United States Patent

Stoffel et al.

[15] **3,658,024**

[45] **Apr. 25, 1972**

[54] OSCILLATING ICE BREAKER

[72] Inventors: **Olly O. Stoffel**, San Diego, Calif.

[73] Assignee: **Stoffel Engineering Corporation**, San Diego, Calif.

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[52] **U.S. Cl.** **114/40**

[51] **Int. Cl.** **B63b 35/10**

[58] **Field of Search** 114/40–42

[56] **References Cited**

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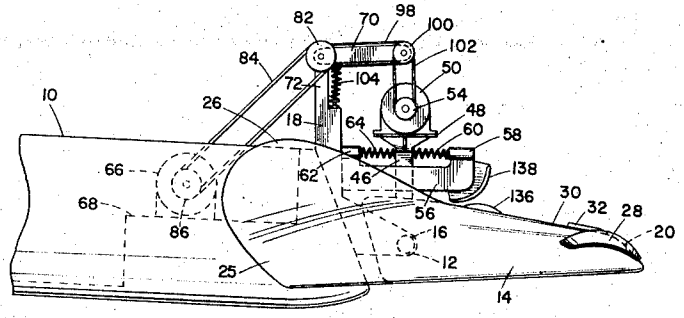
Primary Examiner—Trygve M. Blix

Attorney—Carl R. Brown

[57] **ABSTRACT**

An elongated tongue-like ice breaker mounted on the bow of a vessel and pivoted to swing with a short oscillating stroke in a vertical plane, to drive under and lift a layer of ice. The tongue is powered by an oscillator having its effective power stroke aligned with the plane of tongue motion and at a substantial lever arm for maximum efficiency. Deflection of the tongue and the oscillation of the entire tongue divert broken pieces of ice upward and outward, clear of the vessel, a minimum of propulsive power being needed even with thick ice. To minimize loads on the oscillator and the vessel, the tongue is primarily of buoyant construction.

