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CA 2906831 A1 2016/04/08

(21) 2 906 831

(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) A1

(22) Date de dépôt/Filing Date: 2015/10/02

(41) Mise à la disp. pub./Open to Public Insp.: 2016/04/08

(30) Priorité/Priority: 2014/10/08 (DE10 2014 114 593.3)

(51) Cl.Int./Int.Cl. *G01S 1/68* (2006.01), *H04L 1/22* (2006.01), *H04L 12/70* (2013.01)

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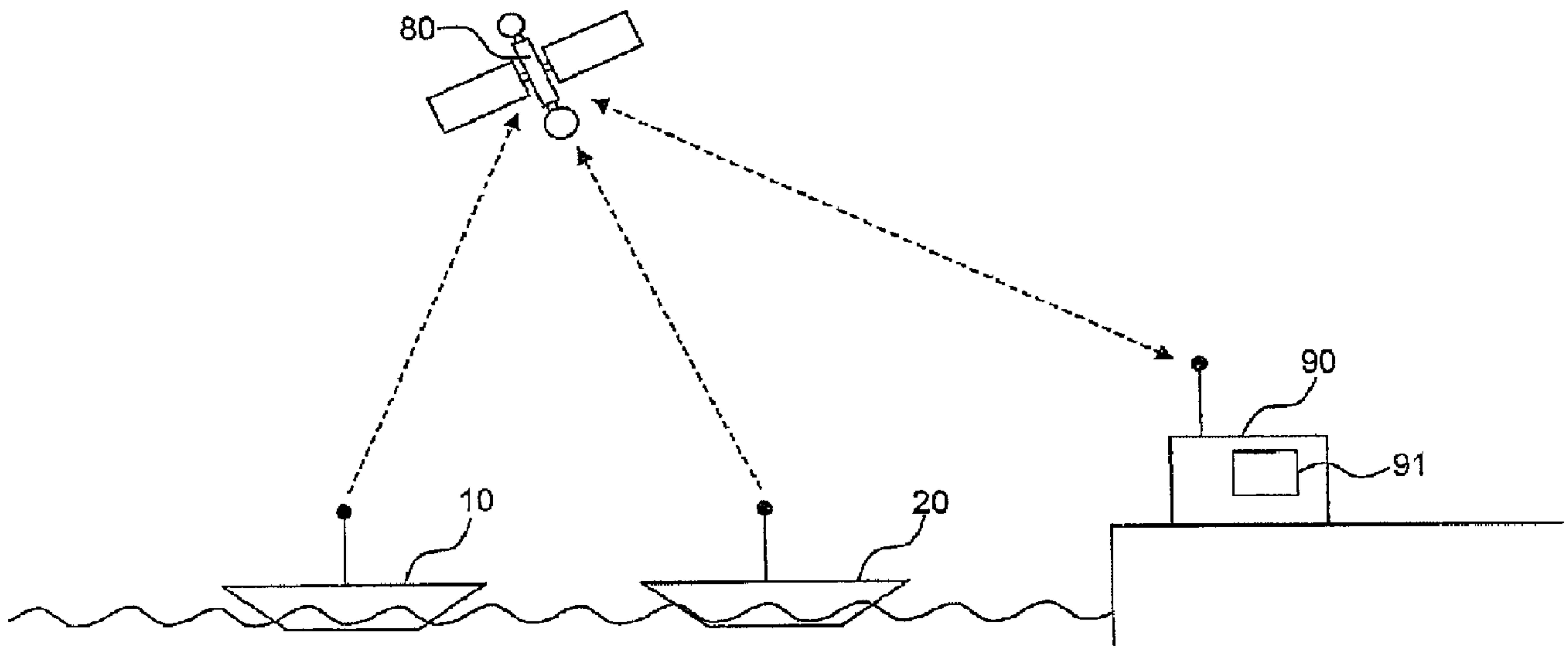
(54) Titre : METHODE DE FOURNITURE DE DONNEES PROVENANT DE PAQUETS DE DONNEES AIS RECUES, DISPOSITIF ET PROGRAMME INFORMATIQUE ASSOCIES

(54) Title: METHOD FOR PROVIDING DATA FROM RECEIVED AIS DATA PACKETS, DEVICE AND COMPUTER PROGRAM THEREFOR



(57) Abrégé/Abstract:
The invention relates to a method for providing data from received AIS data packets, wherein AIS data packets are received by means of at least one AIS receive device and the data of the received AIS data packets are automatically evaluated, wherein those data of an AIS data packet which are errored can be reconstructed at least partially by means of auxiliary data which are located in the access of the AIS receive device and which do not originate from the AIS data packet that is currently being decoded. The invention also relates to a device with an AIS receive device and with a provisioning device to provide data from AIS data packets received via the AIS receive device, and also a computer program.

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Attorney's file ref:
2476-452 DE-1

Date:
08. October 2014

Abstract:

The invention relates to a method for providing data from received AIS data packets, wherein AIS data packets are received by means of at least one AIS receive device and the data of the received AIS data packets are automatically evaluated, wherein those data of an AIS data packet which are errored can be reconstructed at least partially by means of auxiliary data which are located in the access of the AIS receive device and which do not originate from the AIS data packet that is currently being decoded. The invention also relates to a device with an AIS receive device and with a provisioning device to provide data from AIS data packets received via the AIS receive device, and also a computer program.

(Figure 1)

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Method for providing data from received AIS data packets, device and computer program therefor

The invention relates to a method for providing data from received AIS data packets according to claim 1. The invention furthermore relates to a device with an AIS receive device and with a provisioning device for providing data from AIS data packets received via the AIS receive device according to claim 10, and a computer program according to claim 12.

The invention generally relates to the field of AIS communication in the vessel traffic domain. The monitoring of globally increasing vessel traffic is currently based predominantly on radar monitoring, radiotelephony and the use of AIS (Automatic Identification System). Since the year 2000, the AIS has been prescribed by the International Maritime Organization (IMO) as the binding standard in order to increase the safety of international vessel traffic. This locally limited radio system serves to exchange navigation and other vessel data that are intended to enable vessels to obtain a comprehensive overview of nearby vessel traffic. The primary aim is to avoid collisions between vessels.

The AIS transmits alternately on two channels in the VHF maritime communications band, i.e., on the one hand, at 168.975 MHz and, on the other hand, at 162.025 MHz. The individual AIS vessel data are transmitted in fixed time frames, the occupancy of which is coordinated autonomously by the participants concerned (referred to as SOTDMA: Self-Organizing Time-Division Multiple Access). Only 2250 timeslots per minute are therefore available for the transmission of data to the individual participants.

Due to the VHF frequency band that is used, the radio range of AIS from vessel to vessel corresponds to around 40 to 60 km, which is slightly more than the normal visibility range at sea. Due to their higher position, coastal stations can cover a radius of 100 km. Due to the restricted range and the transmission protocol that is used, vessels that can see and receive one another form an AIS radio cell within which the participants can transmit and receive their data in a collision-free manner.

