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(54) **Weir for temporary closing of channels and port entrances**

(57) A mobile weir (1) for temporary closing of channels and port entrances essentially formed by a base (2) extending on the seafloor of the port entrance, and by a series of mobile floodgates (3) of a substantially rectangular shape, which are hinged edgewise on the base (2) adjacent to one another so as to be able to swing around a substantially horizontal axis of rotation (A); each mobile floodgate (3) being connected to the base (2) by means of a pair of disconnectable hinges (4) which are made up of a fixed portion (4a) stably anchored to the base (2), and of a mobile portion (4b) which is, instead, fixed on the mobile floodgate (3) through a mechanical flanged coupling, incorporates the joint for articulation of the hinge about the axis of rotation (A) and is finally structured so as to be coupleable to the fixed portion (4a) of said disconnectable hinge (4) in a stable, but readily releasable, way; the mobile portion (4b) of the disconnectable hinge (4) being provided with an engagement head (8) and a fork (10) made in one piece by means of a die-casting process.

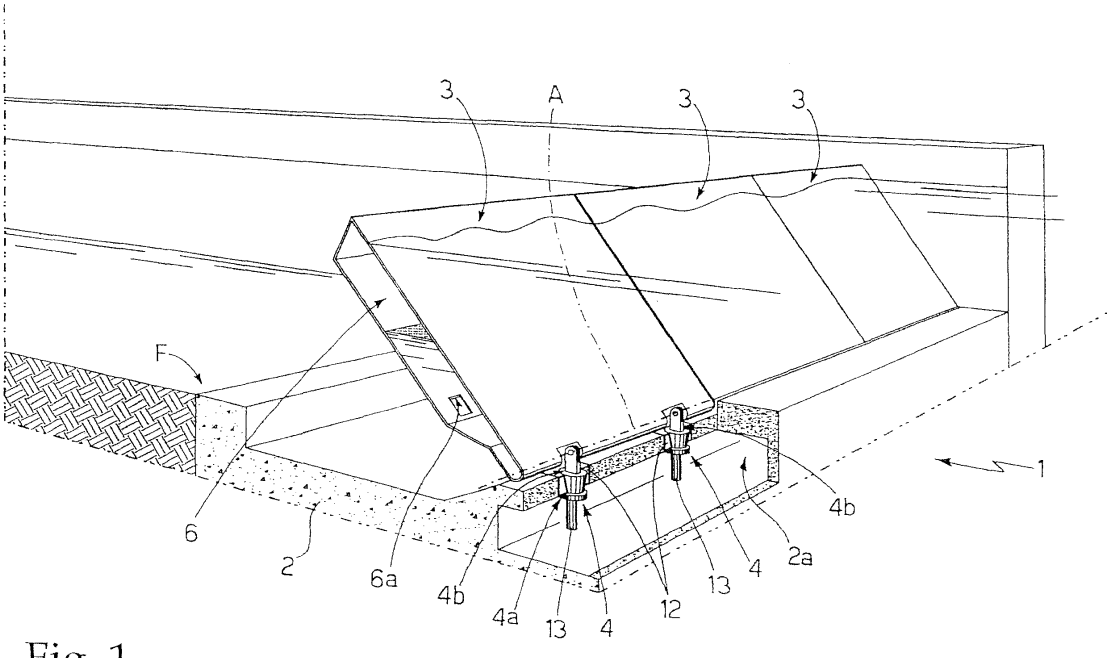

Fig. 1

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Description

[0001] The present invention relates to a mobile weir for temporary closing of channels and port entrances.

[0002] In greater detail, the present invention relates to a submergible mobile weir specifically structured for being positioned in a point corresponding to a navigable port entrance that connects a closed lagoon to the immediately adjacent open sea so as to be able, if need be, to block the flow of water that from the sea flows towards the lagoon and vice versa, preventing only in this case the naval traffic that passes through the access to the port.

[0003] As is known, the level of the sea water is subject to periodic fluctuations (traditionally referred to as tides), which, in coincidence with other atmospheric events of extraordinary intensity, can pour into the lagoon such a large amount of water as to raise the level of the water within the lagoon itself to such a high value as to jeopardize the static stability of the buildings and of the building works distributed along the coast and/or overlooking the lagoon itself.

