Oct. 8, 1940. W. M. HAHNEMANN ET AL 2,217,404

SYSTEM AND METHOD FOR LANDING AIRPLANES

Original Filed April 26, 1934

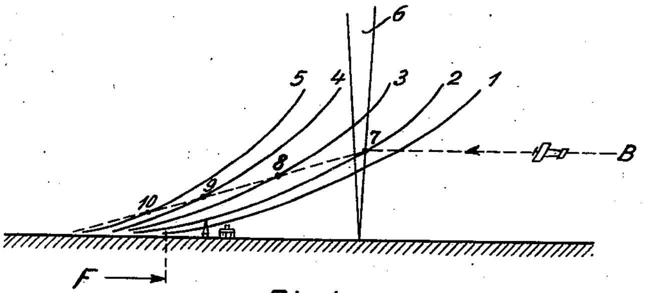


Fig.1

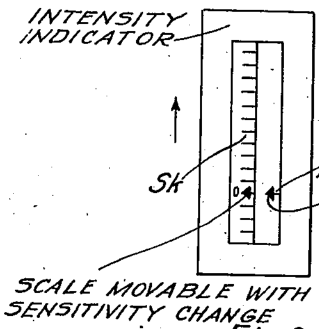


Fig.3

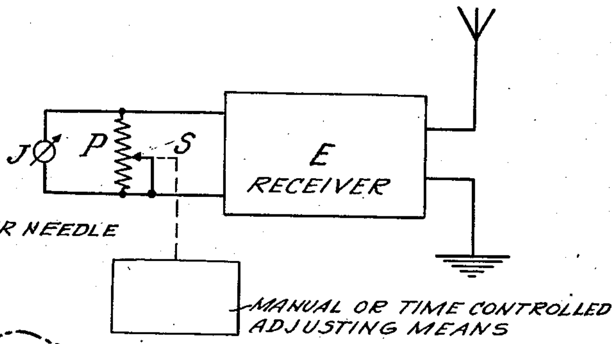
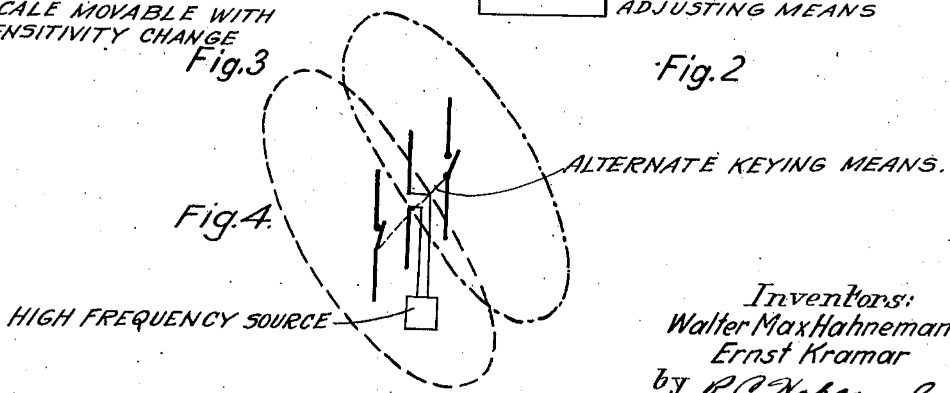


Fig.2

Fig.4



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Patented Oct. 8, 1940 2,217,404

UNITED STATES PATENT OFFICE

2,217,404

SYSTEM AND METHOD FOR LANDING AIRPLANES

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Original application April 26, 1934, Serial No. 722,470. Divided and this application November 19, 1937, Serial No. 175,430. In Germany May 10, 1933

3 Claims. (Cl. 250—11)

The present invention is a divisional from that described in the copending U. S. Patent application Ser. No. 722,470, filed on April 26, 1934, for System for landing airplanes, and relates to an improvement upon such arrangements.

