Nov. 29, 1938. O. B. LANE 2,138,037

EARTH RETAINER

Filed Dec. 29, 1937 3 Sheets-Sheet 1

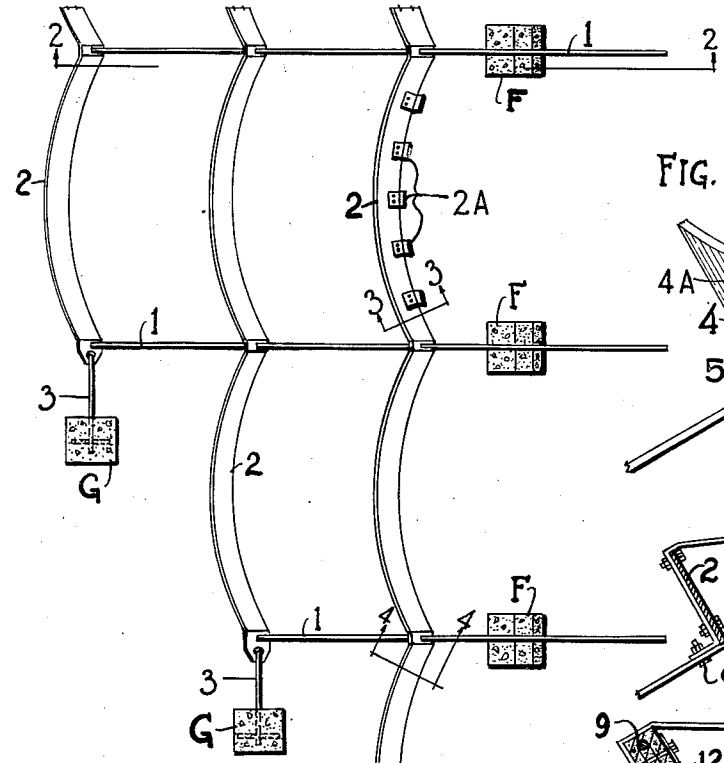


FIG. 1.

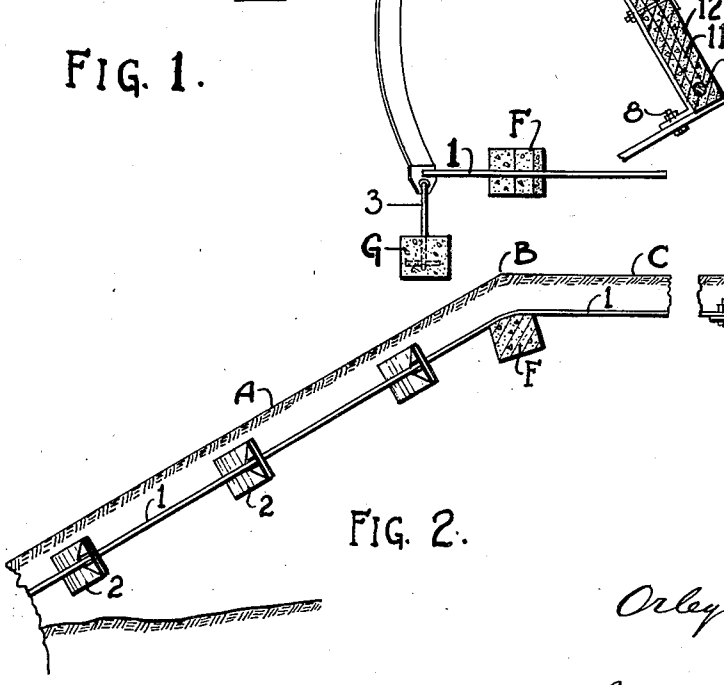


FIG. 2.

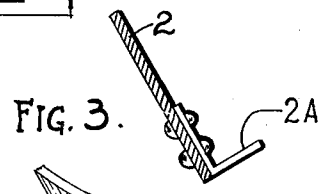


FIG. 3.

