June 29, 1937. W. MOSER 2,085,226

ANTENNA SYSTEM

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Fig. 1

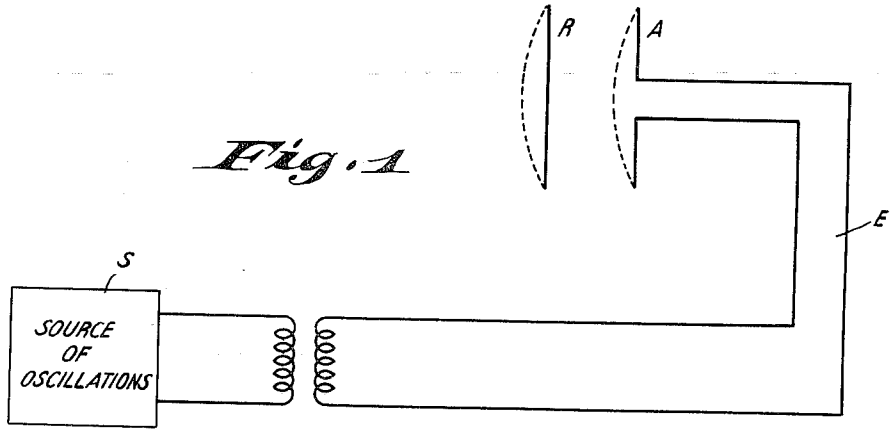


Fig. 2

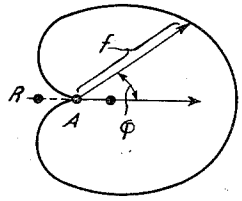


Fig. 3

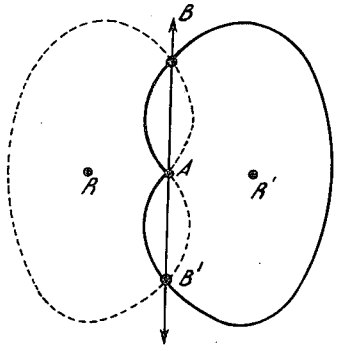
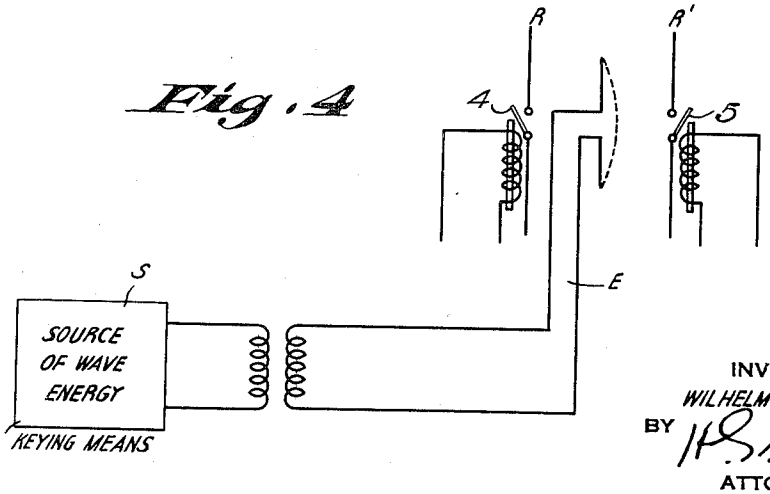