[0004] The US patents Nos. US-3756032 and US-4836711 and the European patent No. EP-0397609 propose a solution to this problem by means of the use of a submergible mobile weir made up of a reinforced-concrete base, which extends on the seafloor of the port entrance for the entire width of the entrance itself, and of y a series of plane rectangular mobile floodgates, which are hinged edgewise on the reinforced-concrete base adjacent to one another so as to occupy the entire width of the port entrance without solution of continuity, and are able to swing with respect to the base about a horizontal reference axis common to all the floodgates.

[0005] In greater detail, the mobile floodgates are able to swing between a lowered position, in which the floodgates rest on the seafloor in a substantially horizontal position, and a raised position, in which the floodgates extend in cantilever fashion from the base in a direction substantially perpendicular to the seafloor of the port entrance so as to emerge partially above the surface of the water and form a barrage that extends without solution of continuity for the entire width of the port entrance so as to prevent the passage of the water through the port entrance itself.

[0006] As regards, instead, the displacement of the mobile floodgates, swinging of the floodgates from the lowered position to the raised position and subsequent return into the lowered position are obtained by appropriately varying the buoyancy of the individual floodgates. Each of the floodgates is in fact provided internally with a tank for regulation of the position, which, in a way similar to the compensation tanks or ballast tanks present in submarines, is designed to be filled with water and/or pressurized air so as to be able to regulate the buoyancy of the floodgate, and the mobile weir is provided with a system for supply of pressurized air, which, upon command, is able to send into the tank for regulation of the position of each mobile floodgate an amount of air sufficient to produce a buoyant force higher than the weight of the floodgate itself so as to cause slow and progressive raising of all the mobile floodgates from the lowered position to the raised position and the consequent constitution of the barrage.

[0007] To facilitate installation of the individual mobile floodgates and the subsequent maintenance operations of the weir, in the U.S. patent No. US-4836711 and in the European patent No. EP-0397609 there is moreover envisaged connection of each mobile floodgate to the reinforced-concrete base sunken in the seafloor of the port entrance by means of a pair of disconnectable hinges, each of which is made up of a fixed portion, which is stably anchored to the reinforced-concrete base immediately on top of an internal service compartment, and a mobile portion, which is instead stably fixed on the side of the mobile floodgate, incorporates the hinge articulation joint, and is finally structured so as to be coupleable to the fixed portion in a stable, but easily releasable, way, guaranteeing in any case the necessary structural stiffness.

[0008] In greater detail, the mobile portion of the disconnectable hinge is basically made up of a plane appendage, which extends in cantilever fashion from the side of the mobile floodgate, an intermediate fork hinged so that it is free to turn on the distal end of the plane appendage by means of a transverse pin perpendicular to the plane of lie of the plane appendage itself, and finally an engagement head substantially shaped like a truncated cone, which is rigidly fixed on the end of the trunk of the intermediate fork.

[0009] In the case in point, in order to guarantee the necessary mechanical strength, the engagement head of the hinge is normally made up of two circular metal plates of appropriate thickness and of different diameter, which are set sharing one and the same reference axis, at a pre-set distance from one another, and of a series of transverse stiffening ribs, which are welded edgewise on the two circular plates so as to form a structure with high stiffness. The fork of the hinge is instead constituted by a flanged metal disk of appropriate thickness, which is designed to be fixed via bolts to the center of the circular plate of larger diameter of the engagement head, and by two plane metal appendages of appropriate thickness, which are welded edgewise on one and the same face of the flanged disk so as to extend in cantilever fashion in a direction perpendicular to the aforesaid face remaining parallel and facing one another.

[0010] The fixed portion of the disconnectable hinge is, instead, basically made up of an anchorage platform, which is embedded in or in any case anchored to the reinforced-concrete wall of the base, and is provided with a central seat that has a shape complementary to that of the engagement head of the mobile portion of the hinge, and of an engagement and clamping member, which is designed, in sequence, to engage the engagement head of the mobile portion of the hinge and then to withhold

the engagement head so that it bears upon the central seat of the anchorage platform exerting a tensile force of a pre-set value.

[0011] Unfortunately, since the mobile portion of the disconnectable hinge is subject to extremely high mechanical stresses, it must be made up of pieces of high-strength stainless steel, and must be assembled with extreme care on account of the extremely small mechanical tolerances, verifying systematically proper positioning of each piece and the quality of each individual weld. This need obviously results in long construction times and wide use of high-quality material, with consequent explosion of the production costs.

