

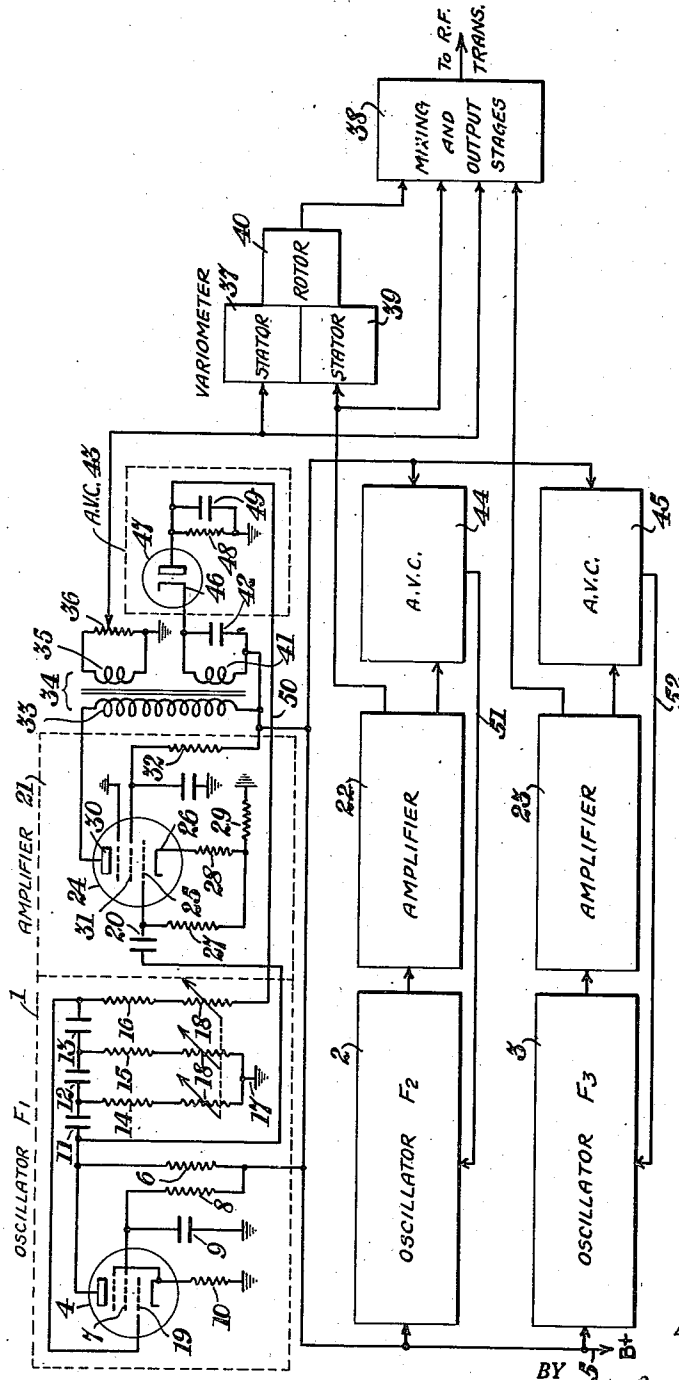
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TRANSMITTER CONTROL CIRCUIT

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TRANSMITTER CONTROL CIRCUIT

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This invention relates to automatic volume control circuits and more particularly to such control circuits applied to radio beacon transmitters of the omni-directional type.

Various forms of omni-directional radio beacons have been proposed in the past. One such form, as for instance disclosed by E. Labin-D. D. Grieg in their application for patent, Ser. No. 581,974, filed March 10, 1945, contemplates a visual indicator beacon system which is applicable to various modulation methods wherein a directive radio beam is rotated and which is modulated in synchronism with its rotation about the transmitter position. The modulation of the beam is such that continuous indications may be had from an indicator at the receiver station in contrast to indications by azimuth segments as in some previous systems. In order that the bearings obtained with such a system remain independent of supply voltage changes or input or output signal amplitude level changes and so forth, the transmitter and receiver signals are provided in the form of components compared in ratio rather than absolute signal value. By this means the accuracy of the system may be maintained independent of the operating parameters.

It is an object of my invention to provide for omni-directional radio beacon system of the above-described type, apparatus suitable for transmitting signals of given ratios for interpretation with respect to directional information by a receiver.

It is a further object to provide a transmitter which will generate signals having ratios which will be maintained substantially constant.

It is still another object of the invention to provide a transmitter having great stability and constancy of operation and which automatically maintains such stability and constancy.