Fig. 4



INVENTOR
WILHELM MOSER
BY
ATTORNEY

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Fig. 5

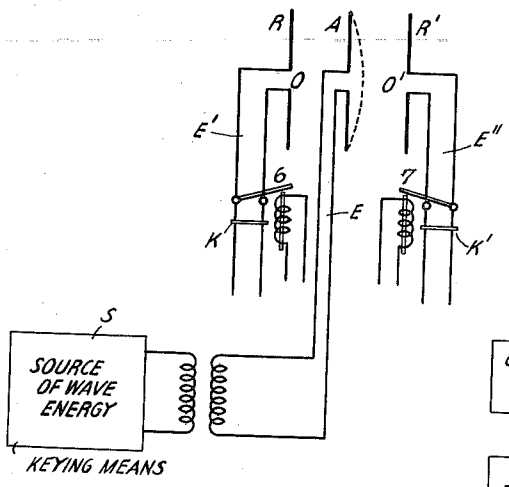


Fig. 7

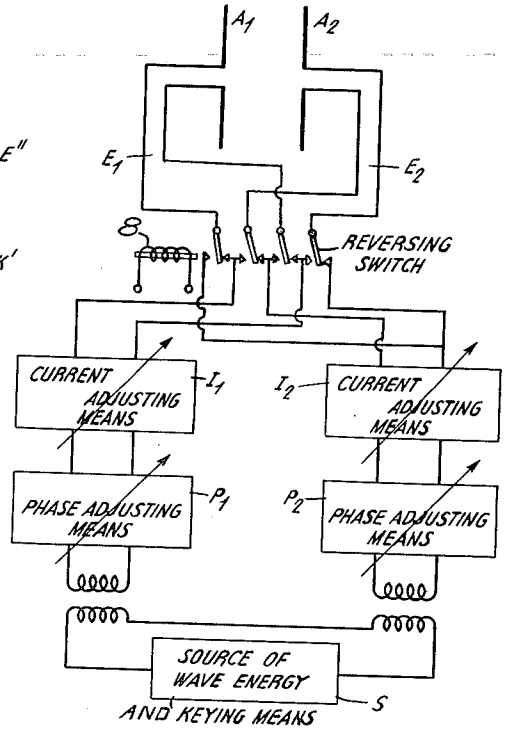


Fig. 8

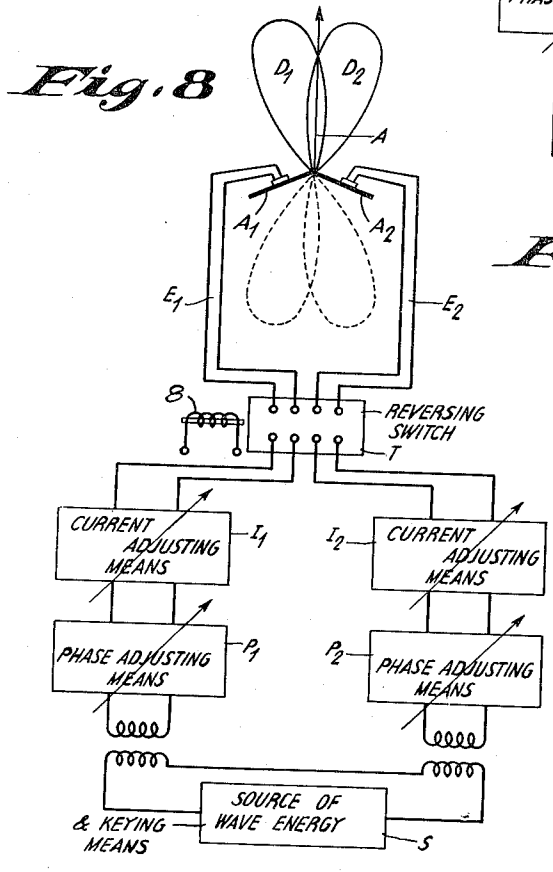
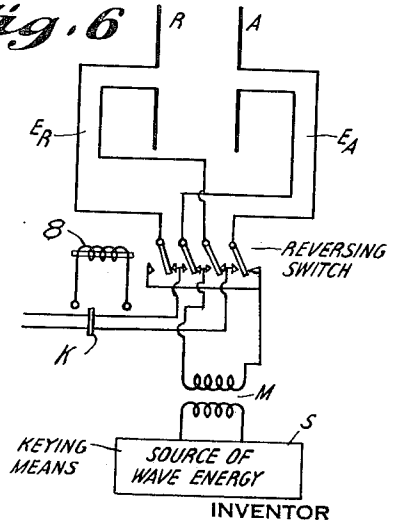


