Jan. 3, 1933. G. M. HOFFMAN 1,892,701

REVETMENT AND PROCESS OF LAYING THE SAME

Filed Feb. 5, 1930 4 Sheets-Sheet 1

Fig. 1.

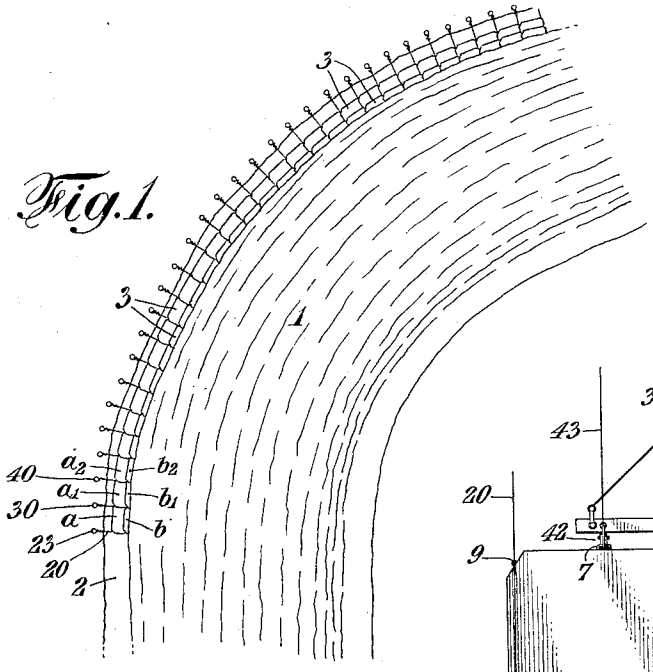


Fig. 7.

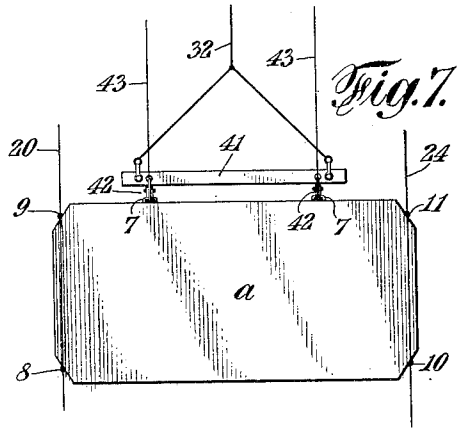
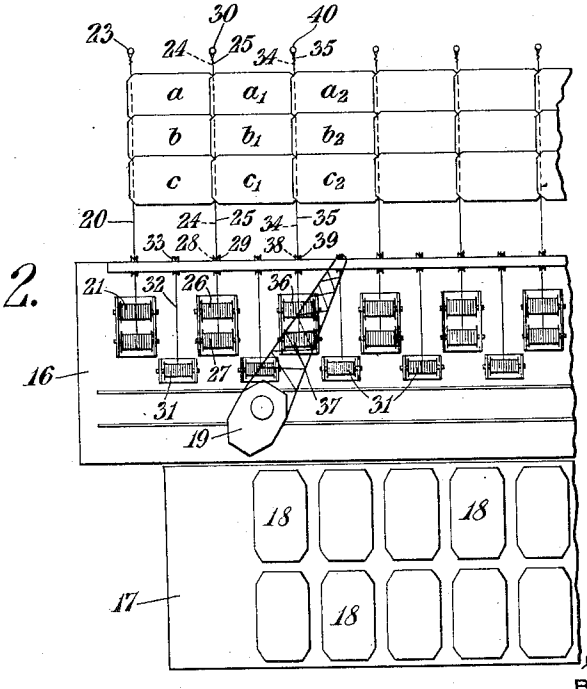


Fig. 2.



