April 13, 1954

F. I. LOUCKES

2,674,856

FLEXIBLE REVETMENT MAT

Filed May 2, 1950

2 Sheets-Sheet 1

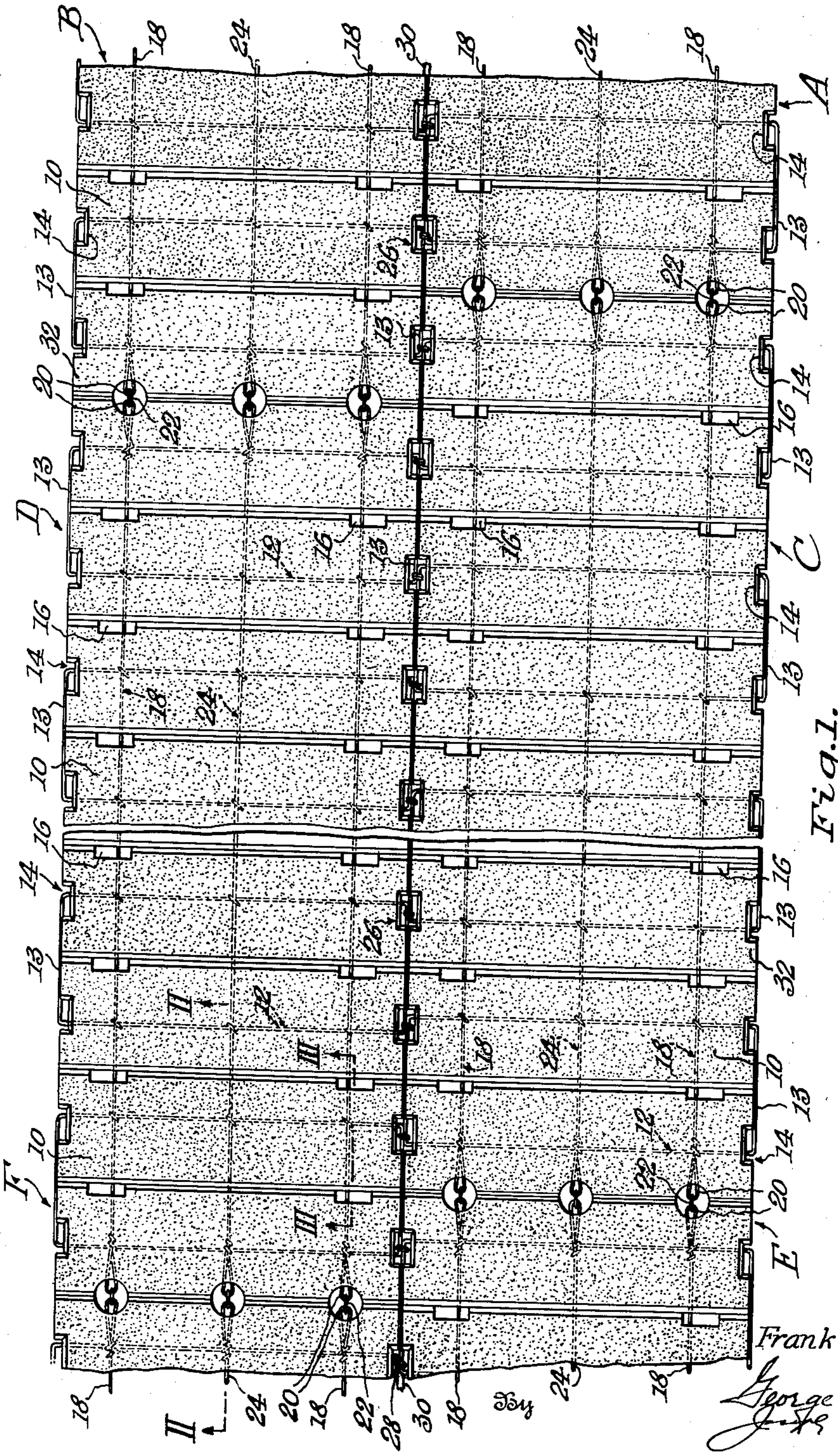

Fig. 1.

