(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 196 801 A2**

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: **86301672.1**

(51) Int. Cl.4: **B63B 21/42**

(22) Date of filing: **10.03.86**

(30) Priority: **08.03.85 GB 8505988**

(43) Date of publication of application: **08.10.86 Bulletin 86/41**

(84) Designated Contracting States: **AT BE CH DE FR GB IT LI LU NL SE**

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(54) **Drag embedment anchors.**

(57) A drag embedment anchor of very high holding power of fixed configuration comprising of a shank, anhedral fluke, a pair of anhedral terrafins in Mooring Anchor form, and with destabiliser bar or bars attached to the shank in Bower Anchor form, and both forms constructed of flat plate and rod or tube, round in cross section. Wherein the shank has more than one lateral shank plate parallel to the medial plane, there is a transverse shank plate normal and symetrical to the medial plane, at the extreme end, ahead of the cable shackle point and lying in a plane parallel or converging with the plane of the fluke.

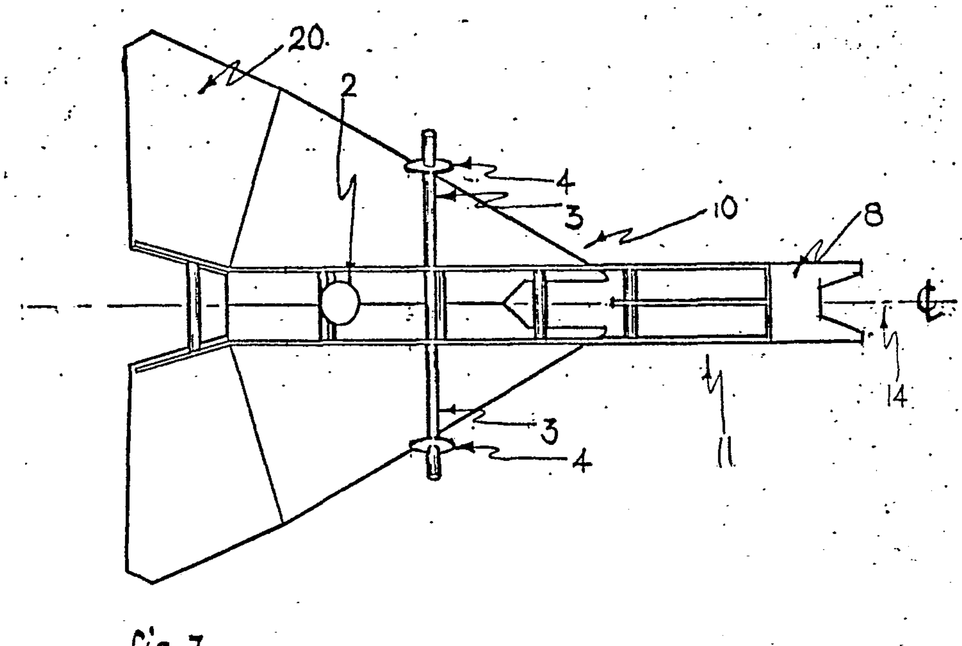

fig.7.

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DRAG EMBEDMENT ANCHORS.

This invention relates to drag embedment anchors, both Mooring and Bower anchors, suitable for mooring boats, ships, buoys and floating structures.

An object of this invention is to provide a very high efficiency single fluke anchor, without moving parts, capable of adjusting its angle of attack in varying mooring bed shear strength conditions, without having to alter shank set angles, for an anchor to be laid between a mooring cable and a pennant cable (MOORING ANCHOR).

Another object of this invention is the same as the above, except that where the anchor is laid by mooring cable only, (BOWER ANCHOR) the anchor is unstable in all attitudes, other than fluke member lowermost, when dragged by the mooring cable. The anchor will roll to fluke member lowermost before the fluke engages the mooring bed toes first, should the anchor, in the unlikely event, land on the mooring bed in an attitude other than fluke member lowermost.

The anchor in MOORING form comprises of four main members; a fluke member, a shank member and two rear anhedral fluke plate members, which are henceforth called TERRAFINS, each attached to the fluke and shank members.

The anchor in BOWER form is as above, but it has at least one de-stabiliser bar attached to the upper rear portion of the shank member.

According to one aspect of the present invention, the combined upper surfaces of the fluke and terrafins are entirely anhedral, with the fluke member providing two upper flat surfaces, mutually inclined, three underside flat surfaces mutually inclined, and the terrafins provide two flat upper surfaces and two flat underside surfaces.

The fluke and terrafins are attached to one another and the fluke and terrafins together are attached to one end of a shank which is generally L-shaped.

Further, according to a second aspect of the present invention, there is provided an anchor with a shank, generally L-shaped, constructed of at least three shank plates set symetrically to the medial plane of the anchor, attached at one end to the fluke and terrafins. At the free end of the shank, there is provided a shackle point for attaching the mooring cable and whereby the shank comprises of more than two lateral shank plates, there is provided a transverse shank plate at the extreme end, ahead of the shackle point, acting as a shank fluke and joining and spacing apart the parallel shank plates, assisting the rods, or hollow tubes, stiffening the shank. Also to add stiffness to the shank, the fluke, the terrafins and shank connection and also to assist in rapid veering at small angles of incidence between the anchor and the cable, the aftmost generally triangular shaped portion attached to the terrafins diverge aft. All of which provides a light stiff shank with a low penetration resistance, with a leading shank fluke area acting in undisturbed mooring bed material maintaining an improved angle of attack.

Further, according to a third aspect of the present invention, there is provided a pair of terrafins attached to the rear of the fluke and the shank, to generate stabilising forces at the commencement of burying, and stability when the anchor is fully buried, to act as extended fluke areas in mooring beds of low shear strength and to add stiffness to the fluke, the shank and the fluke-shank connections.

Further, according to a fourth aspect to the present invention, there is provided in the Bower anchor at least one de-stabilising bar, round in cross section, at the upper rear portion of the shank and in the proximity of a vertical line passing through the centre of gravity of the anchor. The de-stabilising bar or bars, one passing through the shank normal to the medial plane in a stock like fashion, providing a bar, symetrically about the shank, and whereby another bar is provided on the medial plane, attached to the upper shank knee pin, or tube, generally in a vertical position but sloping forward to the free end, which is located generally vertically above the centre of gravity of the anchor, causing the anchor to roll over onto its fluke, if the anchor is in an attitude other than fluke member lowermost, when the anchor is pulled by the anchor cable, whereby the direction of the force is generally horizontal.

Embodiments of the present invention will now be described by way of example with reference to the accompanying drawings.

fig. 1. is a plan view, from above, of a mooring anchor with a shank with a transverse shank plate.

fig. 2. is a plan, from below, of the anchor of fig. 1.

fig. 3. is a side elevation of the anchor of fig. 1.

fig. 4. is a sectional elevation taken alongside the medial plane showing the cable shackle point of the anchor of fig. 1.

fig. 5. is a front elevation of the anchor of fig. 1.

fig. 6. is a rear elevation of the anchor of fig. 1.

fig. 7. is a plan view, from above, of a Bower anchor with a transverse shank plate.

fig. 8. is a plan, from below, of the anchor of fig. 7.

fig. 9. is a sectional elevation of the anchor of fig. 7. taken alongside the medial plane showing the cable shackle point.

fig. 10. is a side elevation of the anchor of fig. 7.

fig. 11. is a front elevation of the anchor of fig. 7.

fig. 12. is a rear elevation of the anchor of fig. 7.

fig. 13. is a plan view, from above, of a Bower anchor with a three plate shank construction without a transverse shank plate.

fig. 14. is a plan, from below, of the anchor of fig. 13.

fig. 15. is a sectional elevation taken alongside the medial plane showing the shank of the anchor of fig. 13.

fig. 16. is a side elevation of the anchor of fig. 13.

fig. 17. is a front elevation of the anchor of fig. 13.

fig. 18 is a rear elevation of the anchor of fig. 13.

Referring to fig. 1 -6, the anchor consists of a single fluke 10, with a pair of terrafins 20, attached rigidly to the trailing edges of the fluke 26, and spaced apart by the fluke heel 18, so that the combined upper flat surfaces are entirely anhedral, together providing at least two flat anhedral surfaces symetrically about the medial plane, and a shank 11, of generally L-shape having a longer leg 11a, with the cable shackle point 12, and a shorter leg 11b, to which is attached, in the same plane, a narrow flange 11c, and a generally triangular shaped plate in a divergent plane to 11a, 11b and 11c. The fluke 10, and Terrafins 20, are connected rigidly to the shank at the lower edges of 9, 11b and 11c, with the medial plane of the fluke and the medial plane of the shank coincident. This connection may be demountable.

