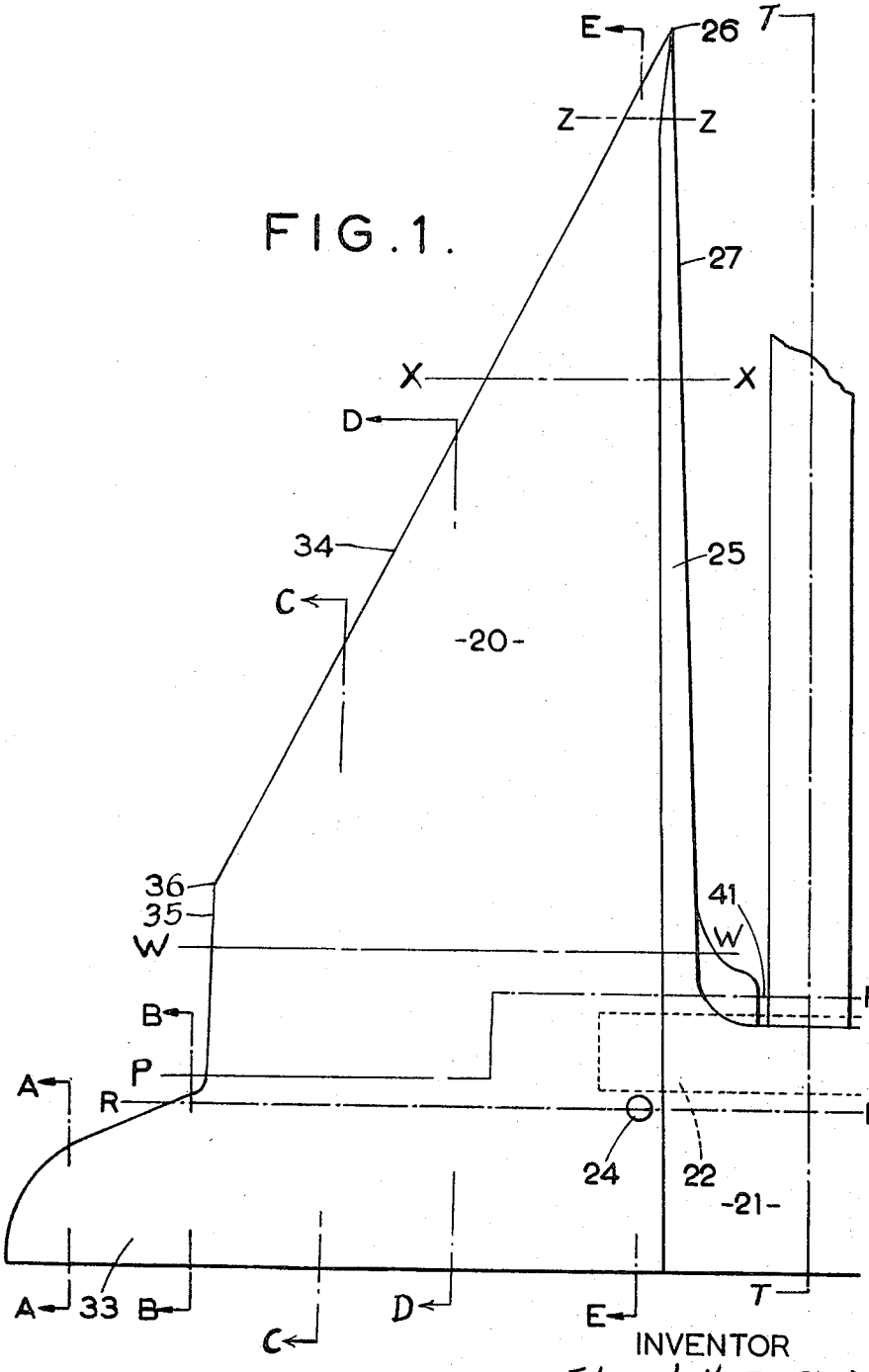
March 19, 1968 E. H. G. STOKES 3,373,712

ANCHOR HAVING PIVOTABLE FLUKES

Filed April 6, 1966 7 Sheets-Sheet 1

FIG. 1.



