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(54) **Tug for rendering assistance to a larger vessel.**

(57) A tug (1) has a towing hook (6) mounted at the outer end of a towing arm (4), the inner end of which is mounted on the main deck (2) of the tug in a manner such that the arm (4) can swivel above the main deck (2) from one side (4*a*) to the other side (4*b*) of the tug about an upright axis. The arm (4) is also pivotted about a horizontal axis so that it can swing upwards and downwards and is mounted on a platform (12*a*, 12*b*) which is movable fore and aft on rails (14) on the main deck (2). The movements of the arm (4) are controlled by power mechanisms and they adjust the position of the point of action of the tow-line (7) in such a way that in whatever direction the tow-line (7) extends, even exactly athwartships from the tug, the line of action of the pull in the tow-line (7) produces only a small capsizing moment upon the tug. This capsizing moment is very much smaller than that which is produced by a similar pull of the tow-line connected to a tow-hook in a conventional fixed position on the main deck of the tug and on the centre line of the tug about 40% to 50% of the length of the tug from its stern. The arm (4) is preferably also mounted on a carriage (13) which is movable on rails (14) in a fore and aft direction on the deck (2) of the tug.

EP 0 174 067 A1

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Fig.1.

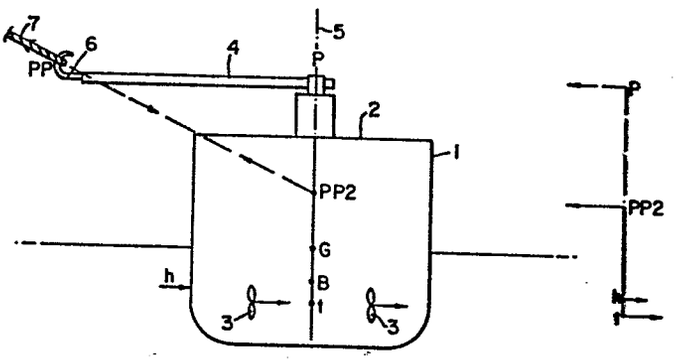
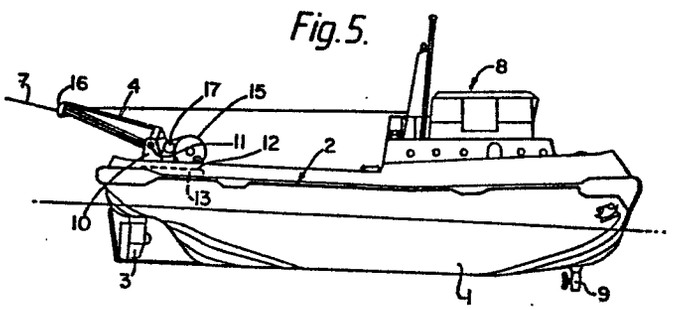


Fig.5.



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TUG FOR RENDERING ASSISTANCE TO A LARGER VESSEL

This invention relates to tugs for rendering assistance to a larger vessel, the tugs having towing means comprising a towing arm which is mounted at or near one end on the deck of the tug in a manner such that the arm can swivel above the deck from one side of the tug to the other about an upright axis and which, at its other end, is provided with tow-line receiving means.

In conventional tugs, the towing means usually consists of a towing hook which is fixed in position on the main deck of the tug and on the longitudinal centre line of the tug usually about 40% to 45% of the length of the tug from its stern.

When a tug is manoeuvring while it is rendering assistance to a larger vessel, three main forces act on the tug and these are the pull of the tow-line, the thrust of the propellers and the hydro-dynamic push of the water against the hull of the tug. The propellers of modern tugs are generally multi-directional and thus able to produce a thrust ahead, astern or in any lateral direction between ahead and astern. When the tow-line leads athwartships from the tug its pull is resisted by both the hydro-dynamic push of the water and by the thrust of the propellers.

Owing to the situation of the tow-hook on the main deck of the tug and on the longitudinal centre line of the tug, the three forces together produce a moment on the tug which causes it to heel. This moment can become very great and it is resisted by the natural stability of the tug in the water. To increase this stability in order to resist increased capsizing moments, it is necessary to increase the beam and displacement of the tug. This is not, however, very satisfactory because the greater the beam and weight, the less manoeuvreable the tug becomes and the power necessary to drive the tug at a particular speed is increased.

