Jan. 19, 1943. CARL-ERIK GRANQVIST 2,309,063

DIRECTIONAL RADIO BEACON

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Fig. 1.

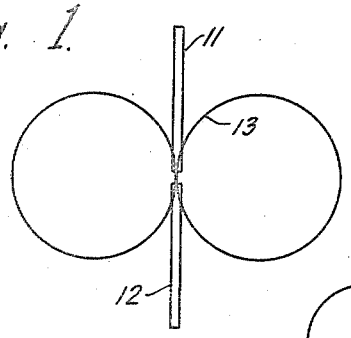
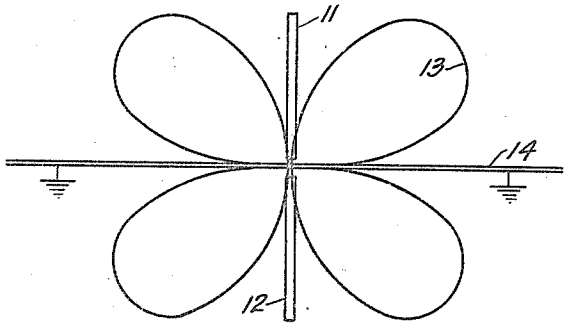


Fig. 2.



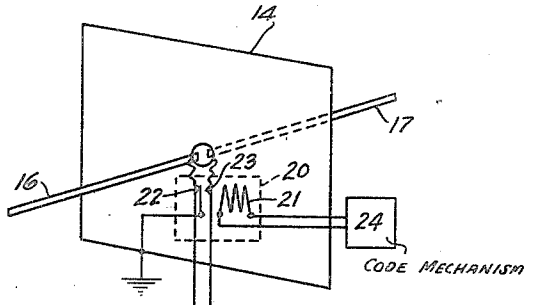


Fig. 4.

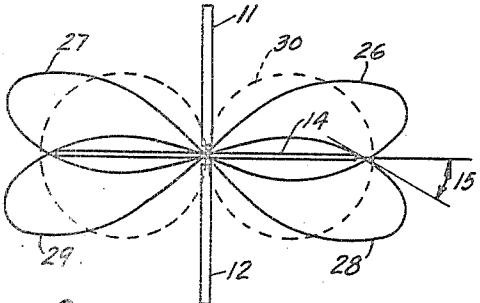
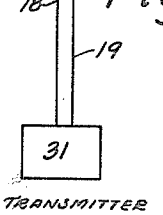


Fig. 3.



INVENTOR.

Carl-Erik Granqvist

BY

James C. Markle

his attorney

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Fig. 5.

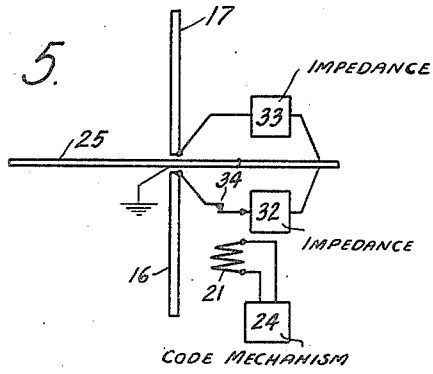


Fig. 6.

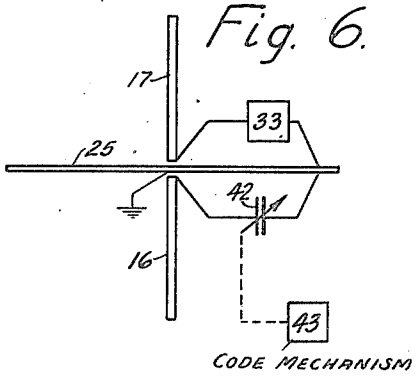
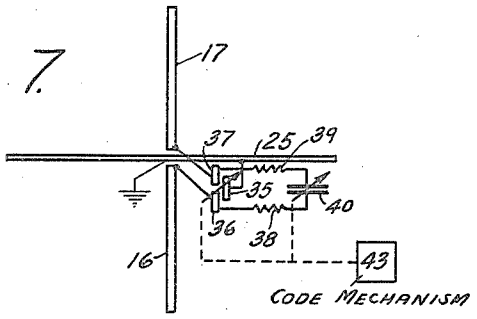


Fig. 7.