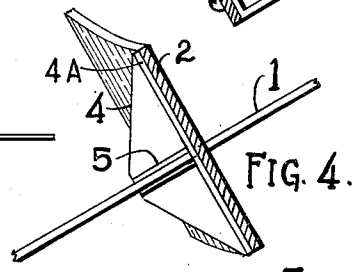


FIG. 4.

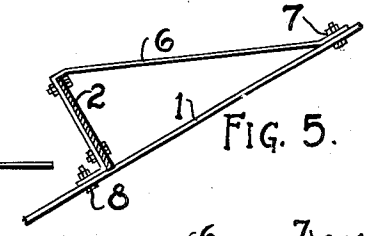


FIG. 5.

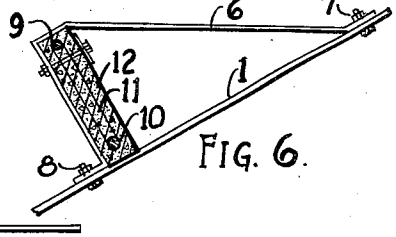
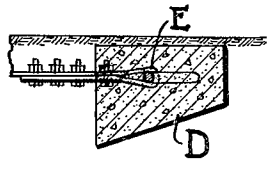


FIG. 6.



Inventor

Orley B. Lane

By J. F. Mothershead

Attorney

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EARTH RETAINER

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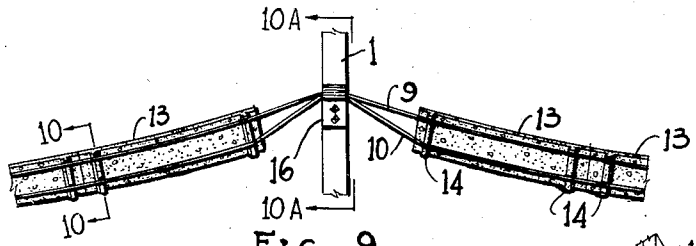


FIG. 9.

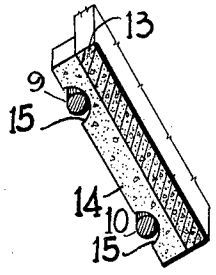


FIG. 10.

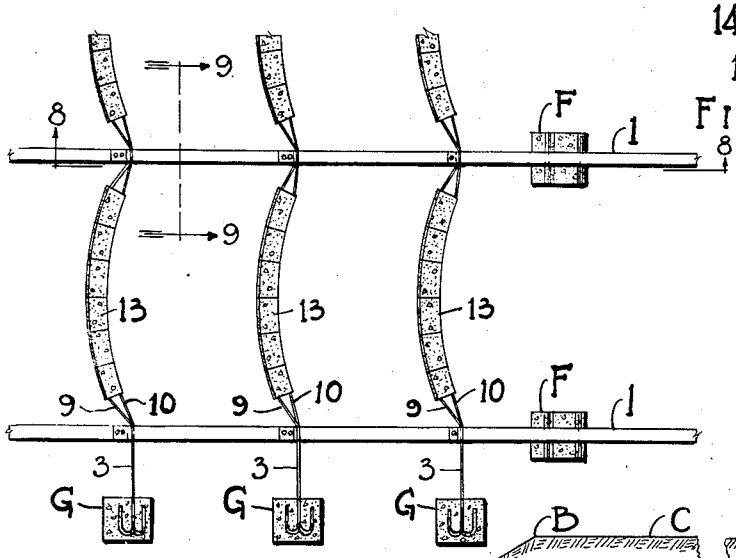


FIG. 7.

