

Nov. 20, 1923.

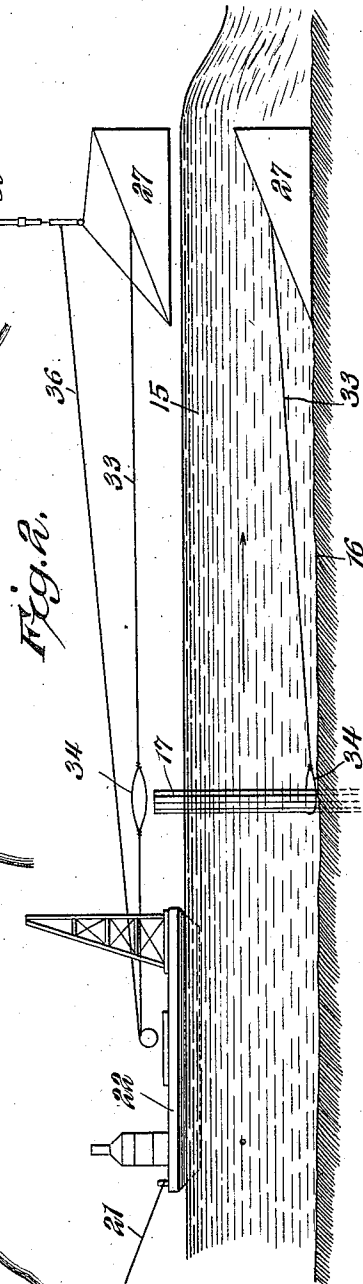
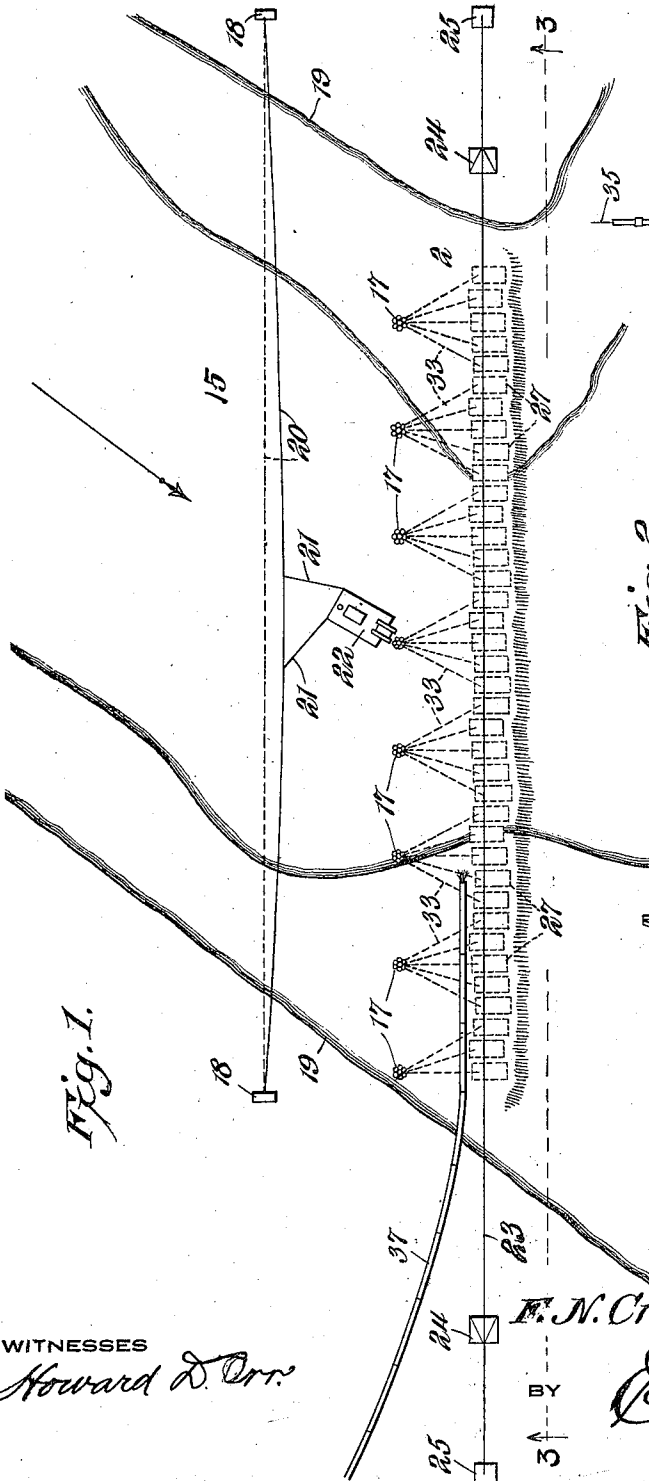
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F. N. CRONHOLM

