

May 28, 1963

P. F. DANEL

3,091,087

BLOCKS FOR PROTECTING HYDRAULIC CONSTRUCTIONS

Filed Nov. 10, 1959

2 Sheets-Sheet 1

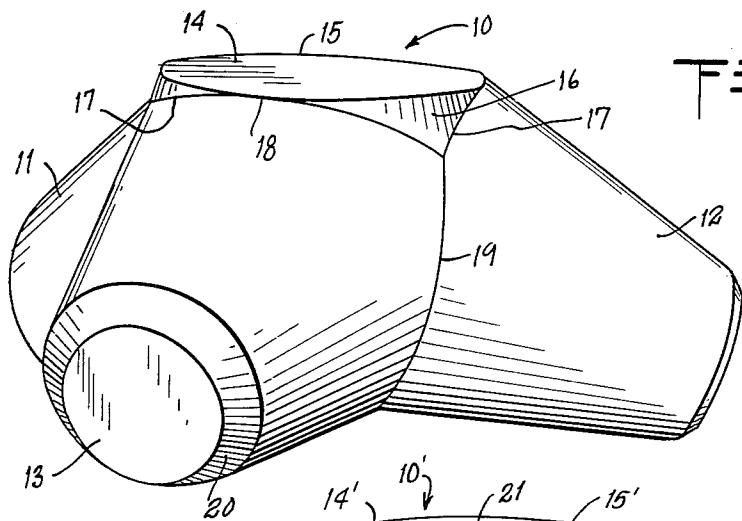


Fig. 1.

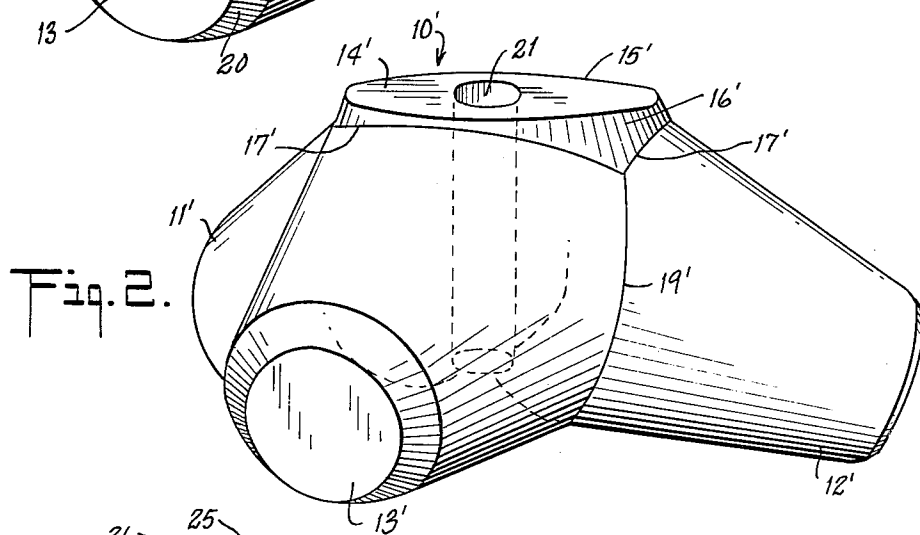


Fig. 2.

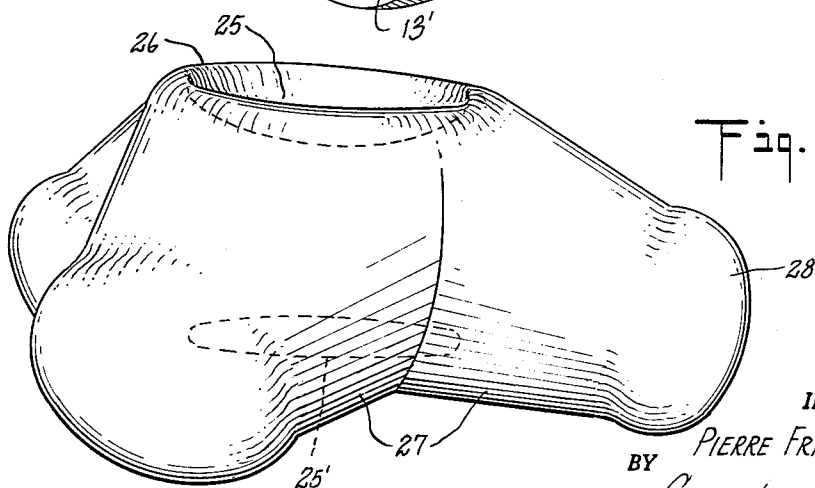


Fig. 3.