In plan view, the fluke is generally pentagonal in shape, with the forwardly swept cutting edges 17, converging at Angle D, which should lie in the range of 53° to 90°, with 60° being found to be optimum. Angle D has a re-entrant slot forming a pair of toes 21, on either side of the medial plane to facilitate rapid mooring bed penetration at mooring bed engagement.

The trailing edges of the fluke 26, are separated by the heel 18, which is normal to the medial plane, and are swept forward, forming Angle F, with 18, in the range 5° to 45°, with 17.5° being found to be optimum, to converge with the leading edges 17, at 15a.

For practical purposes the ratio of L:W will not be greater than unity, with the optimum being found to be 0.87.

The top fluke plate is folded anhedrally along 16, in the medial plane 14, providing two surfaces 15, on either side of the medial plane. The anhedral Angle E, at 16, lies in the range of 5° to 45° with the optimum being found to be 7.5°. On the undersurface of the fluke, flat triangular shaped Plate 10a, is fixed to undersurfaces 10b, along edges 10c, to give the fluke rigidity, and the three mutually inclined flat surfaces provide high roll resistance.

When the anchor is sitting fluke down, the angle of attack of the fluke Angle B, should lie between 5° and 20°, with 10° being found to be optimum.

The terrafins 20, should be generally quadrelateral in plan with the rear edge 28, greater in length than the edge adjoining the fluke at 26, and the outboard edge 27, should be be greater in length than the inboard edge attached to the shank at 9.

The outer corner formed between 27 and 28 should be rounded or chamfered to facilitate the anchor rolling from any attitude other than fluke member lowermost to fluke member lowermost without the corner engaging the mooring bed. For practical purposes, the ratio of area of a terrafin to the area of the upper surface of the fluke should fall in the range 0.125 to 0.6 with the optimum being found to be 0.3

The anhedral angle between the terrafin and the fluke at Angle G, junction line 26, should lie between 5° and 30°, with 15° being found to be optimum.

The shank consists of main lateral shank plates 7, parallel and symetrical to the medial plane, of generally L-shape and for practical purposes the ratio of S_2:S_1 should lie between 0.3 and 0.5, with 0.34 being found to be the optimum. Transverse shank Plate 8 connects and separates lateral shank Plates 7, and cable shackle point Plate 6, on the medial plane along with 5 No. rods or tubes 5, to provide rigidity, and a sixth rod or tubes joins and separates rigidly the divergent aft triangular portions of the shank 9. The angle of divergence between 9 and 7, Angle C, lies between 1° and 45° with the optimum angle found to be 17.5°.

For practical purposes, the shank shackle point should lie on a straight line intersecting the fluke fold line 16, at the heel 18, at angle A, which should lie between 1° and 50° with 20° being found to be optimum.

One of the shank plates 7, has an access hole 12a, for the shackle pin.

Transverse shank plate 8, lies on a plane which intersects the fold line 16, in the medial plane 14, at an angle in the range of 0° and 30°, with 12.5° being found to be optimum.

There are several permutations of rods or tubes which will separate the lateral shank plates 7 and stiffen the shank 11, however by experiment, it has been found that six rods or tubes arranged as in fig. 4 to be efficient. One rod or tube separating and connecting fluke plates 9, one rod or tube separating and connecting the shank knee at the upper edge, one rod or tube at the shank knee at the lower edge and another rod or tube separating and connecting lateral shank plates 7, and centre shackle point plate 6, behind the shackle point. The remaining two rods or tubes are set in 11a separating and connecting lateral shank plates 7, one at the upper edge and one at the lower edge to triangulate the forces within the shank.

For a shank construction as shown in figs. 1 to 12, using a material with physical properties similar to mild steel, the two lateral shank plates can be, in thickness, between 0.042 and 0.083 times the separation between the plates and between 0.046 and 0.064 being found to be the optimum.

The rod or tube diameters can be between 0.096 and 0.193 times the separation in plates 7, however between 0.125 and 0.130 has been found to be optimum.

The rods or tubes are round in cross section since it has been found, by experiment, that a round cross section minimises the obstruction of disturbed mooring bed material passing between the shank plates and, unlike any flat section, it causes no lift to the shank, as there can be no angle of attack in the rods or tubes.

By experiment it has been found that any flat section between the shank plates and behind the cable shackle point, acting in disturbed mooring bed material, produces lift in the shank and thereby negating much of the burial moment in the anchor when it is dragged through the mooring bed material. The round cross section completely obviates this problem.

The flat section, transverse shank plate 8, on the other hand is located ahead of the cable shackle point, and the shackle bow rebate in the leading edge forming a pair of toes similar to the toes 21 of the fluke, acts in undisturbed mooring bed material and experiences a high burial force under drag forces from the anchor cable.

With the transverse shank plate having a low burial resistance, experiencing a high proportion of mooring cable force, in a high passive resistance of undisturbed mooring bed it helps to firmly locate the shank in a nose down attitude.

At the other end of the anchor, the under surfaces of the terrafins 20, presented forward to the mooring bed, as shown in fig. 5, causes an upward moment to the rear of the fluke when the anchor is dragged forward by the mooring cable. That is, the transverse shank plate 8, and the terrafins together cause a moment couple producing a high burial component as the anchor is either dragged forward, or tended to be dragged forward, whether at commencement of burial or fully buried.

The forces acting at both ends of the anchor will also resist any disturbing force in the mooring bed, because of the lever arms ahead and behind the fluke, and the overall result is a higher passive resistance of the mooring bed can be adopted.

Apart from adding to the general stiffness of the anchor, the terrafins perform four separate functions in varying mooring bed materials and stages of operation. The first function is to tilt the fluke with a positive angle of attack when the anchor is at rest on a horizontal mooring bed so that the under surfaces of the terrafins 20, are presented forward and outboard of the fluke abeam extremities, and the fluke toes will engage the mooring bed if dragged forward by the mooring cable, whereby the cable force is generally horizontal in direction.

The second function is as herein before described above in the moment couple with the transverse shank plate.

The third function is for the upper surfaces to act as extended fluke surfaces when the anchor's angle of attack is high enough for the under surfaces of the terrafins to disappear in presentation forward to the mooring bed. This happens in mooring beds of low shear strength.

The fourth function of the terrafins is to act as stabilisers in roll during burial and in a fully buried attitude, should some mooring bed disturbing force overcome the roll resistance of the three flat under surfaces mutually inclined and the anchor roll from medial plane vertical.

The anchor of the present invention rolls generally about axis X-X,13, when under drag by the anchor mooring cable and the fluke is engaged or partially engaged in the mooring bed. This particular axis is not a pure roll axis, and whereby the anchor rotates or rolls about that axis there is a roll-yaw couple. When this occurs and the medial plane moves away from the vertical, the under surface of the lower terrafin is presented forward to the mooring bed, and if the angle of attack is shallow, the under surface of the upper terrafin will also be presented forward, but be of an apparently lesser area of presentation forward.

Due to normal shear strength gradient of mooring beds and the inequality of under surface apparent area of terrafins there will be an inequality of moments about the roll axis, and the forces acting on the under surfaces of the lowermost terrafin will overcome the roll disturbing force and tend to roll the anchor to medial plane vertical.

The self same action occurs at commencement of burial should the anchor, for some reason, commence burial in an attitude which is not medial plane vertical. The terrafin lowermost will resist further penetration until the upper half of the fluke at the opposite side of the medial plane equalises its load and the medial plane is generally vertical.

Apart from adding overall stiffness to the anchor, the divergent aft shank plates 9, fulfil three functions

The primary function is to present a large area forward, to the same side of the shank as the direction of cable veering, when the anchor is engaged in the mooring bed in a working attitude.

Should the anchored vessel swing to tide or wind so that the anchor cable medial plane and the anchor medial plane are not planar, then with a force in the mooring cable, shank plate 9, will have a force acting upon it opposite in direction to the direction of the cable force and the centre of force on plate 9, will lie outboard from the anchor medial plane, thereby causing a moment, forcing the heel of the fluke in the same direction of veering rotation as the anchored vessels veering.

Together with the force in the mooring cable, the anchor will come under the influence of a moment couple, causing the anchor to veer until the cable and anchor medial planes are generally planar.

Anchors dependent upon only the force in the anchor cable to veer the anchor, require enormous sections in the shank to resist transverse bending moments, whereas in the present invention, the rudder like effect of shank plates 9, allows the shank to be of much lighter section, and thereby raise the efficiency of the self weight to holding power ratio.

