Aug. 8, 1961 H. WAAS ET AL 2,995,103

ICEBREAKER

Filed May 4, 1956

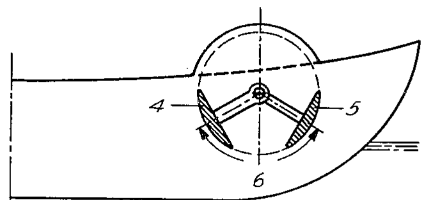

Fig. 2

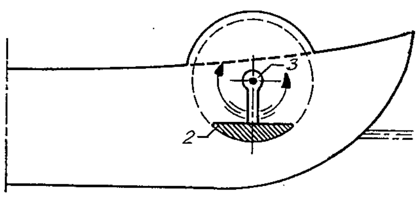

Fig. 1

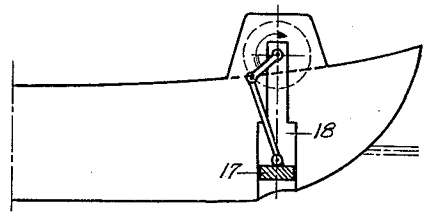

Fig. 6

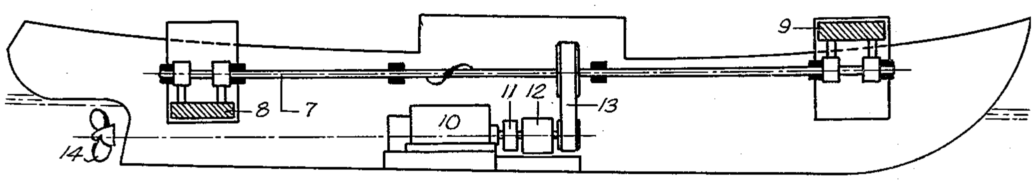

Fig. 3

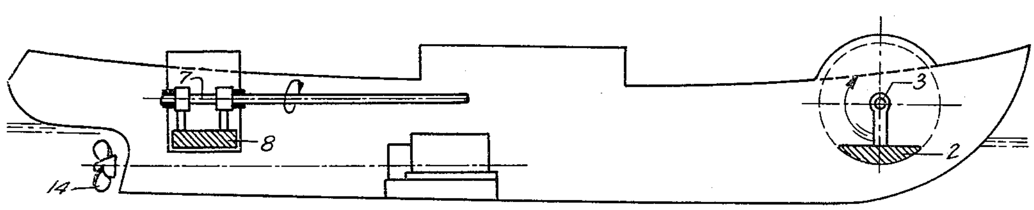

Fig. 4

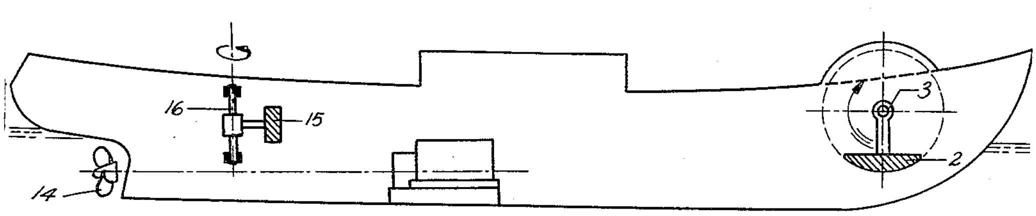

Fig 5

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ICEBREAKER

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In an older unpublished invention it was proposed to provide icebreakers with contrivances that forced upon them movements approximately corresponding to the natural pitching frequency, i.e. the number of pitching movements made by the vessel per minute. By that means the force exerted by the forebody of the vessel when gliding onto the ice can be considerably increased. It has been provide by experience, that icebreakers equipped with such contrivances can break the ice much better.

It is an object of the invention to provide a method and devices for improving the ice-breaking capabilities.

According to the subject of the present invention the movement of the vessel—particularly in the case of fairly thick ice—is improved in that the frequency with which the pitching movements are carried out is increased. The natural pitching frequency of a vessel in ice-free waters increases when the forebody of the ship pushes itself onto a sheet of ice; the thicker the sheet of ice, the stiffer it is, and so much the more does it contribute to increasing the natural pitching frequency of the vessel.