INVENTOR
Edward H. G. Stokes
BY
Stevens, Davis, Miller & Mosher
ATTORNEYS

March 19, 1968 E. H. G. STOKES 3,373,712

ANCHOR HAVING PIVOTABLE FLUKES

Filed April 6, 1966 7 Sheets-Sheet 2

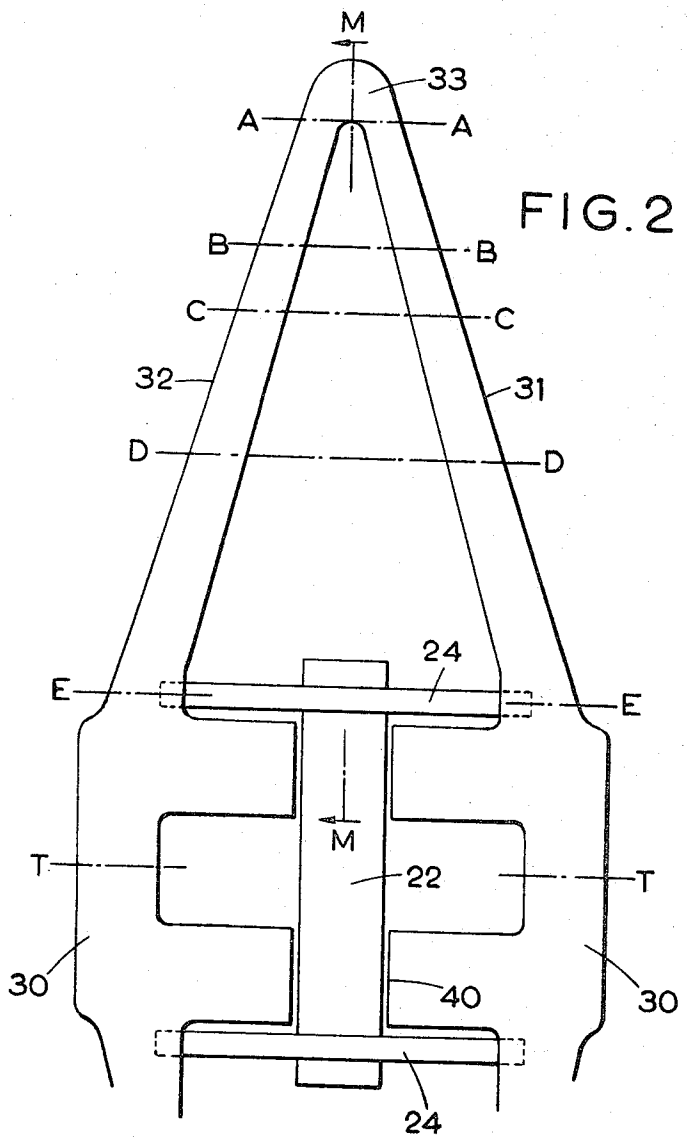


FIG. 2.

INVENTOR
Edward H. G. Stokes

BY
Stevens, Davis, Miller & Mosher
ATTORNEYS

March 19, 1968 E. H. G. STOKES 3,373,712

ANCHOR HAVING PIVOTABLE FLUKES

Filed April 6, 1966 7 Sheets-Sheet 3

FIG.3.

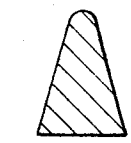


FIG.4.

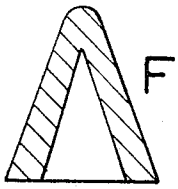


FIG.5.

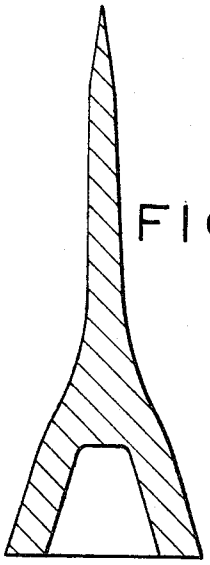


FIG.7.

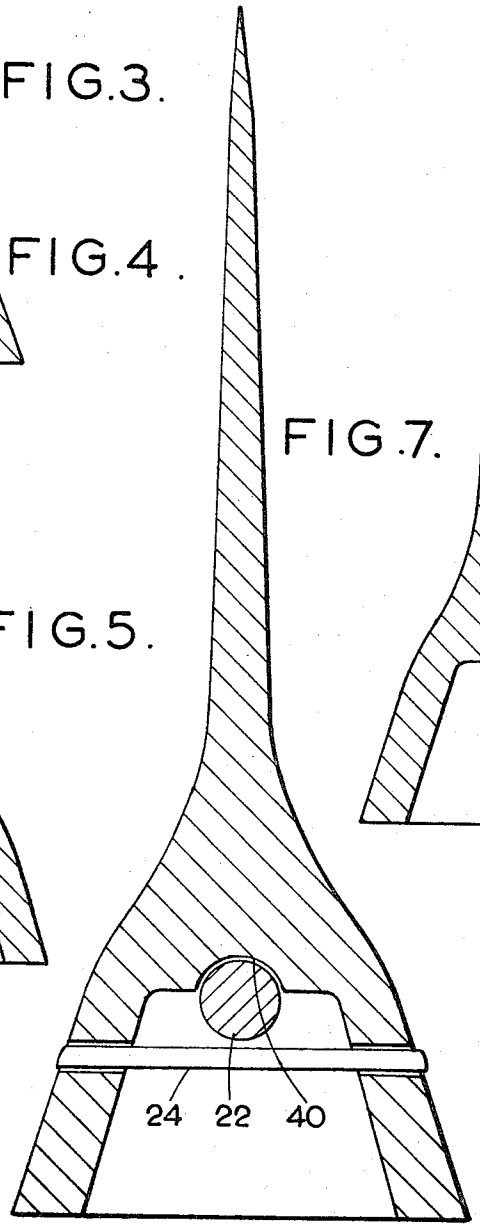
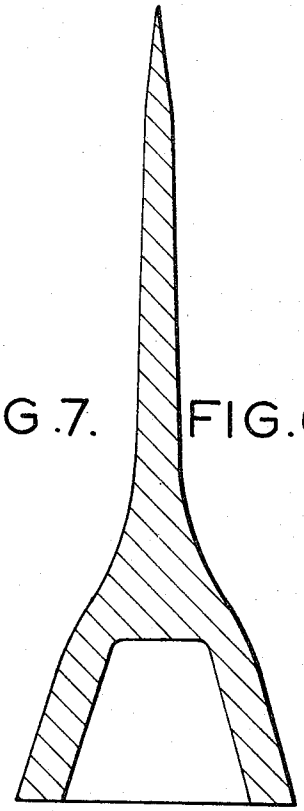


FIG.6.