INVENTOR
George M. Hoffman
BY
Gifford, Scull & Burgess
ATTORNEYS

Jan. 3, 1933. G. M. HOFFMAN 1,892,701

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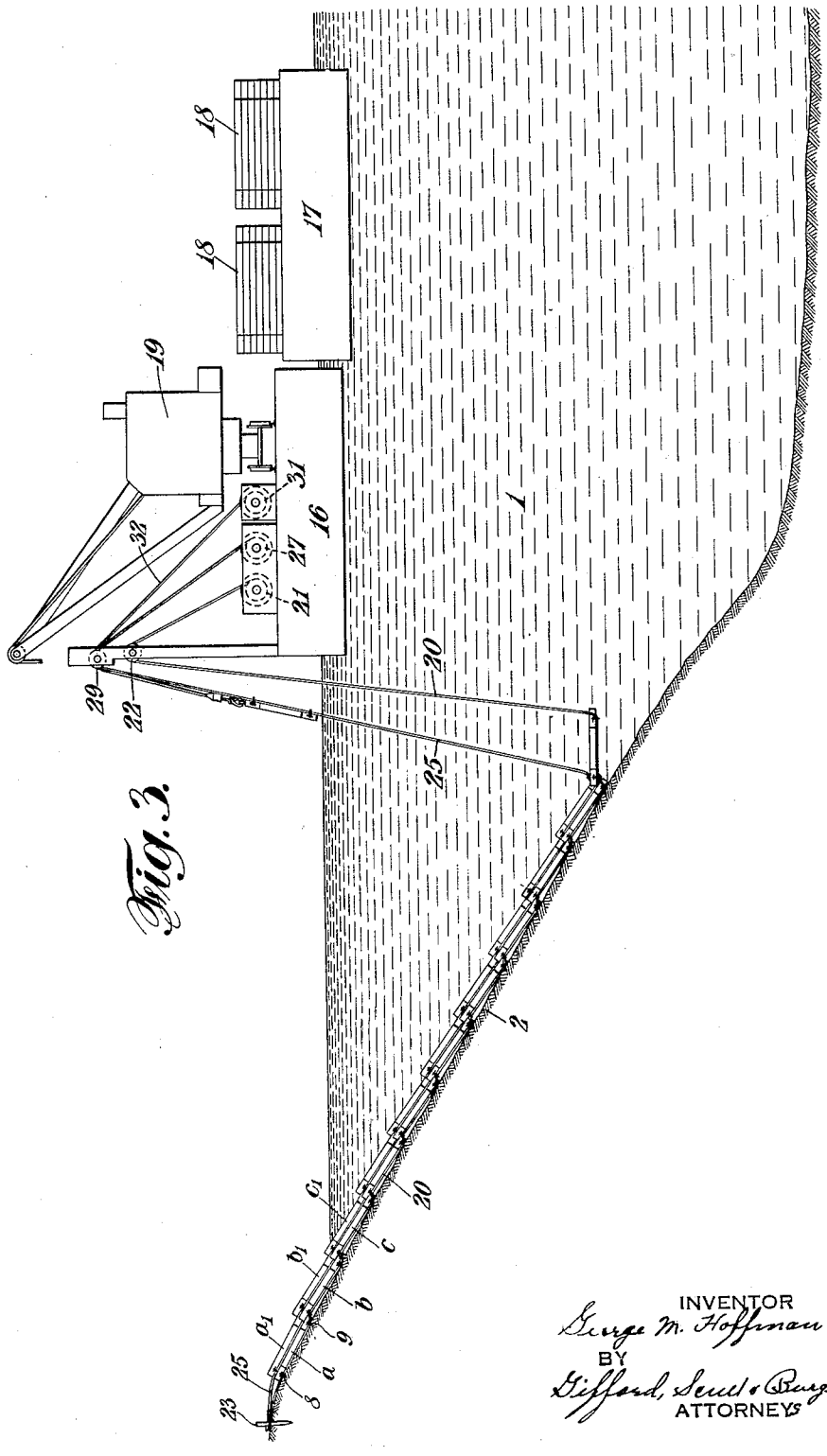


Fig. 3.

INVENTOR
George M. Hoffman
BY
Gifford, Scull & Burgess
ATTORNEYS

Jan. 3, 1933. G. M. HOFFMAN 1,892,701

REVETMENT AND PROCESS OF LAYING THE SAME

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Fig. 6.

