PATENT SPECIFICATION (11) 1 572 696

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(21) Application No. 48095/75 (22) Filed 22 Nov. 1975
(23) Complete Specification Filed 18 Nov. 1976
(44) Complete Specification Published 30 Jul. 1980
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E1B 15C4

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(54) INJECTION-SEALABLE WATER-STOP AND METHOD OF INSTALLING SAME

(71) We, VREDESTEIN N.V. formerly known as INTERNATIONAL B.F. GOODRICH-EUROPE B.V., a Dutch body corporate, of Oude Haagweg 128 The Hague, The Netherlands, do hereby declare the invention, for which we pray that a patent may be granted to us, and the

ERRATUM

SPECIFICATION NO 1572696

Drawings
On sheet of COMPLETE SPECIFICATION drawing *delete* FIG 4

THE PATENT OFFICE
5 August 1980

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for example, are driven and casings installed therein in section by section manner with the necessity to seal each succeeding section to the preceding section. Large concrete dams are also poured in sections with expansion joints dispersed throughout the massive structure and sluices, flumes, tunnels, drains, passageways and other openings incorporated requiring sealing between the latter and the concrete of the dam proper. There are many other structures of concrete requiring expansion joints and/or seals between sections of the concrete themselves, or between the concrete and another structure of the same or different material.

Water-stops of elastic materials heretofore have been of two types, namely passive types and injection-sealed types. An example of the passive type is described and claimed in British Patent Specification No. 1,482,123 wherein the water-stop, which is of rubber, artificial rubber or other deformable material, has a flat middle section, to each side of which is secured a strip of elastic cellular material. On either end of such mid-section are side wings (end anchor portions) provided with anchorage means projecting out of the wings, the anchorage means providing the water tightness. Such

of the other side of the supposedly sealed joint. This effect is increased quite considerably when the hydrostatic head of water on the joint is greater than about 5 or 10 meters or when the concrete (as in a dam exposed to sunlight) is subject to significant expansion, contraction or other form of movement around the joint. Under any of these conditions, the elastic material of the water-stop is extended and the elastic anchor portions may either be slightly reduced in size or at least the contact pressure between the anchors and the concrete may be reduced slightly, leaving a potential area of leakage, especially when the sealing strips are placed in those regions where imperfect concrete matrix exists.

It has thus been recognised that better sealing around the anchor regions of elastic water-stops was needed. The injection-sealed type of water-stop has been described in West German Patent Specification No.

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(71) We, VREDESTEIN N.V. formerly known as INTERNATIONAL B.F. GOODRICH-EUROPE B.V., a Dutch body corporate, of Oude Haagweg 128 The Hague, The Netherlands, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

The present invention relates to an injection-sealable water-stop adapted to be installed in concrete structures such as dams, tunnels, water conduits, sewers, buildings, etc, and to a method of installing the water-stop in such structures.

Water-stops are sealing elements usually made of elastically deformable materials with or without integral elastic and/or metal anchor portions, which water-stops are installed in concrete structures to seal joints, permit expansion and contraction, seal the concrete to other structures, etc. Tunnels, for example, are driven and casings installed therein in section by section manner with the necessity to seal each succeeding section to the preceding section. Large concrete dams are also poured in sections with expansion joints dispersed throughout the massive structure and sluices, flumes, tunnels, drains, passageways and other openings incorporated requiring sealing between the latter and the concrete of the dam proper. There are many other structures of concrete requiring expansion joints and/or seals between sections of the concrete themselves, or between the concrete and another structure of the same or different material.