INVENTOR
Edward H. G. Stokes

BY Stevens, Davis, Miller & Mosher
ATTORNEYS

March 19, 1968 E. H. G. STOKES 3,373,712

ANCHOR HAVING PIVOTABLE FLUKES

Filed April 6, 1966 7 Sheets-Sheet 4

FIG.17.

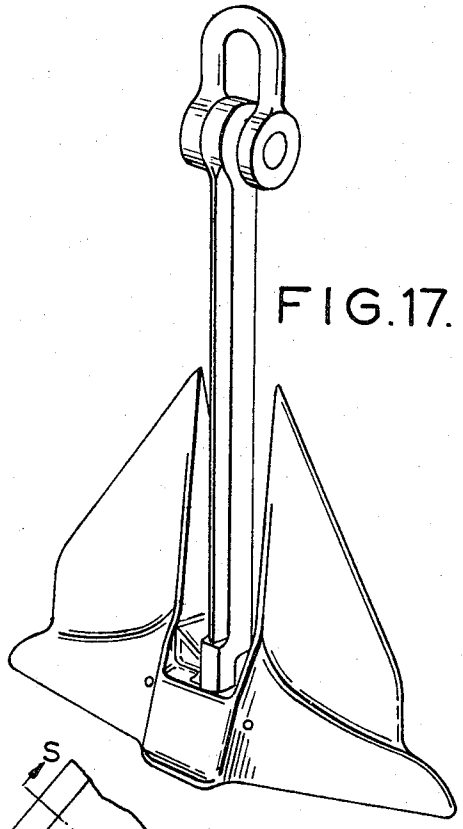
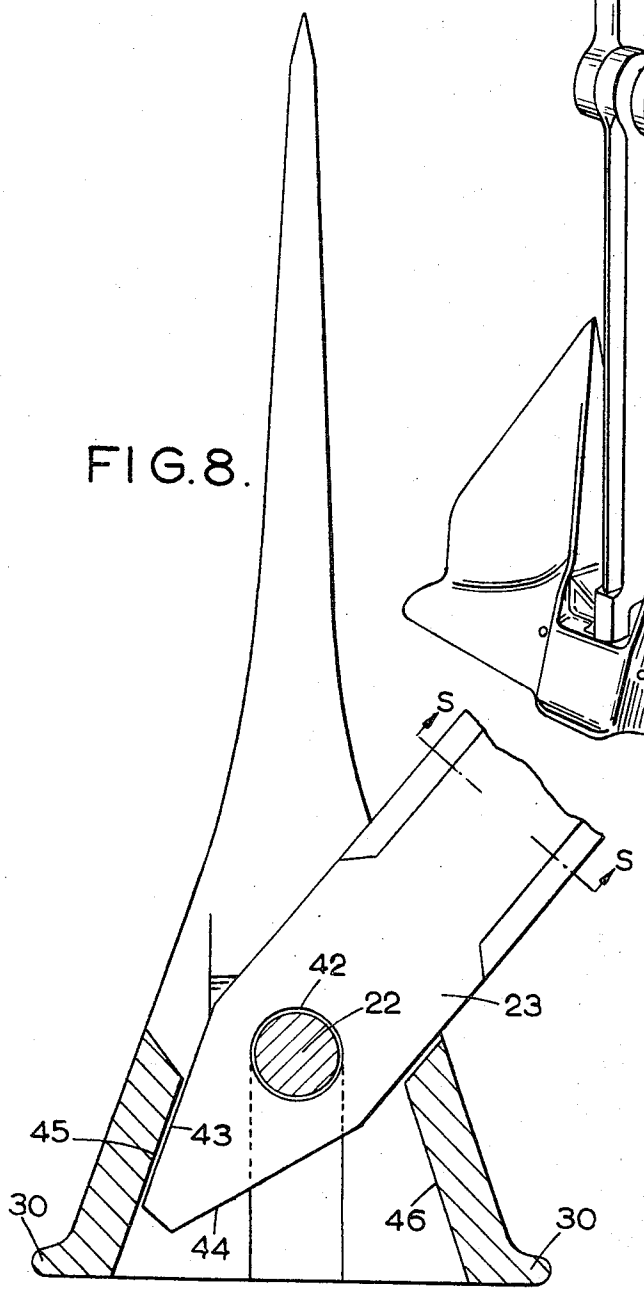


FIG.8.



INVENTOR
Edward H. G. Stokes

BY
Stevens, Davis, Miller & Mosher ATTORNEYS

March 19, 1968 E. H. G. STOKES 3,373,712

ANCHOR HAVING PIVOTABLE FLUKES

Filed April 6, 1966 7 Sheets-Sheet 5

FIG. 9.