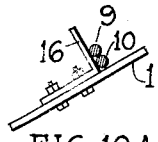


FIG. 10A

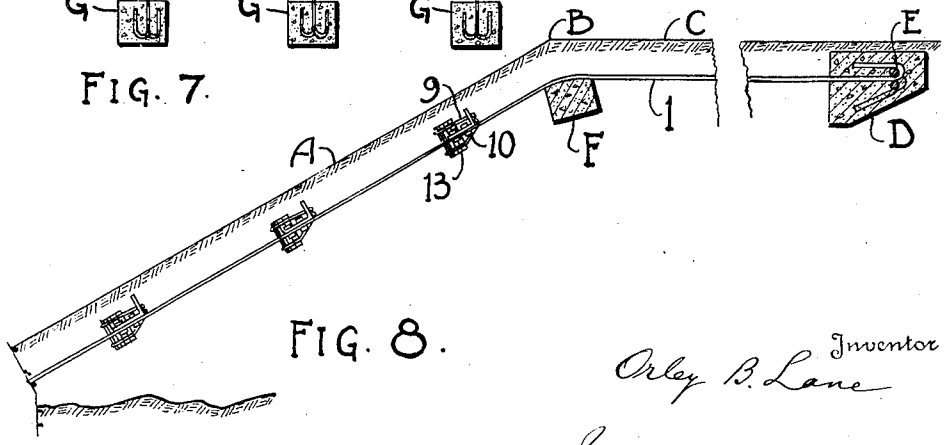


FIG. 8.

Inventor

Orley B. Lane

By J. F. Mothershead

Attorney

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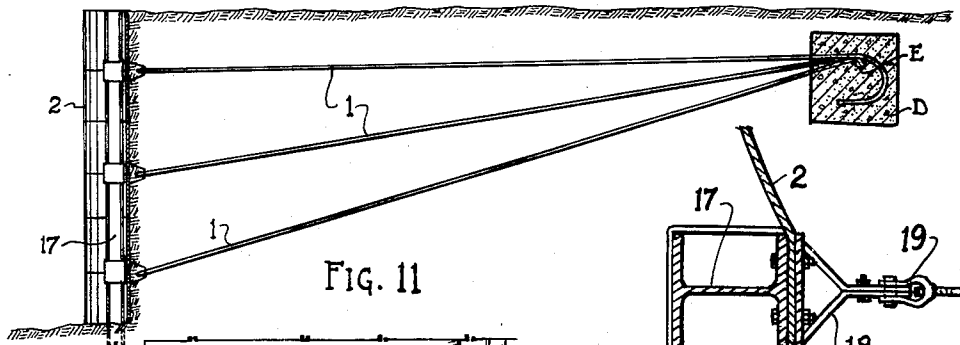


