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MODULATING SYSTEM

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Fig. 1.

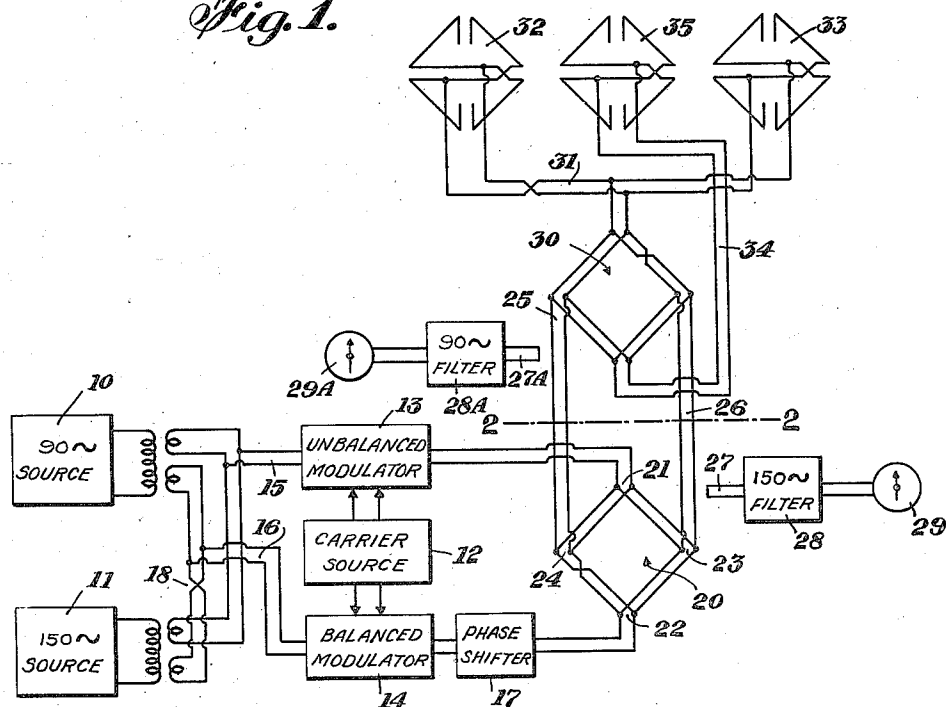
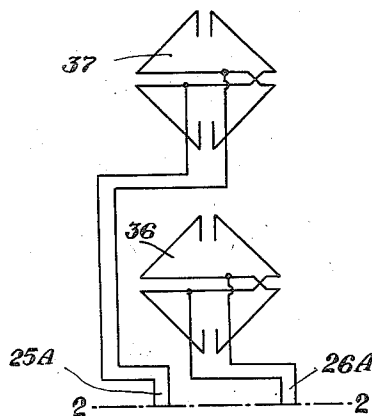


Fig. 2.



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MODULATING SYSTEM

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7 Claims. (Cl. 250-11)

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This invention relates to a modulating system and more particularly to a system designed for use in radio beacons.

In many radio beacons such as course and localizer beacons or equi-signal glide paths, it is desired to transmit differently characterized signals on opposite sides of the beacon guiding line in order to guide the aircraft along a course or into a landing. In such systems it has been a generally common practice to use mechanical modulators or the like in the separate lines to produce the independently modulated carrier signals for application to the beacon antennas.

It is a principal object of my invention to provide a modulating system which is particularly useful for obtaining carrier waves modulated with different signals so that the carrier combined with each of these signals may appear at independent terminals.

It is a still further object of my invention to provide a simple monitoring circuit for use with the beacon modulating system which will indicate the degree of unbalance directly at the transmitting end of the beacon.

In accordance with a feature of my invention, I provide a system in which a carrier wave is modulated with a first and second signal in an unbalanced modulator which produces an output of carrier frequency and the signal sidebands. At the same time, the same carrier frequency is modulated with the two signals in a balanced modulator, one of these signals being reversed in phase with respect to the other modulator. This produces output signal sidebands only. The outputs from these two modulators are then combined with one another across a conjugate network so that in one of the output leads of the network appears carrier energy and sidebands of one of the signals and at the other output terminals appears carrier frequency and the other of the sideband signals. Monitoring can then be achieved merely by coupling a filter circuit to one of the output terminals and connecting an indicator in the output of the filter to show presence of unwanted signals at that terminal.