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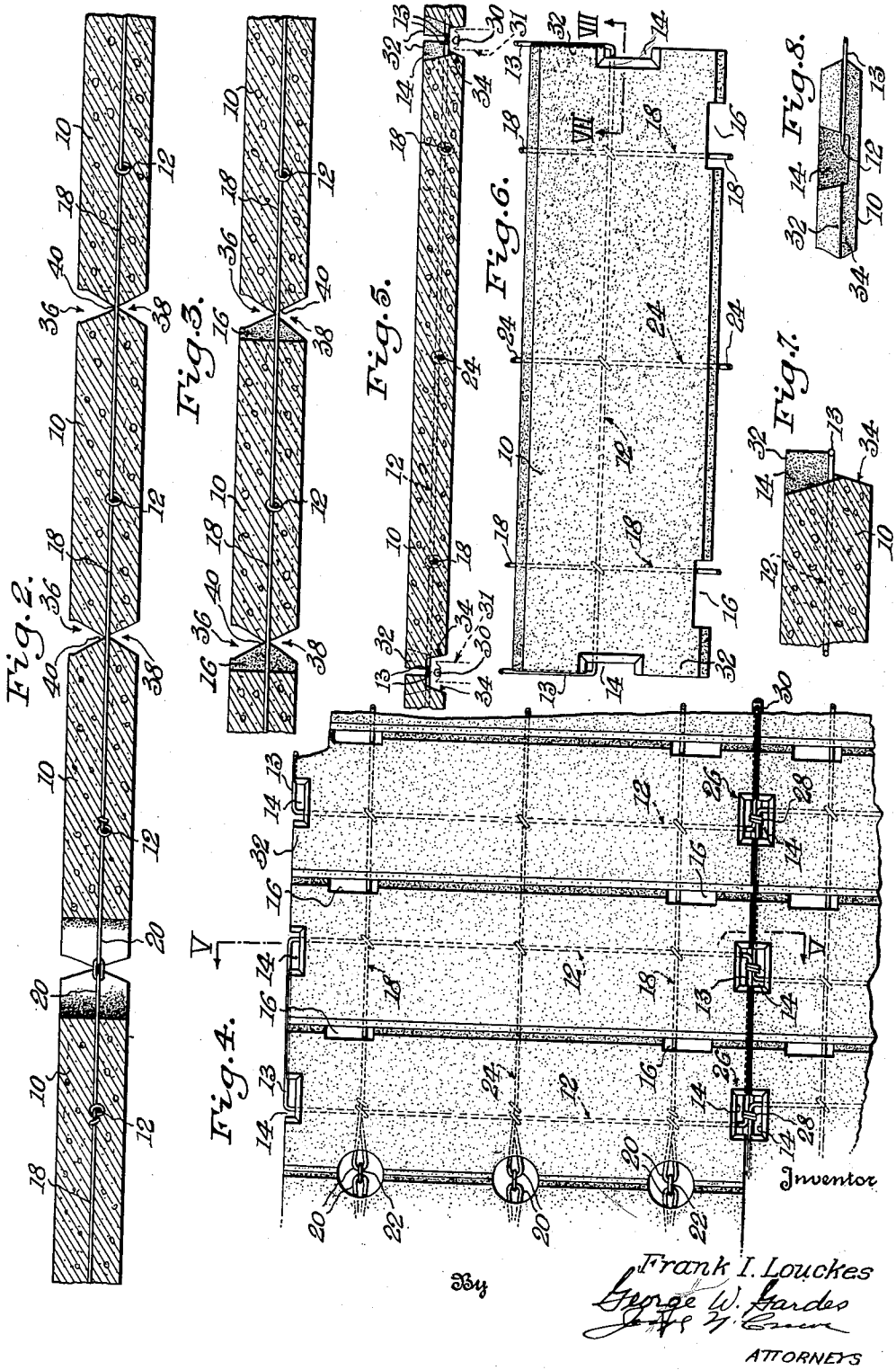

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UNITED STATES PATENT OFFICE

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FLEXIBLE REVETMENT MAT

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4 Claims. (Cl. 61—38)

(Granted under Title 35, U. S. Code (1952), sec. 266)

1

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without payment to me of any royalty thereon.

