

CO. No.

3840877

UNITED STATES PATENT OFFICE

TO ALL TO WHOM THESE PRESENTS SHALL COME:

Whereas, THERE HAS BEEN PRESENTED TO THE

Commissioner of Patents

A PETITION PRAYING FOR THE GRANT OF LETTERS PATENT FOR AN ALLEGED NEW AND USEFUL INVENTION THE TITLE AND DESCRIPTION OF WHICH ARE CONTAINED IN THE SPECIFICATION OF WHICH A COPY IS HEREUNTO ANNEXED AND MADE A PART HEREOF, AND THE VARIOUS REQUIREMENTS OF LAW IN SUCH CASES MADE AND PROVIDED HAVE BEEN COMPLIED WITH, AND THE TITLE THERETO IS, FROM THE RECORDS OF THE PATENT OFFICE IN THE CLAIMANT(S) INDICATED IN THE SAID COPY, AND WHEREAS, UPON DUE EXAMINATION MADE, THE SAID CLAIMANT(S) IS (ARE) ADJUDGED TO BE ENTITLED TO A PATENT UNDER THE LAW.

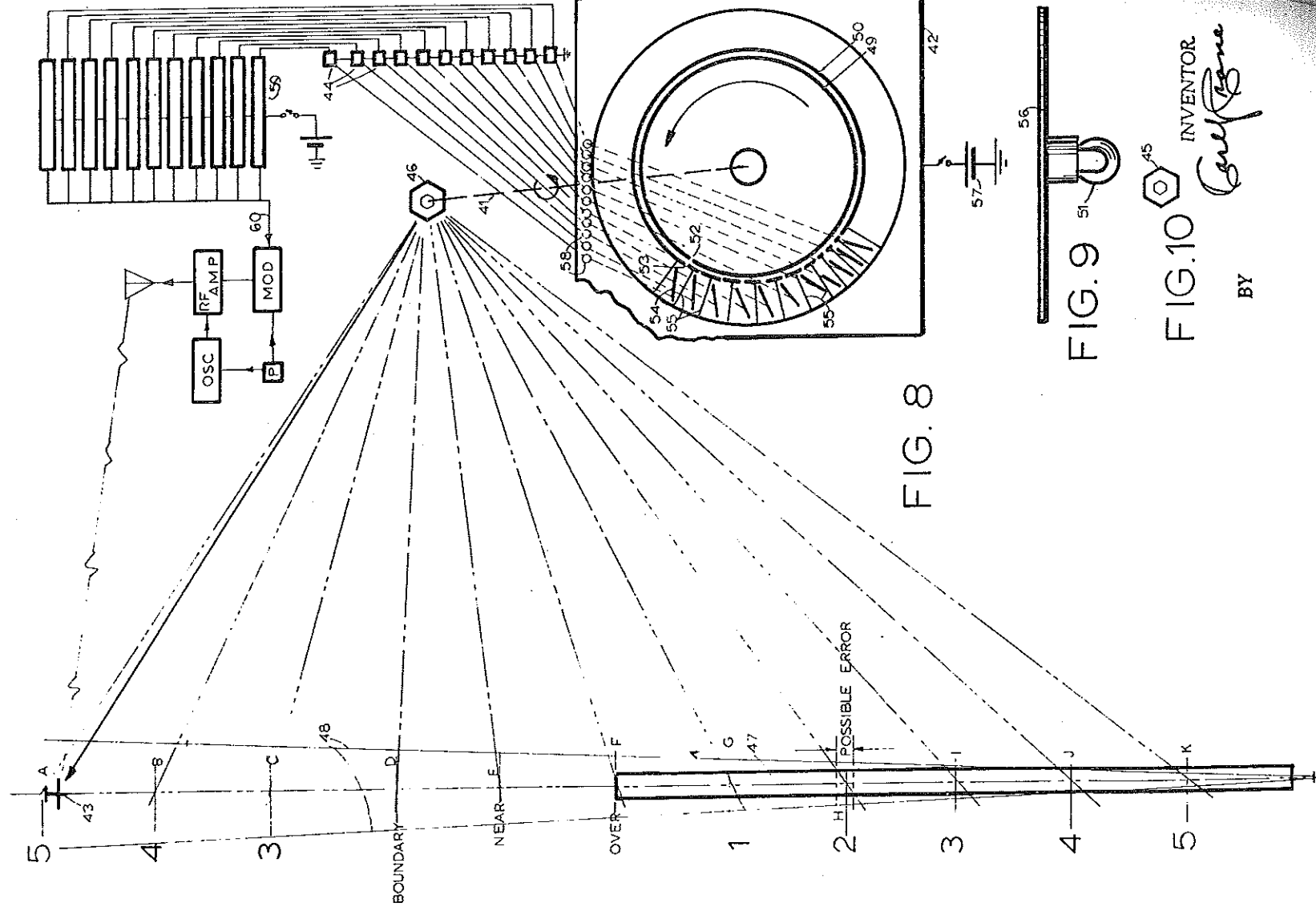
NOW, THEREFORE, THESE Letters Patent ARE TO GRANT UNTO THE SAID CLAIMANT(S) AND THE SUCCESSORS, HEIRS OR ASSIGNS OF THE SAID CLAIMANT(S) FOR THE TERM OF SEVENTEEN YEARS FROM THE DATE OF THIS GRANT, SUBJECT TO THE PAYMENT OF ISSUE FEES AS PROVIDED BY LAW, THE RIGHT TO EXCLUDE OTHERS FROM MAKING, USING OR SELLING THE SAID INVENTION THROUGHOUT THE UNITED STATES.

