

PATENT SPECIFICATION

(11) 1 602 335

1 602 335

- (21) Application No. 22275/78 (22) Filed 25 May 1978
 (31) Convention Application No. 52/147638 (32) Filed 7 Dec. 1977 in
 (33) Japan (JP)
 (44) Complete Specification Published 11 Nov. 1981
 (51) INT. CL.³ E02B 3/10
 (52) Index at Acceptance
 E1H 750 B



CASE 4 (54) INFLATABLE DAMS

(71) We, SUMITOMO ELECTRIC INDUSTRIES LIMITED, a Japanese Company of No. 15, Kitahama 5-chome, Higashi-ku, Osaka-shi, Osaka, Japan, 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:-

This invention relates to inflatable dams of the air or water inflation type, and more particularly to such a dam having a mechanism for inflating and deflating it.

Lately inflatable dams have found a wide range of application for irrigation and other purposes. These dams have an envelope usually made of a flexible membranous material such as rubber-coated fabric, which is secured to a river bed in the direction transverse to the flow of the river and is then inflated with air or water supplied through a fluid supply and discharge pipe connected to a part of the bottom of the envelope, e.g., as mentioned in Japanese Patent Application Nos. Sho-40-11702 and Sho-44-2371.

In cases where such a dam is used, it is considered necessary to deflate the dam to let water flow downstream over it in the event of flooding of the river or the like.

The object of the present invention is to provide such a dam which is automatically deflated when necessary to preclude the breakdown of the dam. It is also desirable to provide a shock-absorbing member in the interior of the envelope so that when it is deflated, the kinetic energy of stones and rocks running over the deflated envelope may not hit directly against the foundation.

According to the present invention, there is provided an inflatable dam comprising a flexible closed envelope attached to a foundation member on a river bed in a transverse direction of the river to form a dam when in its inflated condition, a fluid supply and discharge pipe having one end

connected to at least a bottom portion of said envelope and having the other end connected to a branch pipe provided with a valve which, when opened, allows fluid in said envelope to flow out, a water level detecting pipe having one end open upstream of the dam at a position lower than a water level predetermined for deflating said envelope, a valve actuating means connected to the other end of said water level detecting pipe, said valve being operably connected to said valve actuating means for discharging fluid in said envelope when opened by said valve actuating means when the water level upstream of the dam exceeds said predetermined level.

Preferably, for the purpose of absorbing the kinetic energy of rolling stones, shock-absorbing material is provided on the inner surface of the bottom and part of side walls of the envelope.

This invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a schematic illustration showing a pneumatic inflatable dam constructed in accordance with the present invention;

Figure 2(a) is a perspective view of the main body of a butterfly valve used in the embodiment shown in Figure 1;

Figure 2(b) is a schematic view showing the lever portion of the valve assembly shown in Figure 1;

Figure 3 is a view on a larger scale of the water-tight telescopic coupling shown in Figure 1;

Figure 4 is a view on a larger scale of the air-bleeding-and-overflow-preventing valve portion for use with a bucket as shown in Figure 1;

Figure 5 is a schematic illustration showing a water inflatable dam constructed in accordance with a second embodiment of the present invention;

Figure 6 is a schematic illustration show-

50

55

60

65

70

75

80

85

90

ing a pneumatically inflatable dam constructed in accordance with a third embodiment of the present invention;

Figure 7 is a schematic view of a mechanism for automatically controlling dam shape, which is used with the embodiment shown in Figure 6;

Figure 8(a) and (b) are cross sectional views of a dam constructed according to the present invention; and

Figure 9 is an explanatory view of a further form of inflatable dam constructed in accordance with the present invention.

Referring to Figure 1 of the accompanying drawings, there is shown an envelope 1 made of a flexible material, such as rubber-coated cloth. It is securely fixed to a concrete foundation block 21 disposed in a direction transverse to the direction of flow of a river. The envelope 1 is inflated by air from a blower 19 through pipes 8, 2 and pipes 3, 5. The pipes may be supplemented or replaced with another pipe 4 shown in Figures 5 and 6. After inflation of the envelope 1, a valve 26 is closed and the blower 19 stopped. Shown at 22 and 23 are side wall portions of the foundation block 21, at 24 and 25 banks of the river, and at 20 a room housing the inflating and deflating apparatus.

