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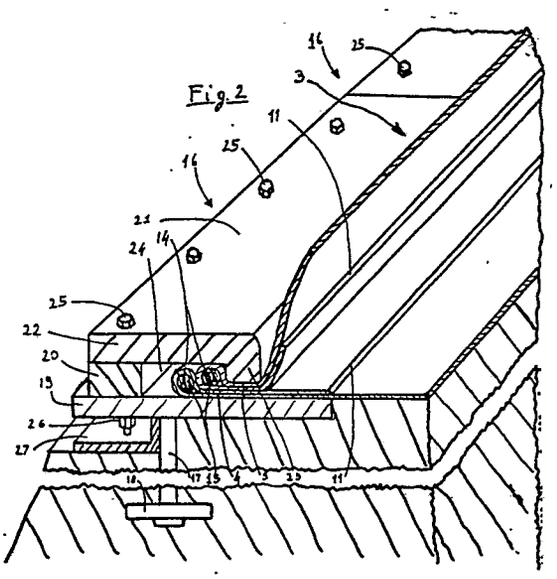
(54) **Collapsible dam.**

(57) The invention concerns a collapsible dam (2) of the type comprising an inflatable sack formed by a casing (3) provided with slots (4, 5) on its longer edges within which are inserted ropes (14) embedded in a mass (15) of elastomeric material. The sack is formed so as to enclose in a single clamp (16) the slots containing the said ropes.



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COLLAPSIBLE DAM

The present invention refers to a collapsible dam, and in particular, to a collapsible dam of the type comprising an inflatable sack.

The collapsible dams according to the present invention can be employed for example for temporarily damming a waterway so as to raise its upstream level, or else the dams may be utilized as an element for raising the level of a water basin which is for example formed by an already existing masonry dam.

There are known dams for this second type of usage, and these known dams comprise a gangway raised with respect to the upper edge of the masonry dam and two guides, one on the upper edge itself, and the other at the level of the gangway or immediately below it. Between these two guides there are inserted slabs (for example of wood) by an operator standing on the gangway itself. These slabs are placed one adjacent to and contacting the other, so as to form a wall that provisionally increases the total height of the basin upstream of the masonry dam itself. For guaranteeing the sealing between the lower guide and the slabs, and between adjacent slabs, slag or earth are thrown into the upstream basin, which in becoming inserted into any existing spaces closes them and renders the dam watertight.

This type of known dam presents apart from the drawback that a perfect sealing can never be guaranteed, also problems concerning a dismantling of the dam, for example in case of unexpected floods.

As a matter of fact in such cases one or more operators must move along the gangway and raise the various slabs.

This work results very difficult and dangerous, since the water in the upstream basin pushes with a great force against the slabs forming the dam and, as soon as it finds any opening between the slabs, rushes in with a great impetus and speed.

The aim of the present invention is to overcome the drawbacks of the known dams used for raising the level of a masonry dam, i.e. to provide a dam which does not present any problem as regards the sealing, and which is easily collapsible, preferably without an intervention of any operators.

A further aim of the present invention is to provide a collapsible dam that can be inserted in the bed of a waterway for forming a weir in the waterway, which dam maintains the advantages just described.

What forms one object of the present invention is a collapsible dam of the type comprising an inflatable sack, characterized by the fact that said sack is made of a casing of flexible material practically inextensible and impervious to water, the longer edges of said casing being provided with a continuous slot, and connecting means being in part inserted into said continuous slots so as to connect in a watertight manner said edges of the casing along a same line.

The present invention will be better understood from the following detailed description given by way of a non-limiting example, with reference to the FIGURES in the attached sheets of drawings, wherein:-

FIG. 1 shows in perspective view a cross section of a dam according to the present invention in operation upon a masonry dam.

FIG. 2 shows in perspective view a cross section of a detail of the anchorage of a dam according to the present invention.

FIG. 3 shows in perspective view a cross section of one extremity of a sheet forming the casing of a dam according to the present invention.

FIG. 4 shows the section IV-IV of FIG. 3.

FIG. 5 shows the detail V of FIG. 1, enlarged and in cross section.

FIG. 6 shows a collapsible dam according to the present invention in its collapsible state.

In the more general idea of solution of a collapsible dam according to the present invention, said dam comprises a casing of flexible, practically inextensible and impermeable material, at least one edge of which casing is provided with a continuous slot into which is inserted a part of the means for connecting said edge along a line belonging to the bed of the waterway in which the dam itself is arranged.

In FIG. 1 there is shown in perspective view a cross section of a masonry dam 1 upon which is placed a collapsible dam 2 according to the present invention.