The second function of shank plates 9 is to present resistance areas forward to the mooring bed material in a plane other than that of the fluke, to adopt passive resistance of the mooring bed in a relatively undisturbed mooring bed area.

The third function of the shank plates 9, is to allow mooring bed material between the lateral shank plates 7, to be easily released when weighing anchor.

The anhedral form of fluke is found by experiment to be superior in rate of burial, holding power, roll stability, and structural integrity to either flat planar, or dihedral shaped flukes. This is due to the fact that for any given depth of anchor burial, the leading edges are reaching a deeper point in the shear strength gradient, and that anchors which are more difficult to roll can maintain higher holding power loads.

The anhedral fluke form, braced from below by plate 10a, makes a very light structure and therefore a very large fluke area can be used without a weight penalty in comparison with any other drag embedment anchor.

When the anchor of the present invention, as shown in fig. 1 -6, is laid as a mooring anchor, the pennant cable can be attached to shank rods or tubes 5, at the shank plates 9, or the upper shank knee rod or pin, since the anchor centre of gravity 19, is very low and close to the fluke.

Referring to fig. 7 -12, the Bower anchor of this invention is identical in every respect to the mooring anchor as herein before described and illustrated in figs. 1 -6, but with at least one destabiliser bar attached to the upper rear portion of the shank.

Transverse destabiliser bar or tube 3, is located generally adjacent to the upper edge of the shank lateral plates 7, generally above the midpoint of the fore and aft dimension of the fluke. The ends of the bar or tube 3, should overhang the fluke leading edges 17, symetrically at each side, outboard, by 10% to 20%, 15% optimum, the width of the fluke vertically below the bar3. To prevent excessive transverse destabiliser bar engagement with the mooring bed, discs or washers 4, should be attached to the bar at each end, generally the dimension of fluke overhang, inboard from the ends. The disc or washer should be of diameter 4 -6 times the diameter of the shank rods or tubes 5.

Destabiliser bar 3, should be angled upward from the shank so that the bar or tube ends are generally level with or above the cable shackle point when the anchor fluke is set on a horizontal surface.

By experiment, destabiliser bars 1 and 3, have been found to require a diameter of 1.0 to 1.5 times the diameter of the shank rods or tubes 5.

Destabiliser bar or tube 1, is attached generally vertically in the medial plane to the upper shank knee rod or tube and destabiliser bar of tube is raked forward until the free end is generally vertically above the centre of gravity of the anchor when the anchor is on a horizontal surface, fluke lowermost.

The length of destabiliser bar or tube 1 should be between 0.3 and 0.4 times the length of destabiliser bar 3. Also destabiliser bar or tube 1, should be capped with a disc2, of similar diameter to disc 4, but preferably convex domed to prevent penetrative engagement with the mooring bed.

After laying the anchor by the anchor cable, and should the anchor, in the unlikely event, come to rest on the mooring bed in an attitude other than fluke lowermost, then the anchor will have either the cap 2, of destabiliser bar 1, in contact with the mooring bed, or one of the ends of destabiliser bar 3, in contact with the mooring bed.

A pull on the cable with a catinery, will cause the anchor to roll from the former attitude to the latter attitude to fluke member lowermost, and the anchor will proceed to take up penetrative engagement with the mooring bed, toes first.

When the anchor is in the latter attitude, a pull on the anchor cable with a catinery will cause the anchor to roll over to fluke member lowermost, and then the anchor will commence penetrative engagement with the mooring bed.

Destabiliser bars or tubes 1 and 3 are round in cross section and when the anchor is fully buried, they operate in disturbed mooring bed material, and by experiment are found not to measurably alter the performance of the mooring anchor, herein before described and illustrated in figs 1-6.

Referring to figs. 13-18, the Bower anchor of this invention is the same in all respects to the Bower anchor as illustrated in figs. 7-12 with the exception of minorfluke amendments, and the lateral shank plate 11a, 11b, and 11c, is a single plate construction without a transverse shank plate 8. The knee of the shank is raised to the equivelant point of the centre of destabiliser bar 1, cap 2, and the shank drops forward to the shackle point end. The shackle point is in the same position ahead and above the fluke as in the Mooring anchor and Bower illustrated in figs. 1 -12.

The destabiliser bar or tube 3, is symetrically located on the shank in generally the same level as the shackle point, at a point generally vertically above the mid point of the fore and aft dimension of the fluke. In all other respects of length, diameter, outboard overhangs and flat disc, or washer 4, the destabiliser bar is the same as that in the Bower anchor in figs 7-12, except the bar or tube does not have to be raked upward from the shank, but can be straight from end to end and normal to the medial plane.

In operation the anchor of figs 13-18 behaves in the same way as the anchor of figs. 7-12, except the top of the shank knee fulfils the function of convex cap 2.

Fluke trailing edges 26, converge on the medial plane 14, without any heel 18, and bottom fluke plate 10a should be extended generally twice the distance forward to the distance in figs. 1-6 and figs. 7-12.

The scantlings of the anchor of figs. 13-18 are best established by experiment.

By experiment, it has been found that an anchor of this invention constructed of mild steel, operating in a mooring bed of submerged loose sand and gravel of load bearing capacity of 65-110 KN/m^2, with a catinery in the anchor cable, to consistently develop a holding power in excess of 120 times self weight force.

Claims

1. An asymetrical anchor of fixed configuration, without moving parts, consisting of a shank generally L-shaped, a fluke, anhedral in form, providing at least two flat upper surfaces mutually inclined, and three flat under surfaces mutually inclined, all symetrically disposed about the medial plane, two flat terrafin stabilising plates, attached anhedrally to the trailing edges of the fluke and the rear of the shank, one at each side of the medial plane, providing two surfaces facing upwards and aft, and two surfaces facing downward and ahead, and arranged such that when the anchor rolls about its axis, a straight line in the medial plane, generally parallel to the fluke and above it, so that the medial plane is not planar with the vertical, the under surface of the lowermost terrafin, in engagement with the mooring bed, presents an area behind and outboard of the outboard extremities of the fluke, which is greater in apparent area from dead ahead than the under surface of the upper terrafin, which may or may not be in engagement with the mooring bed, and thereby causing an inequality of moment about the roll axis, and tends to roll the anchor to medial plane vertical when there is a drag force in the anchor cable which is generally horizontal in direction. The terrafins are also arranged so that when the angle of attack in the fluke is steep enough for the under surfaces of the terrafins to apparently disappear when viewed from ahead, the upper surfaces present extended upper fluke surface areas to ahead, acting in relatively undisturbed mooring bed material.

2. An anchor without moving parts comprising a shank generally L-shaped, arranged at one end for attaching an anchor cable and the other end rigidly fixed symetrically with reference to the medial plane, to the terrafin, and the fluke which is constructed in flat plate providing anhedrally two flat upper surfaces intersecting each other on the medial plane and three mutually inclined flat surfaces at the underside. At the trailing edges of the fluke on either side of the medial plane, a pair of terrafins, generally, of quadrelateral shape, is anhedrally attached and arranged so that the fluke has a positive angle of attack when the anchor is resting on a horizontal surface, fluke lowermost, and such that the outboard undersurface of the terrafin is apparent outboard beyond the outboard extremities of the fluke when viewed from ahead. The inboard edge of each terrafin is attached to a generally triangular shaped rudder-like flat shank plate which lies at an angle incident to the medial plane of the anchor and which is attached to the shorter leg of the shank.

3. An anchor according to Claims 1 and 2 wherein there is more than one main lateral shank plate, parallel to the medial plane of the anchor, spaced apart and connected by rods or tubes, round in cross- section, with a transverse shank plate, with a shackle bow rebate in the leading edge, which is located at the extreme end of the shank, ahead of the cable shackle point, lying in a plane parallel to or converging forward with the plane of the fluke. The transverse shank plate separates and connects the shank plates parallel to and in the medial plane.

4. An anchor according to Claim 3 whereby there are at least three transverse shank rods or tubes spacing apart and connecting the lateral shank plates parallel to the medial plane and the symetrically diverging aft shank plates generally triangular in shape. One rod or tube, spacing and

connecting the main lateral plates symetrically disposed on each side of the medial plane with the central shackle point plate, in a position behind the shackle point. A second rod or tube located in the shank knee adjacent to the shank upper edge and a third rod or tube located between the generally triangular aft divergent shank plates, separating and connecting them.