In this respect, the AIS represents merely a local radio system which, although it makes data available adequately for a vessel located at sea, it is not suitable for the worldwide monitoring of the increasing vessel traffic without additional measures. However, for shipping companies, navigation organizations or environment ministries, a real-time collection of the AIS vessel transport data accumulating worldwide is of great interest, in particular also to counteract illegal activities at sea.

AIS receive antennas have therefore already been disposed on satellites in order to be able to receive globally the AIS radio signals which are transmitted worldwide and which are regularly transmitted by the vessels. This enables a worldwide collection of the vessel traffic data transmitted using AIS, but in practice has severe difficulties and disadvantages, since the AIS was not originally developed for satellite reception.

Due to the extremely high altitude of a satellite orbit, a receive range, which is also referred to as an illumination zone or footprint is created with a diameter of around 5000 km. Since the AIS, as a local radio system, organizes itself autonomously into individual radio cells which all transmit on the same frequency bands, a receive diameter as large as this on the satellite results in the reception of a multiplicity of radio cells with identical transmission frequencies, so that the AIS radio signals of the different AIS radio cells are overlaid on one another in the receive range of the satellite.

Summary of the abbreviations used

AIS	Automatic Identification System
SIC	Successive Interference Cancellation
SOTDMA	Self-Organizing Time Division Multiple Access
CSTDMA	Carrier Sense Time Division Multiple Access
LEO	Low Earth Orbit

Methods for providing data from received AIS data packets are known, e.g. from DE 10 2012 110 384 A1 or WO 2008/148 188 A1.

For various reasons, the limited radio range of the vessels and relatively large coverage areas of the satellites can result in overlays of AIS data packets which are then corrupted as a result of the overlapping transmission in the same timeslot and can therefore be errored. The case will be examined below where AIS data packets are received by an AIS receive device, e.g. a satellite or a gateway, from different transmitters which were unable to coordinate themselves in terms of the transmission time or at least did not do so, said packets overlapping in the same timeslot. This can occur, for example, if a plurality of vessels with AIS functionality are present within the footprint of an AIS satellite, wherein at least some of the vessels are so far distant from one another that no direct radio link is possible between them. In this case, corruption and therefore errors in the data transmission occur in the AIS receive device due to the overlapping transmission of AIS data packets in the same timeslot.

The object of the invention is to indicate a method, a device and a computer program with which the reliability of the data transmission of AIS data packets can be improved with the scenarios as described above.

This object is achieved according to claim 1 by a method for providing data from received AIS data packets, wherein AIS data packets are received by means of at least one AIS receive device and the data of the received AIS data packets are automatically evaluated, wherein those data of an AIS data packet which are errored can be reconstructed at least partially by means of auxiliary data which are located in the access of the AIS receive device and which do not originate from the AIS data packet that is currently being decoded. The invention offers the advantage that the reliability of the correct decoding of the AIS data can be improved in a manner that is simple to implement and economical. This offers the advantage that the overall performance of the AIS data transmission can be significantly improved. This improvement can be implemented economically by supplementing operating software of components of an AIS system, e.g. by supplementing a computer program in a satellite or in a gateway of an AIS system.

A further advantage of the invention is that the AIS standard or the AIS data protocol does not need to be adapted, either at the transmitting end or at the receiving end.

The invention can furthermore be advantageously combined with other improvements in AIS receive devices, such as e.g. with methods for Successive Interference Cancellation, methods for Parallel Interface Cancellation or with Multi-User Detectors (MUD) which have one or more receive antennas. This allows a great variability in the implementation of the invention.

In one advantageous development of the invention, it can be provided that those data of an AIS data packet which are errored are reconstructed at least partially by means of auxiliary data which are located in the access of the AIS receive device and which do not originate from AIS data packets.

The auxiliary data required for this purpose may be of different types. They share the common feature that they do not originate from the AIS data packet currently being decoded or do not originate from AIS data packets at all, so that they are available, in a manner of speaking, as a priori information even if the AIS receive device has not yet been able to receive data from other AIS participants. In this way, an information source model is implemented to improve the reception of AIS data packets.

If the AIS receive device is, for example, part of a satellite, e.g. an LEO satellite, its position coordinates, for example, can then be used as auxiliary data or to form auxiliary data. The auxiliary data may be static data which are permanently stored and do not change. The auxiliary data may also be totally or partially modifiable parameters which, for example, are updated at specific time intervals, which may be regular or irregular.

Insofar as an at least partial reconstruction of data is carried out by the auxiliary data or other, subsequently specified data such as the prior knowledge, this can be carried out, for example, in such a way that at least the values of some data bits of a received AIS data packet are determined using the auxiliary data or prior knowledge data or are at least estimated with a certain probability.

According to one advantageous development of the invention, the AIS receive device has at least two operating modes in which it is operated alternately, wherein the operating modes have at least:

a) a general knowledge mode in which the received AIS data packets are evaluated without consideration of stored data of previously received AIS data packets, and

b) a prior knowledge mode in which the received AIS data packets are evaluated with consideration of data of previously received AIS data packets stored as prior knowledge in order to at least partially reconstruct errored data of received AIS data packets using such prior knowledge.

This offers the advantage that an even further improved reception reliability can be implemented in the reception of AIS data packets through the use of the previously received AIS data packets. In the general knowledge mode, the auxiliary data can be used advantageously for the reconstruction of data of an AIS data packet which are errored.

According to an advantageous development of the invention, the AIS receive device is automatically switched over from the prior knowledge mode to the general knowledge mode if no AIS data packets are received which are error-free or reconstructable in an error-free manner. In this way, an automatic response to an obsolete data stock of the data stored as prior knowledge is enabled, so that the probability of a correct reconstruction of data is in turn not reduced due to obsolete prior knowledge. The predetermined minimum time may be a fixed time or a time that is defined variably according to different criteria. The minimum time can thus be defined, for example, as vessel-data-dependent, i.e. dependent on the content of AIS data packets. The minimum time can also be defined according to a predetermined number of AIS data packets that are expected in this time period, or according to a specific number of received errored AIS data packets.

According to one advantageous development of the invention, the AIS receive device is operated always or at least occasionally in the general knowledge mode only. The AIS receive device can thus be set, for example, by a settable parameter, to a permanent operation in the general knowledge mode. This may be desired, for example, if no vessels transmitting AIS data packets are to be tracked.

According to one advantageous development of the invention, at least one of the following AIS transmission parameters is defined or at least estimated using the auxiliary data: frequency, time synchronization, frame synchronization, channel estimation. Not only an improvement in the detection reliability of the individual data, but additionally an improvement in the remaining receive characteristics can also be implemented in this way by means of the information source model. Thus, for example, using the information source model, by means of which specific data bits of an AIS data packet can be assumed to be known, these known bits can be used as pilot signals for synchronization purposes in the reception of AIS messages.

