March 14, 1944. L. F. HARZA 2,344,302

REVETMENT AND BLOCKS THEREFOR

Filed June 30, 1939

Fig. 1.

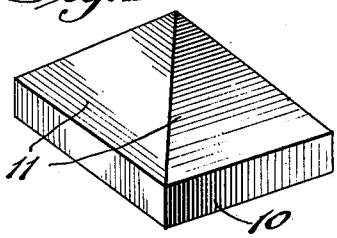


Fig. 2.

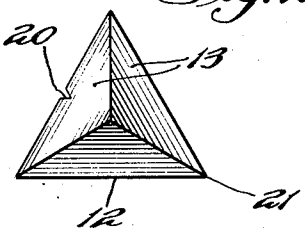


Fig. 3.

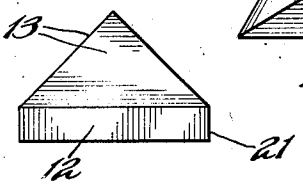


Fig. 4.

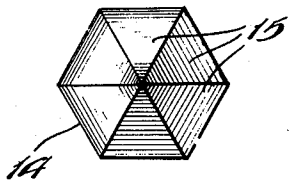


Fig. 5.

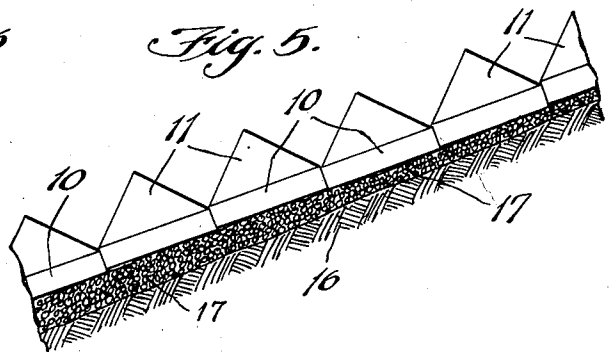


Fig. 6.

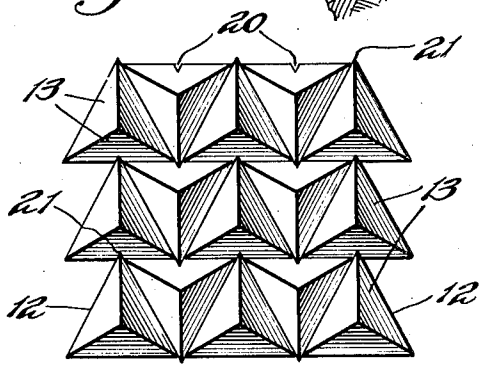


Fig. 8.

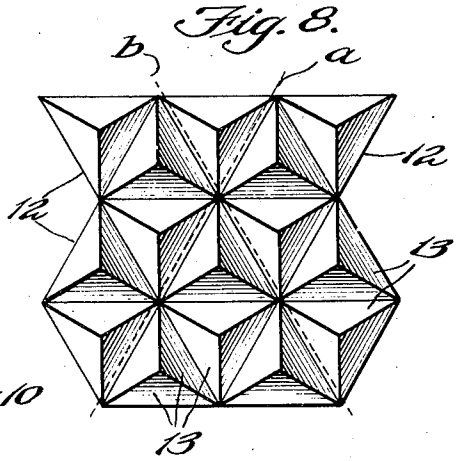
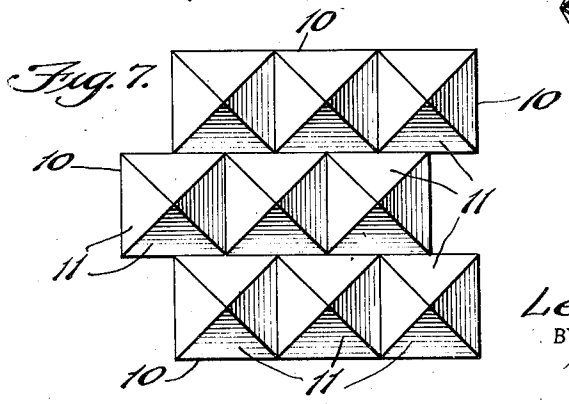


Fig. 7.



