Sept. 23, 1969 M. W. ROSNER ETAL 3,468,277

ICE CHANNEL CUTTER

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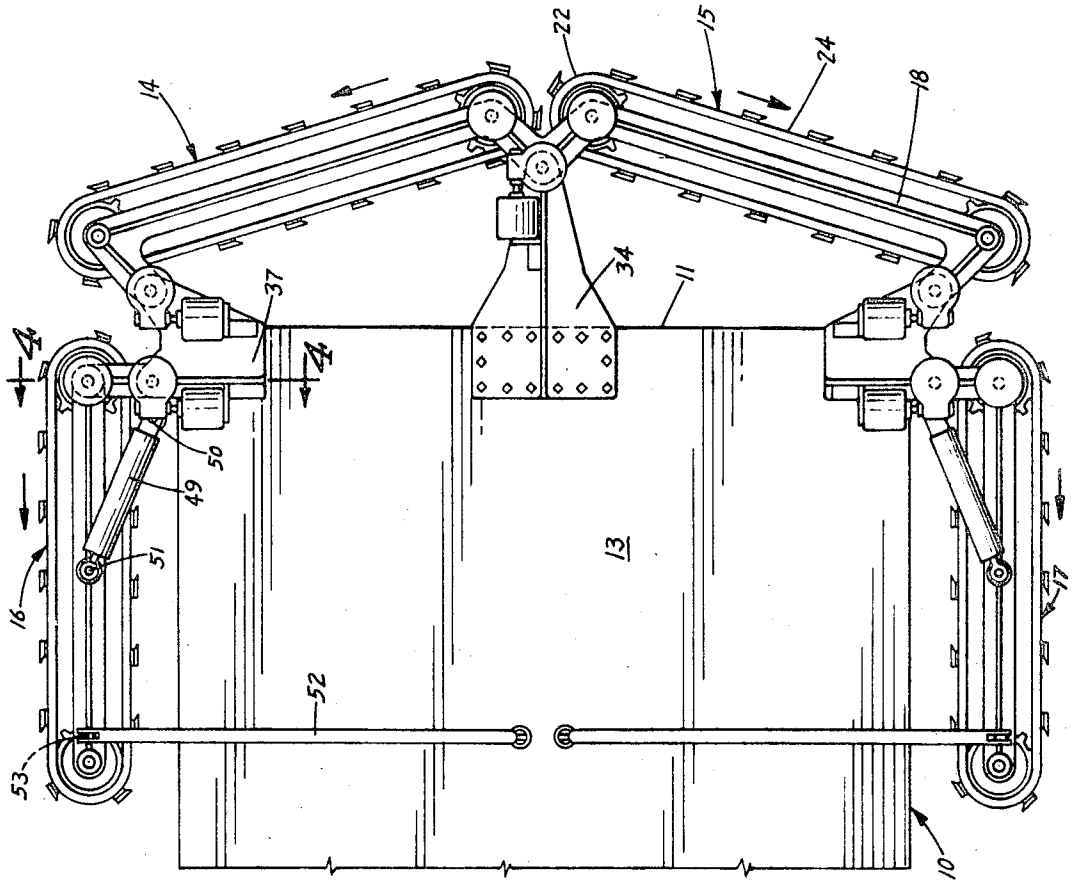


