

SPECIFICATION

A method of mounting a device having an an opening on a ship

5 This invention relates to a method of mounting a device having an opening on a ship, and more particularly, but not exclusively, relates to a method of mounting a ring-shaped device in front of the
10 propeller of a propeller driven ship.

In recent years, in order to get a higher economical efficiency from a ship, the building cost has been reduced by adopting a hull form which is as full as possible for the required dead weight. However, the
15 fullness of hull form increases turbulent flow around the hull and a turbulent flow pattern is produced especially in the vicinity of the ship's stern. As the result, these phenomena cause not only an increase in fluid resistance and a decrease of propulsive
20 efficiency, but also increases in propeller cavitation, hull vibration and noise for example.

It has been found experimentally, from a detailed investigation of flow in the vicinity of the ship's stern, that the turbulent flow and the inequality of
25 flow field around the propeller can be reduced by providing a ring-shaped device which is mounted on the ship's stern in front of the propeller and which does not overlap the propeller. Such a device can reduce the amount of power required, propeller
30 cavitation, vibration and noise.

The ring-shaped device is mounted directly to the ship's stern and/or indirectly via supporting members. It is important that the ring-shaped device is mounted precisely on the ship's stern.

35 If the accuracy of the mounting is low, the effect of the ring-shaped device is decreased. The ring-shaped device is generally large in size, for example in case of a hull of a 250,000 tons tanker, the ring-shaped device has the following dimensions:
40 inner diameter of about 900 cm, length of about 450 cm, and weight of about 90 tons.

It is difficult to mount such a large scale ring-shaped device precisely on the ship's stern without a large amount of error.

45 According to the present invention there is provided a method of mounting a device having an opening on a ship, the method comprising the steps of:

(a) marking the device at a plurality of positions
50 thereon which are an equal distance from a predetermined line passing through the device;

(b) locating the device on the hull of the ship with said predetermined line of the device substantially coincident with a predetermined line passing
55 through the ship; and

(c) effecting a final adjustment of the position of the device with the aid of a source of electromagnetic radiation mounted for rotation about the predetermined line passing through the ship, the source of
60 electromagnetic radiation being used to illuminate the marked positions of the device to indicate any misalignment of the device.

Preferably the ship is a propeller driven ship including a propeller shaft and the predetermined
65 line passing through the ship is coincident with the

axis of the propeller shaft. Preferably the device comprises a ring-shaped device and the predetermined line passing through the device is coincident with the axis of the ring-shaped device.

70 The present invention also provides a ship including a device which has been mounted according to the method of the present invention.

For a better understanding of the present invention and to show more clearly how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings in which

Figure 1 is a side view of part of a ship provided with a ring-shaped device on the stern of the ship;

80 *Figure 2* is a side view, partially in section, of the ring-shaped device mounted on the ship's stern;

Figure 3 is a side view of another embodiment of the ring-shaped device mounted on the stern of another ship;

85 *Figure 4* is a rear view of the ring-shaped device;

Figure 5 is a vertical section through the ring-shaped device of *Figure 4*;

Figure 6 is a plan view of the ring-shaped device of *Figures 4* and *5*;

90 *Figure 7* is an explanatory drawing of the procedure for fixing members to a ring-shaped member and marking the members;

Figure 8 shows the markings made on the ship's hull;

95 *Figure 9* shows a section along the line IX-IX of *Figure 8*;

Figure 10 shows a section along the line X-X of *Figure 8*;

Figure 11 shows a side view of a source of electromagnetic radiation rotatably mounted with respect to the propeller shaft;

Figure 12 shows a section along the line XII of *Figure 11*;

Figure 13 shows schematically the mode of operation of the source of electromagnetic radiation;

105 *Figure 14* shows schematically the mode of operation of a source of electromagnetic radiation mounted on the propeller;

Figure 15 shows a rear view of a ring-shaped device comprising two arcuate members; and

110 *Figure 16* shows a plan view of the ring-shaped device of *Figure 15*.

Referring to *Figure 1*, a hull 1 of a ship is provided with a ring-shaped device 2 which is mounted on the ship's stern 1R in front of a propeller 3. A rudder 4 is located behind the propeller 3.