Water-stops of elastic materials heretofore have been of two types, namely passive types and injection-sealed types. An example of the passive type is described and claimed in British Patent Specification No. 1,482,123 wherein the water-stop, which is of rubber, artificial rubber or other deformable material, has a flat middle section, to each side of which is secured a strip of elastic cellular material. On either end of such mid-section are side wings (end anchor portions) provided with anchorage means projecting out of the wings, the anchorage means providing, the water tightness. Such a water-stop works very well when the concrete in the region of the anchor ends is perfect and is in firm contact with the anchors. However, air bubbles can be trapped in the concrete around the anchor portions, aggregate can settle and/or collect around the anchors during the pouring operation, or cracks and fissures can form around the anchor-portions, including the metal end strips, by shrinkage effects during the setting or early stages of the cure of the concrete. When any of these possibilities happen, water can permeate the concrete along one side of the water-stop, get around the anchors and permeate the region along the other side of the water-stop to drip out of the other side of the supposedly sealed joint. This effect is increased quite considerably when the hydrostatic head of water on the joint is greater than about 5 or 10 meters or when the concrete (as in a dam exposed to sunlight) is subject to significant expansion, contraction or other form of movement around the joint. Under any of these conditions, the elastic material of the water-stop is extended and the elastic anchor portions may either be slightly reduced in size or at least the contact pressure between the anchors and the concrete may be reduced slightly, leaving a potential area of leakage, especially when the sealing strips are placed in those regions where imperfect concrete matrix exists.

It has thus been recognised that better sealing around the anchor regions of elastic water-stops was needed. The injection-sealed type of water-stop has been described in West German Patent Specification No.

1,116,369. In this type of known water-stop, one or more tubes are integrally molded in each of the enlarged elastic anchor portions and, after the concrete is poured, a fluid self-setting or self-curing material is injected into the tubes under pressure which is maintained until the concrete sets and the fluid material solidifies and becomes solid in the tube. The pressurized expansion of the anchor portions is supposed to compensate for the shrinkage of the concrete. While the latter occurs, such expansion cannot fill porous regions of concrete around the anchors nor can it effectively seal cracks, fissures or other imperfections which penetrate the concrete matrix to a significant depth away from the anchor. Permeation leakage of water under pressure can still occur around the ends of the expanded water-stop.

Surprisingly, it has been found that the above disadvantages of existing water-stops, and especially of elastic water-stops, can be overcome by an elastic water-stop which has incorporated therein a displaceable and/or rupturable element attached to the sealing elements and especially to a metal sealing element, such displaceable or rupturable element being adapted to being ruptured, displaced and/or compressed by the injection under pressure of a fluid form of a self-curing or self-setting polymeric or otherwise setable material whereby the fluid material escapes into the concrete matrix, filling and sealing any imperfection therein. After *in situ* cure or setting in such imperfections of the injected material occurs, permeation leakage of water around the water-stop seals is prevented.

According to one embodiment of the present invention there is provided a water-stop for concrete structures composed of elastically-deformable rubbery material and comprising a substantially flat middle portion and enlarged side wing anchor portions provided with metal and/or elastic sealing means, a pad of elastically-deformable material, for example elastically deformable sponge material, being attached to at least one surface of each side sealing means and attached, preferably substantially normal, to each said pad there being at least one injection tube of sufficient length to reach the outside surface of the concrete in which the water-stop is to be installed, each said injection tube being sealed by its respective pad. Each injection tube may be attached to its respective pad by a clamp which is preferably made of spring wire.

Preferably a strip of elastically-deformable sponge material is secured to the flat middle portion.

According to another embodiment of the present invention there is provided a method of installing a water-stop of the present invention in a concrete structure, which comprises placing the water-stop in the desired position, pouring the concrete and, after the concrete has set, injecting a fluid curable or settable material to improve the seal between the concrete and sealing means, the fluid material being injected so as to rupture or displace the pads of elastically-deformable material and admit the fluid material to the concrete material in the region of the elastic and/or metal sealing means. Preferably, the elastically-deformable material of the pads is an elastic sponge material adhered to the metal and/or elastic sealing means attached to the anchor portions.

The metal and/or elastic sealing member is preferably in the form of a metal strip.

The injection tube preferably is attached substantially normal to and temporarily sealed by the elastically-deformable material of the pad. When installed in a concrete structure, the tubes project out of the concrete and can be attached to a pumping circuit which injects a fluid, self-curing or setting form of material through the tube or tubes, either rupturing or compressing and displacing the sponge overlying the tube end allowing fluid to escape into the concrete matrix surrounding the elastically-deformable material pad and the sealing member, filling any air bubbles, cracks or fissures in the concrete surrounding the member and effectively completing the seal. Such tubes preferably are installed at intervals along a continuous sponge strip or pad affixed along the length of at least one side of each of the sealing members such that the pressurized fluid can permeate along-side, through and on all sides of the sponge, reaching all or nearly all of the concrete imperfections as may occur along that side of the strips.

