INSTRUCTIONS
(a) If Convention application insert "Convention"

(a) CONVENTION

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610319

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(b) Delete one

APPLICATION FOR A STANDARD/PETTY~~XXXX~~ PATENT

(c) Insert FULL name(s) of applicant(s)

I/We (c) HOLLANDSE SIGNAALAPPARATEN B.V.

(d) Insert FULL address(es) of applicant(s)

of (d) Zuidelijke Havenweg 40,
7550-GD Hengelo, The Netherlands

(e) Delete one

hereby apply for the grant of a (e) Standard/Petty~~XXXX~~ Patent for an invention entitled

(f) Insert TITLE of invention

(f)

Search radar system

(g) Insert "complete" OR "provisional" OR "petty patent"

which is described in the accompanying (g) COMPLETE specification.

(Note: The following applies only to Convention applications)

Details of basic application(s)

(h) Insert number, country and filing date for EACH basic application

(h)

Application No.	Country	Filing Date
8703113	The Netherlands	23 December 1987

APPLICATION ACCEPTED AND AMENDMENTS ALLOWED 25.2.91

Address for Service:
21/12/88

PHILLIPS ORMONDE AND FITZPATRICK
Patent and Trade Mark Attorneys
367 Collins Street
Melbourne, Australia 3000

(i) Insert DATE of signing

Dated (i) 6th December 1988

(j) Signature of applicant(s) (For body corporate see headnote*)

(j) HOLLANDSE SIGNAALAPPARATEN B.V.

C.M. Jansen, Authorised Patent Agent

(k) Corporate seal if any

(k)

Note: No legalization or other witness required

PHILLIPS ORMONDE AND FITZPATRICK
Patent and Trade Mark Attorneys
367 Collins Street
Melbourne, Australia

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DECLARATION FOR A PATENT APPLICATION

▼ INSTRUCTIONS
(a) Insert "Convention" if applicable
(b) Insert FULL name(s) of applicant(s)

In support of the (a) CONVENTION application made by (b)

HOLLANDSE SIGNAALAPPARATEN B.V.

(c) Insert "of addition" if applicable
(d) Insert TITLE of invention

(hereinafter called "applicant(s)" for a patent (c) for an invention entitled (d)

Search radar system

(e) Insert FULL name(s) AND address(es) of declarant(s) (See headnote*)

I/~~We~~ (e) C.M. Jansen, Authorised Patent Agent of
Hollandse Signaalapparaten B.V.,
Zuidelijke Havenweg 40, 7550-GD Hengelo, The Netherlands

do solemnly and sincerely declare as follows:

1. ~~I am/We are the applicant(s)~~

*(**or**, in the case of an application by a body corporate)*

1. I am/~~We~~ are authorized to make this declaration on behalf of the applicant(s).
2. ~~The actual inventor(s) of the invention~~

*(**or**, where the applicant(s) is/are not the actual inventor(s))*

2. (f) GARSIDE, Peter Frederick
Bierweg 3,
Blaricum, The Netherlands

(f) Insert FULL name(s) AND address(es) of actual inventor(s)

is/~~are~~ the actual inventor(s) of the invention and the facts upon which the applicant(s) is/~~are~~ entitled to make the application are as follows:

(g) Applicant is the assignee of the invention from the actual inventor

(g) Recite how applicant(s) derive(s) title from actual inventor(s) (See headnote**)

*(**Note:** Paragraphs 3 and 4 apply **only** to Convention applications)*

3. The basic application(s) for patent or similar protection on which the application is based is/~~are~~ identified by **country, filing date, and basic applicant(s)** as follows:

(h) country: The Netherlands
filing date: 23 December 1987
applicant: HOLLANDSE SIGNAALAPPARATEN B.V.

(h) Insert country, filing date, and basic applicant(s) for the/or EACH basic application

4. The basic application(s) referred to in paragraph 3 hereof was/~~were~~ the first application(s) made in a Convention country in respect of the invention the subject of the application.

(k) Insert PLACE of signing
(l) Insert DATE of signing
(m) Signature(s) of declarant(s)

Declared at (k) Hengelo, The Netherlands

Dated (l) 6th December 1988

(m) .....

.....

.....

