Aug. 7, 1934. W. L. COX 1,968,993

SLOPE RETAINER

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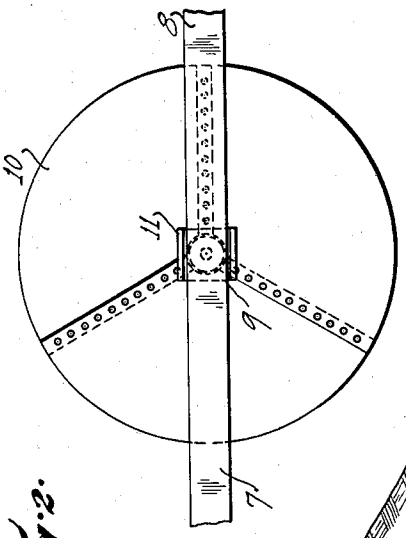


Fig. 2.

Fig. 1.

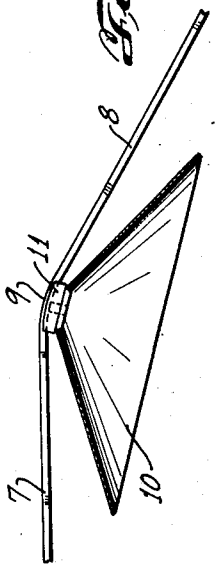


Fig. 3.

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Fig. 4.

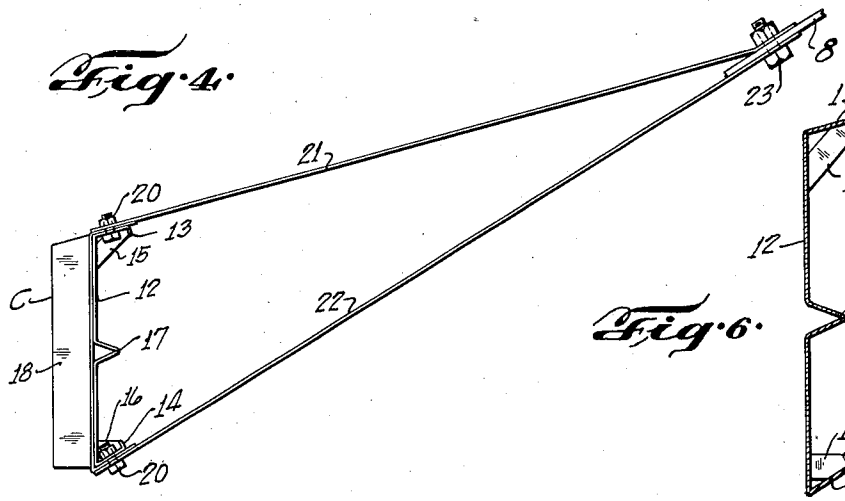
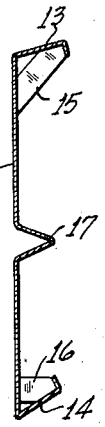


Fig. 6.



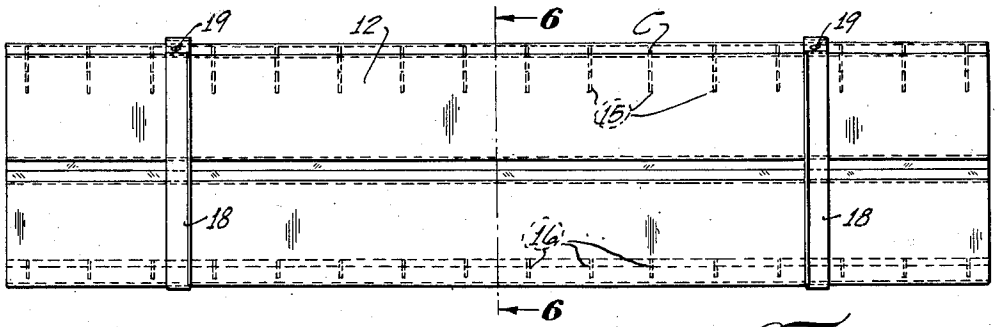


Fig. 5.

