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(54) Method for construction and mutual liquid-tight connection of structural parts and assembly formed by the use of said method.

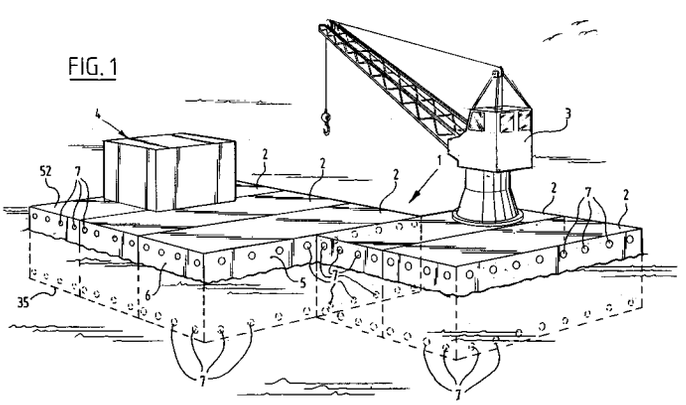
(57) The invention relates to a method for constructing and mutually connecting in liquid-tight and rigid but releasable manner of structural parts for use in a wet environment, in which a required connecting force between the parts are determined and from that a required number of sets of connecting elements are arranged in the structural parts, in which the connecting elements are arranged and connected to each other.

Each set of connecting elements comprises a bolt received in a bush and an associated nut of a determined standard size, and the openings are formed with a large tolerance relative to the standard size.

Before connection the bolt received in the bush and the nut are each placed sealingly in register with their associated opening and secured.

The invention further relates to an assembly of structural parts that is formed by applying this method.

FIG. 1



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The invention relates to a method for constructing and mutually connecting in liquid-tight and rigid but releasable manner of structural parts for use in a wet environment. An example of such a liquid-tight method of connection is described in the European patent EP-A-0 079 911.

In the known method floating standard components are mutually connected to form for instance a pontoon or the like. Use is made therein of standard components provided on each of the four corner points of their surfaces for mutual connection with mutually co-acting, protruding connecting elements. Each set of co-acting connecting elements comprises a female element arranged on the one floating standard component in the form of an eye, and a male connecting element arranged on the other floating component in the form of a hollow pin fitting into the eye. In the known method the two floating components are moved toward each other until the four hollow pins protruding from the connecting surface of the first component are received in the likewise protruding eyes of the other floating component, whereafter a bolt is placed through each hollow pin and the associated eye and fixed and tightened using a nut in order to effect a rigid connection between the floating components.

This known method, which is used particularly to assemble floating constructions such as pontoons, landing stages, artificial islands and the like at poorly accessible locations, has the principal drawback that use is made of connecting elements protruding outside the periphery of the floating standard components. These standard components, which generally have dimensions corresponding with those of so-called ISO containers, are hereby only transportable with great difficulty since the standardized container sizes are exceeded due to the protruding parts. Furthermore, in the known method the force of the connection cannot be adapted to the anticipated load, since use is always made of four bolts with a diameter determined by the bore of the hollow pin and the eye.

In another known system for assembling a floating construction from standard containers which is made commercially available by B.V. Ravestein in Deest (NL), use is likewise made of connecting elements arranged on the outside of the standard containers, here however in the form of a wedge and a wedge-shaped receiving space. The wedge is also locked into the receiving space by a wedge-shaped pin. This system has the same drawbacks as described above, while in addition no sealing attachment can be guaranteed with the use of wedges.

Yet another system for assembling a floating construction from the standard container is known under the trade name "Flexifloat" and makes use of protruding or male connecting elements arranged on the outside of a part of the containers and receiving or female connecting elements recessed into the outer wall of another part of the containers. Each male element is provided with a head and a constriction located therebehind, while each female element has an aperture in the wall and a lock arranged slidably therebehind. Each lock is provided with a slot-like recess, the dimensions of which correspond with those of the constriction in the male element. When the standard containers are joined together the male elements are pushed with their head through the apertures of the female elements to a position beyond the locking elements, whereafter the locking elements are slid downward and the head of each male element is thus secured behind the locking element. This system also has the drawback that a part of the fixing elements protrudes outside the periphery of the containers. In addition the system takes up a relatively large amount of space and there is the danger of the slide locks deforming at high loads such that they can no longer be released. Nor is the distribution of the connecting forces over the different connecting elements determined.

Finally, a method is known from the European patent EP-A-0 469 655 for rigid mutual connection of standard containers to a floating pontoon, wherein each container is provided on its corners with special connecting blocks, and two blocks are mutually connected at a time by a heavy connecting rod which is set hydraulically to a determined bias. The container surfaces are herein not pulled against each other, but a deformable spacer element is arranged round each connecting rod between the containers. Although no connecting parts protruding outside the container have to be used in this method, it nevertheless has a number of drawbacks. The requisite features on the containers are thus comparatively heavy and expensive and the connecting force can hardly be adapted to the anticipated load. In addition, the biasing of the connecting rods by means of hydraulic jacks is difficult work, particularly when it has to be carried out in a corner of a closed container. The fixing of the connecting rods also requires special tools. Finally, the spacer elements located outside the containers can be damaged or lost during coupling or release of the containers.

The invention has for its object to provide a method of the above described type, wherein the said drawbacks do not occur. This is achieved according to the invention by manufacturing the structural parts, determining a required connecting force therebetween, determining a required number of sets of connecting elements from the connecting force and the strength of a set of co-acting standard connecting elements, arranging openings in

the structural parts, arranging the connecting elements in distributed manner from the inside of the structural parts through the openings in surfaces thereof for connecting, and rigidly connecting to each other the co-acting elements of each connecting set.