The collapsible dam 2 used in conjuction with the masonry dam 1 comprises an inflatable sack formed by a casing 3 of flexible, practically inextensible material, which is impermeable to water.

The development of the casing 3 can be for example rectangular in case the masonry dam is substantially

rectilinear, as shown in the FIGURE 1, whereas said casing 3 can assume a more complex development when for example the masonry dam 1 upon which the collapsible dam 2 according to the present invention is arranged, has the shape for example of an arc of a circle or a polygonal shape.

Said casing 3 is formed out of one or more sheets for example of rubberized fabric connected together and having a continuous slot 4 or 5 along each longer edge (see FIG. 2).

The longer edges of the casing 3 which are provided with said continuous slots 4 and 5, are brought into contact with each other so as to obtain a closed sack out of said casing 3.

The lateral extremities 6 of said sack (only one is visible in FIG. 1) are raised with respect to the rest of the dam 2 and lie on the banks 7 of the waterway that is dammed by the dams 1 and 2.

Said lateral extremities 6 are fixed in any known manner to said banks 7 for example by means of stakes and can be either closed with a watertight sealing or not.

One part of the connecting means (described in detail further on) is inserted into said continuous slots 4 and 5, and permits the connection of said slots 4,5(and as a consequence, of the two longer edges of said casing 3) along the same line at the masonry dam 1.

Said line, as shown in FIG. 1, can be on the upper edge (crest) of the dam 1 itself, and it extends also on the inclined part of the walls of the waterway or else, it can be situated on the inclined wall facing the water

basin upstream of the masonry dam 1 itself.

In FIGURES 3 and 4 there are shown in detail a particular embodiment of a connection between adjacent sheets forming the casing 3 itself, and a particular embodiment of a continuous slot 5 (or 4) according to the present invention.

The two adjacent sheets indicated with the reference numerals 8 and 8' are connected to each other in the area comprised between the two slots 4 and 5 of the casing 3 (only partially shown in the FIGURE 3) by an oberlapping between the edge 9 of sheet 8 and the edge 10 of sheet 8'. The connection between said edges 9 and 10 is effected for example by vulcanization, by means of adhesives and/or by mechanical means, such as by stitching, clinching or by suitable rivets.

In correspondence of the slots 4 and 5 obtained by turning on themselves each end 11 of the longer edges of the casing 3 and successively fixing said ends 11 to the casing 3 itself by one of the systems just indicated above, the connection between the sheets 8 and 8' is effected by an end-to-end connection as shown in FIG. 4 and indicated with the reference numeral 13. Said connection can be obtained by means of bonding, vulcanization, welding, riveting and/or clinching or stitching. Preferably moreover a film or a sheet 12 of flexible material which is impermeable to water is placed astride the connection itself, thus acting as a butt strap and guaranteeing the watertight seal of the connection itself.

Said sheet 12 can also be of a flexible, impermeable and substantially inextensible material, in case it should have to provide mechanical resistance to the

connection apart from the seal, in particular during the phases of transporting and installing said sheets 8. In both the just mentioned cases said sheet 12 can be limited to the rectilinear area of the slot 5, or it can be extended either completely or just partially around the slot till it doubles over on itself, as shown in FIG. 4.

In the case of using sheets 8 and 8' of rubberized fabric and a sheet 12 in elastomeric material the connection can be obtained by means of vulcanization or by bonding. For this reason, and for others that will be explained later on, said sheet 12 must have a thickness that is lesser than that of the sheets 8 and 8' so as to provide for said slots 4 and 5 a thickness that is substantially constant along their entire length.

In said FIGURES 3 and 4 there can be seen moreover a part of the means for connecting the dam 2 to the dam 1 and in particular those connecting means that are inserted into the slots 4 and 5. Said connecting means inserted into the slots 4 and 5 comprise elongated elements of a material that is flexible and resistant to tension, such as for example metallic ropes or rods of flexible plastic material.

Said elongated elements have their ends connected in any known manner to the banks 7 of the waterway, and hence they extend with continuity from bank to bank.

Preferably said connecting means comprise as elongated elements metallic ropes 14 embedded in a mass 15 of elastomeric material, or anyway inserted into an elastomeric mass, such as for example a tube.

Said metallic ropes 14 are preferably multi-strand ropes into which the elastomeric material can easily

be introduced for guaranteeing a complete rubberizing of the rope itself.

For improving the rubber-to-metal bonding the ropes 14 are preferably zinc-plated and dry-cabled with a powdery lubricant. The section of the mass 15 of elastomeric material can be circular (as shown in the FIGURES), square, rectangular or polygonal.

