Claims

1. An acoustic detection system for detecting at least partly submerged targets in a sensitive area defined with respect to an infrastructure, characterized in that the system comprises at least one multistatic detection group, each multistatic detection group defining a detection area, and comprising:

- A submerged transmitter (31) emitting at low frequencies;
- A plurality of submerged receivers (32) comprising at least two receivers, each receiver of a given group forming, with the transmitter of said group, a bistatic pair, each bistatic pair generating an elementary detection area (320) surrounding a blind zone (321), the blind zone associated with each bistatic pair corresponding to a non-detection zone, the detection area of said group being formed by all of the elementary detection areas of said receivers of the group, said receivers being arranged in at least one layer,

the blind zone around each receiver in a given detection group being at least partly covered by the elementary detection areas of the two neighboring receivers of the detection system,

and in that, for at least one group of the system, the form described by the receivers of at least one layer of the group is an at least partly circular form of given radius (R), the inter-receiver distance (2a) between two adjacent receivers of said layer depending on the distance (*D*) between the transmitter (31) of the group and the rectilinear segment linking said adjacent receivers of the layer, called reference transmitter-receiver distance.

2. The detection system as claimed in claim 1, characterized in that the at least partly circular form described by at least one layer of receivers formed of at least two receivers is centered substantially on the transmitter (31), and in that the receivers of said layer have at least one axis of symmetry passing through the transmitter.

3. The system as claimed in either of the preceding claims, characterized in that the product $R.d_{inter}$ of the inter-receiver distance d_{inter} between two adjacent receivers of said layer and the radius *R* of the form described by the receivers of said layer is greater than or equal to the square R_{mono}^2 of the detection radius R_{mono} of the equivalent monostatic sonar for a target of minimum given index:

$$R_{mono}^{2} \leq R.d_{inter}$$

4. The system as claimed in one of the preceding claims, characterized in that the inter-receiver distance d_{inter} between two adjacent receivers of said layer by the radius *R* of the form described by the receivers of said layer is less than or equal to double the square of the detection radius R_{mono} of the equivalent monostatic sonar 2.R_{mono}^2 divided by the distance *D* from the transmitter to the segment formed by these two receivers, for a target of minimum given index:

$d_{inter} \leq 2.R_{mono}^{2}/D$

5. The system as claimed in one of the preceding claims, characterized in that it comprises at least one group (3), the receivers of said layer of the group, of at least partly circular form, being arranged on a circle of radius *R* equal to the detection radius R_{mono} of an equivalent monostatic sonar for a target of minimum given index, said layer of the group comprising 6 receivers forming a regular hexagon with a side equal to the radius of the circle, the maximum multistatic range from the transmitter being equal to the product of the radius of said circle *R* and the golden ratio, and in that, for any target having the minimum given index and situated inside this circle, the target is detected by at least two receivers.

6. The detection system as claimed in one of the preceding claims, characterized in that each receiver is configured so as to receive signals in a frequency band lower than 30 kHz.

7. The detection system as claimed in one of the preceding claims, characterized in that it comprises at least two groups, and in that the elementary detection areas of at least some of the end receivers of a given detection group at least partly overlap with the end receivers of an adjacent detection group.

8. The detection system as claimed in claim 7, characterized in that it comprises at least one shared common receiver belonging simultaneously to at least two adjacent groups (3).

9. The detection system as claimed in one of the preceding claims, characterized in that it comprises at least one sensor chosen from among the group consisting of a magnetic sensor, an acoustic sensor, a non-acoustic sensor, and in that it comprises a

classification unit configured so as to use information derived from the signals of the sensor or sensors to classify the target.

10. The detection system as claimed in claim 9, characterized in that the signals of at least some of the receivers are used by said classification unit to classify the detected targets, and in that each receiver is configured so as to operate at least acoustically simultaneously in passive and active mode, each receiver in passive mode processing frequencies lower than the frequencies processed in active mode, a passive acoustic classification being performed by slaving the active tracking, the acoustic or non-acoustic range being at least equal to half the maximum distance between two neighboring receivers, so as to perform classification at least when the target passes between them.

11. The detection system as claimed in one of the preceding claims, characterized in that it comprises at least one group having at least two layers of receivers, the receiver layers being arranged at different reference transmitter-receiver distances.

12. The detection system as claimed in claim 11, characterized in that it comprises layers of receivers that are linear or at least partly circular and concentric, the linear layers comprising receivers aligned substantially in a line, some receivers being shared between two groups.

13. The system as claimed in claim 12, characterized in that the center of the circles described by the concentric layers of a given group coincides substantially with the transmitter, and in that, for propagation losses equal to K times the logarithm of the distance of the propagation paths *TL*, the ratio between the product $d_{inter1}R_1$ of the inter-receiver distance associated with a layer and the radius R_1 of this layer and the product $d_{inter2}R_2$ of the inter-receiver distance d_{inter2} associated with another layer and the radius R_2 of this other layer is determined according to the maximum detection index deviation Δ(*TS*) of the possible targets:

$$2Klog\ ((d_{inter_2}.R_2)/(d_{inter_1}.R_1)\ = \Delta(TS)$$

14. The detection system as claimed in one of the preceding claims, characterized in that it comprises at least one multistatic group, and in that the transmitter (31) of the group is a low-frequency transmitter, of hull sonar of a surface ship type, the receivers

being positioned around the surface ship and communicating with the surface ship in radio mode.

15. The detection system as claimed in one of the preceding claims, characterized in that it comprises a group whose transmitter (31) is not omnidirectional, and in that, in order to determine the positioning of each receiver RXi, the detection radius of the equivalent monostatic sonar is a function of the angle θi denoting the angle of insonification of the transmitter toward said receiver RX_i with respect to the direction of maximum transmission of the transmitter.