May 1, 1934. M. M. UPSON 1,956,967

REVETMENT AND METHOD AND APPARATUS FOR FORMING THE SAME

Filed April 16, 1929 11 Sheets-Sheet 1

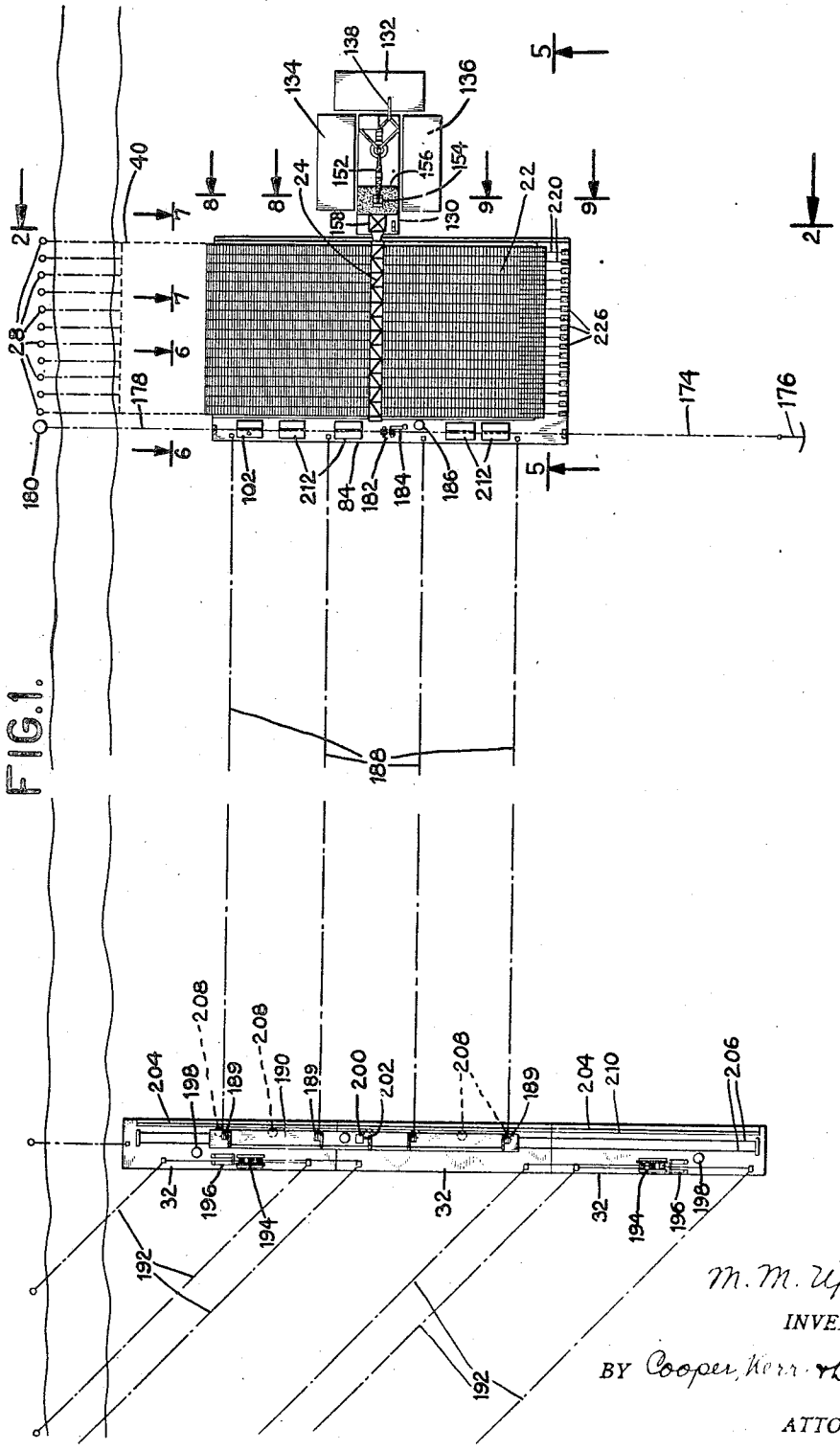


FIG. 1.

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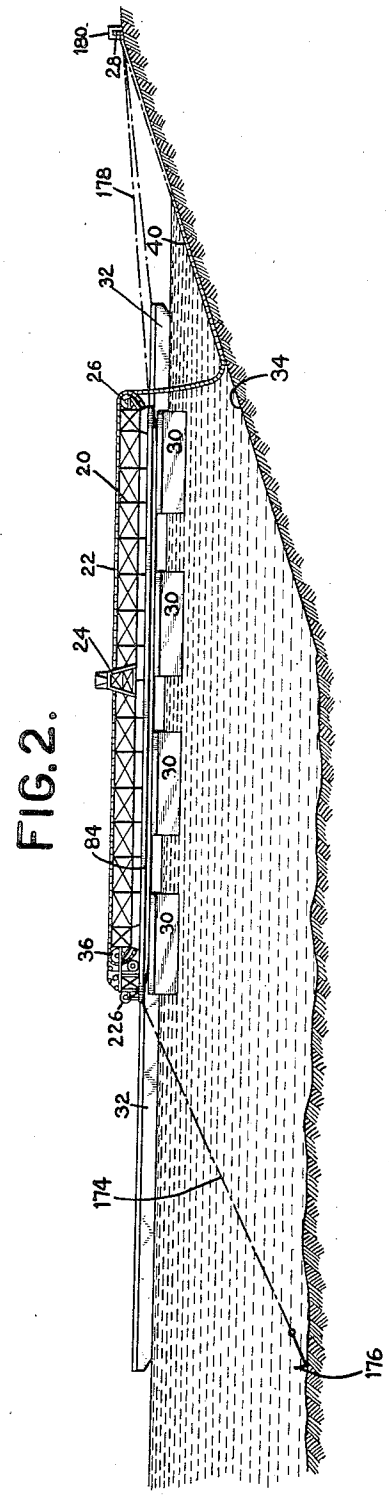


FIG. 2.

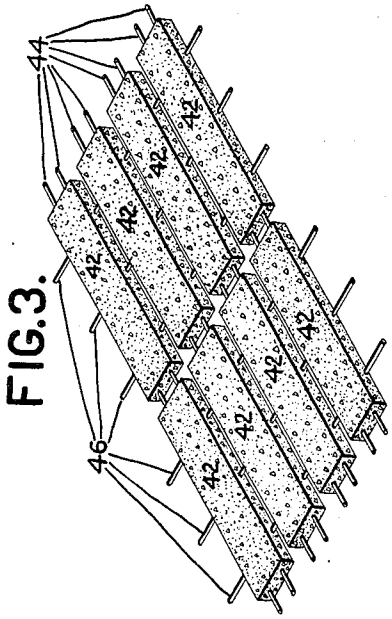


FIG. 3.

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REVETMENT AND METHOD AND APPARATUS FOR FORMING THE SAME

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FIG. 4.

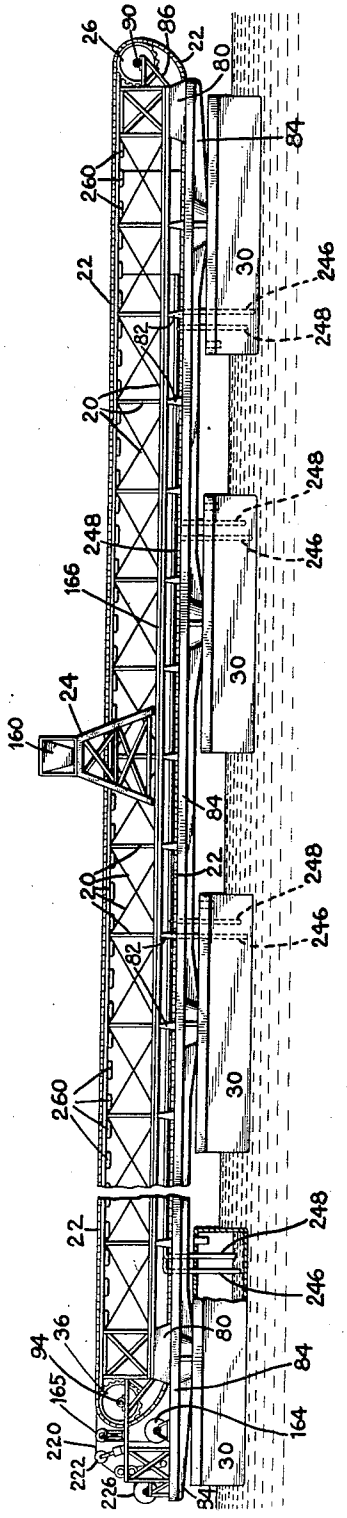
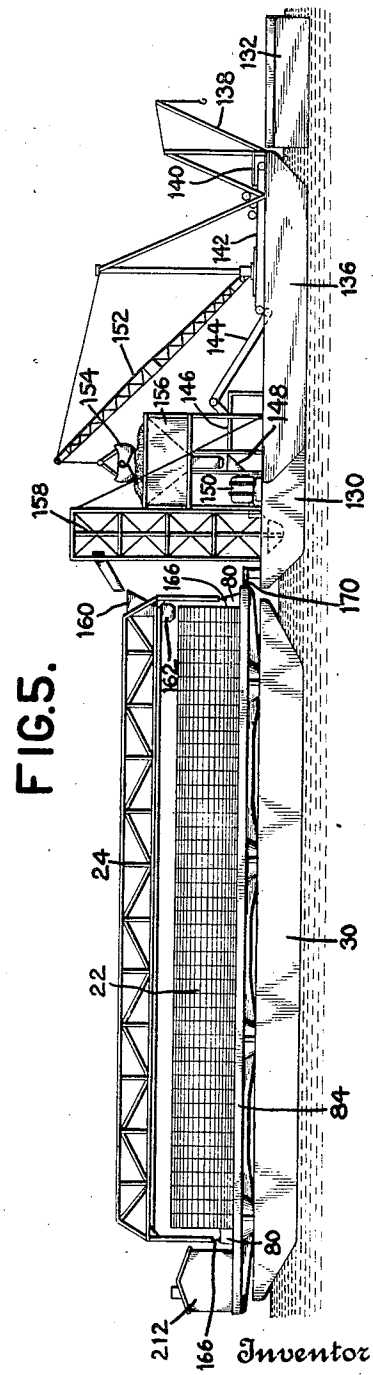