Other elements forming part of said connecting means, not inserted in the slots 4 and 5 of the casing 3, are shown in FIG. 2. These other elements comprise clamps 16 fixed to the masonry dam 1 which enclose at least the portion of said casing 3 that comprises the slots 4 and 5.

In a particular embodiment according to the present invention said clamps 16 (two of which are shown partially in FIG. 2) comprise a plurality of anchors 17, embedded in the bed of the waterway (where for "bed" is meant the banks and the bottom of the waterway) or as shown in the FIGURES, inside the masonry dam 1. Said clamps 16 can, as an alternative, be encased within the masonry dam 1, so as to have their upper surface connected in the plane which contains the upper edge or crest of the masonry dam 1.

For guaranteeing the holding of said anchors 17, in the cement mass forming the masonry dam 1 itself said anchors 17 are provided at one end with a flat plate 18. The opposite end of said anchors 17 is connected for example by welding to a slab 19 that acts as a base for the clamp 16 itself.

One side of said slab 19 is cantilevered from the masonry dam 1 and on the upper part of said side there is fixed a spacer 2o.

Above the spacer 2o is fixed an element 21 having substantially an L-shape. Said L-shaped element 21 is fixed to the spacer 2o by the edge of its longer leg 22, while the shorter leg 23 of said L-shaped element 21 is situated in cantilever fashion from the spacer 2o and parallel to it, and it is turned towards the slab 19 and spaced therefrom.

In this way there is defined a cavity 24 that is substantially rectangular limited on its greater sides by the slab 19 and by the longer leg 22 of the L-shaped element 21 respectively below and above, whereas the lesser sides are limited respectively by the spacer 2o on the side facing towards the upstream water basin, and only partially by the shorter leg 23 of the L-shaped element 21.

In said cavity 24 there are placed the longer edges of the casing 3 having the slots 4 and 5 in such a way that said casing 3 becomes closed on itself, so as to form a sack that can be inflated with a fluid.

In said slots 4 and 5 there are present the ropes 14 embedded inside the mass 15 of elastomeric material. Thus, by blocking together, preferably in a removable way, for example with bolts 25 and nuts 26, the L-shaped element 21, the spacer 2o and the slab 19, the slots 4 and 5 of the casing 3 become blocked inside said cavity 24 in a watertight manner. An L-shaped profile 27 can also be fixed to the anchors 17 and to the slab 19, for strengthening the clamp 16 itself. Squares (not shown in FIG. 2) can finally connect together said L-shaped profile 27 and the slab 19 in the area of said slab overhanging the masonry dam 1.

Said collapsible dam 2 can be inflated by a pumping station 28 (schematically indicated in FIG. 1) with

any fluid, such as for example the water contained in the basin upstream of the masonry dam 1 itself, through a conduit that communicates with the inside of the collapsible dam 2 itself.

For allowing a rapid collapsing of the dam 2, when for example the level of the upstream basin increases rapidly owing to a flooding in the waterway in which the dams 1 and 2 are inserted, the collapsible dam 2 itself (according to the present invention) is provided with an automatic discharging device.

Said automatic discharging device (see FIGURES 1 and 5) comprises at least one hole 29 and preferably a plurality of holes 29, in the casing 3 and in particular on the side 3 of the casing 3, which is in contact with the masonry dam 1.

Said holes 29 are in communication through pipe fittings 3o with a conduit 31. Said conduit 31 is placed under the collapsible dam 2 parallel to its longitudinal axis, and it is preferably contained within the masonry dam 1.

The connection of the pipe fitting 3o to the casing 3 and in particular to the sheets 8 of said casing 3 is shown in detail in FIG. 5. The connection is obtained by means of a flange 32 which for example is circular, and a counterflange 33 in the form of a perforated disc, between which is inserted the edge 34 of the holes 29 present on the sheets 8 of the casing 3.

The flange 32, the counterflange 33 and the edge 34 of the holes 29 are blocked together for example by assemblies of nut bolts 35 (just one is shown in the FIG. 6) of which one element for example the head of the bolt becomes lodged in a circular cavity 36, while

the other, for example a nut, is housed in suitable blind holes 37 present on the outer surface of the flange 32. In the upper surface of the masonry dam 1 a seat is provided so that the upper surface of flange 32 is at the same level as it is the inner surface of the sheet 8 of the casing 3.

Upon each opening corresponding to a hole 29, a rigid netting is provided said netting being for example a grid whose center is in correspondence of the center of the hole 29 and which has a plurality of elements extending radially from the center of the grid to a base bearing on the sheet 8 at a certain distance from the hole 29. Said base must be contained in a plane different from the plane containing the radially extending elements so as to guarantee a complete discharge of the water lodged into the dam.