This invention relates to improvements in suitably dimensioned revetment mats adapted to afford protection against the erosion of levees, river banks, river bottoms, shores, canals and the like.

Generally speaking, these revetment mats, when placed, constitute permanent installations. Therefore, they must be of sufficient weight to prevent displacement or dislocation through current or wave action, and they must be sufficiently flexible to enable them to be self-accommodating to irregularities of the river bottom or shore line.

The present invention relates to a flexible revetment mat which comprises a plurality of flexible unit sections, constructed of a plurality of reinforced concrete blocks or slabs closely spaced apart, and held together by reinforcing wires which extend continuously from block to block both longitudinally and transversely, whereby a flexible unit section is produced. The transverse spaces or joints between the blocks and the spaces between the ends of the blocks permit considerable bending or flexure of the mat in both directions, thus enabling the mat to conform to the irregularities of the underwater area and insuring complete coverage thereof.

The usual type of the revetment mat is open to certain disadvantages, one of which is the tendency of adjacent blocks to become separated to an extent that erosion between the blocks may occur.

That is to say, the usual or "standard" revetment mat is made up of precast sections, each usually three inches thick, and three feet, ten and one fourth inches by twenty-four feet, eleven and one half inches in surface dimensions, designated as a "square," which is composed of twenty concrete blocks fourteen and three fourths inches by three feet, ten and one fourth inches with open spaces one and five eighths inches by three inches between consecutive blocks; and the whole is reinforced and bound together by a continuous structure of wire fabric located in a plane midway between the top and bottom surfaces of the square. The open spaces between the blocks are left to provide the necessary flexibility to permit the mats or mattresses to be launched from the sinking plant and to adjust itself to the irregularities of the river bank and bed. When the mattress squares are assembled on the sinking plant and sunk as revetment or placed on the bank as paving, open spaces one and three fourths inches wide are left between longitudinal edges of consecutive squares. This construction is necessary in order to provide openings through which the squares may be fastened together and to the launching cables between them to form the revetment. The cable is required to support the weight of the mattress squares while they

2

are being launched from the sinking plant and sunk to the river bed. The standard type mattress is cast in stacks, with one square upon another and with paper separations between them. When the concrete which has been poured into a form has set sufficiently, the form is lifted off vertically and the paper separations are spread over the square. The form then is reset on the paper and again is filled with concrete.

The deficiency in the present standard articulated concrete mattress lies in the fact that river bed and river bank materials wash or erode through the openings between the concrete blocks composing the square, and between squares, frequently causing an early failure of the revetment. This is true particularly where the revetment foundation is of sandy material, and it is primarily for the purpose of correcting this objection that led to the development of the improved mattress of the present invention.

From the foregoing, it will be apparent that the present invention has for one of its objects the provision of an improved revetment mattress which is freely flexible in both longitudinal and lateral directions when the revetment has been placed in position, thereby enabling the revetment to adapt itself to irregular and changing contours of a river bank or bed on which the revetment is placed, while at the same time maintaining the blocks of each square in closely adjacent relation, which prevents the foundation material washing out from beneath the positioned revetment.

A further object of the invention is to provide a revetment mattress which positively retains its foundation material from becoming displaced and thereby greatly lessens the tendency of early failure of the revetment which has marked the customary construction.

Further objects of the invention will become apparent as the description proceeds, and the features of novelty will be pointed out in particularity in the appended claims.