In testimony whereof I have hereunto set my hand and caused the seal of the Patent Office to be affixed at the City of Washington this eighth day of October, in the year of our Lord one thousand nine hundred and seventy-four, and of the Independence of the United States of America the one hundred and ninety-ninth.

Attest:

Samuel J. Fowler
Attesting Officer.

C. Marshall Davis
Commissioner of Patents.

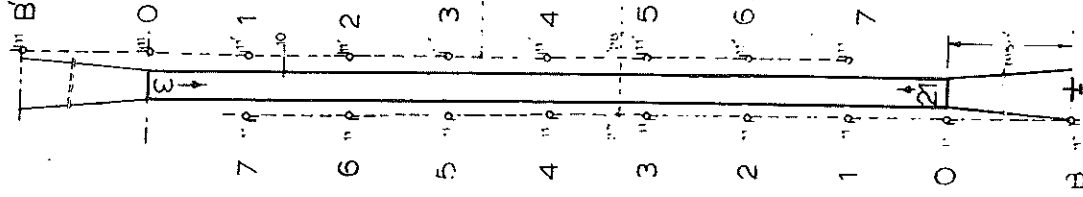


Crane

[45] Oct. 8, 1974

1,885,023	10/1932	Dieckman.....	343/112 R
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1 Claim, 10 Drawing Figures



INVENTOR
Earl R. Gann

VOICE-DIRECTED AIRCRAFT NAVIGATION SYSTEM

This is a continuation of application Ser. No. 870,420 filed Oct. 16, 1969, now abandoned.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The instant invention relates to ground and airborne electronic devices which combine, through systematic operative arrangement of the elements, to properly inform the pilot of his location along the flight path during approach, landing, roll-out and/or take-off to or from a landing area respectively. Normally the landing area is a runway. During clear weather and good light conditions the pilot may see the runway as it is approached in flight. At night he sees the runway as outlined by lights, which are placed in various arrangements to assist in guiding him to the runway threshold and then along the runway. High performance aircraft which land at high speed require a long runway, and even in clear weather and good light the pilot depends on signs placed along the runway which indicate his direction already run, and left to run, along the runway. At night light patterns and colors serve a like nature. When fog or other weather condition obscures the runway the pilot at present has no measure of his location along the runway, and very little aid during the final stage of an instrument approach to the runway.