Said grid is preferably linked in points to the flange 32. In figure 5 is shown as a rigid grid a net 38 of welded meshes. Said net 38 is welded to the flange 32.

Said net 38 can extend for the entire length of the dam or it can be placed just in the correspondence of the holes 29.

The scope of the rigid net 38 is that of preventing any premature closing of the holes 29 by the upper sheet of the casing 3 by the effect of depressions when the outer pressure excercised by the water against the dam 2 is higher than the pressure inside it during the collapsing phases of the dam 2.

The conduit 31 can act besides as an inflation conduit for the collapsible dam 2 and hence it is connected to the pumping station 28 through a suitable union 39' provided with a suitable valve (not shown) that is per

se "known".

A further union 39 connects the conduit 31 to an S-shaped tube 4o connected by means of a flexible joint 41, or else by a ball-and-socket joint, or however by a sealed connection that allows the S-tube 4o to oscillate around a hinge so as to assume at least two positions with respect to the union 39, and as a consequence, with respect to the conduit 31.

In the particular embodiment shown in said FIG. 1 the S-tube 4o is hinged with respect to a wall of a recess 42 at a position indicated with the reference numeral 43 and present on a bank 7 of the waterway.

The automatic discharging devices can be more than one in the case of collapsible dams that are particularly long and in which it may be necessary to collapse the dam in a very short period of time.

In fact, when the level of the upstream basin increases, the pressure exercised by the water on the collapsible dam 2 also increases.

Since the water contained inside the collapsible dam 2 is in direct communication through the conduit 31 and the union 39 with the S-tube 4o, the water level inside the tube 4o raises also, and the S-tube 4o being open, as a consequence the water is in direct communication with the atmosphere.

When the water level inside the S-tube 4o raises owing to the pressure exercised by the water of the upstream basin on the collapsible dam 2 itself beyond the curve present in the tube 4o itself, the weight of the water will unbalance the tube 4o so as to cause it to rotate

around the hinge 43 and to make it assume the discharge position shown in broken lines in the FIG. 1.

In this manner the water contained inside the collapsible dam 2 will be discharged by gravity and by the thrust of the pressure of the water that was accumulated in the upstream basin. Thus there will be obtained a speedy and safe deflation of the collapsible dam 2.

In FIG. 6 there is shown a collapsible dam 2 according to the present invention in the collapsed position. In said FIG. 6 there are clearly visible supplementary means for anchoring the casing 3 for preventing vibrations when the casing 3 is collapsed. Said means foresee at least a continuous groove 44 made in the surface of the masonry dam 1 and placed in a position such as to receive the end of the casing 3 itself when it is collapsed.

Preferably, at least one further continuous groove 45 is present, again in the upper surface of the masonry dam 1, between said first groove 44 and the line along which the casing 3 is closed on itself and fixed by the clamps 16. Said continuous grooves 44 and 45 extend for the entire length of the masonry dam 1, and in correspondence of said grooves 44, 45 there are formed inside the casing 3 itself, when the casing 3 is collapsed, cavities preferably full of water, the weight of which holds down the lower part of the casing 3 thus preventing the rising of vibrations when the dam 2 is overflowed by water, while still maintaining the upper part of the casing 3 as far as possible without troughs that could impede the flow of water over the dam itself.

A collapsible dam 2 according to the present invention achieves the prefixed aims. In fact, no matter whether

a collapsible dam 2 according to the present invention is utilized as a dam for raising the level of the upstream basin of an already existing masonry dam, or else whether it is utilized for blocking by itself a waterway, so as to create in the waterway a basin upstream of the dam itself, the collapsible dams 2 according to the present invention can deflate and collapse automatically when the level of the upstream basin exceeds a certain value apart from also being perfectly impervious to water.

Moreover, the collapsible dams 2 according to the present invention are considerably simple, since their sack is formed by a casing 3 having a substantially rectangular form or a flat polyhedral form that becomes mechanically shut on itself by the clamp associated to the dam itself.

In this way there are eliminated all the longitudinal joints necessary in cases for example of dams having a tubular shaped sack.

Furthermore the particular embodiment of the means for anchoring the collapsible dam, comprising the ropes 14 embedded in a mass 15 of elastomeric material and the clamps 16, consent a better adapting of the dam 2 to the bottom and the walls of the waterway in which the dam itself is inserted, in particular if the line along which the dam 2 is fixed is not rectilinear but follows a broken line or an arc of a circle. Moreover, in particular the presence of the sheathed ropes 14 guarantees a better distribution of the stresses upon the casing 3 of the dam 2, besides guaranteeing precisely with the layer 15 of elastomeric material that clads the ropes 14 themselves, a better watertight seal, even in the presence of any eventual small differences in dimensions and disuniformities that could be had owing to the

dimensional and/or the installing tolerances, or even due to the non-rectilinear development of said line.

