(12) UK Patent Application (19) GB (11) 2 162 014 A

(43) Application published 22 Jan 1986

(21) Application No 8517491

(22) Date of filing 10 Jul 1985

(30) Priority data

(31) 3427020 (32) 21 Jul 1984 (33) DE

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(51) INT CL^4
G01C 21/04
G01D 1/02
G01S 17/42
G06F 15/58

(52) Domestic classification
H4D 266 467 508 66X 716 72X 745 783 AB
U1S 1197 1839 H4D

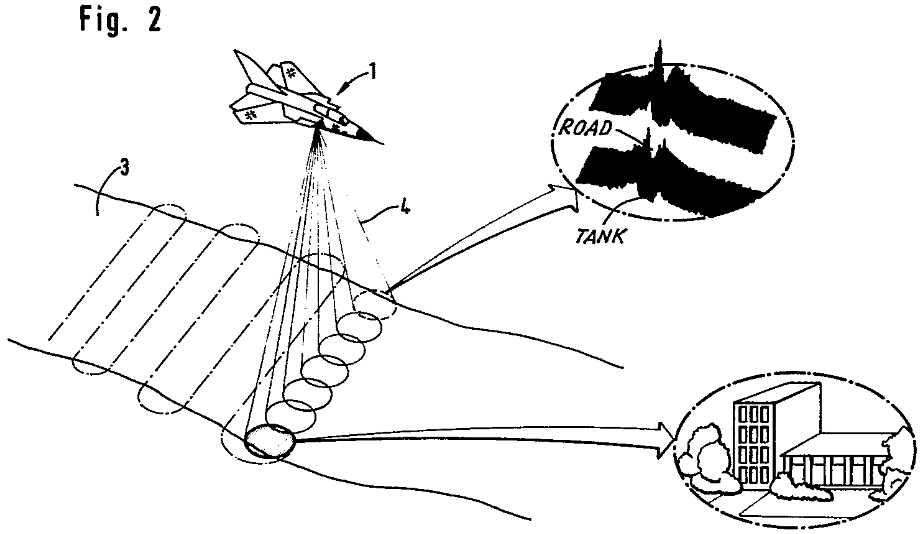
(56) Documents cited
None

(58) Field of search
G2J G1F

(54) **Navigation and flight guidance**

(57) In a method of navigation and flight guidance in which perceived and stored terrain data are correlated, a sensor is used which is directed towards the ground and scans the flight path 3 perpendicularly to the direction of flight with a pivoting mechanism. The same sensor is used for end-phase guiding, for example homing and/or target surveying, by switching over the pivoting mechanism in a forward-looking direction (Fig. 3). The sensor may be an EHF sensor or a laser device.