Preferably applied variants of the method according to the invention form the subject-matter of the dependent claims 2-6.

The invention further relates to an assembly of structural parts formed by applying the above described method. Such an assembly preferably has at least two structural parts rigidly connected to each other along mutually parallel side surfaces by means of at least one set of co-acting standard connecting elements, wherein the connecting elements are arranged releasably from the inside of structural parts.

Preferred embodiments of the assembly according to the invention form the subject-matter of the dependent claims 9-16.

The invention finally also relates to the different individual parts of the assembly, in particular the floating standard component. The invention is now elucidated on the basis of an embodiment, wherein reference is made to the annexed drawing, in which:

Fig. 1 shows a perspective view of an assembly according to the invention formed from a number of floating standard components;

Fig. 2 shows a partly cut away perspective detail view of a connecting set for use in the assembly according to the invention;

Fig. 3 is a partly cross sectional view according to the arrows III-III in fig. 2;

Fig. 4 shows a partly cut away perspective view of an opening in a standard component and first embodiment of a sealing member therefor;

Fig. 5 shows a partly cut away perspective view of a second embodiment of a sealing member for an opening; and

Fig. 6 is a view corresponding with fig. 2 of two standard components for forming the rigid connection, wherein the one standard component is provided with a locating member.

An assembly 1 of a number of floating standard components 2 mutually connected in rigid but releasable manner (fig. 1) forms for instance a pontoon or a floating quay wall for supporting for instance a crane 3 or storing cargo 4. Each standard component, which may be manufactured for instance of steel and the outer dimensions of which correspond with container sizes as defined by the International Standards Organisation, has in its side surfaces 5,6 a series of openings 7 arranged in regular distribution, some of which can be used for passage of sets of connecting elements 8 (fig. 2).

The connecting elements 8 are thus arranged from the inside of the floating components 2 which therefore have no protruding parts. Each standard component 2 is further provided on its corners with fittings manufactured in accordance with ISO norms so that the standard component 2 can be handled and transported as a normal ISO container. A large number of standard components can hereby be carried simply and quickly to a location where a floating assembly has to be constructed. The number of sets of connecting elements which must be arranged between each group of floating standard components 2 is determined by dividing the expected maximum load on the connection between two adjoining standard components 2 by the maximum permissible load on a set of standard connecting elements. The openings 7 not used for lead-through of connecting elements 8 can herein be closed off by sealing members to be further described hereinbelow. Conversely, it is of course also possible that in each floating standard component 2 only as many openings 7 are arranged as are necessary for the connection to be formed. Because only openings 7 have to be arranged in the standard components 2 for connection thereof, the standard components 2 can be manufactured at a relatively favourable cost and are relatively easily adaptable.

Each set of connecting elements 8 comprises a bolt 9 and an associated nut 10 of a determined standard dimension. In the embodiment shown use is made as bolt 9 of a so-called high-strength friction grip bolt (HSFG-bolt) with a nominal diameter of 30 mm. The openings 7 have a large tolerance relative to this dimension so that even when the mutually opposite openings 7 do not lie wholly in register the bolt 9 can still be placed through the openings 7. In order to ensure a watertight connection the nut 10 is embodied as watertight capped nut, while a watertight bush 11 is arranged between the head 33 of bolt 9 and the opening 7 in the container wall 5. The nut 10 comprises a cylindrical part 12 and a closing plate 13 connected thereto by welds 25. The bush 11 likewise has a cylindrical part 14 and a closing plate 15 welded thereon. In order to connect the nut 10 and bush 11 in watertight manner to their associated opening 7, use is made of clamping springs 16. Each spring 16 is a substantially U-shaped torsion spring, the legs of which are located in different planes. This spring 16 is struck between the closing plate 13 respectively 15 of nut 10, bush 11 and two retaining strips 17, whereby nut 10 and bush 11 are pressed tightly against the wall 5 of a respective container. The retaining strips 17 are each connected to reinforcing ribs 18 welded into the container. In order to enable easy pushing or striking of spring 16 between the re-

spective closing plates 13, 15 and the retaining strips 17, its outer ends are provided with chamfered locating surfaces 19. The retaining strips 17 do not run down to the bottom 35 of container 2. The extremity of one of the legs of each spring 16 will thereby tend to move beneath the retaining strip 17 towards the outside of the container (the legs do not in any case lie in one plane in non-tensioned state), whereby the spring 16 is as it were pulled toward the bottom 35.

The nut 10 is provided with a screw thread part 20 (fig. 3) which co-acts with a screw thread part 21 of bolt 9. The length of screw thread part 20 in nut 10 is adapted to the length of screw thread part 21 of the standard HSFG-bolt 9 such that when bolt 9 is fully tightened into nut 10 a good, rigid connection is made between the two containers 2, while it is further ensured that screw thread 21 of bolt 9 never reaches the end of screw thread 20 of nut 10. The force with which bolt 9 and nut 10 are mutually connected is herein otherwise chosen to be so great that the friction force between the mutually connected surfaces of containers 2 is sufficient to withstand transverse forces acting thereon. The length of the screw thread section 20 is determined by a recess 22 in nut 10. This recess 22 otherwise functions as guide and locating opening during mutual positioning and subsequent connecting of the container. Nut 10 is also locked against rotation in that its end face 13 is enclosed non-rotatably between the reinforcing ribs 18.

In order to form a watertight connection between the capped nut 10 and the wall 5 of the container the nut 10 is provided with an annular recess 23 into which is arranged a gasket ring, for instance an O-ring or so-called quadring. Under the influence of the clamping force of spring 16 and the tensile force of bolt 9 the gasket ring 24 is pulled tautly against the container wall 5, whereby a good sealing is ensured. In order to allow escape of moisture possibly remaining behind in nut 10 during screwing in of bolt 9, the weld connection 25 takes an interrupted form so as to form (microscopic) drain orifices 26 (fig. 2).

