

The present invention relates to an anti-collision system for maritime navigation.

At present, the only anti-collision aid available in maritime navigation is primary radar. Each ship that is equipped with it has information on its immediate environment at its disposal: the relative position of the ship in question in relation to other ships and in relation to any obstacle of sufficient size to be detected by the radar - buoys, coasts, etc. Such a radar system however provides very little or no information on the nature of the objects detected (type of ship, for example), their speed, and any possible intentions of manoeuvre. Any concerted manoeuvring of ships located in the same area can be conducted only by wireless, on channels which are at present very busy. Calls cannot be sent on account of not knowing the identity of the ship being addressed, and are therefore inefficient.

From document FR-E-72082 is known a device for the prevention of maritime or aerial collisions, but this device cannot provide with precision the respective positions of the moving bodies concerned, which has great disadvantages in a dense environment, this being on account of the fact that the moving bodies only transmit information relating to their course and their speed, hence the need to make vector calculations in order to determine their relative positions.

The present invention relates to a method allowing ships located in the same geographical area to inform each other automatically and constantly about their respective changes of course in order to avoid any collision and facilitate their manoeuvres when their density in this geographical area is high, without having to make long and complex calculations.

The present invention also relates to a device for carrying out the method, which device is easy to use and can provide the maximum information in the clearest possible manner.

The anti-collision method for maritime navigation

whereby each ship using it transmits repetitively, on a channel common to all ships concerned, information relating to its course and its speed, and receives homologous information from the surrounding ships, which it displays by symbols on a panoramic screen, is characterised in that the whole of the environment of the ship in question is shown on the screen, and each ship further transmits its absolute geographical position which is displayed directly on the screen by a symbol extended by a segment of a straight line representing the speed vector of the corresponding ship, the length of this vector being proportional to the speed of the ship, and its orientation corresponds to the course of this ship.

The anti-collision system for maritime navigation comprising, in each equipped ship, a display device of the panoramic type connected to a radio receiver, as well as a transmitter connected to devices providing the course and speed of the ship, is characterised in that the transmitter is also connected to a radio navigation system providing its absolute geographical position ("latitude," "longitude") and the screen is connected to a screen management device, itself connected to the receiver via a demodulator, as well as to the radio navigation system and to a radar system.

The present invention will be understood better on reading the detailed description of an embodiment taken as an example without limitation, illustrated by the attached drawings in which:

- Fig. 1 is a block diagram of a device with which a ship is equipped and which forms part of the system according to the invention, and
- Fig. 2 is a plan view of an example of a screen of the display device of the equipment in Fig. 1.

Each ship participating in the anti-collision system of the invention is equipped with a device such as the one shown schematically in Fig. 1, and will hereinafter be referred to as the "equipped ship."

The device shown in Fig. 1 comprises a transmitter 1 transmitting messages discontinuously with a very low mean load rate (defined as the ratio of the transmission time to the resting time), of the order of 10^{-4} to 10^{-5} . The power and frequency of transmission are selected so as to limit the range of the transmitter 1 to a few tens of kilometres. The limitation may be that due to the earth's curvature if a transmission frequency of which propagation takes place in direct view is selected, for example a frequency of the UHF band (several hundred MHz) or beyond, without however exceeding the X-band so that propagation remains practically insensitive to weather conditions. The frequency F_0 of the transmitter is the same for all transmitters and receivers of the system.

The transmitter 1 is connected via a switch 2 to an aerial 3 constructed so as to ensure omnidirectional transmission in the horizontal plane.

The transmitter 1 is furthermore connected to a modulator 4. This modulator 4 produces a binary "word" combining all the items of information to be transmitted, and transposes it into a signal modulating the transmitter 1. The form of modulation is of the pulse type so as to allow the total absence of transmission outside of the time during which the message is transmitted. However, the actual type of modulation of the information is not laid down by the method of the invention: each bit can be coded according to any of the known coding techniques, such as for example coding in the pulse position, or by phase jump.

