J. McGILLIVRAY.

PROTECTION OF LEVEES, EMBANKMENTS, DAMS, AND OTHER NATURAL OR ARTIFICIAL STRUCTURES.

APPLICATION FILED MAY 17, 1913.

1,112,018.

Patented Sept. 29, 1914.

2 SHEETS—SHEET 1.

Fig. 1

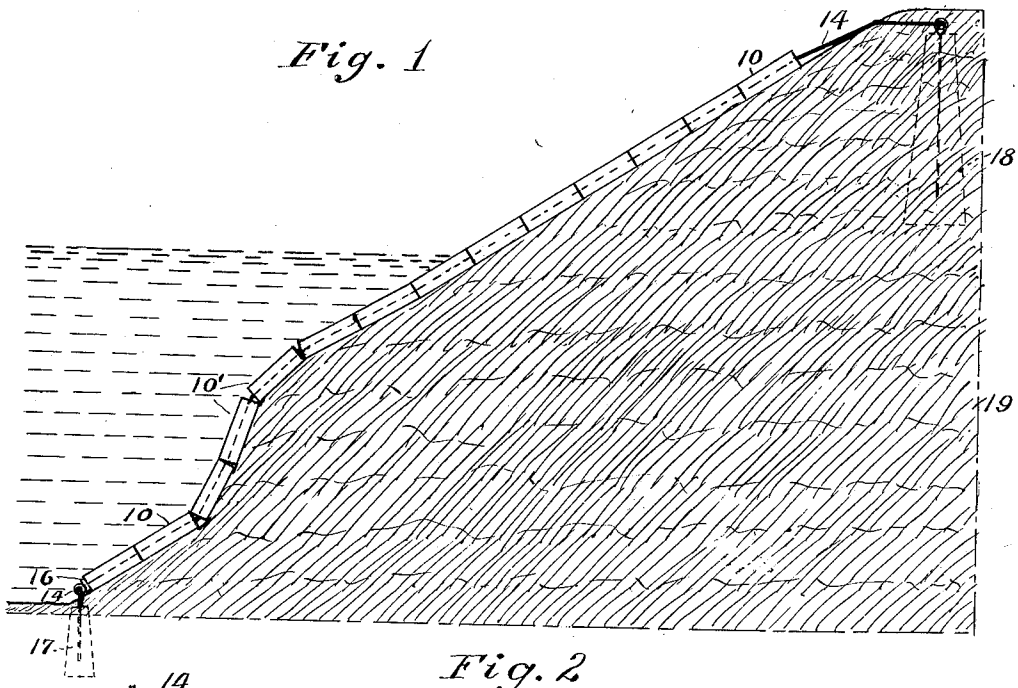
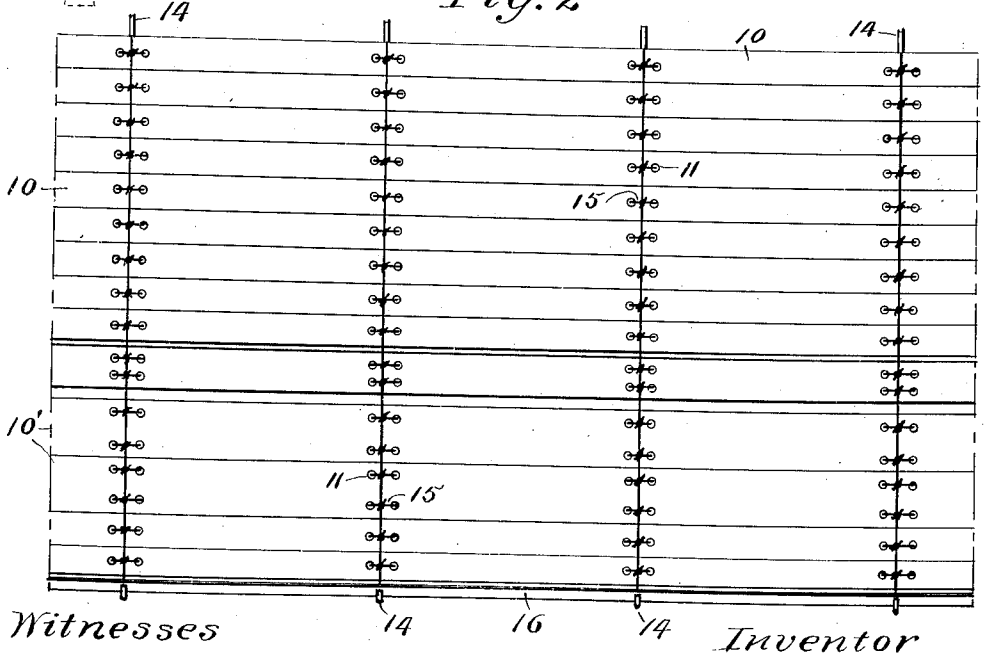