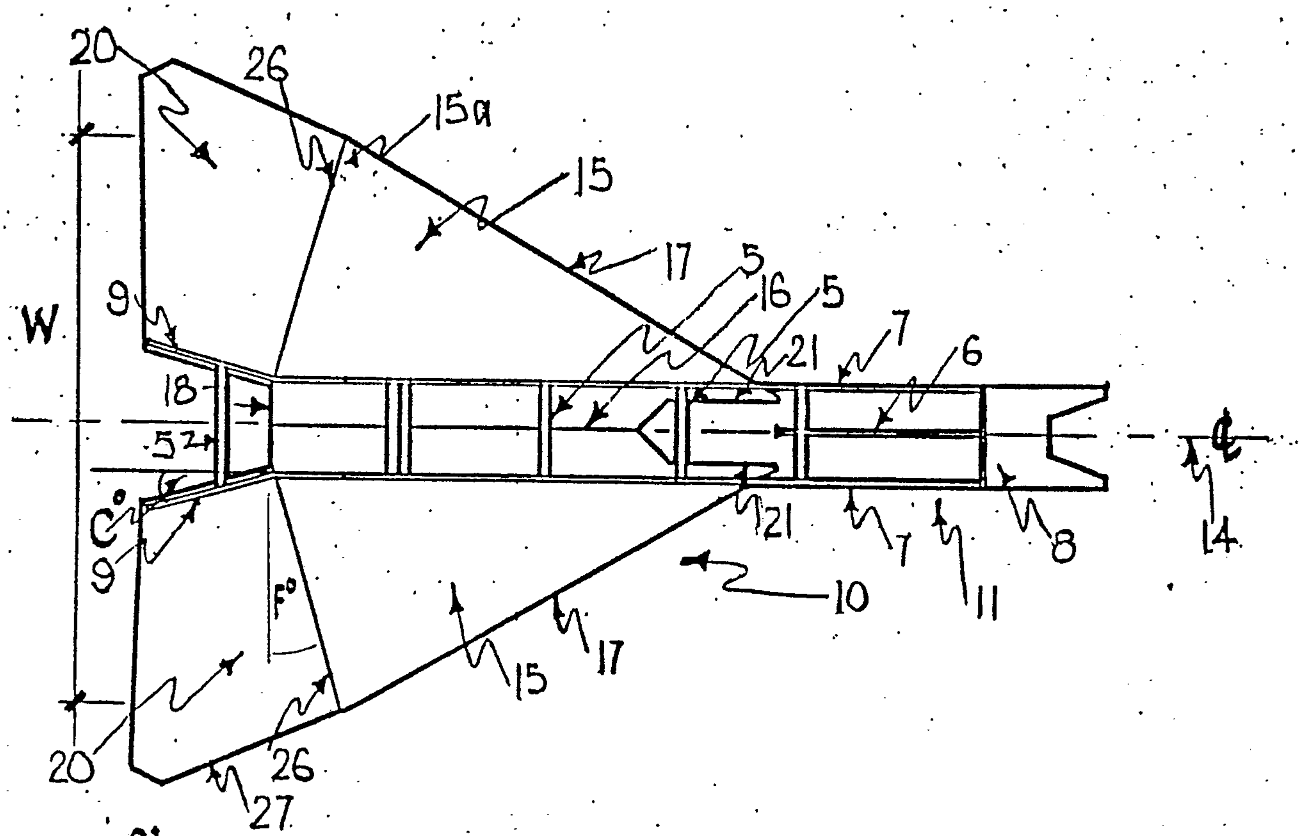
5. An anchor in accordance with any of the preceding claims wherein, the fluke is generally quadrelateral or pentagonal in plan view with the included leading acute angle rebated with a re entrant slot forming a pair of leading toes. The heel of the fluke is normal to,and symetrically about the medial plane whereby the plane form is generally pentagonal. Whereby the fluke is generally quadrelateral, the fluke trailing edges converge in the medial plane.

6. An anchor according to any of the preceding claims wherein at least one destabiliser bar or tube, round in cross section, is located adjacent to the upper edge of the shank in the proximity of the shank knee and having a transverse destabiliser bar or tube disposed symetrically and normal to the medial plane generally vertically above the mid point of the fore and aft fluke dimension in a stock like fashion. Whereby the intersection between the bar or rod and the lateral shank plates, parallel to the medial plane, is substantially lower in level than the cable shackle point, the bar lateral projections, which overhang the fluke leading edges, are arranged so that the bar or tube ends are level with or above the cable shackle point when the anchor is resting on a horizontal surface, fluke lowermost.

7. An anchor according to Claim 6 wherein a convex disc capped destabiliser bar or tube is attached in the medial plane to a shank plate or to a shank transverse rod or tube located in the proximity of the shank knee and adjacent to the shank upper edge with the capped end located generally vertically above the centre of gravity when the anchor is sitting on a horizontal surface, fluke lowermost.

8. An anchor without moving parts of at least a shank and a fluke with a transverse shank plate symetrically disposed about the medial plane at the extreme end of the shank, ahead of the cable shackle point and acting in undisturbed mooring bed material at an angle of attack not shallower than the fluke angle of attack in conjunction with a pair of anhedral plates disposed symetrically about the medial plane, one each side and attached to the trailing edges of the fluke, causing a moment in the fluke to increase its angle of attack and together with the transverse shank plate, produce a moment couple to optimise the angle of attack, influencing the anchor from the extreme ends and not in the plane of the fluke.

9. An anchor substantially as herein before described with reference to figs 1-6. 7-12 or 13-18.



20
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18
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11
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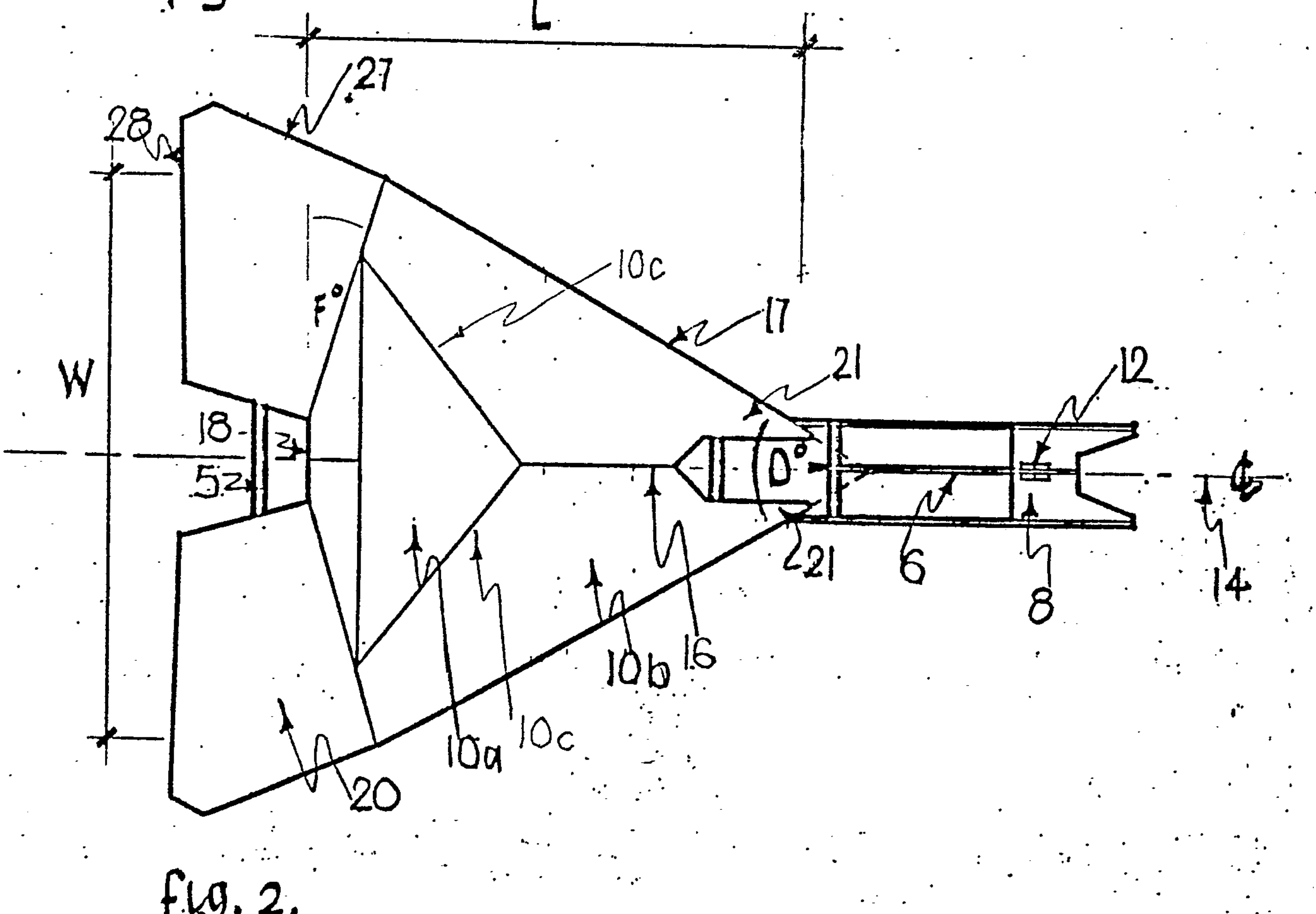
26
27

fig. 1.