As shown in *Figure 1*, when the ring-shaped device 2 is mounted in a manner such that its leading edge lies within a range of turbulence in the flow field, the flow S_1 accompanied by 3-dimensional separation vortices S_2 directed upwards, in front of the ring-shaped device 2, can be regulated and homogenized into parallel substantially laminar flows. Moreover, the flow S_3 above the ring-shaped device 2 can be separated substantially from the flow S_1 by the ring-shaped device 2, so that the turbulence can be suppressed. In consequence, this ring-shaped device 2 reduces the hull resistance and serves as a flow regulator for the fluid flowing to the propeller 3, and supplies a fluid flow which allows
130

the propeller 3 to produce the thrust required.

Considering the mounting position of the ring-shaped device 2, if the ring-shaped device 2 is disposed too far forward of the propeller 3, particularly if it is forward from the propeller by a distance more than 3 times the propeller diameter D_p , since the boundary layer at that position is thin (the thickness of the slow current portion of the fluid flowing adjacent the hull is thin), an effective utilization of the wake is hardly realized. If the leading edge of the ring-shaped device 2 lies too close to the propeller 3 and away from the stern frame, where the wake is in a condition of being diffused, an effective guiding of the wake into the operative plane of the propeller 3 becomes difficult.

Further, if the length of the ring-shaped device 2 is too short, the effect of suppressing turbulence in the stern flow field and effectively guiding the flow cannot be realised; on the contrary, if it is too long, the resistance of this appendage itself becomes too large. Taking these various facts into consideration, the length of the ring-shaped device 2 should effectively be within a range of from about 20% to about 100% of the propeller diameter D_p .

At the position where the upper portion of the ring-shaped device 2 is directly joined to the hull, the distance from the rearmost joining point (in Figure 1, the intersecting point P of the upper end of the ring-shaped device 2 and the stern frame) to the foremost end of the ring-shaped construction 2, namely the length ℓ' of the portion of the device 2 directly joined to the hull, has to be more than 20% of the length ℓ of the ring-shaped device 2 in order to attain a suppression of flow turbulence and homogenization of flow and effective utilization of the wake as described above.

There is an intimate relationship between the inner diameter D_1 of the ring-shaped device 2 and the propeller diameter D_p .

As shown in Figure 1, in the inner face of the trailing edge of the ring-shaped device 2, the diameter D_1 is about 60% to about 150% of the propeller diameter D_p .

When D_1 is too large, the slow flow guided toward the propeller 3 by means of the ring-shaped device 2 cannot be effectively sent into the propeller operative plane, resulting in large loss of energy outside the propeller disc area; and on the contrary, when D_1 is too small, the rate at which the relatively fast flow outside the ring-shaped device 2 gets in the operative plane of the propeller 3 becomes greater, whereby the propulsive efficiency becomes lowered. Accordingly it is necessary to determine the diameter D_1 of the ring-shaped device 2 in consideration of the example of comparative experiments relating to a distribution of flow velocity flowing into the propeller of the ship.

The cross-sectional shape of the ring-shaped device 2 is also important. The ring-shaped device 2 has an aerofoil cross-section. However, since it is necessary to decelerate or diffuse flows near the ship's stern and supply the flow uniformly within the operative plane of the propeller 3, the cross-sectional shape of the ring-shaped device 2 should differ from that of prior art stern fins.

Namely, the ring-shaped device 2 has a cross-section having a convex face inside and straight face outside. Also, the angle of the outer straight face of the cross-section shape relative to the centre line of the hull should suitably be in a range of approximately -10 to 30 degrees.

Figures 2 and 3 show the conditions in which the said ring-shaped device 2 is mounted on a ship with an open stern and a ship with a closed stern respectively.

The ring-shaped device is provided with a notched portion at its upper side, which is welded to the stern after fitting on the ship stern 1R.

Furthermore, the upper end portion is secured to the stern 1R by a supporting member 7 welded to the hull 1 and device 2 together with covers 9 and 10. A portion of the lower end of the ring-shaped device 2 is fixed by a supporting member 8 in case of an open stern in Figure 2. On the other hand in case of the closed stern of Figure 3, the lower end of the device 2 is fixed directly to the stern 1R by the notched portion instead of with a supporting member.