The contrivance in accordance with the invention for the natural generation of pitching movements which is highly effective in the case of very thick ice and contributes in great measure to the breaking of the ice by the fore end of the vessel, is adjusted to a higher frequency than the natural pitching frequency of the vessel in ice-free water.

For an icebreaker of, for example, the following main dimensions:

	M
Length	27
Breadth	7
Draught	3

the suitable frequency in water with very thin ice of about 5 cm. is about 17 cycles per minute, and in ice of a thickness of about 40 cm., about 30 cycles per minute.

The creation of this frequency can be effected, for example, by reversing in variable rhythm the pumps that fill or empty the tanks that are built into the vessel fore and aft.

By the use of rotating out-of-balance weights for the production of the pitching movements in the forebody and the afterbody of the vessel the most suitable frequency can be created by regulating the speed of rotation to a corresponding rhythm of a strain on the vessel.

If the contrivances are to be tuned only to the thickest ice that is generally encountered to save expense the regulation as described above can be renounced and only that frequency used that is tuned to the thickest ice.

For thicker ice not only must the increase in the natural frequency as described above be taken into consideration, but also the circumstance that the icebreaker must push itself higher onto the ice until the latter breaks. Consequently the effective periodic force in the forebody may have a greater role to play than that effective in the afterbody. It may therefore be advantageous to keep the equipment for the effective periodic force in the afterbody smaller in relation to the corresponding equipment in the forebody. If these devices are designed as rotating out-of-balance weights, the out-of-balance weights in the forebody can, for example, have a horizontal axle lying

athwartships, and in an extreme case the weight in the afterbody can be eliminated altogether.

In the annexed drawings a few embodiments of the invention are given as examples.

FIG. 1 is a longitudinal cross-section through a forecastle of a ship provided with a device for the generation of pitching movements in accordance with the invention;

FIG. 2 is a similar longitudinal cross-section through a forecastle provided with a modified device consisting of two unbalance-bodies in accordance with the invention;

FIG. 3 is a longitudinal cross-section through a ship with unbalance-bodies in the forecastle and in the stern with these unbalance-bodies being displaced on a common shaft by 180°;

FIG. 4 is a longitudinal cross-section of a ship with an unbalance-unit in the forecastle and in the stern, the unbalance-unit in the stern rotating about a longitudinal axis and the unbalance-unit in the forecastle rotates about a transverse axis;

FIG. 5 is a longitudinal cross-section of a ship with a different unbalance-unit in the forecastle and the stern; and

FIG. 6 is a longitudinal cross-section of the forecastle of a ship provided with a pump-like installation.

FIG. 1 shows the longitudinal section of a ship forebody and the out-of-balance weight **2** installed therein, which, suitably driven, rotates round the axle **3** and produces the pitching movement. When the weight **2** rotates the forebody will rise and fall periodically and push itself farther and farther onto the ice under the influence of the constantly acting propeller thrust until the ice breaks. Thus the ship climbs, in effect onto the ice, especially when the direction of rotation is that indicated by the arrow in FIG. 1.

Without departing from the idea of the invention, instead of rotating uniformly, the out-of-balance weight can also rotate with a variable angular velocity or oscillate like a pendulum. Instead of an out-of-balance weight with horizontal athwartships axle in the forebody one suitably driven out-of-balance weight can be installed in the forebody and another in the afterbody.

In FIG. 2, a longitudinal section, the out-of-balance weight is divided into two relatively-movable weights **4** and **5**, which by altering the angle **6** can be adjusted relatively to each other during operation. In that way the device can be more easily put into rotation from a stationary position. This is easiest when, for example, the angle **6** is 180°. By reducing that angle the extent of the out-of-balance can be increased during operation.

These contrivances can at the same time also be used for regulating the force exerted on the vessel e.g., by suitable adjustment of the displacement between the weights the vessel can travel in thinner ice with less out-of-balance and consequently with a smaller angle of pitching.

It is not absolutely necessary to have the out-of-balance weight (or in the case of several, the out-of-balance weights) turn about an athwarts axle, they can also rotate or oscillate about an axle parallel to the longitudinal axis of the vessel.