CONSTRUCTION OF DAMS AND METHOD OF BUILDING SAME

Filed March 14, 1922

4 Sheets-Sheet 1



WITNESSES  
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4 Sheets-Sheet 2

Fig. 3.

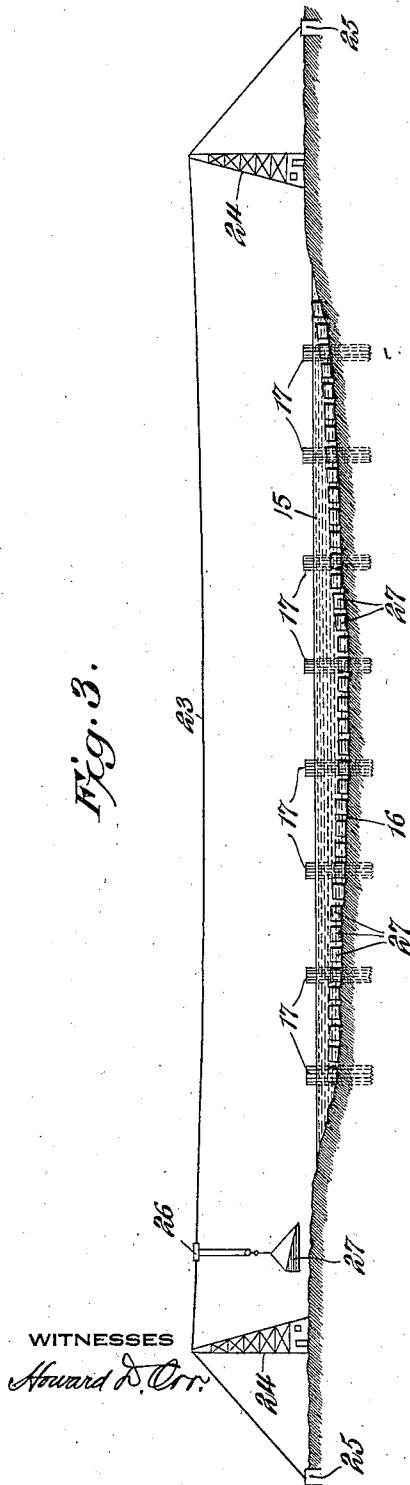


Fig. 8.