According to the method of the present invention, firstly a plurality of centering members are fixed at a predetermined distance on a periphery, more preferably on a radially inner surface, of the ring-shaped device before fixing it to the ship's stern 1R. On these members, marking points which are located at an equal distance from the axis of the ring-shaped device 2 are marked or scribed. A source of electromagnetic radiation rotatable about the axis of the propeller shaft is provided. When the ring-shaped device 2 equipped with members is mounted on the stern, the position of the ring-shaped device is adjusted by referring the marked positions on the members one by one to a beam from the source of electromagnetic radiation. According to the centring operation using such a source, a precise mounting of the ring-shaped device can be attained.

The method for mounting the ring-shaped device according to the present invention consists of three steps: a preparatory operation step on the ring-shaped device on the ground; a preparatory operation step on the hull; and a final fitting operation step. The final fitting operation step comprises locating the device on the hull and then effecting a final adjustment of the position of the device. Hereunder a detail of the method for mounting the ring-shaped device on the ship's stern is described.

Firstly, the ring-shaped device 2 is designed and manufactured to conform to a hull of a ship. The ring-shaped device 2 has an elliptical shape as a whole as shown in Figures 4, 5 and 6, having a notched portion 11 at its upper end.

As the outer shape of the ring-shaped device 2 is decided by the required characteristics of the ship, the shape may be selected from a circular form or another form other than an elliptical form.

The flow cross-section of the forward end of the ring-shaped device 2 as a fitting part is formed larger than the flow cross-section of the rear end. The cross-section through the device 2 is aerofoil shaped, the inside surface forms a convex face, and the outside surface forms a straight face.

Besides the ring-shaped device 2, supporting members 7, 8 and covers 9, 10 as auxiliary parts as shown in Figure 2 are also manufactured. The fabrications of these parts are all carried out on the ground.

On the ring-shaped device 2 manufactured by the above procedure, first lines (M-A)U and (M-A)L are marked, these lines being intended to be coplanar in a vertical plane with the axis of the propeller shaft. Similarly, second lines (M-B)P and (M-B)S are marked, these lines being intended to be coplanar with the axis of the propeller shaft in a horizontal plane. The line connecting (M-B)P to (M-B)S and the line connecting (M-A)U to (M-A)L pass respectively through the axis of the ring-shaped device 2.

Next, eight members 15 as shown in Figure 7 are manufactured and fixed to an inside surface of the ring-shaped device 2 with their inner ends all at approximately the same distance from the axis of the ring-shaped device 2. Marking points P are scribed on these members 15 which points have the same distance from the centre "O" or axis of the ring-shaped device 2. In this case, the centre "O" is intended to be coincident with the axis of the propeller 3. Marking points P may be scribed on members 15 according to calculations based on drawings before the members 15 are fitted to the ring-shaped device 2, or marking points P may be scribed after fitting members 15 to the ring-shaped device 2. The number of members 15 is not limited to eight, but it may be changed to more or less number as needed.

On the ring-shaped device 2, a plurality of hanger members 16 and 17 are fixed as shown in Figures 4, 5 and 6. Hanger members 16 are fitted on an outer surface of the ring-shaped device 2, and hanger members 17 are fitted to a rear end portion of the ring-shaped device 2. These hanger members 16 and 17 are used as means for hanging up the ring-shaped device 2 during fitting.

On the side of the hull, a marking operation is performed in order to mark the positions for mounting the ring-shaped device 2. At first, as shown in Figure 8, a third, front end line (M-C), which corresponds to the intended position of the front end portion of the ring-shaped device 2, is marked symmetrically on both sides of outer plates of the ship stern 1R according to its design. Next, the fourth lines (M-D), which are coplanar with the axis of the propeller shaft and the propeller 3, are marked on a boss of the ship's stern and on both sides of ship stern 1R by using a level gauge. As shown in Figures 8, 9 and 10, a first point (M-2) is marked where the centre line of outer plate of ship stern 1R is intersected with the inside surface of the front end portion of the ring-shaped device 2. Similarly a second point (M-1) is marked where the centre line of outer plate of ship stern 1R intersects the keel of the hull.