In fact, said elastomeric material 15 acts as a gasket that can be compressed or expanded as needed, thanks to its elasticity, thus making uniform the seal along the entire line, where the dam 2 is fixed. Moreover, the sealing is guaranteed precisely by the pull exercised by the sheets 8 which press the two sheathed ropes 14 one against the other, and against the clamp 16. For this reason said ropes 14,or more generally said elongated elements must be such as to result indeformable in the direction perpendicular to their greater dimension, so as not to be able to slip between the clamp 16 and the slab 19 placed on the masonry dam 1 itself.

The particular embodiment of the joints of the sheets 8 of the collapsible dam 2 according to the present invention consent the maintaining of a uniform thickness of the casing 3 itself in the zone where the slits 4, 5 are formed which are blocked inside the clamp 16.

As a matter of fact, the sheets 8 of rubberized fabric that can be utilized for realizing the casing 3 of the dam 2 according to the present invention have a considerable thickness in the order of centimeters. It results from this that if the particular embodiment shown in the drawing should not be adopted for the joints between the sheets 8, the thickness of the casing 3 in correspondence of the slots 4, 5 where adjacent sheets 8 are connected to each other by overlapping, would be of several centimeters and,however, it would be double the thickness of the slots 4, 5 where the sheets 8 are not connected.

As a consequence of this, there would have to be constructed different clamps for the zones correspond-

ing to the joints and/or to insert thicknesses that would make uniform the thickness by increasing the thickness also in those zones where overlapping joints are not present. Nevertheless, there would still be problems as regards an efficient and safe watertight sealing of the casing of the dam according to the present invention.

The solution according to the present invention consents instead to maintain a uniform thickness for the entire length of the casing 3 even in the zones of the slots 4, 5 corresponding to the joints of adjacent sheets 8.

As a matter of fact, by butt-end-joining two adjacent sheets 8, 8' with the interpositioning of a sheet of material that is impervious to water, there is had guaranteed both the continuity of the mechanical resistance and the continuity of the watertight seal.

Said sheet moreover, having to only provide the seal, can be very thin and in particular in the order of millimeters or even less.

Whatever has been described and illustrated regarding several particular embodiments of a collapsible dam according to the present invention, there have to be intended as comprised within the scope of the present invention all the possible variations that are accessible to a technician of the field.

In particular, within the scope of the present invention the term "collapsible dam" is meant as comprising any whatsoever type of collapsible dam, such as for example inflatable dams or manoeuvrable dams, i.e. those dams having an open casing of a substantially rectangular

form, fixed by means of one of their edges to the bottom of the waterway and with the opposite edge kept raised from the bottom so as to form a weir inside the waterway itself. By "bed" of the waterway is meant here in the present invention the bottom, such as for example the bottom and the banks of a waterway obviously in masonry, or the crest of a masonry dam, on which is placed and fixed a collapsible dam according to the present invention.

WHAT IS CLAIMED IS:

1. Collapsible dam (2) of the type comprising an inflatable sack, characterized by the fact that said sack is made of a casing (3) of flexible material practically inextensible and impervious to water, the longer edges of said casing being provided with a continuous slot (4 or 5), connecting means (16) being in part inserted into said continuous slots so as to connect in a watertight way said edges of the casing (3) along a same line.

2. Dam according to claim 1, characterized by the fact that said slots (4, 5) are obtained by turning up the ends of the longer edges of said casing (3) and connecting them to the casing itself.

3. Dam according to claims 1 or 2, characterized by the fact that said casing (3) comprises one or more sheets (8) connected to one another by means of overlapping the edges of the adjacent sheets in the zone comprised between the slots (4, 5), while in the zone of the slots the sheets are butt end joined and a sheet (12) of flexible material which is impervious to water is placed astride said butt end joint.

4. Dam according to anyone of the previous claims, characterized by the fact that said connecting means inserted in said slots (4, 5) comprise a rope (14) having its ends fixed to the two opposite banks (7) of the waterway wherein the dam (2) is arranged.

5. Dam according to claim 4, characterized by the fact that said rope (14) is metallic and that it is embedded in a mass (15) of elastomeric material.

6. Dam according to anyone of the previous claims, characterized by the fact that said connecting means comprise also a clamp (16) that embraces said slots (4, 5) containing said ropes (14).

