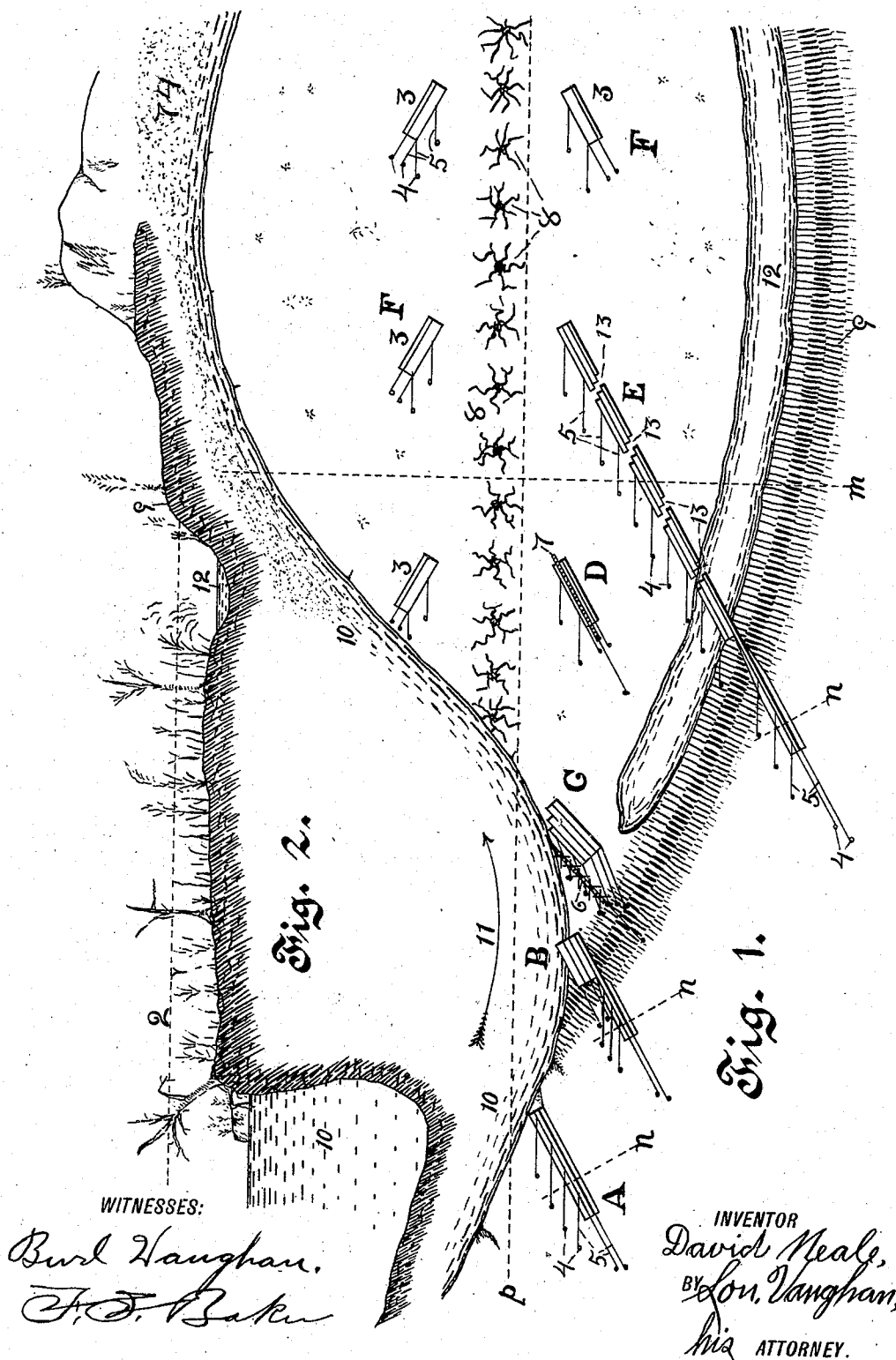


932,565.

D. NEALE.
ANTICIPATORY RIPRAP DIKE.
APPLICATION FILED JAN. 30, 1909.

Patented Aug. 31, 1909.
6 SHEETS—SHEET 1.



WITNESSES:

Burl Vaughan,
F. J. Baker

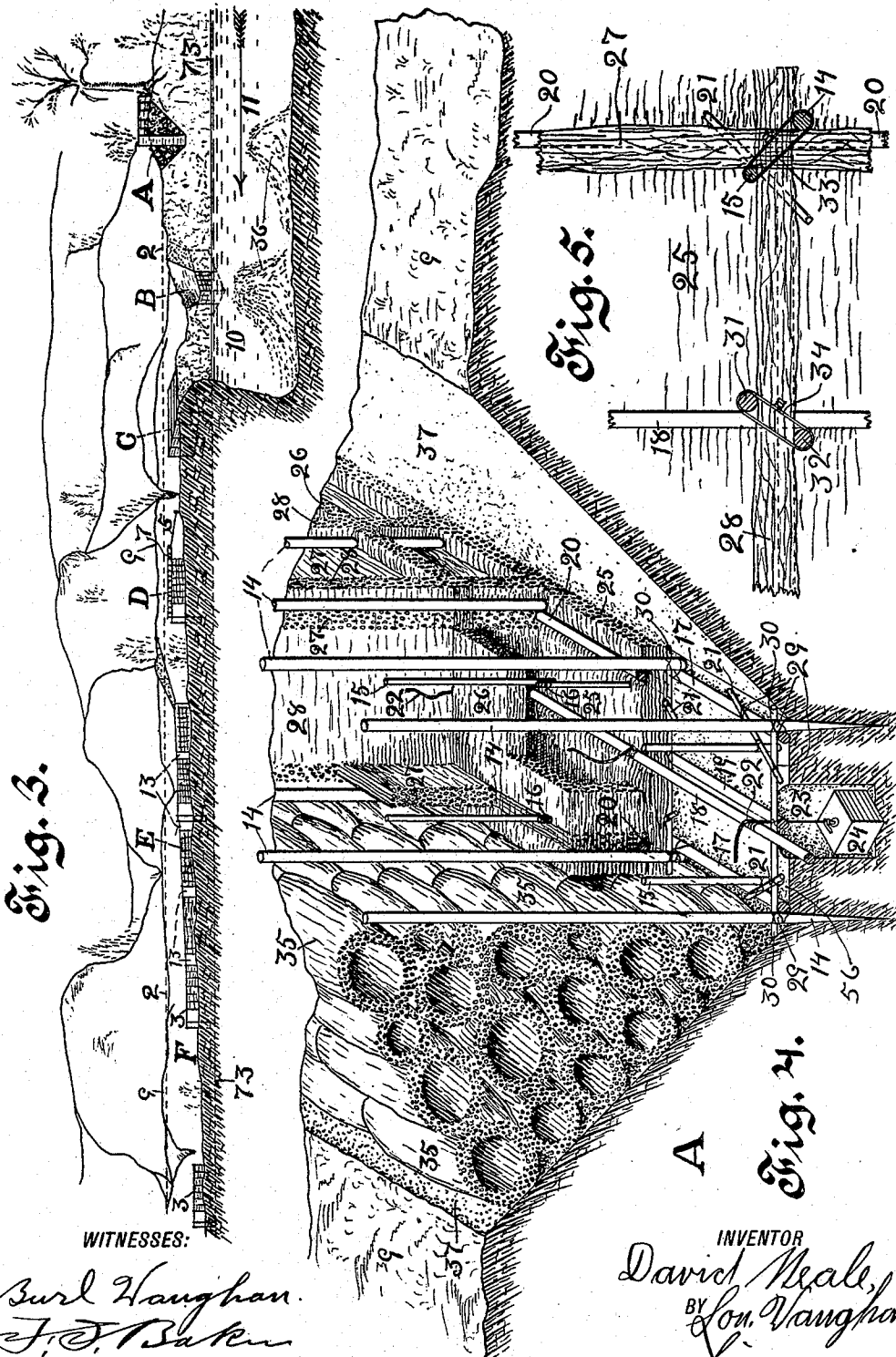
INVENTOR
David Neale,
BY F. J. Baker,
ATTORNEY.

932,565.

D. NEALE.
 ANTICIPATORY RIPRAP DIKE.
 APPLICATION FILED JAN. 30, 1909.

Patented Aug. 31, 1909.

6 SHEETS—SHEET 2.

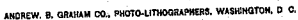


WITNESSES:
 Burl Vaughan.
 J. E. Baker

INVENTOR
 David Neale,
 BY L. M. Vaughan,
 ATTORNEY.

932,565.

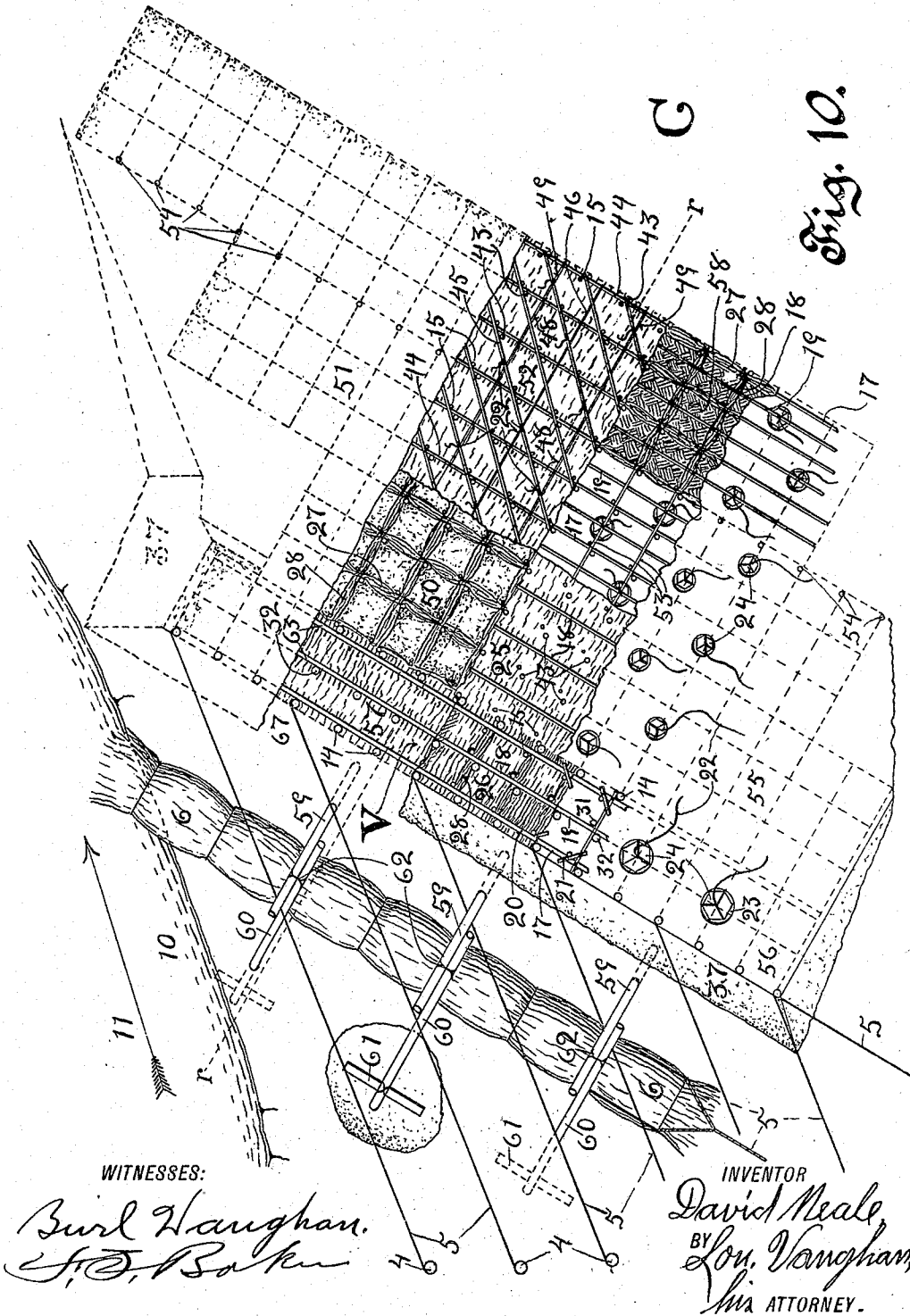
6 SHEETS--SHEET 3.