When the envelope 1 is to be deflated, a valve 6 is opened, thereby discharging air in the envelope 1 to the atmosphere.

As a safety measure, a pipe 9 branches from the pipe 8 and terminates in a tank 10 which is filled with water 11 to such an extent that the head of water at the open end of the pipe 9 corresponds to the predetermined water pressure prevailing on the dam when inflated. Should the ambient water pressure exceed the predetermined pressure in the envelope or the envelope be inflated in excess of the predetermined pressure, air in it would be discharged through the open end of the pipe 9, thereby preventing an excessive air acting on the envelope before it is deflated.

The arrangement of the dam will now be described in more detail. Water level 29 is the level at which the dam should be deflated. Water upstream of the dam fills a pipe 18 extending horizontally from an opening 30 to an inverted U-shaped pipe 17. The 29' of the inverted U-shaped pipe 17 is at the same level as the water level 29. In other words, the inner bottom surface of the highest portion of the pipe 17 is at the same level as the water level 29.

Accordingly, when water level upstream of the dam exceeds the predetermined level 29, water is discharged into a bucket 14 after flowing over the inverted U-shaped pipe 17. The inverted U-shaped pipe 17 is connected through a flexible hose 15 to the bucket 14, which may be stainless steel bucket, for

example, so that the water flowing out through pipe 17 is poured into the bucket 14.

The bucket 14 has a discharge valve 16 and descends by the weight of water in it. Wire 13, such as a stainless steel wire, running through pulleys 12, connects the bucket 14 to a lever 7 associated with the valve 6 to open it.

When the valve 6 is opened, air in the envelope 1 is discharged through pipes 3 and 5 and pipe 2, and then through air discharge pipe 42 to atmosphere, thereby deflating the envelope 1 to allow excessive water at the dam to flow downstream.

The valve 6 is arranged as shown in Figure 2 (a). The valve member 32 is of the butterfly type and is turned by rotating a valve rod 31, thereby opening and closing the air discharge pipe 42. Shown at 33 is the main body proper of the valve, at 34 a seat ring and at 35, 36, 37 O-rings respectively. Lever 7 is shown in Figure 2 (b). As has been mentioned, when the bucket 17 descends, the wire 13 pulls one end of the lever 7 to pivot about the valve rod 31 connected to the other end of the lever 7, thereby turning the valve member 32.

Shown at 28 in Figure 3 is a water-tight telescopic coupling, in which a smaller diameter pipe connected to the inverted U-shaped pipe 17 is telescoped into a larger diameter pipe in a fluid-tight relation to allow adjustment and control of the height of the inverted U-shaped pipe 17. Shown at 38 is an air discharge pipe and at 39 an upstream water level detecting means such as, for instance, a transparent polyvinyl chloride pipe.

In Figure 4 shown at 27 is an air-bleeding and overflow preventing valve, which allows air to bleed from the bucket 14 and prevents the overflow of water from the bucket when water is flowing into it. The valve 27 is of the float type, the upper conical surface of which is adapted to contact a member 27' to prevent water from overflowing. A second embodiment is shown in Figure 5 wherein like parts and components are designated by the same reference numerals as those shown in Figure 1. This embodiment is similar to the dam shown in Figure 1 except for the following points:

Water inflates the flexible envelope 1 by means of a water pump 40, through pipes 8, 2 and a pipe 4. As a safety measure, one end of an inverted U-shaped bypass pipe 41 is connected to the pipe 2 and the other end to a water discharge pipe 42'. A valve 6 which is normally closed is provided to close and open the passage between the ends of the water discharge pipe 42'. The height of the inverted U-shaped pipe is selected to correspond to a predetermined water level upstream of the dam, so that when this water

level is exceeded, water may discharge through the water discharge pipe 42'. The valve 6 operates in the same manner as described relative to Figure 1, so that water in the envelope is further discharged through the water discharge pipe 42'.