According to one advantageous development of the invention, at least AIS data packets received as error-free are stored for use in later timeslots of the AIS protocol, stored, in particular, transmitter-specifically. The AIS data can be stored in decoded or undecoded form, i.e. directly in the form of the received AIS data packet.

According to one advantageous development of the invention, the data are reconstructed packet-by-packet. This allows a precise allocation between data to be reconstructed and corresponding data from earlier timeslots.

According to one advantageous development of the invention, the AIS receive device is operated transmitter-specifically in a general knowledge mode or a prior knowledge mode. In this way, the AIS receive device can be operated not only generally for all transmitters, i.e. all AIS-enabled vessels, in a global general knowledge mode or prior knowledge mode. Instead, a transmitter-specific general knowledge mode and prior knowledge mode can be implemented for each transmitter, i.e. each vessel. Further improvements in the reception of the AIS data packets, particularly if these are errored, are possible as a result.

The aforementioned object is furthermore achieved according to claim 10 by a device with an AIS receive device and with a provisioning device for providing data from AIS data packets received via the AIS receive device, wherein the provisioning device is configured to carry out a method of the previously described type. The aforementioned advantages can be achieved hereby also. The provisioning device may, in particular, be designed as a gateway or part of a gateway of an AIS system.

According to one advantageous development of the invention, the AIS receive device is part of an AIS satellite, e.g. an LEO satellite. The AIS satellite can be configured to forward the received AIS data with or without preprocessing to a common coordination unit, e.g. a gateway. The data packets can be further processed and, in particular, decoded there.

The aforementioned object is furthermore achieved according to claim 12 by a computer program with program code means, configured to carry out a method of the previously described type when the computer program is executed on a computer. The computer program can be executed, for example, on a computer of an AIS receive device, a provisioning device or a gateway.

An AIS receive device is understood in this context to mean any device that can receive AIS data packets. These may be pure AIS receivers, but also AIS transceivers on vessels or AIS communication units in satellites.

The invention is explained in detail below on the basis of example embodiments with reference to drawings.

In the drawings:

Figure 1 shows an AIS system, and

Figure 2 shows a reference topology for the reception of AIS data packets in a satellite, and

Figure 3 shows the reception pattern of the data packets in the satellite in the reference topology shown in Figure 2, and

Figure 4 shows an AIS information source model based on a Markov chain, and

Figure 5 shows an AIS receive device in a block diagram representation in a first embodiment, and

Figure 6 shows an AIS receive device in a block diagram representation in a second embodiment.

The same reference numbers are used in the figures for elements corresponding to one another.

Figure 1 shows the basic structure of an AIS system involving at least one AIS satellite. Vessels 10, 20 communicate with one another or with base stations. An AIS satellite 80 located in the Low Earth Orbit (LEO) monitors the AIS data communication, as shown by the dotted arrow. The AIS satellite 80 communicates with an AIS station 90 which is located, for example, on land in the region of the Earth's atmosphere, and which may be designed, for example, as a gateway. As a development within the meaning of the present invention, the gateway 90 has a provisioning device 91 which carries out a data reconstruction by means of the auxiliary data. To do this, the AIS satellite 80 transmits the AIS data packets received from the vessels 10, 20 and forwards them to the gateway 90. They can be evaluated there by the provisioning device 91.

Figure 2 shows an example of an arrangement of six vessels 10, 20, 30, 40, 50, 60 in a footprint 100 of an AIS satellite. The vessels 10, 20, 30, 40 form a group of vessels which, due to the sufficiently short distance, can carry out an SOTDMA access control among themselves in the subarea 101, thus forming an AIS radio cell. In a comparable manner, the vessels 50, 60 can carry out an SOTDMA access control among themselves in a subarea 102, forming a further AIS radio cell. In each case, no data collision can occur within a subarea

101, 102. However there is no coordination between the subareas 101, 102 in terms of accessing the data transmission channel.

It is generally assumed below that the vessel 10 transmits a data packet 1, the vessel 20 transmits a data packet 2, the vessel 30 transmits a data packet 3, the vessel 40 transmits a data packet 4, the vessel 50 transmits a data packet 5 and the vessel 60 transmits a data packet 6.

The situation shown in Figure 3 is now assumed, which may occur in the topology shown in Figure 2. Figure 3 shows, on a timeline, four frames f1, f2, f3, f4 of an AIS data transmission using SOTDMA for access control. It is evident, in the simplified example shown here, that each frame f1, f2, f3, f4 has ten timeslots s1, s2, s3, s4, s5, s6, s7, s8, s9, s10 in which one of the vessels can in each case transmit one data packet. As already mentioned, six vessels 10, 20, 30, 40, 50, 60 which use the AIS transmission channel are located in the footprint 100 of an AIS satellite. It is furthermore assumed that each vessel transmits one data packet in one frame. Whereas the access control is carried out within a subarea 101, 102 in each case by means of SOTDMA, no access control takes place between vessels of different subareas 101, 102. Accordingly, it may arise that vessels transmit their data packets in the same timeslot, so that overlapping data packets and therefore corrupted and errored data packets arrive in the AIS satellite, which covers a larger area.

If the frame f1 is considered, it is evident that the data packets 1, 2, 4, 6 can be successfully decoded. Corruption occurs in the data packets 5, 3. In this case, the vessel 30 assumes that it has a time slot timeout of four for the transmission of data packets, which means that the selected transmission timeslot is retained for the following four frames. According to the invention, the method for providing data can begin to estimate the position of the vessel 50 using the auxiliary data and to estimate movement parameters for the following frames, and furthermore the method can eliminate the data packets corresponding hereto. Following successful elimination of the data packets of the vessel 50, it is evident that the data packets of the vessel 30 can be correctly decoded since the data collision can be resolved. As a result, the data packets of all vessels can be successfully decoded by means of the method according to the invention.

As already mentioned, an information source model for improving the reception of AIS data packets is implemented with the present invention. The auxiliary data, which are generally known data and do not depend on AIS data packets, can initially be used for this purpose. In addition, the information in received AIS data packets can be used as a further information source. For example, AIS messages contain position data containing information on the geographical position (latitude and longitude) of a vessel. If an AIS receive device is on-board an aircraft or satellite and the antenna covers, for example, a reception area in the Mediterranean region, the knowledge that the vessels from which AIS messages are received must be located in the Mediterranean region is available as generally known information. If it is furthermore taken into account that the longitude and latitude are coded in a two's complement representation, the receiver can assume that the most significant bits (MSBs) of the longitude and latitude fields in the AIS data packets are uniquely known. Auxiliary information that can be used to improve the data reception in an AIS receive device can be derived herefrom in the following manner:

- The auxiliary information helps the receiver to have a more accurate estimation of the data bits and therefore largely to correct errored data bits.

- The auxiliary information helps the receiver to detect AIS data packets and estimate transmission parameters such as frequency, time synchronization, frame synchronization and channel estimation.