The next step is the fitting operation.

In this step, the ring-shaped device 2 is fitted on the ship's stern 1R.

At first, the propeller 3 and the propeller shaft are removed from the ship's stern 1R. Next, after carrying the ring-shaped device 2 across the ground

at the rear of the ship's stern 1R, the ring-shaped device 2 is hung up by winches through wire ropes connected to hanger members 16 and 17 and manoeuvred to the neighbourhood of the rear of the rear portion of boss of the propeller shaft at the ship's stern 1R. The device 2 then has to be precisely positioned. Figure 7 shows a positional relationship between the ship's stern 1R and the ring-shaped device during a positioning step. Positioning the ring-shaped device 2 comprises the following steps:

A. Firstly, the front end of the ring-shaped device 2 is aligned with the marked third lines (M-C) on the ship's stern 1R, and the notched portion 11 of the ring-shaped device 2 engages the stern.

B. Next, by the fine adjustment of the position of the ring-shaped device 2 in a vertical direction, the first marked point (M-2) on the ship's stern 1R is coincided with the first marked line (M-A)U on the ring-shaped device 2. At the same time, the second point (M-1) on the ship's stern 1R is located such that it lies on an extension of the other first marked line (M-A)L on the ring-shaped device 2.

C. The device 2 at the rear end of the line (M-A)U is connected to one end of a wire the other end of which is attached to a weight 20. The wire hangs so that it contacts the other first line (M-A)L. It is then confirmed that the second point (M-1) is located in a vertical plane containing the wire and the propeller axis.

With the above procedures, the positioning has been almost finished, but it is still not confirmed whether or not the centre of the ring-shaped device 2 is coincident with the axis of the propeller shaft and propeller 3. Therefore the final adjustment of the ring-shaped device 2 using a source of electromagnetic radiation mounted for rotation about the axis of the propeller is made.

Figures 11 and 12 show a centring device. A bearing part 22 is provided for the propeller shaft which is removed. A temporary shaft 23 is inserted in the bearing part 22 and supported rotatably by bearing ring 24. A plurality of arms 25 are fixed to the periphery of the bearing rings 24, and are radially adjustable to allow the shaft 23 to be mounted coaxial with the normal position of the propeller shaft axis. Bolts 26 are included in the arms 25 to allow such adjustment to be made. The bolts 26 contact an inside wall of the bearing part 22. Accordingly, by adjusting bolts 26, the temporary shaft 23 can be arranged coaxially at the normal position of the propeller shaft and of the bearing part 22. At an end of the temporary shaft 23, a holder 27 is mounted, the holder 27 being rotatable around the centre of a pin 28. The inclined angle of the holder 27 can be adjusted by a bar 29. A projector 21, which comprises a source of electromagnetic radiation, is fixed to the holder 27 and can be adjusted together with the holder 27 as one body. Accordingly the direction of a beam 30 emitted by the projector 21 can be readily adjusted. The beam 30 emitted from the projector 21 is, in this case, visible light, preferably a laser beam.

When the temporary shaft 23 rotates, the projector 21 is rotated around the axis of the propeller 3. Accordingly, as shown in Figure 13, when the

position of the ring-shaped device 2 is adjusted finely so that the circular locus of the beam passes through the marked points P on the members 15 fixed to the ring-shaped device 2, the centre or axis of the ring-shaped device 2 is coincident with the axis of rotation of the propeller 3.

When the final adjustment is performed with the propeller 3 mounted on the ship's stern 1R, a similar operation can be performed if the projector 21 is fixed to the propeller 3 and rotated together with the propeller 3, as shown in Figure 14.

After the final adjustment, the notched portion 11 of the ring-shaped device 2 is welded to the ship's stern 1R. Next, supporting members 7 and 8 are welded temporarily, and then, after adjustment with the aid of the projector 21, a regular welding work is performed. After welding of supporting members 7 and 8, covers 9 and 10 are fixed by welding with the procedure as described before.