D. NEALE.
 ANTICIPATORY RIPRAP DIKE.
 APPLICATION FILED JAN. 30, 1909.

932,565.

Patented Aug. 31, 1909.
 6 SHEETS—SHEET 4.



6 SHEETS—SHEET 5.

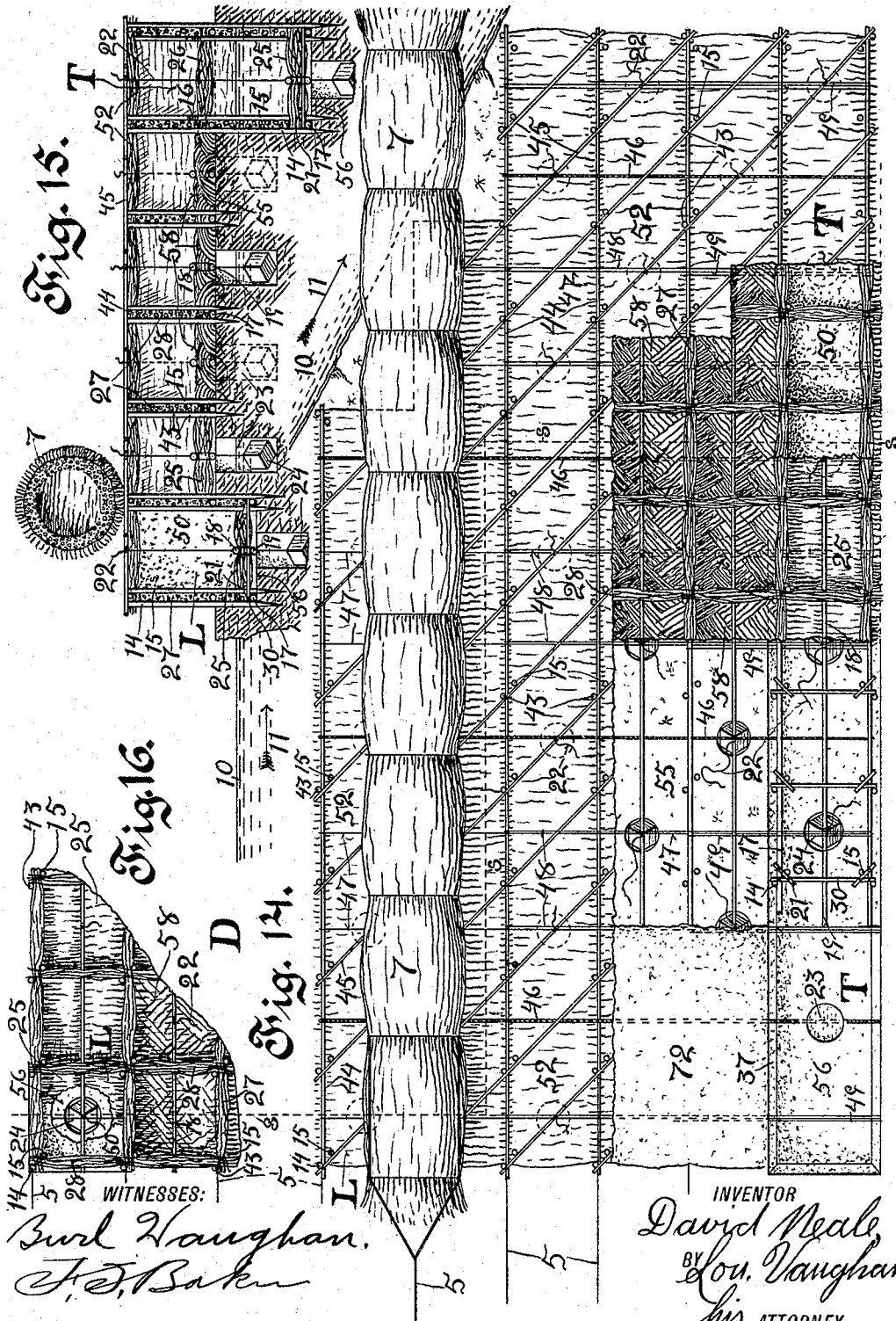
4125-FW. B. GRAHAM CO., PHOTO-LITHOGRAPHERS, WASHINGTON, D. C.

D. NEALE.
 ANTICIPATORY RIPRAP DIKE.
 APPLICATION FILED JAN. 30, 1909.

932,565.

Patented Aug. 31, 1909.

6 SHEETS—SHEET 6.



INVENTOR
 David Neale
 BY
 Lou. Vaughan,
 his ATTORNEY.

UNITED STATES PATENT OFFICE.

DAVID NEALE, OF FORT CALHOUN, NEBRASKA.

ANTICIPATORY RIPRAP-DIKES.

932,565.

Specification of Letters Patent. Patented Aug. 31, 1909.

Application filed January 30, 1909. Serial No. 475,291.

To all whom it may concern:

Be it known that I, DAVID NEALE, a citizen of the United States, residing at Fort Calhoun, in the county of Washington and State of Nebraska, have invented certain new and useful Improvements in Anticipatory Riprap-Dikes, of which the following is a specification.