The sponge pad itself is thus, after cure of the fluid to the solid state, encased in solid elastic material and is itself not a weak point for permeation leakage of water.

Preferably the material of the injection tube seal pad is a closed-cell sponge form of rubber, synthetic rubber or of a polyurethane elastomer. The fluid form of injection material also is preferably a liquid polyurethane mix or liquid epoxy resin composition formulated to self-cure with sufficient pot-life, preferble a pot-life of at least one hour, and most preferably between one and three hours, such that the material can be mixed and injected while remaining in liquid form under pressure in the concrete structure for a time sufficient to permit complete penetration along the length of the pad and the sealing element and reach all imperfections of the concrete matrix in the immediate proximity of each of the sealing elements. After the fluid

congeals and solidifies, it effectively seals the tubes, which can be cut off for appearance sake.

If desired, and if the water-stop is to be utilised in a concrete structure in which convenient access during installation may be had to both sides of the water-stop, elastically-deformable material pads and injection tubes can be attached to both sides of the sealing elements or strips so that injection sealing on both sides of each of the anchor elements can be achieved.

The design of the water-stop of the present invention requires no expensive or special fabrication technique, and does not add unduly either to its cost of manufacture or of its cost of installation.

The water-stop is supported in the concrete form and the injection tubes subsequently attached for example by spring clamps together with any needed protective supports, with the ends of the tubes brought out of the form to a convenient location for attachment to the injection system. The injection should employ a pressure sufficient to compress, crush or displace elastically-deformable material pads, preferably 5 to 10 kgf/cm^2, and should occur after pouring of the concrete, and preferably after the concrete has set and/or cured to a point where the greater part of the concrete shrinkage has occurred. Obviously, the injection preferably should also occur before the water-stop is exposed to a hydrostatic head of water.

The present invention will now be further described with reference to Figures 1 to 4 of the drawings accompanying the Provisional Specification, Figure 5 constituting the accompanying drawing, in which:

Figure 1 is a longitudinal section through an assumed vertical joint in a vertical concrete structure, the Figure showing a water-stop of the present invention installed, but not yet injection sealed;

Figure 2 is an enlarged view of one of the edges of the water-stop of Figure 1 showing a spring clamp for securing the injection tubes to the foam pads;

Figure 3 is a partial view of one edge of the water-stop of Figure 1 somewhat enlarged and showing, after injection sealing, penetration of a fluid elastomer into several aggregate collections in the vicinity of the metal anchor strip and into a void in the concrete possibly caused by deflection or movement of the metal anchor strip after partial setting of the concrete had occurred, and

Figure 4 is a partial view, also in horizontal section, showing how the sealing strip of this invention accommodates itself to expansion and/or other relative movements of the two concrete edges of the joint.

Figure 5 is another example of a water-stop according to the invention in a longitudinal section through an assumed vertical joint in a vertical concrete structure.

In Figure 1, the water-stop 1 of the present invention is shown installed to seal a vertical joint between two walls 2 of a vertical concrete structure. This Figure, however, shows the joint as it appears after the concrete has been poured, but before the injection to the sealing strip has occurred. The water-stop 1 comprises a strip of rubber or of elastic plastics material having a substantially flat mid-section 3 of substantially rectangular cross-section on either outer edge of which is an enlarged anchor section 4 of bulbous or pear shape and a substantially flat metal sealing strip 5 carried by and integrally and adhesively secured in an edgewise slot in each elastic anchor section 4. Since the water-stop 1 is continuous in a direction normal to and out of the plane of the paper in Figure 1, the water-stop 1 may be seen to have a thin mid-section 3 and substantially thicker outer edges 4 each of which terminates in a continuous metal sealing strip 5. At about the middle of mid-section 3, and on each side thereof there are provided a pair of integral, juxtaposed shoulders 6 or retainers between each pair of which is adhesively secured a continuous strip 7 of elastic sponge material which co-operates to seal the form for the concrete, preventing loss of concrete "milk" in the area of the water-stop during and after the pouring. The retainer shoulders 6, moreover, provide a thickened area preventing damage to the thin mid-section 3 of the water-stop during flexing. (See Figure 4).