The accompanying drawings illustrate a preferred embodiment of the invention; and in the drawings:

Fig. 1 is a fragmentary plan view of a revetment mattress embodying the improvements of the present invention;

Fig. 2 is a fragmentary sectional elevation of the improved mattress of Fig. 1, taken on the line II—II of Fig. 1, looking in the direction of the arrows;

Fig. 3 is a fragmentary section elevation of the improved revetment mattress of Fig. 1, the view being taken on the line III—III of Fig. 1;

Fig. 4 is a fragmentary plan view of the revetment mattress of Fig. 1, the view being on an enlarged scale for clarity of detail;

Fig. 5 is a sectional elevational view taken on the line V—V of Fig. 4;

Fig. 6 is an enlarged detail plan view of one of the blocks of the present invention;

Fig. 7 is a detailed section taken on the line VII—VII of Fig. 6; and

Fig. 8 is an end elevation of the block of Fig. 6, the view being taken looking towards the left of Fig. 6.

Referring more particularly to the drawings, the improved revetment mattress of the present invention is assembled of a plurality of interconnected sections or squares, disposed in both side-by-side and end-to-end relation, such squares being indicated by A, B, C, D, E and F, squares A and B being end-to-end, A and C being side-to-side, C and D being end-to-end, C and E being side-to-side, and E and F being end-to-end.

Each square is composed of cast concrete blocks being connected by reinforcing and binding wires 12 which extend longitudinally and approximately centrally of the blocks, these reinforcing wires being bent adjacent to the ends of the blocks as indicated at 13, to form endless, substantially rectangular reinforcing loops or stirrups which will be referred to in greater detail hereinafter.

Each block or slab is cast with end scarf openings 14, and lateral slots 16, provided on a side of the block adjacent to the edges thereof, and over parallel tie wires 18 which extend transversely through each block, and tie adjacent blocks together to form the square, the tie wires 18 therefore extending continuously longitudinally through the square; and their ends project sufficiently beyond the ends of the squares to be wrapped into tie loops 20, which are tied to corresponding loops of corresponding tie wires of the adjacent sections, as is indicated at 22. For further reinforcement of the structure, a third tie wire 24 may be provided intermediate the tie wires 18, and also provided with end loops 20 for the same purpose.

In practice, the reinforcing fabric is procured from the manufacturer thereof in a pre-assembled structure, ready for use as reinforcement for the square.

It will be apparent that the scarf openings 14 in the ends of the blocks 10 engage with, and register with the corresponding openings of the blocks placed end-to-end, so as to form a rectangular opening 26 at the ends of the contiguous blocks when the blocks are thus assembled. It will be observed also that the wires 12 and loops 13 connect the blocks 10 in pairs, so that the successive loops are spaced from one another by a space approximately equal to the width of one of the blocks. This space is bridged by the loop of the wires connecting the pairs of blocks disposed end-to-end, the loops being tied together as indicated at 28 so as to interconnect all of the blocks of all of the adjacent squares, access to the loops, and the launching cables 30, being had through the end openings 26, while the lateral slots 16 permit the insertion of hooks of lifting mechanism (not shown) into engagement with the wires 18 for lifting the squares from the lower mold forms (not shown) and transferring the squares to a stockpile. Corresponding stirrup openings of a generally semicircular form are disposed on the side of each end block of a square opposite to the slots 16, these corresponding stirrup openings registering and forming substantially circular openings in side-by-side blocks at the ends of each square for permitting access to the loops 20 for tying these loops together with similar loops of a succeeding square.

It will be seen also from the drawings that the squares may be connected side-to-side and also