To reduce the heeling moment on the tug it has been proposed, for example in GB-A-817187 and FR-A-1232566 to mount the tow-hook on the outer end of an arm which can swivel above the deck of the tug from one side of the tug to the other about an upright axis. In this way, the point of action on the tug of the pull of a tow-line extending athwartships from the tug is laterally offset from the centre line of the tug in the direction of pull of the tow-line. Owing to this offsetting of the point of action of the pull of the tug tow-line on the tug, the line of action of the pull moves downwards and accordingly the heeling moment produced by the pull in the tow-line and the reactionary thrust produced by the hydro-dynamic push and the thrust of the propellers is substantially reduced.

The aim of the present invention is to construct the towing means of a tug as initially described in such a way that the heeling moment on the tug which results from an athwartships pull on a tow-line extending from the towing means is reduced still further than with the arrangement just described.

To this end, according to this invention, a tug as initially described is characterised in that the towing arm is mounted so that it is swingable upwards and downwards within a limited angular range by a power-operated driving mechanism and has means for holding it in any position into which it is swung.

Preferably, to enable the towing arm to align itself about its upright swivelling axis with the towline, the angular range of the swivelling movement of the towing arm is at least 180°. That is to say the towing arm can swivel at least from a position directly abeam on one side of the tug through a position which is directly aft to a position which is directly abeam on the other side of the tug.

By making the towing arm upwardly and downwardly swingable as well as being able to swivel from side to side, the point of action of the pull of the tow-line on the tug, which is situated at the

tow-line receiving means at the other end of the towing arm, is adjustable in position upwards and downwards relative to the tug and the line of action of the pull is similarly adjusted. By adjusting the point of action and thus also the line of action similarly, the pull of the tow-line can be balanced against the propeller thrust and the hydrodynamic push in such a way that the tug has no heeling moment acting upon it at all. By moving the point and line of action still further downwards, it is possible, if required, to move the line of action of the pull of the tow-line low enough to cause the pull of the tow-line to produce a righting moment if the tug is heeled.

The angular range of the upward and downward swinging movement is preferably between 35° downwards and 20° upwards from a horizontal position. The horizontal position is defined as the position which the arm adopts when the tug is exactly upright and the towing means is at the same level as the axis about which the arm is swingable upwards and downwards.

Preferably the towing arm is also mounted so that it is additionally displaceable in a fore and aft direction on the deck of the tug and has means for holding it at least in its foremost and aftermost positions.

The fore and aft displaceability of the towing arm is very desirable and there are two particular positions in which it is most likely to need to be set when the tug is in operation. These are in its aftermost position, which is generally about 10% of the tug's length from its after end to create a satisfactory

line of action for the tow-line when the tug is used as a stern tractor; and in its foremost position, which is generally about 40% of the tug's length from its after end. This second position is desirable to enable the tug's propellers at its after end to exert a moment to turn the tug about the point of attachment of the tow-line for manoeuvring purposes. It is also desirable for the arm to be able to be held in intermediate fore and aft positions as well. When the towing arm is mounted so that it is displaceable in the fore and aft direction, the range of the displacement is therefore preferably from about 10% to about 40% of the length of the tug from its after end. In order to permit the fore and aft displacement of the towing arm, it may be mounted on a carriage which runs on rails extending fore and aft on the main deck of the tug.

The main function of the towing arm is to balance as far as is practicable the pull of the tow-line with the propeller thrust and the hydrodynamic push for stability reasons and for this purpose, the arm may be placed in any position on the deck of the tug in dependence on the possible different placements of the propeller or propellers on the tug.

The tow-line receiving means may be a tow-hook of a conventional type which is attached to the other end of the towing arm but when, as is sometimes desirable, it is required for the length of the tow-line to be readily adjustable during towing, a tow-line winch is mounted adjacent to the one end of the towing arm and partakes of the swivelling movement of the arm and the tow-line receiving means is then a tow-line guide which guides the tow-line from the other end of the arm to the winch.

The winch may be of the simple type having a drum which is rotated in one direction to wind in the tow-line by a motor and allows the tow-line to be payed out against the action of a brake. In this case the driving motor and the brake of the winch are operated as necessary to adjust the length of the tow-line. Alternatively, however, the winch may be of the tension type which is commonly hydraulically operated and which is controlled automatically in dependence upon the tension in the tow-line in such a way that the tow-line is automatically payed out if the tension rises above a pre-determined value and the tow-line is wound in if the tension falls below another lower pre-determined value.