Fig. 6



INVENTOR
WILHELM MOSER
BY H. G. Grover
ATTORNEY

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UNITED STATES PATENT OFFICE

2,085,226

ANTENNA SYSTEM

Wilhelm Moser, Berlin, Germany, assignor to Telefunken Gesellschaft für Drahtlose Telegraphie m. b. H., Berlin, Germany, a corporation of Germany

Application October 31, 1934, Serial No. 750,777
In Germany October 25, 1933

1 Claim. (Cl. 250—11)

This invention relates to antenna systems and in particular to an arrangement for transmission of radio beacons. Radio beacons, as known in the art, may be built in the following manner: A radiator, say, a vertical dipole A (Fig. 1) is coupled with the transmitter S directly or through an energy-feed lead E. Such a dipole, as is well known, produces a circular horizontal diagram. In parallel relation to the said dipole is stretched another wire R which by making it of suitable length and mounting it at suitable distance acts as a radiation-coupled reflector. In this manner a more or less cardioid-shaped horizontal diagram is obtainable as shown, for instance, in Fig. 2, where φ is the angle between the direction of the radiation and the connecting line AR, and f the relative field intensity as a function of φ. In the direction RA, f has a crest value while in the opposite direction it is of minimum value. Now, to produce a radio beacon, arrangements are made so that, looking from A, in a direction other than R, say, in a direction opposed thereto, there is disposed a second reflector R′ which is preferably identical to the first one. Then, for instance, in the case of opposite arrangement of R and R′, if they are alternately rendered inoperative, cardioids positioned alternately to the left and to the right-hand side will be produced, as shown in Fig. 3. If the two dipoles R and R′ are caused to radiate distinctive identification signals, say by dissimilar modulation or by keying at the rhythm of two interlocking and preferably complementary signals, then the sectional directions AB and AB′ of the diagrams may be used as a directrix or course bearing in so far as this direction furnishes like signal strengths of both signals. Keying means may be associated with the source S and may be synchronized with a field pattern reversing means, as will presently be described.

It is known that the operation of rendering the reflectors alternately effective and ineffective may be performed by the cutting in and out of a portion of the conductor of the reflector wire proper. For instance, in an arrangement of the kind shown in Fig. 1 the reflection effect may be suppressed by the opening of the middle of the reflector. An arrangement for radio beacons of this kind known in the art is shown in Fig. 4 where the switches 4 and 5 alternately open the reflectors R and R′ and as a result cause such a detuning thereof that their effect becomes practically zero.

The switches 4 and 5 are relays of a special type; they must be mounted at the indicated points, that is, at a height above the ground difficult of access. The present invention has as its first object a convenient modification of this arrangement.

My invention will now be described in greater detail reference being made to the accompanying drawings, in which

Figures 1 to 4 inclusive illustrate general features of radio beacon systems both of known types and my improved type, these figures being essential to a full disclosure of the theory of operation of my invention;

Fig. 5 shows an antenna array including a centrally disposed dipole system and two reflecting dipoles oppositely disposed with respect to the radiating dipole; and

Figs. 6, 7 and 8 show different features of a modified arrangement in which only two dipoles are employed.

Instead of the relays and switches 4 and 5, according to the invention, the energy feed leads E′ and E″ (Fig. 5) are connected at the points of opening O and O′. These feed leads are closed or short-circuited and opened at a suitable point by the agency of the relays and switches 6 and 7. A suitable point on the energy-feed lead would be where an oscillatory loop is located. Thus, if the dipole presents a loop at the opening point, the said point will be an integral multiple of a half wave length away from the reflector. Upon short-circuiting of 6 and 7 there will then be practically produced a short-circuit of O and O′, provided that the losses occasioned in the feed lead are minimized by ways and means known in the art. The feed leads E and E′, if they are provided with tuning means at the ends away from the reflector wire, may be employed for insuring convenient tuning of the reflector as known in the prior art. The simplest form of construction of such tuning means, as shown, consists of different short-circuiting bridges K and K′. The arrangement of this invention offers the advantage that the actuation of the reflector (tuning and keying means) can be insured at a point which is more convenient from a technical viewpoint, say, in the vicinity of the transmitter.