The bush 11 is provided on its end facing the opening 7 with a conical locating opening 27 in addition to an annular recess 28 in which a gasket ring 29 is likewise arranged. In addition, a further annular recess 30 is arranged close to the closing plate 15 in the cylindrical part 14 of bush 11, in which recess a gasket ring 31 is arranged. This gasket ring 31 forms with the shank 32 of bolt 9 a watertight sealing. The friction force between the gasket ring 31 and the shank 32 of the bolt is chosen such that even when bolt 9 lies freely in bush 11 it will not be pushed out of bush 11 by the water pressure prevailing outside the container. When the bush 11 with the bolt 9 therein is thus installed in container 2, it seals opening 7 in watertight manner. A force distributing ring 34 is otherwise also arranged between the head 33 of bolt 9 and the end surface 15 of bush 11.

In an alternative embodiment of the nut 10 and bush 11 the conical locating openings 22,27 are replaced by cylindrical recesses and the annular recesses 23,28,30 for the gaskets rings 24,29,31 are omitted. In this embodiment an array of annular gaskets or a single cylindrical gasket is arranged at choice in each of the cylindrical recesses in nut 10 and bush 11. A good sealing is hereby likewise effected, while such a nut or bush is also simpler and can therefore be manufactured at lower cost.

In order to enable temporary watertight sealing of container 2, for instance during interim storage of the container on the quay, when openings 7 are arranged therein which are not used for lead-through of a connecting means 8, sealing members 36 can be arranged in the unused openings 7 (fig. 4). Each sealing member 36 has a shank 37, the diameter of which practically corresponds with the diameter of opening 7 and on which is arranged a number of parallel, resiliently flexible peripheral ribs 38 which in the mounted situation of sealing member 36 completely seal off the space between shank 37 and the inner wall of opening 7. For further sealing and in order to simplify manipulation of, in particular removal of, the sealing member, a closing plate 39 having a larger diameter relative to opening 7 is arranged on the end of the shank. Such sealing members 36, which can otherwise withstand only a limited water pressure and are therefore not particularly suitable for long-term use, can of course also be pressed from the outside into the openings 7 of container 2.

For semi-permanent sealing of an opening 7 use can be made of another embodiment of a sealing member which is designated in fig. 5 with the reference numeral 40. The sealing member 40 comprises a dish-like body 41 with a protruding part 42 which fits tightly into the opening 7. Received in the dish-like part 41 is an annular gasket 50 which in the mounted situation of sealing member 40 provides a watertight closure of opening 7. The dish-like body 41 is first pushed from the inside of container 2 into opening 7, whereafter a slightly flexible, U-shaped closing plate 43 is placed between the body 41 and the retaining strips 17. The closing plate 43 is provided with a central aperture with internal screw thread 44 formed for instance by flow drilling, into which aperture a tensioning bolt 45 is screwed. Tensioning bolt 45 is tightened so far that its end surface 58 rests in a recess 53 in sealing member 40. By further tightening tensioning bolt 45 the U-shaped closing plate 43 is then bent resiliently outward, whereby sealing member 40 is pressed

under bias into opening 7. In this way the sealing member 40 is secured against detachment when unexpectedly high water pressures or impact loads occur.

In order to enable relative mutual positioning of the floating standard components or containers 2 before they are mutually connected, one or more locating members 46 can be arranged in one of the containers. Each locating member 46 (fig. 6) comprises a cylindrical body 49 with a protruding part 47 which runs into a conical tip 48. The cylindrical body 49 which is provided with a gasket ring 51 is fixed, like the sealing member 40, using a separate closing plate 54, which is not however resiliently flexible, and a locking bolt 55 which is screwed through an aperture 56 in closing plate 54 into an opening 57 in locating member 46. When the floating standard components 2 move toward each other, the conical outer end 48 of locating member 49 will come into contact at a determined moment with the edge of opening 7 of the container 2 for connecting and penetrate therein. The required connecting elements 8 can then be arranged and fixed.

The dimensions of nut 10 and bush 11 are otherwise chosen to be substantially the same so that the nut and the bush can be interchanged. The question of on which side of the connection a nut 10 and on which side a bush 11 with bolt 9 must be used can thereby be answered subject to the accessibility of the connecting elements 8 in their respective container 2. Since the nut 10 is anyway locked against rotation and translation, operations only have to be performed on the side of bolt 9. This can then take place in the best accessible container 2.

Because each container 2 is provided in each of its surfaces 5,6 with rows of openings 7 with a standard interspace of for instance a foot (0.3 m), any conceivable floating configuration can be formed with the system according to the present invention. The floating standard components 2 can thus be mutually connected with their side surfaces 5 such that their head end surfaces 6 form a continuous surface as shown on the left of fig. 1, or mutually staggered as shown also in fig. 1. The head end surface 6 of one standard component 2 can also be pulled against the longitudinal surface 5 of another standard component 2. Finally, different construction heights are also possible.

Because the connecting elements 8 are independent of the structural parts for connecting therewith, they can be interchanged simply and at low cost. The manufacturing and replacement costs of the structural parts are thereby also held relatively low.

Although in the embodiments nuts and bushes are shown with annular and cylindrical gaskets in an end surface or on the inside, any configuration can be envisaged wherein the nut, bush and bolt form an integral watertight unit with the container both in tensioned and in non-mounted situation.

Although the invention is elucidated above with reference to a watertight mutual connection of floating containers, it is applicable in any situation in which structural parts have to form a mutual liquid-tight connection in a wet environment.