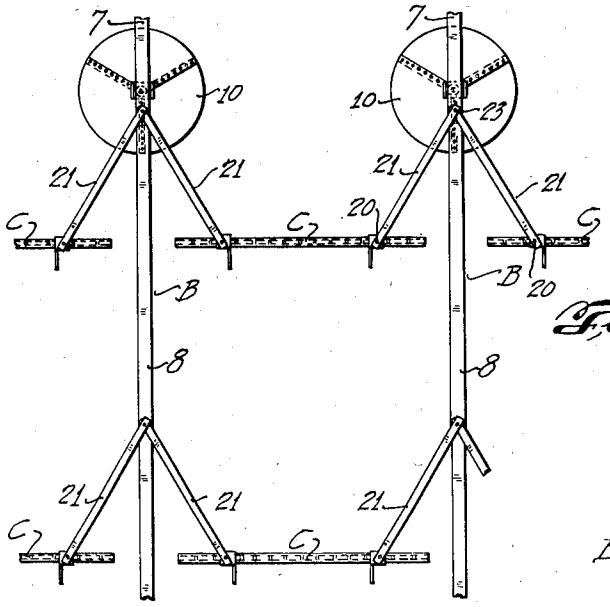


Fig. 7.

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SLOPE RETAINER

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Fig. 8.

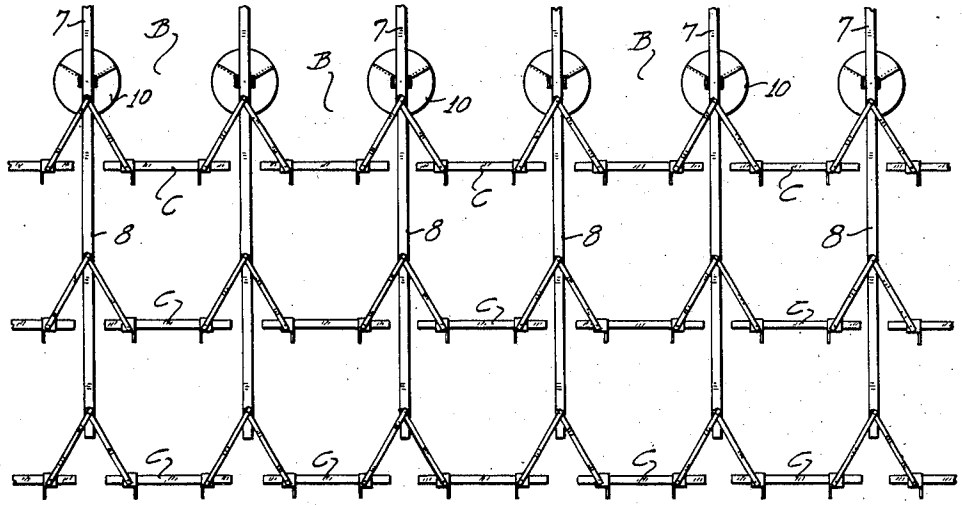
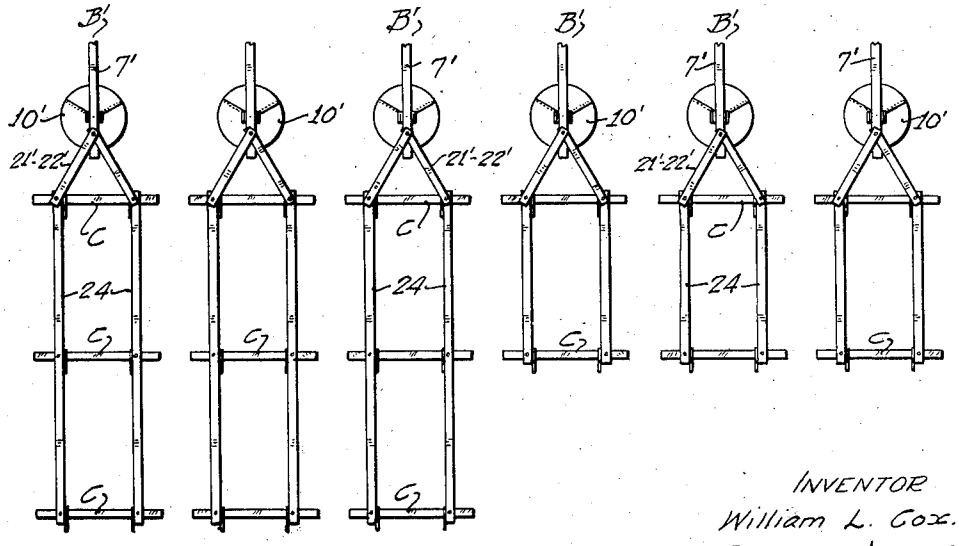


Fig. 9.