FIG. 5.



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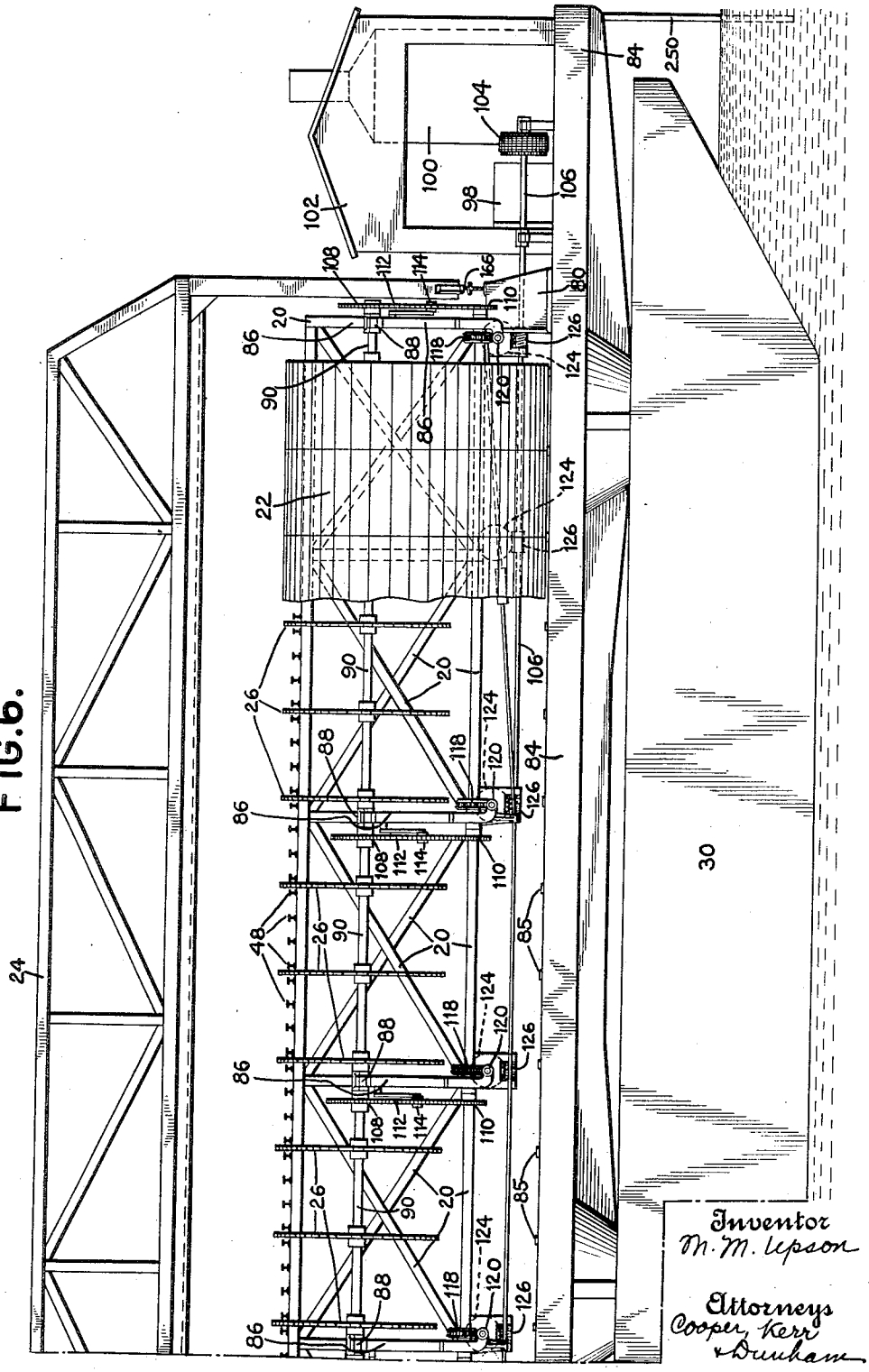
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REVETMENT AND METHOD AND APPARATUS FOR FORMING THE SAME

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FIG. 6.



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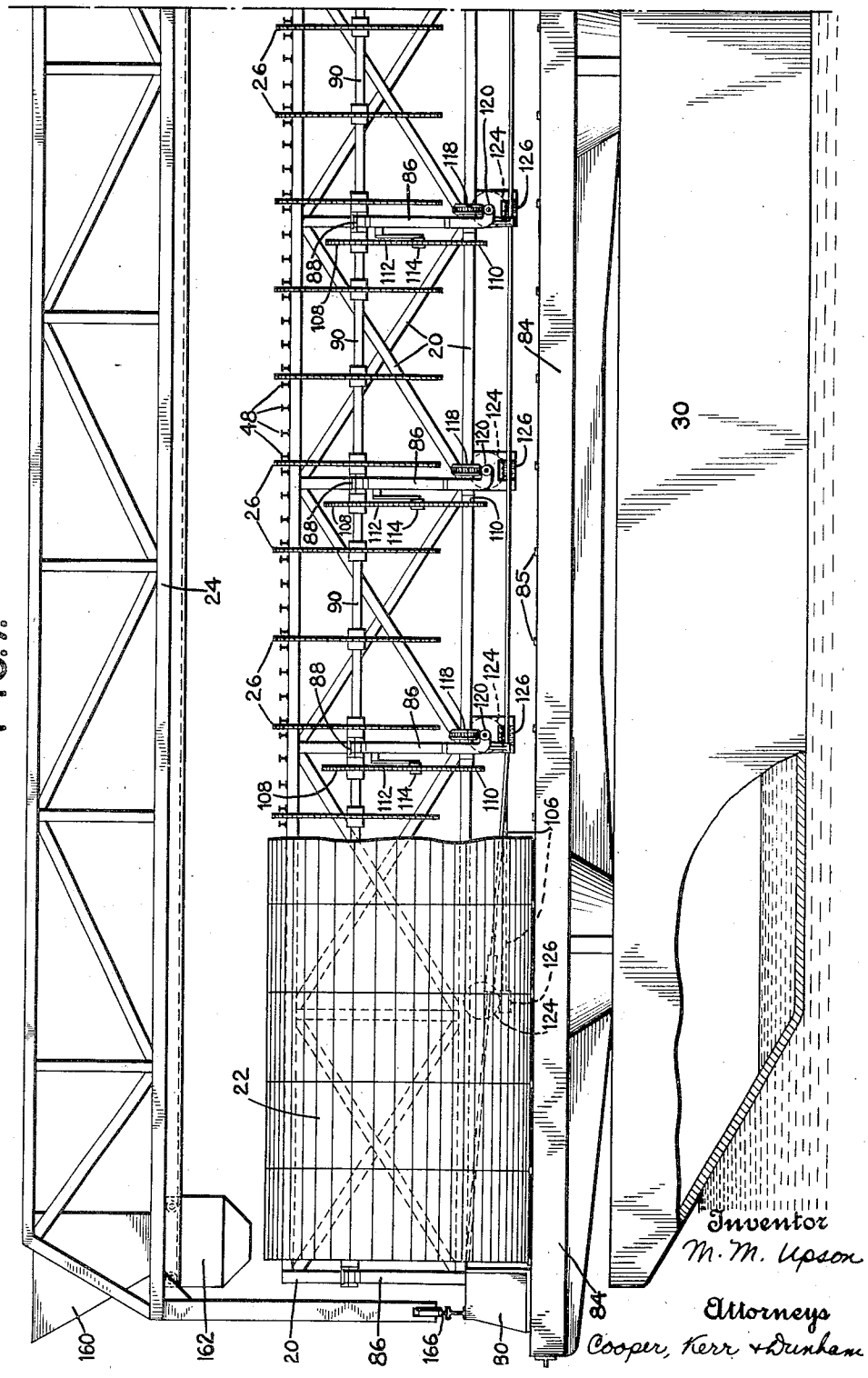
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REVETMENT AND METHOD AND APPARATUS FOR FORMING THE SAME

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FIG. 7.