2. Description of the Prior Art

The contemporary employment of aircraft in day to day operation makes no use of electronic aids in the immediate vicinity of the runway to give the pilot position distance information during the landing/take-off procedure.

In my U.S. Pat. No. 3,307,191, entitled Aircraft Blind Landing Device and Flight Director System, there is disclosed the positioning of low power radio transmitters along the runway. As the landing aircraft passes within a few feet of each transmitter its transmitted signal is received by the airborne receiver in such a manner as to cause an appropriate lamp to be lighted. The positions of the lamps are such as to indicate the successive positions of the aircraft along the runway. This array of lamps is positioned for ease of viewing within the presentation of the flight instrument.

Another patent, U.S. Pat. No. 2,143,137 issued to D. J. Basim, et al., disclosed the use of a boundary marker and only one other marker beacon placed within the runway linear pathway, the purpose of which is as stated in this patent on page 5, column 2, lines 23 to 33 inclusive. This does not anticipate the utilization of electronic transmitters placed and grouped as disclosed herein.

Another patent, U.S. Pat. No. 2,784,307 issued to W. D. Burton, describes in great detail the inner design of an improved marker beacon receiver. One drawing in this patent shows a positioning of three marker beacon transmitters external to the landing area. The purpose of this drawing is to portray the manner in which the improved receiver is energized, in order to limit interference from transients, and for other improvements, but the purpose of this invention is best indicated in column 2 of the patent in the sentence beginning on line 28 which states in part, "This invention relates particularly to a radio receiver . . ."

Another patent, U.S. Pat. No. 2,322,225 issued to Carl J. Crane, Gerge V. Holloman, Raymond K. Stout

and Constantin D. Barbulesco, shows the liberal use of marker beacons positioned in the line of approach to the runway and at the far end of the runway; however the use defined a purpose other than informing the pilot visually or by voice of his location.

Accordingly, none of the prior art noted herein which exemplifies the use of marker beacons employs them to continuously advise the pilot by voice means of his position adjacent to and along the runway landing area during the landing or take-off procedure.

Obviously, with the exception of U.S. Pat. No. 3,307,191 to Crane the prior art does not exemplify an understanding of the problem facing the aircraft pilot in the touch-down/roll-out phase of the blind landing nor does it propose a solution based on the real need to know constantly the aircraft location in its rapidly changing critical positions along the landing area axis. Nothing in the prior art shows means for take-off guidance as the aircraft begins its roll, gains speed and reaches critical positions at which a take-off must be aborted.

SUMMARY

Thus, with the deficiencies of some of the prior art defined, the instant invention proposes alternate means for continuously advising the pilot by voice from ground-based electronic transmitters, the locus of his aircraft with respect to the runway in the direction of flight during approach/landing or take-off procedure. The alternate means are:

1. The use of fixed or portable very low power transmitters placed along and adjacent to the aircraft runway throughout its entire length at selected intervals so arranged that selected voice messages will be transmitted continuously, to be heard by the pilot of an aircraft by means of suitable radio receiver as the aircraft passes in the immediate vicinity of the ground-based transmitter. 2. The use of one or more ground-based automatic direction finders which will track an approach-landing aircraft, or one taking off, in such manner that switching means connected to the tracking mechanism of the automatic direction finder will operate to select appropriate stored voice position information that is continuously transmitted from a ground-based electronic transmitter to the communication receiver of the aircraft being tracked so that it may be heard by the pilot as he passes selected surface loci.