end-to-end to form an assembly of any desired length and width. Typically, each square is composed of twenty concrete blocks placed side-by-side, each block being three inches thick, fifteen inches wide and three feet, eleven and five eighths inches in length. As will be seen from the drawings, the top half of each end of each of the blocks is cast vertically substantially straight so as to form vertical substantially square end butt joints with corresponding ends of the blocks of adjacent squares positioned in end-to-end relation, the lower half of each end being inwardly beveled so that when the sections are assembled with the blocks end-to-end, there will be formed divergingly-sided channels of a width sufficient to receive launching cables 30 and launching pulleys. It will be seen from the drawings that the end loops 13 project partially beyond the square butt ends of corresponding blocks or slabs placed in end-to-end position in laterally disposed mat sections, so that the butt ends of the corresponding squares will be separated a distance equal to the sum of the projecting portions of the end loops, which portions are flexibly interconnected as will be pointed out hereinafter. The flexibly interconnected end loops define bearing surfaces upon which the laterally disposed mat sections or squares are free to articulate, the contact between the said end loops being substantially only a line contact represented by engagement between two tangent circles corresponding to the cross section of the end loops. This construction substantailly eliminates the gaps between the corresponding end-to-end positioned blocks or slabs of the laterally disposed mattress squares or unit sections of an assembled revetment, the width of the squares or unit sections above the plane of the fabric wires 12, 18 and 24 having been increased by the amount of the overhanging square upper butt end portions 32 of the slabs 10, so as to bring the longitudinal square end surfaces of the top half thickness of the laterally interconnected unit sections of the revetment assembly substantially in contact with each other except for the projecting thicknesses of the interconnected end loops 13 and the scarf openings 14 provided in and extending through the overhanging end portions 32 of the blocks or slabs 10, through which openings the contacting loops 13 of the reinforcing wires 12 are fastened together and to the launching cables 30, thus securing the squares or unit sections of the revetment assembly laterally together and to the launching cables, it being understood that the loops 13 and the launching cables 30 are in contact, so that the loop wires and launching cables may be clipped together as indicated at 28, as has been described previously; and the loop wires and launching cables are disposed relatively to the butt joints between the laterally positioned unit sections of the revetment to preserve free lateral articulation between the unit sections of the revetment assembly about the line, contact between the joined end loops which represents a pivotal hinge or bearing surface upon which the lateral articulating movements between the unit sections of the revetment assembly take place. The lower half of the ends of each block or slab is tapered inwardly, as is shown at 34 to form end channels between the blocks or slabs to permit the launching cables 30 and guide sheaves 31 of the sinking plant to function normally, and not be crowded by the slab assembly.

These structural features are illustrated in

Figs. 4 through 8 of the accompanying drawings, from reference to which it will be seen that the contiguous sides of adjacent mattress sections, the individual slabs of which are positioned and connected in end-to-end relation with their similar butt ends adjacent to one another, are staggered in alignment the width of one slab, so that the condition shown at 14, 26, and 28 of Fig. 4 results, and the fastening 28, by being closely confined to the position shown, prevents bowing out of loops 13 and places direct tension in the reinforcing grids 12.

As has been pointed out above, one of the objections to the usual type of flexible revetment mats is the extent of the spaces which heretofore has been necessary to leave between the individual blocks of each square as well as between sequentially connected squares, which spaces have permitted erosion of the bed beneath the mat with consequently a rapid destruction of the revetment. The present invention obviates this difficulty, by forming the transverse joints of the mattress structure along each side of the individual blocks with double V-shaped grooves 36, 38, oppositely disposed in a vertical plane above and below the plane of the longitudinally extending wires 18 and 24, the resulting edges 40 representing the apices of the double V-shaped grooves being brought into contact with each other. The flexibly interconnected loops 20 of the longitudinally extending wires 18 and 24 act as hinges between the blocks at the ends of longitudinally interconnected squares, while the wires themselves act as hinges between the individual blocks of each square.

The vertical flexibly sealed butt joints at the ends of the blocks or slabs and extending transversely of the assembled unit sections of the revetment assembly and the close spacing between the blocks laterally thereof, produce an assembled revetment that obviates the shortcomings of the standard revetment mat, while at the same time maintaining requisite flexibility in the assembled structure.

It will be apparent, therefore, that the present improved construction provides a flexible revetment assembly which is sufficiently articulated in both longitudinal and transverse directions to be self-accommodating to irregular contours on which the revetment mat is laid. The individual blocks closely interfit with adjacent blocks both longitudinally and transversely of the assembled mattress, and the washing and erosion of the underlying bed is eliminated. The arrangement of the grid wires assures strength, with requisite flexibility. It will be apparent, however, that the improvements of the present invention may be realized by structures somewhat different from the embodiment herein specifically disclosed and shown on the accompanying drawings. It will be apparent that the invention is not necessarily limited to the embodiment herein described and shown, but that the invention is intended and desired to embrace within the scope of the invention as may be necessary to adapt it to varying conditions and uses, as set forth in the scope of the appended claims.