FIG. 1

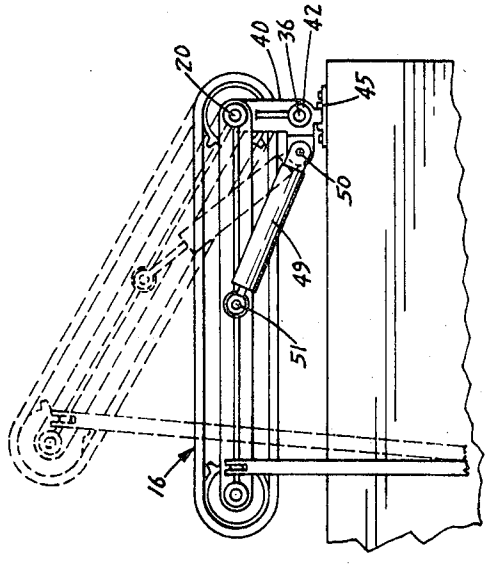


FIG. 2

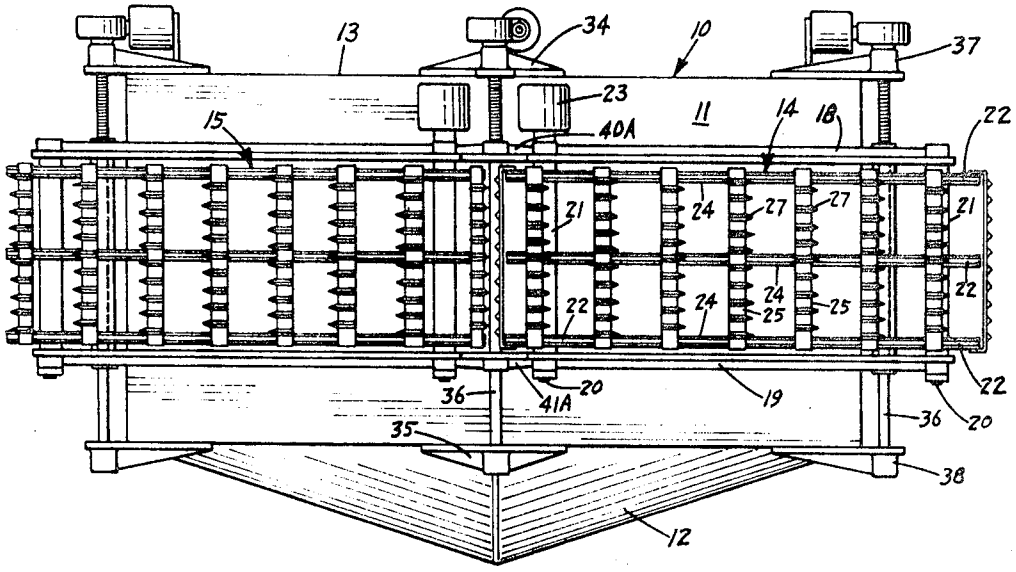
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ICE CHANNEL CUTTER

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FIG. 3



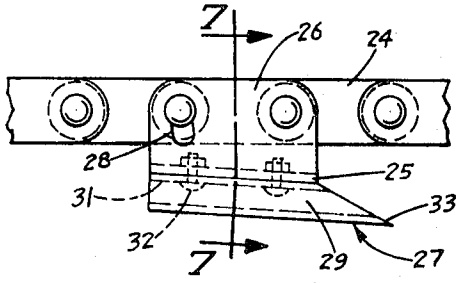


FIG. 6

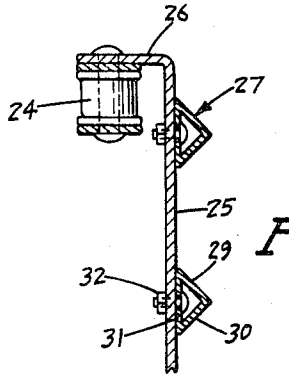


FIG. 7

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ICE CHANNEL CUTTER

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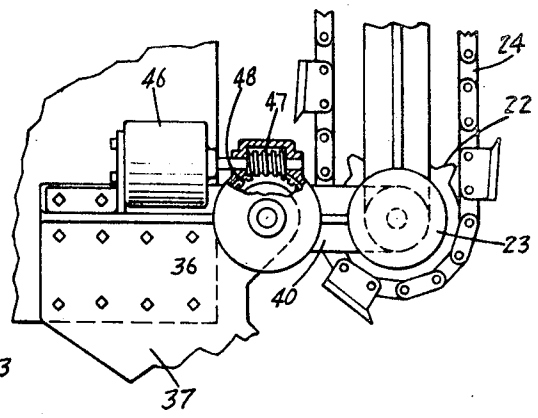