It is well known for the purpose of facilitating the landing of airplanes to employ so-called slip-way beacons which radiate a torus-shaped bundle of ultra-short electromagnetic waves at a certain angle to the ground surface. The landing may be so effected that the airplane descends on a curve of constant field intensity. However, this method involves the disadvantage that the curves of constant field intensity are too steep in major heights, while too flat in minor heights immediately in front of the point at which the airplane touches ground within the airport. Consequently, an airplane flying in major heights must at first descend rather steeply, while on reaching minor heights near the ground change the course so as to fly approximately parallel to the ground surface. The pilot is not in a position to continue the flight with idle motor, but is compelled to give full power just before touching the ground. The unduly high speed in the actual landing moment as a result thereof is critical in many cases. In order to overcome this disadvantage, propositions have been made, according to which the airplane should intersect different curves, each of which having an equal field intensity, instead of descending on one curve of constant field intensity. For reliably realizing the above-said method, it has hitherto been necessary to ensure that the transmitter maintains its power continuously constant, and that the receiver always has the same sensitivity. This requirement may relatively easy be fulfilled on the transmitter side by supervising not only the transmitter, but also the transmitter field. On the receiving side, however, considerable difficulty is experienced, as the sensitivity of the receiver must remain the same over a longer period of time. To give an example in a Berlin to London flight, the receiver which has to be adjusted in Berlin must maintain a constant sensitivity until landing in London, which will take place several hours after. It is, of course, possible to disconnect the receiver during the journey, but upon re-insertion before the actual landing in London it must have the same sensitivity. In will easily be seen that this is not easy to do on account of the extraordinarily high sensitivity of modern receivers.

The invention relates to a fundamental improvement of the slip-way beacon method. According to the invention, the beginning of the landing is indicated by a radiant pattern which also serves to define an equal intensity zone, while the indication of the field intensity which exists at the moment of reception of the additional signal indication is employed to determine the actual landing path.

The invention will be more readily understood from the following description in conjunction with the accompanying drawing, in which:

Fig. 1 shows an elevation of a landing ground,

Fig. 2 diagrammatically illustrates a receiving arrangement according to the invention, adapted to be used in an airplane, while

Fig. 3 schematically demonstrates an indicating device for use in an airplane,

Fig. 4 diagrammatically illustrates in plan a directional beacon for use with the glide path as a marker beacon.

Referring to Fig. 1, the reference numerals **1** to **5** designate different curves of equal field intensity, either of a well known obliquely upwards directed bundle of rays, of two intermittently keyed bundles of rays for obtaining a zone of equal intensity, or of a torus-shaped radiation diagram. The invention is applicable to all methods in connection with the aforesaid types, while in case of need, i. e., in case two keyed bundles are not used, the direction determination must be effected by additional means, a preferred one of which is more fully described hereafter. The course line of the airplane is designated B in the drawing.

The method hitherto employed is based on the fact that the airplane, which in the first instanc arrives horizontally on its guiding course line B, remains on this course in the bundle of rays until it reaches the field intensity in which it must descend. As soon as a predetermined deflection of the indicating device of the receiver is reached, the airplane descends. However, as already explained in the foregoing, this requires a continuous constancy with respect to the sensitivity of the receiver.

According to the invention, the point at which the landing should be commenced is given by an additional signal indication **6**, which is directed perpendicularly, or obliquely upwards. This additional indication may either be given acoustically or by wireless. The airplane flies on horizontally until it reaches the point 7, at which it receives the indication 6. It then descends from point 7 so that the deflection of the indicating device remains the same as it was at the moment of the arrival of the signal indication 6. The curves 3, 4 and 5 are intersected at the points 8, 9 and 10 in order to obtain a particular landing path subsequent to the receipt of the indication. This is obtained for instance in such a manner that the sensitivity of the indicating device of the receiver is varied in dependence upon the time elapsed from the moment in which said indication was received, or by shifting the scale of the indicating device. It is now immaterial whether the indicating instrument indicates two or six points on the scale, i. e., if the sensitivity of the receiver has been changed or not. It is by no means necessary that this change is linearly effected, on the contrary, it may be performed according to any arbitrarily chosen rule. In other words, the landing curve may be optionally designed in response to the intersecting points 7 to 10, so as to be accommodated to the airport conditions and to the type of airplanes.