Claims

1. Method for constructing and mutually connecting in liquid-tight and rigid but releasable manner of structural parts for use in a wet environment, **characterized by** manufacturing the structural parts, determining a required connecting force therebetween, determining a required number of sets of connecting elements from the connecting force and the strength of a set of co-acting standard connecting elements, arranging openings in the structural parts, arranging the connecting elements in distributed manner from the inside of the structural parts through the openings in surfaces thereof for connecting, and rigidly connecting to each other the co-acting elements of each connecting set.

2. Method as claimed in claim 1, **characterized in that** during manufacture of the structural parts a large number of openings are arranged therein at determined interspacing and provided with releasable closing means and for connection the closing means are removed from a required number of openings.

3. Method as claimed in claim 1 or 2, **characterized in that** each set of connecting elements comprises a bolt received in a bush and an associated nut of a determined standard size, and the openings are formed with a large tolerance relative to the standard size.

4. Method as claimed in claim 3, **characterized in that** for connection the bolt received in the bush and the nut are each placed sealingly in register with their associated opening and secured.

5. Method as claimed in any of the foregoing claims, **characterized in that** for connection a locating member protruding outside the surface for connecting is placed through at least one of the openings of one of the structural parts and the structural parts are manoeuvred such that the locating member is received into the corresponding opening in the other struc-

tural part.

6. Method as claimed in any of the foregoing claims, **characterized in that** the structural parts are floating standard components and a floating assembly is formed by connecting thereof.

7. Assembly of structural parts evidently formed by applying the method as claimed in any of the foregoing claims.

8. Assembly as claimed in claim 7, **characterized by** at least two structural parts rigidly connected to each other along mutually parallel surfaces by means of at least one set of co-acting standard connecting elements, wherein the connecting elements are arranged releasably from the inside of structural parts.

9. Assembly as claimed in claim 8, **characterized in that** each set of connecting elements comprises a bolt and an associated nut of a determined standard size, and each of the structural parts has at least in its connecting surface one or more openings having a large tolerance relative to the standard size.

10. Assembly as claimed in claim 9, **characterized in that** the nut is a watertight capped nut, and a watertight bush is arranged between the bolt and its associated opening.

11. Assembly as claimed in claim 10, **characterized in that** the dimensions of the nut and the bush are substantially the same.

12. Assembly as claimed in claim 10 or 11, **characterized by** means for holding the nut and bush with bolt in register with their associated opening.

13. Assembly as claimed in claim 12, **characterized in that** the holding means comprise in each case at least one substantially U-shaped torsion spring.

14. Assembly as claimed in any of the claims 9-13, **characterized in that** in at least one of the structural parts a larger number of openings is arranged than the number of bolts and nuts, wherein the distance between mutually adjacent openings is constant and the free openings are each provided with a sealing member.

15. Assembly as claimed in claim 14, **characterized in that** a locating member protruding outside the connecting surface is placed into at least one of the free openings.

16. Assembly as claimed in any of the claims 7-15, **characterized in that** the structural parts are floating standard components.

17. Floating standard component evidently intended for use in an assembly as claimed in claim 16.

18. Floating standard component as claimed in claim 17, **characterized by** a rectangular bottom, a number of rectangular standing walls enclosing the bottom on all sides and a rectangular deck part connecting the walls, wherein at least one of the walls is provided with a number of openings arranged at fixed interspacing, and wherein the dimensions of the bottom, walls and deck are chosen such that the outer periphery of the floating component complies with international norms for containers.