Fig. 2



Witnesses

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Fig. 3

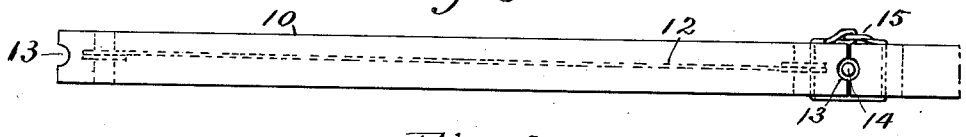


Fig. 4

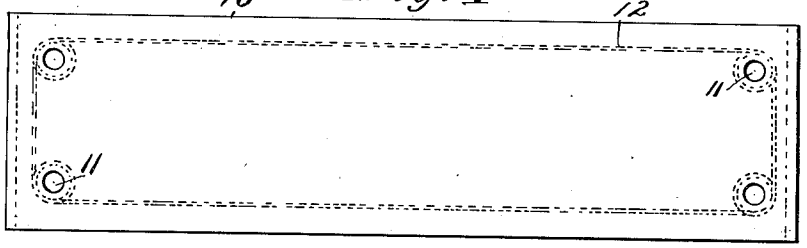


Fig. 5

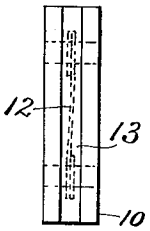


Fig. 6

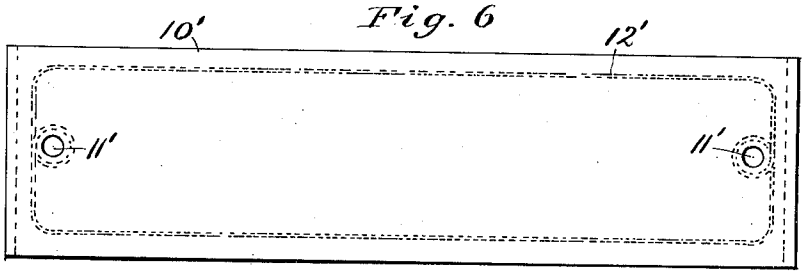


Fig. 7

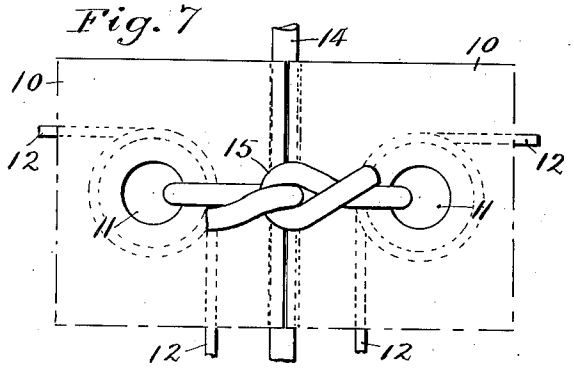


Fig. 8

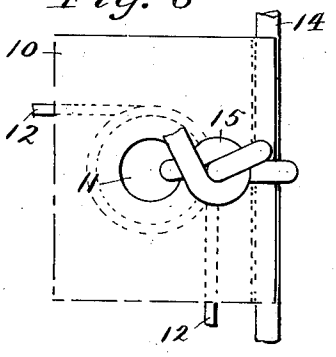
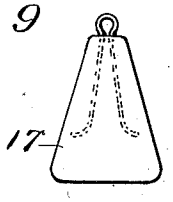


Fig. 9



Witnesses

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UNITED STATES PATENT OFFICE.