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

Fig. 1 shows an example of a modulator in accordance with my invention applied to a course beacon; and

Fig. 2 shows an alternative antenna structure for a glide path beacon which may be substituted in the circuit of Fig. 1.

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Turning first to Fig. 1, 10 and 11 are separate signal sources which may be 90 and 150 cycle sources. Any two differing frequencies may be used, as is well understood in the art. A carrier source 12 is arranged to supply carrier simultaneously to an unbalanced modulator 13 and a balanced modulator 14. Energy from sources 10 and 11 is applied over line 15 to unbalanced modulator 13 and over line 16 to balanced modulator 14, respectively. As shown at 18, one of the signals, for example, that from source 11, is reversed in phase in line 16 with respect to the energy supplied at line 15. In the output of unbalanced modulator 13 will appear carrier frequency and sideband components of the signals from 10 and 11, the signal frequency components being removed in the usual manner. In the output of modulator 14 will appear only sideband components from signal sources 10 and 11 and the component from source 11 will be in phase opposition to the corresponding sideband at the output of modulator 13, the carrier frequency being balanced out, and the signal frequency components being eliminated.

The output energy from modulator 13 is applied to an input terminal 21 of a bridge network 20 and the output of balanced modulator 14 is applied over phase shifter 17 to the diagonally opposite input terminals 22 of bridge 20. The sideband components of source 10 derived from modulators 13 and 14 will add in phase while those of source 11 will be balanced out at output terminals 23. As a consequence, line 26 coupled to terminals 23 will have therein carrier energy and the sideband signal component from source 10. Because of the transposition of one arm of bridge 20, the signal energy sidebands from source 11 as derived from the modulators will add in phase at output terminal 24, while the signal energy sidebands from source 10 will be balanced out. As a consequence, line 25 connected at output terminal 24 will carry only carrier frequency energy and the sideband component from source 11.

These two modulated signals may then be applied to any desired radio beacon arrangement, for example as illustrated, they are shown connected to a localizer or course beacon of the type disclosed in the United States patent to Andrew Alford, No. 2,293,694, issued August 25, 1942. Lines 25 and 26 are coupled to the input terminals of bridge 30 and hence over one of the output terminals and line 31 supply sideband energy components to radiators 32 and 33. From the opposite output terminal of bridge 30 carrier

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and sideband energy are supplied over line 34 to central radiating units 35. Thus is provided an equi-signal radio beacon which may serve either as a localizer beacon at an airfield or as a course beacon for guiding an aircraft between given points.

Because of the combination of the energy from the two modulators through bridge 20 and since signals from both sources 10 and 11 are applied to each of the modulators, reduction of signal strength of one source with respect to the other will not cause a shifting of the beacon course. If one of the sources becomes weak with respect to the other, it will merely result in lack of complete balancing out of the signals causing a broadening of the course but the course line will be maintained in the same position. Similarly, if either of the modulators becomes weakened with respect to the other, a broadening of the courses will result but no shifting thereof. This factor is particularly of value in localizer beacon arrangements or in landing beacon arrangements where a slight shifting of the course line may bring the craft following such a line dangerously close to obstructions.

In order to assure proper balance of the energy supplied in the beacon, I provide a monitoring circuit which may include a coupling loop 27 coupled to line 26. Loop 27 supplies energy to a filter 28 which is tuned to pass only sideband components from source 11. The output of filter 28 is coupled to a meter 29. When the circuit is properly balanced, there will be no component from source 11 in line 26 and meter 29 will read zero. However, in the case of any unbalance, meter 29 will give an indication and the degree of departure of this indication from zero will indicate roughly the degree of unbalance. Balance may be restored by adjusting phase shifter 17 to bring the energy into proper phase agreement at the bridge input terminal and by adjusting the amplitude of energy in the output of either or both of the modulators 13 and 14.

If desired, a second monitoring unit coupled by loop 27A to line 25 and provided with a filter 28A serving to pass only the signal component from source 10 and a meter 29A may be provided. In general, however, a single meter will serve the purpose of monitoring the entire station.

While I have disclosed a preferred form of conjugate network arrangement in bridge 20, it is clear that any desired form of conjugate network may be substituted in its stead. It is only necessary that such network serve to combine the sideband components from the two modulations in the proper phase relationship. Furthermore, it is clear that the particular type of beacon shown in Fig. 1 need not be used, if desired, but the energy from leads 25 and 26 may be taken to any known form of beacon such as the crossed loop type of beacon, if desired.