It is still another object to provide a circuit for accomplishing the above-defined objects.

In accordance with a feature of this invention, I provide an improved transmitter for use in a radio beacon of the type described in detail in the aforesaid application, briefly described below. The transmitter is comprised of three separate oscillators for supplying three different frequencies.

The output circuits for two of the oscillators include the stator coils of a rotating variometer and the output circuit of the third oscillator is applied directly to a mixing circuit which also receives the output voltage of the other two oscillators. The two stator coils are arranged to form a 90° angle. The rotary coil is continuously

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influenced by the respective fields of the stator coils in accordance with its rotative position relative thereto. The effect of this arrangement is such that the outputs of the two first signal sources or oscillators are modulated in accordance with the sine and cosine functions respectively.

The third signal which does not go through the variometer consequently remains at a constant amplitude. These three signals are brought together in the mixer to produce a composite signal which is used as a modulating source for radio frequency transmissions. The modulated energy is transmitted in the form of a beam rotated in timed relation with the rotary coil of the variometer. As a consequence, the radiation pattern will contain the three modulation components having a unique mutual relationship or ratio for each azimuth position of the rotating beam.

In order to maintain the amplitude of the outputs of the three oscillators at a fixed ratio, an automatic amplitude control is used, utilizing a rectifier circuit for each oscillator the rectifiers all being referred to a common reference, in this case a common source of delay bias potential for the rectifiers. Further improved stability of operation is obtained by the provision of considerable negative feedback in the oscillator and amplifier circuits related thereto.

These and other objects and features will be better understood from the detailed description made with reference to the accompanying drawing in which the single figure represents a diagram partly in schematic and partly in block form of the modulating signal generator circuits for the transmitter in a radio beacon system of the above-described type.

In the figure the circuit is seen to comprise three oscillators 1, 2 and 3. The oscillators, as shown in detail for oscillator 1, are of the resistor-capacity phase-shift type and are tuned to frequencies F_1 , F_2 and F_3 , respectively. They each include an oscillator tube 4 which receives its plate energy from a B+ supply 5 over a plate load resistor 6. The supply 5 also provides a load potential for a screen grid 7 over a screen resistor 8, the latter being bypassed to ground by a condenser 9. The oscillator tube 4 is provided with a negative feedback in the form of an unbypassed cathode resistor 10 and with a frequency determining circuit consisting of a three-mesh series-condenser shunt-resistor network, which includes condensers 11, 12, 13 and resistor circuits 14, 15, and 16, of which the circuits 14 and 15 are tied

to a common ground at 17. These resistor circuits 14, 15 and 16 are subject to a ganged adjustment as shown at 18 in order to permit a suitable phase correction. A positive feedback is established over the frequency determining R.-C. mesh circuit connected to grid 19 of the oscillator tube 4. The output of the oscillator circuit is applied over a coupling condenser 20 to an amplifier 21 in the first channel and amplifiers 22 and 23 in the other respective oscillator channels. These amplifiers each comprise an amplifier tube 24 which receives its control energy on a grid 25 over the coupling condenser 20. The grid 25 and a cathode 26 are biased by means of resistors 27 and 28 respectively which are connected together to a negative feedback resistance 29. The amplifier tube 24 is provided with a plate 30 and a screen 31, both of which are supplied with potential from the source 5, the grid over a screen grid resistor 32 and the plate over the primary winding 33 of an output step-up transformer 34. Transformer 34 is split to provide two windings. A normal output circuit for the generated signal is fed from one secondary 35 which by way of a voltage regulating resistance 36 supplies an output potential to a stator coil 37 of a variometer and to a mixing and output stage at 38. This holds true for oscillators 1 and 2, where the amplifier 22 supplies a second stator coil 39, while in the case of the oscillator 3, the amplifier 23 supplies the output potential directly to one of the mixing stages at 38 without going through the stator coils. The effective voltage of a rotary coil 40 which is a function of its rotary position with respect to the two stator coils is also applied to one of the mixer stages at 38. The other secondary winding 41 of the output transformer 34, which is tuned by means of a condenser 42 connected thereacross to improve the waveform and to increase a voltage output thereof, feeds an automatic volume control circuit 43, in the channel of the first oscillator, and similar volume control circuits 44 and 45 for the other two oscillators. To obtain the automatic voltage control the voltage of the transformer secondary 41 is applied to a cathode 46 of a diode rectifier 47. The diodes of the three automatic volume control circuits 43, 44, and 45 are furnished with a common delay bias from the source 5 applied to the respective cathodes by way of the windings of the secondary 41. The output voltage of the diode rectifier 47, as developed across its load resistor 48 which is by-passed by a condenser 49, is fed back over a conductor 50 and analogous conductors 51 and 52 in the case of the other two oscillators as a control bias voltage to the control grid 19 of the oscillator tube 4 by way of the resistor circuit 16.