The message transmitted comprises the following information:

- the coordinates of the ship, preferably in latitude and longitude, each coded for example on twenty-two bits. These coordinates are provided by the radio navigation system of the ship. Ships are generally equipped with radio navigation apparatuses which permanently give them their absolute geographical position in a precise and reliable manner. The precision required by the anti-

collision method of the invention is of the order of about one hundred metres. For example, the radio navigation system known by the name of "NAVSTAR" satisfies these conditions;

- the identity of the ship, to which can be allocated advantageously about twenty bits. This data item is provided permanently by a suitable circuit: prewired circuit, read-only memory, data input by keyboard into a read-write memory, etc. This identity can be used to facilitate a wireless link or to identify quickly the type of ship (oil tanker, ferry, cargo, etc.), and in the latter case some bits of the identity word can be reserved to identify the type of ship;
- the speed and course of the ship, this information being generally available on any ship, at least in analogue form, which it is sufficient to convert to digital form. This information can be coded with sufficient precision by six and eight bits respectively;
- if occasion arises (if it is the rule), the change of course coded by two bits: turning to port or to starboard. Such information can be provided automatically by any known device for indicating direction of rotation, activated from the start of the manoeuvre. The rule could also provide for fuller, earlier information than just an indication of the change of course, namely the value of the future course, but this would require it to be input manually (by keyboard), and would entail risks of the operator forgetting.

Advantageously this information is preceded, according to a conventional message transmitting technique, by a preamble making it possible to initialise some circuits of the receiver. Also advantageously, this information is complemented by bits forming an end-of-message symbol, and, if it is estimated that permanent repetition of the messages is not sufficient to eliminate all errors, error correcting bits can be added (even parity bits, for example).

As stated above, if the ship is equipped with a radio

navigation receiver of the NAVSTAR type, such a receiver provides most of the information mentioned above with a precision much greater than that which is necessary for the system of the invention. In this case one can disregard, for each item of information, the least significant bits which are superfluous, and keep only those considered significant and displaying the necessary precision sufficient for carrying out the method of the invention, as stated above. Thus, the length of the message transmitted is about a hundred bits. If the pass-band allocated to the system is of the order of a few megahertz, the message is transmitted in a few tens of microseconds.

If each equipped ship transmits such a message with a periodicity of about one second, the traffic load induced by a ship on the system is between 10^{-4} and 10^{-5} . If for example about a hundred ships are present simultaneously in the same geographical area (such as a harbour), the traffic load of the system is only 10^{-2} to 10^{-3} , which guarantees a high probability of no mutual scrambling of messages. It should however be noted that a relatively unfavourable case was chosen there, since the orders of magnitude of avoidance manoeuvring times of the ships are very much greater than one second, and one could greatly increase the period of repetition of messages and thus reduce their probability of mutual scrambling.

According to an advantageous characteristic of the invention, the moment of transmission of each message is made random, since mutual scrambling remains possible on account of non-synchronisation of the transmissions of the different ships. Thus, for the above example of a repetition period of one second, this value will only be a mean statistical value, the true period having a wide dispersion. It follows that any scrambled message received from a given ship will not be so for a long time. Moreover the high redundancy of the messages transmitted (for a periodicity of about one second, the same message is repeated several times before a significant change of

course and/or speed and/or geographical position) makes it possible to disregard the scrambled message received.

The NOT circuit 2 connects, outside of the short lapses of transmission time of the transmitter 1, the aerial 3 to a receiver 5 set to the common frequency of the system. The receiver 5 is connected to a data demodulator 6 retrieving the information from the signal received, by performing the reverse operations to those carried out in the modulator 4.

The demodulator 6 is connected via a screen management section 7 to a display screen 8. The components 7 and 8 can for example be a microcomputer and its display monitor.