17 Claims, 8 Drawing Figures



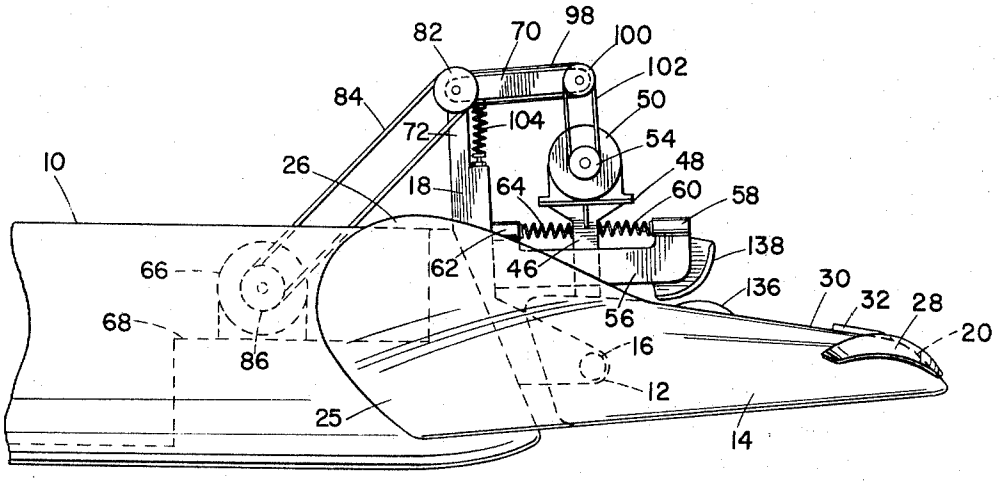


Fig. 1

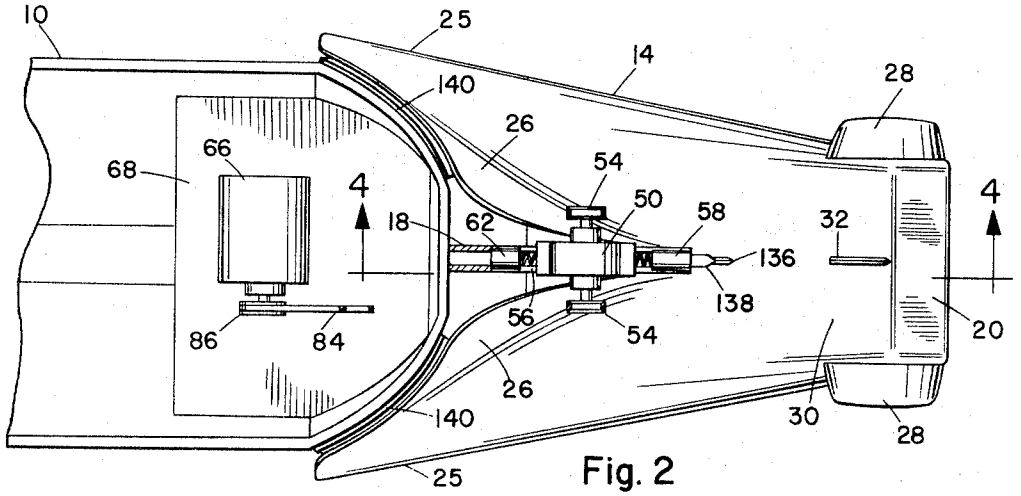


Fig. 2

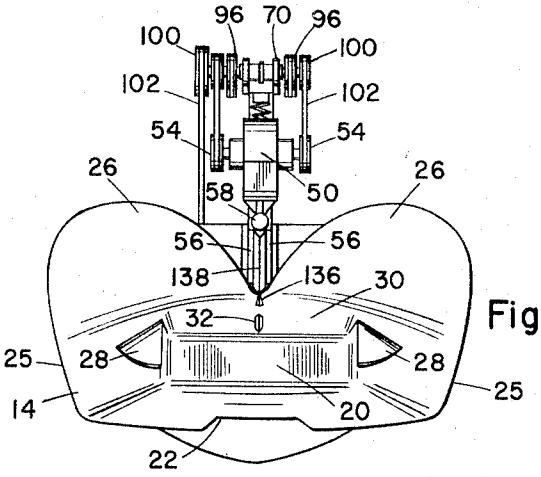


Fig. 3

INVENTOR.
OLLY O. STOFFEL
BY Carl R. Brown
ATTORNEY

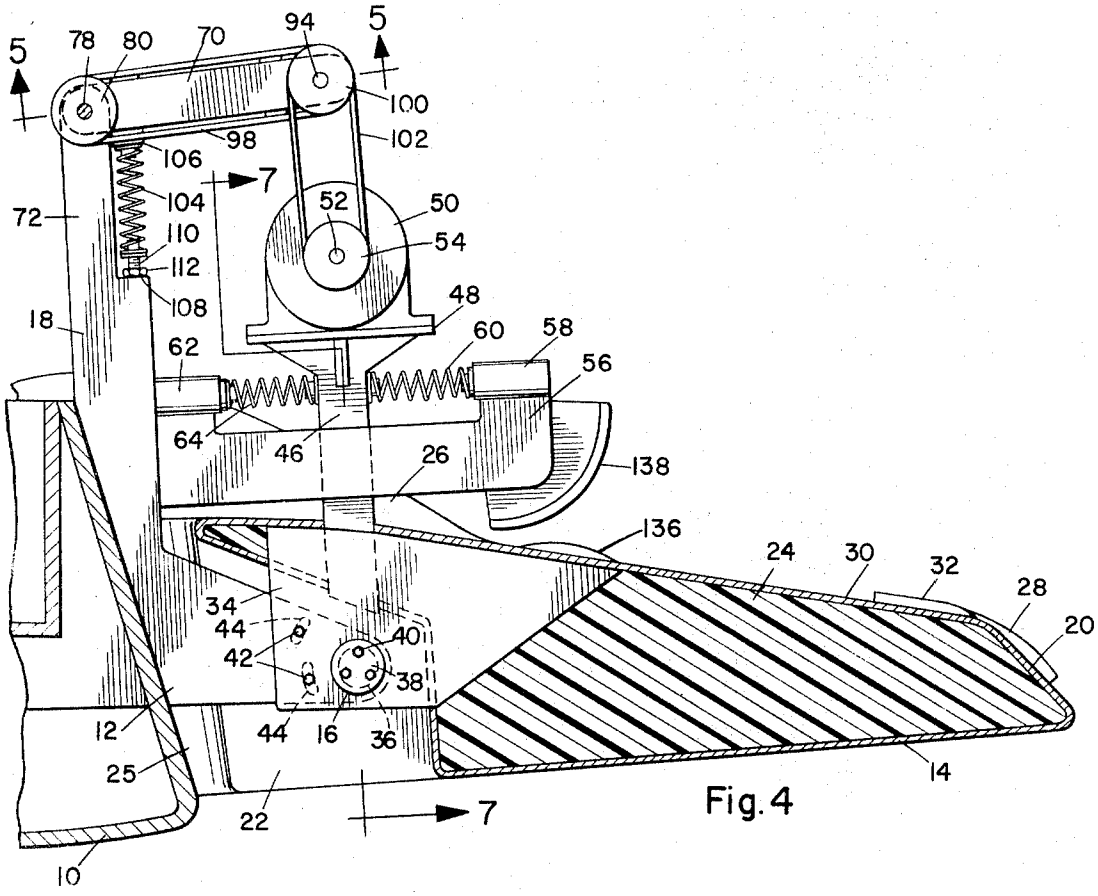


Fig. 4

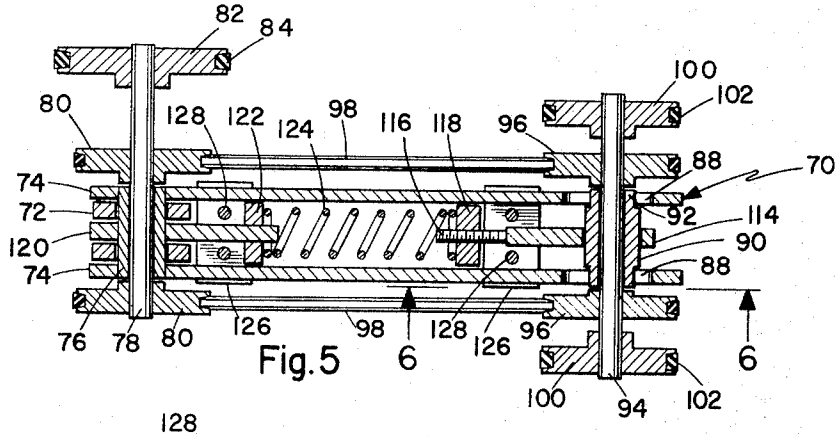


Fig. 5

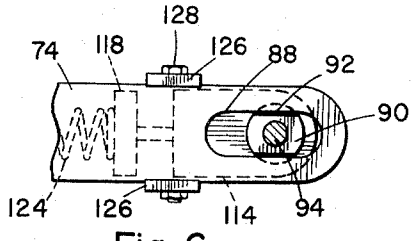


Fig. 6

INVENTOR.
OLLY O. STOFFEL

BY Carl R. Brown

ATTORNEY

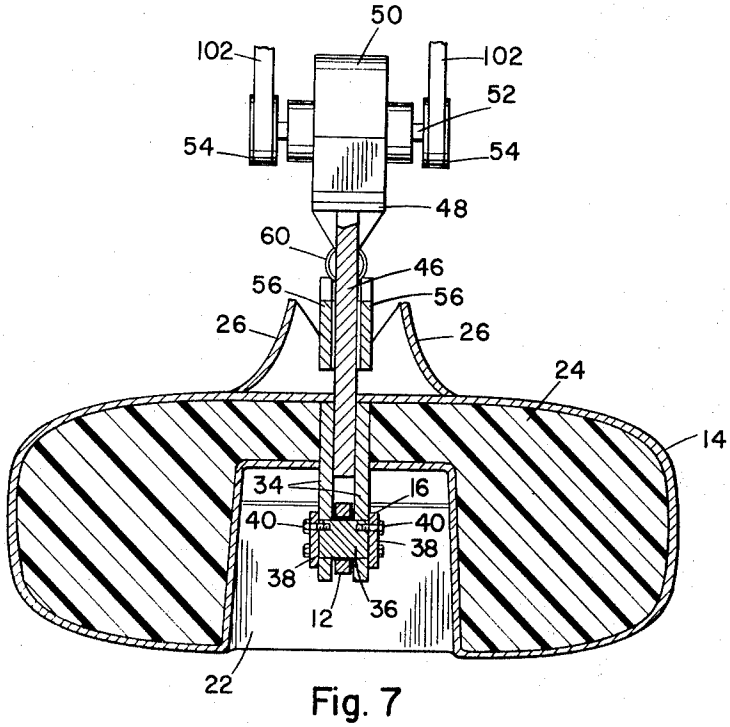


Fig. 7

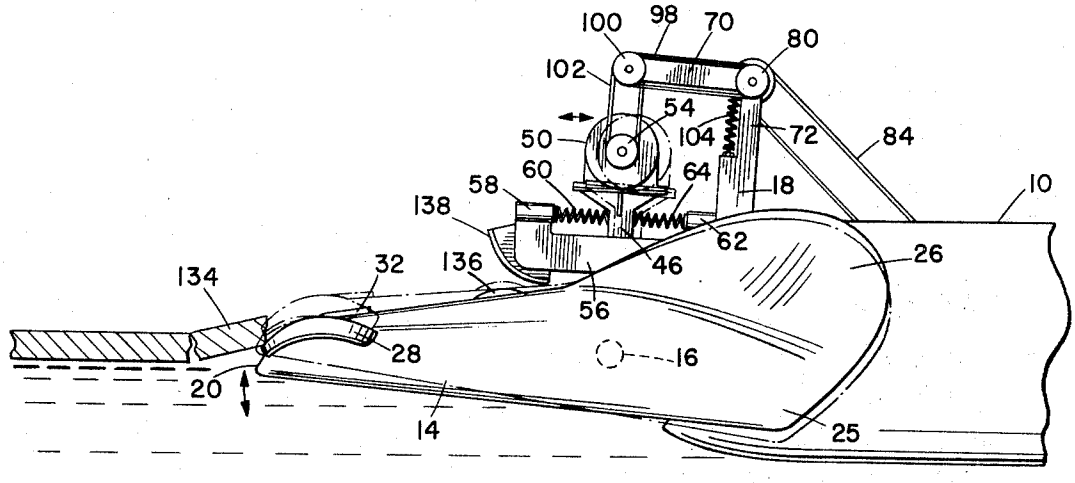


Fig. 8

INVENTOR.
OLLY O. STOFFEL
BY
Carl R. Brown
ATTORNEY

OSCILLATING ICE BREAKER

BACKGROUND OF THE INVENTION

Conventional techniques of ice breaking usually involve the use of a rugged vessel driven into the ice with considerable power, or driven up on the ice and using the weight of the vessel to break the ice. The vessel must then be driven through the broken ice to clear a channel. The continuous pounding and the pitching motion of the entire vessel imposes considerable strain on the structure and the crew.

SUMMARY OF THE INVENTION

The ice breaker described herein comprises an elongated tongue-like member mounted on he bow of a vessel and pivoted to swing in a vertical plane with a short oscillatory stroke. Power is provided by an oscillator mounted on the tongue and having its effective power stroke aligned with the plane of tongue motion, the oscillator being on an extended arm for maximum leverage. The tongue is driven at a high frequency of oscillation to lift and break up the ice, the broken ice being deflected upward and outward over the tongue, and clear of the vessel, resulting in a minimum requirement of propulsive power for the vessel. The oscillator power source is mounted in the vessel and coupled to the oscillator through a simple motion compensating drive means and very little oscillation is transferred to the vessel. To minimize loads the major portion of the tongue is a buoyant structure, and is adaptable to fit various vessel configurations.