As appears in Figure 1, near the outer edge of each of the metal sealing strips 5 there is adhesively secured a continuous strip or pad 8, also of an elastic sponge material which may be a vulcanised rubbery material, foamed polyurethane or the like. To each such pad 8 there is mounted a hollow tube 9 in open communication with and sealed by the material of pad 8. It should be understood that one or more of tubes 9 can be so mounted at intervals along the vertical length of each pad 8 to permit sealing of the entire outer edge of each metal sealing strip 5.

As shown in Figure 2, the tube 9 can be mounted to the pad 8 by a spring clamp 10 which has a tight fitting circular loop 11 into which the tube 9 having a slightly flared end portion 9a is fitted and retained. An enlarged spring clip or loop 12 passes over the end to the other side of the metal sealing strip 5. The end 13 of circular loop 11 is bent sharply at right angles so as to be pressed by spring action into the sponge pad 8 to assist in preventing displacement of the clamp during the concrete pouring operation.

It should be understood that means other than spring clamp 10 can be employed to secure and hold tubes 9 in contact with the pads 8.

The spring clamp 10 could be a double clamp having a circular loop 11 on each of its ends so as to secure a second tube 9 to a second sponge pad 8 on the opposite side of each of the sealing strips 5 where it is desired to injection seal both sides of each of the strips 5.

In Figure 3 the water-stop is shown after the injection sealing step has been performed. For clarity no mode of attaching the tube is shown in the Figure. Note several occlusions 14 of aggregate have been filled with solid injected material as also has a shrinkage fissure 15 located near the end of metal sealing strip 5 which somehow may have been bent or deflected during or just after the concrete pouring step causing the fissure 15 shown. Note also that fluid injection material also has penetrated for a small distance along the underside of metal sealing strip 5 on both sides of foam pad 8 which after curing or setting effectively encases the pad 8 in solid material so that the pad itself is not a point of leakage.

Figure 4 of the drawings shows the water-stop 1 in the deformed condition as may occur when differential longitudinal and/or vertical expansion of the wall sections 2 of the concrete structure have occurred.

It is to be understood that the particular shape of the bulbous anchor portions 4, the shape or disposition of sponge pads 7, or the shape or disposition of the metal sealing strips 5 can differ substantially from those shown herein without interfering with the attachment or functioning of the pads 8 and injection tubes 9 in the injection sealing step.

The water-stop shown in Figure 5 differs from that shown in Figure 1 only in the shape of the bulbous elastomeric anchor section as indicated (4') and in the fact that the sealing end strip (5') is of elastomeric material.

WHAT WE CLAIM IS:-

1. A water-stop composed of elastically deformable rubbery material for use in concrete structures, which comprises a substantially flat middle portion and enlarged side wing anchor portions provided with metal and/or elastic sealing means, a pad of elastically-deformable material being attached to at least one surface of each side sealing means and attached to each said pad there being at least one injection tube of sufficient length to reach the outside surface of the concrete in which the water-stop is to be installed, each said injection tube being sealed by its respective pad.

2. A water-stop as claimed in claim 1, in which the pads of elastically-deformable material are pads of elastically-deformable sponge material.

3. A water-stop as claimed in claim 1 or claim 2, in which each injection tube is attached substantially normal to each said pad.

4. A water-stop as claimed in any of claims 1 to 3, in which there is a strip of elastically-deformable sponge material secured to the flat middle portion.

5. A water-stop as claimed in any of claims 1 to 4, in which to each such pad a respective injection tube is secured to a clamp.

6. A water-stop as claimed in claim 5, in which the clamp is made of spring wire.

7. A water-stop substantially as hereinbefore described with particular reference to Figures 1 to 4 of the drawings accompanying the provisional specification.

8. A water-stop substantially as hereinbefore described with particular reference to Figure 5 of the drawings accompanying the complete specification.

9. A method of installing a water-stop as claimed in any of claims 1 to 8 in a concrete structure which comprises placing the water-stop in the desired position, pouring the concrete and, after the concrete has set, injecting a fluid curable or settable material to improve the seal between the concrete and the sealing means, the fluid material being injected so as to rupture or displace the pads of elastically-deformable material and admit the fluid material to the concrete matrix in the region of the elastic and/or metal sealing means.