After the completion of fitting the ring-shaped device 2 to the ship's stern 1R, the temporary shaft 23 is removed, and the propeller shaft and the propeller 3 are reassembled. The projector 21 is then mounted on the propeller 3. The projector 21 is rotated, whereby the fitting accuracy is confirmed by reading the difference between the points illuminated by the emitted beam and the points P marked on the members 15.

After this operation, the projector 21 is removed, and the members 15 and the hanger members 16 and 17 mounted on the ring-shaped device 2 are removed. By these procedures, all fitting steps of the ring-shaped device have been finished.

Though the ring-shaped device described in the above embodied examples consists of one unit construction, a built-up construction of two separate members can be used. The examples shown in Figures 15 and 16 show a ring-shaped device 2 which comprises a combination of a first arcuate member 2A and a second arcuate member 2B. In case of fitting such a ring-shaped device 2 on to a ship's stern, firstly the first arcuate member 2A with the notched portion is mounted onto the stern. In this mounting, a temporary supporting member 12 is provided inside of the first arcuate member 2A. After mounting this first arcuate member 2A, a second arcuate member 2B is connected to the member 2A at points 18 and 19 to contact the first arcuate member 2A. In this operation, a temporary supporting member 13 is provided inside of the second arcuate member 2B. These temporary supporting members 12 and 13 are used for preventing deformation of the members 2A and 2B during assembling, and fitting with a high accuracy. The arcuate members 18 and 19 are then welded together at the points 18 and 19.

The ring-shaped device of the split type is convenient in the case when the mounting operation is performed with the propeller 3 in place, because separate members can be mounted to the ship's stern around the propeller 3 independently of each other. The split type construction is useful because it simplifies the fitting operation and because the propeller 3 and the propeller shaft do not have to be removed and then remounted.

In the embodied examples, the description above is directed to the case of an open stern, but the method can also be practicable in the case of a closed stern as shown in Figure 2.

70

CLAIMS

1. A method of mounting a device having an opening on a ship, the method comprising the steps of:

(a) marking the device at a plurality of positions thereon which are an equal distance from a predetermined line passing through the device;

(b) locating the device on the hull of the ship with said predetermined line of the device substantially coincident with a predetermined line passing through the ship; and

(c) effecting a final adjustment of the position of the device with the aid of a source of electromagnetic radiation mounted for rotation about the predetermined line passing through the ship, the source of electromagnetic radiation being used to illuminate the marked positions of the device to indicate any misalignment of the device.

2. A method as claimed in claim 1, wherein the ship is a propeller driven ship including a propeller shaft, and wherein the predetermined line passing through the ship is coincident with the axis of the propeller shaft.

3. A method as claimed in claim 2, where the device comprises a ring-shaped device and the predetermined line passing through the device is coincident with the axis of the ring-shaped device.

4. A method as claimed in claim 3, wherein the ring-shaped device comprises a plurality of members secured to a ring-shaped member, and wherein the marking of the ring-shaped device of step (a) is effected by marking the plurality of members either before or after the plurality of members are secured to the ring-shaped member.

5. A method as claimed in claim 4, wherein the plurality of members are secured to a radially inner surface of the ring-shaped member.

6. A method as claimed in claim 3, 4 or 5, wherein, before the step (b) is carried out, a plurality of markings are made on the ship at positions at or adjacent which the device is to be mounted, which markings are used for initially locating the device before making the final adjustment of step (c).

7. A method as claimed in claim 6, wherein, before the step (b) is carried out, a radially inner surface of the ring-shaped device is marked with two diametrically opposed first lines lying in a first plane including the axis of the ring-shaped device and with two diametrically opposed second lines lying in a second plane which includes the axis of the ring-shaped device and is perpendicular to the first plane, wherein the ship's hull is marked on either side with third lines indicating the intended forward position of the ring-shaped device, with fourth lines which include the axis of the propeller shaft and are symmetrically disposed on either side of the ship and with first and second points vertically above and below the propeller shaft respectively at positions corresponding to the position of the first lines, and

position of the ring-shaped device 2 is adjusted finely so that the circular locus of the beam passes through the marked points P on the members 15 fixed to the ring-shaped device 2, the centre or axis of the ring-shaped device 2 is coincident with the axis of rotation of the propeller 3.