FIG. 11

FIG. 16

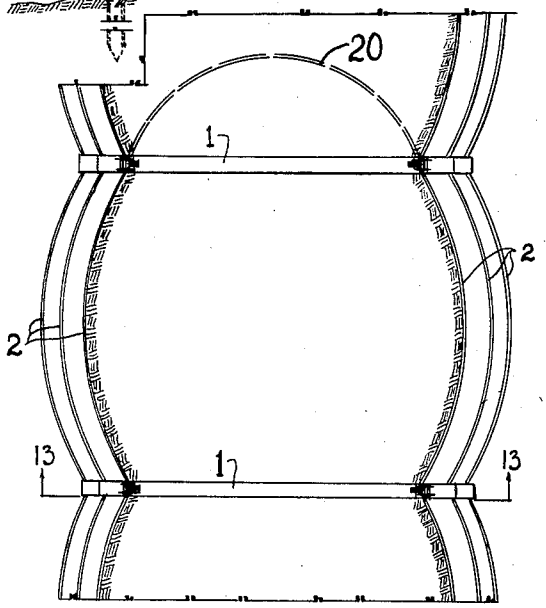


FIG. 12

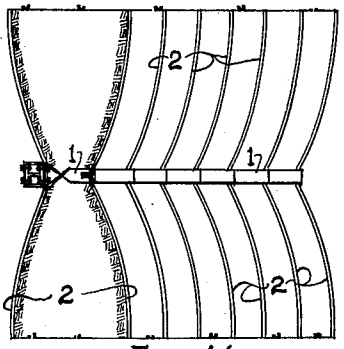


FIG. 14

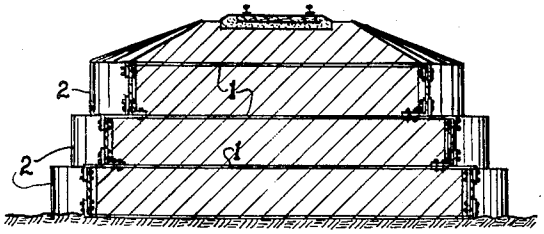


FIG. 13

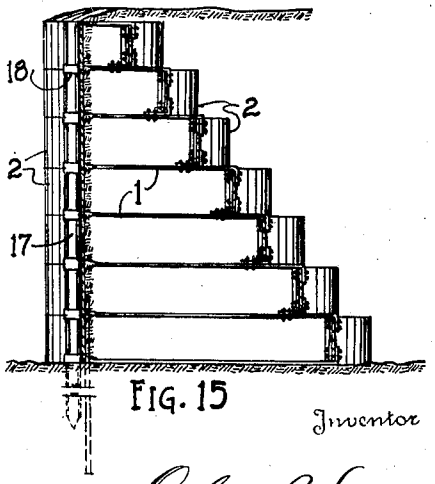


FIG. 15

Inventor

Orley B. Lane

By J. F. Mothershead

Attorney

Patented Nov. 29, 1938

2,138,037

UNITED STATES PATENT OFFICE

2,138,037

EARTH RETAINER

Orley B. Lane, Washington, D. C.

Application December 29, 1937, Serial No. 182,273

13 Claims. (Cl. 61—35)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

The invention described herein may be manufactured and used by or for the Government of the United States for governmental purposes without the payment to me of any royalty thereon in accordance with the provisions of the act of April 30, 1928 (Ch. 460, 45 Stat. L. 467).

This invention relates in general to earth retainers and more particularly has reference to confining earth work to steep slopes or vertical surfaces and the protection of earth slopes against slides.

In earth work as for highways, railroads and canal gradings, embankments, gradings for building sites, terraces, etc., earth is frequently removed from higher places and placed in the hollows or valleys, the place from which the earth is removed being generally called cuts and the placed material called fills. At the margin of such cuts, fills, gradings or embankments there is generally formed a slope. The nature of the earth being worked, its moisture content, the erosion to which it is subjected, and the foundation upon which it rests determine how steep such slopes may be built or at what angle the surface of the embankment may be made with respect to the horizontal surface and still be stable. This is generally called the angle of repose. Frequently it is necessary or desirable to confine earthwork to a slope that is steeper than the angle of repose of the soil or even in a vertical surface.

Natural and constructed grades, slopes and embankments of highways, railroads, buildings, canals, etc., are constantly under both active pressure (i. e., that pressure which the earth exerts in tending to take its natural slope) and to passive pressure (i. e., that pressure required to dislodge the earth). These pressures cause slides and erosion which endanger lives and property as well as obstruct passageways and hamper commerce. There is a great annual expense in constantly removing such obstructions and maintaining such embankments. In correcting the conditions described, I have provided retaining means of the character hereinafter set forth.

My invention has for its purpose the provision of an earth retaining structure which is inexpensive, simple to fabricate and install, and which is dependable and durable for retaining and maintaining earth slopes.

In the accompanying drawings, intended to illustrate the invention and practical applications thereof,—

Fig. 1 is a plan view of the device applied as a slope retainer;

Fig. 2, a vertical section taken at 2—2 of Fig. 1;

Fig. 3, an enlarged section taken at 3—3 Fig. 1;

Fig. 4, an enlarged vertical section taken at 4—4 Fig. 1;

Fig. 5, a vertical view of a modified means for securing the earth checks to their supporting members;

Fig. 6, an enlarged vertical section of another modified form of my earth retainer;

Fig. 7, a diagrammatic plan of the application of the earth retainers, elements of which are illustrated in detail in Figs. 9, 10 and 10A;