In carrying out my invention I have found that simplification of the structure and improvement in the operating characteristics of a radio beacon antenna system may be obtained by arranging to reverse the functions of two dipole antenna systems, first making one of them receptive of the radio frequency energy to be radiated while the other is simultaneously caused to

reflect this energy, and then reversing the connections so that the dipole last mentioned becomes the radiator and the dipole first mentioned becomes the reflector.

If, for example, the source of energy S, as shown in Fig. 6, is coupled through a transformer M to a reversing switch T, then in one position of the switch connections are made as through the solid lines connecting the switch terminals so that the energy from the source is applied to the dipole antenna A, whereas simultaneously the dipole antenna R becomes reflective of this energy and its tuning characteristics are made adjustable by virtue of the location of the short circuiting bridge member K. Now, if a relay 3 is actuated so as to reverse the connections in the switching means T, as shown by the dotted lines, then it will be seen that the antenna R receives energy from the source S, while antenna A is subjected to the same tuning as is provided by the short circuiting bridge member K.

With an arrangement as hereinbefore described, as known from both theory and practice, it is not feasible to insure any desired relationship between antenna current and reflector current, or antenna phase and reflector phase. For instance, it is not possible according to the prior art to make the radiations from the main antenna and the reflector equal to each other and at the same time to produce a phase difference therebetween of 90 degrees. It is, however, desirable to produce maximum field intensity in one direction while producing zero field intensity in the other direction. It may be desirable, however, to adjust other relationships of currents and phases according to fixed values. According to the invention this is obtainable by coupling the reflector wire to the transmitter in a definite manner as illustrated, e. g., in Fig. 7. Antenna A_1 and reflector A_2 thereof as well as the energy-feed leads E_1 and E_2 corresponding thereto are constructed exactly alike. In the two leads, current adjusting means I_1 and I_2, also phase adjusting means P_1 and P_2 are provided. In keying, i. e., in the reversing of the diagrams, by the aid of the keying device T, the coupling means are transposed and connected with the energy-feed leads.

The sharpness of identification of the radio beacon effect is a function of the slope of the field-intensity curves at their point of intersection. As a general rule, it is desirable to choose a field intensity curve such as shown diagrammatically in Fig. 8. It can be readily seen that a dipole antenna and a reflector dipole corresponding thereto may produce only a more or less cardioid or reniform curve and corresponding moderate slopes of the field intensity in the point of intersection. Now, the present invention further discloses radio beacon apparatus including markedly directional antennae for obtaining more precise course bearings. In this connection according to the invention, use is made again of means to transpose or reverse the polarity of the energy-feed leads brought to two radiators for the purpose of keying or reversing the diagram. An exemplified embodiment of this sort is shown in Fig. 8. A_1 is a directional aerial which produces a field intensity diagram D_1; A_2 is another directional antenna with the diagram D_2. The aerial A_1 is fed by way of the lead E_1 and antenna A_2 by way of the lead E_2. The two leads E_1 and E_2, as hereinbefore described, are brought by way of the keying device T in the form of construction as just described and by way of the means adapted to insure amplitude and phase regulation, to the radio-frequency transmitter. If both aerials are constructed in the same manner, e. g., each of four dipoles fed under co-phasal conditions, and if the direction of the main beam of diagram D_1 is turned a suitable angle in relation to the main direction and beam of diagram D_2 it will be seen that a far greater slope of the curve at the point of intersection is secured, in other words, a far sharper beacon in the direction AB.

What is claimed is:

In a radio beacon transmitter, a pair of separated dipole antenna systems disposed with their axes in parallelism, a source of radio frequency signalling energy, current and phase adjusting means disposed in circuit between said source and each of said antenna systems, and key-switching means for cyclically connecting first one and then the other of said antenna systems to said source through a given portion of said current and phase adjusting means, and for simultaneously connecting the remaining antenna system to said source through said remaining portion of said current and phase adjusting means.

WILHELM MOSER.