Other objects of this invention will become more apparent upon a reading of the following detailed description and an examination of the drawings wherein like reference numerals designate like parts throughout and in which:

FIG. 1 is a side elevation view of the ice breaker mounted on a vessel.

FIG. 2 is a top plan view with the oscillator drive means omitted for clarity.

FIG. 3 is a front elevation view of the assembly.

FIG. 4 is an enlarged sectional view taken on line 4–4 of FIG. 2.

FIG. 5 is an enlarged sectional view taken on line 5–5 of FIG. 4.

FIG. 6 is a sectional view taken on line 6–6 of FIG. 5.

FIG. 7 is a sectional view taken on line 7–7 of FIG. 4.

FIG. 8 is a side elevation view showing the operation of the ice breaker.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The ice breaker is shown mounted on the bow of a marine vessel **10**, the configuration of which can vary since the structure is adaptable to existing vessels of suitable type.

Projecting forward from the vessel on the longitudinal center line is a rigid support arm **12**, on which the tongue **14** is pivotally mounted on a bearing **16**, to swing in a vertical plane. Extending upwardly from the rear of support arm **12** is a post **18**, secured to the vessel in a suitable manner. In a vessel built especially for the purpose, the support arm and post would effectively be extensions of the keel, or the primary hull structure, the particular configuration being adapted to the vessel for maximum strength.

The tongue **14** is an elongated member converging in width and depth toward the forward end, which terminates in an upwardly and rearwardly inclined ramp face **20**. The tongue has a flattened ovoid cross section and is constructed as a closed steel shell with internal bracing as necessary, depending on the size of the structure. At the rear the tongue is shaped to fit closely around the bow of the vessel and extends on both sides of the bow, with a large cavity **22** in the underside to provide access to bearing **16**, as in FIG. **4**. For bouyancy the shell structure of the tongue **14** is filled with flotation type plastic foam **24**. As much of the tongue structure as possible, including the side portions **25** extending around the bow, is a foam filled shell, in order to reduce loads on the bearing and the vessel. The type of foam normally used for buoyancy purposes will not become waterlogged, so the tongue will retain its buoyancy even if damaged. On the upper rear portion of the tongue are deflector wings **26** curing upwardly and outwardly on both sides of the bow, preferably extending slightly above the top of the hull to deflect broken ice clear of the interior of the vessel. The deflector wings **26** blend smoothly into the tongue and the overall contours of the structure are as smooth as possible to avoid jamming of broken ice. At the forward end of tongue **14** on opposite sides of ramp face **20**, are outwardly projecting, upwardly arched deflector plates **28**. On the top portion **30** of the tongue, at the center and immediately behind ramp face **20**, is a vertical splitter blade **32**.

Tongue **14** has a pair of bearing plates **34** extending into cavity **22** in spaced parallel relation to straddle support arm **12**. The bearing **16** comprises a cylindrical hub **36** through the bearing plates and support arm, held by end plates **38** which are secured by bolts **40**, the hub acting as a spacer to ensure a free pivotal action, as in FIGS. **4** and **7**. For stability the bearing plates **34** are connected rearwardly of the bearing by tie bolts **42**, which pass through arcuate slots **44** in the support arm **12**, the slots having their center of radius at the axis of hub **36**. A suitable bearing of this type, used in a similar manner, is shown in considerably more detail in my copending U.S. Pat. application, Ser. No. 660,389, filed Aug. 14, 1967 and entitled "Vibrating Ripper".

Fixed to tongue **14** and extending upwardly above bearing **16** is a mounting post **46**, on top of which is a suitably braced platform **48**. Secured to the platform is an oscillator **50** of the rotary eccentric type, having a drive shaft **52** with pulleys **54** on opposite ends. The oscillator **50** is fully disclosed in my copending U.S. Pat. application, filed Sept. 19, 1969 and entitled "Oscillating Power Unit". While other vibrating or oscillating means could be used, this particular oscillator is ideally suited to the purpose since the oscillating power is essentially limited to a linear motion and can be aligned to apply the power in the optimum direction. In the present arrangement the oscillation is generally horizontal in a fore and aft direction, causing the forward end of the tongue **14** to rise and fall.