19. Connecting set evidently intended for use in an assembly as claimed in any of the claims 7-16.

20. Watertight capped nut evidently intended for use in an assembly as claimed in any of the claims 10-16.

21. Watertight bush evidently intended for use in an assembly as claimed in any of the claims 10-16.

22. U-shaped torsion spring evidently intended for use in an assembly as claimed in any of the claims 13-16.

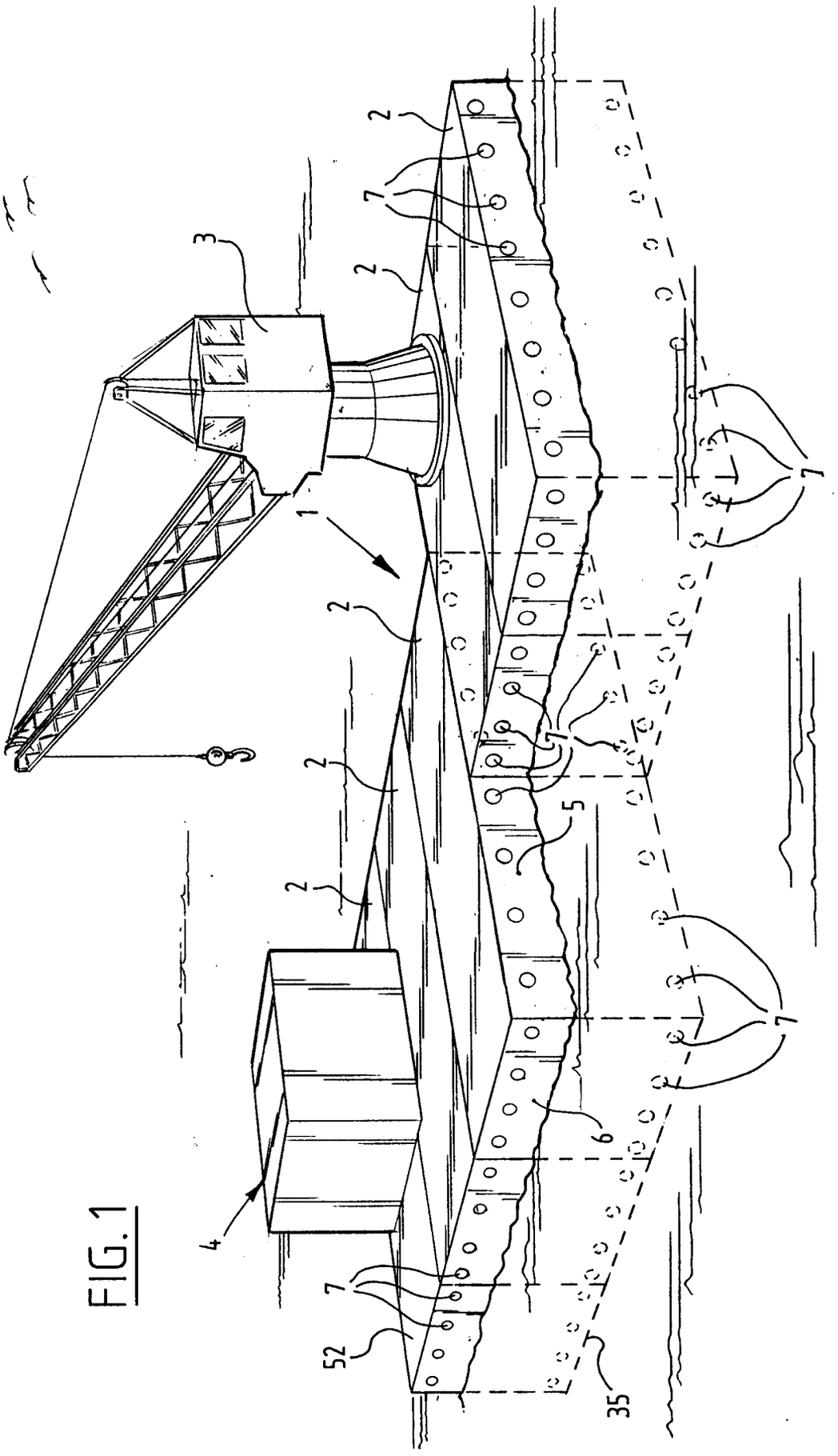

FIG. 1

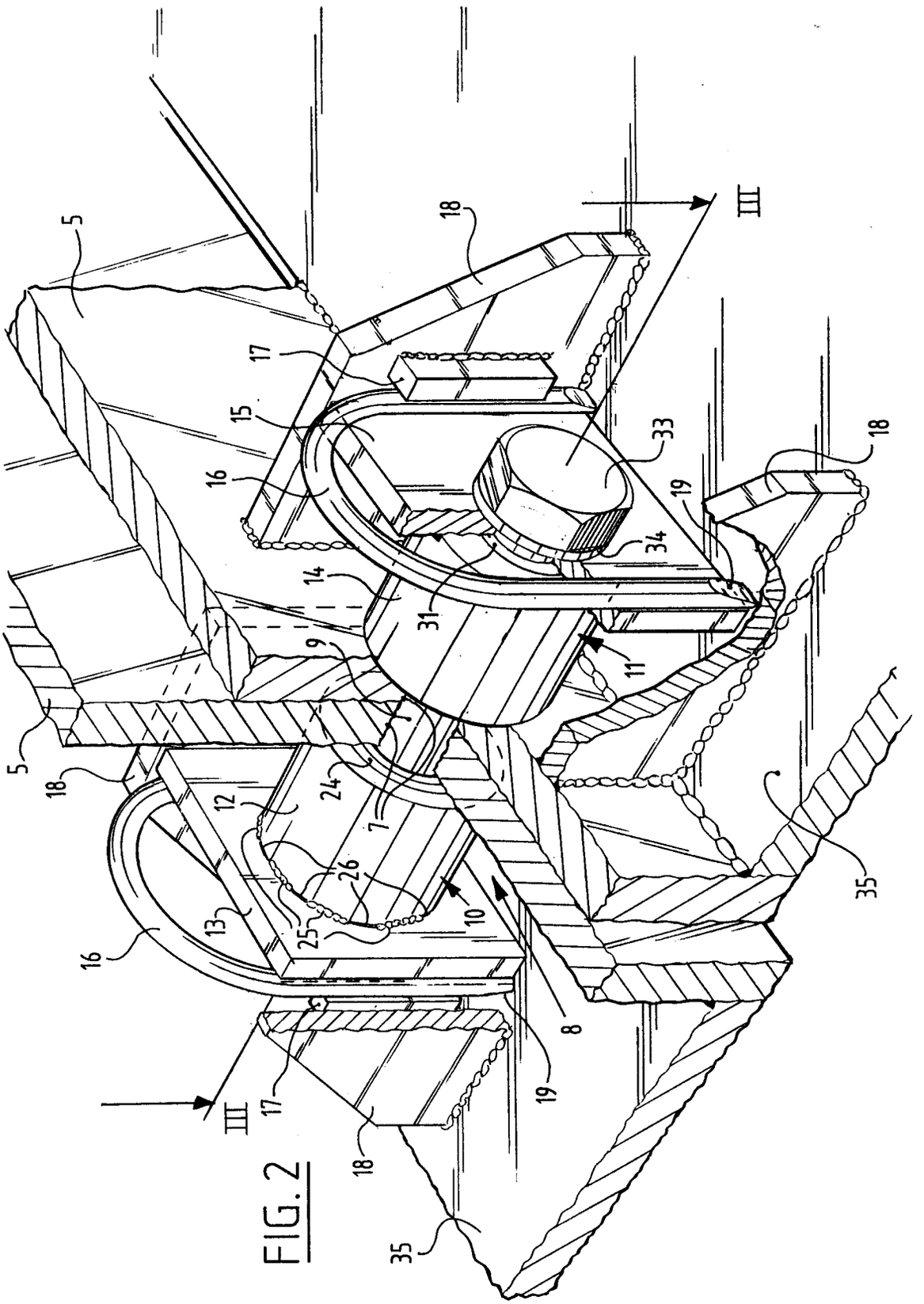
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FIG. 2

