United States Patent [19]

Ganzinotti

[11] 3,928,980

[45] Dec. 30, 1975

[54] **INFLATABLE WATER-RETAINING BARRIER**

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[22] Filed: **Oct. 23, 1973**

[21] Appl. No.: **408,443**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 77,297, Oct. 1, 1970, abandoned.

[30] **Foreign Application Priority Data**

Oct. 6, 1969 France 69.34082

[52] **U.S. Cl.** **61/29;** 61/30

[51] **Int. Cl.²** **E02B 7/20**

[58] **Field of Search** 61/29, 30, 27, 32, 33, 61/22, 38

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Primary Examiner—Philip C. Kannan

Attorney, Agent, or Firm—Brisebois & Kruger

[57] **ABSTRACT**

This invention relates to water-retaining barrier means for a watercourse such as a river. The barrier means includes at least one flexible membrane forming an inflatable enclosure and secured to or otherwise incorporated in said enclosure as a rigid member which extends along the whole length thereof. The ends of this rigid member are arranged to bear against the banks of a watercourse in such a fashion that any stresses exerted on the barrier are transferred to the watercourse banks. In practising this invention rigid blocks may be built on the sides of the watercourse to form abutment members against which the ends of the rigid member are applied. The inflatable enclosure may be in the shape of a 'V' with the apex of the 'V' pointing upstream, and in this case two rigid members are incorporated with the enclosure the one ends of these rigid members being connected together at the apex of the V. In such a case also the inflatable enclosure may be in two parts particularly in the form of two frustra of a cone joined together by their major bases so that they also form a V shape. The invention also provides a method of positioning such a barrier means and also a method for damming a watercourse using such a barrier means.

14 Claims, 12 Drawing Figures

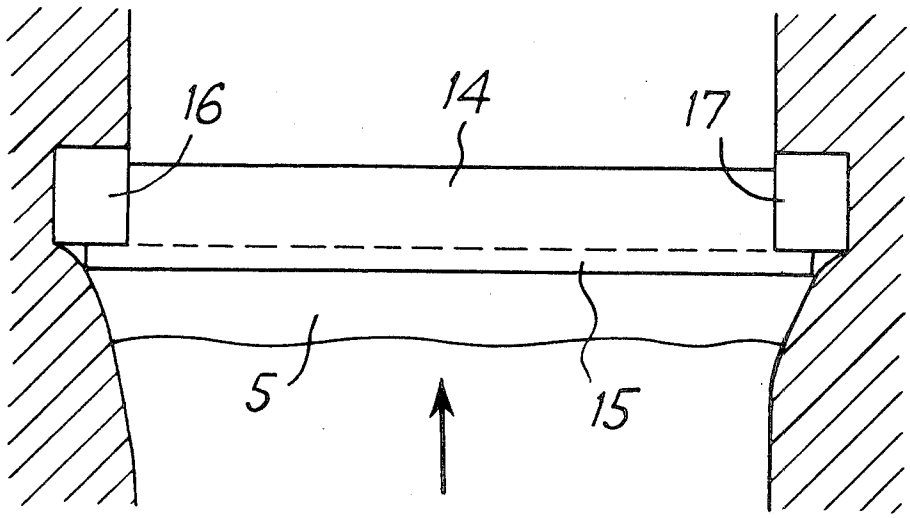


FIG. 1

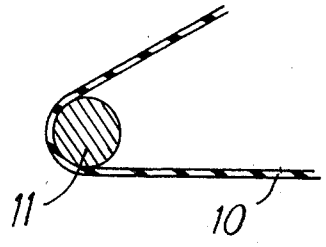


FIG. 2

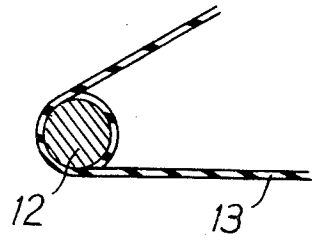
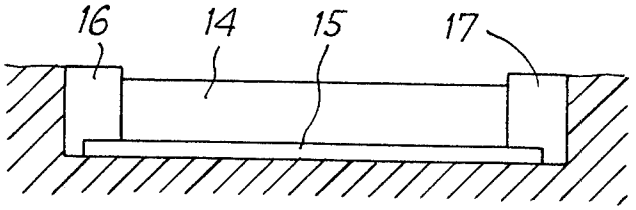