Fig. 8, a diagrammatic vertical section at 8—8 Fig. 7;

Fig. 9, a vertical rear view taken at 9—9 Fig. 7;

Fig. 10, a vertical cross section taken at 10—10 Fig. 9;

Fig. 10A, an enlarged section at 10A—10A Fig. 9;

Fig. 11, a vertical section of the device applied as a vertical retaining wall;

Fig. 12, a fragmentary plan view of the device applied to confining dual sided gradings as shown in vertical cross section in Fig. 13;

Fig. 13, a vertical section taken at 13—13 Fig. 12;

Fig. 14, a fragmentary plan view of the device applied as a vertical retainer anchored within a fill as shown in vertical cross section in Fig. 15;

Fig. 15, a vertical section through the sectional plan shown in Fig. 14;

Fig. 16, an enlargement of the central portion of Fig. 14.

With reference to the drawings for illustrative purposes, my invention comprises, broadly, a plurality of direct-tension supporting members 1; earth checks or baffles 2; sidelong-tension supporting members G; the design, arrangement and construction thereof; and the associated supporting and attaching elements therefor.

For the retention of embankments and terraces having (as illustrated by Figs. 2 and 8, as well as by the respective plans of Figs. 1 and 7) earth slopes A with shoulders B and upper surfaces C, I provide deadmen D, or other anchorages, at predetermined intervals in, or already located in, the surface C remote from the slope A. These deadmen or anchorages are of suitable material such as masonry or may be of natural formation and are provided with any suitable tying means E to which I attach direct-tension supporting members 1, in the form of steel rods, cables, bars, or straps, which are preferably imbedded within the earth to a certain extent and are arranged to run with the dip of the slope A. At the shoulder B of the embankment I propose to also imbed

a bearing block or footing member F of masonry or other suitable material, beneath the supporting members 1 to prevent their cutting into the shoulder B. Running with the strike of the various contour lines of the slope, I provide (as shown in Figs. 3 through 6, 9 and 10) relatively thin elongated plate, slab, or strip-like earth checks or baffles 2 of such material as sheet metal, concrete, terra cotta, asphalt, or other suitable material, which may be self sustaining or reinforced, as described hereinafter.

The earth checks 2 are positioned in an upright edgewise manner substantially at right angles to the supporting members 1, which supporting members are substantially parallel with the direction of the imposed loads. Longitudinally the earth checks are disposed horizontally of the slope A or substantially along contour lines thereof. At the points where these checks intersect their supporting members 1, they are secured thereto by suitable means such as illustrated in Figs. 4, 5, 6 and 10A, also described hereinafter.

In addition to the direct-tension supporting members 1 for the earth checks 2, I provide tension supporting members 3 on the ends of the earth checks for anchoring the same to sidelong deadmen G.

For the formation and retention of vertical walls, as illustrated in Fig. 11, the earth checks 2 are superimposed and their direct-tension supporting members 1 are placed substantially along the shortest line between the deadmen D and the earth checks to which they are respectively attached, rather than as shown in Figs. 2 and 8, where the supporting members 1 follow the surface and dip of the slope.

For the formation and retention of dual sided gradings, such as for road beds having either vertical or sloped sides as illustrated in Figs. 12 and 13, the deadmen D may be eliminated and the supporting members 1 passed directly through the grading and secured to the earth check on the opposite side of the grading, whereby the one earth check serves as an anchor for the other. Depending upon whether the grading is of vertical or sloping sides, the earth checks are arranged in either a superimposed or stepped manner.

In the formation and retention of fills having a vertical wall, such as for wharves, coffer dams, canals, etc., illustrated in Figs. 14 and 15, the deadmen D may again be eliminated and in lieu thereof the superimposed earth checks, forming the vertical wall, may be anchored to other earth checks placed within the fill. For this purpose it is preferable to have the imbedded anchoring earth checks arranged in a stepped manner, whereby the anchorage is increased as the weight of the fill progressively increases its pressure, that is with the increased depth of the fill, on the vertical wall-forming earth checks.

