April 7, 1936. B. J. CHROMY 2,036,187

RADIO RECEIVING SYSTEM

Filed May 8, 1930

FIG. 1

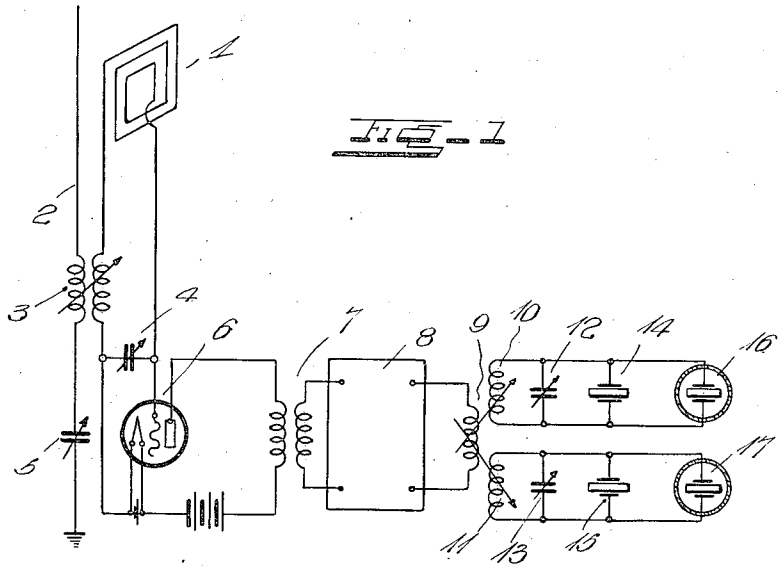


FIG. 2

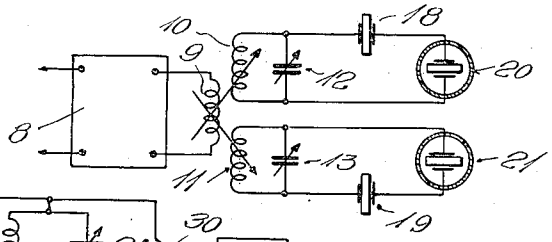


FIG. 3

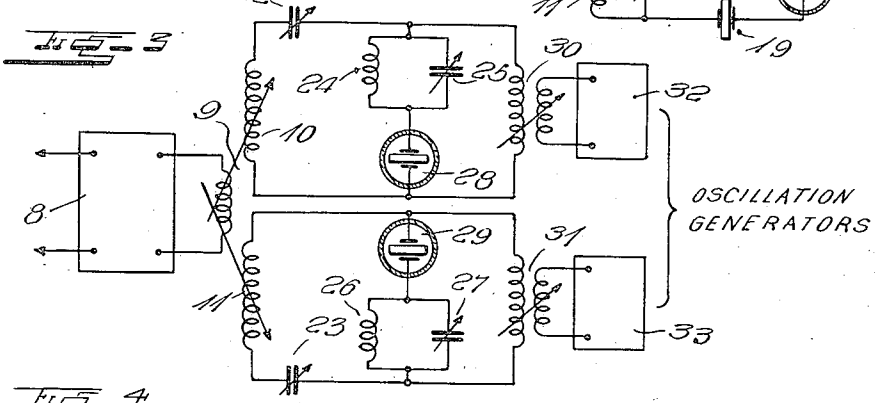
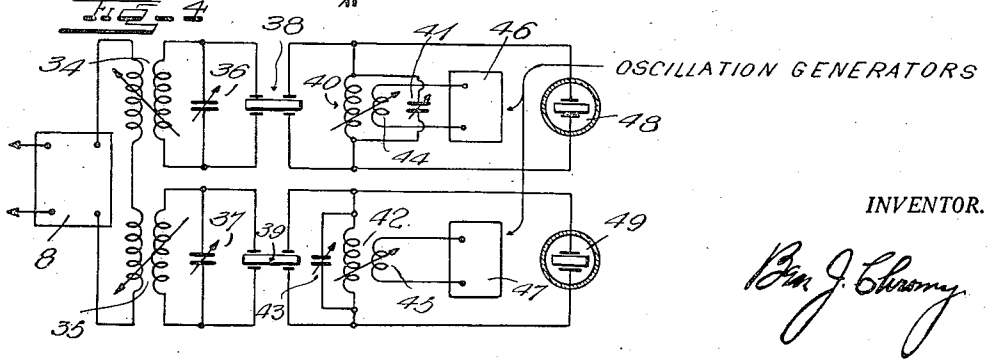