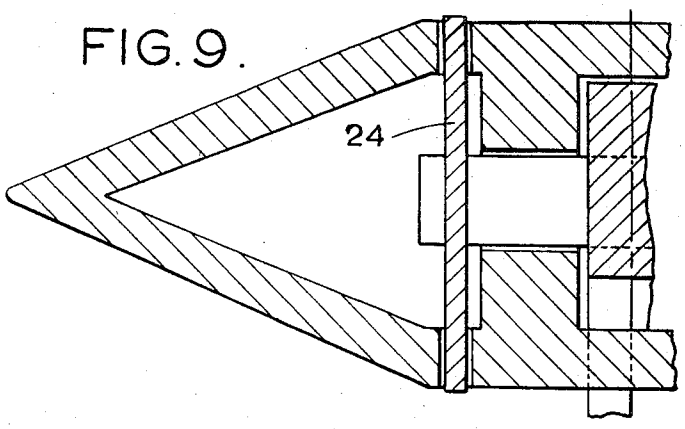


FIG. 10.

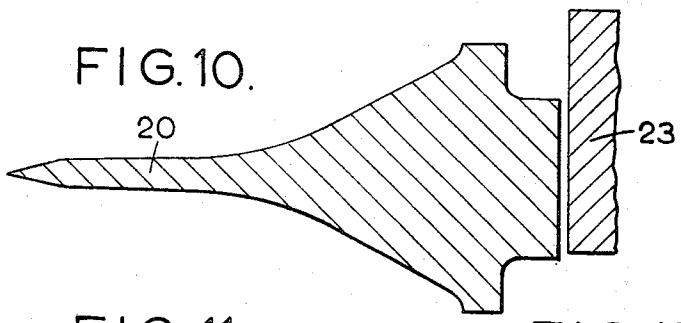


FIG. 11.

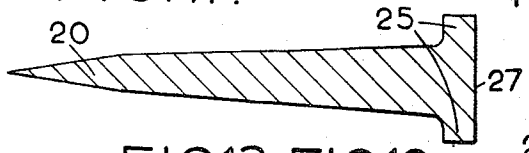


FIG. 15.

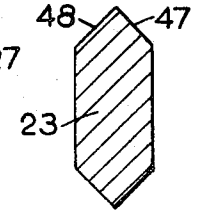


FIG. 13. FIG. 12.

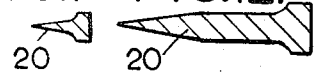
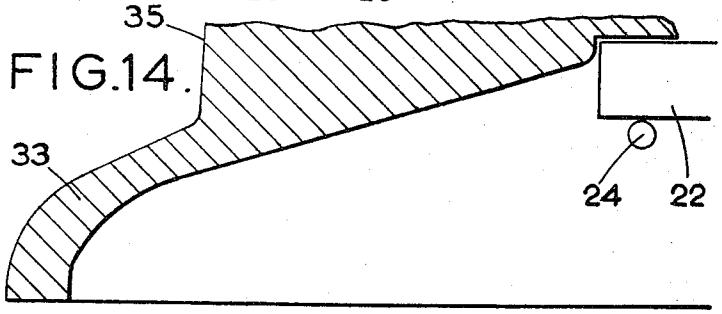


FIG. 14.

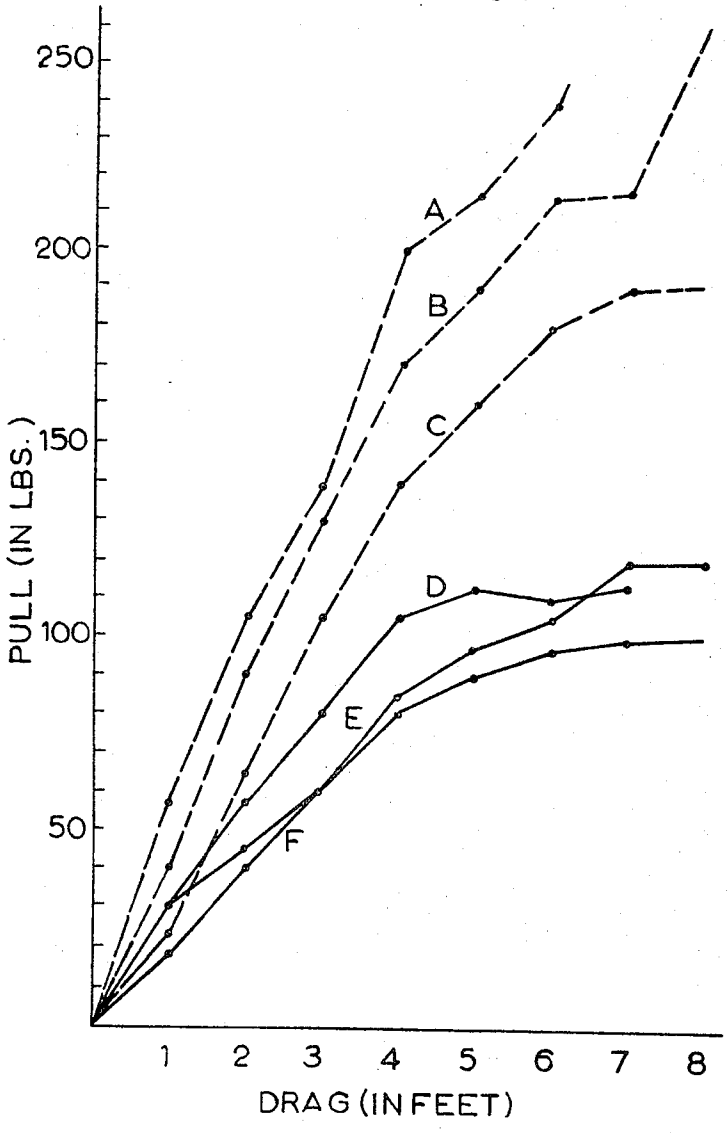


INVENTOR
Edward H. G. Stokes

BY
Stevens, Davis, Miller & Mosher

ATTORNEYS

FIG. 16.