10. A method as claimed in claim 9, in which the elastically-deformable material of the pads is an elastically-deformable sponge material adhered to the sealing means attached to the anchor portions.

11. A method of installing a water-stop element in a concrete structure substantially as hereinbefore particularly described.

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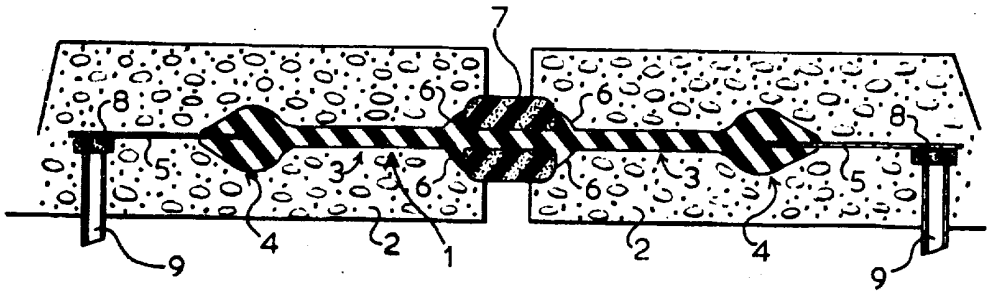
2 SHEETS

PROVISIONAL SPECIFICATION

This drawing is a reproduction of the Original on a reduced scale

Sheet 1

FIG 1



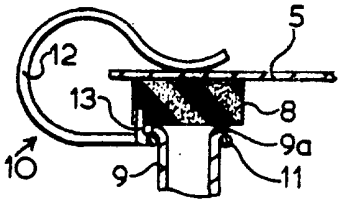
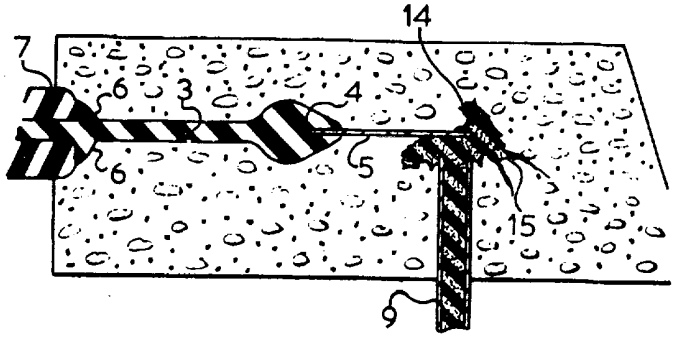


FIG 2

FIG 3



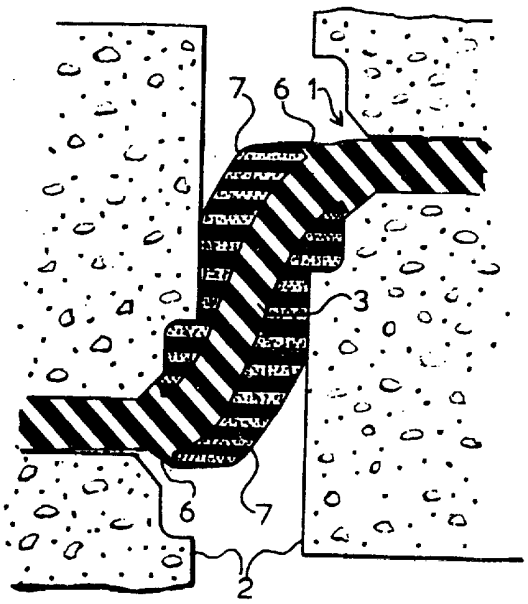


FIG 4

1572696 COMPLETE SPECIFICATION
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

FIG 4

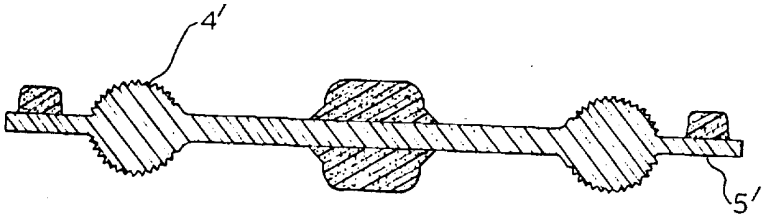


FIG 5