It is well known that effort is being made to supply precision DME (distance measuring equipment) with which to equip an aircraft to be used in making blind landings. This costly equipment employs, among other items, complex airborne transponder devices to measure slant range to a ground-based device which itself is costly and which will be required at both ends of a given runway if bi-directional use of the runway is required. This equipment provides a visual (counter type) readout device similar to an automotive odometer. The visual senses of a pilot of an instrument landing aircraft are so heavily taxed that he has neither the time nor concentration ability to read a fast-moving distance counter, plus a fast-moving altimeter (of the digital or tape type) and at the same time respond to the flight director indications and those of other instruments of the contemporary flight control panel.

By eliminating the digital counter of distance and substituting voice conveyed position information the pilot is placed at greater ease, and hence is safer and

more capable of responding to the visual indicators displayed on the instrument panel.

Accordingly it is the purpose of this invention to provide electro-mechanical and electronic devices in combination, many of well known and proven reliability to insure voice-conveyed position information to the pilot of an aircraft in the approach-landing and/or take-off situation, and to accomplish this without adding any additional electronic device or equipment to the airplane equipped with conventional communication radio receivers and marker beacon receiver.

By the use of the alternative structure, almost any locale can be served, such as overwater approaches where it may be impractical to locate surface based transmitters.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a landing runway, 8,000 feet in length and 200 feet in width, drawn substantially to scale, showing radio transmitter locations to portray the importance of position information and the relationship of the transmitters' locations to a fast-landing aircraft.

FIG. 2 is a vertical view of the approach end of a runway which is assumed to be equipped with the conventional ILS (Instrument Landing System), the glide slope angle of which, for example, is 3°. This portrays a location substantially 1,950 feet from the threshold at which is located one of the transmitter sites called the boundary marker.

FIG. 3 depicts a schematic arrangement of the elements of the portable voice-modulated transmitter assembly.

FIG. 4 shows the heat and rain shield that serves to protect the portable unit.

FIG. 5 shows the diagrammatic external circuitry of one of the several permanently installed voice-modulated transmitters.

FIG. 6 shows the general external appearance of the transmitter site adjacent to and supplied with power from the circuitry serving one of the runway lights.

FIG. 7 shows the tape players and related switch which selects the runway transmitter to be activated for take-off or landing.

FIG. 8 shows a complete schematic array for the combined aircraft, runway, tracking direction finder and related switching device, tape players and simple transmitter needed to transmit position information to the pilot of the aircraft, by means of repeated selected wording to define the locus of the aircraft.

FIG. 9 is an edge view of the photoelectric switch box cover with associated lamp.

FIG. 10 is a second location for another automatic tracking direction finder to be located in the event both landings and take-offs would be made from the opposite direction on the runway from that shown.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Refer to FIG. 1 to note that the runway 10, in this description is served with 9 transmitters 11' on one side of the runway and 9 transmitters 11'' on the other side of the runway. The transmitter itself employed in the structure of FIGS. 1, 3, 5 and 6 is a simple voice-modulated crystal-controlled unit having less than 100 milliwatts power input to the r-f stage and transmitting on the 75 mH portion of the radio spectrum to match

the contemporary marker beacon receiver now in use or a separate receiver if so desired. The performance of the transmitter is empirically determined after useful ground and air tests. The transmitter weighs 5 ounces without power supply, but including the wave antenna, which is oriented as shown in FIG. 1. The size of the transmitter lends itself to encapsulation in a sealed container 12 which is filled with an inert gas, and shielded electrically, and thermally, by means of the shield 13 (FIG. 6). In the form in which the transmitter is employed as shown in FIGS. 1 and 6, it is ranged for plug-in connection to the conduit 14 and in turn may be mechanically and electrically connected to selected runway light support 16 where the transmitter and its associated power converter 17 (transformer and rectifier) may share the electrical energy supplied to the runway light 15. Since the runway lights will be activated during obscure weather and/or light conditions by closing the switch 18 it is an economy in the circuitry provided. In the event the transmitter is not needed, such as on clear nights, the switch 16, 18, 5 and FIG. 7 will remain open to deactivate the transmitter modulation output to the transmitter circuits.