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REVETMENT AND METHOD AND APPARATUS FOR FORMING THE SAME

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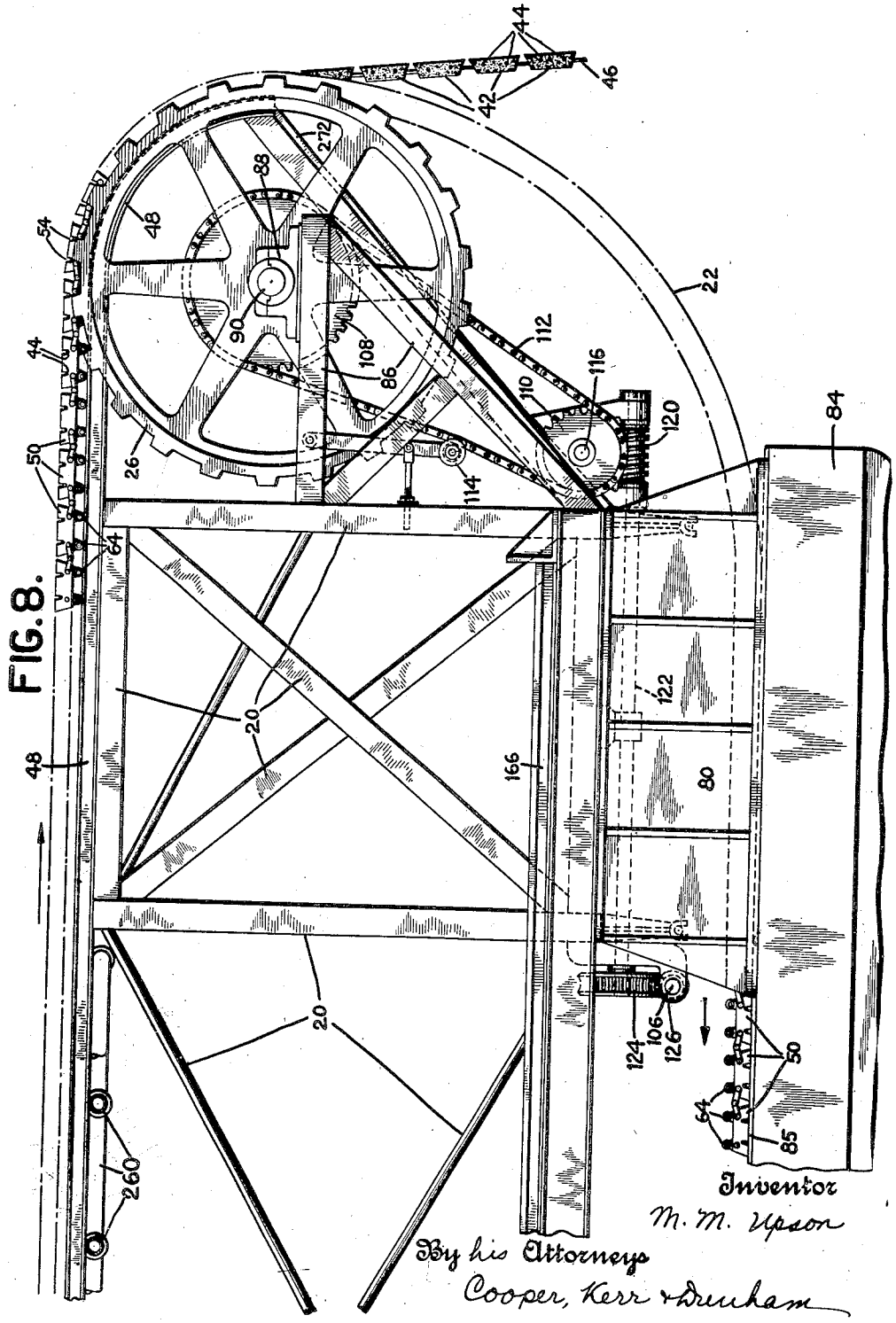


FIG. 8.

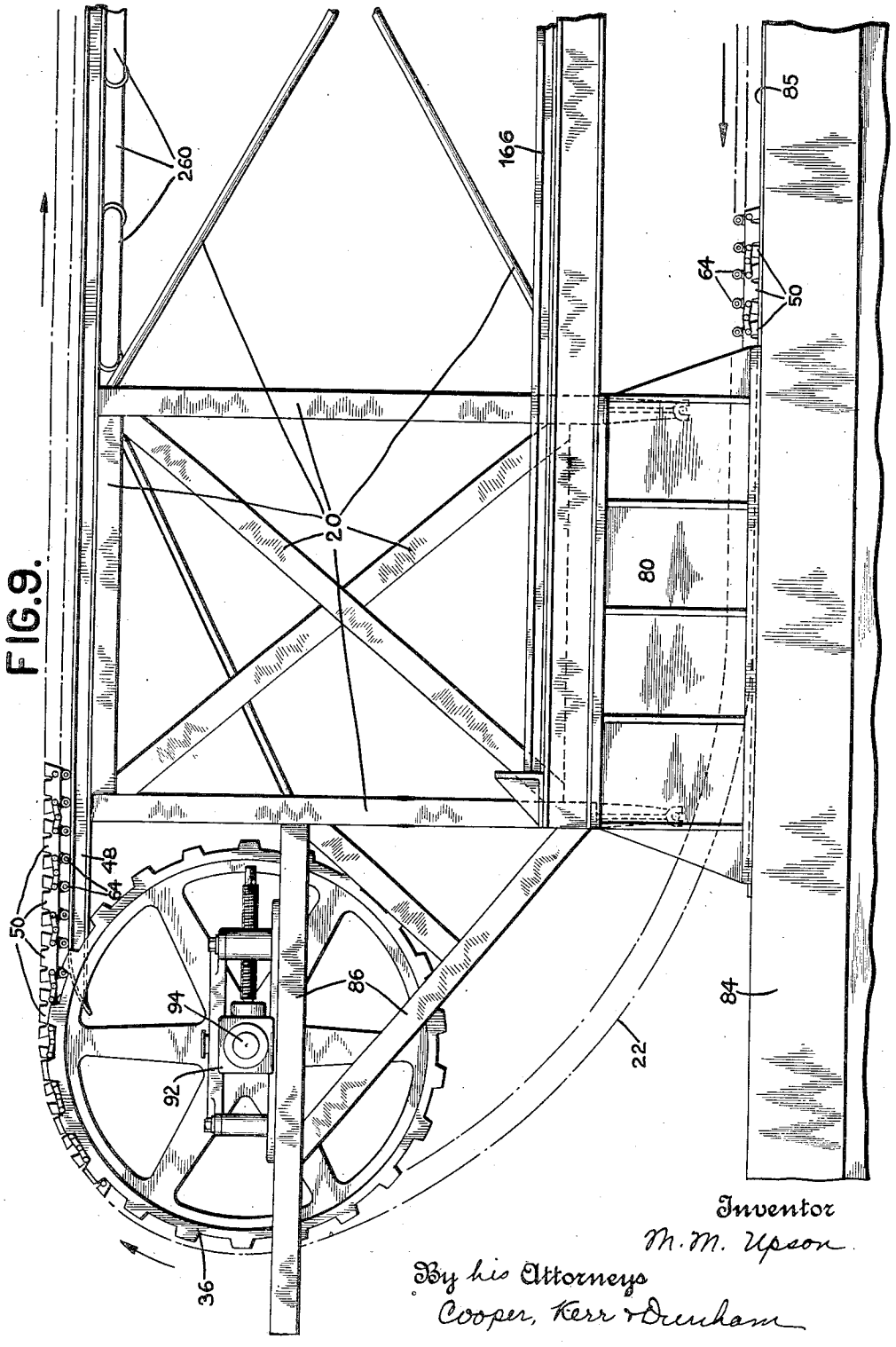
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REVETMENT AND METHOD AND APPARATUS FOR FORMING THE SAME

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FIG. 9.