FIG. 3



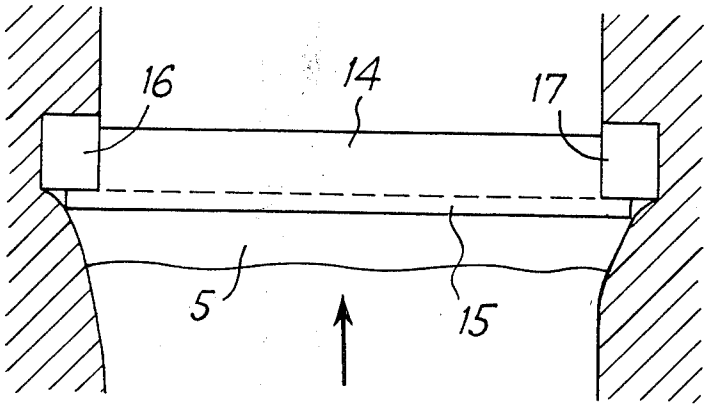


FIG. 4

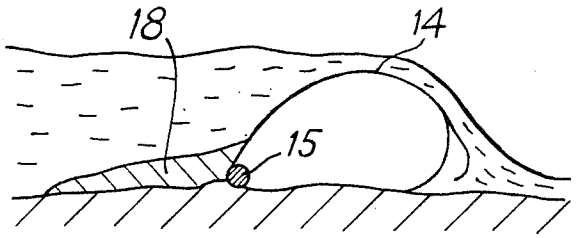


FIG. 5

FIG. 6

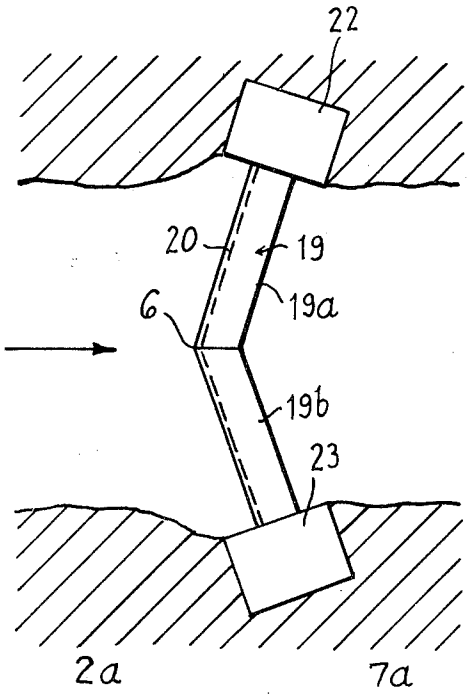


FIG. 7

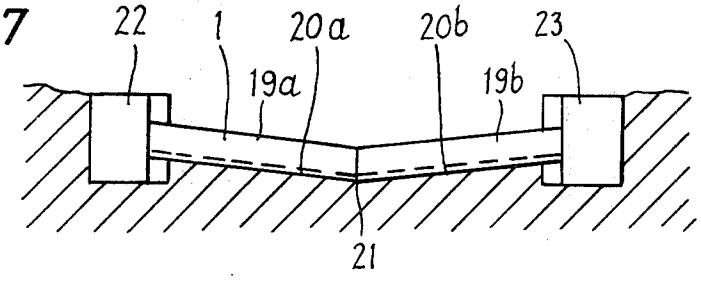


FIG. 8

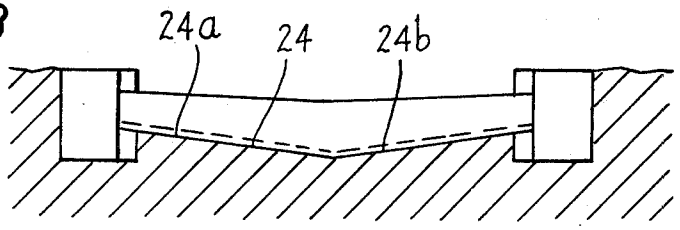


FIG. 9

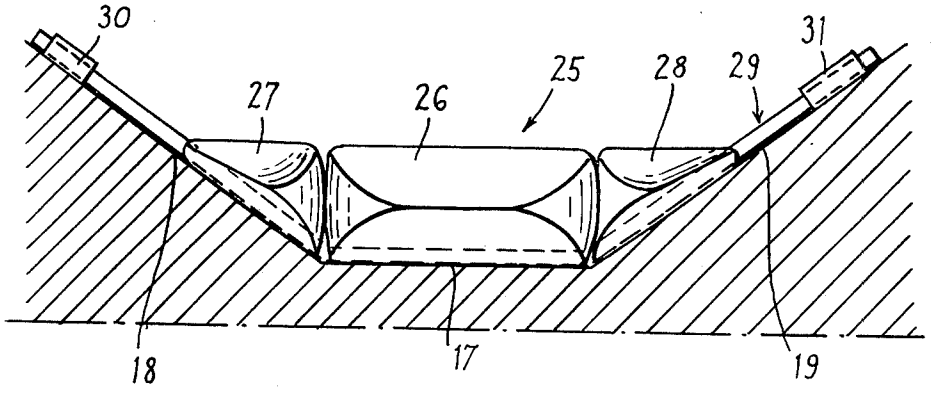


FIG. 10

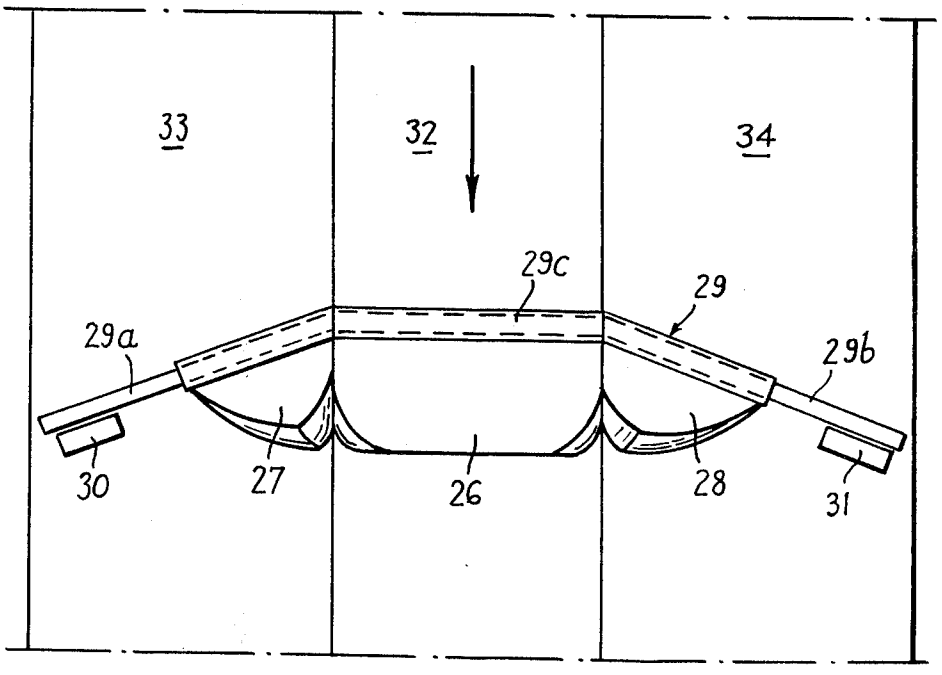


Fig.11

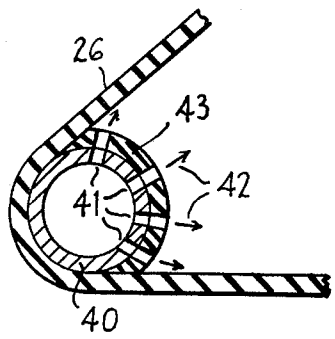
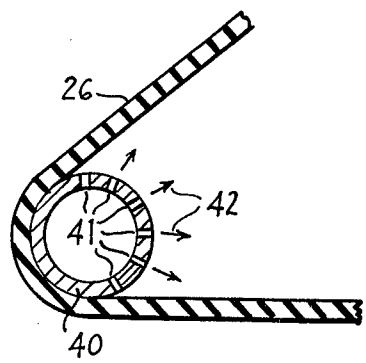


Fig.12



INFLATABLE WATER-RETAINING BARRIER

The present invention relates to inflatable water-retaining barriers, which will hereinafter be referred to simply as "inflatable barriers," and is a continuation-in-part application of application Ser. No. 77,297 filed Oct. 1st, 1970, now abandoned. Such barriers are made up of one or more flexible membranes forming the enclosure and which are used to block a watercourse such as a river. Hereinafter, the word "watercourse" is used to mean all kinds of waterway, rivers, lakes, ponds, canals and the like.