Voice modulation of the transmitter is supplied by various transmitters by means of the playback of recorded voice. Voice recordings may be stored on magnetic tape or disc or drum, or on transparent film disc or drum by means of light modulated recording. Refer to FIG. 7 in which are shown 4 multiple gauged endless tape players, each identified by numerals 19, 20, 21 and 22. The multiple track tape player 19 will supply, by means of ground telephone cable 23 the individual circuits to voice modulate the transmitters 11' for purpose of providing a pilot of an aircraft with needed position information during take-off on runway 30. If a dense fog obscures all vision the pilot would secure the mid-line of the runway by means of the ILS localizer and by moving the heading of 210° proceed until he heard on the receiver the word "zero" being repeated in quick succession (about three words per second). He would then turn the aircraft to assume the runway heading of the runway and begin the take-off roll. His knowledge of the particular aircraft take-off performance will dictate that each 1,000 feet of roll he must secure a proper airspeed indication, which if not achieved will require the aborting of the take-off. As the aircraft passes the runway locus within about 200 feet of position (FIG. 1) the spoken word "one" is heard, first increasing and then decreasing in volume until the aircraft passes from the range of the transmitter at that position. As each transmitter position is reached and indicated by the spoken word indicating distance along the take-off roll the pilot will prepare to "rotate" when the aircraft airspeed reaches an acceptable value, thus completing the lift-off.

The early part of the take-off roll is critical to the position of the aircraft with respect to the performance is extremely important. Accordingly, a position transmitter is passed, the pilot can determine whether to continue or abort the take-off.

During the example just noted, the selector knob would be set at the "3 TAKE-OFF" position as shown in FIG. 7. For the purpose of landing on Runway 30, knob 25 of the selector switch would be set at position "LAND 3" as shown in FIG. 7.

With this position selected, the transmitter is activated in order that the position information needed in landing is provided by the transmitters 11' but now included at B' which is the boundary marker as noted in FIG. 1. The runway threshold and as the aircraft approaches the runway the pilot would hear the quick succession. Expected that in an aircraft who knows, five to six repetitions heard. After passing the runway threshold the aircraft enters the radiate threshold so that the pilot would hear the "over" to indicate the runway. Succeeding transmitters are noted above with the spoken word along the runway.

After halting the roll-out between position "5" and "3" a desire to taxi to position for movement to the parallel expedient ground clear the runway is indicated by transmitters if guide in FIG. 2 the approximate marker MM is shown in the event runway 21 is the selector knob 25 position for "LAND 21" even all the operations will be valid and the transmitters 11' and 11'' will be activated. The tape-player-amplifier unit telephone cable 26 to connect to the various transmitters 11' and 11''.

It will be noted that the purpose of the transmitter is to reduce the number of the interest of safety is considered vital. There may be situation: portable runway transmitter is set up landing area for temporary use. To satisfy the need to FIG. 3 which includes two batteries 30, 31 and switch panel 34, shield container 35, with shield 37 equipped with h: which engage the 1

Another form of the invention is shown in FIGS. 8 and 9. In this structure the transmitter is directed fixing of position use is made of any the aircraft in its path along the runway 47 during roll-out.

receiver now in use. The performance determined after care-
 including the half-
 s shown in FIG. 1.
 self to encapsulation
 ed with an inert dry
 thermally, by means
 a in which the trans-
 GS. 1 and 6 it is ar-
 e conduit 14 which
 electrically connected
 where the transmit-
 ter 17 (transformer
 ical energy supplied
 unway lights will be
 and/or light condi-
 s an economy to use
 t the transmitters are
 s, the switch 16, FIG.
 deactivate the voice
 ter circuits.

ter is supplied to the
 the playback of re-
 ay be stored on mag-
 a transparent film or
 modulated recording.
 own 4 multiple track
 identified by the nu-
 multiple track endless
 eans of ground tele-
 circuits to voice modu-
 ose of providing the
 position information
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 is reached and identi-
 g distance along the
 to "rotate" when the
 ptable value, thereby

all is critical to safety,
 th respect to its per-
 Accordingly as each
 e pilot can determine
 take-off.