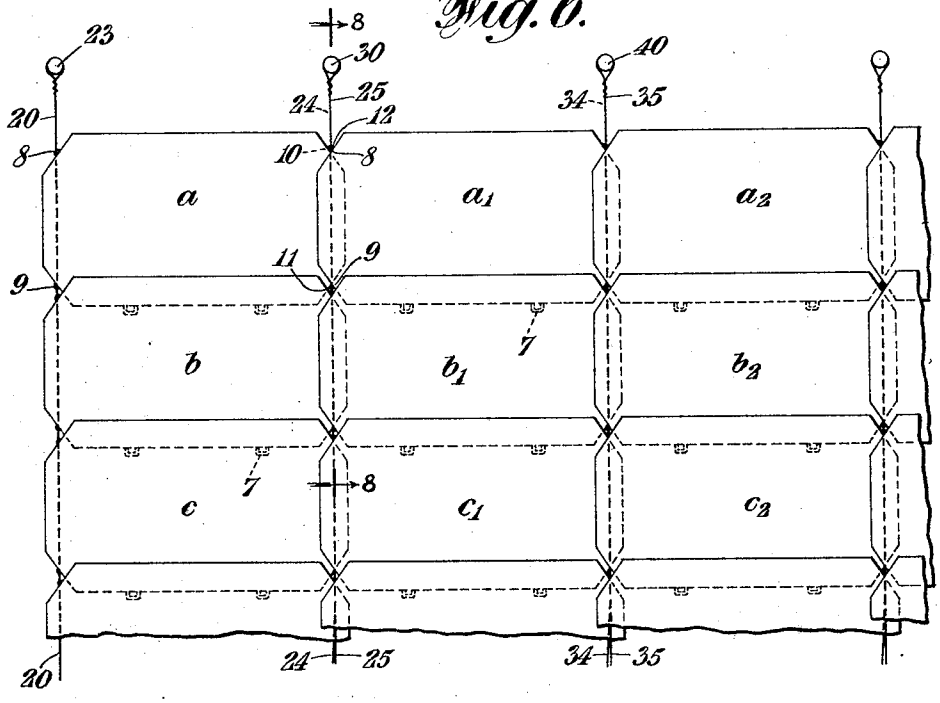


Fig. 4.

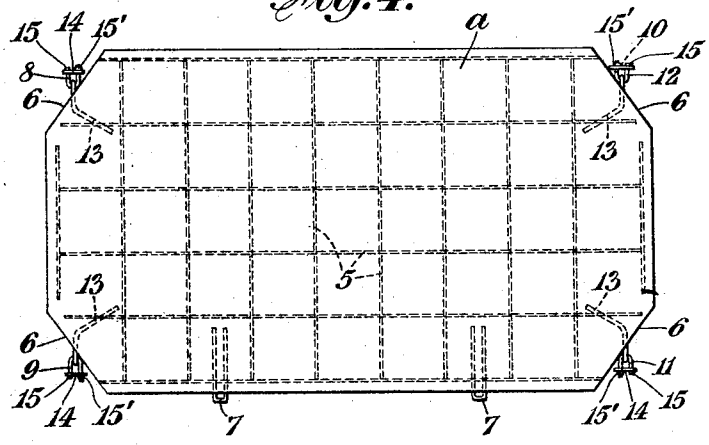
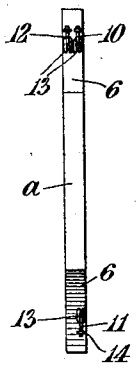


Fig. 5.



INVENTOR
George M. Hoffman
BY
Gifford Scull & Burgess
ATTORNEYS

Jan. 3, 1933. G. M. HOFFMAN 1,892,701

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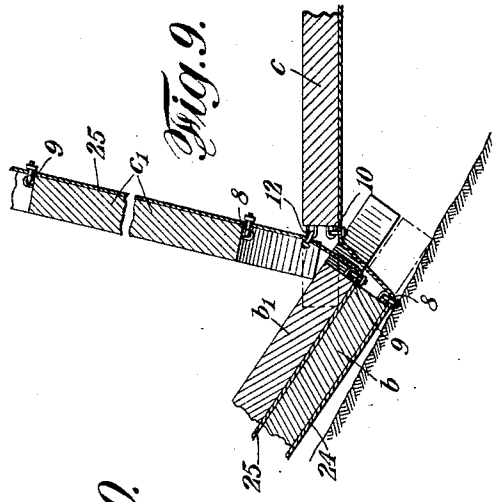


Fig. 9.

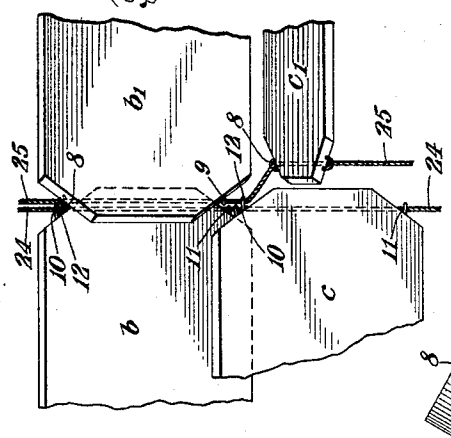


Fig. 10.