My invention relates to improvements in anticipatory riprap dikes in which cellulated vertically disposed structures and laterally extended mattress structures of logs, poles, brush and fibrous materials, such as cane, weeds, straw, hay, corn and cotton stalks and bagasse, framed spiked and wired together and bound and anchored by cables, sunken ground-anchors and piles are disposed in a manner to arrest erosion, straighten and control streams and protect the banks thereof; and the objects of my improvement are, first, to keep out of the channel of the stream while doing such work and thus avoid obstructing navigation; second, to produce facilities to break out new straight channels across the low lands between bends of a stream and protect the new banks athwart such new channels by previously placed riprap; third, to provide a surface riprap and efficient anchorage to sustain it to raise the surface of low lands during the high water floods; fourth, to prevent a river from approaching and regaining an ancient channel now existing as an elongated lake or slough at the base of bench lands or bluffs; and fifth to arrest the erosions and protect the banks at places where the stream has already reached the old high banks or is cutting against high land. These and other minor objects developed in the prosecution of the work and more fully hereinafter set forth are attained by mechanism and in a manner as illustrated in the accompanying drawings, in which—

Figure 1 is a small scale map of a tract of river bottom land and adjacent bench land and bluffs, showing plans and disposition of the works to build up the bottom land, straighten the stream and control and protect its banks; Fig. 2, is a profile on the broken line *m*, of Fig. 1; Fig. 3, is a profile on the broken line *p*, of Fig. 1, looking toward the bench bank 9 and adjacent bluffs; Fig. 4, is a perspective sectional detail on the broken lines *n*, at A, B and E, of Figs. 1 and 6; Fig. 5, is an enlarged detail plan of

the construction, particularly of the part G in Figs. 6 and 7, of part V in Figs. 10 and 11 and of part T in Figs. 14 and 15; Fig. 6, is a plan of the construction and work at B, of Fig. 1; Fig. 7, is a vertical section of stream, bank and work at the broken line O on Figs. 6 and 8, looking at an angle downstream and toward the river; Fig. 8 is a plan of the starting of the river angle K of Figs. 6 and 7, on the ice; Fig. 9 is a perspective view illustrating the arrangement of the binding cables in Figs. 6 and 14; Fig. 10, is a plan of the work at C, in Fig. 1, parts being cut away to disclose the construction; Fig. 11, is a vertical section on the broken line *r*, of Fig. 10; Fig. 12, is a vertical section showing separately the binding cables with the angle poles they engage and the vertical anchor-cables of Figs. 10 and 11; Fig. 13, is a modified structure used where poles and fine fibrous materials are plentiful and ordinary brush scarce; Fig. 14, is a plan of the work as disposed at D in Fig. 1, parts cut away to disclose the construction which is appropriate for all the low land work F, 3, 3, 3 and 3; Fig. 15, is a vertical section on the broken line *s* of Figs. 14 and 16; and Fig. 16, is a plan of the angle portion L, of Figs. 14 and 15.

Similar reference characters refer to similar parts throughout the several views and the arrows 11 always indicate the direction of the water current.

A topography that is very common along erosive streams, I have illustrated by Figs. 1, 2 and 3 and show thereon the application of my invention to reclaim the river-bottom lands by correcting and controlling the course of the stream deepening its channel and protecting its banks.

The nearly level plateau F, lying between the river 10 and the old river-bed 12, is generally the result of accretion, having often been worked over, back and forth, by the ever changing course of the stream cutting away the banks in its outward bends, as at B, and accreting bars to downstream off the same bank, as indicated at 74. This often increases the serpentine of the course until avulsion takes place by the stream breaking through some old bed—now a long curved lake—so located that it spans the narrow neck of land between two bends far apart on the course of the stream, and hence,

the downstream bench at a much lower level. A similar action is imminent at B, in connection with the old river-bed 12 which is now a slough or long curved lake lying along the base of the bench-bank 9. If the erosion at B is not arrested it will soon reach the adjacent head of the old bed 12, when a period of high water would open out the old channel and the tract F be avulsed to the opposite bank. The surface water-line 73 in Fig. 3 shows that the downstream end of the tract F is much lower, there being much less soil above the water-line at this end. Also the high water line 2 in Fig. 2 shows a general descent from the old river-bed toward the stream; although intervening portions left undisturbed by avulsions, rather than formed by accretion, are often more elevated. On these higher places timber often attains considerable age and size and the whole surface, aside from lakes left by avulsions, produces a rank rapid growth of willows, all of which as hereinafter set forth are utilized among the most important features of my invention.

To at once arrest the encroachment of the stream cutting into a high bank, as at A Figs. 1 and 3, I employ the construction illustrated by Fig. 4, of plan and disposition shown in Fig. 1. All of the work, which is generally of much greater length than width, is placed longitudinally at an angle of from 30° to 45° toward the river and downstream as shown. The excavation to receive this structure is made to a desired depth, controlled by the rapidity of the erosion, magnitude and quality of bank and stream. The bottom 56 of the cut, which may be sloped downward toward the stream at low water periods, is straightened to start the work on and the sides 37 retained at a slope as near to the vertical as they will safely stand to work over. A large portion of the excavated earth is pushed out over the bank into the current, as shown at 36 Fig. 3, serving as a temporary check to the erosion while the other part of the work is carried forward. To complete the excavation a centrally disposed row of pits 23 are sunk in the bottom from end to end of the work as shown in plan of part T in Fig. 14. Strong anchor-boxes 24, filled with heavy material, as earth, rocks or sand and having a large cable 22 attached, are deposited in said pits; the cable being cut to sufficient length to reach up through the whole work and attach around the various members from bottom to top, binding them together as well as weighting and anchoring them down. When the bottom 56 is down close to or below the water line these pits may be sunk to any desired depth by a large well-auger. And a large rock may be substituted for the filled anchor-box to form the desired weight-anchors.