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SLOPE RETAINER

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Fig. 10.

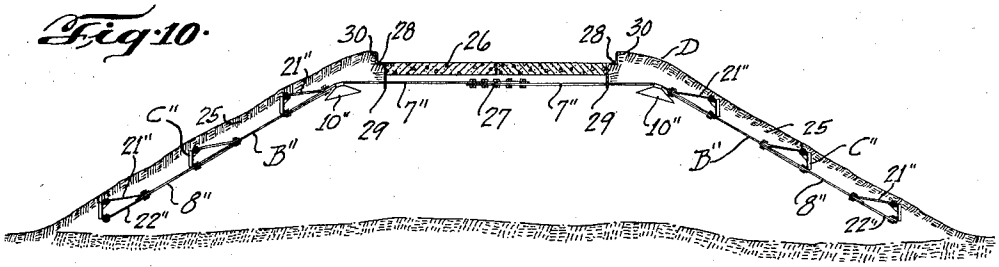


Fig. 11.

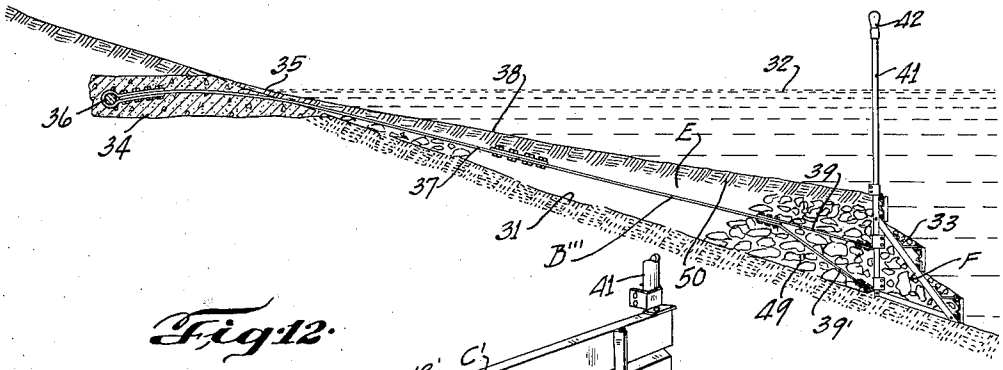
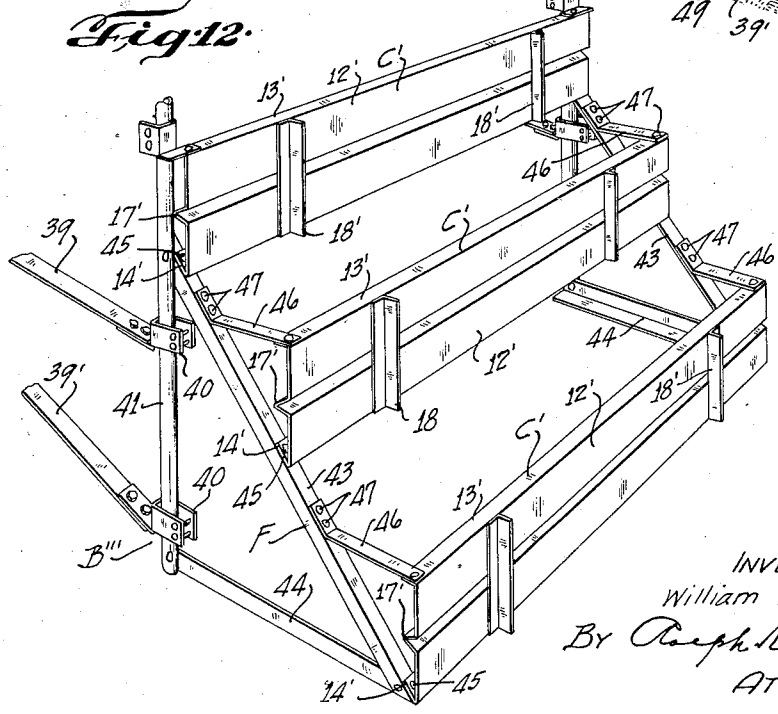


Fig. 12.



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UNITED STATES PATENT OFFICE

1,968,993

SLOPE-RETAINER

William L. Cox, Chillicothe, Mo.