All the movements of the towing arm, that is the swivelling movement about an upright axis and the fore and aft movement, as well as the upward and downward swinging movement are preferably power operated by driving mechanisms. In this case, in order to reduce the number of operations which must be controlled by the tug Master when a tug is rendering assistance to a larger vessel, the driving mechanism for swinging the arm upwards and downwards is preferably controlled automatically by a control device in dependence upon the angle of heel of the tug to reduce automatically the capsizing moment acting on the tug.

For the same reason, the tug master should preferably not need to control continuously the direction of the towing arm around its vertical axis when the tug is pulling on the tow-line. This can be done by releasing the arm so that it is free to swing about its vertical axis to align itself with the towline or by automatically controlling the arm for this purpose.

The lateral force exerted by the tow-line under tension on the arm if the arm is not aligned with the tow-line can be used for actuating any automatic control mechanism for this purpose.

Two examples of tugs in accordance with the invention will now be described with reference to the accompanying diagrammatic drawings in which:-

Figure 1 is a highly diagrammatic cross-section through both examples of the tug showing the towing arm in one positon and the tug upright;

Figure 2 is a highly diagrammatic cross-section similar to Figure 1, but showing the tug heeled;

Figure 3 is a highly diagrammatic cross-section similar to Figures 1 and 2, but showing the tug heeled still further;

Figure 4 is a highly diagrammatic cross-section similar to Figure 1, but showing the towing arm in a different position;

Figure 5 is a less diagrammtic side view of the first example of a tug to a smaller scale;

Figure 6 is a plan view of the tug shown in Figure 5; and,

Figure 7 is a view similar to Figure 5, but showing a tug with a modified towing arm.

Referring to Figure 1, the tug has a hull 1 with a main deck 2 and twin multi-directional rudder propellers 3, which in this example are mounted right aft. A towing arm 4, which in this example is shown extending horizontally, that is parallel to the main deck 2, has one end pivotally mounted on the main deck 2 so that it can swivel about a vertical axis 5, which

coincides with the vertical centre line of the hull 1. At its other end, the towing arm carries a tow-hook 6 from which a tow-line 7 extends at an upward inclination to a larger vessel to which the tug is rendering assistance. The towing arm 4 is of such a length that when it extends athwartships from the tug as shown in Figures 1 to 4, the tow-hook 6 is situated beyond the side of the hull 1.

Referring to Figures 1 to 4, G is the centre of gravity of the tug; B is the centre of buoyancy; pp is the point of application of the pull of the tow-line 7 to the tug, which is situated at the tow-hook 6; h is the line of action of the resultant of the hydro-dynamic push of the water against the hull 1; t is the point of action of the resultants of the thrusts of the propellers 3; and p is the point of action at which the pull of the tow-line would be applied to the tug if the tug were fitted with a fixed tow-hook in a conventional position.

As the tug heels as shown in Figure 2, point B shifts to B1 and the buoyancy forces acting upon the tug pass upwards through this point. The weight of the ship acts downwards through the point G so that a righting moment is produced equal to the distance GZ multiplied by W where W is the displacement of the tug. As the tug heels, pp2 also moves much lower. As a result there is a much smaller capsizing moment arm equal to the distance between pp2 and the resultant of h and t as shown in Figure 2 whereas the capsizing moment arm between p and the resultant of h and t which occurs with a conventionally located towing-hook is hardly

reduced at all. Accordingly the tug reaches a position of stable equilibrium with a very much smaller heel owing to the provision of the towing arm 4.

As can be seen from Figure 3, if the tug heels still further, the line of action of the pull of the tow-line 7 moves below the resultant of h and t on the centre line of the hull and in consequence the pull of the tow-line 7, the hydro-dynamic push and the thrusts of the propellers 3 together produce a righting moment. This righting moment together with the righting moment produced by the buoyancy of the tug, would cause the tug to reduce its angle of heel very quickly and move back to the equilibrium position shown in Figure 2.

Referring to Figure 4, if, instead of the tug heeling, the towing arm 4 is swung downwards from the horizontal position shown at 4', the point of action pp of the pull of the tow-line is lowered so that the tug remains in stable equilibrium under the pull of the tow-line and the propeller and hydro-dynamic thrusts without heeling at all. Thus by allowing the towing arm 4 to swivel about its upright axis to follow the line of pull of the tow-line 7 as seen from above and by positively swinging the towing arm 4 upwards or downwards by means of a power drive and holding it in a position into which it is swung, the heeling of the tug as the direction of the pull of the tow-line changes can be very closely controlled.