Having thus described my invention, what I claim as new and wish to secure by Letters Patent is:

1. A revetment mat section comprising articulated unit slabs disposed in pairs and having endless reinforcing grids embedded therein and laterally interconnecting adjacent pairs of the slabs, the said slabs having substantially square butt ends having a substantially square overhanging upper butt end portion defining a part of the thickness of each slab and having an inward taper extending throughout the remaining thickness of the ends of the slabs beneath the overhanging substantially square butt end portions, the overhanging butt end portions being assembled in end-to-end relation with similar butt ends of similar contiguous slabs with the overhanging square end portions of the contiguous end-to-end slabs adjacent to one another to form vertical butt end joints between the said overhanging square end portions of the slabs together with a continuous channel beneath the overhanging end portions, the said reinforcing grids having continuous end loops located in the channel, the said end loops having a portion of their surfaces extending slightly beyond the square butt end portions of the slabs, each end loop of one reinforcing grid being connected to a pair of abutting end loops of contiguous pairs of slabs disposed in end-to-end position whereby the grids of end-to-end positioned slabs are in substantially staggered relation, and tying means flexibly uniting the projecting portions of contiguous end loops, the tying means being positioned in the channel below the said butt ends of the slabs, the said projecting portions of contiguous end loops being bearing surfaces upon which the said end-to-end positioned slabs freely flex during placement and service of the revetment mat.

2. A revetment mat section comprising articulated unit slabs disposed in pairs and having endless reinforcing grids embedded therein and connecting adjacent pairs of the slabs, the said slabs having substantially square butt ends having a substantially square overhanging butt end portion defining a part of the thickness of each slab, each of the slabs having its ends undercut beneath the overhanging butt end portions, the overhanging butt end portions of the slabs being assembled in end-to-end relation with similar butt ends of similar contiguous slabs with the overhanging square end portions of contiguous slabs closely adjacent to one another to form vertical butt end joints between the said overhanging square end portions of the assembled slabs together with a continuous channel beneath the overhanging end portions, the said overhanging end portions having an opening extending therethrough, the said reinforcing grids having continuous end loops located in the channel beneath the overhanging end portions and in registry with the openings in the said overhanging end portions of the slabs, launching cable means in the said channel, each end loop of one reinforcing grid being connected to a pair of abutting loops of contiguous pairs of slabs disposed in end-to-end position whereby the reinforcing grids of end-to-end positioned slabs are in staggered relation, and tying means flexibly uniting corresponding portions of contiguous end loops and also uniting the launching cable means and the said end loops, the said tying means being in registry with the said openings and being also within the confines of the channel between the slabs, contiguous portions of end-to-end positioned loops extending partially beyond the overhanging square end portions of the slabs and providing bearing surfaces enabling free-flexing between the end-to-end positioned slabs, the said bearing surfaces providing only substantially a line contact between the contiguous portions of end-to-end positioned loops.