Application October 3, 1932, Serial No. 636,046

14 Claims. (Cl. 61—35)

This invention relates generally to bank-protection for earthwork constructions and has more particular reference to a bank-protecting structure of the type commonly known as a slope-retainer.

In highway and railroad construction, for example, embankments frequently occur in the making of cuts through hills, or in making fills across valleys, and the like, the sloping walls or sides of which are subject to erosion or washing away or sliding of the embankment as a result of natural drainage conditions or yielding earth under unrestrained natural forces. Likewise, in revetment work for water-courses and the construction of beaches, and the like, similar erosion effects occur, due to running water and wave-action, tending to destroy the bank or beach, as the case may be.

My present invention has hence for its prime object the provision of an inexpensive, durable, readily installed retainer for efficiently preventing or checking the erosive action of water current or other elements and/or forces of nature upon, and thereby retaining the slope of, an embankment, beach, or the like.

And with the above and other objects in view, my invention resides in the novel features of form, construction, arrangement, and combination of parts hereinafter described and pointed out in the claims.

In the accompanying drawings (four sheets),—

Figure 1 is a fragmentary sectional view of an embankment or slope, illustrating an applied or installed slope-retainer of my invention;

Figure 2 is an enlarged plan-view of one of the knuckle-heads of the slope-retainer;

Figure 3 is an enlarged sectional view of one of the knuckle-heads;

Figure 4 is an enlarged detail end view of one of the retaining-walls and the suspender-bridle or anchorage thereof;

Figure 5 is an enlarged front view of one of the retaining walls;

Figure 6 is a vertical sectional view thereof;

Figure 7 is a fragmentary plan view of a panel-section of the slope-retainer, the anchor blocks being omitted and portions of adjacent panel-sections being also shown;

Figure 8 is a reduced fragmentary plan-view of the slope-retainer with its retaining walls in interconnected or mat relation;

Figure 9 is a reduced fragmentary plan of a slope-retainer having its retaining-walls disposed in individual panels or sections;

Figure 10 is a reduced cross-sectional view of a highway embankment, illustrating bank-protection structures of my invention installed or applied to the respective opposite slopes of the embankment, each protection-structure serving as an anchorage for the other, the view also illustrating a unique form of gutter-construction for the highway paving slab;

Figure 11 is a fragmentary sectional view of a submerged embankment or beach, illustrating an applied or installed modified form of bank-protection structure or revetment of my invention; and

Figure 12 is an enlarged fragmentary perspective view of the revetment structure of Figure 11.

Referring now more in detail and by reference characters to the drawings, which illustrate practical embodiments of my invention, A designates generally an earthwork embankment in the form, in the present instance, of a fill deposited on the natural ground surface 1, the embankment A having a sloping surface 2, which merges at a shoulder, as at 3, into the top-surface 4 thereof.

The slope-retainer comprises preferably any desired number of so-called sections or mats B, each of which includes a pair of anchor-blocks 5 of masonry, concrete, or other suitable construction longitudinally spaced along and embedded in the top-surface 4 of the earthwork A a substantial distance inwardly or remote from the shoulder 3 thereof. Suitably secured, as at 6, to and in the respective anchor-blocks 5, are anchorage-members or bars 7, each of which extends from its anchor block 5 approximately to the shoulder 3 of the slope and is then preferably, though not necessarily, integrally extended, as by a slope-bar 8, from the shoulder 3 to the toe of the embankment surface 2, each of the bars 7 and extensions 8 being embedded beneath and disposed substantially parallel with the top-surface 4 and slope-surface 2, respectively, as best seen in Figure 1.

To thus follow the contour of the earthwork cross-section, each respective anchor-bar 7 is turned or bent downwardly, as at 9, opposite the shoulder 3 for merging into the slope-bar 8, the bar 7 at its bend 9 being supported against vertical and also lateral displacement by means of a knuckle-head 10, which is also embedded in the earthwork A, and which preferably comprises a frusto-conical or spread-base hollow body-member, at the upwardly presented apex of which is mounted a saddle 11 having on its upper face a suitable channel or seat for receiving the bend 9 of the particular bar 7, as best seen in Figures 2 and 3.