With the structure thus employed the active pressure of the earth imparts a pressure on the face of the earth checks, 2, which pressure is transmitted to the supporting members 1 and thence back to their anchorage D. This pressure upon the earth checks also imparts a sidelong tension which is transmitted through the supporting members 3 to the sidelong anchorage G at the ends of the earth checks, or to bulkheads 20, Fig. 12, described hereinafter, whereby a collapse of the structure, by reason of pressure upon the earth checks, is prevented.

In the formation and installation of the structure the earth checks are shown as having a parabolical curve, catenary when determinable, concave with respect to the imposed loads. The curvature may be determined by the approximated maximum earth pressure upon the checks and the distance between supporting members in order to relieve the checks of undue tensile stresses. In very steep slopes or vertical walls the earth pressure increases as its depth increases and should be taken into consideration in the curvature design of the checks placed on each of the lower levels.

The engineering principles involved in my device may be compared to a suspension bridge. The deadmen G serve a purpose similar to the anchorage of the bridge. The supporting bars 1 and the anchorage D (or its equivalent as in Figs. 12 to 15) serve a purpose similar to the towers of the bridge, while the earth checks in my device serve both to engage the earth and to transmit the load to the supporting bars similar to the cables of the bridge transmitting the load to the towers.

The earth checks 2 are not intended to act as a beam between the supports 1. Herein resides the economy of my device, namely, in the utilization of tension or suspension members for transmitting the imposed loads to the supporting members. The economy of this type of earth check as compared to a beam is well known. Beams for this purpose transmit loads to reactions that are parallel to the direction of the loads and the fibers of the beam are subjected to bending stresses which include horizontal as well as vertical shear stresses, compression, tension, and rigidity factors. Flexible curved members, however, such as the earth checks described, transmit loads across spans to reactions both parallel and normal to the loads which subject the curved members only to tension and but a small amount of vertical shear stress. In a tension member, such as I employ, the whole cross sectional area may be stressed to the allowable limit whereas in a beam only the extreme fibers, or a small per cent of the cross sectional area, may be stressed to the allowable limit. The various forms of beams or beam acting walls which have been used to accomplish the same purpose require a greater amount of material, costly fabrication and connecting details and a closer spacing of the supporting members.

Means may also be provided to prevent the checks from lifting and permitting the earth to pass thereunder, such for example as L-shaped bracket-like members or lugs 2A as shown in detail in Figs. 3 and 1, or in lieu thereof a flange (not shown) may be provided at substantially right angles to the upright portions of the checks 2 and serve in a manner similar to the leg of the L-bracket, whereby the weight and downward pressure of the earth thereon will tend to anchor the checks 2 to the surface on which they were originally placed and prevent any tendency of vertical displacement.

The means for securing the earth checks 2 to their supporting members 1 and for maintaining the checks in an upright position also comprise part of my invention. These means are illustrated in detail in Figures 4, 5, 6 and 10A. The form of securing means illustrated in Figures 4 and 2 comprises metal members L-shaped in plan and having one leg 4A extending vertically along the back of the vertically disposed earth check 2 and connected thereto by such means as rivets, bolts or weldings, not shown. The other leg 4 extends rearwardly at an angle to the leg 4A. In this modification the supporting member 1

passes through the earth check and the vertically disposed leg 4A of the L-shaped member and is welded or otherwise secured to the inner face of the leg 4 as indicated at character reference 5.

An alternative form of means for securing the earth check to the supporting member 1 is shown in detail in Figures 5, 6 and 7, where it will be seen that I provide a metal bar 6 which is bolted to the supporting member 1 as at 7 and extends obliquely over the uppermost edge of the earth check 2 and then vertically downward to the supporting member 1, where it is again bolted as at 8. A third modification of the securing means is shown in Figures 10A, 9, 7 and 8 and comprises an L-shaped lug or bracket 16 having one leg bolted or otherwise secured to the supporting member 1 and the other leg extending upwardly. In the utilization of this type of securing means the earth checks or their reinforcing members may be either bolted to the vertical leg of the lug or merely hooked thereover by passing the same along the uphill face thereof.