FIG. 5

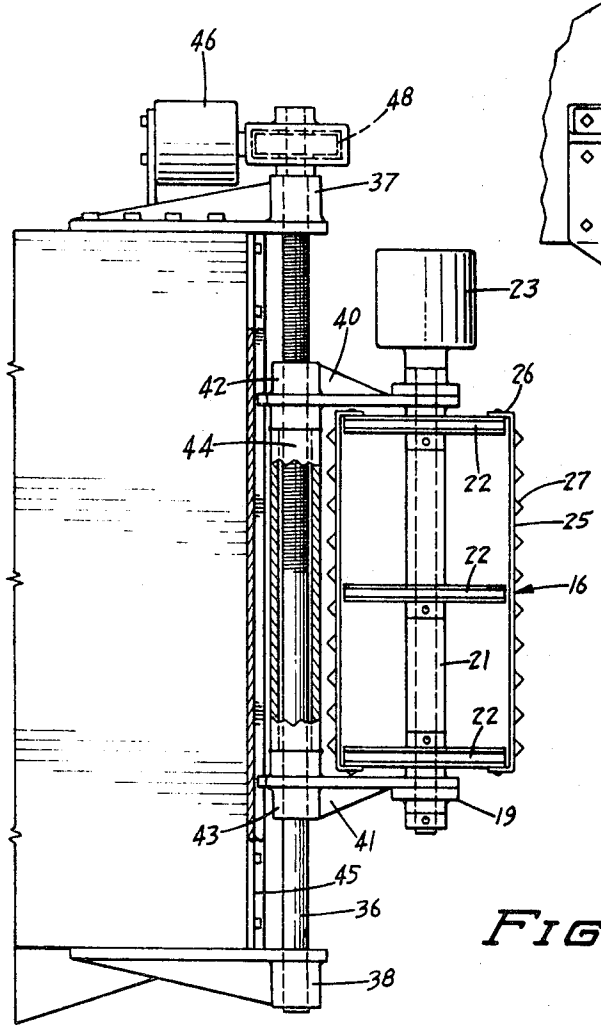


FIG. 4

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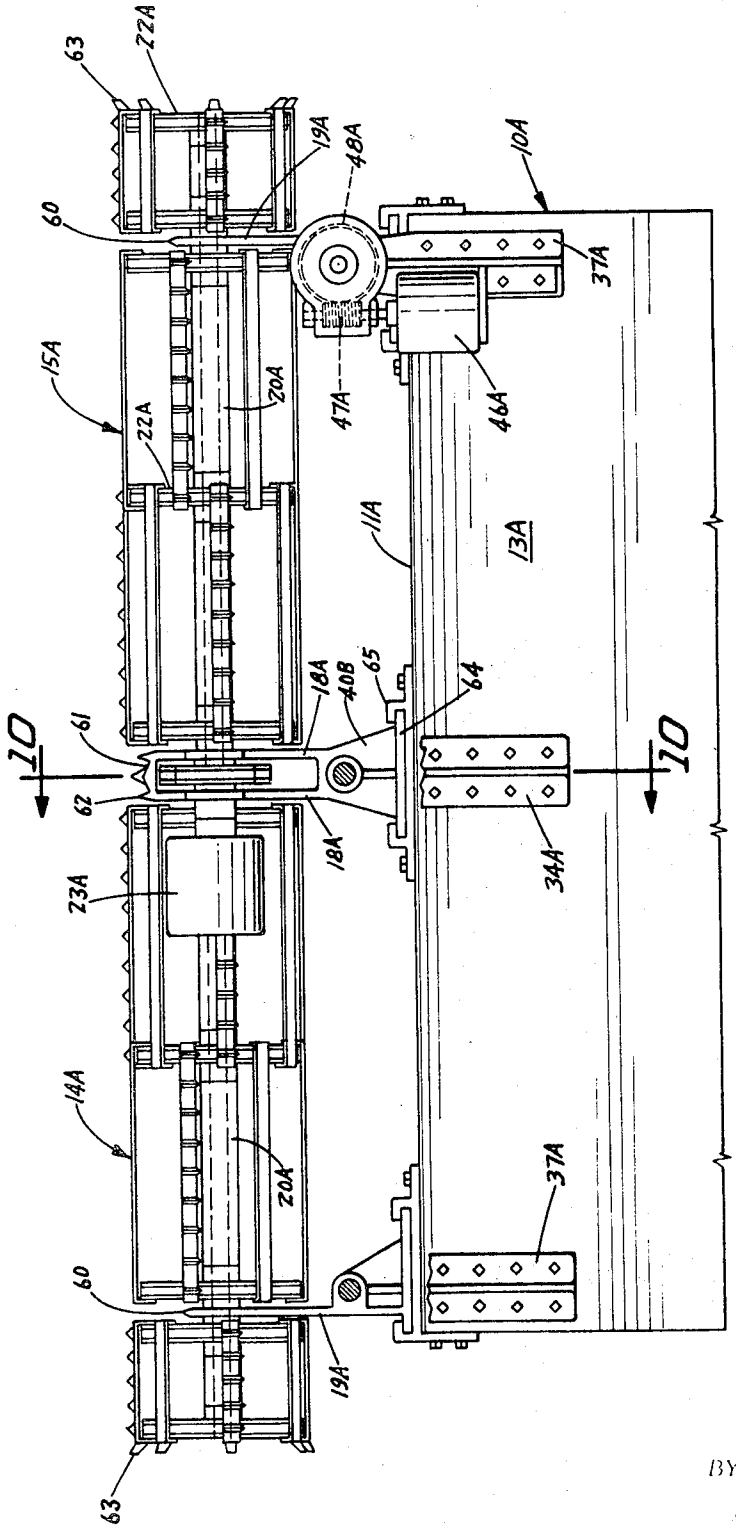


FIG. 8

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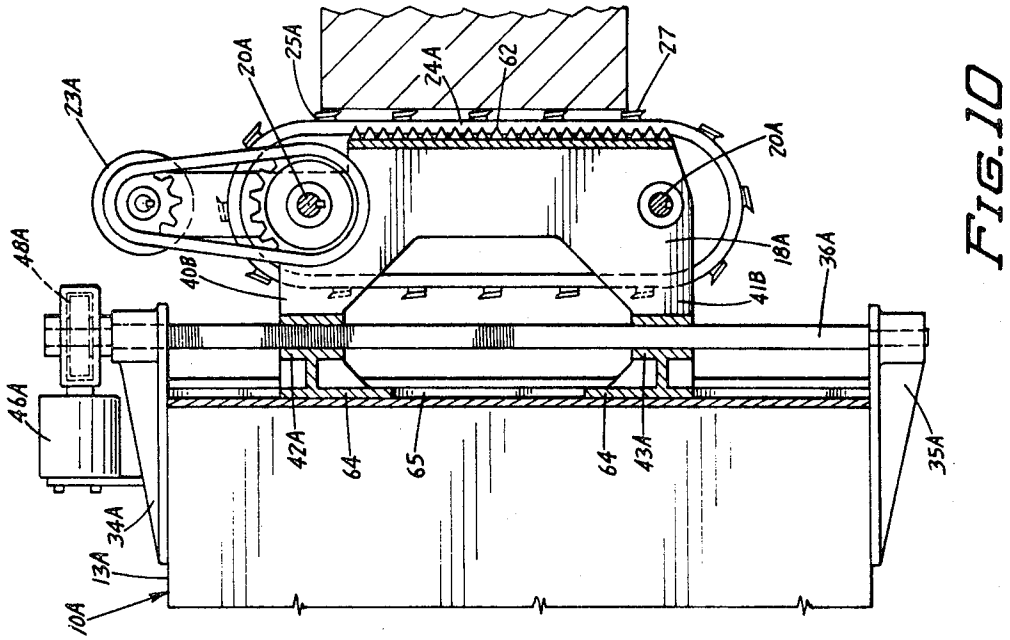