Embedded in the earthwork A intermediate the slope-bars 8 of a pair, is a plurality or series of earth-checks C arranged approximately in parallel relation in a spaced row extending stepwise, as may be said, transversely of the embankment slope 2. Each earth-check C comprises a preferably metallic relatively long and narrow wall or beam 12 of approximate channel-section disposed more or less longitudinally of the embankment 2, each wall 12 being stamped, rolled, or otherwise suitably formed with upper and lower longitudinal flanges 13, 14, respectively, and suitable brackets or corner reinforcements 15, 16, being preferably fitted between the respective flanges 13, 14, and the wall body-portion. For purposes presently appearing and as best seen in Figures 4 and 6, the flanges 13, 14, are obliquely rearwardly and upwardly disposed, and have different angular relation to, the wall 12, and preferably intermediate the flanges 13, 14, the wall 12 is provided with a longitudinal V-shaped stiffening corrugation or rib 17, as best seen in Figure 6.

Preferably the flanges 13, 14, and corrugation 17 project from the rear or uphill face of the wall 12, and on the flush front face of the wall 12 is disposed or mounted a pair of longitudinally spaced vertical posts or stiffeners 18 preferably of angle-section as shown, the wall-engaging leg of each member 18 being extended at its opposite ends over the upper and lower flanges 13, 14, to which the stiffeners 18 are suitably attached, as by welding or the like.

Suitable bolt-openings 19 are provided through the overlapping ends of the stiffeners 18 and the respective flanges 13, 14, as best seen in Figure 5, and attached to the respective opposite ends of each wall 12, as by suitable fastening members or bolts 20 passed through the openings 19, is a pair of upper and lower suspender or tie-bars 21, 22, respectively, which extend rearwardly and laterally and also convergingly upwardly from the wall 12 for disposition upon the opposite faces of the adjacent or co-operable slope-bar 8, to which the pair of tie-bars 21, 22, is secured by a common fastening member or bolt 23, as best seen in Figure 4.

Preferably also, it may be said, the same fastener 23 is employed for securing the like tie-bars 21, 22, of an adjacent aligning earth-check C, as best seen in Figure 7.

In use and operation, the mat type of erosion check or slope-retainer of my invention is constructed of a plurality of the panel-sections B of Figure 7, each anchor-bar 7 and slope-bar 8 thereof, except, of course, the respective end bars, being common to contiguous panels, as seen in Figure 8. When employed in fill construction, where the shoulder 3 is approximately tangent, as in the present instance, the bars 8 at their respective lower ends are extended to more or less degree, so as to substantially reach to the toe of the slope, there being thus as many of the checks C in each panel B as may be required for the purpose. On the other hand, where employed in cuts, as will be understood, the knuckle-heads 10 will lie in a curved line following the shoulder of the cut through the hill.

The mat-construction of erosion-check or slope-retainer shown in Figure 8 provides a highly efficient and flexible arrangement for protecting embankment-slopes, the manner of interconnecting the panels B serving to tie adjacent portions of the earthwork solidly together, while permitting sufficient flexibility to the mat as a whole for accommodating itself to settlement in the earthwork, as may often occur in fills and the like.

Each of the earth-checks C acts as a small retaining wall anchored against displacement downwardly of the slope for supporting a particular portion of the surface layer of slope-material. Drainage water, for example, flowing over the slope-surface 2 of the earthwork A, tends to scour material from the slope-surface, but is prevented from doing so by the check-walls C, which retard the flow of water and cause the deposit of the water-carried earth or silt behind the walls C, the effective action of which is augmented by the angular flanges 13, 14, which not only prevent water entering erosively between the earth and the face of the plate 12, but also accumulate a body of erosion-retarding earth directly and compactly against the face of the wall, and it may here also be noted that the relative angularity of the flanges 13 and 14 may selectively vary with the inclination of the slope and facilitates the attachment through the bars 21, 22, of the member C with the anchoring bar 8. The walls C, being anchored to the main body of the earthwork at a point remote from the effective scouring action of the water, remain substantially fixed in position independently of any local movement of the slope material. By thus preventing movement and erosion of the surface layer of the embankment-slope, the entire underlying body of the embankment is protected from the destructive effects of the natural elements.

I might add that the knuckle-heads 10 serve also most effectively for holding the earth in shape at the shoulder of the embankment.

In some instances, it may be desirable to protect an earthwork construction by individual panels or sections, each independent of the other. For such purpose, the retainer may be modified, as illustrated in Figure 9, to include such individual panel-sections B', each comprising an anchor-bar 7' which is attached at an end to an anchor-block (not shown), as described for a bar 7 of a panel B, and terminating at its outer end adjacent the knuckle-head 10'.