Inflatable barriers have the advantage over barriers built of masonry that they can be more easily and quickly constructed. Furthermore, the fact that they are inflatable enables the level of the watercourse to be varied in a precise way.

Nevertheless, despite this major advantage, inflatable barriers are seldom used; this is due to the fact that the difficult and extensive operations required to fix them in position makes their installation a long and costly operation.

Inflatable watercourse barriers currently proposed or in use, such as those described in U.S. Pat. Nos. 3,173,269 and 3,264,474, are in fact simply formed by water-tight inflatable enclosures which are deformable longitudinally and which are of low mechanical strength. The consequence of this is that, so that the enclosures will not deform longitudinally and so that they will resist the hydrostatic and hydrodynamic stresses to which they are subjected, it is necessary for them to be fixed to the bed of the river at closely spaced points, which makes it necessary to construct a masonry block or apron on the river bed to which a large number of members used to attach the enclosure are anchored. The need to construct a masonry block, which is a long, costly and awkward job (the watercourse bed has to be drained temporarily) means that in most cases the preference is for building up the block of masonry and producing a conventional barrier rather than producing an inflatable barrier. This drawback of having to construct a masonry block remained a fundamental one no matter what improvements were previously put forward, such as those whose object was improved operation of the barrier or better protection for the inflatable enclosure, such a one being that which consisted in constructing a beam on the river bed which was situated upstream of the enclosure so that the deposits which build up on the upstream side of the inflatable enclosure could easily be removed without damaging the said enclosure.

It is thus a principal object of the invention to enable inflatable barriers to enjoy wide use, without firstly constructing an apron such as a masonry block by which the enclosure is fixed to the river bed by this means at a large number of points.

Watercourse barriers according to the invention comprise one or more inflatable enclosures in the same way as barriers existing at present, but the inventive enclosure or enclosures are all fastened to a rigid member which extends along the whole length of the said enclosures and is intended to be supported by the banks of the watercourse, the ends of the rigid member being laid on said banks. The rigid member, such as a metal bar or tube, prevents the enclosures from deforming longitudinally; at the same time, it accepts

strains transmitted to it by the inflatable enclosure and transmits them, in turn, to the banks.

Thus, the result of the way in which the barrier in the invention is formed is that the mechanical stresses exerted on the barrier are transferred to the rigid member and then to the banks. If the latter are insufficiently firm or strong, they may be strengthened by blocks of masonry the production of which presents no difficulty. Another result of the way in which a barrier according to the invention is formed is that it may easily be fitted to or detached from such blocks. For example, to install such a barrier, it is sufficient to inflate it with air until it floats, to position it on the river upstream of the abutments, to let it be carried along by the current under guidance until the rigid member rests against the abutments and then to let out the air and to fill it with water until it sinks.

Other objects and advantages will appear in the course of the ensuing description which is based on non-limiting embodiments of the invention and refers in particular to the accompanying drawings, in which:

FIG. **1** is a cross-section through the upstream part of the inflatable enclosure of a barrier according to the invention,

FIG. **2** is a cross-section through the upstream part of a second embodiment of inflatable enclosure,

FIG. **3** is an elevation view of the upstream part of a barrier when in place, the watercourse being assumed to be dry,

FIG. **4** is a plan view of the barrier shown in FIG. **3**,

FIG. **5** is a cross-section of the barrier shown in FIG. **3**,

FIG. **6** is a plan view of another embodiment of barrier,

FIG. **7** is a view of the upstream part of yet a further embodiment of barrier, the watercourse being assumed to be dry,

FIG. **8** is a view of the upstream part of yet another embodiment, the watercourse being assumed to be dry,

FIG. **9** is a cross-section as seen from the front of a further embodiment of barrier when positioned in a channel of trapezoid cross-section,

FIG. **10** is a view from above of the barrier shown in FIG. **9**, and

FIGS. **11** and **12** are cross-sections through the upstream parts of two modifications of the barrier means of FIGS. **9** and **10**.