INVENTOR.

PIERRE FRANÇOIS DANEL

BY

Cony, Hart & Stimpel

ATTORNEYS

May 28, 1963

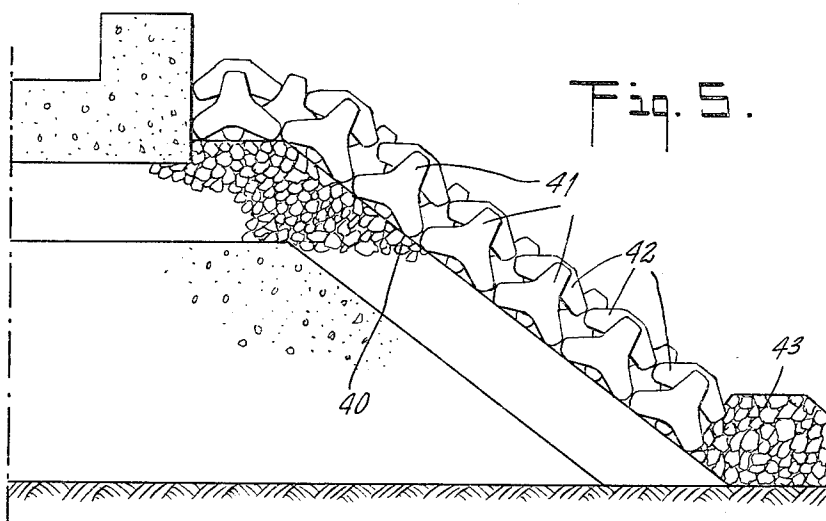
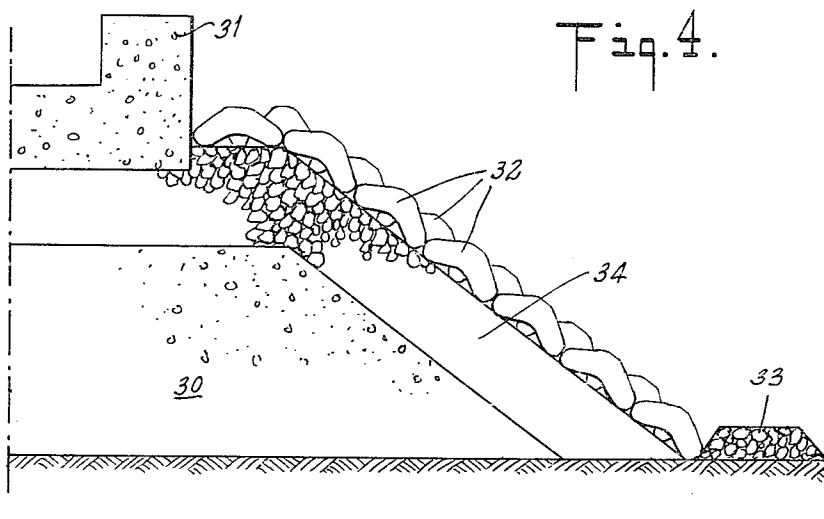
P. F. DANIEL

3,091,087

BLOCKS FOR PROTECTING HYDRAULIC CONSTRUCTIONS

Filed Nov. 10, 1959

2 Sheets-Sheet 2



INVENTOR.
PIERRE FRANÇOIS DANIEL
BY *Corey, Hunt & Stump Co.*
ATTORNEYS

1

3,091,087

BLOCKS FOR PROTECTING HYDRAULIC CONSTRUCTIONS

Pierre François Danel, La Tronche, France, assignor to Société Grenobloise d'Etudes et d'Applications Hydrauliques, Grenoble, France, a corporation of France
Filed Nov. 10, 1959, Ser. No. 852,015

Claims priority, application France Nov. 14, 1958

5 Claims. (Cl. 61-4)

The present invention relates to artificial blocks for protecting hydraulic structures used in the sea, rivers and lakes, such as, jetties, breakwaters, and the like, from the action of moving water produced by waves, currents, variations in level, etc.