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Patented Mar. 14, 1944

2,344,302

UNITED STATES PATENT OFFICE

2,344,302

REVETMENT AND BLOCK THEREFOR

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Application June 30, 1939, Serial No. 282,057

3 Claims. (Cl. 61—37)

This invention relates in general to new and improved blocks adapted to be combined and used to provide a protective cover or revetment for surfaces and embankments, particularly of streams, dams, and the like.

In protecting river banks against scour for high velocity current, or in protecting the upstream slope of an earth dike, levee, or embankment, or for shore or beach protection against waves, it is customary to use, among other means of protection, a so-called riprap consisting of natural and irregular blocks of stone, either hand laid and with cracks chinked up to form a rough effect of paving, or loose dumped, as the case may be.

In either case it is customary and necessary to provide a layer of crushed stone or gravel underneath the riprap, particularly where protection is required, because waves rolling up the face of the riprap will cause a high velocity of water in the spaces between the stones upon its return down the slope, and will scour sand, dirt or clay from underneath the riprap stones causing them to settle into the fill. The riprap must, therefore, be laid on a surface of crushed stone or gravel which is able to resist scour from the current which will exist in the spaces underneath and between the stones.

The use of natural riprap necessarily produces irregular spaces between the stones, with consequent high velocity of the receding water through spaces between the stones, sometimes resulting in local scour even where gravel or crushed stone is used beneath the riprap. The fact that natural stones are of all sizes and shapes necessitates a great amount of careful selection and placing of each stone and much chinking to avoid the above result.

Smooth concrete slabs have been used for many years for bank protection but in general they have produced a very unsatisfactory result. Most concrete slab faces used on earth dams or for other slope protection have been provided with expansion joints to allow for temperature expansion and contraction and these joints are a source of trouble. When a wave rolls up the face of such a protected embankment water will enter these joints and finds its way underneath the slabs, or units of slabs, and unless the water can flow out more freely than it flowed in, it will build up a hydrostatic pressure tending to lift the slab.

It is also true that rain water falling on top of an embankment protected by a concrete slab will often seep into the material and accumulate underneath the slab to an elevation higher than the elevation of water in the reservoir, thus producing an up-lifting hydrostatic pressure behind the slab. Since it is necessary for a slab to lie flat and in close contact with the earth embankment upon which it is built, it requires only a very small amount of water to fill the pores of the material, or any thin film or clearance which may exist beneath the slab, and thus produce hydrostatic pressure. Since concrete weighs about 2.4 times the weight of water it is necessary only for the material beneath the slab to become saturated to a height of 2.4 feet above the elevation of water in the reservoir in order to have lifting effect enough to raise a concrete slab one foot thick.

The result has been that many if not most concrete slabs for wave protection have been destroyed by uplift and the slabs have been lifted off and slid down the face of the dam to the bottom of the reservoir. This has happened in so many cases that such construction is not considered correct and is not now recommended or used.

Small unit paving blocks on the face of an earth embankment avoid the objections and difficulties described for large concrete paving slabs. Any water which enters the joints or clearances between the blocks into the gravel or earth beneath them, cannot build up enough head to lift the block because of the freedom of escape of the water at any joint between the blocks. In other words the water will escape as freely as it entered and cannot accumulate to a height above the height of water in the reservoir nor raise the blocks from their predetermined place.