Figure 4 shows an AIS information source model that is based on a Markov chain. The AIS receive device or its information source model can be operated in two operating modes 110, 111, i.e. a general knowledge mode 110 and a prior knowledge mode 111. The general knowledge mode is assumed if no information that can be evaluated is yet present from received AIS data packets, e.g. because no AIS data packets have yet been received or said packets are errored. As soon as at least one AIS data packet is correctly received, a switchover to the prior knowledge mode 111 is effected via a mode changeover 112. If AIS data packets are absent for a specific time, or if they are not received with correct data content or checksums, a reversion to the general knowledge mode 110 is effected via a mode changeover 113. In the general knowledge mode, only the auxiliary data that are available a priori as generally known data are used for the reconstruction. In the prior knowledge mode, the information that can be extracted from correctly received AIS data packets is additionally used for an improvement in the AIS data reception. For the mode changeover 113, a check can be carried out, for example, to determine whether N AIS data packets with an incorrect checksum have been received or no AIS data packet at all has been received from a vessel for a specific time period. The value of N can be freely selected.

The use of the generally known auxiliary data will be explained below using examples. For this purpose, the typical structure of a class A AIS message is set out in the following table (AIS position report).

Field	Number of bits
Message ID	6
Repeat indicator	2
User ID	30
Navigational status	4
Rate of turn	8
Speed over Ground, SOG	10
Position accuracy	1
Longitude	28
Latitude	27
Course over Ground, COG	12
True heading	9
Time stamp	6
Special maneuver indicator	2
Spare	3
RAIM flag	1
Communication state	19

In the general knowledge mode, a statistical analysis, for example, of all fields of an AIS data packet can be carried out to produce the auxiliary data, wherein it is taken into account that some values are reserved for a future use and are not yet used. Furthermore, it is taken into account that the occurrence of specific values in some fields has a higher probability than that of other values. The statistical distribution is accordingly not even, but has uneven characteristics which can be used.

If, for example, the Message ID field is considered, it can be noted that this field has 6 bits, but only values in the range from 0 to 27 can be used. The values 28 to 63 are reserved for a future use. The fact that the most significant bit of the Message ID field is uniquely known and always has the value 0 can accordingly be used as known a priori information and therefore as auxiliary data. The probability with which the message ID field will assume each available decimal value can additionally be established with a further analysis. For example, a statistical analysis can produce the following probabilities:

Decimal value	Probability
0	0
1, 2, 3	¼
4 to 27	1/(4*24)
28 to 63	0

The probability with which each bit assumes the value 1 can be assumed on the basis of the probabilities determined in this way:

Bit	1	2	3	4	5	6
Probability for the value "1"	0	0.1250	0.1250	0.1250	0.5	0.5

The probability information can additionally be used as auxiliary data in order to estimate the value of data bits of an AIS data packet and, if necessary, reconstruct errored data bits. In the present example, the message ID field has an entropy of 3.53 bits. This means that this field could be compressed to 3.53 bits while avoiding any redundancy or, with 6-bit coding, 2.47 bits are present as redundancy. An inherent redundancy of this type in the message ID field can thus be used to improve the reception of the AIS data packets.

The fields in which the longitude and latitude of a vessel are stored can furthermore be considered. Since the vessel must be located in the coverage area of the AIS receive device, specific auxiliary data can also be derived herefrom. This will be explained below using the example of the field for the longitude. The longitude field contains, coded in the two's complement, the numerical value for the longitude in one by ten thousand minutes. Positive values correspond to easterly degrees of longitude, negative values to westerly degrees of longitude. The field has 22 bits. Here, the most significant bit indicates the sign (East, West), while the remaining 21 bits indicate the absolute value of the longitude. If it is assumed that an AIS receive device covers an area in which the longitude is between 10 and 20 degrees East, and if it is furthermore assumed that the vessels are evenly distributed in terms of longitude in these coverage areas, the probability of each bit having the value 1 is set out in the following table.

Bit	1	2	3	4	5	6	7
Pr("1")	0	0	0	0	0	0	0
Bit	8	9	10	11	12	13	14
Pr("1")	0	1	0	0	0	0.3792	0.6208
Bit	15	16	17	18	19	20	21
Pr("1")	0.4096	0.5840	0.4880	0.4880	0.4928	0.5008	0.5008
Bit	22	23	24	25	26	27	28
Pr("1")	0.4992	0.4992	0.5	0.5	0.5	0.5	0.5

Pr("1") means the probability for the value 1. As is evident, the value can be uniquely established in advance for 12 of these bits, i.e. these bits are in any event uniquely known. In the case of four further bits, i.e. bits 13 to 16, probabilities occur which are not so close to 0.5. A certain redundancy that can be used is therefore present here also. Conversely, a probability of 0.5 would mean that the bits completely randomly assume the value 0 or 1.

In this case, the binary entropy of the coding of the data in the longitude field is 14.8698 bits. The longitude field therefore has a redundancy of almost 50%.

The previously explained information relates to the auxiliary information which is always known and is therefore also already present in the general knowledge mode. If the prior knowledge mode is then additionally used, the reconstruction probability for errored data bits can be further increased. It is assumed that the information source model is in the prior knowledge mode for a specific vessel 10. Accordingly, the geographical position of the vessel 10 at a time T and its direction of travel and speed are known. The position of the vessel at a time T + tau can be relatively accurately estimated on the basis of this further information. If, for example, a vessel is detected at the time T with a longitude of 10 degrees East, moving at a specific speed, the position of the vessel at time T + tau can be estimated as 10.045 degrees +/- 0.05 degrees if an even distribution is assumed. Thus, in conjunction with the previously explained, generally known auxiliary information, 19 bits of the longitude field are then known and the entropy is now 8.99 bits.

As a further advantageous development, the relationships between different fields of an AIS data packet can furthermore be taken into account for the reconstruction of data. If, for example, a vessel at sea is located very far from the coast, it is highly probable that it has a very high travelling speed. If an AIS data packet is thus received from a ship located in mid-ocean, but a speed of zero or virtually zero is indicated in the AIS data packet, it is highly probable that the AIS data packet is errored. This can be taken into account in the information source model by a common distribution for the different AIS fields. The distribution can reproduce the relationships between different fields. An example:

- Latitude and longitude: It can hereby be recognized whether the coordinates of the vessel are located onshore.

- Speed, latitude and longitude: Within a port, a low travelling speed can be assumed with high probability, whereas a high travelling speed is more probable in mid-ocean.

This can then be implemented in a decoder which is disposed in an AIS receive device or in a gateway, which will be additionally explained below using a number of examples.