To the outer end of the bar 7', are, in turn, attached oppositely flaring pairs of tie bars 21', 22', similar to, but preferably of heavier section than, the bars 21, 22. Each pair of the tie-bars 21', 22', is attached to the respective opposite ends of the check C at the head of the slope, and the remainder of the checks C in the row thereof are, in turn, suspended from the topmost check by means of respective pairs of slope-bars 24 disposed approximately parallel with the general slope of the embankment for engaging the also respective opposite ends of the several checks, as will be readily understood from Figure 9.

Thus each panel B' comprises an anchor-block and its attached anchor-rod 7', which, in turn, suspends by the slope-bars 24 a row of checks C along and under the slope of the embankment. Such panel sections B' may usefully be employed in protecting end slopes of embankments, as at bridge-sites and the like. I might add that the walls C may be arranged, if desired, in staggered relation down the embankment slope by disposing some of the walls C under the anchor-bars 7' and others between the bars.

In practice, it is found that the action of the elements or forces of nature tending to erode, loosen, or dislodge the surface material of earthwork embankments is by my check or retainer

most effectively counteracted, and the necessity, for example, of sodding or terracing embankment slopes is thereby avoided. The panel-sections B or B' may be deposited in place prior to completion of an earthwork fill and suitably buried as the fill is completed, or, as in a manner presently appearing, the panel-sections may be laid on the surface of the embankment-slope, reliance being placed on natural erosion effects to fill in between the checks C, which subsequently function to stop further erosion.

Figure 10 illustrates an arrangement for protecting the opposite slopes 25 of an embankment D by means of respective slope-retainers B'' each including the slope-bars 8'', knuckle-heads 10'', bridle-bars 21'', 22'', and wall-sections C'', substantially as set forth for like parts of the slope-retainer B. However, the opposed anchorage bars 7'' of the slope-retainers B'' are in this case extended under the paving-slab 26 of the highway and suitably secured together, as at 27, whereby each slope-retainer B'' serves as an anchor for the other, thus dispensing with or obviating the need of an anchorage-block or blocks for the sections.

28 designates respective gutter-forming members disposed longitudinally on the opposite sides of the slab 26, each gutter-member 28 being composed of preferably sheet-metallic material having a generally Z-shaped cross-section, as best seen in Figure 10. The web of the member 28 is disposed approximately flush with the top of the slab 26, one or the inner leg of the member 28 depending adjacent to, and forming a bounding wall or mold for, the side face of the slab 26, and being preferably apertured or otherwise formed for engagement or connection with the adjacent anchor-rod 7'', as indicated at 29 in Figure 10.

The other or outer leg of the member 28 projects above the plane of the top-surface of the slab 26 and is spaced therefrom the width of the web of the member 28, the latter thus serving as a gutter for the slab 26. At suitable intervals, suitable scuppers or drain-pipes (not shown) may be provided leading from the gutter 28 to a suitable point of discharge, as at the toe of the embankment slope, for removal of the drainage water of the slab 26. Preferably, though not necessarily, the embankment shoulder is carried up to the top of the outer wall of the gutter 28, as best seen at 30 in Figure 10.

My check or retainer is adapted for use both in dry or above-water earthwork constructions and in submerged or underwater constructions, as revetment and beach protection works. For such latter purpose, however, I prefer to employ a type of slope-retainer B''', as best seen in Figures 11 and 12, wherein E designates generally a beach or the like, comprising, in the present instance, a suitable underwater fill deposited on the natural bed 31 of the body of water 32, as a water-course, lake, or the like, the fill E extending from the water-line a desired distance into the body of water 32, and terminating in an embankment slope 33.

The slope-retainer comprises preferably any desired number of the sections B''', each of which includes a pair of anchor-blocks 34, of masonry, concrete, or other suitable construction, suitably spaced along and embedded in the natural ground 31, preferably at the approximate water-line 35 of the beach E. Suitably secured, as at 36, to the respective anchor-blocks 34, are anchorage-members or bars 37, each of which extends from its anchor-block 34 approximately to and opposite the end slope 33, and each of which is embedded beneath and disposed approximately parallel with the top-surface 38, of the beach E.

