

A T L A S E L E K T R O N I K G m b H
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5 METHOD FOR PRODUCTION OF AN ANTENNA SECTION FOR AN
 UNDERWATER ANTENNA

10 The invention relates to a method for production of an
 antenna section, which has hydrophones at a distance
 from one another, for an underwater antenna which can
 be assembled from a plurality of antenna sections, of
 the generic type defined in the precharacterizing
 clause of claim 1.

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 A known underwater antenna (DE 195 18 461 C1), which is
 in the form of a towed array, comprises a plurality of
 towed array sections whose section ends are adjacent to
 one another. Each towed array section has a plurality
20 of hydrophones which are arranged in a row one behind
 the other at a constant distance from one another, are
 accommodated in a flexible tube, which can bend
 elastically and is composed of polyethylene, and are
 fixed in their position at a distance from one another
25 and at a distance from the flexible tube wall by a gel
 which is adhesively bonded to them. The hydrophones are
 connected to the signal line and to electrical lines
 which are used for supplying power and are composed of
 copper or are in the form of optical fibers, which are
30 passed out of the towed array section at the section
 ends for connection to the next towed array section. In
 order to produce a towed array section, the hydrophones
 associated with it are fixed at the precise
 longitudinal distance from one another in a very coarse
35 nylon mesh with a small number of relatively elastic
 longitudinal threads. The so-called element skeleton
 that is produced in this way is floated into the
 flexible tube together with the still liquid gel, with

measures being taken to fix the hydrophones centrally in the flexible tube while being adhesively bonded to the gel. Measures such as these may, for example, comprise the flexible tube being rotated during the adhesive bonding of the gel, so that the skeleton is aligned centrally, or comprise soft, thin bristles being arranged on the skeleton, which are supported on the inner wall of the flexible tube and thus ensure that the hydrophones are centralized.

The invention is based on the object of specifying a method, which is cost-effective from the production engineering point of view, for production of an antenna section, by means of which the hydrophones can be mounted with accurate tolerances with respect to the antenna section.

According to the invention, the object is achieved by the features in claim 1.

The method according to the invention has the advantage that the hydrophones are introduced centrally into the predetermined cavity in a position such that the distances between them are accurate, by simple assembly means, and are fixed in this position by means of the gel, which forms an adhesive bond in a short time period. The suction lifter for transportation and positioning of the hydrophones is simple to manufacture and requires only minor tool costs. The method can be fully automated, in which case the assembly time can also be significantly shortened by the provision of assembly means which operate in parallel, such as suction lifters and grippers. The method can be used not only for production of antenna segments for so-called towed arrays, in which the hydrophones are accommodated arranged in a row one behind the other in a flexible tube which can bend elastically, but also for the production of antenna segments for so-called

antenna arrays, in which the hydrophones are accommodated in rows and/or columns in plastic encapsulation at a constant distance from one another. The plastic encapsulation may be both a planar body and
5 a curved, stiff body.

Expedient embodiments of the method according to the invention, together with advantageous developments and refinements of the invention, are specified in the
10 further claims.

According to one advantageous embodiment of the invention, a tube whose external diameter is considerably smaller than the external diameter of the
15 hydrophones, which are in the form of spheres, is used as the suction lifter. A suction pressure or vacuum pressure is produced at that end of the tube which is remote from the hydrophone, so that the hydrophone is held by means of suction force at the front end of the
20 tube, is moved into the cavity and is held in its position there until the adhesive gel bond has formed. The suction lifter is then detached from the hydrophone by removal of the suction pressure.

25 The invention will be described in more detail in the following text with reference to one exemplary embodiment which is illustrated in the drawing, in which:

30 Figure 1 shows a schematic illustration of individual method steps in the method for production of an antenna section,

35 Figure 2 shows a detail of an antenna section, which has been produced using the method, for an underwater towed antenna,

Figure 3 shows a detail of an antenna section, which has been produced according to the method, for an underwater antenna array.

5 The method whose individual method steps are illustrated in Figure 1 is used, by way of example, to produce an antenna section for a so-called towed antenna, a detail of which is illustrated in the form of a schematic section in Figure 2. The antenna section
10 has a flexible tube 11 which is preferably composed of polyethylene, and a plurality of hydrophones 12, which are arranged in a row one behind the other, at a constant distance from one another and in this may be in the form of spherical elements or else may have
15 other geometric shapes, for example a cylindrical shape. The hydrophones 12 are arranged centrally in the flexible tube 11 at a radial distance from the flexible tube wall, and are fixed in their position by a gel filling 13 in the flexible tube 11. The hydrophones 12
20 are connected to electrical lines composed of copper or to glass fibers, which are used for carrying signals and to supply power to the hydrophones 12. The antenna section as shown in Figure 2 is produced as follows using the method illustrated in Figure 1:

25 The empty flexible tube 11, which represents a cavity 20, is aligned vertically and is closed at one end by a closure plate 15. A suction lifter 16 (Figure 1a) is used for transportation and positioning of the
30 hydrophones 12. The suction lifter 16 comprises a tube 17 whose unobstructed tube diameter is considerably smaller than the external diameter of the hydrophones 12, which are in the form of spheres. A suction pressure or vacuum pressure is produced at that tube
35 end which is remote from the tube end which points toward the hydrophone 12, as is indicated by the arrows 18 in Figure 1.

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This suction pressure fixes the hydrophone 12 to the tube end, allowing it to be transported by means of the suction lifter 16 (Figure 1b).