FIG. 10

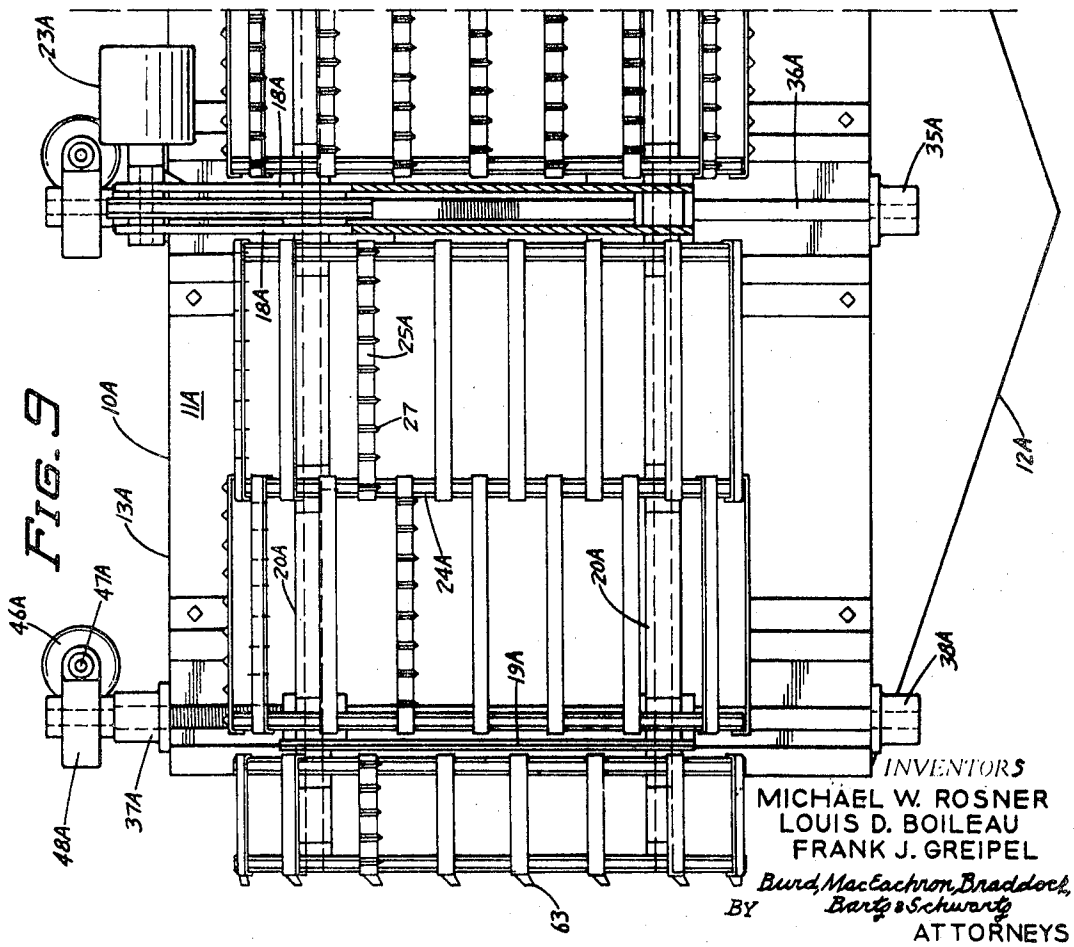


FIG. 9

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3,468,277

ICE CHANNEL CUTTER

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U.S. Cl. 114—42 10 Claims

ABSTRACT OF THE DISCLOSURE

An ice channel cutter for opening and maintaining channels for winter navigation in streams otherwise frozen over. The cutter is a marine vessel whose prow is fitted with a plurality of ice engaging units each presenting an array of ice-chopping blades or cutters disposed in a generally vertically extending plane. The ice choppers may be horizontally movable in the direction toward the sides of the channel and stern of the vessel to chop the ice into relatively small chunks and carry them sideways and rearwardly, or they may be vertically movable in a downward direction to chop the ice and carry it downwardly so the vessel may pass over it. The ice engaging units are desirably movable vertically for positioning for optimum efficiency. Optionally, additional ice-engaging units are pivotally mounted on opposite sides of the vessel adjacent the prow and adapted to be swung outwardly from the vessel for widening the channel initially cut.