When the final adjustment is performed with the propeller 3 mounted on the ship's stern 1R, a similar operation can be performed if the projector 21 is fixed to the propeller 3 and rotated together with the propeller 3, as shown in Figure 14.

After the final adjustment, the notched portion 11 of the ring-shaped device 2 is welded to the ship's stern 1R. Next, supporting members 7 and 8 are welded temporarily, and then, after adjustment with the aid of the projector 21, a regular welding work is performed. After welding of supporting members 7 and 8, covers 9 and 10 are fixed by welding with the procedure as described before.

After the completion of fitting the ring-shaped device 2 to the ship's stern 1R, the temporary shaft 23 is removed, and the propeller shaft and the propeller 3 are reassembled. The projector 21 is then mounted on the propeller 3. The projector 21 is rotated, whereby the fitting accuracy is confirmed by reading the difference between the points illuminated by the emitted beam and the points P marked on the members 15.

After this operation, the projector 21 is removed, and the members 15 and the hanger members 16 and 17 mounted on the ring-shaped device 2 are removed. By these procedures, all fitting steps of the ring-shaped device have been finished.

Though the ring-shaped device described in the above embodied examples consists of one unit construction, a built-up construction of two separate members can be used. The examples shown in Figures 15 and 16 show a ring-shaped device 2 which comprises a combination of a first arcuate member 2A and a second arcuate member 2B. In case of fitting such a ring-shaped device 2 on to a ship's stern, firstly the first arcuate member 2A with the notched portion is mounted onto the stern. In this mounting, a temporary supporting member 12 is provided inside of the first arcuate member 2A. After mounting this first arcuate member 2A, a second arcuate member 2B is connected to the member 2A at points 18 and 19 to contact the first arcuate member 2A. In this operation, a temporary supporting member 13 is provided inside of the second arcuate member 2B. These temporary supporting members 12 and 13 are used for preventing deformation of the members 2A and 2B during assembling, and fitting with a high accuracy. The arcuate members 18 and 19 are then welded together at the points 18 and 19.

The ring-shaped device of the split type is convenient in the case when the mounting operation is performed with the propeller 3 in place, because separate members can be mounted to the ship's stern around the propeller 3 independently of each other. The split type construction is useful because it simplifies the fitting operation and because the propeller 3 and the propeller shaft do not have to be removed and then remounted.

In the embodied examples, the description above is directed to the case of an open stern, but the method can also be practicable in the case of a closed stern as shown in Figure 2.

70

CLAIMS

1. A method of mounting a device having an opening on a ship, the method comprising the steps of:

(a) marking the device at a plurality of positions thereon which are an equal distance from a predetermined line passing through the device;

(b) locating the device on the hull of the ship with said predetermined line of the device substantially coincident with a predetermined line passing through the ship; and

(c) effecting a final adjustment of the position of the device with the aid of a source of electromagnetic radiation mounted for rotation about the predetermined line passing through the ship, the source of electromagnetic radiation being used to illuminate the marked positions of the device to indicate any misalignment of the device.

2. A method as claimed in claim 1, wherein the ship is a propeller driven ship including a propeller shaft, and wherein the predetermined line passing through the ship is coincident with the axis of the propeller shaft.

3. A method as claimed in claim 2, where the device comprises a ring-shaped device and the predetermined line passing through the device is coincident with the axis of the ring-shaped device.

4. A method as claimed in claim 3, wherein the ring-shaped device comprises a plurality of members secured to a ring-shaped member, and wherein the marking of the ring-shaped device of step (a) is effected by marking the plurality of members either before or after the plurality of members are secured to the ring-shaped member.

5. A method as claimed in claim 4, wherein the plurality of members are secured to a radially inner surface of the ring-shaped member.

6. A method as claimed in claim 3, 4 or 5, wherein, before the step (b) is carried out, a plurality of markings are made on the ship at positions at or adjacent which the device is to be mounted, which markings are used for initially locating the device before making the final adjustment of step (c).