[0012] The particularly complex shape of the engagement head of the mobile portion of the hinge does not moreover enable widespread use of automatic welders, which contributes to a further increase in the costs of production of the disconnectable hinges. The hourly cost of a skilled technician is in fact higher than that of automatic welders.

[0013] The aim of the present invention is hence to provide a mobile weir for temporary closing of channels and port entrances that will be provided with disconnectable hinges that will be more economically advantageous to produce.

[0014] According to the present invention, a mobile weir for temporary closing of channels and port entrances is provided as specified in Claim 1 and preferably, but not necessarily, in any one of the dependent claims.

[0015] The present invention will now be described with reference to the annexed drawings, which illustrate a non-limiting example of embodiment thereof and which:

- Figure 1 is a schematic perspective view of a mobile weir for temporary closing of channels and port entrances provided according to the teachings of the present invention;
- Figure 2 is a side view of a mobile floodgate used in the mobile weir illustrated in Figure 1, with parts in cross section and parts removed for reasons of clarity; whilst
- Figures 3 and 4 are two perspective views of a part of the disconnectable hinge illustrated in Figures 1 and 2.

[0016] With reference to Figures 1 and 2, designated as a whole by 1 is a mobile weir for temporary closing of channels and port entrances specifically structured for being positioned on the seafloor F of a navigable port entrance connecting a closed lagoon to the immediately adjacent open sea.

[0017] The mobile weir 1 essentially comprises a base 2 made of reinforced concrete or the like, which extends at the seafloor F of the port entrance for the entire width of the entrance itself, and a series of plane mobile floodgates or flap gates 3 of a substantially rectangular shape, which are hinged edgewise on the base 2 adjacent to one another so as to occupy without solution of continuity the entire width of the port entrance, and so as to be able to swing about a horizontal axis A common to all mobile floodgates 3.

[0018] In greater detail, said mobile floodgates 3 are able to swing around one and the same horizontal axis A between a lowered position, in which the mobile floodgates 3 rest on the seafloor F of the port entrance in a substantially horizontal position, and a raised position (see Figure 1), in which the mobile floodgates 3 extend in cantilever fashion from the base 2 in a direction substantially perpendicular to the seafloor F of the port entrance so as to emerge partially above the surface of the water and form a barrage that extends without solution of continuity from one bank of the port entrance to the other so as to prevent the passage of water through the port entrance itself.

[0019] With reference to Figures 1 and 2, each mobile floodgate 3, in particular, is connected to the base 2 by means of at least one pair of disconnectable hinges 4 (just two of which are visible in Figure 1), which are positioned on the side of the mobile floodgate 3 so as to enable swinging of the mobile floodgate 3 about the axis A, and has a box structure so as to form inside it at least one tank for regulation of the position, which is designed to be filled with water and/or pressurized air so as to be able to regulate the buoyancy of the mobile floodgate 3.

[0020] In addition to what has been said above, the mobile weir 1 is provided also with a system for supply of pressurized air (not illustrated), which, upon command, is able to pump within the tank for regulation of the position of each mobile floodgate 3 an amount of pressurized air sufficient to empty the aforesaid tank at least partially of the water filling it so as to generate a buoyant force higher than the weight of the mobile floodgate 3 itself. Said buoyant force is hence able to cause the progressive raising of all the mobile floodgates 3 from the lowered position to the raised position and the consequent creation of the aforesaid barrage.

[0021] With reference to Figures 1 and 2, in particular, each mobile floodgate 3 is made preferably, but not necessarily, of corrosion-resistant metal material, and basically comprises an internal load-bearing framework 5, which is designed to bestow upon the mobile floodgate 3 the necessary structural stiffness, and a substantially parallelepipedal outer box-like shell 6, which coats the load-bearing framework 5 completely so as to form an enclosed space, which is to be filled with water and/or pressurized air so as to function as ballast tank for regulation of the position of the mobile floodgate 3, and is moreover provided with a series of through openings 6a for taking in and sending out the water, through which the sea water can enter and exit freely from the box-like shell 6, i.e., from the ballast tank for regulation of the position of the floodgate.

[0022] The load-bearing framework 5 is formed, instead, by a series of longitudinal stiffening beams or centerings 7, which extend in a direction perpendicular to the axis A of rotation of the mobile floodgates 3 and

are moreover arranged parallel and set alongside one another in one and the same reference plane, and by a series of reinforcement cross members (not illustrated), each of which is designed to connect two adjacent beams or centerings 7 rigidly to one another as well as to the box-like shell 6.