This invention relates to an ice channel cutter for opening and maintaining channels for winter navigation in streams which would otherwise be frozen over. Shipping on inland waterways is severely curtained because of the shortness of the navigation season. Such major inland waterways as the upper Mississippi, the Great Lakes and the St. Lawrence River are open for navigation for eight months or less each year. Because of this, expensive vessels are tied up and out of use for long periods of time. Because of the short season, the employment of hands is seasonal and recruiting and maintaining crews is made more difficult. Bulky goods such as coal, iron ore and the like must be stockpiled during the relatively short navigation season. This prevents the more efficient utilization of vessels and crews which would be possible if shipping could be distributed evenly throughout the whole year.

The best available ice breakers are ineffective for maintaining winter navigation in northern inland waterways. They may be effective for maintaining open channels for a few extra days in the early winter when ice is initially forming and in early spring when the ice has begun to break up. However, they are helpless against normal winter ice, which commonly attains a thickness of from three to five feet. Although numerous attempts have been made to devise means for maintaining winter navigation in northern climes, none has been successful.

It is the principal object of this invention to provide an ice channel cutter in the form of a marine vessel whose prow is fitted with a plurality of ice engaging units, each of which presents an array of outwardly extending elongated ice-chopping blades of cutter disposed in a generally vertically extending plane and driven to move either horizontally in the direction toward the sides of the channel and stern of the vessel to chop the ice into relatively small chunks and carry them sideways and rearwardly or vertically in a downward direction to chop the ice so the vessel may pass over it.

The invention is illustrated in the accompanying drawings in which:

FIGURE 1 is a fragmentary top plan view of the prow of a marine vessel fitted with one form of ice-engaging unit according to the present invention;

FIGURE 2 is a fragmentary top plan view of the port side ice-engaging unit of FIGURE 1 showing how that unit may be swung outwardly for widening a channel;

FIGURE 3 is a front elevation of an ice channel cutter according to one form of the present invention;

FIGURE 4 is an enlarged fragmentary section on the line 4—4 of FIGURE 1 and in the direction of the arrows showing means by which the ice-engaging units may be raised and lowered;

FIGURE 5 is a top plan view of the structure of FIGURE 4;

FIGURE 6 is an enlarged fragmentary plan view showing the details of construction and attachment of an ice-chopping blade or cutter;

FIGURE 7 is a vertical section on the line 7—7 of FIGURE 6;

FIGURE 8 is a fragmentary top plan view of a marine vessel fitted with another form of ice-engaging unit;

FIGURE 9 is a partial front elevation of the vessel of FIGURE 8; and

FIGURE 10 is a vertical section on the line 9—9 of FIGURE 8 and in the direction of the arrows.

Referring now to the drawings, and particularly to FIGURES 1 and 2, there is shown one form of the invention in which there is shown a marine vessel, indicated generally at **10**, which may be a tugboat or a towboat or a barge or the like built as or converted into an ice channel cutter. As shown, the marine vessel **10** has a relatively flat prow **11**. It is of relatively shallow draft with a relatively shallow bottom **12** and flat deck **13**. A pair of ice-engaging units, indicated generally at **14** for the port side unit and **15** for the starboard side unit, is supported from the prow **11** of the vessel **10** as described in greater detail hereinafter. Optionally the vessel **10** is also provided with a further port side ice-engaging unit, indicated generally at **16**, and further starboard ice-engaging unit, indicated generally at **17**, each disposed along one side of the vessel and adapted to be swung outwardly.

Both prow units **14** and **15** are of identical construction except that one is a mirror image of the other. Similarly, side units **16** and **17** have identical structure except that one is a mirror image of the other and these units are generally similar to the prow units.

Each ice engaging unit is comprised of a rugged frame including an elongated top plate **18** and corresponding vertically spaced apart bottom plate **19** rigidly secured together at each end as described in detail hereinafter. A pair of parallel shafts **20** are journalled to rotate at opposite ends of each unit extending vertically between plates **18** and **19**. A tubular sleeve **21** is keyed to rotate with each of shafts **20**. Each sleeve **21** carries a plurality of heavy duty sprocket wheels **22** spaced evenly between the top and bottom plates **18** and **19**. One of the tubular sleeves **21** of each ice-engaging unit is adapted to be driven by motor means **23** in order to drive the sprocket wheels **22** and the other may be an idler.

A heavy duty endless linear motion means, such as sprocket chain **24**, extends horizontally between each pair of sprocket wheels journalled at opposite ends of the ice engaging units. A plurality of spaced apart parallel vertical chopper carrier plates **25** are carried by sprocket chains **24** around the outer perimeter of the loop formed by each chain. Plates **25** are supported from the chains by means of right angle brackets **26**. Each plate **25** carries a plurality of ice choppers in the form of blades or cutters, indicated generally at **27**.