3. An oblong body of material molded in a

relatively thin flat form as a unit section of a revetment mat, the said body being divided into a plurality of individual unit slabs having separate and independent oppositely disposed V-shaped edges in continuously contacting straight-line engagement along the line of the apex of each V-shaped edge, the said edges being only in a substantially line contact, the said unit section of the revetment mat being provided at its sides and ends with recesses for facilitating uniting the unit section with other similarly formed unit sections, longitudinally extending reinforcing wires embedded in the individual unit slabs serving as means of articulation between the several unit slabs of the section, the said reinforcing wires having at their ends tie portions located in the end recesses of the unit section, other transversely extending endless reinforcing wires embedded in pairs in adjacent individual unit slabs defining endless reinforcing grids tying successive slabs together in pairs and having oppositely directed continuous loop portions lying in the end recesses of the slabs and extending partially beyond the ends of successive slabs, corresponding loop portions of two corresponding endless reinforcing grids of similar slabs of contiguous unit sections of revetment mats disposed in end-to-end position terminating in a single opening provided by registration of adjacent end recesses of the end-to-end positioned slabs, both the longitudinally extending reinforcing wires and the endless reinforcing grids and also the engaging apices of the oppositely disposed V-shaped contacting edges of the unit slabs being located in a median plane passed through the unit section equally distant from the top and bottom surfaces thereof, the ends of the said individual unit slabs being substantially square for a portion of the thickness thereof, and having an inward taper through the remainder of the thickness thereof, the square portion of the ends overhanging the inwardly tapered portion thereof, the individual unit slabs of the mat section being connected with similar individual unit slabs of a second unit section in end-to-end relation and defining vertical butt joints between the overhanging square portions of the ends of contiguous individual unit slabs of the second unit section, the said butt joints also defining a channel beneath the square portions of the vertical butt joints, the said channel having downwardly diverging sides for receiving the continuous loop portions of the reinforcing grids which tie together the ends of adjacent individual unit slabs of each mat section in pairs as aforesaid and also launching cables extending longitudinally of the assembled unit sections of the revetment mats, the said continuous loop portions providing contacting bearing surfaces between corresponding contacting loop portions of the contiguous end-to-end positioned individual unit slabs, each end loop of one reinforcing grid being connected to a pair of abutting end loops of contiguous pairs of slabs disposed in end-to-end position, whereby the reinforcing grids of end-to-end positioned slabs are in substantially staggered relation, and tying means flexibly uniting the said contacting loop portions, the tying means being positioned in the said channel and below the single opening provided by the registration of the adjacent end recesses of the said end-to-end positioned slabs.

4. An oblong body of material molded in a relatively thin flat form as a unit section of a revetment mat, which section is approximately oblong in shape and composed of individual interconnected unit slabs, each slab having its length disposed transversely across the unit section so that the ends of the slabs define in their aggregate the sides of the section and the length of the slabs defines the width of the section, while the sides and width of the slabs define in their aggregate the length of the section, the said slabs having separate and independent oppositely disposed V-shaped edges in continuous straight-line engagement along the line of the apex of each V-shaped edge, the said edges of successive slabs making only an approximately line contact one with another, each slab being provided at its ends with corresponding recesses, reinforcing wires embedded in the slabs extending transversely through the slabs and longitudinally through the section for providing means of articulation between the slabs along the V-shaped sides thereof, endless and approximately rectangular reinforcing grids embedded in adjacent slabs longitudinally thereof, one side of a reinforcing grid being in one slab and an opposite side of the reinforcing grid being in an adjacent slab, the said grid having oppositely disposed endless end loops extending between the ends of adjacent slabs, each reinforcing grid being disposed so that the sides of each grid and the end loops of each grid interconnect alternate pairs of unit slabs of the said unit section of the mat, the end loops of each reinforcing grid extending partially beyond the ends of each pair of slabs interconnected by the grid and passing beneath the end recesses of the slabs, the said reinforcing grids being located entirely in a median plane passed through the slabs equally distant from the top and bottom surfaces thereof, the ends of each slab being substantially square for a portion of the thickness thereof and having an inward taper through the remainder of the thickness thereof, the square portion of the ends overhanging the inwardly tapered portion and containing the end recesses in the slab, the individual unit slabs of the unit section of the mat being connected in end-to-end relation with substantially identical individual unit slabs of a second unit section of the revetment mat so that the resulting pairs of such like individual unit slabs assembled in end-to-end relation define vertical butt joints between the overhanging square portions of the ends, the said butt joints also defining a channel beneath the square portions of contiguous ends of the slabs, the said channel having downwardly diverging sides and receiving end loops of the reinforcing grids, each end loop of one reinforcing grid being connected to a pair of end loops of contiguous pairs of slabs of adjacent unit sections disposed in end-to-end position whereby the reinforcing grids of end-to-end positioned slabs are in substantially staggered relation, contacting loop portions providing bearing surfaces enabling free articulation between the end-to-end disposed pairs of slabs, and tying means flexibly uniting the contacting loop portions.

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