FIG. 4



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2,036,187

RADIO RECEIVING SYSTEM

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11 Claims. (Cl. 250—11)

This invention relates to radio receiving systems generally. More specifically this invention relates to radio receiving systems arranged to intercept signaling energy for the operation of frequency selective indicators.

An object of this invention is to provide an arrangement wherein signaling energy intercepted by a receiving system is selectively impressed upon electro-mechanically vibratile elements for the energization thereof.

Another object of this invention is to provide an arrangement wherein signaling energy transmitted from a radio beacon is intercepted, amplified and impressed selectively upon electro-mechanically vibratile elements having frequency characteristics corresponding to the frequencies of signals transmitted from the beacon whereby the electro-mechanically vibratile elements are caused to glow in accordance with the intercepted signaling energy.

Still another object of this invention is to provide an arrangement wherein signaling energy transmitted from a radio beacon is impressed upon the circuit of an electro-mechanically vibratile element and caused to produce a lower frequency current in that circuit, which lower frequency current is of a frequency corresponding to a period of the electro-mechanically vibratile element for the energization of the latter element.

A further object of this invention is to provide an arrangement wherein signaling energy transmitted from a radio beacon is impressed, together with another high frequency current, upon the circuit of an electro-mechanically vibratile element to produce a beat frequency current in the circuit of the electro-mechanically vibratile element of the same frequency as that of the electro-mechanically vibratile element.

Still a further object of this invention is to provide an arrangement wherein signaling energy is intercepted, selected and impressed upon the circuit of a piezo-electric crystal, the frequency of which bears a certain relation to the frequency of the signaling energy for the energization of the piezo-electric crystal and the rendering of the atmosphere surrounding the crystal visible.

Other objects and features of this invention will be apparent from the following specification and the appended claims.

The system of this invention is related to the systems of my copending applications for Radio receiving systems, Serial Numbers 433,912, 443,564 and 444,836, filed March 7, 1930, April 11, 1930, and April 16, 1930, respectively. This invention is an improvement over the system disclosed in the application for Radio receiving systems, Serial Number 444,836, in which electro-mechanically vibratile elements, such as piezo-electric crystals, are also employed as indicators, in that the present system may be employed in conjunction with radio beacons of different signaling frequencies merely by adjusting the frequency of separate oscillation generating means associated therewith without necessitating a change of the electro-mechanically vibratile indicator elements. Modifications of the present system also employ additional electro-mechanically vibratile elements as a means for preventing selected ones of the indicating electro-mechanical vibrators from being energized at frequencies corresponding to the frequencies of others of the indicating electro-mechanically vibratile elements. In another arrangement of this invention employing a separate source of oscillations, electro-mechanically vibratile elements are employed for coupling the circuits of the indicating elements to the circuit of the amplifier whereby substantially no energy from the oscillation generator coupled to the circuit of the indicating element and of the beat frequency current is fed back to the amplifier. This same result may be accomplished by using a filter or a tuned circuit, as is brought out in conjunction with another form of this invention. The system employing tuned filters instead of the electro-mechanically vibratile elements may be employed in conjunction with beacons of different signaling frequencies merely by readjusting the oscillation generators and the tuned filters. Whereas, in the case of the systems employing the electro-mechanically vibratile element coupling means these means must be replaced by others which have frequency characteristics corresponding to the beams transmitted from the guiding radio beacon when the system is employed in conjunction with a plurality of radio beacons of different signaling frequencies.

This invention will be more clearly understood by reference to the drawing, in which, briefly,

Fig. 1 illustrates an embodiment of this invention;

Fig. 2 shows a slightly modified embodiment thereof;

Fig. 3 illustrates a form of this invention in which auxiliary oscillation generating means are employed for producing a beat frequency current with the incoming signal, and

Fig. 4 shows an embodiment in which electro-mechanically vibratile elements of the proper fre-

quency characteristics are employed for coupling the circuits of the indicating elements to the amplifier system.