Referring now to the drawings, barriers according to the invention are mainly formed by one or more inflatable enclosures and by a mechanically strong rigid member which is secured to the inflatable enclosure or enclosures and extends along its whole length. The rigid member itself may be formed by a plurality of rigid members connected together. The inflatable enclosures, the nature of which per se forms no part of the invention, may, for example, be formed by an inextensible or practically inextensible sheet of elastomer which forms a tube closed at both ends. The rigid member, which is shown in the drawings as a solid cylinder, may also be a tube or a profiled member and may or may not be made of metal. In addition to having the requisite mechanical strength, it should also be sufficiently rigid not to curve appreciably under the stresses and strains to which it is subject when the barrier is in use. The member thus prevents the enclosure from deforming under the action of the current and accepts the strains to which the enclosure is subject; as will be

seen below, it transfers these strains to the banks via the abutments.

In FIG. **1**, there is shown a barrier in which a rigid member **11** is located inside an inflatable enclosure **10**. In FIG. **2**, the rigid member is shown at **12** and is likewise located inside the enclosure, here shown at **13**, but is located within a tube.

In the case of the embodiments shown in FIGS. **3, 4** and **5**, the barrier is principally formed by an inflatable enclosure **14** fitted with a rigid member **15** the ends of which are positioned to bear against the watercourse banks via two masonry blocks **16** and **17**. To prevent undermining there may be positioned upstream, a flexible mat **18**, made of rubber for example (FIG. **5**), or aggregate material held in place by the barrier and which may extend both upstream and downstream of the barrier.

A barrier of this type, the installation of which requires no masonry constructions on the river bed, may be installed easily after being constructed in the factory. It will especially be noted that in the case of prior art barriers fixed to an apron, the enclosure is generally fixed to the apron by means of nuts and bolts, the effect of which is to cause high stresses at these attachment points. In contrast, in the case of barriers according to the invention, these stresses are distributed along the whole length of the rigid member and the strain of holding the barrier in position is transferred laterally to the two abutments.

In the embodiments shown in FIGS. **6** and **7**, the inflatable enclosure is shown at **19** and is in the shape of a V the apex of which points upstream and rests on the bed of a watercourse which has been roughly prepared to give it a V-shaped outline. The inflatable enclosure **19** is in two parts **19***a* and **19***b* incorporates a rigid member **20** which is formed by two parts **20***a* and **20***b* which are connected together at **21** at the apex of the V. At the other end, parts **20***a* and **20***b* bear against the masonry blocks or piers **22** and **23** on the banks. Thus, the enclosure parts **19***a* and **19***b* and mutually dependent and press one against the other when they are inflated. A barrier of this type operates in the same way as well known vaulted or arched barriers; in addition, the strains to which it is subject tend to press it against the bed. As in the embodiment of FIGS. **3, 4** and **5**, aggregates (not shown in FIGS. **6** and **7**) may be laid out upstream to give an improved seal and to prevent undermining. It is also possible to install a mat, as it is in all cases.

In the embodiment shown in FIG. **8**, the inflatable enclosure is also fitted with a rigid member **24** formed by two parts **24***a* and **24***b* which are connected together and bear against the banks, but instead of being formed by two cylinders coupled together, it is formed by two frustra of a cone joined together by their major bases. This arrangement is particularly useful when the outline of the river is V-shaped and enables the height above water to be greater at the sides than at the centre.

In general terms, in all embodiments in which the outline of the top of the barrier is V-shaped (FIG. **7**), at the apex of the V the depth of water spilling over is greater and the current is stronger than in barriers the top of which is horizontal. This enables floating bodies or the like to be drawn along in a more satisfactory manner due to the stronger current and greater depth.

In the enbodiment shown in FIGS. **9** and **10**, the inflatable barrier **25** is formed by three inflatable enclosures **26, 27** and **28** which are connected to a rigid, mechanically strong member **29**. This member is formed in three parts **29***a*, **29***b* and **29***c*, with the two outer parts **29***a* and **29***b* being hinged to the central part **29***c*. The shape of the member **29** thus corresponds to the cross-section of the channel in which it is positioned. Its two ends bear against abutments **30** and **31** fixed to the banks of the watercourse, the abutments **30** and **31** being downstream of the central part **29***b* of the rigid member **29**. Since the lateral parts **29***a* and **29***b* are at an angle, the rigid member **29** can be fixed in position without the necessity for work having to be undertaken to make the banks vertical.