Fig. 2



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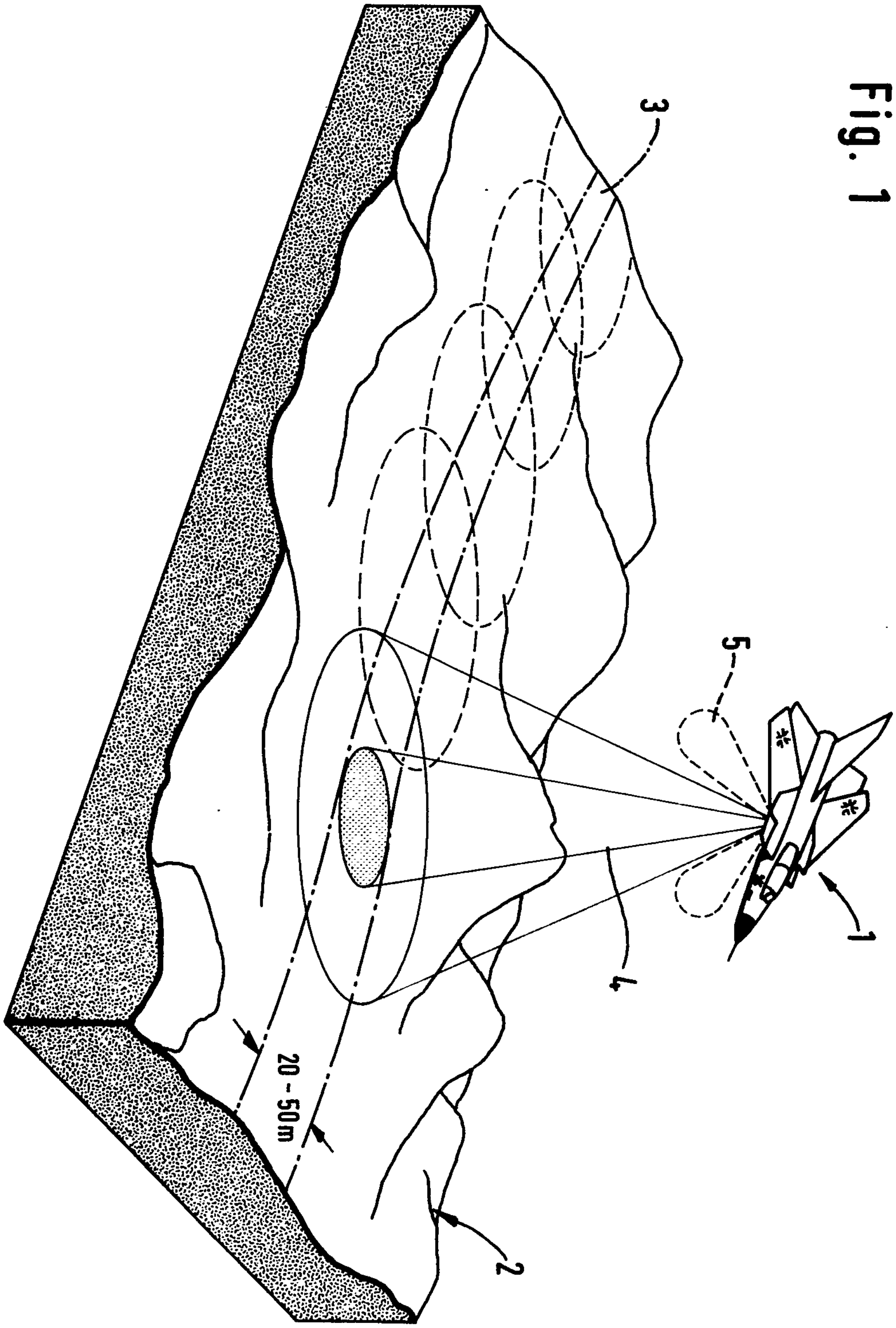