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PROTECTION OF LEVEES, EMBANKMENTS, DAMS, AND OTHER NATURAL OR ARTIFICIAL STRUCTURES.

1,112,018. Specification of Letters Patent. **Patented Sept. 29, 1914.**

Application filed May 17, 1913. Serial No. 768,293.

To all whom it may concern:

Be it known that I, JAMES McGILLIVRAY, a citizen of the United States, residing at Sacramento, in the county of Sacramento, State of California, have invented new and useful Improvements in the Protection of Levees, Embankments, Dams, and other Natural or Artificial Structures, of which the following is a specification.

This invention relates to the protection of levees, embankments, dams or other natural or artificial structures, from erosion, wear, damage or injury by the action of water, or other disintegrating or devastating force, and has for its object to render the protection of levees and other structures above mentioned more expeditious, permanent, durable, practicable, efficient and considerably cheaper and more economical.

Heretofore levees and embankments constructed of sand, earth or other material have generally been left without any special protection other than the material of which they are constructed. In some places, where unusually exposed, however, the embankment has at times been protected by piling driven into the water at the lower edge of the levee or embankment, or by means of brush strewn along or upon the levee, sometimes by brush packed in behind the piling driven at the base of the levee or embankment; and recently an attempt has been made to protect levees by means of a solid concrete coating or surface on the exposed side of the levee. The method of constructing this solid concrete or monolithic surface is similar to that used in the construction of cement or concrete sidewalks, that is to say: the cement, sand and gravel or crushed rock are taken to the point of intended use, and there mixed and dampened and applied to the side of the levee where desired, in one solid and continuous surface.

The present invention contemplates the formation of a revetment from slabs or blocks of concrete or other suitable composition or material, which blocks may be of any suitable size or shape and be made at any convenient place whence to be taken to the place of use and joined together in sufficient numbers to cover the area to be protected.

The invention therefore consists in the structure of parts and in their association, combination and arrangement for the purpose specified, substantially as hereinafter set forth and claimed.

That the invention may be fully and concisely disclosed, reference is made to the accompanying drawings, which form a part of this application and in which—

Figure 1 represents in vertical section an embankment protected by a revetment or mattress embodying this invention; Fig. 2 is an elevation of a portion of such revetment; Fig. 3 is an edge view of a slab constituting one of the units of said revetment, the manner of joining another unit thereto being also shown therein; Figs. 4 & 5 are face and end views of one of said units; Fig. 6 shows the face of one of such units with only one tie hole in each end; Fig. 7 is an enlarged face view of the tie seen in Fig. 3; Fig. 8 is a like view of the end portion of a unit at the end of a revetment; and Fig. 9 shows an anchor that may be used for any portion of the revetment.

The units of the revetment are preferably in the form of slabs from two (2) inches to six (6) inches in thickness; from one (1) foot to three (3) feet in width and from two (2) feet to ten (10) feet in length. The slabs, constructed at the point of manufacture, are transmitted with the cables and other fastenings to the point of use and secured together and in place by means of the cables and other fastenings, as fully described hereinafter.