In Fig. 2, I have shown an antenna arrangement which may be substituted for that of Fig. 1 when an equisignal glide path is desired. The antenna arrangement of this figure corresponds substantially to that disclosed in an application for Letters Patent to Andrew Alford, Serial No. 442,069, filed May 7, 1942, now Patent 2,373,090, issued April 16, 1945. According to this arrangement, energy from leads 25 and 26 is fed over lines 25A and 26A to vertically arranged horizontal loops 37 and 36. Loop 37 is arranged at a height above the earth to produce a plurality of lobes having a null aligned with the desired angle of glide path. Loop 36 is arranged at a

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lower height, for example, half the height of loop 37, so that it provides a radiation lobe overlapping the null produced from antenna 37. In this manner, an equi-signal glide path carrying differently characterized signals is provided for guiding the craft to a proper landing.

It is clear that many different forms of beacon arrangements may be used with the modulating system of my invention without departing from the spirit thereof. Furthermore, other types of systems may be provided to furnish the original modulated waves applied to the conjugate network such as 20. Moreover, any type of antenna desired may be substituted for the particular horizontal loop type illustrated in the drawings.

While I have described above the principles of my invention in connection with specific apparatus and particular modifications thereof, it is to be clearly understood that this description is made only by way of example and not as a limitation on the scope of my invention as set forth in the objects of my invention and the accompanying claims.

What is claimed is:

1. A system for providing a carrier modulated separately with two different signals, comprising first means for supplying carrier energy and a first and a second signal sideband, second means for supplying said first and second sidebands with one of said sidebands being phase reversed with respect to the sideband from said first means, a network having two conjugate input terminals, two conjugate output terminals and phase reversing means between one of said input and one of said output terminals, means for respectively applying energy from said first and second means to said input terminals, and output means coupled to said output terminals for deriving said carrier energy and one of said sideband signals, respectively, from said output terminals.

2. A system according to claim 1 further comprising monitoring means coupled to one of said output means, comprising a filter tuned to pass the signal sideband differing from that wanted at the output terminal, and indicator means in the output of said filter.

3. A method of providing a carrier modulated separated with two different signals, comprising producing a first wave combination consisting essentially of carrier energy and first and second signal sidebands, producing a second wave combination consisting essentially of said first and second sidebands with said first sidebands reversed in phase with respect to the corresponding sideband first named, combining said first and second wave combinations in phase coincidence to provide a first resultant wave combination of said carrier and said second sideband, and combining said first and second wave combinations in phase opposition to provide a second resultant wave combination of said carrier and said first sideband.

4. A method according to claim 3 further comprising the step of measuring the unwanted sideband component in one of said resultant wave combinations to determine unbalance between said first and second wave combinations.

5. A beacon modulating system comprising a first signal source, a second signal source, a carrier frequency source, a balanced modulator, an unbalanced modulator, means for supplying carrier to both said modulators, means for coupling said first and second sources to one of said modulators, means for coupling said first and second

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sources to the other of said modulators with the signals from one of said sources in phase opposition to the corresponding signals supplied to said one of said modulators whereby carrier and sideband energy of both said signals appears at the output of said unbalanced modulator, and sidebands only at the output of said balanced modulator, a four terminal bridge network having a transposition in one arm thereof, means for applying the outputs of said modulators, respectively, to diagonally opposite terminals of said bridge network whereby carrier energy and said first signal sidebands appears at one of the remaining terminals of said bridge, and carrier and said second signal sideband appears at the other terminal of said bridge.

6. A system according to claim 5 further comprising phase shifting means in the output of one of said modulators for shifting the phase of the output energy to assure balance of energy in said bridge.

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7. A system according to claim 5 further comprising output lines coupled to each of said remaining terminals of said bridge, and a monitoring circuit coupled to at least one terminal of said bridge, said monitoring circuit comprising a filter tuned to the frequency of the sideband of the signal not wanted at said one terminal and an indicating meter coupled to the output of said filter.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,302,143	Pickles	Nov. 17, 1942
1,918,402	Klopsteg	July 18, 1933
2,310,202	Alford	Feb. 9, 1943