# PATENT SPECIFICATION

408,321

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COMPLETE SPECIFICATION.

## Radio Beacon for Directing Aircraft.

We, C. LORENZ AKTIENGESELLSCHAFT, a German Company, of Lorenzweg 1, Berlin-Tempelhof, Berlin, Germany, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

Means for providing for fog or blind landing of aeroplanes is becoming of increasing importance in aviation, and the suggestion has been made to make use of ultra-short electromagnetic waves for this purpose. In this connection it has been proposed to employ a directional antenna system arranged at a certain angle to the ground at the landing place, to project a bundle of rays obliquely upwards in the direction of the wind. The pilot of an aeroplane intending to effect a landing as soon as he finds himself in the bundle of rays, pilots the machine so that the deflection of an instrument located in the anode circuit of his receiving apparatus remains constant, that is, the aeroplane is caused to follow a curve of the same field intensity. This method of landing is generally known as "slip-way beacon" landing. To render it practicable however some means must also be provided for indicating lateral deviations. It has also been suggested therefore to use a slip-way beacon in combination with a long wave beacon of a known type. In such combined systems the lateral deviations from the direction of landing (direction of wind) are ascertained from the long wave beacon and the slip curve for the landing is maintained by the ultra-short wave slip-way beacon. Such an arrangement requires however a large expenditure in apparatus, as both a complete long wave equipment and also a short wave equipment must be provided, not only on the transmitting side, but also on the receiving side. In order to simplify this arrangement therefore, it is proposed in accordance with the present invention to radiate two ultra-short waves distinguishable from each other but of the same wave length, at an angle to each other and to the ground. The lateral deviations from the direction of landing are then ascertained by means of the angular bisection of the fields and the landing itself takes place in the manner of a slip-way beacon landing. Such an arrangement results in an economy in apparatus and a simplification in operation.

Referring now to the accompanying drawings:—

Fig. 1 shows the characteristic of the transmitting antennae (a) in side elevation and (b) in plan.

Fig. 2 shows the current curves of the signals sent in the two sections according to one method of carrying out the invention.

Fig. 3 shows the low frequency amplifying stages of a receiving circuit suitable for use with the transmissions indicated in Figs. 1 and 2.

Fig. 4 shows the current curves of signals sent in the two directions according to a modified method of keying.

Fig. 5 shows a method of keying suitable for use with the method of operation of Fig. 4.

Fig. 6 shows a modified method of keying.

The ultra-short wave fields, by means of suitable directional arrangements, are so caused to radiate, that they are at a suitable angle to each other. Their characteristics are shown schematically in Figure 1 in side elevation (a) and in plan (b). The landing curve, which is designated by L, coincides in view (1b) with the angular bisection H. The two fields have the same wave length, but they are distinguishable from each other in some other way, for example so that in the one angular space only dots are transmitted and in the other only dashes, or signals of different form, but one type may be sent in both angular spaces as hereinafter described.

The transmitting arrangement is particularly simple, as the directional systems are keyed with key chokes. The known arrangement described in our prior British Patent No. 353,476 may be employed for this, in which both keying windings of the chokes are connected in series and further one of the chokes has

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a permanently inserted magnetic winding. With this arrangement upon the closing of the key device, one choke coil is magnetised and the other which has the permanently inserted winding, is not magnetised, as the effects of the two windings are cancelled on this choke. This type of keying has the advantage that two transmitted signals are always exact mirror reflections to each other. If now, one signal is so formed that it has a slow current rise and a rapid current fall (preferably by the use in known manner of appropriate band-pass filters in the keying circuits) then the other signal has the reverse characteristic; with it the current rise takes place rapidly and the current fall slowly. The signals thus have the same appearance and per se, are of the same type but are of different form and are as mirror reflections to each other. Keying may be effected in any other suitable manner as for example by the use of a movable coupling coil.

The conditions are shown schematically in Figure 2. The current curves of the signals in the two angular spaces are shown by I and II. It is assumed that the signal I has a slow current rise and a rapid current fall and the signal II a rapid current rise and a slow drop. If these signals are conveyed to a suitable receiving arrangement, which is more fully described in the following description, then it is possible to indicate whether the receiving device is situated on the angular bisection of the fields or not. According to whether the signal rises slowly and falls quickly or vice versa, by interpolating a transformer, the keying characteristic can be utilised to designate the appurtenant field.

For this purpose preferably the receiving arrangement shown in Figure 3 may be employed. The received energy is conveyed to a suitable ultra-short wave receiving device, whose last stages are shown in Figure 3. The received signals are conveyed over a transformer $T_1$ to the grid of a rectifier tube $R_1$. There is arranged in the anode circuit of the tube $R_1$ a transformer $T_2$, whose secondary winding has a centre tap and both of whose ends are connected with the grids of two valves $R_2$ and $R_3$, operating in push-pull and which have no linear portion in their characteristics. A bias potential may be given to the grids over the tap by means of a bias potential battery G. In the anode circuit of the valves $R_2$, $R_3$ is a resistance W, which does not affect the quadratic operation of the valves $R_2$ and $R_3$ and the centre point of which is connected to a source of anode potential supplied by the battery A. Parallel to the resistance W is an indicating instrument J. Instead of the instrument J shown, which is parallel to the resistance W, a corresponding differential instrument (differential galvanometer) may be employed in the same way.