A row of heavy upright posts or piles 14

is driven along each side of the bottom of the cut at its junction with the sloped sides. These piles are spaced in the row about equal to the width of the bottom, as the structure here shown illustrates a single tier of superimposed rectangular cells. For much heavier work a double tier of superimposed cells as shown at V in Figs. 10 and 11 are employed; generally the size of cells and spacing of posts or piles being controlled by the length of the brush used in building up floors and ceilings 25, 26 etc., and the longitudinal walls 27 and cross or partition walls 28; these spans being best made of single lengths of brush. Along the bottom against the inside of each row of piles the heavy longitudinal poles 17 are placed, and centrally parallel therewith the poles 19 are stretched along the bottom; each line of poles being made continuous by fastening them end to end together with wires or cables. The cross-poles 30 are placed across the longitudinal poles with their ends against opposite piles and all the members bound firmly together by the wire lashing 29 at every place of contact with each other.

The short diagonal poles 21 are placed on top across the angle between the cross-poles 30 and the longitudinal poles 17; they are spaced away from the piles 14, as shown in Fig. 5, so that with the short posts 15 set centrally against the diagonal pole the space between the post and pile is just sufficient to contain the longitudinal walls 27 and the cross walls 28 where the brush of which they are composed interlap in forming the angles of the cells. The diagonal poles are fastened to the longitudinal and cross-poles as shown at 29, the short posts are fastened to the diagonal poles and to further secure the corners the binding wires 33 are inserted often, tightly wound around the posts and piles and twisted together as shown.

The posts 15 are applied in short lengths of sufficient height only for each cell-story, at the floors of which they are spliced together by the wire lashing 16; this leaves their tops low enough so that in working from the inside the brush composing the walls and partitions is conveniently passed over them.

After the floor 25 has been laid the central binding pole 18 is placed. The anchor-cables 22, previously fastened around both the central bottom-pole 19 and the cross-pole, is brought up through and fastened around said binding pole to retain the floor material firmly compacted together so as to hold the accumulated mud or filling. In this work at A it is expedient to fill the cells with the excavated earth conveniently at hand. The walls and floors are pressed tightly by any suitable means and strongly bound together that they may be tight enough to retain the added or accumulated

filling. And if the brush at hand are too coarse to afford the requisite tightness finer fibrous material as hay straw or bagasse is added, mixed in with said coarse brush of walls and floors, near or at their inner surfaces.

On the finished floor 25 the walls are started and built up of like materials interlapped at all angles and in these angles the binding wires 33 are inserted often. When the walls are up to the top of the first story of cells the cells are filled with the excavated earth rammed in compactly. Here a ceiling or second floor 26 is laid on of the same materials, thoroughly interlapped and bound into the walls which are continued up for the next story; and so on finishing the top, as shown on part V, of Figs. 10 and 11, with a ceiling and roof 57 of brush, like other ceilings and floors, and the binding poles 63. The free ends of the cables are drawn up taut and made fast to the central top binding pole. Encompassing binding cables like 46, 47, 48 and 49,—illustrated in Figs. 9 and 12,—are added where the requirements are severe.

The triangular spaces between the vertical sides of this cellular crib and the sloped banks 37 of the excavation, I have here shown filled with the cellulated fascines 35; but a single integral cellulated structure built up like the central part could be used. In either case the central part must be entirely independent of the triangular side parts which abut against it and not wider at its top than at its bottom; preferably a little narrower at the top so that if undermined by the eroding current it will slide downward, carried by its own weight and assisted by the weighted anchor-boxes beneath. These anchor-boxes and the pile points prevent the base from being swept out laterally. As it settles the fascines 35, or other filling of the triangles, close in above and follow it down and protect the top if the water raises to high-water-mark, as indicated by the broken lines 2 in Figs. 2 and 3. All the parts are thoroughly anchored by the anchor-cables 5 disposed upstream and out from the river bank and fastened to piles 4 or other suitable anchorages all as shown in Fig. 1 and indicated on other views.

In the general management of long stretches of a stream or the breaking through of a new channel, as across the plateau F, these dikes are placed from 800 to 1,000 feet apart; ordinarily from sixty to eighty feet wide and from 100 to 200 feet long; modified in position, plan and depth to meet the varying requirements of anticipatory riprapping.

At B and C the dikes are placed closer together and in them my invention is applied in a manner to meet the most serious conditions and demands for river riprapping.

If the dike B can be placed in the winter,

the outer angle K is started out on the ice 39, as shown in Figs. 6, 7 and 8, to assist in filling out this bend to bring it in line with the work below across the plateau F. Excavation is started at 38 making the temporary earth fill 36 shown directly under in Fig. 3. As soon as the ice is sufficiently thick to support, the holes 40 are cut and the anchor-boxes 24 with the anchor cables 22 attached are deposited into the fill. Other holes 41 are cut through the ice and the long posts or piles 42 are set agreeing in arrangement with the shorter posts 43 set in the bottom of the excavation for the part H on the bank. The two longitudinal rows of cells lying in the started excavation 38 and on the ice toward the stream, are first built up and filled with the earth excavated for the next two longitudinal rows and so on including the section G. The section G is let down to greater depth if possible to form a downward projecting flange or lip along the land or shore edge of the structure to assist to anchor the whole and is continued back into the bank with triangular side filling 35 as at A. The part H built up on the bottom 55 of the excavation is usually placed about level, but is better sloped toward the stream; if placed at a period of low water it is given such inclination; and in ordinary work it is only made one cell-story high. In all cases these structures are pliant readily fitted to any irregularity during construction and will bend to meet any undermining erosion. The part K, when the cells are filled, as at 50, with the excavated earth from H, will break the ice and settle down; cutting the ice along the margin of the dike is sometimes necessary to facilitate this settlement. That it may go down evenly and gradually, so that additional stories of cells can be added and filled on this part, certain of the long piles 42, selected in regular arrangement, are left loose in the structure so that it will slide down on them; and heavy cables fastened in the structure are snubbed to the tops of these selected piles in a manner to be eased off and control said settlement.