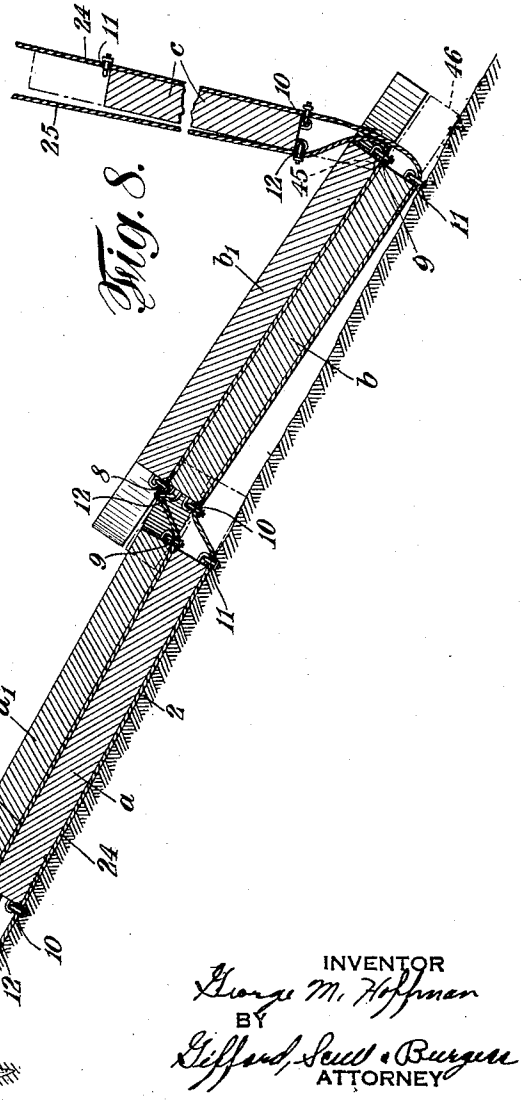


Fig. 8.

INVENTOR
George M. Hoffman
BY
Gifford, Scull & Burgess
ATTORNEY

Patented Jan. 3, 1933

1,892,701

UNITED STATES PATENT OFFICE

GEORGE M. HOFFMAN, OF UPPER MONTCLAIR, NEW JERSEY

REVETMENT AND PROCESS OF LAYING THE SAME

Application filed February 5, 1930. Serial No. 425,935.

This invention relates to a revetment for preventing erosion of river banks and to the process of laying the same or installing it in place. The revetment is made up of slabs, preferably made of reinforced concrete, which overlap at the ends and also at the edges and are assembled to make up a mat which is expansible because the slabs are permitted to move or slide to some extent with respect to each other. In this way, the mat can adjust itself to irregularities on the surface where the mat is laid, which irregularities may, for example, be caused by holes being washed out by the water under the revetment. In this way, the slabs are not required to be suspended across holes to have them form bridges across holes larger than any individual slab.

In carrying out this invention, the slabs are made in the form of rectangular blocks with the corners cut off, and they are lowered into place in such a manner that they overlap in the desired way. The slabs are preferably installed by beginning at the upper portion of the river bank and installing a row of slabs beginning down the river and installing them in succession up the river and following this by successive rows with the upper edges of the slabs overlapping the lower edges of slabs in the preceding row. However, the slabs can be installed by first installing a lower row of slabs and subsequently installing successively higher rows. The former method has been found to be preferable.

Guide cables are used for guiding the slabs into place so that no workmen are required to descend below the water to place or shift the slabs, and the guide cables may be clipped after the slabs have been lowered and left in place to aid in keeping the slabs in their overlapped relation but still permit them to slide to some extent with respect to each other to provide the expansibility of the mat as a whole.

The invention will be understood from the description in connection with the accompanying drawings, in which Fig. 1 is a plan view of a river bend with the revetment in place; Fig. 2 is a plan view showing a part of the revetment and a barge for placing the slabs; Fig. 3 is a vertical section, partly broken away, showing the revetment being installed; Fig. 4 is a plan view of one of the slabs; Fig. 5 is an end view of Fig. 4; Fig. 6 a plan view of a section of the revetment showing a plurality of slabs in place; Fig. 7 is a side view showing one of the slabs being lowered; Fig. 8 is a section on an enlarged scale showing part of the revetment in place and a slab being guided into place; Fig. 9 is a section similar to Fig. 8 showing a later step in the process of laying the revetment, and Fig. 10 is a perspective view corresponding to Fig. 9.