The inflatable enclosures **26, 27, 28** are fixed to parts **29***a*, **29***b* and **29***c* respectively of member **29**. They are mutually independent and the shape of the lateral enclosures **27** and **28** is somewhat like that of a tetrahedron, the apex of which is situated close to the abutments **30** and **31** and the base of which bears against the sides of the central enclosure **26** so as to seal the barrier.

It is possible to alter the amount of flow by inflating or deflating only one of the enclosures. In particular, if the central enclosure **26** is deflated while enclosures **27** and **28** remain inflated, an increase in flow is brought about without causing folds in the lateral parts of the barrier since these are formed by enclosures **27** and **28** which remain inflated. The same applies when it is the central portion **26** which is inflated. It is here observed that it is the formation of these folds in prior art barriers which causes the barriers to wear rapidly.

The watercourse in which the barrier in FIGS. **9** and **10** is positioned is an irrigation channel, the cross-section of which is trapezoid, as is often the case. These channels, which are generally constructed from concrete, comprise a flat central section **32** and two lateral sections **33** and **34** which form the banks.

The length of the central enclosure **26** of the barrier is equivalent to the width of the central section **32** of the channel and the two other enclosures **27** and **28** are then matched to the slope of the lateral sections **33** and **34** of the channel.

As was stated above, the lateral parts **29***a* and **29***b* of the rigid member **29** are preferably angled upstream so that the pressure of water against the barrier presses the member **29** against the abutments **30** and **31.**

The abutments **30** and **31** are positioned at the top of the lateral sections **33** and **34** of the channel. Since this location is easily accessible by reason of the fact that it is out of the water the barrier has the advantage of being capable of being easily installed or removed.

Watercourse barriers according to the invention are of interest to the user in that they can be set up or dismantled with astonishing ease. Because the barrier is effectively held in position by simple abutments against which the ends of the rigid member are merely applied, the barrier is simple to install and, especially where the embodiment shown in FIGS. **10** and **11** is concerned, requires little special work to be done to prepare the bed or drain the watercourse.

To install a barrier according to the invention, the barrier, formed by inflatable enclosures connected to the rigid member, is placed in the water and the enclosures are inflated with air so that they float on the water and can be extended across the watercourse or river so as to be ready for installation. Once this operation of setting the barrier afloat has been performed, upstream of the point at which the barrier is to be installed, the

barrier is carried along to the point in question by the current of the watercourse. In order that the barrier shall not be moved along by the current in an uncontrolled way, guys are connected to it and operations take hold of these guys whereby the movement can be easily controlled as the barrier is carried along by the water. Then, when the barrier is substantially at right angles to the point at which it is to be installed, the water is prevented from carrying it further by the operations pulling on the guys, and the air which was keeping the enclosures inflated, is let out and replaced by water so that the barrier sinks and comes into position on the river bed. As soon as the ends of the rigid member have been suitably placed to rest against the abutments, the piers or the banks, the barrier can be considered to be installed.

It is likewise very simple to remove the barrier; the water contained in the inflatable enclosure or enclosures in expelled and replaced by air, which buoys them and the rigid member up to the surface of the water and makes recovery remarkably easy, as will be appreciated.

Inflating fluid may be fed into the barriers of the invention using known apparatus, by means of openings made in the inflatable enclosures. However, because of the presence of a rigid member fastened to the inflatable members and forming a permanent part thereof, the barriers may be supplied through such rigid member, which may for this purpose, as shown in FIGS. **11** and **12**, take the form of a rigid pipe **40** in which radially oriented openings **41** are made discharging into the interior of the enclosures in the direction of the arrows **42**. One of the ends of the pipes is closed off, while the other is connectable to a source of inflating fluid. In FIG. **11** the pipe **40** inside the enclosure **26** is located within a tube **43**.

I claim:

1. A water retaining barrier means of unitary structure for a watercourse, said water retaining barrier means having upstream and downstream sides and comprising:

a. at least one flexible membrane forming at least one inflatable enclosure,

b. a rigid, mechanically strong, member of which at least a substantial portion is disposed within, and secured to, said at least one inflatable enclosure in a position to lie at least across the bed of the watercourse and the upstream side of the barrier means, said rigid member extending along the whole length of said barrier means, whereby when said barrier means is positioned in the watercourse, the ends of said rigid member bear freely against the banks of the watercourse and any stresses on the barrier means are distributed along the whole length of the barrier means and thereby the strain of holding the said barrier means in position is transferred laterally to the banks of the watercourse.