By reference to Figures 3 through 6, 9 and 10, illustrating details of components of my invention, it will be seen that the earth checks 2 are relatively thin and are of such flexible material as plain sheet or plate metal (Figs. 3, 4 and 5). As a modification for the steel plate type of earth check I provide reinforced or supported earth checks of pre-cast concrete, terra cotta, gypsum, asphalt, or the like, as illustrated in detail by Figures 6, 9 and 10, and by the diagrammatic views of Figures 7 and 8. The pre-cast types of earth check are either formed with a parabolical curve or with interval joints, scores or grooves for flexure and expansion which will permit the earth checks to take a curve in the placement thereof or under pressure of the earth and thereby be subjected to tension stresses rather than bending or flexural stresses as in a beam.

In the construction of the cast type of check illustrated in Figure 6, I imbed metal rods 9 and 10, near the top and bottom of the slab-like check, which extend transversely throughout the earth check. Wire fabric or metal lath 11 may also be passed around, and secured if necessary, the metal rods 9 and 10 before the application of the concrete or other plastic substance 12 to the reinforcements. The rods 9 and 10 should be allowed a parabolical curve before the plastic substance is applied. In the modified form of cast material earth checks illustrated in Figures 7 to 10, the cast slab 13 is provided with ribs 14 at intervals vertically across the downhill side of the slab. These ribs are provided with notches 15 adapted to receive metal rods 9 and 10 similar to those imbedded in the form illustrated in Figure 6. The rods in the form shown in Figure 9, etc., continue from the ends of the slabs to hook over the lugs shown in Figures 10A and 4 or through the securing means shown in Figures 5 and 6. The rods projecting from the outermost ends of the series of slabs are anchored to the deadmen G.

In the cast type of earth check, the rods 9 and 10 provide the tensile strength and transmit the loads coming to the earth checks in the same manner as the metal plate type of earth check hereinbefore described. In the form shown in Figure 6 the cast material serves to protect the reinforcements against corrosion.

In the use of my invention for the maintenance of vertical or substantially vertical walls such as described in connection with Figures 11 to 15 I propose to utilize a pile or post 17 at the lower ends of the supporting members 1 to serve, among other purposes, to maintain vertical alignment. Suitable means for securing the supporting members 1 to the pile 17 is shown in Figure 16 as a bar 18 placed around the pile and secured to the end of the supporting member 1 by such means as indicated at 19. The earth checks may be secured to the pile 17 and also spliced at this point. By such a piling and securing method an uplifting of the earth checks is prevented and a wider vertical spacing between the supporting member 1 is afforded. The piling 17 may be of reinforced concrete or in the alternative form of steel H-beams as shown in Figure 16.

For the maintenance of vertical or substantially vertical walls, such as illustrated in Figs. 12 to 15, it may be impractical to utilize such sidelong anchorages as described in connection with Figs. 1 to 7. In lieu thereof, a bulkhead 20, Fig. 12, may be substituted. This bulkhead is shown as comprising an earth check 2, as previously described, which continues from the longitudinally disposed earth checks on one side of the grading, or fill, to anchorages within the grading or on the opposite side thereof. The anchorage may be another earth check on the opposite side of the grading. The earth check type of bulkhead may be substituted by a supporting member 1 having a depth substantially that of the earth check which it supports.

Having thus described my invention, what I claim is:—

1. A retainer for earthen embankments of the class employing a pair of substantially parallel elongated supporting members spaced transversely of the embankment and anchored at their upper ends, the combination with said supporting members of a curved earth check acting in tension as distinguished from beam action for opposing active pressures of said embankments, said earth check being connected to and extending from one of said supports to the other.

2. The structure claimed in claim 1 in combination with sidelong means for opposing longitudinal components of force upon said earth check.