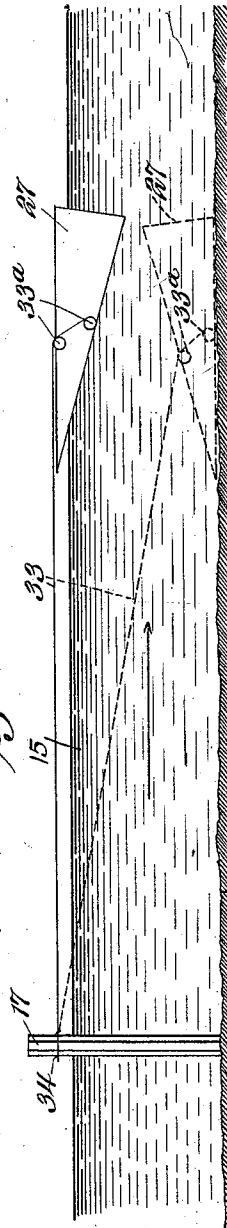
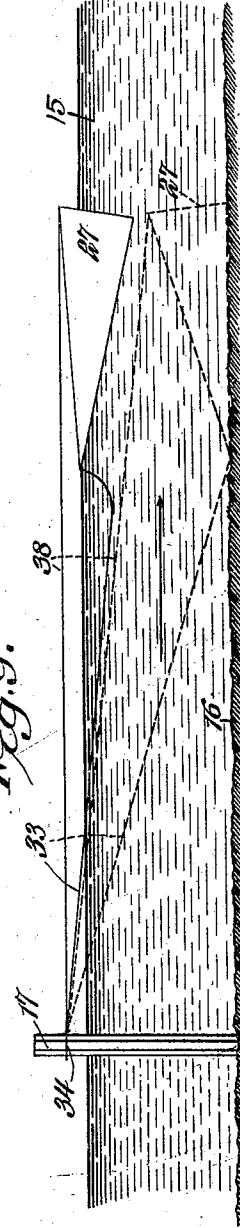


Fig. 9.



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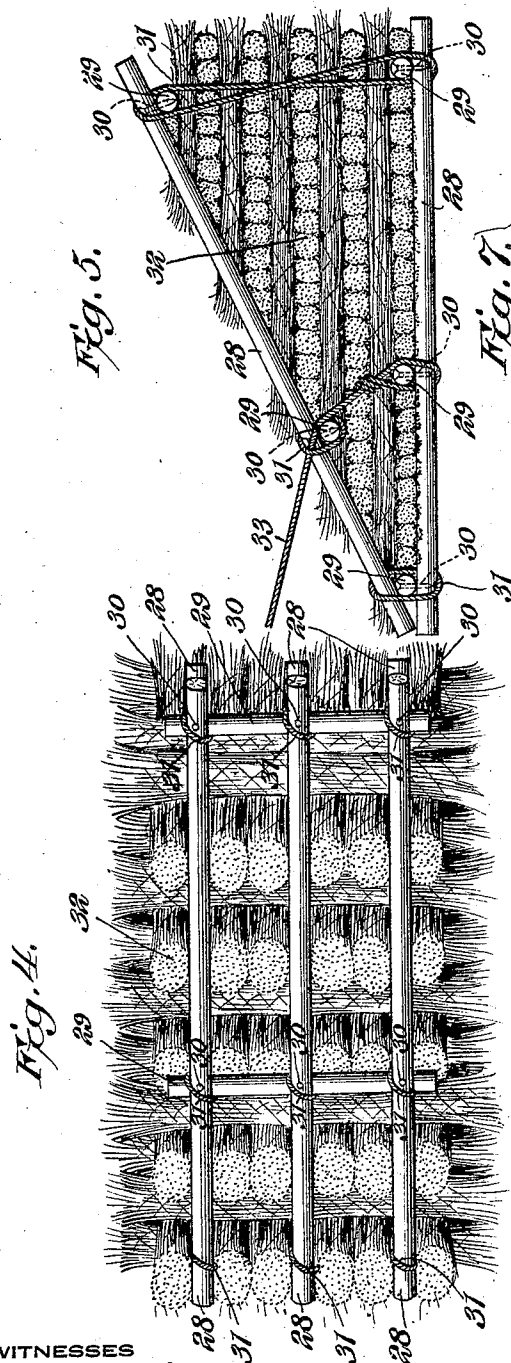
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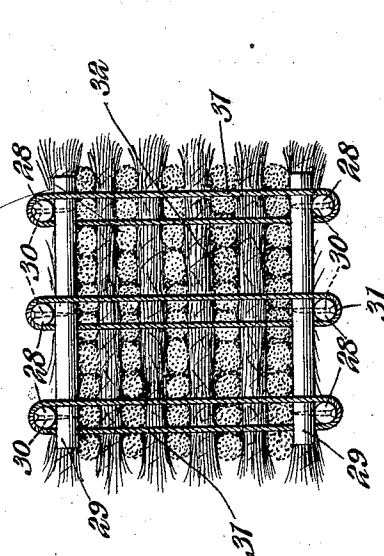
Filed March 14, 1922