[0023] As regards, instead, the disconnectable hinges 4, each of these is made up of a fixed portion 4a (schematically illustrated in Figure 1), which is stably anchored to the base 2 immediately on top of an internal service compartment 2a, and of a mobile portion 4b, which is instead fixed on the side of the mobile floodgate 3, incorporates the joint for articulation of the hinge about the axis A, and is finally structured so as to be coupleable to the fixed portion 4a in a stable, but easily releasable, way.

[0024] In particular, with reference to Figures 2, 3 and 4, the mobile portion 4b of the disconnectable hinge 4 comprises: an engagement head 8, which is substantially shaped like a truncated cone, extends sharing an axis L locally perpendicular to the axis A and is finally structured so as to be fittable in the fixed portion 4a of the disconnectable hinge 4 in a stable, but readily releasable, way, providing at the same time a fluid-tight coupling; a bracket 9 for connection to the floodgate, which is structured so as to be fixed in cantilever fashion directly on the load-bearing framework 5 of the mobile floodgate 3, in a position corresponding to the side thereof, and is provided with a plane appendage, which extends in cantilever fashion from the side of the mobile floodgate 3 remaining locally perpendicular to the axis A; and finally an intermediate fork 10, which extends in cantilever fashion from the head 8, and is pivoted on the plane appendage of the bracket 9 by means of a transverse through pin 11 sharing the axis A so as to be able to swing freely about the aforesaid axis A.

[0025] In greater detail, in the example illustrated, the bracket 9 for connection to the floodgate is constituted by a plane metal plate 9 of appropriate thickness and of a substantially rectangular shape, which lies in a plane locally perpendicular to the axis A, is provided with a through hole designed to be rotatably engaged by the through pin 11, and finally is provided with a flanged side edge with which it is to be bolted edgewise on the flanged end 7a of a purposely provided beam or centering 7 of the load-bearing framework 5, which projects from the box-like shell 6.

[0026] In other words, the bracket 9 is fixed to the side of the mobile floodgate 3 by means of a rigid and disconnectable mechanical coupling.

[0027] With reference to Figure 1, the fixed portion 4a of the disconnectable hinge 4 is instead formed by an anchorage platform 12, which is stably fixed on the base 2 and is provided with a central seat substantially shaped like a truncated cone, which is shaped so as to be able to receive the head 8 of the mobile portion 4b, and by an engagement and clamping member 13, which is designed, in sequence, to engage the head 8 of the mobile portion 4b and then withhold said head 8 so that it bears upon the central seat exerting a tensile force of a pre-set value. The anchorage platform 12 and the engagement and clamping member 13 are both of the type known and will not be described further.

[0028] With reference to Figures 2, 3 and 4, unlike the currently known solutions, the fork 10 is made in one piece with head 8 by means of a die-casting process.

[0029] In greater detail, the head 8 is formed by a substantially bell-shaped metal body 14, which develops sharing the axis L, and is provided with a blind internal cavity 14a, which communicates with the outside through a central opening made on one of the two axial ends of the body, whilst the fork 10 is formed by two substantially trapezial plane appendages 15 that extend in cantilever fashion from the roof of the metal body 14, i.e., from the vault of the bell, until they reach the plane appendage of the bracket 9 remaining locally parallel and facing one another and the axis L.

[0030] The two plane appendages 15 are obviously arranged on opposite sides of the plane of lie of the plane appendage of the bracket 9 and of the midplane of the metal body 14 - said planes in the example illustrated coinciding with one another -, and are both provided with a through hole designed to be rotatably engaged by the through pin 11.

[0031] To obtain the necessary shape of a truncated cone, the head 8 is moreover provided with two projecting annular flanges 16 and 17 of different diameter, which extend in cantilever fashion from the metal body 14 at the two axial ends thereof remaining locally coplanar to two reference planes perpendicular to the axis L.

[0032] The annular flange 16 surrounds the roof of the metal body 14, departing from which are the two plane appendages 15, and has the side delimited by a truncated-cone surface 16a which is coaxial with axis L, and that converges towards the annular flange 17. The annular flange 17 surrounds, instead, the axial end of the metal body 14 in which the inlet to the internal cavity 14a of the body is made, and has the side delimited by barrel-, or spherical-annulus-shaped toroidal surface 17a which is coaxial with axis L. The maximum diameter of the annular flange 17 is moreover smaller than the minimum diameter of the projecting annular flange 16.