When the tug is being used to tow a larger vessel ahead, the tow-line may lead at a sharp inclination upwards from the tug to the bow or stern of the assisted vessel and under these circumstances, particularly when the tow-line leads directly, or nearly directly, astern from the tug, it is better for the towing arm to be inclined upwards from the tug. When the tow-line leads athwartships from the tug, however, the towing arm should be horizontal or be inclined downwardly as explained with reference to Figure 4.

Generally for towing ahead and when the tug is performing stern tractor manoeuvres, an upward inclination of the towing arm of up to about 20° is sufficient. Depending upon the length of the towing arm, the arm should be inclined downwards at an angle of up to about 35° when the tow-line extends athwartships from the tug.

Referring to Figures 5 and 6, the tug has a super-structure 8 and a bow propeller 9, which is retractable into the hull in addition to the stern propellers 3.

The towing arm 4 is mounted on a bracket 10 so that it is upwardly and downwardly swingable about an axis 11. The bracket 10 is mounted on a platform 12 which is rotatable about an upright axis so that the arm 4 can swivel about this upright axis into any positions between the positions shown at 4a, 4b and 4c in Figure 6.

The platform 12 is in turn mounted on a carriage 13 which is movable along rails 14 between the aft position shown at 12a and the forward position shown at 12b in Figure 6.

The platform 12 also carries a winch 15 and the tow-line 7, instead of being connected to a tow-hook at the end of the arm 4 passes through a fairlead 16 at the outer end of the arm 4 and then around a further guide to the drum of the winch 15.

Driving mechanisms 17, which are operated by electric motors, are provided on the platform 12 for swinging the towing arm 4 upwards and downwards about its pivot axis 11 and for rotating the platform 12 to effect the side to side swivelling movements of the arm 4. The mechanisms 17 include means for holding the arm 4 in any position into which it is swung or swivelled. The movement of the carriage 13 along the rails 14 is performed by a further driving mechanism, which moves the carriage by means of cables or chains and holds the carriage in any position into which it is moved.

In Figure 5 the towing arm 4 is shown in the position in which it is set for towing a vessel being assisted ahead with the tow-line 7 extending directly astern from the tug.

The hull and superstructure of the tug shown in Figure 7 are the same as those of the tug shown in Figures 5 and 6, but it is provided with a different

towing arm assembly 18. The assembly 18 has a towing arm 19 which is balanced by a counterweight 20. In this Figure, the towing arm 19 is shown in a stowed position. The arm 19 is swung upwards and downwards and held in any position into which it is swung by means of cables 21 and 22 leading to a winch mechanism 23.

The towing arm 19 together with the winch mechanism 23 are again mounted on a platform 24 which is rotatable about an upright axis and is itself mounted on a carriage 25 which is movable in a fore and aft direction on rails 26.

If owing to some failure the towing arm gets jammed in the wrong position it can form a powerful capsizing lever under the pull of the tow-line. Conventional tugs used for assisting vessels in restricted waters, have emergency tow-line releasing means remotely controlled by the tug master and such emergency tow-line releasing means are also preferably provided on the towing arm of the tug in accordance with the present invention. When such a release is provided, it is preferably automatically actuated when the angle of heel of the tug reaches a predetermined maximum. For this purpose the same control device may be used as that which controls the upward and downward swinging of the arm.

CLAIMS

1. A tug for rendering assistance to a larger vessel, the tug having towing means comprising a towing arm which is mounted at or near one end on the deck of the tug in a manner such that the arm can swivel above the deck from one side of the tug to the other about an upright axis and which, at its other end, is provided with tow-line receiving means, characterised in that the towing arm is mounted so that it is swingable upwards and downwards within a limited angular range by a power-operated driving mechanism and has means for holding it in any position into which it is swung.

2. A tug according to Claim 1, characterised in that the angular range of the swivelling movement of the arm from one side of the tug to the other is at least 180°, that is at least from a position abeam on one side, through an aft position and to a position abeam on the other side of the tug.

3. A tug according to Claim 1 or Claim 2, characterised in that the angular range of the upward and downward swinging movement of the arm is between 35° downwards and 20° upwards from a horizontal position substantially parallel to the main deck.

4. A tug according to any one of Claims 1 to 3, characterised in that the towing arm is mounted so that it is additionally displaceable in a fore and aft

direction on the deck of the tug and has means for holding it at least in its foremost and aftermost positions.

5. A tug according to any one of Claims 1 to 4, characterised in that the range of the fore and aft displacement of the arm is from 10% to 40% of the length of the tug from its aft end.