A third embodiment is shown in Figure 6, wherein like parts and components are designated by the same reference numerals as those in Figure 1. Shown at 43 is a water reservoir or water tube, the lower end of bottom of which is connected to the pipe 18, while a float 44 is positioned in the water tube 43.

Water upstream of the dam is introduced through the pipe 18 into the water tube 43 and the float 44 ascends as the water level upstream of the dam rises. The tip of the float 44 opens a mechanical valve 45 provided in a compressed air circuit, when the upstream water level exceeds the predetermined level.

The arrangement of the compressed air circuit and mechanical valve 45 will be described in detail. As shown in Figure 6 and Figure 7, which is a partial enlargement of Figure 6, compressed air fed from an air compressor 46 and a compressed air tank 47 is introduced into a pipe 48 and two pipes 49, 50 branched from the pipe 48. Pipe 49 is connected to a lower portion of a cylinder of a cylinder type butterfly valve 6', maintaining the valve 6' in its closed position in the normal condition.

On the other hand, the end of the pipe line 50 communicates with a pipe 51, through the valve 45, communicating with an upper portion of the cylinder type butterfly valve 6'. Thus, when the water level reaches that requiring deflation of the dam, the float 44 presses on the mechanical valve 45, so that compressed air opens the valve 6'. This causes air to be discharged through discharge pipe 42 to atmosphere, thereby collapsing the envelope 1.

Figure 6 refers to the air inflation type automatic collapsing mechanism which however may be utilised for water inflation, as is clear from Figure 1 and 5.

The flexible envelope employed in these constructions is shown in Figures 8 (a) and 9. The flexible envelope 1 is inflated by supplying fluid thereto as aforementioned to keep upright position as illustrated in Figure 8 (a). The flexible envelope 1 is fixed to the foundation block 21 on the river bed by fixing members 62 and 62'. A bottom portion and the part of the side wall portion of the envelope are interiorly provided with shock absorbing mats 66 and 67. The mats preferably have such length so as to be substantially in contact with the entire inner surface of the envelope 1 when the envelope is completely deflated as shown in Figure 8 (b). That is, the length ℓ_2 of the mat

provided at the bottom of the envelope plus the length ℓ_3 of the mat provided in the side wall thereof should preferably be substantially equal to the deflated length ℓ_1 of the envelope 1. If the length of the mat 67 is larger than the length ℓ_3 the envelope does not become flat when it is deflated, whereas if the length of the mat 67 is smaller than ℓ_3 , some parts of the envelope may be damaged by rolling stones in the river. Further, since the envelope 1 provides a thickness ℓ_4 when it is deflated, it is preferable that the foundation block 21 be lower in level than the river bed by an amount at least equal to the thickness of the absorbing mat, so as to provide a channel 68, whereby the river flows smoothly when the envelope is collapsed. Furthermore, one end of the mat 67 is bevelled so as to permit desirable contact with the inclined surface of the fixing member 62 as shown in Figure 8 (b).

Any shock absorbing materials can be used as shock absorbing mats. Relatively light and flexible foam materials are preferable.

In the embodiment shown in Figure 9 shock absorbing mats made of sponge or rubber like foam material, are respectively covered with sheets 72 made of plastic sheet, cloth or rubber coated cloth. The sheet 72 is tightly connected to the mats by rope members 71 so as to prevent these mats from being displaced in the envelope 1. The end of the mats are provided with hangers 70 and inner surface of the envelope 1 is provided with hangers 69. These hangers 69 and 70 are connected with each other to secure end portions of the mats to the envelope 1.

Since the movement of air or liquid in the sponge is rather slow when the envelope is subjected to shock, high shock absorbing effect is obtainable and since the mats are loosely connected to the envelope 1 by ropes, these mats smoothly follow the movement of the envelope 1.