2. The combination of a barrier means according to claim **15**, positioned into a watercourse and two rigid abutments incorporated into the banks of the watercourse, said rigid mechanically strong, member lying at least across the bed of the watercourse with the ends of said rigid member bearing freely against the rigid abutments, whereby the stresses on the barrier means are distributed along the whole length of the rigid member and thereby the strain of holding the barrier means in position is transferred to the two rigid abutments incorporated in the watercourse banks.

3. A barrier means according to claim **1**, wherein a flexible mat is secured to said at least one enclosure in a position to cover the bed of the watercourse immediately adjacent said at least one enclosure.

4. A barrier means according to claim **1**, for use in a watercourse having sloping banks, which comprises a central enclosure arranged to bear against the bed of the watercourse, and two lateral enclosures which are arranged to bear against the watercourse banks and have a tetrahedron-like shape having a base which presses against the sides of said central enclosure and wherein said rigid member is made up of three parts consisting of a central part disposed inside and secured to said central enclosure and two lateral parts of which at least a portion is disposed inside and secured to a respective said lateral enclosure, said two lateral parts being hinged to said central part to permit said lateral enclosures to move upwardly and thereby bear against the watercourse banks downstream of said central part of said rigid member and yet remain rigid in the direction at right angles to the direction of upward movement of said lateral enclosures.

5. A barrier means according to claim **1**, wherein said rigid member comprises a tube defining a plurality of radially oriented openings for discharging into said at least one enclosure for inflation thereof.

6. A method of positioning a barrier means of unitary structure according to claim **1** into a watercourse, which method consists in placing said barrier means in the water upstream of the point at which it is to be installed, and inflating said enclosure with air to float said barrier means on the water in an extended position, allowing said barrier means to be carried along by the current of the water until it is substantially at right angles to the point at which it is to be installed and allowing the ends of said rigid member bear freely against the watercourse banks, and then sinking said barrier means to the bottom of the water by replacing the inflating air with a liquid.

7. A method of removing a barrier means according to claim **1** from a watercourse into which said barrier means has been positioned according to the method of claim **6**, which method of removing consists in replacing said liquid in said enclosure by air, thus enabling said barrier means to float on the surface of the water in the watercourse, thus rendering said barrier means readily attainable and removable.

8. A barrier means according to claim **1**, wherein in plan view, the upstream side of the inflated barrier means has side portions which are inclined towards each other in the direction from the ends of the rigid member towards its centre and in the upstream direction and wherein said rigid member extends along said side portions and is of similar shape to said upstream side of said barrier means.

9. A barrier means as claimed in claim **8**, wherein in cross-section, the bottom surface of the inflated barrier means has side-portions which are inclined towards each other in the direction from the ends of the rigid member towards centre of the bottom of the barrier means and in the watercourse bed direction.

10. A barrier means as claimed in claim **1**, wherein in cross-section, the bottom surface of the inflated barrier means has side-portions which are inclined towards each other in the direction from the ends of the rigid

member towards centre of the bottom of the barrier means and in the watercourse bed direction.

11. A barrier means according to claim **1**, wherein, inside said at least one enclosure, said rigid member is intimately surrounded by flexible membrane.

12. A barrier means according to claim **1**, wherein, inside said at least one enclosure, said rigid member is located within a tube.

13. A barrier means according to claim **1**, wherein the ends of said rigid member project outwardly from inside of and beyond the confines of said at least one inflatable enclosure.

14. A method of damming a watercourse, which method consists in taking a barrier means of unitary structure that comprises at least one inflatable enclosure and rigid stiffening member of which at least a substantial portion is disposed within, and secured to said at least one enclosure in a position to lie at least across the bed of the watercourse, said rigid member extending for the whole length of the barrier means, placing said barrier means in the watercourse to be dammed, upstream of the damming position, inflating said at least one enclosure with air causing it to float on the surface of the water in said watercourse, allowing said barrier means to travel downstream to said damming position, deflating said at least one enclosure, filling said at least one enclosure with water to cause it to sink to the bottom of said watercourse with the ends of said rigid stiffening member bearing freely against the banks of said watercourse, to retain said barrier means at said damming position.

* * * * *