the selector knob 25
 "F" position as shown
 ding on Runway 3 the
 could be set at position

With this position selected the tape player 20 will be
 activated in order that it will supply the position infor-
 mation needed in landing. All the tracks of the tape
 player 20 are activated to modulate the same transmit-
 ters 11' but now including the transmitter 11'' located
 at B' which is the boundary transmitter. It would be lo-
 cated as noted in FIG. 2 at approximately 1,950 feet
 from the runway threshold (for a 3° glide slope configu-
 ration) and as the aircraft passes the boundary position
 the pilot would hear the word "boundary" repeated in
 quick succession. Experience with this system indicates
 that in an aircraft whose approach speed is about 125
 knots, five to six repetitions of the identifying word are
 heard. After passing the boundary transmitter the air-
 craft enters the radiated space pattern of the runway
 threshold so that the pilot will hear the spoken word
 "over" to indicate the aircraft position over the run-
 way. Succeeding transmitter locations would be identi-
 fied as noted above with each thousand feet being iden-
 tified by the spoken word corresponding to the distance
 along the runway.

After halting the roll-out should the aircraft stop, say,
 between position "5" and position "6" the pilot may
 desire to taxi to position "7" where a taxiway is located
 for movement to the parking ramp. In obscure weather
 the expeditious ground operation of the aircraft to
 clear the runway is important and is aided by the run-
 way transmitters if guide lights cannot be seen.

In FIG. 2 the approximate location of the ILS middle
 marker MM is shown in relation to the boundary
 marker BM and the runway threshold.

In the event runway 21 is to be used for flight opera-
 tions the selector knob 25 will be adjusted to the proper
 position for "LAND 21" or "21 TAKE-OFF." In this
 event all the operations described above for runway 3
 will be valid and the transmitters 11 and 11'' at posi-
 tion B will be activated. This will place in operation the
 tape player-amplifier units 21 and 22 and energize the
 telephone cable 26 to connect with the cable 27 under-
 ground to the various transmitter positions 11 as the
 cable 23 connects with the cable 28 to energize the
 transmitters 11' and 11'' at position B'.

It will be noted that certain simplifications can be
 made to reduce the number of transmitters by cross-use
 but in the interest of safety some duplication of the sys-
 tem is considered vital.

There may be situations where a limited number of
 portable runway transmitters may be used at small or
 hastily set up landing areas, or needed for emergency
 or temporary use. To satisfy these possible needs refer-
 ence is made to FIG. 3 which shows a complete runway
 transmitter which includes the transmitter 29, the tape
 player 30, two batteries 31 and 32, battery test meter
 33 and switch panel 34, suitably enclosed in a venti-
 lated container 35, with shelf 36 and weather and heat
 shield 37 equipped with handle 38 and tubular exten-
 sions 39 which engage the leg extensions 40 of the con-
 tainer.

Another form of the invention is shown schematically
 in FIGS. 8 and 9. In this embodiment of the voice-
 directed fixing of position during either take-off or
 landing use is made of any precise method of tracking
 the aircraft in its path along the localizer 48 of the ILS
 (instrument landing system), while in flight, and along
 the runway 47 during roll-out as well as during take-off
 roll.