6. A tug according to any one of the preceding Claims, characterised in that the towing arm is mounted on a carriage which is movable on rails extending fore and aft on the main deck of the tug to provide the fore and aft displacement.

7. A tug according to any one of the preceding Claims, characterised in that the tow-line receiving means is a tow-hook attached to the other end of the towing arm.

8. A tug according to any one of the prceding Claims, characterised in that a tow-line winch is mounted adjacent the one end of the towing arm and partakes of the swivelling movement of the arm, and the tow-line receiving means is a tow-line guide which guides the tow-line from the other end of the arm to the winch.

9. A tug according to Claim 8, characterised in that the winch is of the tension type, which is controlled in dependence upon the tension in the tow-line and automatically pays out the tow-line if the

tension rises above a pre-determined value and winds the tow-line in if the tension falls below another lower pre-determined value.

10 A tug according to any one of the preceding Claims, in which the swivelling movement about an upright axis and the fore and aft movement of the towing arm are also power-operated by driving mechanisms.

11. A tug according to Claim 10, characterised in that the driving mechanism for swinging the arm upwards and downwards is controlled by a control device in dependence upon the angle of heel of the tug to reduce automatically the capsizing moment acting on the tug.

Fig.1.

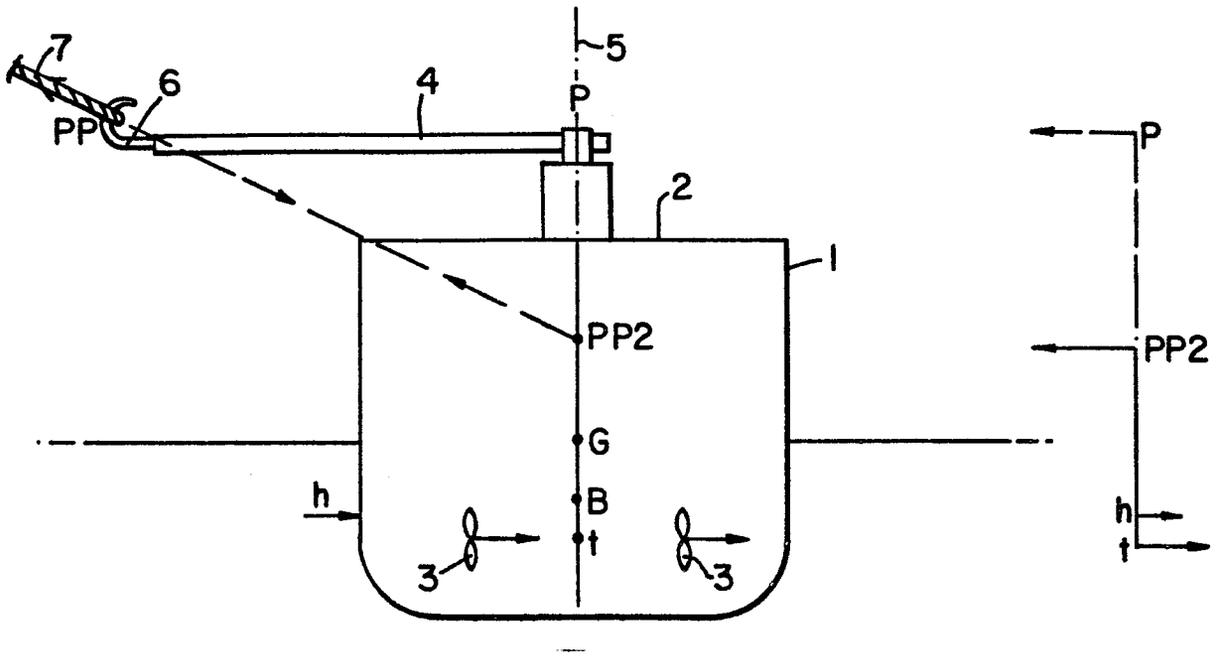
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Fig.2.