In Fig. 1 of the drawing reference numeral 1 designates a loop antenna. Reference numeral 2 designates a substantially non-directional antenna. Antenna 2 is coupled to the antenna 1 thru the transformer 3 in the proper degree to obtain practically a cardioidal field strength characteristic. Condenser 5 is connected into the circuit of antenna 2 for the purpose of tuning; likewise for the same purpose condenser 4 is connected into the circuit of loop antenna 1. The input circuit of the electron discharge device 6 is connected to the circuit of the loop for energization thereof by signaling energy intercepted by the antenna array. The output circuit of the electron discharge device 6 is coupled thru the transformer 7 to the amplifier 8. This amplifier may be of any of the approved high frequency designs, and where high amplification per stage is desired the shield grid electron discharge devices may be employed. The output of the amplifier 8 is impressed upon the transformer 9 with which are associated secondary windings 10 and 11. Variable tuning condensers 12 and 13 are connected across the secondary coils 10 and 11. Electro-mechanically vibratile elements 14 and 15 of the piezo-electrical crystal type are connected across the tuning condensers 12 and 13 for the purpose of absorbing certain undesired oscillations. For example, the element 14 is so chosen that its frequency corresponds to the frequency of the electro-mechanically vibratile element 17 which is of the piezo-electric type and is used for indicating purposes. The element 15 is chosen to have a frequency corresponding to a frequency of the indicating element 16. The elements 16 and 17 are both immersed in a rarefied atmosphere of inert gas, such as neon, helium, krypton or mixtures of inert gases.

In operation the antenna array is arranged to intercept signaling energy transmitted from the radio beacon to which the aircraft employing the system of this invention is proceeding. Two beams of signaling energy of slightly different frequency are transmitted from the radio beacon along slightly displaced paths. These beams may be caused to overlap to a certain extent so that a zone will exist in which signals of both frequencies are transmitted. When the aircraft is in the path of one of the beams of signaling energy, for example, the path of the beam having a frequency corresponding to a frequency of the indicator element 16, then this indicator element is energized and the rarefied atmosphere surrounding it is caused to glow. Simultaneously the electro-mechanically vibratile element 15 absorbs any oscillations of a frequency corresponding to a frequency of the indicator element 16, since this element 15 is chosen to have substantially the same frequency characteristics as the indicator element 16. Any signaling energy of the frequency corresponding to the frequency of the indicator 16 is thus substantially filtered or absorbed from the circuit of the indicator element 17. Likewise the electro-mechanically vibratile element 14, which is chosen to have substantially the same frequency characteristics as the electro-mechanically vibratile indicator element 17, prevents signaling energy of substantial magnitude of a frequency corresponding to a frequency of the indicator element 17 from being impressed upon the electro-mechanically vibratile indicator element 16.

The pilot of the aircraft, by observing the indicator elements 16 and 17, is at all times informed of the position of the aircraft, since the rarefied atmosphere surrounding one of the indicator elements is caused to glow when the craft deviates to the left or right of the true course, whereas the atmosphere surrounding both indicator elements is caused to glow when the craft is proceeding along the true course, since the two beams of different frequencies transmitted from the beacon overlap along a zone which corresponds to the true course. The antennæ of the aircraft consequently intercept energy from both beams when proceeding along in the true course. The natural period of the electro-mechanically vibratile elements 16 and 17 when these elements are caused to oscillate along the X-axis are chosen to correspond to the frequencies of the beams of signaling energy transmitted from the radio beacon.

In Fig. 2 a slightly modified form of this invention is illustrated wherein the electro-mechanically vibratile elements 18 and 19, corresponding in frequency to the frequencies of the electro-mechanically vibratile elements 20 and 21, respectively, are connected in series with these latter elements, respectively. The element 18, being of the same frequency as the indicator element 20, will pass high frequency energy of the same frequency much more freely than energy of other frequencies. Likewise the element 19 will pass energy corresponding in frequency to that of the indicator element 21 much more readily than other frequencies. The elements 18 and 19 thereby substantially prevent the indicator elements 20 and 21 from being energized at other than natural frequencies.