Example 1: Synchronization

The auxiliary data can be used for a detection and synchronization. One possibility for this entails using only those bits whose value is exactly previously known. The detection and estimation are carried out using the training sequence and the start and end flags of an AIS message, which has 40 bits in total. If only those bits that are known with the probability 1 are used, the decoder, e.g. the AIS receive device, can create longer training sequences in order to improve the results of the detection and estimation. If it is assumed, for example, on the basis of the proposed information source model that the data are evenly distributed in the longitude field between 10 degrees and 20 degrees East, 10 bits in the longitude field are exactly known and can be used for the synchronization, e.g. by extending the training sequence from 40 bits to 50 bits. A comparable procedure can be followed with the other fields of an AIS message.

Example 2: Multi-user detection

The AIS receive device can be constructed e.g. as shown in Figure 5. It has an input buffer 120 in which received AIS data packets are stored in raw form. A detection unit 121 is furthermore present to which the raw data are fed from the buffer 120 and in which they are detected. A demodulation and checksum-decoding unit 122 is furthermore present. The results of the detection unit 121 and the raw data from the input buffer 120 are fed to said unit. The AIS data packets are decoded and checked in the decoding unit 123. The finished decoded AIS data 125 are output via an output. A remodulation unit 124 is furthermore present. The information source model according to the invention is furthermore present as the block 122. The auxiliary data 126 are fed from said block to the detection unit 121 and to the decoding unit 122.

AIS data packets are detected in the detection unit 121 using the auxiliary data 126. As soon as an AIS data packet has been detected, it is decoded via the decoding unit 123. The checksum is furthermore checked. The auxiliary data 126 are used here also. Certain errors can already be eliminated or reduced on the basis of probabilities using the auxiliary data 126. The totally or at least partially reconstructed data initially determined here are remodulated once more via the remodulation unit 124 according to the AIS protocol and are fed back into the input buffer 120. The interference of the remodulated AIS data packets is then removed from the input buffer 120. The resulting data can be detected and decoded there once more by the detection unit 121 and the decoding unit 123. In this way, interference of the received raw data can be eliminated. A software-based decoding of the checksum can be carried out to improve the received power.

In the example according to Figure 5, a Successive Interference Cancellation method can be used to improve the reconstruction of errored data. A Partial Successive Interference Cancellation method can also be used. In this case, at least some of the errors in an AIS data packet can be eliminated, even with an errored checksum.

Example 3: Multi-user detection with integrity check

Figure 6 shows a further embodiment of an AIS receive device in which, in contrast to the embodiment shown in Figure 5, an integrity-checking unit 128 is additionally disposed in the path between the decoding unit 123 and the remodulation unit 124. Otherwise, the embodiment according to Figure 6 corresponds to the embodiment shown in Figure 5. The prior knowledge 127 is fed from the information source model 122 to the integrity-checking unit 128. This prior knowledge is used in the integrity-checking unit 128 to improve the reconstruction of errored AIS data. As a result, an even higher yield of correct AIS data 125 can thereby be achieved.

In further examples, instead of a Successive Interference Cancellation method, a different method can also be used, such as e.g. Parallel Interface Cancellation or a different, suitable method, in particular a method which can use the auxiliary data and/or the prior knowledge.

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Date:
08. October 2014

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Patent claims:

1. Method for providing data from received AIS data packets (1, 2, 3, 4, 5, 6), wherein AIS data packets (1, 2, 3, 4, 5, 6) are received by means of at least one AIS receive device (80) and the data of the received AIS data packets (1, 2, 3, 4, 5, 6) are automatically evaluated, characterized in that those data of an AIS data packet (1, 2, 3, 4, 5, 6) which are errored can be reconstructed at least partially by means of auxiliary data (126) which are located in the access of the AIS receive device (80) and which do not originate from the AIS data packet (1, 2, 3, 4, 5, 6) that is currently being decoded.

2. Method according to claim 1, characterized in that the AIS receive device (80) has at least two operating modes (110, 111) in which it is operated alternately, wherein the operating modes (110, 111) have at least:
   a) a general knowledge mode (110) in which the received AIS data packets (1, 2, 3, 4, 5, 6) are evaluated without consideration of stored data of previously received AIS data packets (1, 2, 3, 4, 5, 6), and
   b) a prior knowledge mode (111) in which the received AIS data packets (1, 2, 3, 4, 5, 6) are evaluated with consideration of data of previously received AIS data packets (1, 2, 3, 4, 5, 6) stored as prior knowledge in order to at least partially reconstruct errored data of received AIS data packets using such prior knowledge (127).

3. Method according to claim 2, characterized in that the AIS receive device (80) is automatically switched over from the prior knowledge mode (111) to the general knowledge mode (110) if no AIS data packets (1, 2, 3, 4, 5, 6) are received which are error-free or reconstructable in an error-free manner.

4. Method according to claim 2 or 3, characterized in that the auxiliary data (126) are used in the general knowledge mode (110) for the reconstruction of data of an AIS data packet (1, 2, 3, 4, 5, 6) which are errored.

5. Method according to one of claims 2 to 4, characterized in that the AIS receive device (80) is operated always or at least occasionally in the general knowledge mode only (110).

6. Method according to one of the preceding claims, characterized in that at least one of the following AIS transmission parameters is defined or at least estimated using the auxiliary data: frequency, time synchronization, frame synchronization, channel estimation.

7. Method according to one of the preceding claims, characterized in that at least AIS data packets (1, 2, 3, 4, 5, 6) received as error-free are stored for a use in later timeslots of the AIS protocol, stored, in particular, transmitter-specifically.

8. Method according to one of the preceding claims, characterized in that the AIS receive device (80) is operated transmitter-specifically in a general

knowledge mode (110) or a prior knowledge mode (111).

9. Method according to one of the preceding claims, characterized in that those data of an AIS data packet (1, 2, 3, 4, 5, 6) which are errored are reconstructed at least partially by means of auxiliary data (126) which are located in the access of the AIS receive device (80) and which do not originate from AIS data packets (1, 2, 3, 4, 5, 6).

10. Device with an AIS receive device (80) and with a provisioning device (91) for providing data and AIS data packets (1, 2, 3, 4, 5, 6) received via the AIS receive device (80), characterized in that the provisioning device (91) is configured to carry out a method according to one of the preceding claims

11. Device according to claim 10, characterized in that the provisioning device (91) is designed as a gateway (90) or part of a gateway (90).

12. Computer program with program code means, configured to carry out a method according to one of claims 1 to 9 when the computer program is executed on a computer.