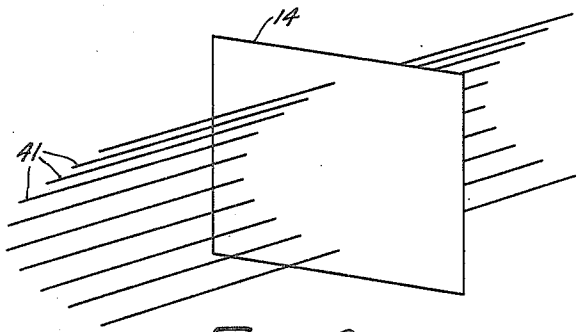


Fig. 8.

Carl-Erik Granqvist INVENTOR.

BY

Samuel C. Mabbs
his attorney

Patented Jan. 19, 1943

2,309,063

UNITED STATES PATENT OFFICE

2,309,063

DIRECTIONAL RADIO BEACON

Carl-Erik Granqvist, Stockholm, Sweden, assignor to Aga-Baltic Radio Aktiebolag, Stockholm, Sweden, a corporation of Sweden

Application October 29, 1940, Serial No. 363,281
In Sweden April 10, 1940

13 Claims. (Cl. 250—11)

My invention relates to directional radio beacons.

Directional radio beacons, are known, in which the direction of transmission is periodically reversed, to form the code letters *e* and *t* or *a* and *n* or with other code letters. Hence a listener who is on one side of a certain plane through the radio beacon will only hear the letter *e* (or *a*) whereas a listener on the other side of this plane will only hear the letter *t* (*n*). If the listener is travelling from one side of the radio beacon to the other he will pass a certain position, viz. the said plane, where he hears the signal *e* and the signal *t* simultaneously with equal intensity. As these signals were formed by shifting the direction of propagation of the beacon, the signals will complete each other, so that a continuous tone is heard.

These radio beacons are usually called E-T-beacons. The sharpness of the directional characteristic of this kind of beacon is relatively good, but it has been found that for certain purposes a greater sharpness is desirable. This is the case when the beacons are arranged as an aid for navigating in very narrow or difficult waters. The present invention relates to an arrangement by means of which the sharpness of the directional characteristic may be varied as desired. One special advantage of the invention is that the apparatus is very simple and dependable and the sharpness of the directional characteristic can be changed by changing only one simple directing means, no change in the parts associated with the radio transmitter being required. Radio beacons of a standard type may be used and the directional sharpness may be varied as desired.

According to the invention dipole antennas are used. In the dipole plane there is applied as a director a screen of metal or other conducting material, and the antenna is fed nonsymmetrically.

The invention is further described in connection with the annexed drawings, in which Figs. 1, 2 and 3 show different diagrams in explanation of the directional characteristics of dipoles, and Figs. 4–8 show different forms of transmitters embodying the invention.

The field intensity diagram for a normal dipole antenna has the form of the letter 8. This is shown in Fig. 1. The dipole contains the two half parts 11 and 12. The directional characteristic is indicated by the curve 13. If a screen 14, Fig. 2, of infinite extent is placed between the inner ends of the dipoles and connected to ground the transmission diagram is changed into the diagram shown in Fig. 2, composed of four loops. Between the two forms of the characteristic shown in Figs. 1 and 2, viz. for a dipole antenna with screen of zero extension and of infinite extension, there is an innumerable number of intermediate forms, produced by different screens with various finite, predetermined extensions. Fig. 3 shows such an arrangement together with the characteristics, obtained by the same. The invention is based upon the observation that the angle 15, at which the characteristic crosses the plane through the screen, varies from 90°, when the screen has zero extension (Fig. 1) to 0°, when the screen has infinite extension (Fig. 2), and that thus any desired angle can be obtained by varying the extension of the screen.

It is the steepness of the angle 15 which determines the sharpness of the directional characteristic in the plane of the screen. Hence by choosing a screen of suitable magnitude the sharpness of the directional characteristic may be varied as desired.

Fig. 4 shows perspectively an arrangement according to the present invention, partly in block diagram. The antenna in this arrangement is formed by dipole bars 16 and 17, which are preferably made of pipes, and which are connected to the transmitter 31 by means of the conductors 18 and 19. A contact device 20 is provided at the connection point of the conductors 18 and 19 to the antenna bars 16 and 17, respectively. This may comprise a relay 21, having a contact spring which makes contact with a back-contact 22, when the relay is deenergized and with a front contact 23 when the relay 21 is energized. The counter-contacts 22 and 23 are connected to the feeder conductors 18 and 19, respectively, adjacent the antenna bars 16 and 17 by means of very short conductors.