As best seen in FIGURES 6, plate **25** is preferably disposed at a slight angle between about 5 and 15 degrees relative to the sprocket chain link to which it is secured in order that the pointed tip of each blade or cutter **27** projects slightly outwardly. Desirably, each bracket **26** is provided with a slot **28** to permit adjustment of the

relative angle between plate **25** and the link of the sprocket chain to which it is secured.

As best seen in FIGURE 3, the blades or cutters **27** on one plate **25** are staggered vertically relative to the blades or cutters on the next adjacent plates.

As best seen in FIGURES 6 and 7, each blade or cutter **27** is desirably in the form of an elongated tube which is triangular in cross section presenting oblique faces **29** and **30** outwardly and a flat face **31** in abutment with the outer surface of plate **25**. That flat base **31** is desirably provided with an elongated central slot extending the length of the blade or cutter base. Each blade or cutter is secured to the plate by means of a plurality of bolts **32** whose heads fit within the blade or cutter member and engage the inside surface of the base **31** and whose shank extends through the slot in that base and suitably spaced holes in plate **25**. In this manner, the cutters or blades **27** may be easily removed for resharpening or replacement or adjusted to compensate for wear. One end of each blade or cutter **27** is desirably beveled to provide a sharp point or tip **33** which projects forwardly and outwardly.

In the form of ice channel cutter shown in FIGURES 1 to 5, blades or cutters **27** are disposed to extend generally horizontally and the tip **33** is pointed in the direction of travel when the plates and chains move in response to rotation of the drive sprocket wheels. As the blades or cutters are so driven simultaneously with pressure exerted by forward motion of the marine vessel and are urged into engagement with the edge surface of the ice floe or covering on the stream on which the channel is desired to be opened, the blades or cutters being driven at high speed perform a constant chipping action against the ice breaking it up into many relatively small sized chunks which are carried to opposite sides of the vessel and then discharged rearwardly.

These ice engaging units may be secured to the marine vessel so as to be fixed relative to the deck of the vessel. Preferably, however, the units are mounted so as to be vertically adjustable to accommodate for differences in ice thickness, variations in draft, and the like. As illustrated, the marine vessel is provided with a heavy duty top bracket **34** supported from the deck and a corresponding heavy duty lower bracket **35** supported adjacent the bottom and located on the approximate longitudinal center line of the vessel. A screw threaded shaft **36** extends between the brackets. Corresponding top and bottom brackets **37** and **38** are disposed adjacent each front corner of the vessel and carry a screw threaded shaft **36** between them.

As best seen in FIGURE 4, the port side end of ice engaging unit **16** is supported in a carrier for vertical movement on threaded shaft **36**. One end of upper plate **18** is rigidly secured to a carrier **40** and the corresponding end of lower plate **19** is rigidly secured to a carrier **41**. The hubs **42** and **43** of the carriers **40** and **41**, respectively, are each threaded to engage shaft **36**. Carriers **40** and **41** are rigidly secured together by means of an interconnecting sleeve **44** which surrounds but does not necessarily engage the threaded shaft. In the case of the side swinging units **16** and **17** which are secured in the vessel at only one end, the carriers **40** and **41** are each provided with an end projection which engages the slot, a vertical keyway **45**, secured to the hull in order to prevent rotation of the entire unit about the threaded shaft.

Units **14** and **15** are secured to the vessel at both ends. The outboard ends of the prow units **14** and **15** are supported in a carriage substantially as described and illustrated in detail with respect to swinging unit **16**. The inboard ends of prow units **14** and **15** are carried by a common carriage comprised of upper carrier **40A** and lower carrier **41A** whose function is the same and whose structure differs from that already described only to the extent of supporting two units instead of one.

Motor drive means **46** connected through worm gear **47** and pinion **48** function to rotate threaded shaft **36** to raise and lower the units. Obviously the three threaded shafts **36** supporting the prow units must be rotated simultaneously to raise and lower those units. The side swinging units **16** and **17** may be raised and lowered independently.

Each of the side swinging units **16** and **17** is mounted on the vessel only at one end, that being the forward end. Each of these units is mounted to pivot on its forward shaft **20**. To facilitate swinging movement of these units and to maintain them in fixed position, means, such as a hydraulic jack **49**, is provided. One end of jack **49** is pivotally secured to the carriage as at pivot **50** on carrier **40** while the other end is pivotally secured to the upper plate **18** intermediate of its ends. The manner in which the side swinging units are extended outwardly so that the channel opened by means of the prow units **14** and **15** can be widened is shown in FIGURE 2. Normally ice engaging units **16** and **17** would be swung out symmetrically.

Because the aft or outboard ends of units **16** and **17** are otherwise unsupported, and because of the considerable weight of the units, auxiliary support means are provided. As shown, a pivoting boom **52** is suitably mounted on the deck or otherwise on the vessel **10** so that its outermost end may overlie the aft or outboard end of the unit. Cable means dropped from the end of the boom to an eye **53** on the top plate **18** or similar fasting means provides suspension support for the ice engaging means, the cable being maintained taut by suitable winch means or otherwise.