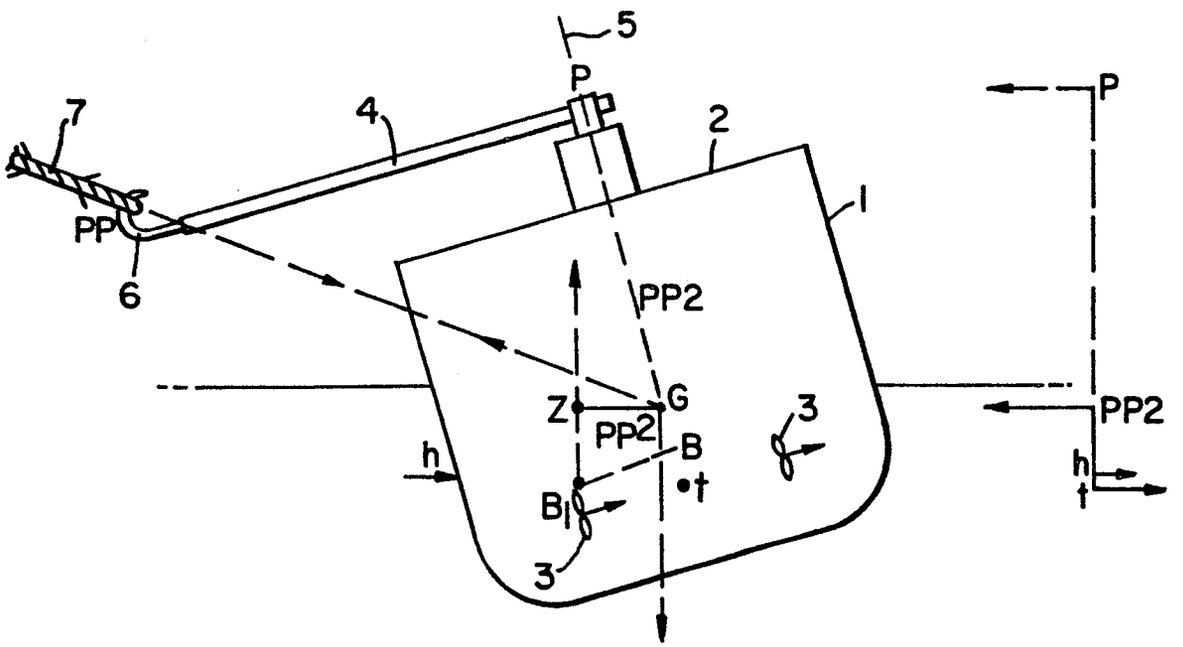
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Fig.3.

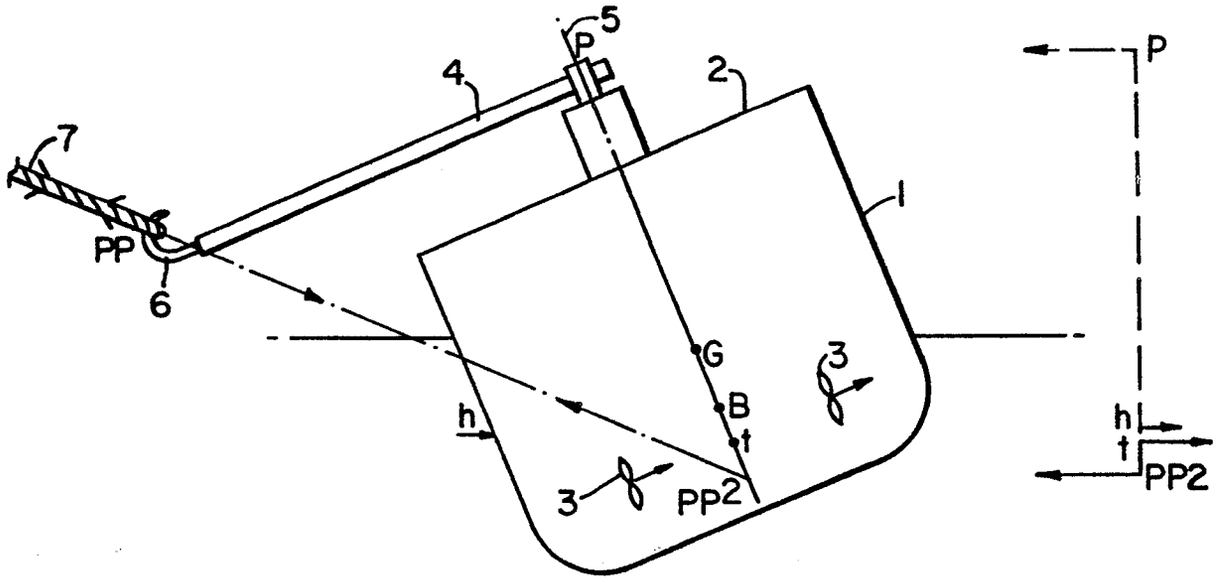

Fig.4.