Several methods of tracking the aircraft may be em-
 ployed, namely:

1. By primary radar
2. By secondary radar, transponder equipped
3. By low frequency automatic direction finder, ne-
 cessitating a non-directional low power transmitter
 aboard the aircraft

4. By VHF direction finder utilizing the normal air-
 craft communication transmitter

In FIG. 8 the servo-driven rotating shaft 41 of the au-
 tomatic direction finder is connected to the shaft of a
 rotating switch 42, in this instance a photoelectric shut-
 ter switch. As the aircraft 43 is tracked in its approach
 path the photoelectric shutter switch will successively
 energize each of the relays 44 as the aircraft succes-
 sively passes the position A to K inclusive. In so doing
 the pilot of the aircraft will hear, for about 1½ seconds
 the quickly spoken words in succession as follows:

Five — four — three — boundary — near — over —
 one — two — three — four — five —

In this instance the runway of FIG. 8 is 6,000 feet
 long. The first heard spoken word "five" indicates the
 aircraft to be 5,000 feet from the threshold, and ap-
 proaching the average location of the middle marker of
 the ILS aid. Since the tracking angle (with the runway
 axis) from the direction finder is 90° at the locus of the
 boundary marker (position D) it is at this position
 where the greatest accuracy of "line of position" ob-
 tains. Only slightly less accurate is position E and F
 near and at the threshold. The probable error is well
 within practical limits at all position fixes.

On very long runways it may be desirable to add an-
 other tracking station 45 in addition to the tracking sta-
 tion 46.

As the direction finder tracks the aircraft to position
 A, its shaft 41 rotates the cup-shaped shutter 49 within
 and close to the cylindrical wall 50 of the photoelectric
 switch. Light from the lamp 51 (FIG. 9) will be admit-
 ted through both the aperture 52 of the shutter and the
 slit 53 in the wall 50. For about 1½ seconds this will ac-
 tivate the photoconductive cell 54 which is light
 shielded from adjacent photocells by the bulkhead 55.
 Each of the 11 photocells is light-shielded in like man-
 ner from the others and from external light by the cir-
 cular cover 56 which supports the lamp 51. The power
 source 57 supplies current to each photocell, one ter-
 minal of which is grounded to a common ground which
 also serves each of the relays 44. The other terminals
 of the photocells lead to a series of binding posts 58
 which in turn serve the coils of the relays 44. As each
 relay is activated, so is its matching tape player of the
 group of tape players 59. The output of each tape
 player connects to a common lead 60 which is the lead-
 in to the modulator of the single communication trans-
 mitter used to communicate position information to the
 aircraft. It may be that one special frequency may be
 allotted by the Federal Communication Commission
 for this particular service.

I claim:

1. In combination with an Instrument Landing Sys-
 tem having a glide slope angle of about 3° for take-off
 and landing to the runway, an aircraft runway distance
 monitor system for providing an audible and vocal indi-
 cation of the longitudinal position of the aircraft along
 the runway, said monitor system comprising:
 a plurality of low-power voice modulated portable
 transmitters with half wave antenna each posi-

tioned at marker locations fitted with lights on each side of said runway, said marker locations being spaced at regular intervals along said runway and opposite each other serving as runway marker lights with a power source and switching means for energizing and actuating said lights;
 said low-power voice modulated transmitter including endless magnetic tape reproducer means for playing selected words for transmission at each of said transmitters which indicate by the word and repeating of said words, the longitudinal position of the aircraft when received by a receiver in the aircraft;
 said low-power transmitter broadcasting a distance of about 200 feet in the radiospectrum and being a voice modulated crystal controlled unit having less than 100 milliwatts power to the r - f stage whereby the weak audio signals of all of the transmitters in the same row permit a clear repetition of the voice

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signal for a short distance of about 200 feet and less than 300 feet within a succession of said signals along the runway, this distance defining a proximate range for each transmitter;
 receiver means in the aircraft including an audio indicator means for successively receiving the radiated voice signals from said transmitter within the proximate range for each transmitter, the voice signal received first increasing in volume as the aircraft approaches the selected transmitter and then decreasing in volume as the aircraft passes beyond the proximate range of said transmitter; and,
 a selector switch means for the rows of said runway transmitters having two positions, one for take-off and one for landing, the setting of said switch energizing words for transmission from said endless tape reproducers selected either for aircraft take-off or selected for aircraft landing.

* * * * *