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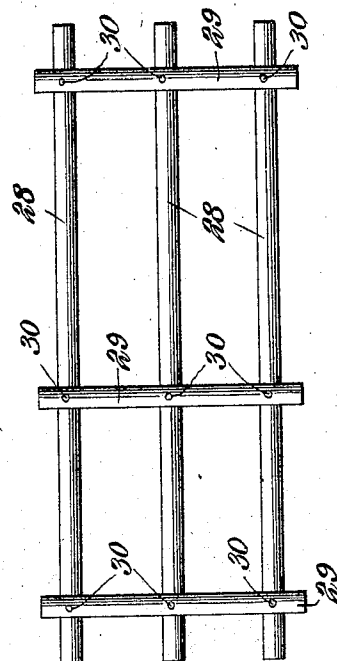


WITNESSES

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*Fig. 6.*



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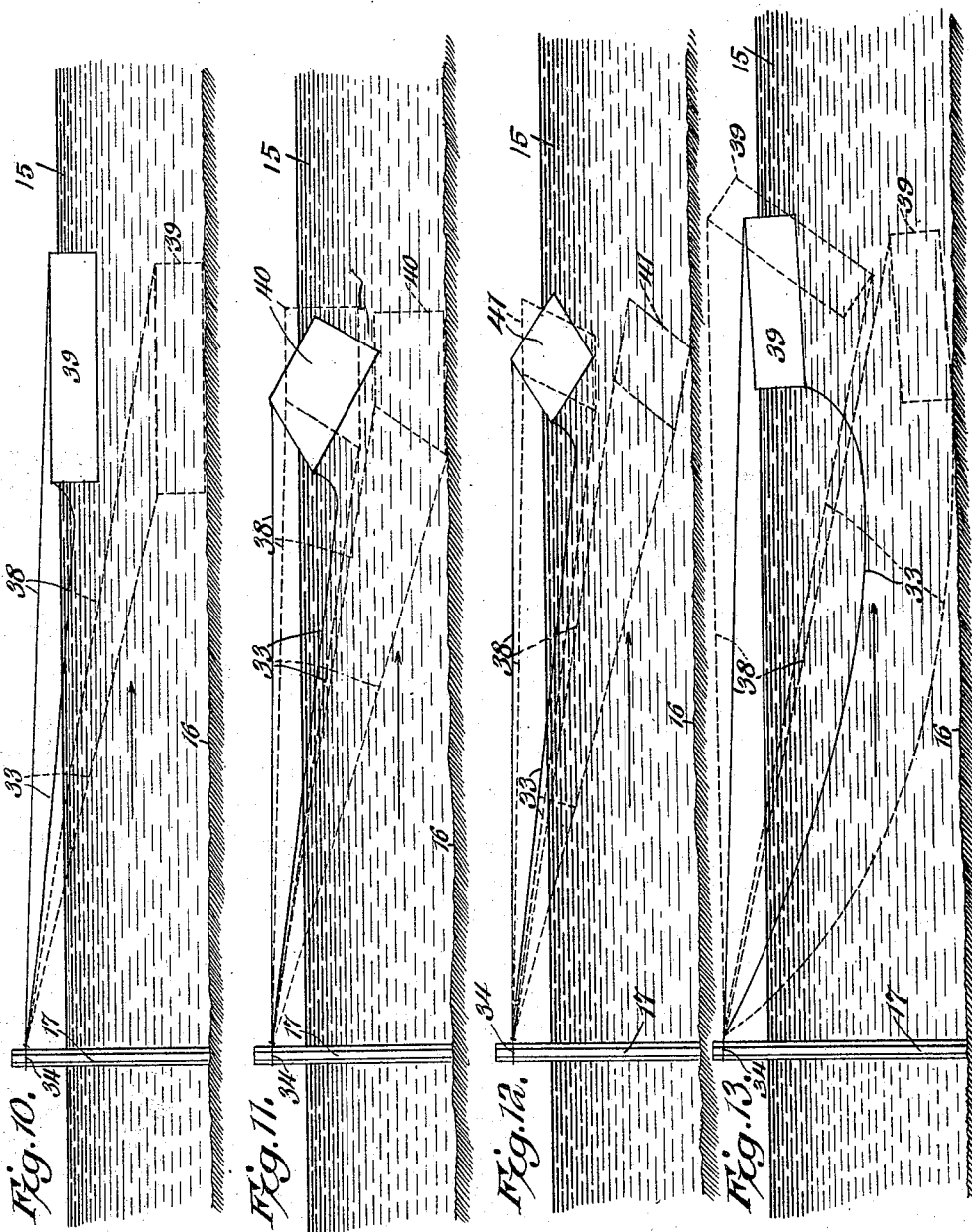
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CONSTRUCTION OF DAMS AND METHOD OF BUILDING SAME