In operation, the oscillators 1, 2, and 3 supply signal frequencies preferably in the audio range, designated as F_1 , F_2 , and F_3 . These frequencies are each determined by the respective R.-C. meshes and the plate and load resistors of the respective oscillators. Corrective adjustments in the frequency may be made by means of the ganged adjusters 18 in each of the mesh networks. The oscillator's output is amplified in the amplifier circuits 21, 22, and 23, the outputs of which in part will supply voltages to the two variometer stator coils 37 and 39 and to the mixing circuit 38 and in part to the delayed automatic volume control circuits 43, 44, and 45 which produce the volume control voltages for the oscillators. The amplitude of the three oscillators must always be maintained in a fixed ratio since otherwise the ultimate azimuth in formation will be in error.

In order to keep the three oscillator voltages in a fixed ratio, a common delay bias is applied to all of the three diode rectifiers. This common bias thus acts as a reference for the three oscillators. The larger the signal voltage applied to the diode in comparison with the D.-C. control voltage developed thereby, the more effective will be the automatic amplitude control. Since the modulating output voltage to the stator coils is taken from a low impedance winding on the output transformer 34 distortion should be held to a minimum. To achieve this, the full output of the oscillator is applied to the amplifier tube grid and a large negative feedback is used. The amplifier tube should be such so as to have enough gain to utilize all the feedback possible. A common voltage supply is used to provide the operating potentials for the oscillator, amplifier and the rectifier tubes. Should any of the amplifiers have a reduced output due to any cause whatsoever such as variation of supply voltage, changes in the tube characteristics or variations in the individual oscillator outputs themselves then the automatic volume control of the separate circuits will serve to bring these back to the value determined by the common delay bias. The reference voltage 5, itself, may be subject to regulation to improve general operation stability.

Since the variometer, as already disclosed in the above-mentioned depending applications, comprises two stator coils physically at an angle of 90° to one another and a rotary coil, each of the stator coils induces a voltage in the rotary coil which varies sinusoidally in amplitude in the rotary coil. Due to the relative positions of the two stator coils, the amplitude variations of the two voltages induced in the rotary coil are 90° out of phase, that is, one is a sine and the other a cosine function of the rotary angle. The output of the three oscillator circuits, therefore, will consist of two varying amplitude voltages each consisting of a fixed amplitude component supplied by a stator coil and a varying amplitude component supplied by the rotary coil, and a fixed amplitude voltage connected directly to the mixing network 38.

In view of the necessity as shown above, for the proper operation of the beacon system for the ratio of the signals of the respective oscillators to be maintained substantially constant, the importance of the automatic volume control having a common reference and of the considerable negative feedback for improving the stability of operation of the system will be appreciated.

While I have described my invention particularly in connection with a rotary radio beacon, it shall be understood that this is only one use thereof. My invention may be used whenever it is required that the ratio of energies from two or more oscillators be maintained substantially constant.

It will be understood that the particular embodiment as given above is presented merely by way of illustration and should not be considered as a limitation of my invention as set forth in the objects thereof.

I claim:

1. A radio circuit for generating a composite signal consisting of a plurality of signals having constant mutual ratios, comprising a plurality of oscillators, one each for generating a signal at a given frequency, signal amplifying means for each oscillator, a load output circuit for each of said amplifying means, a control output circuit coupled to each of said amplifying means for

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deriving a corrective biasing voltage therefrom, means for applying said biasing voltage to the respective oscillators, to compensate for variation in amplitude of the output energy thereof, and means for applying a delaying bias common to all of said control circuits, whereby a common reference is obtained for said oscillators.

2. A circuit in accordance with claim 1, wherein said control output circuit comprises a rectifying diode.

3. A circuit in accordance with claim 1, further including means for producing negative feedback for each of said oscillators and said amplifying means.

4. A circuit in accordance with claim 1, wherein each of said amplifying means includes a step-up transformer having a secondary portion for energizing said load output circuit and another secondary portion to energize said control output circuit.

5. A circuit in accordance with claim 1, wherein said plurality of oscillators are three in number and the load output circuits of two of said oscillators include the two stator coils of a variometer comprised of two stator and one rotary

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coil, further including a mixing circuit for combining the outputs of said amplifiers and of the rotor of said variometer.

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