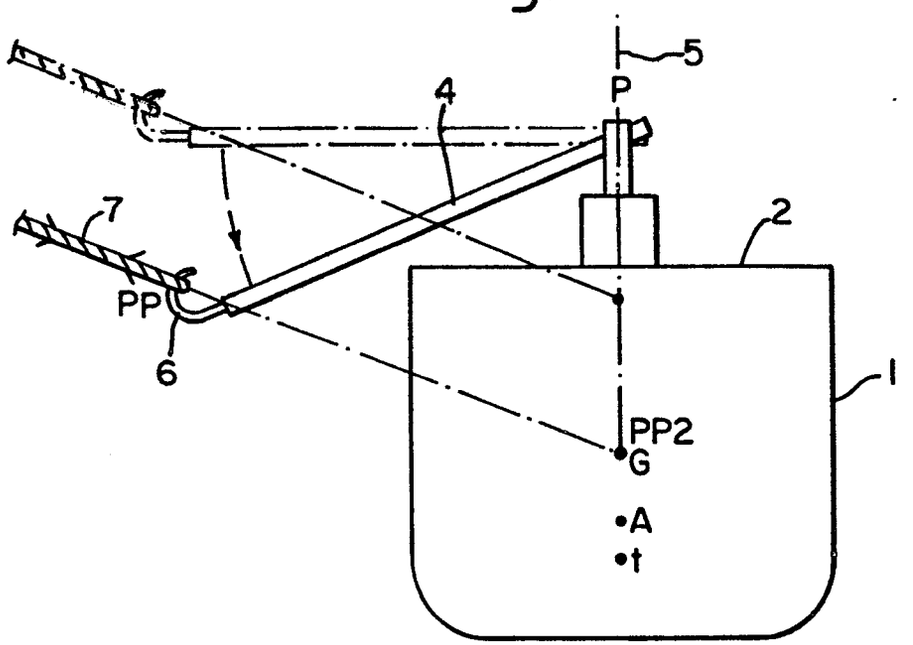

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Fig.5.

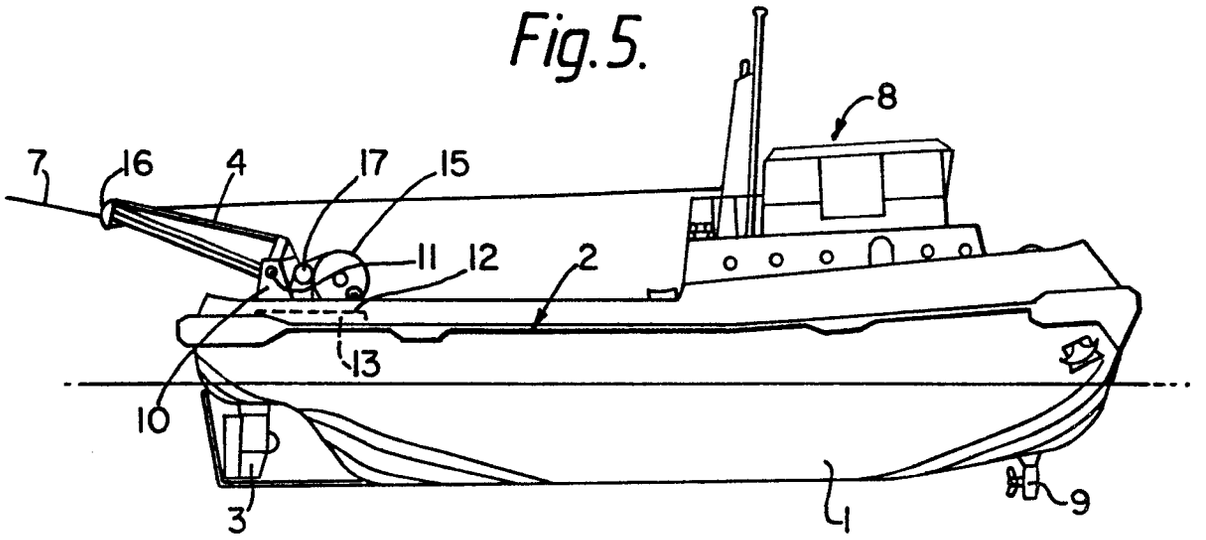


Fig.6.