The current curves shown in Figure 2 are perceptible in the secondary winding of the transformer $T_2$ as potential peaks in one or other direction. According to whether the signals 1 or 2 are less preponderant, the potential impulse is accordingly greater or less, and a greater or less flow of anode current is obtained in the valves $R_2$ and $R_3$, whose characteristics, as stated, have no linear component. If both fields are of equal magnitude, that is, if the pilot is on the line of angular bisection, then the anode currents of both valves $R_2$, $R_3$ are also of equal magnitude and the pointer of the instrument J is therefore in the middle position. If the signal 1 or the signal 2 preponderates, then the deflection of the instrument J deviates more or less from the middle position to one side or the other. Thus, the pilot can read from this instrument the deviation from the line of symmetry of the two directional fields.

The instrument M, on the other hand, serves to maintain the landing curve. The instrument M shows the total value of the currents of the rectifier valve $R_1$. The pilot is instructed to pilot his machine in such a way that the deflection of the instrument M remains constant, that is, he is in this way forced to keep to the landing curve.

The receiving device described is essentially similar to that described in our copending application No. 17,945/31 (Serial No. 380,166).

The keying described by means of Figure 2, in which continuous simultaneous radiation takes place in both angular spaces, has under the circumstances certain disadvantages, which are avoided in accordance with a further embodiment of the invention. The perfect operation of this arrangement is, for example, doubtful if the phase relations of the two simultaneous transmissions are not kept exactly constant. It is therefore proposed to avoid simultaneous keying and to key the fields alternately. The signals now obtained are shown in Figure 4. It is even possible to allow a small pause between the end of a signal in one direction and the beginning of a signal in the other.

The keying in this case can be conveniently effected in the following manner. Figures 5 and 6 show schematically two arrangements suitable for this.

In the arrangement according to Figure 5, across the antenna leads there are corresponding resistances $W_1$ and $W_2$, which are short-circuited by a keying device T, so that the radiation takes place according to Figure 4. The arrangement according to Figure 6 is to be preferred in many cases. Here, in order to avoid high frequency keying, two separate output valves $E_1$ and $E_2$ are provided. These output-valves are keyed on the grid side by the keying device T.

It is also possible to couple the instruments M and J together in order to force the pilot to maintain both the lateral direction and also the landing curve. An illuminating device, for example, may be so controlled that the instrument M is only illuminated and can be read if the instrument J indicates that the aeroplane is on the line of angular intersection.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. Radio beacon for aeroplanes, characterised in this, that two ultra-short wave fields, different from each other, but of the same wave length, are radiated at an angle to each other and to the ground, so that lateral deflections of the aeroplane are ascertained relative to the angular bisection of the fields, and the landing curve indicated by a curve of constant field intensity.

2. Radio beacon as claimed in claim 1, in which one signal element only is transmitted in each field.

3. Radio beacon as claimed in claim 2, in which by the use of different switching-in and switching-out operations, signals of the same type are sent mirror fashion to each other in the two directions.

4. Radio beacon as claimed in claim 3, in which keying is effected by means of direct current magnetised chokes.

5. Radio beacon as claimed in claim 3, in which keying is effected by means of a movable coupling coil.

6. Radio beacon as claimed in claim 3, in which the fields are alternately keyed.

7. Radio beacon as claimed in claim 6, in which there is allotted to each antenna system a separate output valve, means being provided for keying each output valve.

8. Receiving arrangement for radio beacons as claimed in claim 1, characterised in this, that the received signals are rectified and conveyed to push-pull tubes, in the anode circuit of which is inserted a resistance not affecting the quadratic operation, the anode potential being conveyed over the centre point of said resistance and an instrument for indicating deviations from the line of angular bisection being connected parallel thereto.

9. Receiving arrangement as claimed in claim 8, in which a further instrument for indicating the maintenance of the landing curve is provided in a stage preceding the push-pull circuit.

10. Receiving arrangement as claimed in claim 9, in which the instrument situated in the preceding stage can only be read if the receiving arrangement is situated on the line of angular bisection of the transmitter fields.

11. Radio beacon substantially as described or as illustrated in the accompanying drawings.

12. Receiving arrangement for a radio beacon as claimed in claim 1, substantially as described and as illustrated in Fig. 3 of the accompanying drawings.

Dated this 7th day of October, 1932.

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SHEET 1

Fig.1

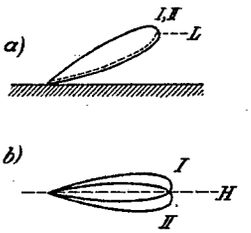



Fig.2

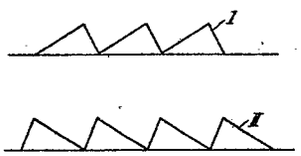
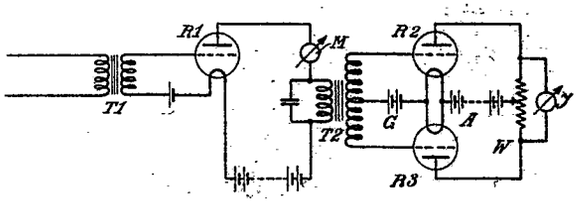



Fig.3




SHEET 2

Fig.4

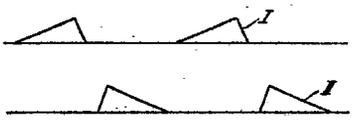



Fig.5

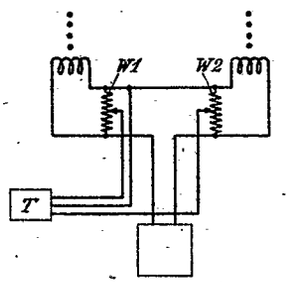
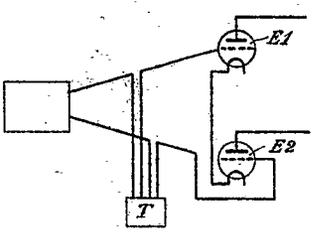



Fig.6

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