INVENTOR
Edward H. G. Stokes
BY
Stevens, Davis, Miller & Mosher
ATTORNEYS

March 19, 1968 E. H. G. STOKES 3,373,712

ANCHOR HAVING PIVOTABLE FLUKES

Filed April 6, 1966 7 Sheets-Sheet 7

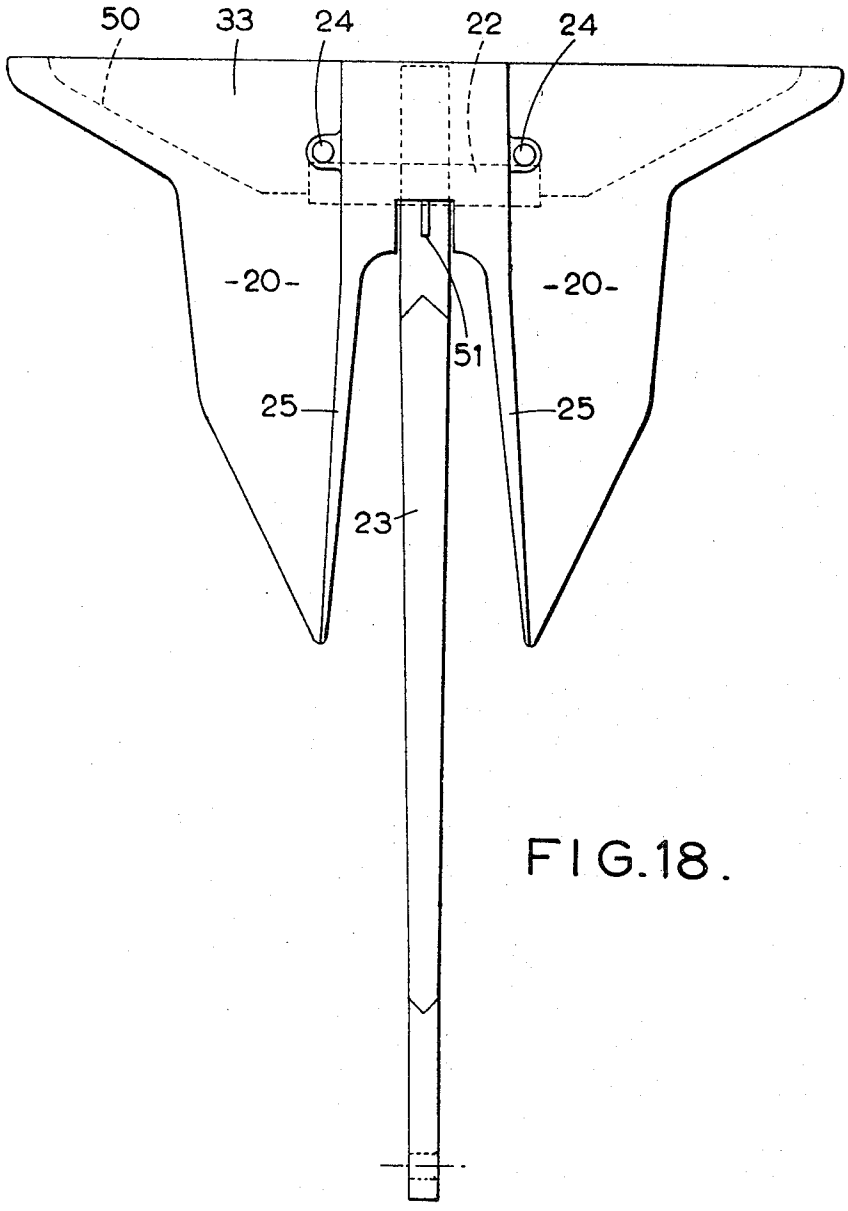


FIG. 18.

INVENTOR
Edward H. G. Stokes
BY
Stevens, Davis, Miller & Mosher ATTORNEYS

United States Patent Office 3,373,712 Patented Mar. 19, 1968

3,373,712

ANCHOR HAVING PIVOTABLE FLUKES

Edward H. G. Stokes, Droxford, Southampton, England, assignor to Armstrong Whitworth (Marine) Limited, Droxford, Southampton, England

Filed Apr. 6, 1966, Ser. No. 540,666
Claims priority, application Great Britain, Apr. 13, 1965, 15,670/65
5 Claims. (Cl. 114—208)

ABSTRACT OF THE DISCLOSURE

A stockless marine anchor of the kind comprising a crown, a shank pivotally mounted in the crown for limited pivotal movement about a transverse axis, two flukes formed integrally with said crown and projecting forwardly therefrom one on each side of said shank, said flukes comprising generally co-planar blades each having two mutually opposed sea-bed engaging surfaces, said blades being pointed in plan view at their forward ends and widening out towards a portion of maximum width adjacent the crown. The two sea-bed engaging surfaces on each side of the anchor are inclined one with the other as viewed in lateral cross section to provide a dihedral angle between said surfaces to stabilize the anchor.