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REVETMENT AND METHOD AND APPARATUS FOR FORMING THE SAME

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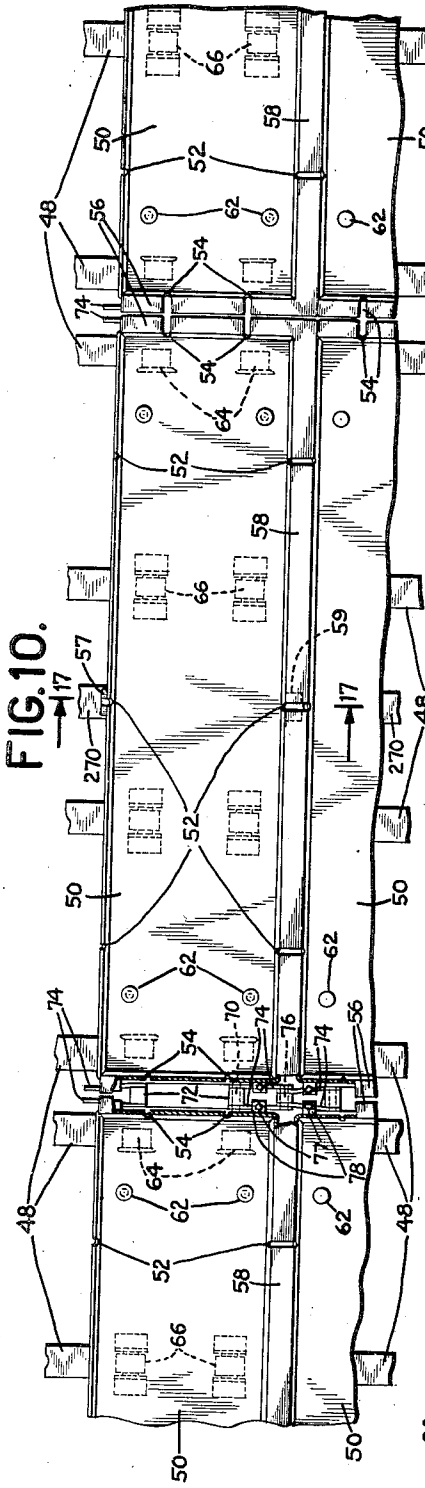


FIG. 10.

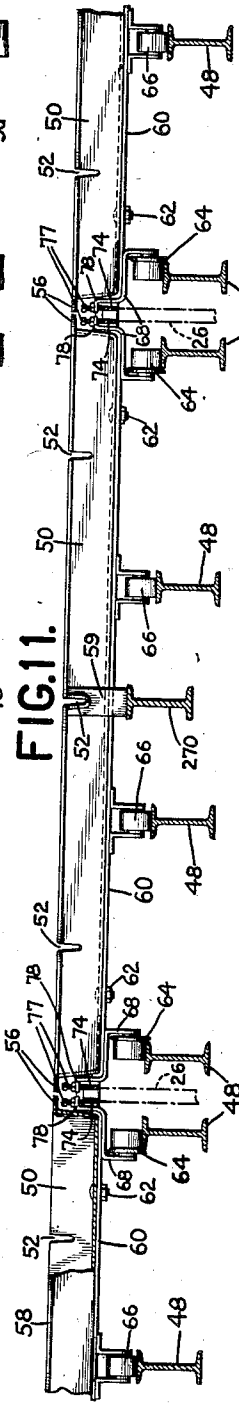


FIG. 11.

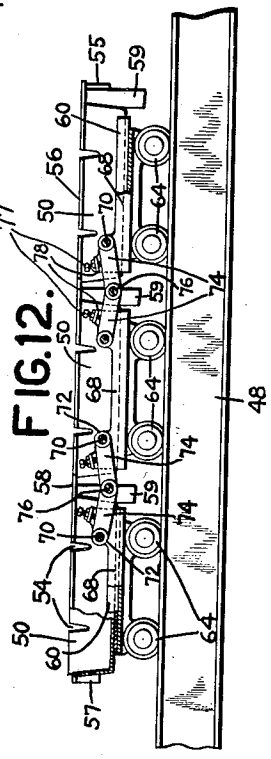


FIG. 12.

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FIG. 14.

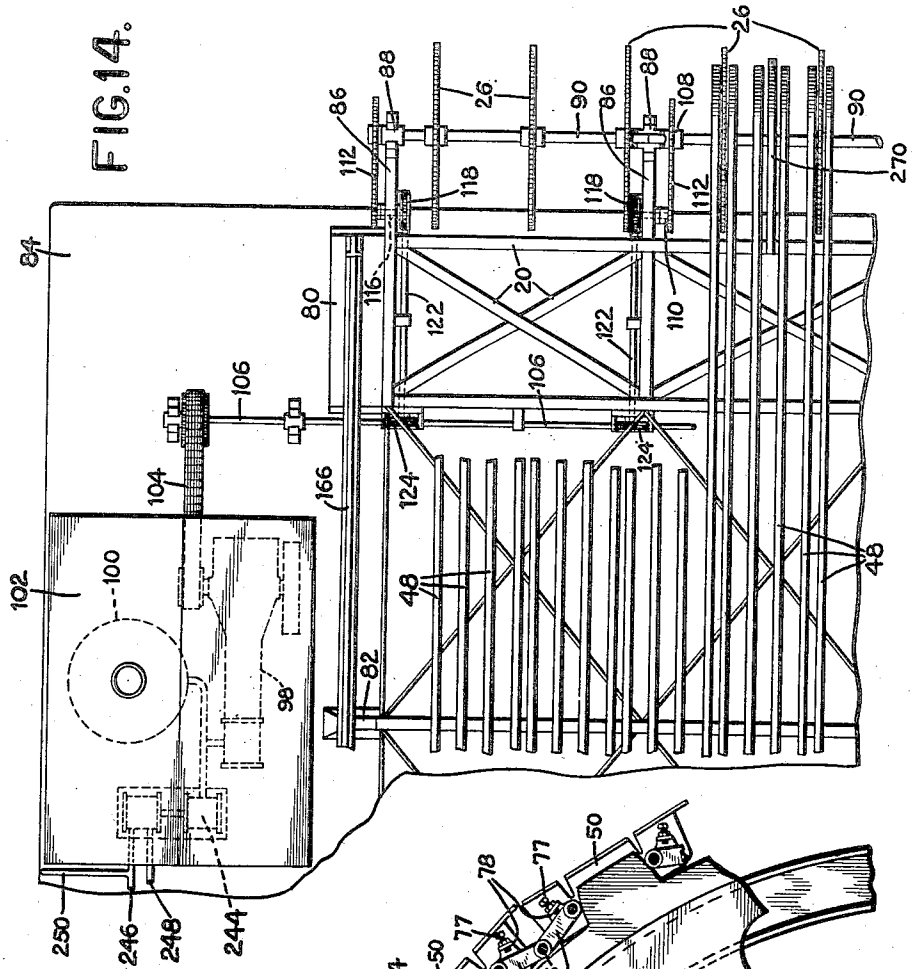
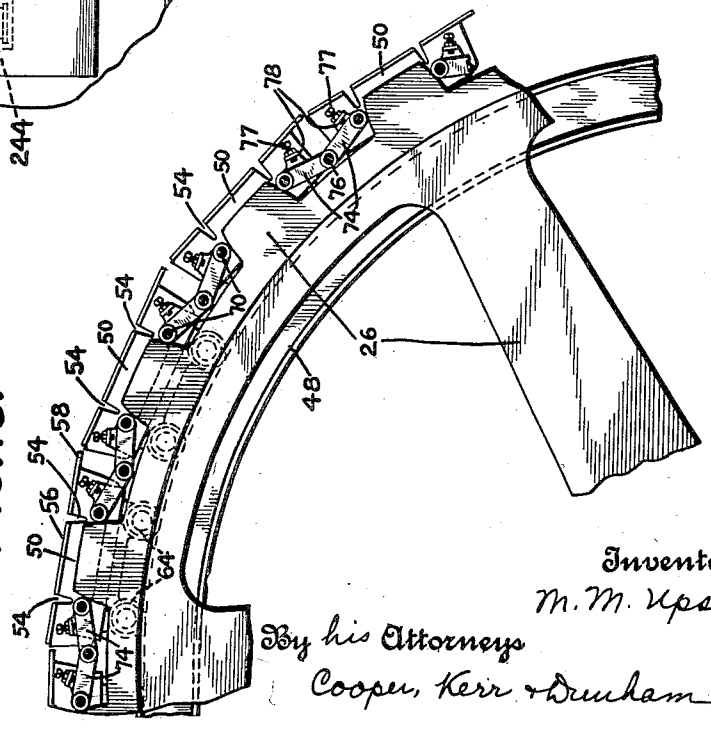


FIG. 13.