WHAT WE CLAIM IS:

1. An inflatable dam comprising a flexible closed envelope attached to a foundation member on a river bed in a transverse direction of the river to form a dam when in its inflated condition, a fluid supply and discharge pipe having one end connected to at least a bottom portion of said envelope and having the other end connected to a branch pipe provided with a valve which, when opened, allows fluid in said envelope to flow out, a water level detecting pipe having one end open upstream of the dam at a position lower than a water level predetermined for deflating said envelope, a valve actuating means connected to the other end of said water level detecting pipe, said valve being operably connected to said valve actuating means for discharging fluid in said



level is exceeded, water may discharge through the water discharge pipe 42'. The valve 6 operates in the same manner as described relative to Figure 1, so that water in the envelope is further discharged through the water discharge pipe 42'.

A third embodiment is shown in Figure 6, wherein like parts and components are designated by the same reference numerals as those in Figure 1. Shown at 43 is a water reservoir or water tube, the lower end of bottom of which is connected to the pipe 18, while a float 44 is positioned in the water tube 43.

Water upstream of the dam is introduced through the pipe 18 into the water tube 43 and the float 44 ascends as the water level upstream of the dam rises. The tip of the float 44 opens a mechanical valve 45 provided in a compressed air circuit, when the upstream water level exceeds the predetermined level.

The arrangement of the compressed air circuit and mechanical valve 45 will be described in detail. As shown in Figure 6 and Figure 7, which is a partial enlargement of Figure 6, compressed air fed from an air compressor 46 and a compressed air tank 47 is introduced into a pipe 48 and two pipes 49, 50 branched from the pipe 48. Pipe 49 is connected to a lower portion of a cylinder of a cylinder type butterfly valve 6', maintaining the valve 6' in its closed position in the normal condition.

On the other hand, the end of the pipe line 50 communicates with a pipe 51, through the valve 45, communicating with an upper portion of the cylinder type butterfly valve 6'. Thus, when the water level reaches that requiring deflation of the dam, the float 44 presses on the mechanical valve 45, so that compressed air opens the valve 6'. This causes air to be discharged through discharge pipe 42 to atmosphere, thereby collapsing the envelope 1.

Figure 6 refers to the air inflation type automatic collapsing mechanism which however may be utilised for water inflation, as is clear from Figure 1 and 5.

The flexible envelope employed in these constructions is shown in Figures 8 (a) and 9. The flexible envelope 1 is inflated by supplying fluid thereto as aforementioned to keep upright position as illustrated in Figure 8 (a). The flexible envelope 1 is fixed to the foundation block 21 on the river bed by fixing members 62 and 62'. A bottom portion and the part of the side wall portion of the envelope are interiorly provided with shock absorbing mats 66 and 67. The mats preferably have such length so as to be substantially in contact with the entire inner surface of the envelope 1 when the envelope is completely deflated as shown in Figure 8 (b). That is, the length ℓ_2 of the mat

provided at the bottom of the envelope plus the length ℓ_3 of the mat provided in the side wall thereof should preferably be substantially equal to the deflated length ℓ_1 of the envelope 1. If the length of the mat 67 is larger than the length ℓ_3 the envelope does not become flat when it is deflated, whereas if the length of the mat 67 is smaller than ℓ_3 , some parts of the envelope may be damaged by rolling stones in the river. Further, since the envelope 1 provides a thickness ℓ_4 when it is deflated, it is preferable that the foundation block 21 be lower in level than the river bed by an amount at least equal to the thickness of the absorbing mat, so as to provide a channel 68, whereby the river flows smoothly when the envelope is collapsed. Furthermore, one end of the mat 67 is bevelled so as to permit desirable contact with the inclined surface of the fixing member 62 as shown in Figure 8 (b).

Any shock absorbing materials can be used as shock absorbing mats. Relatively light and flexible foam materials are preferable.

In the embodiment shown in Figure 9 shock absorbing mats made of sponge or rubber like foam material, are respectively covered with sheets 72 made of plastic sheet, cloth or rubber coated cloth. The sheet 72 is tightly connected to the mats by rope members 71 so as to prevent these mats from being displaced in the envelope 1. The end of the mats are provided with hangers 70 and inner surface of the envelope 1 is provided with hangers 69. These hangers 69 and 70 are connected with each other to secure end portions of the mats to the envelope 1.