At their outer or free ends, the anchor-bars 37 terminate in respective pairs of diverging upper and lower bridle-bars 39, 39', respectively, each of which is, as by a suitable clamp 40, attached or secured to a corresponding vertical or corner-post 41 of a pair of spaced "A frames" or panel-supporting structures F, the posts 41 being of such height as to extend substantially from the natural ground-line 31 to and a suitable distance above the level of the water 32 for serving as a marker, as at 42, for indicating the outer limit of the beach E.

Each frame F includes a slope-bar 43 disposed approximately parallel with the general slope of the embankment 33, and attached at its upper end to the post 41 for extending downwardly and forwardly therefrom a suitable distance approximately to the level of the ground 31, that is to say, substantially to the toe of the slope 33, the bar 43 at its outer end being connected to the lower end of the post 41 by means of a suitable tie-bar 44, as best seen in Figure 12.

Supported by and between the pair of frames F, is a plurality of check-walls C', in the present instance three in number, arranged approximately in parallel relation in a spaced row extending stepwise transversely of the embankment-slope 33. The check-walls C' are substantially similar in structure to the earth-checks C and each includes a channel-shaped body portion 12' having upper and lower longitudinal flanges 13', 14', respectively, a longitudinal stiffening-rib 17', and cross or vertical stiffening-posts 18', as best seen in Figure 12.

The opposite end portions, or if desired the entire length, of the lower flanges 14' is suitably bent angularly with respect to the body or web 12' for accurately and firmly engaging the sloping upper face of the slope-bar 43, to which the walls C' are secured or fixed by suitable fastening elements or rivets 45.

At its respective opposite ends, the upper flange 13' of each of the lower walls C' of the series, is secured or fixed, preferably also by rivets or other suitable fastening elements, to a brace-bar 46 extending rearwardly to, and having a portion suitably bent for residing firmly also on, the upper face of the bar 43, to which the bar 46 is fixed by rivets 47. The upper flange 14 of the topmost wall C', however, is suitably fixed preferably directly to the posts 41, as best seen in Figure 12.

In use, the foregoing modified form of revetment-work or beach-protection structure of my invention is constructed of a suitable plurality of the panel-sections B''', suitably arranged in contiguous relation according to the shape or plan of the beach or river-wall to be protected, as will be understood, and, if desired, the slope-bars 43 may be widened so as to support the adjacent ends of abutting walls C' of contiguous sections B'''.

The several sections B''' being disposed on the natural ground 31 of the river or lake, as the case may be, a suitable filling material, as 49, is deposited behind the walls C', which filling extends as far toward the shore-line as may best serve the purpose, the filling 49 for beach-construction work being preferably covered with a sand or earth topping 50, as best seen in Figure 11.

The filling 49 may also, is desired, be extended

outwardly of and over the series of check-walls C' for substantially covering the same, although for underwater or revetment work, such covering of the walls C' is not deemed necessary, inasmuch as, in course of time, the beach debris or detritus will accumulate along and on the slope 33 for more or less covering the slope-retainer structure.

It will be understood that other changes and modifications in the form, construction, arrangement and combination of the several parts of my erosion-check may be made and substituted for those herein shown and described without departing from the nature and principle of my invention.

Having thus described my invention, what I claim and desire to secure by Letters Patent is,—

1. A slope-retainer comprising a wall for disposition longitudinally and downwardly from the shoulder of an embankment-slope, a head disposed on the embankment opposite the shoulder of the slope, and means including a bar fixed at an end in the earthwork remote from the shoulder of the slope and extending transversely of the embankment approximately parallel with the slope-surface, the bar resting on the head intermediate its ends and having connection at its other end with the wall for anchoring the same against displacement.

2. A slope-retainer comprising a wall for disposition longitudinally and downwardly from the shoulder of an embankment-slope, a frustro-conical member embedded in the earthwork opposite the shoulder of the slope and having a saddle at its upwardly presented apex, and means including a bar fixed at an end in the earthwork remote from the shoulder of the slope and embedded in the embankment approximately parallel with the slope-surface, the bar resting intermediate its ends on said saddle and having connection at its other end with said wall for anchoring the same against displacement.

3. A slope-retainer comprising, in combination, a plurality of longitudinally spaced rows of transversely spaced check-walls for disposition in an embankment slope, anchor-members embedded in and extending transversely of the slope intermediate respective pairs of rows of said walls, means for securing the anchor-members in the earthwork at points remote from the shoulder of the slope, and members connecting the respective anchor-members with adjacent check-walls for preventing displacement thereof.