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4 Sheets-Sheet 4



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WITNESSES

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## UNITED STATES PATENT OFFICE.

FREDERICK N. CRONHOLM, OF LOS ANGELES, CALIFORNIA.

CONSTRUCTION OF DAMS AND METHOD OF BUILDING SAME.

Application filed March 14, 1922. Serial No. 543,707.

*To all whom it may concern:*

Be it known that I, FREDERICK N. CRONHOLM, a citizen of the United States, residing at Los Angeles, in the county of Los Angeles and State of California, have invented new and useful Improvements in Construction of Dams and Methods of Building Same, of which the following is a specification.

This invention pertains to the construction of dams, and especially to an improved method of building dams.

The object of the invention is to provide an economical plan of constructing dams and a novel method by which dams of any size may be built or levees constructed.

The invention contemplates the employment of dam elements in the form of bundles or mattresses which are buoyant and which, when anchored and held taut and subjected to the flow of the stream, are caused to nose or dive under at the upstream end and sink to and rest upon the bottom of the stream, where they are held by the flow of water until the sand or silt carried down by the stream gathers upon the dam elements and finally anchors them in place.

The invention has various other objects which will be understood from the following detailed description.

In the drawings which accompany and form a part of this specification, and wherein several illustrative embodiments of the invention are shown,

Figure 1 is a diagrammatic plan view showing the construction of a dam in accordance with the principles of this invention;

Figure 2 is a cross section through a river bed showing more or less schematically some of the dam elements and the method followed in placing said elements upon the bottom, and the manner of anchoring the same;

Figure 3 is a transverse section through a river bed substantially on the line 3—3 of Figure 1;

Figure 4 is a plan view of a preferred form of dam element;

Figure 5 is a side elevation of the same;

Figure 6 is a plan view of one of the frames used in constructing the preferred form of element which go to make up a dam according to my invention;

Figure 7 is an end elevation of the larger end of one of the dam elements;

Figures 8 to 13 are somewhat diagrammatic views illustrating some of the forms which the improved dam elements may assume and also showing the method followed in placing such elements.

Referring more specifically to the drawing and to the illustrative embodiment of my invention shown therein, there appears a body of water 15 which may be considered to be a river flowing with a considerable velocity, because the invention is most easily carried out with such streams. The invention has been tried out on the Colorado River and has proven successful in damming the river where it is from 15 to 20 feet deep and approximately 800 feet wide. The direction of the flow is indicated by the arrow in all the necessary figures.

Into the bed 16 of the stream, piles are driven to form dolphins 17, which may be about 100 feet apart and project a foot or so above the surface of the water when at its highest level. The dolphins are used as a convenient but not indispensable means for anchoring the dam elements to be described. In Figure 1, there are shown towers 18 erected upon opposite banks 19 of the river, and a cable 20 stretched between said towers. Lines 21 anchor a barge 22 to the cable 20 so that the barge is held upstream relative to the site of the dam and in convenient positions to drive the piles which make up the dolphins. The barge 22 also may be used in anchoring the dam elements to the dolphins, and in Figure 2 it is shown as so used.