[0033] Finally, in the example illustrated, the two annular flanges 16 and 17 are skirted by two collars or annular skirts 18 and 19 made of high-strength material, which are designed to come into direct contact with the walls of the anchorage platform 12 that delimit the central seat thereof.

[0034] With reference to Figure 4, the head 8 is finally provided with an engagement plate or bushing 20, which is provided with a central through hole 20a, shaped so as to be engaged in a known way by the mobile stem 13a of the member for 13 engagement and clamping of the fixed portion 4a of the disconnectable hinge 4, and is fixed in a rigid way on the axial end of the metal body 14 in which the inlet to the internal cavity 14a of the body is made in such a way that the through hole 20a is aligned

with the inlet to the internal cavity 14a.

[0035] In particular, in the example illustrated, the engagement plate or bushing 20 shares the axis L, and is fixed in a rigid way on the axial end of the metal body 14 by means of a series of anchoring bolts of a known type.

[0036] In a different embodiment, the inlet to the internal cavity 14a of the body is circular, and is provided with a thread, whilst the engagement plate or bushing 20 is sized so as to be screwed at least partially within the aforesaid inlet of the internal cavity 14a.

[0037] Operation of the mobile weir 1 is similar to the mobile barriers for temporary closing of channels and port entrances described in the patents Nos. US-3756032, US-4836711 and EP-0397609, and does hence not require any further explanation.

[0038] The advantages deriving from the adoption of the disconnectable hinges 4 with the head 8 and the fork 10 made of a single piece are considerable: thanks to the absence of welds, the head 8 and the fork 10 of the hinge have, given the same mechanical strength, an overall volume and weight sensibly lower than those of the disconnectable hinges experimented up to now, enabling an unexpected reduction in the costs of production.

[0039] Notwithstanding the fact that the die-casting process is intrinsically more costly than welding, the higher cost of the die-casting process is in fact amply compensated for by the savings deriving from the reduction of the amount of material used for each single piece and by the reduction of the costs of labour and handling of the piece.

[0040] In addition, the mechanical flanged coupling between the bracket 9 of the disconnectable hinge 4 and the beam or centering 7 of the mobile floodgate 3 enables rapid separation of the two elements, enormously speeding up the maintenance operations.

[0041] As is known, in fact, the mobile floodgate 3 and the mobile portion 4b of the disconnectable hinge 4 require completely different maintenance operations, which, with the adoption of the solution described above, can be performed simultaneously in two distinct places. In addition, the possibility of detaching from the mobile floodgate 3 the mobile portions 4b of the two disconnectable hinges 4 renders handling of the single parts much more convenient.

[0042] The fact that the fork 10 is made of a single piece with the head 8 moreover enables sizing of the mechanical flanged coupling between the bracket 9 of the disconnectable hinge 4 and the beam or centering 7 of the mobile floodgate 3 so as to constitute a preferential point of failure of the structure, on which, with relatively contained costs of renewal, the mechanical impulsive stresses deriving from impact of a vessel of large dimensions against the mobile floodgate 3 would be discharged.

[0043] Finally, it is clear that modifications and variations may be made to the mobile weir 1 described and illustrated above, without thereby departing from the scope of the present invention.

Claims

1. A mobile weir (1) for temporary closing of channels and port entrances comprising a base (2) extending on the seafloor of the port entrance, and a series of mobile floodgates (3) which are hinged edgewise on the base (2) adjacent to one another, so as to be able to swing about a substantially horizontal main axis of rotation (A) between a lowered position, in which the mobile floodgates (3) rest on the seafloor (F) of the port entrance, and a raised position, in which the mobile floodgates (3) extend in cantilever fashion from the base (2) in a direction substantially perpendicular to the seafloor (F) so as to emerge partially above the surface of the water and form a barrage designed to prevent the passage of water through said port entrance; each mobile floodgate (3) being connected to the base (2) by means of a plurality of disconnectable hinges (4) which are made up of a fixed portion (4a) stably anchored to the base (2), and a mobile portion (4b) which is instead fixed to the mobile floodgate (3), incorporates the joint for articulation of the hinge about said main axis of rotation (A), and is finally structured so as to be coupleable to the fixed portion (4a) in a stable, but readily releasable, way;
   the mobile portion (4b) of at least one disconnectable hinge (4) comprising an engagement head (8) structured so as to be fittable in the fixed portion (4a) of the disconnectable hinge (4) itself in a stable, but readily releasable, manner, a bracket (9) for connection to the floodgate, which is provided with a plane appendage (9) extending in cantilever fashion from the side of the mobile floodgate (3), remaining locally perpendicular to the main axis of rotation (A), and finally an intermediate fork (10) extending in cantilever fashion from the engagement head (8) and pivoted on the plane appendage of said bracket (9) by means of a through pin (11) coaxial to said main axis of rotation (A);
   said mobile weir (1) being **characterized in that** said fork (10) is made in one piece with the head (8) by means of a die-casting process.

