adjusting the bias of said control grids, and a differential condenser coupled across said loop output circuit to adjust the phase balance therein.

5. A modulating system according to claim 1, further comprising a resonant circuit coupled to the center tap of said loop output circuit for receiving said side band energy only, and shielded means for shielding said resonant circuit from said loop output circuit.

6. A modulating system according to claim 1, further comprising voice signal means, and means for applying said voice signals to said control grids in push-pull relation, whereby voice modulated energy is developed in said loop output circuit but is balanced out at said center tap.

7. In a radio beacon having a central radiating means, two side radiating means arranged on opposite sides of said central radiating means and a line interconnecting said side radiating means in phase opposition, means for supplying carrier and side band energy to said central radiating means and substantially side band energy only to said side radiating means, comprising vacuum tube means having two control grids and two anodes, an input circuit coupled to said grids, a center tapped loop output circuit coupled to said anodes, a source of carrier frequency energy, means for coupling said source of carrier frequency energy to said control grids in push-pull relation, a source of signal energy, means for coupling said source of signal energy to one only of said control grids to modulate said carrier frequency energy to produce side bands, whereby carrier frequency and side band energy is developed in said loop output circuit, and side band energy only in at said center tap, first coupling means for coupling said loop output circuit to

said central radiating means, a second output circuit connected to the center tap of said loop output circuit, second coupling means for coupling said second circuit to the interconnecting line of said side radiating means and means for alternately reversing the phase of side band energy supplied to said interconnecting line.

8. A radio beacon according to claim 7, wherein said last named means comprises keying means for alternately reversing said second coupling means.

9. A modulating system according to claim 7, further comprising bias control means for independently adjusting the bias of said control grids, and a differential condenser coupled across said loop output circuit to adjust the phase balance therein.

10. A modulating system according to claim 7, further comprising voice signal means, and means for applying said voice signals to said control grids in push-pull relation, whereby voice modulated energy is developed in said loop output circuit but is balanced out at said center tap.

11. A modulating system according to claim 7, further comprising bias control means for inde-

pendently adjusting the bias of said control grids, a differential condenser coupled across said loop output circuit to adjust the phase balance therein, and shielded means for shielding said loop output circuit and said second output circuits from one another.

12. A modulating system for producing two output waves, one of carrier frequency plus side bands and the other of side band frequencies only, comprising vacuum tube means having two control grids and two anodes, a loop output circuit coupled to said anodes, a second output circuit coupled to the electrical midpoint of said electric loop circuit, a source of carrier frequency energy, means for coupling said source of carrier frequency energy to said control grids in push-pull relation, a source of signal energy, and means for coupling said source of signal energy to only one of said control grids to modulate said carrier frequency energy to produce side bands, whereby carrier frequency side band energy is developed in said loop output circuit and side band energy only in said second output circuit.

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