Downstream from the cable 20 and located directly above the site of the dam is a cableway 23 supported by skeleton towers 24 upon the banks of the stream, and anchored as at 25. See Figure 3. This cableway is preferably used for supporting a trolley 26 employed to carry the dam units to a position directly above the places where they are to be sunk. One form of a dam unit is indicated at 27 in Figure 3. The specific construction of this unit or dam element is shown in Figures 4, 5, 6 and 7 to which reference is now made.

The dam elements or units employed in the practice of my invention may assume a variety of shapes, but preferably are of some one of the shapes shown in the drawings. An angular form gives the best results. It will be understood that in whatever shape the elements are made, and from

whatever materials, such elements are to be considered as within the scope of my invention; provided they are included within one or more of the appended claims, or the  
 5 claims of my co-pending application, Serial No. 463,141, the claims herein being generic to the disclosed invention in both applications.

Each dam unit or element is preferably  
 10 made of longitudinal beams 28 and cross beams 29 secured together and constituting top and bottom frames. Spikes or bolts 30 and ropes, wires or cables 31 are shown as the preferred means by which the beams are  
 15 held together, so that an interior filling 32, which may be of brush, is held under more or less compression between the frames. The brush, which may be cut from along the banks of the stream which is to be dammed,  
 20 may be first tied into bundles, and these bundles stacked lengthwise and crosswise in alternate layers, or in any other manner, which will give the dam element the desired compactness. In practice the dam units may  
 25 be about ten feet wide, fourteen feet high at the back or downstream end, and thirty feet long, although units of widely varying dimensions may be used successfully in constructing dams.

30 In Figures 4 to 7 inclusive the dam elements are shown as having a wedge shape, and in the co-pending application to which reference has already been made, this specific shape enters into the claims. In the other  
 35 figures of the drawing, no attempt has been made to indicate more than the outline of the dam elements, as this is considered unnecessary in view of the detailed illustration of the wedge-shaped form.

40 When the elements are made from timbers and brush they will be buoyant and may be floated into position above the dam site before being sunk to the bottom of the stream; but it will be understood that it lies within  
 45 the scope of my invention to employ dam units which are heavier than water. I prefer to use bouyant elements, first, because the labor of handling them is little; second, the cost of making them is low; and third,  
 50 the interstices of the brush with which they are filled become clogged with silt and sand brought down by the waters of the stream.

The preferred method of constructing a dam in accordance with my invention is  
 55 briefly to anchor a series of dam elements from each dolphin so that a row, or several rows of elements, stretch across from bank to bank as shown in Figures 1 and 3. In order to anchor the elements, they are first transported to the place where they are to be  
 60 sunk, as by being floated, or by means of the trolley 26. A cable 33 is attached to each unit before it is sunk, and a loop 34 is formed in the cable 33 so that when the loop  
 65 is slipped over the dolphin the unit will be

held directly over the spot where it is to rest (see Fig. 2). The dam elements when made of bouyant material are sunk by making use of the force of the flowing stream acting on one of the sides or faces of the  
 70 unit. The unit 27 may be held above the water by a cable 35 suspended from the trolley, and a line 36 is attached to cable 35 so as to steady and guide the element into position. Both the line 36 and cable 33 are conveniently controlled from the barge 22. The  
 75 element 27 is lowered until it floats in the water when it will assume approximately the position shown in Figure 8, and the swift flowing water aided by a pull on the  
 80 cable 33 when it becomes taut will cause the element to oscillate about its center of gravity, and the upstream pointed end will dive or nose under the water and present the top surface of the element at an acute  
 85 angle to the direction of flow of the stream. The resultant force derived from the kinetic energy of the flowing water is more than sufficient to overcome the buoyancy of the element, and the force of the stream acting  
 90 upon the inclined upper face of the element causes it to sink to the bottom of the stream as shown in Figure 8.