The object of the screen 8 is to present to an operator the whole of the environment of his ship by operating on the information received from the surrounding equipped ships, as well as of the information received from its own equipment. In Fig. 2 is shown an example without limitation, of information which can be displayed on the screen 8. This information can be displayed in a form analogous to that of the screen of a panoramic radar system.

According to the example of Fig. 2, the screen 8 displays in the form of large light spots the different ships (10, 11, 12, for example), its own ship (referenced 13) being of a colour and/or form and/or brightness different to those of the other ships. Furthermore, different forms and/or colours of spots can correspond to different types of ships. Each spot representing a ship is extended by a segment of a straight line representing the speed vector of the corresponding ship. The length of this vector is proportional to the speed of the ship, and its orientation corresponds to the course of this ship. Advantageously, one can also represent by a particular symbol, for example by a dot or a dash of a different colour, the information of changing course close to the speed vector, on its left or on its right according to the direction of changing. The general layout of the screen 8 can be arranged by placing north at the top of the screen,

but advantageously the top of the screen can also be made to correspond to the bow of the ship, the lubber's line of this ship then being fixed. The speed vector of each ship can correspond to an absolute speed, or else, according to a variant, to a relative speed in relation to that of the ship 13 (the own speed vector of which is then zero), the different vectors of relative speed of the other ships then being determined by vector composition of their own speed and that of the ship 13. The spot representing the ship 13 can equally well be located at the centre of the screen as be put off centre in a direction opposite its speed vector in order to favour the "view ahead."

Advantageously, close to the spot representing each other ship (10, 11, 12 in Fig. 2) is displayed its identity (10A, 11A, 12A respectively).

Also advantageously, each equipped ship comprises a radar system allowing it to detect the surrounding ships which are unequipped or of which the equipment is broken down, as well as fixed obstacles (rocks, coasts, etc.). In Fig. 2 are shown two echos 14, 15 representing unequipped ships as well as the profile 16 of a coast. The echos 14, 15 are preferably displayed in a form and/or colour different to those of the spots 10 to 13 so as to point out immediately to the operator that they correspond to ships which are unequipped or of which the equipment is broken down, and that the absence of a corresponding speed vector does not mean zero speed of these ships.

All transforms of coordinates, vectors and, if occasion arises, information from the ship's radar are obtained in a manner known in the art by the management section 7, the construction of which is obvious to anyone skilled in the art on reading the present description.

Moreover, constant data stored in a bulk memory can also be supplied to the management section 7. Thus, cartographic data such as coast, buoys, lighthouse, etc. can be shown on the screen.

According to an advantageous variant of the invention,

an item of ship's equipment further comprises a radio call recognition circuit 9 connected on the one hand to the output of the demodulator 6, and on the other hand to a data input keyboard (not shown) on which the operator selects the call signal of the ship with which he wants to make contact, this call signal also being sent to the modulator 4 and incorporated into the message periodically transmitted by the transmitter 1. The circuit 9 may be an ordinary comparator which, in the called ship, compares the call signal received from the calling ship with its own call signal and which, if they are the same, triggers a sound and/or visual alarm. Of course, the message received by the called ship contains the call signal of the calling ship, and this call signal may be displayed by the screen 8 of the called ship. This display may be for example in plain language (alphanumerical call signal) in a corner of this screen. According to an advantageous variant, instead of this display or in addition to this display, a symbol may appear close to the spot (such as one of the spots 10 to 12) representing the calling ship, or else this spot itself may be modified: the symbol may be for example a circle surrounding the spot representing the calling ship, and/or this spot may flash or appear brightened.

According to another variant of the invention, the screen management section 7 is associated with a device of the "mouse" type commonly used with microcomputers, this device producing on the screen 8 a movable cursor 17 in the form of a cross, for example. When this cursor has superimposed on it the symbol representing a ship which the operator wants to call by radio, this operator actuates the starter or "click" button of the "mouse." This order is processed by the section 7 which produces a corresponding call signal (symbolised by the broken line 18) and sends it to the modulator 4. In order to produce this call signal, the section 7 stores the call signals received from all the neighbouring ships (displayed on the screen 8), establishes a relationship between the spot on which the cursor 17 has

stopped and the corresponding call signal, and sends this call signal. These functions performed by the section 7, being obvious for anyone skilled in the art to perform, will not be described in more detail. Naturally, in the called ship, said "mouse" can be used to acknowledge the call, and if occasion arises to initiate a radio link. Use of the "mouse" avoids in both ships (calling and called) any errors due to incorrect input of a call signal by keyboard.