Fig. 1

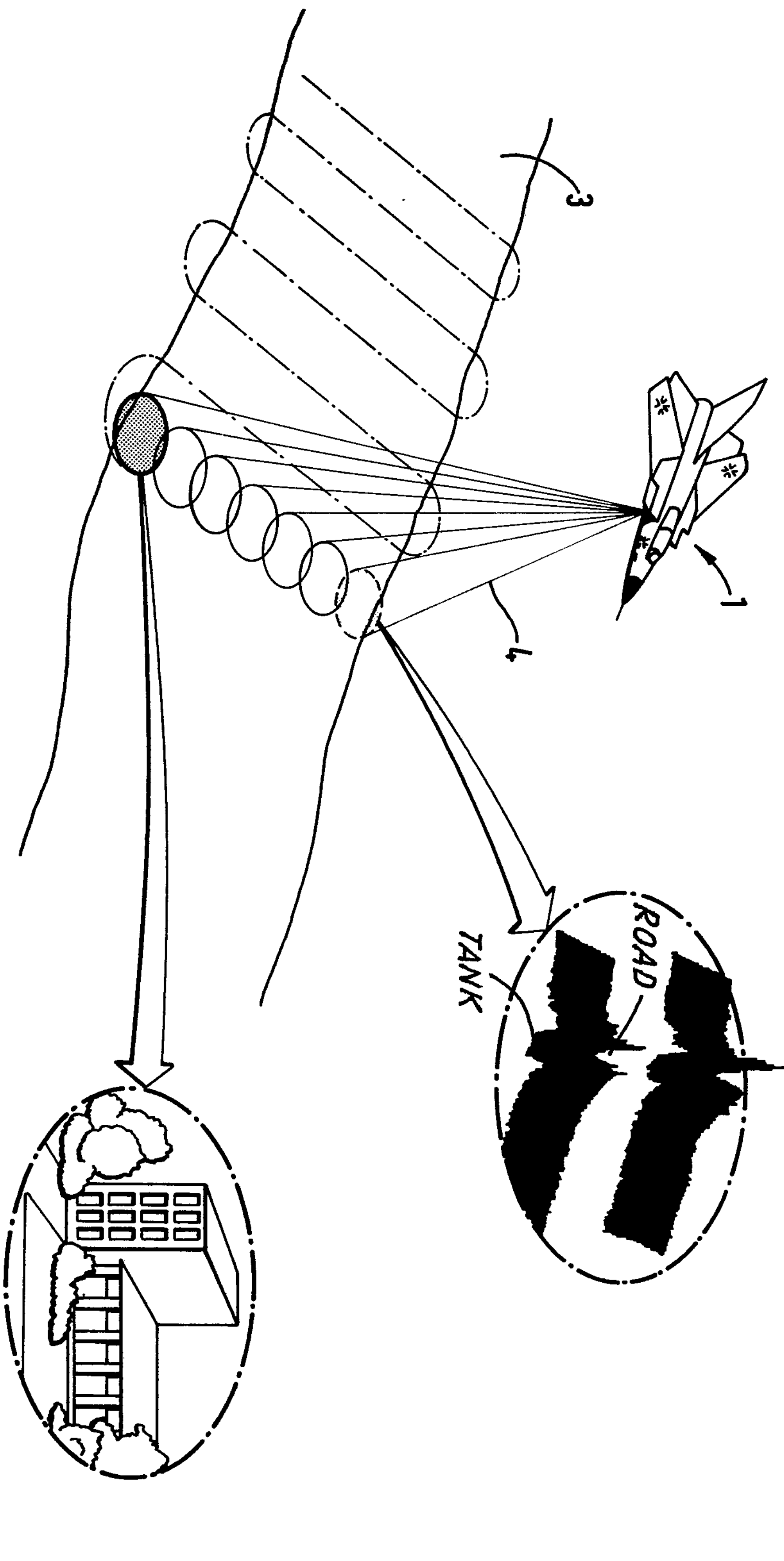
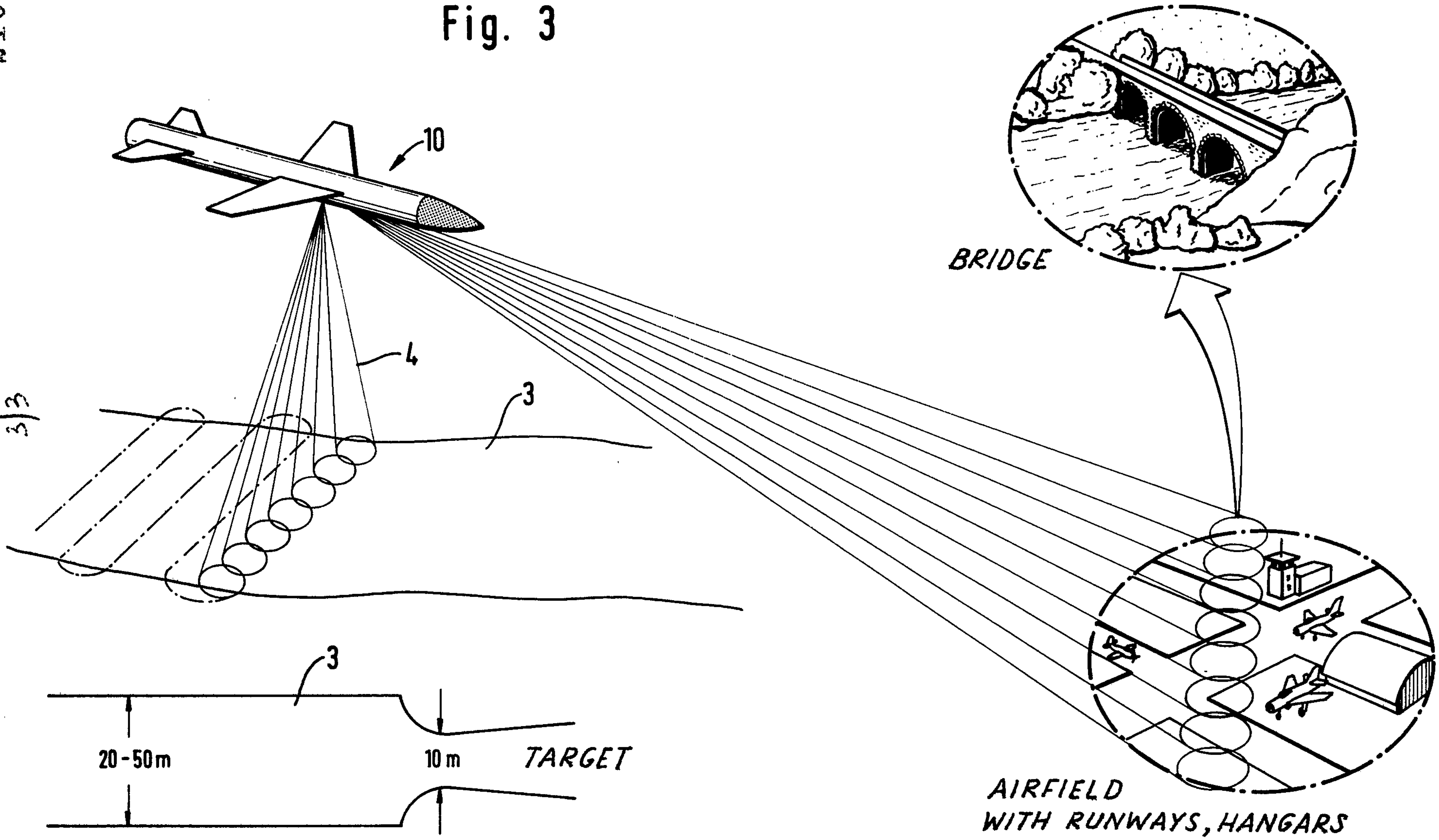