The indicator elements 16, 17, 20 and 21, instead of being of a size as to resonate at the high frequencies, may be chosen to have natural periods in the lower frequencies, in which case the amplifier 8 is made up of a high frequency amplifier, detector and low or intermediate frequency amplifier. A single double modulated beam is sent out from the radio beacon. For example, instead of two high frequency beams being set out along a partially coinciding path a single beam having a part thereof modulated with a low frequency corresponding to the frequency of one of the indicator elements, that is, indicator element 16, for instance, and another part thereof modulated with a low frequency corresponding to the frequency of indicator element 17, for instance, may be employed. Portions of the beam modulated by one frequency coincide with portions of the beam modulated by the other frequency whereby a double modulated zone is obtained in the beam.

Another form of this invention is illustrated in Fig. 3 of the drawing. In this latter arrangement oscillation generators 32 and 33 are coupled thru the variable coupling transformers 30 and 31 to the circuits including the tuning condensers 22 and 23 and the transformer secondaries 10 and 11, respectively. The electro-mechanically vibratile element 28 is connected in series with the filter circuit comprising the coil 24 and the variable condenser 25 across the variable condenser 22 and the secondary 10. The electro-mechanically vibratile element 29 is connected in series with the filter circuit including the coil 26 and the variable condenser 27 across the secondary 11 and the variable condenser 23.

The filter circuit including the coil 24 and

the variable condenser 25 is adjusted to present a high impedance to oscillations amplified by the amplifier 8 and to oscillations generated by the oscillation generator 32. The coil 24 may be provided with a small core of extremely thin iron, steel, silicon steel or of nickel iron alloy in order to broaden its frequency characteristic so that the filter circuit including it may more efficiently filter out the oscillations generated by the generator 32 and those amplified by the amplifier 8 where these oscillations differ materially in frequency. The filter circuit including the coil 26 and the variable condenser 27 is adjusted to present a high impedance to oscillations amplified by the amplifier 8 and to oscillations generated by the generator 33.

In operation the oscillations amplified by the amplifier 8 are impressed upon the circuits of the secondary windings 10 and 11 of the transformer 9. These oscillations combine with the oscillations generated by the generators 32 and 33 to produce beat frequency oscillations corresponding in frequency to the frequencies of the electro-mechanically vibratile elements 28 and 29 which are immersed in transparent vessels containing rarefied inert gas or similar gas which ionizes at relatively low potentials and does not have a deleterious effect upon the electro-mechanically vibratile elements. The indicator elements 28 and 29 are chosen to have frequency characteristics such that the beat frequency oscillations produced by the interaction of the oscillation generator 32, for example, with the signaling energy intercepted from one side of the beam transmitted from radio beacon corresponds to the natural period of the indicator element 28. The beat frequency oscillations produced by the interaction of the oscillations generated by the generator 33 with signaling energy intercepted from the other side of the radio beacon beam correspond to the natural period of the indicator element 29. By observing the indicator elements 28 and 29 the pilot of the aircraft is constantly informed whether or not the aircraft is proceeding toward the radio beacon or not, since either one or the other of the indicator elements cause the rarefied atmosphere surrounding them to glow when the craft is deviating to the left or right from the true course and the atmosphere surrounding both of the indicator elements glow when the craft is on the true course.

Where it is desired to employ the system illustrated in Fig. 3 in conjunction with a plurality of radio beacons employing different signaling frequencies the oscillation generators 32 and 33 must be adjusted to generate oscillations of the current frequency so that beat frequency oscillations of the correct frequencies are produced with the amplified signals. The condensers 22 and 23 should also be adjusted to a certain extent each time the frequency of the intercepted signal is changed; however, the adjustment of these condensers is not critical, inasmuch as they are employed primarily for the purpose of preventing the beat frequency current from circulating thru the inductances 10 and 11, respectively.