Once upon the bed of the stream, the continued flow of the water and the anchoring  
 95 cable 33 will hold the unit in position; in due time mud and silt will fill the interstices and cause the dam elements to become heavier than the water, and the units will remain anchored on the bottom and  
 100 form substantially one homogeneous mass, providing a lasting barrier for the stream. If desired, a discharge pipe 37 leading from a suction dredge (not shown) may be used to deposit mud and sand at the dam site,  
 105 so that the interstices of the dam elements may be more quickly filled. The weight of the units will increase as silt is accumulated so that shortly they will lose all their buoyancy; and the lowermost units will be  
 110 pressed into the bed of the river.

The barge 22 is used not only for driving the piles forming the dolphins, but for placing the loops 39 of the cables 33 over the dolphins to anchor the dam elements.  
 115

In Figure 8 there is shown a buoyant wedge-shaped element 27 having cables 33 attached at each side to the element at a point 33<sup>a</sup> intermediate of the length of the element. This is the construction shown in  
 120 my co-pending application. The element oscillates about the point of attachment 33<sup>a</sup> of the cables to the element, when the force of the water raises the downstream end of the element.  
 125

Figure 9 shows cable 38 secured to the top of the element at the downstream end and a cable 33 connected to the opposite and upstream end, both cables being looped about the dolphin. In this form the dam  
 130

element oscillates at the point of connection of the cable 38 with the downstream end and this continues until the line 33 becomes taut, when the element sinks, it being noted that the pointed upstream end is held lower than the downstream end so that the upper face of the element is slightly inclined to the horizontal.

The buoyant element 39 in Figure 10 has a rectangular shape and is controlled by cables 38, 33 attached respectively to the downstream and upstream ends of the unit. The force of the flowing stream is against the upstream end and along the bottom of the element. Being restrained from going with the flow by anchorage line 38, the element raises slightly on the downstream end, the front end dips because the line 33 is slack, and the force of the flow is transferred from the bottom and upstream end to the sloping top face, thus forcing the element to sink to the bottom of the stream, as shown.

Figure 11 shows an angular element 40 with six sides, but the upstream side is disposed at an acute angle with the bottom of the element. The cables 38 and 33 are both connected to the upstream end at the top and bottom respectively. The force of the water striking against the inclined upstream face and along the bottom causes the lower end, to which the slack cable 33 is attached, to tip under, causing the same result as in the other forms.

In Figure 12 the dam element is a parallelogram. The cables 38, 33 in Figure 12 are attached to the upstream face at the upper and lower edges respectively. In this form, the angle of the upstream face of the dam element becomes greater to the stream the more the element submerges. The operation of this form does not differ from the form shown in Figure 11.

The element 39 in Figure 13 has the lines 33, 38 attached to the upper downstream edge and to the lower upstream edge. The element does not commence to submerge as soon as line 38 is taut, but begins when line 33 is taut, after which the element proceeds to the bottom because of the force of the stream against the top face of the element.

It will be observed that in all forms of the invention the dam element must have a flat face or faces, and that the attachment of the cable or cables thereto must be such that the velocity of the stream strikes the element at an angle; or stated in other language, the mode of attachment of the cable causes a face of the element to become exposed to the flow of the stream at an angle which brings about the submerging of the element. The angle of the element to the flow of the stream is predetermined by the varied length of the anchorage cables and by the manner of their attachment to the element.

What is claimed is:—

1. The method of constructing dams in flowing streams, from dam elements having at least one flat face and which are buoyant at the time the dam is constructed, which consists in anchoring said elements in the stream against participation in the flow of the stream, and manipulating said elements so that the current strikes said flat faces at an angle and causes the upstream ends of the elements to be depressed thereby increasing the resultant of forces due to the flow of the water acting against the upper faces of the elements, whereby said elements sink to the bottom of the stream and remain there without the necessity of ballast being added thereto.

2. The method of constructing dams of initially buoyant angular-shaped elements in flowing streams, which consists in anchoring said elements in the stream against participation in the flow of the stream, and moving the elements so that the resultant of forces due to the flow of the stream will act against the elements and cause them to be depressed and sink in opposition to their buoyancy until such elements rest upon the bed of the stream.