To stablize the oscillating mechanism, mounting post **46** is slidably held between spaced parallel guide arms **56**, extending forwardly from post **18**. On the forward end of guide arms **56** is a front spring adjuster **58**, from which a front spring **60** extends to mounting post **46** below the platform **48**. At the rear of the guide arms is a rear spring adjuster **62**, from which a rear spring **64** extends to the mounting post **46**, which is thus balanced between the two springs. The spring adjusters may be operated by screw means, or by conventional hydraulic means to adjust the compression load of the individual springs. This provides for damping and control of the oscillating motion and also permits vertical adjustment of the forward end of the tongue **14** in relation to the water line of the vessel, to ensure proper engagement with the ice.

Power for the oscillator **50** is provided by a motor **66** mounted on internal structure **68** of the vessel. Installing the motor in the vessel rather than on the tongue reduces the weight of the moving structure. To apply driving power while the oscillator is moving, an arrangement of tensioned belts has been found satisfactory, although other means could be used. In the arrangement shown, a cantilever arm **70** is pivotally attached to the top of an upward extension **72** of post **18**, the arm extending forward and swinging vertically. The arm **70** is composed of a pair of spaced parallel side plates **74** straddling post extension **72** and being pivotal on a bearing sleeve **76** passing through the extension and both side plates, as in FIG. **5**. Rotatably mounted in bearing sleeve **76** is a shaft **78** having pulleys **80** fixed thereon on opposite sides of the arm **70**. One end of shaft **78** carries a driven pulley **82**, which is coupled by a drive belt **84** to the drive pulley **86** of motor **66**. At the forward end, side plates **74** have corresponding longitudinal slots **88**, and between the side plates is a trunnion block **90** having fattened ends **92** which ride in the slots. Rotatably mounted in trunnion block **90** is a transfer shaft **94** on which are inner pul-

leys 96, coupled by belts 98 to the pulleys 80. On the outer ends of transfer shaft 94 are outer pulleys 100, coupled by belts 102 to the pulleys 54 on oscillator 50.

To maintain tension in belts 102, the arm 70 is urged upwardly by a lift spring 104 between a retainer 106 on the underside of the arm forward of the pivot and a step 108 on post 18. The lower end of spring 104 is held on a threaded pin 110 threaded into post 18 and secured by a lock nut 112, which allows adjustment of the spring load.

Attached to trunnion block 90 and extending between side plates 74 is a pressure plate 114 having a threaded stud 116 on which is an adjustable stop 118, the stop being slidably held between the side plates. Extending from bearing sleeve 76 is a stop plate 120 having a fixed stop 122, a spring 124 inserted between stops 122 and 118 maintaining tension on belts 98. Side plates 74 are held in alignment by upper and lower clamp plates 126 secured by bolts 128.

In operation, the oscillator 50 has a fore and aft power stroke which, amplified through the lever arm of mounting post 46 about bearing 16, causes the forward end of the tongue 14 to pulsate vertically. The angular motion of the tongue is not great, being on the order of 5° to 10°. However, the oscillation rate is high, on the order of 2,400 cycles per minute in a working model which was successfully tested. The tongue 14 is set so that the ramp face 20 slides under and tends to lift the ice as the vessel is propelled forward. With the oscillation in operation the pulsating tongue sets up powerful vibration waves through the ice and cracks pieces of ice upwardly, as indicated at 134 in FIG. 8. Instead of being driven down, as in the usual ice breaking operation, the broken ice is lifted and thrown to the sides, initially by deflector plates 28 and then by deflector wings 26, to clear a passage for the vessel. Pieces of ice which move up over ramp face 20 are broken by splitter blade 32 and any pieces which may continue to travel along the top of the tongue are deflected from the moving mechanism by a further blade 136 on the top of the tongue, cooperating with a cutter blade 138 projecting forwardly and downwardly from the forward end of guide arms 56. At the rear of the tongue all of the broken ice is deflected outwardly clear of the vessel by wings 26.