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10c
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20

fig. 2.

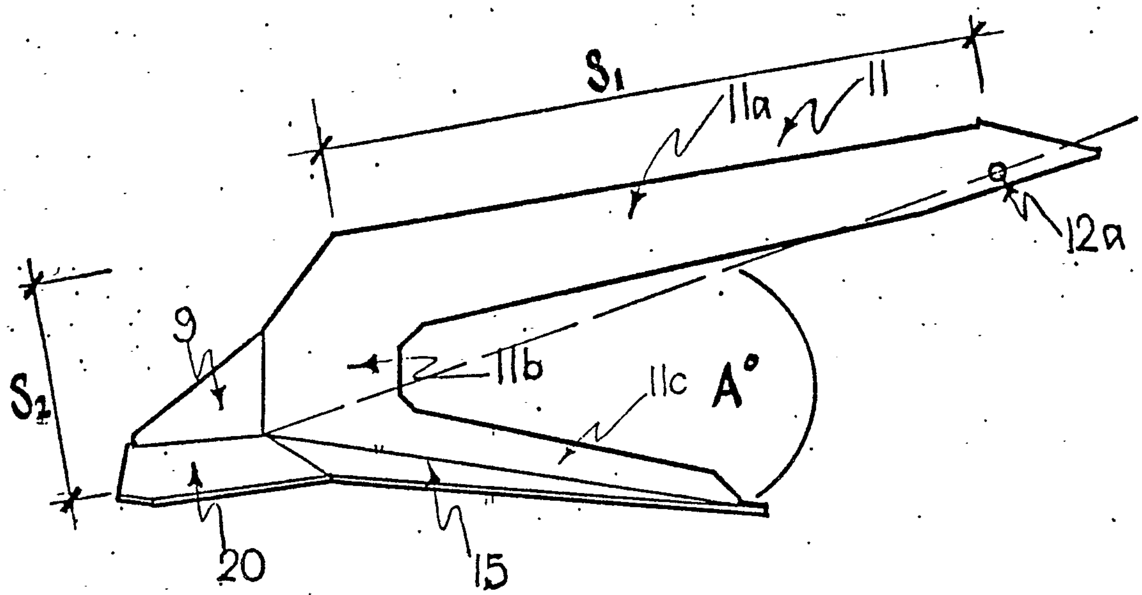


fig.3.

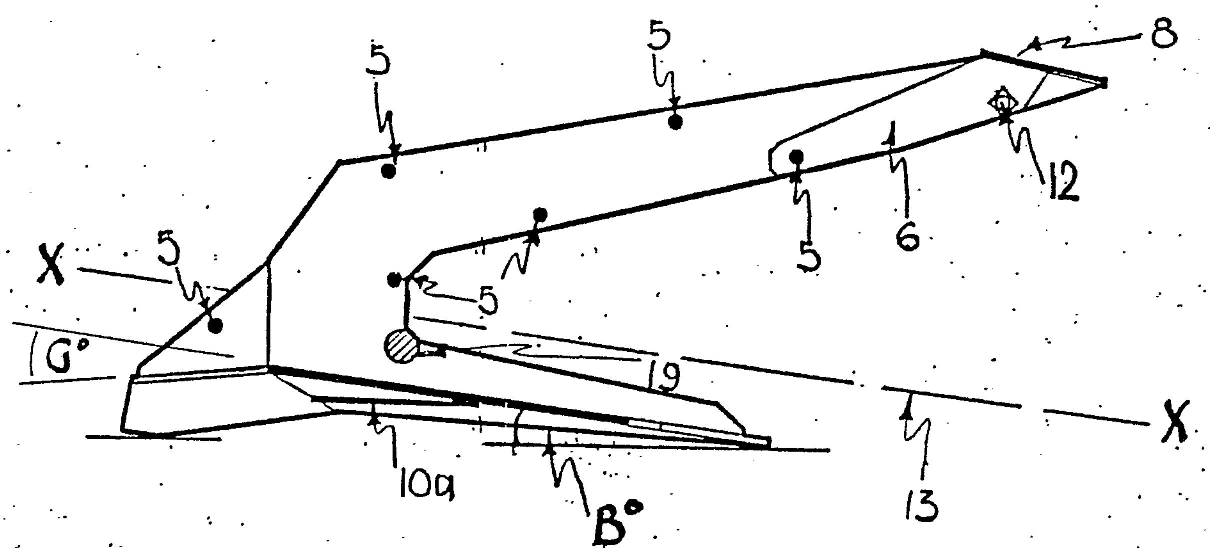


fig.4.