Blocks of the above indicated type are disclosed in United States Reissue Patent No. 24,632, dated April 14, 1959. The blocks of that patent have a form derived from a tetrahedron and are essentially constituted of a central mass from which project four or five divergent protuberances uniformly distributed about such central mass and produced by changing the sides of a tetrahedron between the points thereof to a concave form. Blocks of such form are utilized to provide for constructions such as dikes and sloping jetties, protective coatings having excellent stability and great roughness, which qualities are those usually most sought for in constructions of this type. Additionally, such blocks provide the coverings made therefrom with adequate permeability to enable the water to pass therethrough with sufficient readiness to avoid the possible creation of pressure differences of such magnitude as to cause the destruction of such coverings by upheaval of the blocks forming the same.

The general purpose of the present invention is to provide a block which is an improvement on the block of said Re. 24,632, with which it may be used to advantage in the formation of protective coatings for hydraulic structures as will be hereinafter made more clear.

A particular object of the invention is to provide an improved block having qualities for the purposes intended therefor comparable to those of the block of said Re. 24,632, but having a simpler construction than the latter so that it is more economical to manufacture.

Another object of the invention is to provide an improved block having a stability superior to that of the block of said Re. 24,632, thus rendering it less susceptible to displacement from its position in the protective covering of which it forms a part.

A further object of the invention is to provide an improved block having a configuration that will tend, when the block is employed in a protective covering, to cause the block to assume a more secure position in such covering under the pressures due to wave action.

Another object of the invention is to provide an improved hydraulic structure constituted of the blocks of this invention or of the latter in combination with the blocks of said Re. 24,632.

Other objects of the invention, as well as the advantages and features thereof will become apparent from a perusal of the following description, when read in connection with the accompanying drawings in which

FIG. 1 is a perspective view of a block embodying the invention;

FIG. 2 is a perspective view of a modified form of the block shown in FIG. 1;

FIG. 3 is a perspective view of another embodiment of the invention;

FIG. 4 is a vertical sectional view of a dike provided with a protective covering constituted of blocks constructed in accordance with the invention; and

FIG. 5 is a view similar to FIG. 4 showing the dike provided with a protective coating constructed with a

2

base layer of blocks similar to those disclosed in said Re. 24,632 and a top layer of blocks constructed according to the instant invention.

It will be observed from FIGS. 1-4 of the drawings that the block of this invention has a low lying, squat, massive appearance due in part to its generally ground hugging form, and in part to the semi-massive, simple configuration of its parts which, as a whole, may weigh approximately 15 tons. The parts forming the block are few in number, the block being constituted of a massive central section from which project a plurality, at least three and no more than four, laterally extending leg-like protuberances. Because of its relatively few simple parts the block readily lends itself to construction with a number of suitable materials, but it is preferably formed of molded concrete which is vibrated during the process of making the block.

In the embodiment shown in FIG. 1 of the drawings, the central section thereof is designated generally by the reference numeral 10 and the three protuberances thereof by the reference numerals 11, 12 and 13. The central section 10 is provided with a planar top surface 14 which is disposed at right angles to the vertical central axis of such section. The surface 14 is bounded by a circular edge or perimeter 15 and forms the top or uppermost surface of the block. The three protuberances 11, 12 and 13 project laterally from the central section 10 in equidistant relation so that their central longitudinal axes are substantially equally angularly spaced. In the embodiment shown in FIG. 1, such longitudinal axes extend outwardly and downwardly from the vertical central axis of the central section so that they form obtuse angles with the upper portion of such central axis. It will be understood, however, that it is within the contemplation of this invention to orient the protuberances on the central section so that their longitudinal axes are at right angles to the vertical central axis of such section and are all contained in the same plane.

The protuberances 11, 12 and 13 are each in the form of a truncated body and each have a rounded, generally tapered form, being joined to the central section at their enlarged bases which have such cross-sectional dimensions that they enclose the central section 10 except for the three side surface portions 16 of such central section positioned adjacent to the perimeter 15 thereof. The cross-sections of the protuberances at their points of attachment to the central section are approximately equal to each other and to the cross-section of the central section indicated by the surface 14 thereof. The protuberances illustrated each have the form of a truncated cone and in the embodiment of FIG. 1 the line of intersection 17 between the enlarged base of each protuberance and the upper exterior side surfaces of the central section is tangent at 18 to the perimeter 15. The side surface portions 16 are defined by such lines of intersection 17 and the perimeter 15 and are separated at the places of tangency of the latter. The enlarged bases of the protuberances intersect with each other along three lines of intersection 19, each of the latter of which starts at its upper end at the juncture of the lines of intersection 17 of two adjacent protuberances and extends downwardly therefrom in a convexly curved fashion and then inwardly under the central body section in a smooth curve to join at its bottom end with the other two lines of intersection 19. The body section will as a consequence gradually increase in cross-section to a point somewhat midway of its height and then gradually decrease in cross-section to an area substantially less than the area of its top surface 14. The meeting place for the three lines of intersection 19 at the bottom ends thereof is on the terminal bottom end of the vertical axis of the central section 10 and such lines of intersection give the block