Note: No legalization or other witness required

To: The Commissioner of Patents

P18/7/81

PHILLIPS ORMONDE & FITZPATRICK
Patent and Trade Mark Attorneys
367 Collins Street
Melbourne, Australia

STUART TAYLOR

(12) PATENT ABRIDGMENT (11) Document No. AU-B-27369/88
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 610319

(54) Title
SEARCH RADAR SYSTEM

International Patent Classification(s)
(51)[4] G01S 013/87

(21) Application No. : 27369/88 (22) Application Date : 21.12.88

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(31) Number	(32) Date	(33) Country
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(56) Prior Art Documents
US 4224618
US 3997897
DE 2260857

(57) Claim

1. A search radar system including at least first and second radar devices coupled to respective first and second radar antennas, which antennas are continuously and synchronously rotatable around a common vertical axis of rotation, and target data processing means for processing target data produced by said radar devices, characterised in that:

a. the antennas are arranged for rotation together but with mutually different orientations in azimuth;

b. the radar devices individually produce target data representative of successive detections by the respective antennas of identical targets; and

c. the target data processing means is adapted to correlate the target data for identical targets which is produced by the radar devices and comprises means for predicting from the target data of the first radar device the position of each target for a subsequent revolution of the first antenna as well as the position of each target at the moment when the at least one

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second antenna will detect said target, and to predict, from the target data of the at least one second radar device, the position of each target for subsequent revolutions of the at least one second antenna, said predictions being correlated with said detections to establish which target data obtained from the different radar devices originate from identical targets.

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COMPLETE SPECIFICATION
(ORIGINAL)

Class Int. Class

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Complete Specification Lodged:
Accepted:
Published:

Priority

Related Art:

This document contains the amendments made under Section 49 and is correct for printing.

APPLICANT'S REFERENCE: H.S.A.D. 253

Name(s) of Applicant(s):

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Complete Specification for the invention entitled:

SEARCH RADAR SYSTEM

Our Ref : 118619
POF Code: 1399/1399

The following statement is a full description of this invention, including the best method of performing it known to applicant(s):

Search radar system

The present invention relates to a search radar system provided with at least one search radar device having a primary antenna and at least one secondary radar device having an SSR/IFF antenna, which radar devices independently of each other provide plot messages from which signals are derived that are suitable for presentation on a radar display.

In such search radar systems, provided with one search radar device having a primary antenna and one secondary radar device having an SSF/IFF antenna, it is common that the SSR/IFF antenna is fitted on top of the primary antenna, aligned in azimuth with and synchronously rotatable with the primary antenna. The secondary radar device only serves as a support for the search radar: it supplements the information obtained by the search radar apparatus with, for example, an identity code of a target. The plot messages obtained by the two radar devices are combined and presented as one picture on the radar display.

If such a search radar system is used for Air Traffic Control purposes, and particularly for the guidance of air traffic approaching the airport, it is favourable to maintain a relatively high antenna rotation rate, thus achieving a high refreshment rate of the received data on a radar display. On the other hand, it is also favourable to keep the antenna rotation rate relatively low, because in that way the demands on the antenna drive mechanism of the search radar system are lower, and the number of hits per scan can become higher, resulting in a better MTI performance.

The present invention has for its object to provide a search radar system, as described in the opening paragraphs, providing on the one hand a relatively low antenna rotation speed and on the other hand a sufficiently high refreshment rate of the received information to

make the search radar system particularly suitable for control of air traffic approaching airports.

According to the invention, there is provided a search radar system including at least first and second radar devices coupled to respective first and second radar antennas, which antennas are continuously and synchronously rotatable around a common vertical axis of rotation and target data processing means for processing target data produced by said radar devices, characterised in that:

a. the antennas are arranged for rotation together but with mutually different orientations in azimuth;

b. the radar devices individually produce target data representative of successive detections by the respective antennas of identical targets; and

c. the target data processing means is adapted to correlate the target data for identical targets which is produced by the radar devices and comprises means for predicting from the target data of the first radar device the position of each target for a subsequent revolution of the first antenna as well as the position of each target at the moment when the at least one second antenna will detect said target, and to predict, from the target data of the at least one second radar device, the position of each target for subsequent revolutions of the at least one second antenna, said predictions being correlated with said detections to establish which target data obtained from the different radar devices originate from identical targets.