3. A retainer for earthen embankments comprising a series of parabolically curved earth checks disposed longitudinally of said embankment, a series of elongated supporting members each having one end anchored at a predetermined point beyond the shoulder of the embankment and extending from said anchorage to said earth checks, said elongated supporting members being spaced to traverse said earth checks at the ends respectively of the parabolical curves, means for securing said earth checks to said supporting members at the said points of intersection, and means for opposing longitudinal components of force upon said earth checks resulting from normal forces thereon and lateral forces on said supporting members.

4. A retainer for earthen embankments comprising a relatively thin elongated slab-like earth check having sufficient flexibility to substantially parabolize itself in opposing components of force resulting from active earth pressures normal to said earth check whereby the stresses thereon are those of tension as contradistinguished from beam action stresses, means secured to the ends of said earth check to which normal components of force upon said earth check may be trans-

mitted, and means to which parallel components of force upon said earth check may be transmitted.

5. A retainer for earthen embankments comprising a relatively thin elongated slab-like catenary earth check operable in tension to oppose components of force normal thereto, means disposed from the ends of said earth check for opposing components of force upon said earth check, and means disposed from the ends of said earth check for opposing parallel components of force resulting from the opposition to the normal components of force.

6. A retainer for earthen embankments comprising a relatively thin elongated slab-like earth check running longitudinally of the embankment below the shoulder thereof and positioned in an upright edgewise manner substantially at right angles with respect to the direction of the active earth pressures of said embankment, said earth check having recurring parabolical curves in series whereby the earth check acts in tension in opposing the normal components of force of the active earth pressures of the embankment, supporting members running parallel with components of force of the active earth pressures of the embankment secured to the earth check at the ends respectively of said curves and anchored beyond the shoulder of said embankment, and means secured to the ends of said earth check for opposing longitudinal components of force on the earth checks which may be converted from the normal components of force by the opposition thereto.

7. An earthen embankment retainer wherein a pair of spaced substantially parallel elongated supporting members anchored at their upper ends are disposed at intervals transversely of the embankment to support earth checks disposed longitudinally of the embankment, characterized by the fact that there is combined with said support a paraboliform earth check spanning said supporting members and subjected to normal, longitudinal and vertical components of force, means connected to said earth check for opposing the vertical component of force thereon, and means connected to said assembly for opposing both the longitudinal component of force on said earth check and the lateral component of force on said supporting members.

8. A retainer for earthen embankments comprising an elongated member so shaped that its resistance to normal earth pressures thereon is greater in tension than in compression, and means attached to the ends of said elongated member for anchoring the member against both normal and longitudinal forces tending to displace the same.

9. An earthen embankment retainer comprising a relatively thin elongated strip-like member having sufficient flexibility to flex under bending forces and act substantially as a tension member and means secured to the ends of said member to resist normal and lateral displacement by earth pressures thereon.

10. In combination with supporting and anchoring members for the retention of earthen embankments, means to resist the active earth pressures of said embankment comprising a curved elongated member secured transversely of said supporting means and adapted in normal use to act predominantly as a tension member whereby beam action and beam strength is eliminated.

11. An earth check having sufficient curvature to have, when subjected to normal stresses, a greater cross sectional area act in tension than that of the cross sectional area which acts in compression, and means secured to the ends of said earth check for opposing longitudinal stresses on said earth check converted from the normal stresses by reason of the opposition thereto.

12. In combination with earth checks and supporting members therefor, means for securing the one to the other comprising a member secured to the supporting member fore and aft of and embracing said earth check.

13. Means tending to prevent displacement of an earth check with respect to its supporting members comprising a member L-shaped in cross sectional plan, one leg of which is adapted to lie substantially parallel with said earth check and support the same, said leg having an aperture adapted to receive said supporting member in a manner substantially parallel and contiguous with the second leg of said L-shaped means, said supporting member being secured to said second leg.

ORLEY B. LANE.