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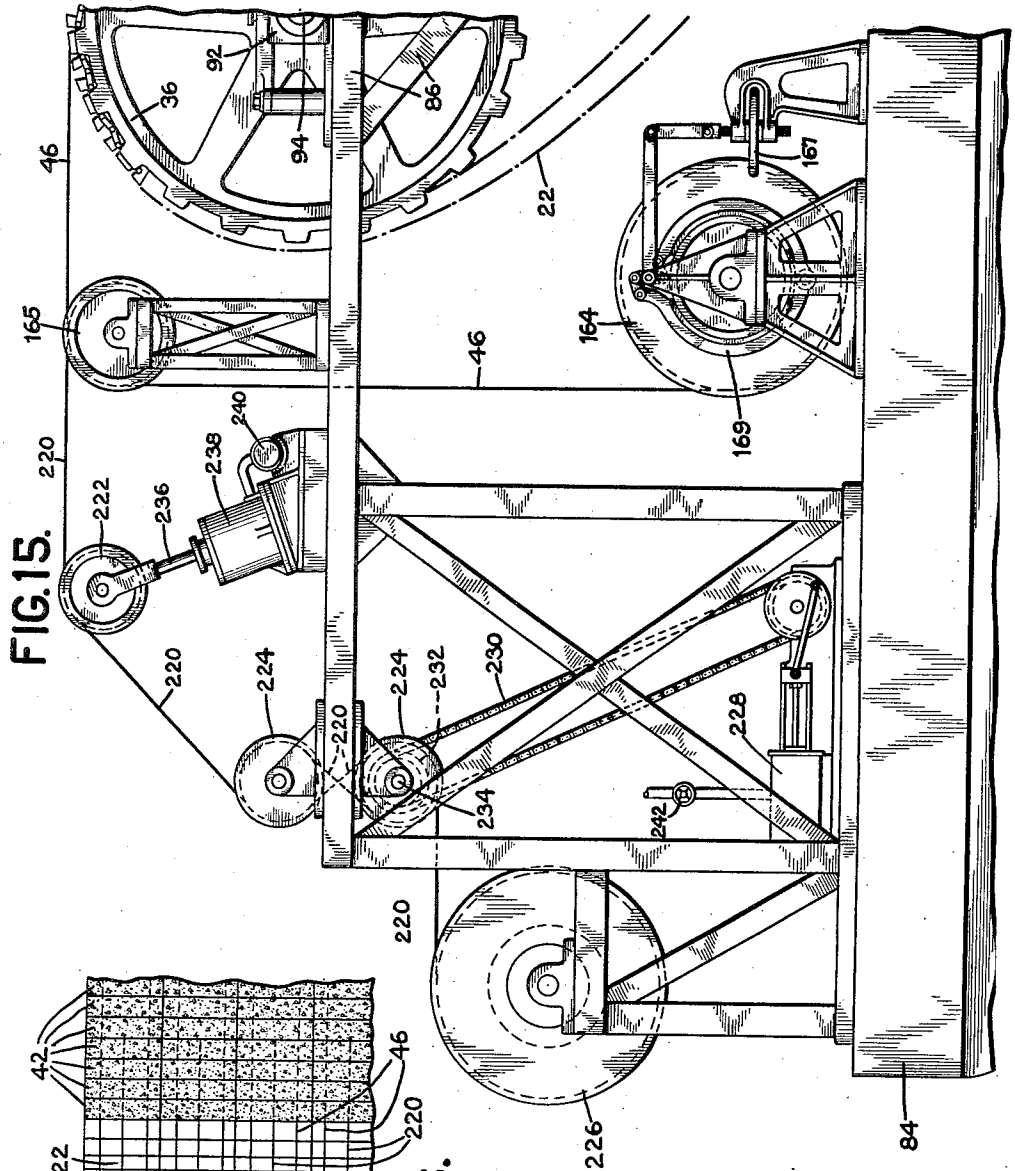


FIG. 15.

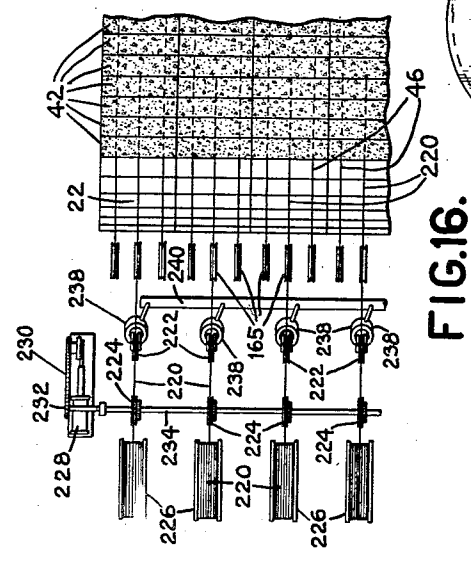


FIG. 16.

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FIG. 17.

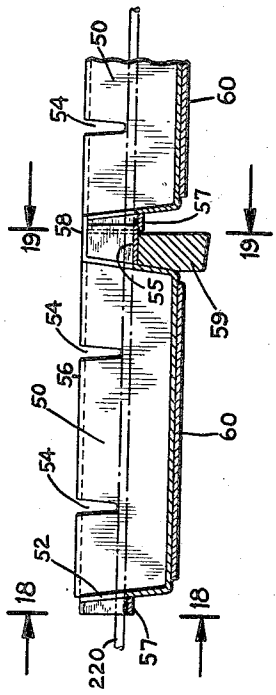


FIG. 18.

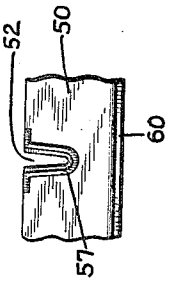


FIG. 19.

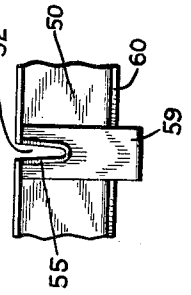
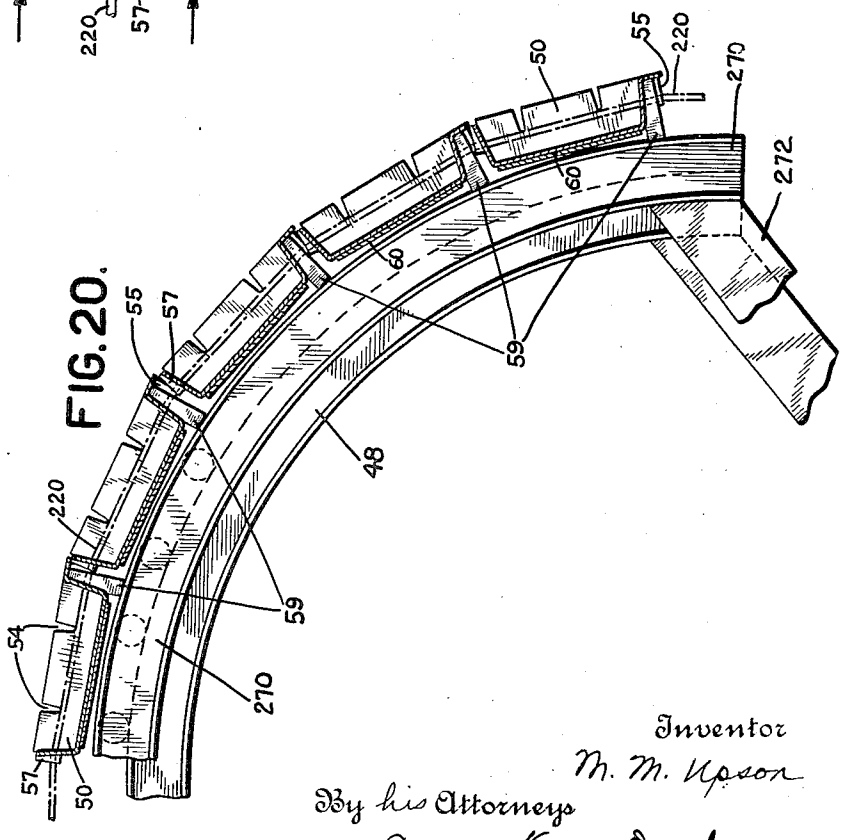


FIG. 20.