The small short posts 15 are used at the cell angles with the piles 42 of part K, posts 43 of part H and posts 14 in the part G. This structure is built in double longitudinal rows of cells accommodating long brush for the cross partitions floors and ceilings. And the central longitudinal walls above each longitudinal row of sunken anchor-boxes 24,—including walls 66 in part G and part V in Figs. 10 and 11,—are secured with the cross walls by the posts 31 and 32 and the wire lashings 34, as shown in Figs. 5, 6 and 7. In parts H and K, base cross poles 53 are made continuous by splicing the same as the longitudinal poles. The lateral encompassing binding cables 46, 47, 48 and 49 arranged as shown in Figs. 9 and 6 and more

particularly shown on Fig. 14, are placed with the starting of each double row of cells; they are continued around all the double rows added, ending around the part G; using for every third or fourth the larger cable 46 encompassing the whole as shown.

When the cells are all filled—50—with the excavated earth, the top covering 52 of brush or other fibrous material is placed; the longitudinal binding poles 44, are placed on said top covering and fastened to the tops of all vertical members. Over these the diagonally disposed fender poles 45, to ward off drift and ice, are placed as nearly in line with the current of the stream as possible and still conform to the structure. These fender poles are very securely fastened down to all the lower work including the top ends of the anchor cables 22 which are fastened around them, and such other vertical bindings as may be employed. As there is generally a large excess of excavated earth where this dike is placed a full top dressing 51 is piled over the whole.

The dike at C is fully illustrated in construction, disposition and manner of placing by Figs. 10, 11 and 12. Located at the highest part of plateau F where there is a dense growth of willows, these are employed directly, without cutting them, to construct one important feature of the dike: First, the long row of posts 54, spaced to serve like the regular posts 43 in forming the cells, is set as a guide for the length and position of the work. This row also marks the division line between the level portion built above the natural surface of the ground and the inclined part lying on the bottom 55 of an excavation cut between the level part and the deep vertically disposed independent part V. This inclined part pitches downward toward said part V and toward the stream, as shown in Fig. 11. The level and inclined portions of the work are carried forward in three sections each consisting of three longitudinal rows of cells: The level section contained within the encompassing binding cables 49,—see Figs. 10 and 12,—the upper inclined section is bound therewith by the binding cables 48 and the lower inclined section subjacent to the part V is encompassed with the other two sections by the larger binding cables 46.

From the line of posts 54 toward the stream the land is cleared of timber and brush which are prepared for use in constructing the cells. The encompassing binding cables are then placed on the ground among the standing willows and the longitudinal floor poles 17 and 19 placed on said cables; the pits 23 having been previously dug and the weighted anchor-boxes with the attached cables 22 deposited therein. Then the standing willows and other brush are

bent down singly or in clusters—according to size, those too large to bend being scored to make them yield—and interlapped and interwoven with each other across and on the longitudinal ground poles and cables to which they are securely bound by wires to form the cell floors 58. At places where the growth of brush is sparse or too coarse loose brush or finer fibrous material is added to give the bottom the requisite tightness. The longitudinal central binding poles 18 are now laid and fastened to the poles 19 by the cables 22 disposed through the compacted floor and the cell structure carried forward as shown, and heretofore described.

When the cells or any part of them in this level section are completed, the excavation for the inclined part may be started and the removed earth used for the filling 50 in the finished or partly finished cells. The inclination is made as steep as convenient to work on, if the water level is not encountered; in which case the part V may not be carried to greater depth than the lowest part of the incline. The last section of the incline is generally made two stories in height as shown, the top of the whole finished at a less inclination to give heavier work toward the stream. The part V is entirely detached from the subjacent inclined section which abuts against it so that it will settle vertically and independently if undermined, like the center at A; like which it is constructed except that it is two cells wide and has the central longitudinal partition 66 as heretofore described. When all is filled, roofed and the anchor cables 5 attached and secured to the piles 4, the earth covering 51 is applied. The angle between the part V and the bank cutting 37 may be filled with fascines or cell-work as in A, or have the earth filling 67, as here shown.

To reinforce this dike against the action of a sudden rise of the stream, carrying a heavy ice floe and drift, and to increase the inclined face filling 67 rather than to allow it and the top of part V to be carried away by the flood current, the large long cellulated fascine 6 is placed as shown. It is anchored longitudinally by the cable 5, and laterally at a number of points in its length, by the inclined anchor posts 59 and 60 set deep in the ground crossed and bound together against the fascine by a wire lashing 62 at the crossing of the posts. The ground ends of the posts 60 disposed toward the expected current are lashed securely to a buried cross-log 61 see Fig. 10. This cellulated fascine resists the first flood action becoming more secure as itself and the space between it and the top of part V rapidly fills with the insinuating mud silt and sand.

The points 8 in Fig. 1 represent exploded mines of some powerful explosive,

placed close enough together to act unitedly and discharged simultaneously to open out a new straight channel through the plateau F as indicated. The dike D, lower end of E and those of 3, 3, 3 and 3, are all substantially the same in construction and are positioned to protect the banks of and control this newly opened channel.

The dike as applied at D, E, 3, etc., is fully illustrated in detail in Figs. 14, 15 and 16, showing most of the construction features heretofore set forth. As it is applied where the ground water-line is very near the surface, excavations are reduced to the minimum; in some cases only what is required to sink the weighted anchor-boxes 24: generally limited to the single longitudinal row of two-story cells T, on the shore or land edge in like manner as at G in Figs. 6 and 7 let down as low as possible to form a downward projecting flange or lip to better anchor this edge; and an excavation for the single upstream corner cell L; and possibly in some cases for an intervening end cell, to assist in anchoring down the upper end of the dike. And in some cases it is expedient to excavate only half, making the row of cells T alternately one and two stories. Usually only to the extent of this excavation do the parts constructed therein receive the earth filling 50; otherwise the cells are left to fill with mud silt and sand through their permeable walls and coverings; unless the conditions require and afford some other weighty filling. Often a large area of this work is started by laying and finishing the ground floor during the summer and fall and covering it with a light dressing of earth to protect it from fire; during the subsequent winter the work is carried forward to completion before the spring high water period.