The exciting current to the relay 21 is closed and broken in time with the code letters which are to be transmitted by a code mechanism 24. The contact spring of relay 21 is conductively connected with the screen 14 which is connected to ground.

The operation of the arrangement is obvious from the above. The antenna bars each create a field, which may be represented by the field characteristics 26 and 27 for the antenna 16 and the field characteristics 28 and 29 for the antenna 17, as shown in Fig. 3. Only one of these characteristics will be transmitted if one of the bars is connected to ground through the screen 25. The transmission takes place as described

above in time with an easily recognizable code, for instance the code letters *e* and *t*, so that a listener on one side of the plane of the screen 14 will hear only one of the letters, whereas a listener on the other side of this plane will hear only the other letter. A listener located in this plane will however hear a continuous tone formed by both of the code letters in such a way, that no interruption and no change of the sound intensity is present.

In practice it is impossible to so adjust the contacts of relay 21 that no disturbances arise at the moment of switching over. The back-contact 22 may be opened either after or before the front-contact 23 is closed. In both cases an audible click will be produced in the receiving apparatus. Such a click interferes with the observations and decreases the effectiveness of the very high theoretical sharpness of the directional characteristic.

This disadvantage is avoided according to one embodiment of the present invention by making the intensity of the transmitter such, that the characteristic when both of the dipole half parts are transmitting, is of the form shown by the dotted line curve 30 in Fig. 3. This can be obtained by a certain extension of the screen 14. If the steepness of the curve and the sharpness of the directional characteristic which is obtained by this dimension of the screen 14 is sufficient, it is obvious that a directional transmitter is thus obtained having a higher sharpness of its directional characteristics than those obtained by previous arrangements of similar simplicity. If, on the other hand, the requirements for sharpness are such that the screen 14 must be of a magnitude at which freedom from audible switching click is not obtained, other steps must be taken for decreasing or avoiding the switching click. To a certain extent this can be attained by suitably choosing the length of the dipole antennas. Other arrangements for this purpose are shown in Figs. 4 to 8.

In Fig. 4 two contacts are used for the change of transmission. This can, however, also be produced by using only one contact, as shown in Fig. 5. In this arrangement both of the dipole antenna parts are connected in a bridge coupling together with two impedances 32 and 33, two adjacent bridge branches being formed by the capacities to ground of the dipole antenna parts and the screen, respectively, whereas the two impedances form the two remaining branches. The reference characters are otherwise the same as in Fig. 4. The impedances 32 and 33 are connected to the screen, the impedance 33 directly and the impedance 32 through a contact 34, which is influenced by a relay 21 operated by a code mechanism 24. The impedances 32 and 33 are not equal, the impedance 33 preferably being larger than the impedance 32. The dipole antenna 16 is thus rendered partly inactive when the contact 34 is closed, as the impedance 32 is then acting as a short circuiting resistance, whereas with the contact 34 open the impedance 33 causes an unbalance in such a direction that the antenna 17 is partly short circuited. With this arrangement the characteristics are not reduced to zero, but they change between two unequal values, so that one or the other is greater depending upon whether the contact 34 is open or closed. By suitably choosing the impedances 32 and 33 symmetry may be obtained between the characteristics of the two dipole antenna parts.

A clickless change over may also be obtained by a continuous switching system as shown in Figs. 6 and 7.

In the arrangement according to Fig. 6 one of the impedances 32 has been replaced by a continuously variable condenser 42, which rotates and thereby continuously varies between a maximum value, corresponding to minimum of impedance, and a minimum value, corresponding to maximum of impedance. The condenser 42 is mechanically controlled by a code mechanism 43, and the movement of this may not be at constant speed, but the speed may be varied in any suitable manner. It is especially suitable to use a pendulum movement or an oscillating movement, interrupted by shorter or longer periods of rest.

A more advantageous action is obtained by providing a differential condenser as shown in Fig. 7. The rotor 35 of this condenser is connected to the code mechanism, whereas the two stator parts 36 and 37 are fixed. The rotor is electrically connected to the screen 25, whereas the stators 36 and 37 are electrically connected with the respective dipole antenna parts 16 and 17.