the aspect of a star with three points when viewed from the bottom thereof. Due to the angular relation of the longitudinal axes of the protuberances with such vertical axis, the embodiment of FIG. 1 also has the aspect of a tripod. Thus, the lower longitudinal sections of the protuberances are so formed that when the block is resting on a plane surface, the block is supported on the ends on the ends of such protuberances with the central section thereof slightly raised from the plane surface, as is shown more clearly in FIG. 3 of the drawings. This form of the protuberances enables the block to assume a firm seat on the ground or on other blocks and from which it is not likely to be displaced by the action of the water. The form of the protuberances is semi-massive throughout their lengths, the diameter of each protuberance at its end being approximately one-half the diameter of the surface 15 of the central section. At their ends the protuberances may be provided with bevels 20 so as to strengthen such ends against shock.

In the modified form of FIG. 2, the size of the bases of the protuberances 11', 12' and 13' is somewhat reduced so that the lines of intersection 17' formed by such bases with the exterior side surfaces of the central section 10' are spaced below the periphery 15' of the top surface 14' of such central section. The central section side surface portions 16' defined by the periphery 15' and the bases of intersection 17' therefore will be connected together at their ends so that as a whole they completely encircle the upper end of the central section, instead of being separate as in the embodiment of FIG. 1. The block of FIG. 2 is further provided with a passageway 21 which extends throughout the vertical length of the central section 10' and terminates at one end in the surface 14' and at its other end forms the place of juncture for the intersecting lines 19'. The passageways 21 in a protective covering of blocks constructed as in the embodiment of FIG. 2 will increase the coefficient of permeability of such covering and thereby render its likelihood of destruction by pressures tending to upheave the blocks more remote.

FIG. 4 shows the use of blocks of the type shown in FIGS. 1 and 2 in a dike whose slope on the seaward side is faced by a layer 34 of natural stones and which is surmounted by a concrete crest 31. The slope on the seaward side is protected by a facing of blocks 32 made according to the invention and disposed in a single layer on the stone layer 34. The lowermost blocks in the layer bear on a footing abutment 33 provided at the bottom of the slope. The blocks are positioned on the stone layer with their protuberances disposed in the spaces between adjacent protuberances of other blocks so that the blocks are interlocked with one another. Because of the fact that the center of gravity of these blocks is very low, the blocks taken individually are very stable and are not subject to see-sawing despite the grade of the slope. Moreover, because of their low lying, squat form and their interlocked condition the blocks form a revetment which will not slip on the underlying foundation. This clinging action of the blocks is enhanced when the central sections thereof are slightly raised with relation to the ends of the protuberances so that such blocks seat on the foundation in the manner of tripods. The pressures due to wave action will have a tendency to further stabilize the blocks in such position because the greater portion of such forces will be applied to the plane surfaces at the tops of such blocks and will press the blocks more firmly against the foundation so as to minimize any tendency of the blocks to move from their interlocked condition. Because of their form the blocks will present a surface of excellent roughness to the movement of the water and will provide very good permeability which may be enhanced by providing passages therethrough as in the embodiment of FIG. 2.

If the dike of FIG. 4 is likely to be subject often to waves of fairly large size, it is preferred that the protec-