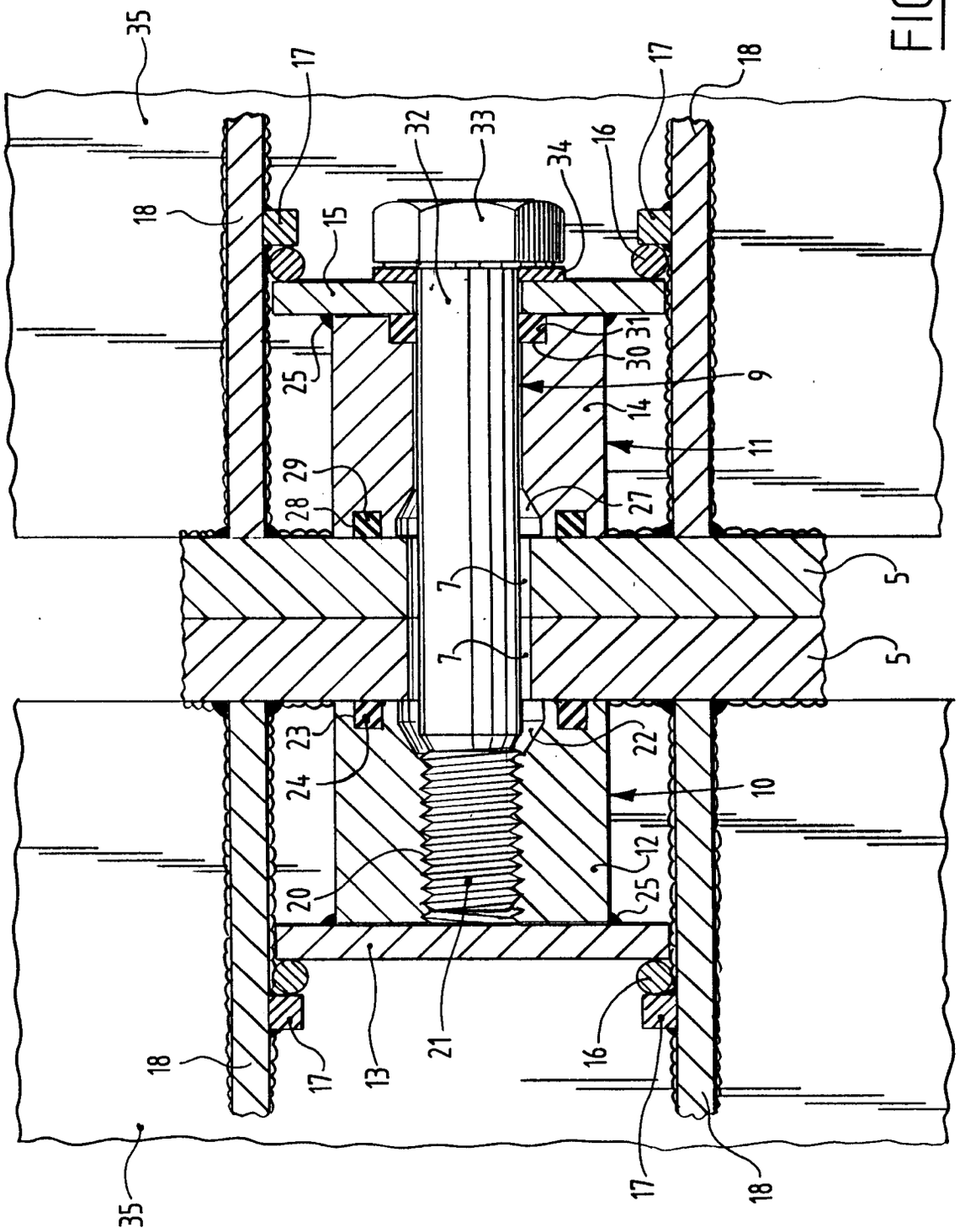
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FIG. 3