A special embodiment comprises only one search radar device having a primary antenna and only one secondary radar device having an SSR/IFF antenna; according to the invention this secondary radar device is not only used to support the search radar device, but independently thereof provides plot messages that, because the two antennas are mounted back-to-back facing opposite directions, increase the frequency with which a target can be indicated on a radar display by a factor of two, resulting in a high refreshment rate of the data while the antenna rotation rate can be maintained

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at a relatively low level. This effect becomes even more apparent when e.g. two search radar devices are present, each fitted with a primary antenna, and two secondary radar devices, each fitted with an SSR/IFF antenna, where both primary antennas and both SSR/IFF antennas are pointed in opposite directions, while the primary antennas on the one hand and the SSR/IFF antennas on the other hand are mounted in such a way that they are oriented perpendicular to each other in azimuth. The frequency at which target information is presented on a display is thus four times as high as the rotation frequency of the antenna combination.

The invention will now be explained with reference to the accompanying figures 1, 2 and 3, showing block diagrams of different embodiments of the search radar system according to the invention.

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The invention is in no way limited to the embodiments as described with reference to these figures; it should be regarded merely as an illustration of the invention.

Fig. 1 shows a search radar apparatus 1 provided with a primary antenna 2. This search radar apparatus is in the customary way provided with a transmitter and receiver, a detector and a video processor (not shown), and supplies plot messages consisting of information on the target position and, if possible, additional data, such as target width, target strength, etc. The figure also shows a secondary radar device 3 having an SSR/IFF antenna 4. The SSR/IFF antenna can either be an SSR antenna, or an IFF antenna used for the same purpose but in the military sector. The secondary radar device is in a customary way provided with a transmitter, receiver and video extractor, and supplies plot messages comprising data on target position as well as an identity code and, if applicable, a target height code and possibly additional data such as target width, target strength, quality indication of the received code, etc.

SSR/IFF antenna 4 has been mounted in a customary way on top of primary antenna 2. However, in accordance with the invention, oriented in a direction opposite to that of primary antenna 2. Fig. 1 is a schematic illustration of the antenna configuration seen in profile.

The plot messages of both radar devices are supplied to a target track data processing unit 5. This data processing unit comprises means to:

- correct the plot messages from secondary radar device 3 for the angle difference of 180° in orientation of SSR/IFF antenna 4 with respect to that of primary antenna 2, in order to prevent that echoes from the same target are assigned azimuth angle values differing in turn by 180° and that they would be presented as such on a radar display to be connected;

- predict from the plot messages of the search radar apparatus the target position for subsequent revolutions of the primary antenna, upon which each time the target positions obtained during subsequent revolutions of this antenna by the search radar apparatus are compared with the predicted target positions and if these target positions are the same, observing certain tolerance limits, signals are produced that can be individually presented on a radar display;
- predict from the plot messages of the secondary radar device the target positions for subsequent revolutions of the SSR/IFF antenna, upon which each time the target positions obtained during subsequent revolutions of this antenna by the secondary radar device are compared with the predicted target positions and, if these target positions are the same, observing certain tolerance limits, signals are produced that can be individually presented on a radar display;
- predict from the plot messages of the search radar apparatus the target positions for the moments at which the SSR/IFF antenna will spot the target during subsequent revolutions, upon which each time the target positions predicted by the search radar apparatus during subsequent revolutions of the primary antenna for the moments at which the SSR/IFF antenna will spot the target during subsequent antenna revolutions, are compared with the target positions obtained by the secondary radar device during subsequent antenna revolutions and, if the target positions are the same, observing certain tolerance limits, it may be determined that the plot messages obtained by the two radar devices originate from the same target. In that case, for instance, the plots from the search radar apparatus presented on a radar display may be provided with information originating from the secondary radar device, such as identity and height codes.

The procedure described above will result in a refreshment rate of the plots of a single target on a radar display which is twice as

high as the rotation rate. The advantages thus obtained, as described in the introduction to this description, will be even greater if two search radar devices are used, each provided with a primary antenna, and two secondary radar devices, each provided with an SSR/IFF antenna. Both the two primary antennas and the two SSR/IFF antennas are then mounted back-to-back facing opposite directions while the primary antennas on the one hand and the SSR/IFF antennas on the other hand are mounted in such a way that they are oriented perpendicular to each other in azimuth. In principle, the target track data processing unit will be capable of plot processing according to the method described above. For this purpose, again the plot messages of a search radar apparatus are used as reference for the then 90°, 180° and 270° azimuth angle difference correction of the plot messages from the other radar devices and for correlation of the plots from the individual radar devices. It goes without saying that multiple correlation of plots from the four radar devices will provide a more reliable answer to the question whether the individual plots originate from one and the same target.