This invention relates to stockless marine anchors, and particularly to an anchor which combines high efficiency with ease of stowing in existing hawse pipe arrangements of ships, and which may be manufactured at low cost.

The ability to anchor a vessel securely is dependent (for a given weight of anchor) upon the efficiency of the anchor and the substance of the sea bottom on which it is to be anchored. Every type of penetrable bottom, i.e., sand, mud, silt, clay, gravel and pebbles, has one feature in common with all others—the inter-particle pressure, that is, the compactness of the substance, increases in proportion to the depth from the surface of the substance. The deeper the anchor digs, the greater the pull it will resist. The first requirement for high efficiency, therefore, is that the anchor should, when subjected to a horizontal pull along the sea bottom, bury itself in the substance of the bottom and continue to dig deeper into the bottom as it is dragged along.

The efficiency of an anchor is generally expressed as the maximum holding power against a horizontal pull applied to the anchor, divided by the weight of the anchor. That is to say, an anchor which weighs 200 pounds and will withstand a horizontal pull of 2,000 pounds is said to have an efficiency of 10. The normal commercial stockless anchor in present day use has an efficiency of the order of 4 to 6.

The efficiency of an anchor depends upon three factors:

(a) The ability of the anchor to penetrate and dig into the substance of the sea bottom.
(b) The effective surface area of the anchor, which should be as large as possible consistent with its weight, so as to resist horizontal movement through the substance of the sea bottom.
(c) The stability of the anchor, that is to say, its ability to resist rolling over when subjected to a horizontal pull.

Stability against rolling over has previously been provided by the stock, that is, a bar set at right angles to the shank. In the Admiralty pattern or Fisherman anchor the stock is provided at the shackle end, and in the Chinese anchor and the Danforth anchor, the stock is provided at the crown end. The stock is usually in the form of a long bar, which makes stowage and handling

awkward. Because of the awkwardness of the stock in handling, the stockless anchor was invented, but it has the disadvantage that when subjected to a horizontal pull above a certain limit it rolls right over and breaks out of the sea bottom. Thus, in the past high efficiency has been achieved, at the expense of ease of handling, and ease of handling has been achieved at the expense of efficiency. Both high efficiency and comparative ease of handling have been achieved together, but only at unreasonably high cost.

In order to achieve ease of handling it is important that the means for stabilizing the anchor against roll should not cause obstruction to handling and should not damage the side of the ship when the anchor spins on being hoisted, and it should not project in such a way that wire hawsers and ropes can easily get entangled with it. When the anchor is lifted from the shackle end of the shank the flukes should not swing violently over in such a manner as may cause serious bumping and damage. The anchor should fit as snugly as possible against the side of the ship without necessitating expensive alterations to the ship.

The principal object of the invention is to provide a marine anchor which combines exceptionally high efficiency with ease of handling and low cost of manufacture.

The invention consists of a stockless marine anchor comprising a crown, two flukes made integrally with the crown, the crown being of hollow domed form open at its rear and the flukes projecting forwardly from the crown and being in the form of substantially flat co-planar blades which are pointed at their front ends and widen out towards the crown, the adjacent edges of the flukes being formed with ribs set at right angles to the flukes to provide strength, an opening in the centre of the crown between the flukes, a shank formed at its inner end with an eye passing through the opening, and a pivot pin located within the hollow of the crown passing through the eye to permit the shank to pivot with respect to the crown and flukes.

In the anchor according to the invention the flukes are made as thin as possible, consistent with the necessary strength, so as to enhance their ability to penetrate the substance of the sea bed. The crown and flukes are formed in a single casting and the whole of the crown and fluke casting presents a large holding surface area which provides high resistance to movement of the anchor through the substance of the sea bed. The crown is also formed with extensions adjacent the outer edges of the flukes to provide wings which act like a stock to enhance the stability of the anchor, the wings being so faired off that they present a minimum risk of snagging. The anchor may also be provided with waterways cut in the crown end of the shank which are in communication with the opening in the crown in which the shank is located and which provide a venturi effect to ensure free flow of the substance of the sea bottom between the flukes and out of the anchor when the anchor is pulled through the substance of the sea bottom while the shank is tilted to its maximum extent with respect to the crown. The crown and fluke casting is so shaped that the surfaces between the crown and the wings are in dihedral relation so as to produce a righting moment if the anchor should tend to turn when buried.

Selected embodiments of the invention will now be described, by way of example, with reference to the drawings accompanying this specification, in which—

FIGURE 1 is a part plan view of the anchor;

FIGURE 2 is an end view looking from the left in FIGURE 1;

FIGURE 3 is a section along the line A—A of FIGURE 1;

FIGURE 4 is a section along the line B—B of FIGURE 1;

FIGURE 5 is a section along the line C—C of FIGURE 1;

FIGURE 6 is a section along the line D—D of FIGURE 1;

FIGURE 7 is a section along the line E—E of FIGURE 1;

FIGURE 8 is a section along the line T—T of FIGURE 1;

FIGURE 9 is a section along the line R—R of FIGURE 1;

FIGURE 10 is a section along the line P—P of FIGURE 1;

FIGURE 11 is a section along the line W—W of FIGURE 1;

FIGURE 12 is a section along the line X—X of FIGURE 1;

FIGURE 13 is a section along the line Z—Z of FIGURE 1;

FIGURE 14 is a section along the line M—M of FIGURE 2;

FIGURE 15 is a section along the line S—S of FIGURE 8;

FIGURE 16 is a graph showing the performance of an anchor constructed in accordance with the invention as compared with known anchors;

FIGURE 17 is a perspective view of an anchor according to the invention; and

FIGURE 18 is a plan view of an assembled anchor in slightly modified form.