Fig. 2

Fig. 3


10
4
3
3
20-50m
10m
TARGET
BRIDGE
AIRFIELD
WITH RUNWAYS, HANGARS

SPECIFICATION

Method of navigation and flight guidance

The present invention relates to a method of navigation and flight guidance and more particularly to a method employing the principle of correlation of height data, using a store for the previously known terrain data of an area of operation. This information is processed, with the currently detected and prepared terrain data of a sensor, in a correlator in order to determine position.

Navigation systems of this type are known, for example from DE-OS 30 11 556. With these it is possible to achieve more or less satisfactory results, according to expenditure, on the basis of the currently detected and stored height data. The navigation equipment disclosed in the above document enables any flight paths to be followed while the height data which can be currently detected serves to update the stored reference data of the terrain at the same time. Although the accuracy of the navigation equipment described in DE-OS 30 11 556 is considerable, it is desirable to increase the accuracy of the equipment still further.

The present invention seeks to provide a method of navigation which renders possible a precise flight guidance, including target surveying or end-phase guiding, with comparatively little expenditure.

According to a first aspect of the present invention there is provided a method of navigation and flight guidance operating according to the principle of correlation of data with a store of which the previously known terrain data of an area of operation are processed with the currently detected and prepared terrain data of a sensor in a correlator to determine position, wherein the sensor is directed towards the ground, and continuously scans the flight path perpendicularly to the direction of flight with a pivoting mechanism, and the pivoting mechanism switches over the sensor for forward-looking directions of view.

According to a second aspect of the present invention there is provided navigation and flight guidance apparatus comprising a store containing previously known terrain data of an area of operation, a sensor for detecting actual terrain data, and a correlator for processing said data to determine position wherein there are also provided means for causing the sensor to scan the flight path perpendicular to the direction of flight and/or means for causing the sensor to switch from a downward-looking to a forward-looking direction of view.

As a result of the use of the extremely high frequency sensor and its method of operation, the accuracy can be increased considerably both during long-distance flight and during end-phase piloting. In addition, the characteristic emission can be considerably weakened by a narrow beam focussing and a powerful side-lobe attenuation, as a result of which the risk of discovery is greatly counteracted and the ability to survive is considerably increased.

The sensor may be an extremely high frequency (EHF) sensor, that is one operating in the millimetre wavelength region, with an atmosphere window of 94 GHz.

Alternatively the sensor may be a scanning distance measuring sensor such as a laser.

The pivoting mechanism switches over the sensor for forward looking directions of view for the purposes of housing and/or target evaluation.

Long distance navigation may be improved by processing the sensor-dependent information density in a two-dimensional direction.

Preferably the navigation accuracy is additionally increased by preplanned updating of individual data. The surveying may be carried out by simple algorithms based on special features of the terrain such as isolated buildings or structures.

During homing, surveying can be effected using the increased resolution of the EHF sensor, by evaluating isolated, prominent features of the terrain, which can be referenced or classified.

Surveying may be effected by evaluating changes in contrast and/or sudden changes in height and/or by evaluating relevant target signatures such as airfields, bridges.

A preferred embodiment of the present invention will now be described, by way of examply only, with reference to the accompany drawings, of which:

Figure 1 illustrates the principle of a method of navigation and flight guidance employing autonomous, all-weather, continuous height contour correlation;

Figure 2 illustrates the increase in navigation accuracy by deflecting the sensor prependicular to the direction of flight in accordance with the present invention; and

Figure 3 illustrates the switching over of the pivoting mechanism for homing and/or target surveying in accordance with the present invention.

Figure 1, an aircraft namely a bomber or fighter aircraft 1, can be seen which is flying at a relatively low height above an area of operation 2. This aircraft scans the resulting flight path 3 with a height-measuring instrument installed in the bomber or fighter aircraft and directed vertically downwards. The height data of the terrain are appropriately prepared for correlation with previously known data of the area of operation, stored in a store in the aircraft.