In the drawings, reference character 1 indicates a bend in a river and 2 indicates the sloping bank of the river along the outside of the bend in the river that needs protection against erosion by the current of the stream.

The revetment 3 is in the form of a mat of slabs, such as concrete, with their edges as well as their ends overlapping in such a manner that they can move relative to each other, thus producing an expansible revetment that will effectively protect the bank.

One of the slabs *a* of concrete is shown on an enlarged scale in Fig. 4 having reinforcing rods 5 and having its corners cut off, as indicated at 6, for a purpose which will be understood as the description proceeds. The upper edge of the slab when it is being lowered, or the lower edge of the same when it is in place in the revetment, is provided with suspension members 7 for lowering the slab into position which may be embedded in the concrete. Five slip clips through which guide cables are adapted to slip are provided for each slab near the corners thereof. These clips are numbered 8, 9, 10 and 11 at the respective corners with an extra one 12 near the same corner as the clip 10. When a slab is being lowered into position, one cable passes along one side of the end of the slab through clips 8 and 9, another cable passes along the same side near the other end of the slab through the clips 10 and 11, and a third cable passes through the clip 12 on the other side of the slab, as will be explained more in detail below.

Anchor bolts 13 for the clips are embedded in the concrete near the corners of the slab. Each slip clip may be made up of a short U-bolt with a head 15 at the end of one leg and a nut 15′ at the end of the other leg with a cross bar 14 extending from one leg to the other so that, by removing the nut 15′, the cross bar 14 may be turned to admit a cable, whereupon the cross bar is returned and the nut 15′ screwed on. Or clips of other sorts may be attached to the slabs to enable them to be guided into position by the guide cables.

A barge from which the slabs may be lowered or placed in position is indicated at 16 with a barge 17 for a supply of the slabs anchored near it. Piles of slabs 18 are indicated on the barge 17 and the barge 16 is provided with a crane 19 for picking up the slabs and moving them into place to be lowered by the lowering cable on the barge 16.

The operation of lowering the slabs into place to form the mat for the revetment will now be described. The barge 16 is put in place so that the side thereof is parallel to the river bank where the revetment is to be placed and approximately above the first or uppermost row of slabs that are to extend up and down the river. Cables are then extended from reels on the placing barge 16 almost vertically downwardly and then to stakes on the shore, these stakes being spaced apart distances slightly less than the length of one of the slabs. One cable 20 at the beginning of the row of slabs extends from a reel 21 on the barge over a sheave 22 almost straight downwardly and thence to the stake 23 above the water level. Two cables, 24, 25, constituting a pair, spaced from the cable 20 a distance corresponding to the distance between the stakes on the shore, extend from reels 26 and 27, respectively, on the barge over sheaves 28 and 29, respectively, downwardly and then to the next stake 30 up the river. The cable 24 lies behind the cable 25 in Figs. 2 and 6, so the lead line therefrom is made dotted in these figures.

A lowering reel 31 is located so that the cable 32, therefrom which passes over the sheave 33, lies between the cable 20 and the pair of cables 24 and 25.

Two more cables 34 and 35, constituting another pair, spaced from the pair 24 and 25 a distance corresponding to the distance between the stakes on the shore, extend from the reels 36 and 37, respectively, on the barge over sheaves 38 and 39, respectively, to the next stake 40 up the river, and so on to the end of the barge with a corresponding number of lowering reels 31.

The slabs are lowered and placed as follows:

The slab *a* is picked up by the crane 19 from a pile 18 and swung into position where the cable 32 from the lowering reel 31 can be attached. The cable 32 carries a cross bar 41 (Fig. 7) that is provided with grab hooks 42 for the suspension members 7 and releasing lines 43 pass from any convenient place on the barge to the hooks 42, so that these hooks can be released when the slab has been lowered into position. Any other convenient lowering device may be used for this purpose.