The slabs are so constructed as to be placed lengthwise of the levee, that is, a cable is attached to each end of the slab by the means hereinafter indicated and as shown in the drawings. The cables extend from the bottom of the levee, or the lowest point to be protected, up to the upper portion, or top, of the levee, and are there fastened to a permanent or artificial anchor, generally a concrete base or dead man sunk into the top of the levee. The lower slab is placed in position at the bottom of the levee and each end of this slab is fastened to the cable adjoining such end. The next slab is then placed immediately above the lower slab and fastened likewise to the same cables. This process is continued until enough slabs have been placed one above another to reach to

the height to be protected, then the next row of slabs is placed in position. The end of the slab nearest the row of slabs already in place being attached to the same cable and the opposite end of the slab to another cable. When this row of slabs is completed to the height desired, the next row of slabs is put in place, fastened to the cables and completed, until there is thus formed one complete mattress covering the space desired. Each row of slabs is fastened to the adjoining row of slabs by being fastened to the same cable and by additional means, if required; that is, the ends of the two slabs where they come together, are fastened to the cable running through the groove in the ends of the slab, as more fully shown in the drawings. By this means a pliable mat or mattress composed of these various units or slabs, with the cables running between each set of units, and the various units fastened together as indicated, is formed, and this mattress thus formed will conform to any settling and erosion or other changes in the form of the embankment upon which it rests. In most instances the weight of the slabs will be sufficient to hold the entire structure in place. In some instances where the current is strong or wash severe, the lower end of the cables are anchored by means of cement or granite blocks or other weights or to cement or other piles driven into the ground. A large number of slabs can be assembled at the upper portion of the embankment or on barges or boats, there tied to the cables and fastened together and then lowered to the point to which it is desired to lower them beneath the surface of the water, and this protection can therefore be placed in the desired position at any stage of the water and under any conditions of weather.

The most practicable slab is one weighing not to exceed one hundred and fifty (150) pounds as such a slab is more readily handled and placed in position. On ordinary work, where there is no unusual exposure or wash or pressure, the slabs are made thinner than are those used in more exposed work.

The slabs may be composed of concrete, made in the usual manner, that is a combination of cement, gravel and sand in proportion ranging from one of cement to three or more of gravel or crushed rock and three or more of sand, up to a mixture of one part of cement to ten or fifteen parts of sand and gravel as desired. These slabs may also be made of clay or clay products; they may be made of asphalt; they may be made of asphalt macadam, which is a mixture or combination of asphalt and gravel or crushed rock; they may be made of crude oil and crushed rock reinforced with iron or steel; they may be made of concrete and steel (or other metal) or asphalt and steel or other metal (the steel or other metal being used as a reinforcement or protection to the asphalt, concrete, and crude oil and crushed rock; thus—wire mesh coated or covered with concrete, asphalt, crude oil and rock screenings, or clay products would make a cheap and durable slab;) and they may also be made of steel, iron or other materials as may be found suitable or adaptable to the varying conditions; the idea being to construct a flexible mattress where the component parts can be constructed at a point other than the place of use and put together readily at the place of use and which, when constructed and in place, will conform to the changing and varying conditions of the levee, embankment, dam or other structure upon which the same rests. The slabs may be varied in weight in accordance with the position in which and the circumstances under which they are to be used.

Where the mattress is to be placed beneath the surface of the water, it will be found beneficial to have the mattresses more flexible, which can be brought about by changing to some extent the formation of the slabs, by looser tying and by other means as hereinafter indicated; and for use beneath the water, instead of placing the second slab above the first, it is placed at the end of the first, that is, several cables are placed in position, the first slab at the ends of the first two cables, the second slab between the second and third cables, the third slab between the third and fourth cables and so on until the desired number in length has been obtained to allow the first slab to be lowered into the water and still permit the others, particularly the last, to remain on the surface. Other slabs are then placed on top of the first, second and third, and these gradually lowered into the water, at the same time the line of slabs being extended as the work progresses and when the required number of slabs are beneath the water the first row of slabs can then be completed to the height desired and so on with the other rows.

The slabs may be reinforced by means of iron, steel or other metal reinforcement. This reinforcement is arranged in such a manner that the strain from the attachment of the slabs to the cable and the slabs to each other will come on the metal reinforcement and not on the concrete asphaltum or other material used in the construction of the slab or unit.