In FIG. 3 (longitudinal section) such a case is shown as an example. A shaft **7** arranged in the longitudinal direction of the ship has at its ends in the forebody and afterbody of the vessel out-of-balance weights **8** and **9** with the two weights displaced at an angle of 180° to each other. For the sake of expediency and economy in this instance the shaft **7** is driven over a coupling **11**, an adjustable reducing gear **12** and a belt drive **13** direct from the main engine **10**, which at the same time drives the propeller **14**. If, for instance for lack of space, the shaft **7** is not desirable, it can also be eliminated, whereby each out-of-balance weight has its own special drive. Arrangement and operation of out-of-balance weights around longitudinal axles with 180° angle displacement has the advantage that if the out-of-balance weights are arranged as shown in FIG. 3 the drive is very simple and in principle the ship not only pitches, but also carries out yawing motions, in addition to which, when out-of-balance weights of unequal size are used, rolling movements are caused. These combined movements are of great value for the ice-breaking.

These combined movements can also be reached by an angle displacement of 180° with the out-of-balance weights, or by a combination of out-of-balance weights on an athwarts axle with out-of-balance weights on a longitudinal axle as shown in

FIG. 4 (longitudinal section), where for instance in the forebody the out-of-balance weight **2** is represented as around the athwarts axle **3** and in the afterbody the out-of-balance weight is shown around the longitudinal axle **7**. The drive may be effected in any suitable manner. Another example of the invention is shown in

FIG. 5 (in longitudinal section). With this arrangement combined pitching, yawing and rolling movements are reached by the operating of the out-of-balance weight **2** on the horizontal transverse shaft **3** in the forebody in co-operation with the out-of-balance weight **15** on the vertical shaft **16** in the afterbody. The drive of these contrivances may also be effected in any suitable manner.

In FIG. 6 (longitudinal section) (of the forebody) an example is given which shows that periodic vertical oscillating masses can serve for the production of pitching movements or to assist pitching movements already produced by other contrivances. A piston **17** is moved up and down in suitable rhythm in a cylinder **18** erected in the forebody and/or in the afterbody, whereby the suction of the water results in a force directed downward on the ship and the discharge of the water in a force directed upward.

In addition to the combinations already described in the foregoing, numerous other combinations are possible within the scope of this invention.

Without altering the essence of the invention other available technical means can therefore be employed for the production of pitching movements and of a combination of pitching movements with yawing or rolling movements of the respective most serviceable frequency.

What we claim is:

1. An ice breaking vessel provided with devices for the production of periodic pitching movements, said devices comprising at least one first movable weight in the forepart of the vessel and at least one second movable weight in the after part of the vessel, said first and second weights being movable about axes of rotation to create pitching movements having a frequency which is higher than the natural pitching frequency of the vessel in ice-free water due to the stiffness of the ice to be broken, and means for moving said weights, at least one of said first and second weights being a mass oscillatable in a fore and aft direction about a transverse axis.

2. An ice breaking vessel provided with devices for the production of periodic pitching movements, said devices comprising at least one first movable weight in the forepart of the vessel and at least one second movable weight in the after part of the vessel, said first and second weights being movable about axes of rotation to create pitching movements having a frequency which is higher than the natural pitching frequency of the vessel in ice-free water due to the stiffness of the ice to be broken, and means for moving said weights, the weight in the fore part of the vessel comprising an out-of-balance weight mounted for movement about a transverse axis and the weight in the after part of the vessel comprising an out-of-balance weight mounted for movement about a longitudinal axis.

3. An ice breaking vessel provided with devices for the production of periodic pitching movements, said devices comprising at least one first movable weight in the forepart of the vessel and at least one second movable weight in the after part of the vessel, said first and second weights being movable about axes of rotation to create pitching movements having a frequency which is higher than the natural pitching frequency of the vessel in ice-free water due to the stiffness of the ice to be broken, and means for moving said weights, the weight in the fore part of the vessel comprising an out-of-balance weight mounted for movement about a transverse axis and the weight in the after part of the vessel comprising an out-of-balance weight mounted for movement about a vertical axis.

4. An ice breaking vessel provided with devices for the production of periodic pitching movements, said devices comprising at least one first movable weight in the forepart of the vessel and at least one second movable weight in the after part of the vessel, said first and second weights being movable about axes of rotation to create pitching movements having a frequency which is higher than the natural pitching frequency of the vessel in ice-free water due to the stiffness of the ice to be broken, and means for moving said weights, at least one of said first and second weights comprising two masses oscillatable in opposite fore and aft directions about a transverse axis.

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