In lowering the first slab *a*, it is brought by the crane into such a position that the cable 20 passes through the slip clips 8 and 9 on the side toward the barge, and the next cable up the river, namely, cable 24, passes through the slip clips 10 and 11 on the same side of the slab. Also, the cable 25 passes through the clip 12 on the other side of the slab from the clip 10 and near it, and the slab is lowered until its lower edge strikes the ground. Thereupon the cables 20 and 24 are slacked, permitting the edge carrying the suspension members 7 to turn downwardly in a clockwise direction as seen in Fig. 1, while the cable 25 is kept taut. The cable 25 will then extend in substantially a straight line from the clip 12 on the slab *a*, which clip 12 is now along the upper edge of the slab, to the sheave 29. This cable 25 is now in position to serve as a guide for the next slab a_1 of the row.

The next slab a_1 is lowered in exactly the same manner above described for the slab *a*, the cable 25 serving for slab a_1 in the way cable 20 had served for the slab *a*, and the cable 34 serving for the slab a_1 the same way that cable 24 had served for slab *a*, and the cable 35 passing through the clip 12 of slab a_1 the same way that cable 25 passed through the clip 12 of slab *a*. This is repeated for the whole row of slabs *a*, a_1, a_2, etc. to the end of the barge. The cables may be slacked during the placing of the slabs a sufficient amount to permit the slabs to become substantially horizontal and then slacked some more to permit the slabs to lie flat upon the surface of the ground after a row has been installed or the slacking of the cables can be permitted to be finished without stopping the slabs near the horizontal position.

The first slab *b* of the next row is laid in a similar way, the placing barge 16 being moved about the width of a slab away from the shore at the beginning of the placing of the next row of slabs *b*, b_1, b_2, etc. In the lowering of the first slab *b* of the second row, the cables 20 and 24 serve the same way they did for the slab *a*, and the cable 25 passes through the clip 12 of slab *b* the same way it passed through the clip 12 of slab *a*. The slab *b* is thus guided so that it will overlap the slab *a* when it is lowered into position. When the cables 20 and 24 are slacked, slab *b* will still overlap slab *a*. The cable 25 is then in position to cause the next slab b_1 to be guided by it and the cable 34 so that its upper edge will overlap the lower edge of the slab a_1 and its

lower end will overlap the upper end of the slab b. This is continued until the entire mat has been laid. The cables 25, 35, etc. may then be cut and spliced to the cables 24, 34, etc., and a sufficient length of the cables 20, 34, etc. cut off to extend from the lower edge of the lowest row of slabs of the revetment back to the stakes 23, 30, 40, etc., thus aiding in keeping the slabs from separating.

The result of cutting away the corners of the slabs and locating the guide clips on the cut-away portions cause the slabs to overlap in the proper positions. Although small areas are left at the corners of the assembled slabs through which the ground is exposed, this does no harm. In fact, there is an advantage in this because water from underneath the revetment can escape through these openings.

The cross-sectional views 8 and 9 and the perspective view 10 will aid in understanding how the slabs c, c_1, etc. are guided into place, although the operation is the same as that already described. The sections through Figs. 8 and 9 are taken along the line of the cables 24 and 25 of Fig. 6. In Fig. 8, the row a, a_1, etc. and the row b, b_1, etc. have been finished and the first slab of the row c is being lowered into position. The cable 20 that is parallel to the cable 24 is, of course, not shown on this figure, but the cable 24 is shown passing through the clips 10 and 11 and the cable 25 is shown passing through the clip 12 of the slab c. The cables guide the slab c so that its lower edge 45 strikes the topside of the slab b the proper distance above its lower edge 46 to provide the desired amount of overlapping. The cables 20 and 24 are then slacked, permitting the slab c to assume a horizontal position or even the position shown in Fig. 3. The guide clip 12 on the slab c causes the lower portion of the cable 25 to assume such a position that it will guide the end of the next slab c_1 of this row into position so that it will overlap the lower edge of the slab b_1 and also its down-the-river end will overlap the up-the-river end of the slab c.

The slab c_1 is shown being guided into position in Figs. 9 and 10 with the cable 25 passing through its clips 8 and 9. Of course, the cable 34 of the next pair is passing through its clips 10 and 11 and the cable 35 of the next pair is passing through its clip 12. These two cables and corresponding clips are not shown in Fig. 9 to avoid confusing the drawing. The slab c_1 is shown in Fig. 10 as having assumed an unlikely position, so that it will be more clear from this figure how the cable 25 guides the slab c_1 into position to make it overlap the slabs c and b_1.

I claim:

1. In combination, a revetment slab having a plurality of guide clips for one side and one for the other side and guide cables, said slab being adapted to slide on said guide cables.