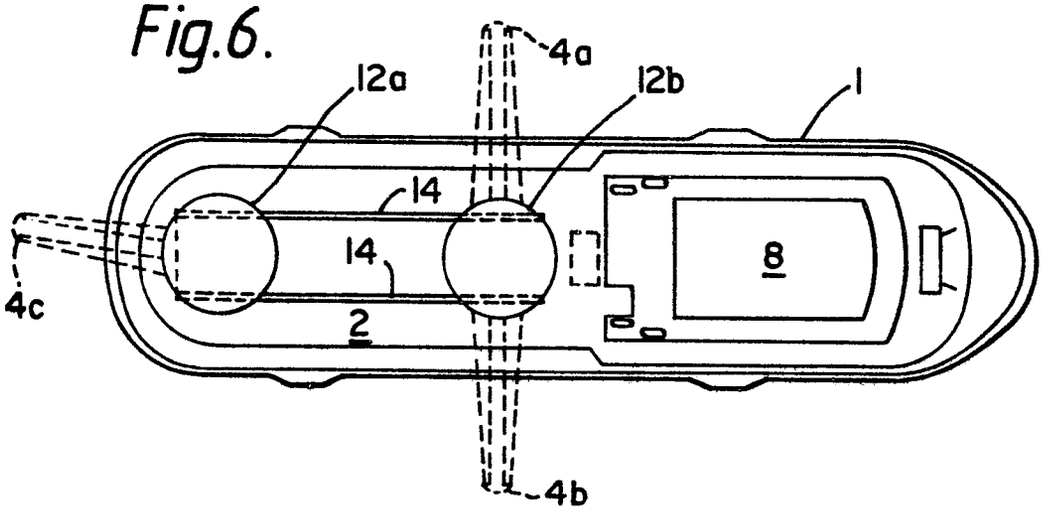
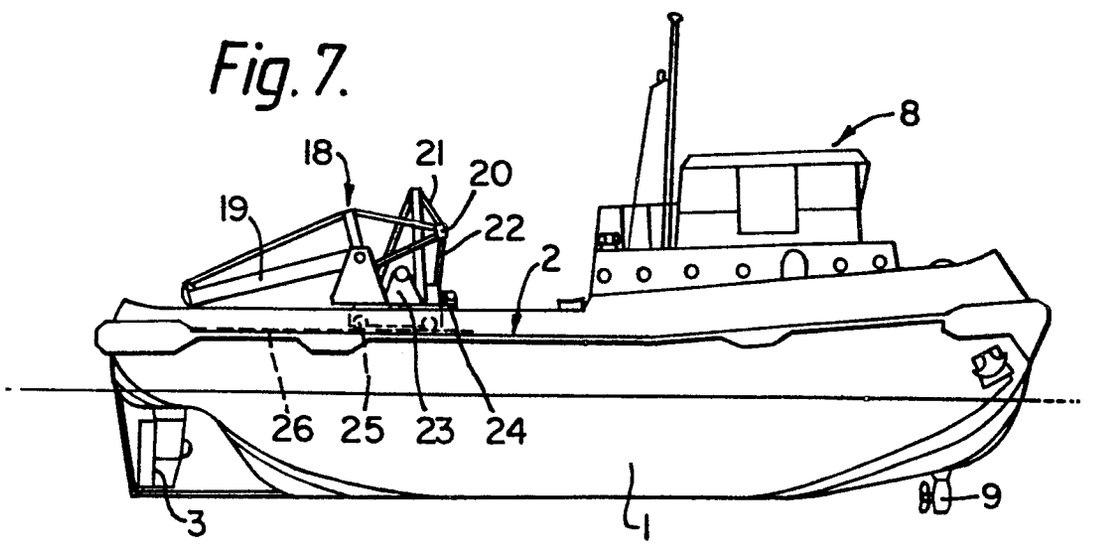


Fig.7.



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EUROPEAN SEARCH REPORT

0174067
Application number

EP 85 30 4515

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl 4)
X	FR-A-1 492 939 (VAN DER KUIL) * Pages 3-5; figures 1-3,7-10 *	1,2,10	B 63 B 35/68
A	DE-C- 447 183 (KLUVER) * Page 2, line 21; figures 1,2,4 *	1-3,7	
A	FR-A-1 158 501 (MERY) * Column 2; figures 2-5 *	1,2,4, 6	
A	GB-A-1 357 327 (CLARK et al.) * Page 2, line 29 - page 3, line 73; figures 1-5 *	1	
A	US-A-1 530 395 (MULLER)		TECHNICAL FIELDS SEARCHED (Int. Cl.4) B 63 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	22-11-1985	BRUMER A.M.

CATEGORY OF CITED DOCUMENTS

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