Referring now to FIGURES 8 to 10, there is shown an alternative form of the invention including a marine vessel, indicated generally at **10A**, built as or converted into an ice channel cutter. As shown, the marine vessel **10A** has a relatively flat prow **11A**. It is of a relatively shallow draft with a relatively shallow bottom **12A** and flat deck **13A**. A pair of ice-engaging units, indicated generally at **14A** for the port side unit and **15A** for the starboard side unit, are supported from the prow **11A** of the vessel **10A** as described in greater detail hereinafter. Both prow units **14A** and **15A** are of identical construction except that one is a mirror image of the other.

Each ice-engaging unit is comprised of a rugged frame including an inboard end plate **18A** and corresponding horizontally spaced apart outboard end plate **19A**. A pair of vertically spaced parallel shafts **20A** is journalled to rotate at the top and bottom of each unit extending horizontally between plates **18A** and **19A**. One end of each shaft extends outboard from end plate **19A**. Each shaft **20A** carries a plurality of heavy duty sprocket wheels **22A** spaced evenly between the end plates **18A** and **19A** and on the segment of shaft extending outboard from plate **19A**. One of the shafts **20A** of each ice-engaging unit is adapted to be driven by motor means **23A** in order to drive the sprocket wheels **22A** and the other may be an idler.

A heavy duty endless linear motion means, such as sprocket chain **24A**, extends vertically between each pair of sprocket wheels journalled at the upper and lower ends of the ice engaging units. A plurality of spaced apart parallel horizontally extending chopper carrier plates **25A** are carried by sprocket chains **24A** around the outer perimeter of the loop formed by each chain. Each plate **25A** carries a plurality of ice choppers in the form of blades or cutters, indicated generally at **27**, as already described. As best seen in FIGURE 9, the blades or cutters **27** on one plate **25A** are staggered horizontally relative to the blades or cutters on the next adjacent plates.

The blades or cutters **27** on this form of the invention are disposed to extend generally vertically and the tip **33** is pointed downward in the direction of travel when the plates and chains move in response to rotation of the drive sprocket wheels. As the blades or cutters are so driven simultaneously with pressure exerted by forward motion of the marine vessel and are urged into engage-

ment with the edge surface of the ice floe or covering on the stream on which the channel is desired to be opened, the blades or cutters being driven at high speed perform a constant chipping action against the ice breaking it up into many relatively small sized chunks which are carried downwardly and then discharged rearwardly as the vessel passes over them. Of necessity, using this form of ice chopper with vertically movable blades, in order to permit clearance between the chopper plates **25**A and end plates **18**A and **19**A, narrow vertically extending ribs or fins of ice are left uncut between the ends of the chopper plates on opposite sides of the end plates. The forward vertical edge of each end plate **19**A is provided with projecting teeth **60**, which, under force of the forward thrust of the vessel, ram and split the rib of ice. Similarly, the forward edges of plates **18**A are bridged by a vertical wedge **61** whose forward face is fitted with projecting teeth **62** which likewise aid in chipping the rib of ice. Because the ribs of ice jutting from the face of the ice floe are supported only at their points of connection to the floe, they shatter and chip relatively easily under impact of the forward movement of the vessel forcing the projecting teeth into the ice.

In order to prevent binding between the ends of the ice-engaging units and the sides of the channel cut through the ice, side cutting ice chipping teeth or blades **63** are mounted on the outboard ends of the blade carrier plates **25**A carried by the sprocket wheels and chains carried by the cantilevered ends of shaft **20**A extending beyond bearing plates **19**A. The side cutters also aid in maneuvering the vessel, the degree of maneuverability being related to the overall width of channel cut, as determined by the length of the ice-engaging units, relative to the width of the vessel.

The modified ice-engaging units may be secured to the marine vessel so as to be fixed relative to the deck of the vessel, but preferably, the units are mounted so as to be vertically adjustable to accommodate for differences in ice thickness, variations in draft, and the like. As illustrated, the marine vessel is provided with a heavy duty top bracket **34**A supported from the deck and a corresponding heavy duty lower bracket **35**A supported adjacent the bottom and located on the approximate longitudinal center line of the vessel. A screw threaded shaft **36**A extends between the brackets. Corresponding top and bottom brackets **37**A and **38**A are disposed adjacent each front corner of the vessel and carry a screw threaded shaft **36**A between them.

As best seen in FIGURE 10, the inboard end of port side ice engaging unit **14**A is supported in a carrier for vertical movement on threaded shaft **36**A. End plates **18** together comprise a carrier whose upper and lower rearwardly extending arms **40**B and **41**B carry hubs **42**A and **43**A respectively, which are each threaded to engage shaft **36**A. Arms **40**B and **41**B are rigidly secured to a slide plate **64** which engages a vertical keyway **65**, secured to the hull in order to prevent rotation of the unit about the threaded shaft.

Units **14**A and **15**A are secured to the vessel at both ends. The outboard ends of the prow units **14** and **15** are supported in a carriage substantially as described and illustrated in detail with respect to the inboard ends whose function is the same and whose structure differs from that already described only to the extent of supporting one unit instead of two.