2. Mobile weir according to Claim 1, **characterized in that** said engagement head (8) comprises a substantially bell-shaped metal body (14) which develops according to a reference axis (L) locally perpendicular to said main axis of rotation (A), and is provided with an internal cavity (14a) which communicates with the outside through a central opening made on one of the two axial ends of the metal body (14) itself; whilst said fork (10) is formed by two plane appendages (15) which extend in cantilever fashion from the roof of said metal body (14) until they reach

the plane appendage (9) of said bracket (9), remaining locally parallel and facing one another and said reference axis (L); the plane appendages (15) that form said fork (10) being both provided with a respective through hole designed to be engaged in a rotatable way by said through pin (11).

3. Mobile weir according to Claim 2, **characterized in that** said engagement head (8) also comprises an engagement plate or bushing (20) which is centrally provided with a through hole (20a), and is fixed in a rigid way on the end of the metal body (14) in which the inlet to the internal cavity (14a) of the body is made so that said through hole (20a) is aligned with the inlet of said internal cavity (14a).

4. Mobile weir according to Claim 3, **characterized in that** said engagement plate or bushing (20) is fixed in a rigid way on the end of the metal body (14) by means of bolts.

5. Mobile weir according to Claim 3, **characterized in that** the inlet to the internal cavity (14a) of said body is circular and is provided with a thread, and said engagement plate or bushing (20) is sized so as to be screwed at least partially within the inlet of said internal cavity (14a).

6. Mobile weir according to any one of Claims 2 to 5, **characterized in that** said engagement head (8) also comprises a first (16) and a second projecting annular flange (17) which extend in cantilever fashion from the metal body (14) at the two axial ends thereof, remaining locally coplanar to two reference planes perpendicular to said reference axis (L).

7. Mobile weir according to Claim 6, **characterized in that** said first annular flange (16) surrounds the roof of the metal body (14), departing from which are the two plane appendages (15) that form said fork (10), and has the side delimited by a truncated-cone surface (16a) which is coaxial with said reference axis (L) and that converges towards said second annular flange (17).

8. Mobile weir according to Claim 6 or Claim 7, **characterized in that** said second annular flange (17) surrounds the axial end of the metal body (14) in which the inlet to said internal cavity (14a) is made, and has the side delimited by a barrel-, or spherical-annulus-shaped toroidal surface (17a) coaxial to said reference axis (L).

9. Mobile weir according to any one of the preceding claims, **characterized in that** said bracket (9) for connection to the floodgate is fixed to the side of the mobile floodgate (3) by means of a rigid and disconnectable mechanical coupling.

10. Mobile weir according to Claim 9, **characterized in that** said rigid and disconnectable mechanical coupling is a flanged coupling.