tive covering therefor be composed of more than one layer of block made according to the invention. However, if the dike is in a location where it will be subject to strong attack by the sea, it has been found that a protective covering capable of better withstanding such attack may be formed by using as a first or base layer the type of blocks disclosed in said Re. 24,632 and as a covering layer the blocks of this invention. Such a dike construction is shown in FIG. 5 of the drawings, in which the reference numeral 41 indicates blocks made in accordance with the disclosure of said patent Re. 24,632. The blocks 41 are placed upon the facing 40 of the dike slope so that at least three of the protuberances of each of such blocks rest on such facing in interlocked relation with corresponding protuberances of the other blocks 41 and so that the remaining protuberances of each of such blocks projects normally outwardly from the facing 40. The blocks designated 42 in the covering are constructed in accordance with the instant invention and are positioned upon the blocks 41 so that the protuberances thereof interlock with the outwardly projecting protuberances of the blocks 41 and with the protuberances of each other. The blocks 42 in such an arrangement serve as locking keys for the blocks 41 and prevent the tendency of the latter to move under the applied water forces. The assembly composed of the blocks 41 and 42 are supported at the bottom of the slope by a footing abutment 43 which preferably has a depth greater than the depth of both layers of blocks 41 and 42.

In the embodiment of FIG. 3, the block is formed to establish a better interlocking relation between a plurality of such blocks or with blocks of the type designated 41 in FIG. 5 of the drawings, and especially when dropped into position in forming the hydraulic structure. In the block of FIG. 3, the top surface of the central section thereof is made in the form of a dish-shaped recess 25, the outer peripheral edge 26 of which is rounded so as to smoothly merge with the exterior surfaces of the bases of the protuberances 27 thereof. A like recess may be provided at the bottom of the central section of the block, as indicated by the dotted line designated 25' in FIG. 3. The ends of the protuberances 27 have enlarged ball-shaped ends 28 which may interlock with the ball-shaped ends of the protuberances of adjacently positioned blocks or with the recesses 25, 25' at the ends of the central sections of adjacently positioned blocks.

I claim:

1. An artificial block for the construction of hydraulic structures such as dikes, jetties and the like, said block having a generally squat, massive form consisting essentially of a massive central body portion having a top surface forming the top of the block, and several massive protuberances located wholly below said top surface and all radiating generally horizontally from said body portion, said protuberances each being in the form of a truncated body of generally tapered configuration and with cross-sections of substantial extent throughout its length and being joined to said body portion at its enlarged base, the enlarged bases of said protuberances joining said body portion along perimeters that are adjacent each other for the respective adjacent protuberances and having a substantially vertical dimension approximating the length of the vertical axis of said body portion so that the sides of said body portion are substantially enclosed by said protuberances, and said top surface being disposed transversely to the vertical central axis of said body portion and of an area approximating the cross-sectional area of said body portion so that when the block is positioned upright on a hydraulic structure it is enabled to utilize a substantial portion of the pressures due to wave action to press it more firmly against such structure and thereby to increase the stability thereof under wave action.

2. A block such as defined in claim 1, in which said top surface is planar and perpendicular to said vertical

5

axis, and in which the perimeters of said protuberances are adjacent to the perimeter of said top surface.

3. A block such as defined in claim 1, in which said perimeters of said protuberances have substantial portions in common which extend under the block to substantially the lower terminal end of the vertical axis of said body portion, so that the bases of such protuberances define the underside of the block and the form of said block, in major part at least, is constituted of said top surface and the exterior surfaces of said protuberances.

4. A hydraulic structure such as a dike, jetty, or the like, comprising a foundation body having a sloping surface exposed to the action of moving water, a plurality of blocks such as defined in claim 1 positioned on the sloping surface of said foundation body and forming a protective covering therefor, said blocks being generally positioned as a layer on such foundation surface with said top surfaces thereof substantially in parallelism with respect to such foundation surface and with the protuberances of substantially all of said blocks generally disposed in the direction of the slope of said foundation surface and interlocked with the protuberances of adjacent blocks.

5. A hydraulic structure such as defined in claim 4,

6

including an underlying layer of blocks positioned on said sloping surface of said foundation body and supporting said layer of blocks forming said protective covering, the blocks in said underlying layer having protuberances extending outwardly from said sloping surface and into said overlying layer of blocks forming said protective covering, said outwardly extending protuberances of the blocks in said underlying layer being interlocked with the protuberances of the blocks in said overlying layer to increase the stability of both layers of blocks against the pressures due to wave action.

References Cited in the file of this patent

UNITED STATES PATENTS

2,474,786	Humphrey	June 28, 1949
2,766,592	Danel et al.	Mar. 6, 1951
2,897,654	Harris	Aug. 4, 1959
2,909,037	Palmer	Oct. 20, 1959

FOREIGN PATENTS

146,720	Sweden	Aug. 31, 1954
746,161	Great Britain	Mar. 7, 1956
1,148,412	France	June 24, 1957