4. A slope-retainer comprising, in combination, a plurality of longitudinally spaced rows of transversely spaced check-walls for disposition in an embankment slope, anchor-bars embedded transversely in the slope between and common to respective pairs of rows of said walls, means for securing the anchor-members in the earthwork at points remote from the shoulder of the slope, and means including respective pairs of upper and lower tie-members for connecting the respective anchor-members with adjacent check-walls of the respective rows for preventing displacement thereof.

5. In a slope-retainer, a pair of spaced wall-sections disposed longitudinally of the embankment-slope, and means for anchoring the sections in spaced relation transversely of the slope, said means including a slope-bar common to, and extending approximately parallel with the general slope of the embankment intermediate the sections, and tie-bars connecting the bar to the respective sections.

6. In a slope-retainer, a pair of spaced wall-sections disposed longitudinally of the embankment-slope, and means for anchoring the sections in spaced relation transversely of the slope, said means including a slope-bar common to, and extending approximately parallel with the general slope of the embankment intermediate the sections, and pairs of opposed tie-bars extending obliquely between, and fastened at their ends to, the slope-bar and the respective sections.

7. In a slope-retainer, a pair of spaced wall-sections disposed longitudinally of the embankment-slope, and means for anchoring the sections in spaced relation transversely of the slope, said means including a block anchored in the embankment adjacent the head thereof, a slope-bar fixed at an end to the block and extending approximately parallel with the general slope of the embankment intermediate the sections, and pairs of opposed tie-bars extending obliquely between, and fastened at their ends to, the slope-bar and the respective sections.

8. In a slope-retainer, a wall for disposition longitudinally of the embankment-slope, said wall comprising a beam having upper and lower longitudinally extending lateral flanges, and means for anchoring the wall against displacement, said means including a slope-bar fixed upon and extending transversely of the embankment slope and tie-bars bolted at their ends to the flanges of the wall and to the slope-bar.

9. In a slope-retainer, a wall for disposition longitudinally of the embankment-slope, said wall comprising a beam having upper and lower longitudinally extending rearwardly presented lateral flanges, and means for anchoring the wall against displacement, said means including a slope-bar fixed upon and extending transversely of the embankment slope, and upper and lower tie-bars bolted to the flanges of the wall and to the slope-bar, said tie-bars extending convergingly from the wall, and being bolted at a common point, to the slope-bar.

10. In a slope-retainer, a wall for disposition longitudinally of the embankment slope, said wall having, at its respective upper and lower margins, longitudinally extending obliquely rearwardly and upwardly presented lateral flanges, and means for anchoring the wall against displacement, said means including a slope-bar fixed to and extending transversely of the embankment, and tie-bars having connection at their opposite ends with the slope-bar and with the respective flanges of the wall.

11. In a slope-retainer, a wall for disposition longitudinally of the embankment-slope, said wall comprising a beam having, at its respective upper and lower margins, longitudinally extending flanges, said flanges being presented obliquely laterally and upwardly from, and at different angles to, the beam, and means for anchoring the wall against displacement, said means including a slope-bar fixed to and extending transversely of the embankment, and tie-bars having connection at their opposite ends with the slope-bar and with the respective flanges of the wall.

12. In a slope-retainer, a wall disposed longitudinally of the embankment-slope, a block embedded in the embankment remote from the shoulder thereof, a bar fixed at an end to the block and extending from the block transversely of the embankment approximately parallel with the slope surface, means connecting the bar with the wall for anchoring the wall against displacement, and a head disposed in operative relation

to the embankment for supporting the bar at its bend opposite the shoulder of the slope.

13. In a slope-retainer, a wall disposed longitudinally and downwardly from the shoulder of the embankment-slope, a knuckle-head comprising a frustro-conical body-member for embedment in the embankment with its apex presented upwardly, and a wall-retaining slope-bar fixed at an end to the embankment and having connection at its other end with the wall, the bar intermediate its ends resting on the apex of said body-member.

14. In a slope-retainer, a wall disposed longitudinally and downwardly from the shoulder of the embankment-slope, a knuckle-head comprising a frustro-conical body-member for embedment in the embankment with its apex presented upwardly, and a wall-securing slope-bar fixed at an end to the embankment and having connection at its other end with the wall, the bar resting intermediate its ends on the apex of the body-member.

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