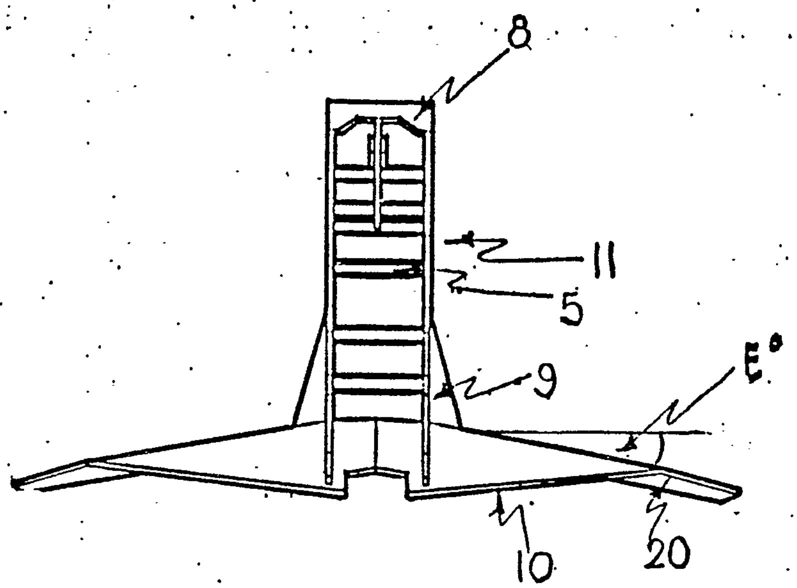


fig 5

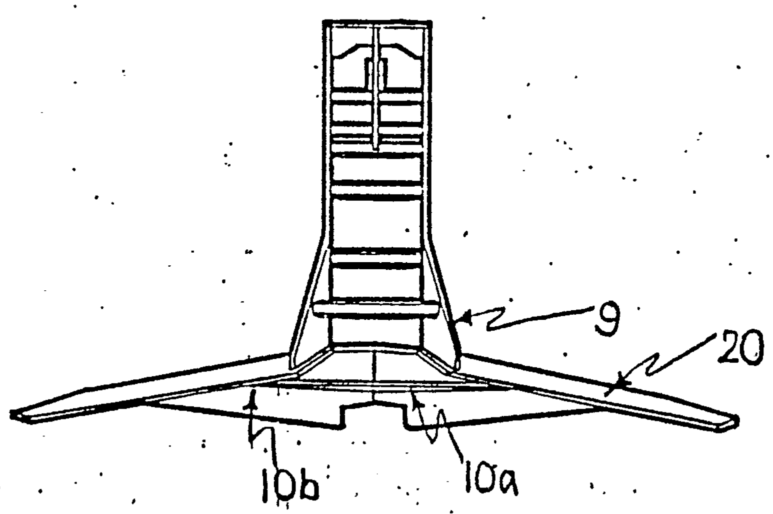
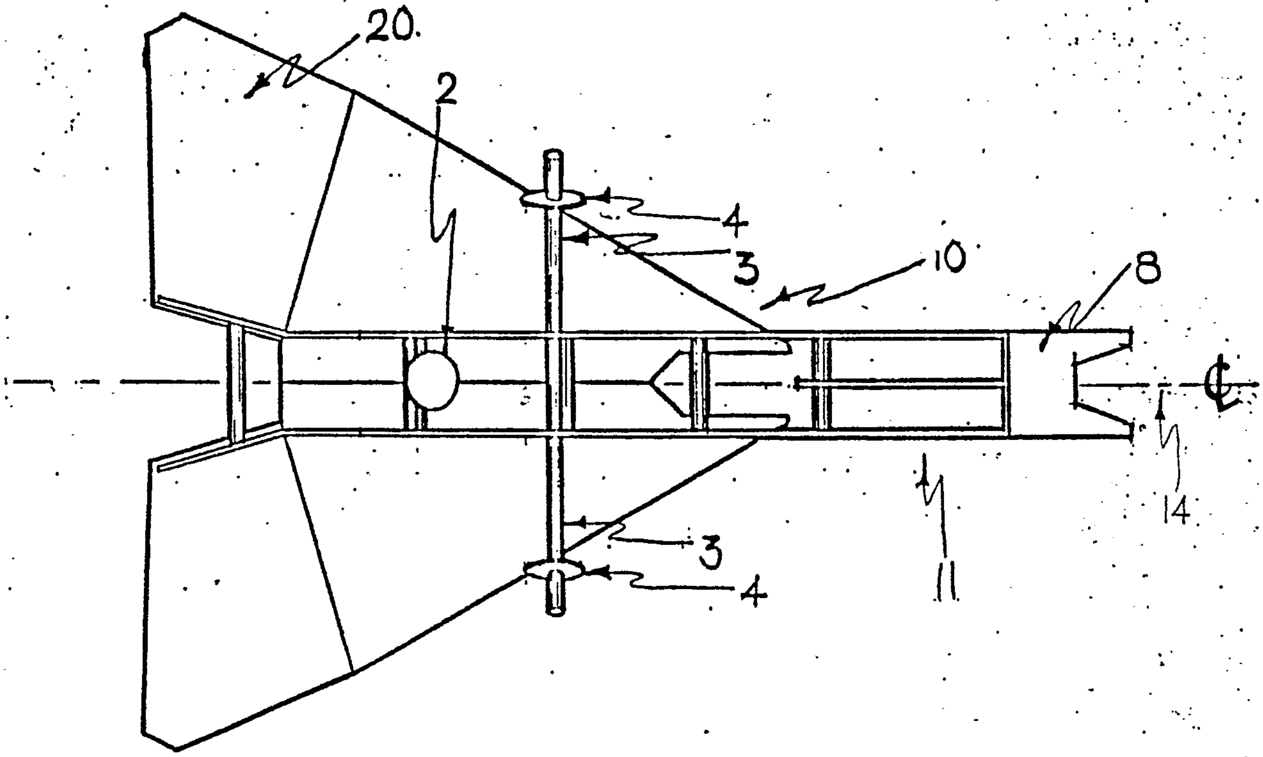


fig 6



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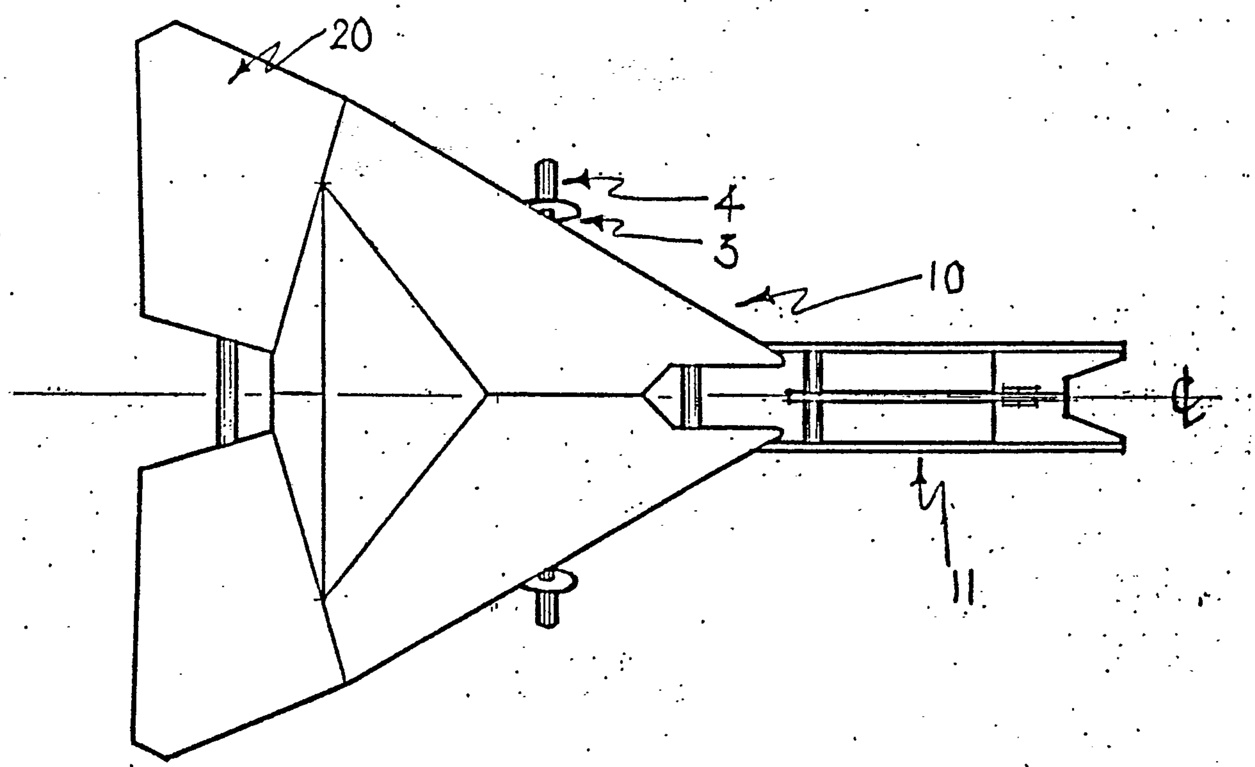

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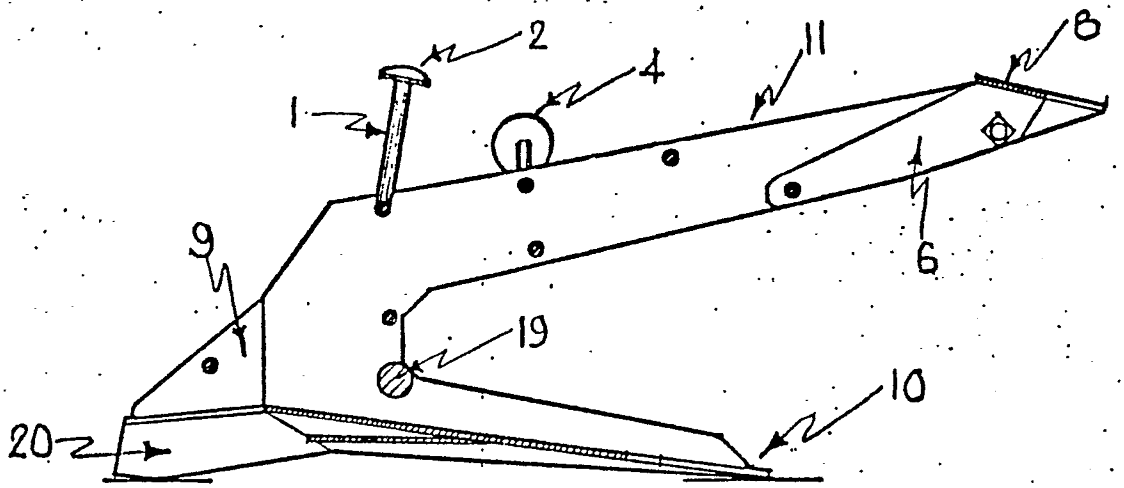