Motor drive means **46**A connected through worm gear **47**A and pinion **48**A function to rotate threaded shaft **36**A to raise and lower the units. Obviously the three threaded shafts **36**A supporting the prow units must be rotated simultaneously to raise and lower those units.

All of the motor drive means **23**, **23**A, **46** and **46**A are preferably electric motors driven from a common generating plant. However, if necessary, the units may be driven from internal combustion engines mounted on the deck and connected through suitable drive means. The mechanisms for raising and lowering the units are used only at widely spaced intervals and then only for short periods of time. They may be manually operated.

We claim:

1. A channel ice cutter comprising:
- (A) a marine vessel;
- (B) at least one ice-engaging unit supported on the prow of the vessel and presenting a forward facing ice-engaging vertical plane extending transversely across the width of the vessel;
- (C) said ice-engaging units each comprising a vertically disposed elongated horizontally and transversely extending frame secured to said prow and fixed against horizontal and pivotal movement relative to said prow;
- (D) said ice engaging units each comprising an array of a plurality of spaced apart ice choppers disposed in said forward facing transversely extending ice-engaging vertical plane across the prow of said vessel;
- (E) the ice choppers being supported from endless flexible linear motion means for ice-engaging movement in said vertical plane;
- (F) the linear motion means being mounted in said frame to carry the ice choppers into transverse vertical plane engagement with ice covering a body of water; and
- (G) power means to drive the linear motion means.

2. A channel ice cutter according to claim **1** further characterized in that:
- (A) means are journalled for rotation in said frame about a pair of parallel axes for carrying a plurality of endless flexible linear motion means;
- (B) a plurality of ice chopper carrier plates are supported from the outside perimeter of the linear motions means, each of said carrier plates being supported from at least two of the linear motion means and spanning the space therebetween; and
- (C) said ice choppers are carried on the outwardly facing surface of said plates.

3. An ice channel cutter according to claim **2** further characterized in that the tips of said ice choppers are pointed and canted outwardly relative to their paths of travel and the ice choppers on adjacent carrier plates are staggered.

4. An ice channel cutter according to claim **2** further characterized in that the frames of the ice engaging units are mounted on the marine vessel for movement vertically.

5. An ice channel cutter according to claim **4** further characterized in that said means for movably mounting the ice-engaging units comprises for each unit:
- (A) at least one bracket rigidly secured to the marine vessel including a pair of arms spaced apart to embrace one end of the ice-engaging unit;
- (B) a vertical screw threaded shaft extending between said arms and journalled therein for rotation;
- (C) a carriage rigidly secured to the ice-engaging unit;
- (D) said carriage engaging said screw threaded shaft; and
- (E) means for rotating said shaft to raise and lower said carriage.

6. An ice channel cutter according to claim **2** further characterized in that each of said ice-engaging units includes:
- (A) a pair of parallel shafts journalled for rotation in the elongated horizontally extending frame;
- (B) at least a pair of spaced apart sprocket wheels keyed to said shafts for rotation therewith;
- (C) an endless sprocket chain extending between corresponding sprocket wheels on said pair of shafts;
- (D) said ice chopper carrier plates being secured to said sprocket chains; and
- (E) motor means operatively connected for rotating one of said shafts.

7. An ice channel cutter according to claim 1 further characterized in that:

(A) one pair of ice-engaging units is disposed supported on but forward of the prow of the marine vessel;

(B) one unit of said pair is disposed on each opposite side of the longitudinal centerline of the vessel;

(C) the ice choppers extend horizontally supported from vertically extending carrier plates secured to horizontally extending linear motion means;

(D) said units are disposed obliquely such that the ice choppers carried thereby lie in vertical planes which intersect on that centerline and form an obtuse angle whose apex is in the normal direction of travel of the vessel; and

(E) the linear motion means are mounted to carry the ice choppers horizontally in a direction generally sidewardly and rearwardly of the vessel.

8. An ice channel cutter according to claim 7 further characterized in that:

(A) one pair of ice-engaging units is disposed supported on the prow of the marine vessel to extend aft thereof;

(B) one unit of said pair is disposed in the port side and the other on starboard;

(C) the forward end of each of said units is pivotally supported; and

(D) means are provided for moving each of said units on its pivotal support to swing the aft end away from the hull of the vessel.

9. An ice channel cutter according to claim 8 further characterized in that:

(A) hydraulic jack means are provided for moving said ice-engaging units; and

(B) suspension means are provided to support the free aft end of each of said units.

10. An ice channel cutter according to claim 1 further characterized in that:

(A) said ice-engaging unit includes a pair of horizontal shafts supported in said frame vertically spaced apart and lying in a vertical plane;

(B) the ice choppers extend vertically supported from horizontally extending carrier plates secured to at least two of the vertically extending linear motion means carried by said shafts and spanning the space therebetween; and

(C) the linear motion means are mounted to carry the ice choppers in their forwardmost path vertically and downwardly.

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TRYGVE M. BLIX, Primary Examiner