2. A revetment comprising slabs of parallelepipedon form having their edges overlapping.

3. A revetment comprising slabs of parallelepipedon form having their edges and their ends overlapping in longitudinal and transverse rows.

4. A revetment comprising slabs having their edges and their ends overlapping in longitudinal and transverse rows with cables along the transverse rows.

5. A revetment comprising slabs having their edges and their ends overlapping in longitudinal and transverse rows with cables along the transverse rows between the slabs.

6. A revetment comprising slabs having their edges and their ends overlapping in longitudinal and transverse rows with cables passing under each end of the slabs.

7. A revetment comprising slabs rectangular in cross section in all planes perpendicular to its surface having at least one of their edges overlapping.

8. A revetment comprising parallelepipedon shaped slabs with cut-away corners having their edges and their ends overlapping with open spaces through the revetment at the cut-away portions of the slabs.

9. The process of placing slabs to form a revetment which comprises lowering slabs edgewise in succession so that the end of one will overlap the end of a preceding one and its edge will overlap the edge of another preceding one.

10. The process of placing slabs to form a revetment which comprises lowering slabs edgewise in succession so that the end of one will overlap the end of a preceding one and its edge will overlap the edge of another preceding one by causing the preceding ones to hold guides in position for succeeding ones.

11. The process of placing slabs to form a revetment which comprises lowering slabs edgewise in succession so that the end of one will overlap the end of a preceding one and its edge will overlap the edge of another preceding one, each one that is lowered positioning guides for following slabs.

12. The process of forming a revetment which comprises providing a plurality of flexible guides and using said guides for guiding slabs of said revetment into position to form a revetment of overlapping slabs.

13. The process of forming a revetment which comprises providing a plurality of flexible guides and using said guides for guiding slabs of said revetment into position to form a revetment of overlapping slabs, and causing the slabs to move the guides into positions for guiding succeeding slabs.

14. A revetment comprising slabs having their edges overlapping in longitudinal rows

with cables across transverse rows of said slabs.

15. A revetment comprising slabs having their sides entirely of plane surfaces, each slab having an edge overlapped by another slab.

16. A revetment comprising rectangular slabs with cut-away corners, each slab having an edge overlapped by another slab.

17. A revetment comprising rectangular slabs with corners cut off having their sides and ends overlapping with open spaces through the revetment at the cut-away portions of the slabs, said slabs being at an angle to the surface on which said revetment lies.

18. A revetment comprising slabs and pairs of cables slidably connected to said slabs, one of the cables of each pair lying at a higher elevation than the other one, and the slabs overlapping at each pair of cables.

19. In a revetment, pairs of cables, the cables of each pair lying in substantially vertical planes, and a row of slabs, each one of said slabs having one end above the two cables of one pair and below one cable of an adjacent pair of cables.

20. In a revetment, pairs of cables, the cables of each pair lying in substantially vertical planes, and a row of overlapping slabs, each one of said slabs having an end extending between a pair of cables.

21. A revetment comprising pairs of cables, one of the cables of each pair lying at a higher elevation than the other one, slabs overlapping at each pair of cables, and guide clips on said slabs for said cables.

22. The process which comprises sliding and guiding a slab downwardly along two parallel cables at substantially the same level into place in a revetment and simultaneously causing said slab to move a third guide cable for a succeeding slab into place for guiding another slab into position in said revetment.

23. A revetment slab of substantially rectangular shape having cable guiding means located near opposite ends thereof for engagement by cables on the same side thereof, and cable guiding means located near a corner of said slab engageable by a cable passing along the opposite side of said slab.

24. A revetment slab of substantially rectangular shape having cable guiding means located near opposite ends thereof for engagement by cables on the same side thereof, cable guiding means located near a corner of said slab engageable by a cable passing along the opposite side of said slab, and a suspension member at one edge of said slab.

25. A revetment slab of substantially rectangular shape having corners cut off and having cable guiding means located near opposite ends thereof for engagement by cables on the same side thereof, and cable guiding means located near a corner of said slab engageable by a cable passing along the opposite side of said slab.

26. In combination, a revetment slab having a plurality of cable guides thereon, a plurality of cables for engaging guides on one side of said slab, and a cable on the other side thereof engaging one of said guides.

27. A revetment comprising slabs rectangular in cross section in all planes perpendicular to its surface having at least two of their edges overlapping.

28. A revetment comprising slabs rectangular in cross section in all planes perpendicular to its surface having their adjacent edges overlapping.

GEORGE M. HOFFMAN.