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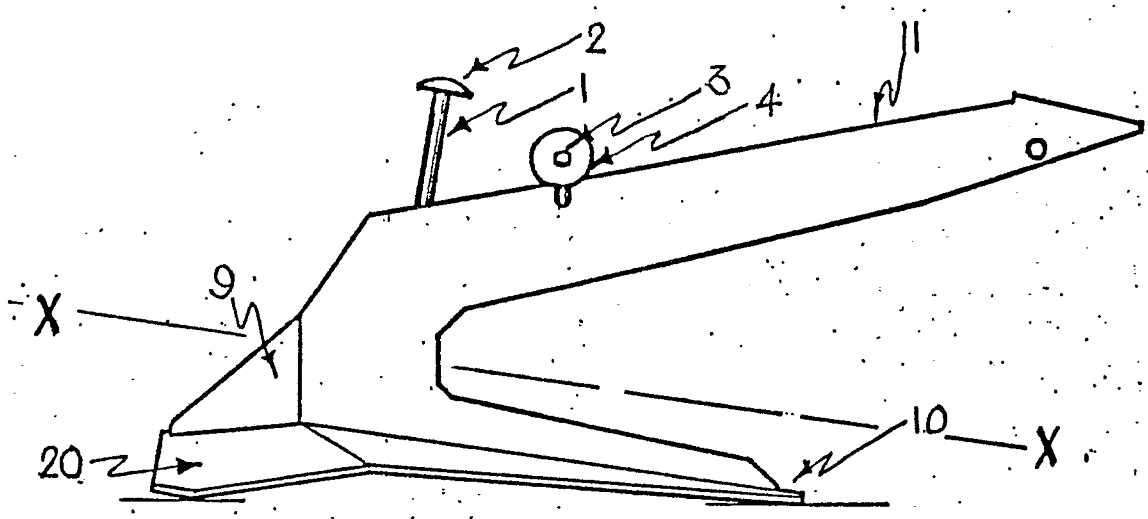

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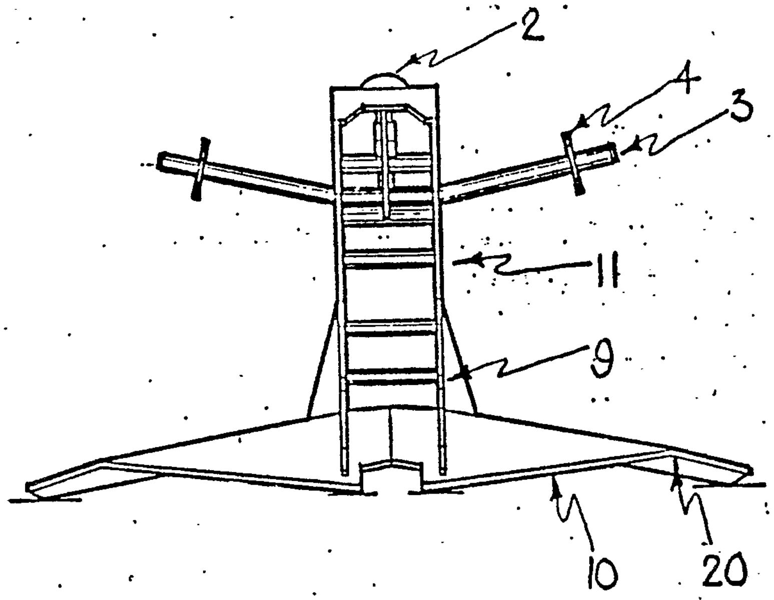
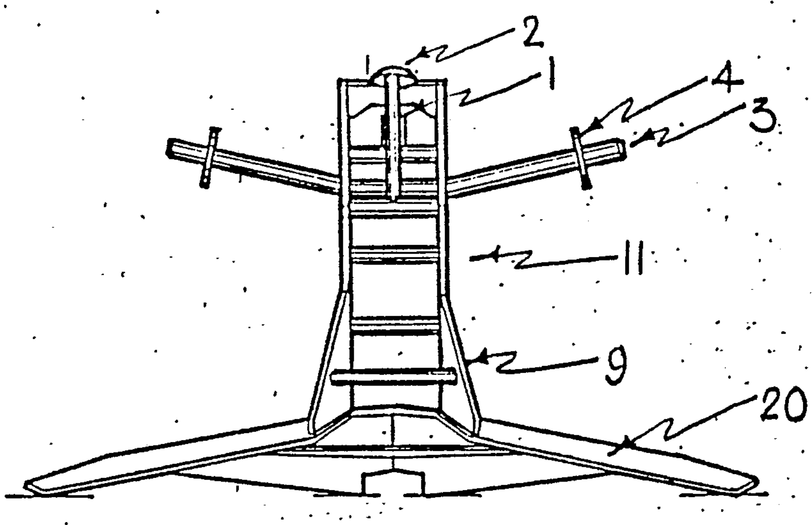


fig. 11.



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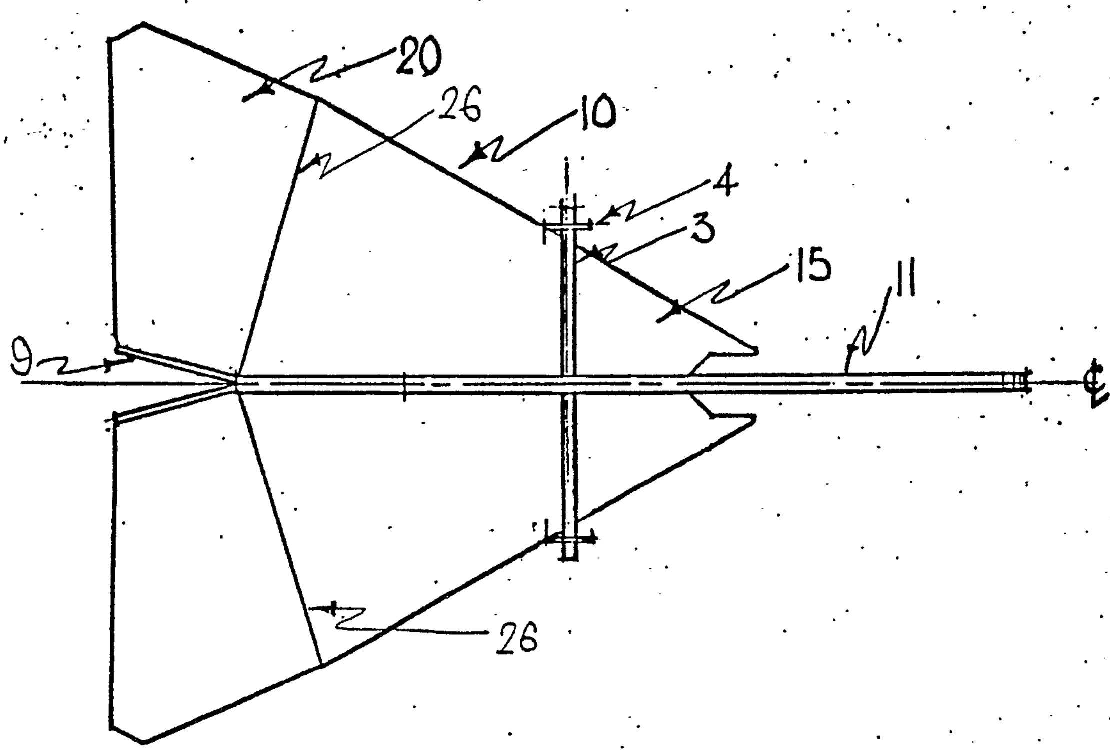

fig.13.

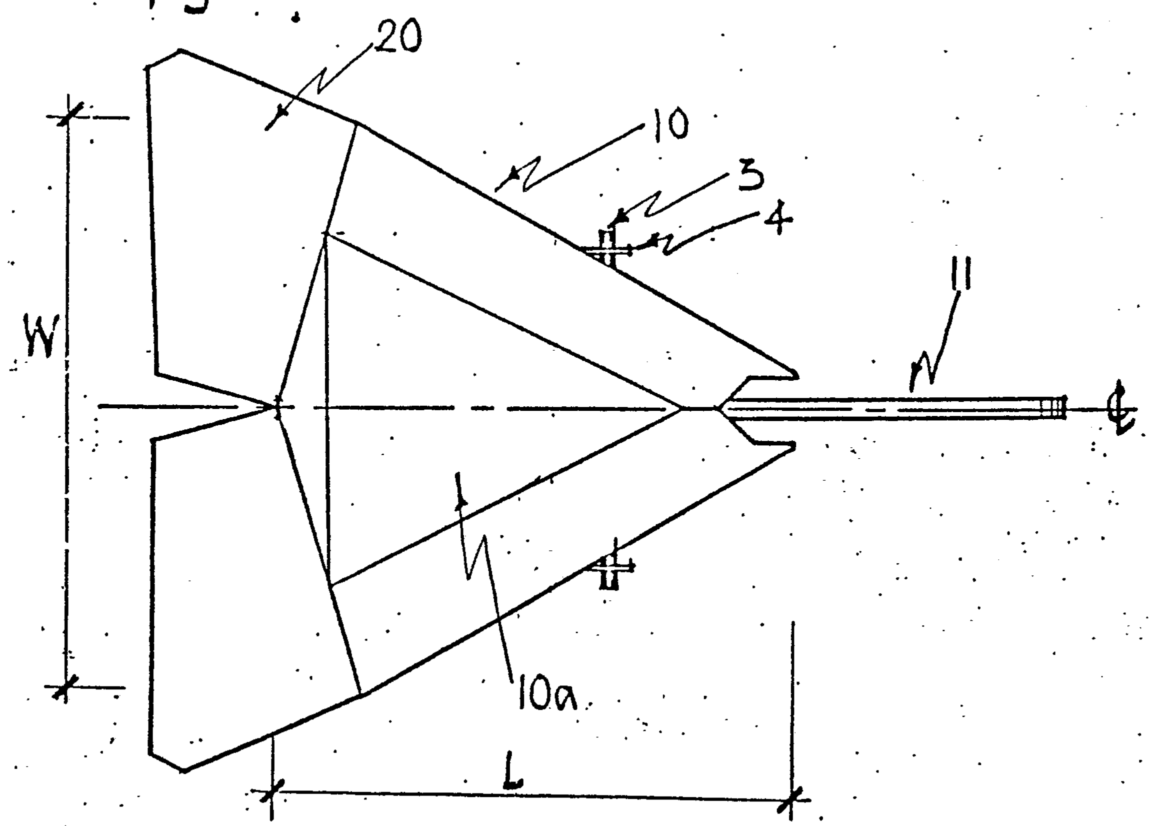

fig.14.