Figure 2 illustrates the greater information density as a result of transverse pivoting of the sensor, and also precise individual updates by surveying isolated prominent structures. As can be seen from the Figure, the beam of rays 4 of an extremely high frequency sensor is deflected perpendicular to the direction of height by a deflecting mechanism not illustrated. In this case, the flight path 3 is scanned meanderingly by means of a pivoting mechanism, not illustrated, as a result of which a greater information density of the scanned terrain data results, particularly because of the strong beam focussing, and hence a considerable improvement in the long-distance navigation. In this manner, as the two enlarged detail illustrations show, relatively small objects can be detected as targets, distinguished, surveyed and taken into consideration when updating the data.

Figure 3 shows a missile, for example a cruise missile 10, in which a navigation and flight-guidance instrument with an extremely high frequency sensor is likewise installed. Apart from the scanning of the flight path with a pivoting mechanism, there is also illustrated the switching over of the pivoting mechanism to a forward-looking direction of view, preferably for end-phase guiding such as homing and/or target surveying. In addition, it can be seen from this Figure that the end-phase guiding can be programmed to different targets. In addition, the Figure shows that the end-phase guiding is effected inside a narrowed down flight path within a narrow search range.

The above-described method of navigating and flight guidance operates according to the principle of continuous correlation of height contours with precise updating of individual data by means of terrain comparison. During the long-distance flight, a narrowly focussed, extremely high frequency sensor continuously scans its own position, for example with a pivoting mechanism, so that the terrain data currently detected can be used both to bring the current position up to date and for position finding by means of correlators. In addition, the same sensor is used for end-phase guiding by switching over the pivoting mechanism so that very accurate target measurements and homing can be carried out by this means. The success of a mission of an airborne vehicle equipped with apparatus as described above can be substantially increased by this means, particularly because of considerably improved accuracy in the long-distance navigation, improved survival chances as a result of greatly reduced characteristic emission and precise end-phase guiding.

CLAIMS

1. A method of navigation and flight guidance operating according to the principle of correlation of data with a store of which the previously known terrain data of an area of operation are processed with the currently detected and prepared terrain data of a sensor in a correlator to determine position, wherein the sensor is directed towards the ground, and continuously scans the flight path perpendicularly to the direction of flight with a pivoting mechanism, and the pivoting mechanism switches over the sensor for forward-looking directions of view.

2. A method as claimed in claim 1, wherein the sensor is an extremely high frequency sensor.

3. A method as claimed in claim 2, wherein the characteristic emission of the extremely high frequency sensor is reduced by narrow beam focussing and powerful side-lobe attenuation.

4. A method as claimed in claim 1, wherein the sensor is a scanning distance-measuring sensor.

5. A method as claimed in claim 4, wherein the sensor is a laser.

6. A method as claimed in any preceding claim, wherein the pivoting mechanism switches over the sensor for forward looking directions of view for homing and/or target evaluation.

7. A method as claimed in any preceding claim, wherein long-distance navigation is improved by processing the sensor-dependent information density in a two-dimensional direction.

8. A method as claimed in any preceding claim, wherein the navigation accuracy is additionally increased by preplanned updating of individual data.

9. A method as claimed in any preceding claim, wherein surveying is carried out by simple algorithms based on special features of the terrain such as isolated buildings or structures.

10. A method as claimed in claim 2 or any of claims 6 to 9 when appended to claim 2, wherein, during homing, surveying is effected using the increased resolution of the extremely high frequency sensor, by evaluating isolated, prominent features of the terrain.

11. A method as claimed in any preceding claim, wherein surveying is effected by evaluating changes in contrast and/or sudden changes in height.

12. A method as claimed in any preceding claim, wherein surveying is effected by evaluating relevant target signatures such as airfields, bridges.

13. A method of navigation and flight guidance substantially as herein described with reference to Figs 2 and 3 of the accompanying drawings.

14. As an independent invention the additional feature of any of claims 2 to 12.

15. Navigation and flight guidance apparatus comprising a store containing previously known terrain data of an area of operation, a sensor for detecting actual terrain data, and a correlator for processing said data to determine position wherein there are also provided means for causing the sensor to scan the flight path perpendicular to the direction of flight and/or means for causing the sensor to switch from a downward-looking to a forward-looking direction of view.

16. Apparatus according to claim 14, wherein the sensor is an extremely high frequency sensor.

17. Navigation and flight guidance apparatus substantially as herein described with reference to Figs 2 and 3 of the accompanying drawings.

Printed in the United Kingdom for Her Majesty's Stationery Office, 8818935, 1/86 18996. Published at the Patent Office, 25 Southampton Buildings, London WC2A 1AY, from which copies may be obtained.