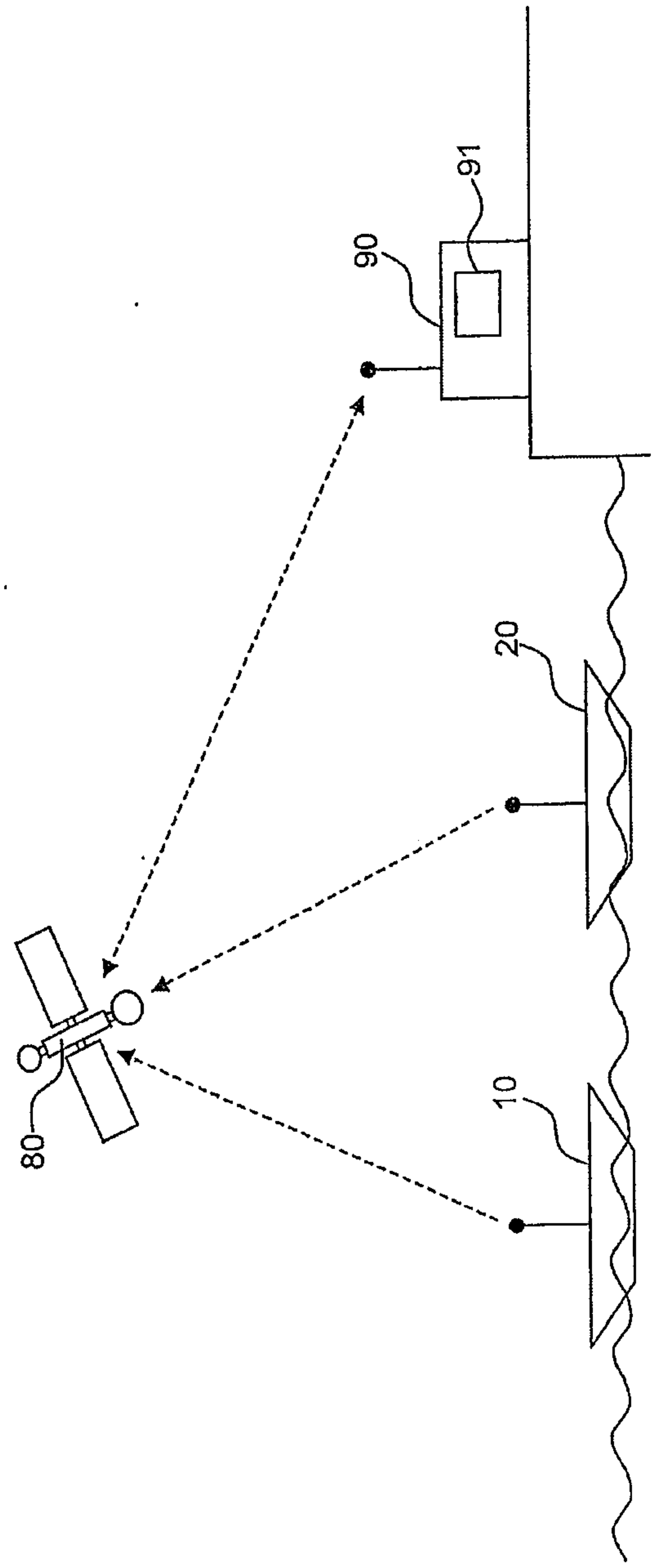


Fig. 1

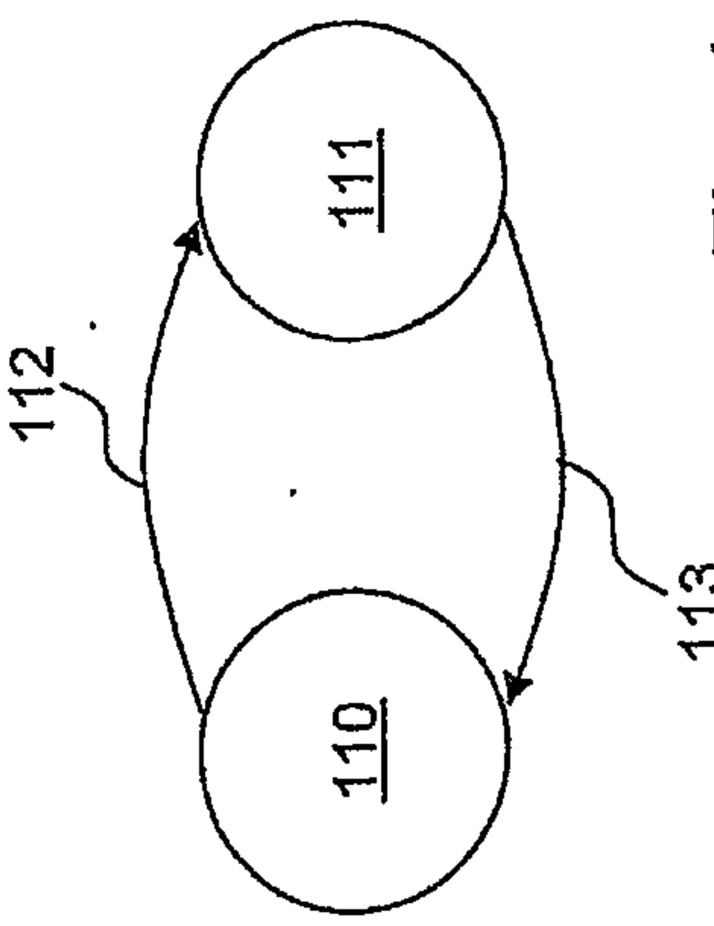


Fig. 4

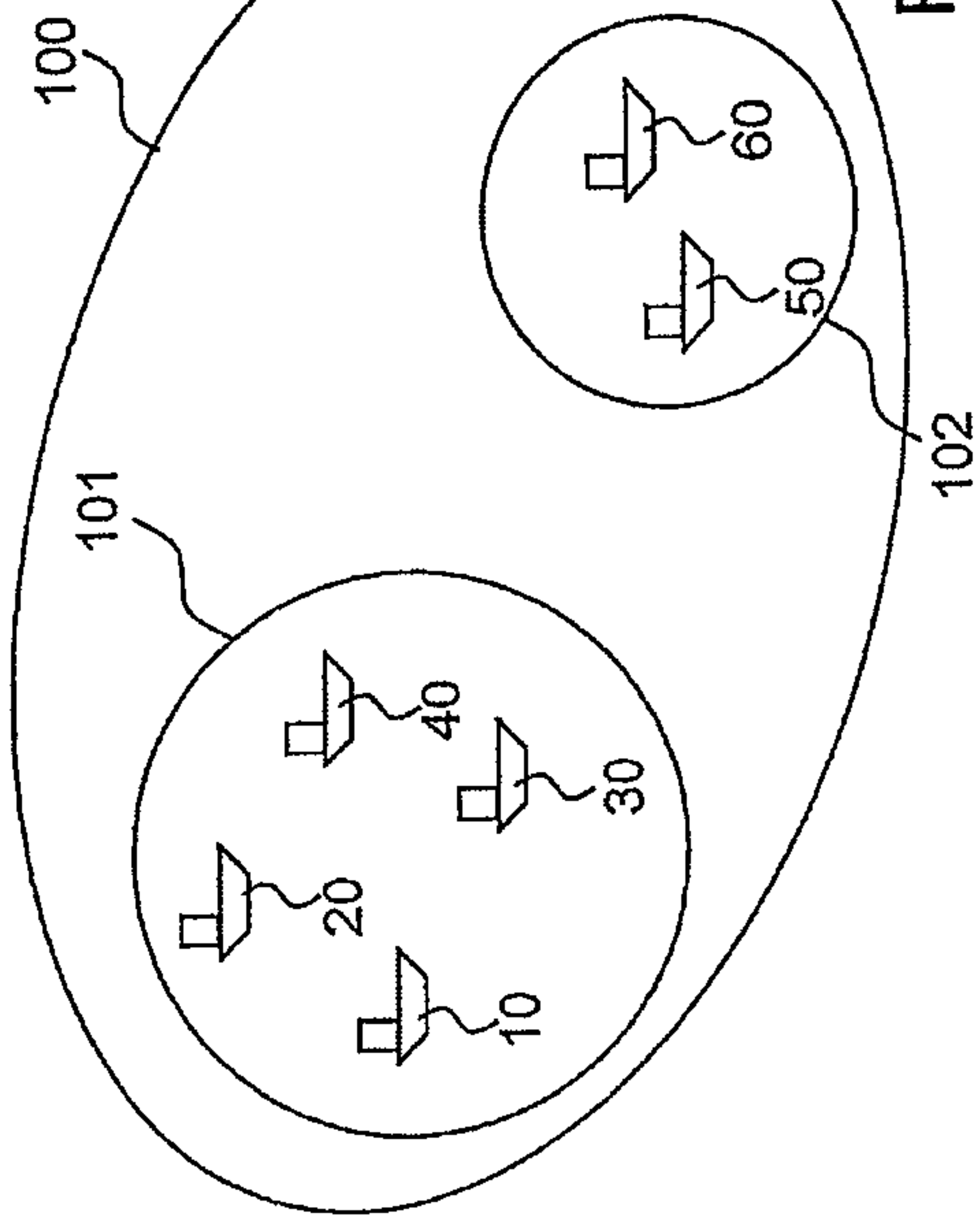