In Fig. 4 electro-mechanically vibratile elements 38 and 39 are employed for coupling the circuits of the indicator elements 48 and 49 to the circuits of transformers 34 and 35, respectively. Tuning condensers 36 and 37 are provided to tune the secondary windings of the transformers 34 and 35. High frequency oscillation generators 46 and 47 are coupled by means of the coupling coils 40, 44 and 42, 45 to the circuits of the indicator elements 48 and 49, respectively. Condensers 41 and 43 are provided across the coils 40 and 42, respectively, for tuning these coils to the frequencies of the oscillations generated by the generators 46 and 47, respectively.

In operation the signaling energy intercepted from one side of the radio beam is impressed through the electro-mechanically vibratile element 38, for example, upon the circuit of the coil 40, whereupon the oscillations produced by the generator 46 combine with the signal oscillations and produce a beat frequency current of a frequency corresponding to that of the indicator element 48. Likewise the signaling energy intercepted from the other side of the radio beacon beam is impressed thru the electro-mechanically vibratile element 39 upon the circuit of the coil 42 and interacts with the oscillations generated by the generator 47 to produce beat frequency oscillations which energize the indicator element 49.

The indicator elements 48 and 49 are housed in a transparent vessel in an atmosphere of inert gas or gases. Different gases may be used in each vessel to glow a different color in each case. The electro-mechanically vibratile elements 38 and 39 may be tapered in such a manner that the dimension along the X-axis is gradually increased from one end to the other or in such a way that the dimension along the Y-axis is not uniform. In this way these coupling elements 38 and 39 may be used to couple the circuits of the inductances 40 and 42 and the transformers 34 and 35, respectively, over a band of frequencies. The same coupling elements may then be employed in conjunction with a plurality of radio beacons of different frequencies without necessitating a change each time signals of a different frequency radio beacon are intercepted. Only the oscillation generators 46 and 47 and the condensers 41 and 43, together with the condensers 36 and 37, need be adjusted each time signals of a different radio beacon are intercepted. These condensers may be arranged in a gang control unit according to methods well known in the art.

While I have described several modified forms of this invention in detail, it is, of course, understood that I do not desire to limit this invention to the exact details as described except in so far as those details may be defined by the appended claims.

What I claim and desire to secure by Letters Patent of the United States is:

1. In course finding apparatus the combination of signal receiving means having input and output circuits, an antenna coupled to said input circuit for intercepting signalling energy from a beacon station, said beacon station being adjusted to transmit signals of at least two predetermined frequencies, high frequency selective indicator elements coupled to said signal receiving means, oscillation generating means coupled to circuits connected with said indicator elements for heterodyning with intercepted signals corresponding to said predetermined frequencies and filter means connected to said indicator elements for preventing oscillations of large amplitude generated by said oscillation generating means from affecting said indicator elements.

2. In course finding apparatus the combination of signal receiving means having input and out-

put circuits, an antenna coupled to said input circuit for intercepting signalling energy from a beacon station, said beacon station being adjusted to transmit signals of at least two predetermined frequencies, high frequency selective indicator elements coupled to said signal receiving means, oscillation generating means coupled to circuits connected with said elements and electrical filter means connected to said elements for substantially rejecting oscillations of large amplitude generated by said generating means from said indicator elements, said indicator elements being adjusted to operate on the beat frequency oscillations produced by said generating means and signals intercepted by said first mentioned means.

3. In course finding apparatus the combination of signal receiving means having input and output circuits, an antenna coupled to said input circuit for intercepting signalling energy from a beacon station, said beacon station being adjusted to transmit signals of at least two predetermined frequencies, high frequency selective indicator elements coupled to said signal receiving means, oscillation generating means of adjustable frequency coupled to circuits of said elements, and means to prevent excessive potentials from said oscillation generating means from affecting said high frequency selective indicator elements.

4. In course finding apparatus the combination of signal receiving means having input and output circuits, an antenna coupled to said input circuit for intercepting signalling energy from a beacon station, said beacon station being adjusted to transmit signals of at least two predetermined frequencies, a pair of vibratory members, means for coupling said vibratory members to said signal receiving means, each of said vibratory members operating to select certain of said signalling frequencies, oscillation generating means, means for heterodyning current generated by said oscillation generating means with energy of the signalling frequencies, indicating means for indicating the extent of deviation of said aircraft from a predetermined path, and means for impressing heterodyning frequency currents derived from currents of signalling frequencies and currents generated by said oscillation generating means upon the circuits of said indicating means.