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Patented May 1, 1934 1,956,967

UNITED STATES PATENT OFFICE

1,956,967

REVETMENT AND METHOD AND APPARATUS FOR FORMING THE SAME

Maxwell M. Upson, Englewood, N. J., assignor to Raymond Concrete Pile Company, New York, N. Y., a corporation of New Jersey

Application April 16, 1929, Serial No. 355,483

29 Claims. (Cl. 25—41)

This invention pertains to method and apparatus for the formation of revetments of the type now being used in the control of the Mississippi River.

Such revetments are composed of small concrete slabs tied together by wires or cables to form large articulated concrete mats with which the river bank is paved to a point well out in the stream. This invention covers an improved method and apparatus for making the mats and for putting them in position.

In present practice the mat is made up of concrete slabs three inches thick, eleven and one-half inches wide, and three feet eleven inches long, reinforced and interconnected by wire laid twelve by twelve inch mesh. Allowing for clearance between the slabs, each slab occupies a space of about one foot by four feet and contains approximately one cubic foot of concrete.

Mats are cast on barges, one mat being formed on top of another after several hours curing, one or two sheets of paper being laid over the green mat to prevent sticking. Twenty-five slabs are cast in each mat unit. The mats are stacked fourteen to twenty-one layers high. In operation six or more barges are moored end to end near a gravel bar, and a floating mixing plant travels up and down the line of barges, filling the mat forms in succession.

Each barge holds from 250 to 300 units of twenty-five slabs each. It takes about a week to fill a barge and another week before the greenest (uppermost)) slabs can be removed. By the time the barge has been emptied and returned to the gravel bed for refilling another week or more has been consumed. Therefore each barge requires at least three weeks for a round trip, which means that an enormous number of barges is required in order to keep a laying crew busy.

The previous type of laying plant includes a mat boat to which the articulated units are transferred from the barges. On the mat boat the units are assembled by cranes so that a section of articulated mat 140 feet by 25 feet may be laid. Such a mat section consists of 35 mat units each clipped to mat cables and to each other by Crosby clips. The mat cables run across the mat boat four feet apart, their shore ends being anchored on the river bank. Reinforcing wires projecting from the ends of the slabs are attached to the cables by clips at intervals of about five feet, the remaining reinforcing wires being attached to each other and to the cables by twisted wire ties. Thus there is formed a mat section 140 by 25 feet fastened together at intervals of one foot in all directions. This section is launched on skids from the mat boat until the lower edge is in the water or on shore. Another mat section is then assembled on the boat, attached to the retained end of the preceding section and the launching process continued.

Mat sections are formed and launched as above until a mat extending 140 feet along the shore and 200 to 300 feet (usually) out into the stream is formed. Then the mat boat is moved 132 feet up stream and another similar mat is laid which overlaps the edge of the first mat eight feet.

It will be readily appreciated that the above process is very inefficient and expensive. The investment in barges, tugs, and other equipment is enormous, as is also the expense of operation and unkeep. The manufacture of each mat is a piecemeal performance involving great expense for handling the mat units, and mat sections, and attaching them together.

The object of the present invention is to disclose an apparatus and method for forming and laying the mats in a more efficient manner and at greatly reduced cost.

To these and other ends the invention comprises the novel features and combinations of elements described and shown in the drawings, which by way of illustration show what is now considered to be a preferred form of the invention.

Fig. 1 is a plan view of the apparatus in position to manufacture and lay a mat.

Fig. 2 is a view on the line 2—2 of Fig. 1.

Fig. 3 is a perspective view of eight slabs showing interconnection and method of reinforcement.

Fig. 4 is an enlarged view somewhat similar to Fig. 2, showing more of the details.

Fig. 5 is an enlarged view on the line 5—5 of Fig. 1.

Fig. 6 is an enlarged view, on the line 6—6 of Fig. 1, partly broken away to show details of the apparatus.

Fig. 7 is an enlarged view on the line 7—7 of Fig. 1, partly broken away to show details of the apparatus.

Fig. 8 is an enlarged view on the line 8—8 of Fig. 1, partly broken away to show details of the apparatus.

Fig. 9 is an enlarged view on the line 9—9 of Fig. 1, partly broken away to show details of the apparatus.

Fig. 10 is an enlarged plan view showing details of slab molds and method of supporting them.

Fig. 11 is a view of Fig. 10 taken from the bottom of Fig. 10.

Fig. 12 is a side view of three molds showing method of interconnection and support.

Fig. 13 is an enlarged view of a portion of the sprocket shown in Fig. 8 with the molds passing around it.

Fig. 14 is a plan view of the power plant corner of the apparatus, partly broken away to show details of the drive.

Fig. 15 is an enlarged view on the line 9—9 of Fig. 1, showing details of the tension devices.

Fig. 16 is a fragmentary plan of Fig. 15 in reduced scale.

Fig. 17 is an enlarged cross-section of buckets on the line 17—17 of Fig. 10.

Fig. 18 is a fragmentary view, on the line 18—18 of Fig. 17.

Fig. 19 is a fragmentary view on the line 19—19 of Fig. 17.

Fig. 20 is an enlarged detail showing supplemental support for mold while passing over discharge sprockets.

On account of the great size of some parts of the apparatus and the restrictions imposed by the size of Patent Office drawing paper it has been necessary to take unusual liberties with dimensions in the drawings. The design and operation of the mechanism will, however, be readily understood by those skilled in the art.

My method and apparatus cover the manufacture and laying of a complete mat in a 24-hour cycle. The general scheme may be readily understood from Figs. 1, 2 and 4 in which 20 represents a trussed girder which supports an endless belt of slab molds 22. The girder is of sufficient length and width to accommodate on it upper side enough molds to form a complete mat, which under the particular conditions discussed herein is 140 feet wide and 250 feet long. As each mold occupies a space one foot by four feet there are thirty-five molds crosswise, and 250 molds lengthwise of the girder, or at least 8750 molds on top of the girder at all times. All molds being empty, they are all rapidly filled by the aid of one or more gantry cranes 24. The slabs are then allowed to set over night, and, since quick strength cement is used, the mat is ready to lay the next morning. The laying is accomplished by actuating sprockets 26 whereby the mat, its slabs being interconnected by the reinforcing wires, is discharged over the right hand end of the girder (Figs. 2 and 4). The shore end of the mat is attached at the top of the bank to anchors 28 and then the girder, supported by barges 30, is moved slowly away from the bank, guided from anchored barges 32, and the mat is laid on the sloping bank 34 as indicated in Fig. 2. After the molds pass over sprockets 26 they pass back underneath the girder, to finally reach the top of the girder again by passing over sprockets 36 at the other end of the girder. As the molds change direction to pass back under the girder each mold frees itself from the slab which was cast in it, and the finished mat 40 passes downwardly to rest on the bank.

After the laying of a mat is finished a new mat is poured in the empty molds then on top of the girder and, after setting over night, is laid 132 feet up stream, so as to provide an eight-foot overlap on the previously laid mat.

Now that the principle of operation has been briefly described, the details of the apparatus and method will be explained.

In Fig. 3 is shown a fragment of the mat, each slab being designated 42, the cross wires 44, and the longitudinal wires 46. Each slab is tapered inwardly from top to bottom on edges and ends in order that it will draw easily from its mold.

Referring now to Figs. 10, 11, 12, 17, 18 and 19, the construction and arrangement of the molds will be understood. The top of girder 20 comprises parallel longitudinal beams 48. Each mold 50 is a shallow pan provided with outwardly projecting flanges around its top, and with open topped slots or notches in its ends and sides to accommodate the wires. The slots for longitudinal wires are designated 52, and those for the cross wires 54. The flange 56 at each end of the mold projects sufficiently to contact with the corresponding flange on the adjacent mold. One long side of the mold is unflanged, while the other long side has a flange 58 of sufficient width to slightly overlap the unflanged side of the adjoining mold.

Surrounding each slot 52 on one side of the mold is a flange 55 which projects into a corresponding flange 57 of the next adjoining mold, thereby preventing material from falling between the molds at the slots. Underneath the middle flange 55 of each mold is a downwardly projecting block 59 for a purpose which will later appear.

Each mold 50 is supported in and by a shallow cradle 60, to which it is fastened by bolts 62. This arrangement permits almost instant replacement of any mold. Each cradle is carried by four pairs of rollers which run on the longitudinal beams 48. The end rollers 64 are flanged while the others 66 are plain. End rollers 64 are attached to cradle 60 through the instrumentality of a fitting 68 which extends upwardly around the end of each mold to a point about half way up the mold.