At the lower end of each cable a washer is used. This washer may be a continuous washer or chain or cable extending from the lower end of each cable to the adjoining cable to form a rest for the lower slab and to hold each series of slabs in position and

thus release the strain on the various ties and fastenings.

The ties are preferably made by means of separate metal rods and drawn tight or loose, or some tight and some loose as may be desired or required. Ties may be made from the four corners of the slab; from the center of the slab or from whatever positions may be desired or required to conform to conditions.

Referring specifically to the drawings, 10 indicates the unit structure or slab provided with tie holes 11 at the four corners, about which holes and extending from hole to hole is an embedded reinforcing rod or cable 12, Figs. 3, 4 & 5. The ends of the slabs 10 are grooved at 13 for the reception of a cable 14 to which the slabs are connected. A convenient form of this tie is represented at 15. These ties are preferably metal rods, the ends of which may be twisted or hooked together. At the ends of a mattress these rods tie the slabs directly to the cables, Fig. 8, while throughout the body of the mattress, they tie adjacent slabs together with the cable intervening, Fig. 7.

The slabs may be provided with but one tie hole in each end as indicated in the slab 10′ in Fig. 6, in which the reinforcing rod 12′ encircles the tie holes 11′ and extends around the border of the slab as in the first form. Obviously any other form of reinforcement and manner of locating the same may be adopted.

A revetment may be made up of one or more forms of slabs. Fig. 2 shows the two forms above described associated in the same mattress. The washer 16 at the lower edge of the mattress is held in place by a knot or eye in the lower end of the cables 14 and to these eyes may be attached, if desired, suitable anchors such as typified at 17, Figs. 1 & 9, the anchor for the upper end of such cable being indicated at 18, Fig. 1. These anchors may be conveniently made of concrete as indicated.

The mattress as seen in Fig. 1 is applied to a bank or levee 19 and extends below the water as indicated at 20. Obviously to a mattress of this sort anchors 17 may be applied where needed and when needed.

The invention claimed is:

1. A revetment unit of composition provided with tie holes for the purpose set forth and with grooves along its ends for the reception of assembling cables.

2. A slab of reinforced concrete adapted to serve as a portion of a revetment and provided with reinforced tie holes at its ends, and with grooves along its ends for the reception of assembling cables.

3. A revetment unit consisting of a slab of reinforced concrete provided with a cable groove along each end wall thereof and with transverse reinforced tie holes at the corners of said unit.

4. A revetment consisting of a series of slabs provided with grooves in their adjacent ends, cables extending through the channels formed by said adjacent grooves, and means for holding adjacent slabs together, thereby inclosing the cables in said grooves and making close union between the slabs.

5. A revetment consisting of a series of concrete slabs provided with transverse tie holes, cables extending along the ends of said slabs, and means for tying the slabs together whereby to hold them to said cables and close to each other.

6. A revetment consisting of a series of composition slabs provided with transverse tie holes and having metallic reinforcement about each tie hole and extending from tie hole to tie hole, ties extending through adjacent holes for holding the slabs together, and cables confined between the ends of said slabs.

7. A revetment consisting of a series of composition slabs provided with transverse tie holes and having metallic reinforcement about each tie hole and extending from tie hole to tie hole, and also having cable grooves in adjacent ends, anchor cables in said grooves, and ties for joining adjacent slabs together, thereby confining said cables in the grooves and holding the slabs to the cables.

8. A revetment consisting of a number of parallel cables anchored as desired, a series of concrete slabs arranged side-by-side between each two adjacent cables and means for joining said slabs of one series to adjacent slabs of the next series and thereby joining the slabs to the cables.

9. A revetment consisting of a number of upwardly extending cables, a washer joining the lower adjacent ends of the cables, series of concrete slabs arranged one above the other between adjacent cables and provided with tie holes at their ends, and ties extending through said holes whereby to join slabs of adjacent series and bind them together and to the cables.

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