Claims

1. Anti-collision method for maritime navigation whereby each ship using it transmits repetitively, on a channel common to all ships concerned, information relating to its course and its speed, and receives homologous information from the surrounding ships, which it displays by symbols on a panoramic screen, characterised in that the whole of the environment (10 to 16) of the ship in question is shown on the screen, and each ship further transmits its absolute geographical position which is displayed directly on the screen by a symbol (10 to 13) extended by a segment of a straight line representing the speed vector of the corresponding ship, the length of this vector being proportional to the speed of the ship, and its orientation corresponds to the course of this ship.

2. Method according to claim 1, characterised in that each ship transmits the information relating to its identity, and receives homologous information from the surrounding ships, which it displays close to the corresponding symbols (10A, 11A, 12A).

3. Method according to either of claims 1 or 2, characterised in that each ship transmits information relating to its change of course, and receives homologous information from the surrounding ships, which it displays close to the corresponding symbols of these surrounding ships.

4. Method according to any of the preceding claims, of which at least some ships using it comprise a ship's radar system, characterised in that these radar systems produce the display on said screen of all the surrounding obstacles (14 to 16) other than the ships using the method, the ships (14, 15) forming part of these other obstacles being represented by symbols different to those representing the ships using the method.



5. Method according to any of the preceding claims, characterised in that the items of information transmitted by each ship, numbered if occasion arises, are combined into a binary "word."

6. Method according to claim 5, characterised in that for each ship the repetition period of the binary word varies randomly.

7. Method according to any of the preceding claims, characterised in that the ships display the speeds of the surrounding ships in the form of a relative speed vector in relation to their own speed vector.

8. Method according to any of claims 2 to 7, characterised in that the operator of a ship wishing to make radio contact with that of another ship incorporates the call signal of this other ship into the information which he transmits repetitively, and the ships capable of being called detect the transmitted call signals in the information received, compare them with their own call signal, and if they are the same transmit an alarm.

9. Method according to any of the preceding claims, characterised in that the symbol displayed on the panoramic screen and corresponding to its own ship (13) is of a colour and/or form and/or brightness different to those of the other ships.

10. Method according to any of the preceding claims, characterised in that the symbol (13) representing its own ship on the panoramic screen is situated at the centre of the screen.

11. Method according to any of claims 1 to 9, characterised in that the symbol (13) representing its own ship on the panoramic screen is put off centre in a direction opposite



its speed vector in order to favour the "view ahead."

12. Anti-collision system for maritime navigation comprising, in each equipped ship, a display device of the panoramic type (8) connected to a radio receiver (5), as well as a transmitter (1) connected to devices providing the course and speed of the ship and transmitting at regular intervals the information provided by these devices, characterised in that the transmitter (1) is also connected to a radio navigation system providing its absolute geographical position ("latitude," "longitude") which is transmitted at regular intervals by the transmitter (1), and the screen (8) is connected to a screen management device (7), itself connected to the receiver (5) via a demodulator (6), as well as to the radio navigation system and to a radar system.

13. System according to claim 12, characterised in that it comprises a comparator (9) receiving the identity of its own ship and connected to the demodulator.

14. System according to either of claims 12 or 13, characterised in that the management section (7) of the display device cooperates with a device of the "mouse" type producing a movable cursor (17) on the screen of the display device.

15. System according to claim 14, characterised in that the management section (7), which is also connected to the modulator, produces a call signal corresponding to the ship with the symbol of which the cursor is made to coincide.