Since the movement of air or liquid in the sponge is rather slow when the envelope is subjected to shock, high shock absorbing effect is obtainable and since the mats are loosely connected to the envelope 1 by ropes, these mats smoothly follow the movement of the envelope 1.

WHAT WE CLAIM IS:

1. An inflatable dam comprising a flexible closed envelope attached to a foundation member on a river bed in a transverse direction of the river to form a dam when in its inflated condition, a fluid supply and discharge pipe having one end connected to at least a bottom portion of said envelope and having the other end connected to a branch pipe provided with a valve which, when opened, allows fluid in said envelope to flow out, a water level detecting pipe having one end open upstream of the dam at a position lower than a water level predetermined for deflating said envelope, a valve actuating means connected to the other end of said water level detecting pipe, said valve being operably connected to said valve actuating means for discharging fluid in said



envelope when opened by said valve actuating means when the water level upstream of the dam exceeds said predetermined level.

5 2. An inflatable dam as claimed in claim 1, wherein the dam is provided with a shock-absorbent material at least on a part of the inner surface of the envelope and the bottom surface.

10 3. An inflatable dam as claimed in claim 1, wherein said valve actuating means comprises an inverted U-bend connected to said other end of the water level detecting pipe, said inverted U-bend having a height equal to said predetermined water level and being arranged to deliver water into a bucket which is movable downward by weight of water, and a rope member which has one end connected to said bucket and the other end connected to said valve means.

20 4. An inflatable dam as claimed in claim 3, wherein said valve means is a butterfly valve which is opened and closed by a lever connected to said rope.

25 5. An inflatable dam as claimed in claim 3 or claim 4, wherein said inverted U-bend consists of a smaller diameter pipe which is telescopically fitted in an airtight manner into a larger diameter pipe thereby allowing height adjustment of the U-shaped pipe.

30 6. An inflatable dam as claimed in claim 1 or claim 2, wherein the envelope is inflatable by water.

35 7. An inflatable dam as claimed in any of claims 1, 2 and 6, wherein said other end of the fluid supply and discharge pipe is connected to one end of an inverted U-shaped bypass pipe, the other end of which is connected to a water discharge pipe, said bypass pipe having a height equal to said predetermined water level and said valve means being connected between said ends of the inverted U-shaped bypass pipe.

40 8. An inflatable dam as claimed in claim 1 or claim 2, wherein said valve actuating means comprises a water tube having a bottom connected to said other end of the water level detecting pipe to introduce water thereinto, a float member positioned in said water tube, and a mechanical valve for applying compressed air to said valve means, said mechanical valve being actuated upon contact with said float member being moved up by its buoyancy.

50 9. An inflatable dam as claimed in claim 6, wherein said valve means is a cylinder type butterfly valve.

55 10. An inflatable dam as claimed in claim 3, wherein said bucket is provided with an air bleeding and overflow preventing valve adapted to prevent water from overflowing therefrom.

60 11. An inflatable dam as claimed in claim 2, wherein the entire surface of said shock absorbing material is covered with a sheet, said sheet being fixed to said shock

absorbing material.

12. A dam substantially as hereinbefore described with reference to and as shown in Figures 1 to 4 of the accompanying drawings.

13. A dam substantially as hereinbefore described with reference to and as shown in Figure 5 of the accompanying drawings.

14. A dam substantially as hereinbefore described with reference to and as shown in Figures 6 and 7 of the accompanying drawings.

15. A dam substantially as hereinbefore described with reference to and as shown in Figures 8 and 9 of the accompanying drawings.

MARKS & CLERK
Alpha Tower,
ATV Centre,
Birmingham B1 1TT.
Agents for the Applicants

Printed for Her Majesty's Stationery Office,
by Croydon Printing Company Limited, Croydon, Surrey, 1981.
Published by The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.