A possible embodiment is indicated in Fig. 2. Besides search radar apparatus 1 with primary antenna 2, secondary radar device 3 with secondary radar antenna 4 and a target data processing unit 5, a second search radar apparatus 6 with a second primary antenna 7 and a second secondary radar device 8 with a second radar antenna 9 is present. Fig. 2 is a schematic illustration of the antenna configuration seen from above.

Target data processing unit 5 comprises means to:

- correct the plot messages from secondary radar device 3, secondary radar device 6 and secondary radar device 8 respectively, for the angle difference of 90°, 180° and 270° in orientation of SSR/IFF antenna 4, second primary antenna 7 and second secondary antenna 9 respectively with respect to that of primary antenna 2, in order to prevent that echoes from the same target are assigned azimuth

angle values differing in turn by 90°, 180° and 270° respectively, and that they would be presented as such on a radar display to be connected;

- predict from the plot messages of search radar apparatus 1 the target position for subsequent revolutions of primary antenna 2, upon which each time the target positions obtained during subsequent revolutions of this antenna by search radar apparatus 1 are compared with the predicted target positions and if these target positions are the same, observing certain tolerance limits, signals are produced that can be individually presented on a radar display;
- predict from the plot messages of secondary radar device 3 the target positions for subsequent revolutions of SSR/IFF antenna 4, upon which each time the target positions obtained during subsequent revolutions of this antenna by secondary radar device 3 are compared with the predicted target positions and, if these target positions are the same, observing certain tolerance limits, signals are produced that can be individually presented on a radar display;
- predict from the plot messages of the second search radar apparatus 6 the target position for subsequent revolutions of the primary antenna 7, upon which each time the target positions obtained during subsequent revolutions of this antenna by the second search radar apparatus 6 are compared with the predicted target positions and if these target positions are the same, observing certain tolerance limits, signals are produced that can be individually presented on a radar display;
- predict from the plot messages of the second secondary radar device 8 the target positions for subsequent revolutions of SSR/IFF antenna 9, upon which each time the target positions obtained during subsequent revolutions of this antenna by the second secondary radar device 8 are compared with the predicted target positions and, if these target positions are the same, observing certain tolerance limits, signals are produced that can be individually presented on a radar display;

- predict from the plot messages of search radar apparatus 1 the target positions for the moments at which SSR/IFF antenna 3, second primary antenne 7 and second secondary antenne 9 respectively, will spot the target during subsequent revolutions, upon which each time the target positions predicted by the search radar apparatus during subsequent revolutions of the primary antenna for the moments at which the other antennas will spot the target during subsequent antenna revolutions, are compared with the target positions obtained by the other radar devices, during subsequent antenna revolutions and, if the target positions are the same, observing certain tolerance limits, it may be determined that the plot messages obtained by the two radar devices originate from the same target.

Another embodiment is illustrated in Fig. 3. Here the antennas are arranged in a manner deviating from the arrangement in Fig. 2 and schematically illustrated as seen from above.
It will be clear that target data processing unit 5 can have the same embodiment as described for Fig. 2. The radar information originating from the four antennas can however also be correlated in another way to obtain univocal target observations. For instance, the plot messages from antennas 2 and 4 may be correlated, as well as the plot messages from antennas 7 and 9. Subsequently, the combined plot messages from antennas 2 and 4 and antennas 7 and 9 respectively, may be correlated with each other to establish whether the individual plots originate from the same target.

Finally it will be clear that it is possible to replace the second primary antenna of Fig. 2 by a third secondary antenna, while making use of target data processing unit 5 as described for fig. 2.

The claims defining the invention are as follows:

1. A search radar system including at least first and second radar devices coupled to respective first and second radar antennas, which antennas are continuously and synchronously rotatable around a common vertical axis of rotation, and target data processing means for processing target data produced by said radar devices, characterised in that:

a. the antennas are arranged for rotation together but with mutually different orientations in azimuth;

b. the radar devices individually produce target data representative of successive detections by the respective antennas of identical targets; and

c. the target data processing means is adapted to correlate the target data for identical targets which is produced by the radar devices and comprises means for predicting from the target data of the first radar device the position of each target for a subsequent revolution of the first antenna as well as the position of each target at the moment when the at least one second antenna will detect said target, and to predict, from the target data of the at least one second radar device, the position of each target for subsequent revolutions of the at least one second antenna, said predictions being correlated with said detections to establish which target data obtained from the different radar devices originate from identical targets.