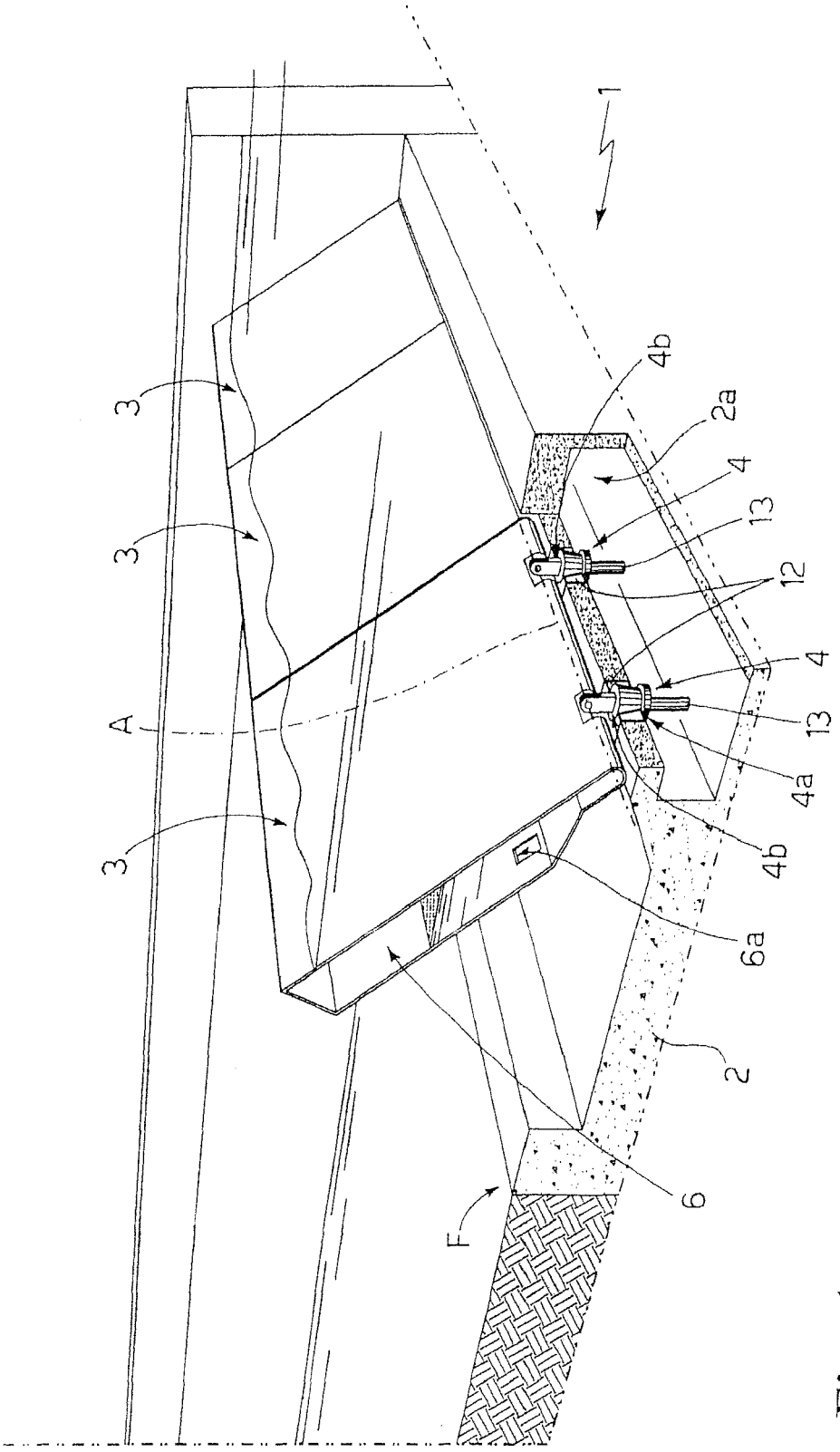
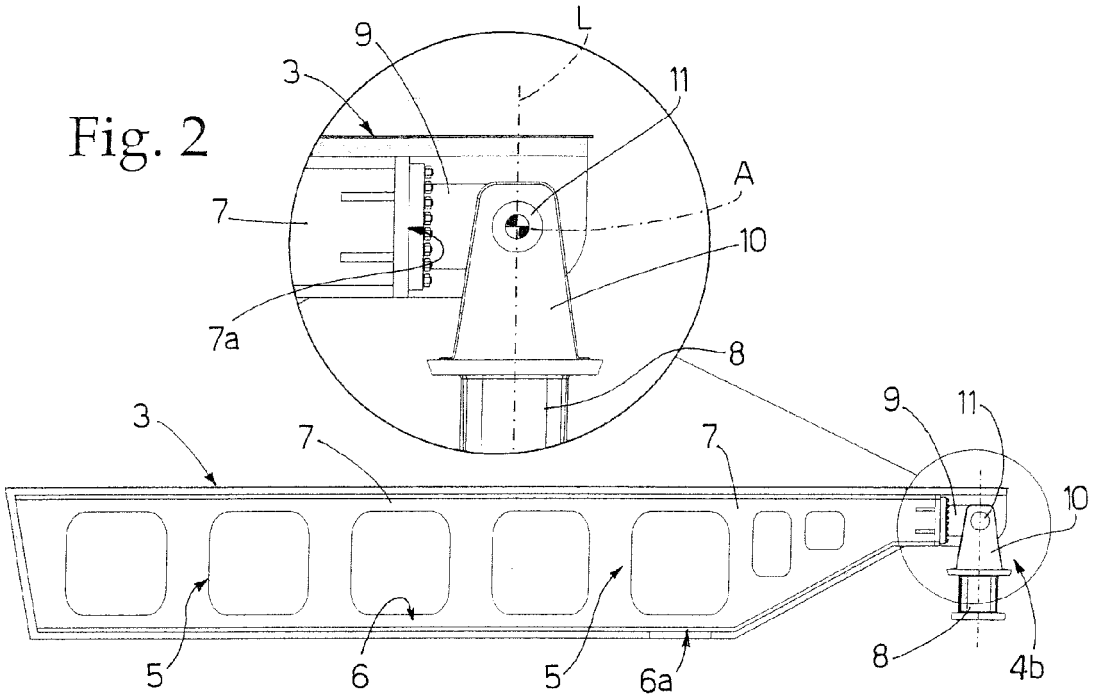