The Figs. 2 and 3 diagrammatically illustrate suitable equipments for realizing the above disclosed idea. These equipments are simple means adapted to be added to known devices. A shunt resistance or a series resistance may be connected to the indicating device, the magnitude of said resistance being varied in dependence upon time, e. g., by a watch or the like. Means are thereby provided which connect said resistance to the indicating device from the moment in which the signal indication was received. Referring to Fig. 2, E designates the receiver mounted on the airplane, and J the indicating device which indicates the landing path and which is connected to the output side of the receiver E. A variable resistance P is shunted to the indicating device J, and the slidable contact S of said resistance is shifted dependent upon time in accordance with a certain rule from the moment in which the signal indication was received. It will also be possible to connect the resistance P in series with the indicating device J.

Furthermore, a particularly constructed indicating instrument as illustrated in Fig. 3 may be employed. The pointer Z is controlled by the output circuit of the receiver in the well known manner. However, contradictory to the known arrangements in which the scale is fixed, the scale Sk is moved, e. g., upwardly, in dependence upon time by any well known means (not shown) from the moment in which the signal indication is received. Nevertheless, the pilot must navigate the airplane so, that the pointer Z continuously remains on the same point of the scale, on the zero line, for instance.

The additional signal indication may be given by means of devices which are in themselves well known, and arrangements for indicating the landing ground boundaries are readily adaptable for this purpose. In the simplest case a parabolic reflector may be employed which concentrates a beam of electromagnetic rays perpendicularly or obliquely upwards. In accordance with a novel feature of my invention I propose to employ an arrangement which produces a zone of equal intensity, particularly such an arrangement which operates by means of vertical polarization. Such an arrangement is described for example in U. S. Patent 2,028,510 issued to Ernst Kramar January 21, 1936, which shows a vertical dipole which continuously is fed by one transmitter, and two dipoles acting as reflectors. Fig. 4 shows such an arrangement together with a plan of the field pattern produced thereby. These reflector dipoles are alternately manipulated according to one of the known methods, for example in the A-N-rhythm. Thus in the well known manner a zone of equal intensity is obtained, that is by the fact that the circular radiation diagram of the middle dipole continuously fed by the transmitter is alternately distorted so as to be displaced to one side and then to the other side in a pattern of oblate shape as more fully set forth in the above mentioned patent. If an airplane overflies such an arrangement, the reception on this airplane decays because the transmitter is operating with vertical polarization. The moment of decay is extremely sharply defined so that it may be employed as the said additional indication and possibly for the automatic release of a suitable scale-moving or shunt-adjusting mechanism, which may be used in the arrangements of Figs. 2 or 3, in order to change the sensitivity of the indicating device in dependence upon time.

It is also possible to employ a plane of radiation instead of a bundle of rays, this plane being penetrated by the airplane. These arrangements are preferably such that two transmitters are installed at two diagonally opposite corners of the airport, each transmitter providing two sides of the airport with such planes of radiation. If an acoustic indication is employed, then suitable directing means may be used for the sound transmitters or sound transmitting combinations.

What is claimed is:

1. The method of landing airplanes which comprises radiating a short wave field of electromagnetic energy at an angle to the ground, radiating two further vertically polarized fields upwardly and outwardly, said polarized fields having a zone of substantially zero intensity, employing the relative field strengths of said two fields to determine the direction of flight of the airplane, employing the zone of zero intensity formed by the vertical polarization of said further fields to determine a region of reference in space, obtaining an indication of the intensity of said short wave field at a point in said determined region in space, and thereafter employing said indication as a reference standard with which to compare the short wave field intensities subsequently encountered in landing said airplane within said short wave field.

2. An airplane landing path system comprising means for radiating a short wave glide path field having equal field strength surfaces obliquely inclined with respect to the ground to produce glide paths terminating at a particular landing point, means for radiating two distinguishable electromagnetic signals with substantially vertical polarization in upwardly and outwardly extending radiation patterns which mutually intersect to define a zone of equal intensity to provide for lateral guidance of said airplane, said signals having an inherent zone of substantially zero intensity, said last mentioned means being arranged so that the zone of equal intensity is in line with said landing point, and being spaced from said landing point a distance such that said zone of zero intensity resulting from the substantially vertical polarization of said electromagnetic signals intersects one of

said equal field strength surfaces of said short wave field at a location suitable for commencing the descent of an airplane along said equal field strength surface.

3. A system as claimed in claim 2, wherein said means for radiating two distinguishable signals comprises a vertical dipole, means for feeding waves to said dipole, and a plurality of variably effective reflectors for variably distorting the patterns radiated by said dipole.

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