7. Dam according to claim 6, characterized by the fact that said clamp (16) comprises a plurality of anchors (17) embedded in the bed of the waterway, slabs (19) connected to the ends of said anchors issuing from the bed of the waterway, a spacer (2o) connected to one end of said slab, and a substantially L-shaped element (21) connected in cantilever fashion by means of its own longer side to the spacer, the shorter side being turned towards and maintained spaced apart from said slab (19), so as to define a substantially rectangular cavity (24) limited on two facing sides by said longer side of the L-shaped element and by said slab and on the other two sides adjacent to the first sides, by said spacer and said shorter side of the L-shaped element.

8. Dam according to claim 7, characterized by the fact that said slots (4, 5) containing said ropes (14) are lodged in said cavity (24).

9. Dam according to any of the previous claims, characterized by the fact of comprising an automatic discharging device comprising a plurality of holes (29) in the casing (3), that communicate with a conduit (31) placed under the dam itself and an S-tube (4o) connected to the conduit by means of a flexible joint so as to be able to oscillate with respect to the conduit around a hinge (43) for deflating the dam (2) when the pressure exercised by the water in the upstream basin on the collapsible dam exceeds a certain value.

10. Dam according to claim 9, characterized by the fact of comprising a rigid net in correspondence of each hole (29).

11. Dam according to any whatsoever of the previous claims, characterized by the fact of comprising supplementary anchoring means.

12. Dam according to claim 11, characterized by the fact that said means are at least one continuous groove (44) present on the bed of the waterway in correspondence of the zone where the end of the collapsed casing (3) contacts the bed of the waterway.

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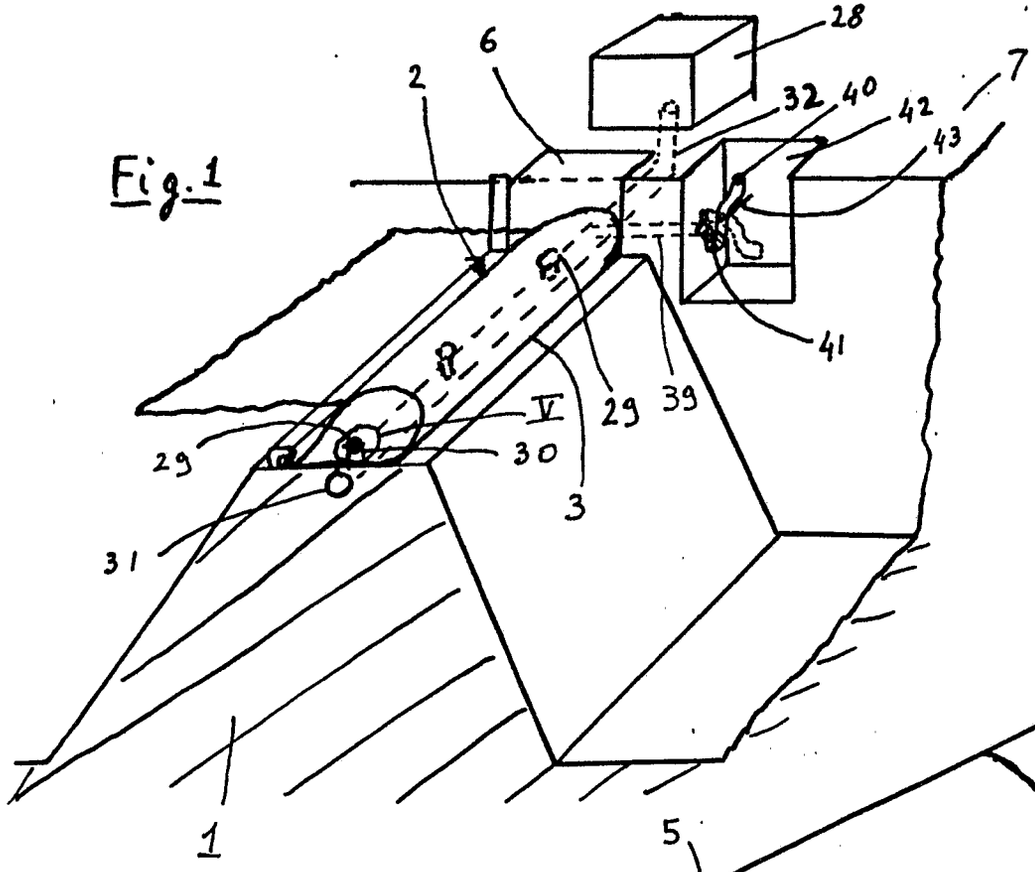