3. The method of constructing dams of initially buoyant elements having at least one flat face in flowing streams, which consists in anchoring said elements in the stream against participation in the flow of the stream, with the flat faces presented upstream, and moving the elements so that the resultant of forces due to the flow of the stream will counteract the buoyancy of the elements and cause them to be depressed and sink until such elements are arrested by the bed of the stream, and maintaining the anchoring of the elements until sufficient foreign material has been deposited by the stream in or upon the elements to overcome their buoyancy and maintain them permanently resting on the stream bed independently of the anchoring means.

4. The method of constructing dams in flowing streams from buoyant elements of angular shape, which consists in locating anchoring means transversely of the stream in a line upstream from the dam site, transporting the elements to points directly over the dam site, connecting the elements to said anchoring means so that one flat face of each element is presented to the velocity of the stream at an angle, whereby the flow of the stream causes the depression of the elements in opposition to the buoyancy thereof until said elements are pressed against the bottom of the stream, and maintaining the depression of the dam elements by the flow of the stream and by the anchoring means until said elements become permanently anchored by accumulations of material thereon.

5. The method of constructing dams for flowing streams from a plurality of buoyant dam elements having at least one substantially flat face, which consists in transporting the elements to a place directly over the dam site, lowering the elements until they float on the water, and anchoring the elements so that said flat faces may be presented at an angle to the direction of flow of the stream, whereby the kinetic energy of the water forces the elements to dive to the bottom of the stream and remain there permanently.

6. The method of constructing dams in flowing streams, which consists in anchoring angular-shaped buoyant elements with the inclined upper surfaces of the elements presented upstream, such anchoring being located at points further upstream than the site of the dam, in positions whereby the stream will overflow the elements and by reaction thereon depress said elements until their downward movement is arrested by engagement with the bed of the stream, to be there held by the continued reaction of the flowing water on the surfaces of the elements.

7. The method of constructing dams in flowing streams from buoyant dam elements of angular shape, which consists in locating said elements with the upper faces of the elements in an inclined position directed upstream, attaching anchoring means to an intermediate point of the upper surface of each element and at an angle thereto, whereby the reaction of the flow of the stream causes the depression of the elements in opposition to the buoyancy of said elements until the elements are pressed against the bottom of the stream, and maintaining the depression of the dam elements by the flow of the stream until said elements become permanently anchored by accumulations of material thereon.

8. In dam construction, in combination, a plurality of buoyant dam elements each formed from an upper frame and an interior filling and having at least one substantially

flat face which is presented upstream, fixed means rising from the bed of the stream and located upstream from the dam site for anchoring said elements, and flexible means for joining each element at two relatively remote points one in a higher plane than the other with one of the anchoring means, whereby the dam elements may be manipulated into a position such that the force of the flowing stream acts to cause said elements to sink to the stream bed without the use of ballast and remain there.

9. In dam construction, dolphins spaced upstream from the location of the dam, angular-shaped buoyant dam elements, separate cables secured at different points to each dam element, and anchored to the dolphins, one of said cables being located above the other, and the lower cable being normally slack, whereby the force of the flowing stream causes the upstream end of said elements to tip and the upper faces of the elements to assume an inclined position to the flow of the stream, thereby tending to depress the elements in opposition to their buoyancy until such elements are arrested by the bed of the stream.

10. In dam construction, dolphins rising from the bed of the stream and spaced upstream from the location of the dam, angular-shaped buoyant dam elements, and cables secured to the dolphins and connected to the dam elements at two remote points of the latter and at an angle thereto, one of the two points being on a higher plane than the other so as to cause the upper face of the element to assume an inclined position with relation to the direction of flow of the stream, whereby the reaction of the force of the flow of the stream against the elements depresses the elements in opposition to the buoyancy thereof and causes them to sink until such elements are arrested by the bed of the stream.

In testimony that I claim the foregoing as my own, I have hereto affixed my signature.

FREDERICK N. CRONHOLM.