Passing rather loosely through holes in each fitting 68 are a pair of horizontal pins 70 which enter corresponding holes in the fitting 68 on the next adjacent mold. On each pin 70 is a roller 72 which serves as a contact member to engage the teeth of sprockets 26 while passing thereabout. On each side of each roller 72 is a link 74, each pair of links being connected to a corresponding pair on the next adjoining mold by a toggle pin 76. When sprocket 26 are rotated, the molds are drawn along beams 48 by tension transmitted through links 74, which therefore tend to straighten the toggle formed by the links between each pair of buckets. However, the toggles are prevented from straightening by screws 77 through ears 78 integral with fittings 68. Screws 77 contact with the top sides of links 74 as shown in Fig. 12. This arrangement is provided so that the toggles may "break" sufficiently (Figs. 8 and 13) while the molds are passing around the sprockets so as to throw no extra strain on the longitudinal wires or cables. It also provides an adjustment of distance between buckets.

As already stated, the entire mold handling apparatus is mounted on trussed girder 20. The girder is supported on a large pillar 80 at each corner and on a series of small pillars 82 along each side. The pillars rest on a substantial base 84, which in turn rests on a plurality of barges 30. The top of base 84 is provided with steel rails 85 upon which the molds rest, bottom side up, while returning empty to the left hand end of the machine, as in Figs. 8 and 9.

On the discharge end of the girder (Figs. 6, 7 and 8) are mounted a series of brackets 86 which carry bearings 88 in which rotate shafts 90 to which are fast drive sprockets 26. A similar series

of brackets 86 at the other end of the machine (Fig. 9) carry take-up boxes 92 in which rotate the tail shafts 94 upon which are mounted sprockets 36.

The method of supplying power to sprockets 26 will be understood by reference to Figs. 6, 8 and 14. Upon base 84 is mounted a power plant comprising a steam engine 98 and boiler 100, sheltered by a house 102. The engine drives by chain 104 a shaft 106 carried in suitable bearings and extending across the width of girder 20. Shaft 90 is not continuous but is in short lengths, each extending from one bearing 88 to the next, and each carrying three sprockets 26. Shafts 90 abut in bearings 86 as shown in Fig. 14. Each shaft 90 is provided with a drive sprocket 108, driven by a sprocket 110 through chain 112. A manually adjustable chain tightener 114 bears against the slack side of the chain. Each sprocket 110 is fast on one end of a short countershaft 116, on the other end of which is a worm wheel 118 driven by a worm 120 on a short shaft 122 running lengthwise of the girder and provided at its other end with a worm wheel 124 which is driven by a worm 126 on shaft 106. By this method sufficient speed reduction is obtained to drive the molds at the exceedingly slow speed required while they are discharging the mat. Tail shafts 94 are in short lengths corresponding to the shafts 90.

The method and apparatus for filling the molds will be understood from Figs. 1 and 5. 130 represents a barge on which is carried the concrete mixing plant, arranged to receive cement in sacks from barge 132, gravel from barge 134, and sand from barge 136. The cement is lifted by crane 138 to platform 140 from which it is moved by conveyors 142 and 144 to platform 146, from which it is dumped through hopper 148 into mixer 150. Sand and gravel are lifted from their barges by crane 152 and bucket 154 into overhead bins 156, from which measured quantities are dropped through hopper 148 into the mixer. From the mixer the mixed concrete is elevated by elevator 158 through hopper 160 into bottom discharge bucket 162, adapted to travel along the gantry crane 24 so as to discharge its contents at any desired point in the width of the mat. The concrete so discharged is leveled into the molds with hoes and rakes, the flanged tops of the molds presenting level surfaces to guide the leveling and smoothing tools. Of course before pouring the concrete the reinforcing wires 44 and 46 are placed in position, the lengthwise wires 46 having been drawn into position from friction-retarded reels 164 over sheaves 165, while the preceding mat was being laid. There is one reel 164 for each wire 46, the reels being mounted on base 84, with sheaves 165 above them as shown in Fig. 15. Suitable tension is applied to each wire by hand wheel 167 through the instrumentality of brake 169. Crane 24 travels the entire length of the mat on tracks 166 supported on extensions of pillars 80 and 82. Only one crane and one mixing plant are illustrated, but two or more cranes and mixers may be used if desired. The mixing plant is adapted to be moved lengthwise of the mat by cables shown diagrammatically at 170 (Fig. 5) and the crane is adapted to be moved by well known power devices which are not shown for lack of space.

After the mat has been poured and allowed to set over night it is laid as shown in Figs. 1 and 2. The mat manufacturing plant is adapted to be moved at right angles to the bank by cable 174 attached to anchor 176 out in the stream, and cable 178 attached to shore anchor 180. The cables are wound on and off drums 182 by means of engine 184, steam being supplied by boiler 186. This arrangement permits movement of the mat plant at right angles to the shore line.

The plant is located and held in proper up-and-down stream position by cables 188 extending upstream to a drum 189 on carriage 190, adapted to travel longitudinally of barges 32, which are held in position and alignment by cables 192 anchored on shore and passing around suitable hoisting drums 194 driven by engines 196 and boilers 198.

Carriage 190 is movable along barges 32 by engine 200 which drives gears 202 engaging a toothed rack 204 extending lengthwise of the barges. Carriage 190 travels on rails 206, and the horizontal pull of cables 188 is taken through wheels 208 in contact with a rail 210 adjacent rack 204.

At the beginning of the laying operation the mat boat is moved in-shore as close as possible, wires 46 are connected to shore anchors 28, engine 98 is started, and sprockets 26 are rotated to discharge the mat. At the same time the mold boat is backed away from the shore with the result that the mat 40 is laid on the sloping bank as indicated in Fig. 2. When the mat is finally laid a new set of wires 46 has been drawn into place in the set of empty molds then covering the top of girder 20. These wires are then secured in place and the protruding ends are cut in order to separate them from the rear end of the mat which has been laid.

It has been found advisable to provide supplemental means in addition to wire 46 to support the weight of the mat while it is hanging over the discharge edge during the final stages of the laying operation. This supplemental means is shown in Figs. 15 and 16, and comprises cables 220, the ends of which are imbedded in the last few slabs 42 of the mat. The free end of a cable 220 is placed alongside wire 46, in the middle slots 52 of the last few molds comprising the mat,—therefore when the molds are filled and the concrete is set, there will be a cable, preferably one-half inch, anchored in the middle of all the rearmost slabs 42.

From the slabs each cable 220 extends over an equalizer sheave 222 around friction sheaves 224, to a drum 226. A steam engine 228 is belted by chain 230 to a sprocket 232 on shaft 234 which carries the lower friction sheaves 224.

Each equalizer sheave 222 is carried by the free end of a piston rod 236 fast to a piston in a cylinder 238. All the cylinders 238 are connected at their lower ends to a hydraulic main 240 and therefore sheaves 222 will adjust themselves to maintain equal tensions in all cables 220.

While the mat is being lowered during the final stages of the launching operation, steam is turned off from engine 98 and on to engine 228. The weight of the mat, through cables 220, sheaves 224 and chain 230, turns engine 228 backwards against the steam pressure, and thus provides a convenient means for controlling the speed of launching because the steam may be regulated by throttle 242.

In order to prevent cables 220 from bending or otherwise damaging the molds while they are passing over the discharge sprockets, means is provided for supporting the mold at a point immediately underneath each cable. This supporting means comprises an arcuate track or rail 270,

upon which supporting block 59 is arranged to slide as shown in Fig. 20. The outer end of track 270 is supported by a brace 272 extending to the base of the main truss.

When the mat is launched, cables 220 are cut, and the unused portions drawn back by means of engine 228.

Near the end of the laying operation the weight of the mat becomes concentrated on the barges 30 at the discharge end of the plant and the following precautions are taken to keep the outfit level. Each barge 30 is normally about half full of water. As the weight shifts, water is pumped from the barges most heavily loaded into those more lightly loaded, or into the river, the pumping being done by steam pump 244 in power house 102. Each barge 30 is provided with a suction hose 246 connected through suitable valves to the suction end of the pump, and with a discharge hose 248 connected to the discharge end of the pump. A branch suction hose 250 dips into the river.

After the mat has been laid as above described, new longitudinal wires 46 are already in place. Cables 220 and cross wires 44 are put in position and a new mat is poured. If desired, the new mat may be poured while its predecessor is being laid.

As the empty molds approach sprockets 36 on their return journey they are inspected and any damaged molds are replaced by loosening bolts 62.

To expedite the setting of the concrete in the molds it is sometimes desirable to apply heat by means of steam coils 260 supported on girder 20 underneath the molds (Figs. 4, 8 and 9).

While the new mat is being prepared, winches 189 on barges 32 are operated to wind up cables 188 to move the entire plant 132 feet up stream in position to lay the next mat with an eight-foot lap over the previous mat. Buildings 212 on the extended base 84 serve as bunk houses, machine shops, store rooms, etc.

It is to be understood that the invention is not limited to the construction and operation herein specifically set forth, but may be used in other forms without departure from the spirit of the invention as defined by the claims which follow.