As far as the growth of willows is ample, the ground floor 58 is constructed of these, uncut, as described above and also shown in Figs. 10 and 11. On this the excavated earth from T may be piled, as shown at 72, until the cells of this part are made, when the earth is thrown back into said cells.

Another feature, that can also be combined with the other dikes, is illustrated in Figs. 1, 14 and 15: the superimposed cellulated fascine 7, which is anchored by a single cable attached to its upstream end. This is constructed where it is shown, toward the river edge of the dike. It may be of large diameter and preferably longer than the dike. In serious cases a number of these are built on, each one independently, in a pile forming a magazine of fascines that will roll off into the stream and assist to arrest the erosion immediately the edge of the cellular structure beneath them is undermined and sinks down.

In some instances where ordinary suitable brush are not at hand and the supply of poles and finer materials as corn and cotton stalks, hay, straw, bagasse etc., are plentiful the modification illustrated in Fig. 13 is resorted to:—A line of narrow cells around the outside of the dike are built up on a floor of cross-poles 71 laid close on the longitudinal ground poles 17 and 19 and wire lashed thereto. The superimposed wall-poles 68 are wire-lashed —29— to the posts 43, scored interlapped and lashed at angles, and the cell walls 69 and floors 70, and floor of the whole dike, lined with a suitable thickness of said finer materials; and this marginal line of cells filled with the earth filling 50.

At E the dikes are repeated in a line of direction agreeing with the angled position of that one at the end of the line on the bank of the new channel; extending the work across the plateau F to and across the lake 12 and into the bench-bank 9. This operates conjointly with D, C and B to still the high-water current and cause a heavy flood deposit in the lake and raise the soil surface over the adjoining plateau. The dikes in this line of dikes are separated end from end leaving the embrasures or open spaces 13 between; these serve as driveways in delivering materials on the work during construction and are left open to allow a part of the current to pass through; thus avoiding a too strong deflection of the whole current, an undermining fall over the dike or a destructive eddy below. If this dike or line of dikes have a sunken anchor portion T, it should be continued under said open spaces or special work be put in to prevent the current from cutting down therein. After the flood has nearly subsided and little further surface filling of lake or plateau can be gained, the conjunct mines are exploded to open out the new channel. And if laid of sufficient magnitude and followed by dredging, and diking on the stream below, future floods or damaging erosions may be avoided. Otherwise the flooding and raising of the surface of the plateau and operations along the channel may continue throughout several high-water periods; until the altitude of the plateau and the magnitude and protection of the banks of the channel are such that floods and erosions do not occur. In emergencies this work is always advantageously supplemented by the use of cellulated fascines rolled in independently or carried down on running cables attached to heavy box anchors in the bed of the stream. The fascines are sometimes expediently substituted for the inclined part at C, breaking joints in placing them end to end, employing the anchor boxes and attached cables, encompassing cables 46, 48

and 49, in the manner set forth with the square cell work, to retain the fascines in position, and finishing with the same top work.

- 5 Any of the cellular work described above is supposed to be added to in height by building up on top, as it settles away by being undermined or sinking in soft strata, if, it is found necessary so to do to attain a permanent result.

10 It is obvious that the riprapping herein shown and described can be placed on or in any land, according to conditions, to anticipate the approach of an eroding stream and to control its flow along desired lines.

I claim—

1. A riprap cell filled with weighting material and a supplemental weight-anchor attached to said cell.
- 20 2. A riprap cell disposed above the surface of the ground and a weight-anchor attached and sunk beneath said cell.
3. A permeably walled riprap cell connected by a cable to a dependent weight-
25 anchor.
4. A riprap cell inclosed by a permeable wall, a weight-anchor, and a cable to connect said anchor to said cell.
5. A riprap dike comprising two abutted
30 structures adapted to slide upon each other at their contact surfaces and settle independently.
6. A riprap dike comprising two abutted structures adapted to support and slide
35 against each other and settle independently.
7. A riprap dike comprising a vertically disposed structure, a structure abutted against said vertically disposed structure, and said vertically disposed structure adapted
40 to slide along said abutting structure and settle independently thereagainst.
8. A riprap dike comprising a weighted structure, a structure abutted against said weighted structure, and said weighted structure adapted to slide along the contact surface of said abutting structure and settle independently thereof.
9. A riprap dike comprising two independently constructed weighted structures
50 abutted together and adapted to slide upon each other and settle independently.
10. A riprap dike comprising a horizontally extended structure, a vertical structure disposed against the edge of said horizontally extended structure and adapted to slide
55 thereon and settle independently thereagainst.
11. A riprap dike comprising a structure weighted by heavy anchors sunk beneath it, a structure abutted against said weighted structure, and said weighted structure adapted to settle independently of said abutting structure.
12. A riprap dike comprising an inclined
65 edly extended structure, and a contiguous

vertical structure adapted to settle independently against the edge of said inclined structure.

13. A riprap dike comprising a cellulated structure built up from the ground surface and anchored by weight-anchors sunk in the ground beneath.

14. A riprap dike comprising a cellulated structure, weight-anchors attached and sunk beneath said cellulated structure, and an independent structure abutted against said cellulated anchored structure.

15. A riprap dike comprising a cellulated structure, weighting materials in the cells of said structure, and weight-anchors sunk beneath and attached to said structure.

16. A riprap dike comprising a vertically disposed structure, and a subjacent laterally extended mattress structure having one edge abutted against to support said vertically
85 disposed structure.