2. A search radar system as in claim 1, where the target data processing means is adapted to correct the target data produced by the radar devices for the different orientations in azimuth of the respective antennas coupled to said radar devices.

3. A search radar system as in claim 1 or 2, where the first and second radar antennas are oriented in mutually opposite directions.

4. A search radar system as in claim 1 or 2 comprising two primary radar devices coupled to respective primary radar antennas oriented in mutually opposite directions and two secondary radar devices coupled to respective secondary radar antennas oriented in mutually opposite directions, the directions in which said primary antennas are oriented being orthogonal to the directions in which said secondary antennas are oriented.

5. A search radar system as in claim 1 or 2 comprising one primary radar device coupled to a respective primary radar antenna and three secondary radar devices coupled to respective secondary radar antennas, said antennas being oriented in four respective azimuths which are angularly separated by ninety degrees.

6. A search radar system substantially as herein described with reference to any one of the embodiments illustrated in the drawings.

DATED: 4 February 1991
PHILLIPS ORMONDE & FITZPATRICK
Attorneys for:
HOLLANDSE SIGNAALAPPARATEN B.V.

David B Fitzpatrick

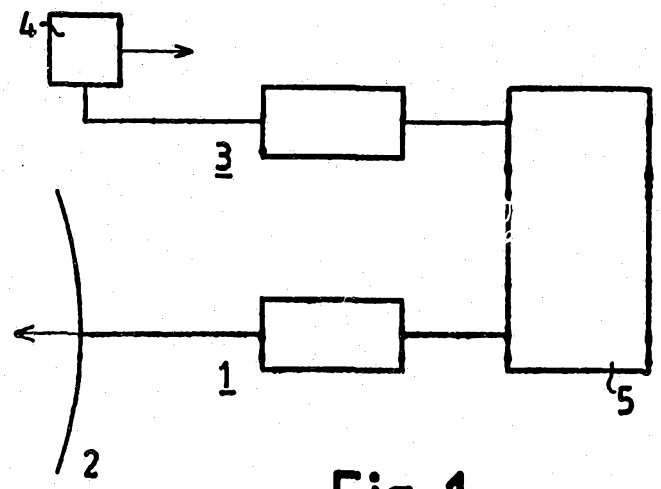

Fig. 1

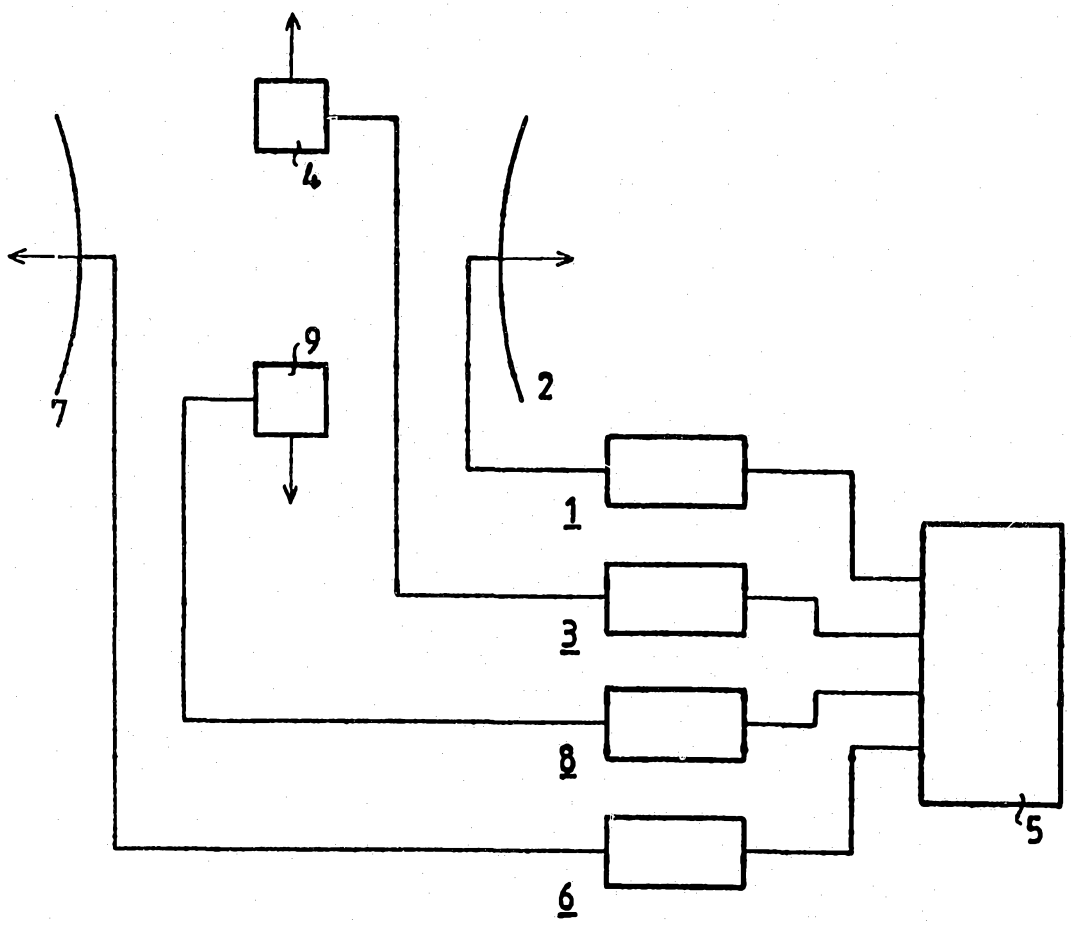

Fig. 2

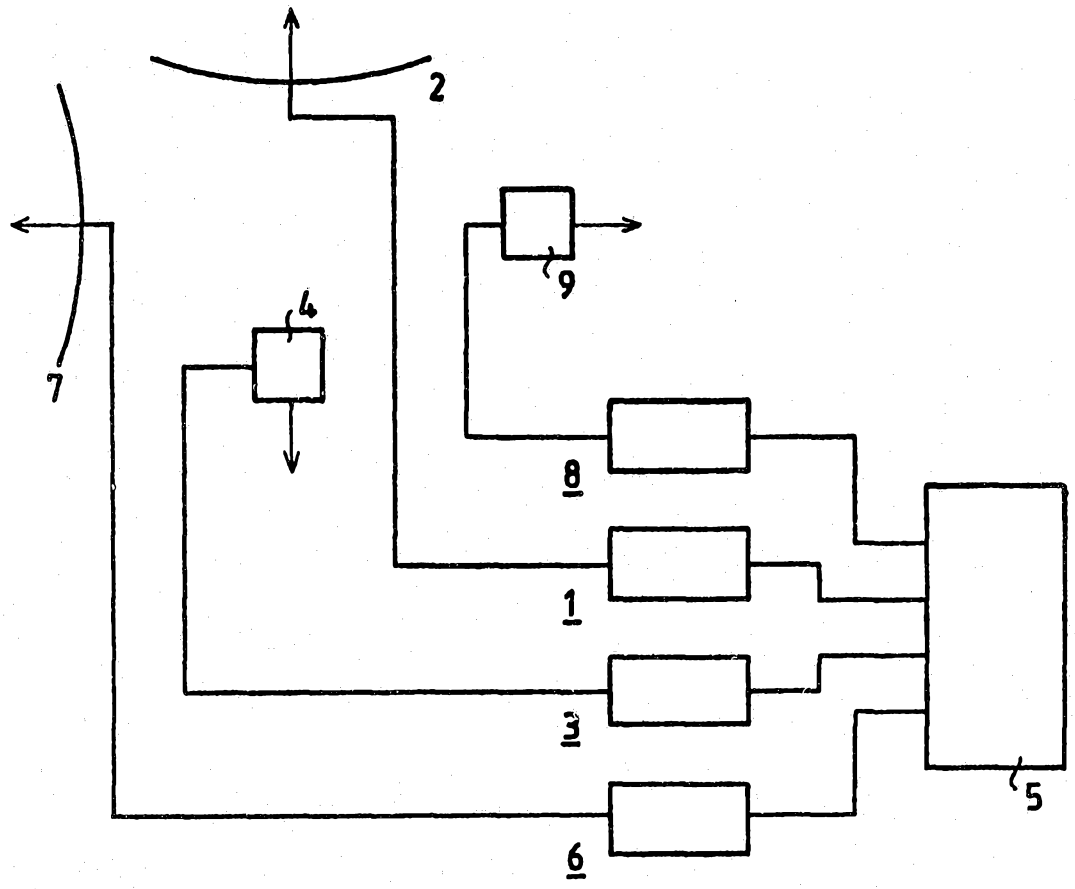

Fig. 3