I claim—

1. In apparatus of the class described, in combination, a support and a plurality of connected slab molds carried thereon, said molds being adapted to accommodate cross wires therethrough, means for supporting wires in said molds, means for filling said molds with plastic concrete whereby an articulated mat of slabs interconnected by wires is formed, and means carried by said support for discharging said mat from said molds downwardly over a side of said support, for the purpose set forth.

2. In apparatus of the class described, in combination, a plurality of slab molds, means for interconnecting said molds to form an endless chain thereof, means for supporting said chain whereby the same will pass over and under said support, means for supporting wires in said molds whereby when the molds are filled with concrete an articulated mat or slab will be formed, means for moving said chain of molds about said support, and means for producing relative separation of the wires and molds to cause removal of the slabs from the molds at one point in the movement of the chain.

3. In apparatus of the class described, in combination, a plurality of slab molds, means for interconnecting said molds to form a plurality of endless chains thereof, means for supporting said chains whereby said chains pass over and under said support, devices for interconnecting said chains, crosswire of said support, and power means engaging said interconnecting devices for moving said chains simultaneously lengthwise of said support.

4. The invention set forth in claim 2 in which means is provided for adjusting the widths of the spaces between said molds, lengthwise of the chain.

5. The invention set forth in claim 2 in which said molds are interconnected lengthwise of the chain by toggle links, with devices for adjusting the angle between said toggle links whereby the distance between said molds may be adjusted.

6. The invention set forth in claim 2 in which said interconnecting means are arranged to automatically change length when the chain of molds changes direction in passing about said support.

7. In apparatus of the class described, in combination, a plurality of slab molds adapted to accommodate cross wires therethrough, means for filling said molds with plastic concrete whereby an articulated mat of slabs interconnected by wires is formed, a support for said molds, means for moving said molds, and means for changing the direction of said motion whereby the slabs and wires comprising the articulated mat move relatively to the molds and are automatically removed from said molds.

8. The invention set forth in claim 7 in which the molds are flared outwardly toward their tops, and in which the wires pass through outwardly flaring notches in the sides of said molds, whereby the removal of slabs and wires is facilitated when the direction of motion of the molds is changed.

9. In apparatus of the class described, a support, means for forming on said support a plurality of rows of concrete slabs interconnected to form an articulated mat, means for moving said mat lengthwise of said rows in order to discharge the mat over the end of said support, and means comprising a cable imbedded in a plurality of slabs of each row for supporting the weight of that row of slabs after the slabs are discharged over the end of said support.

10. The invention set forth in claim 9 in which means is provided for equalizing the strain between the cables of the various rows of slabs.

11. The invention set forth in claim 9 in which means is provided for equalizing the strain between the cables of the various rows of slabs, said equalizing means comprising a plurality of interconnected hydraulic cylinders each adapted to maintain a sheave in contact with one of said cables.

12. The method of forming and laying revetments which comprises placing continuous reinforcing wires through a plurality of interconnected slab molds, filling the molds with plastic concrete, allowing the concrete to set, holding one end of the reinforcing wires, and moving the molds to discharge the slabs therefrom and lay the same in the form of an articulated mat.

13. The method of forming and laying revetments which comprises forming an articulated concrete mat in a plurality of slab molds mounted on a support holding one end of the articulating elements moving said molds to discharge the mat over the edge of said support to lay the same

and simultaneously moving a plurality of empty molds onto said support.

14. The method of forming and laying revetments which comprises placing a plurality of slab molds on a support, laying continuous reinforcing wires through said molds, filling said molds with plastic concrete, permitting said concrete to set, holding one end of said wires, then moving said molds to discharge said slabs, interconnected by said wires, over the end of said support to lay the same and simultaneously moving a plurality of empty molds onto said support.

15. The method of forming and laying revetments which comprises placing continuous wires through a plurality of molds mounted on a support, filling the molds with plastic concrete surrounding said wires, allowing said concrete to set, whereby an articulated reinforced concrete mat is formed, holding one end of said wires, moving said molds to discharge said mat over the edge of the support to lay the same and simultaneously moving a plurality of empty molds with wires therethrough onto said support.

16. The method of forming and laying revetments which comprises moving onto a support a plurality of rows of empty molds with continuous wires therethrough lengthwise of said molds, placing continuous wires through said molds crosswise of the rows, filling the molds with plastic concrete, allowing said concrete to set, whereby an articulated reinforced concrete mat is formed, holding one end of the lengthwise wires moving said molds to discharge said mat over the edge of the support and lay the same and simultaneously moving a plurality of empty molds with wires therethrough onto said support.

17. In apparatus of the class described, in combination, a plurality of slab molds adapted to accommodate cross wires therethrough, means for filling said molds with plastic concrete whereby an articulated mat of slabs interconnected by wires is formed, a support for said molds, means for discharging said mat over the side of said support, and means for preventing the wires from damaging said molds while being so discharged which comprises a compression member interposed between the wire and said support.

18. The invention set forth in claim 17 in which said last mentioned means comprises a block attached to said mold and adapted to support said wires during the discharging operation, substantially as described.

19. In apparatus of the class described, in combination, a support for a plurality of slab molds, means for interconnecting said molds side by side on said support, means integral with said molds and effective when the molds are interconnected for providing a substantially continuous trough between said molds, and adapted to accommodate reinforcing wires passing through said molds.

20. The invention set forth in claim 19 in which said molds are provided with trough-like projections which overlap each other to form said continuous troughs, substantially as described.

21. The method of forming and laying revetments which comprises forming a plurality of slabs in molds mounted on a support and connecting said slabs to form a reticulated mat, moving said molds over the edge of the support and causing relative movement between the same and the connecting means to discharge said slabs over the edge of the support and simultaneously moving the support to spread the mat.

22. The method of forming and laying revetments which comprises forming a plurality of slabs in molds mounted on a support and connecting said slabs to form a reticulated mat, moving said molds over the edge of the support and causing relative movement between the same and the connecting means to discharge said slabs over the edge of the support, simultaneously moving the support to spread the mat, and simultaneously moving a plurality of empty molds onto said support.

23. In a revetment forming and laying apparatus, the combination with a support, a continuous chain of molds mounted on said support, means for supporting reinforcing and connecting elements in said molds, means for filling said molds with plastic concrete, embedding said reinforcing elements, means for moving said mold chain, and means for causing relative separation of the reinforcing and connecting elements and said molds to cause discharge of the contents of the mold seriatim.

24. In apparatus for forming and laying revetments, a support, a continuous chain of slab molds movable over said support, means for moving the molds, means for supporting reinforcing elements movable with said chain, means for filling the molds on said support to embed the reinforcing elements and form reinforced slabs, means for causing relative movement between the reinforcing elements and the molds to produce separation of the slabs from the molds seriatim and lay the reticulated mat thus formed, and means for simultaneously returning the empty molds to said support and inserting new reinforcing elements in the molds.

25. Apparatus for forming and laying revetments comprising a support, a continuous mold chain movable over said support, reinforcing elements supported in said mold and having one end connected to a stationary part, means for filling said molds with plastic concrete to embed the reinforcing elements, means for moving said support away from said stationary part and thus causing relative movement between the molds and the reinforcing elements which separates the slabs formed in the molds from the molds, and means for returning the empty molds to said support, and simultaneously inserting additional reinforcing elements in said molds.

26. In apparatus for forming revetments on river banks, in combination, means for forming a reticulated concrete mat, a plurality of movable supports for said mat, means for discharging the mat over the edge of one of said supports, and means for maintaining the relative heights of said supports constant while said mat is being discharged.

27. In apparatus of the class described, in combination, a support and a plurality of slab molds supported thereby, means for supporting interconnecting instrumentalities in said molds whereby when said molds are filled with concrete an articulated mat is formed of slabs interconnected by said instrumentalities, means for moving said molds on said support, and means for producing relative separation of said instrumentalities and molds to cause removal of the slabs from the molds.

28. In a molding device of the class described, a support and a plurality of slab molds supported thereby, means for supporting interconnecting instrumentalities in said molds whereby when said molds are filled with concrete an articulated mat is formed of slabs interconnected by said in-

strumentalities, in combination with means for anchoring a portion of said instrumentalities exteriorly of said molding device, and means for inverting said molds to cause relative movement between said molds and instrumentalities whereby said slabs are removed seriatim from said molds.

29. In a molding device of the class described, a support and a plurality of slab molds supported thereby, means for supporting interconnecting instrumentalities in said molds whereby when said molds are filled with concrete an articulated mat is formed of slabs interconnected by said instrumentalities, in combination with means for anchoring one end of said instrumentalities exteriorly of said molding device, and means for moving said molds relative to said support and relative to said instrumentalities to produce separation of said instrumentalities and molds whereby said interconnected slabs are discharged in series downwardly over a side of said support.

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