5 A first hydrophone 12 is now inserted centrally into the flexible tube 11 at a predetermined distance from the flexible tube end, that is to say from the closure plate 15, and is held in this position (Figure 1c). An amount of liquid gel 19 is now introduced into the
10 flexible tube 11 such that the hydrophone 12 which is held by the suction lifter 16 is partially surrounded by the gel 19. The amount of gel must not be so great that the tube 17 of the suction lifter 16 is also surrounded by the gel 19. By way of example, the amount
15 of gel introduced in Figure 1 is such that half of the hydrophone 12 is surrounded by the gel 19. The suction pressure on the suction lifter 16 and the positioning of the suction lifter 16 are maintained until the gel 19 has largely formed an adhesive bond, that is to say
20 it has formed a gel (Figure 1d). As a result of the gel formation, the hydrophone 12 can no longer change its position in the flexible tube 11 when the suction pressure for the suction lifter 16 is switched off and the suction lifter 16 is removed from the flexible tube
25 11 again (Figure 1e). The suction lifter 16 is used to grip a further hydrophone 12 (Figure 1f) and to move it into the flexible tube 11 at a predetermined distance from the previously inserted hydrophone 12 (Figure 1g). The second hydrophone 12 is held in this position while
30 liquid gel 19 is once again introduced into the flexible tube 11, partially surrounding the second hydrophone 12 (Figure 1h). Once the new gel filling has formed a gel, then the suction lifter 16 is lifted off from the second hydrophone 12 by switching off the
35 suction pressure, and is removed from the flexible tube 11 (Figure 1i). The suction lifter 16 is used to grip a new hydrophone 12 (Figure 1k), which is inserted into the flexible tube 11 in the same way as that described

above, after which liquid gel 19 is once again introduced. The described method steps are repeated until the predetermined number of hydrophones 12 have been inserted into the flexible tube 11.

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The antenna section, a detail of which is illustrated in Figure 3, for an underwater antenna array, a so-called flat antenna, is produced using the same method as that illustrated in Figure 1. The antenna section
10 has a cavity 20 in the form of a plurality of channels 21 which are arranged at the same distance from one another, are embedded in a plastic body 22, and pass entirely through it. These cylindrical channels 21 are produced by inserting small tubes into a casting mold
15 at a predetermined distance from one another, and encapsulating them with plastic. After removal from the mold, the small tubes are removed again from the plastic body 22, thus resulting in the cylindrical channels 21 which pass completely through the plastic
20 body 22. As can be seen from Figure 3, four hydrophones 12, by way of example, are arranged one above the other and at a defined distance from one another in each channel 21 and maintain a radial distance from the inner wall of the channel 21. The channel 21 is filled
25 with the gel 19, and the gel 19 fixes the hydrophones 12, once it has formed a gel. Each hydrophone 12 is connected to an electrical supply line 14, and all of the electrical supply lines are passed out on one side of the channels 21.

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The hydrophones 12 are introduced into the channels 21 in the plastic body 22 in the same manner as in Figure 1 for the flexible tube 11, which likewise forms a cavity 20, for the towed antenna as shown in
35 Figure 2. The plastic body 22 is for this purpose placed on a closure plate 15 at the position illustrated in Figure 3, so that all of the channels 21 are closed at the lower end. The individual hydrophones

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12 are then inserted - as described with reference to Figure 1 - into the channels 21 by means of suction lifters 16, which preferably operate in parallel, and the channels 21 are successively filled with gel 19, as
5 described in Figure 1. This results in the antenna section, a detail of which is sketched in Figure 3, and which can have further identical antenna sections added to it, whose plastic bodies are placed on the plastic
body 21 in the longitudinal direction or lateral
10 direction, to form a flat antenna. The hydrophones 12 which are held "floating" in the plastic body 21 by means of the gel filling 13 are largely decoupled, in terms of sound, from the plastic body 21.

PATENT CLAIMS

1. A method for production of an antenna section, which has hydrophones at a distance from one another, for an underwater antenna which can be assembled from a plurality of antenna sections, in which the hydrophones (12) are introduced in a row one behind the other into an elongated cavity (20), at a distance from one another and at a distance from the inner wall of the cavity (20), and the cavity (20) is filled with a liquid gel (19) in order to fix the hydrophones (12), which liquid gel (19) forms a gel after being introduced, characterized in that each hydrophone (12) is inserted and held approximately centrally by means of a suction lifter (16) into the cavity (20), whose longitudinal axis is aligned essentially vertically, at a predetermined distance from the previously inserted hydrophone (12), an amount of liquid gel (19) is then introduced into the cavity (20) such that the liquid gel (19) at least partially surrounds the hydrophone (12) which is being held by the suction lifter (16), in that, once the gel (19) which has been introduced has formed a gel, the suction lifter (16) is removed from the cavity (20) for insertion of a next hydrophone (12) and in that these method steps are repeated until the predetermined number of hydrophones (12) have been placed in the cavity (20).

2. The method as claimed in claim 1, characterized in that a flexible tube (11) which defines an antenna section of the underwater antenna is used as the cavity (20).

3. The method as claimed in claim 2, characterized in that polyethylene is used as the flexible tube material.

4. The method as claimed in claim 1, characterized in that a plurality of channels (21), which preferably run parallel at the same distance from one another, are used as the cavity (20) in a plastic body (22) which
5 defines one antenna section of the underwater antenna.

5. The method as claimed in claim 4, characterized in that small tubes are inserted, separated from one another but parallel, into a casting mold in order to
10 produce the channels (21), and are encapsulated with plastic, and in that, after removal from the mold, the small tubes are removed from the plastic body (22).

6. The method as claimed in one of claims 1-5,
15 characterized in that a tube (17) whose unobstructed diameter is less than the external diameter of the hydrophones (12), which are in the form of spheres, is used as the suction lifter (16), and in that the one
tube end of the suction lifter (16) is placed on the
20 hydrophone (12), and a suction pressure is produced at the other tube end.