7. A method as claimed in claim 6, wherein, before the step (b) is carried out, a radially inner surface of the ring-shaped device is marked with two diametrically opposed first lines lying in a first plane including the axis of the ring-shaped device and with two diametrically opposed second lines lying in a second plane which includes the axis of the ring-shaped device and is perpendicular to the first plane, wherein the ship's hull is marked on either side with third lines indicating the intended forward position of the ring-shaped device, with fourth lines which include the axis of the propeller shaft and are symmetrically disposed on either side of the ship and with first and second points vertically above and below the propeller shaft respectively at positions corresponding to the position of the first lines, and



20

wherein the step (b) comprises the following operations:

- (i) locating the ring-shaped device on the hull of the ship with a front edge of the ring-shaped device coplanar with the third lines;
- (ii) adjusting the vertical position of the ring-shaped device so that the second lines are coplanar with the fourth lines; and
- (iii) adjusting the horizontal position of the ring-shaped device so that the first lines are coplanar with the first and second points.

8. A method as claimed in claim 7, wherein the ring-shaped device includes a notch adapted to engage a corresponding projection of the ship's hull, and wherein the operations of step (b) are replaced by the following operations;

- (i) locating the ring-shaped device on the hull of the ship with a front edge of the ring-shaped device coplanar with the third lines and the notch engaging the projection of the ship's hull to align the ring-shaped member horizontally;

- (ii) adjusting the vertical position of the ring-shaped device so that the second lines are coplanar with the fourth lines and the first point on the ship's hull coincides with a point on the uppermost first line and so that the first lines are coplanar with the first and second points; and

- (iii) confirming that the first lines are coplanar with the second point by attaching one end of a wire (or other elongate member), the other end of which is attached to a weight, to the ring-shaped device so that the wire is coplanar with the first lines and checking that the wire is also coplanar with the second point and the axis of the propeller shaft.

9. A method as claimed in claim 7 or 8, wherein the propeller shaft of the ship is normally horizontal and, when the ring-shaped device is secured to the ship the first lines are normally disposed in a vertical plane and the second and fourth lines are normally disposed in a horizontal plane.

10. A method as claimed in any one of claims 2 to 9, wherein the ring-shaped device is mounted on the stern of the ship.

11. A method as claimed in any one of claims 2 to 10, wherein, after the step (c) has been carried out, the ring-shaped device is welded to the hull of the ship.

12. A method as claimed in any one of claims 2 to 11, wherein the ring-shaped device is elliptical.

13. A method as claimed in any one of claims 2 to 11, wherein the ring-shaped device is circular.

14. A method as claimed in any one of claims 2 to 13, wherein the source of electromagnetic radiation comprises a laser.

15. A method as claimed in any one of claims 2 to 14, wherein the ring-shaped device comprises two arcuate members.

16. A method as claimed in claim 15 when appendant to claim 8, wherein one of the arcuate members is provided with the notch.

17. A method as claimed in claim 16, wherein the arcuate member provided with the notch is mounted on the ship first, and then the other arcuate member is secured to the first-mentioned arcuate member.

18. A method as claimed in claim 15, 16 or 17,

wherein one or both of the arcuate members is/are provided with temporary support member(s), which are removed after the arcuate members have been mounted on the ship.

19. A method as claimed in any preceding claim, wherein the source of electromagnetic radiation is secured to the propeller.

20. A method as claimed in any one of claims 1 to 18, wherein the source of electromagnetic radiation is secured to a shaft rotatably mounted in a tube of the ship in which the propeller shaft is normally rotatably mounted, the propeller and propeller shaft being removed from the ship.

21. A method substantially as hereinbefore described with reference to Figure 1; Figure 2 or 3; Figures 4, 5 and 6 or Figures 15 and 16; Figures 7, 8, 9 and 10, and Figures 11, 12 and 13, or Figure 14.

22. A ship including a device which has been mounted on the ship according to a method as claimed in any preceding claim.

Printed for Her Majesty's Stationery Office, by Croydon Printing Company Limited, Croydon, Surrey, 1982.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.