5. In course finding apparatus the combination of signal receiving means having input and output circuits, an antenna coupled to said input circuit for intercepting signalling energy from a beacon station, said beacon station being adjusted to transmit signals of at least two predetermined radio frequencies, a pair of electro-mechanically vibratile members coupled to the output circuit of said signal receiving means, each of said electro-mechanically vibratile members operating to select one of said signalling frequencies and a pair of indicator elements connected to said electro-mechanically vibratile members to be energized at the signaling frequencies selected by said members.

6. In course finding apparatus the combination of signal receiving means having input and output circuits, an antenna coupled to said input circuit for intercepting signalling energy from a beacon station, said beacon station being adjusted to transmit signals of at least two predetermined frequencies, a pair of vibratory members coupled to the output circuit of said signal receiving means, each of said vibratory members operating to select one of said frequencies, oscillation generating means, means for mixing currents of signalling frequencies selected by said vibratory members and current generated by said oscillation generating means, indicating means, and means for impressing heterodyne currents produced by mixing currents of the signalling frequencies with the current generated by said oscillation generating means upon the circuit of said indicating means.

7. In direction and course finding apparatus the combination of signal receiving means having input and output circuits, an antenna coupled to said input circuit for intercepting signalling energy from a beacon station, said beacon station being adjusted to transmit signals of at least two predetermined frequencies, indicator means, high frequency selective means coupled to said signal receiving means and to said indicator means, oscillation generating means coupled to circuits connected with said indicator means for heterodyning with intercepted signals corresponding to said predetermined frequencies, said high frequency selective means being connected to said indicator elements for preventing oscillations of large amplitude generated by said oscillation generating means from affecting said indicator elements.

8. In direction and course finding apparatus the combination of signal receiving means having input and output circuits, an antenna coupled to said input circuit for intercepting signalling energy from a beacon station, said beacon station being adjusted to transmit signals of at least two predetermined frequencies, indicator elements, high frequency selective means coupled to said signal receiving means and said indicator elements, oscillation generating means coupled to circuits connected with said indicator elements and means connected to said elements for preventing potentials of large amplitude generated by said generating means from affecting said indicator elements, said indicator elements being adjusted to operate on the beat frequency oscillations produced by said generating means and signals intercepted by said first mentioned means.

9. In navigational systems, a plurality of signal transmitters, each adapted to emit a particular modulation, a receiving apparatus carried by a mobile body for receiving the signals thus transmitted, and an apparatus connected with said receiving apparatus including vibratory devices responding to the modulation frequencies of the transmitting stations and means for altering the frequencies of said modulation frequencies to render said vibratory devices responsive to the modulation frequencies of all of said signal transmitters selectively for indicating the position of said mobile body with respect to any of said signal transmitters selectively.

10. In a navigational system, a plurality of signal transmission stations adapted to emit signals of different frequencies, signal receiving apparatus carried by a mobile body navigable with respect to said signal transmission stations, an indicator apparatus carried by the mobile body, said indicator apparatus having vibratory members resonant to predetermined frequencies, and means connected to said indicator apparatus for altering the frequencies of the signals received by said signal receiving apparatus from said signal transmission stations to render said vibratory members carried by said mobile body responsive to signals transmitted from different ones of said stations for energizing said indicator

apparatus in accordance with signals transmitted from different ones of said stations.

11. In direction and course finding apparatus, the combination of a plurality of stations each adjusted to emit different signalling frequencies, signalling receiving means having input and output circuits, an antenna coupled to said input circuit for intercepting signalling energy from said stations, a plurality of indicators connected to said output circuit to be energized in accordance with signalling energy received from said stations, vibratory devices resonant to predetermined frequencies, and means for rendering said vibratory devices responsive to frequencies emitted by all of said stations selectively.

BEN J. CHROMY.