If an exceptional freedom from switching clicks is desired the changes of the load produced by the movement of the condenser may be compensated for by two symmetrical load compensation resistors 38 and 39 and a condenser 40 in a compensation circuit between the two stators 36 and 37. The condenser 40 is mechanically controlled in accordance with the movement of the rotor 35, preferably by connecting the rotors of both of the condensers to the same shaft, but electrically isolated from each other. Of course both of the resistors 38 and 39 may be replaced by one common resistance although a certain unsymmetry may be thus produced.

The system can of course be modified in various ways. If the directional transmitter is arranged at the end of a channel, for example, a reflector may be used to eliminate the loops 27 and 29 of the characteristic in Fig. 3, the loops 26 and 28 thereby being made correspondingly greater. One suitable method of accomplishing this is to arrange in the screen 14 a number of metallic bars 41 as shown in Fig. 8. A metallic part of the transmitter itself, such as its chassis may be used as the screen if desired, to thereby obtain an easily transportable unit, containing the transmitter system as well as the antenna system.

What is claimed is:

1. A directional radio transmitter comprising a single dipole antenna having two oppositely extending linear radiators, a generator of radio frequency oscillations connected to feed said antenna, control means alternately rendering said radiators inactive, and a reflector screen between said dipole antenna radiators in a plane perpendicular to said radiators suited to alter the directional characteristics thereof.

2. A directional radio transmitter as set forth in claim 1 in which the control means comprises means for alternately connecting said radiators to said screen.

3. A directional radio transmitter as set forth in claim 1 in which said screen is grounded and the control means comprises means for alternately connecting said radiators to said screen.

4. A directional radio transmitter as set forth in claim 1 in which the control means comprises

a make and break contact connected to alternately connect said radiators to said screen.

5. A directional radio transmitter as set forth in claim 1 in which the control means comprises a make and break contact connected to alternately connect said radiators to said screen, a relay connected to actuate said contact and code mechanism actuating said relay.

6. A directional radio transmitter as set forth in claim 1 in which the radiators are connected to said screen through impedances constituting, with the capacity of the radiators to ground, a bridge circuit and in which the control means varies the value of one of said impedances so that the radiators transmit alternately with different field intensities.

7. A directional radio transmitter as set forth in claim 1 in which the radiators are connected to said screen through impedances constituting, with the capacity of the radiators to ground, a bridge circuit and in which the control means comprises a contact connected to open and close one of the branches of said bridge.

8. A directional radio transmitter as set forth in claim 1 in which the radiators are connected to said screen through impedances constituting, with the capacity of the radiators to ground, a bridge circuit and in which the control means varies the value of one of said impedances so that the radiators transmit alternately different field intensities, one of said impedances comprising a condenser which is continuously variable between a maximum and minimum value.

9. A directional radio transmitter as set forth in claim 1 in which the radiators are connected to said screen through impedances constituting, with the capacity of the radiators to ground, a bridge circuit and in which the control means varies the value of one of said impedances so that the radiators transmit alternately different field intensities, said impedances comprising a differential condenser having fixed plates connected to said radiators and a movable plate connected to said screen to provide a continuously variable control for the radiation characteristics of said radiators.

10. A directional radio transmitter as set forth in claim 1 in which the radiators are connected to said screen through impedances constituting, with the capacity of the radiators to ground, a bridge circuit and in which the control means varies the value of one of said impedances so that the radiators transmit alternately different field intensities, said impedances comprising a differential condenser having fixed plates connected to said radiators and a movable plate connected to said screen to provide a continuously variable control for the radiation characteristics of said radiators and a variable balance circuit containing symmetrically arranged resistances in series with a variable condenser connected to said differential plates, said condenser being actuated in unison with said first condenser in a manner to avoid irregularities in operation during the change-over periods.

11. A directional radio transmitter as set forth in claim 1 in which the reflector screen and the radiators are so related that the field intensity is substantially the same throughout the entire period of operation of the system.

12. A directional radio transmitter as set forth in claim 1 in which an additional reflector is provided to direct the transmitted energy in a single direction only.

13. A directional radio transmitter as set forth in claim 1 in which a reflector is provided comprising a plurality of bars extending substantially perpendicular to said screen and parallel with said radiators, said reflector being adapted to confine the transmission to a single direction only.

CARL-ERIK GRANQVIST.