It is recognized that a rough surface on the slope of a dam will assist in breaking up the waves and in preventing them from rolling as far up the slope as they would on a smooth surface such as a concrete slab. The experiment has been made of setting concrete tetrahedrons on the sloping face of a dam or river bank, their bases serving to cover the entire surface, but this experiment was not attended with success. A tetrahedron is so high in comparison with its base, width, and area that it is unstable and subject to being tipped over by a heavy blow from a wave or from driftwood which is pounded against the face of a slope by the waves. Moreover a true tetrahedron has no thickness of base and it is necessary for the edges to match and meet each other accurately in order to protect the entire surface. As the edges are thin, any slight inequalities in the bed of gravel underneath them will raise the edge of one tetrahedron slightly

above the other, leaving an opening underneath for the entrance of high velocity water, causing it to scour the gravel from beneath the higher tetrahedron. It has therefore been proven to be necessary for successful application, that the pyramidal unit be lower in height in comparison with base width than a tetrahedron in order to be stable, and also that it should have a sufficient thickness of base in the form of a prism having the same base area as the unit, and with essentially parallel sides several inches thick so that any inequalities in the surface of the gravel bed beneath the concrete units will not cause one block to be lifted higher than another to such an extent as to expose to the high current and wave action the gravel underneath the higher block.

The present invention therefore has a number of important objects, among which are the following:

To provide a new and improved form of block; to provide a new and improved revetment made of the block; to prevent accessibility of water to the bed or layer below the blocks; to prevent the formation of direct channels or passageways between the blocks; to obviate the necessity of accurately aligning or leveling blocks on their bases; to provide means for locating blocks in adjacent courses; and in general to produce a new and improved revetment by the use and combination of the blocks herein shown and described.

Other and further objects of the invention will appear hereinafter, the accompanying drawing illustrating the preferred construction, shapes and combinations of blocks to produce a protective cover or revetment, in which

Fig. 1 is a perspective of a pyramidal block in accordance with this invention;

Figs. 2 and 3 are top and side views respectively of a triangular pyramidal block;

Fig. 4 is a top view of a hexagonal block;

Fig. 5 is a view illustrating the application of blocks of the type shown in Fig. 1 to an inclined revetment surface;

Fig. 6 illustrates a means for interlocking triangular blocks in courses;

Fig. 7 illustrates the location of pyramidal blocks in staggered courses to prevent the formation of continuous channels between them; and

Fig. 8 illustrates the objectionable location of pyramidal blocks in successive courses which provide a continuous scouring channel.

In this type of revetment blocks, to make them safe from overturning, it is evident that the force against any of the faces of the pyramids caused by the blow of a wave or of driftwood, should have a direction which would fall within the base of the unit. For this to be true any face of the pyramid must ehave an angle substantially ninety degrees or more with the opposite edge or side of the pyramid. Pyramids could be of any base shape which will fit readily into a complete pattern to cover the entire area and the most convenient shapes for this purpose are triangular, square, rectangular, or hexagonal.

Referring now more particularly to the drawing, Fig. 1 shows a quadralateral prismatic base 10 with a superposed pyramidal structure 11 of equal sides having an apex in which the opposite sides are at an angle of about ninety degrees.

In Figs. 2 and 3 a triangular block is shown having a triangular prismatic base 12 and a unitary triangular pyramidal super-structure 13, preferably equi-lateral, in which the angle made by any edge with the opposite side face is substantially ninety degrees.

In Fig. 4 is shown a top view of a hexagonal block with a similar prismatic base 14 of uniform thickness as in Fig. 1, surmounted by a hexagonal structure 15 in which opposite faces are substantially at right angles to each other.

In Fig. 5 is shown a portion of an inclined bank 16 covered with a gravel bed 17 which may be of graduated thickness and this bed surmounted by a plurality of revetment blocks 10 arranged in succeeding courses and spaced close together so that there are no substantial spaces between the blocks even though there is some difference in elevation of the gravel bed which tilts some blocks with respect to the other, the prismatic bases being of sufficient height so that the gravel bed is not exposed at any point to the direct scour of waves or returning water passing between the blocks.

In Fig. 6 is shown a plan of a portion of an area of slope protected by triangular blocks having triangular bases, the point of one block in each course being upward and the next block in the same course being downward and thus alternating throughout the course. It is desirable that the blocks in one course shall break joints with the blocks in the course above and below so that a wave in rolling up the face or in returning down the face of the revetment will not have a continuous channel to follow but will continually strike against the angular face of one block and will be diverted around the face of that block to the adjoining channels on either side, striking the face of the blocks in the next course in the same way and thus making its course as tortuous as possible to destroy the energy of the wave, reduce its velocity and dissipate its force.