It should be noted that it is the oscillation which makes the ice breaker so effective. The constant high frequency vibration as the edge of the ice is lifted, literally shakes the ice apart for a considerable distance on either side of the tongue, making it easy to clear a channel with minimum propulsive power and with very little lurching or shaking of the vessel. There is no tendency for the ice to jam on the tongue, since the constant oscillation keeps the ice in motion and tends to "walk" the broken pieces along the tongue.

For further avoidance of jamming, it is desirable to minimize the working clearance between deflector wings 26 and the hull of the vessel. To prevent undue wear on the vessel, hardened wear plates 140 are attached to the vessel in the appropriate areas, as in FIG. 2, and may be made replaceable. In the event that the tongue is subjected to a side load, as by ramming an obstruction, the wear plates provide bearings to support and stabilize the tongue and prevent distortion of bearing 16.

Since the ice is broken primarily by vibration rather than by impact, the tongue structure need not be particularly massive. This makes it practical to use the foam filled shell shown, which reduces structural leads and requires a minimum of operating power. Further, the buoyancy reduces the longitudinal unbalance of the vessel due to the added load at the bow.

Having described my invention, I now claim.

1. In an oscillating ice breaker for mounting on the forward end of a marine vessel,

an elongated tongue having a forward ice engaging upper face surface extending forwardly from the vessel with said tongue being pivotally mounted on the vessel to move said face in a substantially vertical plane,

oscillator means coupled to said tongue for exerting a power stroke to said tongue in the direction of swing of the tongue,

and said upper face surface being angled downwardly in the forward direction to pass under the ice in normal movement of the vessel, whereby said swing movement of said face causes the ice to break up over and about the upper face surface.

2. An oscillating ice breaker according to claim 1 including,

damping means connected to said oscillator to limit the angular motion of said tongue.

3. An oscillating ice breaker according to claim 1 wherein,

said oscillator means is mounted above and substantially vertical to said pivotal mounted connection.

4. An oscillating ice breaker according to claim 1 wherein,

said oscillator means creates a substantially horizontal vibrating force,

and means for converting said oscillator vibrating force to said power stroke of said tongue.

5. An ice breaker according to claim 1 wherein,

the rate of oscillation is on the order of 2,400 cycles per minute.

6. An ice breaker according to claim 1 wherein,

the major portion of said tongue is buoyant.

7. An ice breaker according to claim 1 including,

a fixed support arm projecting forwardly from the vessel and having a bearing on which said tongue is supported, said tongue extending rearwardly of said bearing and fitting closely around the forward end of the vessel.

8. An ice breaker according to claim 7 wherein,

the rear portion of said tongue has upwardly and outwardly curving deflector wings extending on opposite sides of the front end of the vessel.

9. An ice breaker according to claim 8 wherein,

said tongue has outwardly projecting deflector plates on opposite sides of said ice engaging face.

10. An ice breaker according to claim 9 including,

at least one substantially vertical ice splitter blade on the upper portion of said tongue.

11. An ice breaker according to claim 8 wherein,

said tongue has an upwardly extending mounting post above said bearing, said oscillator being secured on top of said mounting post.

12. An ice breaker according to claim 11 including,

a source of power mounted in the vessel,

and motion compensating drive means coupling said source of power to said oscillator.

13. An ice breaker according to claim 11 including,

fixed guide arms extending forwardly from the vessel, between which said mounting post is slidably retained.

14. An ice breaker according to claim 13 wherein,

said damping means comprises front and rear springs mounted on said guide arms and engaging said mounting post therebetween.

15. An ice breaker according to claim 14 wherein,

at least one of said springs is adjustable.

16. An ice breaker according to claim 1 wherein,

said tongue is convergent horizontally and vertically forward of the pivotal mounting, and has portions rearward of the pivotal mounting extending outwardly on opposite sides of the vessel in close fitting relation thereto.

17. An ice breaker according to claim 16 wherein,

said tongue has deflector means thereon for guiding broken ice upwardly and outwardly over the tongue.

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