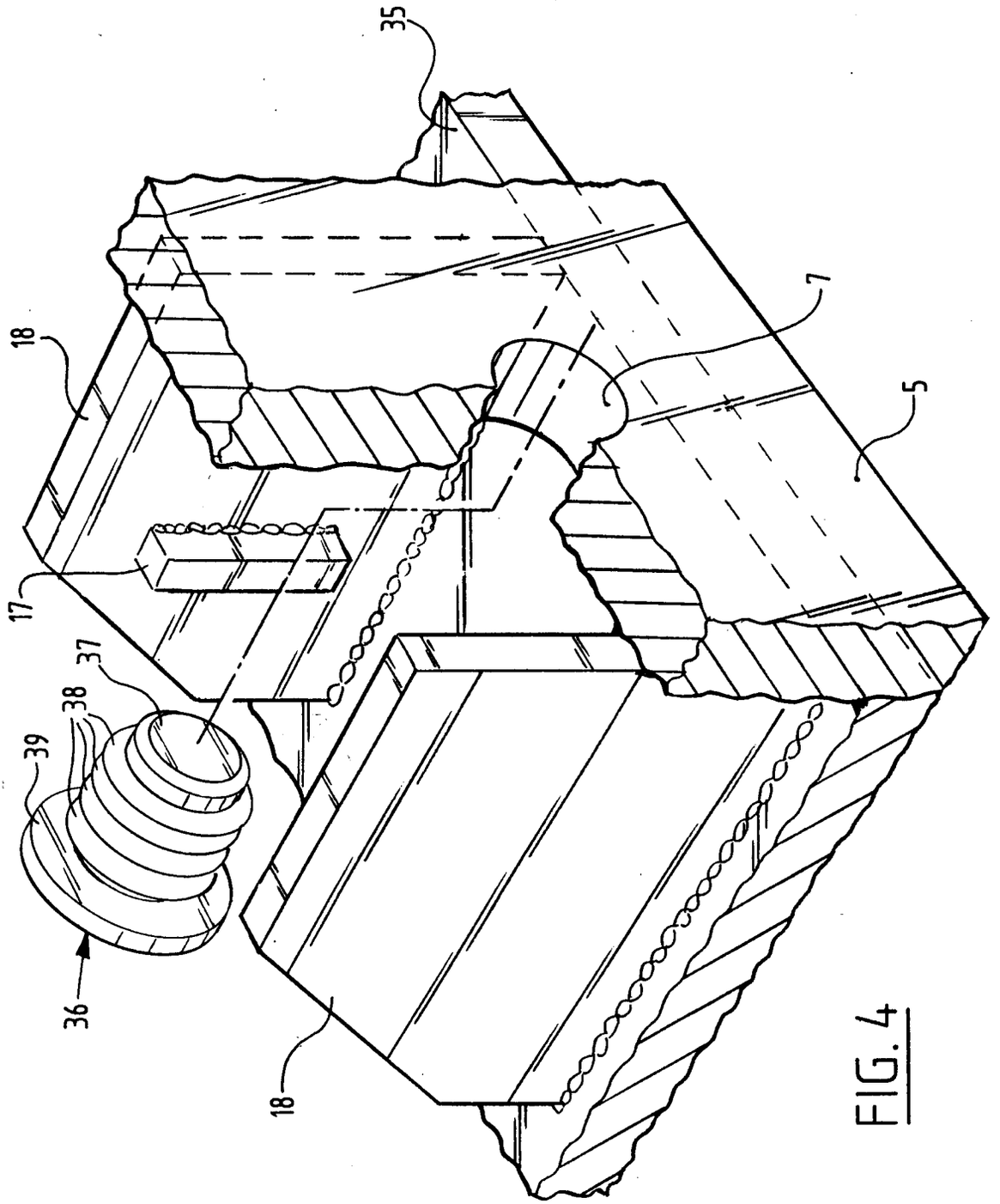

FIG. 4

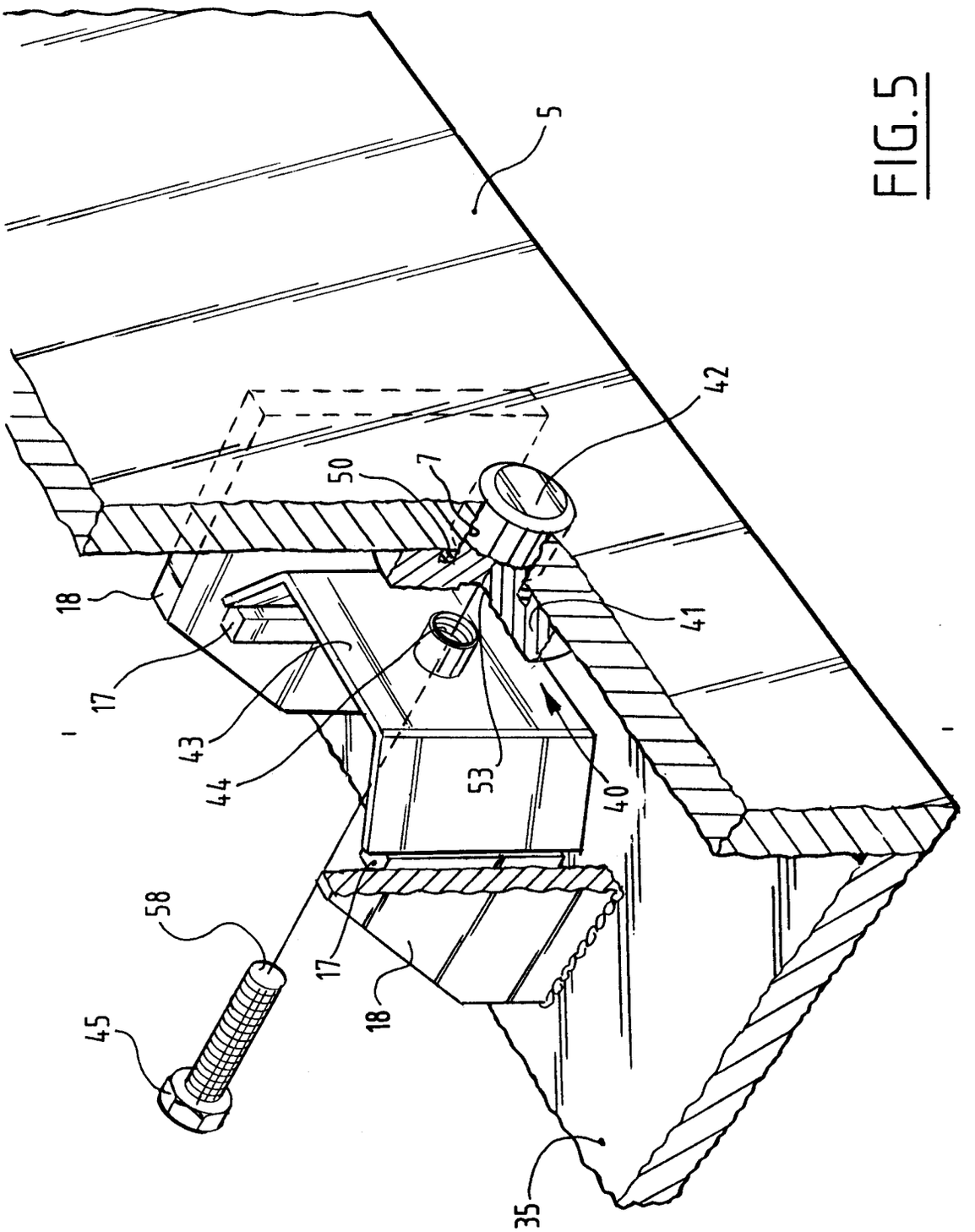

FIG.5

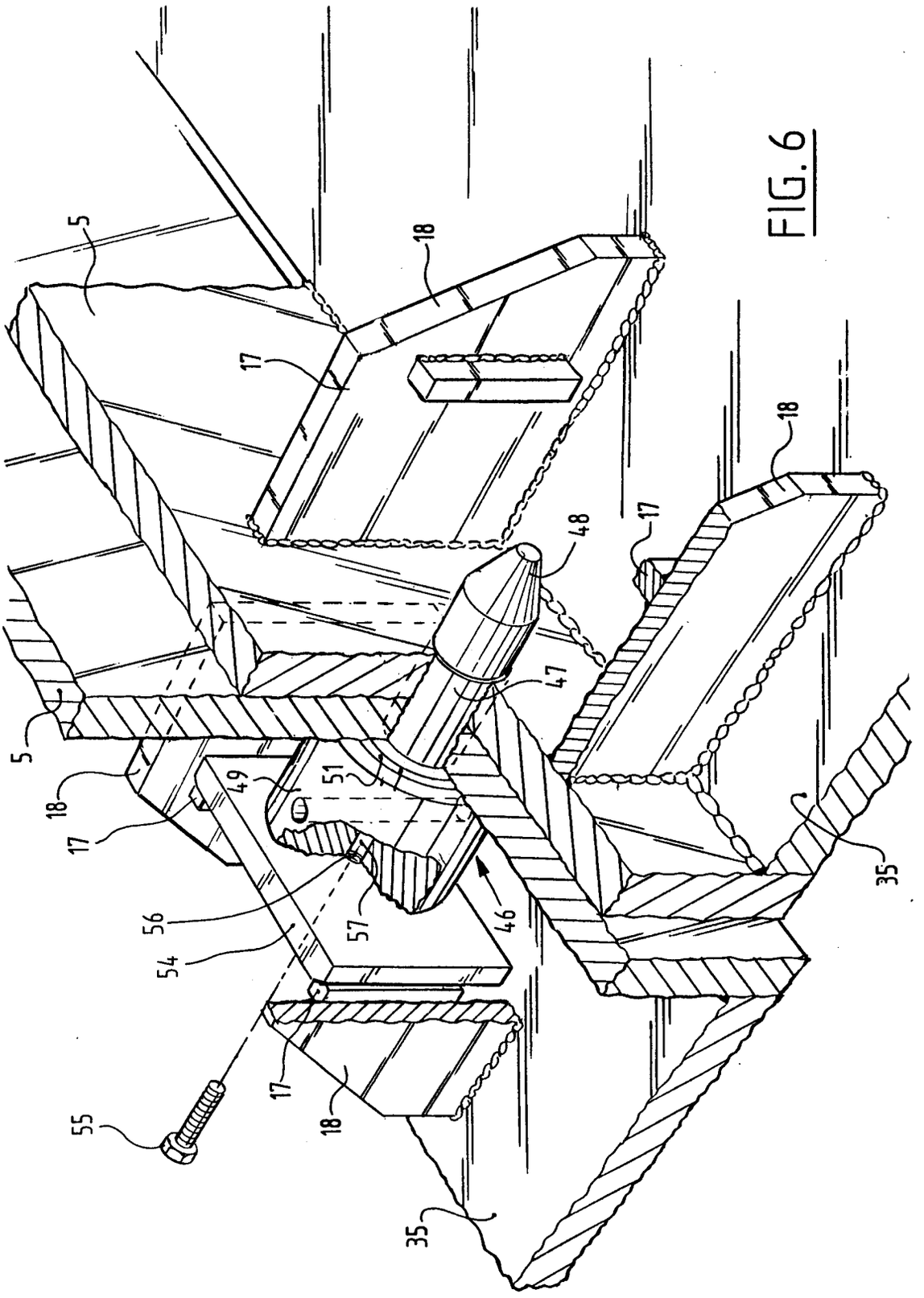

FIG. 6

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 20 1028

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X,D	EP-A-0 469 655 (IHC HOLLAND) 5 February 1992 * abstract; figures * * column 4, line 55 - column 5, line 31 *	1,3-9, 16-19	B63B35/38 E02B3/06
X X,D	WO-A-82 04294 (NEUMANN EQUIPMENT MARKETING CO.) 9 December 1982 & EP-A-0 079 911 * abstract; figures *	1,3,5-9, 16,17,19 1,3,5-9, 16,17,19	
X	US-A-4 335 670 (C.SKAALEN) 22 June 1982 * abstract; figures *	1,5-8, 16,17,19	
X	US-A-4 936 238 (J.CHILDRESS) 26 June 1990 * abstract; figures *	1,7-9, 17,19	
A	EP-A-0 312 139 (A.ROBISHAW) 19 April 1989 * abstract; figures *	1,7, 17-19	TECHNICAL FIELDS SEARCHED (Int.Cl.6) B63B E01D E02B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	10 July 1995	Stierman, E

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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