17. A riprap dike comprising a vertically disposed cellulated structure, weighting materials in the cells of said structure, and an inclined cellular structure abutted against
90 said vertical structure but not attached thereto.

18. A riprap dike comprising a cellulated structure having weighting materials in the cells thereof and a subjacent structure abutted against said cellulated structure.

19. A riprap dike comprising a vertically disposed structure, and a subjacent inclined laterally extended mattress structure abutted against said vertically disposed structure.

20. A riprap dike comprising a laterally extended structure having an integral downwardly extended smaller portion embedded in the earth below to anchor said structure.

21. A riprap dike comprising a structure
105 having a downward extension embedded in the earth below said structure, and an attached weight-anchor suspended in a pit beneath said extension.

22. A riprap dike comprising a structure
110 having an integral downwardly extended flange or lip along one edge to anchor said structure in the ground and against lateral movement.

23. A riprap dike comprising a flat cellulated structure having an integral downwardly projected cell built in a pit below the general structure and filled with earth or other weighting material to anchor said dike.

24. A riprap dike comprising a structure having an integral downwardly projected part embedded below the general structure and an attached weight-anchor disposed below said embedded part.

25. A riprap dike comprising a cellulated structure having an integral portion containing an additional lower story embedded in the ground to anchor said dike.

26. A floor for cellulated riprap dikes, 130

consisting of poles disposed parallelly and a distance apart on the ground among uncut willows and said willows bent downward and interwoven with each other on said poles and bound thereto.

27. A pole frame for cellular riprap dikes with brush walls, comprising longitudinal-ground-poles, cross-poles fastened on said longitudinal-poles, a post fastened in one of the angles between said cross-poles and said longitudinal-poles, a diagonal pole fastened on the cross-pole and longitudinal-pole across the angle opposite to said post, and a post fastened centrally to said diagonal pole.

28. In a storied cellular riprap dike having walls of fibrous materials, a retaining frame comprising longitudinal side-poles, cross-poles fastened across said side-poles, tall posts fastened in angles between cross-poles and side-poles, diagonal poles fastened on said cross-poles and side-poles across the angles opposite to said tall posts, and short posts fastened centrally to said diagonal poles.

29. A cellular riprap dike bottom, comprising side bottom-poles and a central bottom-pole, cross-poles fastened on said central and side bottom-poles, posts fastened in angles between cross-poles and side bottom-poles, diagonal poles fastened to said side bottom-poles and cross-poles across the angle opposite to said posts, other posts fastened centrally to said diagonal poles, a layer of fibrous material laid across said central and side bottom-poles, and a central binding-pole disposed on said layer of fibrous material and fastened therethrough to said central bottom-pole.

30. In a riprap dike, the combination of top and bottom pole members, a cable disposed vertically through the dike and made fast to said top and bottom members, and a weight-anchor disposed beneath the dike and made fast to the lower end of said cable.

31. A sub-anchor for riprap dikes, comprising a heavy body disposed in an excavation beneath the dike and connected by a cable fastened to said heavy body and to the structure of the dike.

32. A dike having an anchored edge, a binding cable disposed to laterally embrace the whole dike including said anchored edge, and a binding cable to laterally embrace only a part of the dike including said anchored edge.

33. A dike having binding cables of different lengths disposed to secure together different quantities of the dike and all of said binding cables disposed to embrace a selected portion of said dike.

34. In an anticipatory riprap, the combination with a riprap dike of a superimposed fascine adapted to be launched by rolling off from the dike when the edge of the dike is undermined and settles down.

35. In an anticipatory riprap the combination of a dike having a head edge projecting above the surface of the ground, a fascine disposed on said ground surface parallel with said edge and a distance away toward the anticipated flood and there anchored securely.

36. An anchorage to secure a fascine lying above the surface of the ground, consisting of an inclined post having its base fastened to a buried cross-log and its top above the fascine crossed with and fastened to a post set on the opposite side of said fascine.

37. A long low-land dike having narrow cross-openings for driveways and to let pass through a small portion of the flood.

38. A long continuous dike constructed partly above and partly below the surface of the ground, the portion above the ground transversely cut to leave narrow embrasures between merlons of greater length.

39. The method of opening and controlling a new course for a stream, consisting in disposing anticipatory riprap dikes along the proposed lines of banks for said new course, and then discharging an intermediate line of conjunct explosive mines to open out the new channel.

40. A method of anticipatory riprapping, consisting in forming and protecting new banks along a predetermined course for a stream by building riprap dikes in excavations made in the high land to arrest the erosions and form and protect the new banks therein, and building riprap dikes above the surface of the low land to raise said new banks thereon by flood deposits.

41. A method of anticipatory riprapping consisting in forming and protecting new banks along a predetermined course for a stream by building riprap dikes in excavations made in the high land to arrest the erosions and form and protect the new banks therein and building riprap dikes above the surface of the low land to raise new banks thereon by flood deposits and to protect said new banks and extending said low-land dikes out from said predetermined course across contiguous low land to raise the surface thereof by flood deposits.

42. The method of depositing anticipatory cellulated riprap dikes in high land or banks, consisting in excavating for a small lower part of the structure, building up the cells in this first excavated part, and filling and burying the cells with the earth from excavation for space to further extend said cell structure as fast as said cells are built up filled and closed.

43. The art of constructing and placing dikes for riprapping the banks of streams, consisting in extending part of the dike structure out from the bank onto the ice of a stream, setting piles through perforations

through the ice to form part of the structure and control the sinking thereof, and building up the dike structure as it settles with the broken ice support beneath it.

- 5 44. The art of riprapping high banks of streams, consisting in starting a cellulated structure on the stream ice close to said bank, filling said cells from an excavation

into said bank, and extending said structure with said filling into said excavation.

13

In testimony whereof I affix my signature in presence of two witnesses.

DAVID NEALE.

Witnesses:

MARION O. WILLSON,
F. R. KLINE.