Fig. 2

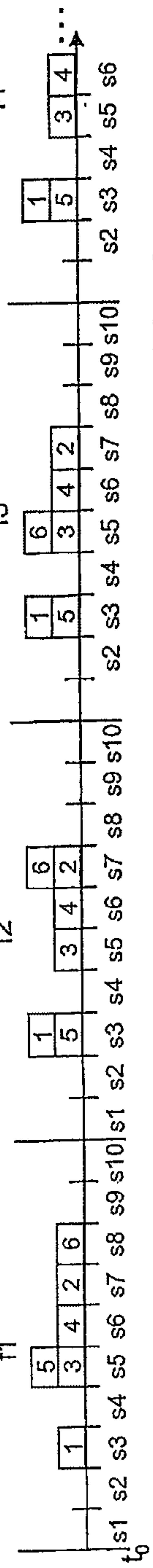


Fig. 3

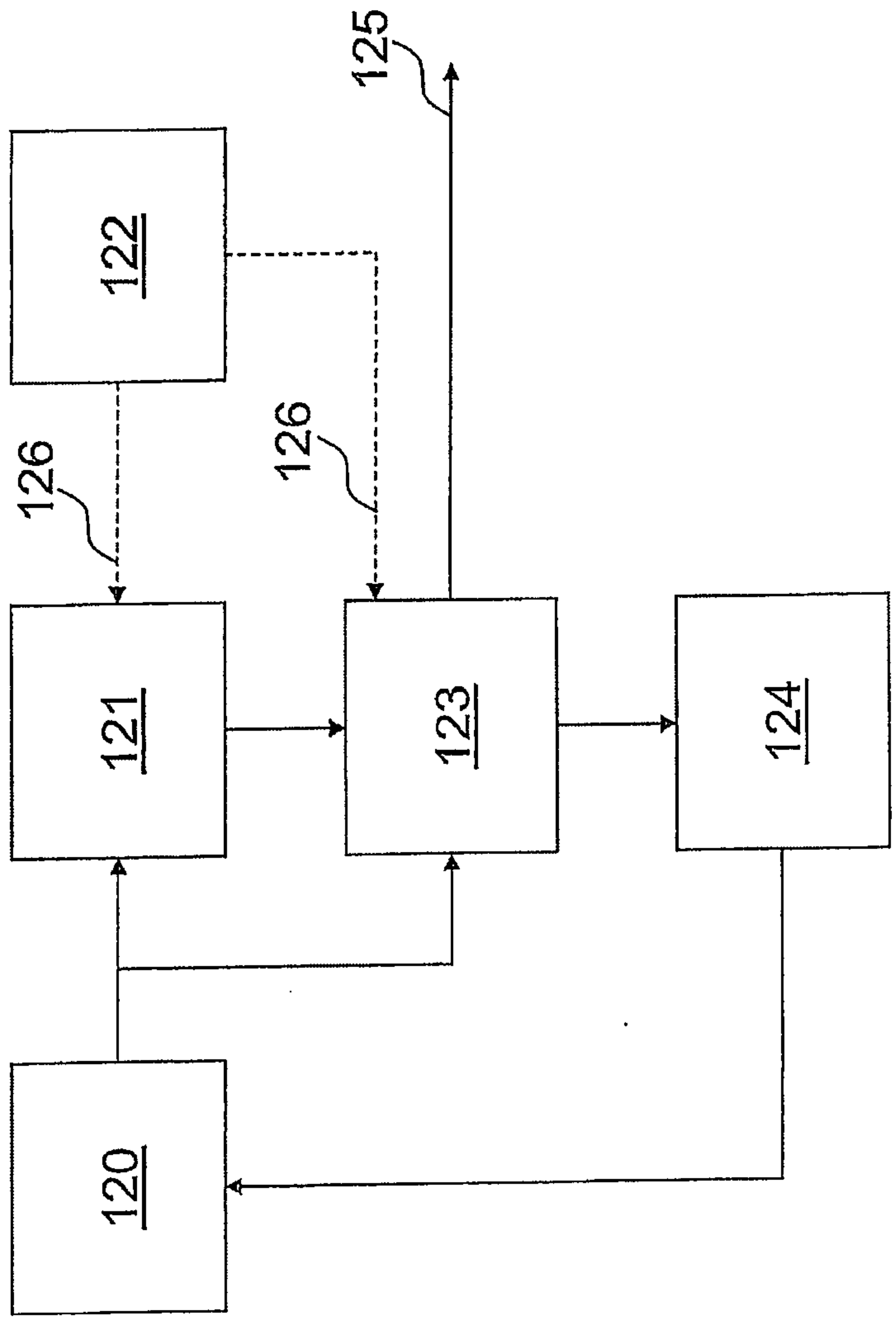


Fig. 5