Fig.1

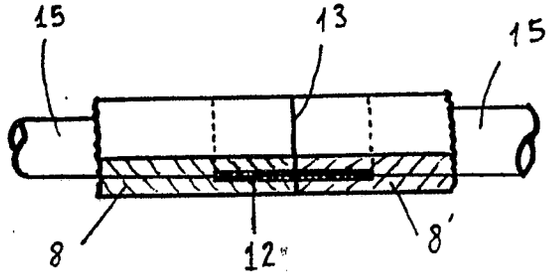

Fig.4

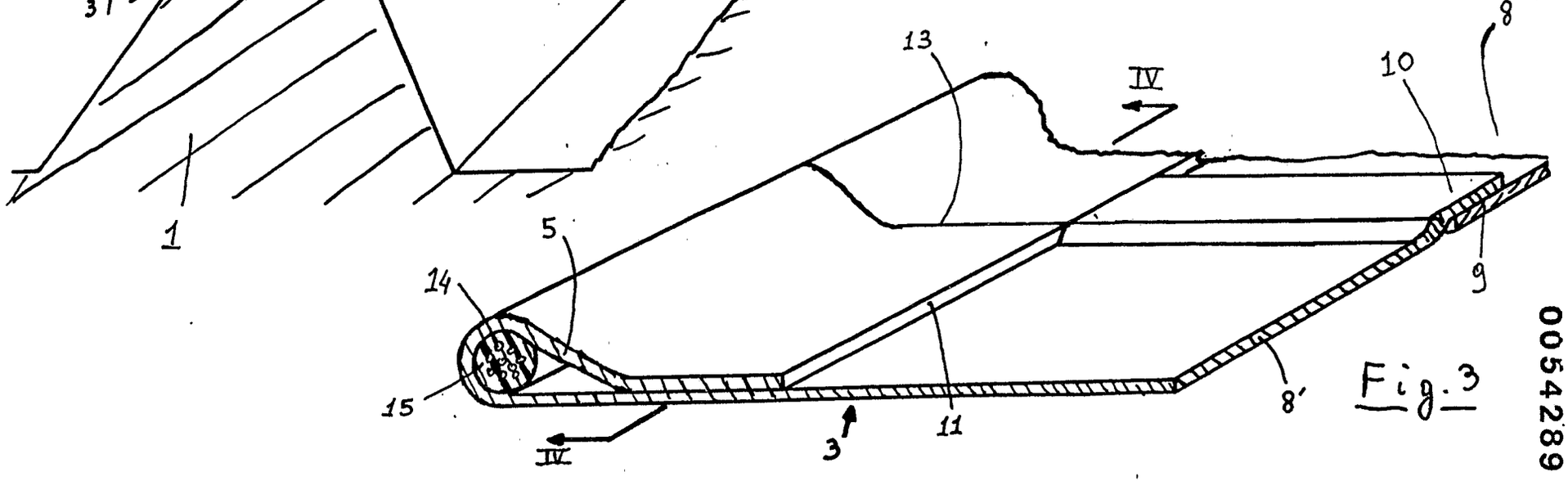

Fig.3

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Fig. 6

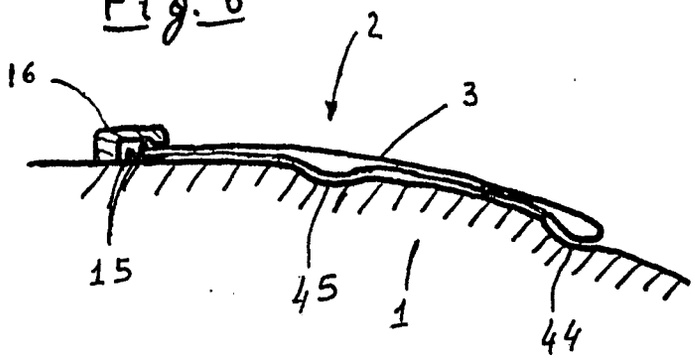


Fig. 5

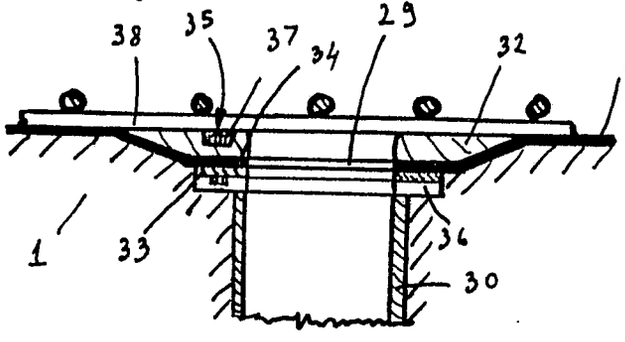
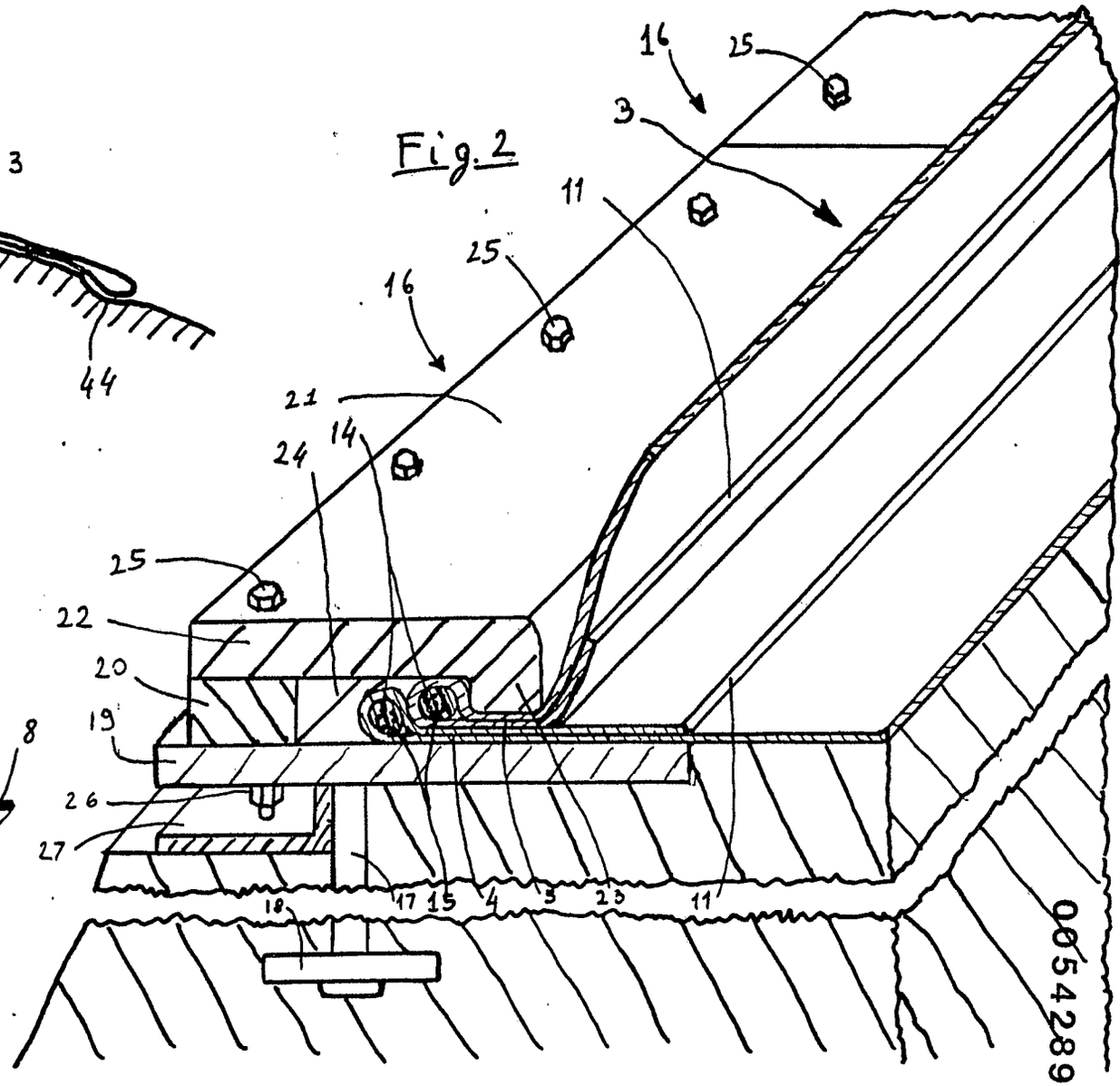


Fig. 2



European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 81 11 0420

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
X	US - A - 3 975 915 (S.G. HAW) * Column 2, lines 7-47; column 3, line 10-41; claim 1; figures 1, 2 *	1,4,5, 6,7
A	US - A - 3 355 851 (N.M. IMBERTSON) * Column 3, line 10 - column 5, line 10; figure 7 *	1,4,5, 6
A	US - A - 4 167 358 (J.A. BESHA) * Column 3, lines 8-54; figures 5, 10 *	1,4,6

CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)

E 02 B 7/00

TECHNICAL FIELDS SEARCHED (Int.Cl. 3)

E 02 B

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
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E: earlier patent document, but published on, or after the filing date
D: document cited in the application
L: document cited for other reasons

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X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	24-02-1982	CLASING

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