Referring to the drawings, the anchor according to the invention comprises two flukes **20**, only one of which is shown in FIGURE 1, the two flukes being integrally cast with a crown **21** as a single casting. The crown and fluke casting is connected by a shank pivot pin **22** to a shank (shown in FIGURE 1 and having reference **23** in FIGURE 8). The shackle end (not shown in FIGURE 2 but included in FIGURE 17) of the shank **23** is arranged in known fashion for connection by means of a shackle to the anchor cable or chain. The pivot pin **22** is retained by two retaining pins **24** which are drive fits in holes in the walls of the casting, and which have their ends riveted over or welded in after they are driven into position in the casting.

As is best seen in FIGURES 5, 6 and 7, the major part of each fluke **20** is made very thin and is, in fact, as thin as is possible consistent with the strength required to withstand the anchoring loads, so that the two flukes are substantially flat co-planar blades set on opposite sides of the centre line of the crown. The inner edge of each fluke is bounded by a rib **25** and the rib increases in width from the tip **26** of the fluke up to the junction of the fluke with the crown, there being a boss adjacent the shank **23**, as may be seen in FIGURE 1. The inside face **27** of each rib is inclined with respect to the centre line so that the adjacent edges of the flukes are more widely separated at the front than at the rear. The reason is that if the anchor is initially unable to bury itself, the points are sufficiently widely spaced to enable the anchor to "stand up" instead of falling on its side. The thickness of the flukes **20** increases somewhat from the tip towards the crown. The included angle of the taper of the flukes may be anything between 3° and 10°. This taper may vary at different points.

Considering FIGURES 2 to 8 and 17, it will be seen that the centre section of the crown is bounded by outstanding ribs **30** which act as tripping palms. The surfaces **31**, **32** and the corresponding surfaces on the other side of the crown (not shown) are inclined with respect to each other and the inclination of these two surfaces defines a dihedral angle between them which provides stability for the anchor and resists any tendency for the anchor to roll right over under an anchoring load. Thus, for example, when the anchor turns about its longitudinal

axis TT (FIGURE 2) a greater vertical thrust is applied to the surface **31** or **32** on the side towards which the anchor is turning than to the equivalent surface on the other side, which is now tilted at such an angle that the resolved vertical thrust is less. A correcting moment is thus automatically set up. It will also be seen, particularly from FIGURE 8, that when the anchor rests on the ribs **30** the tips **26** are brought into contact with the sea bottom and as the anchor is dragged along horizontally it will automatically bite into the substance of the sea bottom and bury itself.

From the foregoing description and the relevant drawings it will be clear that the crown, looked at from the rear, is generally of diamond shape with the tripping palms **30** projecting beyond this shape. The centre section of the crown is strengthened around the opening through which the shank **23** passes.

Each fluke **20** has an edge **34** extending from the tip **26** and a further edge **35** joining the wing portion **33**. The edges **34** and **35** together define an obtuse angle and form a corner **36**. This corner lies inside a line running from the tip **26** to the outer edge of the wing.

The shank pin **22** is seated in a recess **40** formed in the crown and fluke casting. In assembly, the shank **23** is passed between the flukes and through the opening **23** in the casting until its projects through the back of the casting, whereupon the pivot pin **22** can be passed through a hole **42** in an eye formed at the inner end of the shank. Thereafter the shank is pulled in the reverse direction so that the pivot pin **22** seats in the recess. Retaining pins **24** are then driven through holes provided for them in the casting to retain the pivot pin, and the ends of the retaining pins **24** are preferably riveted over or welded when in position to prevent them from loosening and disengaging themselves from the crown and fluke casting. The pivot pin **22** has clearance in the hole in the eye of the shank and an appropriate clearance is allowed between the wall of the recess **40** and the retaining pins **24** to permit the pivot pin to rotate.

The end of the shank **23** has two inclined surfaces **43**, **44** (FIGURE 8) which are arranged to abut inside surfaces **45** and **46** of the crown, respectively, in the two extreme tilted positions of the shank. This limits the amount of swing of the shank in relation to the crown and flukes.

The angle of inclination of the flukes with respect to the sea bed to achieve the quickest penetration of the average sea bed is believed to be about 30°. Some anchors have been designed with an angle of swing of 30°, the angle of swing being the angle between the centre line of the flukes and the centre line of the shank in the tilted position. However, the important factor is not the angle between the flukes and the shank but the angle of attack of the flukes on the sea bed. The shank of an anchor will never be quite horizontal when it is being dragged by the cable attached to a ship on the surface of the sea, because the cable lying on the surface of the sea bottom resists burial, so that the pull on a buried anchor is slightly above the horizontal. For this reason it is thought that the best angle of swing between flukes and the shank is probably about 35°, but this may be varied.