Fig. 1

Fig. 2



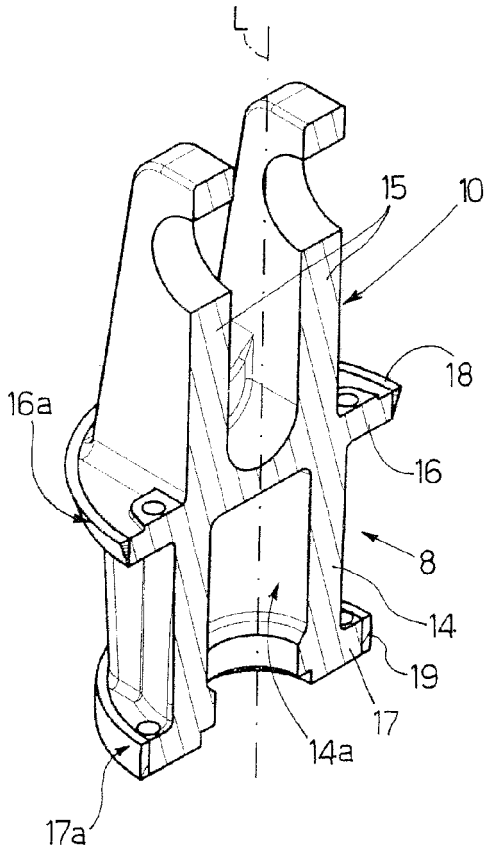


Fig. 3

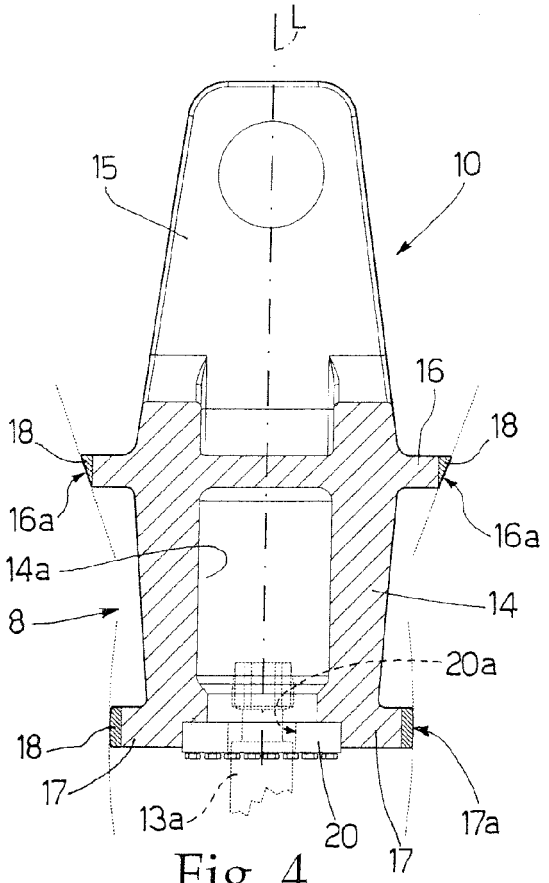


Fig. 4

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 3756032 A **[0004] [0037]**
- US 4836711 A **[0004] [0007] [0037]**
- EP 0397609 A **[0004] [0007] [0037]**