In laying up the blocks of a true triangular pattern as shown in Figs. 2 and 3, it is conceivable that the blocks of one course will gradually gain in horizontal distance over the blocks in the next upper or lower course, due to slight difference in sizes of the blocks, the closeness with which they are packed, or even to the contour of the surface to which they are applied, until the V-shaped channels would form a continuous passage as represented by the lines *a* and *b* in Fig. 8, which are objectionable for the reasons above set forth.

In order to maintain and insure the pattern indicated in Fig. 6, a small V-shaped notch or groove 20 is provided in one side of the base of each block so that a point or the opposite point 21 of corresponding blocks in the courses above or below will fit into the notches of the blocks below or above as the case may be, thus aligning the blocks in adjacent courses and preventing them from forming a continuous path as in Fig. 8.

Blocks of this kind and shape may be conveniently formed with the points downward in metal forms which can be packed continuously together so that concrete can be poured from a moving concrete mixer and screeded over the surface to fill all of the forms at a correspondingly low cost. The blocks may also be made in concrete block machines, the forms removed and the blocks carried to one side on a belt conveyor or other means for storage.

In Fig. 7 is shown a pattern of square base pyramids built and set up in staggered courses to break joints and serve the same purpose as the triangular pyramids. This form does not readily admit of the provision of the notch as shown in

the triangular form, in order to insure definite positioning of each block, but otherwise would be as satisfactory as the triangular base.

A similar pattern may be built up of hexagonal base pyramids set in succeeding and somewhat inter-engaging courses, as each pyramid would have a definite position and the water flowing between them would have a tortuous path. The forms for constructing them would be more complicated to make and more expensive, and more skill would be required to lay these blocks correctly.

With this type of block which covers substantially the entire face of the wall or bank which it protects, the water even from a rapid stream or from waves is not accessible to the space beneath the blocks, there is no scouring action which tends to remove the supporting sub-soil or gravel, there is no tendency for the blocks to become displaced, and even the path of water up and down the face of the revetment is so tortuous that the force of the water is reduced, dispelled and dissipated.

In carrying out the method of constructing a revetment of this kind, the surface to be protected is first provided with a layer of crushed stone, aggregate, or gravel 17, substantially leveled on its upper or outer surface, and graduated in thickness from top to bottom if desired. Upon this are placed the blocks which are laid in a pattern depending upon their shape, with the bases fitting closely together, and entirely covering the surface. The blocks are laid in courses or tiers, the blocks staggered in adjacent courses to break joints and prevent the formation of continuous channels in successive courses.

This protects the bed or bank against erosion or scouring, the high bases of the blocks prevent the water from scouring the aggregate from beneath the blocks, and the close spacing of the blocks prevents displacement of the blocks by water scouring between them.

I claim:

1. A revetment block with a triangular prismatic base and an upper angular apex, the base having a notch in one side to receive the extremity of an angular corner of the base of a similar block to position and interengage blocks in adjacent courses for holding them in predetermined position.

2. A revetment comprising a layer of aggregate covering a surface to be protected from water action; a plurality of concrete blocks supported by the layer and spaced with open joints no wider than the particle size of the aggregate; and each block comprising an equilateral right angled prismatic base of a height which allows opposed bottom side edges of adjacent blocks to shift relatively, either upwardly or downwardly without exposing the layer beneath; and each block having a pyramidal superstructure rising centrally from its base to break up said water action.

3. A revetment in accordance with claim 2 in which the angular relation of the faces of the pyramidal superstructure is that they are equilateral and make an angle of ninety degrees or more at the apex with the opposite faces or edges so that the force of an impact on the face will have a direction to fall with the base of the unit and will not tend to overturn it.

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