Quite apart from these considerations, the angle between the existing hawse pipes and the shell of a ship has considerable bearing on the angle of swing which can be accepted from the point of view of neat storage. The commercial stockless anchor has an angle of swing ranging between 45° and 50° and, therefore, if the angle of swing in a new anchor is too heavily reduced the new anchor will not stow properly without structural modification to the ship. This could be very expensive. For the above reasons the anchor according to the invention has been designed with a standard angle of swing of 40° but provision is made to vary this angle in manufacture between 30° and 50°. By varying the angle of inclination of the faces **43**, **44** ship owners and designers may choose the angle of swing best suited to their requirements.

As is shown in FIGURE 15, the narrower edges of the shank are bevelled at **47, 48** to give the shank a form of cutting action when the anchor is pulled through the substance of the sea bottom.

In order that the swing of the flukes shall not be violent when the anchor is hoisted, as it often is with existing stockless anchors, the pivot pin is situated close to the centre of gravity of the fluke and crown casting and is preferably in such a position that when the anchor is lifted from the shackle end of the shank the flukes naturally take up a vertical position in alignment with the shank.

The dihedral angle incorporated in the surfaces **31, 32** and the corresponding surfaces on the other flukes provides a natural flat stowage against the curve of the bows of a ship.

The anchor is made from two simple steel castings, the crown and fluke casting and the shank casting, and the only separate parts required for assembly of the anchor are the pivot pin and the two retaining pins. The crown and fluke casting is comparatively simple in form and lends itself very well to easy and quick assembly.

Referring to FIGURE 16 there is shown a graph of horizontal pull applied to the shackle end of the shank of an anchor plotted against the distance through which the anchor drags. Line A refers to a ten-pound model anchor constructed in accordance with the invention and shows the force required to drag the anchor through the sea bottom for varying distances. The line D shows the holding power of this anchor after it has been dragged for the distances shown. Lines B and E show corresponding values for a slightly modified anchor constructed in accordance with the invention, while lines C and F show corresponding values for a model Danforth anchor of the same weight made in accordance with British Patent No. 553,235, which is recognised as a "high holding power" anchor. The tests were carried out under proper laboratory conditions by pulling the anchor along in an anchor testing tank having a sand bottom compacted so as to be equal to a soft sand sea bottom.

FIGURE 18 shows a side view of an assembled anchor according to the invention. The hollowed-out portion of the crown **21** is indicated by the dotted line **50**. The two flukes **20** are bounded at their inner edges by the ribs **25**. The pivot pin **22** is located in its groove and is retained in position by the two retaining pins **24**. The shank **23** has a waterway **51** machined in each of the two opposite side faces. These waterways coact with the inside walls of the crown to provide a venturi effect when the shank is tilted to its maximum extent.

I claim:

1. A stockless marine anchor comprising:
(a) a crown,
(b) a shank pivotally mounted in the crown for limited pivotal movement about a transverse axis, and
(c) two flukes formed integrally with said crown, merging smoothly with said crown, and projecting forwardly from said crown one on each side of said shank,
(d) said flukes comprising generally co-planar blades together defining two sea-bed engaging surfaces to either side of said blades, the surfaces on the same sides of said blades being inclined at a dihedral angle with respect to each other,
(e) said blades being pointed in plan view at their forward ends and widening out towards a portion of maximum width adjacent the crown,
(f) said crown being generally diamond shaped in a plane parallel to said transverse axis to form two additional sea-bed engaging surfaces to either side of said crown, the additional sea-bed engaging surfaces on the same side of said crown being inclined at a dihedral angle with respect to each other.

2. A stockless marine anchor comprising:
(a) a crown,
(b) a shank pivotally mounted in the crown for limited pivotal movement about a transverse axis, and
(c) two flukes formed integrally with said crown, merging smoothly with said crown, and projecting forwardly from said crown one on each side of said shank,
(d) said flukes comprising generally co-planar blades together defining two mutually opposed sea-bed engaging surfaces to either side of said blades, the surfaces on the same sides of said blades being inclined at a dihedral angle with respect to each other,
(e) said blades being pointed in plan view at their forward ends and widening out towards a portion of maximum width adjacent the crown,
(f) the opposite side faces of said shank having waterways cut therein to permit the flow of the substance of the sea-bed through them, the inside walls of the crown being so formed that, with said waterways, they provide the effect of a venturi, the rear portion of the crown being open to permit free flow through the waterways.

3. An anchor according to claim **1**, wherein said flukes converge forwardly with the pointed ends thereof lying adjacent to the shank.

4. An anchor according to claim **1**, wherein said crown extends beyond the outer edges of the flukes to form wings which act like a stock to enhance the stability of the anchor.

5. An anchor according to claim **4**, wherein the outer edge of each fluke is formed by two substantially straight portions defining an obtuse angle, the corner formed at the junction of the straight portions lying within a line running from the pointed end of the fluke to the outer edge of the respective wing.

References Cited

UNITED STATES PATENTS

998,152	7/1911	Birdsey	114—208
1,297,987	3/1919	Baldt	114—208
1,513,025	10/1924	Becker	114—208
2,480,188	8/1949	Gardiner	114—208
3,286,679	11/1966	Wood	114—208

FOREIGN PATENTS

519,577 12/1955 Canada.

MILTON BUCHLER, *Primary Examiner.*
TRYGVE M. BLIX, *Examiner.*