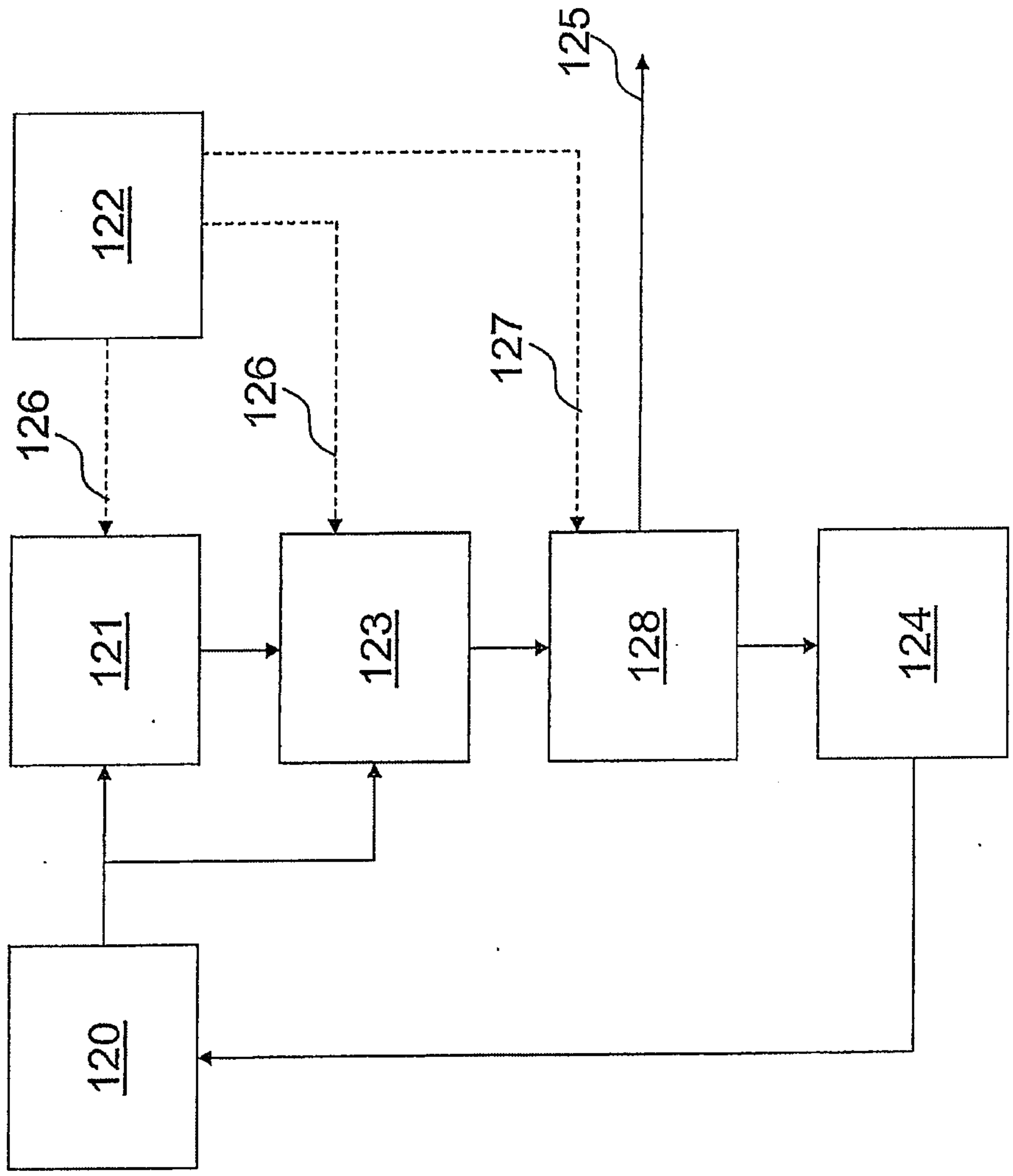
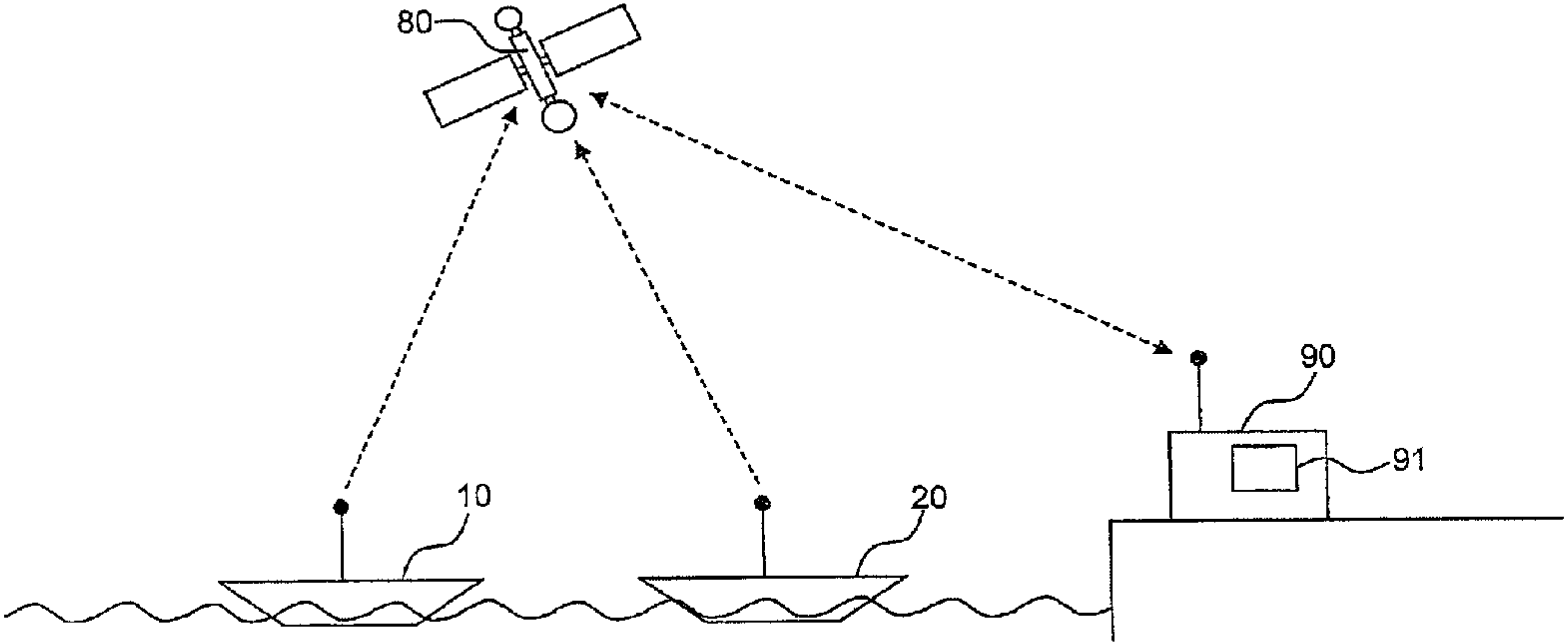


Fig. 6



80
90
91
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