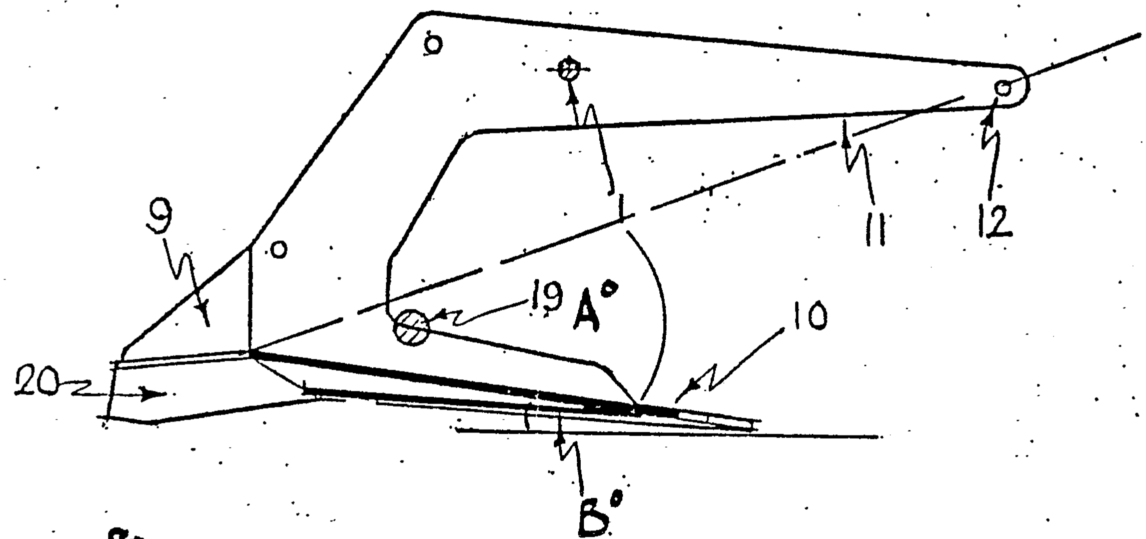

fig. 15

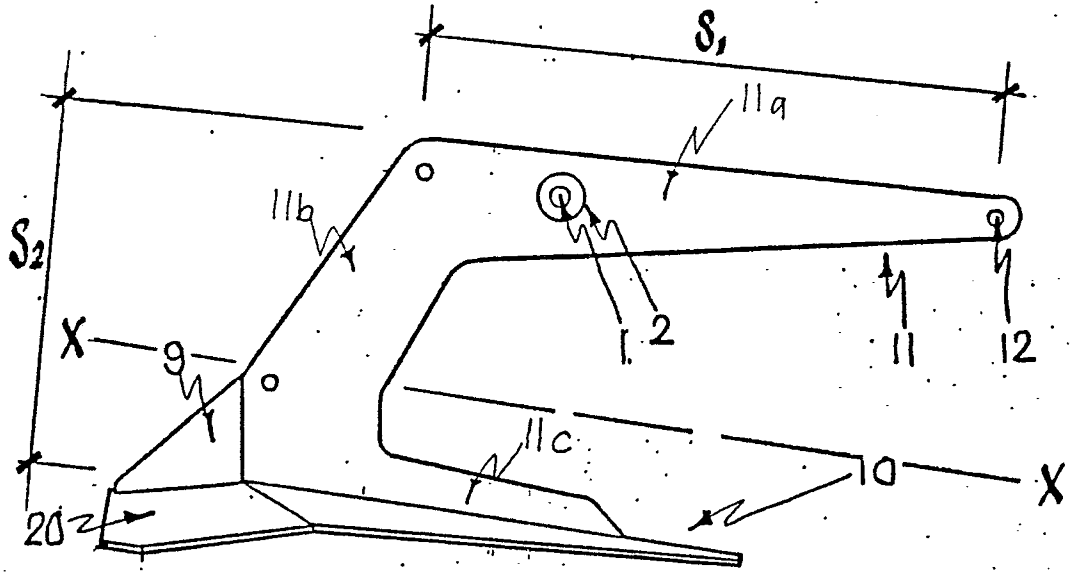

fig. 16.

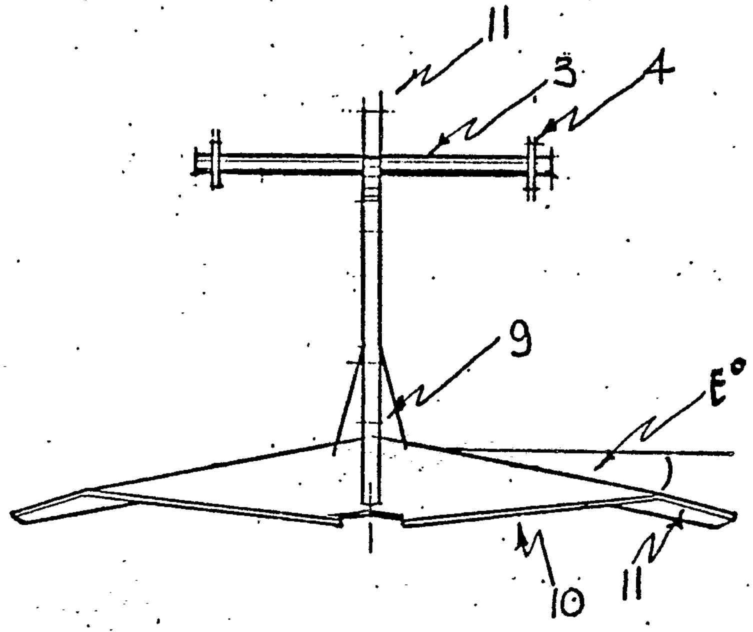

fig. 17.

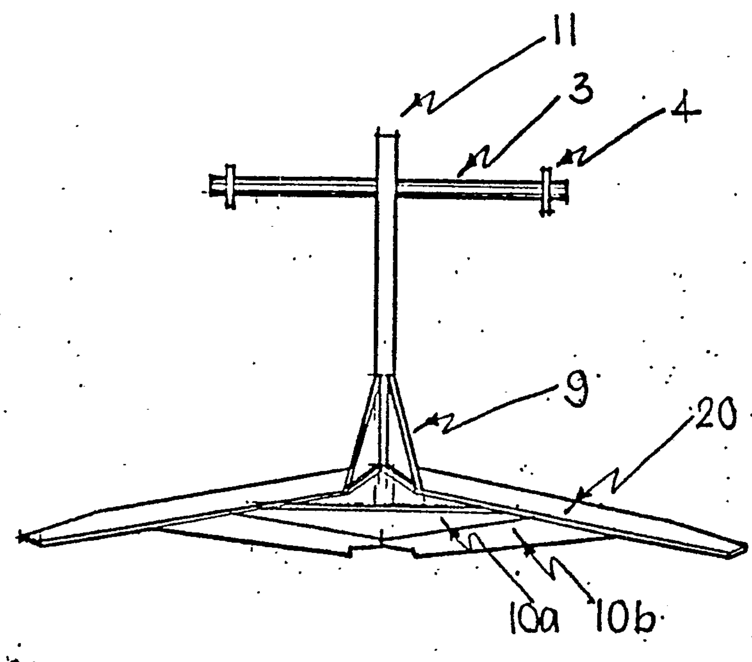

fig. 18